

Massachusetts Bay Transportation Authority

Green Line Extension Design Build Project

Cambridge, Somerville, and Medford Massachusetts

Execution Version

VOLUME 2

Technical Provisions

MBTA Contract No. E22CN07

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1 General

1.1 General Requirements; General Provisions

Section 1 includes a general description of the Project requirements pertaining to the Work and a general statement of the scope of the Work for the Project.

Capitalized terms have definitions set forth in Exhibit 1A of the DB Contract.

DB Entity shall perform, as part of the Work, the obligations set forth in Exhibit 2F.

Except where otherwise specifically set forth, MBTA shall have thirty (30) Days to review any submission by DB Entity prior to commencement of construction on that portion of the Site as indicated on the latest Project Schedule.

Unless otherwise specifically stated in these Technical Provisions to the contrary, all obligations are obligations of DB Entity. By means of example, if a provision reads “provide X” or “supply Y”, or “the Z shall be...,” these Technical Provisions shall be construed to mean “DB Entity shall provide X,” “DB Entity shall supply Y” and “DB Entity shall provide, as part of the Work, Z.”

1.2 Project Description

1.2.1 General

The Project is the extension of existing light rail transit service, with associated infrastructure, support facilities, as further described below, the requirements for which are further described in the Technical Provisions, to be developed by DB Entity as described in the Technical Provisions and other Contract Documents, including (a) the System, (b) the facilities, equipment, subsystems and other components of the System, (c) other structures and improvements to be developed by DB Entity, and (d) all other work product of DB Entity relating to the foregoing. A portion of the Project comprises light rail service on two new branches extending Existing Green Line active, electrified light rail service from a new Lechmere Station in Cambridge, Massachusetts to the Red Bridge Interlocking (to be located North of the new Lechmere Station and generally on the southern end of the Project), where the Project branches (a) to Union Square Station in Somerville, Massachusetts (the “Union Square Branch”) and (b) to College Avenue Station in Medford, Massachusetts (the “Medford Branch”), as each such term is further defined by reference to applicably-titled “Project Definition Plans” and “Concept Plans” attached as Exhibit 2B.1 and Exhibit 2B.2; respectively, to these Technical Provisions.

A portion of the Project comprises a Vehicle Maintenance Facility (VMF).

A portion of the Project comprises, six new Stations and one relocated Station (each a “Station” and collectively the “Stations”) in the following locations:

- (a) Lechmere (relocated to the north side of Monsignor O’Brien Highway);
- (b) East Somerville (formerly Washington Street);
- (c) Gilman Square;
- (d) Magoun Square (formerly Lowell Street);
- (e) Ball Square;

- (f) College Avenue; and
- (g) Union Square.

A portion of the Project comprises above-grade sections at the following locations:

- (a) Structure #1: The double track Medford Branch from “East Cambridge Viaduct” north over Fitchburg Main Line (FML) to touchdown near “Washington Street Interlocking”;
- (b) Structure #2: The double track connection from Union to Medford Branch via two separate structures, westward to touchdown near “McGrath Highway”; and
- (c) Structure #3: New structure over Washington Street on the Medford Branch. This structure will support two Medford Branch tracks, two “Lowell Main Line” commuter Railroad tracks and the freight lead to “Yard 10” of the “MBTA Commuter Rail Maintenance Facility.”

1.2.2 Certain Details Regarding the Project

The System’s light rail service tracks for the Union Square Branch and Medford Branch consist of two tracks each (generally eastbound and generally westbound) and are to be located adjacent to the existing MBTA “Lowell Main Line” and FML active commuter rail service lines, respectively, each currently operated by the Commuter Rail Operator (currently Keolis) under a separate contract with the MBTA. Two tracks (also generally eastbound and generally westbound) connect the Red Bridge Interlocking with the Existing Green Line.

The VMF is to be located in Somerville, Massachusetts within the “Inner Belt Road” area.

The new Lechmere Station will replace the existing Lechmere Station, and the new Lechmere Station will be the only Station on the Project that serves Light Rail Vehicles (LRVs) from both Branches.

The Medford Branch will extend along the existing New Hampshire Mainline active commuter rail service to the new College Station in Medford, Massachusetts. The new Stations along the Medford Branch will be the East Somerville Station, the Gilman Square Station, the Magoun Square Station, the Ball Square Station, and the College Avenue Station.

The Union Square Branch will extend along the existing FML active commuter rail service line to the new Union Square Station in Somerville, Massachusetts. Union Square Station will be the only Station on the Union Square Branch.

This Project is situated within a densely developed urban area with limited points of access, staging and laydown areas and several other physical constraints.

MBTA intends to acquire 24 new LRVs under a separate contract.

1.3 Scope of Work

DB Entity shall perform all work necessary to design and construct the Project and to integrate the Project with the Existing Green Line, all in accordance with, and as more fully set forth under, these Technical Provisions and remaining Contract Documents. Such work includes DB Entity’s obligation to design, construct, equip, start-up, test, commission, turn-over and close-out of the Project in accordance with all requirements of the Contract Documents, and to otherwise comply with all of the requirements in the Contract Documents and reasonably inferable from the Contract Documents (collectively, the “Work”).

The Project shall be compatible, in all material respects, with the Existing Green Line. DB Entity shall fully integrate the Work such that the Project efficiently, safely, and reliably extends the Existing Green Line, based in part upon life-cycle considerations and MBTA operation and maintenance (O&M) rules, methods, practices and procedures. The System shall not compromise continued operations of the Existing Green Line either during or as a result of the Work, except for shutdown to complete sections between Land Boulevard and East Street.

Additional detail, requirements, restrictions and other provisions regarding the Work is provided in the subsequent sections of these Technical Provisions.

The Work includes public information and community engagement support, performance and observance of certain environmental requirements and obligations, surveying services, Site preparation, design and construction of System-related structures and subsystems (e.g., lighting/signaling), other right of way structures, roadways and pathways, relocation of commuter rail track work, design and construction of System track work, design and construction of Station and other building structures, system and related infrastructure, performance and observance of certain geotechnical requirements and obligations, performance of observance of certain MBTA commitments to third parties and Utility Owners and as provided in Section 7.4.

DB Entity's design and construction shall not preclude the future extension of the Project beyond the Union Square terminus. DB Entity's design and construction shall not preclude the future extension of the Project to Route 16.

The Work also includes:

- (a) Start-up, testing, commissioning, configuration management and safety and security certification activities with respect to the System and balance of the Project;
- (b) Construction of retaining walls and noise walls along all Railroad's Corridors to increase the width of the right of way available for the Project;
- (c) Relocation of existing MBTA commuter rail tracks along such Corridors to accommodate the new, adjacent System light rail tracks;
- (d) Relocation of existing utilities as needed;
- (e) Reconstruction and widening of the Railroad bridge along the Medford Branch Corridor;
- (f) Reconstruction or replacement of roadway bridges crossing over Medford Branch and Union Square Branch corridors;
- (g) Construction of underpasses and other roadway and intersection improvements;
- (h) Construction of all necessary traction power, overhead contact, communications and signal systems for the System and for the commuter rail Railroads;
- (i) Construction of drainage and utilities in the Railroad corridors;
- (j) Construction of a viaduct; and
- (k) Construction of the Community Path.

Except, and only to the extent, as explicitly permitted under the Contract Documents, the Work shall not impede MBTA commuter rail service, Amtrak intercity passenger rail service, Pan Am Railway's freight

service, and CSX Railway’s freight service to operate along the Railroads’ respective corridors within the Site. The Work shall also accommodate non-automobile travel through coordination of transit and bicycle/pedestrian facilities between the Project and the Community Path.

The Work may also include one or more Additive Options as identified in Table 1-1 and as more fully described in Exhibit 2K of the Contract Documents.

Table 1-1: Additive Options

Priority	Additive Option
1.	Addition of Station canopies to all Stations.
2.	Addition of elevators to Stations proposed for new/additional elevators.
3.	Art program (allowance item)
4.	Design and construction of the Chester Street path connection.
5.	Design and construction of the Community Path connection from East Somerville to Lechmere.
6.	Design and construction of an enhanced VMF.

1.3.1 Basis of Design

1.3.1.1 System Operation

DB Entity shall design the System with sufficient capacity to support the light rail transit operations, as more specifically detailed in this Section 1.3.1.1.

- (a) The scheduled LRV headway is 5 minutes on the Union Square Branch, 5 minutes on the Medford Branch between College Avenue and the Red Bridge Interlocking and 2 ½ minutes between the Science Park and the Red Bridge Interlocking, in each case at “maximum” load (i.e., maximum capacity, as set forth in Exhibit 2H).
- (b) The System shall have 25% additional capacity to permit closer LRV headways for recovery of the scheduled headway after resolution of a service disruption.
- (c) Travel time, inclusive of on-Station dwell time, not including turn-back operation at each end-of-line Station to turn LRVs from outbound to inbound direction of service shall be:
 - (i) Not greater than 4.75 minutes from Union Square Station to Lechmere Station;
 - (ii) Not greater than 14.0 minutes from College Station to Science Park;
 - (iii) Not greater than 14.0 from Science Park Station to College Avenue Station; and
 - (iv) Not greater than 4.75 minutes between Lechmere Station and Union Square Station.

Additional requirements are provided in the MBTA Light Rail Transit System Operations and Maintenance Plan, provided in Exhibit 2H.

Maximum Authorized Speed

DB Entity shall design the System based on the following maximum speeds:

- (a) Between Science Park and the Red Bridge Interlocking outbound and inbound: 50mph;
- (b) Medford Branch between the Red Bridge Interlocking and the end-of-line at College inbound and outbound: 50 mph;
- (c) Union Square Branch between the Red Bridge Interlocking and end-of-line at Union Square Station inbound and outbound: 50 mph;
- (d) Through the Red Bridge Interlocking:
 - (i) Eastbound to Union Square: 10 mph; and
 - (ii) Westbound to Lechmere: 20 mph.
- (e) Over VMF Yard tracks and track leads: 6 mph.

Additional alignment design requirements are provided in Section 10 of these Technical Provisions.

System Operation Modeling [Click here to View RFI #87](#)

DB Entity shall procure a proven simulation model (OnTrack, RailSim, or accepted equal), and thereafter deliver the model to MBTA as part of the Work, to verify System performance supported by its design. The model shall be integrated and comprehensive multi-train and provide operations simulation performance ~~over an entire week~~ for System operations between Science Park Station and the end of both Branches using the system operations requirements described in Section 1.3.1.1 and 1.3.1.2. The operating scenarios shall mimic actual operating scenarios encountered on the Existing Green Line, and DB Entity shall develop and calibrate the base model to mimic current operations of Existing Green Line and the existing signal system between Haymarket Station and Science Park Station. This model shall be a complete model considering and accurately simulating actual operating rules, operating schedules, vehicle performance characteristics, signal system operations, track configuration and geometry, passenger loading and flow, and random failure/delay algorithms. The simulation will also include regularly occurring equipment moves. The simulation shall include Consists entering and exiting service from the VMF and end of line storage tracks. Simulation cases to be modeled include:

- (a) Verify conformance to headway requirements. Station stops and berthing times shall be included;
- (b) Unimpeded maximum speed;
- (c) Simulate peak hour periods to demonstrate the ability of the proposed signal system to support the proposed schedule. Randomization parameters will be applied and enabled for this simulation. A minimum of 5 randomization iterations will be run; and
- (d) Recovery after long dwell times at platforms.

After DB Entity demonstrates the base model accurately simulates the Existing Green Line, DB Entity shall incorporate its System design to the model and simulate Consist performance between Science Park and the end of each of the Branches. DB Entity shall develop and submit a "System Performance Report" prior to completion of the design of the System that describes the simulation modeling work, methodology and summarizes the results.

Vehicle Maintenance Facility (VMF)

The VMF means the Vehicle Maintenance Building itself, the Transportation Building, the VMF Yard, related facilities and equipment, all as more specifically defined in Section 14 of these Technical Provisions

and as depicted in the MAF-A-1000 drawing, with associated drawings, in [Exhibit 2B.1](#). What follows are general descriptions.

1.3.1.4.1 Transportation Building

The Transportation Building shall be an administrative office building located at the VMF where LRV operators report to convene and establish their day-to-day operation of LRVs. DB Entity shall provide parking facilities on-site for MBTA's employees' and DB Entity's (and each of the multiple-shift LRV operators) personal vehicles as shown on the Project Definition Plans. A waiting room for LRV operators, restrooms, kitchenette, offices and a storage area are housed within this building.

1.3.1.4.2 Vehicle Maintenance Building

The Vehicle Maintenance Building shall be a 24-hour operating, enclosed LRV maintenance and inspection facility serving the Medford Branch. The building shall house four service tracks, an office suite, conference space, locker rooms, restrooms, occupant break space, a System service floor area, storage, and utility rooms. The Building shall be designed to accommodate MBTA's expected functions of light duty service and inspection, truck repair and wheel truing, pantograph service, HVAC and electronics component change out of Existing Green Line LRV types 7 and 8 and forthcoming type 9. The Building shall be designed and constructed in the footprint shown in order to accommodate potential future expansion by the MBTA. DB Entity shall provide parking facilities on-site for MBTA's employees and DB Entity's (and each of the multiple-shift LRV operators') personal vehicles directly adjacent to the building as shown on the Project Definition Plans.

Two of the four tracks within the building shall be pedestal track service bays set in two separate pits with shared work areas within each pit. These tracks shall have access to electrical power via overhead catenary power. The remaining two tracks shall be flat floor service bays that shall have access to electrical power, but without supply via overhead catenary power. DB Entity shall provide a mobile elevated service platform gantry, recessed floor pits for in-ground wheel truing equipment, and two recessed hoist pits with the full hoisting equipment fit-out for one of the two of LRV hoisting areas. These tracks shall be serviced with a 10-ton overhead crane and dead track feeding into the truck service area, to be serviced by a 7.5-ton overhead crane as shown on the Project Definition Plans.

1.3.1.4.3 VMF Yard

The Vehicle Maintenance Facility shall include a yard (the "VMF Yard") of sufficient size so as both to provide storage capacity for no less than 43 LRVs and afford MBTA sufficient space for maintenance of LRVs and other System equipment, as more fully depicted in the MAF-A-1000 drawing, with associated drawings, in [Exhibit 2B.1](#). The VMF shall be designed such that LRVs operate in the VMF Yard compliant with MBTA operating rules contained in [Exhibit 2H](#) without impact to revenue service of the System.

The limits of VMF Yard operations will be the points on the Yard lead tracks where LRVs are "clear" of revenue service on the Branch lines. A single track yard lead shall be provided to directly connect VMF Yard operations to the Union Square Branch outbound track. A two track yard lead shall be provided to connect VMF Yard operations to the Medford Branch. Yard leads shall support LRVs operating in either direction; either entering service or exiting service.

1.3.2 Site Work

DB Entity shall design and perform Work necessary to construct the Project in accordance with specifications in Section 01500, 01520, 01560, 01570, and 01571 in Exhibit 2I. Materials and equipment shall be delivered, handled, and transported, and stored in accordance with Section 01600 in Exhibit 2I. Such site Work includes:

- (a) Temporary facilities;
- (b) Dust and erosion control;
- (c) Pollution control;
- (d) Site clearing and grubbing;
- (e) Rodent control;
- (f) General earthwork;
- (g) Structure excavation;
- (h) Backfill;
- (i) Site grading and subgrade preparation;
- (j) Protection of adjacent properties;
- (k) Site maintenance & cleaning; and
- (l) Site restoration.

1.3.3 Utilities and Utility Relocations

As part of the Work, all Utilities on the Site that interfere with the Project shall either be removed, protected-in-place, abandoned, or rearranged (modified, temporarily relocated, or permanently relocated) or otherwise accommodated. DB Entity shall also provide new service connections for all Utilities as may be required for the Work or for the Project. DB Entity shall coordinate its utility Work directly with the respective utility companies.

1.3.4 Roadway and Bridge Work

DB Entity shall design and construct all roadway modifications required for the Project, including roadway reconstruction, realignment, bridge replacement, bridge modifications, underpass construction, and any other action required to accommodate the Project. All roadway modifications shall be performed within the existing MBTA real property rights, or as part of Work identified under Exhibit 2F.

Roadway Work includes any required traffic control, signal modifications and provisions for street lighting required for the Project.

1.3.5 Community Path

DB Entity shall design and construct the Community Path, including associated facilities, access points, retaining walls, underpass structures, ramp structures, lighting, signage, and paved walkway improvements.

DB Entity shall not preclude construction of the Community Path connection from East Somerville to Lechmere noted in the RIDs.

1.3.6 Landscaping

DB Entity shall provide all landscaping, including temporary landscaping/screening, for the Project, including hardscape, signage, lighting, furniture, and other landscaping with respect to each Station entrance.

Landscaping shall also be provided for the Community Path and at locations adjacent to Station access points, Traction Power Substations (TPSS) locations and the perimeter of the Site. Landscape screening shall be provided adjacent to the TPSSs and other portions of the Site containing Project equipment.

Landscaping shall be coordinated with civil engineering design and, to the greatest degree possible, perform as Best Management Practices for stormwater on site management.

1.3.7 Demolition and Monitoring and Protection of Buildings, Utilities, and Structures

DB Entity shall demolish certain buildings and structures within the Site (specifically, within the Railroad corridors and site of the VMF Yard) as identified more specifically in these Technical Provisions.

DB Entity shall prepare and perform a monitoring and protection plan, to include installation, monitoring, repair of monitoring instrumentation and the collection, interpretation, reporting and preservation of monitoring data. DB Entity shall protect all existing structures, whether on or off the Site but within the Work's "Zone of Influence" as defined in Technical Provision Section 15.1.

Third party property appurtenances such as signage, foundations, other structures, utilities, landscape, fencing, and walkways may be encountered along the Project ROW. All such appurtenances shall be protected; provided, however, that if DB Entity seeks to remove, effect the abandonment of, or rearrange (modify, temporarily relocate, or permanently relocate) or otherwise accommodate any such appurtenance, then DB Entity shall prepare a plan, seek MBTA's prior acceptance (and that of any affected third-party with affected rights in such appurtenances) before doing so. DB Entity's plan shall include an obligation, as part of the Work, to reinstate the affected appurtenance or replace the affected appurtenance with like in kind, during the restoration of the affected area(s). DB Entity shall identify all appurtenances it expects not to protect-in-place as part of its precondition survey documentation process and corresponding submittals.

DB Entity shall include temporary relocation, protection, and final placement of the MBTA's Commuter Rail Positive Train Control (PTC) system fiber optic communication system with the design and construction of the Work.

1.3.8 Stormwater Collection and Management

DB Entity shall provide, or provide for, stormwater collection and management throughout the Site and as otherwise required, necessary or appropriate for the Project, including:

- (a) Along at-grade ballasted tracks via track under drains;
- (b) Along elevated track and bridges;
- (c) At Station sites;
- (d) At the VMF site;
- (e) At TPSS sites;

- (f) Providing drainage modifications as a result of roadway modifications;
- (g) Along the Community Path;
- (h) At roadways and other adjacent facilities affected by the Work; and
- (i) Incorporate Best Management Practices (BMPs) wherever possible coordinated with landscaping.

DB Entity shall provide all temporary and permanent facilities for collection and treatment of stormwater on or from the Site, whether using in new or existing facilities, including:

- (a) Pump stations;
- (b) Conveyance infrastructure into new or existing storm drain pipes; and
- (c) Hydrodynamic separation stormwater treatment devices or any other appropriate Best Management Practices (BMPs) for discharge into existing facilities where required.

Stormwater modeling shall be conducted and provided as part of the design Work. DB Entity may incorporate two constructed MBTA pump stations for stormwater management into its design of the Project as specified in [Section 7](#).

1.3.9 Above-Grade Structures

DB Entity shall design and construct all above-grade structures required by its accepted design, including all viaducts (including modification of the existing historic viaduct structure in Cambridge, Massachusetts), retained fill structures and retaining structures. Permanent retaining structures shall be capable of supporting both MBTA commuter rail, Project and Existing Green Line facilities.

1.3.10 Stations

Stations shall be designed and constructed to be fully accessible and integral with the neighborhoods in which the Stations will exist. All means of access and egress at Stations shall be ADA compliant. Stations require structural, mechanical, electrical, communications, and fire and life safety and other systems identified under these Technical Provisions. Emergency egress shall be provided at each Station.

1.3.10.1 Lechmere Station (Aerial); North Head House

The Lechmere Station shall be located across and north of McGrath Boulevard and just east of East Street as shown in the Project Definition Plan.

The Lechmere Station shall be an aerial island platform, accessed by way of two elevators and stairs via a street-level entrance concourse for the “North Head House.” The North Head House shall include facilities for bus operations, police reporting, two bathrooms (1 male, 1 female), and electrical and communications rooms. The south end of the platform shall have emergency exit stairs near the corner of East Street and McGrath Blvd.

1.3.10.2 Union Square Station (At-Grade)

DB Entity shall design and construct the at-grade level Union Square Station. Access shall be via at-grade walkway from the corner of Bennett Court and Prospect Street. Egress from the station shall be via at-grade walkway at Sound Wall accessible gate, located at the opposite side of the platform.

1.3.10.3 East Somerville Station (At-Grade) (Formerly Washington Street Station)

DB Entity shall design and construct the at-grade East Somerville Station. Access shall be provided from the south end of the platform via sloped walkway. Egress shall be provided to the north end of the platform via emergency egress sloped walkway.

1.3.10.4 Gilman Square Station (At-Grade)

DB Entity shall design and construct the at-grade Gilman Square Station. The South end will have access via a single elevator and stairs. Egress shall be provided from the north end of the platform via sloped ramp.

1.3.10.5 Magoun Square Station (At-Grade) (Formerly Lowell Street Street)

DB Entity shall design and construct the at-grade Magoun Square Station. The south end will have access via single elevator and stairs. Egress shall be provided from the north end of the platform via sloped ramp to the point of safety.

1.3.10.6 Ball Square Station (At-Grade)

DB Entity shall design and construct the at-grade street level Ball Square Station. Access will be via at-grade walkway from Boston Avenue. Egress shall be provided from the north end of the platform via emergency egress sloped walkway and ramp.

1.3.10.7 College Avenue Station (At-Grade)

DB Entity shall design and construct the at-grade College Avenue Station. The south end will have access via two elevators and stairs. Egress shall be provided from the north end of the platform via emergency egress sloped walkway to the point of safety.

1.3.11 Track

DB Entity shall plan, design and construct ballasted and/or direct fixation track, rail, and associated track materials. Vibration mats shall be provided per the Technical Provisions.

DB Entity shall relocate portions of the NHML railroad tracks and relocate the FML railroad in the area of the proposed alignment. DB Entity shall construct the connection to "Yard 10" freight lead near Washington Street. Running rail accepted by the MBTA for reuse shall be removed from the FML and stockpiled by DB Entity for MBTA re-use as relay rail.

1.3.11.1 Trackwork

DB Entity shall design and construct all track and related facilities on aerial, and at-grade sections along the Corridor.

DB Entity shall provide trackwork for both northbound and southbound tracks along the entire Corridor; encompassing both Branch segments (i.e., (a) at the south end of the Project, a rail connection with the Existing Green Line, including switches and controls, (b) at the north end of the Medford Branch, termination north of the College Avenue Station, with tracks extended to allow for storage of 4 LRVs on each track (for a total of 8 LRVs) north of the platform at College Avenue Station and (c) at the northwest end of the Union Square Branch, termination at the Union Square Station) and as needed for Commuter

Rail. The DB Entity is permitted to revise the Project alignment within the requirements of Section 10.1 and Section 10.2, and the Design Submittal process outlined in Section 2.7.

1.3.12 Power, OCS, Communications, and Signal Systems

DB Entity shall design, furnish, install, test and commission the systems necessary for operation of the Project, including:

- (a) Traction power system, supplied via Traction Power Substations (TPSSs), identified in Section 1.3.12.1. The MBTA will furnish certain traction power materials, identified in Exhibit 1D;
- (b) An overhead contact system (OCS), for direct current (DC) powering of LRVs, compatible with the Existing Green Line. DB Entity shall design and construct OCS foundations and grounding, OCS poles, and other OCS elements. DB Entity shall design and construct interconnection with the Existing Green Line in the vicinity of the "East Cambridge Viaduct," including OCS pole and foundation modifications. The OCS for the VMF Yard tracks shall be provided and fully interconnected to the mainline OCS;
- (c) System signals facilities and equipment shall extend from the Existing Green Line LRV control system so there is seamless transition of the LRVs between the Existing Green Line and the System. The signal system shall support the safe operation of LRVs, at the headways identified in Section 1.3.1.1 and with the prescribed travel times;
- (d) A communications system involving various subsystems, facilities and equipment that supports operations, passenger information, and security shall be designed and constructed by DB Entity. The communications system shall be compatible and integrated with the existing MBTA Rail Operations Control Center (ROCC); and
- (e) Other mechanical, electrical, fire/life safety, ductbank and conduit systems identified in these Technical Provisions and otherwise as is required for the Project.

MBTA will supply and install the fibers, network equipment, and infrastructure to connect communications at North Station to the ROCC and connect to the System no later than the date identified in the latest accepted Project Schedule, but DB Entity shall perform the testing of the System with the Existing Green Line in coordination with MBTA and in accordance with Exhibit 2I.

DB Entity shall interconnect, test and integrate all such systems with the Existing Green Line at the south end of the Project.

DB Entity shall perform all testing and commissioning of systems and development and implementation of a Systems Test Plan, as addressed in greater detail in Sections 01700, 01701, 01702, 01703, 01704, 01705, 01706 and any other applicable sections in Exhibit 2I of these Technical Provisions.

1.3.12.1 Traction Power Substations (TPSSs)

Traction power shall be provided for System operations. The Traction power system shall be designed so that the Project accommodates three-LRV Consists on both Branches at design headways and speeds set forth in Section 1.3.1.1 and 1.3.1.2. The associated Work includes:

- (a) Design and construction of three TPSSs and sites, named Red Bridge, Pearl Street and Ball Square; and
- (b) Installation and testing of all TPSSs.

The traction power system shall be integrated with the Existing Green Line. The traction power system shall also interface with the VMF Yard.

The Work includes coordination with applicable Utilities with respect to bringing electrical service to the TPSS sites consistent with [Section 7.4](#). DB Entity shall, as part of the Work, perform all work necessary to bring such electrical service to the TPSS sites that the Utility Owners are not performing under applicable Utility Agreements.

1.3.12.2 TPSS interfaces with other Systems

TPSSs shall interface with the systems being provided as part of the Work as well as Existing Green Line systems and facilities, including:

- (a) The traction power negative return shall interface with components being provided for the signals;
- (b) TPSSs shall interface with the OCS for distribution of traction power; and
- (c) TPSSs shall interface with other electrical systems including feeders for Stations, signals, and communications and their respective emergency back-up power supplies.

1.3.12.3 Overhead Contact System (OCS)

DB Entity shall design and construct a fully operational and integrated OCS along the entire System Corridor guideway.

At the south end, DB Entity shall interconnect the System with the Existing Green Line's OCS, including any required OCS pole relocations. DB Entity shall also integrate the OCS with the VMF.

1.3.12.4 Signal System

DB Entity shall design, procure, install and construct all signal and related equipment for the System. DB Entity shall coordinate such Work with Railroads. DB Entity shall ensure the design of the Project signal system accommodates LRV characteristics, as set forth in [Exhibit 2H](#).

1.3.12.5 Communication System

DB Entity shall design, procure, install and construct the communications system with subsystems necessary to service the Project, interconnect with the ROCC, and interface with the VMF.

The following subsystems and network components shall be considered part of the Project communication system:

- (a) Fiber optic network;
- (b) Voice over Internet Protocol (VoIP) telephone system;
- (c) Public address and Transit Passenger Information System (TPIS);
- (d) Closed Circuit Television (CCTV);
- (e) Supervisory Control and Data Acquisition System (SCADA) with Hub Monitoring and Control Systems (HMCS);
- (f) Access control system;

- (g) Fare system interface; and
- (h) Uninterruptible Power Supply (UPS).

The communications system shall provide all voice, data and video transmission capability and capacity for each of the Project's passenger stations, VMF, Transportation Building, TPSSs, "Train Control and Communications" (TC&C) rooms and other wayside facilities included in the Work.

The MBTA has existing CCTV, "access control," telephone, and passenger information systems. DB Entity shall obtain and deliver such additional licenses, hardware and equipment as may be required such that Project systems will interface seamlessly with these existing systems.

The MBTA has two existing fiber optic networks - one that supports MBTA operations purposes and a second, separate system that supports MBTA security purposes. Except as otherwise set forth in Section 1, DB Entity shall obtain and deliver such additional equipment and materials as may be required to extend both of these networks to and through the Project.

1.3.12.6 Electrical

DB Entity shall design and construct all temporary and permanent electrical systems for the Project, including:

- (a) Secondary electrical distribution systems to stations, VMF, signal houses, communications rooms and other facilities;
- (b) Standby power systems;
- (c) Grounding and bonding; and
- (d) Power for pumps, lighting and any other systems.

1.3.12.7 Fire/Life Safety

DB Entity shall design, procure, install and construct all fire and life safety systems (and associated mechanical systems) for the Project to provide a safe environment for people, equipment, LRVs, commuter, passenger and freight rail trains along the System Corridor, including:

- (a) Fire alarm systems;
- (b) Fire suppression systems;
- (c) Wet and dry standpipes;
- (d) Fire hose connections;
- (e) Fire pumps; and
- (f) Systems for the monitoring and control of all fire and life safety systems.

1.3.12.8 Ductbank/Covered Cable Troughs and Conduit Systems

DB Entity shall design and install ductbank or covered cable troughs, including conduit, raceways, and associated infrastructure along the entire alignment of the Project for signal cabling. Power and communications cables may be supported aerially from the OCS or in at-grade ductbank.

1.3.13 Miscellaneous Items

1.3.13.1 Project Signage

DB Entity shall provide all signs on the Site for the Project. Signage shall meet MBTA signage standards and shall follow specifications in Section 01580 in Exhibit 21.

DB Entity shall design a Project-wide program for implementation, coordination, and review of Station and customer-oriented signage, including electronic display systems.

Station and customer oriented designs shall be Station type-specific, and shall be presented on signage plans with elevations, schedules and coded locations, to include: signage details by location (entrance, concourse, plaza, subway, side platform, center platform, and aerial stations), type, lettering, indicating attachments, mounting details, illumination, size, and dimensioned arrangements as well as signage for any parking lots and structures intended for use by MBTA employees.

1.3.14 Testing and Commissioning

The Project shall be fully tested and commissioned by DB Entity in cooperation with MBTA. Except, and only to the extent, as explicitly permitted in the Contract Documents, testing and commissioning shall not impede Existing Green Line operations.

Testing and commissioning requirements are provided in Exhibit 21. DB Entity shall develop the required documentation specified or otherwise required under the Contract Documents for fixed facilities, trackwork, Stations, mechanical and electrical elements, and all systems (including TPSS, OCS, signals, communications and SCADA subsystems within the System). Specific field and local testing requirements related to individual elements of Work are provided in the corresponding Technical Provisions. The documentation shall also address, at a minimum, testing and commissioning of the following systems and subsystems:

- (a) Plumbing;
- (b) Mechanical;
- (c) Electrical;
- (d) Fire and life safety;
- (e) HVAC;
- (f) Security; and
- (g) Communication.

DB Entity shall include within the documentation required by these Technical Provisions subsequent testing of all systems and commissioning of the entire Project, to include integration with the Existing Green Line.

The DB Entity shall demonstrate and verify that the design, procurement, fabrication, installation, construction, commissioning and overall implementation of the Project and performance of the Work establishes performance and proper function of the System, integrity of the Project, integration with the Existing Green Line and otherwise complies with all requirements of the Contract Documents.

Test documentation shall be organized and provided as necessary to support Safety and Security Certification of the Project.

MBTA will provide LRVs for the DB Entity to use for testing and commissioning as outlined in Section 2I Additional Project Requirements. Six LRVs will be provided: two type #7, two type #8, and two type #9.

The DB Entity is responsible to determine the date of delivery of the MBTA LRV. At least six (6) months in advance of the DB Entity's proposed delivery date, the DB Entity shall submit to the MBTA a LRV Use Plan which includes at a minimum:

- (a) Proposed date of receipt of LRVs;
- (b) Proposed method of delivery;
- (c) Proposed specific location of delivery;
- (d) Proposed method of safe storage of cars; and
- (e) Duration the six (6) LRVs will be needed by the DB Entity.

DB Entity shall provide the safe storage of LRVs under their control. DB Entity shall coordinate with MBTA for any maintenance to the LRVs and include time in schedule. Upon completion, of the Testing and Commissioning the LRVs will be returned by the DB Entity to the MBTA at the VMF facility.

MBTA will provide operators for movement of the LRV's during testing and commissioning. As part of testing and commissioning, the DB Entity shall provide detailed schedule including the dates, times and number of operators required for testing the System. DB Entity shall provide a reporting location that includes restroom facilities and shall honor all MBTA work rules for the MBTA operators.

1.3.15 Operations and Maintenance Manuals

DB Entity shall provide operations and maintenance manuals and data that address all systems, subsystems, assemblies and equipment delivered to the Project for the commuter rail system, freight rail system, as well as the System. DB Entity shall coordinate with MBTA operations and maintenance staff in preparation of these manuals.

1.3.15.1 General Manual Requirements

Manuals provided under this Section 1.3.15 shall be substantially similar to existing MBTA operations and maintenance manuals, utilizing similar organization and terminology. As and when required under these Technical Provisions, DB Entity shall submit manuals consistent with MBTA's existing manuals. Where any existing MBTA facilities are modified while performing the Work, DB Entity shall update existing relevant MBTA O&M manuals.

Manuals shall be written in American English, and at a 12th grade reading level for a reader with minimal knowledge of commuter, passenger and freight rail operations.

The writing shall be clear and concise. Manufacturer's standard manuals may be acceptable, subject to MBTA's acceptance. Revisions to any manual shall be reflected in a revision index included within each manual and updated with each such revision.

Operation and maintenance manual hardcopies shall be printed on 8.5x11 paper and bound by three-ring binders, or otherwise accepted in advance by MBTA. Diagrams or illustrations shall be printed on a maximum size of 11x17 and creased such that the title of each sheet is visible when folded.

1.3.15.2 Operating Manuals

DB Entity shall prepare and submit for MBTA acceptance a complete set of operating manuals addressing the detailed operating procedures for the Project, to the subsystem and component level.

The operating manuals shall contain all information needed to operate the equipment, and shall include, at a minimum:

- (a) General familiarization materials;
- (b) Location, function, and operation of pertinent systems and subsystems;
- (c) Description of Project operation including interactions between major subsystem elements;
- (d) Start-up and shut-down procedures;
- (e) Trouble symptoms, diagnostic methods, and procedures for isolating faults;
- (f) Operating data, initial calibration and setup; and
- (g) Emergency procedures.

1.3.15.3 Maintenance Manuals

DB Entity shall prepare and submit for MBTA acceptance a complete set of maintenance manuals addressing maintenance of all equipment and materials incorporated into the Project as part of the Work.

The maintenance manuals shall provide detailed procedures and reference data for performing all of maintenance tasks. The manuals shall include expanded assembly pictorials and complete instructions for assembly and disassembly as required. The maintenance manuals shall include, at a minimum:

- (a) Preventative maintenance and overhaul schedules for all Project systems, subsystems, components and assemblies;
- (b) Descriptions of maintenance procedures of all Project systems, subsystems, components and assemblies;
- (c) Detailed descriptions of individual Project systems, subsystems, components and assemblies, including clearances; tolerances; circuit operations, test point voltages, waveforms, etc., with reference to Project drawings as applicable down to the lowest replaceable unit;
- (d) Integrated wiring diagrams, schematic drawings, and interconnection diagrams;
- (e) Detailed description of test equipment operation and procedures for its correct use in equipment maintenance;
- (f) Basic schematic and block diagrams and the requirements for setting up and use of diagnostic test equipment and special tools;
- (g) Description of replacement parts, including identifying description and part numbers as necessary to order such parts from the original parts supplier or manufacturer (OEM). These shall be a complete parts list of all numbered parts, correlating the parts number with the parts name, and name of the original manufacturer down to and including the lowest replaceable unit. Where a lowest replaceable unit is not a DB Entity-specific design or product, but is purchased from a vendor or subcontractor, the OEM shall be identified together with the OEM-specified part and/or model numbers and copies of the OEM maintenance instructions. Replacement parts are not

“spare parts,” as discussed below;

- (h) Drawings, literature, and other information that accompany lowest replaceable units procured from vendors, which may be provided as appendices to the manuals;
- (i) Trouble shooting guides at the system, subsystem, component and assembly equipment level to aid diagnosis of common failure modes;
- (j) Maintenance data, inspection logs, adjustments, repairs, etc.; and
- (k) Schedule of maintenance activities necessary to preserve warranties.

1.3.15.4 Required Submittals

With respect to preparation and delivery of both operations and maintenance manuals, DB Entity shall observe the following submittals protocol:

- (a) Manual format- Submit the proposed format and table of contents for the operations and maintenance manuals for MBTA review and acceptance;
- (b) Draft manuals- Submit proposed-final draft operations and maintenance manuals for MBTA review and acceptance;
- (c) Final manuals- Submit the final operations and maintenance manuals with MBTA comments addressed with separate annotations referencing how and where such MBTA comments were addressed for ease of review; and
- (d) Manual revisions- Until expiration of the Warranty Period, update pages, as necessary for each operation manual and maintenance manual. The manual revisions shall be submitted in the same format as the final manuals.

DB Entity shall provide two hard copies and six electronic copies of all operations and maintenance manuals.

1.3.16 Spare Parts and Materials

The DB Entity shall provide spare parts, special tools, and test equipment as required by the Contract Documents or as recommended by the manufacturer. The DB Entity shall prepare a list of recommended spare parts for submittal to the MBTA for review and acceptance.

The spare parts and materials list shall describe and quantify the parts and material required to properly maintain equipment provided, to include parts and materials (i) subject to normal wear, (ii) having a high probability of damage under normal use, and (iii) reflecting manufacturer recommendations. Spare parts and materials shall be, to the maximum extent possible, identical to the corresponding installed item, and if otherwise, its equivalent. DB Entity shall include in the Work only those parts that are reasonably likely to be available for a period of not less than seven years after the completion of the Project. DB Entity shall exclude any parts that it knows, or reasonably should have known, are or will be unavailable within such period

In addition, spare parts and material lists shall be organized to identify:

- (a) Equipment (system, subsystem, component);
- (b) Product name and description;

- (c) Recommended quantity;
- (d) Manufacturer's name, and contact information;
- (e) Manufacturer's part number;
- (f) Manufacturer's model number;
- (g) Local distributor or vendors and contact information;
- (h) Current unit cost;
- (i) Authorized OEM rebuild facility and contact information; and
- (j) Hazards identification.

Spare parts and materials shall be packaged and labeled for easy storage and retrieval. All spare parts and material shall be properly documented, delivered in good order, and unloaded by DB Entity at MBTA designated location(s).

DB Entity shall at all times have ready access and supply to spare parts and materials, special tools, and equipment for the performance of the Work. DB Entity shall provide spare parts in accordance with the following:

1. Spare parts indicated in the following Volume 2, Exhibit 2A.1, Sections 02687, 14210, 14450, 14610, 14630, 16140, 16311, 16701, 16711, 16717, 16790, 16791, 16801, 16859, and 16866 shall be paid for under the GLX Lump Sum.
2. Spare parts required by Volume 2, Exhibit 2I, Section 01710 will be paid for under an Allowance Item. If spare parts items noted in Section 01710 duplicate items noted in Paragraph 1 above, they shall be paid for under the GLX Lump Sum.

1.3.17 Reliability Demonstration Test

DB Entity shall coordinate with MBTA operations prior to Revenue Service to confirm Corridor reliability as defined in Exhibit 2I.

1.3.18 Fences

DB Entity shall install or construct and maintain temporary fences, maintain existing fences, or by other means, isolate the Site from the public and to isolate Railroad alignment from the Work.

DB Entity shall use care to avoid damaging existing fences on the Site. DB Entity shall repair or replace to the satisfaction of the MBTA and, as applicable, any third party owner, all fences which are in any way damaged due to, arising under, or relating to the Work.

DB Entity's clearing and grubbing Work shall include tearing down and removal of fences existing within the Site that are necessary to remove so as to construct a portion of the Project.

1.3.19 Training

In addition to requirements to train MBTA staff elsewhere in the Contract Documents, the DB Entity shall provide training to MBTA staff necessary for the MBTA to take over operations and maintenance of the Project at the completion of the Project and any interim opening Milestone. Unless specified elsewhere in the Technical Provisions, training shall be as recommended by the equipment manufacturer.

1.3.20 Third Party and Abutter Requirements

The DB Entity shall perform Work identified in Exhibit 2F for each Third Party and abutter property indicated.

1.3.21 Noise Walls

DB Entity shall design and construct noise walls along the Corridor per the requirements of Section 3.0.

1.3.22 Environmental Remediation

DB Entity shall perform required remediation as part of the Work specified in Section 4.0.

1.3.23 Governmental Approvals

Except for the MBTA-Provided Approvals, the DB Entity shall obtain all Governmental Approvals in accordance with the Contract Documents. Exhibit 1C of Volume 1 references authorities, agencies, cities, towns, and departments which may have jurisdiction over the identified categories of Governmental Approvals. It remains the DB Entity's obligation to determine the appropriate authorities, agencies, cities and towns which have actual jurisdiction.

The DB Entity shall comply with the requirements, provisions, and reporting requirements of all Governmental Approvals.

1.3.23.1 Governmental Approvals Obtained by the MBTA

- (a) The MBTA-Provided Approvals are listed in Exhibit 1C of Volume 1. The MBTA-Provided Approvals obtained as of the Effective Date are included in Exhibit 2G Environmental Documents.
- (b) The DB Entity shall assist the MBTA's permitting efforts and will prepare and submit to the MBTA applications, plans, calculations, or other information (stamped and signed by a Professional Engineer licensed in the Commonwealth of Massachusetts) required to obtain Governmental Approvals or amendments for the MBTA-Provided Approvals that may be necessitated by the means and methods of construction chosen by the DB Entity.

1.3.23.2 Governmental Approvals to be Obtained by the DB Entity

- (a) Without limiting or changing the provisions under Section 6.1 of the DB Contract, the MBTA will provide all reasonable support to the DB Entity in the preparation of permit applications and other materials. This support may include providing: electronic files of survey information and design drawings; records of geotechnical, flood plain, drainage, environmental, and other studies of the project area; records of agency and community contacts; and briefings on relevant issues.
- (b) The preparation of permit applications shall be conducted under the supervision of individuals qualified in the required areas practice, and the applications will meet industry standards in terms of completeness and presentation.
- (c) Draft copies of all permit applications and all other information or documents intended to be submitted to regulatory authorities must be submitted to the MBTA for review and comment, a minimum of five (5) days before the document is submitted to the permitting agency.

END OF SECTION

2 PROJECT MANAGEMENT

2.1 General Requirements

DB Entity shall perform all Work necessary to comply with the requirements of this Section.

2.2 Meetings

DB Entity shall arrange and conduct the mandatory Project Meetings with MBTA and other parties as determined by MBTA, as reflected in Table 2-1. The meetings outlined in Table 2-1 are intended to outline certain minimum mandatory meetings to comply with the requirements of this Section, and are not intended to limit in any way the DB Entity's obligation to arrange, attend and conduct meetings as necessary to comply with all of the requirements set forth in the Contract Documents.

Table 2-1: Minimum Mandatory Meetings

Description	Frequency	Section Reference
Project kick-off Meeting	Once	2.2.1
QA/QC Pre-Construction Conference	Once	2.2.4
Progress Meetings	Weekly during design, Weekly during construction	2.2.2
Technical Working Group Meetings	As requested by the DB Entity	2.2.3
Pre-construction Meeting	Once per construction package	2.2.4
Design and Construction Coordination Meeting	Weekly during design and construction	2.2.5
Design Review Meeting	As required by the MBTA or as requested by the DB Entity	2.2.8
Senior Project Management Meeting	Quarterly	2.2.9
Signage Pre-Design Meeting	Once per construction package	2.2.3
Signage Pre-Construction Meeting	Once per construction package	2.2.3
Commuter Rail and Green Line Track Construction Coordination Meeting	Weekly during construction when requested by the MBTA	2.2.6 and 2.2.7
Partnering Meeting	As required under the DB Contract	Volume 1, Section 24
Dispute Resolution Board Meeting	Quarterly and otherwise as necessary	Volume 1, Section 24
Safety Certification Working Group	As required by the MBTA	2.6.6

Description	Frequency	Section Reference
Schedule Meetings	Twice per month	2.4
Public Involvement Meetings(s)	As required by the MBTA	2.9

DB Entity shall schedule meetings, develop meeting agendas, attend, and provide all meeting facilities and materials for all meetings required by the Contract Documents or as otherwise requested by MBTA. Meeting schedules and agendas shall be provided to the MBTA a minimum of 24 hours prior to each meeting.

For all meetings relating to the Project at which the DB Entity is in attendance (not just those called or requested by DB Entity or MBTA), the DB Entity shall record minutes of each meeting and distribute copies to MBTA for review and comment within seven (7) Days. MBTA will return comments to the DB Entity, and the DB Entity shall finalize minutes within seven (7) Days of receiving MBTA's comments. The MBTA may, at its sole option, authorize certain meeting minutes. In such case, the MBTA will distribute copies to the DB Entity for review and comment. The DB Entity shall return comments to the MBTA within seven (7) Days of receipt of meeting minutes, and the MBTA will finalize the minutes.

2.2.1 Project Kick-off Meeting

The DB Entity shall schedule a Project kick-off Meeting with MBTA to discuss the Project and to exchange information no more than ten (10) Days after issuance of the Notice to Proceed (NTP).

The meeting shall include staff as identified by the DB Entity. Additional topics relevant to the Project, as identified by MBTA or the DB Entity, shall also be discussed at this meeting. DB Entity and MBTA shall jointly agree on topics to be covered at the meeting.

2.2.2 Progress Meetings

The DB Entity shall participate in progress meetings to review and discuss the status of the Project ("Progress Meetings"). The meetings shall be held weekly during design and weekly during construction, or upon request by the MBTA. Each meeting will reserve, among other items, time to discuss safety and time to discuss quality. In order to accomplish this, the DB Entity shall provide the following staff support and discuss the following topics:

- (a) Make available the DB Entity Project Manager and appropriate personnel to participate in the Progress Meetings;
- (b) RFI status including total number, outstanding, overdue, and urgent issues;
- (c) Safety including Project hours worked, Incident rate, lost time rate, total number of incidents (lost time or other), actions implemented as result of those incidents, and urgent issues;
- (d) Schedule, including:
 - (i) Activities completed since previous meeting;
 - (ii) 4 week Look-Ahead Schedule; and

- (iii) Schedule progress against plan;
- (e) DBE including Commitment, forecast, and current status;
- (f) Potential changes including: total number, outstanding, overdue, and urgent issues;
- (g) NCR's including total number to date, open, and urgent issues;
- (h) Make and record an action item list that specifies who is responsible for resolving existing or pending issues and the date by which the issue shall be resolved;
- (i) Make available the site safety officer; and
- (j) Stakeholder issues.

To the extent practical, meetings shall be pro-active. They shall anticipate issues before they impact the Project so that they can be resolved with no impact to design, construction, or Project Milestones.

2.2.3 Technical Working Group Meeting

DB Entity shall arrange and conduct Technical Working Group (TWG) meetings with MBTA to identify and resolve issues and concerns raised by MBTA or DB Entity. The purpose of these TWG meetings is to acquaint technical discipline leads with the details and features of the Work and to facilitate completion of the Project. The DB Entity shall participate in pre-design and pre-construction meetings with MBTA staff concerning the design and construction of Project signage.

TWG meetings shall be conducted for the following disciplines of the Work at a minimum. The DB Entity may choose to hold TWG meetings for other disciplines at their discretion.

- (a) Power, OCS, Communications and Signals;
- (b) Environmental;
- (c) Geotechnical;
- (d) Hydraulics;
- (e) Structures including stations and the VMF;
- (f) Bridges, underpasses, and retaining walls; and
- (g) Testing, commissioning, and startup.

The TWG meetings may include Project visits at either Party's request. At a minimum, DB Entity's technical discipline leads assigned to perform the relevant type of Work shall attend. MBTA, its representatives, and other relevant Governmental Entities' staff shall be invited.

Within seven (7) Days after each TWG meeting, DB Entity shall issue meeting minutes, action items, and any questions that pertain to the items discussed.

2.2.4 Pre-Construction Meeting

DB Entity shall schedule a pre-construction meeting with MBTA, no later than 14 Days prior to beginning construction of each construction package, unless otherwise authorized in writing by MBTA. DB Entity shall establish the level of detail to be required for measuring progress with regard to construction and to discuss its Safety Management Plan, Construction Quality Plan, and Comprehensive Environmental

Protection Program. The DB Entity shall discuss its construction schedule and identify the early construction elements of each package.

2.2.5 Design and Construction Coordination Meetings

The DB Entity shall participate in design and construction coordination meetings with the MBTA, any adjacent Contractors, Utility Companies, Municipalities, FTA/PMOC and the Commuter Rail Operator (CRO). The construction coordination meeting shall include discussion, schedules, and progress updates of the Work being performed by the DB Entity. The intent of the meeting is to plan and schedule the Work efforts to minimize impacts to and resulting from the adjacent contractor's or stakeholder's work. The construction coordination meetings shall be held as necessary during the construction phase. The DB Entity shall also participate in construction coordination during the DB Entity's design and construction phase, when requested by the MBTA.

2.2.6 Commuter Rail Track Construction Coordination Meeting

DB Entity shall coordinate Work with the MBTA and Railroads throughout the duration of the Project. DB Entity shall attend the weekly Commuter Rail Track Construction Coordination Meeting.

DB Entity shall provide a minimum four week look ahead projection of its track access and railroad flagging requirements at each weekly coordination meeting. The immediate two week projection shall serve as the DB Entity definitive flagging staff request.

Work shall not interfere with Railroad operations, unless the DB Entity obtains prior written authorization from the MBTA and the affected Railroad.

The Commuter Rail Track Construction Coordination Meetings may include Project visits at any Party's request. At a minimum, DB Entity's technical discipline leads assigned to perform the relevant type of Work shall attend. MBTA, its representatives, and other relevant Governmental Entities' staff shall be invited.

2.2.7 Green Line Track Construction Coordination Meeting

DB Entity shall coordinate Work with the MBTA as operator of the Existing Green Line throughout the duration of the Project. DB Entity shall attend the weekly Green Line Track Construction Coordination Meetings.

DB Entity shall provide a minimum four week look ahead projection of its track access and railroad flagging requirements at each weekly coordination meeting. The immediate two week projection shall serve as the DB Entity's definitive flagging staff request.

Work shall not interfere with Existing Green Line operations, unless the DB Entity obtains prior written authorization from the MBTA.

The Green Line Track Construction Coordination meetings may include Project visits at any Party's request. At a minimum, DB Entity's technical discipline leads assigned to perform the relevant type of Work shall attend. MBTA, its representatives, and other relevant Governmental Entities' staff shall be invited.

2.2.8 Design Review Meetings

At each design Submittal phase for each construction package, a Design Review Meeting shall be held. The DB Entity's designer shall present the design to the MBTA and its representatives. The purpose of this meeting shall be to facilitate review of the design and comments.

Design Review Meetings shall be scheduled with time allocated to each technical specialty so that appropriate personnel can attend the parts that are relevant for their discipline.

2.2.9 Senior Project Management Meetings

DB Entity shall participate in quarterly Senior Project Management Meeting which shall include sponsor Principals from the DB Entity, Major Participants, Principals from the DB Entity's Design Consultant, the MBTA Program Manager and entities requested by the MBTA and the DB Entity.

2.3 Project Management Plan

DB Entity shall establish and maintain an organization that effectively manages all elements of the Work. This Project management effort is to be defined by and guided by the DB Entity's Project Management Plan (PMP), which is a collection of several management plan elements. The PMP describes DB Entity's managerial approach, strategy, and quality procedures to design and build the Project and achieve all requirements of the Contract Documents. PMP elements are specified throughout the Technical Provisions.

An acceptable structure of the PMP is outlined in Table 2-2. DB Entity may propose an alternative outline for the PMP, provided that the proposed PMP outline and content complies with the requirements of the Contract Documents.

Table 2-2: Elements of the Project Management Plan

PMP Chapter	PMP Chapter Title	Section Reference
1	Project Administration	2.3.1
2	Quality Management Plan	2.5.1
2A	Design Quality Management Plan	2.5.2
2B	Construction Quality Management Plan	2.5.3
3	Safety Management Plan	2.6.1
4	Comprehensive Environmental Protection Program	3.3.2

DB Entity shall prepare and submit a PMP for review and comment to MBTA within 60 Days after issuance of NTP. The PMP shall be substantially as provided with the Proposal. DB Entity shall ensure that all plans and components of the PMP remain current throughout the term of the Project. DB Entity shall propose updates to the PMP and/or affected components in the event of occurrence of any accepted changes to the Key Personnel, Quality Management Plan, Safety Management Plan, Project administration policies and procedures. The occurrence of other changes necessitating revision to the PMP. The MBTA may direct the DB Entity to submit an updated PMP as it sees fit.

DB Entity shall provide the revised PMP to the MBTA not later than 14 Days after the occurrence of the change or direction triggering the need for the revisions to the PMP.

MBTA may audit and monitor the activities described in the PMP to assess DB Entity's performance, but MBTA's audit and monitoring activities shall not relieve the DB Entity of its obligations to satisfy the terms and requirements of its PMP. All commitments and requirements contained in the PMP shall be verifiable.

2.3.1 Project Administration

At a minimum, the Project Administration portion of the PMP shall address the following:

- (a) Organization: Include an organization diagram. See Section 2.5.1.1 for requirements;
- (b) Personnel: Establish Project Management personnel and provide names, contact details, titles, and job roles;
- (c) Schedule: Discuss schedule management procedures;
- (d) PMP Updates: Procedures for preparation of amendments and submission of amendments to any part of the PMP; and
- (e) Document Management: Document management procedures in accordance with Section 2.3.1.1 of the Technical Provisions.

2.3.1.1 Document Management

DB Entity shall utilize MBTA's furnished PMIS to transfer, store, catalog, and retrieve all Project-related documents. The DB Entity will provide any outstanding records to the MBTA as a condition of Contract Final Acceptance. All electronic information provided shall be in English text searchable and legible.

DB Entity shall prepare and submit a Document Management Plan as part of the Project administration section of the PMP. The DB Entity's Document Management Plan shall:

- (a) Meet the requirements established by the QMP General Requirements of Section 2.5.1.1 Documentation;
- (b) Identify how all documents will be submitted and integrated, and be compatible with, the MBTA's existing document storage system, at the completion of the Project; and
- (c) Include the process for controlling documents.

DB Entity shall provide MBTA with procedures, software for accessing and exporting all documents generated under the Contract Documents, and accesses to DB Entity's document control database in accordance with the requirements of the Contract Documents and as deemed necessary by MBTA.

2.3.1.2 Asset Management

The PMP shall incorporate the MBTA's asset management requirements, as set forth in Exhibit 2H, as may be revised from time to time. These MBTA Asset Management documents govern the DB Entity's responsibility with respect to Project closeout. In performing this function, the DB Entity shall coordinate closely with the MBTA Asset Management Department.

The DB Entity shall submit, as part of the Project Administration section of its PMP, an Asset Management Strategy Plan. This plan will be used to outline the specific requirements in coordination with the MBTA. The DB Entity shall include in its PMP, at minimum, the following Asset Management elements:

- (a) Documentation of equipment, their outputs, warranties, required operator and/or maintenance personnel training, certificates, and manuals
- (b) Define O&M manual formats, including personal protective equipment (PPE) requirements during O&M
- (c) Definition of performance criteria and service outputs by manufacturers
- (d) Define condition assessment and inspection criteria per asset type in line with Asset Management best practices and recognized international and national standards.
- (e) Define, design and require ease of maintainability (i.e. ergonomics, anthropometrics) for assets in its physical final location.

Note: This includes the placement of assets, such as Catenary Poles, Signal Bungalows, Train Lifts and so on in locations that limit the exposure to the hazard(s) identified in the Hazard Assessment to maintenance personnel, as well as ease of identification of said assets.

- (f) Discuss ability to provide remote sensors (reporting via cloud based platform with an open API) to monitor asset health and define optimal operating characteristics in relation to the MBTA's operating environment in which the asset is to function.
- (g) If BIM is used, ensure the BIM model is provided to the MBTA
- (h) LiDAR shall be used in as-builts
- (i) Warranties should include response time and the potential to train MBTA staff to respond, while maintaining the warranty
- (j) Define equipment that is climate sensitive, life safety critical, and operationally critical.
- (k) All coordination and Submittals shall be performed using the GLX PMIS system.

2.3.1.3 Documentation of the Site

DB Entity shall identify and document the existing conditions within the Site, including videotaping the whole Project. Documentation shall include adjacent roadways, drainage channels, existing buildings, bridges, walls, houses and any other structures, and areas where activities will be performed by or could be impacted by activities of, the DB Entity or its Subcontractors. DB Entity shall pay special attention to all adjacent facilities and utilities that may be impacted by the Work and to the documentation of downstream drainage channels, adjacent roadway conditions, and sensitive habitats. The videotape shall show details of the condition of all adjacent properties and structures, pavement conditions of crossroads, and proposed and potential haul routes.

At commencement of construction, DB Entity shall furnish construction activities video footage and two sets of digitally produced photographs, covering the following:

- (a) All structures and adjacent properties and building details; and
- (b) Any unusual conditions

DB Entity shall furnish video footage in triplicate copies in digital versatile disc (DVD) format, on at least a monthly basis, and provide this footage to MBTA upon request. DB Entity shall label all photographs and video footage according to Activity and date. DB Entity shall obtain all necessary permission from property owners to enter their property for any documentation of the Site. On a monthly basis, the DB Entity shall submit video tape and photographs of the property conditions adjacent to the locations of construction activities that occurred during the previous month.

2.3.2 PMP Deliverables

Table 2-3 reflects a nonexclusive list of deliverables identified in these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.5 of the Technical Provisions, unless otherwise specified in the Contract Documents:

Table 2-3: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Project Management Plan	2	1	30 Days after issuance of NTP	2.3
Technical Submittals			As per Contract Documents	All

2.3.3 Monthly Status Report

The DB Entity shall submit a report, on a monthly basis, that provides (and provides supporting documentation, as may be required) the information required below (the “Monthly Status Report” or “DB-MSR”). The DB-MSR shall include narratives with applicable performance measures within each section of the report. DB Entity shall submit the DB-MSR with requests for payment delivered under and in accordance with Section 14.2 of the DB Contract.

The DB Entity shall submit a draft "mockup" of this report within 30 Days after Notice-to-Proceed, for acceptance by the MBTA. The Parties acknowledge and agree that format and content of the report will evolve as the final design progresses into the construction phase and into start-up and testing, and DB Entity shall submit DB-MSRs that conform to such revised form with such revised content requirements. The MBTA may routinely request additional information be added to the following minimum requirements, and DB Entity shall provide such information:

- (a) Executive Summary - providing a status narrative of major accomplishments for the month - summary of schedule - summary of budget - summary of safety - summary of quality
- (b) Project Management - design phase summary - breakdown of design packages - critical design issues - pre-construction summary - construction management summary - construction support

- services - subcontractor activity - startup/testing summary - other key activities - status of additive options - status of ATCs
- (c) Key meetings - outcomes of internal and external meetings within the past month and a summary of upcoming critical meetings
 - (d) Safety - craft hours worked - training -toolbox meetings - near miss incidents - incidents/accidents - lost time
 - (e) Change Management - change and claims summary - scope change log - change requests - DB initiated changes - MBTA initiated changes - other pending changes - change order notice log - differing site conditions notice log - request for information log
 - (f) Budget - contract amount status - paid-to-date - pending invoice amounts - change order log - approved changes - pending changes - cash projections/curves - budget forecast - certified payroll (exhibit) - status of additive options
 - (g) Schedule - summary of information provided within Section 2.4 - critical issues from MBTA (i.e., those issues that are related to Activities that have less than 30 days of positive Contract Float) - critical issues from third-parties - critical issues, critical path description, status of updates, status of Milestones
 - (h) Quality Assurance / Quality Control - overall summary - log for non-conforming work - training update - status of the Quality Management Plan - summary of Early Release for Fabrication and Early Release for Construction
 - (i) Project Management Plan - status of PMP development/approval - updated sections - activity summary of PMP requirements
 - (j) Project Risk - summary of DB risk management activities
 - (k) Environmental / Permitting - summary of key issues - treatment of hazardous materials
 - (l) Abutter & Stakeholder - summary activities completed and upcoming activities - outreach efforts - log of property inspections/contacts - complaints
 - (m) Utility - summary activities completed and upcoming activities
 - (n) Force Account (Keolis interface) - summary activities completed and upcoming activities
 - (o) Interface with MBTA Commuter Rail - summary activities completed and upcoming activities
 - (p) Interface with MBTA Green Line Operations - summary activities completed and upcoming activities
 - (q) Right-of-Way - summary of property needs over the next 6 months - summary of property acquisition plans initiated by the DB Entity, in each case in conformity with the acquisition schedule for ROW.
 - (r) Field Activities - site investigation - test pitting - survey - geotechnical investigations - utility work - other key construction activities (not already reported above) - major commodity (planned projection vs. actual)
 - (s) Testing and Commissioning - summary of integration with design - summary of integration with construction - summary of testing plans - status of all upcoming and completed test - interface with MBTA

- (t) DBE Status - including status vs. plan
- (u) Americans with Disabilities Act (ADA) - status of ADA design and construction activity
- (v) Buy America - summary of conformance to date
- (w) Progress photos depicting key activities each month (minimum 20)
- (x) Other items as requested by the MBTA

2.4 Schedule Management

2.4.1 General Requirements

DB Entity shall perform all Work necessary to comply with the requirements of this Section 2.4. The Project Schedule shall clearly define the prosecution of the Work from issuance of NTP to the Contract Final Acceptance by using separate critical path method (CPM) activities. Baseline Activities and logic ties shall be detailed as necessary to show the Work sequencing and separately define all requisite MBTA tasks. The Project Schedule shall be used to monitor progress through earned value analysis- (EVA) and denote changes that occur during design and construction.

2.4.2 Scheduler Requirements:

- (a) The DB Entity shall employ at least two full-time Project schedulers from NTP until the Contract Substantial Completion. The qualifications for the DB Entity's proposed Project schedulers, shall be submitted to MBTA for review and acceptance. The Project schedulers shall have a minimum of ten years of project baseline scheduling experience, seven years of which shall have been on projects of similar scope and value to this Project. References shall be provided from past projects that can attest to the capabilities of the Project schedulers. The DB Entity shall meet all requirements in this Section as well as all others that relate to planning, scheduling, coordination and reporting of the Project status.

2.4.3 Schedule Requirements

- (a) The DB Entity's schedules and reports, as specified herein, will be an integral part of MBTA's management program. The DB Entity's Schedules will be used by MBTA to monitor Project progress, plan the level-of-effort by its own work forces and consultants, and as a critical decision making tool. Accordingly, the DB Entity shall ensure that it complies fully with the requirements specified herein and that its Schedules are timely and accurate throughout the life of the Project. The utilization of secondary schedules (those other than the Baseline Schedule or Progress Schedule Updates that do not directly utilize the Activity coding within the Baseline Schedule and subsequent Progress Schedule Updates) is prohibited. The DB Entity's Schedules shall be used by MBTA and DB Entity for the following purposes as well as any other purpose where the issue of time is relevant:
 - (i) Communicate to MBTA the DB Entity's current plan for performing and completing the Work;
 - (ii) Identify Work items and paths that are critical to the timely completion of the Work;
 - (iii) Identify upcoming activities on the Critical Path(s);
 - (iv) Identify and properly prioritize long lead procurement items;
 - (v) Evaluate the best course of action for recovering Schedule Delays;

- (vi) Be used as the basis of progress payments to the DB Entity;
 - (vii) Be used as the basis for analyzing the time impact of changes in the Work;
 - (viii) Identify when Submittals and resubmittals will be made by the DB Entity for MBTA's review.
 - (ix) Aid in prioritizing MBTA's review of Submittals;
 - (x) Document the actual progress of the Work;
 - (xi) Evaluate resource requirements of the DB Entity and MBTA;
 - (xii) Aid in integrating the Work with the operational requirements of MBTA;
 - (xiii) Facilitate efforts to complete the Work in a timely manner;
 - (xiv) Assign responsibility for performing specific activities;
 - (xv) Identify access to, and availability of, work areas;
 - (xvi) Identify interfaces and dependencies with preceding, concurrent, and adjacent contractors if any;
 - (xvii) Identify interfaces and dependencies with work performed by third parties or providing services in and along the Corridor (or near the Existing Green Line);
 - (xviii) Track actual tests, submission of test reports, and acceptance of test results; and
 - (xix) Plan for phased or total takeover by MBTA.
- (b) A detailed Initial Baseline Schedule will be submitted as part of the Proposal. DB Entity shall use that Initial Baseline Schedule as a foundation to prepare the Proposed Baseline Schedule and shall submit the Proposed Baseline Schedule to MBTA for review within 30 Days after NTP. The Proposed Baseline Schedule is subject to acceptance by the MBTA.
- (c) The DB Entity's approach to prosecution of the Work shall be provided to the MBTA by submission of the computerized cost/resource loaded Schedule required in this Section 2.4. These requirements are in addition to, and not in limitation of, requirements imposed in other sections. The DB shall utilize the latest version of Primavera.
- (d) Within 10 Days after issuance of NTP, and prior to submission of the Proposed Baseline Schedule, the DB Entity shall attend a schedule planning session with MBTA. At the meeting the MBTA will provide an agenda, typical schedule setting document, and sample cost report and procedure. Appropriate members of the DB Entity staff (consisting of no less than the Project Manager, the site supervisor, an office engineer, and the scheduler), plus representatives of appropriate Subcontractors (as determined by MBTA), shall attend this meeting. During this session, the DB Entity shall present its planned approach to the Project (including the Work to be performed by the DB Entity's Subcontractors) including the information identified on the list below. This will be an interactive session, and the DB Entity shall answer all questions that MBTA and its consultants may have. DB Entity shall provide copies of a written summary of the information presented and discussed during the session to MBTA.
- (e) The DB Entity's Proposed Baseline Schedule Revision 0 and accompanying Schedule Narrative shall incorporate the information discussed at this schedule planning session and shall include the following components and features:

1. NTP;
2. Each component of the Work defined by specific activities;
3. Design development, progression, Submittals, activities;
4. Quality control (as it impacts the start and progression of the work);
5. Detailed activities to satisfy permit requirements;
6. Procurement of fabricated materials and equipment with long lead times, including time for review and acceptance of Submittals required before purchasing;
7. Work Breakdown Structure as specified in Section 2.4.5(e);
8. The preparation and submission of shop drawings, procedures and other required Submittals, with a planned duration that is to be demonstrated to the MBTA as reasonable;
9. MBTA and Third Party reviews;
10. The review and return of shop drawings requiring MBTA review, procedures and other required Submittals, accepted or with comments, the duration of which shall be 30 Days, including one resubmittal unless otherwise specified or as accepted by the MBTA;
11. Interfaces with adjacent work, utility companies, other public agencies, sensitive abutters, and any other Third Party work affecting the Project;
12. Relocations and interfaces with Positive Train Control (PTC);
13. Early planning needs;
14. Coordination with third-party utilities and others;
15. The planned design and construction sequence and phasing; planned crew sizes for Work self-performed and sub-contracted;
16. Summary of equipment types, and quantities of equipment to be used for Work activities;
17. Anticipated production rates for operations;
18. A listing of all design packages and Submittals with an initial priority rating for each of them;
19. The anticipated Critical Path of the Project and a summary of the Activities on that Critical Path;
20. The Critical Path, clearly defined and organized;
21. Float shall be clearly identified;
22. Access Restraints;
23. Limitations of Operations;
24. Milestones;
25. Manuals and plans required under the Contract Documents required plans;

26. DB Entity's Subcontractor acceptances at 15 Days from Submittal to response;
 27. Traffic closures and re-open to traffic;
 28. The MBTA's confirmation of completed Work to allow for the Milestones;
 29. DB Entity's request for validation of Contract Substantial Completion;
 30. Utility work;
 31. System commissioning and testing;
 32. Operation and Maintenance Manual development, submission and accepted (prior to testing);
 33. Punch List completion period of at least 30 Days;
 34. DB Entity confirmation that all Punch List work and documentation has been completed;
 35. Resolution to conformance actions and deficiencies;
 36. Inspection;
 37. Traffic Work zone set-up and removal, night Work and phasing;
 38. Utility Relocation (by others) that has been identified in the Contract Documents;
 39. Additional Properties required;
 40. Material certifications;
 41. All Work to be subject to payment requests shall be identified by Activity. This shall include all non-construction Activities such as engineering Work; purchase of permanent materials and equipment, purchase of structural steel stock, equipment procurement, equipment delivery to the Site or storage location and the representative amount of overhead/indirect costs that was included in the Price Proposal;
 42. A summary of the primary Schedule challenges the DB Entity is anticipating and how it plans to manage and control those challenges;
 43. A summary of the anticipated monthly cash flow over the life of the Project; and
 44. The close out period.
- (f) CPM Activities and logic ties shall be detailed as necessary to show the DB Entity's Work sequencing and separately define all requisite MBTA tasks.
- (g) The DB Entity shall incorporate the Subcontractors and Suppliers input into the Schedule for Activities, logic ties, restraint dates, etc. involving their Work.
- (h) Acceptance of the Schedule by MBTA shall not relieve the DB Entity from compliance with the requirements of the Contract Documents, or result in the acceptance of any variation from the Contract Documents.
- (i) The latest version of Oracle Primavera Scheduling Software shall be used for all Schedules. Six licenses shall be provided to the MBTA.
- (j) The DB Entity shall submit as part of the Rev. 0 and monthly Progress Schedule Update(s) an

electronic file containing the complete Project Schedule data and files in compliance with the requirements of this Section. Submit electronic files to correspond to the scheduling software mentioned or accepted above. Provide 3 hardcopy submissions and an electronic submission through the PMIS.

- (k) DB Entity agrees that the DB Entity will not:
- (i) Misrepresent scheduling or execution of the Work;
 - (ii) Utilize schedules substantially different from those submitted to MBTA or any Subcontractors for performance or coordination of the Work; and
 - (iii) Submit schedules that do not accurately reflect the intent or reasonable expectations of the DB Entity and its Subcontractors.
- (l) The DB Entity is required to provide a Cost and Resource Loaded Schedule.
- (i) These Project controls tools are to include the accurate allocation of the costs to complete the Work for all Schedule Activities. Costs allocated to each Activity are to be proportional to the scope of the Work of the Activity and consistent with the DB Entity's final allocation of the Price Proposal. The design Activities should be broken down into deliverable packages as required by the Technical Provisions and design packages for a given element or area. The cost of the design shall be assigned to the proper deliverable design Activities and shall include the labor-hour allocation of the necessary resources to perform the design Work. The DB Entity shall provide written quotes from Subcontractors and suppliers to MBTA upon request. The MBTA reserves the right to use the Cost-Loading as a means to resolve Change Order Requests changes and/or claims. Front-loading or other unbalancing of the cost distribution will not be permitted. The sum of the cost of all Schedule Activities, including the Allowance items, is equal to the Contact Price excluding the Owner's Contingency.

The CPM Schedule shall include the accurate allocation of the resources to perform the Work. Resources allocated to each Activity are to be proportional to the scope of the Work of the Activity and consistent with the DB Entity's Price Proposal. MBTA reserves the right to use the resource loading as a means to resolve changes and/or claims. Indicating the labor-hours per day, by craft, and equipment hours/day will be acceptable. In addition, all construction related Change Order requests and Change Orders will be required to be resource loaded to validate and monitor the duration of the Work to be performed.
 - (ii) The DB Entity shall resource load all construction activities to demonstrate the DB Entity's anticipated crew sizes and production-based assessments, serve as a reasonable plan for the overall time requirements of the Contract Documents. The DB Entity shall show the labor hours for each individual construction Activity. The construction Activities included in the Schedule shall be analyzed, in detail, to determine activity durations in units of Work Day. Durations shall be based on the planned production rates, the labor (craft), equipment, crew sizes, and materials required to perform each Activity on a Work Day basis. All durations shall be the result of estimated labor hours and resource planning by the DB Entity to perform the work in consideration of contractually defined on-site Work conditions. The craft hours assigned, by craft definition, shall be shown on each construction activity of the Schedule. All of these construction Activities shall remain craft hour loaded, until Contract Final Acceptance.

- (m) Default progress data is not allowed. Actual start and finish dates shall not be automatically updated by default mechanisms that may be included in the software used for the Baseline Schedules. Actual start and finish dates and remaining duration on the Baseline schedule shall match those dates provided from the DB Entity back up paperwork (i.e. daily reports, delivery slips, etc.).
- (n) 'Out-of-sequence progress' - Activities that have posted progress without predecessors being completed, based on the Baseline Schedule, are not allowed without the written acceptance of MBTA. The DB Entity shall not utilize "Progress Override" (schedule calculation) unless written acceptance is provided by the MBTA. The DB Entity shall only utilize "Retain Logic" (schedule calculation).
- (o) The DB Entity shall not artificially improve its progress by revising Schedule logic restraints or shortening planned Activity durations. The DB Entity may improve its progress by performing sequential Activities concurrently or by performing Activities more quickly than plan, but such improvement shall not be recorded on the Schedule until the Activities have actually been achieved by the DB Entity, nor shall such improvement entitle the DB Entity to any additional compensation.
- (p) Time-Location-Diagram – In addition to the Progress Schedule Updates, the DB Entity will be required to provide Time-Location-Diagrams that show the planned progression of each of the major crews, over-laid with the Project location graphic. This can be done in a roll-plan that shows the location on the top (X access) and time on the slides (Y access). This will be a requirement of the Proposed Baseline Schedule and once every two months to reflect progress within the previously submitted Progress Schedule Update.

2.4.4 Use of Contract Float

- (a) Contract Float is not for the exclusive use or benefit of either MBTA or the DB Entity, but shall be used in the best interest of completing the Project within the Milestone Deadlines. If the dates in any Progress Schedule Update forecast any slippage or overrun of the Milestones, the DB Entity shall indicate such slippage or overrun by reporting negative Contract Float.
- (b) The DB Entity shall not utilize (1) Contract Float suppression techniques in any including interim dates imposed by the DB Entity other than Milestone(s), or (2) the inclusion of Activities or constraints in a path or chain leading to a Milestone which are unrelated to the Work as stated and specified in the Contract Documents, or (3) Activity durations or sequences deemed by MBTA to be unreasonable in whole or in part.
- (c) Preferential sequencing (i.e., whereby Activities that could be performed concurrently and are established in a Schedule as sequential simply to consume Contract Float), and/or indicating Artificial Activity Durations (i.e., inflating activities in the schedule to consume Contract Float and influence the critical path) are unacceptable. Sequestering of Contract Float shall be cause for rejection of the DB Entity's Schedule. In the event that float sequestering is identified, the Schedule shall be revised appropriately.
- (d) All Milestones shall be imposed, coded and separately identified in all Progress Schedule Updates in conformance with the Milestone(s) set forth in the Contract Documents. The DB Entity shall impose no other date restraints in the Schedule, unless an explanation of their bases is provided and is acceptable to MBTA.
- (e) The total Contract Float calculation shall be the number of Days between the anticipated date shown in the Project Schedule for early completion of Milestone 2 and the Milestone Deadline for

Milestone 2. A “finish no later than” constraint must remain on Milestone 2 at all times.

- (f) Extensions of time for performance of the Work required under the Contract Documents will be permitted (subject to all requirements, conditions, and limitations in the Contract Documents, including those in Volume 1, Section 15) only to the extent that the time required to complete Activities affected by any condition or event which entitles the DB Entity to a time extension, exceeds the Contract Float along the path of the Activities affected at the time of Notice to Proceed of a Change Order or commencement of any delay or condition for which an adjustment is warranted under the Contract Documents.
- (g) If the DB Entity is delayed in performing the Work, the DB Entity shall absorb any related Delay, disruption, interference, hindrance, extension and acceleration costs, however caused, until all Contract Float, if any, is consumed and performance or completion of the Work, or specified part, necessarily extends beyond the corresponding Milestone Deadline. The DB Entity shall work cooperatively with MBTA, adjacent contractors, and third parties, to identify and implement to the maximum extent possible, no-cost measures to recover all Schedule Delays, regardless of the cause of the Delays. One example of such measures is no-cost re-sequencing of Work Activities.

2.4.5 Activity Requirements

- (a) Activity durations shall equate to the Work Day required to complete the Work included in each Activity. Activities shall be in sufficient detail to breakout distinct classes of Work (e.g., CSI Divisions/Sections or equivalent) and Work in separate areas or locations, as specified by MBTA. Work being performed by DBE firms shall be identified as separate Activities.
- (b) Activities shall be detailed in a manner that utilizes planned durations from one Day to 30 Days, and shall have a value not to exceed of \$70,000 for the combined total of labor and equipment costs. Material costs shall be included in the cost and resource loading of the Activities, but will not be factored into the limit described in the sentence above. Activity durations greater than 30 Days shall be kept to a minimum, and may be accepted by MBTA. Mobilization, procurement of materials, and delivery of equipment may exceed 30 Days.
- (c) Activities shall be assigned consistent descriptions, identification codes and sort codes. Sort code organization shall: (a) be subject to MBTA's prior consent; (b) include group Activities using meaningful organizations defined by DB Entity and MBTA; and (c) designate lead responsibility for each Activity. The DB Entity shall include specific Schedule Activity identification codes in its daily field reports when describing the items of Work performed each Day.
- (d) The Contract Price, excluding the Owner Contingency shall be allocated to the Activities. When the Schedule is grouped by “price item” code, the summary value should be equal to each item in the Price Proposal.
- (e) Each Schedule shall utilize the following Work Breakdown Structure (WBS):

WBS Code	WBS Name
1	GLX Project
1.1	Milestones
1.1.1	Contract Milestones
1.1.2	Internal Deliverables
1.1.2.1	Design
1.1.2.2	Procurement

- 1.1.2.3 Construction
- 1.2 Design
 - 1.2.1 Phase 1 - Preliminary Design
 - 1.2.1.1 Prepare and Submit
 - 1.2.1.2 Review, Comment, and Accept
 - 1.2.3 Phase 2 - Intermediate Design
 - 1.2.3.1 Prepare and Submit
 - 1.2.3.2 Review, Comment, and Accept
 - 1.2.4 Phase 3 – Pre- Release for Construction (PRFC)
 - 1.2.4.1 Prepare and Submit
 - 1.2.4.2 Review, Comment, and Accept
 - 1.2.5 Phase 4 – Release for Construction (RFC)
 - 1.2.5.1 Prepare and Submit
 - 1.2.5.2 Review, Comment, and Accept
 - 1.2.6 Early Release Packages
 - 1.2.6.1 Early Release for Construction (ERC)
 - 1.2.6.2 Early Release for Fabrication (ERF)
- 1.3 Procurement
 - 1.3.1 Fabrication
 - 1.3.2 Delivery
- 1.4 Construction
 - 1.4.2 Allowances
 - 1.4.1 Phase/Location/Area
 - 1.4.1.1 Preconstruction Activities
 - 1.4.1.2 Construction Activities
 - 1.4.1.3 Commissioning and Testing
- 1.5 Close Out

(i) Each Schedule shall utilize the following Cost Breakdown Structure (CBS) within the cost accounts of Primavera for the purposes of cost loading the schedule. The cost account breakdown should contain the Four (4) Levels (as shown below) with a four (4) digit numbering convention (example 10.01.01.01).

- Level 1: SCC Category
- Level 2: SCC Sub-category
- Level 3: Project Element
- Level 4: Location (to be determined by DB Entity)

CBS Level 1 and 2 – SCC Category and Sub-Category

<p>Standard Cost Categories for Core Capacity Projects (Rev.19, June 2017)</p>
<p>10 GUIDEWAY & TRACK ELEMENTS (route miles)</p>

Standard Cost Categories for Core Capacity Projects	
(Rev.19, June 2017)	
10.01	Guideway: At-grade exclusive right-of-way
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)
10.03	Guideway: At-grade in mixed traffic
10.04	Guideway: Aerial structure
10.05	Guideway: Built-up fill
10.06	Guideway: Underground cut & cover
10.07	Guideway: Underground tunnel
10.08	Guideway: Retained cut or fill
10.09	Track: Direct fixation
10.10	Track: Embedded
10.11	Track: Ballasted
10.12	Track: Special (switches, turnouts)
10.13	Track: Vibration and noise dampening
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	
20.01	At-grade station, stop, shelter, mall, terminal, platform
20.02	Aerial station, stop, shelter, mall, terminal, platform
20.03	Underground station, stop, shelter, mall, terminal, platform
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.
20.05	Joint development
20.06	Automobile parking multi-story structure
20.07	Elevators, escalators
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	
30.01	Administration Building: Office, sales, storage, revenue counting
30.02	Light Maintenance Facility
30.03	Heavy Maintenance Facility
30.04	Storage or Maintenance of Way Building
30.05	Yard and Yard Track
40 SITEWORK & SPECIAL CONDITIONS	
40.01	Demolition, Clearing, Earthwork
40.02	Site Utilities, Utility Relocation
40.03	Hazardous material, contaminated soil removal/mitigation, ground water treatments
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks
40.05	Site structures including retaining walls, sound walls
40.06	Pedestrian / bike access and accommodation, landscaping
40.07	Automobile, bus, van access ways including roads, parking lots
40.08	Temporary Facilities and other indirect costs during construction
50 SYSTEMS	
50.01	Train control and signals
50.02	Traffic signals and crossing protection
50.03	Traction power supply: substations
50.04	Traction power distribution: catenary and third rail
50.05	Communications
50.06	Fare collection system and equipment
50.07	Central Control

Standard Cost Categories for Core Capacity Projects (Rev.19, June 2017)	
60 ROW, LAND, EXISTING IMPROVEMENTS	
60.01	Purchase or lease of real estate
60.02	Relocation of existing households and businesses
70 VEHICLES (number)	
70.01	Light Rail
70.02	Heavy Rail
70.03	Commuter Rail
70.04	Bus
70.05	Other
70.06	Non-revenue vehicles
70.07	Spare parts
80 PROFESSIONAL SERVICES (applies to Cats. 10-50)	
80.01	Project Development
80.02	Engineering
80.03	Project Management for Design and Construction
80.04	Construction Administration & Management
80.05	Professional Liability and other Non-Construction Insurance
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.
80.07	Surveys, Testing, Investigation, Inspection
80.08	Start up

CBS Level 3 – Project Element

Code	Name
01	Elevator
02	Escalator
03	Mechanical
04	Electrical/Power/Comm.
05	Plumbing
06	Architectural Site
07	Architectural Facility
08	Architectural Station
09	Structural Site
10	Structural Facility
11	Structural Station
12	Civil Site
13	Civil Facility
14	Civil Station
15	Track
16	Signals
17	Furniture
18	Vehicles

Code	Name
19	Real Estate
20	Utilities
21	External Flagging
22	Diversions/Ops
23	MBTA F.A. - Electrical/Power/Comm.
24	MBTA F.A. - Inspection
25	MBTA F.A. - Project Admin
26	MBTA F.A. - Flagging
27	MBTA F.A. - Signals
28	MBTA F.A. - Track
29	MBTA F.A. - Other
30	Management - Other

(ii) Activity Code – The Schedule shall include but not be limited to the following Activity codes:

1. Price item
2. Design
3. Submittal
4. Review/acceptance
5. Procurement/fabrication
6. Delivery
7. Construction/installation
8. Change order
9. Milestone
10. Responsibility
11. Areas
12. Construction phase
13. Standard Cost Category (SCC) (reference link - <https://www.transit.dot.gov/funding/grant-programs/capital-investments/new-starts-scc-workbook>)

(f) Activities shall be broken down to a sufficient level of detail to avoid the use of lag. The DB Entity shall seek acceptance and provide justification for the use of logic 'lags.' 'Negative lags' are not allowed.

(g) All notices of non-conformance shall be included as a separate activity code.

2.4.6 Schedules/Reports/Plots

(a) Activity Reports shall include Activity ID, description, duration, calendar, Early Dates and Late

Dates, Contract Float and sort codes as specified by MBTA. In addition, Activity reports shall show, for each Activity, all preceding and succeeding driving logic ties or attach a separate report combining such Activity and logic tie data.

- (b) Bid Item Report shall include Activity ID, description, duration, Early Dates, total Contract Float, budgeted cost, physical percent completed, and actual cost this period.
- (c) Resources: The DB Entity shall provide monthly and cumulative craft hour performance curves for its own forces and Subcontractors, as designated by MBTA, with all Schedule submissions. These performance curves shall be based on current Early Dates and Late Dates and shall compare Baseline Early Dates and current Early Dates. The DB Entity shall also resource load its planned equipment for all activities. At all times throughout the duration of the Project, the craft loaded Schedules, craft hour performance curves, and list of equipment shall be kept current and shall accurately represent the DB Entity's current actual plan for performing the Work.
- (d) Craft Hour Analysis: The DB Entity shall prepare a craft hour analysis in the form of a series of graphic displays depicting manpower by principal trades in the aggregate, and in accordance with the Project Schedule. The graphs shall display the number of craft-Days of effort, for each month, over the life of the Project. This submission shall be computerized and shall correlate with the labor data, exported from the Scheduling software
- (e) Cash Flow: Using the cost assigned to each Activity of the Project Schedule, the DB Entity shall develop a monthly cash flow projection, illustrated by exporting the scheduling data in graphic display and tabular form (cumulative and incremental) and broken out by major cost centers determined by the MBTA. The cash flow projection shall demonstrate the estimated cash drawdown in the aggregate, by month, over the life of the Project. Additionally, the data shall be organized/sortable by Activity.
- (f) Look-Back and Look-Ahead Schedules: Provide look-ahead and look-back schedules at each Schedule Meeting and Progress Meeting (Look-Back and Look-Ahead Schedules). Each Look-Back and Look-Ahead Schedule shall display the Activities planned at the closing (i.e., data, cut-off) date that cover the previous two weeks and the next four weeks and shall be derived from the Progress Schedule Updates Look-Back and Look-Ahead Schedules, shall use the same Activity coding as used within the Baseline Schedule and the Progress Schedule Updates.
- (g) If the MBTA returns a Progress Schedule Update or any other Schedule related submission to the DB Entity for correction/revision the DB Entity shall correct, revise, and resubmit the submission to the MBTA, along with an electronic file, for acceptance within 10 Days after the return. Such resubmittal shall be subject to acceptance by the MBTA.
- (h) Time-Location-Diagram – In addition to the Progress Schedule Updates and other monthly submissions relating to Schedules, the DB Entity shall provide Time-Location-Diagrams that show the planned progression of each of the major crews, over-laid with the Project location graphic. This can be done in a roll-plan that shows the location on the top (X access) and time on the slides (Y access). This will be a requirement of the Baseline Schedule and for every two Progress Schedule Updates.

2.4.7 Resources

Resources - The DB Entity shall resource load all Schedules to demonstrate the DB's anticipated crew sizes and that the DB Entity's production-based assessments, adequately serve as a reasonable plan for the overall Time requirements of the Contract Documents. The DB Entity shall show the labor hours for each

individual Activity. The Activities included in the Schedule shall be analyzed, in detail, to determine Activity durations in units of Work Day.

Durations shall be based on the planned production rates, taking into account the labor (craft), equipment, crew sizes, and materials required to perform each activity on a normal Work Day basis, in accordance with the DB Entity's Price Proposal. All durations shall be the result of definite craft hours (labor hours) and resource planning by the DB Entity to perform the Work. The craft hours to be assigned, by craft definition, shall be shown on each construction Activity of the Schedule. All of these Activities shall remain craft hour loaded, and updated, until Contract Substantial Completion. The DB Entity shall provide weekly, monthly, and cumulative craft hour performance curves for its own forces and Subcontractors, as designated by the MBTA, with all Schedule submissions.

These performance curves shall be based on current Early Dates and Late Dates and, when requested by the MBTA, shall compare As-Planned Early Dates and current Early Dates. The DB Entity shall also resource load its planned equipment for all Activities. At all times throughout the duration of the Project, the craft loaded Schedules, craft hour performance curves, and list of equipment shall be kept current and shall accurately represent the DB Entity's current actual plan for performing the Work.

The DB Entity shall prepare a craft hour analysis in the form of a series of graphic displays depicting manpower by principal trades in the aggregate, and in accordance with the Project Schedule.

The graphs shall display the number of craft-Days of effort, for each month, over the life of the Project. This submission shall be computerized and shall correlate with the manpower data, exported from the Scheduling software. The craft hour requirements forecast shall be updated monthly and shall include the manpower expended, by trade, as of the current report period and the manpower required to complete all remaining Work.

2.4.8 Proposal Schedules

A Proposal Schedule is a schedule used to evaluate proposed changes to the Contract Documents or significant alternatives to previously accepted approaches to complete the Work, which may include changes to Activity durations, logic and sequence. Proposal Schedules shall be cost and resource-loaded.

A Proposal Schedule may be requested by the MBTA at any time or may be offered by the DB Entity. The MBTA may request that the DB Entity prepare a Proposal Schedule to further mitigate any delays that are shown in Progress Schedule Update. The DB Entity shall submit the Proposal Schedule within 30 Days of a request from the MBTA.

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

Proposal Schedules shall clearly indicate any proposed overtime hours or additional shifts that are proposed to be incorporated in the Schedule. The DB Entity shall have final discretion over the use of overtime hours and additional shifts. Changes represented in accepted Proposal Schedules shall be

incorporated into the next Progress Schedule Update. During the review of any Proposal Schedule, Progress Schedule Updates shall continue to be required every month.

2.4.9 Narratives

- (a) Schedule Narratives - Each narrative shall list the Activities on each Critical Path and compare Early Dates and Late Dates for Activities designating Milestones.
- (b) The Schedule Narrative shall include the following components, to communicate to MBTA the DB Entity's current plan for performing and completing the Work:
 - (i) Identification of each PCO Notice and CO Request that includes a potential time extension over the past 4 months (rolling);
 - (ii) Identify Work items and paths that are critical to the timely completion of the Work;
 - (iii) Upcoming Activities that MBTA needs to be aware of;
 - (iv) The proposed course of action for recovering any Schedule Delays;
 - (v) Critical Submittals by the DB Entity, for MBTA's review;
 - (vi) Any significant changes to resources for future or past Work;
 - (vii) All labor and equipment resources shall be defined according to each crew composition by trade;
 - (viii) Any upcoming information that is important to the operational requirements of MBTA;
 - (ix) Alerts MBTA of any potential/future/pending changes in access to or availability of Work areas;
 - (x) Highlights future tests, submission of test reports, and acceptance of test results;
 - (xi) Addresses any upcoming phased or total takeover by the MBTA. Overview of progress and changes since the last Submittal and discussion of potential and actual Delays;
 - (xii) Describes the plan and approach to sequencing of the Work;
 - (xiii) Highlights and describes any Change Orders and Change Order Requests that have been included or are pending for acceptance; and
 - (xiv) A glossary of terms, Schedule coding, and abbreviations used in the Schedule.
- (c) For each Progress Schedule Update, the narrative shall respond to previous update review comments from MBTA, recap progress and Days gained or lost versus the previous Progress Schedule Update, describe changes in resources to be used on remaining Work and identify Delays, their extent and causes. For each Progress Schedule Update, the narrative also shall itemize and explain changes in Activities, calendar, and logic ties, schedule recovery plans and DB Entity-initiated revisions. Provide summary cost data to include: cost this period, cost to date, remaining cost.
- (d) Baseline narrative shall include details regarding (a) the use of construction equipment and resources, (b) basis and assumptions for Activity durations and logic, (c) any shifts, non-Business Days and multiple calendars applied to the Activities (d) any weather calendars that are to be used for all temperature and moisture sensitive Activities.
- (e) Work is to take place in a New England area that is prone to extensive snow, freezing, rain, wind

events and temperature fluctuations. The DB Entity shall familiarize itself with the conditions that have occurred in the Boston area, within the past 25 years and shall ensure that its planned durations for Activities account for the variety of weather conditions that have occurred in the Boston area over the past 25 years.

- (f) The DB Entity shall confirm, as part of the narrative, that it has checked each section of the Contract Documents for weather related restraints and that an applicable weather related calendar has been applied to each operation. All Schedules shall have black-out (non-work) Days for the average weather events over the past 25 years.
- (g) Each narrative shall certify that the DB Entity has not been delayed, as of the closing date, by any act, error or omission of MBTA, except as otherwise specifically stated in the narrative or identified in a Change Order Request submitted in accordance with the Contract Documents.

2.4.10 Proposed Baseline Schedule

- (a) The Proposed Baseline Schedule (fully cost and resource loaded) shall be due within 30 Days from NTP.
- (b) The Proposed Baseline Schedule shall reflect the Work as awarded and shall exclude any Delays, Change Orders, proposed changes and proposed deviations from the DB Entity's Proposal.
- (c) The Proposed Baseline Schedule shall only include the Work at the time of NTP. No changes to the Work may be incorporated until after the Proposed Baseline Schedule has been accepted.
- (d) Once the Proposed Baseline Schedule is returned to the DB Entity as "Accepted" or "Accepted as Noted," it shall become the "Baseline Schedule" and be used as the basis for Progress Schedule Updates. The Baseline Schedule also constitutes the first "Project Schedule."
- (e) After acceptance of the Proposed Baseline Schedule, redistribution of costs in the Baseline Schedule is prohibited unless accepted, by the MBTA, with a full demonstration of the bid base costs (including documentation from the Escrow bid documents) as compared to proposed/adjusted re-distribution.
- (f) Each Schedule Submittal shall include an electronic file with the DB Entity's schedule data files (including activity data, logic, coding, resource and cost data), a narrative and four copies of the specified Activity Reports, Cash Flow Plots, Resource Plots and Look-Ahead Schedules as defined elsewhere within the Contract Documents, all in formats, sorts and sequences acceptable to MBTA.

2.4.11 Progress Schedule Update

- (a) Progress Schedule Update
 - (i) The DB Entity shall meet with the MBTA to review each Progress Schedule Update and computer tabulations for the purpose of verifying:
 1. Actual start dates;
 2. Actual completion dates;
 3. Cost value of Work reported in place;
 4. Activity physical percent completion;
 5. Revised logic (record and projected);
 6. Remaining duration;

7. Influence of Change Orders and Change Order Requests; and
 8. Revisions due to unauthorized modifications.
- (ii) Prior to each monthly Schedule Meeting the DB Entity shall submit a draft Progress Schedule Update and invoice to MBTA to validate the progress data. At each Schedule Meeting, the DB Entity shall be prepared to discuss, at a minimum: any delays, schedule recovery plan, change order Schedules (sub rates), plan vs. current performance, head-count, crew performance, progress with respect to obtaining or maintain Governmental Approvals. The monthly Schedule Meeting is to be separate from the Progress Meeting. After the Schedule Meeting, the DB Entity shall submit a Progress Schedule Update , which among other things, shall reflect the agreements made. Progress Schedule Updates using the Baseline Schedule (as the basis) shall be due with each partial payment request, starting with the second request and with each subsequent monthly partial payment request. The MBTA's acceptance of a Progress Schedule Update will be dependent upon the accuracy of the information provided, the reasonableness of the execution of the Work, the detailed presentation of the resources and approach to completing the remaining Work and the satisfying MBTA Schedule review process.
 - (iii) The DB Entity shall uniquely identify each Progress Schedule Update by using a numbering convention similar to that used on technical Submittals. Resubmissions shall be assigned the corresponding Progress Schedule Update number and the letter A, or B, or C, etc., and shall fully address all MBTA's review comments and objections on the previous Project Schedule Update and on the most recent draft Progress Schedule Update.
 - (iv) Progress Schedule Updates shall reflect progress up to data date, forecasted finish for in-progress Activities and re-forecasted Early Dates for Activities planned in the next update period. The current Progress Schedule Updates should incorporate all proposed Activity, logic revisions required to (a) implement changes in the Work, (b) detail all impacts on pre-existing Activities, (c) recover schedule, (d) reflect the DB Entity's current approach for Work remaining, (e) incorporate any accepted Delays that are being negotiated between MBTA and DB Entity, and (f) reflect "or equal" or substitution proposals. Progress up to the closing date shall be limited to changes in as-built dates for completed and in-progress Activities. As-built data shall include actual start dates (excluding premature starts), remaining durations, actual finish dates (when dependent Work could/did proceed), physical % complete, actual cost this period, Delays and other events significant to the Project Schedule that occurred since the previous Progress Schedule Update.
 - (v) The DB Entity's Progress Schedule Update shall maintain accepted Activities, logics, sequences and durations. The DB Entity may request that Activities, logics, sequences and durations be revised, but the DB Entity shall not submit a Progress Schedule Update that revises, deletes, or adds Activities, logics, sequences or durations without the prior acceptance of the MBTA. The MBTA shall promptly review any logic or Activity changes requested by the DB Entity.
 - (vi) The MBTA and DB Entity shall employ the most current Project Schedule to monitor progress against the Milestone Deadline(s), evaluate the effect of Delays on Milestone Deadlines(s) and Contract Price and control any assessment of liquidated damages.
 - (vii) In the event the evolution of the Project Schedule is interrupted, Delay evaluation and

Project Schedule update procedures will occur.

- (viii) The DB Entity shall submit an As-Built Schedule to the MBTA, which shall be subject to the MBTA's acceptance, before the DB Entity shall be entitled to Final Payment.

(b) Schedule Calendars

Different calendars may be created and assigned to all Activities or to individual Activities. Calendars define the available hours of work in each Day, holidays and general or Project-specific non-Work Day such as railroad work restrictions, material installation restrictions related to temperatures, time-of-year (TOY) restrictions and/or area roadway restrictions, night-time paving, utility restrictions for summer time work.

(c) Other Meetings

- (i) DB Entity shall schedule and conduct a Schedule Meeting twice per month jointly by the DB Entity, the MBTA's consultant, and MBTA field staff to discuss and agree on monthly schedule progress. This meeting is to be separate from the weekly Progress Meeting.
 - (ii) Work-Off Meeting (and Work-Off List) – A series of meetings in which representatives from the MBTA, the DB Entity (consisting of no less than the Project Manager, the site supervisor, the office engineer, and the construction scheduler), and representatives from every Key Subcontractor that the MBTA requests attend, are present to review the specific details of the Work that remains to be completed, the interdependencies within each area and crew, the remaining acceptances and inspections, the requirements to obtain certificate of occupancy, and the detailed status of each Work Activity and sub-Work Activity. In preparation for Work-Off Meetings, the DB Entity should be prepared to discuss the status of Activities in greater detail than such Activities identified in the Project Schedule. The DB Entity is responsible to prepare and maintain the 'work-off list' consisting of detailed Schedule Activity data, with the same Activity coding that is in the Project Schedule. The DB Entity shall allocate enough time in its Price Proposal and Schedule to support Work-Off Meetings at the following frequency:
 - 1. 2-6 months prior to Milestone 3D and Milestone 4C deadlines –once per week;
 - 2. Less than two months prior to Milestone 3D and Milestone 4C deadlines – two times per week; and
 - 3. One month prior to Milestone 3D and Milestone 4C deadlines – three times per week.
- (d) In preparing the Schedule Submittals, the DB Entity has the responsibility to request clarification from the MBTA on any areas of the Schedule which reflect the DB Entity's interpretations of, or variations from, the requirements of the Contract Documents. The DB Entity also has the responsibility to incorporate its Subcontractors' and Suppliers' input into the Schedules for Activities, logic ties, restraint dates, etc. involving their portions of Work.
- (e) Acceptance of the Schedule by the MBTA shall not relieve the DB Entity from compliance with the requirements of the Contract Documents, or result in the acceptance of any variation from the Contract Documents.
- (f) Terms used in this Section shall have the meanings assigned to them in the Contract Documents, and if not assigned and where the context will permit, as used or defined in Massachusetts General

Laws (M.G.L.).

2.4.12 As-Built Schedule

30 Days prior to Contract Final Acceptance, DB Entity shall submit an As-Built Schedule for review and acceptance by MBTA, with actual start and actual finish dates for all Activities. The As-Built Schedule, once accepted, will serve as the final update of the Project Schedule. DB Entity shall provide a written certification with the As-Built Schedule Submittal signed by the Project Manager and an officer of the DB Entity with the following:

“The enclosed As-Built Schedule reflects the actual start and completion dates of the Activities for the Project contained herein.”

The DB Entity’s Submittal of the As-Built Schedule and the Project Manager’s certification is a condition precedent to the release of any funds retained in accordance with Volume I of the DB Contract.

2.4.13 Deliverables

Table 2-4 reflects a nonexclusive list of deliverables identified in this Section 2.4 and is not intended to be an all-inclusive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7 of the Technical Provisions, unless otherwise specified in the Contract Documents:

Table 2-4: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Schedule Narrative	2	1	At each Schedule Submittal	2.4.9
Time-Location- Diagram	2	1	Every two months	2.4
Proposed Baseline Schedule	2	1	30 Days after issuance of NTP	2.4.10
Draft Progress Schedule Update	2	1	Prior to the monthly Schedule Meeting	2.4.11
Progress Schedule Update	2	1	Monthly Submittal concurrent with each partial payment request	2.4.11
As-Built Schedule	2	1	30 Days prior to Contract Final Acceptance	
Look-Ahead and Look-Back Schedules	2	1	At each Schedule Meeting and each Progress Meeting	2.4

2.4.14 Schedule Reviews by the MBTA

(a) Baseline Schedule Reviews

The MBTA will respond to the Proposed Baseline Schedule within 30 Days of receipt providing comments, questions and/or disposition that either accepts the Proposed Baseline Schedule or requires revision and resubmittal. Revised Proposed Baseline Schedules shall be resubmitted within 15 Days after receipt of the MBTA's comments.

(b) Progress Schedule Update / Monthly Update Reviews

The MBTA will respond to each Project Schedule Update within 15 Days. Progress Schedule Updates shall be resubmitted by the DB Entity within five (5) Days after receipt of the MBTA's comments.

2.5 Quality Management

Quality Management consists of both Quality Assurance (QA) and Quality Control (QC) functions. DB Entity has the full responsibility for both QA and QC of the Work, including all Work and products of subconsultants, Subcontractors and Suppliers. DB Entity shall develop, implement, and maintain a Quality Management Plan that at a minimum complies with the requirements of the US Department of Transportation Federal Transit Administration Quality Management System Guideline (FTA-PA-27-5194-12.1). The Quality Management Plan shall be substantially as provided with the Proposal. The Plan shall be tailored to the scope and complexity of the Work and shall include implementing procedures and use of all required forms. Samples of inspection forms have been included as Reference Information Documents. The DB Entity's Quality Management Plan shall describe the process for completing the standard MBTA forms "Nonconformance Report (NCR)", "Design Change Request (DCR)", and "DB Entity QC Manager Daily Log". Subcontractors, subconsultants, and Suppliers may use the DB Entity Quality Management Plan in lieu of developing their own. The DB Entity's Quality Management Plan shall:

- (a) Document a Quality Management System;
- (b) Establish comprehensive quality management processes and procedures;
- (c) Establish the mission, vision, and quality goals of both the design and construction elements of the Project;
- (d) Define the minimum standards and procedures for quality management;
- (e) Define and assign the responsibilities for specific quality management functions;
- (f) Establish procedures to ensure that design, procurement, shipping, handling, fabrication, installation, cleaning, inspection, construction, testing, storage, examination, repair, maintenance, and required modifications of all materials, equipment, and elements of the Work will comply with the requirements of the Contract Documents;
- (g) Establish procedures for internal and external audits, including auditing and management review of DB Entity's own activities under the DB Entity's Project Management Plan and Auditing and management review of Subcontractor's activities and management procedures;
- (h) Establish requirements for inspection and testing to validate and verify that all materials, equipment, and other elements of the Work will perform satisfactorily for the purpose intended;
- (i) Provide MBTA the opportunity to perform construction Independent Assurance inspection and testing; and
- (j) A "living document" that shall be updated and revised as required by the DB Entity or the MBTA.

The Persons and organizations performing Quality Management Plan functions shall have sufficient freedom from the DB Entity to identify quality problems and to initiate, recommend, provide, and verify implementation of solutions. The overall administration of the Quality Management Plan shall be vested in a responsible section of the DB Entity's organization. This section shall contain a QA/QC organization headed by an on-site Quality Manager who is a member of the DB Entity, not a subcontractor. The Quality Manager shall be located at the project office and shall be dedicated fulltime to the Project. The Quality Manager shall have clear access to top-level management and to Subcontractors' officers responsible for the execution of the Subcontractor's Quality Management Plan. The Quality Manager's sole duty is to manage and administer the Quality Management Plan. The Quality Manager shall have at least ten years' experience in administering quality control program on rail transportation construction and/or operation projects.

The QA/QC organization shall be staffed by technically competent personnel with freedom to make decisions without pressure or bias to ensure that quality requirements are consistently maintained and the ability to stop the Work if the quality requirements are not being met. Any DB Entity staff in a supervisory role shall have minimum five years' experience.

The MBTA will monitor and evaluate DB Entity's performance in implementing the Quality Management Plan. The purpose of such quality oversight program is to assist in communicating MBTA's independent assessment of such performance. As part of such quality oversight program, should DB Entity not be meeting MBTA's reasonable expectations in performing its QMP, DB Entity shall prepare and submit a recovery plan to MBTA, articulating changes in personnel, processes, organization and/or amendments to the QMP. MBTA reserves the right to step-in and assume some or all of DB Entity's quality-related obligations under this [Section 2.5](#) and under [Volume 1, Section 4.2.4](#), at the DB Entity's expense if the DB Entity does not meet the MBTA's reasonable expectations in the performance of the requirements of the QMP.

2.5.1 Quality Management Plan

DB Entity shall develop, implement, and maintain a Quality Management Plan (QMP) that encompasses the design and construction quality aspects, as well as documentation requirements for the Project. MBTA may audit DB Entity to determine whether quality activities are being carried out and implemented effectively in accordance with the QMP.

The QMP shall be prepared under the direction of the Design Quality Manager and Construction Quality Manager and shall consist of the following components:

- (a) Volume I – QMP General Requirements
- (b) Volume II – Design Quality Management Plan
- (c) Volume III – Construction Quality Management Plan
- (d) Volume IV – Testing and Commissioning Quality Management Plan

The QMP may be submitted by the DB Entity in phases by total chapters or volumes, and shall be subject to acceptance by the MBTA. The QMP shall be incorporated into the PMP as set forth in Table 2-2.

2.5.1.1 Volume I – QMP General Requirements

The QMP shall include the following:

- (a) Organization. Provide a chart showing lines of authority and reporting structure with the specific Quality Management Plan responsibilities. Identify the names, contact information, qualifications, duties, responsibilities, and authorities of each Person and/or firm proposed by DB Entity to be assigned a Quality Management Plan function, including the Design Quality Manager, the Construction Quality Manager, and the Testing and Commissioning Quality Manager. Provide for updating the Quality Management Plan staffing schedule to reflect accurate forecasting of QA/QC staffing requirements, as necessary, through Contract Final Acceptance.
- (b) General Procedures. Describe procedures for:
 - (i) Coordinating and ensuring consistency and quality of Work;
 - (ii) Ensuring that DB Entity staff and Subcontractors comply with all applicable aspects of the Quality Management Plan relating to their Work. The DB Entity shall require that its Subcontractors and fabricators follow the DB Entity's Quality Management Plan, unless the DB Entity documents in writing whether such Subcontractor or fabricator will follow its own Quality Management System, if required for specific certifications. In both cases the DB Entity shall monitor and perform oversight of all Subcontractors, supplier and fabricator by performing inspection and audits as necessary. The DB Entity is responsible for close over sight of all Subcontractor, supplier and fabricator work, and issuing non-conformance reports for work not meeting the requirements of the Contract Documents. As required by the Contract Documents, the DB Entity is responsible to perform its own inspection at any fabricator's plant, in addition to the fabricator's own internal QC/QA;
 - (iii) Coordinating and ensuring consistency and quality of materials and products;
 - (iv) QC and QA review processes for management, administrative, and nontechnical functions for the Project, including clear criteria and procedures for issuing, tracking, and closing non-conformance Reports;
 - (v) Integrates all subconsultants, Subcontractors, Suppliers, and fabricat0ors;
 - (vi) Includes clear criteria and procedures for providing timely, regular updates of the QMP.
- (c) Documentation. Describe procedures for identifying, controlling, and storing all Project documentation, including:
 - (i) Complete records of Quality Management Plan activities and accountability, including all Quality Management Plan operations, inspections, Activities, and tests performed, as well as all communications among the DB Entity's Quality Management Plan organization, design organizations, construction organizations, all Subcontractors, Suppliers, fabricators, and MBTA, relate to the Work or the Contract Documents. These records are subject to MBTA's inspection and audit at any time;
 - (ii) Easy retrieval and dissemination to all affected disciplines;
 - (iii) Identify how all documents will be tracked using a unique document control number and index;
 - (iv) Describe the methods by which all documents issued and received by the DB Entity will be logged tracked and retrieved;
 - (v) Identify how records are to be maintained and kept throughout the duration of the

- Project;
- (vi) Identify how documents subject to configuration management will be controlled;
 - (vii) Availability to MBTA and MBTA's representatives at all times during the performance of the Work;
 - (viii) Documentation of Delays encountered and Work that does not conform to the requirements of the Contract Documents, including the Final Design Documents, together with the corrective actions taken regarding such Work;
 - (ix) Evidence that the required activities and tests have been performed and documented describing as follows:
 - 1. Type, number, material placement, and results of QA/QC activities including:
 - a. Reviews, inspections, factory acceptance and field verification tests, audits, monitoring of Work performance, and materials analysis;
 - b. Closely related data, such as qualifications of personnel, procedures, and equipment used;
 - c. The name of data recorder, the type of test or observation employed, the results and the acceptability of the Work, and action taken in connection with any errors noted; and
 - d. Nature of Nonconforming Work and reasons for rejection.
 - (x) Training of staff (including Subcontractors and fabricators) to ensure roles and responsibilities are understood; and
 - (xi) Any other information required by the Contract Documents.
- (d) Audits and Surveillances. Describe procedures to plan, perform, report and follow-up on DB Entity's internal and external audits, including:
- (i) A list and schedule of planned audits; the DB Entity shall cross reference the item to be audited with the associated activity in the DB Entity's progress schedule;
 - (ii) Invite MBTA QA/QC Personnel, and forward audit reports to MBTA;
 - (iii) Independence of auditors; and
 - (iv) Documenting non-conformances and who is responsible for their corrective actions.

2.5.1.2 Volume II – Design Quality Management Plan

DB Entity shall develop, implement, and maintain a Design Quality Management Plan (DQMP) that includes the following:

- (a) Provides design QC and QA review processes;
- (b) Makes certain the Design Documents comply with the requirements of the Contract Documents;
- (c) Provides quality measures and encourages continuous improvement of the design Submittals;
- (d) Involves MBTA in the design development process as appropriate;
- (e) Includes stakeholders such as Utilities, Railroads, Authorities Having Jurisdiction, etc. in the Design

- Review comment process, as required by the Contract Documents or otherwise as appropriate;
- (f) Provides assurance that comments will be responded to and corresponding changes incorporated into the design;
 - (g) Includes inter-disciplinary reviews of deliverables;
 - (h) Includes constructability peer reviews of construction documents prior to issuance for construction, including a review to confirm that all design meets all applicable codes and standards; and
 - (i) Design Basis Report for each design element indicating design criteria and codes utilized in the design.

2.5.1.3 Volume III – Construction Quality Management Plan

DB Entity shall develop, implement, and maintain a Construction Quality Management Plan (CQMP) that satisfies the requirements of Section 2.5.3 and includes the following:

- (a) Provides quality measures and encourages continuous quality improvement during the construction phase;
- (b) Training all construction staff of their role in the QMP and makes certain they understand their role is to construct the Project in accordance with the Contract Documents;
- (c) Makes certain all construction quality staff understand their role is to determine whether the Work complies with the Project requirements. A training session with the DB Entity staff shall be completed to educate all personnel on inspection of Work, the non-conformance process and the resolution of non-conformances. A refresher session shall take place at least annually;
- (d) Integrates all Subcontractors, Suppliers, and fabricators in the Quality Management Plan; and
- (e) Keeps MBTA informed throughout the entire construction process as appropriate.

In addition to completing the Work specific inspection/testing forms the DB Entity's Construction Quality Manager is required to complete the following Daily Logs during the course of construction:

- (a) DB Entity QC Manager Daily Log
 - (i) The logs are to be completed by DB Entity's accepted Quality Manager or accepted designees. The logs shall be completed whenever construction is taking place and submitted to the MBTA on a monthly basis with its payment request;
 - (ii) If the DB Entity's Quality Manager will be out of work for an extended period, the DB Entity will propose a temporary replacement; and
 - (iii) If there are serious quality issues identified and noted on the Daily Log, the DB Entity shall notify the MBTA immediately and shall ensure the issues are documented with non-conformance Reports.

2.5.1.4 Volume IV – Testing and Commissioning Quality Management Plan

DB Entity shall develop, implement, and maintain a Testing and Commissioning Quality Management Plan (TCQMP) that satisfies the requirements of Section 2.5.4 and includes the following:

- (a) Provides quality measures and encourages continuous quality improvement during the testing and commissioning phase;

- (b) Training all testing and commissioning staff of their role in the QMP and makes certain they understand their role is to test and commission the Project in accordance with the Contract Documents;
- (c) Makes certain all testing and commissioning quality staff understand their role is to determine whether the Work complies with the Project requirements. A training session with the DB Entity staff shall be completed to educate all personnel on inspection of Work, the non-conformance process and the resolution of non-conformances;
- (d) Integrates all Subcontractors and fabricators in the Quality Management Plan; and
- (e) Keeps MBTA informed throughout the entire testing and commissioning process as appropriate.
- (f) Documents a procedure for creating and maintaining a log of all necessary documentation (Certificates, test reports, etc.) required for final acceptance.

In addition to completing the work specific inspection/testing forms the DB Entity's Testing and Commissioning Quality Manager is required to complete the following Daily Logs during the course of testing and commissioning:

- (g) DB Entity QC Manager Daily Log
 - (i) The logs are to be completed by DB Entity's accepted Quality Manager or accepted designees. The logs shall be completed each day during the testing and commissioning process, and submitted to the MBTA in a timely manner;
 - (ii) If either individual will be out of work for an extended period, the DB Entity will propose a temporary replacement. If either individual is to be permanently replaced a formal submission shall be made to the MBTA; and

If there are serious quality issues identified and noted on the Daily Log, the DB Entity shall notify the MBTA immediately and documented by a non-conformance Report.

2.5.1.5 QMP Acceptance

DB Entity's Project Executive shall approve and endorse the QMP prior to Submittal to MBTA. DB Entity shall address MBTA's comments, if any, in the QMP. DB Entity is responsible to meet with MBTA as often as necessary to discuss and resolve MBTA's comments.

MBTA will not review any design Submittal without an accepted Design QMP and Design Quality Manager in place. In addition, the MBTA will not review any construction Submittal, or allow any construction to proceed without an accepted Construction QMP and Construction Quality Manager in place. In addition, the MBTA will not review any testing and commissioning Submittal, or accept results of any testing and commissioning without an accepted Testing and Commissioning QMP and Testing and Commissioning Quality Manager in place. The QMP is in effect until such time that all requirements of the Contract Documents have been fulfilled. After concurrence of the QMP (in whole or in part) by MBTA, DB Entity shall not revise the plan or the staffing levels, or replace key QA/QC personnel without the prior written concurrence of MBTA. Following concurrence, DB Entity shall provide MBTA with electronic (native and PDF) copies of the QMP.

2.5.1.6 QMP Updates/Revisions

DB Entity shall regularly maintain the QMP to contain current versions of the following information:

- (a) Organization charts that identify all QA/QC personnel and the line reporting relationships within DB Entity's management, design, and construction organizations;
- (b) Description of the roles and responsibilities of all QA/QC personnel who have the authority to stop Work;
- (c) Identification of testing agencies, including information on each agency's capability to provide specific services required for the Work, certifications held, equipment, and location of laboratories;
- (d) Resumes for all QA/QC personnel; and
- (e) Updates and revision of the QMP shall conform to document control requirements such as those established in Section 2.5.1.1 of this document.

Without limiting Volume 1, Section 4.2.4, if the MBTA determines, in its sole discretion, that DB Entity's QA/QC procedures are not adequate, or if a problem is spotted during oversight reviews or becomes evident during the Work, MBTA may, at its sole discretion, direct DB Entity to suspend the Work until sufficient QA/QC procedures are in place. If the errors affect the Work in progress, MBTA will require correction of the errors before any affected Work may proceed further. DB Entity shall revise its QMP to include these updates/revisions. DB Entity shall submit QMP updates/revisions for review and comment to MBTA 14 Days prior to implementing the proposed changes.

2.5.2 Design Quality Management Plan

The DQMP process places the responsibility for design quality on DB Entity and its designers, facilitates the completion of Design Documents, and allows MBTA to oversee the design process and design products. The DQMP shall provide processes that ensure all Design Documents are prepared in accordance with Good Industry Practice and comply with all requirements of the Contract Documents.

2.5.2.1 DQMP Process

DB Entity shall provide Quality Management Plan procedures for Design Documents and other design information, organizing the procedures by each engineering discipline performing the Work (e.g., structural, drainage/hydraulics, environmental, etc.). The DQMP procedures and methods shall include the following requirements:

- (a) Verify Functions
 - (i) Confirm quality requirements are specified and included in the development of Design Documents;
 - (ii) Verify design inputs and outputs;
 - (iii) Validate computer software used for performing design and design calculations; and
 - (iv) Confirm all Work is performed in accordance with the DQMP and Contract Documents.
- (b) Checking Functions
 - (i) Include independent checking and back-checking by a qualified reviewer not involved in the preparation of Design Documents being checked;
 - (ii) The roles, responsibilities and experiences of a "qualified reviewer" shall be established;
 - (iii) Include checking and back-checking level, frequency, and methods to ensure the

- adequacy of the Design Documents; and
- (iv) Clearly identify designer and checker on each sheet of all Design Documents.
- (c) Training Functions
- (i) Confirm through training and review sessions that all personnel performing design Work are familiar with all requirements of the Quality Management Plan and Contract Documents pertaining to their responsibilities; and
 - (ii) Include training certificates for personnel performing activities affecting or measuring quality of the Work, as required in the Contract Documents. Implement and document DQMP training of DB Entity's design personnel.
- (d) Roles and Responsibilities
- (i) Identify the roles and responsibility for quality personnel and Project engineers assigned for the design Work;
 - (ii) A DB Entity Organization chart shall be issued to the MBTA identifying key staff and reporting relationships;
 - (iii) Confirm that assigned quality personnel and Project engineers participate in the reviews for all Design Documents;
 - (iv) Define how DB Entity will accommodate MBTA in the over-the-shoulder reviews during the course of the development of each design package, to provide informal comments and feedback on the design; and
 - (v) Specify how DB Entity will coordinate design among designers for the Work and for other Work near the site, or related tasks to eliminate conflicts, errors, and misalignments in elements for the Design Documents.
- (e) Design Change Functions
- (i) Include a process whereby design changes to previous Release for Construction (RFC) packages are prepared, reviewed, submitted, and released for construction;
 - (ii) Specify procedures for tracking and distributing design changes made after the RFC package.
 - (iii) Identify, document, and resolve deviations;
 - (iv) Changes to RFC packages and Design Documents shall be reviewed and otherwise accepted by the same organizations that performed the original review and otherwise accepted unless specifically excused in writing by MBTA; and
 - (v) Document the incorporation into the Record Drawings of any changes from the Final Design Documents.

2.5.2.2 Design Certification

As part of the DQMP, the DB Entity shall provide a design certificate pro forma for review and acceptance by the MBTA. The DB Entity's Design Quality Manager shall certify, prior to delivery of the Design Documents Submittals, that:

- (a) The design complies with all applicable requirements of the Contract Documents;

- (b) An environmental review of the design package has been completed confirming the design does not change any conditions of the original environmental commitments and, the original environmental commitments remain valid;
- (c) The design has been prepared and checked in accordance with DB Entity's accepted QMP and its procedures; and
- (d) All necessary acceptances have been obtained and documented from applicable Governmental Entities and the AHJs.

2.5.2.3 Design Package Submittals

The purpose of the design package Submittal reviews is for the Design Quality Manager to verify and document that certain professional services proceed in accordance with Project requirements, Laws, Good Industry Practice, Governmental Approvals, and the Contract Documents. All Submittals are subject to review and comment as defined by the Quality Management Plan and as provided herein. The Design Quality Manager shall have the authority to refuse and reject any Submittal that does not comply with the requirements of Governmental Approvals, Laws, and/or the Contract Documents.

Submittal of Design Documents shall be accompanied by documentation confirming that DB Entity has fully applied and followed the concurred DQMP. Documentation of conformance to the DQMP is a requisite element of each Submittal, and design review Submittals not accompanied by written certification will be returned to DB Entity.

2.5.2.4 Final Design Documents

When DB Entity has completed the design, the DB Entity's Design Manager and the DB Entity's Design Quality Manager shall certify the Final Design Documents. The DB Entity Design Quality Manager shall confirm that the Final Design Documents are 100% complete and compiled. Prior to submitting and certifying the Final Design Documents, the DB Entity Design Quality Manager shall schedule a review with MBTA to review the content of the Final Design Documents Submittal.

2.5.3 Construction Quality Management Plan

The CQMP shall be written to place the primary responsibility for construction quality on the DB Entity to perform, control, and make certain that operational techniques and activities provide acceptable quality and are in compliance with the Contract Documents.

DB Entity shall identify all materials, equipment, and all elements of the Work, as well as the individuals and organizations performing any functions under the CQMP, and provide control over all activities affecting the quality of all such materials, equipment, and elements of the Work.

The CQMP shall be accepted by MBTA prior to release of any RFC package. No construction Work activities may commence until CQMP has been concurred with in writing by MBTA.

MBTA has the right to conduct quality oversight including:

- (a) Oversight of DB Entity's QA/QC activities to evaluate compliance with the CQMP;
- (b) Auditing of DB Entity's construction management, including scheduling, invoicing, shop drawing review, document control; and

- (c) Evaluation of DB Entity QC inspection and testing activities in comparison with MBTA Independent Assurance (IA) testing.

2.5.3.1 CQMP Procedures

The CQMP procedures and methods shall include the following requirements:

(a) Verify Functions

- (i) All activities affecting the quality of the construction Work are accomplished under acceptable conditions, using appropriate equipment, and executed in accordance with Good Industry Practice;
- (ii) All of the Work conforms to all of the requirements of the Contract Documents;
- (iii) All material, equipment, and elements of the Work used in the Project will perform satisfactorily for the intended purpose;
- (iv) The Work is prescribed by and performed in accordance with the RFC packages;
- (v) Purchased materials, equipment, and services conform to the Contract Documents;
- (vi) An independent check of shop and working drawings, including the review and the review stamp by an independent engineer working on behalf of DB Entity. The engineer performing the independent check may be employed by a different entity, if desired, and the checking shall be independent from the designer;
- (vii) Certificate of accreditation, scope of accreditation and testing methods, inspection of testing laboratories, capability check, and test results for independent testing laboratories. MBTA reserves the right to check independent testing laboratories' equipment and laboratory technicians' testing procedures, techniques, and other items pertinent to testing, for compliance with the Contract Documents;
- (viii) Tools, gages, instruments, and other measuring and testing devices used in activities affecting quality are properly installed, monitored, maintained, controlled, calibrated, and adjusted at specified periods to maintain accuracy within necessary limits and in accordance with applicable specifications. An inspection, measurement and test equipment procedure shall be created to control all activities affecting quality. This procedure shall include standards to be followed, equipment calibration frequency, and equipment calibration status; and
- (ix) Handling, storage, shipping, cleaning, and preservation of materials and equipment that prevents damage or deterioration.

(b) Inspection and Testing

- (i) Obtain concurrence from the MBTA for all staff proposed to perform construction inspection at least 30 Days prior to construction Activities;
- (ii) Provide testing program that incorporates the requirements and acceptance limits contained in applicable Design Documents and Construction Documents, ensures that all prerequisites for the given test have been met and that adequate test instrumentation is available and used, and documents and evaluates that the test requirements and results have been satisfied;
- (iii) The construction QA laboratory is not owned by DB Entity or any subsidiary or Affiliate

unless agreed to in writing by MBTA;

- (iv) The construction QA laboratory is located within 60 miles of the Project and possesses independent accreditation for all applicable testing as required by Project specifications;
- (v) Address QC and QA of sampling, testing, and checking the Work, including initial and source testing and Work performed by Subcontractors;
- (vi) Prevent the use of incorrect or defective materials and equipment. The DB Entity shall document all construction non-conformance and prepare Submittals to resolve non-conformances. The CQMP shall include a timeframe (maximum allowable is 14 Days) by which the DB Entity will propose a resolution of any non-conformance report;
- (vii) Provide quantitative and/or qualitative criteria, as appropriate, to demonstrate satisfactory performance;
- (viii) Provide source evaluation and selection, objective evidence of quality furnished by Subcontractors, inspection at the manufacturer or vendor source, and examination of products on delivery;
- (ix) Provide examinations, measurement, and tests of materials or elements of the Work for each Work operation, where appropriate, to ensure quality, and is not limited to that required for acceptance or assurance testing purposes. If the Contract Documents specify mandatory inspection hold points that require witnessing, inspecting, or acceptance by DB Entity or MBTA, indicate the specific hold points on the appropriate documents;
- (x) Demonstrate that all materials, equipment, and elements of the Work will perform satisfactorily for the intended purpose and comply with the standards specified in the Contract Documents, including the Final Design Documents;
- (xi) Comply with manufacturer's recommended quality testing procedures, and any other quality testing procedures that serve as a substitute for the manufacturer's procedures; and
- (xii) Resolve disputes that may arise in the QA sampling and testing process. If the recommended dispute resolution system involves use of an independent testing laboratory, include the name of a recommended independent testing laboratory. The independent testing laboratory shall not be a participant in the Quality Management Plan for either DB Entity or MBTA.

(c) Training Functions

- (i) Provide training for QA/QC personnel performing activities affecting or measuring quality of the Work, and demonstrate that the CQMP is understood and followed by DB Entity's construction personnel;
- (ii) Confirm all personnel performing construction Work are familiar with all requirements of the QMP and Contract Documents pertaining to their responsibilities; and
- (iii) Provide for the effectiveness of the control of quality by DB Entity's own forces and Subcontractors at intervals consistent with the importance, complexity, and quantity of the product or services.

(d) Roles and Responsibilities

- (i) Specify the personnel assigned for shop drawing review and acceptance, including

falsework drawings and other critical structure shop drawings, procedures for documenting reviews and concurrence from MBTA and for obtaining corrective action, when necessary, and checking of shop drawings and falsework drawings; and

- (ii) Cooperate with and coordinate inspection and testing by Governmental Entities and Utility Owners.

(e) Construction Change Functions

- (i) Control the issuance of and changes to RFC packages and Construction Documents in accordance with the DB Entity's Configuration Management Plan;
- (ii) Confirm concurred RFC packages and Construction Documents, including all authorized changes thereto, are reviewed for adequacy, and concurred for release by authorized personnel;
- (iii) Avoid Nonconforming Work, including procedures for identification, documentation, segregation, disposition, and notification to MBTA and all other affected Persons, as well as procedures for MBTA to review Nonconforming Work and accept, reject, or require repair and/or reworking of Nonconforming Work; and
- (iv) Changes to RFC packages and Construction Documents are reviewed and concurred with by the same organizations that performed the original review and concurrence unless concurred with in writing by MBTA.

(f) Document-related Functions

- (i) Materials and equipment conform to the Contract Documents, and that such documentation is available at the jobsite no less than 24 hours prior to installation or use of such material and equipment;
- (ii) Retain documentation at the jobsite;
- (iii) Track materials, equipment, and elements of the Work by appropriate means, either on the item or on records traceable to the item, as necessary, throughout fabrication, assembly, erection, installation, and use of the item. Electronic tracking of materials and equipment incorporated into the Work is required. Test/inspection results will be tracked in the same database which will be accessible by the MBTA;
- (iv) List the independent testing laboratories and the qualified QA/QC personnel that are used to perform sampling and testing;
- (v) Indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed on individual items of the Work, including identification of items that have satisfactorily passed required inspections and tests, where necessary, to preclude inadvertent bypassing or duplication of such inspections and tests;
- (vi) Identify methods that will be used to segregate or prevent material not yet accepted or not in compliance with specifications from being incorporated into the Work;
- (vii) Promptly identify conditions adverse to quality, such as failures, malfunctions, errors, defective material and equipment, deviations, and other Nonconforming Work. In case of significant conditions adverse to quality, take corrective actions to preclude repetition, and document and report the corrective action taken to DB Entity's management and

- MBTA;
- (viii) Retain survey records and checks of the accuracy of construction stakes, lines, and grades established by DB Entity;
 - (ix) Furnish the signed certificates for laboratory accreditation and other documentation to MBTA;
 - (x) Summarize reporting of field tests at the end of each month;
 - (xi) Track design changes, RFIs, and requests for clarification during construction. Document how these changes will be passed along to those responsible for performing the Work;
 - (xii) Provide daily reports of all Work performed by the end of the shift; and
 - (xiii) Incorporate into the Record Drawings any changes from the Final Design Documents, and provide certification of the Record Drawings by the Construction Quality Manager.
- (g) Geotechnical Inspection Functions
- (i) Provide inspection and testing for all compressible/collapsible soil and/or debris, and excavations for spread footings for structures;
 - (ii) Verify that unsuitable material has been removed prior to backfilling;
 - (iii) Prepare record materials reports containing cut slope mapping, cleanout notes; and
 - (iv) Provide grout installation records and results of QA/QC testing during and following completion of grouting program.

2.5.3.2 Source of Supply and Quality

Unless otherwise allowed by other sections of the Contract Documents, all materials used on the Project shall be new and first quality materials conforming to the requirements of the construction specifications and concurred with by MBTA, except for material used by the DB Entity for its convenience and which is not to be permanently incorporated in the Work.

Unless otherwise stipulated the DB Entity shall furnish all materials required for the Work specified in the Contract Documents, and said materials shall meet the requirements of the Specifications for the kind of Work involving their use.

After testing if the sources of supply do not furnish a uniform product or if the product from such sources proves unacceptable at any time, the DB Entity shall, take any and all steps necessary to furnish acceptable materials.

If the MBTA so desires, materials such as crushed stone, gravel borrow, or ordinary borrow, shall be sampled at the source. Samples shall be taken by or in the presence of the MBTA. The DB Entity shall furnish such facilities as the MBTA may require for collecting and forwarding samples to the MBTA Laboratory. Samples shall be furnished without charge and with any shipping charges prepaid. However, preliminary acceptance by the MBTA does not relieve the DB Entity of the responsibility for placing satisfactory material in the Work as determined by subsequent samples taken at the source or at the Site, prior to the material being incorporated into the Work and if the Site samples test satisfactorily the material will be considered to meet the Contract Document's requirements as to quality. If such sampling and testing reveal that the material is unsatisfactory it shall be removed from the Work or blended in with

such other materials so that an acceptable material will be produced. Removal and blending of such material shall be done by the DB Entity without additional compensation.

2.5.3.3 Submittals, Samples and Tests

The DB Entity shall submit the name, address, and qualifications, together with the scope of proposed services, of proposed inspection and testing firms to the MBTA for acceptance at least 30 Days prior to the scheduled commencement of any Work involving such inspection or testing.

Within five (5) Days after completion of testing performed, the DB Entity shall enter test results into an electronic database and submit to the MBTA. The DB Entity shall identify the test reports to be submitted as required in this Section. Test reports shall be identified with the information specified for samples in this Section and additionally, the name and address of the organization performing the test, the date of the tests, results of the test (pass/fail), and a signature of an authorized representative attesting to the validity of the test results.

Inspection and sampling of materials will be carried out, ordinarily at the source or at the site of the Work in accordance with the CQMP. Responsibility for incorporating satisfactory material in the Work rests entirely with the DB Entity.

When requested, the DB Entity shall furnish to the MBTA samples specified in the various specification sections and the DB Entity shall prepay shipping charges on samples. Materials or equipment for which samples are required shall not be used in the Work until accepted in writing by the MBTA.

Unless otherwise indicated, submit not less than two identical samples of each type required. Label each sample indicating:

- (a) Name of Project and contract number;
- (b) Name of DB Entity and Subcontractor;
- (c) Material or equipment represented;
- (d) Source;
- (e) Name of producer and brand (if any);
- (f) Specification Section, article, and paragraph; and
- (g) Location in Project.

The DB Entity shall submit a transmittal for each shipment of samples and containing all the information required in this Section. Enclose a copy of the transmittal letter with the shipment and a copy to the MBTA. Acceptance of a sample shall be only for the characteristics and use named in the Submittal and acceptance, and will not be construed to change or modify any requirements of the Contract Documents. Before submitting samples, the DB Entity shall confirm that the materials or equipment will be available in the quantities required in the Contract Documents, as no change, nor substitution, will be permitted after a sample has been accepted, unless the change/substitution accepted by the MBTA in writing.

Accepted samples not damaged in testing may be incorporated in the finished Work if marked for identification and accepted by the MBTA. Materials incorporated in the Work shall match the accepted samples.

Failure of any material to pass the specified tests will be sufficient cause for the MBTA to refuse to consider any further samples of the same brand, make, or source of that material. The MBTA reserves the right to reject any material, which has previously proven unsatisfactory in service. If the MBTA rejects any material then DB Entity shall replace all portions of the Project that use or rely upon such materials without right to claim adjustment to the Contract Price or any of the Milestones.

Samples of various materials or equipment delivered on the Site or in place may be taken by the MBTA for testing. Failure of samples to meet requirements of the Contract Documents will automatically void previous acceptances of the item tested. If any such voided previous acceptance occurs, then DB Entity shall replace all portions of the Project that use or rely upon such material without right to claim adjustment to the Contract Price or any of the Milestones.

As soon as possible and a minimum of 35 Days in advance of the time when placing of concrete is expected to begin, the DB Entity shall deliver to the accepted laboratory samples and available analysis of concrete ingredients. Quantities of materials, aggregate sizes, cement, admixtures, and bitumen's as may be required for the performance of necessary tests and trial mixes will be determined by the Contract Documents or such testing laboratory that has been accepted by the MBTA in writing.

2.5.3.4 Independent Assurance Testing

Independent Assurance (IA) testing is the testing of materials and workmanship that maybe conducted by the MBTA as part of the audit program. The MBTA may perform IA testing of materials and workmanship in accordance with the Contract Documents in conjunction with the DB Entity's testing agency and at a frequency determined by the MBTA. The MBTA reserves the right to perform additional testing at any time to determine conformance with the requirements of the Contract Documents.

IA testing by the MBTA is not to be considered a replacement for control testing conducted by the DB Entity or a manufacturer producing materials for the Project. IA testing will be at the expense of the MBTA.

2.5.3.5 Hold and Notification Points

DB Entity shall establish activity points acceptable to MBTA where the DB Entity shall notify MBTA when certain activities will be performed. There are two types of activity points that require notification as follows:

- (a) Hold Point – A point in a function or process in which MBTA performs a planned inspection and beyond which Work may not proceed without prior concurrence from MBTA.
- (b) Notification Point – A point in a function or process in which MBTA may perform an inspection. MBTA shall be notified at this point and Work may proceed.

DB Entity shall provide written notification of activity points to MBTA no later than 14 Days prior to the date of the proposed activity point. Failure to provide notification to MBTA or violating a "Hold Point" may, in MBTA's sole discretion, result in the subsequent rejection of the Work.

2.5.3.6 Control Inspection and Testing

Control inspection and testing are the testing or inspection of materials prior to their delivery from a manufacturer, or during construction. Examples of such testing are soils tests before and after

compaction, concrete tests during placement, and other tests and inspections specified in the various sections of the Specifications to ensure compliance with the requirements of the Contract Documents. The DB Entity shall perform, or cause to be performed, all control inspection and testing and giving sufficient notice to the MBTA to permit the witnessing of the inspections or tests. Control inspection and testing and may be performed by independent firms.

2.5.3.7 Notification Point

Notification Point - The QC Manager shall make periodic Site inspections of the Work areas with the construction supervisors to assure that there are no conditions that would affect the quality of the installation or product. The QC Manager shall identify deficient conditions and causes identified and ensure that deficient conditions are corrected. Inspections shall be documented on a form similar to the "General Inspection Form" contained in the Reference Information Documents. The DB Entity shall prepare additional forms for inspections as required. Procedures shall be prepared and submitted that clearly define the process and responsibilities for documenting inspections on forms. The DB Entity shall notify the MBTA in advance of the periodic inspections to allow participation by the MBTA.

2.5.4 Testing and Commissioning Quality Management Plan (TCQMP)

The CQMP shall be written so as to place the primary responsibility for testing and commissioning quality on the DB Entity, and for the DB Entity to perform, control, and make certain that operational techniques and activities provide acceptable quality and are in compliance with the Contract Documents.

DB Entity shall identify all materials, equipment, and all elements of the Work, as well as the individuals and organizations performing any functions under the TCQMP, and provide control over all activities affecting the quality of all such materials, equipment, and elements of the Work.

The TCQMP shall be accepted by MBTA prior to commencement of any testing and commissioning Work activities.

MBTA has the right to conduct quality oversight including:

- (a) Concurrence of the TCQMP;
- (b) Oversight of DB Entity's QA/QC activities to evaluate compliance with the TCQMP;
- (c) Auditing of DB Entity's testing and commissioning management, including scheduling, invoicing, shop drawing review, document control; and
- (d) Evaluation of DB Entity QC inspection and testing activities in comparison with MBTA Independent Assurance (IA) testing.

2.5.4.1 TCQMP Procedures

The TCQMP procedures and methods shall include the following requirements:

- (a) Verify
 - (i) All activities affecting the quality of the testing and commissioning Work are accomplished under acceptable conditions, using appropriate equipment, and executed in accordance with Good Industry Practice;
 - (ii) All of the Work conforms to all of the requirements of the Contract Documents;

- (iii) All material, equipment, and elements of the Work used in the Project will perform satisfactorily for the intended purpose;
- (iv) The Work is prescribed by and performed in accordance with the RFC packages and Contract Documents;
- (v) Purchased materials, equipment, and services conform to the Contract Documents;
- (vi) Certificate of accreditation, scope of accreditation and testing methods, inspection of testing laboratories, capability check, and test results for independent testing laboratories. MBTA reserves the right to check independent testing laboratories' equipment and laboratory technician's testing procedures, techniques, and other items pertinent to testing, for compliance with the Contract Documents;
- (vii) Tools, gages, instruments, and other measuring and testing devices used in activities affecting quality are properly installed, monitored, maintained, controlled, calibrated, and adjusted at specified periods to maintain accuracy within necessary limits and in accordance with applicable specifications. An inspection, measurement and test equipment procedure shall be created to control all activities affecting quality. This procedure shall include standards to be followed, equipment calibration frequency, and equipment calibration status; and
- (viii) Handling, storage, shipping, cleaning, and preservation of materials and equipment that prevents damage or deterioration.

(b) Inspection and Testing

- (i) Obtain acceptance from the MBTA for all staff proposed to perform testing and commissioning inspection at least 365 Days prior to testing and commissioning activities;
- (ii) Provide testing program that incorporates the requirements and acceptance limits contained in applicable Design Documents and Construction Documents, ensures that all prerequisites for the given test have been met and that adequate test instrumentation is available and used, and documents and evaluates that the test requirements and results have been satisfied;
- (iii) Address QC and QA of acceptance testing including initial and source testing and Work performed by Subcontractors;
- (iv) Prevent the use of incorrect or defective materials and equipment. The DB Entity shall document all non-conformance and prepare Submittals to resolve non-conformances. The TCQMP shall include a timeframe (maximum allowable is 14 Days) by which the DB Entity will propose a resolution of any non-conformance report;
- (v) Provide quantitative and/or qualitative criteria, as appropriate, to demonstrate satisfactory performance;
- (vi) Provide source evaluation and selection, objective evidence of quality furnished by Subcontractors, inspection at the manufacturer or vendor source, and examination of products on delivery;
- (vii) Provide examinations, measurement, and tests of materials or elements of the Work for each Work operation, where appropriate, to ensure quality, and is not limited to that required for acceptance or assurance testing purposes. If the Contract Documents specify mandatory inspection hold points that require witnessing, inspecting, or acceptance by

- DB Entity or MBTA, indicate the specific hold points on the appropriate documents;
- (viii) Demonstrate that all materials, equipment, and elements of the Work will perform satisfactorily for the intended purpose and complies with the standards specified in the Contract Documents, including the Final Design Documents;
 - (ix) Provide documentation confirming all manufacturer's recommended quality testing procedures, and any other specified quality testing procedures have been satisfactorily completed. Resolve disagreements that may arise in the QA sampling and testing process. If the recommended disagreement resolution system involves use of an independent testing laboratory, include the name of a recommended independent testing laboratory. The independent testing laboratory is not a participant in the Quality Management Plan for either DB Entity or MBTA.
- (c) Training
- (i) Provide training for QA/QC personnel performing activities affecting or measuring quality of the Work, and demonstrate that the TCQMP is understood and followed by DB Entity's testing and commissioning personnel;
 - (ii) Confirm all personnel performing testing and commissioning Work are familiar with all requirements of the QMP and Contract Documents pertaining to their responsibilities; and
 - (iii) Provide for the effectiveness of the control of quality by DB Entity's own forces and Subcontractors at intervals consistent with the importance, complexity, and quantity of the product or services.
- (d) Roles and Responsibilities
- (i) Specify the personnel assigned for design review, procedures for documenting reviews and concurrence from MBTA and for obtaining corrective action, when necessary; and
 - (ii) Cooperate and coordinate inspection and testing by Governmental Entities and Utility Owners.
- (e) Changes
- (i) Control the issuance of and changes to RFC packages and Construction Documents;

Provide confirmation the item being commissioned was constructed/fabricated in accordance with latest revision of RFC packages and Construction Documents, including all authorized changes thereto. Provide procedure for addressing non-conforming items found during commissioning: including procedures for identification, documentation, segregation, disposition, and notification to MBTA and all other affected Persons, as well as procedures for MBTA to review non-conforming work and accept, reject, or require repair and/or reworking of Nonconforming

2.5.5 Deliverables

Table 2-5 reflects a nonexclusive list of deliverables identified in Section 2.5 of these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic

format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.5, unless otherwise specified in the Contract Documents:

Table 2-5: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Quality Management Plan	2	1	Within 30 Days after issuance of NTP	2.5.1
QMP Updates/Revisions	2	1	14 Days prior to implementing the proposed changes	2.5

2.6 Safety Management

Subject to provisions of Volume 1 Section 13.2, DB Entity shall have sole responsibility for safety and security on the Project until Contract Final Acceptance of the Project. All DB Entity employees and Subcontractors (including fabricators) shall comply with the Safety Management Plan, applicable Laws, and associated elements of DB Entity's injury and illness prevention program. The DB Entity shall designate a full time, on site Safety and Security Manager who will be responsible to oversee all elements of the DB Entity Safety Management Plan.

The DB Entity shall have one or more full-time (all working hours/one each shift) on-site experienced Safety Supervisor(s), as well as appropriate Safety Representatives, whose sole responsibility is safety management at the site or otherwise relating to the Work. The DB Entity shall submit, within 30 Days after receipt of Notice to Proceed, to the MBTA a detailed site-specific Safety Program, including the name, experience, and qualifications of the DB Entity's Safety and Security Manager and full-time, on site Safety Supervisor(s) and alternates. If the DB Entity designates more than one Safety Supervisor for a shift, then DB Entity shall designate a Project Safety Manager (minimum Class III, as described below) who is the single responsible party for all shift-based Safety Supervisor(s). For those instances when the Safety Supervisor is unavailable because of vacation, sick leave, and short term shift work not exceeding two weeks, the DB Entity shall assign a full time MBTA accepted alternate Safety Supervisor. All safety Submittals shall be accepted by the MBTA prior to the start of construction. No work at the Site shall begin until the MBTA has reviewed and accepted the DB Entity's Safety Management Plan. Implementation and enforcement of the Safety Program for the forces of the DB Entity and all Subcontractors shall be the responsibility of the DB Entity.

Each of the DB Entity's full-time Project Safety Supervisor(s) shall have a thorough knowledge of construction safety and OSHA regulations. If, in the opinion of the MBTA, the DB Entity's Safety Representative is not effective in carrying out the assigned duties as described herein, the MBTA may require the DB Entity to replace the Safety Representative.

DB Entity's Safety Supervisors/Representatives and alternate shall be classified into one of the levels below based on their qualifications and extent of their construction safety supervisory experience and capabilities. All Work requires a Project Safety and Security Manager and Class III Full-time Safety Supervisor unless otherwise specified in the Contract Documents. The qualifications of all safety alternates shall be subject to acceptance by the MBTA Safety Department and shall satisfy, at a minimum, Class I qualifications. Qualifications for each classification shall include, at minimum:

Class I

Basic safety and health training (minimum requirement: successful completion of OSHA 10 hour Construction Safety and Health training course):

- (a) Two years of experience as a construction safety supervisor where safety was 100% of the position responsibility;
- (b) Working knowledge of safety regulations and hazard control measures;
- (c) Demonstrated ability to conduct safety training;
- (d) Working knowledge of safety specific contract hazardous work procedures; and
- (e) Physically able to perform the job.

Class II

Five years of experience as a construction safety supervisor, three of which include full-time on-site construction safety experience (minimum requirement: successful completion of OSHA 30-hour Construction Safety and Health training course):

- (a) Specialized safety training relevant to the Project;
- (b) Demonstrated ability in creating a safe work environment;
- (c) Working knowledge of safety regulations and hazard control measures;
- (d) Demonstrated ability to conduct safety training;
- (e) Working knowledge of safety specific contract hazardous work procedures; and
- (f) Physically able to perform the job.

Class III

Seven years of experience as a construction safety supervisor, five of which include full-time on-site construction safety experience (minimum requirement: successful completion OSHA 30 hour Construction Safety and Health or OSHA's Instructor # 500 Training course):

- (a) Specialized safety training relevant to the Project;
- (b) Demonstrated ability in creating a safe work environment in accordance with OSHA and Good Industry Practice;
- (c) Working knowledge of safety regulations and hazard control measures; and
- (d) Demonstrated ability to conduct safety training;
- (e) Working knowledge of safety specific contract hazardous work procedures; and
- (f) Physically able to perform the job.

The duties of the Safety Supervisor shall include maintenance of the DB Entity's Safety Program, enforcement of safe practices, and the use of safety equipment and personal protective equipment, and other such activities as may be required by OSHA and the MBTA to maintain job safety and accident prevention. The Safety Supervisor shall be assigned full-time to the Project. The Safety Supervisor's sole responsibility for the Project shall be to carry out on-site safety management duties required under the

Contract Documents and specifically under the Safety Program. The Safety Supervisor shall not perform work that will interfere with or compromise his/her ability to focus on these duties. The Safety Supervisor shall not be replaced, terminated, or reassigned without the written acceptance of the MBTA. A minimum two-week transition period shall occur prior to the Safety Supervisor's replacement or reassignment to allow for the transition of the Safety Supervisors work, responsibilities and assignments to his/her replacement. All unforeseeable vacancies in these positions shall be filled within two weeks of the vacancy occurring.

2.6.1 Safety Management Plan

DB Entity shall develop, implement, and maintain a comprehensive written Safety Management Plan that describes the processes to be followed and is consistent with applicable Laws.

The Safety Management Plan shall be Project-specific, and shall include Work to be performed by Subcontractors. The DB Entity's Safety Management Plan shall be in accordance with, and shall not be in conflict with, the MBTA standard documents included in Exhibit 2H, including but not limited to MBTA's Accident Investigation Manual, MBTA Safety Plan for Light and Heavy Rail, Crane Memo, and MBTA Safety Certification Program. DB Entity shall follow and implement specifications in Section 01550 in Exhibit 2I.

At a minimum, DB Entity's Safety Management Plan shall:

- (a) Be consistent with the Project insurance requirements;
- (b) Be consistent with Railroad safety requirements;
- (c) Clearly establish the safety organization described in Section 2.6.1.1 ;
- (d) Describe the process of conducting safety orientation for all employees, including MBTA oversight employees;
- (e) Describe DB Entity's alcohol and drug free workplace policy (in accordance with recently updated FRA guidance in 49CFR219);
- (f) Describe employee training requirements;
- (g) Describe safety inspection procedures;
- (h) Describe procedures and policies for working in active traffic locations;
- (i) Describe incident reporting procedures including near-miss incidents (refer to 2.6.1.8), including DB Entity accident investigation procedure (in accordance with MBTA Accident Investigation procedures) and Submittal of a monthly report detailing incident and accident statistics;
- (j) Describe DB Entity's hazard communication program;
- (k) Describe DB Entity's management and auditing of the Safety Management Plan;
- (l) Describe PPE requirements and policy;
- (m) Describe Site access and Site security;
- (n) Describe safety procedures for DB Entity's employees working around and handling contaminated materials; and
- (o) Describe safety certification procedures to ensure how each safety critical sub-system and the Project as a whole will be safety certified in accordance with the MBTA's Safety Certification

Program.

DB Entity shall submit the Safety Management Plan for review and acceptance to MBTA within 30 Days after NTP. The Safety Management Plan shall be incorporated into the PMP as set forth in Section 2.3.

2.6.1.1 Safety Organization

The Safety Management Plan shall clearly establish the specific chain of command and specify the lines of authority, responsibility, and communication with regard to safety compliance activities. The Safety Management Plan shall identify a full-time dedicated Safety Manager and safety professionals or managers covering all production shifts. The Safety Management Plan shall delineate administrative responsibilities for implementing the Safety Program. The Safety Management Plan shall describe the process of including representatives from DB Entity and all Subcontractors, as well as MBTA personnel working on the Project. The Safety Management Plan shall specify which on-Site personnel have the authority to stop on-Site activities when unanticipated and/or uncontrolled hazards are recognized and also specify those personnel with the authority to restart Site activities after the hazards have been controlled. DB Entity's Project Manager shall be held accountable for health and safety performance. The Safety Management Plan shall specifically define the safety responsibilities of each level of supervision.

2.6.1.2 Process of Employee Safety Orientation

The Safety Management Plan shall describe the safety orientation process including the following:

- (a) The extent and nature of the Project;
- (b) Any hazards that can typically be expected during the course of work that is specific to the job assignment;
- (c) Required work practices, job conduct, and injury-reporting procedures;
- (d) Acquaint the employee with special work and safety requirements at the Site;
- (e) Documentation of training, including attendance files and documentation (such as hard hat stickers) for employees to have on their body;
- (f) Develop two tiers of orientation – one for all employees (including MBTA staff and consultants) who will be on Site regularly, and one for employees who will only visit the Site occasionally; and
- (g) Ensure that all people accessing the Site go through an orientation unless otherwise approved by the DB Entity's Safety Manager;

2.6.1.3 Employee Training Requirements

In addition to the statutory OSHA training required by MGL Chapter 30, Section 39S, the DB Entity shall establish a safety training program that includes requirements for general and Project-specific training. All levels of staff shall be trained.

DB Entity shall conduct, at a minimum, weekly safety meetings that are relevant to the specific types of work at the Project Site, which comply with applicable Laws. DB Entity shall prepare documentation of meeting content and employee attendance.

2.6.1.4 Personal Protective Equipment Requirements and Policy

The Safety Management Plan shall define specific PPE requirements for all employees for each task. At a minimum, DB Entity shall provide a consistent type of high-visibility safety vest to be worn by all personnel, as well as an ANSI-accepted hard hat, safety glasses with side shields, and sturdy work boots, specific for the job being performed.

DB Entity shall ensure that all vendors and visitors wear hard hats, as well as other required PPE while on the Site. DB Entity shall ensure that anyone not complying with these requirements will not be allowed to enter the Site or will be required to leave the Site. DB Entity shall document all such incidents. DB Entity's job hazard analysis shall include all required PPE for the specific task.

2.6.1.5 Alcohol and Drug Free Workplace Policy

DB Entity shall provide policy for promoting a safe, alcohol and drug free workplace. The policy shall be consistent, fair, manageable, and subject to audit. The policy shall be in accordance with FRA guidance in 49CFR219. The policy shall provide the immediate removal for disciplinary action or termination and restriction on return for an employee reporting for work under the influence of alcohol or a prohibited substance or possession of a prohibited substance. The policy shall require drug testing to satisfy Project insurance requirements, including post-incident drug testing.

2.6.1.6 Safety Inspection Procedures

The Safety Management Plan shall describe safety inspection procedures of work areas, materials, and equipment to ensure compliance with the Safety Program. DB Entity shall schedule, conduct, and document safety inspections in all work areas to identify and reduce physical and/or environmental hazards that could contribute to injuries or illnesses.

2.6.1.7 Emergency Procedures

The DB Entity shall develop an emergency action plan for the Project that specifies the procedures for each identified potential emergency, notification requirements, and training, and identify those individuals responsible for implementing the plan if the plan is activated. The potential for an emergency exists at all construction areas and operational areas. The emergency action plan shall identify the various response activities necessary to minimize the dangers and confusion associated with an emergency. The emergency action plan shall address, at a minimum, fire, explosions, hazardous materials, natural disasters, and civil disruptions.

2.6.1.8 Incident Response Procedures

The Safety Management Plan shall include processes to investigate and report accidents and incidents and to retain safety records. DB Entity shall develop a list of Project-specific requirements for documentation and reporting. DB Entity shall include the reporting of near-miss incidents. DB Entity shall provide verbal notification and a written report to MBTA of all incidents arising out of or in connection with the performance of the Work, whether on or adjacent to the Site, which cause death, personal injury, or property damage. DB Entity shall verbally notify MBTA within one hour from time of occurrence of an event (or DB Entity's discovery of the occurrence thereof), and include date and time, location, brief description, extent of property damage, and extent of injuries. When such incidents take place, DB Entity shall promptly initiate an investigation and notify appropriate individuals, including MBTA. DB Entity shall coordinate all accident investigations with the MBTA pursuant to Safety Directive Advisory 15-001 and

2015-02 Volume 25 MBTA D-C Bulletin provided in Exhibit 2H. The DB Entity's accident investigation procedure shall accommodate any processes and procedures contained within the MBTA Accident Investigation Manual.

DB Entity shall maintain a 24-hour-per-day, seven-day-per-week emergency contact telephone number with a responsible person in charge, empowered to take any necessary actions on behalf of DB Entity.

2.6.1.9 Job Hazard Analysis and Communications

DB Entity shall provide policy and procedures for job hazard analysis and how that analysis will be communicated to foremen and workers as the day's Work and tasks are outlined. All employees involved with the task shall discuss the hazards anticipated, equipment needed to work safely, and PPE to be provided and worn. The communications may include on-Site gatherings where the task is to be performed. DB Entity shall give employees an opportunity to provide input regarding task steps, hazards identified, and appropriate control measures. DB Entity shall document all job hazard analysis training.

2.6.1.10 Materials Safety Procedures and Communication Policy

The Safety Management Plan shall describe safety procedures and communication policy for DB Entity's employees working around and handling hazardous materials.

Employees shall be provided information and training regarding any hazardous materials to which they may be exposed. Additionally, no hazardous materials will be delivered, stored, or used at the Site or at any other location unless they are properly labeled, tagged, or marked and the Safety Data Sheets are readily available.

2.6.1.11 Managing and Auditing of Safety Management

The Safety Management Plan shall describe the audit process for safety management. The Safety Management Plan shall describe frequency and scope of audit, how it is to be conducted, how the results are to be communicated, and how findings and corrective actions are to be tracked.

2.6.2 Periodic Updates to Safety Management Plan

DB Entity shall update the Safety Management Plan at least yearly to incorporate corrective action recommendations and other clarifications. In addition, the DB Entity shall update the Safety Management Plan as appropriate based on changes at the Site and to ensure the Safety Management Plan complies with Laws and MBTA regulations, policies and procedures.

2.6.3 Safety Performance Analysis

DB Entity shall complete a detailed analysis of safety performance each quarter. DB Entity shall conduct the safety performance analysis to document that DB Entity and its Subcontractors are performing work in a safe way and in compliance with the Safety Management Plan and applicable Laws. The analysis shall define and measure specific proactive program elements designed to prevent incidents, such as employee training and orientations, toolbox meetings, audits and inspections. DB Entity shall document the measures to verify proactive efforts relative to safety performance results. DB Entity shall submit a safety performance analysis report to MBTA each quarter by the 15th of the month after the quarter ends.

If the safety performance analysis reveals an error or deficiency, DB Entity shall take immediate measures to correct the observed error and submit the corrective measure to MBTA for review and comment.

2.6.3.1 Other Safety Requirements

DB Entity shall prepare a monthly safety report detailing the specific types of injuries, incident rates, and corrective actions taken to prevent reoccurrence of similar incidents for DB Entity and all Subcontractors. DB Entity shall evaluate individual supervisor safety performance. DB Entity shall submit the monthly safety report to MBTA within seven (7) Days after the end of the month.

In addition, the DB Entity shall submit annually to the MBTA all Illness/Injury Reports for the duration of the Project.

The DB Entity's Safety Supervisor shall:

- (a) Complete daily safety inspections of the Site and contiguous public areas, and take any corrective actions to eliminate unsafe conditions;
- (b) Establish and implement a Project safety training program for supervisors and employees as applicable to their job;
- (c) Attend Project safety meetings;
- (d) Review foreman accident and investigation reports, and initiate corrective action to prevent reoccurrence;
- (e) Maintain copies of all DB Entity monthly safety reports;
- (f) Assist foremen in accident investigations;
- (g) Encourage establishment of incentive programs designed to recognize individual employee safety efforts and contributions towards improved safety;
- (h) Prepare a "Safety Audit Checklist" and complete the checklist each week during the course of construction. The completed Safety Audit Checklists shall be submitted to the MBTA weekly; and
- (i) The Safety Supervisor needs to be on the Site when Work is being performed. During periods when the DB Entity is not performing Work, the Safety Supervisor can be absent from the Project site with permission from the MBTA.

1. Accident Investigation - Serious accidents, as defined by the DB Safety Manager in concert with the MBTA, shall be reported immediately to the MBTA and MBTA Safety. DB Entity shall issue standing orders to all supervisors directly in charge of operations that the scene of the accident shall not be disturbed, except for rescue or other emergency measures, until otherwise directed. DB Entity's forces either witnessing or party to the accident shall be detained at the site to provide detailed accounting of facts.

All reports shall be submitted timely to the MBTA. The accident investigation shall generate appropriate recommendations for corrective actions to prevent occurrence of similar accidents.

2. First Aid Facilities - In formulating the Safety Management Plan, the DB Entity shall provide for the establishment and staffing of appropriate first aid facilities for the

- treatment of injuries. Off-site medical treatment of employee injuries shall be performed at medical facilities named in the DB Entity's Safety Management Plan.
3. Emergency Telephone Numbers - To ensure that emergency actions are promptly taken, DB Entity shall post emergency telephone numbers in conspicuous places.
 4. Orientation Program - The DB Entity shall establish and maintain an orientation program for new employees which shall include:
 - a. For each individual, the hazards present in his/her assignment and in the general area in which he or she will be working.
 - b. Personal protective equipment required.
 - c. Instruction in the proper procedure for reporting unsafe job conditions which he/she may encounter.
 5. Right-of-Way (ROW) Safety Awareness - All DB Entity and Subcontractor personnel shall complete the MBTA Right-of-Way safety training and/or the Commuter Rail Roadway Worker Protection (RWP) training, as required, prior to entering the Site. RWP and ROW safety training will be required on all MBTA property including track, transit stations, parking garages and maintenance car houses. Personnel will not be allowed on the Site unless they have attended the required RWP and ROW safety training session. Workers are required to carry their certification cards while on Site.
 6. OSHA - The DB Entity shall comply with the OSHA 1926 Safety and Health Regulations for Construction. The DB Entity shall meet the reporting requirements, and employers with eleven (11) or more employees shall meet recordkeeping requirements. All DB Entity and Subcontractor personnel shall possess an OSHA 10 Hour Certification card when working on the Site.

All fatality cases and/or serious accidents and illness in accordance with OSHA guidelines shall be reported to MBTA immediately and to OSHA immediately by phone to an Occupational Safety and Health Area Office. Employers shall report immediately to both MBTA and OSHA all blasting accidents.

of the DB Entity and all Subcontractors shall comply with the OSHA requirements to post in a prominent location the "Safety and Health Protection on the Job" poster. The poster briefly states the intent and coverage of the Act. Failure to post this document is a citable offense under the Act.

Execution of the Work - The DB Entity shall take all reasonable precautions in the performance of the Work to protect the safety and health of its employees and members of the public.

The DB Entity Safety Supervisor is charged with sole responsibility of Site safety management under the direction of the DB Entity. All potential safety hazards identified shall be promptly corrected. The DB Entity Safety Supervisor shall complete daily inspections of the Site and document the results of the inspections.

The MBTA may elect to notify the DB Entity of any safety non-compliance and of the corrective action required. This notice, when delivered to the DB Entity or the DB Entity's representative at the Site, shall be deemed sufficient notice of the non-compliance. The DB Entity shall immediately take corrective action required after receiving the notice.

The DB Entity shall maintain an accurate record of exposure data on all accidents and incidents relating to the Project and report this data in a manner prescribed by the MBTA.

DB Entity management shall make a commitment for accident prevention and fire prevention.

7. Hazardous Substances - Any person for whom DB Entity is responsible for who uses substances on the hazardous substances list to which workers might be exposed under either normal work conditions or reasonable foreseeable emergency conditions shall be provided by DB Entity with the required hazardous substance information.
8. Personal Protective Equipment - All DB Entity personnel shall wear the required personal protective equipment when on the Site. Personal protective equipment includes hard hats, safety vest, safety glasses and proper footwear.
9. Protection of the Public - All necessary precautions to prevent injury to the public or damage to property of others shall be taken. The public is defined as all persons not employed by or under contract or subcontract to the MBTA. Installation of temporary barriers and/or fencing designated to protect the public shall be reviewed and accepted by the MBTA. Work shall not be performed in any area occupied by the public unless specifically permitted by the Contract Documents or in writing by the MBTA.
10. Substance Abuse/Prevention /Testing Program - The DB Entity shall establish a substance abuse policy and testing program that includes the following elements:
 - a. Deterrence
 - b. Treatment and Rehabilitation
 - c. Detection
 - d. Enforcement

The MBTA reserves the right to review and comment on the proposed substance abuse program.

Whenever any of the following conditions occur, the DB Entity personnel involved will be required to submit to a drug and alcohol screen:

- a. Any event on/or involving the Site, MBTA property or any personnel that results in a fatality.
- b. Any personal injury to an employee of the DB Entity, Subcontractor, or any member of the public which requires or should reasonably require medical attention.
- c. Any event causing significant or unusual property damage, as determined by an MBTA official.
- d. Any event which appears to involve a violation of DB Entity or MBTA rules which poses a safety threat to employees of the DB Entity or its Subcontractors or members of the public. The employees in these situations shall be tested unless at the time of the accident/incident the employee's performance can be completely discounted as a contributing factor to the accident/incident. The drug and alcohol screen should be completed immediately, but absent unusual circumstances, not more than eight hours after the accident/incident in question occurred.
- e. In the event of hospitalization and unless medically precluded, a drug and alcohol screen shall be ordered at the treatment facility if treatment is expected to exceed eight hours. This screen will

be identical to that utilized in probable cause.

1. Conduct of Tours – Group tours shall be cleared through the MBTA, allowing maximum advance notice. MBTA will coordinate the tour arrangements and ensure notification to the DB Entity.
2. Housekeeping – Storage areas and walkways on the site shall be maintained free of depressions, obstructions and debris, see Volume 1, Section 9.10.

2.6.4 Noncompliance with the Safety Program

MBTA personnel will have the right to require the DB Entity to stop any activity that such individual determines, in his or her sole discretion, constitutes or is perceived to present a threat of imminent danger. If any conditions or activities may present an imminent danger of serious injury, death, or significant property damage, DB Entity shall stop the affected portion of the Work immediately and shall not recommence until the practices or conditions are corrected to the satisfaction of MBTA. DB Entity shall discipline and/or dismiss employees who violate established safety rules and regulations. This includes immediate termination for serious violations, repeated violations, or the refusal to follow health and safety rules.

MBTA intends to develop a safety oversight program for the Project, pursuant to which MBTA will monitor and evaluate DB Entity's performance in implementing the Safety Management Plan. The purpose of such safety oversight program is to assist in communicating MBTA's independent assessment of such performance. As part of such safety oversight program, should DB Entity not be meeting MBTA's reasonable expectations in performing its Safety Management Plan, DB Entity shall prepare and submit a recovery plan to MBTA, articulating changes in personnel, processes, organization and/or amendments to the Safety Management Plan.

2.6.5 Audits/Inspections

MBTA reserves the right to perform audits and inspections to confirm that DB Entity is complying with health and safety rules and procedures. A qualified safety representative from MBTA will perform audits/inspections on a periodic basis.

2.6.6 Safety and Security Certification Plan

DB Entity shall develop a Safety and Security Certification Plan (SSCP) which shall detail how safety certifications of each sub-system and the Project as a whole will be achieved, in accordance with the requirements of Section 01569 in Exhibit 2I. The DB Entity's SSCP shall be in compliance with, and not in conflict with, the MBTA safety documents included in Exhibit 2H. The DB Entity shall note that the MBTA Safety Certification Program included in Exhibit 2H is designed for a typical design-bid-build project; the DB Entity shall tailor it for the Project. The DB Entity shall write its SSCP such that the DB Entity is responsible for activities assigned to both the Design Consultant and the Contractor in the MBTA SSCP, including development of any Preliminary Hazard Analysis, Threat and Vulnerability Assessment, and Certifiable Items List. The SSCP shall describe what process will be followed during the entire Project duration to identify, track, and maintain these certifications. DB Entity shall submit the SSCP for review and comment by MBTA within 28 Days after issuance of NTP. See Exhibit 2I for additional requirements.

2.6.7 Deliverables

Table 2-6 reflects a nonexclusive list of deliverables identified in these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.5, unless otherwise specified in the Contract Documents:

Table 2-6: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Safety Management Plan	2	1	Within 30 Days after issuance of NTP	2.6.1
Safety Performance Analysis	2	1	Each quarter by the 15th of the month after the quarter ends	2.6.3
Monthly Safety Report	2	1	Within seven Days after the end of the month	2.6.3.1
Safety Incident Report	2	1	Upon Occurrence of an incident	2.6.1.8
Safety and Security Certification Plan	2	1	Within 28 Days after issuance of NTP	2.6.6

2.7 Design Submittal Management

2.7.1 General

DB Entity shall prepare all Design Documents by or under the supervision of a Professional Engineer registered in the Commonwealth of Massachusetts. All Release for Construction (RFC) packages, Final Design Documents, and Record Drawings shall be sealed, signed, and dated by the Engineer of Record.

DB Entity shall provide Submittal packages via the Project document management system in accordance with the Contract Documents and the PMP for any Submittal package along with all supporting information necessary for MBTA, Governmental Entities, Utility Owners and other appropriate third parties to conduct a review and to ensure that the design is progressing appropriately. In general, Submittal packages include the following:

- (a) Administrative documents (PMP, other plans);
- (b) Design Documents; and
- (c) Construction Documents.

The DB Entity shall prepare and deliver to the MBTA a Requirements Management Plan. The purpose of this plan is to demonstrate to the MBTA that the DB Entity is aware of and is compliant with all of the requirements of the Contract Documents. The Requirements Management Plan shall include the following:

- (a) DB Entity shall prepare and submit a formal protocol for requirements management that identifies, captures, documents, traces, manages, verifies and validates compliance with the RFP, (the "Requirements Management Plan").

- (b) The Requirements Management Plan shall include a tool to record and keep current all data and tracking fields required to identify, capture, document, trace, manage, verify and validate compliance required in the Technical Provisions.
- (c) The DB Entity shall maintain and keep current all Requirements Management data.
- (d) The Final Design(s) for each Package shall include evidence of traceability between the content of the Final Design and all applicable Project Requirements.

Throughout the Term, DB Entity shall implement and comply, and ensure that all DB Entity personnel comply, with the Requirements Management Plan, and any amendments or updates, which have been accepted by the MBTA. Prior to implementation of any amendments or updates to the Requirements Management Plan, DB Entity shall submit the proposed amendments or updates to the MBTA for review and comment. The DB Entity shall continue to maintain the Requirements Management Plan throughout the term of the Project and shall submit a copy in redline/strikeout format, to enable the MBTA to readily identify any changes made since the previous Submittal.

The Requirements Management Plan shall be submitted to the MBTA within 120 Days after NTP or completion of its first design package, whichever is sooner. The DB Entity shall identify whether design and construction are compliant, partially compliant or non-compliant against each requirement.

The DB Entity and the MBTA shall then review every requirement that is not compliant or partially non-compliant. If the MBTA agrees in its sole discretion, to change any requirements as a result of that review, the change will be issued by the MBTA via Change Order. The DB Entity shall update the requirements as necessary to conform the Requirements Management Plan to any such Change Orders. All items identified in the Requirements Management Plan shall be reconciled to the satisfaction of the MBTA prior to construction of the impacted items of Work.

2.7.2 Early Start of Construction Process (ESCP)

In order for the DB Entity to adequately prepare for construction Work that is within the first construction season in 2018, the MBTA will support a streamlined process that is applicable to only specific design Submittals that are critical to the 2018 construction season. The requirements of this ESCP are applicable only to those Submittals that are for pre-determined elements (e.g. retaining wall footings), items (e.g. rebar for retaining walls), critical operations (e.g. utility investigation) or critical segments (e.g. specific drainage runs). Refer to [Section 2.7.4.5](#) for further details.

The ESC Submittal process will involve two specific categories of Early Release Packages (ERP) design Submittals as follows:

- (a) Early Release for Fabrication (ERF)
- (b) Early Release for Construction (ERC)

In addition to being limited to only 2018 construction operations, this ESCP is limited to maximum of twelve (12) Early Release Packages. Additional ERP submissions will not be allowed without MBTA advance acceptance and at its sole discretion.

The DB Entity shall not commence early fabrication or early construction until the MBTA ESCP review is complete and MBTA concurs in writing with the DB Entity's QC Manager's certification statement approving the early fabrication or early construction operation. MBTA's concurrence will not constitute

approval or acceptance of the design or subsequent construction, nor relieve the DB Entity of its responsibility to meet the requirements hereof. Prior to the completion of the entire design (submissions), the DB Entity shall bear the responsibility to assure that all Work within this ESCP conforms to the Contract Documents. Any accepted elements or materials procured under the ESCP shall have actual dimensions and unique fabrication information incorporated into all subsequent design and construction Submittals.

As part of each Early Release for Fabrication (ERF), Early Release for Construction (ERC), or Preliminary Design Submittal, the DB Entity shall complete and submit where necessary, an updated survey of the existing conditions for the applicable design package locations. This updated survey component of the Submittal shall clearly identify any survey data variations such as altered physical conditions that the DB Entity notes will require a change as part of the design or the construction of those applicable design package locations.

2.7.3 Design Submittal Schedule

An indicative design Submittal breakdown for development by the DB Entity is included in Exhibit 2J, and includes potential ERPs. Proposed revisions and changes to this indicative breakdown shall be submitted to the MBTA for review and comment within 15 Days after NTP. The DB Entity shall prepare a design Submittal schedule that lists all the design Submittal packages, including potential ERPs, which the DB Entity intends to submit to the MBTA at each submission stage. The schedule of Submittals will enable the MBTA to plan reviews. The DB Entity shall submit the design Submittal schedule for review and comments by MBTA within 30 Days after NTP.

DB Entity shall coordinate and prioritize the schedule of design Submittals with the MBTA so that the MBTA can adequately resource and complete reviews within the timeframe specified in Section 2.7. The design Submittal schedule shall be discussed at the Progress Meetings. Amendments to the design Submittal schedule shall be submitted in writing to MBTA for review and acceptance.

2.7.4 Design Submittals

Except as otherwise specified in the Contract Documents or accepted by the MBTA, DB Entity shall develop Design Documents Submittals following the steps described in this Section 2.7. The Project primary design Submittal package stages are:

- (a) Phase I: Preliminary;
- (b) Phase II: Intermediate;
- (c) Phase III: Pre-Release for Construction;
- (d) Phase IV: Release for Construction

Notwithstanding the above stages, the DB Entity may request to eliminate a Phase I or Phase II design package as reflected by DB Entity's proposed Design Submittal Schedule at DB Entity's sole risk. MBTA reserves the right to reject such request at its sole discretion.

In the case of ERPs for the 2018 construction season, the design Submittal process will be streamlined as described in Section 2.7.4.5

DB Entity shall coordinate with other Governmental Entities, Utility Owners and Railroads to determine those entities' Submittal requirements and make appropriate Submittals to the MBTA, providing concurrent copies of any such Submittals and respective correspondence to MBTA. DB Entity shall immediately inform MBTA in writing of any additional Governmental Entity's requirements that might become a cause for scope or schedule impacts in accordance with Volume 1 [Section 6.1](#).

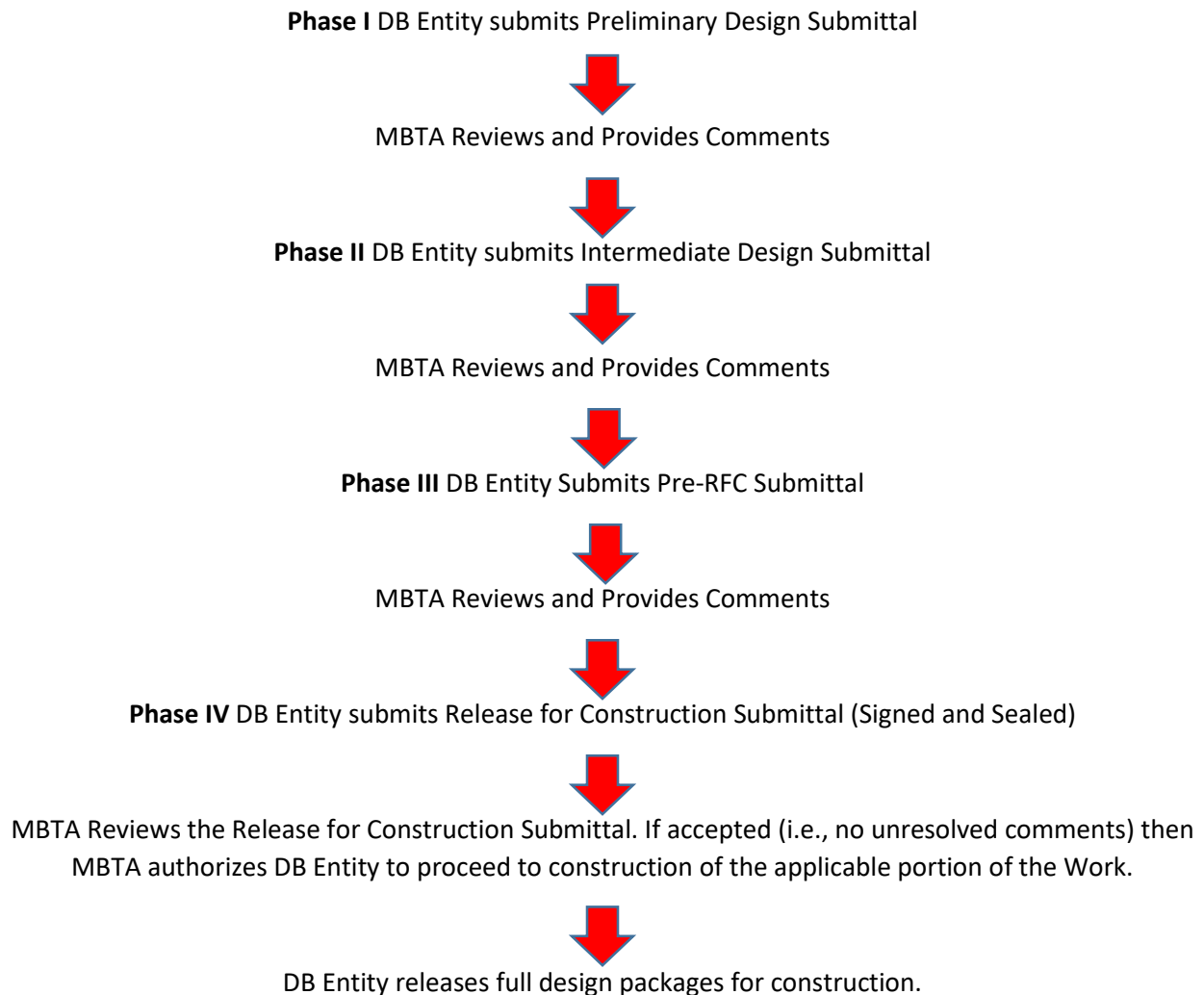
DB Entity shall prepare specifications in conformance with the MBTA Standard Construction Specification, Bidding and Contract Requirements. The DB Entity shall utilize the Mandatory Specifications ([Exhibit 2A.1](#)) and Base Specifications ([Exhibit 2A.2](#)), as modified consistent with the Contract Documents. These Technical Specifications shall represent the minimum standards. The DB Entity shall supplement these with Project specific information and its means and methods as applicable to the design and construction of the Work.

Each Submittal of specifications shall include redline pdf files and Microsoft Word files with tracked changes for MBTA's review and acceptance pursuant to [Exhibit 2A.2](#), so that the reviewer will be able to easily identify any changes. Design Submittals shall include specifications, as required, to understand the design alongside the specification intended for construction. Additional MBTA standards (within the Project Standards under [Exhibit 2H](#)) shall be used as applicable by the DB Entity for Submittals; these standards include, but are not limited to: Guidelines for Load Rating Transit Bridges, MBTA Railroad Operations Directorate Guidelines and MBTA Railroad Operations Book of Standard Plans.

Bridge Design shall be prepared in accordance with the MassDOT Bridge Manual. Temporary works that may impact public safety shall be submitted to the MBTA for review.

The Design Quality Management Plan shall be reviewed and accepted by the MBTA prior to the review of any design Submittals.

The Submittal process is illustrated below:



As part of the process the MBTA may request meetings, or require further information regarding any and all of submissions. The DB Entity will be required to attend such meetings and provide such information as required.

2.7.4.1 Phase I - Preliminary Design Stage

The purpose of the Preliminary Design Stage is to define requirements and solutions to be followed for detailed design. This design phase shall ensure that all RFP requirements have been identified and design solutions have been developed.

The contents for each design submission shall be included with the DB Entity's Packaging Strategy and agreed with by the MBTA in advance of submissions being made. The Preliminary Design Submittal shall include, as applicable:

- (a) Checklist identifying package content;
- (b) A Preliminary Design Report describing the content of the preliminary design, how the package

addresses the Technical Provisions and Standards, the functional capacity and life-cycle expected for each Project element, and a description of the work that will be performed to progress the design to the next level including any actions required by the MBTA;

- (c) A Requirements Exception Report identifying requirements relating to the particular package elements that cannot be met. This should be based on the Requirements Management Plan;
- (d) Preliminary geotechnical interpretive reports;
- (e) Preliminary Design Drawings that present the configuration of Project elements in sufficient detail to allow the MBTA to review the DB Entity's proposed design;
- (f) Identification of required permits with details of status and how these are to be tracked
- (g) Outline list of specifications indicating the Technical Specification sections that will be used to control the construction Work. This will include additional sections to be added above those included in the Contract Documents and a general description of information to be added to the contractual sections (See Exhibits 2A, 2H and 2I);
- (h) A Project Integration Plan describing the procedures and methods the DB Entity will employ to assure that the design of Project elements are fully integrated and interconnected to form a fully functional System that seamlessly connects to the Existing Green Line system. The Project Integration Plan shall be aligned with the quality deliverables of the Quality Management Plan;
- (i) A Configuration Management Plan to describe how the DB Entity will control changes to the accepted design. The Configuration Management Plan should be aligned with the quality deliverables of the QMP;
- (j) A Project-Specific-System Safety Program including a Hazards Analysis, Safety Certification, and Integrated Test Plans;
- (k) An Operations Study developed to verify that the DB Entity's design supports Green Line operations. The Study shall be developed with similar detail and format to the draft Green Line study provided in Exhibit 2H;
- (l) Safety Review in accordance with the Safety and Security Plan;
- (m) Evidence of any documentation required for and by Government Approvals with respect to preliminary design;
- (n) Preliminary Risk Register;
- (o) Environmental input as required by Volume 2, Section 3 Environmental Approvals and Mitigation;
- (p) Constructability Review including evidence of cross discipline coordination;
- (q) Documentation regarding any variations to the design criteria that the DB Entity intends to pursue;
- (r) Documentation regarding any concerns with the adequacy of the Project ROW; and
- (s) Updated survey.

2.7.4.2 Phase II - Intermediate Design Stage

Following the Preliminary Design Stage the DB Entity shall address comments raised by the MBTA and continue with the design. The intermediate Design Submittal shall be sufficient to show that design is proceeding in accordance with the RFP.

The contents for each design submission shall be included with the DB Entity's Packaging Strategy and agreed with the MBTA in advance of submissions being made. The Intermediate Design Submittal shall include, as applicable:

- (a) Checklist identifying package content;
- (b) An Intermediate Design Basis Report that describes the design basis, summarizes the design features, describes the content of the design plans and how that content will be used in the next design stage, and specific identification and explanation of any changes made to the design previously submitted. The Report shall also provide a description of the work to be performed to advance the design to the next stage including any actions required by the MBTA;
- (c) Identification of required permits with details of status and how these are to be tracked;
- (d) An updated Requirements Exception Report;
- (e) Updated Engineering drawings sufficient to convey the Intermediate Design Stage;
- (f) Written response to previous comments to the Preliminary Design Submittal demonstrating that comments have been addressed in this Submittal;
- (g) NFPA 130 Fire Life Safety – evidence of a fire life safety report and a partially completed NFPA 130 compliance matrix;
- (h) Evidence of any documentation required for and by Government Approvals with respect to intermediate design;
- (i) Draft Project Specific Specifications that accurately define the methods and products to be used by the DB Entity to complete the Work and are built on the contract specifications;
- (j) A Construction Sequencing Plan that describes the stages and phases in which the Work will be built and commissioned. The construction phasing shall be logically tied to design packages; and
- (k) Design certification, if applicable;
- (l) Update documents from previous Submittal stage as applicable;
- (m) Update Safety Review;
- (n) Updated Risk Register;
- (o) Identify any Operations and Maintenance requirements as identified in Section 2.8.7.3;
- (p) Update on Environmental input as required by Volume 2, Section 3 Environmental Approvals and Mitigation;
- (q) Updated Constructability Review including evidence of cross discipline coordination;
- (r) Identification and correction of any errors, omissions, inconsistencies or other defects in any prescriptive requirements of the Mandatory Specifications;
- (s) Other information as required by the MBTA; and
- (t) Updated survey.

2.7.4.3 Phase III – Pre-Release for Construction Stage

Following the Intermediate Design Stage the DB Entity shall address comments raised by the MBTA and finalize the design. The Pre-RFC Submittal shall be sufficient to show that the design has been completed and certified in accordance with the RFP.

Design submission contents for each design submission shall be included with the DB Entity's Packaging Strategy and agreed with the MBTA in advance of submissions being made. Design submissions made at the Pre-RFC Stage shall include all of the following:

- (a) Checklist identifying package content;
- (b) Final Design Basis Report (See Section 2.5);
- (c) Engineering drawings;
- (d) Identification of required permits with details of status and how these are to be tracked;
- (e) Updated Safety Review;
- (f) Updated Risk Register;
- (g) Update on any Operations and Maintenance requirements as identified in Section 2.8.7.3;
- (h) Update on any Environmental Issues as required by Volume 2, Section 3 Environmental Approvals and Mitigation;
- (i) Updated Constructability Review including evidence of cross discipline coordination;
- (j) Update documents from previous Submittal stage as applicable;
- (k) Specifications (See Exhibits 2A, 2H and 2I);
- (l) Calculations as applicable (to be agreed in advance with MBTA);
- (m) Final Requirements review identifying all requirements that pertain to the package being submitted;
- (n) Design certificates in accordance with Section 2.5;
- (o) Comments Log showing that comments from the previous design stage have been addressed; and
- (p) Other information as required by the MBTA.

2.7.4.4 Phase IV - Release for Construction

The DB Entity shall address comments arising from the Pre-RFC Submittal and prepare and submit its Release for Construction Submittal. The Release for Construction Submittal shall be signed and sealed by the DB Entity's Architect/Engineer of Record (by discipline) registered in the Commonwealth of Massachusetts.

The MBTA will review the Release for Construction Submittal to ensure comments made on the Pre-RFC Submittal have been addressed satisfactorily. Once this has been determined, and the requirements of Volume 1, Section 9.1 have also been met, the MBTA will authorize the DB Entity to proceed to construction.

The DB Entity shall also submit within 60 Days after MBTA's acceptance of a Release for Construction Submittal, for each Release for Construction Submittal, a Design Package Milestone Requirements List to the MBTA for review and acceptance. The Design Package Milestone Requirements List shall clearly list,

by narrative and/or marked up drawings, which portions of each Pre-RFC Submittal, when completed, are included in each of the Milestones. Certain Release for Construction Submittals may achieve only part of a Milestone or more than one Milestone. This list will be a living document, and shall be maintained and updated by the DB Entity during construction (and submitted to the MBTA upon request). With respect to any Milestone, DB Entity shall present the Design Package Milestone Requirements List for final MBTA acceptance no later than 30 Days prior to scheduled achievement of such Milestone, as reflected on the then-current Project Schedule. The Design Package Milestone Requirements List will establish the criteria for achieving the relevant Milestone.

Any design changes required after the Release for Construction Submittal will be submitted to the MBTA for review and acceptance and recorded by the DB Entity as required. DB Entity shall issue updates to the Release for Construction Submittals reflecting changes that have occurred on a quarterly basis.

2.7.4.5 Early Release Packages Submission Requirements

(a) Early Release for Construction (ERC):

All ERC Packages shall generally follow the process set out in Section 2.7.4. Preliminary Submissions will not be required for ERC Packages. Intermediate, Pre-RFC and RFC submissions shall generally follow the requirements set out in Section 2.7.4 and should be agreed in advance with the MBTA. All ERCs will need to have signed and sealed drawings prior to being released for construction.

(b) Early Release for Fabrication (ERF):

The ERF packages shall include (as applicable):

- (i) Shop drawings with stamp that clearly indicates it is intended for Early Release for Fabrication (only).
- (ii) Welding procedures
- (iii) Other fabrication procedures
- (iv) A fabrication schedule prepared by the fabricator and approved by the DB Entity
- (v) Special provisions that are relevant to the fabrication
- (vi) Fabricator's quality system manual (QSM)
- (vii) QC Plan(s) and checklist for the Work item(s)

At the time of submission of ERF packages, DB Entity shall identify the formal package that will contain the signed and sealed documentation that will be required prior to any package being released for construction.

The DB Entity will be required to maintain a log for all Early Release Packages and will be required to report the status of each of them in weekly Progress Meetings, on the four-week Look Ahead Schedule and in the Progress Schedule Update.

2.7.4.6 Submittal of Combined RFC Packages

DB Entity shall combine the Release for Construction Submittals (and any subsequent revisions) for the entire Project upon completion of all design Work into a Final Design Documents package. The purpose of the Final Design Documents package is to create a single package of the design for the entire Project

that was concurred with for MBTA record keeping purposes. DB Entity shall organize the Release for Construction Submittals for individual Work items, components, elements, or phases such that the Final Design Documents package is assembled in a manner similar to the standard construction documents typically provided to MBTA for conventional Project bidding, as mutually agreed upon by DB Entity and MBTA.

DB Entity shall submit the Final Design Documents package for review and comment by MBTA within 28 Days after the MBTA accepts the DB Entity’s final Release for Construction Submittal. DB Entity acknowledges that resubmittal of the Final Design Documents package or other design Submittals may be required by MBTA. DB Entity shall resubmit Final Design Documents package as many times as necessary to obtain MBTA acceptance of the Final Design Documents package. No additional compensation and/or time extension will be allowed for any Final Design Documents package resubmittal.

2.7.5 Submittal Format

Submittal packages shall have a unique alphanumeric identifier that remains with the package and identifies each Submittal stage (i.e., Preliminary Design, Intermediate Design, Pre-Release for Construction, Release for Construction, etc.). The alphanumeric identifier shall remain constant and track the design package through the life of the Project.

All Submittal documents shall be submitted in hardcopy and electronic submission through the PMIS as specified in Table 2-7A unless otherwise specified in the Contract Documents.

Table 2-7A: Submittal Format

Submittal Stage/Deliverable	Hardcopy			Electronic	
	Varies	11x17	22x34	Native	PDF
Administrative Documents (e.g. PMP, Project Schedule, etc.)	X			X	X
Preliminary Design		X			X
Intermediate Design		X			X
Pre - Release for Construction		X	X	X	X
Release for Construction		X	X	X	X
Shop and Working Drawings to be Reviewed by MBTA		X	X		X
Request for Information	X	X			X
Design Changes	X	X		X	X
Record Drawings			X	X	X
Other Governmental Entities, Utility Owners, and Railroad Submittals	X				X
Note: DB Entity shall determine the additional format requirements required by the applicable Governmental Entity, Utility Owner, and/or Railroad.					

2.7.5.1 CAD Requirements

All drawings, plans, and exhibits shall be prepared in accordance with the CAD Standards, provided in Exhibit 2H.

2.7.5.2 Hardcopy Format

All documents, reports, and calculations shall be prepared on 8.5" x 11" sheets, unless otherwise noted in the Contract Documents. Exhibits may be prepared on 8.5" x 11", 11" x 17", or 22" x 34" sized sheets.

2.7.5.3 Electronic Format

DB Entity shall submit, as identified in the Contract Documents, electronic Submittals compatible with the following program systems and/or software:

- (a) Microsoft Windows 7 (operating system);
- (b) Microsoft Office with Word, Excel, Outlook, and Media Player;
- (c) CAD in accordance with CAD Standards in Exhibit 2H;
- (d) HEC-RAS 4.1.0 (hydraulic software); and
- (e) Oracle Primavera Scheduling Software 6.

DB Entity shall submit electronic files to MBTA per the PMIS identified in the Contract Documents.

2.7.6 Design Review Process

Without limiting Volume 1, Section 9.3, MBTA's participation in Design Reviews will not relieve DB Entity of its responsibility for the satisfactory completion of all Work in accordance with the Contract Documents. MBTA maintains the right to refuse and reject any Submittal that does not comply with the Contract Documents, including QA/QC requirements. If any Submittal is rejected, the DB Entity shall notify all recipients to remove all copies from circulation. DB Entity shall redistribute the replacement Submittal to MBTA and other appropriate Governmental Entities. MBTA will provide review comments to DB Entity numbered in a manner corresponding to the drawing or report page in question. Space will be provided after each comment for a brief response by DB Entity. DB Entity is advised that comments on the Submittals received from parties other than MBTA may not follow the above-described MBTA comment format. In addition, DB Entity may receive separate comment packages from each party that reviews a Submittal. DB Entity shall compile all Submittal review comments on a comment resolution document in the form provided by the MBTA. The comment resolution form is a living document incorporating all comments and resulting resolutions for the Submittal package for the duration of the Submittal. DB Entity shall include previous Submittal comments, if applicable, and comment resolution form(s) with each subsequent Submittal identified with an alphanumeric tracking number corresponding to the package submission in accordance with Section 2.7.5.

DB Entity shall provide MBTA with written responses to all review comments within 14 Days of receipt of comments.

A Comment Resolution Meeting (CRM) shall be scheduled by the DB Entity or MBTA to address unresolved comments. DB Entity can request to waive a CRM if accepted by MBTA. The purpose of the CRM is to discuss DB Entity's responses and proposed disposition of review comments, determine which of the

review comments should be incorporated into the Work, and to discuss and resolve the outstanding comments. More than one CRM per Submittal may be necessary to discuss all review comments provided to DB Entity. DB Entity is responsible for attending the CRM and for preparation and Submittal of objective meeting minutes to MBTA within three Business Days of the CRM. The DB Entity's Project Manager, Design Manager, responsible engineer, and all DB Entity staff requested by MBTA shall attend the CRM. Review comments not resolved after the first complete CRM will be escalated to the CRM comment resolution board consisting of MBTA, Project Manager, and Design Manager. Review comments not resolved at the CRM comment resolution board shall be referred to the Senior Project Management group for resolution. Preliminary Design Submittal comment resolution that requires a change in the Submittal package can be addressed in the Intermediate Design Submittal. All Preliminary Design Submittal comments shall be addressed in the Intermediate Design Submittal prior to submitting the Pre-RFC Submittal. In addition, all Intermediate Design Submittal comments shall be addressed prior to submitting the Pre-RFC Submittal.

The Final Design Documents and RFC packages shall be concurred with by MBTA. Concurrence of the Final Design Documents and RFC packages does not relieve DB Entity of its responsibility for the satisfactory completion of the Work in accordance with the Contract Documents. DB Entity acknowledges that resubmittal of the Final Design Documents, RFC packages, or other design Submittals may be required by MBTA. DB Entity shall resubmit the Final Design Documents and RFC packages as many times as necessary to obtain concurrence of the Final Design Documents and RFC package. No additional compensation and/or time extension is allowed for any resubmittals.

The designs prepared by the DB Entity shall comply with FM Global requirements provided in [Exhibit 2I](#). Design progress Submittals shall be submitted to the MBTA for FM Global review and comments. FM Global Submittal review period is provided in Table 2-7B.

2.7.6.1 Early Release Packages Review process

(a) ERC

(i) Intermediate Stage:

DB Entity makes Submission. Within seven Business Days, MBTA issues review comments to the DB Entity. No later than five Business Days later, DB Entity shall arrange a workshop to discuss MBTA comments

(ii) Pre-RFC:

DB Entity addresses comments raised at the Intermediate Stage and issues the Pre-RFC submission. No later than five Business Days later MBTA issues comments to DB Entity.

(iii) RFC:

DB Entity addresses comments from the Pre-RFC Stage and submits signed and sealed drawings to MBTA. Within five Business Days, MBTA verifies whether all comments have been satisfactorily addressed. If all comments have been satisfactorily addressed, MBTA provides authorization for Release for Construction.

(b) ERF

The DB Entity shall make a submission for ERF based on the criteria identified above. Within seven Business Days, MBTA issues review comments to the DB Entity. No later than five Business Days later, DB Entity shall arrange a workshop to discuss MBTA comments. No later than five Business

Days after this workshop the DB Entity shall make a revised Submittal addressing comments raised by the MBTA. Within five Business Days, the MBTA will review the revised Submittal to ensure all comments have been satisfactorily addressed and confirm that that the package can proceed to fabrication. Incomplete submissions will require additional review time by the MBTA and will not be allowed as a justification for an excusable delay.

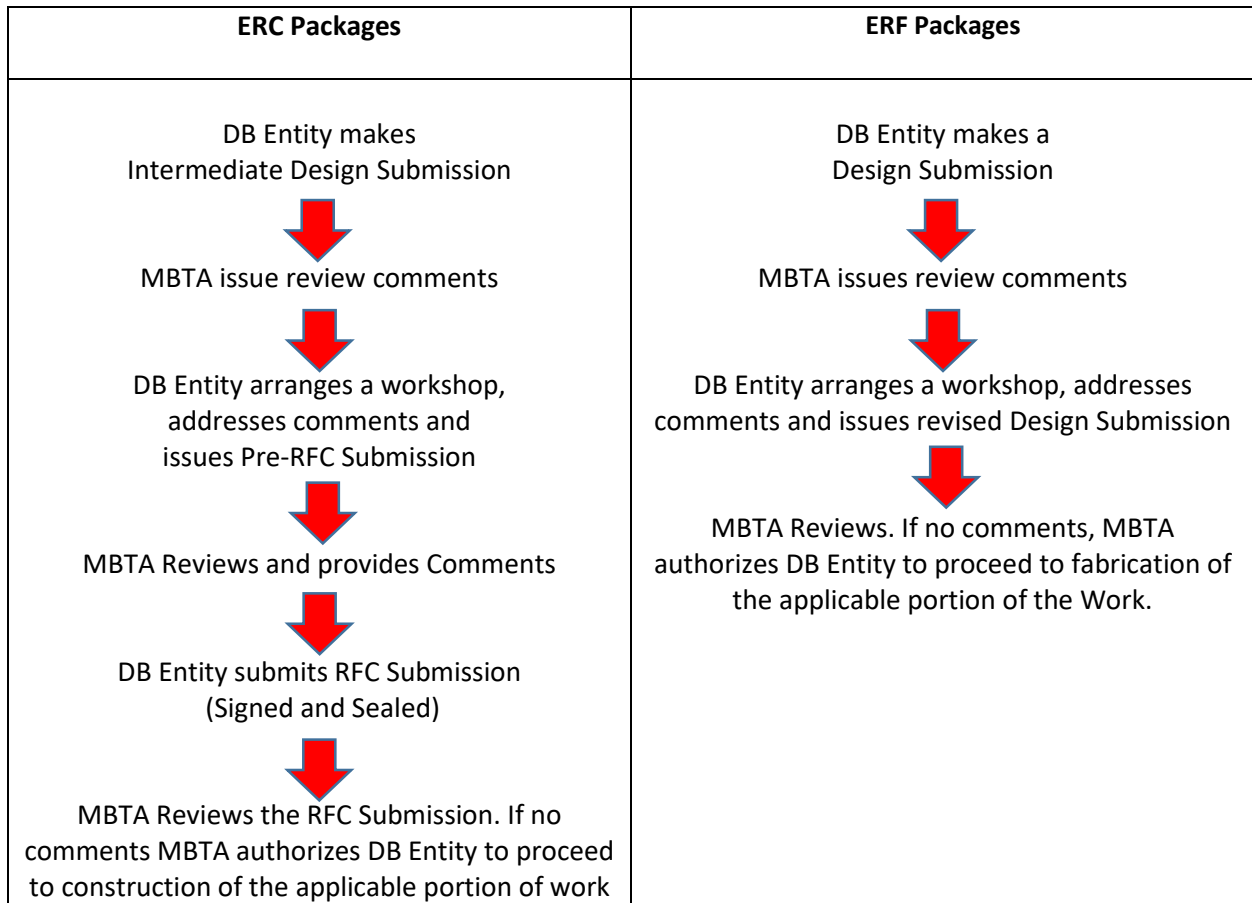
All ERF and ERC submissions that have a third-party reviewer involved will require an additional 30 Days beyond MBTA review for the reviews, as applicable. These review durations shall be incorporated into the Proposed Baseline Schedule submission and Design Submittal Schedule for each specific Submittal that the DB Entity elects to insert into this ESCP; and no ESCP submission is to be scheduled (within the Baseline) any sooner than 40 Days after NTP.

In order to receive MBTA concurrence of a proposed ERF or ERC submission, the DB Entity shall have completed the design for the applicable ESCP element, item, operation or segment and the DB Entity QC Manager shall certify that:

- (a) The design meets all applicable requirements;
- (b) The design has been checked in accordance with the DB Entity's accepted QMP;
- (c) Said item or segment is ready for fabrication or construction;
- (d) The DB Entity has incorporated/addressed all of the previous (applicable) comments from the MBTA; and
- (e) The DB Entity has obtained all required State, Local, Environmental and Utilities approvals and permits.

Following the MBTA concurrence of each ERF or EFC, the DB Entity shall provide a method to document the incorporation of the ESCP comments in subsequent design Submittal stages. The DB Entity shall annotate (redline) the design package to document MBTA comments given at the design review and have been identified in Section 2.7.4. The DB Entity shall incorporate the ESCP design review comments into its design and/or resolve any additional questions to the satisfaction of MBTA. The DB Entity shall address and/or incorporate any ESCP related comments from MBTA in its final design prior to MBTA's acceptance of the final design Submittals.

The ERP design Submittal process is illustrated below:



2.7.6.2 Over-the-Shoulder

MBTA may conduct “over-the-shoulder” reviews, which are examinations by the MBTA of Design Documents during the design process. The over-the-shoulder reviews may be conducted in either the DB Entity’s office (including its designer’s office) or at the MBTA’s offices, with the intent to minimize disruption of on-going design work. Formal assembly and Submittal of drawings or other documents may not be required. The review may be of progress prints, computer images, draft documents, working calculations, draft specifications or reports, or other Design Documents. If mutually agreed for specific review items, the over-the-shoulder review may consist of an exchange of electronic files between DB Entity’s and the MBTA. The DB Entity may request, subject to MBTA acceptance, an over-the-shoulder review of Design Documents.

MBTA shall have no obligation to conduct “over-the-shoulder” reviews.

2.7.6.3 Submittal Review Requirements

All Submittal packages as required by the Contract Documents shall be submitted to MBTA for review. DB Entity shall coordinate with other Governmental Entities and Utility Owners to determine those entities’ Submittal review requirements.

Submittals at all Submittal stages require the review period duration applicable for that category of Submittal as reflected in Table 2-7B below. Review times are applicable only for the submission of complete and comprehensive documents that are deemed acceptable by MBTA for review.

Table 2-7B: Submittal Requirements

Category	Submittal To	Maximum Review Period (Days)
Design		
A	MBTA (except as specifically covered in Category B) and Owner's Representative	21
B	MBTA (Commuter Rail Operations)	30
C	Third Parties, Governmental Entities, and Utility Owners.	45
D	FM Global	45
E	MassDOT	30
Construction		
F	Shop and Working Drawings	30
G	Request for Information	14
H	Design Changes	14
I	Record Drawings	14

2.7.7 Deliverables

Table 2-7C reflects a nonexclusive list of deliverables identified in [Section 2.7](#) of these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in [Section 2.7.5](#) of the Technical Provisions, unless otherwise specified in the Contract Documents:

Table 2-7C: Non-exclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Design Submittal schedule	2	1	Within 30 Days after issuance of NTP	2.7.1
Preliminary Design	2	1	Per accepted Design Submittal Schedule	2.7.1
Intermediate Design	2	1	Per accepted Design Submittal Schedule	2.7.1
Pre-Release for Construction	2	1	Per accepted Design Submittal Schedule	2.7.1.
Release for Construction	2	1	Within 28 Days after the final concurrence of Pre-Release for Construction Submittal by MBTA	2.7.1

2.8 Construction Requirements

2.8.1 Definitions

The following definitions shall apply to this [Section 2.8](#).

Shop Drawings: Original drawings, prepared by the DB Entity pursuant to the Work, including: calculations, working drawings, diagrams, illustrations, schedules, performance charts, catalog cuts, erection plans, falsework plans, framework plans, support of excavation (SOE) plans, bending diagrams for reinforcing steel, and other supplementary plans or similar data.

Working Drawings: DB Entity prepared plans for temporary structures and facilities, including: DB Entity's plans for decking, temporary bulkheads, support of utilities, and for such other work as may be required for construction but which do not become part of completed Project.

Miscellaneous Submittals: Those Submittals directly related to the Work (non-administrative) including quality assurance program, warranties, guarantees, maintenance agreements, maintenance of traffic plans, Project photographs, survey data and reports, physical work records, quality testing and certifying reports, record and record drawings and data, operating and maintenance manuals, security and protection lists (including keying) and other similar information and materials not defined as shop drawings, working drawings, product data, samples mockups or sample panels, or as specified herein. Mockups shall be prepared in accordance with Section 01420 in [Exhibit 2I](#).

2.8.2 General Procedures

Within 120 Days of receipt of Notice to Proceed, the DB Entity shall submit to MBTA, a comprehensive list and schedule of all construction Submittals required by the Contract Documents. Certain shop drawings and working drawings shall be submitted for MBTA review as specified in the Technical Provisions. The MBTA will review the DB Entity's comprehensive Submittal listing and note which Submittals require

MBTA review. The Submittal list shall also indicate those that are being accepted by the Engineer of Record, and are submitted to the MBTA for information only. Submittal lists shall also indicate which Submittals require the acceptance of other Governmental Entities. DB Entity shall submit schedules for submission of shop drawings, working drawings, mock-ups, sample panels, product literature and miscellaneous Submittals in that order of priority which reflects sequence of construction requirements, Project Schedule logistics, and includes review time by MBTA for these submissions. DB Entity shall show all Submittals on Progress Schedule Updates required by Section 2.4. Submittal schedules shall contain the following information as a minimum:

- (a) Submittal number, including revisions;
- (b) Specification section and paragraph reference;
- (c) Submittal title and description;
- (d) Date needed to support construction schedule;
- (e) Date sent to MBTA;
- (f) Date returned from MBTA; and
- (g) Comments. Included within this section will be references to any new RFIs issued as a result, reasons for delay and any other relevant information.

The DB Entity shall transmit Submittals sufficiently in advance of construction requirements to permit at least of 30 Days for review and appropriate action by the MBTA. The DB Entity shall submit all Submittals using the Project Management Information System. A transmittal form shall be attached to the Submittal package. The DB Entity shall prepare draft of required transmittal form and submit it to the MBTA for acceptance prior to use. At a minimum, the DB Entity shall furnish transmittal forms with assigned number and show contract number, Project name, date, names of Subcontractors, Suppliers, manufacturers, and required specification references, category and type of Submittal, purpose, planned application, description, distribution record (for both transmittals and Submittals) and signature of transmitter. The DB Entity shall:

- (a) Examine and check submission for accuracy, completeness, and compliance with the Contract Documents before delivery to the MBTA. The QA/QC revision process shall be used;
- (b) Stamp and sign a cover sheet for each Submittal with following statement: "Having checked this submission, we certify that it conforms to the requirements of the Contract Documents in all respects, except as otherwise indicated";
- (c) Review and approve each Submittal and represent that the DB Entity has determined and verified materials, field measurements and field construction criteria related thereto, and has checked and coordinated information contained within such Submittals with requirements of Work and Contract Documents;
- (d) Submit one construction material or set of related drawings per Submittal review;
- (e) Maintain at Site a complete up-to-date, organized file of all past and current Submittals including an index and locating system, which identifies the status of each submission;
- (f) Assign sequential numbers to each Submittal;
- (g) Cross-reference re-submissions to previous Submittals; and

- (h) Certify shop drawings, working drawings and calculations as submitted by a Professional Engineer registered in the Commonwealth of Massachusetts when required by individual Specification Sections. Convey, or be accompanied by, information sufficient to completely explain the structures, machines, or systems described and their intended manner of use. When professional certification is required by Laws or the Contract Documents, MBTA is entitled to rely upon accuracy and completeness of such calculations and certifications.

2.8.3 Review and Action

Without limiting the provisions of Volume 1, Section 9.3, MBTA's review of Submittals is not conducted for purpose of determining accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain responsibility of the DB Entity as required by the Contract Documents. The MBTA's review will not constitute the review of safety precautions, unless specifically stated by the MBTA, of any construction means, methods, techniques, sequences or procedures. The MBTA's review of a specific item does not indicate review of entire assembly of which the item is a component.

Time permitted for review of Submittals and resubmittals by the MBTA will be at least 30 Days for each Submittal, except as otherwise specified. All of DB Entity's Submittals will be stamped with one of following dispositions:

- (a) Accepted as Submitted;
- (b) Accepted with Comments;
- (c) Partial Acceptance, Revise and Resubmit;
- (d) Received for Record; or
- (e) Revise and Resubmit.

See Exhibit 1A for definitions and requirements for each Submittal disposition.

The DB Entity shall handle re-submissions in the same manner as initial Submittals. On re-submissions, DB Entity shall direct specific attention in writing to revisions other than the corrections on previous submissions. DB Entity shall make any correction required by the MBTA.

2.8.4 Shop and Working Drawings

The DB Entity shall submit a comprehensive list of shop drawings and working drawings to the MBTA. The MBTA will designate which shop drawings and/or working drawings it intends to review. Copies of working drawings and shop drawings the MBTA does not intend to review shall be furnished to the MBTA for record keeping only.

DB Entity shall prepare shop and working drawings for the Work as specifically set forth in the Contract Documents. Shop and working drawings Submittals shall include drawings, calculations, and certifications, describe the methods of construction proposed, and adequately define and control the Work. The Design Quality Manager (DQM) shall review and certify shop and working drawings in accordance with Section 2.5 of the Technical Provisions. DB Entity shall submit Engineer of Record accepted shop plans for record to MBTA within seven (7) Days of acceptance. MBTA reserves the right to review and comment on all shop and working drawings.

Shop drawings shall include calculations, fabrication details, bending schedules for reinforcing steel, location and details of construction joints in concrete, catalog cuts of equipment or fixtures, wiring or piping diagrams, data sheets and performance curves for electrical, mechanical, or other equipment and any other supplementary data required by the MBTA.

Detail drawings for cribs, support of excavation, falsework, shoring, decking, form work, and for other temporary work and methods of construction the DB Entity proposes to use, shall be made available at the request of the MBTA. Such drawings may be subject to review, but details of design will be left to the DB Entity who shall be responsible for the safety and successful construction of the Work. Drawings, the original design for which is the responsibility of the DB Entity, shall bear the seal of a Professional Engineer registered in the Commonwealth of Massachusetts.

Shop drawings shall show design, dimensions, connections, and other details necessary to ensure that the Contract Documents are accurately interpreted. Shop drawings shall show proper connections with adjoining Work in detail where adjoining work requires shop drawings.

Shop drawings shall establish the actual detail of all manufactured or fabricated items, indicate proper relation to adjoining Work, amplify design details of mechanical and electrical equipment in the physical spaces in any structure, and incorporate minor changes of design or construction details to suit actual conditions. Where separate sections or trades are involved, shop drawings shall be coordinated and where required by the MBTA shall be submitted in composite form (coordination drawings) clearly designating which trade will perform which Work; the words "work by others" will not be accepted.

All Submittals of materials and equipment and submissions of drawings shall indicate the corresponding number of the section and paragraph of the Contract Documents and reference to the drawings in the Project Definitions Plan (Exhibit 2A.1) under which each of the above are required.

All shop drawings shall be thoroughly checked by the DB Entity for compliance with the Contract Documents before submitting them to the MBTA for review and shall bear the DB Entity's stamp of acceptance certifying that they have been so checked. Shop drawings submitted without the stamp of acceptance and certification, or which are incomplete, contain errors, have not been checked, or have been checked only superficially will be returned not reviewed by the MBTA and shall require resubmission by the DB Entity. The DB Entity shall certify: "This shop drawing has been thoroughly checked and complies with the Contract Documents and field measurements and the item fits with adjoining Work except as noted."

In checking shop drawings, the DB Entity shall verify all dimensions and field conditions and shall check and coordinate the shop drawings with the requirements of all other Sections, adjoining materials or trades whose work is related thereto, as required for the proper and complete installation of the Work.

When submitting shop drawings or working drawings for review by the MBTA, the following procedures shall apply:

- (a) DB Entity shall submit to the MBTA the shop drawings and detail drawings specifically required by the Technical Provisions;
- (b) The MBTA will review drawings no later than 30 Days after Submittal;
- (c) If corrections are required by the MBTA, the DB Entity shall make such corrections and resubmit

the drawings to the MBTA for review. If corrections are still required, the same procedure shall be carried out until the comments on the drawings are closed;

- (d) Upon the satisfactory disposition of all MBTA's comments, the DB Entity shall provide the MBTA corrected blackline prints; and
- (e) All items shown on shop drawings shall be clearly identified with their location in the Contract Documents, or by the sheet or detail number in which they appear, in order to facilitate review by the MBTA.

2.8.5 Requests for Information

DB Entity shall utilize the request for information (RFI) process as a communication tool during both the design and construction stages of the Work. RFIs may be initiated by DB Entity or MBTA and shall be controlled by the QMP and an accepted Project specific procedure. The RFI initiated by DB Entity shall reflect the general nature, location, and description of the issue, DB Entity's proposed mitigation of the issue with supporting documentation, and Design and/or Construction Quality Manager's acceptance on such mitigation. MBTA may transmit identified issues in writing to DB Entity summarizing the general nature, location, and description of the issue for incorporation into the RFI process.

DB Entity shall only submit to the MBTA an RFI that requests clarification of information contained in the Contract Documents or that change designs previous reviewed and accepted by the MBTA.

Upon discovery of the need for interpretation of the Contract Documents, the DB Entity shall prepare and submit an RFI using the Project Software Platform. RFIs shall not be used to request acceptance of Submittals, design changes, substitutions, or nonconforming conditions, RFIs shall not be used to request changes to the Project Schedule or changes in quantities.

When an issue or change arises, including those identified by MBTA-prepared RFIs, DB Entity shall maintain an RFI log to track all open issues and submit RFIs and the updated log for review by MBTA every week. MBTA will submit RFIs to the DB Entity for issues identified by MBTA. DB Entity shall provide independent and unique numbering system for RFIs initiated by DB Entity from those initiated by MBTA.

RFIs submitted by entities other than the DB Entity will not be actioned. The DB Entity shall coordinate and submit RFIs in a prompt manner so as to avoid delays in the Work.

Content of the RFI- RFIs shall include a detailed, legible description of items needing interpretation and the following:

- (a) Project Name;
- (b) Contract Number;
- (c) Date;
- (d) Name of DB Entity;
- (e) RFI Number, numbered sequentially;
- (f) Specification Section number and title and related paragraphs, as appropriate;
- (g) Drawing number and detail references, as appropriate;
- (h) Field dimensions and conditions, as appropriate;

- (i) The DB Entity's suggested solution(s). If DB Entity's solution(s) impact any Milestone or any quantities, DB Entity shall state the impact in the RFI;
- (j) DB Entity's signature; and
- (k) Attachments: Include drawings, descriptions, measurements, photos, product data, shop drawings, and other information necessary to fully describe item needing interpretation.

RFI Log- The DB Entity shall prepare, maintain and submit a log of RFIs organized by the RFI number containing the following information:

- (a) Project Name;
- (b) Project Contract Number;
- (c) Name of DB Entity;
- (d) RFI number and Revision Indicator;
- (e) RFI description;
- (f) Date RFI was submitted;
- (g) Date response required;
- (h) Date response received;
- (i) Date closed; and
- (j) Number of Days for response cycle.

MBTA Action- The MBTA will review each RFI, determine action required and return to the DB Entity within 10 Days.

2.8.6 Design Changes During Construction

During construction, adjustments to the design may be required to fit field conditions. DB Entity shall implement a Configuration Management Program to control changes to accepted design during construction. Configuration Management requirements are defined in Exhibit 2I. The DB Entity shall provide written acceptance from the DB Entity's Design Quality Manager for any design changes that occur during construction, or design changes that occur to Design Documents. All design changes shall undergo the same Quality Management Plan checks, reviews, and certifications and are subject to the same review process as the original design. Design changes shall include plan sheets, specifications, technical memos, reports, studies, calculations, and other pertinent data, as applicable per the deliverable content required by the level of the Submittal.

Plan change documentation shall include confirmation that:

- (a) The design change has been designed in accordance with the requirements of the Contract Documents;
- (b) The design change has been checked in accordance with DB Entity's concurred DQMP;
- (c) The design change has been prepared consistently with other elements of the original design;
- (d) The design change complies with the design certification requirements as set forth in the Quality Management Plan; and

- (e) MBTA comments are resolved.

DB Entity shall request and schedule design review(s) for all design changes made during construction or to the Final Design Documents. DB Entity shall document all changes made through the design change process on the Record Drawings. The DB Entity shall issue periodic updates to the Design Documents as specified in Section 2.7.1.2.4 of the Technical Provisions

2.8.7 Project Close-Out

In addition to the provisions in Volume 1, this Section 2.8.7 specifies requirements for achieving the applicable Milestones and Project closeout, including the following:

- (a) Record Drawings;
- (b) Final Acceptance Closeout Plans;
- (c) Training of MBTA's personnel; and
- (d) Final cleaning.

2.8.7.1 Record Drawings

DB Entity shall prepare and submit Record Drawings consisting of drawings, specifications, calculations, and a Record Drawings Design Report for review and comment by MBTA at least 90 Days before anticipated Contract Final Acceptance for the Project, as reflected in the Project Schedule as of such date. DB Entity's Design Quality Manager shall certify that all Record Drawings have been signed and sealed by the appropriate Engineer of Record.

DB Entity shall submit a Record Drawings Design Report that certifies that the constructed design has been verified to fully comply with the Contract Documents. The Report shall provide explanation of changes and modifications made to the design during construction, testing, and commissioning. The Report shall contain evidence that changes and modifications made were accepted by the Engineer of Record responsible for the design.

The DB Entity shall record as-built information on media accepted by the MBTA. The DB Entity shall maintain these drawings at the Site and at all times, absolutely, clearly, and completely show the actual installations in accordance with the Contract Documents. The DB Entity shall record all Subcontractors' changes.

Upon completion of the Work and after checking the subcontractors' Record Drawings, the DB Entity shall submit a complete set of marked-up Record Drawings to the MBTA electronically for use in the final inspection, and for review, comments, and acceptance by the designer. Non-availability of Record Drawings or inaccuracies therein may be grounds for cancellation and postponement of any scheduled final inspection by the MBTA until such time as the Record Drawings are available or the discrepancy has been corrected. Upon completion of the Work, the Record Drawings shall become the property of the MBTA.

The DB Entity shall incorporate changes into electronic record files on a contemporaneous basis and submit to the MBTA, three (3) complete copies of electronic, Record Drawings of all Work installed, relocated or abandoned. The Record Drawings shall be prepared and submitted in electronic format (PDF format and as an AutoCAD electronic files) in a DVD or storage device acceptable to the MBTA. Electronic

record files shall be submitted prior to Contract Final Acceptance and shall conform, where applicable, to the requirements of these Technical Provisions. Electronic record files shall be submitted to and accepted by the MBTA before final payment will be issued

2.8.7.2 Final Acceptance Closeout Plan

The Final Acceptance Closeout Plan shall be the DB Entity's approach for handling closeout of the Project and shall identify:

- (a) Schedule – including meetings, field inspection walkthroughs, Submittals, instruction of MBTA personnel, and other relevant closeout activities;
- (b) All closeout deliverables – including columns for specification section reference, description of requirements, and any other relevant information; and
- (c) All DB Entity closeout responsibilities.

The Final Acceptance Closeout Plan shall be presented to the MBTA at the initial closeout meeting which shall be scheduled by the DB Entity within 180 Days after NTP. The Final Acceptance Closeout Plan shall address how the DB Entity shall comply with Exhibit 2H. The MBTA will review the Final Acceptance Closeout plan and provide comments in a follow-up meeting to be scheduled by the MBTA.

The execution of the Final Acceptance Closeout Plan by the DB Entity will be monitored by the MBTA. The DB Entity shall update the status of the Final Acceptance Closeout Plan as required.

2.8.7.3 Training

Operating and Maintenance Instruction- The DB Entity shall: instruct MBTA's personnel to operate, adjust and maintain systems, subsystems and stand-alone equipment that is not part of a system. Such instruction shall be provided by instructors experienced in operation and maintenance procedures; arrange for each installer of equipment that requires regular maintenance to meet with the MBTA's personnel to provide instruction in proper operation and maintenance at each location. If installers are not experienced in all relevant procedures, DB Entity shall arrange for manufacturer's representatives to provide instruction to the MBTA at no additional cost to the MBTA. For equipment that requires seasonal operation, DB Entity shall provide similar instruction at the start of each season. DB Entity shall provide the MBTA at least 14 Days advance notice for any training and instruction required or appropriate pursuant to the Contract Documents.

Instruction for operating equipment shall include, but not be limited to, the following:

- (a) System design and operating requirements review;
- (b) Document review, including operation and maintenance manuals and as-built documents;
- (c) Operations review, including:
 - (i) Safety procedures;
 - (ii) Hazards;
 - (iii) Control sequences;
 - (iv) Startup;

- (v) Shutdown; and
- (vi) Emergency operations.
- (d) Adjustments, including those for noise, vibration economy, and energy efficiency;
- (e) Troubleshooting;
- (f) Maintenance, including:
 - (i) Safety procedures;
 - (ii) Hazards;
 - (iii) Spare parts and materials;
 - (iv) Tools;
 - (v) Lubricants;
 - (vi) Fuels;
 - (vii) Cleaning;
 - (viii) Warranties; and
 - (ix) Maintenance agreements and similar continuing commitments.
- (g) Repairs.

2.8.7.4 Final Cleaning

Provide a final cleaning, with cleaning and waste removal activities to be conducted in compliance with Laws.

Complete the following cleaning operations before requesting inspection for certification of Contract Final Acceptance.

- (a) Remove labels that are not permanent labels;
- (b) Clean transparent materials, including mirrors and glass in doors and windows, of glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces;
- (c) Touch up and otherwise repair and restore marred, exposed finishes and surfaces, replacing those that cannot be satisfactorily repaired or that evidence repair or restoration;
- (d) Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces. Shampoo if visible soil or stains remain;
- (e) Remove debris and surface dust from limited access spaces, including roofs, plenums, ducts, shafts, trenches, equipment vaults, manholes, attics, and similar spaces;
- (f) Replace disposable air filters or clean permanent air filters. Clean diffusers, registers and grilles;
- (g) Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication, paint and mortar droppings, and other substances. Clean plumbing fixtures to a sanitary and stain-free condition. Clean light fixtures and lamps. Replace burned out or dimmed bulbs and replace noisy

starters;

- (h) Clean the site, including landscape development and yard areas, removing rubbish, litter and other foreign substances. Sweep paved areas broom clean; remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth, even-textured surface. Remove tools, construction equipment, machinery and surplus materials from site. Remove snow and ice to provide safe access to buildings; and
- (i) Leave Site and facilities clean and ready for efficient use and occupancy.

Pest Control- The DB Entity shall make a final inspection and clean exterminate in accordance with the Contract Documents and Laws.

2.8.7.5 Deliverables

Table 2-8 reflects a nonexclusive list of deliverables identified in this Section 2.8 of the Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables in the Technical Provisions. DB Entity shall determine and submit all deliverables as required by the Contract Documents. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.5, unless otherwise specified in the Contract Documents:

Table 2-8: Non-exclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Shop and Working Drawings	2	1	Minimum 30 Days prior to construction of the applicable portion of the Work	2.8.4
RFI Log	2	1	Every Week	2.8.5
Design Changes	2	1	See above	2.8.6
Record Drawings	2	1	Prior to Contract Final Acceptance	2.8.7

2.8.8 Construction Field Office

2.8.8.1 Central Field Office

- (a) The DB Entity shall co-locate its staff with the MBTA and its consultants at 200 Inner Belt Road, Somerville, Massachusetts (the “Central Field Office”), and any other subsidiary field offices that are determined by the DB Entity to be necessary to support the Work. The Central Field Office is included as a part of a Lease dated November 19, 2014 between North River II LLC (as landlord) and White Skanska Kiewit Joint Venture (as tenant) that was assigned to the MBTA as of April 19, 2017 (the “Lease”) and under which the MBTA has leased space and land (the “Leased Premises”). The MBTA will occupy the third floor of the Central Field Office.
- (b) The DB Entity shall occupy the 2nd Floor of the Central Field Office constituting approximately 24,243 rentable square feet (RSF). DB Entity’s Key Personnel shall be

primarily located at the Central Field Office. The MBTA shall have the right to schedule meetings in the conference areas with the 2nd floor of the Central Field Office in cooperation with the DB Entity.

- (c) Parking in the lot adjacent to the Central Field Office comprising approximately 150 paved parking spaces (the "Central Field Office Parking Area") will be shared with the MBTA and its consultants as follows: 100 spaces allocated to MBTA and its consultants and 50 spaces allocated to DB Entity and its Subcontractors. All 50 DB Entity parking spaces shall be located on the southernmost portion of the parking lot as assigned by the landlord. If DB Entity requires more space for parking, DB Entity may, subject to obtaining necessary local approvals, develop a portion of the laydown area that is a part of the Leased Premises for additional parking on a non-paved surface (the "Central Field Office Laydown Area") provided by or on behalf of MBTA adjacent to the Central Field Office Parking Area for such purpose.
- (d) The DB Entity shall maintain its own office space on the 2nd Floor of the Central Field Office including all information technology infrastructure (including, by way of example, servers, wiring, etc.), all office systems, including telephone systems; fax machines; copiers; computer systems; furniture and equipment, including any maintenance contracts, costs of supplies (paper for printers/copier/fax machines, ink cartridges, etc.), utilities (to include internet connectivity and service with on-site server facilities), consumables (paper towels, pens, pencils, tape, etc.), and incidentals to permit the efficient and uninterrupted operation of the Central Field Office; custodial and cleaning services (and shall arrange for waste disposal) sufficient to keep the Central Field Office in a clean, safe and sanitary condition; but the DB Entity shall not be responsible for lease or other payments (including charges for gas, electricity, water and sewer charges) for the Central Field Office, the Central Field Office Parking Area, or the Central Field Office Laydown Area (collectively, the "DB Occupied Areas") which, as between MBTA and DB Entity, shall be the responsibility of the MBTA under the Lease. DB Entity may use any furniture remaining on the 2nd floor of the Central Field Office as of the date of DB Entity's occupation.
- (e) DB Entity may hang pictures, install shelving and paint and otherwise decorate the Central Field Office, but shall not otherwise modify the Central Field Office (including, by way of example, structural changes, relocation of plumbing fixtures, removal of a wall), without the DB Entity first obtaining the MBTA's prior written consent. DB Entity acknowledges that such consent is subject to the MBTA receipt of the approval of the landlord under the Lease, which approval may not be unreasonably withheld, delayed or conditioned.
- (f) Payment of regular telephone, cable, internet and related charges incurred by the DB Entity will remain the responsibility of the DB Entity.
- (g) The DB Entity shall be permitted to construct and/or maintain the 72-inch high chain link fence and a twelve-foot clear opening double-swing gate and a four-foot pedestrian gate around the perimeter of the Central Field Office Laydown Area. The DB Entity shall maintain these clearance areas and any parking areas established within the Central Field Office Laydown Area, including snow removal. The DB Entity shall protect the Central Field Office Laydown Area, the Central Field Office Parking Area and the 2nd Floor of the Central Field

Office and, in each instance, all contents therein 24 hours per Day and be responsible for any loss of property of MBTA employees and its Indemnified Parties housed therein, due to fire, theft, vandalism or other causes. DB Entity shall coordinate with MBTA for access to such other areas within the Central Field Office. DB Entity shall be responsible for the safety and security of all areas of the Central Field Office that are occupied or controlled by DB Entity, its Subcontractors or any other person or entity for whom they are responsible.

- (h) The DB Entity shall conduct snow removal activities with respect to the Central Field Office Laydown Area, as may be necessary. At the end of the Project and as a condition of Final Payment, DB Entity shall return and restore the Central Field Office Laydown Area substantially to the condition it was before the DB Entity began to use/occupy it.
- (i) The DB Entity acknowledges that certain of the approvals required from the MBTA are conditioned on the MBTA's receipt of approval from the landlord. DB Entity shall also observe the following obligations pertaining to the use of any portion of the DB Occupied Areas:
1. The standard building hours for the Leased Premises are 7:00 AM to 6:00 PM Monday through Friday and 9:00 AM to 1:00 PM on Saturday. DB Entity shall have 24 hour, seven day a week access to the 2nd Floor of the DB Occupied Areas, subject to the rules and regulations of the Leased Premises. Gates providing access to the Leased Premises are locked overnight;
 2. Building holidays for the Leased Premises are New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Christmas Day, and any other dates legally observed by the Federal government;
 3. Any work to be conducted by DB Entity in the DB Occupied Areas shall be subject to the further approval of the MBTA and the landlord, and shall be completed by a contractor licensed in Massachusetts;
 4. Work to be conducted in the DB Occupied Areas may be subject to the submission of lien waivers and subordinations, paid invoices, or valid Certificates of Occupancy as may be required by the landlord;
 5. DB Entity shall be responsible for all permitting obligations with respect to its work on or in the DB Occupied Areas. All such work is subject receipt of the MBTA's prior written approval;
 6. DB Entity shall use the DB Occupied Areas for the purposes of operating a general office for a joint venture contracting company and no other purpose and shall undertake no activity on or in the DB Occupied Areas that will cause the MBTA to be in violation of the Lease, to cause an increase in landlord's fire insurance premiums or to cause the MBTA to lose its security deposit;
 7. DB Entity may install exterior lighting over the Central Field Office Laydown Area;
 8. DB Entity shall install a mesh privacy screen along the Central Field Office Laydown Area;
 9. DB Entity shall install stone tracking pads (minimum depth of 12" and 30' in length) at each entrance and exit of the Central Field Office Laydown Area;
 10. Street sweeping shall be provided by the DB Entity to control dust at the Central Field Office Parking Area and Central Field Office Laydown Area to the MBTA's reasonable satisfaction, which may require the submission of a dust control plan;

11. All laborers entering the Central Field Office shall enter through the south entrance of the Leased Premises;
12. Porta-johns for laborers shall be provided by DB Entity in a manner and location to be approved by the MBTA;
13. DB Entity may not use any portion of the DB Occupied Areas to generate, use, release, store or dispose on any hazardous materials except in compliance with law and either not in excess of amounts necessary to operate the DB Occupied Areas (such as cleaning products) or fully disclosed to and approved by the MBTA;
14. DB Entity shall not place any fixture, equipment or machinery on the Central Field Office in excess of the designed load capacity of 150 psf;
15. DB Entity shall use and comply with the security and access requirements established by landlord with respect to the Leased Premises, which requirements are usual and customary with respect to buildings of a similar size, condition and age in the Somerville submarket;
16. DB Entity shall provide reasonable access by the landlord to the DB Occupied Spaces;
17. DB Entity acknowledges that landlord has retained the obligation to maintain the Central Office Parking Area and that landlord may reconfigure the Central Field Office Parking Area or modify ingress to and egress from the Central Office Parking Area;
18. Overnight parking and the storage of vehicles in the Central Office Parking Area is prohibited; and
19. DB Entity shall not permit any other entity to occupy any portion of the DB Occupied Areas without the MBTA's prior approval.

2.8.8.2 General Requirements for Construction Field Offices

- (a) Construction Field Offices shall consist of all field office locations used and occupied by DB Entity to complete the Work, except for the Central Field Office.
- (b) The DB Entity may use the MBTA owned property located at 35 Charlestown Street, Somerville MA 02143 ("Community Alternatives Building") for storage and office space as a Construction Field Office.
- (c) With respect to each Construction Field Office and related facilities, DB Entity shall be responsible for the all-inclusive management, insurance, and costs of all capital; costs set forth in any lease agreements (excepting only those pertaining to the Community Alternatives Building, which is MBTA owned and is provided to the DB Entity under the DB Contract); janitorial services; maintenance of electrical, heating, ventilation, and air-conditioning (HVAC); plumbing; telephone systems; fax machines; copiers; computer systems; and equipment, including any maintenance contracts, costs of supplies (paper for printers/copier/fax machines, ink cartridges, etc.), utilities (to include internet connectivity and service with on-site server facilities), consumables (paper towels, pens, pencils, tape, etc.); all other utilities; and other incidentals to permit the efficient and uninterrupted operation of each Construction Field Office. Payment for all of the foregoing, including of regular utility and related service charges, remain the responsibility of the DB Entity, except that DB Entity shall not owe rent to MBTA for use of the Community Alternatives Building during the term of the DB Contract.
- (d) The DB Entity shall provide the MBTA heated and air conditioned space within all Construction Field Offices (including trailers) and associated parking sufficient to support the field operations that the DB Entity is managing from the particular Construction Field Office locations. MBTA's use

and occupancy of any other Construction Field Office shall be without cost or fee owing to DB Entity. DB Entity shall ensure that the space occupied by MBTA personnel be integral with that of DB Entity to facilitate teamwork and continuous interaction. However, MBTA space shall be sufficiently separated within each overall Construction Field Office space to allow internal MBTA functions and interaction to take place apart from DB Entity's.

- (e) All build-outs/fit-outs of the Construction Field Offices and related facilities shall be constructed and maintained in accordance with federal, state and local building codes.
- (f) As part of performance of the Site Security Plan, DB Entity shall protect and provide security at each Construction Field Office. DB Entity's security obligations include protection of the building or space within a building and all contents within each from all perils, including fire, theft, vandalism, malicious acts and other human activity or related causes, 24 hours per day. DB Entity shall take responsibility for loss of property (including personal property) of MBTA and any of the Indemnified Parties that occurs on or in property occupied or controlled by the DB Entity, its Subcontractors or other persons or entities for whom they are responsible.
- (g) In addition to the responsibility to maintain all internal office spaces and equipment, DB Entity shall be responsible for the maintenance of the immediate grounds and landscaping and for the removal of snow and ice, including the supply and application of deicing or ice-melting agents, from parking areas and walks in a timely manner to ensure safe passage to and from any Construction Field Office.

2.9 Stakeholder Engagement and Public Involvement

- 2.9.1 DB Entity shall participate and support the MBTA's public involvement efforts with respect to the Project. The goal of the stakeholder engagement activities is to engage a diverse group of public and agency participants, seeking their views, and providing timely information throughout the construction process.
- 2.9.2 The DB Entity shall furnish a representative to the MBTA who is experienced in stakeholder engagement and public involvement on large projects. The DB Entity's representative shall be intimately familiar with the DB Entity's construction activities and shall attend all public meetings and preparatory meetings requested by the MBTA.
- 2.9.3 The DB Entity shall provide Project information concerning progress of the Work, construction work zones, pedestrian access points, vehicle traffic patterns, design and construction details including construction methods and equipment, construction schedules and any other information requested by the MBTA to support the stakeholder engagement and public involvement program. The DB Entity shall provide this information in the format requested by the MBTA. The DB Entity shall participate in and provide Project information in support of the following MBTA activities:
 - (a) Updating the Project website;
 - (b) Weekly press releases;
 - (c) Public Involvement meetings;
 - (d) Stakeholder meetings including meetings with public officials;
 - (e) Work zone public information; and

(f) Project newsletter.

2.9.4 Project Phone Hotline- The DB Entity shall provide and maintain for the duration of the Project (until Contract Final Acceptance) a toll-free phone for individuals to call with concerns or questions. The DB Entity shall be responsible for ensuring that the hotline is staffed from 7:00a.m. to 5:00p.m. on any day in which construction activities are occurring and at nights when work is being performed. The hotline shall accept messages at all other times. The DB Entity shall establish a procedure for timely review of messages and responding to messages. The phone number of the hotline shall be posted by the DB Entity on the Project website, and in the GLX Project newsletter. The DB Entity shall maintain a log of all calls received through the hotline. The log shall include the date and time of the call, the caller name and telephone number if available, the nature of the call and the DB Entity's proposed solution for the issue. A copy of the log shall be furnished to the MBTA within eight hours of receipt of the call. All emergencies shall be reported to the MBTA immediately.

END OF SECTION

3 ENVIRONMENTAL APPROVALS AND MITIGATION

3.1 Scope of Work

The DB Entity shall satisfy the environmental commitments required by the Contract Documents, Laws, Governmental Entities, and Governmental Approval. Environmental mitigation commitments for the Project are contained in the MEPA Draft Section 61 Finding and the FONSI in Exhibit 2G. DB Entity shall follow and implement specifications in Section 01060 in Exhibit 2I.

3.2 Codes, Standards, and Manuals

All Work shall be done as applicable in compliance with applicable Laws including:

- (a) 301 CMR 11.00 - Massachusetts Environmental Policy Act Regulations;
- (b) 23 CFR 771 – Environmental Impact and Related Procedures;
- (c) Section 106 of the National Historic Preservation Act;
- (d) Section 4(f) of the Department of Transportation Act of 1966;
- (e) Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment guidance manual (Report FTA-VA-90-1003-06, May 2006);
- (f) Clean Water Act, 33 U.S.C. Section 1251 et seq;
- (g) 40 CFR, Chapter I, Subchapter D, Part 122 - EPA Administered Permit Programs: The National Pollutant Discharge Elimination System;
- (h) Clean Air Act, 42 U.S.C. Section 7401 et seq;
- (i) 310 CMR 7.09: Air Pollution Control Regulations;
- (j) 314 CMR 4.00 – Massachusetts Surface Water Quality;
- (k) Environmental Protection Agency’s National Emission Standards for Hazardous Air Pollutants, Part 61, Chapter I, Title 40, Code of Federal Regulations;
- (l) OSHA Occupational Noise Exposure Hearing Conservation Amendment;
- (m) MBTA Anti-Idling Policy;
- (n) MassDOT’s diesel retrofit specification;
- (o) FSC-Forest Stewardship Council U.S.- <http://www.fscus.org>;
- (p) Green Seal www.greenseal.org/;
- (q) Sheet Metal and Air Conditioning Contractors National Association (SMACNA);
 - (i) SMACNA IAQ Guidelines for Occupied Buildings under Construction, Chapter 3.
- (r) South Coast Air Quality Management District (SCAQMD)- www.aqmd.gov/rules;
 - (i) South Coast Rule #1113, Architectural Coatings- www.aqmd.gov/rules.
 - (ii) South Coast Rule #1168, Adhesive/Sealant VOC Limits (www.aqmd.gov/rules/reg/reg11/r1168.pdf), State of California.
- (s) Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for

Occupied Buildings Under Construction;

- (t) Green Seal Standards;
- (u) Standards from the Carpet and Rug Institute (CRI) of Dalton, Georgia. <http://www.carpet-rug.org/index.cfm>; and
- (v) FloorScore <http://rfci.com/knowledge-center/floorscore/>.

3.3 Project Specific Requirements

3.3.1 Environmental Acceptances and Mitigation Commitments

Without limitation, the DB Entity shall:

- (a) Incorporate into the final design the stipulations contained and conditions in Governmental Approvals and Contract Documents and identify and inform MBTA of any new or changed conditions that may impact Government Approvals under MBTA's responsibility.
- (b) Provide mitigation commitments contained in the Draft Section 61 Finding contained within the Notice of Project Change (January 31, 2017) and the FONSI provided in Exhibit 2G; provided, however, that the following mitigation measures shall not be part of the Work:
 - (i) Traffic and transportations systems improvements in the City of Somerville, including optimization of traffic signal timing and phasing;
 - (ii) Traffic and transportation systems improvements in the City of Cambridge including optimization of traffic signal timing and phasing;
 - (iii) Work with Cities to develop station-area parking enforcement plans;
 - (iv) Pedestrian improvements in the Cities of Somerville and Cambridge;
 - (v) Sound insulation of private property;
 - (vi) Work with property owners to provide fair market value of acquisition and job relocations;
 - (vii) Work with the community in the area of the future Mystic Valley/Route 16 to consider land use and Station design elements;
 - (viii) Work with the City of Somerville to identify opportunities for state and Federal funding for construction of the Community Path (see Section 9.2);
 - (ix) Provide vegetation on and/or above retaining walls to minimize visual changes;
 - (x) Work with affected communities on design of noise barriers and vegetated walls;
 - (xi) Perform archival and written documentation of historic structures to be removed or altered;
 - (xii) Develop interpretive displays of historic elements; and
 - (xiii) Conduct land use workshops with affected communities to further identify community needs and issues near the Station areas.
- (c) DB Entity shall install all interpretive displays.

3.3.2 Comprehensive Environmental Protection Program (CEPP)

DB Entity shall develop and implement a Comprehensive Environmental Protection Program (CEPP), which is an overarching system by which the DB Entity shall ensure that commitments made during the environmental approval and permitting process, and other environmental requirements, are carried forward and reflected as appropriate in the design and implementation throughout the Work. The CEPP shall contain the following elements at a minimum:

- (a) Establish processes that DB Entity will follow to manage and comply with Environmental Approvals, commitments, resource agency requirements, FTA requirements, and applicable Laws;
- (b) Demonstrate DB Entity's comprehensive knowledge of the environmental issues associated with all aspects of the Work, the environmental scope as set forth herein, and describe the processes that will be followed during the course of the Work to comply with those Environmental Approvals, mitigate environmental impacts and adopt measures to ensure compliance with all applicable environmental Laws;
- (c) Inclusion of a commitment tracking system, which DB Entity shall use to identify and track the responsibility and status of all Project environmental commitments;
- (d) Identification and tracking of environmental compliance efforts, unresolved issues, noncompliance events, and the identified actions required and taken to make appropriate notifications and correct any noncompliance event via a commitment tracking database;
- (e) Method and frequency for reporting commitment compliance to MBTA;
- (f) Method for reporting environmental non-compliance to MBTA;
- (g) Measures to be taken to ensure protection for the environment;
- (h) The process to be implemented by DB Entity to record and document the measures taken during the performance of the Work to avoid and minimize impacts on the environment;
- (i) A goal of zero environmental violations during the performance of all Work;
- (j) Detailed processes for rectifying violations in an appropriate and timely manner;
- (k) A contingency plan for unanticipated events that have the potential to impact environmental resources;
- (l) Protection of historic properties, according to the Memorandum of Agreement (MOA) (Copy provided in [Exhibit 2G](#));
- (m) An appropriate notification system upon discovery of unknown historic or archaeological remains;
- (n) Noise mitigation measures;
- (o) Air quality monitoring and assurance;
- (p) Any other environmental items required by the Contract Documents and Governmental Approvals or applicable Laws;
- (q) An Environmental Mitigation and Monitoring Plan (EMP);
- (r) An Environmental Protection Training Plan (EPTP);
- (s) A Construction Noise Mitigation Plan [See [Section 3.4.5](#)]; and
- (t) Stormwater Pollution Prevention Plan.

DB Entity shall incorporate all permanent environmental protection features into the Work at the earliest practicable time. Temporary environmental protection measures will be used to correct conditions that develop during construction that were not foreseen during design; that are needed prior to installation of environmental protection features; or that are needed temporarily to control any erosion that develops during normal construction practices, but are not associated with permanent control features on the Project.

The CEPP shall be reviewed and accepted by the MBTA prior to the commencement of construction Work.

3.3.2.1 Environmental Mitigation and Monitoring Plan (EMP)

DB Entity shall prepare an Environmental Mitigation and Monitoring Plan (EMP) that clearly identifies all environmental mitigation and monitoring requirements of all Governmental Approvals, and applicable Environmental Laws; and the Contract Documents. DB Entity shall submit the EMP with the CEPP to the MBTA for review and acceptance.

Prior to and during construction, DB Entity shall implement the EMP and perform all monitoring in compliance with the Project environmental requirements and Contract Documents. DB Entity shall document the compliance with all environmental requirements through testing, reports, memos, video, photographs, etc. For each environmental requirement, DB Entity shall identify all compliance actions and the party responsible for monitoring and documenting compliance.

DB Entity shall minimize and/or mitigate potential environmental impacts, including those described in Governmental Approvals, the Contract Documents, and the CEPP. If requested by the MBTA or any Government Entity, DB Entity shall conduct and finalize environmental studies and develop any necessary plans to support preparation of Design Documents and Construction Documents.

Upon completion of the compliance action, DB Entity shall provide the documentation to MBTA for review.

DB Entity shall prepare weekly monitoring reports to document DB Entity actions to monitor and maintain compliance with any applicable Environmental Laws and Governmental Approvals. DB Entity shall compile the weekly monitoring reports into a monthly Environmental Monitoring Report. Environmental Monitoring Reports shall include the following information and any other information required by the Governmental Approval:

- (a) Name of environmental monitoring inspector;
- (b) Date of monitoring;
- (c) Weather conditions;
- (d) Location;
- (e) Resource(s) addressed;
- (f) Locations and nature of occurrence;
- (g) Locations and nature of violations, if any;
- (h) Recommended remedial actions; and
- (i) Updated status matrix of DB Entity's responsible environmental commitment requirements.

DB Entity shall furnish monthly Environmental Monitoring Reports to the MBTA reflecting the status and implementation of the Environmental Mitigation and Monitoring Plan from issuance of NTP through Contract Final Acceptance. DB Entity shall amend and update the EMP as necessary to address changing conditions and environmental requirements in accordance with the procedures for amendments to the Project Management Plan.

3.3.2.2 Environmental Protection Training Program

DB Entity shall design and implement an environmental protection training program for any persons performing the Work. Every DB Entity employee and Subcontractor employee who works on the Project, including each new employee who begins Work after issuance of NTP, shall participate in the Project environmental protection training program. The environmental protection training program shall include training with respect to the Safety Management Plan.

The environmental protection training program shall include all necessary instruction to facilitate compliance with the CEPP Governmental Approvals, including:

- (a) Clear lines of authority;
- (b) Reporting flow; and
- (c) Decision trees for response to unanticipated discoveries, accidents, spills, or other circumstances that require rapid response for compliance with all environmental requirements.

DB Entity shall provide for environmental protection training program sessions at appropriate times (e.g., prior to construction, and prior to each rainy season) to update workers on specific restrictions, conditions, concerns, and/or requirements.

DB Entity shall furnish the environmental protection training program in a detailed document for hand out to the employees at the training events. DB Entity shall train employees of DB Entity and Subcontractors with respect to the following environmental matters:

- (a) The overall importance of environmental issues in achieving a successful Project;
- (b) The particular environmental sensitivities of the Project;
- (c) The importance of Environmentally Sensitive Area protection, and potential Project and personal liabilities resulting from Environmentally Sensitive Area damage/impact;
- (d) Erosion and sediment control procedures in accordance with the Stormwater Pollution Prevention Plan (SWPPP), including the functions and proper installation of Best Management Practices (BMPs); and
- (e) Proper procedures for spill containment.

DB Entity shall provide proof, through signature, that each employee has attended the training, understands the environmental constraints and whom to contact with questions regarding the training, and compliance with the conditions of the applicable Governmental Approvals. No employee of DB Entity or any Subcontractor may work on the Project without first completing all required environmental training.

The DB Entity's environmental manager is responsible for making sure all employees have participated in the environmental protection training program and are provided with any updates to the Governmental Approvals.

DB Entity shall notify MBTA of the training sessions and invite them to participate.

3.3.2.3 Stormwater Pollution Protection Plan

DB Entity shall prepare and implement a Stormwater Pollution Prevention Plan required by the US Environmental Protection Agency under the National Pollutant Discharge Elimination System (NPDES) 2017 General Permit for Construction Activities (GCP).

3.3.3 Sustainability Requirements

- (a) Comply with requirements of Exhibit 2I Section 01800- Sustainability Requirements.
- (b) Envision Rating System Checklist and Documentation:
 - (i) ISI Envision Checklist and Narrative: Provide completed Pre-Assessment Checklists for the Institute for Sustainable Infrastructure's (ISI) Envision rating system for the Project. With the completed checklists, provide a narrative explaining the approach for each credit.
 - (ii) ISI Envision Credits Documentation: For each Envision Credit identified in the Pre-Assessment Checklist as being met by the Project, collect and/or produce documentation demonstrating how the Project meets the requirements of each credit, including documentation addressing the Evaluation Criteria and Documentation questions listed in the ISI Envision Guidance Manual. Categorize and/or identify documentation by credit.
- (c) Progress Meetings: Include sustainability on the agenda for Progress Meetings.
 - (i) Provide overall status update on meeting requirements defined in the sustainability management plans in accordance with Section 01800 in Exhibit 2I.
 - (ii) Any issues identified by the DB Entity during the Progress Meeting shall be added to an action item log for timely resolution during construction.
- (d) Sustainability Management Plans, to be submitted to MBTA for review and acceptance within sixty (60) days from Notice to Proceed.
 - (i) Construction and Demolition Waste Management Plan: Refer to section 3.3.7.3
 - (ii) Construction Indoor Air Quality Management Plan:

Develop and implement a Construction Indoor Air Quality Management Plan. The plan shall at minimum meet the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, for control measures for HVAC Protection, source control, pathway interruption, housekeeping and scheduling (Chapter 3).
 - (iii) Replace all air filters immediately prior to occupancy with MERV 13 filters.

Progress reports shall be provided on at least a monthly basis and shall indicate progress both cumulatively since project inception and since the last report was submitted. A final report shall be provided at the end of construction. The DB entity shall save such original documents (as above) for the life of the Project plus three (3) years.

(iv) Integrated Pest Management Plan: Refer to Section 01565 Integrated Pest Management in Exhibit 2I.

(v) Pre-purchased Equipment and Materials Productive Use Plan

Develop a Pre-Purchased Equipment and Materials Productive Use Plan. Plan shall list all pre-purchased equipment and materials that are not anticipated to be used/reused as part of the Project, and shall include an explanation of why the items are not incorporated into the Project. At MBTA's request, the DB Entity shall deliver any unused equipment and materials to a location to be determined by the MBTA.

(vi) Landscape Tracking Plan

Develop and implement a landscape tracking plan. The plan shall be developed to meet the requirements and targets defined in the sustainability specification, Section 01800 in Exhibit 2I for non-hazardous landscape waste, non-hazardous soil, existing trees, tree planting and plant materials.

Progress reports shall be provided on at least a monthly basis and shall indicate progress both cumulatively since project inception and since the last report was submitted. A final report shall be provided at the end of construction that summarizes the results for landscape waste, non-hazardous soil, existing trees, tree planting and plant materials. The DB entity shall save such original documents (as above) for the life of the Project plus three (3) years.

Engage a landscape management coordinator to be responsible for implementing, monitoring and reporting the status of the landscape tracking plan; provided, however, that as between DB Entity and MBTA, DB Entity is responsible for such implementation, monitoring, and reporting.

The plan shall include sections on non-hazardous landscape waste, non-hazardous soil, existing trees, tree planting and plant materials.

1. Non-hazardous landscaping waste. Indicate anticipated types and quantities/percentages by weight the non-hazardous landscape waste generated by the Work. Use the same units of measurement consistently throughout the Plan.

Waste reduction plan: Indicate each type of landscape waste and whether it will be reused on-site or off-site, composted on-site or off-site or disposed including names of vendors/locations. Include points of waste generation, total quantity of each type of waste, quantity for each means disposal, and handling and transportation procedures.

Include legible copies of on-site logs, weight tickets and receipts. Receipts shall be from reuse, composting and/or disposal site operators who can legally accept the materials for the purpose of reuse, recycling or disposal.

2. Non-hazardous soil. Indicate anticipated types and quantities/percentages by weight the non-hazardous soil waste generated by the Work. Use the same units of measurement consistently throughout the Plan.

Waste reduction plan: Indicate each type of soil waste and whether it will be reused on-site or off-site or disposed including names of vendors/locations. Include points of waste generation, total quantity of each type of waste, quantity for each means

disposal, and handling and transportation procedures.

Include legible copies of on-site logs, weight tickets and receipts. Receipts shall be from on-site reuse, off-site reuse and/or disposal site operators who can legally accept the materials for the purpose of reuse, recycling or disposal.

3. Existing Trees. Before beginning work at a site, engage an independent Person to prepare a record of trees that are within the Limit of Works with a caliper greater than 6". The record shall include photographs, location, species, and caliper of the trees and indicate if the tree will remain or will be removed. For all removed trees with a caliper greater than 6", record the date and means of removal and location to which it will be moved if applicable. If a tree with a caliper greater than 6" is removed, the property owner and MBTA shall receive 30 Days' notice before the tree removal.

Include legible copies of on-site logs, receipts and plans. Documentation to confirm the trees, the species, caliper and removal.

4. Tree planting. Identify sourcing locations within a 200 mile radius of the project. Track and record all trees planted as part of the Work. For each tree, indicate the species, caliper, sourced location and planting location. Planting location to be recorded in plan drawings as well as written record. Track and record the distance in miles of the sourced location from the project site for all trees.

Include legible copies of on-site logs, receipts and plans. Documentation to confirm sourcing location and vendor of the trees, the species, caliper and planting location. Receipts shall be from suppliers of the trees.

5. Plant materials. Identify sourcing locations within a 200 mile radius of the project. Track and record all planting materials as part of the Work. For each plant, indicate species, if it is non-invasive, native or adapted, and/or drought tolerant, the sourced location and planting location. Planting location to be recorded in plan drawings as well as written record. Track and record distance in miles of the sourced location from the project site for all trees.

Include legible copies of on-site logs, receipts and plans. Documentation to confirm sourcing location and vendor of the plant, the species, and planting location. Receipts shall be from suppliers of the plant material.

- (vii) Sustainable Materials Tracking Plan: Develop and implement a sustainable materials tracking plan. Identify materials to meet the requirements defined in sustainability Section 01800 in Exhibit 2I. The plan shall be developed to meet the requirements and targets defined in the sustainability Section 01800 in Exhibit 2I for recycled content, regionally manufactured materials, regionally extracted, harvested or recovered materials, certified wood, insulation products, refrigerants, VOC content, flooring and urea-formaldehyde content in composite wood products. Tracking matrix to be approved by the MBTA.

Progress reports shall be provided on at least a monthly basis and shall indicate progress both cumulatively since project inception and since the last report was submitted. A final report shall be provided at the end of construction that summarizes the results recycled content, regionally manufactured materials, regionally extracted, harvested or recovered materials, certified wood, insulation products, refrigerants, VOC content, flooring and

urea-formaldehyde content in composite wood products as defined below. The DB entity shall save such original documents (as above) for the life of the Project plus three (3) years.

Engage a Materials coordinator to be responsible for implementing, monitoring and reporting the status of the sustainable materials plan; provided, however, that as between DB Entity and MBTA, DB Entity is responsible for such implementation, monitoring, and reporting.

The plan shall include sections on recycled content, regionally manufactured materials, regionally extracted, harvested or recovered materials, certified wood, insulation products, refrigerants, VOC content, flooring and urea-formaldehyde content in composite wood products. Each section shall identify the materials to meet the requirements.

Submittal requirements are defined in Section 01800 in Exhibit 2I. Reporting metrics for each item to be tracked as defined in the Sustainability Submittal Form in Section 01800 in Exhibit 2I.

3.3.4 Historic Properties Section 106 MOA Compliance

DB Entity shall become familiar with and shall follow and implement all requirements relative to identified historic properties (historic and archaeological resources) in relevant stipulations of the Section 106 Memorandum of Agreement and Amendment #1 of the MOA, included in Exhibit 2G.

3.3.4.1 Design Review

DB Entity shall prepare designs and specifications for Project elements that have been identified to affect historic properties to avoid or minimize any adverse effects to such properties and in accordance with MOA Stipulation V. Development of Design Plans and Specifications provided in Exhibit 2G. DB Entity shall prepare designs at the Preliminary, Intermediate, and Release for Construction completion stages for MBTA review provided that the MBTA finds that DB Entity designs and specifications prepared for the Lechmere Viaduct are fully consistent at each completion stage with the approved Section 106 plan design that were discussed and agreed upon by the MOA consulting parties, from the tie-in point with the existing East Cambridge concrete viaduct westward up to and including Pier 8, the MBTA shall not require a submittal to the MOA consulting parties. For all other plans, following MBTA acceptance, DB Entity plans shall be submitted to the MOA consulting parties for review and comment. Upon acceptance by FTA and State Historic Preservation Office (SHPO) of a design completion stage, MBTA shall direct DB Entity to proceed with the portion of the Project that relates to those accepted design plans and specifications. DB Entity shall incorporate any design changes directed by the MBTA into the next stage of design.

DB Entity shall package and deliver all design submittals in accordance with MOA Stipulation IV. SHPO Review Specifications provided in Exhibit 2G.

Stations and Traction Power Substations (TPSS) that are within or visible from historic districts and that impact directly or are visible from individual historic properties are to be reviewed by the MOA consulting parties.

DB Entity shall follow the MOA design review requirements for the following new stations and the new Lechmere viaduct:

- (a) Gilman Square Station— A medium to dark tone in paint color shall be used for the Traction Power Substation (TPSS) and enclosed transformer yard.
- (b) New Lechmere Viaduct

DB Entity shall follow the design submittal requirements provided in Section 2 for the design of the new Lechmere Viaduct. In addition, DB Entity shall maintain all aspects of the Section 106 accepted design [Exhibit 2G] that were discussed and agreed upon by the MOA consulting parties. These aspects are minimally as follows:

- (i) Overall visual compatibility with the historic concrete Lechmere Viaduct and the Charles River Basin Historic District, which are listed in the National Register of Historic Places;
- (ii) Minimal physical impact to the historic concrete Lechmere Viaduct at the junction of the two structures [See Sheet LEV-S-4000 in Exhibit 2G];
- (iii) Horizontal ribbing in concrete parapet that continues the line of the molding at the base of the historic concrete Lechmere Viaduct onto the new construction;
- (iv) Spacing of piers that corresponds to the approved Section 106 plan design. This will apply up to Pier 8. [See Exhibit 2G];
- (v) Design of ribbed elliptical concrete piers;
- (vi) Concrete parapet;
- (vii) Spacing and connection of catenary poles; and
- (viii) Color of Steel Tubs/Girders shall be Sherwin Williams Hazel or approved equal. Refer to Section 8.7 for the extent of viaduct painting.

3.3.4.2 Historical Interpretation

DB Entity shall follow the design submittal requirements provided in Section 2 and the MOA and Amendment #1 for Stipulation VI. Historical Interpretation and Reuse of Architectural Elements.

MBTA will design and procure the historical interpretive displays that will be installed at Lechmere Station, Ball Square Station, and Gilman Square Station, and DB Entity shall fabricate and install such displays in accordance with Exhibit 2A.1, Division 10 and Exhibit 2B.1. DB Entity shall design the location and installation of the displays at each of the stations. DB Entity shall provide such plans to MBTA for review, and following acceptance, for MBTA to submit with the interpretive display layout designs to the consulting parties for review and comment.

3.3.4.3 Removal, Preservation and Reuse of Architectural Elements

DB Entity shall follow the design review requirements in 3.3.4.1 and the MOA and Amendment #1 for Stipulation VI. Historical Interpretation and Reuse of Architectural Elements. DB Entity shall implement all existing MOA, Amendment #1, and consulting party accepted commitments, measures, and designs and specifications in the Section 106 accepted design for the salvage removal, repair and preparation, and reinstallation as an interpretive object of a section of the existing historic steel Lechmere Viaduct. DB Entity shall follow and implement Specifications Section 02224 REMOVAL, PRESERVATION, AND REUSE OF HISTORIC ELEMENTS included in Exhibit 2A.1. These measures and commitments minimally include:

- (a) Exact section to be removed;

- (b) How it will be cut to minimize damage;
- (c) Cleaning, preparation, and repainting, including color, methods of the salvaged section;
- (d) Placement of salvaged section on new concrete footings at the original location and alignment;
- (e) Construction of new concrete footings;
- (f) Intersection treatment of the historic salvaged section and the underside of the new Lechmere Viaduct;
- (g) Provision of bracket for a sign (to be designed by MBTA) to be installed on one of the steel posts explaining what the salvaged section is and directing viewers to the large interpretive display in Lechmere Station;
- (h) Fabrication of previously designed bronze medallions to be placed in the sidewalk; and
- (i) Development of designs to include bronze medallions. See plan sheet LES-A-1200 in Exhibit 2B.1, and Section 7.5.4.2- Lechmere Station.

Refer to plan sheets LEV-X-1000, LEV-X-1001, LEV-S-4007, LEV-S-4011 and LES-A-1200 in Exhibit 2B.1, and Proposed Viaduct Reuse - Option A (4 sheets) and plan sheet LEV-S-4000 in Exhibit 2G.

Area for salvage to be subject to Construction Schedule for Historic Elements and Preconstruction Documentation by Historical Conservator, per Exhibit 2A.1 Section 02224.1.2.D.

Removal and dismantling work to be performed by a qualified Historic Metalwork Specialist in consultation with the Historical Conservator, per Exhibit 2A.1 Section 02224.1.3.B.

Structural steel of the existing Lechmere Viaduct is a Historic Element protected under Specifications Exhibit 2A.1 Section 02224. DB Entity shall salvage structural steel as indicated; no damage shall be done to any item to be salvaged. DB Entity shall use tools and procedures in accordance with Exhibit 2A.1 Sections 02224.3.2 and 02224.3.4. DB Entity shall remove existing rivets in connections via drilling or shearing and punching only, no thermal cutting will be allowed. Dismantle pieces into the largest sections possible for shipping and storage for reuse. Historic Items (Bents 570 and 571 and easterly girder of Connecting Span 570) shall be salvaged and stored in accordance with Exhibit 2A.1 Section 02224.3.5, and then refinished and reinstalled.

Demolition of all structural steel between bents 569 and 572 shall proceed in accordance with this section.

Bent Sections 570 and 571 and easterly girder of Connecting Span 570 are Historic Elements under Exhibit 2A.1 Section 02224. DB Entity and DB Entity's Historical Conservator shall prepare and submit a specific staging sequence for steel viaduct demolition between Bent Sections 569–572, inclusive. Staging sequence document shall be in the form of a Construction Approach for Historic Elements, as described under Exhibit 2A.1 Section 02224.1.2.E.

Concrete portion of Lechmere Viaduct (Pier 13) is a Historic Element protected under Exhibit 2A.1 Section 02224. When demolishing historic concrete elements, DB Entity shall only employ accepted equipment and methods, as described under Exhibit 2A.1 Sections 02224.3.2 and 02224.3. Partially demolish existing concrete cap, strictly limited to extent necessary to allow for reinstallation of structural steel. Existing concrete underpinning to be protected from damage during demolition to allow for reinstallation of structural steel.

All anchor hardware employed in Historic Elements is to be stainless steel, and all anchor hardware and epoxy grout materials proposed to be employed in Historic Elements are to be reviewed by the Historical Conservator before use.

Per Exhibit 2A.1 Section 02224, Historic Elements consisting of Bents 570 and 571 and girders of Span 570 are to be treated as specified and reinstalled on their respective existing piers. Prior to installation, the historic steel bents shall be cut as necessary to fit beneath new steel trapezoidal tub girders, then cleaned and recoated. Shop Drawings and a Structural Procedures Report in accordance with Exhibit 2A.1 Sections 02224.1.2B and 02224.1.2F shall include approximate steel cut lines necessary to fit the bottom profile of the new steel trapezoidal tub girders and shall be submitted and accepted prior to commencement of any Historic Element. Reinstallation will comply with Exhibit 2A.1 Section 02224.3.6. Refer to renderings of Proposed Viaduct Reuse - Option A (4 sheets) in Exhibit 2G.

3.3.5 Noise Mitigation

DB Entity shall provide noise mitigation consistent with the Project commitments included in the Project Finding of No Significant Impact for the Project under full operation (FONSI) and the following requirements, consistent with the methodology included in Section 3.3.5.2 Noise Impact Analysis:

- (a) provide noise mitigation to mitigate severe noise impacts;
- (b) provide mitigation for moderate noise impact where existing day-night average noise levels (Ldn) are above 65 dBA (exterior); and
- (c) provide noise mitigation for impacts with no significant outdoor land use if the interior Ldn is above 45 dBA from Project sources, or if single-event maximum noise levels (Lmax) are above 65dBA (interior).

DB Entity shall provide noise walls identified in the Project Environmental Assessment that met the noise mitigation requirements identified above, as well as the requirement to provide a minimum 5 dBA Noise Reduction at each impacted site are described in Table 3-1. The noise barrier walls in the following table were designed to mitigate airborne noise impacts due to train operations on the Green Line Extension Project consistent with the methods and procedures in the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment guidance manual (Report FTA-VA-90-1003-06, May 2006).

DB Entity is required to revise and update the information provided in Table 3-1 in order to satisfy the requirements listed in this Section 3.3.5 to reflect the final alignment and profile of the Commuter Rail Line and Green Line tracks. DB Entity also shall provide vibration mitigation as in Section 3.3.6, as well as noise mitigation during the construction of the Project as in Section 3.3.7.1.

Table 3-1 Summary of Noise Mitigation Commitments by Means of Noise Barrier Walls

Noise Barrier ID	Noise Barrier Location	Civil Station Number		Absorptive Treatment? (NRC _{min} = 0.7) (Track Side/Both Sides)	Noise Barrier Dimensions	
		Start	End		Length (feet)	Height (feet)
N-1A	Glass Factory ¹	MB-EB 192+74	MB-EB 195+53	Both Sides	279 ea.	12

Noise Barrier ID	Noise Barrier Location	Civil Station Number		Absorptive Treatment? (NRC _{min} = 0.7) (Track Side/Both Sides)	Noise Barrier Dimensions	
		Start	End		Length (feet)	Height (feet)
N-1B		MB-EB 192+25	MB-EB 199+00	Track Side	675	13
N-2A	Brickbottom (northeast façade) ¹	MB-EB 211+53	MB-EB 218+91	Track Side	738	8
N-2B		MAF-1R 39+80	YL3 218+12	Track Side	656	8 to 10
N-3A	Brickbottom (south façade) 1, 2	US-EB 12+32	US-EB 18+68	Track Side	636	12
N-3B		US-WB 5+84	US-WB 11+48	Both Sides	564 ea.	12
N-6	Gilman Street	MB-EB 254+03	MB-EB 262+32	Track Side	396	8 to 18
N-7	Richdale Avenue	MB-EB 276+33	MB-EB 284+69	Track Side	915	8 to 10
N-9A	Vernon Street	MB-EB 298+06	MB-EB 301+11	Track Side	135	10
N-9B		MB-EB 300+50	MB-EB 304+46	Track Side	331	12
N-10	Lowell Street to Charles E. Ryan Road	MB-EB 305+35	MB-EB 314+50	Track Side	842	10 to 18
N-11	Trum playground	MB-EB 320+25	MB-EB 321+60	Track Side	185	16 to 18
N-12	Cedar Street to Wilson Avenue	MB-EB 321+57	MB-EB 324+88	Track Side	265	14 to 16
N-14A	Broadway to Winchester Court	MB-EB 330+37	MB-EB 332+21	Track Side	1,235	8 to 10
N-14B		MB-EB 333+64	MB-EB 336+29	Track Side	305	18
N-14 Ph. 1		MB-EB 336+29	MB-EB 341+94	Track Side	396	8 to 18

Noise Barrier ID	Noise Barrier Location	Civil Station Number		Absorptive Treatment? (NRC _{min} = 0.7) (Track Side/Both Sides)	Noise Barrier Dimensions	
		Start	End		Length (feet)	Height (feet)
N-15	Burget Avenue and Brookings Street	MB-EB 366+62	NH-T1 235+42	Track Side	915	8 to 10
N-17	Charlestown Street and Merriam Street	US-EB 37+23	US-EB 41+94	Track Side	470	16

¹ The noise mitigation commitment for these receptor locations includes track vibration isolation to reduce the contribution of structure-radiated noise to the predicted overall Project noise level.

² The topmost 4 feet of Noise Barriers 3A and 3B for the south façade of Brickbottom shall consist of 4-foot high acrylic panels, such that the total height of each noise barrier does not exceed the height shown in the table above. For a portion of Noise Barrier 3B, 150' shall consist of 8' high acrylic panels (at the topmost portion of the Noise Barrier) such that the total height of the noise barrier does not exceed the height shown in the table above. Final location of this section of the noise wall is US WB 6+30 to US-WB 7+80.

Note that several noise barrier walls that were previously identified in the Environmental Assessment do not appear in Table 3-1. Noise Barriers N-4, N-5, N-8 and N-13 were replaced with sound insulation treatments. In addition, Noise Barrier N-16 is not included in Table 3-1. Summary of Noise Mitigation Commitments by Means of Noise Barrier Walls because it has already been constructed. Noise Barrier N-1B as listed in Table 3-1 was evaluated in conjunction with sound insulation treatments for floors 6 and 7 of the Hampton Inn Hotel site, at 191 Monsignor O’Brien Highway, Cambridge. DB Entity shall provide noise mitigation for severe impacts at the Hampton Inn Hotel up to and including the 5th floor of the hotel. The DB entity is not responsible for sound insulation on floors 6 and 7 of the hotel.

DB Entity shall review consistency of Project design and noise mitigation commitments including both Project-wide commitment and identified range of noise reduction requirements at each impacted location. DB Entity is responsible for confirming that the final design and constructed Project meets noise mitigation commitments.

3.3.5.1 Design Requirements

Noise Barrier Acoustical Design Criteria

The DB Entity shall ensure that all noise barrier designs adhere to the following acoustical design criteria:

- (a) Mitigate all severe noise impacts;
- (b) Mitigate moderate noise impacts, where existing exterior noise levels exceed 65 dBA Ldn;
- (c) Minimize reflected noise to opposite side of the tracks through the use of absorptive treatments on the track side of the barrier, where applicable;

- (d) Reduce estimated future Project noise levels to below the severe impact threshold;
- (e) Reduce estimated future (unmitigated) Project noise levels by at least 5 dBA at impacted receptors; and,
- (f) Break the line-of-sight between exterior ground-level receptors and the top of the MBTA commuter rail trains (i.e. the locomotive exhaust stack).

Noise Barrier Physical Design Criteria

DB Entity shall develop noise barrier plans and designs, and shall perform construction Work in accordance with the Contract Documents. The following is a list of material design standards that shall be used for the noise barriers.

- (a) After installation, all noise barrier walls shall have sound-absorbing panels with the following performance: a minimum NRC (noise reduction coefficient) rating of 0.7 or greater, in accordance with ASTM C423 “Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method,” and a Sound Transmission Class (STC) rating of 30 or greater, in accordance with ASTM E90 and ASTM E413. See also Section 03460 “Noise Barrier Assemblies” in [Exhibit 2A.2](#);
- (b) The topmost 4 feet of Noise Barriers 3A and 3B for the south façade of Brickbottom shall consist of 4-foot high acrylic panels, such that the total height of each noise barrier does not exceed the height shown in Table 3-1. Acrylic panels shall be vertical unless otherwise required to be angled due to noise constraints. Acrylic panels shall have an STC-rating of 30, or greater, in accordance with ASTM E90 “Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions” and ASTM E413 “Classification for Rating Sound Insulation.” ;
- (c) Dimensional lumber will not be used for noise barrier walls or any of its components and shall not be part of the permanent structure. Wood may be used as a component of a non-combustible manufactured “sandwich” wall panel; and
- (d) Any gaps shall be less than 3% of the surface area of the barrier and fill materials shall be used to seal all gaps.

Noise barrier walls may be designed as stand-alone walls supported by shafts or they may be mounted on retaining walls; either mounted on a concrete cap beam or directly mounted on structural steel.

Noise barrier walls shall be designed for wind loads only with no provisions for vehicle impact loads except where noted. The bottom 5 feet of the stand-alone noise wall (formerly known as noise barrier N-3A) at Brick-bottom shall be designed for a vehicle impact force (TL-1) of 13.5 kips which may occur anywhere along the length of the wall. Any other areas along the length of a noise barrier wall which may be impacted by a vehicle will need to be designed accordingly.

In addition to noise barriers, noise mitigation measures include the use of track vibration isolation for some sections of elevated guideway to minimize radiated noise from the structure and the use of specially-engineered trackwork (e.g. flange-bearing, spring-rail or moveable-point frogs) to minimize the increase in noise from special trackwork (turnouts and crossovers). These mitigation components are presented in [Section 3.3.6](#) on Vibration Mitigation.

3.3.5.2 Noise Impact Analysis

DB Entity shall develop a Noise Assessment Protocol that details the methods and procedures to be used for a detailed noise impact assessment, including: the noise prediction model and its inputs (e.g. operations, source levels, types of trains, numbers of trains, etc.); the methods for establishing Existing Noise Exposure. The Noise Assessment Protocol shall be consistent with the methods and procedures in the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment guidance manual (Report FTA-VA-90-1003-06, May 2006). The basis of the FTA's noise impact criteria depend upon comparisons of existing outdoor noise levels and the future outdoor noise levels due to the project, as discussed in detail in Chapter 3 of the FTA guidance manual.

The noise barrier walls summarized in Table 3-1 were developed as a basis of design during development of the Environmental Assessment. DB Entity shall perform a detailed noise impact assessment of the Preliminary Design in accordance with the FTA Transit Noise and Vibration Impact Assessment guidance manual (Report FTA-VA-90-1003-06, May 2006) and prepare a Design Noise and Vibration Mitigation Report (Design NVMR) that will be submitted with the Preliminary Design. The Design NVMR will identify receptors, by FTA land use category, along the entire Project Corridor that would be exposed to airborne noise impacts, ground-borne noise impacts, and ground-borne vibration impacts due to the train operations modeled in its Preliminary Design, including the future unmitigated estimated Project noise levels. Levels of noise impact will be consistent with FTA guidelines and categorized as either severe impacts or moderate impacts. The Design NVMR will identify the locations, dimensions, and acoustical performance of noise mitigation measures that meet the Noise Barrier Acoustical Design Criteria. The Design NVMR will include tables and figures that show the extent of noise impact and the location of all mitigation measures. The basis of the FTA's vibration impact criteria are presented in Chapter 8 of the FTA guidance manual.

DB Entity shall prepare individual Noise Barrier Design Reports (NBDR) – one NBDR for each noise barrier wall to be constructed to mitigate train noise impacts with the Preliminary Design. Each NBDR shall include tables that provide detailed noise barrier design parameters, including: noise barrier height by track Station number; the corresponding top of rail elevation at said Station number; horizontal offset from and perpendicular to the near track centerline at said Station number; noise barrier base elevation at said Station number, and the noise barrier top elevation at said Station number. Each NBDR also shall include plan views, profiles, and cross-sections that show the noise barrier design, the impacted receptors for which mitigation is required. Each NBDR shall identify any supplemental noise mitigation measures that may be required to reduce future Project noise levels to below the severe impact threshold, such as the use of track vibration isolation to reduce the contribution of structure-radiated noise to the overall Project noise level.

As the Project design develops from Preliminary Design to Release for Construction Design (See [Section 2.7](#)), DB Entity shall submit revised NBDRs, at intermediate phases, for each noise barrier wall design that changes as a consequence of changes to the Project design, including changes in the track horizontal and/or vertical alignment.

Each document produced under this sub-section shall be identified and numbered in a manner consistent with [Section 2.7.1](#).

3.3.5.3 Noise Mitigation Design Review

Noise mitigation design review shall be conducted in accordance with the Design Review Process in Section 2.7.2 of these Technical Provisions. MBTA shall have the right to review and comment on all documents and noise barrier wall designs described under Section 3.3.5.1.

3.3.6 Vibration Mitigation

DB Entity shall provide mitigation for ground-borne vibration from train operations consistent with the Project commitments included in the Project FONSI and the following requirements: maintain vibration levels due to commuter trains at or below the greater of existing vibration levels and the applicable vibration criterion (i.e. 75 VdB for residential, 78 VdB for institutional receptors); maintain vibrations levels due to Green Line trains below applicable impact criteria (i.e. 72 VdB for residential, 75 VdB for institutional receptors).

Table 3-2 summarizes the locations, length, and rail line of vibration mitigation that meets the design requirements above, as well as the Project commitments included in the FONSI. The table identifies a total of 16 track vibration isolation locations that are required to mitigate potential noise and vibration impacts at 19 locations from the MBTA Green Line Extension. Note that some of the vibration isolation locations summarized in the following table are required to minimize noise radiated from elevated guideways. DB Entity is required to revise and update the information provided in the following table to reflect the ultimate alignment and profile of the Commuter Rail Line and Green Line tracks. DB Entity shall comply with the requirements of Exhibit 2H specifications 02866 Ballast Material.

DB Entity shall review consistency of Project design and vibration mitigation commitments including both Project-wide commitments and identified range of vibration reduction requirements at each impacted location. DB Entity is responsible for confirming that the final design and constructed Project meets vibration mitigation commitments.

Table 3-2 Summary of Vibration Mitigation Commitments by Means of Vibration Isolation

Vibration Mitigation Identifier	Vibration Mitigation Location	Start (Station Number)	End (Station Number)	Tracks
V-1	Glass Factory Condominiums ¹	MB-EB 191+64	MB-WB 198+66	MB-WB & MB- EB
V-2	Brickbottom Artists Building (northeast façade) ¹	MB-EB 211+65	MB-EB 218+12	MB-WB & MB- EB
V-3a	Brickbottom Artists Building (south façade) ²	US-EB 11+75	US-EB 19+00	US-EB
V-3b	Brickbottom Artists Building (south façade) ²	US-WB 4+80	US-WB 12+00	US-WB
V-4	Alston St (south of Cross St)	MB-WB 242+87	MB-WB 245+87	MB-WB & MB- EB

Vibration Mitigation Identifier	Vibration Mitigation Location	Start (Station Number)	End (Station Number)	Tracks
V-5 & 6	Tufts St/Avon Pl/Auburn Ave (south of Cross St to McGrath Highway) & Gilman Street (McGrath Highway to Walnut Street)	NH-T1 99+00	NH-T1 118+30	NH-T1 & NH- T2
V-7	Medford St (north of Walnut St)	MB-EB 261+15	MB-WB 265+17	MB-WB & MB- EB
V-8	Pearl Street Apartments	NH-T1 123+30	NH-T1 125+30	NH-T1 & NH- T2
V-9	Richdale Ave (School St to Sycamore St)	NH-T1 132+80	NH-T1 141+80	NH-T1 & NH- T2
V-10	Lowell St/Nashua St/Hinckley St/Berwick St (Lowell St to Charles E Ryan Rd)	NH-T1 158+30	NH-T1 170+30	NH-T1 & NH- T2
V-11	Murdock St (south of Cedar St)	MB-WB 316+59	MB-WB 320+59	MB-WB & MB- EB
V-12	Cedar St (north of Cedar St)	NH-T1 177+30	NH-T1 178+80	NH-T1 & NH- T2
V-13	Newbern Ave/Morton Ave/Granville Ave/Winchester Pl/Wareham St (Broadway to Warren St)	NH-T1 186+30	NH-T1 198+06 to NH- T2 199+77	NH-T1 & NH- T2
V-15 & V- 17 & V-18	Tufts Bacon Hall, Bray Labs, Psychology and Curtis Hall	MB-WB 353+09	MB-WB 364+11	MB-WB & MB- EB
¹ Mitigation to reduce airborne noise from elevated structure. ² Mitigation on Union Square Inbound track is to reduce airborne noise and mitigation on Union Square Outbound track is for ground-borne vibration.				

Note that several vibration mitigation locations that were previously identified in the Environmental Assessment do not appear in Table 3-2. Vibration mitigation locations V-14, V-16 and V-19 have been completed. In addition, vibration mitigation at Location V-13 has been partially completed.

3.3.6.1 Vibration Impact Analysis

DB Entity shall develop a Vibration Assessment Protocol that details the methods and procedures to be used for a detailed vibration impact assessment, including: the prediction model and its inputs (e.g. operations, source levels, types of trains, numbers of trains, etc.); the methods for establishing existing vibration levels, as needed. The Vibration Assessment Protocol shall be consistent with the methods and procedures of the Detailed Vibration Assessment in the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment guidance manual (Report FTA-VA-90-1003-06, May 2006).

The vibration mitigation locations summarized in the previous table were developed as a basis of design. DB Entity shall perform a detailed vibration impact assessment of the Preliminary Design in accordance with the FTA Transit Noise and Vibration Impact Assessment guidance manual (Report FTA-VA-90-1003-06, May 2006) and prepare a section on vibration that will be included in the Design NVMR to be submitted with the Preliminary Design. The Design NVMR will identify receptors, by FTA land use category, along the entire Project Corridor that would be exposed to ground-borne vibration impacts due to the train operations with Preliminary Design. The Design NVMR will identify the locations, dimensions, and performance of mitigation measures that meet the general requirements above. The Design NVMR will include tables and figures that show the extent of ground-borne vibration impact and the location of vibration mitigation.

3.3.6.2 Vibration Mitigation Design Review

Vibration mitigation design review shall be consistent with the Design Review Process in Section 2.7.2.

3.3.7 Environmental Requirements

DB Entity shall perform the Work in compliance with:

- (a) Emission Limits;
- (b) Construction Noise and Vibration;
- (c) MBTA Sustainable Construction, Vehicles, And Equipment Policy requirements defined in Section 3.3.7.2;
- (d) MBTA Construction and Demolition Waste Management Plan requirements defined in Section 3.3.7.3;
- (e) Smoking shall not be permitted during construction while onsite, within the buildings, or within 25 feet of entrances, operable windows, or outdoor air intakes;
- (f) Any other restrictions as determined by the Governmental Entities as it relates to any and all changes DB Entity proposes to the Contract Documents;
- (g) Construction IAQ Management Plan requirements defined in Section 3.3.3 and Section 01800 in Exhibit 2I.
- (h) Integrated Pest Management Plan requirements defined in Section 01565 in in Exhibit 2I.
- (i) Pre-Purchased Equipment and Materials Productive Use Plan requirements defined in Section 3.3.3 and Section 01800 in Exhibit 2I.
- (j) Landscape Tracking Plan requirements defined in Section 3.3.3 and Section 01800 in Exhibit 2I.
- (k) Sustainable Materials Plan requirements defined in Section 3.3.3 and Section 01800 in Exhibit 2I.

DB Entity shall comply with the applicable requirements of the Environmental Protection Agency's National Emission Standards for Hazardous Air Pollutants, Part 61, Chapter I, Title 40, Code of Federal Regulations.

3.3.7.1 Construction Noise and Vibration Control

DB Entity shall comply fully with all governmental guidelines and noise limits.

(a) Noise Control Plan

DB Entity shall prepare and submit a Noise Control Plan to the MBTA for review and acceptance prior to any construction activity. The Noise Control Plan shall be Project specific and deal with the equipment and the methods of construction to be used. The Noise Control Plan shall at a minimum require (1) the use of specifically quieted equipment with enclosed engines, high performance mufflers, or both, (2) construction equipment noise certification testing, (3) ambient adjusting or manually adjusted back-up alarms set to 5 dBA over background noise levels, (4) a program for the minimization of truck and equipment idling, (5) acoustic shields for jackhammers, chain saws, pavement breakers, and other exceptionally loud equipment, (6) an approach for responding to community complaints, and (7) a protocol for reporting noise monitoring results, noise reduction initiatives, and responses made to the community.

(b) Noise and Vibration Complaint Report

DB Entity shall submit a Noise and Vibration Complaint Report to the MBTA within seven (7) days of the receipt of a community complaint related to construction noise or vibration. The report shall document the construction activity or equipment that was the subject of the complaint, noise and/or vibration monitoring results, subsequent actions undertaken to control noise and/or vibration, and copies of responses to the community. One report shall be prepared per complaint. In the event multiple complaints are received from a single entity within the community, DB Entity shall coordinate with the MBTA to determine the appropriate response protocol.

(c) Federal and State Guidelines and Limits

DB Entity shall comply with all applicable government noise limitations and requirements, including National Environmental Policy Act (NEPA), Massachusetts Environmental Policy Act, Certificate of Energy and Environmental Affairs on the Notice of Project Change, Notice of Project Change, Green Line Extension Project, EEA #133886, the FTA Transit Noise and Vibration Impact Assessment (May 2006 or the most recent version if updated), and OSHA Occupational Noise Exposure Hearing Conversation Amendment.

(d) Noise Minimization

DB Entity shall use every reasonable effort and means possible to minimize noises caused by construction operations including:

- (i) Locating stationary construction equipment as far as possible from noise sensitive sites;
- (ii) Installing or constructing temporary noise barriers such as walls or piles of excavated material between noisy activities and sensitive areas, or applying acoustic enclosures;
- (iii) Take immediate measures to eliminate or minimize noise which the MBTA considers objectionable;
- (iv) Provide working machinery and equipment designed to operate with the least possible noise, and when gearing is used, such gearing shall be of a type designed to reduce noise to a minimum.
- (v) Equip compressors with silencers on intake lines;
- (vi) Equip gas or oil operated equipment with silencers or mufflers on intake and exhaust

- lines;
- (vii) Fit any air-powered equipment with pneumatic exhaust silencers;
- (viii) Wherever practicable, electricity shall be used for power to reduce noise;
- (ix) Dumping bins, hoppers, and trucks used for disposal of excavated materials shall be lined with wood or other sound-deadening material if deemed necessary by the MBTA; and
- (x) Ambient adjusting or manually adjusted back-up alarms set to 5 dBA over background noise levels.

3.3.7.2 MBTA Sustainable Construction, Vehicles, and Equipment Policy

All rented and DB Entity-owned equipment greater than 50 horsepower, and all vehicles that will be located at the Project for at least thirty (30) cumulative days during the performance of the Work shall comply with the following:

MBTA Anti-Idling Policy

- (a) All vehicles shall comply with the MBTA Anti-Idling Policy.
- (b) Anti-idling signage shall be provided at all storage yards and work sites.
- (c) The MBTA Anti-Idling Policy shall be included in all subcontractor contracts.

Construction

- (a) Construction sites shall be kept clean and tidy to avoid pest infestations.
- (b) Store components off the ground and protect from the weather.

Construction Equipment and Vehicles

- (a) DB Entity shall develop and implement a plan to reduce particulate matter (PM) emissions from non-road and on-road diesel fueled vehicles, construction equipment, and temporary power generation used during the Project.
- (b) Non-road construction equipment with a power rating over 50 horsepower shall meet the requirements of MassDOT's revised diesel retrofit specification.
- (c) On-road construction vehicles shall meet Massachusetts's diesel emission test requirements.
- (d) All non-road and on-road diesel fueled construction vehicles, construction equipment, and temporary power generation shall use ultra-low-sulfur-diesel (ULSD) fuel.
- (e) Vehicle and equipment schedules to demonstrate that the requirements of this policy are achieved shall be submitted to the MBTA on a monthly basis.
- (f) Supporting Documentation should be submitted annually that includes the following information for each piece of equipment:
 - (i) Vehicle type;
 - (ii) Engine make;
 - (iii) Engine model number;
 - (iv) Serial number of engine;

- (v) Engine family name and model year;
- (vi) Horse power and/or Kilowatts (for non-road only);
- (vii) Current Tier level (for non-road only);
- (viii) Serial number and VIN of vehicle;
- (ix) Make and model number of USEPA/CARB verified emission control technology, if applicable (or local equivalent for projects outside the U.S.);
- (x) Type of fuel used; and
- (xi) Number of use hours (if available).

Locate equipment, vehicles, and loading/unloading staging areas away from air intakes or operable openings of adjacent buildings.

3.3.7.3 Construction and Demolition Waste Management Plan

The DB Entity shall comply with the following sustainable waste management requirements:

- (a) Develop and implement a Construction and Demolition Waste Management Plan. Plan shall be submitted to MBTA for acceptance within sixty (60) days from Notice to Proceed. Plan shall include waste identification, anticipated percentage breakdown of materials, and a waste reduction work plan.
 - (i) Waste Identification: Indicate anticipated types and quantities/percentages by weight or volume of demolition, site-clearing, and construction waste generated by the Work. Use same units of measure throughout Construction and Demolition Waste Management Plan. Include estimated quantities and assumptions for estimates. Indicate whether the quantities are from sorting on-site or from comingled collection. In the case of comingled collection, indicate the diversion rates from the recycling facility's monthly totals for use as totals on this Project
 - (ii) Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. At a minimum, types of waste must include wood, paper and cardboard, concrete, metals, and mixed construction and demolition waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - (iii) Concurrent with each partial Payment request, or monthly basis (whichever is most appropriate), submit a Waste Management Progress Report, substantially in the form set forth in Exhibit 2I, Section 01800, to the Engineer that demonstrates progress towards Project recycling goal.
 - (iv) Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of Construction and Demolition Waste Management Plan; provided, however, that as between DB Entity and MBTA, DB Entity is responsible for such implementation, monitoring, and reporting.
- (b) Target end-of-Project rates for salvage/recycling of at least 90% by weight of total non-hazardous solid construction and demolition waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators.

- (c) Construction and demolition waste shall be tracked and reported on a monthly basis. Where the 90 percent target is not achieved each month the DB Entity shall explain reasons why this is the case.
- (d) Achieve end-of-Project rates for reuse/composting of at least 90 percent by weight of total non-hazardous landscaping waste generated by the Work. Use all reasonable means to divert construction waste from landfills and incinerators.
- (e) Train workers, Subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
- (f) Recycle paper and beverage and food containers and all other metal, glass, plastic and/or paper recyclables used by on-site workers.
- (g) Develop and implement a Hazardous Waste Management Plan to identify how hazardous waste will be recycled or disposed of via proper handling procedures. At least 80 percent of all hazardous waste materials that is able to be recycled should be recycled.
- (h) Use all reasonable means to divert construction and demolition waste from landfills and incinerators.
- (i) Separate recyclable waste from other waste materials, trash, and waste. Separate recyclable waste by type at Project site to the maximum extent practical according to accepted Construction and Demolition Waste Management Plan.
- (j) All non-hazardous soil will be reused at least 50% to the extent possible and where appropriate for planting. Any soil proposed for onsite reuse shall meet the requirements as outlined in Section 02932 Planting Soils in Exhibit 2A.2, and Section 7.5 of the Technical Provisions. Soils may be amended, if possible, and retested to meet the requirements. Soils not meeting these standards will not be allowed for reuse in planting areas within the project limits.

3.4 Deliverables

Table 3-3 reflects a nonexclusive list of deliverables identified in these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.1.3, unless otherwise specified in the Contract Documents:

Table 3-3: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Comprehensive Environmental Protection Plan	2	1	No more than 60 days after issuance of NTP	3.3.2
Environmental Mitigation and Monitoring Plan	2	1	No more than 60 days after issuance of NTP	3.3.2.1

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Noise Assessment Protocol	2	1	Within 90 days after NTP	3.3.5.2
Design Noise & Vibration Mitigation Report	2	1	With the submittal of the Preliminary Design	3.3.5.2
Noise Barrier Design Reports	2 per noise barrier	1 per noise barrier	With the submittal of the Preliminary Design	3.3.5.2
Revised Noise Barrier Design Reports (as needed)	2 per noise barrier	1 per noise barrier	With the submittal of the Intermediate Design	3.3.5.2
Final Noise Barrier Design Reports	2 per noise barrier	1 per noise barrier	With the submittal of the request for Release for Construction	3.3.5.2
(Construction) Noise Control Plan	2	1	30 days prior to construction	3.3.7.1
Noise and Vibration Complaint Report	2 per complaint	1 per complaint	Within 7 days of receipt of complaint.	3.3.7.1
Vehicle and equipment schedules demonstrating that the MBTA Sustainable Construction, Vehicles, and Equipment Policy requirements of <u>Section 3.3.7.2</u> are achieved	2	1	Monthly	3.3.7.2
Report the total number of trees planted and the source of these trees	2	1	Once, at the Contract Substantial Completion	
Historic Conservator Qualifications	2	1	Within 30 days after NTP	3.3.4

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Submittals for review and acceptance by the MBTA. a. Removal Specialists Qualifications b. Shop Drawings c. Construction Schedule for Historic Elements d. Preconstruction Documentation e. Construction Approach for Historic Elements f. Structural Procedures Report g. Cleaning and Protection	2	1	Due 14 days prior to any scheduled Work	3.3.4
Phase I: Preliminary designs and specifications for Lechmere, Gilman Square, Ball Square and College Avenue Stations; New Lechmere Viaduct; location and design of interpretive displays at Lechmere, Ball and Gilman Square stations; and salvage and reuse of section of historic steel Lechmere Viaduct, including bronze sidewalk medallions for Section 106 review	2	1	Refer to <u>Section 2.7</u>	3.3.4
Phase II: Intermediate designs and specifications for Lechmere, Gilman Square, Ball Square and College Avenue Stations; New Lechmere Viaduct; location and design of interpretive displays at Lechmere, Ball and Gilman Square stations; and salvage reuse of section of historic steel Lechmere Viaduct, including bronze sidewalk medallions for Section 106 review	2	1	Refer to <u>Section 2.7</u>	3.3.4

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Phase III: Pre - Release for construction design and specifications for Lechmere, Gilman Square, Ball Square and College Avenue Stations; New Lechmere Viaduct; location and design of interpretive displays at Lechmere, Ball and Gilman Square stations; and salvage reuse of section of historic steel Lechmere Viaduct, including bronze sidewalk medallions, for Section 106 review	2	1	Refer to <u>Section 2.7</u>	3.3.4
Vehicle and equipment schedules demonstrating that the MBTA Sustainable Construction Vehicles and Equipment Policy requirements of <u>Section 4.4.6.2</u> are achieved.	2	1	Monthly	
ISI Envision Checklist and narrative	2	1	Twice a year, on the anniversary of the Effective Date, until the Contract Final Acceptance	3.3.3
ISI Envision Credits Documentation	2	1	Once, at the Contract Final Acceptance	3.3.3
Waste Management Progress Report	2	1	Monthly	Section 01800 (<u>Exhibit 21</u>)- Sustainability Requirements
Waste Management Final Report	2	1	Once, at Contract Final Acceptance	Section 01800 (<u>Exhibit 21</u>)- Sustainability Requirements
Construction and Demolition Waste Management Plan	2	1	No more than 60 days after issuance of NTP	Section 01800 (<u>Exhibit 21</u>)- Sustainability Requirements

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Construction Indoor Air Quality Management Plan	2	1	No more than 60 days after issuance of NTP	Section 01800 (Exhibit 2I)- Sustainability Requirements
Construction Indoor Air Quality Management Plan Final Report	2	1	Once, at the Contract Final Acceptance	3.3.3
Integrated Pest Management Plan	2	1	No more than 60 days after issuance of NTP	Section 01565 (Exhibit 2I)- Integrated Pest Management specification
Pre-Purchased Equipment and Materials Productive Use Plan	2	1	No more than 60 days after issuance of NTP	Section 01800 (Exhibit 2I)- Sustainability Requirements
Stormwater Pollution Prevention Plan	2	1	30 days after issuance of NTP	3.3.2.3
Sustainable Materials Tracking Plan	2	1	No more than 60 days after issuance of NTP	3.3.3
Sustainable Materials progress reports.	2	1	Monthly	3.3.3
Sustainable Materials Final Report	2	1	Once, at Contract Final Acceptance	3.3.3
Landscape Tracking Plan	2	1	No more than 60 days after issuance of NTP	3.3.3
Landscape Tracking progress reports	2	1	Monthly	3.3.3
Landscape Tracking Plan Final Report	2	1	Once, at Contract Substantial Completion	3.3.3

The above listed final document submissions shall be electronically submitted to the MBTA.

END OF SECTION

4 HAZARDOUS MATERIALS AND MATERIALS MANAGEMENT

4.1 Scope of Work

The Work includes excavation and handling of soil (including stone ballast, sediments and track bed for purposes of this Section) and debris that may be contaminated with oil and/or hazardous materials (OHM) as defined in 310 CMR 40.0000 (the Massachusetts Contingency Plan, or MCP). The DB Entity shall excavate, stockpile, sample, and manage the excavated materials in accordance with the accepted Excavated Materials Management Plan (EMMP), discussed in Section 4.4.1. Some excavation work will be conducted within the disposal site boundaries of known Release Tracking Numbers (RTNs). Therefore, the excavation activities in these areas shall be completed in accordance with the accepted EMMP and coordinated with the MBTA's Licensed Site Professional (LSP). All MCP documentation related to the RTNs created prior to the Effective Date will be the responsibility of the MBTA and its LSP. DB Entity shall coordinate with the MBTA and MBTA's LSP to close all such RTNs. The DB Entity's LSP shall be responsible for any Release of OHM caused by DB Entity's operations, and any associated RTNs.

The Work also includes dewatering of groundwater potentially contaminated with OHM. The DB Entity shall manage contaminated groundwater in accordance with the requirements of the 2017 Remediation General Permit (RGP). Unless otherwise required by the Contract Documents, the DB Entity shall secure coverage under the 2017 RGP for any dewatering at contaminated sites.

The DB Entity shall demolish certain structures that contain hazardous building materials, including asbestos, lead-based paint, mold, PCBs, mercury and others. The DB Entity shall abate all hazardous building materials prior to demolition of any structure(s). Hazardous Building Materials reports and Phase I Environmental Site Assessment Reports are provided among the Reference Information Documents.

Hazardous Building Materials

The Contract Price includes, as part of the Work, presumptions with respect to encountering and abating quantities of hazardous building materials as set forth in the table below. The Contract Price includes full compensation for encountering and abating the following quantities of hazardous building materials:

Quantity	Unit	Item
2,824	Linear Foot	Disposal of Asbestos Containing Materials
51,531	Square Foot	Disposal of Asbestos Containing Materials
49,578	Square Foot	Disposal of Polychlorinated Biphenyl Containing Materials
14	55-Gallon Drum	Disposal of Oil Containing Drums
1,265	Gallon	Disposal of Waste Rags / Waste Solvents
1,020	Gallon	Disposal of Printing Ink and Waste Ink
385	Gallon	Disposal of Surface Cleaners / Auto Wash
2,916	Each	Disposal of Fluorescent Light Bulbs
1,376	Each	Disposal of Fluorescent Light Bulb Ballasts
4	Fixture	Disposal of Mercury Containing Lamps

Quantity	Unit	Item
30,000	Gallon	Disposal of Ethanol and Alcohol

These materials have been found on or within the following structures: 48 Third Avenue, Somerville; 350 Medford Street, Somerville; 642-646 and 662 Boston Avenue, Medford; 664 Boston Avenue/675 Broadway Somerville; Lechmere Station, Cambridge; Lechmere Viaduct, Cambridge; and the Washington Street Bridge, Somerville.

Soil Excavation

The Contract Price includes, as part of the Work, all costs for excavating, stockpiling, testing and classifying soil regardless of the quantity and type/classification of the soil involved. The Contract Price includes full compensation for all excavation, stockpiling, testing and classifying of soil.

Transportation and Disposal of Soil

The Contract Price includes all costs for identifying disposal facilities, gaining approval from the disposal facilities, preparing disposal paperwork, loading excavated soil, and transportation and disposal of soil in the classifications and quantities as set forth in the table below. The Contract Price includes full compensation for all Work required or reasonably necessary to transport and dispose of the following classifications of soil in the following quantities:

Classification	Quantity (tons)	Item
Class A	All	Managed fill locations (<RCS-1 or RCS-2)
Class B-1	29,535	In-state unlined landfill daily cover
Class B-2	660	In-state unlined landfill disposal
Class B-3	7,425	Asphalt-batch recycling
Class B-4	0	Out-of-state thermal treatment
Class B-5	12,870	Non-RCRA out-of-state landfill disposal
Class C-1	165	Characteristically hazardous – may be treated to be non-hazardous
Class C-2	0	Listed hazardous waste – must be sent to approved RCRA Subtitle C treatment or disposal facility

The DB Entity shall make all reasonable efforts to avoid the need to transport and dispose of soil off-Site in quantities that exceed the quantities shown in the table above. If the Work requires transportation and off-Site disposal of excavated soil in quantities that exceed the quantities shown in the table above for a specific soil classification with the exception of Class A, the costs for transportation and disposal of the quantity of soil in excess of the quantities shown in the table will be paid for by the Allowance established in Section 14.1.2.4 of Volume 1. Notwithstanding the preceding sentence, the DB Entity shall not be

entitled to any payment from the Allowance, and shall not be entitled to any Change Order, for transportation or disposal of soil (of any classification) that reasonably could have been left on Site.

The DB Entity may encounter contaminated groundwater at portions of the Site where dewatering is required. In these areas, the DB Entity shall obtain coverage under the 2017 RGP, and groundwater treatment may be required, unless otherwise required by the Contract Documents. These areas include, but are not limited to, the Washington Street area in Somerville and the Union Square area in Somerville. The DB Entity shall work diligently and without interruption to the extent possible within areas of known groundwater contamination to minimize and reduce the amount of water to treat and dispose of. If Work requiring the use of a groundwater treatment system is suspended for any reason, the DB Entity shall provide notification of the event to the MBTA no later than 2 days after the occurrence of the event or notification in accordance with Section 15.7 of Volume 1. The DB Entity shall provide prompt written notice to the MBTA when treatment will commence and upon any interruptions of the groundwater treatment system. The DB Entity shall communicate with MBTA regarding the treatment as to special field engineering reports, complications, upcoming work, and any adjustments to the treatment system required.

Allowance Items for the treatment of contaminated groundwater only applies to Washington Street and Union Square areas in Somerville. All other costs associated with construction dewatering are included in the Contract Price.

4.2 Background

Existing information available for key MCP sites identified along the Project corridor with active RTNs and other sites with available historical environmental assessments are provided in this section for use by the DB Entity. The DB Entity shall familiarize itself with all relevant available information. A partial list of available MCP Reports and other environmental information is provided in the Reference Information Documents. Other documents that may contain additional site-specific information are available on the MassDEP website for each RTN:

<http://public.dep.state.ma.us/SearchableSites2/Search.aspx>

4.2.1 21 Water Street

The property at 21 Water Street is owned by the MBTA, and has been used in the past for MBTA vehicle tire maintenance as well as a parking lot. The former on-site building was constructed of concrete masonry units and a concrete slab-on-grade. Window and expansion joint caulking was found to contain elevated concentrations of PCBs, and MBTA undertook a Self-Implementing Plan (SIP), in coordination with USEPA, to remove and properly manage PCB-impacted building materials prior to demolition.

Sampling of soil and asphalt in the vicinity of the building has been performed. A total of 159 soil samples and a total of 85 asphalt samples have been analyzed to date. Based on the asphalt sampling and analysis, a total of 122.07 tons of asphalt was removed from adjacent to the western, southern and eastern sides of the building slab, and disposed off-site. Soil from an on-site soil pile was used to backfill the voids where asphalt was removed from the property.

No PCB-impacted soil has been removed from the property to date. Soil removal is subject to USEPA authorization under an amended SIP currently being prepared on behalf of the MBTA. Once approved by

EPA, the amended SIP will be provided to the DB Entity. Prior to construction being completed, the DB Entity shall address the remaining soil and asphalt contamination as part of the Work.

Additionally, three (RTNs) have been linked together under RTN 3-18502 for the release of gasoline to soil and groundwater from an on-site underground storage tank (UST) and detection of light non-aqueous phase liquid (LNAPL). A Permanent Solution Statement (PSS) with Conditions was filed for this site in February 2016. An Activity and Use Limitation (AUL) was filed for a portion of the property in February 2016.

PCBs are known to exist in the soil. Gasoline contamination and LNAPL have been identified in the groundwater. Specifically, the contamination is expected to include EPH and VPH constituents, including benzene, ethylbenzene, methyl-tert-butyl ether, toluene, xylenes, naphthalene, C5-C8 aliphatics, C9-C12 aliphatics, C9-C10 aromatics, VPH and EPH fractions, and polycyclic aromatic hydrocarbons.

4.2.2 22 Water Street

The property at 22 Water Street was recently redeveloped as a multi-family residential/commercial building. Historically, the site had been developed since the mid-1800s with various industrial occupants, including the Winchester Soap Works Manufacturer, the Revere Sugar Refinery Factory, the Wellington and Buck Wood & Coal Yard, the Johns-Manville Corporation (a manufacturer of asbestos insulation and roofing), the John McCourt Asphalt Mixing company, the Bay State Smelting Corporation, the Clark-Lurton Corporation (primarily a warehousing operation), and the Mac-Gray Company (a household and commercial laundry appliance warehouse, which reportedly stored virgin and waste chlorinated solvents on-site).

Five Release Tracking Numbers (RTNs) are associated with the property including 3-1532, 3-30560, 3-31471, 3-31695, and 3-31829. Reports related to each of these RTNs are referenced in the Reference Information Documents.

RTN 3-1532 is associated with a historical petroleum release that was associated with the removal of several underground storage tanks (USTs) from a former gasoline Station that had been located in the northeastern portion of the site. A Class B-1 Response Action Outcome (RAO) was reportedly filed for this RTN.

RTN 3-30560 is associated with trichloroethylene (TCE), tetrachloroethylene (PCE) and metals (arsenic, cadmium, chromium, and lead) in soils at concentrations that exceeded RCS-1 standards. The release was originally reported to Massachusetts Department of Environmental Protection (MassDEP) in January 2012 and was attributed to urban fill material known to exist across the site and the historic industrial/commercial usage of the property. Concentrations of nickel in soil and PCE and dissolved lead in groundwater were later reported above applicable RCs under this RTN. An Activity and Use Limitation (AUL) and combined Release Abatement Measure (RAM) Completion Report and Permanent Solution Statement with Conditions Report was filed for the site in April 2016. Over 2,200 cubic yards of contaminated soil were sent to an asphalt batch facility and over 3,400 cubic yards of contaminated soil were disposed at two landfills as part of the RAM activities.

RTN 3-31471 is associated with the December 2012 detection of total petroleum hydrocarbons, C11-C22 aromatics, 2-methylnaphthalene, naphthalene, and 1,3,5-trimethylbenzene in soil at concentrations

greater than RCS-1 standards. The MassDEP Sites Database lists this RTN as being closed as the RTN was reportedly linked to RTN 3-30560.

RTN 3-31695 is associated with the detection of dense non-aqueous phase liquid (DNAPL) in the southern portion of the property near the historic location of a “gas works” and “gas holder”. Based on assessment activities completed, coal tar was identified in the area at a depth of approximately 60 feet. An Immediate Response Action (IRA) Completion Report, Phase I Site Assessment, Tier II Tier Classification, and Phase II Scope of Work were submitted for the site in August 2014.

RTN 3-31829 is associated with the discovery of dissolved lead in groundwater above applicable Reportable Concentrations (RCs) at the northerly adjacent Northpoint Development Site and the dissolved lead in groundwater on the 22 Water Street site. A Phase I Site Assessment, Tier II Tier Classification, and Phase II Scope of Work were submitted for the site in February 2015

Based on the industrial/commercial history of the property and surrounding area, the use of historic fill on-site, and the documented releases on-site, the following contaminants could be encountered on the property: petroleum constituents, chlorinated solvents, metals, polynuclear aromatic hydrocarbons (PAHs) in soil and groundwater, as well as coal tar DNAPL in groundwater.

4.2.3 Washington Street Utilities

Groundwater in the vicinity of Washington Street in Somerville has been impacted by a release of chlorinated volatile organic compounds (CVOCs) from the property at 50 Tufts Street owned by UniFirst Corporation. Underground construction in and near Washington Street will encounter the contaminated groundwater. To the extent that dewatering will be required for construction, the DB Entity shall address the contamination.

The predominant contaminants present in groundwater include Tetrachloroethylene (PCE), Trichloroethylene (TCE), 1,1,1-Trichloroethane (TCA), and 1,1-Dichloroethylene. Other CVOCs as well as non-chlorinated volatile organic compounds (VOCs) are also present in the groundwater. Naturally-occurring iron is present in the groundwater at concentrations that might require treatment.

The DB Entity shall anticipate total VOC concentrations in groundwater to exceed 50,000 µg/L.

4.2.4 Ball Square Station

Two RTNs associated with the Ball Square Station area include 3-32975 and 3-30612.

4.2.4.1 RTN 3-32975 at 664 Boston Avenue and 675 Broadway

The properties are located at 664 Boston Avenue and 675 Broadway in Somerville and Medford. The 675 Broadway property is occupied by a vacant building and parking lot. The 664 Boston Avenue property contains two buildings, one has historically operated as an automotive repair facility and the other building as a bowling alley.

RTN 3-32975 is associated with reportable concentrations of lead and PAHs in soil and both VOCs and petroleum hydrocarbon fractions in groundwater.

4.2.4.2 RTN 3-30612 at 662 Boston Avenue

The property located at 662 Boston Avenue in Ball Square, Medford has operated as an automotive repair shop and/or sales business since at least 1930 and was reportedly a garage for a coal company circa 1911.

RTN 3-30612 is associated with reportable concentrations of lead in soils and lead, VOCs, and petroleum hydrocarbon fractions in groundwater.

4.2.5 Union Square Station

Eight RTNs associated with the Union Square Station area include 3-32976, 3-30848, 3-30849, 3-30850, 3-32130, 3-32131, 3-24339, and 3-24921.

4.2.5.1 RTN 3-32976 at 35 Charlestown Street

The property located at 35 Charlestown Street in Somerville is currently occupied by the Walnut Street Center, Inc., a nonprofit human services agency for adults with developmental disabilities. The eastern portion of the Site is occupied by a slab-on-grade building, with an associated parking lot on the western half of the property. With the exception of a small grass strip along the northern parking lot edge, the entire Site is paved or covered by the building slab.

RTN 3-32976 is associated with reportable concentrations of arsenic, PAHs, and petroleum hydrocarbon fractions in soils.

4.2.5.2 RTN 3-30848 at 40 Bennett Street

The property located at 40 Bennett Street in Somerville is a commercial property occupied by a large industrial building and surrounded by asphalt paved parking areas.

RTN 3-30848 is associated with reportable concentrations of metals, VOCs, and PAHS in soil and groundwater.

4.2.5.3 RTN 3-30849 at 50 Prospect Street

The property located at 50 Prospect Street in Somerville is a commercial property occupied by a large industrial building and surrounded by asphalt paved parking areas.

RTN 3-30849 is associated with reportable concentrations of metals in the soils.

4.2.5.4 RTN 3-30850 at 51 Allen Street

The property located at 51 Allen Street in Somerville is occupied by a garage building and is currently owned by the Somerville Redevelopment Authority. Previous tenants have included an automobile repair shop, a parts salvage operation, a sawdust distributor, and a fuel oil distributor.

RTN 3-30850 is associated with non-aqueous phase liquid (NAPL) in groundwater.

4.2.5.5 RTN 3-32130 at 49-51 Allen Street

The property located at 49-51 Allen Street in Somerville is occupied by a garage building and is currently owned by the Somerville Redevelopment Authority. Previous tenants have included an automobile repair shop, a parts salvage operation, a sawdust distributor, and a fuel oil distributor.

RTN 3-32130 is associated with reportable concentrations of petroleum hydrocarbons, PAHs, and metals in soils.

4.2.5.6 RTN 3-32131 at 40 Bennett Street

The property located at 40 Bennett Street in Somerville is currently owned by the Somerville Redevelopment Authority and is the former location of the Prospect Iron & Steel Corporation, a scrap metal salvaging yard.

RTN 3-32131 is associated with reportable concentrations of EPH, PCBs, and metals in soils.

4.2.5.7 RTN 3-24339 at 49-51 Allen Street

The property located at 49-51 Allen Street in Somerville is occupied by a garage building and is currently owned by the Somerville Redevelopment Authority. Previous tenants have included an automobile repair shop, a parts salvage operation, a sawdust distributor, and a fuel oil distributor.

RTN 3-24339 is associated with reportable concentrations of petroleum hydrocarbons and PAHs in soil and groundwater at the site.

4.2.5.8 RTN 3-24921 at 49-51 Allen Street

The property located at 49-51 Allen Street in Somerville is occupied by a garage building and is currently owned by the Somerville Redevelopment Authority. Previous tenants have included an automobile repair shop, a parts salvage operation, a sawdust distributor, and a fuel oil distributor.

RTN 3-24921 is associated with reportable concentrations of PAHs, PCBs, and metals in soils.

4.2.6 Vehicle Maintenance Facility (VMF)

Three RTNs associated with the VMF area include 3-30628, 3-30048, and 3-0974.

4.2.6.1 RTN 3-30628 at 48 Third Avenue

The property located at 48 Third Avenue in Somerville encompasses approximately 121,000 square feet and currently contains a commercial building housing a commercial printer and publishing operation. The remainder of the property is paved for parking and vehicle access, with limited landscaped areas.

RTN 3-30628 is associated with reportable concentrations of PCBs, metals, and PAHs in soils. Reportable concentrations of PAHs were detected in groundwater.

4.2.6.2 RTN 3-30048 at 20 Third Avenue

The property located at 20 Third Avenue in Somerville is the location of the former MS Walker facility and currently contains warehouse and manufacturing buildings and parking lots. The property currently has an AUL in place.

RTN 3-30048 is associated with reportable concentrations of arsenic and PCBs in soils.

4.2.6.3 RTN 3-0974 at 100 Innerbelt Road

The property is a 1.2 acre parcel formerly owned by Boston & Maine Railroad Corporation that was used as a railway yard.

RTN 3-0974 is associated with reportable concentrations of petroleum. The RTN is closed and the property currently has an “activity and use limitation” (AUL) in place under the State Laws.

The DB Entity shall provide a work plan at least 90 days in advance of the planned work, to guide the MBTA’s LSP in amending the AUL, if necessary.

4.2.7 Gilman Square

Eight RTNs associated with the Gilman Square area include 3-15184, 3-16624, 3-28903, 3-17076, 3-29612, 3-29617, 3-30623, and 3-31954.

4.2.7.1 RTNs 3-15184, 3-16624, and 3-28903 at 360 Medford Street

The property located at 360 Medford Street in Somerville is a former gasoline and automobile service station and currently a gasoline station and convenience store. RTN 3-15184 is associated with reportable concentrations of petroleum hydrocarbons in soil and groundwater; the RTN is closed and the property currently has an AUL in place. RTN 3-16624 is associated with a release of petroleum to pavement; the RTN is closed. RTN 3-28903 is associated with reportable concentrations of petroleum hydrocarbons in soil and groundwater; the RTN is closed.

4.2.7.2 RTN 3-17076 at 358 Medford Street

The property identified as 358 Medford Street appears to be the driveway of the Homan’s Building located at 350 Medford Street. RTN 3-17076 is associated with a release of diesel from a truck to pavement; the RTN is closed.

4.2.7.3 RTN 3-29612 at Railroad Tracks Under Medford Street

This site is located within the ROW and is associated with reportable concentrations of polynuclear aromatic hydrocarbons (PAHs) in soil. This site remains open with regard to the MCP.

4.2.7.4 RTN 3-29617 at Railroad Tracks Under School Street

This site is located within the ROW and is associated with reportable concentrations of PAHs and metals in soil. This site remains open with regard to the MCP.

4.2.7.5 RTN 3-30623 Within ROW Near School Street

This site is located within the ROW and is associated with reportable concentrations of metals in soil. This site remains open with regard to the MCP.

4.2.7.6 RTN 3-31954 at 240 Pearl Street

This site is an apartment building. RTN 3-31954 is associated with a release of petroleum hydrocarbons in soil. This RTN is closed.

4.2.8 137 Washington Street, Somerville, MA

The site is a vacant unpaved and vegetated strip of land paralleling the MBTA ROW. It is the MBTA's intent to acquire the Site as a permanent easement for the construction of a bridge abutment as part of the Project. The site is located in the vicinity of the Disposal Site Boundary associated with 50 Tufts Street, RTN 3-23246 (discussed in Section 4.2.3); therefore, contaminated groundwater may be encountered if dewatering activities are required. During previous geotechnical investigations, a crushed 55-gallon metal drum buried approximately 1 foot below grade was encountered within the southern portion of the site. A strong solvent odor from the drum was detected. An American Society for Testing and Materials (ASTM) Phase I Environmental Site Assessment (ESA) was completed in January 2014 for 137 Washington Street and 30 Alston Street in Somerville. The 2014 Phase I ESA concluded that there was potential for additional drums to exist, material to have been released from the drum, or that there could be other buried debris at the Site and identified this as a Recognized Environmental Condition. In April 2014, a Geophysical Investigation was completed to assess the area where the drum had been discovered. The results of this investigation identified anomalies in the subsurface that warranted further investigation. A Phase I ESA Update was completed in 2017. No additional information regarding the potential for debris or other drums was identified as part of the update.

4.3 Codes, Standards and Manuals

All work shall be done as applicable in compliance with applicable Laws including the following:

4.3.1 Specific to Asbestos Abatement:

Federal Requirements: Which govern asbestos abatement work or hauling and disposal of asbestos waste materials include the following:

- (a) U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA) including:
 - (i) Asbestos 29 CFR 1926.1101;
 - (ii) Respiratory Protection Standard, 29 CFR 1910.134;
 - (iii) Safety and Health Regulations for Construction, 29 CFR 1926;
 - (iv) Hazard Communication, 29 CFR 1910.1200;
 - (v) Specifications for Accident Prevention Signs and Tags, 29 CFR 1910.145; and
 - (vi) Asbestos General Standard 29 CFR 1910.1101.
- (b) U.S. Environmental Protection Agency (EPA) including:
 - (i) National Emission Standard for Hazardous Air Pollutants (NESHAPs) 40 CFR, Part 61, Subpart M;
 - (ii) Asbestos Worker Protection Rule (40 CFR Part 763, Subpart G); and
 - (iii) Hazardous Waste Regulations (Resource Conservation & Recovery Act) 40 CFR 260-265
- (c) U.S. Department of Transportation, 49 CFR 172 - 173:

State Requirements: Which govern asbestos abatement work or hauling and disposal of asbestos waste materials include the following:

- (i) Massachusetts Division of Occupational Safety Regulations for the Removal, Containment or Encapsulation of Asbestos 453 CMR 6.00;

- (ii) Massachusetts Department of Environmental Protection:
 - 1. Air Pollution Control Regulations, 310 CMR 7.00;
 - 2. Solid Waste Regulations, 310 CMR 18.000, 310 CMR 19.000; and
 - 3. Sewer Use Regulations, 314 CMR 7.00.
- (iii) Massachusetts Water Resources MBTA
 - 1. Discharge permitting requirements, 360 CMR 10.000.

Local Requirements: Abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials.

Reference Guidelines: Which govern asbestos abatement work or hauling and disposal of asbestos waste materials include the following:

- (a) American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018, (212) 354-3300
 - (i) Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Publication Z9.2-79; and
 - (ii) Practices for Respiratory Protection, ANSI Publication Z288.2-80.

4.3.2 Specific to Hazardous Materials Abatement:

- (a) Massachusetts Hazardous Waste Regulations, 310 CMR 30.000;
- (b) Massachusetts Contingency Plan (MCP) 310 CMR 40.0000;
- (c) Massachusetts DEP Policy #COMM-97-001 – Reuse and Disposal of Contaminated Soil at Massachusetts Landfills;
- (d) Solid Waste Management Facility Regulations, 310 CMR 19.00;
- (e) Site Assignment Regulation for Solid Waste Facilities, 310 CMR 16.000;
- (f) Universal Waste Management Standards, 310 CMR 30.1000 – MassDEP;
- (g) Rubbish Handling Regulations, 527 CMR 34.00 - Massachusetts Department of Fire Services (MADFS);
- (h) Transportation of Flammable and Combustible Liquids, 527 CMR 8.00 – MADFS;
- (i) “Hazardous Waste Operations and Emergency Response”, Federal Occupational Safety and Health Act (OSHA), Title 29 CFR, Part 1910.120;
- (j) “General Regulations for Hazardous Waste Management”, EPA, Title 40 CFR, Part 260;
- (k) “Regulations for Identifying Hazardous Waste, Hazardous Waste Generators and Hazardous Waste Transporters”, EPA, Title 40 CFR, Parts 261, 262 and 263;
- (l) Regulations for Owners and Operators of Permitted Hazardous Waste Facilities”, EPA, Title 40 CFR, Part 264;
- (m) “Interim Status Standards for Owners and Operators of Permitted Hazardous Waste Facilities”, EPA. Title 40 CFR, Part 265;

- (n) “Standards for Management of Specific Hazardous Wastes and Facilities”, EPA, Title 40 CFR, Part 266;
- (o) “Standards for Owners and Operators of Hazardous Waste Facilities under a Standardized Permit”, EPA, Title 40 CFR, Part 267;
- (p) Universal Waste Management Standards, Title 40 CFR, Part 273 – USEPA;
- (q) Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, And Use Prohibition, Title 40 CFR, Part 761 – USEPA (TSCA);
- (r) Hazardous Materials Regulations Relating to Transportation, Title 49 CFR, Parts 171-180 – U.S. Department of Transportation (U.S. DOT);
- (s) Recycling and Emissions Reduction of Refrigerants, Title 40 CFR, Part 82 - Subpart F – USEPA;
- (t) Management of Used Oil Standards, Title 40 CFR, Part 279 – USEPA;
- (u) 29 CFR 1910, “Occupational Safety and Health Standards” (General Industry Standards);
- (v) 29 CFR 1910.20, “Access to Employee Exposure and Medical Records;
- (w) 29 CFR 1910.134, “Respiratory Protection” 29 CFR 1910.146 “Permit Required Confined Space”;
- (x) 29 CFR 1910.1025 “Lead”;
- (y) 29 CFR 1910.1200, “Hazard Communication”;
- (z) 29 CFR 1926, “Safety and Health Regulations for Construction” (Construction Industry Standards);
and
- (aa) 29 CFR 1926.62, “Lead-Construction”.

4.3.3 Specific to Lead Abatement:

- (a) Code of Federal Regulations (CFR) Publications:
 - (i) 29 CFR 1910 General Industry;
 - (ii) 29 CFR 1926.55 Gases, Vapors, Fumes, Dusts and Mists 29 CFR 1926.57 Ventilation;
 - (iii) 29 CFR 1926.62 Lead in Construction;
 - (iv) 29 CFR 1926.200 Signs, Signals and Barricades;
 - (v) 29 CFR 1926.354 Welding, Cutting and Heating in Way of Preservative Coating;
 - (vi) 29 CFR Subpart T Demolition;
 - (vii) 40 CFR 50 National Primary and Secondary Ambient Air Quality Standards for Lead;
 - (viii) 40 CFR 61 Subpart A General Provisions;
 - (ix) 40 CFR 61.152 Standard for Waste Manufacturing, Demolition, Renovation, Spraying, and Fabricating Operations;
 - (x) 40 CFR 241 Guidelines for the Land Disposal of Solid Wastes;
 - (xi) 40 CFR 257 Criteria for Classification of Solid Waste; and
 - (xii) 40 CFR 261 – 263 Waste Disposal Facilities and Practices.
- (b) Massachusetts Regulations:

- (i) 310 CMR 30.000 Massachusetts Hazardous Waste Regulations;
 - (ii) 310 CMR 40.0000 Massachusetts Contingency Plan; and
 - (iii) 454 CMR 22.00 Deleading.
- (c) American National Standards Institute (ANSI) Publications:
- (i) 29.2-79 Fundamentals Governing the Design and Operation of Local Exhaust Systems; and
 - (ii) 288.2-80 Practices for Respiratory Protection
- (d) National Institute of Occupational Safety and Health (NIOSH) Publications: Manual of Analytical Methods, 4th Edition
- (e) Underwriters Laboratories, Inc. (UL) Fire Resistance Directory Publications:
- (i) 586-77 (R 1982) Test Performance of High Efficiency Particulate Air Filter Units.
- 4.3.4 Specific to Removal of Contaminated Fixtures:
- (a) DOT: 49 CFR Part 171 - 180, Hazardous Materials Transportation Regulations;
 - (b) 40 CFR 761, Polychlorinated Biphenyls Manufacturing, Processing, Distribution in Commerce and Use Prohibitions;
 - (c) 29 CFR 1926.62 - Lead in Construction;
 - (d) 15 U.S.C. 2605, Toxic Substances Control Act;
 - (e) 310 CMR 30.0000, Massachusetts Hazardous Waste Regulations;
 - (f) 40 CFR 273 and 310 CMR 30.1000 (Universal Waste Rule); and
 - (g) 40 CFR 240-299, Resource Conservation and Recovery Act.
- 4.3.5 Specific to PCB Bulk Product Waste Abatement:
- (a) Title 40 CFR, Part 261 as it relates to the generation, staging, labeling, removal and off-site management of the PCB wastes summarized in the specification.
- 4.3.6 Specific to Handling, Transportation, and Disposal of Excavated Materials:
- (a) Massachusetts Contingency Plan (MCP), 310 CMR 40.0000;
 - (b) Massachusetts Hazardous Waste Regulations, 310 CMR 30.00;
 - (c) Solid Waste Management Facility Regulations, 310 CMR 19.00;
 - (d) Site Assignment Regulation for Solid Waste Facilities, 310 CMR 16.000;
 - (e) Interim Remediation Waste Management Policy for Petroleum Contaminated Soils, DEP Bureau of Waste Site Cleanup Policy No. WSC-94-400;
 - (f) "Hazardous Waste Operations and Emergency Response", Federal Occupational Safety and Health Act (OSHA), 29 CFR 1910.120;
 - (g) "General Regulations for Hazardous Waste Management", EPA, 40 CFR 260;
 - (h) "Regulations for Identifying Hazardous Waste, Hazardous Waste Generators and Hazardous Waste Transporters", EPA, 40 CFR 261, 262 and 263;

- (i) "Standards for Management of Specific Hazardous Wastes and Facilities", EPA, 40 CFR 266;
- (j) "Construction of Buildings in Contaminated Areas," DEP, Bureau of Waste Site Cleanup Policy #WSC-00-425, dated January 2000;
- (k) Massachusetts DEP Policy #COMM-97-001;
- (l) Local regulations governing dust control, soil handling, and health and safety;
- (m) Compendium of Quality Assurance and Quality Control Requirements and Performance Standards (CAM) DEP WSC #02320;
- (n) MassDEP Technical Update Background Levels of Polycyclic Aromatic Hydrocarbons and metals in soils;
- (o) MassDEP Similar Soils Provision Guidance (WSC#-13-500); and
- (p) Interim Remediation Waste Management Policy for Petroleum Contaminated Soils Attachment II, Jar headspace analytical Screening Procedure. MassDEP Policy No. WSC-94-900.

4.3.7 Specific to Handling and Disposal of Contaminated Groundwater:

- (a) MA Department of Environmental Protection (DEP) Policy WSC-94-400, Interim Remediation Waste Management Policy for Petroleum Contaminated Soils;
- (b) Massachusetts DEP, 310 CMR 40.0000, The Massachusetts Contingency Plan;
- (c) Massachusetts DEP, 310 CMR 30.0000, Hazardous Waste Regulations;
- (d) 314 CMR 3.00, "Massachusetts Surface Water Quality Permit Program.";
- (e) 314 CMR 5.00, "Ground Water Discharge Permit Program.";
- (f) U.S. Environmental Protection Agency, Requirements under the National Pollution Discharge Elimination System;
- (g) NIOSH/OSHA/USCG/EPA: "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," DHHS/NIOSH Pub. 85-115;
- (h) OSHA 29 CFR 1910: Safety and Health Regulations for General Industry, OSHA, as amended 10/86, and HAZWOPER: OSHA Regulations 29 CFR 1910.120;
- (i) 29 CFR 1926: Safety and Health Regulations for Construction, OSHA, as amended;
- (j) Protection of Health and Safety at Hazardous Waste Sites: An Overview, USEPA, 9/85 EPA/625/9-85/006; and
- (k) 105 CMR 670.000 and 441 CMR 21.00 (Right to Know).

4.3.8 General Permits

Federal, State and appropriate City and other local regulations, standards and codes pertaining to worker health protection, protection of the public health and the environment, and the removal, sampling, transportation, and disposal of oil and/or hazardous materials.

4.4 Project Specific Requirements

4.4.1 Handling, Transportation, and Disposal of Excavated Materials

The DB Entity shall provide all labor, equipment, appliances and materials, and perform all operations for and in connection with handling, segregating, testing, treating, stockpiling, transporting, disposing of and/or re-using soil and associated fill and waste material as necessary for the Work and/or resulting from the DB Entity's construction operations. The DB Entity shall provide all labor, materials, equipment and incidentals necessary to properly sample, classify, segregate, handle/manage, load, transport, and dispose of excavated materials located within the Site. Work covered by this Section shall include furnishing, operating, and maintaining soil stockpile/staging areas and equipment decontamination stations for the duration of excavation activities and dismantling, disposing of decontamination stations, and stockpile/staging areas at Project completion. Decontamination stations shall be capable of eliminating the dispersion of dust and mud caused by vehicles exiting the Site.

- (a) The DB Entity shall prepare an EMMP that describes the Work to be performed under this Technical Provision. The DB Entity shall reuse or dispose excavated soil on Site to the maximum extent possible. The EMMP shall be submitted within ninety (90) days after the issuance of the Notice to Proceed. The EMMP shall be accepted by the MBTA before any excavated soil is disposed of off-Site or re-used. At a minimum, the EMMP shall address the following:
- (i) The name and current licensure of the DB Entity's Environmental Consultant;
 - (ii) The procedures that will be used for field screening of the excavated soils;
 - (iii) The procedures for the collection of soil samples for laboratory chemical analysis. The plan shall list the proposed laboratory analytical parameters;
 - (iv) A plan for the on-Site or off-Site contaminated soil staging/stockpiling for each active construction area and the DB Entity's plan for reusing or disposing excavated soil on site. The excavated soil reuse plan shall indicate quantities, soil classifications and locations where the DB Entity intends to reuse or dispose excavated materials on Site. The excavated soil reuse plan shall be updated monthly;
 - (v) A material management system plan to track the excavated materials through final disposition. The plan shall be updated monthly and include at a minimum the following:
 - 1. Provisions for tracking the excavated material from the "point of excavation" to the location of the stockpile material in the storage/staging area to the final disposition of the stockpiled material including all proposed daily log sheets.
 - 2. A description of the tracking methodology that will be implemented to identify the source excavation area(s) and the final disposition of the excavated soil from each area of excavation.
 - 3. Person(s) responsible for maintaining the tracking system, and the plan to provide the MBTA with electronic access to the material management system and its updates.
 - (vi) The means and methods for decontaminating all equipment and personnel, including provisions for installing equipment decontamination pad(s) within the Work zone;
 - (vii) The mean and methods for on-Site treatment of soil requiring off-Site disposal determined through TCLP analysis to be characteristically hazardous pursuant to RCRA (310 CMR 30.00 et. seq.);
 - (viii) The DB Entity shall identify each waste stream and propose an appropriate disposal facility that will accept the excavated material as classified. The DB Entity shall submit

acceptances or letters of intent and facility information for each facility proposed. For each facility, the DB Entity shall submit the following information:

1. General Information
 - a. Facility Name;
 - b. Facility Address;
 - c. Name of Contract Person;
 - d. Title of Contact Person;
 - e. Telephone Number of Contact Person; and
 - f. Permit Number.
 2. The facility shall specify the volume of material that can be accepted from the Site on a weekly and a total basis.
 3. The facility shall provide written confirmation that they are permitted to accept and will accept classified material of the general quality and quantity described required by the Work.
 4. The facility shall provide a listing of all current and valid permits, licenses, letters of acceptance, and other authorizations to operate that it holds, pertaining to the receipt and management of the soils or materials specified in the DB Contract.
 5. The DB Entity shall submit a complete list of the disposal facility's permitted allowable contaminant levels and physical characteristic requirements for excavated material, and list any required regulatory acceptances for individual waste streams.
- (ix) A plan for dust monitoring on-Site during any earthwork activities; and
- (x) The plan shall be amended as necessary.
- (b) Laboratory results for all samples collected and/or analyzed by the DB Entity shall be tabulated and compared to applicable MCP standards by the DB Entity's Environmental Consultant and subsequently submitted to the MBTA within five days of receipt. The results shall include all chain-of-custody forms and all documentation provided by the laboratory.
- (c) All data shall be provided as Electronic Data Deliverables (EDDs) formatted for upload to EQUiS™ software. Tabulated analytical results shall be provided in Excel table format, compared to applicable regulatory standards. Final laboratory analytical reports shall be provided in PDF format.
- (d) The DB Entity shall submit the following soil disposal documentation:
- (i) Pre-disposal documentation shall be prepared and submitted to the MBTA within five (5) Business Days of preparation. Each documentation submittal shall be assigned a unique identification referenced to the area of excavation, stockpile and sample name, and shall include:
 1. Completed Manifest Summary Record (MSR), Bill of Landing (BOL), or manifest signed by the MBTA and/or MBTA's Licensed Site Professional (LSP), as required;
 2. Completed and signed profiles as required by the receiving facility;

3. Analytical data report provided by the analytical laboratory;
 4. Sketch plan showing sampling location;
 5. Summary of soil source location; site history; sampling methods and data comparison to facility criteria and MCP reporting criteria;
 6. Written acceptance from the disposal facility that the material has been accepted; and
 7. Receiving facility–required checklist of requirements.
- (ii) Post disposal documentation shall be prepared and submitted following disposal and referenced to the pre-disposal documentation by name:
1. Load sheets completed and signed by the hauler and the receiving facility;
 2. Certified weight slips from the receiving facility; and
 3. For BOLs only, the facility and MBTA attestations of shipment and receipt.
- (iii) All soil disposal documentation shall be compiled and re-submitted at the completion of the disposal activities. The submittal shall consist of one or more PDF-Searchable electronic files submitted through the document control system. The final submittal shall be organized by the uniquely identified MSR, BOL, or manifest.
- (e) All elements of the EMMP shall be submitted as a final close-out document within four weeks after the completion of all excavation and disposal activities. The final submittal shall consist of one or more PDF-searchable electronic files on a CD. Previous submittals of one or more of the elements described herein or previous eDEP filings shall not modify the requirements of the final submittal. The final submittal shall contain the supporting documentation identified in 1 (a) through (c) of this part.
- (f) The DB Entity shall submit its work zone air quality monitoring program for review prior to commencement of site activities.

4.4.2 Contaminated Groundwater Management

4.4.2.1 Groundwater Pre-Characterization Plan

Within ninety (90) days of the DB Entity receiving a Notice to Proceed, the DB Entity shall prepare and submit a Groundwater Pre-Characterization Sampling Plan for the pre-testing of groundwater for contaminants. The groundwater investigations shall be required in areas of known or suspected groundwater contamination and/or within the limits of MCP Disposal Sites and where excavation dewatering is anticipated based on Project design drawings and available information on depths to groundwater. DB Entity shall not begin dewatering until the submittal relevant to that dewatering location and permit has been accepted by the MBTA and required Permit(s) have been obtained.

The DB Entity's Groundwater Pre-Characterization Sampling Plan is to be submitted for acceptance by the MBTA, and include at a minimum:

- (a) Locations of existing and proposed groundwater monitoring wells to be sampled for the purpose of pre-characterization sample collection. DB Entity shall install and sample an adequate number of wells at appropriate depths to adequately characterize groundwater in areas where dewatering will be required;

- (b) Field screening and sample collection method(s) to be used, including a description of sample compositing techniques to obtain a vertical representation of the groundwater quality at each sample location;
- (c) A scaled engineering drawing showing proposed sampling locations, known subsurface utilities, and other major site features; and
- (d) Number of samples to be collected from each location, sample preservation, and the laboratory methods for which the samples will be submitted for analysis.

After acceptance of the Groundwater Pre-Characterization Plan, the DB Entity shall perform the groundwater testing in accordance with the accepted plan.

4.4.2.2 Groundwater Management Plan

Within twenty one (21) days following the completion of groundwater testing, the DB Entity shall submit a Groundwater Management Plan for acceptance, prepared by the DB Entity's Environmental Consultant, based upon the results of pre-characterization testing and containing, at a minimum:

- (a) Conceptual schematics of anticipated treatment methodologies based on available data. As detailed designs are developed for specific areas, DB Entity shall provide drafts of all applicable groundwater discharge Permits for review by MBTA prior to submittal to relevant agency. DB Entity shall allow a minimum of thirty (30) days review period by the MBTA;
- (b) Prior to start of dewatering at each location or separate treatment system location, DB Entity shall provide groundwater treatment design details, including storage, treatment equipment and methods, sampling procedures, discharge or off-site disposal locations (including liquid waste, NAPL, and contaminated sediments), and treatment and dilution calculations;
- (c) A scaled drawing of the work site(s) showing approximate limits of each area of contaminated groundwater identified in the Groundwater Management Plan, the related MassDEP release tracking numbers, and the locations where groundwater treatment systems are anticipated to be temporarily located during excavation in those areas. This portion of the Groundwater Management Plan shall be updated as applicable during construction;
- (d) Anticipated locations of effluent discharge;
- (e) A plan showing location of proposed temporary off-site storage areas, if needed;
- (f) An Emergency Response Plan for addressing oil and/or hazardous materials released by the DB Entity or encountered during the Work;
- (g) Name and address of proposed Hauler licensed to transport Hazardous Waste material;
- (h) Field screening and sample collection method(s) to be used, including a description of sample compositing techniques to obtain an adequate representation of the groundwater quality, in any areas where pre-characterization testing is not performed;
- (i) Sample preservation methods and the laboratory methods for which the samples will be submitted for analysis, in any areas where pre-characterization testing is not performed;
- (j) Evidence that the DB Entity's analytical laboratory is currently certified to perform these analyses in Massachusetts, if pre-characterization testing is not performed; and
- (k) Tabulated results of all pre-characterization testing performed, compared with regulatory criteria

in 310 CMR 40.0932 for the appropriate groundwater category. This data shall be provided as developed. All data shall be submitted as Electronic Data Deliverables (EDDs) formatted for upload to EQUiS™ software. Tabulated analytical results shall be provided in Excel table format, compared to applicable regulatory standards. Final laboratory analytical reports shall be provided in PDF format.

4.4.2.3 Environmental Health and Safety Plan

Based upon the groundwater sampling results, the DB Entity shall prepare and submit an Environmental Health and Safety Plan (EH&SP) prepared by a qualified Health and Safety Professional experienced in working in contaminated environments. The EH&SP shall be submitted prior to the health and safety coordination meeting. The DB Entity shall schedule the health and safety coordination meeting, to be held at least three (3) days prior to commencement of excavation work, to discuss issues relating to possible exposure to groundwater contamination and the provisions of the EH&SP. The DB Entity shall provide written notice of this meeting to all interested parties, including the MBTA, the MBTA's LSP, and any subcontractors retained by the DB Entity. Health and safety training of DB Entity's workers and subcontractors shall be provided by the DB Entity.

4.4.2.4 Discharge Permits

The DB Entity shall obtain and submit a copy of each discharge permit, and a map showing the accepted groundwater extraction area and discharge location represented by each permit. Permit information shall be updated as applicable during construction.

The DB Entity shall submit the following to the MBTA's LSP within one (1) week of receipt:

- (a) Acceptance letters from the receiving facility indicating their acceptance of the material and a complete list of their acceptance criteria;
- (b) Copies of disposal or treatment facility weight slips and manifests, and certifications of disposal or recycling;
- (c) Copies of field screening data and monitoring observations of the DB Entity's Environmental Consultant during work in contaminated areas; and
- (d) Copies of all permits obtained by the DB Entity for the work described herein, and all compliance and/or monitoring documents submitted, including completion reports, for these permits.

Copies of laboratory reports showing a summary of analytical methods, analytical results, a QA/QC statement and Chain-of-Custody log. Tabulated results of all testing performed, compared with regulatory criteria in 310 CMR 40.0932 for the appropriate groundwater category.

4.4.2.5 Washington Street Utilities

Contaminated groundwater shall be prevented from infiltrating the MBTA's storm drains. The following are required to ensure the long-term viability of the Project infrastructure's resistance to degradation by CVOC contamination originating from the release(s) at 50 Tufts Street, and to eliminate the existing, and to prevent future discharges, of CVOCs via the MBTA drainage system to the Millers River.

A. Washington Street Pump Station

The current concentrations of CVOCs in groundwater in the area of the pump station exceed the USEPA Remediation General Permit discharge standards. The DB Entity shall inspect the pump station and seal any cracks.

B. Lining of the Existing 42-inch RCP and 20-inch Siphons

The existing 42-inch drain line from just south of Cross Street to the Washington Street pump station, including the twin 20-inch siphons under Washington Street, passes through the highest concentrations of CVOCs detected from the 50 Tufts Street property. Testing of stormwater from within a catch basin on the 50 Tufts Street property indicates that the CVOC contaminants are infiltrating into the storm drain and discharging downstream. The 42-inch RCP that will discharge into the Washington Street pump station will ultimately discharge to the Millers River. DB Entity shall line the existing drain pipes with a CVOC resistant lining material designed and constructed to minimize any ongoing and/or potential future infiltration of CVOCs to the MBTA storm drain system for a service life of 75 years or greater.

C. Polymer grout seepage collars

Polymer grout seepage collars shall be installed by the DB Entity along the existing 42-inch storm drain to prevent a preferential pathway in the pipe bedding from transmitting contaminants further into the MBTA property.

D. Waterproofing All New Concrete Manholes and Catch Basin Structures

Water quality testing results from inside the existing pump station, which collects stormwater from the Washington Street underpass, indicates that concentrations of CVOCs exceed the MassDEP surface water quality standards. The proposed storm drains planned for construction in the Washington Street underpass require materials that will be waterproof and not susceptible to deterioration over the service life of the drainage system. Concrete piping, drain manholes and catch basins shall use an Integral Crystalline Concrete waterproofing system to prevent any penetration through the structures. Viton gaskets, which provide long-term resistance to CVOCs and will help minimize contaminated groundwater from entering the storm drain system, shall be utilized by the DB Entity in lieu of rubber piping gaskets. Refer to Section 7.3 for drainage system service life requirements.

E. Washington Street Underpass Groundwater Management System

DB Entity shall design and install a groundwater management system to collect and convey groundwater to a new manhole on the north side of Washington Street. This manhole shall connect to the Washington Street Pump Station (WSPS) via a new gravity drain with a valve to remain closed at all times to prevent discharge of contaminated groundwater to the WSPS. The groundwater management system shall be designed to maintain the groundwater elevation below the finish grade of Washington Street at all times. The groundwater management system shall not be used for temporary dewatering or stormwater management. Treatment of water discharged from this groundwater management system and associated permitting will be provided by others. The groundwater management system shall be designed and constructed to have a service life of 75 years or greater.

F. Dewatering (Groundwater) Management

Groundwater collected during excavation dewatering from within the area of CVOC contamination will require treatment to remove CVOCs and, potentially, iron to meet NPDES Remediation General Permit (RGP) requirements. Treatment requirements for construction will be performance-based to meet NPDES RGP and other applicable state and Federal standards. Refer to 2F.

G. Confirmation

The DB Entity shall submit plans and specifications for the pipe lining materials, polymer grout seepage collars, waterproofing materials for new catch basins and manholes, the new Washington Street underpass knee-wall underdrains, and groundwater treatment system associated with the NPDES RGP. DB Entity shall submit such plans and specifications to MBTA for its review and acceptance.

4.4.3 Hazardous Materials Abatement

Unless otherwise required by the Contract Documents, provide all labor, equipment, materials, and services to remove and dispose of potentially hazardous materials encountered during the Project. These materials may include, but are not limited to, hazardous building materials, PCB-containing or mercury-containing equipment, motors/pumps, batteries, white goods, compressed gas cylinders, containerized paints, oils, and lubricants, miscellaneous cleaning/maintenance products and unlabeled containers. The materials may also include contaminated sediments, debris and/or miscellaneous waste contained within pipes, vaults or other structures.

Unless otherwise required by the Contract Documents, provide all labor, equipment, appliances, testing, permits, and materials to extract, handle, store, transport, treat, recycle, reuse and properly discharge or dispose of on or off-site all contaminated materials (sediments, oil, and liquid waste) generated by the work under this contract in a manner that ensures the protection of health, safety, public welfare, and the environment.

The Contract Price includes all costs for all labor, equipment, appliances, testing, permits, and materials to perform the work required to extract, handle, store, transport all hazardous materials.

4.4.3.1 Hazardous Materials Abatement Work Plan

- (a) A Hazardous Materials Abatement Work Plan including all pertinent information relating to the removal and transportation of hazardous materials from the Site shall be submitted to MBTA for review and acceptance within ninety (90) days after issuance of the Notice to Proceed. The Work Plan, at a minimum, shall include:
- (i) The name(s), address(es), and contact(s) of subcontractors including Environmental Consultant retained for Work of this section;
 - (ii) A detailed description of Work activities and progress schedule for each phase of the Work associated with the removal, transportation, and disposal of hazardous materials;
 - (iii) A summary estimate of the quantities of hazardous materials that will be recycled or re-used, and the destination for those quantities of materials by category;
 - (iv) A statement of compliance, and evidence of said compliance, with applicable Federal, State, Regional, and Local regulations covering such work;

- (v) Name(s), address(es), and contact(s) of hazardous waste transporter(s) that transport hazardous waste from the Site(s) to a TSD facility, including EPA identification numbers(s) and proof of permit, license, or authorization to transport hazardous waste in all affected states;
 - (vi) Name(s), address(es), and contact(s) of TSD facilities that will accept hazardous waste from the Site and a letter of acceptance indicating that the facilities will accept hazardous waste from the Site; and
 - (vii) List and match each TSD facility with the hazardous waste it will accept from the site
- (b) DB Entity is to provide the following Contract Closeout Submittals (Prior to authorization of final payment)
- (i) Records of the amounts of waste generated, by waste type, and address of origin;
 - (ii) Fully executed and completed waste manifests;
 - (iii) Copies of laboratory analysis of confirmatory substrate sampling;
 - (iv) Drawings showing specific locations of substrate samples and distance from assumed PCB material, for each property and building where PCB waste was removed; and
 - (v) Final PCB Abatement Report with tabulated data demonstrating that PCB bulk product, and PCB remediation wastes were removed in entirety.

4.4.3.2 Removal of Asbestos Containing Materials

Provide all labor, materials and services to perform all the work required for the removal of all asbestos-containing materials (ACMs) at the MBTA Green Line Extension Project, in compliance with local, state, and federal regulations.

- (a) The DB Entity shall submit to the MBTA the following listed items within ninety (90) days after Notice to Proceed.
- (i) Name and experience of proposed Supervisors and Foremen;
 - (ii) Summary of workforce by disciplines, and a notarized statement documenting that all proposed workers, by name, have received all required medical exams and have been properly trained in asbestos removal work, respirator use, and appropriate Massachusetts Division Labor Standards (MA DLS), USEPA & OSHA standards;
 - (iii) Copies of all current training certifications (including original and refresher), MA DLS licenses, fit test clearances and medical clearances to wear a respirator. The DB Entity shall submit to the MBTA, copies of requested records for new site workers whose certifications have not previously been reviewed;
 - (iv) Notarized Certification: Submit notarized certification signed by an officer of the abatement contracting firm that exposure measurements, medical surveillance, and worker training records are being kept in conformance with OSHA, EPA, MA DEP and MA DLS requirements;
 - (v) Plan of Action & Standard Operating Procedures: Submit a detailed site-specific plan of the procedures proposed for use in complying with the requirements of this Technical Provision. Include in the plan the specific location and layout of decontamination areas and negative air units; location of lighting and power outlets; distribution of amended

water; the sequencing of asbestos work; detailed schedules by dates, shift times, and work activities during that shift; the interface of trades involved in the performance of work; methods to be used to ensure the safety of occupants and visitors to the Site, and a detailed description of the methods to be employed to control pollution. The Plan shall also include/address the following:

1. Proper protective clothing and respiratory protection prior to entering the work space from the outside;
2. Safe work practices in the work place, including provisions for inter-room communications; exclusion of eating, drinking, smoking, and application of cosmetics; or use of procedures or equipment that would in any way reduce the effectiveness of respiratory protection or other engineering controls;
3. Proper exit practices from the work space to the outside through the showering and decontamination facilities;
4. Preventing a fiber release episode;
5. Packing, labeling, loading, transporting, and disposing of contaminated material in a way that minimizes or prevents exposure and contamination;
6. Emergency evacuation of personnel, for medical or safety (fire and smoke) so that exposure will be minimized;
7. Safety from accidents in the work space, especially from electrical shocks, slippery surfaces, and entanglements in loose hoses and equipment;
8. Provisions for effective supervision, and OSHA-specified personnel air monitoring for exposure during the work;
9. Project sequencing;
10. Waste segregation, minimization, decontamination packaging and disposal;
11. Any other items as noted in this Technical Provision or as required by the MBTA to be addressed upon submittal review;
12. Provide the following information for exposure controls:
 - a. Number of negative air machines required and the calculations necessary to determine the number of machines for each work area;
 - b. Description of projected airflow within each work area and methods required to provide adequate air flow in all portions of the work area;
 - c. Pressure differential across work area enclosures anticipated;
 - d. Description of methods of testing for correct airflow and pressure differentials;
 - e. Manufacturer's product data on the machines to be used;
 - f. Location of the machines in the work space;
 - g. Method of supplying adequate power to the machines;
 - h. Description of work practices to reduce worker exposure to airborne fibers; and
 - i. Manufacturer's product data on equipment used to monitor pressure differential

between inside and outside of work area.

13. Contingency Plan: Submit a contingency plan for emergencies including fire, accident, power failure, negative air system failure, supplied air system failure, or any other event that may require modifications or abridgment of decontamination or work area isolation procedures. Include in plan specific procedures for decontamination or work area isolation. Note that nothing in this Technical Provision should impede safe exiting or providing adequate medical attention in the event of an emergency. Include telephone number and locations of emergency services including fire, ambulance, doctor, hospital, police, power company, telephone company;
14. Summary of other proposed materials and equipment (manufacturer, catalog number or model, and description) and method of application or use, including wetting agents, personal protective equipment, and test samples of all proposed materials for performing the work;
15. A plan describing the method for exposure monitoring to document compliance with OSHA Asbestos Standard, including frequency of monitoring, equipment and calibration methods, and name of analysis laboratory;
16. All required permits, certifications and licenses;
17. Copies of the completed USEPA, State, and local asbestos removal pre-abatement notification forms;
18. Copies of all proposed daily inspection and record logs, including work area entry data, respirator inspections and maintenance, HEPA-exhaust inspections and maintenance, and other work applicable activities;
19. Name, location, and applicable licenses, operating permits and insurance certificate for primary and secondary landfill for disposal of asbestos-containing or asbestos-contaminated waste. Name and applicable federal and state permits and insurance certificate for transporter of asbestos waste materials;
20. Respiratory Protection Program: Submit level of respiratory protection intended for each operation required by the Project;
21. Historic Airborne Fiber Data: Submit airborne asbestos fiber count data from an independent air monitoring firm to substantiate selection of respiratory protection proposed. Data submitted shall include at least the following for each procedure required by the work:
 - a. Name of Testing Laboratory (Shall be a Massachusetts State-Certified Lab);
 - b. Dates of measurements;
 - c. Operations monitored;
 - d. Sampling and analytical methods used and evidence of their accuracy; and
 - e. Number, duration, and results of samples taken.
22. Resume Information: Submit resume and information on training for individual monitoring the operation of supplied air respiratory systems. Submit training certifications where applicable.

- (b) No asbestos removal work activities shall commence until these items are reviewed and accepted by the MBTA. Submittal data shall be in sufficient detail to enable the MBTA to identify the particular product or equipment and to form an opinion as to its conformity to the Contract Documents. Each submittal item shall be identified with a cover page and/or transmittal sheet containing the listed submittal number. The MBTA may reject the entire submittal package if not submitted in the same order presented above.
- (c) The DB Entity shall submit to the MBTA the following items prior to individual workers being allowed to work on the Project:
- (i) Submit copies of the training certificates and current MADLS certificate for each worker;
 - (ii) Report from Medical Examination: Submit a copy of Physician's Written Opinion for medical examination conducted within last twelve (12) months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area; and
 - (iii) Current (within twelve (12) months) respirator fit test record for each employee anticipated to conduct work on the Project.
- (d) During Abatement Activities:
- (i) Submit weekly job progress reports detailing abatement activities. Include review of progress with respect to previously established milestones and schedules, major problems and action taken, injury reports, equipment breakdown, and bulk material and air sampling results conducted by DB Entity;
 - (ii) Submit each week copies of all transport manifests, trip tickets, and disposal receipts for all asbestos waste materials removed from the work area during the abatement process;
 - (iii) Submit each week daily copies of worksite entry logbooks with information on worker and visitor access;
 - (iv) Submit each week logs documenting filter changes on respirators, HEPA vacuums, negative pressure ventilation units, and other engineering controls; and
 - (v) Submit each week results of air sampling data collected during the course of the abatement including OSHA compliance air monitoring results.

Post outside or immediately adjacent to the clean room of the worker decontamination enclosure, a list containing names, addresses, and telephone numbers of the DB Entity, the MBTA, the asbestos abatement Project monitor, the General Superintendent, the testing laboratory, and any other personnel who may be required to assist during abatement activities.

4.4.3.3 Removal of Lead Containing Materials

Provide all labor, materials, and equipment required to test, contain, recover, and dispose of lead coatings and associated waste at the Project, in compliance with local, state, and federal regulations.

With regard to Lead Abatement, provide three (3) copies of the following Submittals to the MBTA for review and acceptance:

- (a) Copies of all notifications, permits, applications, licenses and like documents required by Federal, State, or Local regulations and this Technical Provision obtained or submitted in proper fashion;

- (b) List of total number of supervisors and workers intended to be assigned to the Project, including name and lead awareness qualification;
- (c) Copies of written medical opinions for each employee who may be occupationally exposed to lead as required by Title 29 CFR, Part 1926.62 (j)(3)(v);
- (d) Record of successful respirator fit testing performed by a qualified individual within the previous twelve (12) months for each employee to be used on this Project with the employee's name and social security number with each record;
- (e) Employer's Lead Compliance Program as required by Title 29 CFR, Part 1926.62, including proposed respiratory protection program and medical monitoring for all employees throughout all phases of the job, including make, model, and NIOSH acceptance numbers of respirators to be used; worker orientation plan; written description of all proposed procedures, methods, or equipment to be utilized. In all instances, DB Entity shall comply with all applicable federal, state and local regulations;
- (f) Material Safety Data Sheets on potentially hazardous materials to be used on the Project;
- (g) Waste Disposal Plan which describes the waste stream and the disposal means (i.e., landfill, recycle, etc.) and includes the name, address, and ID number of the proposed hazardous waste hauler, waste transfer route, and proposed disposal reclamation or treatment facility;
- (h) Details of any proposed work platforms and or containment system design features including description and/or drawings of the following:
 - (i) Locations, sizes, elevations, and numbers of individuals work platforms and/or enclosure systems;
 - (ii) Manner of construction, anticipated loads during operations, and load bearing capacities for each work area platform and/or enclosure system designed by a Registered Professional Engineer;
 - (iii) Proposed use and engineering of any proposed contamination control features such as HEPA- filtered negative pressure systems and decontamination facilities;
 - (iv) Special considerations used to protect the containment Integrity from effects of the local climate (e.g., wind, rain, snow, etc.); and
 - (v) Discussion of special permitting and construction code requirements applicable to installation of any work platform and containment system.
- (i) Name and address of the proposed recycler who will accept painted metal component construction debris, including letter stating that it will accept such waste;
- (j) Construction schedule including sequence of critical work; and
- (k) Submit the following to the MBTA as a Post-Construction submittal package:
 - (i) Copies of waste manifests and receipts acknowledging disposal of all lead waste material from the Project, showing delivery date, quantity, and appropriate signature of landfill's authorized representative;
 - (ii) Summary report with quantities of lead painted wastes recycled;
 - (iii) All personnel monitoring results; and

- (iv) All Toxic Characteristic Leaching Procedure (TCLP) testing results.

With regard to Lead Abatement, air sampling results shall be transmitted to the MBTA and individual workers available at the job site in written form no more than forty-eight (48) hours after the completion of a sampling cycle. The reporting document shall list each sample result, sampling duration, sample yield, cassette size, and analyst's name and company, and shall include an interpretation of the results. Air sample analysis results will be reported in micrograms/cubic meter ($\mu\text{g}/\text{m}^3$).

4.4.3.4 Removal of PCB Containing Materials

Provide all labor, materials, facilities, equipment, services, employee training, testing, permits and agreements necessary to perform the work required for the removal and disposal/recycling of all polychlorinated biphenyls (PCBs) as part of demolition and rehabilitation included in the Project in compliance with local, state, and federal regulations.

4.4.3.5 Removal of Contaminated Fixtures

Provide all labor, materials, facilities, equipment, services, employee training, testing, permits and agreements necessary to perform the work required for the removal and disposal/recycling of all mercury-containing materials as part of demolition and rehabilitation included in the Project in compliance with local, state, and federal regulations.

4.4.3.6 21 Water Street Abatement

The DB shall remove approximately 22 cubic yards of PCB-impacted soil from around the perimeter of the demolished building at 21 Water Street. A stockpile of clean soil still remains at the site on asphalt southwest of the demolished building and once this is removed, additional soil and asphalt sampling will be necessary by the MBTA's LSP to determine if additional materials below this stockpile will require off-site disposal.

One of the planned viaduct drilled shafts will be installed in the area of the AUL that was filed for RTN 3-18502. To comply with the terms of the AUL, the DB Entity shall prepare a Soil Management Plan for the soil generated during the installation of the drilled shaft. If dewatering is required during this construction, the DB Entity may encounter LNAPL on the groundwater or contaminated groundwater that will either need to be containerized for off-site disposal or treated. Refer to the Technical Memorandum in Exhibit 2G that further defines the work.

The DB Entity shall submit plans and specifications for the removal of the PCB-contaminated soil and asphalt, sampling of soil and asphalt below the existing stockpile, and potential contaminated groundwater and LNAPL collection and/or treatment.

4.4.3.7 22 Water Street Abatement

If any construction activities are to be completed within the limits of the AUL filed for RTN 3-30560, to comply with the terms of the AUL the DB Entity shall prepare a Soil Management Plan, Health and Safety Plan, and supporting documentation, including quantities of remediation waste and receiving facility, to document the Work within the contaminated area.

In other areas of the site where construction may be completed, the DB Entity shall file MCP reports to document work within contaminated area(s). If dewatering will be required during this construction, the

DB Entity may encounter DNAPL or contaminated groundwater that will either need to be containerized for off-site disposal or treated by the DB Entity.

The DB Entity shall submit plans and specifications for the removal of any contaminated soil and potential contaminated groundwater and DNAPL collection and/or treatment.

4.5 Deliverables

Table 4-1 reflects a non-exclusive list of deliverables identified in these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables required by the Contract Documents, Governmental Approvals, and Government Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.1.3, unless otherwise specified in the Contract Documents.

Table 4-1 Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule
	Hardcopies	Electronic	
21 Water Street Soil Management Plan	2	1	Within 90 days after issuance of NTP
21 Water Street Health and Safety Plan	2	1	Within 90 days after issuance of NTP
22 Water Street Soil Management Plan	2	1	Within 90 days after issuance of NTP
22 Water Street Health and Safety Plan	2	1	Within 90 days after issuance of NTP
Excavated Materials Management Plan (EMMP)	2	1	Within 90 days after issuance of NTP
Washington Street Utilities Remediation General Permit (RGP) NOI	2	1	Within 90 days after issuance of NTP
Washington Street Utilities RGP Coverage Authorization	2	1	Within 5 days of Receipt
Plans and Specifications for Washington Street Utility Work	2	1	Within 90 days after issuance of NTP
Construction General Permit (CGP) NOI	2	1	Within 90 days after issuance of NTP
CGP Coverage Authorization	2	1	Within 5 days of Receipt
Laboratory Results for all Samples	2	1	Within 5 days of Receipt
Soil Disposal Documentation	2	1	Within 5 days after relevant Work completed
Work Zone Air Quality Monitoring Program	2	1	Within 90 days after issuance of NTP
Groundwater Pre-characterization Sampling Plan	2	1	Within 90 days after issuance of NTP

Deliverables	Number of Copies		Submittal Schedule
	Hardcopies	Electronic	
Groundwater Management Plan	2	1	Within 21 days of Receipt of Sampling Results
Environmental Health & Safety Plan	2	1	Within 90 days after issuance of NTP
Health & Safety Training Records for all worker's and subcontractors	2	1	Within 90 days after issuance of NTP
Hazardous Materials Abatement Work Plan	2	1	Within 90 days after issuance of NTP
Hazardous Materials Abatement Contract Closeout Submittals	2	1	Within 5 days after relevant Work completed
Asbestos Abatement name and experience of proposed Supervisors and Foremen	2	1	Within 90 days after issuance of NTP
Asbestos Abatement summary of workforce by discipline	2	1	Within 90 days after issuance of NTP
Asbestos Abatement Notarized Certification	2	1	Within 90 days after issuance of NTP
Asbestos Abatement Plan of Action and Standard Operating Procedures	2	1	Within 90 days after issuance of NTP
Asbestos Abatement Contingency Plan	2	1	Within 90 days after issuance of NTP
Asbestos Abatement summary of other proposed materials and equipment	2	1	Within 90 days after issuance of NTP
Asbestos Abatement exposure monitoring plan	2	1	Within 90 days after issuance of NTP
Asbestos Abatement permits, certifications and licenses	2	1	Within 90 days after issuance of NTP
Asbestos Abatement USEPS, state and local pre-abatement notification forms	2	1	Within 90 days after issuance of NTP
Asbestos Abatement daily reports	2	1	Within 5 days after relevant Work completed
Asbestos Abatement operating permits and insurance certificates for primary and secondary landfills	2	1	Within 90 days after issuance of NTP
Asbestos Abatement respiratory protection program	2	1	Within 90 days after issuance of NTP
Asbestos Abatement Historic Airborne Fiber Data	2	1	Within 5 days after relevant Work completed

Deliverables	Number of Copies		Submittal Schedule
	Hardcopies	Electronic	
Asbestos Abatement resume for individual monitoring the supplied air respiratory system	2	1	Within 90 days after issuance of NTP
Asbestos Abatement weekly job progress reports	2	1	Within 5 days of work completed
Lead Abatement licenses permits and notifications	2	1	Within 90 days after issuance of NTP
Lead Abatement number of supervisors and workers	2	1	Within 90 days after issuance of NTP
Lead Abatement written medical opinions for each employee	2	1	Within 90 days after issuance of NTP
Lead Abatement respiratory fit testing records	2	1	Within 90 days after issuance of NTP
Employer's Lead Compliance Program	2	1	Within 90 days after issuance of NTP
Lead Abatement Safety Data Sheets	2	1	Within 90 days after issuance of NTP
Lead Abatement Waste Disposal Plan	2	1	Within 90 days after issuance of NTP
Lead Abatement name and address of proposed recycler	2	1	Within 90 days after issuance of NTP
Lead Abatement Construction Schedule	2	1	Within 90 days after issuance of NTP
Lead Abatement Post-Construction submittal package	2	1	Within 5 days after relevant Work completed
Lead Abatement air sampling results	2	1	Within 48 hours of sampling cycle
Contaminated Fixtures written Project schedule	2	1	Within 90 days after issuance of NTP
Contaminated Fixtures list of proposed electric safeguards	2	1	Within 90 days after issuance of NTP
Contaminated Fixtures written proposed emergency plan	2	1	Within 90 days after issuance of NTP
Contaminated Fixtures waste transporters	2	1	Within 90 days after issuance of NTP
Contaminated Fixtures completed waste manifests	2	1	Within 5 days after relevant Work completed
PCB Bulk Product Waste Performance- Based Work Plan	2	1	Within 90 days after issuance of NTP
Copies of all Waste Manifests/Bills of Lading for all materials shipped off-site	2	1	Within 5 days after relevant Work completed

END OF SECTION

5 RIGHT OF WAY

5.1 General Requirements

DB Entity shall perform all Work necessary to comply with the requirements of this Section 5. The DB Entity shall design and construct the Project within the existing Project Right of Way (ROW) and/or within the MBTA designated parcels identified in Exhibit 2C. MBTA does not intend to acquire additional property and/or easements for the Project. DB Entity acknowledges that the existing ROW and such other designated parcels is adequate to construct the Project.

5.1.1 Staging Area

DB Entity, unless specifically stated otherwise in the Contract Documents, shall obtain access to any property for construction staging and storing of materials. The DB Entity is advised that minimal staging and laydown area will be provided by the MBTA.

5.2 Administrative Requirements

5.2.1 Right-of-Entry

The right-of-entry request, if the DB Entity requires additional properties, shall include the following information:

- (a) Assessor's Parcel Number assigned to the requested parcel(s);
- (b) Analysis regarding the need and proposed use for such right-of-entry;
- (c) Duration of need for parcel if for temporary use;
- (d) Proposed date of need;
- (e) Plan to restore property to original condition;
- (f) Any additional information as requested by MBTA; and
- (g) DB Entity shall submit written right-of-entry request for review and comment by MBTA prior to presenting the right-of-entry request to a parcel owner.

5.2.2 Property Conditions

The DB Entity shall perform a preconstruction survey of all parcels and properties abutting the ROW and other potentially affected properties. The DB Entity is responsible for obtaining access inside any dwelling. The preconstruction survey shall be used to establish the pre-existing condition of the properties which may be affected by the DB Entity's Work. Refer to Section 6.3.1 and Table 6-1.

The DB Entity shall protect all real and personal property during the performance of the Work. The DB Entity shall restore all property of abutters to the same condition that existed before the DB Entity's Work as established by the preconstruction survey. Exhibit 2C and Exhibit 2F include easement type and durations and specify certain of the DB Entity's Work requirements for each property.

The DB Entity shall remove all trees and grind the tree stumps 18 inches below grade on the Project ROW. For the Temporary ROW, the DB Entity shall make all reasonable efforts to work around existing trees but is allowed to remove the trees and shrubs to support its Work. If any tree is damaged or removed on the Temporary ROW, the DB Entity shall also grind the stumps 18 inches below grade. If the DB Entity removes

or damages any trees not previously identified for removal in the Contract Documents from abutting properties, the DB Entity shall replace the tree in kind.

The DB Entity shall remove, stack, and store fences located on private property and shall coordinate storage with the property owner. At completion of the Work, the DB Entity shall reinstall the fence using the stacked fence material. If the stacked fence is unusable, the DB Entity shall coordinate with the Owner to replace the unusable fence with a similar fence type and obtain a release from the property owner that documents acceptance of the replacement fence. If the original fence was encroaching on MBTA property, the DB Entity shall stack and store the fence on the Owner's property. The DB Entity shall not install the fence on MBTA property. Other private property impacted by the Work, such as pavers, paved and lawn areas shall be replaced in kind unless they encroach on MBTA property. Restoration of areas that encroach on MBTA property shall be loam and seed.

The DB Entity shall provide a two week notice to the property owner prior to performing any Work within the temporary or permanent easement parcels.

The DB Entity shall work around all permanent and semi-permanent structures. If the DB Entity removes any permanent or semi-permanent structure, or part thereof, the DB Entity shall, replace in kind and/or negotiate and compensate the affected land owner for damage to affected permanent or semi-permanent structures.

The DB Entity shall name all property owners on whose property the DB Entity will be performing work as additional insured under the DB Entity's commercial general liability and umbrella insurance policies.

5.3 Third Party Commitments

The DB Entity shall construct and provide all mitigation measures that have been identified in Exhibit 2F.

5.4 Laydown Areas

The following laydown areas are intended for use by the DB Entity:

- (a) Union Square – Refer to the Somerville Memorandum of Agreement in Exhibit 2F;
- (b) Northpoint – Refer to the North Point Boulevard and others, Cambridge and Somerville, Agreements in Exhibit 2E;
- (c) Homans – Refer to the Somerville Memorandum of Agreement in Exhibit 2F;
- (d) Tufts – Refer to the Tuft's Boston Avenue, Medford Agreement in Exhibit 2F; and
- (e) 200 Innerbelt – Unpaved portion of Parcel VMF-901 to the southeast of the existing parking lot within the limits of the existing fence not otherwise designated for other uses in Section 2.8.8.1.

The DB Entity shall comply with the use, timing, and other restrictions with respect to the laydown areas as set forth in Exhibit 2F and Section 2.8.8.1, as applicable. Nothing in this section 5.4 warrants the adequacy or sufficiency of these laydown areas.

5.5 Deliverables

Table 5-1 reflects a nonexclusive list of deliverables identified in these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit

all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2, unless otherwise specified in the Contract Documents:

Table 5-1: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Right-of-Entry Request	1	1	60 Days prior to presenting the right- of-entry request to a parcel owner	5.2.1

END OF SECTION

6 SURVEYING

6.1 General Requirements

DB Entity shall provide accurate and consistent land surveying and mapping necessary for the support, design, monumentation and construction of the Project.

DB Entity shall review existing survey data and determine the requirements for updating or extending the existing survey and mapping data. DB Entity is responsible for the final precision, accuracy, and comprehensiveness of all survey and mapping. The DB Entity shall perform all land surveying, boundary survey and mapping under the direction of a Massachusetts Registered Professional Land Surveyor.

6.1.1 Overview

The DB Entity shall perform all land surveying, boundary surveying and mapping under the direction of a Massachusetts Registered Professional Land Surveyor.

The DB Entity shall prepare and secure all applications, permits, access rights, permissions and acceptances necessary for non-MBTA property access to carry out survey work. The DB Entity shall provide copies of titles to the MBTA for this use and records. The DB Entity shall provide copies of Property Access Permission and point of contact information before performing the survey work.

The DB Entity shall carefully protect from disturbance and damage all land monuments and property marks until DB Entity has recorded their location. The DB Entity shall replace such monuments and marks upon completion of construction.

In addition to the survey listed below, the DB Entity shall review and incorporate information provided by the MBTA from the construction records and record drawings generated from the prior Green Line Extension construction contracts.

Survey related documents being provided by the MBTA are as follows:

- (a) Existing Conditions – Corridor, Roadway & Railroad Bridges, Roadways and Intersections, Building Surveys- Exhibit 2D;
- (b) Property ROW Plans – Program-wide property acquisitions and easements secured by the MBTA for the Project- Exhibit 2C; and
- (c) Control – MBTA Green Line Extension Project Control Verification and Densification survey Final Report dated May 20, 2015 and prepared by CHA Consulting, Inc.

6.1.2 Codes and Standards

- (a) The DB Entity shall comply with all applicable Laws pertaining to surveying, and without limitation shall ensure that all surveying follows the requirements of Commonwealth of Massachusetts Regulations 250, Section 6 and the Massachusetts Department of Transportation (MassDOT) Surveys Manual.

6.1.3 Datum and Units

Except where specified otherwise by Authority Having Jurisdiction, the DB Entity shall perform all land survey and mapping in accordance with the following:

- (a) Units: All survey measurements and dimensions shall be in US survey foot;
- (b) Project Control Horizontal Datum by CHA Consulting (CHA): GLX Horizontal Project Datum as established by CHA;
- (c) Project Control Vertical Datum by CHA (CHA): GLX Vertical Project Datum as established by CHA;
- (d) Existing Conditions Horizontal Datum: Massachusetts State Plane coordinate system and 1983 (1996) derived by control on plan entitled "Existing Conditions" dated March 11, 2011 prepared by Vanasse Hangen Brustlin, Inc. (VHB);
- (e) Existing Conditions Vertical Datum: North American Vertical Datum 1988 (NAVD 1988) and derived by control on plan entitled "Existing Conditions" dated March 11, 2011 prepared by Vanasse Hangen Brustlin, Inc. (VHB); and

The DB Entity shall coordinate the translation of datum information related to the Northpoint Development. Refer to the coordinate system translation sketch found on the plan entitled "Horizontal Control Plan, Northpoint in Cambridge and Somerville MA (Middlesex County) and Boston MA (Suffolk County) Sheet 1 of 1" dated March 30, 2015 prepared by Beals + Thomas (B+T Plan No. 208402P195A-001) in the RIDs.

6.2 Control Requirements

6.2.1 Horizontal Accuracy Requirements

6.2.1.1 Project Control

DB Entity shall utilize the established Project Control as reported in the MBTA Green Line Extension Project Control Verification and Densification Survey Final Report as noted in [Section 6.1.1](#) as a basis for control on the Project. The Project Control established by the DB Entity shall be tied and connected to as well as conformed to the standards set forth in the Project Control, a copy of which is provided in among the Reference Information Documents.

6.2.1.2 Primary Control

DB Entity shall establish primary control by either Global Navigation Satellite System (GNSS) methods or conventional traversing methods. DB Entity shall tie primary control to NAD 83 static monuments, published by CHA.

The densified Project Control can no longer be considered as referenced precisely to the NAD 83 datum due to the fact that the control exists on a local horizontal datum. Thus horizontal datum for the Project be referred to as the Project Horizontal Datum. [Exhibit 2H](#) contains a list of the adjusted horizontal coordinates referenced to the Project Horizontal Datum. A coordinate list is also included of the orthometric heights referenced to the Project Vertical Datum.

DB Entity shall survey the primary control network to an accuracy standard of 1 centimeter of positional tolerance as described in the Federal Geodetic Control Subcommittee – Federal Geographic Data Committee’s Geospatial Positioning Accuracy Standards, Parts, 1, 2, and 3, document FGDC-STD-007.1, .2, and .3-1998.

DB Entity shall not use Real-Time Kinematic (RTK) or Real-Time Network (RTN) surveys for establishment of primary control. DB Entity shall not use the NGS's Online Positioning User System (OPUS) as a means for determining GNSS positions.

6.2.1.3 Secondary Control

DB Entity shall establish secondary control to control the mapping of the Project Corridors. Secondary control shall be tied to and connect the primary control. Secondary control shall be established using GNSS or conventional traversing methods.

The secondary control shall be surveyed to an accuracy standard of 2 centimeters of positional tolerance as described in the Federal Geographic Data Committee – Federal Geodetic Control Subcommittee's Geospatial Positioning Accuracy Standards, Part 1: Reporting Methodology, document FGDC-STD-007.1-1998, and Part 2: Standards for Geodetic Networks, document FGDC-STD-007.2-1998.

RTK surveys meeting the Class RT1 specifications as detailed in the NGS User Guidelines for Single Base Real Time GNSS Positioning, Version 2.1 (August 2011) are acceptable for the establishment of secondary control. RTN surveys shall not be used for the establishment of secondary control. DB Entity shall not use the NGS's Online Positioning User System (OPUS) as a means for determining GNSS positions.

6.2.1.4 Supplemental Control

DB Entity shall establish supplemental control for the purpose of gathering design-related data, and metes and bounds surveys.

The supplemental control shall be tied to either the secondary control networks or the primary control networks, or a combination of both, and shall be surveyed to an accuracy standard of 2 centimeters plus 50 parts per million of positional tolerance.

RTK surveys meeting the Class RT1 specifications as detailed in the NGS User Guidelines for Single Base Real Time GNSS Positioning, Version 2.1 (August 2011) are acceptable for the establishment of secondary control. RTN surveys shall not be used for the establishment of secondary control. DB Entity shall not use the NGS's Online Positioning User System (OPUS) as a means for determining GNSS positions.

6.2.1.5 Vertical Accuracy Requirements

DB Entity shall establish primary control and secondary control networks by digital leveling with the use of an invar rod or by differential leveling using the three-wire method. Primary and secondary control shall be established to an accuracy of Second Order, Class 1.

Supplemental Control networks shall be established to an accuracy of Third Order. GNSS survey shall not be used for the establishment of vertical control.

6.2.1.6 Permanent Control Monuments

DB Entity shall place permanent control monuments in accordance with the following:

- (a) Monuments shall be brass monument discs permanently anchored in concrete;
- (b) DB Entity shall place a minimum of three monuments within each one-mile increment along the Project Corridor;

- (c) DB Entity shall set monuments in a way so as to minimize the chances of being disturbed or destroyed during construction. Disturbed or destroyed monuments shall be replaced within 7 calendar days. Each monument shall be visible to the next monument before and after construction. DB Entity shall not set monuments in roadways; and
- (d) Monuments, stakes, and marks shall be preserved by the DB Entity. If such monuments, stakes, or marks are destroyed or damaged, they shall be replaced by the DB Entity.

6.2.1.7 Survey Control Requirements

The DB Entity shall proceed from the Project controls established to make all surveys and layouts necessary to conform all the Work to the requirements of the Contract Documents; shall provide qualified engineering and other personnel for the purpose; and shall be solely responsible for the accuracy of the line and grade features of its Work.

The MBTA retains all rights to make such checks, as necessary, of the control work established by the DB Entity as the Work progresses. The DB Entity will be informed of results of such checks but the MBTA by so doing will in no way relieve the DB Entity of responsibility for accuracy of the Contract control. The DB Entity shall provide such assistance as may be required for checking purposes when requested by the MBTA.

The DB Entity shall ensure that any person in charge of a survey field party is proficient in the technical aspects of surveying.

DB Entity shall establish and maintain additional survey control as needed throughout the duration of the Project.

DB Entity shall tie any additional horizontal and vertical control for the Project to the MBTA-supplied control network (available in the RIDs). If DB Entity chooses to use GPS methods, DB Entity shall meet the accuracy of the appropriate level of survey.

All survey control points shall be set and/or verified by a Registered Professional Land Surveyor licensed in the State of Massachusetts.

DB Entity shall verify the coordinates and elevation values of the MBTA supplied information prior to the commencement of any Work or layout, including the elevations of the existing structures.

6.2.2 Survey Records and Reports

DB Entity shall maintain neat, accurate, and complete documentation for all land survey work performed for the Project. These records shall include all calculations, mapping, staking notes, and field crew daily diaries. DB Entity shall compile and prepare a formal survey report for all survey calculations related to survey control networks, and design surveys. Each report shall document and perpetuate the information and rationale used to perform the land surveying task. DB Entity shall provide the design survey report to MBTA upon request.

6.2.2.1 Survey Control Field Books and Records

DB Entity shall obtain and maintain necessary survey field books that pertain to Project Survey Control.

DB Entity shall reference each monument to at least three permanent, physical features to remain during Construction Work. DB Entity shall prepare detailed sketches showing the monument and reference ties, as well as the general physical location.

DB Entity shall record all horizontal and vertical control work, including angles, distances, adjusted coordinates, levels, elevations, and references, in a field book. DB Entity shall catalog copies of their horizontal and vertical control adjustment files and final adjusted coordinates and elevations.

DB Entity shall submit Control Survey Field Books and Records for Information within fourteen (14) calendar days of completion of the control establishment.

6.2.3 ROW and Permanent / Temporary Construction Easement Surveys

DB Entity shall perform ROW and easement surveys and stakeout as necessary to prosecute the Work.

Upon request from the MBTA or a property owner abutting the Project ROW, DB Entity shall stake out the Project ROW and easements at the abutting property within fourteen (14) calendar days.

6.2.3.1 ROW and Permanent Easement Monuments

DB Entity shall place permanent monuments to define the Project ROW and permanent easement in accordance with the following:

- (a) DB Entity shall place metal discs stamped with "MBTA ROW" "SURVEY MARKER", or approved equal, permanently anchored in concrete at 2,000-foot intervals along the Project Corridor. The disc shall be a minimum of 2" and a maximum of 4" in diameter with a split-style tapered stem. Where the monument falls near a control station (P.C., P.T., P.R.C., P.C.C), that monument shall be placed at that Station;
- (b) DB Entity shall place rebar and caps in between the metal disc concrete monuments in such a way that there is an approximate 1,000-foot interval between monumental. Rebar shall be a minimum of ½ in diameter and 18" long. Cap shall be a minimum of 2" and a maximum of 4" in diameter, made of a metal material and stamped with "MBTA ROW" "SURVEY MARKER", or approved equal; and
- (c) DB Entity shall set monuments in a way to minimize the chances of being disturbed or destroyed during construction. Disturbed or destroyed monuments shall be replaced within seven (7) days.

6.2.3.2 ROW and Permanent Easement Field Books and Records

DB Entity shall record all ROW and permanent easement monument stakeout, including traverse used, stakeout computations with angles and distances, and references sketches, in a field book.

DB Entity shall maintain a CAD drawing with all staked locations of the ROW and permanent easements and provide to the MBTA as requested and at the completion of the Project.

DB Entity shall submit ROW and Permanent Easement Field Books and Records for Information within thirty (30) calendar days of the monument stakeout.

6.3 Construction Requirements

6.3.1 Pre-Construction Survey

The DB Entity shall record the existing conditions of abutting property and other potentially affected properties in a timely manner and in accordance with the Technical Provisions. The DB Entity shall provide a description of its plan for obtaining the preconstruction survey, including dates of commencement of the survey at the various abutting and affected properties. The DB Entity shall provide 60 Days notice to the MBTA prior to beginning any preconstruction survey. The pre-construction condition survey shall be comprised of notes, digital photographs and digital video sufficient to accurately and appropriately document the preconstruction condition. All defects shall be noted and recorded. A preconstruction condition survey report, comprising all notes and copies of digital photos and videos along with a log describing the address, date, and viewing orientation of each photo and video segment shall be submitted to MBTA prior to disturbing any area.

6.3.2 Construction Survey Staking

DB Entity shall perform all construction surveying necessary to facilitate all construction operations for the duration of the Project and shall conform to the specifications within the Commonwealth of Massachusetts Regulations 250, Section 6 and the MassDOT Surveys Manual.

6.3.3 Construction Survey Records

DB Entity shall maintain neat, accurate, and complete documentation for all land survey work performed for the Project. These records shall include all calculations, mapping, staking notes, and field crew daily diaries. DB Entity shall compile and prepare a formal Survey Report for all survey calculations related to survey control networks, and construction surveys. The intent of the Construction Survey Report is to document and perpetuate the information and rationale used to perform the land surveying task. DB Entity shall submit the construction survey report to MBTA with the Record Drawings.

6.3.4 As-Built Survey Records

DB Entity shall prepare and submit Record Drawings in accordance with Section 2.8.

DB Entity shall prepare and submit As-Built Utility Location and Condition Surveys in accordance with Section 7.4.

6.4 Deliverables

Table 6-1 reflects a nonexclusive list of deliverables identified in these Technical Provisions and is not intended to be an all-inclusive or exhaustive listing of deliverables. DB Entity shall determine and submit all deliverables as required by the Contract Documents, Governmental Approvals, and Governmental Entities. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. At a minimum, DB Entity shall submit the following to the MBTA in the formats described in Section 2.7.1.3 of the Technical Provisions, unless otherwise specified in the Contract Documents:

Table 6-1: Nonexclusive Deliverables List

Deliverables	Number of Copies		Submittal Schedule	Section Reference
	Hardcopies	Electronic		
Design survey records and reports	2	1	Upon request by MBTA	6.2.1
Preconstruction Survey	2	1	Provide notice 60 Days prior to commencement of Preconstruction Survey	6.3.1
Construction survey report	2	1	With the Record Drawings	6.3.3

END OF SECTION

7.1 DEMOLITION

7.1.1 Scope of Work

The Work includes:

- (a) Demolition, selective demolition, and removal of structures and buildings including:
 - i. Homan's Building (also known as and referred to as Holman's Building) at 350 Medford Street – Full building demolition to 2 feet below existing grade, or as required for completion of the Work, whichever is deeper. Salvage the lions' heads per agreement with City of Somerville. Finish site with gravel and fencing.
 - ii. Sako Auto Body Shop at 642 Boston Avenue and Building at 646 Boston Avenue – Full building demolition to 2 feet below existing grade, or as required for completion of the Work, whichever is deeper.
 - iii. Bowling Alley and Ball Square Auto Body at 662 Boston Ave – Full building demolition to 2 feet below existing grade, or as required for completion of the Work, whichever is deeper.
 - iv. Sako Auto Body Shop at 675 Broadway – Full building demolition to 2 feet below existing grade, or as required for completion of the Work, whichever is deeper.
 - v. ACPA Building at 40-48 3rd Avenue – Full building demolition to 2 feet below existing grade, or as required for completion of the Work, whichever is deeper. The facility at 44 3rd Avenue is currently being used as a temporary storage facility for the TPSS equipment. Coordination is required with MBTA for removal of stored materials prior to demolition of this facility.
 - vi. Walker Building at 20 3rd Avenue – to 2 feet below existing grade, or as required for completion of the Work, whichever is deeper.
 - vii. Existing Viaduct structure – East Cambridge Viaduct to the existing abutment (excluding abutment) at Lechmere Station. Coordinate demolition with the NorthPoint property developer.
 - viii. Existing Washington Street Pump Station – Removal of all equipment and full demolition 2' below existing grade and as further depth is required for DB Entity Work of the pump station structure
 - ix. Roadway Bridges including full demolition of Broadway Bridge and selective demolition of other roadway bridges and utility bridges as described in Section 8.4 and Section 8.5.
 - x. Washington Street Railroad Bridge – Full demolition
 - xi. Existing Retaining Walls as described in Section 8.1.
 - xii. Site clearing and demolition of the yard at 90 Innerbelt Road. This lot is being used to store the Red Bridge transformers, WPS generator, and other items. Coordination is required with MBTA for removal of stored materials prior to demolition at this lot.
- (b) Demolition, selective demolition, and removal of any site improvements required for

completion of the Work.

- (c) Salvaging items for reuse by MBTA
- (d) All other Work necessary for completion of the demolition requirements, including associated support of excavation and dewatering as necessary to provide a safe adequate work site in accordance with applicable regulations
- (e) Refer to all sections of Volume 2 for additional specific demolition requirements.

7.1.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code, referred to below as “MBC” or “780 CMR”
- NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations
- 527 CMR – Massachusetts Fire Prevention Regulations
- ASCE 7, Minimum Design Loads for Buildings and Other Structures
- AREMA Manual for the Railway Engineering
- AISC Steel Construction Manual 14th Edition
- ACI-318 Building Code Requirements for Structural Concrete
- ACI 301 Specifications for Structural Concrete
- ACI-530 Building Code Requirements for Masonry Structures
- OSHA Part 1926
- Section 106 of the National Historic Preservation Act

7.1.3 The Project Specific Requirements

Develop a project specific Comprehensive Demolition Plan that defines the Work the DB Entity will perform at each site requiring demolishing work. The Comprehensive Demolition Plan shall show site specific demolition plans, sequence of work, traffic controls, laydown areas, haul roads, and any supporting design plans and calculations required for the Work. Site specific plans shall ensure or address at a minimum:

- (a) Identification of all utilities to be disconnected, abandoned, and removed at the site.
- (b) Disconnect and cap and/or seal all Utilities. Such Work shall permit removal of building and the performance of the Work without unplanned disruption of services to adjacent properties.
- (c) Verification of all existing conditions information necessary to complete the demolition requirements.
- (d) Citation of all reference plans used to develop site specific plans.
- (e) Removal means and methods of site demolition work including the removal and legal disposal of all building structure and other building components. Remove all below grade structures as necessary for construction of the Project.

- (f) Demolition procedures shall include the identification of equipment, cranes, lifts, etc. proposed to be used and the preparation of a plan layout including site access and egress for debris removal.
- (g) Recover and furnish commemorative bronze plaques per Contract Documents to Avalon Bay or current developer of the parcel adjacent to Lechmere Station. Recycling and salvaging of all elements shall be in accordance with the Section 8 and Exhibit 2B.1. The DB Entity shall repair and replace with new material any salvaged material damaged or destroyed by the DB Entity.
- (h) Salvage all Lechmere yard, viaduct, and lead track rail, all switch machines and signals, and all Automatic Fare Collection (AFC) fare gates. All salvaged items shall be delivered to the MBTA Railroad Operations material yard in Charlestown, MA, unless otherwise directed by the MBTA. No delivery will be greater than 50 miles, one way. The DB Entity shall repair and replace with new material any salvaged material damaged or destroyed by the DB Entity. Items to salvage include:
 - a. OCS poles
 - b. Trolley wire splices, 2/0
 - c. Special track work including 4 RH point/mate turnouts
 - d. Switch boxes with power craft switches
 - e. Switches in chamber under the viaduct at Lechmere Station
 - f. Balance weights
 - g. Greaser equipment
- (i) Locations of temporary protection and means of access and egress for adjacent occupied buildings.
- (j) Protection plans for any trees or plant material to remain on the demolition site or adjacent properties.
- (k) Proposed locations of soil stockpiles.
- (l) Comply with Exhibit 2F.

7.1.3.1 Traffic Detours

Temporary traffic detours and controls shall be in compliance with Section 9.3 for the demolition of the following:

- (a) The existing Lechmere Viaduct over Monsignor O'Brien Highway, which may require temporary closure of Monsignor O'Brien Highway. Access and egress to local properties shall be maintained at all times.

7.1.4 Deliverables

- (a) The Comprehensive Demolition Plan. Demolition shall not proceed without written approval of the Comprehensive Demolition Plan from the MBTA.
- (b) Proposed Protection Measures: Submit informational report in accordance with OSHA Part 1926 procedures, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers. Refer to Volume 2 Section 3 and Section 4 for additional environmental and hazardous materials requirements, respectively.
- (c) Schedule of building and structure demolition activities: Indicate the following:
- Detailed sequence of demolition work, with starting and ending dates for each activity.
 - Temporary interruptions of utility services.
 - Shutoff and capping or re-routing of utility services.

Refer to Volume 2 Section 3 and Section 4 for additional environmental and hazardous materials requirements, respectively.

- (d) Inventory: Submit a list of items to be removed and salvaged and deliver to the MBTA prior to the approval of the demolition plan.
- (e) Pre-demolition Photographs and Video: Show existing conditions of adjoining construction and site improvements, including stone designated for repurposing, and finish surfaces that might be misconstrued as damage caused by demolition operations. Documentation of existing damage shall include a close up with a readable scale in the photograph and video. Submit before the Work begins.
- (f) Certificates, issued by the Utility Owners, of utility services severed, for record purposes.
- (g) Refer to Section 3 and Section 4 for additional environmental and hazardous materials requirements, respectively, including required submissions for tracking and disposing of hazardous and non-hazardous waste.

7.2 SITEWORK

7.2.1 Scope of Work

The Work includes:

Provide all sitework within (1) the project area, and (2) adjacent areas defined in this Section (the "Sitework Areas"), including: site grading, earthwork, surface materials, site restoration, and fencing defined in this Section.

The Sitework Areas include: proposed stations and adjacent site areas; demolition sites; Vehicle Maintenance Facility (VMF) site; Traction Power Substation (TPSS) sites; Washington Street Pump Station (WSPS) and Red Bridge Pump Station (RBPS) sites; vehicle access drives from local roadways to the VMF, TPSSs, WSPS, RBPS, signal bungalows and various other locations; pedestrian access to various facilities; the Community Path; the Lechmere Station bus loop; emergency egress walkways from the corridor to public ways; bridge crossings and roadway intersections, and all areas disturbed as part of the Work.

Fencing, sitework associated with utilities, and site work associated with stormwater systems may extend beyond the boundaries of the Limit of Works, except as otherwise noted in this Section.

The Project shall include the relocation of portions of the New Hampshire Mainline Tracks and Fitchburg Mainline Tracks, both active rail systems, to allow construction of the Project in those active rail corridors. Coordinate with all other work abutting the Project.

7.2.2 Codes, Standards and Manuals include:

- MBTA Railroad Operations Commuter Rail Design Standards Manual for Track and Roadway
- MBTA Commuter Rail Track and Roadway Book of Standard Plans
- MBTA Railroad Operations Commuter Rail Design Standards Manual
- MBTA Railroad Operations Directorate MBTA Manual of Guidelines and Standards
- MBTA Guidelines for Designing Barrier-Free Transportation Facilities
- MBTA Commuter Rail Station Access Guidelines
- MBTA Maintenance of Way Division Green Line – Light Rail Transit Track Maintenance and Safety Standards
- MassHighway Project Development and Design Guide
- MassDOT Highway Division Right of Way (ROW) Manual
- MassHighway Standard Specifications for Highways and Bridges
- MassDOT Highway Division Supplemental Specifications to the Standard Specifications for Highways and Bridges
- Massachusetts Building Code – 780 CMR
- Massachusetts Fire Prevention Regulations – 527 CMR

- Massachusetts Architectural Access Board (MAAB)
- Americans with Disabilities Act (ADA)
- United States Access Board ADA Accessibility Guidelines (ADAAG)
- Respective Municipality (Cambridge, Somerville, Medford) DPW Standards
- AASHTO Guide to Bicycle Facilities
- U.S. Department of Transportation Federal Highway Administration Manual on Uniform Traffic Control Devices (MUTCD)
- Massachusetts Amendments to the Manual on Uniform Traffic Control Devices (MUTCD) and the Standard Municipal Traffic Code

7.2.3 The Project Specific Requirements

7.2.3.1 General Sitework Requirements

- (a) Protect all existing structures and property not required for construction of the Project to be demolished or removed.
- (b) Unless otherwise required by Exhibit 2F, all grading shall meet the existing grades on abutting properties, and grading shall be performed so as not to increase or change the flow of water onto abutting properties.
- (c) Provide dewatering as required for construction of the Project.
- (d) Provide earthworks, including excavation, backfill, and shoring as required for construction of the Project.
- (e) Site design shall comply with ADA and ADAAG requirements.
- (f) Provide a layer of crushed stone at any disturbed areas within the MBTA property, unless otherwise required by the Contract Documents. The crushed stone surface shall be the post-construction finished surface for these areas, and shall be a minimum of 3" deep consisting of ¾" stone with a 20 year, 4.1 oz weed fabric underlayment.
- (g) Unless explicitly required otherwise by the Contract Documents, restore all disturbed areas on abutting and other affected properties to conditions existing immediately prior to disturbance, including restoration of existing site grading, surface materials, and landscaping.
- (h) All VMF accesses shall be designed to accommodate a gross vehicle weight of 32,000 lbs. and a minimum width of 12'.
- (i) All parking shall be designed to accommodate a gross vehicle weight of 18,000 lbs and a minimum width of 10'.
- (j) All emergency vehicle access shall be designed to accommodate a maximum gross vehicle weight of 62,000 lbs. and a minimum width of 12'.

- (k) Provide support pads for exterior utility equipment, including switchgear, transformers, generators, and condensers, unless otherwise required by the Utility Owner.
- (l) Provide bollards with 5-foot maximum center-to-center spacing around exterior utility equipment, unless otherwise required by the Utility Owner.

7.2.3.2 Grading and Ground Cover

- (a) Except as otherwise stated in the Contract Documents, at all areas disturbed between East Street and Charlestown Avenue/Gilmore Bridge, level and grade all disturbed non-paved areas to provide finish grade slopes not exceeding 5.0%, and, place gravel at-grade and level to meet existing grade. Gravel shall be a minimum of 6" deep.
- (b) At areas disturbed between Water Street and East Street, level and grade all disturbed non-paved areas to provide finish grade slopes not exceeding 3:1 (horizontal:vertical), and place gravel at-grade and level to meet existing grade.
- (c) At Gilman Station, grade the site as required to maintain an accessible route during construction to the emergency stairway adjacent to the site.
- (d) The WSPS access hatches shall be raised to the finished grade of the Site. Grading shall provide an unobstructed visual line of sight for operators of the pump station control shelter and to all pump station access hatches. All sitework in this area shall ensure vehicle access for maintenance and emergency vehicles to the pump station hatches, control shelter entrance, and the emergency generator.
- (e) Site grading shall be provided to direct stormwater surface runoff away from all structures, including Stations, VMF, and TPSS sites.

7.2.3.3 Access Walkways, Drives, and Parking Areas:

(a) General Requirements:

- (i) All walkways, drives, and parking areas shall be paved with a bound surface, with a 25 year design life.
- (ii) Provide paved access drives and parking areas for maintenance and emergency vehicles from all TPSSs, RBPS, and the WSPS to public ways.
- (iii) Provide paved access drives from all Hi-Rail vehicle access points to a public way for maintenance and emergency vehicles.
- (iv) Accommodate access for maintenance and emergency vehicles for access drives unless otherwise noted on the Contract Documents.
- (v) All access drives shall be designed to accommodate loading of MBTA standard maintenance vehicles and emergency vehicles.
- (vi) All walkways, drives, and paths located within the Cities of Somerville, Medford and

Cambridge respectively, shall comply with each City's respective specific standards and requirements. Where there is a need to transition between two jurisdictions, coordinate the design and construction of the transition with the respective Cities.

- (vii) Provide ADA compliant accessible curb ramps where access paths and accessible routes cross any road or drive.
 - (viii) Provide all pavement markings including crosswalk markings at all crosswalks.
 - (ix) Grade site to prevent water from draining across all walkways. Grade walks and paving to drain to adjacent planted or gravel areas.
 - (x) In the area from East Somerville Station to Lechmere Station, MBTA maintenance tracks and access roadways shall not be used as shared space for any public pathways or public access to paths.
 - (xi) Provide an unobstructed 10' wide access road to the signal hut in the vicinity of the Redbridge TPSS.
- (b) Lechmere Station
- (i) Provide an ADA compliant accessible walkway from the Lechmere Station South Headhouse station entrance to the sidewalk outside of the station.
 - (ii) Provide ADA compliant accessible walkways from the bike storage racks and enclosure at Lechmere Station to the sidewalks at East Street and Monsignor O'Brien Boulevard.
 - (iii) Provide ADA compliant accessible walkways from Lechmere Station North Headhouse station entrance to the sidewalks of both adjacent streets (Water Street and North First Street) and temporary access to existing travel routes.
 - (iv) All permanent Work and associated siteworks (including fencing, utilities, and stormwater systems) associated with the Lechmere Station North Headhouse shall be installed within the Limit of Works indicated in Exhibit 2B.1, and/or within the adjacent roadway right-of-ways.
- (c) Union Square Station
- (i) Provide a concrete ADA compliant accessible walkway from the station entrance to the street connection walkway (also known as the Bennet Court walkway) indicated on in Exhibit 2B.2. Coordinate work with adjacent property developers.
 - (ii) Provide fencing and associated fence gates around new station tracks as shown indicatively on the Concept Plans.
- (d) East Somerville Station
- (i) Refer to Section 12 for Station requirements.

(e) Gilman Square Station

- (i) Refer to Section 12 for Station requirements.

(f) Magoun Square Station

- (i) Provide an ADA compliant pedestrian walkway from the station entrance to the Lowell Street Bridge sidewalk.

(g) Ball Square Station

- (i) Refer to Section 12 for Station requirements.
- (ii) Refer to Section 7.5 for Landscape requirements.

(h) College Avenue Station

- (i) Provide an ADA compliant pedestrian plaza from the pedestrian bridge and intersection of Boston Avenue and College Avenue to the station entrance and the bicycle rack and enclosure. Refer to Section 8.6 for pedestrian bridge requirements.
- (ii) Refer to Section 7.5 for Landscape requirements.

(i) Building / Structure Access

- (i) Provide a 12' wide minimum access road from all signal bungalows to the nearest public roadway for MBTA signal maintenance vehicles.
- (ii) Provide 10' wide minimum ADA compliant accessible walkways from public ways to all station entrance points.
- (iii) Provide 10' wide minimum ADA compliant accessible walkways from public ways to all bicycle racks and enclosures.
- (iv) Provide a paved vehicle access drive from Third Avenue to the VMF parking lot and building. Access shall be designed and constructed to accommodate WB-50 delivery trucks, capable of receiving GLX rolling stock delivered on trailer by road.
- (v) Provide paved vehicular and pedestrian access to the north side of the VMF building per Exhibit 2B.1 from the paved access path and parking lot.
- (vi) Provide a paved vehicle access drive from Washington Street to the existing MBTA facility adjacent to Cobblehill Road. The driveway shall be a bound pavement surface with a minimum width of 22'.
- (vii) Provide a bound pavement surface for vehicle access from the RBPS to 66 Joy Street designed for WB-50 vehicle loads.
- (viii) Provide access from all TPSSs to public ways for maintenance utility truck vehicles. A paved

vehicle access drive shall be provided to each substation, from the following designated points:

- (a) Red Bridge TPSS: Access shall be provided from West Boulevard.
- (b) Gilman Square TPSS: Access shall be provided from Medford Street.
- (c) Ball Square TPSS: Access shall be provided from Boston Avenue.

(j) 200 Innerbelt Road Access

- (i) Provide a 12' wide minimum clear access drive with vehicle gates, designed to WB-50, as required to the corridor from 200 Innerbelt Road.

(k) Washington Street Underpass

- (i) At the Washington Street underpass, provide safety railings to be compliant with 780 CMR 1012.0 GUARDS. Provide these railings along the elevated sidewalk and shared-use path to comply with OSHA fall height requirements. Also comply with AASHTO Guide to Bicycle Facilities where the sidewalk accommodates the shared-use path.

7.2.3.4 Fencing Requirements

(a) General Requirements

- (i) Install fence foundations to a minimum depth of the regional frost depth stated in the Massachusetts Building Code.
- (ii) The fencing shall be minimum 6' tall fusion bonded black vinyl coated chain link unless otherwise required.
- (iii) Provide grounding systems for fences along the Corridor. Refer to stray current and corrosion control requirements in Section 8.
- (iv) "No Trespassing" signs shall be attached to deter trespassing along the corridor.
- (v) Arc flash protection and heavier duty fencing shall be provided in accordance with Exhibit 2H MBTA standards.

(b) Gates

- (i) All gates shall be lockable, minimum 6' tall, with width commensurate and compatible to the access path being gated, as defined in Volume 2, Exhibit 2H. Gates shall be galvanized steel, non-motorized and vertically hinged at 2' centers. Where Right-of-Way or other factors preclude the use of a hinged gate, non-motorized sliding gates shall be provided.
- (ii) Include personnel and vehicle gates at all locations where required.
- (iii) Install gates as part of the security fence around the perimeter of the VMF building and the

storage track as shown on the Project Definition Plans. Relocate any existing fence to provide required clearance.

- (iv) Provide a lockable gate in the fencing that provides a 12' clear entrance to the corridor at all Hi-Rail access points.
- (v) Provide emergency egress gates along the rail corridor and platform gates with communication lines running back to the MBTA monitoring station at 45 High Street, Boston. Refer to Section 11.7 for additional requirements regarding the communications.
- (vi) The existing security gate at the stairs for the detention basin near Red Bridge Pumping Station and the rail flyover, shall be connected to the project trackside communication system.
- (vii) At East Somerville Station, a vinyl-coated chain link fence and vehicular security gate shall be provided between the MBTA's commuter rail provider's (currently Keolis) facility and the eastern limits of the station site.

(c) Location

- (i) Provide fencing along the entire length of the Project Right of Way boundary except in areas where noise walls or system structures provide a barrier preventing unauthorized entry to the Right of Way.
- (ii) Where the Community Path runs along the corridor, provide an 8' tall, tight mesh (1") vinyl coated chain-link security fence, with no barbed wire, between the path and the MBTA operating right-of-way.
- (iii) Provide a 6' tall, black vinyl extruded knuckled end fence, with no barbed wire, between the Community Path and all adjacent properties, unless otherwise required by Exhibit 2E. Fencing is not required on the viaduct.
- (iv) Provide inter-track fencing as defined in Exhibit 2H at all locations between the LRT and Commuter Rail.
- (v) Provide 8' fence along station areas.
- (vi) Provide fencing along the entire perimeter of the Glassworks property (near Lechmere Station), except along the McGrath Boulevard right-of-way and under the Viaduct. Fencing to be 6' tall, black vinyl extruded knuckled end chain-link fence, with no barbed wire, unless otherwise required by Exhibit 2E.
- (vii) Provide 8' high security fencing and lockable gates across the vehicle accesses (as defined in Volume 2 Technical Provisions) to secure the TPSS and southwest side of detention pond area at Red Bridge.

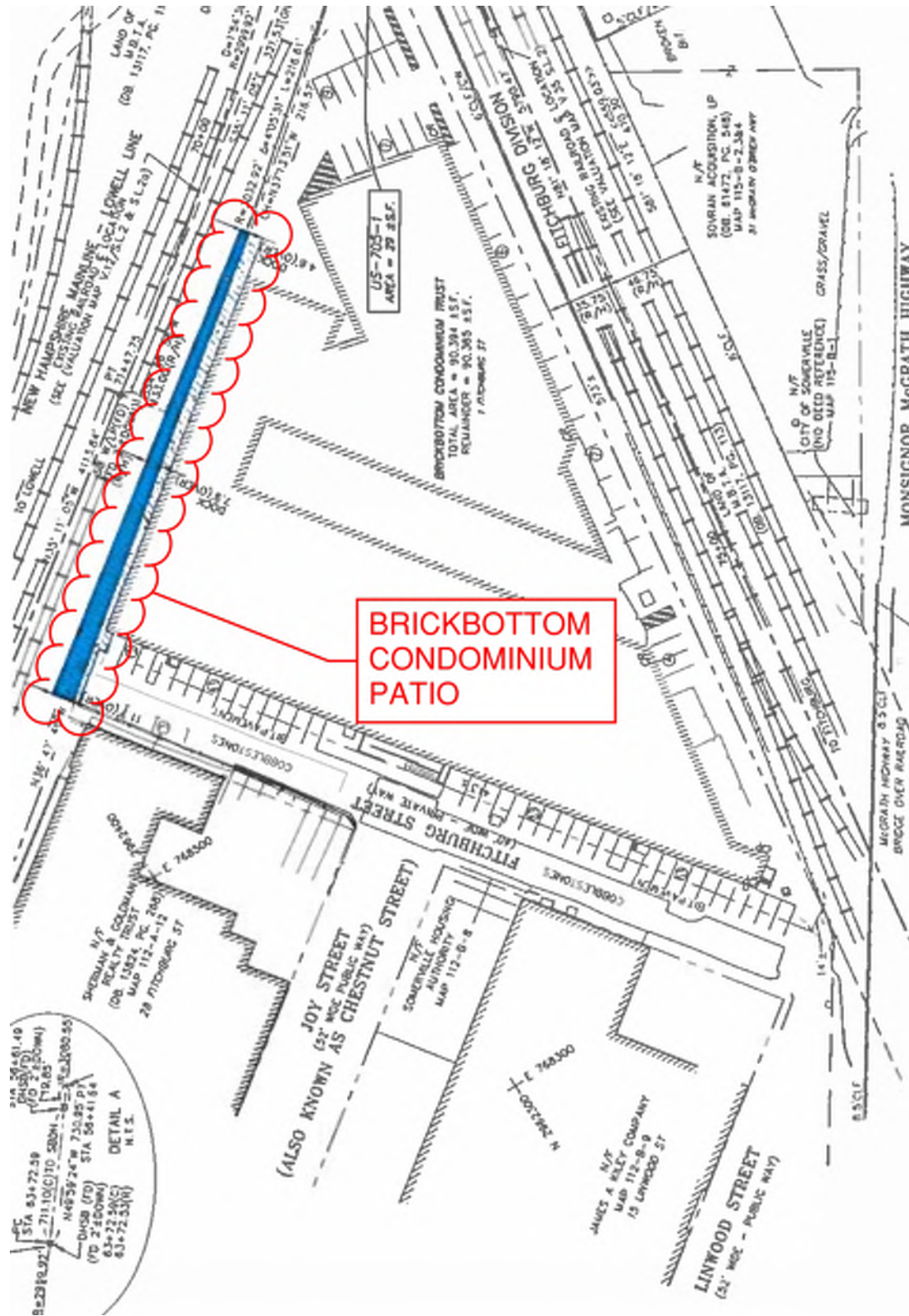
7.2.3.5 Brick Bottom Patio

- (a) Grade the area around the Brickbottom Condominium patio foundations to provide frost

protection.

- (b) Protect Brickbottom Condominium patio, including all associated foundations and appurtenances. The extent of work for the Project shall not encroach within the footprint of the patio and its foundations and appurtenances.
- (c) Refer to Figure 7.2-1: Brickbottom Condominium Patio Location – Excerpt from Parcel US-705 Land Acquisition Plan – City of Somerville, Middlesex County.
- (d) Refer to Figure 7.2-1: Brickbottom Condominium Location – Elevated track shall be on viaduct type structure adjacent to Brickbottom.

Figure 7.2-1: Brickbottom Condominium Patio Location – Excerpt from Parcel US-705 Land Acquisition Plan – City of Somerville, Middlesex County



7.2.3.6 Lechmere Bus Loop

Construct a bus loop with access from Water Street, located between Water Street and the Lechmere Station North Headhouse. Provide the following:

(a) Within the Bus Loop Driveway:

- (i) Provide a minimum 12'-6" vertical clearance above the bus loop driveway finish grade.
- (ii) Four (4) 40-foot long, 10-foot wide pick-up/drop-off berths for MBTA busses adjacent to accessible walkways to station.
- (iii) Four (4) 40-foot long, 10-foot wide layover berths for MBTA busses.
- (iv) Accessible curb ramp from bus loop driveway to sidewalk, located at the east side of the bus loop.
- (v) Each Pick-up/drop-off and Layover berth shall be separated from all other berths by no less than 40-feet.
- (vi) Minimum 15-foot wide drive aisle between vehicle berths.
- (vii) Sufficient space for an MBTA bus to travel through bus loop without intersecting any vehicle berths, and without needing to reverse direction for any vehicle maneuvers.
- (viii) 6-Inch vertical granite curbs shall be provided along the perimeter of the bus loop.
- (ix) Any traffic islands within the bus loop shall be paved with concrete, and shall have 6-inch vertical granite curbs along the perimeter.
- (x) Any structures located on traffic islands within the bus loop shall be protected with bollards.
- (xi) Pavement markings, including "Bus Only" markings, directional traffic flow arrows, stop bars, and crosswalk markings.
- (xii) Signage, including 'Stop', 'No Parking - Bus Stop', and wayfinding signage including bus route signs at bus pick-up berths. Refer to [Section 12.5](#) for additional signage requirements.
- (xiii) Exterior site lighting shall be provided along the bus loop and within any associated traffic islands, and along any walkways and plazas required by the Contract Documents between Water Street and North First Street. Refer to [Section 12.4](#) for Station Exterior Site Lighting Requirements.

(b) Walkways and Plazas:

- (i) Accessible paths shall be provided along all walkways from Water Street and North

First Street to the Lechmere North Headhouse, and to any Bus Operations Buildings. Painted crosswalks shall be provided where the accessible paths cross the bus loop.

- (ii) One (1) 44-foot long minimum bus canopy, located on the walkways in the vicinity of each pick-up berth (four total).
 - (iii) 14-foot wide minimum ADA compliant accessible concrete walkway along the north side of the bus loop, from Water Street to east side of bus loop.
 - (iv) 10-foot wide minimum ADA compliant accessible concrete walkway along the south side of the bus loop, from Water Street to east side of bus loop.
 - (v) 15-foot wide minimum ADA compliant accessible concrete walkway/plaza adjacent the east side of the bus loop, between the bus loop and Lechmere Station North Headhouse.
 - (vi) 10-foot wide minimum ADA compliant accessible concrete walkway connecting the walkways at the bus loop to the Lechmere North Headhouse stairs and North First Street.
 - (vii) ADA compliant accessible 6-foot wide minimum concrete walkway around the perimeter of the Lechmere North Headhouse, connecting all headhouse service entrances to the walkways at the bus loop and the walkway to North First Street.
 - (viii) ADA compliant accessible concrete walkway from Water Street to the Bus Operations Building.
- (c) Permanent Work associated with the bus loop and associated siteworks shall be installed within the Limit of Works indicated on the Project Definition Plans.
- (d) Refer to Section 12.3 for AFC 2.0 requirements.

7.2.3.7 Traffic Detours

Temporary traffic detours and controls, including for pedestrian and bike detours, shall be provided in compliance with Section 9.3 as required to complete the siteworks for the Project.

7.2.4 Deliverables

- (a) Submit a Conceptual Sitework Plan to MBTA for approval showing proposed locations of Work, general dimensions, type of materials and other descriptive materials to indicate the general layout and functional intent shall be prepared. This plan shall be submitted to the MBTA to demonstrate an understanding of and general compliance with the Technical Provisions.
- (b) Upon acceptance of the Conceptual Sitework Plan by MBTA, submit a Comprehensive Sitework Plan to MBTA for approval describing the proposed sequence relative to other work on the project and describe methods of construction. This Plan shall include detailed dimensioned drawings and calculations. It shall also indicate how the Work interfaces with the Work of other disciplines. It shall include the location of all sitework signage required by the Contract Documents.

- (c) Submit pavement design for all pavements required by the Contract Documents to MBTA for approval.
- (d) Proposed Protection Measures: Submit to MBTA for approval an informational report in accordance with OSHA Part 1926 procedures, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- (e) Submit copies of requests for and certificates of severance of Utility services to the MBTA at least ten days prior to start of site preparation work.

7.3 STORMWATER SYSTEM

7.3.1 Scope of Work

The Work includes the modeling, design, permitting and construction of all drainage infrastructure for the Project, including track areas, viaducts, stations, VMF, driveways, roadways and intersections, bridges, parking areas, Community Path, access/egress paths and areas abutting the Project where other Work shall be constructed by the DB Entity. Provide the following:

- Collect stormwater runoff and groundwater flows within the Project area, as well as flows from tributary off-site areas to the project area;
- Collect building-source stormwater runoff from interior and exterior stormwater sub-grade conductors, coordinated with [Section 14.1](#);
- Convey the collected flows and discharge that flow at permitted locations;
- Provide sufficient stormwater management facilities so as to comply with all applicable federal, state and municipal requirements and permits related to stormwater management, including measures to control water quality, flow rates and flow volumes. The Project has been designated as a redevelopment project relative to Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards;

Incorporate the partially constructed drainage system, primarily in the Millers River Drainage Area from south of Washington Street to the Millers River outfall into the DB Entity's design. The remaining Work to the Millers River drainage area includes the remaining construction and activation of two large pump stations, including various controls that monitor and interface with the operation of the stormwater detention systems.

Stormwater systems may extend beyond the boundaries of the Limit of Works, except as otherwise noted in this Section.

Refer to [Section 4](#) for additional environmental conditions and requirements.

Refer to [Exhibit 2D](#), RIDs, and as-builts for existing condition drawings of previously constructed components.

7.3.2 Codes, Standards and Manuals include:

7.3.2.1 MBTA

- Railroad Operations Commuter Rail Design Standards Manual include:
- Book of Standard Trackwork Plans
- Book of Standard Plans – Track and Roadway
- Railroad Operations Commuter Rail Design Standards Manual for Track and Roadway
- Commuter Rail Track and Roadway Book of Standard Plan
- Railroad Operations Commuter Rail Design Standards Manual for Bridges.

- Railroad Operations Directorate Guidelines and Procedures for Construction on MBTA Railroad Property
- Manual of Guidelines and Standards
- Guidelines for Designing Barrier-Free Transportation Facilities
- Commuter Rail Station Access Guidelines
- Maintenance of Way Division Green Line-Light Rail Transit Track Maintenance & Safety Standards

7.3.2.2 AREMA

- AREMA, Part 5, Pipelines

7.3.2.3 MassHighway

- Project Development and Design Guide
- Construction Standard Details
- Standard Specifications for Highways and Bridges
- Storm Water Handbook for Highways and Bridges
- Engineering and Policy Directives

7.3.2.4 MassDOT (Highway Division)

- Supplemental Specifications to the Standard Specifications for Highways and Bridges
- Engineering and Policy Directives
- Standard Special Provisions

7.3.2.5 MassDEP

- Stormwater Policy
- Stormwater Management Standards
- Stormwater Handbook
- Erosion and Sediment Control Guidelines for Urban and Suburban Areas
- Protocol for Stormwater Best Management Practice Demonstrations
- Category 5 303(d) List of Impaired Waters in Massachusetts Year 2010 Integrated List of Waters
- NPDES Stormwater Management Plan for MassHighway Owned and Operated Highways
- NPDES Stormwater Discharges from Municipal Sources (MS4) Guidelines

7.3.2.6 Other

- Cambridge Wastewater and Stormwater Guidelines
- Stormwater Management Policy for the City of Somerville
- Medford Stormwater Management Program and Design Guidelines
- Massachusetts State Building Code
- City of Cambridge Planning Board – Notice of Decision on Final Development Case No. PB#179
- National Fire Protection Association (NFPA) Publication 70, National Electric Code (NEC)

7.3.3 The Project Specific Requirements

7.3.3.1 Overall Project Area

Assess, design, and construct the overall corridor drainage system.

The DB Entity shall model the drainage design. This shall be an iterative modeling and coordination process that identifies design refinements required for the constructed system to function in accordance with the Project's requirements and enable the MBTA to understand the impacts of any proposed designs on the existing and new drainage systems.

Provide temporary and permanent stormwater management systems as necessary to control and convey stormwater flows at the Project, including the MBTA drainage systems and municipal drainage systems discharged into or passing through the MBTA corridor. This shall include flow bypasses around work areas, bypass pumping and measures to limit the hydraulic grade line on all potentially impacted MBTA drainage systems and drainage systems owned by others.

If the DB Entity utilizes the existing pipe in the Work, it shall have the pipe cleaned of sediment and debris and inspected by CCTV prior to construction. The cleaned / inspected system shall be documented and all data provided to the MBTA to demonstrate the pipe is in an acceptable condition. Pending the determination by the MBTA, provide calculations, stamped by a licensed Massachusetts Professional Engineer, demonstrating the functionality and hydraulic adequacy of any existing drainage system components to handle proposed flows and structural adequacy taking into account final loading conditions. Materials that shall not be re-used regardless of condition include: corrugated metal pipe, non-reinforced concrete pipe or any previously excavated and salvaged pipe.

All new drainage systems installed by the DB Entity shall be designed and constructed to have a service life of 75 years or greater, unless otherwise specified.

Meet all permit and regulatory requirements and guidelines, including requirements that exceed the requirements of other project specific requirements.

Comply with the utility design and construction requirements laid out in [Section 7.4](#).

7.3.3.2 Corridor

(a) Design Storms:

- (i) Corridor underpass at Prospect Street: At the Prospect Street underpass, the system shall maintain a maximum water level no greater than 5-inches above the top of the rail on the Commuter Rail, during the 100-year storm event, and below the top of tie on the new Union Square branch during the 50-year storm event.
- (ii) All Corridor Areas, except at the Corridor underpass at Prospect Street: system shall maintain a maximum water level below the top of tie during the 50-year storm event.
- (b) Track underdrain elevation: Invert of pipe shall be a minimum of 3'-6" below top of rail elevation.
- (c) Track underdrain alignment: Centerline shall be a minimum of 6'-6" from track centerline.
- (d) Diameter and materials of perforated pipe underdrain: Minimum of 12" (HDPE pipe preferred). If perforated pipe is acting as a carrier pipe, pipe shall be laid with perforations up.
- (e) Stormwater Manhole / Cleanout Spacing: Maximum of 300 linear feet. Manholes and/or cleanouts are required at any change in horizontal or vertical alignment.
- (f) Pipe elevation crossing under railroad tracks: Minimum of 2' of cover from top of pipe to bottom of tie.
- (g) Pipe loading crossing under railroad tracks: Cooper E80.
- (h) Pipe Capacity: Pipe capacity shall be based on the maximum hydraulic grade line not exceeding the top of tie at any location during the peak flow from a 50-year rainfall.
- (i) Outfall Pipe Discharge Rate Discharging to Municipal System: Post-development stormwater discharge peak flow rates shall not to exceed pre-development stormwater discharge peak flow rates based on the design storms required by the Municipality when tying into a municipal system. Comply with all respective municipal requirements.
- (j) Flow Patterns: Maintain existing patterns to the maximum extent practicable.
- (k) Runoff Volume and Water Quality and Quantity: Unless otherwise required by applicable permits and/or Municipal requirements that are more stringent, project runoff shall at a minimum comply with MassDEP Stormwater Management Standards as a designated Redevelopment Project.

7.3.3.3 Design Precipitation Rates:

- (a) As required by MassDEP Hydrology Manual for Conservation Commissioners, use Technical Paper 40 (TP-40) rainfall atlas for 24-hour storm duration rainfall depths. For Millers River watershed (which outlets into the Millers River in Boston) use rainfall data for Essex County. For all other Project locations use Middlesex County rainfall data policy decision.
- (b) Rainfall Distribution: Rainfall distribution shall be based on SCS Type III, 24-hour storm.

7.3.3.4 Design Storms

- (a) Roadways and Intersections:
 - (i) For MassDOT roadways comply with drainage criteria for the functional classification of the roadway.
 - (ii) For Washington Street, the underpass area shall be designed for a 100-year event with a peak water surface elevation 12" above the roadway surface.
 - (iii) For local roadways, comply with all respective required municipal criteria for drainage work.
- (b) General:
 - (i) For all areas of the Project not covered by more restrictive permit requirements, municipal requirements, corridor drainage design requirements, roadway and intersection design storm requirements, and/or other MBTA criteria: design stormwater management systems with a hydraulic grade line at or below the crown of the stormwater pipes during a 10-year design storm.

7.3.3.5 Pump Systems

Provide the following for all stormwater system pump systems:

- (a) National Fire Protection Association (NFPA) Class I, Division 1 Explosion-proof motors, control panels, cables, lights and associated components.
- (b) Control panel(s) and communications system(s) compatible with MBTA's existing SCADA HMCS/PLC System.
- (c) Active ventilation systems
- (d) Platforms, ladders, and access hatches sufficient to provide access to all areas of the pump stations. Washington Street shall be graded to allow hatches to be installed and HS-20 truck loading on the wet well.
- (e) Stainless steel piping for all piping within the pump stations and associated valve chambers
- (f) Wired pump control communication connections from pump station controls/alarms to the OCC at 45 High Street. Communication cables installed outside of the pump stations and buildings shall be installed within concrete ductbanks. Refer to [Section 11.7](#) for communication system requirements. If the pump systems are operational prior to completion of the associated communication systems required by [Section 11.7](#), provide a temporary communication system from the pump systems to 45 High Street.
- (g) Emergency power natural gas generators.
- (h) All associated utility connections, including a gas main for the Washington Street Pump Station (WSPS) emergency power generator.

- (i) Grounding systems.

Refer to Volume 1, Section 3 for a summary of MBTA-Furnished Materials and Equipment, including equipment that may be used for the new pump stations.

Refer to Exhibit 2D for existing condition drawings of previously constructed components, including portions of communications ductbanks from the Red Bridge Pump Station (RBPS) to 32 Cobblehill Road.

Refer to Section 14.6 for additional information and requirements for MBTA's SCADA HMCS/PLC System.

7.3.3.6 Government Approvals

Comply with all existing permits, regulatory requirements and regulatory agency guidelines, including those listed below and any subsequent modifications thereto. Identify and obtain any remaining permits and approvals required to construct and operate the drainage systems.

- (a) National Pollutant Discharge Elimination System (NPDES)

- (i) Permit No. MA0003590, 2007 Reissuance

Generally, this permit authorizes MBTA and the Massachusetts Bay Commuter Railroad (MBCR) Operator, currently Keolis, to discharge treated stormwater from the facility located at the MBTA Commuter Rail Maintenance Facility (CRMF, also known as the Boston Engine Terminal yard) to the Millers River (segment ID MA 72-31). This system ultimately connects to the Old Stone Culvert that outfalls to the Millers River and is regulated by this permit.

<https://www3.epa.gov/region1/npdes/permits/2007/finalma0003590permit.pdf>

- (ii) Permit No. MA0101982

This permit authorizes the City of Somerville to discharge from two combined sewer overflows (CSO) to Alewife Brook and Upper Mystic River. This storm drain ultimately discharges to the Somerville Marginal CSO screening and chlorination facility, and outfalls to the Mystic River, which is regulated by this permit.

<https://www3.epa.gov/region1/npdes/permits/2012/finalma0101982permit.pdf>

- (iii) Permit No. MA0101974

This permit authorizes the City of Cambridge to discharge from 12 CSO's to Alewife Brook and Charles River. Stormwater discharge from the 48" drainage trunk line that conveys from the Fitchburg line and the CRMF to the Charles River is regulated by this permit.

<https://www3.epa.gov/region1/npdes/permits/2009/finalma0101974permit.pdf>

- (iv) NPDES Stormwater Management Plan for MassHighway Owned and Operated Highways

This plan was developed to comply with EPA's general NPDES permit MAR043025, which authorizes MassHighway to discharge stormwater, specifically Part V – Transportation MS4 Stormwater Management Program. The project site lies in District 4 of MassHighway Districts and the overall drainage criteria shall be in compliance with MassHighway's existing stormwater management program.

<https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/ma/swmp/MassHighwaySWMP.pdf>

- (v) NPDES General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts.

This permit authorizes operators of Small Municipal Separate Storm Sewer Systems to discharge stormwater. Stormwater phosphorus load reductions shall be designed in accordance with the methods and reduction credits defined in Appendix F, including Attachments 1, 2, and 3.

https://www3.epa.gov/region1/npdes/stormwater/MS4_MA.html

(b) Environmental Protection Agency (EPA) Impaired Waters

- (i) Charles River Segment (ID MA72-38)

Causes of impairment include metals (other than mercury), nutrients, oil and grease, pathogens, priority organic compounds, turbidity, taste, color and odor. Total Maximum Daily Loads (TMDLs) have already been completed for nutrients and pathogens in the lower Charles River watershed. Stormwater discharges from the project site to this water body shall meet the waste load allocations (WLA), respectively for each pollutant set forth in the respective TMDLs without exceeding the water quality standard for that pollutant.

- (ii) Mystic River Segment (ID MA71-02)

Causes of impairment include metals (other than mercury), nutrients and pathogens. Stormwater management design criteria shall be in compliance with TMDL requirements for these pollutants as and when they are developed.

(c) Municipalities

- (i) City of Cambridge

Obtain a Stormwater Control Permit from the Cambridge Department of Public Works (DPW) for all work within the City of Cambridge.

Comply with the requirements of the Cambridge DPW, including the following:

- Wastewater and Stormwater Drainage Use Regulations
- Wastewater and Stormwater Management Guidance
- Land Disturbance Regulations

Comply with the requirements of MassDEP's Stormwater Management Standards and Massachusetts Stormwater Handbook.

Stormwater management systems shall be designed to remove at least 80% of the average annual post-construction load of Total Suspended Solids (TSS).

Stormwater management systems shall be designed to reduce the stormwater phosphorus baseline load by at least 65%.

Stormwater runoff from either of the following site areas may be considered clean when calculating phosphorus and TSS baseline load:

- Building roofs
- Above-grade viaducts

Site areas meeting both of the following conditions may be considered clean when calculating phosphorus baseline load:

- The area is located within the viaduct dripline, and
- The area does not receive tributary stormwater runoff from areas located outside the viaduct dripline

(ii) City of Somerville

Comply with the Stormwater Management Policy for the City of Somerville as well as MassDEP's Stormwater Management Standards and Massachusetts Stormwater Handbook.

(iii) City of Medford

Comply with the requirements of the City of Medford Stormwater Management Program, MassDEP's Stormwater Management Standards and the Massachusetts Stormwater Handbook, and the NPDES Municipal Separate Storm Sewer System (MS4) requirements.

7.3.3.7 Millers River Drainage Area

(a) Washington Street Area

The Washington Street roadway underpass is prone to chronic flooding.

Complete the design and construction of WSPS. Provide pumping and convey stormwater flows from the Washington Street area to the Red Bridge area.

(b) Contamination from 50 Tufts Street Site

Refer to [Section 4](#) for additional provisions for contamination associated with the 50 Tufts Street site, including requirements for the drainage work in the Washington Street area and along a portion of the New Hampshire Mainline extending both north and south of Washington Street. The impact of that contamination on the Project, all measures to protect MBTA facilities and property, as well as all personnel, shall be established by the DB Entity's Licensed Site Professional (LSP) of Record for the Project. Provide a design and construction solution that prevents contaminated materials (groundwater, soils, vapors or other contaminants) from entering the existing and proposed drainage systems and undertake all Work in full compliance with all reports, memos, directives and other communications issued by the LSP of Record. At a minimum, the design and construction solution shall include the following replacement and/or rehabilitation of the existing storm sewer systems:

- Extent of the replacement and/or rehabilitation shall be established by the LSP of Record for the Project, and shall include the portion of the existing storm sewer system located along the east

side of track corridor from a point on the existing 42-inch RCP trunk drain point located at least 60 feet west of the centerline of Cross Street to the WSPS, including:

- all existing 42-inch RCP pipes
- the twin 20-inch siphons at Washington Street
- all sewer structures including manholes
- the full length of all lateral connections
- Requirements for the replacement and/or rehabilitation shall be established by the LSP of Record for the Project, and shall include either:
 - Replacement: Abandon or remove the existing storm sewer system. Install new storm sewer systems constructed of materials that will be waterproof and not susceptible to deterioration over the life of the drainage system. Confirm all flows to any existing abandoned storm sewer systems are redirected to new storm sewer systems.
 - Rehabilitation: Installation of storm sewer system liners that are chemically resistant to exposure to chlorinated volatile organic compounds (CVOC). Install pipe liners that are continuous, seamless, and jointless from manhole to manhole. Custom fabricate and install structure liners for each structure shape and size to provide a tight fit to the host structure.
- Record technical comparison and design decisions to either replace and/or rehabilitate the existing storm sewer systems in the Design Basis Report per Volume 2, Section 2.5 and Volume 2, Section 2.7.

(c) Red Bridge Area

The Red Bridge area is prone to chronic flooding.

Complete the design and construction of the Red Bridge Pump Station (RBPS). Provide pumping to convey stormwater flows from the 48" Fitchburg Main Drain (FMD) to an existing offline detention pond to prevent surface flooding resulting from FMD hydraulic grade line surcharge conditions.

(d) Vehicle Maintenance Facility

Drainage from the VMF site includes two existing primary stormwater discharge points. Confirm the existing drainage systems have sufficient capacity to convey flows from the VMF site in conformance with the Corridor stormwater requirements prior to conveying stormwater from the VMF site to the existing drainage systems.

(e) 200 Inner Belt Road Drainage System and Connection

200 Inner Belt Road (IBR) is an off-site abutting private development connected into the MBTA drainage system near Red Bridge. The Inner Belt Road (IBR) industrial / commercial area is prone to chronic flooding.

The IBR connection and outlet location are confirmed to connect to the MBTA system. Although MBTA Railroad Operations accepted the connection, an easement or license was never issued. Obtain the necessary license agreements for the 200 IBR connection to ensure that the discharge that currently exists is accepted by the MBTA. Test the 200 IBR drainage system for water quality

and any potential contamination. Confirm the IBR connection to the MBTA system has sufficient capacity to handle stormwater flows from the upstream drainage system.

(f) Existing 54-Inch New Washington Street Storm Sewer

There is an existing 54-inch RCP storm sewer located immediately north of the WSPS routed south of New Washington Street. Provide drainage systems to route all stormwater flows entering this 54-inch storm sewer from MBTA property and the Project areas to the WSPS. Provide a water tight bulkhead on the 54-inch storm sewer at a point between the WSPS and the intersection of New Washington Street and Inner Belt Road to prevent contributing stormwater flows from MBTA property and the Project areas from being conveyed within the 54-inch storm sewer downstream of the bulkhead.

7.3.3.8 Lechmere / NorthPoint Development Areas

The Lechmere/NorthPoint Development area includes an above-grade viaduct for the relocated Lechmere Station and the proposed Medford Branch track, both of which are located immediately adjacent to and within the on-going NorthPoint Development.

Permanent works (including stormwater systems) associated with the Lechmere Station North Headhouse shall be installed within the Limit of Works indicated in [Exhibit 2B.1](#), and/or within the adjacent roadway right-of-ways.

Coordinate with the Cambridge DPW to identify requirements and obtain permits for construction of the Lechmere Station South Headhouse over the existing twin 36-inch drains, including for DPW structural review of loads on the drains. The existing manholes located on either side of the South Headhouse shall be protected and maintained for future access to the existing twin 36-inch drains.

7.3.3.9 Ball Square-Gilman Square-Washington Street Area

The existing trunk drain in the corridor north of Washington Street, and all connections to the Washington Street pump station, shall be modified or replaced to be watertight and prevent groundwater contamination from the 50 Tufts Street site reaching Washington Street, the WSPS and the Millers Rivers drainage system. All design items shall be coordinated with the LSP of Record.

7.3.3.10 Washington Street Area

In the Washington Street underpass low area, the maximum 100-year flood elevation shall not exceed 12" above the roadway surface at the low point along the gutter.

Take all practicable measures to protect MBTA facilities, property and personnel from the volatile organic compounds (VOC's) contamination from the 50 Tufts Street site. Criteria to be followed shall be established by the LSP of Record. Prevent any contaminated materials (groundwater, soils) from the 50 Tufts Street contamination release from entering the Project drainage system. Undertake all Work in full compliance with all reports, memo's, directives and other communications issued by the LSP of Record. Track and report all costs associated with Work involved with the contamination at 50 Tufts Street separately from the rest of the Project costs.

If the DB Entity uses the existing trunk line in the NHML rail corridor north of Washington Street, it shall be rehabilitated to a watertight condition as to prevent groundwater contamination from the 50 Tufts Street site entering the MBTA drainage system. All designs shall be coordinated with the LSP of Record.

A high water control signal, from a sensor at the outlet control structure of the WSPS, shall be transmitted to the RBPS control panel to indicate a potential blockage of the orifice (or weir), an unusually large storm event, or other problem with the storage system.

7.3.3.11 Tufts University

Coordinate with Tufts University per [Exhibit 2F](#).

7.3.3.12 Offsite drainage

- (a) Comply with the respective Municipality DPW Standards or developer's standards if applicable.
- (b) Runoff Volume and Water Quality and Quantity: Unless otherwise required by applicable permits and/or Municipal requirements that are more stringent, project runoff shall at a minimum comply with MassDEP Stormwater Management Standards as a designated "Redevelopment Project".
- (c) Construct grading to not impact existing drainage flow paths and create new offsite areas of ponding. Proposed flow patterns cannot divert water towards abutting private properties unless matching existing grading. If an interruption to flow paths is unavoidable, obtain specific acceptance from the MBTA to reroute and incorporate the flow into an existing drainage system with available capacity.
- (d) The drainage system shall be designed to pick up drainage at any low points outside of the corridor created by the Work along the corridor, including low points at Nashua Street, Hinkley Street and Charles Ryan Road.

7.3.3.13 Drainage Connection Points

- (a) Drainage connections shall be coordinated with the owning municipality or agency and comply with all of their requirements, including flow rates/volumes and water quality requirements.
- (b) No new drainage connections from offsite private properties shall be allowed unless that connection has received written acceptance from the MBTA Legal Department.

7.3.4 Deliverables

- (a) A Conceptual Drainage Plan and Design Memorandum, describing the proposed sequence, methods of construction (open-cut, jacking, slip-lining, etc.), pipe sizes and material, general alignment, proposed pumping stations, if any (gravity systems preferred), proposed discharge locations and locations of abutting drainage systems entering the Project area (including drainage system and drainage area tributary to each location) shall be prepared. The Design Memorandum shall document the significant elements of the proposed system, reasons for variation from requirements of the Contract Documents (if applicable), and discuss pertinent issues with design and construction. This document shall be submitted to

the MBTA for acceptance prior to the development of a Final Comprehensive Project-Wide Stormwater Plan and detailed Drainage Report

- (b) A Final Comprehensive Project-Wide Stormwater Plan and detailed Drainage Report shall include detailed plans with all final alignments, final pipe sizes & materials, final discharge locations, including consistency with all Technical Provisions and regulatory requirements. The Drainage Report shall include calculations, hydraulic model results, and supporting documentation for all proposed stormwater management systems demonstrating compliance with all Project Specific Requirements of the Technical Provisions, and all design criteria required by regulatory agencies.
- (c) Design exceptions shall be described and documentation shall be provided summarizing why a Project Specific Requirements of the Technical Provisions required by a regulatory agency, cannot be met. All required documentation for each design exception, if any, shall be submitted to the MBTA for approval.

7.4 UTILITIES

7.4.1 Scope of Work

The Utility Work includes the coordination, design, and construction of all protected, relocated, and new utilities for the Project, including:

- The relocation/protection of existing Utility lines within the Rail Corridor, proposed station footprints, adjacent areas to the rail corridor including the proposed Community Path, bridge crossings, VMF, Lechmere Station bus loop, and roadway intersections.
- New Utility services to the proposed stations and other facilities.

Utilities may extend beyond the boundaries of the Limit of Works, except as otherwise noted in this Section.

7.4.2 Codes, Standards and Manuals include:

7.4.2.1 Utilities within the Corridor

- American Railway Engineering and Maintenance-of-Way Association (AREMA) Part 5 Pipelines, which includes specifications for pipelines conveying flammable and non-flammable substances, uncased gas pipelines within the Right-of-Way, overhead pipelines crossings, and fiber optic construction on railroad Right-of-Way
- MBTA Railroad Operations Commuter Rail Design Standards Manual for Track and Roadway
- MBTA Commuter Rail Track and Roadway Book of Standard Plans
- MBTA Railroad Operations Commuter Rail Design Standards Manual for Bridges.
- MBTA Railroad Operations Directorate MBTA Manual of Guidelines and Standards
- MBTA Guidelines for Designing Barrier-Free Transportation Facilities
- MBTA Commuter Rail Station Access Guidelines
- MBTA Maintenance of Way Division Green Line – Light Rail Transit Track Maintenance and Safety Standards

7.4.2.2 Utilities located within the Right-of-Way of State Roads and/or located on Bridges include

- MassHighway Project Development and Design Guide
- MassHighway Design Manual
- MassDOT Highway Division Load and Resistance Factor Design (LRFD) Bridge Manual Design Guidelines
- MassDOT Highway Division Right of Way (ROW) Manual

- MassHighway Standard Specifications for Highways and Bridges
- MassDOT Highway Division Supplemental Specifications to the Standard Specifications for Highways and Bridges
- MassDOT Highway Division Standard Special Provisions
- MassHighway Construction and Traffic Standard Details
- MassDOT Highway Division Engineering Directives
- MassDOT Highway Division Policy Directives

7.4.2.3 Utilities Owned by Municipalities, or Connected to Municipal Utility Systems

(a) City of Cambridge – Water and Sewer

Comply with the City of Cambridge Construction and Operating Procedures when relocating or constructing new water lines in Cambridge as part of the project.

(b) City of Somerville – Water and Sewer

Comply with the City of Cambridge Construction and Operating Procedures with the exception of fire hydrants. Verify the fire hydrant standards with the City Engineer, and comply with City requirements.

(c) City of Medford – Water and Sewer

Comply with the State of Massachusetts Utility Standards. Verify the status of City specific standards with the City Engineer, and comply with City requirements.

7.4.2.4 Utilities Owned by Private Companies

Table 7.4.1 – All Private Utility Companies

Private Company	Requirement
General Requirements for All private utilities.	<p>(1) Comply with all Utility Agreements and comply with all design criteria set forth by the private Utility Owner, and the private utility owner’s respective parent lessor company at the respective relocation sites, whichever is more restrictive, including those identified in the Contract Documents.</p> <p>(2) Comply with all design criteria of the respective municipality for Work associated with the private utilities located within jurisdictional boundaries of the municipalities.</p>

Table 7.4.2 – Private Gas Companies

Private Company	Requirement
National Grid - Gas	(1) National Grid Blue Book Specifications and Requirements for Gas Installation (2) Specifications for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties
Eversource (formally NSTAR) - Gas	(1) Operating and Maintenance Procedures for NSTAR Gas Distribution (2) Information and Requirements for Gas Service
Algonquin Gas (Spectra Energy) - Gas	Require a steel casing for any gas lines that cross below railroad tracks

Table 7.4.3 – Private Electric Companies

Private Company	Requirement
National Grid - Electric	(1) National Grid Specifications for Electrical Installations Covering Service Areas in MA, NH, NY and RI (2) National Electric Safety Code (3) National Grid’s Overhead Construction Standards
Eversource (NSTAR) - Electric	(1) D3820 Construction, Material, and Work Specifications for New 15/25 kV Primary Underground Distribution Systems up to 200 Amps (2) Information and Requirements for Electric Service (3) C3802 Clearance Requirements from Equipment Buildings, Landscaping, or Traveled Way

Table 7.4.4 – Private Telecommunications Companies

Private Company	Requirement
AT&T (Siena Engineering) - Telecom	(1) AT&T Specifications for Trenching, Conduit, Boxes and Manholes, Aerial Entrance Mast, Service Cabinets, Bonding and Grounding, (2) AT&T Guidelines for Access to AT&T Inc. and Operating Companies Structure (3) Interstate (Long Lines) Specifications
Verizon - Telecom	Network Equipment Installation Standards, Information Publication IP7220, Issue 4
Eversource (NSTAR) - Telecom	Criteria shall be in accordance with the same design criteria and standards set forth by Eversource (NSTAR) Electric, per Eversource (NSTAR) Telecom
Comcast - Telecom	Specifications and Installation Guide for Underground Service to Residential Development and exposed services within public way.
RCN - Telecom	<ul style="list-style-type: none"> • No more than two (2) - 90 degree bends may be allowed in any line. • The majority of cable is coaxial and copper is being phased out. • The number of conduits pulled out during construction has to equal at least the number of conduits replaced, even if they are empty. • DB Entity shall comply with all RCN criteria requirements.
Above Net - Telecom	Any line with less than 48" of cover requires steel plating. Comply with all Above Net criteria requirements.
NextG – Telecom Lightover - Telecom	Comply with all NextG and Lightover criteria requirements.
Bell Canada - Telecom	Comply with all Bell Canada design criteria requirements.
Crown Castle - Telecom	Comply with all Crown Castle design criteria requirements.
Level 3 - Telecom	Comply with all Level 3 design criteria requirements.
Zayo - Telecom	Comply with all Zayo design criteria requirements.

7.4.3 The Project Specific Requirements

7.4.3.1 School Street Bridge

- (a) School Street Bridge Electric (Eversource) – Protect 12 3.5" conduits in place or 1)

coordinate and pay for the relocation by Eversource of the electric lines to the conduits installed on the Temporary School Street Utility Bridge and then 2) install the conduits and infrastructure on the School Street Bridge and coordinate and pay for the relocation of the electric lines by Eversource to the final locations on the School Street Bridge.

- (b) School Street Bridge (MBTA Power) –1) Install cables and coordinate the cut-over by MBTA Power of the existing 13.8 kV power lines to the Temporary School Street Utility Bridge and 2) install the conduits, cables infrastructure on the School Street Bridge and coordinate the cut-over of the 13.8 kV power lines by MBTA Power to the final locations on the School Street Bridge. The MBTA will perform the cut-over work.
- (c) School Street Bridge Telephone (Verizon) – Protect existing eight (8) 4” Verizon conduits in place and incorporate the Verizon conduits into the bridge.

7.4.3.2 Medford Street Bridge

- (a) Medford Street Bridge Gas Transmission Pipe (Algonquin/Spectra) – Protect in place pursuant to the requirements of the Technical Provisions the 433 psi steel sleeved gas main traversing the right of way underneath the tracks adjacent to the Medford Street Bridge.
- (b) Medford Street Bridge Telephone (Verizon) - Support and protect existing Verizon conduits, fiber optics, cables and infrastructure that shall be relocated to the Permanent Medford Street Utility Bridge by Verizon prior to 140 Days after Notice to Proceed.
- (c) Medford Street Bridge Fiber Optics (Zayo) - Support and protect existing Zayo conduits, fiber optics, cables and infrastructure that are located on the Permanent Medford Street Utility Bridge.

7.4.3.3 Broadway Bridge

- (a) Broadway Bridge (Eversource):
 - Protect existing Eversource conduits, cables and infrastructure.
- (b) Broadway Bridge (Verizon):
 - Protect existing Verizon conduits, fiber optics, cables and infrastructure.

7.4.3.4 Coordination

Conform to the requirements, specifications, and standard practices of the affected Utility Owners. Coordinate with Utility Owners which work shall be done by the DB Entity and which work shall be done by Utility Owner. Ensure continuity of all existing utility services to all users except when the Utility Owner determines that temporary interruption is required.

Coordinate the relocation of existing utilities in order to accomplish the Work.

Coordinate with National Grid regarding their concerns with the project interfering with the power lines buried near the proposed Ball Square Station.

Refer to the RIDs for design drawings of work anticipated to be constructed by adjacent property developers, including:

- DW NP Property LLC NorthPoint development – new sanitary sewer forcemain along Water Street in Cambridge
- Avalon Bay NorthPoint II development – new stormwater management systems adjacent the viaduct south of Glassworks Avenue in Cambridge

7.4.3.5 Utility Investigation

Investigate the existing utility systems for interface aspects along the entire alignment. Utility investigation and the disposition of each system shall be submitted and accepted by the MBTA in two phases:

- Stage 1 - For all subsurface, bridge, railroad, and traffic operations that are planned to occur in the 2018 calendar year, the test pit plan Investigations and dispositions need to be completed within 120 days from the NTP date. The specific utility investigation plan, including the proposed locations of the test-pits/investigations, shall be submitted to the MBTA within 30 days from NTP.
- Stage 2 - For all other Work, planned to occur beyond January 1st, 2019, the test pit plan Investigations and dispositions need to be completed within 220 days from the NTP date. The specific utility investigation plan, including the proposed locations of the test-pits/investigations, shall be submitted to the MBTA within 90 days from NTP.

Provide all results of these Utility surveys within 10 working days after the investigation has been completed. The location of those test pits shall be proposed by the DB Entity and accepted by the MBTA.

7.4.3.6 Utility Connections

Provide all utility connections required for the Project, including storm sewer, sanitary sewer, domestic water, fire protection water, electric, telecommunication, power monitoring controls, and gas to all stations, VMF, TPSS's, and other structures and components of the Project.

Connect the sanitary system of the Red Bridge Traction Power Substation (Red Bridge TPSS) to the 2-inch diameter sanitary sewer service force main stub located in the West Boulevard turnaround to be provided by the NorthPoint developer.

NorthPoint will provide the Project a single 4-inch diameter conduit for Verizon telecommunication service to the Red Bridge TPSS from West Boulevard turnaround, along with the sewer line stub. Connect the telecomm conduit that feeds from Lechmere Station to Red Bridge TPSS to this NorthPoint connection.

Coordinate connections to utilities in Water Street, North First Street, and West Boulevard in Cambridge with the NorthPoint Developer.

AT&T / Siena will have performed the relocation of their telecommunication conduits from where it enters the rail corridor at Broadway, to a point north of College Ave (approximately

700 feet north of College Avenue adjacent to the signal instrument hut) within 140 Days after Notice to Proceed. The continuation of this Work up to Winthrop Street shall be completed by the DB Entity as part of the Project. The DB Entity shall coordinate with AT&T and its consultants and contractors to relocate the AT&T conduits and cables that are within the section of the railroad right of way between the Signal Instrument Hut located approximately 700 feet north of College Avenue to the location adjacent to Winthrop Street where the AT&T conduits exit the railroad right of way.

7.4.3.7 Utility Verifications

- (a) Verify the flow quantity entering the corridor from the pipe off Vernon Street approximately 600' east of Lowell Street, and verify if the flow is sanitary sewage, stormwater, potable water, or other type of flow.
- (b) Maintain existing cover over all functioning sewer siphons or reconstruct as needed.

7.4.3.8 Utility Relocations to be performed by Utility Owner

- (a) For Utility Relocations to be performed by a Utility Owner or its separate contractors, coordinate, monitor, perform, and otherwise undertake the necessary efforts required under the Contract Documents to enable such Utility Owners or their separate contractors to perform such Work in a timely manner, in compliance with the standards of design and construction and other applicable requirements specified in the Contract Documents.
- (b) For Utility Relocations to be performed by a Utility Owner or its separate contractors that are paid for by the MBTA, the DB Entity shall procure and install utility infrastructure including manholes, conduits, supports, cables and other utility systems necessary to relocate the Utility Owner's facilities to temporary or permanent locations. Coordinate with the Utility Owners to perform the cut-overs and testing of their facilities.

7.4.3.9 Watermain Testing and Disinfection

- (a) Lining Toxicity Test
 - Procedure: FDA Method of Testing for Toxicity of Coating Material Intended for Use in Transporting or Holding Food or Potable Water.
 - Requirements: Certified test results by pipe manufacturer; no more than 18 mg. per square inch exposed surface and no more than 50 ppm by weight of the water capacity of the test container, of chloroform-soluble extractives, corrected for zinc extractives such as zinc oleate.
- (b) Perform Field Pressure and Leakage Tests, Flushing, Disinfection, and Bacteriological Tests of domestic and service water piping and fire water piping in accordance with AWWA methods, and public health authority and Utility Owner requirements.

7.4.3.10 Settlement and Movement

- (a) Provide suitable settlement or movement monitoring systems where required, including as

required by affected Utility Owners. If a settlement or movement monitoring system is required, submit copies of readings to the MBTA and affected Utility Owner within 24 hours of the reading.

- (b) In case of settlement or other movement which might cause damage, take immediate remedial measures to correct the conditions and damages caused by the settlement.

7.4.3.11 As-Built Utility Location and Condition Survey

- (a) For each new or relocated utility installed, including those installed or relocated by others in the Project Area, perform an as-built location survey by coordinates prior to backfilling the excavation. Coordinate requirements of the survey with the Utility Owner.
- (b) The survey data shall be obtained by Global Positioning Survey (GPS) and certified by a Professional Land Surveyor registered in Massachusetts.
- (c) Provide a complete as-built digital base plan in AutoCAD in accordance with CAD Standards in Exhibit 2H, properly referenced to the coordinate system established in the contract. The following standards shall be applicable:
 - Text: Text shall be drawn using a STYLE of "L100-XX" (where XX refers to the plotted scale) and a font style of "ARIAL" as defined in the AutoCAD survey template provided by the MBTA. The style shall be defined as a "fixed height" style, and have a height of 0.125 and width factor of 0.85 times the drawing plotted annotated text scale (i.e. 4.0 for 40 scale plan, 2.0 for 20 scale etc.).
 - Precision and Accuracy:
 - Horizontal Survey:
 - Precision: Horizontal control and surveyed points shall maintain a minimum precision of 1:10,000.
 - Accuracy: No more than 10% of the survey points shall be in error by more than 1/100" or 0.25 mm when viewed at the requested scale.
 - Vertical Survey:
 - Precision: Vertical Control shall have a maximum error of closure no greater than 0.075' or 0.02 meters.
 - Accuracy: No more than 10% of elevations when interpolated from a Surface shall be in error of more than 1/2 a contour interval.
- (d) Surface Data: The data format shall conform to CAD Standards in Exhibit 2H. If the DB Entity uses a different software product to create a surface, then the surface must be represented as a TIN (Triangulated Irregular Network) of 3D lines on a separate, distinct layer within the AutoCAD drawing file. 3D faces or 2 dimensional lines are NOT acceptable.

7.4.3.12 Other

- (a) Support and protect all Utilities that are impacted by all Work as required by Exhibit 2I Section 01545 including drains, sewers, gas pipes, water mains, underground power and

communication conduit, Utility poles and overhead wires, traffic signals and roadway lighting systems, and other Utilities and structures.

- (b) Coordinate and provide all temporary and permanent services to avoid service interruptions for electric, gas, telephone, fiber optic, signal, power, drain, sewer, water and other Utilities required. DB Entity shall follow specifications in Section 01500 in Exhibit 2I.
- (c) Provide, install, and maintain all temporary facilities required providing interim Utility service when a utility facility is to be relocated and when a utility facility to be replaced is abandoned prior to replacement.
- (d) Coordinate and relocate any electric, gas, telephone, fiber optic, signal, power, drain, sewer, water and other utilities that need to be moved to accommodate Work.
- (e) Perform Field Pressure and Leakage Tests for all sewer force main piping in accordance with AWWA methods, and public health authority requirements.
- (f) Obtain acceptance of all new utilities from the respective Utility Owners, including the Cambridge Water Department (CWD) for all new water lines in Cambridge.
- (g) Provide a gas connection to the Lechmere Station natural gas generator as required by the Contract Documents.
- (h) Provide a 1-inch water service from the Lechmere Station's north headhouse across North First Street to a new utility bollard hose bib at the Lechmere Station bike shelter. Coordinate utility bollard hose bib requirements with MBTA
- (i) Permanent works (including utility systems) associated with the Lechmere Station North Headhouse and shall be installed within the Limit of Works indicated in Exhibit 2B.1, and/or within the adjacent roadway right-of-ways.
- (j) Where an existing Utility facility is encountered which is not indicated, or which is determined to be a different utility service than that indicated, promptly notify the MBTA. The DB Entity shall determine the owner of the facility and the disposition of the facility.
- (k) If, upon exposure, the condition or location of a facility to be supported complete-in-place is found by the Owner to be unsafe for support or for maintenance of service, replace or reconstruct the facility as required, with prior acceptance of the MBTA and the Utility Owner.
- (l) Hydrants shall open clockwise and shall be marked with an arrow and word "OPEN" to indicate the direction of turn of the stem to open the hydrant, unless otherwise required by the Utility Owner.
- (m) Watermains shall be separated from sewers in accordance with the Massachusetts Department of Environmental Protection (MassDEP) Guidelines for Public Water Systems.
- (n) Watermain insulation shall meet the standard requirements of the municipality and MWRA.
- (o) Install new ductbanks and Utility structures to ensure the intended utility cables can be pulled through the conduits.

- Demonstrate capability and compliance with Utility Owner requirements on completion of installation of underground ducts and utility structures.
- Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6" (150-mm-) long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- (p) There is an Algonquin gas main that crosses under the rail corridor at the Medford Street Bridge. The DB Entity shall coordinate with Spectra regarding their gas main to ensure that the proposed project cover and loading on this main are acceptable by Spectra and the MBTA's requirements. Loading and cover requirements shall be as required under codes, standards, and manuals applicable to the Work described in this Section.
- (q) The sewer from the Somerville DPW building ties into an existing siphon under the tracks prior to Lowell Street. The DB Entity shall evaluate the existing siphon to ensure proper cover and any loading concerns have been addressed.
- (r) Refer to Exhibit 2D for existing condition drawings for previously constructed components.
- (s) Install the Massachusetts Water Resources Authority (MWRA) 24" water main design at Ball Square Station approved by MWRA.
- (t) Coordinate with Eversource and connect the electric feeds from: (1) the Red Bridge TPSS to the vault to be provided by Eversource (formerly NStar) vault off of Water Street near the viaduct; (2) the Pearl Street TPSS to the Eversource transition vault in Medford Street, and; (3) the Vehicle Maintenance Facility substation to the Eversource transition vault in Third Avenue.
- (u) Coordinate with AT&T (Siena Engineering) and complete the continuation of the relocation work up to Winthrop Street per Exhibit 2F.
- (v) Coordinate requirements with the City of Cambridge Fire Department and provide new fire hydrants and associated watermain work along the access road adjacent the existing tracks north of Lechmere Station, in the vicinity of Gilmore Bridge. Water supply for the new hydrants shall be from the City of Cambridge's water supply system.

7.4.3.13 Positive Train Control (PTC)

DB Entity shall include all Work related to the temporary relocation, protection, and final placement of the fiber optic communication system, which is part of the MBTA's Commuter Rail Positive Train Control (PTC) system. Refer to Exhibit 2J.

7.4.4 Deliverables

7.4.4.1 Submittals

- (a) Develop and submit comprehensive utility drawings to the MBTA. Provide plans and details of all proposed temporary and permanent Utility work for the Project. Show actual location of existing utility facilities; interferences which these facilities present to the new Work; location of settlement markers; method proposed to proceed with the

construction; details of proposed support systems; and, if applicable, method of testing and procedure for restoration.

- (b) Submit shop drawings, details, procedures, and scheduling for performance of the Utility Work required under this Section 7 to the MBTA.
- (c) Submit written evidence of affected Utility Owners' acceptance of the details, procedure, and scheduling to the MBTA.
- (d) Verify the notice procedures of each affected Utility Owner and party and properly notify them based on their requirements. Furnish the MBTA with copies of all notices.
- (e) If a settlement or movement monitoring system is required, submit copies of readings to the MBTA and affected Utility Owner within 24 hours of the reading.
- (f) Submit to the MBTA, certifications from the respective suppliers that the products to be incorporated in the Work are in conformance with applicable requirements.
- (g) Submit to the MBTA completed Utility Completion Forms.
- (h) Watermains
 - a. Submit to the MBTA shop drawings showing the details, procedures, and scheduling for water utility installation. Coordinate with the water Utility Owner when the MBTA's main is ready for connection to Utility Owner's meter or piping. Shop drawings shall include the maximum anticipated working pressure in each main and branch, the proposed pressure test pressure, and the fittings material class.
 - b. Submit to both the MBTA and the Utility Owner detailed hydrostatic test and disinfection plans and test results meeting the requirements of AWWA and the Utility Owner, including all proposed materials, concentrations, equipment, temporary piping, valving, connections, flow rates, equipment, methods of metering and measuring, and method of flushing and disposal.
 - c. Submit to both the MBTA and the water Utility Owner for acceptance all manufacturer's and independent laboratory certified test reports as specified above and in cited standards.
 - d. Submit certifications to the MBTA and Utility Owner that all wetted surface metals in contact with potable water comply with the 2014 Safe Drinking Water Act Lead Reduction law and comply with NSF 372.
- (i) Submit As-Built Utility Location and Condition Survey in conformance with the Utility Owner's requirements to the MBTA and Utility Owner.

7.4.4.2 Notifications

- (a) Interruptions of Utilities shall not be permitted without written notice to the MBTA,

Utility Owner and affected property owners and written consent of the MBTA. Notify the appropriate Utility Owner, and the MBTA per their requirements but no less than 72 hours prior to starting any work involving or adjacent to utility service facilities. The DB Entity shall provide sufficient notice to the utility companies; and for any delays due to insufficient advance notice to the Utility companies.

- (b) Where an existing utility facility is encountered that is not indicated or that is determined to be a different utility facility than that indicated, promptly notify the MBTA. The DB Entity shall be responsible for determining the owner of the facility and the disposition of the facility.
- (c) For proposed water, sewer and stormwater upgrades located with a respective City, coordinate the installation schedule with the respective municipalities' inspectors.

7.5 LANDSCAPING

7.5.1 Scope of Work

The Work includes construction of all landscaping for the Project.

This Section 7.5 describes certain materials, construction, and coordination requirements for landscaping as they relate to all areas disturbed as part of the Work, including the four distinct components of the Project: Stations, VMF, the Corridor, and Community Path. Landscaping scope pertains to: soils, softscape, and protection of existing vegetation. Landscaping may also be used to contain embankments and earthworks that shape the Site and its drainage, Best Management Practices (BMPs) as part of stormwater treatment facilities, and planting and grading and BMPs to prevent erosion. Softscape includes all plant materials (deciduous and coniferous trees, shrubs, grasses, woody ground covers, and seed mixes), as well as soil preparation, final grading, landscape planting installation and mulching. Softscape shall be installed throughout the project limits where noted in the Technical Provisions.

Refer to Section 7.2 and Section 9 for additional Site hardscape and Site furnishing requirements.

7.5.2 Codes, Standards and Manuals include:

- Commonwealth of Massachusetts Department of Public Works, Standard Specifications for Highways and Bridges
- MassHighway Project Development and Design Guide, Chapter 13: Landscape and Aesthetics.
- Massachusetts Department of Environmental Protection (MassDEP), Massachusetts Stormwater Handbook
- United States Department of Justice, 2010 ADA Standards for Accessible Design
- United States Department of Transportation, ADA Standards for Transportation Facilities
- Massachusetts Architectural Access Board (MAAB), 521 CMR
- American Nursery and Landscape Association (ANLA), American Standard for Nursery Stock ANSI Z60.1
- American Society of Testing Materials (ASTM) International
- Association of Official Agricultural Chemists (AOAC)
- United States Department of Agriculture (USDA), Plant Hardiness Zone Map
- Massachusetts General Laws Chapter 87: Shade Trees
- City of Cambridge Code of Ordinances, Chapter 8.66: Tree Protection
- City of Somerville Code of Ordinances, Chapter 12 Article VI: Tree Preservation Ordinance
- City of Medford, MA Code of Ordinances, Chapter 86: Vegetation
- US Forest Stewardship Council (FSC), US Forest Management Standard Certification

7.5.3 The Project Specific Requirements

7.5.3.1 General Requirements

- (a) Evaluate the health of trees and plantings on the Project properties and create a Plan to protect, prune or remove as required for safety and design purposes.
- (b) Protect existing plantings and trees on abutting properties with canopies or drip lines extending within the Site, unless otherwise required by Exhibit 2F.
- (c) Provide permanent slope stabilization for all slopes greater than 3:1 (horizontal:vertical).
- (d) Restore all disturbed areas on abutting properties to conditions existing immediately prior to disturbance, unless otherwise required by Exhibit 2F.
- (e) Minimum depth of topsoil shall be 6" in seeding or turf areas, 18" in areas to be planted with shrubs, and 36" in areas to be planted with trees unless otherwise approved by the MBTA. Amend or cover all planting media and areas with topsoil, except for planting pits which shall not be amended in order to prevent inadequate root development. Place topsoil and compact in a uniform manner to prevent uneven settlement. Coordinate topsoil nutrients with the plant material to be installed.
- (f) Finished settled grade of topsoil in lawn areas shall be 1/2" below adjacent hardscape. No soil shall be stripped, placed or worked while frozen or wet. Topsoil shall not be placed on untilled or un-scarified surfaces. Decompact planting areas to achieve adequate drainage immediately prior to placing planting soil.
- (g) Design landscape and exterior lighting taking into consideration the principles of Crime Prevention through Environmental Design (CPTED).
- (h) Coordinate landscape design around stations and parking lots with the communications systems design to maintain sight lines of surveillance cameras, especially with respect to anticipated vegetation growth.
- (i) Design landscape in parking lots and around stations to perform water quality and detention functions.
- (j) The landscaping shall not reduce the sight distance of train operators, bus operators, and the public with respect to other vehicular traffic.
- (k) Plant materials installed around any historic building(s) shall be used in a manner that enhances the historic setting and character of the building.
- (l) Design a landscape that requires low maintenance in the short- and long- term, and consider the long-term growth and health of the plantings when selecting plant materials. Utilize appropriate native plants wherever possible.
- (m) High maintenance residentially-scaled plant materials shall not be used.

- (n) Apply 2" of fine-shredded pine back mulch to all tree and shrub planting areas.
- (o) Tree pits shall be minimum of three (3) times the size of the rootball diameter.
- (p) Plant material adjacent to paved surfaces shall be salt tolerant to withstand winter applications of ice melt. Identify snow storage areas on the landscape plans of each station and parking lot. Provide plantings at snow storage areas to withstand winter snow piles.
- (q) Evaluate health and protect significant existing plant material to the greatest extent possible and appropriate, so as to preserve a sense of scale and the Site's history.

7.5.3.2 East Somerville Station

Provide a landscape treatment to stabilize the steep slopes between the rail corridor and the existing pump station facilities under the access drive. Furnish and install 12" of planting medium and seed with drought-tolerant Erosion-Control/Restoration mix in the area between the corridor fence and the driveway to the Commuter Rail Operator facility; use slope stabilization fabric until the establishment of the planting.

7.5.3.3 Union Square Station

Coordinate with third party developers regarding the phasing of potentially concurrent development activities.

7.5.3.4 Gilman Square Station

Furnish and install 6" of planting medium and seed with drought-tolerant Erosion Control/Restoration mix in all disturbed areas between the wall/community access path and the existing hillside. Stabilization fabric shall be provided until the establishment of the planting.

7.5.3.5 Ball Square Station

- Furnish and install 6" of planting medium and seed with drought tolerant Erosion Control/Restoration mix in all disturbed landscape areas on site. Use stabilization fabric until the establishment of the planting.
- Provide gravel surfaces as shown on the Concept Plans.

7.5.3.6 College Avenue Station

Provide a minimum of 1,200 square feet of landscape area within the new pedestrian plaza. Provide trees within the landscape area(s), spaced 25' on-center.

Provide a landscape area located west of the new pedestrian plaza along the north side of Boston Avenue in an area general bound as follows:

- To the north by any existing or new retaining walls

- To the east by the new pedestrian plaza
- To the south by the existing Boston Avenue sidewalk
- To the west by the western limits of any existing or new retaining walls

Provide a minimum of four (4) trees, spaced 25' on-center within the landscape area located west of the new pedestrian plaza. One tree shall be provided within 12.5' of the western edge of the new pedestrian plaza.

Within landscape areas, furnish and install 18" (shrubs) or 36" (trees) depth of planting medium, and plant landscape areas with native shrubs and woody ground covers to offset the loss of the existing densely wooded buffer. Shrub planting shall be 24"-36" height spaced at 30"-36" on-center; and perennial planting shall be spaced at 18" on-center typical. Trees shall be deciduous flowering trees 13-15' height and shall not be planted closer than 10' from the corridor fence. Provide mulch on all plant beds.

Refer to [Section 7.2](#) for additional pedestrian plaza requirements.

7.5.3.7 Vehicle Maintenance Facility

Furnish and install 18" (shrubs) or 36" (trees) depth of planting medium, and plant landscape areas with native shrubs and ground covers/grasses. Shrub planting shall be 24"-36" height spaced at 30"-36" on-center; and perennial planting shall be spaced at 18" on-center typical. Trees shall be deciduous canopy trees min 3 – 3 ½" cal. Provide mulch on all plant beds. Furnish and install the open space adjacent to the transportation building, where the future TSP building is to be located, with 6" planting medium and seed with drought-tolerant Erosion Control/Restoration mix.

7.5.3.8 Corridor

The Project traverses through areas that are currently vegetated. Protect and maintain existing trees/vegetation on abutter's properties with canopies or drip lines extending within the Site during active construction Work in the vicinity, unless otherwise required in [Exhibit 2F](#). Perform a tree/vegetation survey along the Corridor to identify existing vegetation that shall be impacted by the project. Establish and execute a tree protection and maintenance program in advance of the commencement of construction operations.

7.5.3.9 Community Path

Refer to [Section 9.2](#) for information regarding the Community Path.

7.5.3.10 Vegetation

Plants shall be disease resistant and tolerant of urban conditions. Avoid plants known to produce excessive litter. Utilize native plants. Avoid plants with high-maintenance requirements.

There shall not be any landscape irrigation provided as part of the Project, therefore all vegetation shall not require additional watering after the one-year planted material guaranty period.

- (a) Provide a one-year planted material guaranty period that shall commence following the initial acceptance of all landscape plantings within the project. Water and upkeep all planted material during this one-year period. Provide a Landscape Maintenance Plan detailing how and how often plants will be managed/maintained during the guaranty period.
- (b) Plant Material
 - (i) All plant material shall conform to the American Standard for Nursery Stock ANSI Z60.1.
 - (ii) Trees and shrubs shall be native to New England, and suitable to the United States Department of Agriculture (USDA) Plant Hardiness Zone 5.
 - (iii) Trees and Shrubs shall be drought tolerant and low maintenance
 - (iv) Street trees shall be selected and planted to conform to the requirements of the local municipality. They should allow adequate pedestrian, bicycle, and vehicular clearances under branches, with canopies of trees adjacent to walking or driving surfaces having a minimum branching height of 6’.
 - (v) Minimum size of deciduous trees shall be 3 to 3-1/2” caliper. Minimum size of coniferous trees shall be 8 to 10’ height. Plant selection shall consider size at maturity, and correctly space plant materials to minimize pruning requirements
 - (vi) Avoid planting new trees in areas where leaves may become a slip or operational hazard and minimize leaf litter in the train tracks. Trees shall be planted a minimum of 10’ from the operating right-of-way fence.
 - (vii) New tree planting shall not endanger or damage underground and overhead utilities.
- (c) Lawns and meadows
 - (i) Lawns and other plant material requiring intensive maintenance shall not be used, unless they are in-kind replacement of existing planting that was affected by the construction. Similarly, “meadow” or other seed mixes containing flowering plants shall not be used unless they are an in-kind replacement.
 - (ii) Seed mixes shall be drought-tolerant, and suitable to the USDA Plant Hardiness Zone 5.

7.5.3.11 Soils

Soil tests and submittals shall include:

- (a) Chemical and physical analysis of stockpiled or base loam proposed for planting soil;
- (b) Analysis of all proposed amendments including compost (organics) and sand;
- (c) Proposed ratios of all components for planting soils;

- (d) Test results for blended planting soils (require approval prior to placement);
- (e) Proctor or other tests verifying decompaction of subgrade prior to placement of planting soils;
and
- (f) Proposed means and methods for procurement, placement and management of planting soils.

7.5.4 Deliverables

- (a) Submit planting plans for approval by MBTA for each section of the Project shall indicate the quantity and location of specific proposed plant materials, and include a planting legend and a planting list. The planting list should identify all proposed deciduous and coniferous trees, shrubs, grasses, perennials, woody ground covers, and seed mixes, including botanical name, common name, cultivar, quantity and size.
- (b) Submit materials plan for approval by MBTA indicating the type, location, and quantity of all proposed Site amenities to be installed.
- (c) Submit Soil Tests and Soils Submittals as stated above for approval by MBTA.

8.1 RETAINING WALLS

8.1.1 Scope of Work

The Work under Section 8.1 includes permanent retaining walls along the Corridor to create the necessary space for the System, relocated Railroad and Community Path. New retaining walls shall be provided within the Project limits as required by the design. The Work includes replacement and rehabilitation of existing walls within the Project limits. Temporary support of excavation walls shall be utilized as necessary to enable construction of permanent structures and utilities. Geotechnical requirements for retaining walls are contained in Section 15.

8.1.2 Codes, Standards and Manuals include:

- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures, (Light Rail Code)
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for the Railway Engineering
- Load and Resistance Factor Design (LRFD) Bridge Manual, Parts I, II, and III of the Massachusetts Department of Transportation
- Massachusetts State Building Code, of the Commonwealth of Massachusetts
- IBC International Building Code, the latest edition as referenced in the Massachusetts Building Code, of the International Code Council
- American Institute of Steel Construction (AISC) "Manual of Steel Construction", 13th Edition
- American Concrete Institute (ACI), "Building Code Requirements for Structural Concrete - ACI 318", including its commentary
- American Concrete Institute (ACI), "Manual of Concrete Practice"
- Standard Specifications for Highways and Bridges, 1988 with the latest supplemental specifications and Standard Special Provisions, of the Massachusetts Highway Department
- MBTA Railroad Design Construction Standard Specifications

8.1.3 Project Specific Design Requirements

Retaining walls shall be designed and constructed to meet the requirements including track clearances, clearance for Community Path, design loading, materials, and finishes.

8.1.3.1 Wall Life

Retaining walls installed as a new wall system shall be designed for a 75 year design life. Existing wall systems to be repaired or modified and left in place for use as a permanent retaining wall system shall be designed for a 25 year design life.

8.1.3.2 Design Methodology

The following design methodology shall be used for wall elements, per the applicable codes and standards:

- (a) Concrete components, structural steel components, geotechnical sliding and overturning stability and bearing pressure calculations per Load and Resistance Factor Design (LRFD).

8.1.3.3 Loads

Retaining walls shall be designed for all applicable loads including soil and groundwater pressures, live load surcharge, seismic loads, wind loads, and loading from elements attached to the walls. Refer to Section 15 for geotechnical requirements.

- (a) Lateral Earth Pressure Loads shall be taken as the more stringent of AREMA, the Light Rail Code, and the AASHTO Standard Specifications.
- (b) Live surcharge Loads:
 - (i) For walls with light rail within their zone of influence – the more stringent of Article 4 of the Light Rail Code and AREMA;
 - (ii) For walls with commuter rail and freight rail within their zone of influence - per AREMA;
 - (iii) For walls with vehicles and pedestrians within their zone of influence - per AASHTO Standard Specifications;
 - (iv) For walls with buildings within their zone of influence - per Massachusetts State Building Code.
- (c) Seismic Loads:
 - (i) For walls with surcharge from light rail - per Article 4 of the Light Rail Code, in accordance with AASHTO Standard Specifications;
 - (ii) For walls with surcharge from commuter rail and freight rail – the more stringent of AREMA and the AASHTO Standard Specifications;
 - (iii) For walls with surcharge from vehicles and pedestrians - per AASHTO Standard Specifications.
 - (iv) For walls with surcharge from buildings – per Massachusetts Building Code.
- (d) Load Combinations:
 - (i) For walls with surcharge from light rail - per Article 4 of the Light Rail;
 - (ii) For walls with surcharge from commuter rail and freight rail - per AREMA;

- (iii) For walls with surcharge from vehicles and pedestrians - per AASHTO Standard Specifications;
- (iv) For walls with surcharge from buildings - per Massachusetts State Building Code.

8.1.3.4 Materials

(a) Concrete

- (i) Cast-in place concrete shall have a minimum compressive strength of 4,000 psi at 28 days.
- (ii) Pre-cast concrete shall have a minimum compressive strength of 5,000 psi at 28 days.

(b) Reinforcing steel

- (i) Steel reinforcement for retaining wall structures shall be uncoated black bar ASTM A615, Grade 60, minimum.
- (ii) Pre-stressing reinforcement shall conform to high strength steel wire, ASTM A421, high strength strand wire, ASTM A416, Grade 270, or high strength alloy bars, ASTM A722.

(c) Structural steel used for retaining walls shall be ASTM A572, A709 or A992, Grade 50. Any structural steel member part of soldier pile and lagging retaining walls which are not fully encased in concrete shall be galvanized. Metalizing is not allowed.

(d) Retaining walls shall be constructed of non-combustible materials and may be continuous or segmental. Retaining walls shall not be made of timber or have exposed timber products; Timber may be used to construct the lagging for soldier pile and lagging walls and shall be confined behind the permanent face of the wall. If the end of a wall has exposed timber lagging then a cast-in-place concrete closure placement is required.

8.1.3.5 Other Requirements and Considerations

- (a) Horizontal Clearances: Clearances at all walls shall meet or exceed the Project track design clearance criteria, for both the Railroad and System tracks, which are described in Sections 10.1 and 10.2. Clearances to Community Path, where applicable, shall meet clearance requirements of Section 9.2.
- (b) Accommodation of Noise Barrier: Retaining walls shall be designed to incorporate noise barriers mounted above retaining walls where required (refer to the Section 8.2 for noise barrier requirements). Design of the noise barriers and retaining walls shall be coordinated including layout, and design loading.
- (c) Top of Wall Profile: The top of retaining wall profile shall be smooth and regular with small uniform incremental steps where needed so as to avoid sharp angles or abrupt transitions. Niches and cubby holes are not allowed. Wall interruptions, such as Traction Power Substation (TPSS) bump outs and signal bungalow bump outs, shall have a smooth wall transition on either side of the interruption of the wall line. Certain wall profiles may have to follow the top of tie elevations where room is needed to accommodate NFPA 130 requirements.

- (d) Inclination of retaining walls face: Retaining walls may be constructed with a small laid back angle so as to avoid the illusion of the wall leaning forward. If the retaining walls are to be constructed vertically, measures such as cap beams or coping beams with a protruding lip shall be included in the details to provide a shadow line to allay the illusion of the wall leaning forward.
- (e) Interface with existing corridor wall: The retaining wall that meets up with the existing wall located on the east side of the corridor between Broadway and Harvard Street shall be constructed with the same look and feel as the existing wall, including reveals, construction joints and top banding.
- (f) Chording: Retaining walls may be placed in chords with a maximum chord to curve dimension of 3". Retaining walls placed in chords shall respect the minimum track offset to the face of wall and shall be adjusted accordingly.
- (g) Wall Deflection and Placement Tolerances: Minimum clearances to the face of wall shall take into consideration the calculated deflection of retaining walls and installation tolerances.
- (h) Concrete Joints: For continuous cast-in-place retaining walls or cap beams, if used, an expansion joint shall be detailed. Expansion joints shall not exceed 100'-0" spacing. Between expansion joints, construction joints are required and shall not exceed 40'-0" spacing.
- (i) Retaining Wall Southwest of Harvard Street: The retaining wall that is necessary on the south side of Harvard Street underpass shall accommodate the use of the Titan Car Wash facility. Refer to Footnote 4 in Table 8.1-1.

8.1.3.6 Rehabilitation and Replacement of Existing Retaining Walls

Existing retaining walls within the Project limits are listed in Table 8.1-1 below. The existing walls shall remain, be rehabilitated, or replaced as indicated in the Table. For locations and information on the condition of the existing walls, refer to the RIDs (sections 5.1 and 15.3).

The following definitions apply for the Table:

Medford Branch – Walls along the existing MBTA NH Mainline.

Union Branch – Walls along the existing MBTA Fitchburg Mainline.

Location – The approximate location of the wall along the corridor.

Side – The track side location of the wall (Note for this purpose, NH Mainline is considered a north-south line and the Fitchburg Mainline is considered an east-west line).

Type – The type of wall construction.

Notes – The disposition of the wall.

Table 8.1-1 Existing Wall Index

Medford Branch			
Location	Side	Type	Notes
Between Washington St. and Cross St.	West	Cast-In-Place Concrete	To remain as is ¹
	East	N/A	
Cross St. Bridge Wingwalls	Southwest	Cast-In-Place Concrete	To remain as is ¹
	Southeast	Granite	To remain as is ¹
	Northwest	Cast-In-Place Concrete	To remain as is ¹
	Northeast	Granite	To remain as is ¹
Between Cross St. and McGrath Hwy.	West	Crib Wall	Rehabilitate
	East	Crib Wall	A minimum of 150' of wall (adjacent to Cross St. Bridge) to be replaced due to condition. Rehabilitate the remainder.
McGrath Hwy. Bridge Wingwalls	Southwest	Cast-In-Place Concrete	To remain as is ¹
	Southeast	N/A	
	Northwest	Cast-In-Place Concrete	To remain as is ¹
	Northeast	N/A	
Between McGrath Hwy. and Walnut St.	West	Crib Wall	Demolish near Walnut St. due to Work. Rehabilitate the remainder.
	East	Sheet Pile	To remain as is ¹
Walnut St. Bridge Wingwalls	Southwest	Granite	To be demolished due to Work.
	Southeast	Granite	To remain as is ¹
	Northwest	Granite	To be demolished due to Work.
	Northeast	Granite	To remain as is ¹
Between Walnut St. and Medford St.	West	N/A	
	East	Cast-In-Place Concrete	To remain as is ¹
Medford St. Bridge Wingwalls	Southwest	Cast-In-Place Concrete	Demolish section of wingwall due to Work.
	Southeast	Cast-In-Place Concrete	To remain as is ¹

Medford Branch			
Location	Side	Type	Notes
	Northwest	Granite	To remain as is ¹
	Northeast	Cast-In-Place Concrete	To remain as is ¹
Between Medford St. and School St.	West	Granite	Demolish front wall and portion of back wall due to Work
		SPL MW-8B, IGMP-02	See Footnote 3
	East	Stacked Concrete Blocks	To remain as is ¹
School St. Bridge Wingwalls	Southwest	Granite	To remain as is ¹
	Southeast	Granite	To remain as is ¹
	Northwest	Granite	To remain as is ¹
	Northeast	Granite	To remain as is ¹
Between School St. and Sycamore St.	West	Crib Wall	To be demolished due to Work.
	East	Green Wall ²	To remain as is ¹
Sycamore St. Bridge Wingwalls	Southwest	Granite	To remain as is ¹
	Southeast	Granite	To remain as is ¹
	Northwest	Granite	To remain as is ¹
	Northeast	Granite	To remain as is ¹
Between Sycamore St. and Central St.	West	Crib Wall	Rehabilitate or replace.
	East	Green Wall ²	Repair broken area (1 location).
Central St. Bridge Wingwalls	Southwest	Granite	To remain as is ¹
	Southeast	Granite	To remain as is ¹
	Northwest	Granite	Remove existing stairs, retaining wall to remain as is, unless the DB Entity's work affects the wall, in which case modifications as required.
	Northeast	Granite	To remain as is ¹
Between Central St. and Lowell St.	West	Crib Wall	To be demolished due to Work.
	East	N/A	

Medford Branch			
Location	Side	Type	Notes
Lowell St. Bridge Wingwalls	Southwest	Cast-In-Place Concrete	Repair concrete spalls
	Southeast	Cast-In-Place Concrete	Repair concrete spalls
	Northwest	"Max-Pac" Mechanically Stabilized Earth (MSE) Wall	To remain as is ¹
	Northeast	Cast-In-Place Concrete	Repair concrete spalls
Between Lowell St. to Cedar St.	West	N/A	
	East	N/A	
Cedar St. Bridge Wingwalls	Southwest	Cast-In-Place Concrete	To remain as is ¹
	Southeast	Cast-In-Place Concrete	Repair concrete spalls
	Northwest	Granite	To remain as is ¹
	Northeast	Granite	To remain as is ¹
Between Cedar St. to Broadway	West	N/A	
	East	N/A	
Broadway Bridge Wingwalls	Southwest	Cast-In-Place Concrete (Wingwall); Modular Precast Block (MPB) Wall	Wingwall to remain as is ¹ . Remove and reset MPB Wall.
	Southeast	Cast-In-Place Concrete	To remain as is ¹
	Northwest	Cast-In-Place Concrete	To remain as is ¹
	Northeast	Cast-In-Place Concrete	To remain as is ¹
Between Broadway to Harvard St.	West	Cast-In-Place Concrete (North & South)	To remain as is ¹
	East	Cast-In-Place Concrete (Phase I E-7)	To remain as is ¹
Harvard St. Bridge Wingwalls	Southwest	Cast-In-Place Concrete	To remain as is ¹
		Timber	Demolish due to the Work ⁴
	Southeast	Cast-In-Place Concrete (Phase I E-7)	To remain as is ¹
	Northwest	Cast-In-Place Concrete	To remain as is ¹
	Northeast	Cast-In-Place Concrete (Phase I E-8)	To remain as is ¹
Between Harvard St. to College Ave.	West	N/A	
	East	N/A	

Medford Branch			
Location	Side	Type	Notes
College Ave. Bridge Wingwalls	Southwest	Granite	To remain as is ¹
	Southeast	Cast-In-Place Concrete	To remain as is ¹
	Northwest	Cast-In-Place Concrete	To remain as is ¹
	Northeast	Cast-In-Place Concrete	To remain as is ¹
South of College Ave.	West	Granite	To remain as is ¹
	East	N/A	
<p><u>Footnotes:</u></p> <p>¹ Wall to remain as is, unless DB Entity’s Work affects the wall, in which case, modifications as DB Entity’s Work requires.</p> <p>² Green Wall is a precast concrete gravity wall with planter areas within the wall, commonly also known by the “Evergreen” wall brand name. The manufacturer of the original wall is unknown.</p> <p>³ Existing wall (MW-8B) installed under IGMP-02 shall either be finished or abandoned based on the DB Entity’s final design.</p> <p>⁴ Any retaining wall constructed within the proposed easement adjacent to the Titan Carwash property shall not further restrict clearance to the existing carwash. Any retaining wall constructed shall be located no closer to the Titan Carwash property line than the existing wall from existing grade to 6’-8” above existing grade. The DB Entity may construct below-grade foundations and a cantilever necessary within the ROW.</p>			

Table 8.1-1 Existing Wall Index (continued)

Union Branch			
Location	Side	Type	Notes
Between Medford St. and McGrath Highway.	North	Cast-In-Place Concrete	To remain as is ¹
	South	Soldier Pile and Lagging	To remain as is ¹
Between Medford St. and Prospect St.	North	Cast-In-Place Concrete	Replace
	South	Soldier Pile and Lagging	To remain as is ¹
Footnote:			
¹ Wall to remain as is, unless DB Entity’s Work affects the wall, in which case, modifications as DB Entity’s Work requires.			

Existing Walls to be replaced:

Existing walls to be replaced shall be designed to meet all of the requirements here within and in Section 15.1. Options for replacement of existing crib walls may include construction of a new wall in front of the existing and burying the existing walls, or removing and replacing the wall. Demolition of existing walls shall meet the requirements of Section 7.1.

Existing Walls to be Rehabilitated:

Design and construction shall meet the above requirements for retaining walls including Codes (Section 8.1.2) , track clearance, and finishes. Wall rehabilitation shall be designed and constructed to provide a 25 year design life for the rehabilitated portion of the walls. The DB Entity may choose to replace walls which are indicated to be rehabilitated, in which case the requirements for permanent retaining walls shall be met. Wall rehabilitation shall meet the following requirements:

(a) Crib Wall Rehabilitation:

- Vegetation and organics shall be cleared from the face of the existing wall and between the existing cribs. Vegetation shall also be cleared at the top of the wall for distance of 2’ behind the top of wall.
- Rehabilitation shall be designed as a permanent facing to the existing wall. The entire height of walls shall be refaced. Due to the deteriorated nature of the existing facing, the rehabilitation design shall ignore any contribution from the existing facing.
- The tops of the rehabilitated walls shall be finished with a cap of either cast-in-place or precast concrete. The rehabilitation shall be designed such that the free draining nature of the existing crib walls is maintained and in accordance with requirements in Section 7.3.
- Finishing of the face of the rehabilitated wall shall meet the above requirements.

(b) Cast-in-Place Concrete Wall repairs: Repair spalled areas by removing loose and deteriorated concrete and patching with cementitious materials to match adjacent walls.

(c) Green Wall Repair:

Repair broken concrete facing element located approximately 25' north of Sycamore Street by chipping away the loose concrete, forming and placing a new facing piece to match existing.

8.2 NOISE BARRIERS

8.2.1 Scope of Work

Noise Barrier walls shall be provided based on Project noise constraints as required in [Section 4](#).

8.2.2 Codes, Standards and Manuals include:

- Standard Specifications for Highway Bridges, 17th Edition – 2002 with latest Interim Revisions, of the American Association of State Highway and Transportation Officials (AASHTO). Standard Specifications for Highways and Bridges, 1988 with the latest supplemental specifications and Standard Special Provisions, of the Massachusetts Highway Department

8.2.3 Project Specific Design Requirements

Noise Barrier walls shall be designed and constructed to meet the requirements including track clearances, clearance for Community Path, design loading, materials, and finishes. Noise barrier walls shall be designed as stand-alone walls, or mounted on retaining walls.

8.2.3.1 Wall Life

Noise barrier walls shall be designed for a 75 year design life.

8.2.3.2 Design Methodology

The following design methodology shall be used for wall elements, per the applicable codes and standards:

- (a) Geotechnical sliding and overturning stability and bearing pressure calculations – per Load Resistance Factor Design
- (b) Concrete Components - per Load Factor Design
- (c) Structural Steel Components - per Allowable Stress Design

8.2.3.3 Design Loads

Noise barriers shall be designed for all applicable loads. Design Loads and Load Combinations shall be in accordance with the AASHTO Standard Specifications. Refer to [Section 15](#) for geotechnical requirements.

The bottom 5'-0" of the stand-alone noise barrier at on the north side of the Union Branch between McGrath Highway and the Yard 4 Lead at Brickbottom shall be designed for a vehicle impact force (AASHTO, TL-1 Level) in addition to all other applicable loads.

Design of the noise barrier on the west side of the Medford Branch, between Cedar Street and Broadway shall also include the following special loading conditions:

- Design to preclude or minimize debris and/or fill from accumulating behind the noise barrier.
- In addition to all other applicable loads, the noise barrier in this area shall be designed for soil loading. The minimum height of this soil loading shall be equal to the projected height of the existing level area of the adjacent properties. See Section 8.1 for retaining wall design requirements and Section 15 for Geotechnical Requirements.

8.2.3.4 Materials

(a) Concrete

- (i) Foundation concrete elements shall have a minimum compressive strength of 4,000 psi at 28 days.
- (ii) Cast-in place concrete elements shall have a minimum compressive strength of 4,000 psi at 28 days.
- (iii) Pre-cast concrete elements shall have a minimum compressive strength of 5,000 psi at 28 days.
- (iv) Panels should be resistant to freeze-thaw cycles. Protective coatings shall be applied to all permanently exposed faces of concrete surfaces.

(b) Reinforcing steel

- (i) Steel reinforcement for noise barrier wall structures shall be epoxy coated bar ASTM A615, AASHTO M31, Grade 60, except for foundations and drilled shafts which shall be ASTM A615, AASHTO M31, Grade 60 uncoated bars, unless noted otherwise.
 - (ii) Pre-stressing reinforcement shall conform to high strength steel wire, ASTM A421, high strength strand wire, ASTM A416, Grade 270, or high strength alloy bars, ASTM A722.
- (c) Structural steel used for noise barrier walls shall be ASTM A572, A709 or A992, Grade 50. All exposed structural steel shall be hot-dipped galvanized in accordance with ASTM A123.
- (d) Timber and other combustible materials shall not be used for noise barrier walls or any of its components and shall not be part of the permanent construction.
- (e) Acoustical Panels: All acoustical panels shall conform to the following performance requirements:
- (i) Minimum noise reduction coefficient rating of 0.7 or greater and Sound Transmission Class (STC) of 30 or greater after barrier installation.
 - (ii) To aid in preventing the transmission of soil through the barrier, the payout should minimize or eliminate gaps or openings. Gaps shall be less than 3% of the surface area of the barrier and fill materials shall be used to seal all gaps.

- (f) Refer to Section 3 for noise barrier walls that abut “Brickbottom” private property.

8.2.3.5 Other Design Requirements and Considerations

- (a) Horizontal Clearances: Clearances at all walls shall meet or exceed the Project track design clearance criteria, for the Project’s tracks, which are described in Sections 10.1 and 10.2. Clearances to Community Path, where applicable, shall meet clearance requirements Section 9.2.
- (b) Finished Surface of Noise Barriers: All noise barrier walls shall have any surface that meets the noise reduction requirements in Section 3.
- (c) The appearance and aesthetic of the panels shall be subject to MBTA’s approval.

8.3 RAILROAD BRIDGES

8.3.1 Scope of Work

- Washington Street Bridge: The railroad bridge over Washington Street shall be demolished and replaced with a structure which accommodates two proposed System tracks, two existing Railroad tracks, one proposed maintenance track, the Community Path, and new approach slabs. The vertical clearance between Washington Street and the proposed structure shall be increased from 13'-10" to 14'-6" at the minimum. Demolition and removal of the existing bridge and its approach slabs is included in this scope.

Steel has been procured for a bridge, which was not constructed. This stock steel is property of the MBTA. See Volume I, Exhibit 1D for further details.

- Medford Street Rail Bridge: New approach slabs shall be provided to accommodate the existing bridge deck previously complete. The new approach slabs shall run the full width of the new structures and accommodate all drainage and utility requirements as outlined in Section 7.3 and Section 7.4.
- Harvard Street Rail Bridge: New approach slabs shall be provided to accommodate the existing bridge deck previously complete. The new approach slabs shall run the full width of the new structures and accommodate all drainage and utility requirements as outlined in Section 7.3 and Section 7.4.

8.3.2 Codes, Standards and Manuals include:

- MassDOT Highway Division – LRFD Bridge Manual, "Bridge Manual"
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association, the latest edition.
- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures.
- MBTA Guidelines for Load Rating Transit Bridges.
- Standard Specifications for Highway Bridges, of the American Association of State Highway and Transportation Officials.
- MBTA Railroad Design Construction Standard Specifications, the latest edition.

8.3.3 Project Specific Requirements

8.3.3.1 Design Methodology

- (a) Structural steel elements per Allowable Stress Design methodology, AREMA Manual.
- (b) Concrete elements per Strength Design methodology, AREMA Manual.
- (c) All elements shall be designed for a 75 year design life for new structures.

- (d) Design of foundations, earth retaining structures and associated geotechnical elements shall be in accordance with Section 15.1.

8.3.3.2 Loads

- (a) Design live loads on commuter rail tracks in accordance with Cooper E-80 plus Diesel, with impact $N > 2,000,000$ cycles, or the Alternative Live Load in AREMA Chapter 15, Section 1.3.3 – whichever produces the greater stresses. For the System tracks, follow MBTA Guide Specification for Structural Design of Transit and Light Rail Structures, 2005.
- (b) Thermal forces: Mean Temperature 68 degrees Fahrenheit.
- (c) Loading requirements and combinations for design shall be in accordance with AREMA Manual. For combining the loads from multiple tracks, follow provisions in AREMA.
- (d) Community Path shall accommodate pedestrian bridge loading from AASHTO, as well as 12,000 lb. maintenance vehicle.



8.3.3.3 Geometry

- (a) For vertical clearances refer to applicable criteria in Section 9. The vertical clearance between Washington Street and the proposed structure shall be increased from 13'-10" to 14'-6" at the minimum.
- (b) For horizontal clearance refer to applicable criteria in Section 9. Horizontal clearance from Washington Street to the proposed structure shall meet MassDOT clearance requirements. The Washington Street sidewalks shall meet all applicable MassDOT standards. The drainage at Washington Street under the Rail Road Bridge shall meet civil design requirements in Section 7.3.
- (c) The Community Path shall be separated from the tracks by a fence/barrier that meets the criteria in Section 10.

8.4 ROADWAY BRIDGES

8.4.1 Scope of Work

The Roadway Bridge Scope includes:

- Walnut Street (Somerville) (Bridge No. S-17-006): The Walnut Street Bridge shall be supported in place and the south abutment replaced. Behind the new abutment, an underpass structure shall be constructed to accommodate the Community Path.
- School Street (Somerville) (Bridge No. S-17-008): The School Street Bridge shall be supported in place and the south abutment replaced. Behind the new abutment, an underpass structure shall be constructed to accommodate a new System track. 
[Click here to View RFI #25](#)
- Medford Street (Somerville) (Bridge No. S-17-007):  An underpass shall be provided at the Medford Street Bridge behind the south abutment. The underpass shall be wide enough to accommodate one System track and its associated dynamic clearance envelope (See [Section 10](#)), a separation wall with fence, and a minimum 8'-0" clear width for the Community Path.
- Cedar Street (Somerville) (Bridge No. S-17-012): The existing southeast wingwall shall be demolished and a new wingwall shall be installed which provides horizontal clearances to the tracks in accordance with [Section 10](#). Safety niches shall be installed in the existing south abutment stem to meet the horizontal clearance criteria described in [Section 10](#).
- Lowell Street (Somerville) (Bridge No. S-17-011): The existing stone masonry abutment on the south side of the bridge shall be removed to widen the clear horizontal space beneath the bridge to accommodate a fourth track. The existing drilled shafts and pile cap behind the stone masonry abutment shall be stabilized with an additional structural system which provides clearances for the proposed tracks in accordance with [Section 10](#). That system shall also be designed to retain the earth.
- Broadway Bridge (Bridge No. S-17-013): The existing Broadway Bridge shall be demolished and a new bridge shall be constructed whose clear span is long enough to accommodate the two proposed System tracks and two Railroad tracks in accordance with [Section 10](#).
- College Avenue (Medford) (Bridge No. M-12-012): The sidewalk on the north side of the existing bridge shall be removed and this space shall be replaced with a 10'-6" right turn lane. The existing College Avenue Bridge shall be modified as necessary to accommodate (from South to North) a 6'-6" sidewalk, 1'-0" shoulder, 12'-2" lane, an 11' lane, a 10'-6" right turn lane, and a 1' shoulder and the two existing bridge rails on both sides. The total width of the existing structure shall be maintained. A separate pedestrian bridge with a minimum clear path width of 12'-0" shall be constructed north of the MWRA utility support structure that is adjacent to the College Avenue Bridge to accommodate both pedestrian and bicycle traffic over the tracks. See [Section 8.6](#) for further information.
- DB Entity shall inspect and rate all of the reconstructed or modified bridges for the Project in accordance with the MBTA Bridge Inspection and Rating Requirements/Standards.

8.4.2 Codes, Standards and Manuals include:

(a) Bridges

- Load and Resistance Factor Design (LRFD) Bridge Manual, Parts I, II, and III of the Massachusetts Department of Transportation, the latest edition
- Massachusetts Highway Department Project Development & Design Guide
- MassDOT Construction Standard Details
- MassDOT Engineering Directives and Policies
- MassDOT Utility Accommodation Policy
- MassDOT Survey Manual
- MassDOT CAD Standards
- FHWA MUTCD for Streets and Highways
- Standard Specifications for Highways and Bridges, 1988 with the latest supplemental specifications and Standard Special Provisions, of the Massachusetts Highway Department
- American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications, the latest edition, of the American Association of State Highway and Transportation Officials
- AASHTO Guide Specifications for LRFD Seismic Bridge Design, the latest edition, of the American Association of State Highway and Transportation Officials
- MBTA Bridge Inspection and Rating Requirements/Standards

(b) Underpasses

- AREMA Manual for Railway Engineering, the latest edition
- MBTA Standard Specifications
- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures, the latest edition
- National Fire Protection Association, NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems, the latest edition
- Load and Resistance Factor Design (LRFD) Bridge Manual, Parts I, II, and III of the Massachusetts Department of Transportation
- Standard Specifications for Highways and Bridges, 1988 with the latest supplemental specifications and Standard Special Provisions, of the Massachusetts Highway Department
- American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications, the latest edition, of the American Association of State Highway and Transportation Officials

- AASHTO Guide Specifications for LRFD Seismic Bridge Design, the latest edition, of the American Association of State Highway and Transportation Officials
- MBTA Bridge Inspection and Rating Requirements/Standards

8.4.3 The Project Specific Requirements

8.4.3.1 Design Methodology

(a) Bridges

For all elements the design methodology, loadings and load combinations, shall be in accordance with MassDOT and AASHTO Standards using the Load and Resistance Factor Design (LRFD) Methodology. If conflicts occur, the MassDOT Standards shall govern.

(b) Underpasses

At Walnut St, for all elements, the design methodology, loadings and load combinations, shall be in accordance with MassDOT and AASHTO Standards, using the Load and Resistance Factor Design (LRFD) Methodology. At School and Medford Streets, for all elements, the design methodology, loadings and load combinations, shall be in accordance with MassDOT, AASHTO, MBTA and AREMA Standards, using the Load and Resistance Factor Design (LRFD) Methodology.

- (c) Design of foundations, earth retaining structures and associated geotechnical elements shall be in accordance with Section 15.1 of the Technical Provisions.

8.4.3.2 General Bridge and Underpass Requirements:

(a) Clearances

(i) Bridges

The vertical and horizontal clearances at all bridges over the proposed and existing tracks shall meet or exceed the Project track design clearance criteria, for both the Railroad and System tracks, which are described in Section 10. If the structures do not meet minimum clearance requirements outlined in Section 10, safety niches shall be provided.

(ii) Underpasses

The vertical and horizontal clearances provided by all underpasses that carry System tracks shall meet or exceed the clearance criteria defined in Section 10.

(b) Design Loads

(i) Modification of Existing Bridges

1. Modifications to existing bridges shall not reduce the capacities below statutory rating factors per the MassDOT Bridge Manual. If the statutory capacity is currently not met, then the existing capacity shall not be reduced.

2. In addition to collision protection measures as outlined in MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures and AREMA, bridge substructure elements with a clear distance of 25 feet or less from the centerline of railroad track shall be evaluated for a crash loading as described in [Section 12](#). This crash loading shall be investigated as part of the AASHTO Extreme Event II Load Combination.

(ii) Underpasses

Underpasses shall be designed for a roof live load of the HL-93 truck. The tunnel structure shall also be designed for a base slab live load of either the pedestrian load, or combined pedestrian load and System vehicle, where appropriate. School Street and Medford Street underpass walls shall be evaluated for a crash loading as described in [Section 12](#). This crash loading shall be investigated as part of the AASHTO Extreme Event II Load Combination. The underpass roof and walls shall be designed based on buried structures criteria in AASHTO and shall meet all strength, service, constructability, geometric, crack control, deflection and other relevant criteria.

(c) Road Closures

Refer to [Volume 1](#) for work hour restrictions and road closure limitations.

(d) Barriers and Protective Screen

The S3-TL4 steel bridge railing with a modified Type I Protective Screen shall be used on any proposed bridge. 1" mesh by 9 gage fabric shall be used in the protective screen in lieu of 2" mesh by 6 gage fabric shown in the MassDOT Standard Drawings. Refer to [Section 8.6](#) and [Section 12.1](#) for barriers and protective screens at pedestrian bridges and station entrances; respectively.

(e) Profiles and Approaches

For any proposed or modified bridge structures, the profile and alignment of the bridge shall match the existing profile and alignment at the tie in points of the bridge or roadway. For other civil design requirements, refer to [Section 9](#).

(f) Sidewalk Accessibility

For accessibility requirements, refer to [Section 9](#).

(g) Bridge Configuration

The existing total bridge widths, their respective sidewalk and lane widths shall be maintained unless otherwise noted.

(h) Frost Protection

Adequate depth of structure shall be maintained at all existing bridges (4 feet from top of grade to bottom of footing). If it is not possible to maintain proper frost depth, frost protection shall be provided. Details are subject to MassDOT approval.

(i) Utilities

(i) Utilities at Bridges

Each bridge carries various Utilities. The temporary relocation, support, as well as the replacement of all Utilities shall be coordinated with MassDOT and the Utility Owner during design and construction.

(ii) Utilities at Underpasses

The DB Entity shall locate and protect from damage all existing Utilities prior to the commencement of construction. Any conflicts between the underpass structures and existing Utilities shall be coordinated with the Utility Owner. At Medford Street and Walnut Street, lighting shall be provided in accordance with Sections 9 and 12.

(j) Construction

(i) Bridge

The following items shall not be permitted for use in the design or construction of proposed bridges:

- Use of partial depth precast slabs
- Use of orthotropic decks
- Use of timber bridge elements
- Use of gabion retaining walls
- Use of steel sheet piling for permanent retaining walls

(ii) Underpasses

- All underpasses shall be constructed of reinforced concrete (either cast-in place or precast). If precast segmental construction is chosen the individual elements shall be post-tensioned together and all anchorages shall be infilled with concrete to form a smooth surface and match adjacent concrete attributes.
- All inside walls of underpasses shall have a striated surface which matches the standard bridge striations in the MassDOT Bridge Manual.

(iii) Materials and Samples

- All construction materials shall be in accordance with the Standard Specifications and the qualified construction materials list maintained by MassDOT's Research and Materials section.

- No experimental or previously un-approved materials shall be used without prior written approval by MassDOT.
- (k) Underpass Waterproofing and Drainage
- (i) All underpass structures shall be designed to be waterproofed.
 - (ii) Base slab drainage shall be provided to carry all water outside of the underpass, either to the ballast or tied into a drainage system.
 - (iii) Membrane waterproofing shall be applied over the underpass roof and walls and shall meet the requirements of MassDOT bridge deck membrane waterproofing.
- (l) Underpass Ventilation
- (i) If any proposed underpass is longer than 200 feet, an engineering analysis, which includes a validated subway analytical simulation program as described in NFPA 130, shall be provided. The analysis shall confirm that mechanical emergency ventilation is not required, otherwise mechanical emergency ventilation shall be provided.
 - (ii) A mechanical emergency ventilation system shall not be required where the length of an underground Corridor is less than or equal to 200 ft.
- (m) Design Team

The design consultant team shall include firms prequalified by MassDOT for Intermediate Bridge Design/Rating as well as Geotechnical Engineering including Soils and Foundation Studies.

8.4.3.3 Specific Bridge Requirements:

- (a) Medford Street (Somerville) near Somerville High School (Bridge No. S-17-007)

A utility bridge is adjacent to the west side of the roadway bridge. Further requirements are set forth in [Section 8.5](#).

- (b) School Street (Somerville) (Bridge No. S-17-008)

A temporary utility bridge is adjacent to the roadway bridge. For more information and coordination issues see [Section 8.5](#).

- (c) Lowell Street (Somerville) (Bridge No. S-17-011)

(i) There is an existing bridge, S-17-015 (3GG), just south of the existing Lowell Street Bridge. This bridge has exiting tie-backs supporting its abutment. The exact limits of the tiebacks are unknown. The existing tie-back system shall not be disturbed unless bridge S-17-015 (3GG) is modified to maintain the bridge stability and capacities.

(ii) Movements of the drilled shafts, as well as their interaction with the proposed stabilization and retaining structure shall be analyzed. Special care shall be taken to account for the

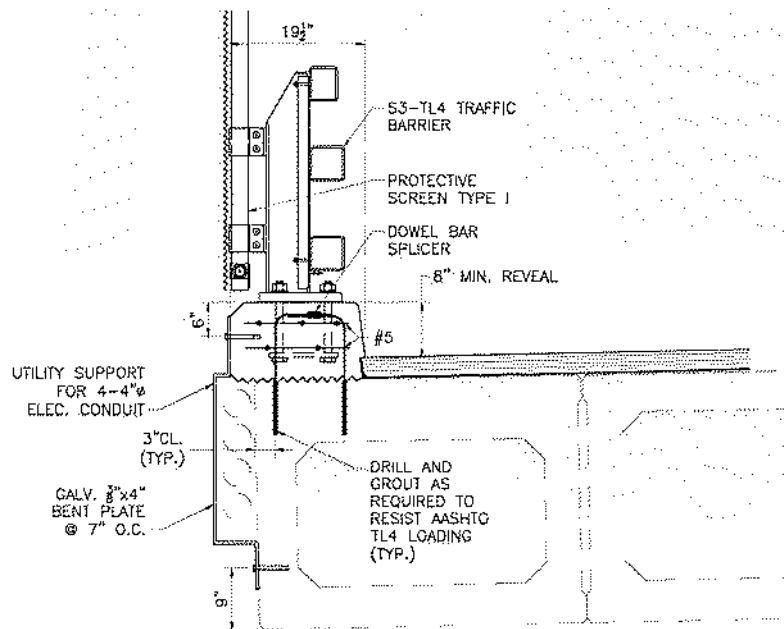
secondary effects of these movements. Analysis of shaft movements shall consider the flexibility of the proposed structure.

(d) Broadway (Somerville) (Bridge No. S-17-013)

- (i) The new bridge shall accommodate from north to south, an S3-TL4 railing, an 8'-8" sidewalk, a 5' bike lane, two 12' travel lanes, another 5' bike lane, a 7'-6" sidewalk and another S3-TL4 railing.
- (ii) A temporary utility bridge is adjacent to the south side of the bridge. For more information and coordination issues see Section 8.5.

(e) College Avenue (Medford) (Bridge No. M-12-012)

- (i) The existing north sidewalk shall be removed and the curb shall be modified to provide a moment resisting connection between the existing deck slab and curb that shall resist crash loads transferred from the barrier. The following modified version of MassDOT LRFD Bridge Manual Part II Detail 9.3.1 shall be used (see Figure 8.4-1). Information not provided in this figure shall meet the MassDOT requirements.



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NOTES:

1. CONTRACTOR SHALL USE PACHOMETER TO LOCATE AND MARK EXISTING REINFORCING BEFORE DRILLING ANCHORAGE INTO EXISTING BEAMS.
2. SAFETY CURB CONCRETE SHALL BE 5000 PSI, 3/4", 635 SILICA FUME MODIFIED CEMENT CONCRETE.
3. REINFORCING SHALL CONFORM TO THE REQUIREMENTS OF AASHTO M31 GRADE 60 AND SHALL BE EPOXY COATED.
4. GROUT PRODUCT SHALL BE OFF MASSDOT APPROVED MATERIAL LIST.

Figure 8.4-1: Bridge Sketch

- (ii) The load carrying capacity of the reconfigured bridge shall meet all required design standards.

8.4.3.4 Specific Underpass Requirements:

(a) Walnut Street (Somerville)

- (i) Underpass shall accommodate 10'-0" clear height from the wearing surface of the path and horizontal clearance in accordance with Section 9.
- (ii) It is anticipated that the underpass structure will conflict with the existing MWRA water main. If required, water main shall be temporarily and/or permanently relocated. See Section 3 for permitting criteria.

(b) Medford Street (Somerville) near Somerville High School

- (i) Underpass shall accommodate one System track and its associated dynamic clearance envelope, a separation wall with fence, and 8'-0" clear width for the Community Path. See Sections 9 and 10.
- (ii) The implications of underpass construction directly adjacent to, and/or on top of existing foundations shall be assessed. The abutment's foundation shall be analyzed for additional loading that it may pick up as a result of the underpass construction including the impact of any support displacement on the bridge's performance. The foundation shall be underpinned or improved if required as a result of the additional loading, to ensure it meets the requirements of the relevant geotechnical and structural codes and standards.
- (iii) It is anticipated that the underpass structure will conflict with the existing temporary utility support bridge. For more information and coordination issues see Section 8.5.

(c) School Street (Somerville)

- (i) Underpass shall accommodate one System track and its associated dynamic clearance envelope.
- (ii) The implications of underpass construction directly adjacent to, and/or on top of existing foundations shall be assessed. The abutment's settlements shall be limited to a safe amount, considering the impact of any support displacement on the bridge's performance. The abutment's foundation shall be analyzed for additional loading that it may pick up as a result of the underpass construction. The foundation shall be underpinned or improved if required as a result of the additional loading, to ensure it meets the requirements of the relevant geotechnical and structural codes and standards.

8.4.4 Deliverables

8.4.4.1 Proposed Bridges and Underpasses

All submittals, including plans, calculations and specifications shall be made in accordance with the MassDOT Bridge Manual and the MassDOT Design Submission Distribution chart. After sketch plans of

the proposed bridge and/or underpass are approved, the DB Entity is responsible for the submission of the First and Second Structural Submissions (as well as additional submittals if deemed necessary by MassDOT). Construction shall not commence until MassDOT has approved each submittal of each bridge and/or underpass.

- A new bridge number shall be requested from MassDOT for each new bridge and underpass.
- All plans shall be created in AutoCAD Civil 3D and shall conform to MassDOT CAD Standards Manual and developed using the MassDOT Bridge Manual Standards, Details, Title Blocks and Drawing Templates.
- Electronic submittals shall be made in AutoCAD Civil 3D, Microsoft Word, Microsoft Excel and Adobe format via email, CD, flash drive, FTP site or as directed by the Engineer.
- After construction is complete and an inspection performed by MassDOT, a Bridge Load Rating Report shall be submitted for each new bridge and/or underpass, in accordance with the MassDOT Bridge Manual, Chapter 7. All MassDOT review comments shall be addressed and a final report submitted. Underpasses shall be classified as bridges in the MassDOT identification system, and shall follow bridge rating report guidelines established in the MassDOT Bridge Manual.
- All plans and calculations shall be stamped by a Professional Engineer registered in Massachusetts.

8.4.4.2 Modified Bridges, in Accordance with the MassDOT Bridge Manual

Construction shall not commence until MassDOT has approved MassDOT required submittals from the DB Entity. Drawings and associated calculations shall be provided to adequately convey the intent of the modifications and are subject to MassDOT approval. Calculations shall be submitted to MassDOT to illustrate that the load carrying capacities of the existing and modified bridge components meet the requirements of relevant codes and standards.

8.4.4.3 Construction Submittals

- (a) Shop Drawing submittals and distribution for MassDOT Bridges and Underpasses shall be in accordance with the MassDOT Bridge Manual, the MassDOT Standard Specifications, and the Supplemental Specifications.
- (b) Details and specifications of all underpass waterproofing shall be submitted to the MBTA and MassDOT for approval.

8.5 UTILITY BRIDGES

8.5.1 Scope of Work

The utility bridge Work includes:

- (a) Medford Street: The Medford Street utility bridge pier interferes with the proposed track alignment and shall be removed. A temporary steel bent which supports the south end of the utility bridge also conflicts with the proposed track alignment and shall be replaced with a permanent support. The existing girders may be retained if they, in a revised span arrangement, meet the requirements of the relevant codes and standards with or without proposed modifications to strengthen those girders. Temporary relocation, support, and/or replacement of the Utilities shall be provided and shall be coordinated with and approved by the MBTA, MassDOT, and the Utility Owners during design and prior to construction; in accordance with the requirements of Section 7.4.
- (b) School Street: A pedestrian/utility bridge supports several utilities at School Street. These Utilities shall be moved back to the permanent School Street Roadway Bridge and the utility bridge shall be demolished and removed. The existing truss supporting Utilities on the sidewalk of the existing roadway bridge shall be removed and the sidewalk repaired.
- (c) Broadway Bridge: The existing utility bridge shall be painted and the soldier pile and lagging wall modified to meet the requirements of Section 8.1.

8.5.2 Codes, Standards and Manuals include:

- LRFD Bridge Manual, Parts I, II, and III of the Massachusetts Department of Transportation, the latest edition
- Standard Specifications for Highways and Bridges with the latest supplemental specifications and Standard Special Provisions, of the Massachusetts Highway Department
- AASHTO LRFD Bridge Design Specifications, the latest edition, of the American Association of State Highway and Transportation Officials
- MassDOT Utility Accommodation Policy
- MassDOT Survey Manual
- MassDOT Engineering Directives and Policies

8.5.3 The Project Specific Requirements

8.5.3.1 Design Methodology

- (a) The design shall be in accordance with AASHTO Load and Resistance Factor Design (LRFD)

Specifications.

- (b) For vertical and horizontal clearances refer to Section 10.
- (c) Design of foundations, earth retaining structures and associated geotechnical elements shall be in accordance with Section 15.1 of the Technical Provisions.

8.5.3.2 Utility Coordination

The DB Entity shall coordinate with the applicable Utility Owner prior to relocating any utility. If the work requires removing an existing utility bridge and incorporating the Utilities into a bridge maintained by MassDOT, the DB Entity shall also coordinate, and get approval from MassDOT and the corresponding municipal department prior to relocation of the utility.

8.5.3.3 Additional Loading and Design Standards

The DB Entity shall confirm with the Utility Owner if they have any requirements for loading and applicable design standards when modifying utility bridges. All utility weights and loading, and utility support requirements shall conform with respective utility and municipality requirements.

8.5.3.4 Medford Street Utility Bridge

The temporary shoring tower shall be removed and replaced with a permanent structure.

The north Utility bridge abutment shall be permanently tied into the DB Entity's final abutment at Medford Street. The Utility tie into the sidewalk shall be adjusted and repaired for the permanent condition.

8.5.3.5 School Street Pedestrian/Utility Bridge

The Utilities from the School Street pedestrian/Utility bridge shall be relocated to the School Street Roadway Bridge. The School Street Utility Bridge shall be demolished including temporary substructure elements to a depth of 2' minimum below proposed finish grade and in accordance with Section 7.1. The truss above the east sidewalk shall be removed and the sidewalk of the School Street Bridge shall be repaired.

8.5.3.6 Broadway Utility Bridge

The steel girders shall be painted in accordance with MassDOT requirements. The existing temporary wall at the southwest corner of the bridge shall be replaced with a permanent retaining wall. The soldier pile and lagging walls shall be modified to be incorporated into a permanent retaining wall and shall meet all design criteria in Section 8.1.

8.6 PEDESTRIAN BRIDGES

8.6.1 Scope of Work

At College Avenue, a separate pedestrian bridge, with a minimum clear path width of 12' shall be constructed to accommodate both pedestrian and bicycle traffic over the tracks. This bridge is to be located north of the MWRA utility support structure that is adjacent to the College Avenue Roadway Bridge.

The DB Entity shall maintain the existing School Street pedestrian bridge to remain open from NTP to demolition.

8.6.2 Codes, Standards and Manuals include:

- AASHTO Load and Resistance Factor Design (LRFD) Guide Specifications for the Design of Pedestrian Bridges
- AASHTO LRFD Bridge Design Specifications, the latest edition, of the American Association of State Highway and Transportation Officials
- AASHTO Guide Specifications for LRFD Seismic Bridge Design, of the American Association of State Highway and Transportation Officials
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association
- LRFD Bridge Manual, Parts I, II, and III of the Massachusetts Department of Transportation, as applicable
- Standard Specifications for Highways and Bridges, 1988 with the latest supplemental specifications and Standard Special Provisions, of the Massachusetts Highway Department
- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures, October 2005
- MBTA Railroad Design Construction Standard Specifications
- Load and Resistance Factor Design (LRFD) Bridge Manual, Parts I, II, and III of the Massachusetts Department of Transportation

8.6.3 Project Specific Requirements

Widths of any shared use or pedestrian paths shall comply with ADA standards. Profile, alignment, and cross slopes of any pedestrian bridge paths shall meet all accessibility standards (refer to [Section 9](#)).

8.6.3.1 Design Methodology

All elements shall be designed in accordance with AASHTO LRFD Pedestrian Bridge Specifications, AASHTO LRFD specifications, and the AASHTO Seismic Guide Specifications. Design of foundations, earth retaining structures and associated geotechnical elements shall be in accordance with Section 15.1 of the Technical Provisions.

8.6.3.2 Geometry

- (a) For vertical clearances below the bridge, refer to Section 10.
- (b) For horizontal clearance refer to Section 10.
- (c) The bridge shall comply with ADA slope requirements with a maximum profile grade slope of 5%. This also applies to the approaches to the bridge that connect to the existing sidewalk, with the exception that the slope may exceed 5% provided it meets ADA requirements.
- (d) The alignment of the pedestrian bridge at College Ave, shall tie into the existing sidewalks on College Avenue on the East side of the corridor, and shall tie into the Boston Avenue sidewalk on the West side.

8.6.3.3 Bridge Railings

All railings shall meet all AASHTO standards for pedestrian bridges.

8.6.3.4 Wearing Surface

Pedestrian bridges shall have an integral concrete wearing surface.

8.6.3.5 Lighting

Pedestrian bridges shall have lighting in accordance with Section 14.

8.6.3.6 Protective Screen

Pedestrian bridges shall include a modified Type I Protective Screen, as shown in MassDOT Standard Drawings, installed on any side of the bridge adjacent to the railroad. 1" mesh by 9 gauge fabric shall be used for the protective screen in lieu of the 2" mesh by 6 gauge fabric shown in the MassDOT Standard Drawings.

8.6.3.7 Structural Independence

Pedestrian bridges shall be independent of other structures.

8.6.3.8 Bridge Life

Pedestrian bridges shall be designed for a 75 year design life.

8.6.3.9 Security

Pedestrian bridges shall be designed with clear lines of sight, and with open railings and barriers.

8.6.3.10 Vehicle Clearances and Loads

Pedestrian bridges shall be designed for vehicle loads (minimum 12 kips) and clearances as per applicable standards.

8.6.3.11 Striations

All vertical walls shall have a striation pattern to match the MassDOT standard striation patterns found in the MassDOT Bridge Manual.

8.6.3.12 Pedestrian Bridge Vibrations

For pedestrian bridges with fundamental vertical frequency less than 3 Hz, vibrations shall be evaluated in accordance with *SETRA Footbridges Assessment of Vibrational Behavior of Footbridges Under Pedestrian Loading* and *FIB Bulletin 32 Section 5*. At minimum, the following two load scenarios shall be evaluated:

- Response from 1 walker shall have maximum acceleration $a_{v,max}$ (m/s²) of $0.45\sqrt{f}$, where f is the fundamental vertical frequency
- Response from 1 runner shall have maximum acceleration $a_{v,max}$ (m/s²) of $0.9\sqrt{f}$, where f is the fundamental vertical frequency

In the lateral direction, the fundamental frequency of the pedestrian bridge shall be greater than 1.3 Hz. If damping is achieved using specialty equipment such as tuned mass dampers or viscous dampers, commission testing shall be required prior to bridge opening.

8.7 VIADUCTS

8.7.1 Scope of Work

The viaduct Work consists of design and construction of a new light rail transit viaduct structure for the elevated and approach sections of the Project. The viaduct structure has been divided into four sections; two of which shall be designed and constructed with stubs for future extension. DB Entity shall design and construct four viaduct sections: the Lechmere Viaduct, the Medford Branch Viaduct, the Union Square Eastbound Viaduct and the Union Square Westbound Viaduct. The approximate limits of these viaduct structures are shown in Exhibit 2B. The following is a brief description of the four viaduct structures:

8.7.1.1 Lechmere Viaduct

Lechmere Viaduct (Cambridge) shall be an aerial structure at approximately the same elevation as the existing East Cambridge viaduct. It shall extend west from the tie-in point with the existing East Cambridge concrete viaduct at Pier 13 to the first pier west of Water Street. The double track structure shall support both eastbound and westbound tracks of the Medford Branch alignment.

8.7.1.2 Medford Branch Viaduct

Medford Branch Viaduct (Somerville) shall be an aerial structure that extends west from the first pier west of Water Street, over the existing rail yard to where it comes to grade west of the rail yard. The double track structure shall support both the eastbound and westbound tracks of the Medford Branch track alignment.

8.7.1.3 Union Square Eastbound Viaduct

Union Square Eastbound Viaduct (Somerville) shall be an aerial structure that bifurcates off the Medford Branch Viaduct and extends west to south along the Union Square Eastbound track alignment over the rail yard. The single track structure shall tie into the Medford Branch Viaduct structure along the eastbound Medford Branch track alignment.

8.7.1.4 Union Square Westbound Viaduct

Union Square Westbound Viaduct (Somerville) shall be an aerial structure that bifurcates off the Medford Branch Viaduct and extends north to south along the Union Square Westbound track alignment over the rail yard and parallel to the Fitchburg Main Line (FML). The single track structure shall tie into the Medford Branch Viaduct structure along the westbound Medford Branch track alignment.

8.7.1.5 Demolition

Portions of the existing East Cambridge Viaduct west of Land Boulevard shall be demolished for the construction of the new viaduct structures, refer Section 7.1 Demolition for requirements.

8.7.1.6 Means of Egress

Means of egress from the viaduct, equipment platforms and other aerial structures shall be provided.

8.7.2 Codes, Standards and Manuals include:

- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures, referenced in this document as the “Light Rail Code”
- MBTA Guidelines for Load Rating Transit Bridges, referenced in this document as the “Light Rail Load Rating Code”
- Standard Specifications for Highway Bridges, 17th Edition - 2002 with latest Interim Revisions, of the American Association of State Highway and Transportation Officials, referenced in this document as the “AASHTO Standard Specifications”
- AREMA Manual for Railway Engineering, of the American Railway Engineering and Maintenance-of-Way Association, referenced in this document as the “AREMA Manual”
- MBTA Railroad Design Construction Standard Specifications, referenced in this document as the “MBTA Specifications”
- AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, as supplemented by the Federal Highway Administration (FHWA) 2010 Drilled Shaft Manual
- MBTA Maintenance of Way Division, Green Line – Light Rail Transit Track Maintenance and Safety Standards, referenced in this document as the “MBTA LRT MOW and Safety Standards”
- MassDOT Highway Division – LRFD Bridge Manual, “Bridge Manual”

8.7.3 The Project Specific Requirements**8.7.3.1 Design Methodology**

- The viaduct shall be designed in accordance with the Light Rail Code.
- Viaduct design life shall be a minimum 80 years in accordance with the Light Rail Code.
- The viaduct design shall take into account the Stray Current Protection per Section 8.9 of this document.
- Detailing for structural elements including plate girders, box girders and deck slabs, shall comply with the Bridge Manual.
- Design of foundations, earth retaining structures and associated geotechnical elements shall be in accordance with Section 15.1 of the Technical Provisions.

8.7.3.2 Demolition

- Portions of the existing East Cambridge Viaduct west of Land Boulevard shall be demolished for the construction of the new viaduct structures. The steel superstructure of the existing East Cambridge Green Line viaduct shall be removed in its entirety from Lechmere Station abutment to the centerline of bearing of existing Pier 13. The steel bents and concrete foundations of the existing East Cambridge Green Line viaduct shall be removed down to a minimum of 2 feet below adjacent roadway grades, or to the extent necessary for the Work, whichever is deeper. The limits of removal are shown on Sheets LEV-X-1000 and LEV-X-1001.

- Portions of the existing East Cambridge steel viaduct shall be salvaged for reuse per drawings LEV-X-1000 and LEV-X-1001. Steel that is to be salvaged is to be disassembled in a manner that shall not damage or cause harm to the section being salvaged. Flame cutting, shearing or saw cutting is not permitted. Existing connections shall have their rivets and/or bolts removed by mechanical methods. Salvaged steel shall be delivered to the locations indicated in the table on LEV-X-1001.
- Existing steel viaduct structure shall be demolished to a minimum of 2' below adjacent roadway grade, or to the extent necessary to construct the proposed viaduct, whichever is deeper.
- If paint on the existing steel contains lead, refer to Section 4.
- Demolition in area of the existing East Cambridge viaduct Pier 13 that is to remain, shall be kept to a minimum to allow for the tie-in of the new viaduct to the existing viaduct. Any modifications to the existing bridge seat, backwall, side walls, and parapet walls shall neither reduce the load carrying capacity, increase the deflection, nor increase the vibration of the remaining structure. The remaining structure shall not become unstable or be damaged in any way.

8.7.3.3 The Lechmere viaduct superstructure shall be independent from the Lechmere station platform, to minimize structural interactions between the two structures.

8.7.3.4 The Union Square Eastbound viaduct shall be designed and constructed to accommodate the future tie-in of the Yard Lead Flyover viaduct. The Union Square Westbound viaduct shall be designed and constructed to accommodate the future tie-in of the Union Square Yard Lead viaduct.

8.7.3.5 Loads and Load Combinations

- Design loads in accordance with Article 4 of the Light Rail Code for both Revenue Vehicles and Non-Revenue Vehicles as applicable.
- For Existing Green Line Car Type #8 and Type #9 live loadings, see Figures 8.7-1, 8.7-2 and 8.7-3. Car Type #8 and Type #9 live loadings, shall also be included as revenue Live Load, plus impact, for design of viaduct structure.
- Final design of the Lechmere Viaduct shall provide for use of Type #9 LRV that the MBTA is currently in the process of acquiring, and the requirements for future "Level Boarding" between the LRV and Lechmere Station platform.
- Earthquake Forces (EQ), per Article 4.14 of the Light Rail Code.
- In addition to requirements of 4.14 of Light Rail code, seismic analysis shall be performed in accordance with Article 4.2 in Division 1A – Seismic Design of the AASHTO Standard Specifications – Procedure 3, as a minimum.
- The loads due to Noise Barrier and Wind Screen as required on the viaduct shall be computed based on the requirements of Section 8 of this document.
- Loading on Handrails, Guardrails and Other Protective railings along viaduct shall be in accordance with Article 4.4.4 of the Light Rail Code.
- Final loads on the existing East Cambridge Viaduct Pier 13 Tie-In, shall not exceed maximum historical Dead Load with Live Load plus Impact, along with other applicable loads per Article 4

of the Light Rail Code, using Load Combinations per Article 5 of the Light Rail Code. The historical Live Load shall be interpreted to mean the use of the Type #7 or Type #8 revenue car, whichever produces the higher loading. Additionally, final deflections and vibrations at existing Pier 13 shall not exceed those already imposed on the pier structure.

- Load Combinations shall be in accordance with Article 5 of the Light Rail Code.

8.7.3.6 Camber and Deflections - Superstructure and Pier Caps

- Camber and Deflections shall be in accordance with Article 6.2 of the Light Rail Code, with the following exceptions.
 - (a) Revenue Existing Green Line Trains Type #7, #8 and #9, whichever produces the higher values, maximum deflections of Live Load, plus impact, not to exceed 1/1000 of the span length.
 - (b) Non-Revenue, Work Car Combination Trains, maximum deflections of Live Load, plus impact, not to exceed 1/800 of the span length.
- “Level Boarding” requirements between the Lechmere Viaduct and Lechmere Station Platform Interface, shall conform to the maximum vertical difference between the floor of the LRV and the station platform for the future Type #9 LRV as stated under the Americans with Disabilities Act (ADA), Accessibility Guidelines, section 10.3.1(9). The design shall consider the maximum vertical difference due to deflections under all the applicable loading conditions of the viaduct and the station platform for when the LRV is at rest.

8.7.3.7 Deformation and Settlement – Foundations

- Abutment, Approach Structures, Piers and Bents– Vertical, shall be in accordance with Article 8.1 and 8.4 of the Light Rail Code.
- Abutment, Approach Structures, Piers and Bents– Lateral, shall be in accordance with Article 4.4.7.2.5 of AASHTO Standard Specifications and Article LRT213.55 of the MBTA LRT MOW and Safety Standards. Allowable horizontal track misalignment shall be considered when determining the allowable lateral deflections. The maximum deviation from uniform horizontal track alignment shall be the Green maintenance threshold.

8.7.3.8 Foundations Near Track

- Foundation cap structures in the Railroad track loading zone of influence shall not be used.
- Installation of foundations and any required excavations in vicinity of the tracks shall conform to the requirements of MassDOT LRFD Bridge Manual Part II, Chapter 2 – Bridge Geometry and MBTA Railroad Operation Book of Standard Plans Track and Roadway.

8.7.3.9 Clearances

- Viaduct clearances, vertical and lateral, adjacent to and over Railroad shall be in accordance with the requirements of Section 10.

- Viaduct clearances over and adjacent to roadways; Vertical clearance shall be a minimum 16'-6", except at Lechmere bus loop, per MassDOT Highway for new bridges. Horizontal clearances adjacent to roadways shall conform MassDOT Project Development and Design Guide (PDDG) Chapter 5 and MassDOT Engineering Directive E-14-006. Refer to [Section 7.2](#) for the Lechmere bus loop clearance.
- Viaduct Clearances, vertical and lateral, adjacent to and over pedestrian walkways and bicycle paths shall conform to the requirements of MassDOT PDDG. Refer to [Section 9.2](#) and [Exhibit 2F](#) for additional clearance requirements.

8.7.3.10 Means of Egress

Egress from viaduct structure shall conform to the requirements of NFPA-130. Access stairways and platforms away from stations shall also conform to NFPA-130.

8.7.3.11 Drainage and Waterproofing

- Drainage for the viaduct shall be provided through deck scuppers and drain pipes sized in accordance with the requirements of [Section 7](#). Drain pipes shall be supported from the deck level to ground level. Drain pipes shall not be installed within box girders. Drainage pipes along other sections of the viaduct shall be brought down to grade and allowed to discharge water to the surface of the ballast in the rail yard area. Scupper frames, covers, attachments and embedments shall be designed to support all superimposed loads. Scupper covers shall provide for the free drainage of water, but shall prevent ballast and other debris from passing through.
- For ballasted deck structures, waterproofing of the viaduct shall consist of a spray applied continuous membrane that provides an impermeable barrier to the flow of water. Acceptable products are, the Eliminator Waterproofing Membrane, by Stirling Lloyd Product, Inc., the Bridge Deck Membrane, by Bridge Preservation LLC, or MBTA approved equal.
- Joints in the deck shall utilize a flexible type system that is integral and compatible with the waterproofing system. Waterproofing shall extend up the inside of parapet walls, haunches, pole bases, and any other vertical or inclined surface that is embedded within the ballast, a minimum height of the depth of ballast. Joint systems shall extend up the full height of the parapet walls on the inside of the deck structure, turn up over the top of the wall and then extend a minimum 12" down the exterior face.
- All waterproofing membrane shall be protected from the track structure ballast with Asphaltic Protection Boards that conform to the requirements of AREMA, Chapter 8, Asphaltic Panels.

8.7.3.12 Utilities

Utilities and drainage shall not be carried within box girders where used.

8.7.3.13 Fire Protection

Provide a dry standpipe system between Water Street and the RBPS to provide fire protection of viaduct conforming to the requirements the applicable codes and standards including NFPA 130 and NFPA 14. The system shall provide for connections at grade and track level that are acceptable to the Cambridge Fire Department. The system shall be connected to piers and parapet walls for support. Standpipe between

the pier and viaduct superstructure shall be designed to accommodate movement between the two structures.

8.7.3.14 Viaduct Foundations and Piers Previously Constructed under Separate Contract

The DB Entity is notified that there are foundations and piers previously constructed under a separate contract (IGMP-03) for the System. Figure 8.7-4 provides a table with a breakdown of the level of completed construction for these elements. These foundation and pier structures may be utilized by the DB Entity as part of their final viaduct structure design otherwise they shall be removed.

If the DB Entity chooses to utilize these elements as part of the final viaduct structure, the DB Entity shall verify the adequacy of these previously constructed elements and the condition and viability of these structures prior to incorporating them into the final viaduct design. The DB Entity shall mitigate any deficiencies of these elements to meet the contractual requirements to the satisfaction of the MBTA as part of the final viaduct design.

If the DB Entity does not utilize these previously constructed elements in the final viaduct design, then the DB Entity shall remove them in their entirety to a minimum of 2 feet below finished grade, or to the extent necessary to construct the proposed new work, whichever is deeper.

8.7.3.15 Plant-Precast Structural Concrete

Plant-Precast structural concrete, either reinforced or prestressed shall conform to the following requirements.

- Fabricator Qualifications: A firm that has plant certification by the Precast Concrete Institute and is experienced in manufacturing precast structural concrete units similar to those required for the Project and with a record of successful in-service performance. The plant is subject to inspection by the MBTA.
- DB Entity shall engage an independent testing agency, acceptable to the MBTA, qualified according to ASTM C 1077 and ASTM E 329 to conduct the quality control testing required for the Work, as documented according to ASTM E 548.
- Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete".
- Quality control standard for manufacturing procedures and testing requirements, quality-control recommendations, and camber and dimensional tolerances for types of units required, shall comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products".
- Calculated fire resistance where required, for precast structural concrete units shall be calculated according to PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete", and ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies".

- Fire test response characteristics, DB Entity shall provide precast structural concrete units that comply with the following requirements, fire-response testing shall be performed by UL, ITS or another testing and inspecting agency that is acceptable to the MBTA. Fire resistance rated assemblies, which are indicated by design designations from UL's "Fire Resistance Directory", from ITS's "Directory of Listed Products" or from the listings of another testing and inspecting agency, shall be identical in materials and construction to those tested per ASTM E 119.

8.7.3.16 Non-Shrink Construction Grout

Non-Shrink construction grout shall conform to the following requirements.

- Grout shall comply with ASTM C1107, Grade A, B or C.
- Unless otherwise required by design, the grout shall have a compressive strength of at least 3,500 psi in 7 days when tested in accordance with AASHTO T106, and a minimum of 8,000 psi at 28 days. DB Entity shall coordinate between trades, so that appropriate grout strengths are supplied and used for the proposed work.

8.7.3.17 Post Installed Anchors

- DB Entity shall conform to the requirements of MBTA, Adhesive Anchor Policy 070808.

8.7.3.18 Painting of Structural Steel

All painting of structural steel shall be in accordance with the Mass DOT Standard Specifications for Highway Bridges. In addition, the following provisions shall apply:

- Bridge Structural Steel, Non-Weathering steel girders and framing members shall be fully painted, with a three coat system, color of top coat shall conform to The Sherwin-Williams Company, color SW-6471 Hazel, or MBTA approved equal. Girders and framing members of Weathering steel shall be painted, with a three coat system, within 1.5 times the girder depth or 7'-0" minimum, whichever is larger, from centerline of all joints. Color of weathering steel top coat shall conform to Federal Standard 595B, chip number 30045.
- Where box girders are used, the interior surfaces including all structural steel components within the box girders (including but not limited to diaphragms, cross-frames, connection plates) shall be painted in accordance with the requirements of MassDOT LRFD Bridge Manual Drawing 5.3.16.

Miscellaneous Structural Steel (all steel that is not part of the primary load carrying girder system of the viaduct or access platform structures), shall be hot dipped galvanized.

8.7.4 Deliverables

DB Entity shall submit all design and analysis calculations for the viaduct structure for review.

DB Entity shall also submit electronic analysis and design software (including CSI Bridge, SAP, STAAD Pro, RAM, L-Pile, RC Pier) models created for the use in evaluating the viaduct structure.

- Models shall be in their natural/native file format, and be capable of being run and reviewed by

the MBTA.

- DB Entity shall indicate the version of software being used and provide a narrative on assumptions used to develop the models and identify which item or items the software is being used to analyze and or design.

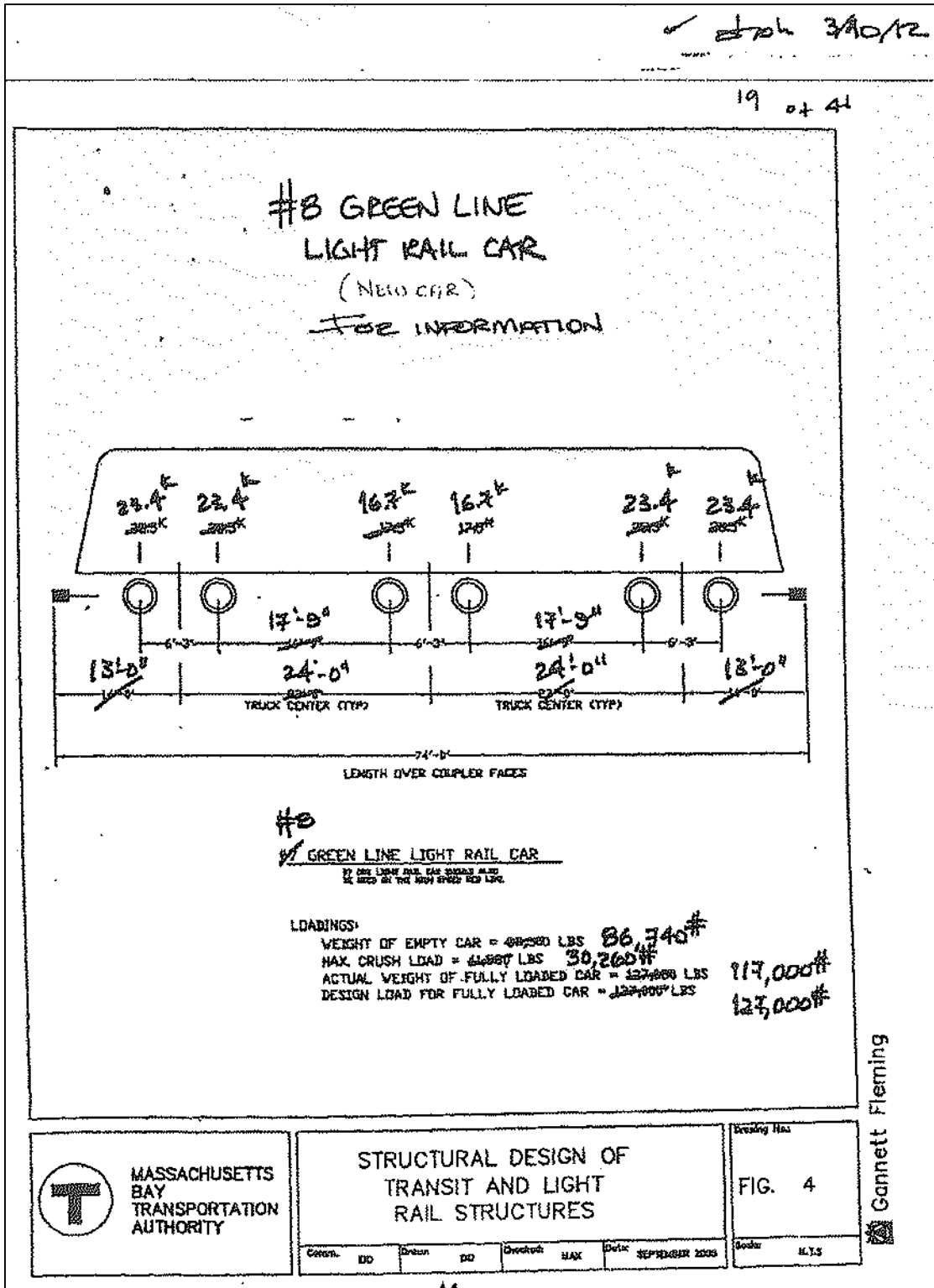


Figure 8.7-1 – Existing Green Line #8 Revenue Car – Loading Diagram

January 30, 2017

L9I-Click here to enter text.-

The current Type 9 weight estimate is AW3=127,830 pounds and AW4=134.666 pounds. The resultant axle loadings are:

	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6
Type 7 @ 129,000 pounds	24K	24K	16.5K	16.5K	24K	24K
Type 9 AW3 = 127,830 pounds	22.2	22.2	19.5	19.5	22.2	22.2
Type 9 AW4 = 134.666 pounds	23.0	23.0	21.1	21.2	23.1	23.1

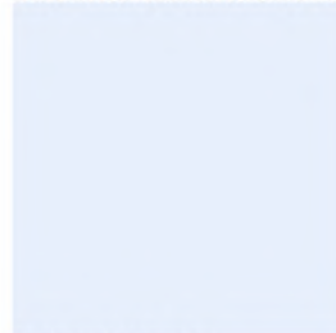
Please note that:

- All Type 9 axle loads are less than the existing highest axle load of 24K pounds.
- The Type 9 loading between motor and trailer trucks is more uniform than the Type 7.

Please call me if you have any questions, or if you require any more information to support your review.

Respectfully Submitted,

LTK ENGINEERING SERVICES



Christopher Pacher
Project Manager

CP/gmd

cc: Nicole Mason (MBTA)

Attachments

Figure 8.7-2 – Existing Green Line #9 Revenue Car – Criteria

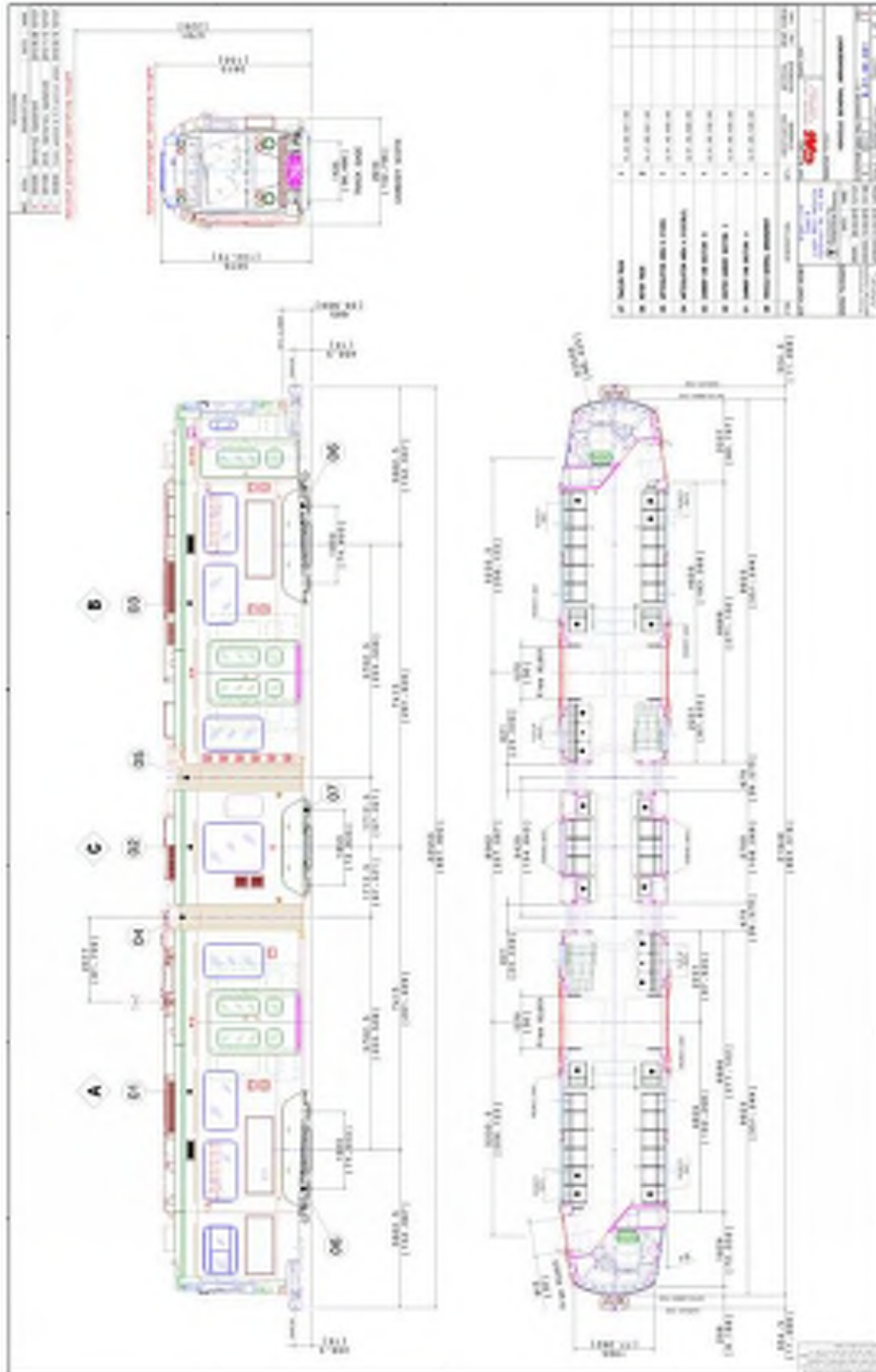


Figure 8.7-3 – Existing Green Line #9 Revenue Car – Criteria

IGMP-03 Viaduct Foundation and Pier Structures Disposition

Pier Location	Status	Elements Constructed
EEV Pier 17	Completed	Shaft, Column, Cap
EEV Pier 18	Completed	Shaft, Column, Cap
MBV Pier 26	Completed	Shaft, Column, Cap
MBV Pier 27	Completed	Shaft, Column, Cap
UEV Pier 3	Completed	Shaft, Column, Cap
MBV Pier 28	Partially Completed	MBV-28-1 constructed to top of column CJ, MBV-28-2 constructed to top of shaft CJ
UWV Pier 2	Partially Completed	UWV-2-2 constructed to top of column CJ, the rest not started
YLF Pier 2	Partially Completed	YLF-2-1 (single column) constructed to top of column CJ
MBV Pier 29	Not Started	None
UEV Pier 4	Not Started	None
UEV Pier 5	Not Started	None

Figure 8.7-4 – Existing GLX Viaduct Foundations and Piers IGMP-03 Contract Status

8.8 TRACTION POWER SUBSTATION STRUCTURES

8.8.1 Scope of Work

The traction power substation structures (TPSS) Work consists of the construction of three (3) traction power substations in this Project. Red Bridge will feed the storage maintenance yard, one will be located at Ball Square, and the other at Pearl Street.

8.8.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code (MSBC), referred to below as “780 CMR”
- ASCE 7, Minimum Design Loads for Buildings and Other Structures
- AISC Steel Construction Manual
- ACI-318 Building Code Requirements for Structural Concrete
- ACI 301 Specifications for Structural Concrete
- ACI-530 Building Code Requirements for Masonry Structures
- FM Global Property Loss Prevention Data Sheets: 1-28 Design Wind Loads, 1-31 Panel Roof Systems, and 1-54 Roof Loads for New Construction

8.8.3 The Project Specific Requirements

8.8.3.1 Design Methodology

- a) Steel Elements - Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD) Method
- b) Concrete Elements - Ultimate Strength Method
- c) Masonry Elements - ASD or LRFD Method

8.8.3.2 Live Loads

- a) Corridor - 100 PSF
- b) Offices - 50 PSF
- c) Electrical, storage and telecommunications rooms - 250 PSF or actual equipment weight if heavier
- d) Stairways - Max of (150 PSF) or (100PSF with concentrated forces of 300 lbs.) on the center of tread
- e) All Other Areas - In accordance with Mass Building Code 780 CMR

8.8.3.3 Deflections

- (a) Floor Framing Deflections - Live Load Deflection = $L/360$ Total Load Deflection = $L/240$

- (b) Roof Framing Deflections - Live Load Deflection = $L/240$ Total Load Deflection = $L/180$
- (c) Lateral System Deflections - Wind Load Deflection = $L/400$ and Seismic Load Deflection per ASCE 7, Section 12.12

8.8.3.4 Corrosion Control

- (a) Corrosion Inhibitor - Provide Calcium Nitrate corrosion inhibitor (DCI) per Manufacturer's requirements in all concrete surfaces exposed to deicing salts or salt water

8.8.3.5 Concrete Serviceability

- (a) Construction Joints and Control Joints - Provide construction joints and Control Joints to minimize the effect of shrinkage and drying cracks

8.8.3.6 Post Installed Anchors

- (a) The use of Adhesive Post Installed Anchors is prohibited in all applications.

8.9. STRAY CURRENT AND CORROSION CONTROL

8.9.1 Scope of Work

The Work consists of requirements to mitigate corrosion caused by contact with corrosive environments and the effects of stray current. The corrosion control and stray current mitigation design shall be coordinated, as necessary, with other design disciplines to produce a comprehensive and fully integrated design.

The requirements are separated into three areas: stray current mitigation; soil and water corrosion mitigation and atmospheric corrosion mitigation.

8.9.1.1 Stray Current Mitigation

Stray current mitigation design criteria shall apply to facilities and systems in order to mitigate the corrosive effects of stray current to a reasonably achievable level primarily by maintaining acceptable levels of track-to-earth voltage. Stray current mitigation shall be designed to reduce or limit the emissions of stray earth currents at the source, under normal operating conditions, and mitigating corresponding detrimental effects which may occur.

(a) Traction Power System

The traction power distribution system shall be designed as a dedicated system, providing traction power solely to the System. Shared use of traction power facilities is not permitted, except for common transit-related systems such as providing a power source and feeders for communications and train control.

(b) Traction Power Substations

All traction power stray current and corrosion control provisions shall be coordinated with the traction power design discipline.

The spacing between traction power substations shall be as shown in the traction power design to ensure that the track-to-earth voltage limits are not exceeded.

The traction power substations shall be designed with provisions for stray current collection and monitoring facilities. Each traction power substation shall be provided with equipment to allow the connection of the negative bus to a stray current drainage system or earth ground mat through a contactor and diode. The drainage contactors shall be installed in the negative drainage board portion of the negative return bus enclosure.

(c) Traction Power Positive Distribution System

The DC positive distribution system shall be designed in accordance with the provisions established in the overhead contact system (OCS) requirements. Stray current mitigation criteria related to the OCS system are:

- The OCS shall be double-isolated from supporting structures to limit current leakage to ground. The maximum current leakage to ground from the OCS shall not exceed 2.5 milliamperes per mile of single track OCS with 2,500 dc voltage applied between the OCS and ground.
- For locations other than at bridge structures, electrical grounds for adjacent OCS support poles shall not be interconnected to each other or to a common ground system. Separate ground rods and copper cable shall be provided for each OCS support pole. The purpose of the separate grounds is to minimize the possible transference of stray current from one portion of the transit system to another through an electrically continuous ground system. Steel reinforcement in concrete foundations should be made electrically continuous.
- For OCS poles located on aerial structures, electrical grounding shall be common either through existing structure grounds or by providing a common electrical grounding cable for interconnection of the pole grounds.
- For OCS bridge soffit supports (embedded and externally attached) under a bridge, provisions shall be made for galvanized catenary support channels, swivel pins and eyebolts. The supports shall be interconnected through an appropriately sized copper ground cable that extends to a grounding electrode. Any embedded portions of the OCS support hardware, concrete inserts, and studs shall be coated with an approved epoxy.

(d) Traction Power Negative Return System

The negative return system of the main line shall be electrically continuous. The magnitude of electrical isolation of the negative return system from ground shall be determined through track-to-earth resistance testing in accordance with ASTM G165. The minimum acceptable uniformly distributed as-constructed track-to-earth resistance, normalized to 1,000 track-feet (2 rails) is:

- At grade ballasted track with concrete or composite ties, 100 ohms;
- At grade ballasted track with wooden ties, 50 ohms;
- Aerial ballasted track with concrete or composite ties and electrical isolation membrane, 500 ohms; and
- Grade crossings and embedded track, 50 ohms.

Test facilities shall be provided, where necessary, to facilitate track-to-earth resistance testing and monitoring.

Where ballasted track construction is utilized, the minimum separation between the ballast and any part of the rail shall be 1 inch.

For embedded track construction, the minimum volume resistivity of electrical insulating materials shall be 1×10^{14} ohm-cm as measured in accordance with ASTM D257. The surface profile of the final grade shall be sloped away from the rail to allow for proper drainage and reduced accumulation of debris.

Rails at grade crossings shall be coated (except the rail head and gauge face) with an SSPC Paint 16 compliant epoxy coating. The coating shall extend a minimum of 12" beyond the limits of the grade

crossing. Track drains shall be provided near the ends of each grade crossing to aid in preventing debris build up and moisture retention.

All tracks shall be constructed with proper drainage to prevent water from contacting the rails or connected appurtenances under normal operating conditions.

The negative return system shall be constructed as electrically continuous circuits. Rail electrical continuity shall be accomplished through the use of continuously welded rail (CWR), rail-to-rail bonding (impedance bonds), track-to-track cross bonding, and bonding around all mechanical rail joints (except rail isolation joints) in special trackwork locations.

(e) Retaining Walls

Retaining walls constructed for the Project that are within 200' of the nearest rail and parallel to the track route shall be evaluated for the necessity of stray current control requirements. Retaining walls in excess of 100' in length and within 30' of the nearest rail and parallel to the track route shall require provisions for stray current control.

Cast-in-place reinforced concrete structures: Bare steel reinforcement shall be utilized in locations identified for stray current bonding of cast-in-place reinforced concrete structures. All longitudinal reinforcement in both faces shall be bonded for electrical continuity. The longitudinal reinforcement in the foundation top and bottom layers for retaining walls and abutments shall also be bonded for electrical continuity and bonded to the wall reinforcement. Stray current collector bars shall be installed at all physical breaks in the reinforcement such as expansion and contraction joints. A silver/silver chloride reference electrode shall be attached to the reinforcement and embedded in the concrete on each side of the discontinuity if the bonding cables are routed to a test station. Additional, intermediate collector bars are required at intervals not exceeding 500' along the structure and at each end of a structure. A minimum of two cables shall be connected to each collector bar and routed to a test station. A silver/silver chloride reference electrode shall be connected to the reinforcement and embedded in the concrete with wires routed to the test station.

Soldier Pile Retaining Walls with Reinforced Concrete Cap Beams: A minimum of one dedicated longitudinal reinforcing bar in the concrete cap beam shall be bonded(welded) to each soldier pile for electrical continuity of the soldier piles if the cap beam is not in contact with the soil. Lap splices in the designated longitudinal reinforcing bar shall be bonded(welded). For walls where the cap beam is in contact with the soil, all longitudinal reinforcing steel in each face of the cap beam shall be bonded for electrical continuity. Lap splices in the longitudinal reinforcing bar shall be bonded(welded). At approximate 250' intervals along the wall a physical break in the longitudinal reinforcement of the cap beam shall be installed (expansion joint type break). A collector bar assembly shall be installed on each side of the break when all longitudinal reinforcing steel is bonded for electrical continuity. Two cables shall be connected to the soldier piles on each side of the break and routed to a stray current control junction box. A copper/copper sulfate reference electrode shall be installed below the subgrade at each stray current control junction box.

Sheet Pile Retaining Walls with Reinforced Concrete Cap Beams: A minimum of one dedicated longitudinal reinforcing bar in the concrete cap beam shall be bonded(welded) to each sheet pile for electrical continuity of the sheet piles if the cap beam is not in contact with the soil. The

dedicated reinforcing bar may be welded to the headed studs or directly to the sheet pile. Lap splices in the designated longitudinal reinforcing bar shall be bonded(welded). For walls where the cap beam is in contact with the soil, all longitudinal reinforcing steel in each face of the cap beam shall be bonded for electrical continuity. Lap splices in the longitudinal reinforcing bar shall be bonded(welded). At each end of the sheet pile wall and intervals not exceeding 500' a stray current monitoring test station shall be installed. Two cables shall be exothermically welded to the sheet pile and terminated in the test station. In addition, one copper/copper sulfate reference electrode shall be installed below the subgrade on the train-side of the wall and the reference electrode test wire terminated in the test station. The test station shall be mounted on or against the sheet pile wall at a location conveniently accessible for testing and outside of the train envelope, if practical.

Mechanically Stabilized Earth Walls: Mechanically stabilized earth (MSE) walls constructed where the reinforcing elements do not extend beneath the track bed do not require bonding for stray current control. Non-metallic reinforcing strips shall be utilized where practical. Where metallic reinforcing strips are necessary, the reinforcing strips and anchors shall be fusion-bond epoxy or liquid epoxy coated and the reinforcements of adjacent modules shall not be electrically interconnected. Longitudinal reinforcing steel within precast concrete parapets and cast-in-place junction slabs shall not be made electrically continuous. MSE walls constructed where the reinforcing elements extend beneath the track bed require bonding for stray current control if metallic reinforcing strips are utilized. If metallic reinforcing strips are utilized they shall be electrically continuous for the length of the strip, no splicing is permitted. The reinforcing strips of adjacent modules shall be made electrically continuous through bonding along the soil-side face of the wall. At each end of the MSE wall and intervals not exceeding 500' a stray current monitoring test station shall be installed. Two cables shall be exothermically welded to the reinforcing strip bonding elements and terminated in the test station. In addition, one copper/copper sulfate reference electrode shall be installed below the subgrade on the train-side of the wall and the reference electrode test wire terminated in the test station. The test station shall be mounted on or against the sheet pile wall at a location conveniently accessible for testing and outside of the train envelope, if practical.

Soil Nail Walls: Soil nail walls constructed roughly parallel to and within 30' of the nearest electrified rail require stray current control provisions. The stray current control provisions include electrical isolation between the soil nail and the reinforcement of the wall so that electrical continuity between individual soil nails is avoided. The soil nails shall be installed in non-perforated corrugated HDPE sheaths.

(f) Viaduct

The viaduct for the System shall have a reinforced concrete deck with tie and ballast track construction. A heavy-duty electrical isolation membrane shall be spray applied to the deck within the ballasted area. Protection board shall be placed over the membrane. The membrane shall provide electrical isolation of the tracks from the concrete reinforcing steel and ground.

Electrical continuity bonding of steel reinforcement in the concrete viaduct deck is not necessary due to the electrical isolation membrane.

Track drainage shall be constructed of non-metallic materials if practical. If metallic materials are necessary, provision shall be included to electrically insulate (or provide physical gaps) in the drainpipe at 50' intervals and to electrically isolate the track drains from the deck reinforcement.

(g) Existing Rail Bridges

The Project shall include installing tie and ballast new tracks on existing steel girder superstructure rail bridges. Floor beam panels shall be non-metallic unless calculations demonstrate that metallic materials are necessary. The ballast pan shall be coated with a heavy-duty spray-applied electrical isolation membrane. Protection board shall be placed over the membrane. Track drainage shall be constructed of non-metallic materials if practical. If metallic materials are necessary, provision shall be included to electrically insulate (or provide physical gaps) in the drainpipe at 50 foot intervals and to electrically isolate the track drains from the deck reinforcement.

Testing facilities shall be included to provide a means to monitor stray current activity on the bridge superstructure.

(h) Existing Roadway Bridges

The track route crosses under several existing roadway bridges with concrete abutments and wing walls parallel to and near the tracks. It is impractical to retrofit existing reinforced concrete structures for stray current control due to the lack of reliable electrical continuity of the reinforcing steel.

All new construction cast-in-place reinforced abutments and wing walls for bridges crossing over the tracks shall be provided with provisions for stray current mitigation. The provisions shall include electrical continuity bonding of all horizontal reinforcement in both faces of the abutment, wing walls and footing. Vertical collector bars shall be welded to the horizontal reinforcement at a maximum spacing of 250' and at each end of the abutment. At each end of the abutment two test cables shall be exothermically welded to the collector bar and routed to a test station embedded in or mounted on the face of the abutment at a height convenient for testing. The two test cables shall be terminated on a non-conductive panel.

In addition to the electrical continuity bonding, the face of the abutment adjacent to the tracks shall be coated with a dielectric coating that extends 12" above final grade.

(i) Station Structures

The Project includes grade level and elevated station structures. Stray current control requirements for grade level stations shall consist of, at a minimum, electrical continuity bonding and testing facilities. Dielectric coatings, if utilized shall extend a 12" above final grade.

Elevated stations shall be evaluated on an individual basis to determine the provisions necessary for stray current mitigation.

(j) Underground Reinforced Concrete and Metallic Utilities

At a minimum, all underground Utilities installed under the Project shall follow the requirements of the MBTA Railroad Operations Directorate – Pipeline Occupancy Specifications. MBTA-owned

underground reinforced concrete and metallic Utilities require provisions for stray current mitigation.

Prestressed concrete cylinder pipe shall not be installed in the vicinity of the tracks or traction power substations without a request submitted on a case-by-case basis and approved by the MBTA. The request shall demonstrate that the installation of other pipe materials is impractical based on engineering calculations.

The design of prestressed concrete cylinder pipe, if approved, shall include the following minimum provisions:

- Electrical continuity between the prestressed wires and steel cylinder;
- Each pipe joint shall be provided with electrical continuity bonding plates on each end. The number of bonding plates required shall be determined on an individual basis;
- Electrical isolation devices/fittings for electrical isolation of the pipe from interconnecting pipelines, other structures, and for segregation into discreet electrically isolated sections, depending upon the total length and orientation of the pipeline;
- Testing facilities to allow for the verification of electrical continuity and effectiveness of electrical isolation devices. Test facilities shall be located at all electrical isolation devices and at intermediate locations determined on an individual basis; and
- External coating with a dielectric coating material.

Reinforced concrete non-pressure piping does not require electrical continuity of the reinforcing steel or bonding of the pipe joints. Reinforced concrete non-pressure pipe and associated manholes shall be coated on the external surface with a dielectric coating.

The minimum stray current mitigation provisions for underground metallic Utilities include:

- Electrical continuity through welded or bonded pipe joints;
- Electrical isolation from interconnecting non-MBTA Utilities;
- Electrical isolation from grounded piping within structures;
- Installation of testing facilities at all electrical isolation locations and intermediate locations determined on a case-by-case basis; and
- Protective coatings and cathodic protection requirements will be determined on a case-by-case basis.

All Utilities that cross under the tracks should cross as close to perpendicular to the tracks as practical. Pipelines transporting flammable or hazardous materials shall be installed in casings that extend across the entire track right-of-way when crossing the tracks. Exterior protective coatings and cathodic protection shall be applied to all pipelines transporting flammable or hazardous materials.

(k) Facilities Owned by Others

Stray current and corrosion control requirements for existing Utilities and structures or Utilities and structures installed and/or relocated or modified by the Utility or structure owner as part of this Project shall be the responsibility of the Utility or structure owner unless otherwise stipulated in an Agreement between the owner and the MBTA. Minimum stray current and corrosion control requirements, when guidance is requested by the Utility or structure owner shall be in accordance with the Technical Provisions for MBTA-owned structures and Utilities. Maintenance and monitoring of test facilities installed on facilities owned by others is the responsibility of the facility owner unless stipulated otherwise in an Agreement between the owner and the MBTA.

8.9.1.2 Soil and Water Corrosion

The corrosion mitigation design shall be coordinated with the stray current mitigation design in order to identify proper placement of test facilities so that evaluation of the soil/water and stray current mitigation effectiveness can be achieved, while minimizing the number of test facilities required. Corrosion mitigation designs that include the installation of cathodic protection shall be coordinated with owners of adjacent underground structures through a corrosion coordinating committee to ensure stray current interference is minimized or avoided.

Corrosion mitigation is required for all structures where failure of such structures caused by corrosion may affect safety or interrupt continuity of operations.

Piping (pressure and non-pressure) and conduit shall be non-metallic unless metallic materials are required for specific engineering purposes. Use of metallic materials shall be supported by engineering calculations when used in lieu of non-metallic materials.

Aluminum and aluminum alloys shall not be used for direct burial purposes.

(a) Electrical Isolation of Piping

Electrical isolation of cathodically protected pipelines shall be in accordance with NACE International SP0286. Devices used for electrical isolators for corrosion control shall include nonmetallic inserts, isolating flanges, couplings, unions, and/or concentric support spacers. Devices shall meet the following criteria:

- Following insertion of the isolation into the operating piping system, the isolation shall have sufficient electrical resistance so that no more than 2% of a test current applied across the device shall flow through the isolator and through any conductive fluids, if present;
- Mechanical and temperature ratings equivalent to the structure in which they are installed;
- Where isolating devices are used in metallic pipelines, internal polyamide epoxy coating shall be applied on each side of the isolator for a distance equal to two times the pipe diameter on which they are used. Where conductive fluids with a resistivity of less than 2,000 Ω -cm are present, internal coating requirements shall be based on separate evaluation determining need for additional coating. All internal coatings utilized for pipelines that transport potable water shall satisfy the requirements of NSF-61;

- Non-metallic, concentric support spacers and watertight end seals shall be used where the piping is routed through a metallic casing. An isolated connection shall be provided at all tie-ins to non-protected facilities;
- Isolating devices for metallic pipelines (except non-metallic units) installed in hand hole, vault or chambers or otherwise exposed to partial immersion or high humidity shall have an AWWA C217 compliant protective coating applied over all components;
- Design shall specify the need for, and location of, isolating devices. Inaccessible isolating devices, such as buried or elevated isolators, shall be equipped with accessible permanent test facilities. The test facilities shall include, as a minimum, 2 isolated and tagged test leads connected to each side of the isolating device and terminated at a test station; and
- A minimum clearance of 12" shall be provided between new and existing metallic structures.
- When conditions do not allow 12" of clearance, the design shall include one of the following special provisions to prevent electrical contact between the existing structure(s):
 - Installation of a high density polyethylene sheet between the structures.
 - Installation of a pre-formed, correctly sized, reinforced fiberglass pipe saddle around the appropriate pipe where it crosses the existing structures.

(b) Electrical Continuity of Piping

Electrical continuity shall be provided for all pressurized non-welded metallic pipe joints and shall meet the following criteria:

- Electrical continuity shall be achieved by directly buried, isolated, stranded copper wire with the minimum length necessary to span the joint being bonded. Wires shall be rated at 600 V with HMWPE isolation;
- To minimize current attenuation in cathodic protection installations, wire size shall be based on the electrical characteristics of the structure and resulting electrical network;
- A minimum of two wires shall be used per joint for redundancy. The bonding wires shall be installed using the thermite welding method; and
- Exothermic welds and adjacent bare piping shall be coated with a coal tar epoxy coating after the welding.

The measured resistance of the bonded pipeline shall not exceed 110% of the theoretical resistance of the pipeline and bond cables.

(c) Cathodic Protection

Cathodic protection systems for buried metallic structures shall be used where soil conditions indicate that corrosion may reduce the service life of the facility below the design requirements consistent with the structure life objectives. The presence of stray currents and regulations may also require the design and installation of cathodic protection for underground metallic structures. Design of cathodic protection shall be performed by a registered professional corrosion engineer, a NACE International Corrosion Specialist or a NACE International Cathodic Protection Specialist.

Cathodic protection design shall be in accordance with NACE International SP0169. Testing of cathodic protection systems for compliance with NACE SP0169 shall be performed in accordance with NACE TM0497.

Galvanic cathodic protection shall be used wherever feasible to minimize interference with other underground metallic utilities. When galvanic cathodic protection is used for new facilities, the facilities shall be provided with a compatible coating system. All galvanic anodes shall be connected to the structure via test stations.

Impressed current systems shall be used only when the use of galvanic systems is not technically and/or economically feasible. The systems shall utilize separate and isolated anode beds. Cathodic protection schemes that require connection to the transit system's negative return system, in lieu of using a separate isolated anode bed, shall not be permitted.

The cathodic protection system design shall be based on theoretical calculations that result in a minimum design life of 30 years.

Impressed current systems shall be designed using constant output voltage rectifiers or automatic potentially controlled rectifier units, with permanent reference electrode facilities. Rectifiers shall be rated at a minimum of 50% above calculated operating levels to overcome a higher-than-anticipated anode bed resistance, lower-than-anticipated coating resistance, or the presence of interference mitigation bonds. Other conditions which may result in increased voltage and current requirements shall be considered.

Cathodic protection designs shall include test facilities that permit initial and periodic testing of cathodic protection levels, structure-to-electrolyte potentials, interference currents and system components (such as anodes, isolating devices and continuity bonds). The number, type and spacing of the test facilities shall be sufficient to determine the adequacy of cathodic protection, electrical continuity and electrical isolation.

(d) Ferrous Pressure Piping

All new buried cast iron, ductile iron and steel pressure piping shall be made electrically continuous and cathodically protected on an individual structure basis.

For pressure piping entering MBTA facilities below grade, electrically isolate pipe immediately inside of the wall penetration. For pressure piping entering MBTA facilities above grade, electrically isolate pipe immediately outside of the wall penetration. Pipe penetrations through the walls and floors shall be electrically isolated from building structural elements.

Piping encased in concrete, including thrust blocks, shall be provided with a coating material that extends a minimum of 6" beyond the concrete-to-soil interface.

(e) Copper Piping

Buried copper pipe shall be electrically isolated from non-buried piping, such as that contained in a station structure, through use of an accessible isolating union installed where the piping enters through a wall or floor. The necessity for cathodic protection of copper piping shall be determined

on an individual basis. Cathodically protected copper pipe shall be provided with a polyethylene-backed butyl rubber tape protective coating system compliant with AWWA C209.

Pipe penetrations through the walls and floors shall be electrically isolated from building structural elements. The isolator should be located inside the structure and not buried where practical.

Copper water service lines shall be electrically isolated from ductile iron mains utilizing isolating corporation stops.

(f) Gravity Flow Piping (Non-Pressure)

Corrugated steel piping shall be internally and externally coated with a sacrificial metallic coating and a protective organic coating.

Cast or ductile iron non-pressure piping shall be designed and fabricated to include the following provisions:

- An internal AWWA C104 compliant mortar lining with a bituminous coating on ductile iron pipe only and shall not be required for cast iron soil pipes; and
- A bituminous mastic coating on the external surfaces of pipe 6" on each side of a concrete/soil interface.

Evaluation of the need for electrical continuity, electrical isolation and cathodic protection shall be conducted on an individual basis.

Reinforced concrete non-pressure piping shall include the following provisions:

- Chloride ion concentration shall not exceed 150 ppm in the total concrete mix of mixing water, cement, admixture and aggregates;
- Pipe design shall be in accordance with ASTM C76; and
- Concrete used in the manufacture of this pipe shall be in accordance with ACI 201.2R and ASTM C150.

(g) Buried Concrete/Reinforced Concrete Structures

The design of cast-in-place concrete structures, precast utility structures or other precast structures shall be based on the following criteria:

- The type of cement utilized shall be based on the anticipated exposure conditions in accordance with ACI 201.2R and ASTM C150. ASTM C452 shall be used as criteria for evaluation of the sulfate resistance of concrete mixes with non-standard cement types;
- Concrete to be in contact with soil or groundwater shall have a water/cement ratio not greater than 0.45. Refer to applicable sections of ACI 201.2R;
- The concrete mix should be such that the water soluble and acid soluble chloride concentrations, at the concrete/reinforcing steel interface, do not exceed the values stated in ACI 222R for reinforced concrete in wet conditions;

- Concrete cover shall be a minimum of 2" of cover on the soil/rock side of reinforcement when pouring within a form and a minimum of 3" of cover when pouring directly against soil/rock or excavation support systems;
- Epoxy coated reinforcing steel is approved for use in structures that do not require electrical continuity bonding of the reinforcement for stray current mitigation purposes; and
- The need for additional measures, as a result of localized special conditions, shall be determined on an individual basis. Additional measures may include application of sealers, corrosion inhibitors and protective coating to concrete and reinforcing steel.

Precast standardized facilities, such as manholes, vaults and pull boxes shall meet the requirements specified in this section or shall be reviewed on an individual basis to determine alternative criteria when they cannot be practically modified to meet some or all of the provisions specified.

Below grade shotcrete used for permanent support shall be in accordance with ACI 506.2 and applicable provisions specified in this section. In the case of conflicting specifications, the more rigid or conservative specification shall be applicable. No special corrosion control measures are required for shotcrete applications, which are not used for permanent support.

(h) Reinforced Concrete Retaining Walls

Cast-in-place concrete retaining walls shall be in accordance with the requirements in Buried Concrete/Reinforced Concrete Structures.

Mechanically stabilized earth (MSE) retaining walls that do not require stray current mitigation provisions in accordance with Retaining Walls shall meet the requirements in Buried Concrete/Reinforced Concrete Structures, and the following provisions:

- Steel reinforcement and embedded tie strip anchors shall be constructed without special provisions for establishing electrical continuity;
- Steel reinforcement of adjacent modules shall not be electrically interconnected. The reinforcing strips shall be coated with a fluidized-bed epoxy resin system or liquid 100% epoxy system;
- Tie strips shall be coated with a fluidized-bed epoxy resin system or coal-tar epoxy system prior to module construction; and
- Longitudinal reinforcing steel within precast concrete parapets and cast-in-place junction slabs shall not be made electrically continuous.

(i) Support Pilings

The following is applicable only to support piling systems which are to provide permanent support. Pilings used for temporary support do not require corrosion control provisions.

Designs based on the use of metallic supports exposed to the environment shall be designed to meet the following minimum criteria. The minimum requirements listed shall be coordinated with the structural design discipline. The minimum corrosion control specification may not be appropriate in all conditions.

- Application of a barrier coating to the pile from 1' above the surface to a minimum of 5' below the expected low groundwater level. The barrier coating shall be applied to all exposed surfaces including splices; and
- Inclusion of a corrosion allowance in the wall thickness to the structural requirements for the pile. A minimum of 0.125" shall be included for each face or surface contacting the soil environment from the surface to a minimum of 5' below the expected low groundwater level.

~~The interior of open ended pipe piles shall be considered exposed to the soil environment and provided with a corrosion allowance of a minimum 0.125".~~ The interior of closed end pipe piles shall be considered as a surface contacting the soils unless filled with a cementitious mortar. [Click here to View RFI #34](#)

The need for special measures, such as electrical isolation measures, electrical continuity, monitoring devices and cathodic protection, shall be determined on an individual basis, based on type of structure, analysis of soil borings for corrosive characteristics and the degree of anticipated structural deterioration caused by corrosion.

Reinforced concrete piling, including fabrications with prestressed members, shall be designed to meet the requirements in Buried Concrete/Reinforced Concrete Structures.

Concrete-filled steel cylinder columns, where the steel is an integral part of the load bearing characteristics of the support structure, shall be designed considering the need for special measures, such as increased cylinder wall thickness, external coating system, stray current mitigation and/or cathodic protection. The design shall be determined on an individual basis, based on type of structure, analysis of soil borings for corrosive characteristics and the degree of anticipated structural deterioration caused by corrosion. Chloride restrictions for the concrete fill shall be in accordance with ACI 222R.

(j) Electrical Conduits

Galvanized steel conduits shall have the following minimum provisions:

- Direct burial conduit shall be coated with PVC or other accepted coating system regularly in use for direct burial;
- Conduit within duct banks shall have a minimum of 3" of concrete cover on soil sides. Coating shall not be required when conduits are installed in concrete;
- Coating shall be provided for conduits installed above grade, in a corrosive atmosphere, and in wet atmospheres. Coating shall be of a type suitable for exposure to wet and corrosive atmospheres; and
- All couplings and fittings shall be coated with the identical coating materials used for the conduit lengths.

Electrical continuity shall be established throughout the conduit using standard threaded joints or by installing bond wires across the conduit joints.

Buried non-metallic conduits shall be encased in concrete including couplings and fittings except at transitions where metallic materials are required such as at stub-ups and penetrations.

(k) Casings

Pipeline casings, if required, shall be installed bare, unless coating and cathodic protection is required by the owner. Casing isolators and spacers shall be installed on the carrier pipe to avoid electrical contact between the casing and the carrier pipe. Test facilities shall be provided at each end of the casing to allow testing of the status of electrical isolation between the casing and carrier pipe. The test stations shall contain at a minimum:

- Two test wires connected to the carrier pipe;
- Two test wires connected to the casing;
- A test wire to a reference electrode located adjacent to the carrier pipe near the end of the casing; and
- A terminal board for and enclosure to house the test wires located in a location easily accessible for testing.

8.9.1.3 Atmospheric Corrosion

Designs shall ensure the required service life of a particular facility is not compromised because of corrosion-related problems or failures due to exposure to the atmosphere or ice melting chemicals. Structures and systems shall be protected against atmospheric conditions, meteorological conditions, air pollutants and ice melting chemicals by proper material selection, the use of coatings and sealants in order to maintain necessary function and appearance of transit system structures exposed to the environment.

The evaluation of the atmosphere corrosivity shall be performed in accordance with ISO 9223.

(a) Steels and Ferrous Alloys

Carbon steel, ductile, and cast iron exposed to the atmosphere, except for track and track fasteners, such as spring clips, spikes and rail plates, shall have a barrier or sacrificial coating applied to all external surfaces. Barrier coatings may be appropriate for track fastening hardware in locations subject to ice melting chemicals. High strength, low alloy steels shall be protected similarly to carbon steels except where used as a weathering steel exposed to the outside environment. The design shall incorporate complete drainage of all surfaces, coating of metal-to-metal contacting surfaces, and sealing of crevices. The potential staining of adjacent structures shall be considered.

Stainless steel surfaces shall be cleaned and passivated after fabrication. Series 200 and 300 stainless steels are suitable for use in most exposed situations without further protection, with Type 316 being preferred for its superior corrosion resistance. Series 400 stainless steel can also be used, but might exhibit staining. A barrier coating should be used on stainless steel exposed to roadway deicing salts and certain marine environments. All hardware used to couple or connect shall be the same stainless series.

(b) Aluminum Alloys

All aluminum alloys shall receive a sealed, hard anodized finish to provide the best weather-resistant surface. A barrier coating should be used on aluminum exposed to roadway deicing salts or other atmospheric corrosive pollutants.

(c) Copper Alloys

Copper and its alloys can be used where equipment is exposed to weather without additional protection. A coating shall be utilized only where a natural patina is not desired. Bimetallic couplings shall be prohibited.

(d) Magnesium Alloys

Magnesium alloys shall have a barrier coating applied when long-term appearance is critical. Bimetallic coupling shall be prohibited.

(e) Zinc Alloys

Zinc alloys can be used without additional protection. A shop-applied barrier coating may be utilized to extend the design life of components or to enhance component appearance. Bimetallic coupling shall be prohibited unless the intent of the coupling is for sacrificial protection by the zinc alloy.

(f) Coatings

Coatings shall have established performance records for the intended service and be compatible with the base metal to which they are applied. Coatings shall be able to demonstrate satisfactory gloss retention, color retention and resistance to chalking over their minimum life expectancies. Coatings shall have a minimum life expectancy of 15 years, defined as the time prior to major maintenance or reapplication.

Metallic-Sacrificial Coatings

Acceptable coatings for carbon and alloy steels are as follows:

- Zinc (hot-dip galvanizing [2 ounces per square foot (oz/ft²)] or flame sprayed);
- Aluminum (hot-dip galvanizing [2 mil thickness] or flame sprayed);
- Flame sprayed aluminum-zinc alloy;
- Cadmium and electroplated zinc (for fastening hardware located in sheltered areas only); and
- Inorganic zinc (used as a primer).

Organic Coatings

Organic coating systems typically consist of a wash primer (for galvanized and aluminum substrates only), a primer, intermediate coat(s) and a finish coat. Acceptable organic coatings, for exposure to the atmosphere, include, but may not be limited to:

- Aliphatic polyurethanes
- Vinyl copolymers
- Fusion-bonded epoxy polyesters, polyethylenes, and nylons
- Acrylics
- Alkyds
- Epoxy
- Organic zinc-rich epoxy (used as a primer)

Conversion Coatings

Conversion coatings, such as phosphate and chromate coatings, shall be used as pretreatment only for further application of organic coatings.

Ceramic-Metallic Coatings (Cermets)

Ceramic-metallic coatings are acceptable for use on metal panels and fastening hardware.

Graffiti-Resistant Coatings

Surfaces which are accessible to graffiti shall be protected with a graffiti-resistant coating. This includes concrete and painted steel surfaces within stations, such as walls, columns and equipment enclosures. Such areas shall be protected up to a minimum height of 10'. The coating shall be a urethane-type coating and shall be applied in accordance with the manufacturer's latest published instructions.

Sealants

All crevices shall be sealed with a polysulfide, polyurethane or silicone sealant.

(g) Corrosion Control Surveys

Baseline Corrosion Control Survey

A baseline corrosion control survey shall be performed to evaluate the corrosive tendencies of the soil and atmosphere along the proposed route. Soil sample collection and testing should be coordinated with the requirements of Volume 2, Section 15 Geotechnical to minimize costs to the Project. Collect soil samples at depths of 5, 10 and 15'. The testing shall include on-site measurement of soil temperature, pH and oxidation-reduction potential. Laboratory testing shall include measurement of soil resistivity/conductivity, determination of the presence of sulfides if the oxidation-reduction potential measured was less than 100 millivolts and the measurement of anions and cations if the soil resistivity measured is less than 5000 ohm-cm. Testing results from the soil borings should be supplemented where necessary with measurement of soil resistivity from grade utilizing the Wenner 4-Electrode testing method. Upon completion of the testing and analysis of the data prepare and submit a Baseline Corrosion Control Survey Report. The Baseline Corrosion Control Survey Report shall also include the results of the atmospheric corrosivity evaluation.

The baseline corrosion control survey information shall be utilized for determining the appropriate corrosion control measures for atmospherically exposed structures and underground metallic and reinforced concrete structures.

(h) Pre-Revenue Stray Current Survey

A stray current survey shall be planned and executed after construction of the Project is completed and prior to energization of the traction power system. A detailed survey plan shall be prepared and submitted to MBTA for review and acceptance prior to execution of the survey. The plan shall include a list of all test points that will be included in the survey, testing procedures that will be utilized, testing equipment required for the survey, parties that will participate in the survey, criteria that will be utilized to evaluate the survey data, and a proposed survey schedule. The survey shall be coordinated with local utility companies. The purpose of the survey is to document the baseline stray current activity on the Project structures and adjacent underground utilities prior to energizing the traction power system. The survey results shall be utilized for comparison with subsequent surveys to evaluate the level of stray current activity that can be attributed to the System.

(i) Post-Revenue Stray Current Survey

A stray current survey shall be planned and executed after full revenue service is established on each branch and prior to Milestone 2. A detailed survey plan shall be prepared and submitted to MBTA for review and acceptance prior to execution of the survey. The plan shall include a list of all test points that will be included in the survey, testing procedures that will be utilized, testing equipment required for the survey, parties that will participate in the survey, criteria that will be utilized to evaluate the survey data and a proposed survey schedule. The survey shall be coordinated with local utility companies. At a minimum, the same test points utilized for the pre-revenue survey shall be included in the post-revenue survey. The data shall be evaluated to determine the level of stray current activity attributed to the System and to identify all locations requiring stray current mitigation as a result of the System stray current activity.

8.9.2 Codes, Standards and Manuals include

- American Association of State Highway and Transportation Officials, HB 17, Standard Specification for Highway Bridges
- ASTM International A48, Standard Specification for Gray Iron Castings
- ASTM International B843, Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
- ASTM International C150, Standard Specification for Portland Cement
- ASTM International C452, Standard Test Method for Potential Expansion of Portland-Cement Mortars Exposed To Sulfate
- ASTM International D257, Standard Test Methods for DC Resistance or Conductance of Insulating Materials
- ASTM International D512, Standard Test Methods for Chloride Ion in Water
- ASTM International D513, Standard Test Methods for Total and Dissolved Carbon Dioxide in

Water

- ASTM International D1293, Standard Test Methods for pH of Water
- ASTM International D1452, Standard Practice for Soil Exploration and Sampling by Auger Borings
- ASTM International D1498, Standard Test Method for Oxidation-Reduction Potential of Water
- ASTM International D2000, Standard Classification System for Rubber Products in Automotive Applications
- ASTM International D4220, Standard Practices for Preserving and Transporting Soil Samples
- ASTM International D4327, Standard Test Method for Anions in Water by Suppressed Ion Chromatography
- ASTM International D4658, Standard Test Method for Sulfide Ion in Water
- ASTM International G51, Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
- ASTM International G57, Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
- ASTM International G165, Standard Practice for Determining Rail-to-Earth Resistance
- ASTM International – NACE International G193, Joint Standard, Standard Terminology and Acronyms Related to Corrosion
- ASTM International G200, Standard Test Method for Measurement of Oxidation-Reduction Potential (ORP) of Soil
- American Petroleum Institute 5L, Specification for Line Pipe
- American Water Works Association C104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
- American Water Works Association C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- American Water Works Association C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- American Water Works Association C210, Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
- American Water Works Association C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
- American Water Works Association C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe
- American Water Works Association C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. (100 mm Through 300 mm) for Water Transmission and Distribution
- Institute of Electrical and Electronics Engineers (IEEE), IEEE C2, National Electrical Safety Code (NESC)

- International Organization for Standardization, ISO 9223, Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation
- NACE International – The Society for Protective Coatings, NACE No. 2/SSPC-SP10, Joint Surface Preparation Standard, Near-White Metal Blast Cleaning
- NACE International – The Society for Protective Coatings, NACE No. 3/SSPC-SP6, Joint Surface Preparation Standard, Commercial Blast Cleaning
- NACE International, SP0169, Standard Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- NACE International, SP0177, Standard Practice, Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
- NACE International SP0188, Standard Practice, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
- NACE International SP0274, Standard Practice, High-Voltage Electrical Inspection of Pipeline Coatings
- NACE International SP0286, Standard Practice, Electrical Isolation of Cathodically Protected Pipelines
- NACE International TM0497, Standard Test Method, Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems
- National Electrical Manufacturers Association, 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- NSF International/American National Standard Institute NSF/ANSI 61, Drinking Water System Components – Health Effects
- The Society for Protective Coatings, Paint 16, Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
- The Society for Protective Coatings, Paint 33, Coal Tar Mastic, Cold Applied
- Transit Cooperative Research Program, Report 155, Track Design Handbook for Light Rail Transit, Second Edition
- Underwriters Laboratories 508A, Standard for Industrial Control Panel

8.9.3 The Project Specific Requirements

ISSUE	REQUIREMENT
Track-to-Earth Resistance	At grade ballasted track with concrete or composite ties, 100 ohms; At grade ballasted track with wooden ties, 50 ohms; Aerial ballasted track with concrete or composite ties and electrical isolation membrane, 500 ohms; Grade crossings and embedded track, 50 ohms. Requirement is for as-constructed track-to-earth resistance normalized to 1,000 track feet.
Bonded Joint Pipeline Electrical Continuity	Field measured resistance maximum of 110% of theoretical resistance.
Bonded Concrete Reinforcing Steel Electrical Continuity	Field measured resistance maximum of 120% of theoretical resistance.
Rails at Grade Crossings	Rails at grade crossings shall be coated with an SSPC Paint 16 compliant epoxy coating. The coating shall extend a minimum of 12" beyond the limits of the crossing.
Retaining Walls	Retaining walls constructed for the Project that are within 200' of the nearest rail and parallel to the track route shall be evaluated for the necessity of stray current control requirements. Retaining walls in excess of 100' in length and within 30' of the nearest rail and parallel to the track route shall require provisions for stray current control.
Cathodic Protection	Cathodic protection systems shall have a minimum 30 year design life.
Track Drainage	Metallic track drainage pipes on the Viaduct and other structures utilizing a dielectric membrane for stray current control shall be electrically segregated/insulated in intervals not exceeding 50'. Minimize exposure of metallic drainage pipe to stray current.
Baseline Corrosion Control Survey	Soil corrosivity testing of geotechnical boring samples from depths of 5, 10, and 15' supplemented with Wenner 4-Electrode testing from grade where necessary. Also, evaluate atmospheric corrosivity in accordance with ISO 9223.
Pre-Revenue Stray Current Survey	Plan and execute a pre-revenue stray current survey. Document existing stray current activity prior to energizing the System.

ISSUE	REQUIREMENT
Post-Revenue Stray Current Survey	Plan and execute a post-revenue stray current survey. Compare the data with the pre-revenue survey to document the level of stray current activity attributable to the Green Line Extension and to identify any stray current interference that requires mitigation.

9.1 ROADWAYS AND INTERSECTIONS

9.1.1 Scope of Work

The roadway and intersection Work includes roadway and intersection improvements to accommodate and interface with the Project infrastructure.

The Work includes sidewalk replacement, curb cuts, wheelchair ramps, granite curbing, asphalt pavement, Portland cement concrete curbs and gutters, backfill, signage, striping, Utility Relocation, full depth and micro milling and overlay pavement, maintenance of traffic and temporary traffic staging as required in the Environmental Assessment and as otherwise required as a result of the Work.

9.1.2 Codes, Standards and Manuals include:

- MassHighway Project Development and Design Guide
- MassHighway Department of Conservation and Recreation Historic Parkway Preservation Treatment Guidelines (for parkways only)
- MassHighway Bridge Manual
- Massachusetts 250 Code of Massachusetts Regulations (CMR) 6.00 Procedural and Technical Standards for the Practice of Land Surveying
- Minimum Standard Detail Requirements for American Land Title Association (ALTA)/ American Congress on Surveying and Mapping ACSM Land Title Surveys
- United States National Map Accuracy Standards
- MassHighway Construction and Traffic Standard Details
- MassHighway Standard Specifications for Highways and Bridges
- MassHighway Storm Water Handbook for Highways and Bridges
- MassHighway Building Better Bicycling Manual
- MassHighway Standard Traffic Management Plans
- MassHighway Standard Drawings for Traffic Signals and Highway Lighting
- Massachusetts Amendments to the Manual on Uniform Traffic Control Devices (MUTCD) and the Standard Municipal Traffic Code
- Massachusetts State Building Code (MSBC)
- National Fire Protection Agency 502 Manual
- MassHighway Engineering Directives
- MassHighway Policy Directives
- MassDOT Highway Division Engineering Directives
- MassDOT Highway Division Policy Directives

- Federal Highway Administration (FHA)
- Federal Transit Administration (FTA)
- American Association of State Highway and Transportation Officials (AASHTO)
- Transportation Research Board
- United States Access Board
- Massachusetts Architectural Access Board (MAAB)
- American Nursery and Landscape Association
- American Railway Engineering and Maintenance-of-Way Association
- American Society of Testing Materials (ASTM) International
- City of Cambridge Standards, City of Somerville Standards, and City of Medford Standards

9.1.3 The Project Specific Requirements

Coordinate with all private developers to ensure the Work matches elevations of adjacent private properties and adjoining infrastructure. Obtain all required agreements and exemptions necessary to complete the design and construction of the Project.

9.1.3.1 Maintenance of Traffic

Work shall include traffic staging and detours necessary to ensure proper maintenance of traffic. Traffic maintenance shall be coordinated with, and subject to approval by, local authorities.

9.1.3.2 City of Somerville Intersections

Coordinate all changes with MassDOT and the City of Somerville to complete the Work including bridge, roadway, station and TPSS Work required under Exhibit 2F. The Limits of Works under such Exhibit 2F, with respect to the City of Somerville and MassDOT, shall meet existing conditions and be coordinated with MassDOT and the City of Somerville.

(a) Washington Street

Provide at a minimum four 10'-6" lanes and minimum 1' curb and gutters with one sidewalk on the north side and one MassDOT standard shared use path on the south side of Washington Street underneath the rail bridge. Replace all cheek walls. Complete all Work as shown within DB Entity minimum limits of work in Exhibit 2F. Clearances, widths of sidewalks and paths shall comply with MassDOT and City of Somerville requirements.

(b) Broadway and Boston Avenue

Provide at a minimum two 12' lanes, two 5' bike paths, and two minimum 6' sidewalks. Complete all additional Work as shown within DB Entity minimum limits of work in Exhibit 2F. Clearances, widths of sidewalks and paths shall comply with MassDOT and City of Somerville requirements. The station entrance from the Broadway & Boston Avenue intersection shall be from Boston Avenue. Refer to Exhibit 2F, Section 12, and Section 8.

9.1.3.3 City of Medford Intersections

Coordinate all changes with MassDOT and the City of Medford to complete the Work including the bridge, roadway, station and TPSS Work as required. Refer to [Section 9.3](#) for the traffic signal Work to be accomplished at the intersections in the City of Medford.

(a) Broadway & Dexter Street (Magoun Square)

There are no roadway items required at this intersection. Refer to [Section 9.3](#) for traffic signal Work requirements.

(b) Broadway & Powder House Boulevard

There are no roadway items required at this intersection Refer to [Section 9.3](#) for traffic signal Work requirements.

(c) College Avenue & Boston Avenue

Modify the intersection and approaching roadway to transition to match the lane widths, provided on the bridge plan, and required transitions to meet MassDOT standard roadway requirements. Refer to [Section 8.4](#) for roadway bridge requirements.

Modify and relocate one (1) pedestrian signal and all associated utilities as required.

Relocate existing utility poles and associated utilities as required.

Intersection improvement Work shall include:

(i) Milling and Overlay

Mill and overlay the College Avenue bridge from the right turn lane to the College Ave and Boston Ave intersection (including the extents of the required work).

(ii) Full Depth Pavement

Provide full depth pavement for the widened College Avenue Bridge to provide additional travel lanes on College Avenue. Additionally, provide full depth reconstruction on Boston Avenue at the proposed MBTA accessible drop off location.

(iii) Granite Curb

Install granite curb on the east side of Boston Avenue and on both sides of College Avenue within the Project limits. This Work shall include removal of existing curb and installation of proposed granite curb.

(iv) Sign Assemblies

Install required signs and supports.

(v) Sidewalk

Install sidewalk adjacent to the wheelchair ramp locations for the extent of the ramps to the sidewalk tie in on College Avenue and Boston Avenue. The proposed sidewalks shall also be installed and tie-in to existing sidewalks on the northeast side of College Avenue and northeast side of Boston Avenue as part of the Project.

(vi) Wheel Chair Ramps

Install one wheelchair ramp to cross Boston Avenue and one wheelchair ramp to cross College Avenue at this intersection.

(vii) Cross Walk and Roadway Striping

Provide all pavement markings including lane lines, extension lines, center lines, edge lines, stop lines, and crosswalks along Boston Avenue and College Avenue as required by the Work.

(d) Boston Avenue & Winthrop Street

Intersection improvements shall include:

(i) Sign Assemblies

Install required signs and sign supports.

(ii) Cross Walk and Roadway Striping

Remove existing striping and install proposed pavement markings, including lane lines, center lines, edge lines, stop lines, crosswalks and pavement marking arrows along Boston Avenue and Winthrop Street.

(e) Boston Avenue & North Street

There are no roadway items required at this intersection. Refer to [Section 9.3](#) for traffic signal Work requirements.

(f) College Avenue & George Street

Intersection improvements shall include:

(i) Granite Curb

Install granite curb at locations where sidewalk and wheelchair ramps are installed as part of the Project. This Work shall include removal of existing curb and installation of granite curb.

(ii) Sidewalk

Install sidewalk adjacent to the wheelchair ramp locations for sidewalk tie-in at each corner of this intersection.

(iii) Wheel Chair Ramps

Install two wheelchair ramps to cross College Avenue on the south side and two wheelchair ramps to cross College Avenue on the north side. Install two wheelchair ramps to cross George Street on the east side and two wheelchair ramps to cross George Street on the west side of this intersection.

(iv) Cross Walk Striping

Remove existing crosswalk striping and realign proposed crosswalks to match the location of the new wheelchair ramp locations at this intersection.

(g) Mystic Avenue & Main Street / Mystic Valley

Intersection improvements shall include:

(i) Crosswalks

Remove existing crosswalks and install crosswalks at the following locations:

- The junction of Mystic Avenue and Main Street
Crosswalks shall be installed on the south leg to cross Mystic Avenue.
- The intersection of Emerson Street and Mystic Avenue
Crosswalks shall be installed on the north leg up to the median to cross Mystic Avenue.
- The intersection of Mystic Avenue and Route 16 eastbound ramps
Crosswalks shall be installed on the south leg to cross Mystic Avenue and on the east and west legs to cross Route 16 eastbound on ramp and off ramp respectively.
- The intersection of Mystic Avenue and Route 16 westbound ramps
Crosswalks shall be installed on the east and west legs to cross Route 16 westbound off ramp and on ramp respectively.

(h) Main Street & Harvard Street

Intersection improvements shall include:

Remove existing crosswalk and install crosswalks on all four legs of this intersection.

(i) College Ave Mid-Block Crosswalk between Boston Ave & Frederick Avenue

Intersection improvements shall include:

(i) Crosswalk

Remove existing crosswalk and install mid-block crosswalk on College Avenue between Boston Avenue and Frederick Avenue.

(ii) Sign Assemblies

Install pedestrian warning signs associated with the mid-block crosswalk on College Avenue between Boston Avenue and Frederick Avenue.

(j) Harvard Street at Boston Ave

Roadway improvements shall include:

Raise the finished road level (FRL) of Harvard Street at Boston Ave, under the GLX / NHML Bridge. The FRL of Harvard Street shall be reconstructed with full depth pavement and raised 16" at the PVI of the existing sag curve. The final elevation shall meet the minimum MassDOT and Somerville clearance requirements. Crosswalk markings shall be restriped. All drainage structures and covers, utility access covers, signs, curbs, sidewalks, and other infrastructure as required shall be modified to be compatible with the revised Harvard Street roadway.

(k) Boston Avenue between Winthrop and College Avenue

Install warning signage for midblock crossing.

(l) Main Street at George Street

Install crosswalks across George Street and install wheelchair ramps.

9.1.4 Deliverables

Maintenance of Traffic and staging plans, of all intersections and roadways where traffic patterns shall be altered during construction, for MassDOT and municipal approval. Roadway submissions shall follow MassDOT PDDG required submissions.

9.2 PEDESTRIAN AND BICYCLE PATHWAYS

9.2.1 Scope of Work

9.2.1.1 The Community Path

The Community Path is a shared-use path intended for pedestrians, joggers, bicycle riders, and roller skaters that runs in a generally parallel direction to a section of the Medford Branch. The Work includes sections of Community Path between the current terminus of the City of Somerville's existing path, at Lowell Street, and Washington Street via East Somerville Station.

9.2.2 Codes, Standards and Manuals include:

- United States Department of Justice (US DOJ), ADA Standards for Accessible Design
- US DOJ, Guidance on the 2010 ADA Standards for Accessible Design
- United States Access Board, Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG)
- Massachusetts Architectural Access Board Regulations (521 CMR)
- American with Disabilities Act and Architectural Barriers Act - Accessibility Guidelines for Outdoor Developed Areas (36 CFR Part 1195)
- American with Disabilities Act Accessible Rights-of-Way, A Design Guide
- Federal Highway Administration, Designing Sidewalks and Trails for Access, Part II of II: Best Practices Design Guide
- American Association of State Highway and Transportation Officials (AASHTO), Guide for the Development of Bicycle Facilities, 4th Edition
- Federal Highway Administration, Manual on Uniform Traffic Control Devices (MUTCD) (with all revisions and Massachusetts amendments)
- Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards
- Massachusetts Department of Transportation (MassDOT), Shared Use Paths and Greenways
- City of Somerville, Planning and Zoning Ordinances, and the City's Parks Specifications, and Department of Public Works (DPW) permits
- City of Cambridge, Planning and Zoning Ordinances, and Department of Public Works (DPW) permits
- City of Somerville DPW and FD – maintenance and access requirement

9.2.3 The Project Specific Requirements

9.2.3.1 Design Speed

The design speed shall be 20 mph for bicycles; 30 mph for steep (over 4%) downgrades.

9.2.3.2 Load Capacity

The load capacity shall be 12 kips.

9.2.3.3 Geometry

(a) Pavement Width

The Community Path width shall be a minimum width of 10'. The MBTA will consider exceptions to this width requirement at the following locations:

- Underpass beneath Medford Street
- Path alongside the VMA
- Washington Street Bridge

(b) Shoulders

The Community Path shall have additional 1' shoulders (in width) on each side (grass or non-paved material). Obstructions including sign posts, lighting columns, trash cans, and benches adjacent to the Community Path shall be located outside the shoulder.

(c) Curvature

Where the design speed is 20 mph, the minimum radius shall be 100'. Where the design speed is 30 mph, the minimum radius shall be 225'.

(d) Vertical Clearance

The minimum vertical clearance shall be 10'.

(e) Grades

The maximum constructed grade shall be 5.0%.

(f) Cross Slope

The maximum cross slope shall be less than 2.0%. Minimum 0.5%.

(g) Vehicular Turning Radius

The maximum turning radius shall be 12' to allow an EMS vehicle space to turn around at the connection with the Lowell Street extension, per the agreement with the City of Somerville.

(h) Roadway Crossings

The table below designates all of the locations the Community Path shall interface with City roadways and the elevation at which the Community Path shall interface with each road.

Table 9.2-1 — Community Path & Roadway Interfaces

Name	Town	Relative Path Elevation
Central Street	Somerville	At Grade
Sycamore Street	Somerville	At Grade
School Street	Somerville	At Grade
Medford Street	Somerville	Underpass
Walnut Street	Somerville	Underpass
McGrath Highway	Somerville	Underpass
Cross Street	Somerville	Underpass
Washington Street	Somerville	Overpass

9.2.3.4 Materials

(a) Pavement / Surface

Where the Community Path is located on a structure the surface shall be concrete. Where the Community Path is located on the ground, the surface shall be either concrete or bituminous concrete pavement.

(b) Striping

Design and install 6'' wide retro reflective single yellow centerline and stop lines at locations where the Community Path is not located within a city street.

(c) Drainage

Design and construct a drainage system for the Community Path. Catch basins, if utilized, shall be flush with surface, located outside of the Community Path, and contain bicycle-safe grates. Refer to [Section 7.3](#) for applicable drainage standards.

(d) Fencing

Refer to [Section 7.2](#) for fencing information and requirements.

(e) Lighting

Providing lighting per the requirements [Section 12.4](#) and [Exhibit 2F](#) for path lighting details and all applicable codes, standards and requirements.

(f) Lighting for Pedestrian and Bike Underpasses and underneath Bridges

Provide lighting fixtures for safety and security of users of the Community Path. Refer to [Section 12.4](#) for lighting details, standards and requirements.

(g) Emergency Equipment

Emergency call boxes shall be installed every 1,000', with a minimum of one centered between each set of path entrance points, and at all underpass locations as coordinated with the City of Somerville's emergency responders. City of Somerville's standard emergency call box type with

concrete call box terminal foundation shall be used. Emergency call box concrete foundations shall be designed to meet MassDOT requirements. For placement of the solar powered emergency call boxes, provide maximum opportunity for a clear path (radio transmission) from the unit radio antenna to the reception point. Emergency call box foundations shall be designed to extend at least to the minimum regional frost depth. Refer to Exhibit 2H.

(h) Bollards

Lockable, removable bollards shall be placed at all access points of the Community Path to prohibit unauthorized vehicle access. Bollards shall be a single style, high visibility type and be consistent with those installed throughout the City of Somerville path. 36" clearance width between bollards shall be maintained.

(i) Guard Rails

Guard rail shall not be required through Junction Park, the driveway and the parking lot located at Central Street. From Central Street through Washington Street guard rail shall be installed for the full length on the trackside of the Community Path. Guard rails shall be required where vehicular access is permitted on the track side of the path. Guardrail shall be installed within the 1' shoulder space as to maximize the Community Path cross section width.

(j) Railings

At locations where the Community Path width is less than 10' wide and no guardrail is provided, continuous railings shall be provided at a height of 42". Reinforced supplemental hand / bicycle 'rub rail' shall be placed along the trackside fence, at a height of 36", to prevent pedestrian or bicycle traffic from entering the track corridor. Curb rail may be utilized as necessary along the top edge of retaining walls where the path is adjacent to the tracks. Openings in the railing shall be designed to meet AASHTO requirements.

(k) Signage

Signage for the Community Path shall conform to the Federal Highway Administration, MUTCD (with all revisions), AASHTO, and Guide for the Development of Bicycle Facilities. Signage shall be placed as so not to interfere with the user's safety, or their approach to roadway intersections on the path.

9.2.3.5 Structure

All elevated structure shall comply with Section 8.6.

9.2.4 Deliverables

The DB Entity shall provide the following:

(a) Signage Design Intent Report

Sign Type List, (sign type label and sign type convention, to be consistent throughout different path and roadways).

Message Schedule, to be organized by sign types, including location plan drawing number, sign message, material, application method, color, dimensions, finishes and mounting system for each location.

9.3 ROADWAY TRAFFIC CONTROL SYSTEMS

9.3.1 Scope of Work

The roadway traffic control systems Work shall include traffic control adjustments for the specified roadways and intersections in the cities of Cambridge, Somerville and Medford.

This Work includes traffic signal equipment, dual displays, signal posts, pull boxes, signal timing adjustments, modified signal controllers, maintenance of traffic and temporary traffic staging as required by the Environmental Assessment and as otherwise required as a result of the Work.

The DB Entity Shall:

- Provide and coordinate all control measures and devices for all relevant site work, and all roadway work, Utility work and drainage work as outlined in Section 9.1;
- Coordinate during design and construction as required with the Cities of Somerville, Medford and Cambridge, who are responsible for all the roadway traffic work wherein the Project is located;
- Coordinate with other entities relative to all the roadway and traffic work that needs to be accomplished in the roadways in the Cities of Somerville, Medford and Cambridge; and
- Identify and agree to all control measures and devices to be used at all intersections and pedestrian facilities.

9.3.2 Codes, Standards and Manuals include:

- MassDOT Project Development and Design Guide
- Manual on Uniform Traffic Control Devices for Streets and Highways, with Massachusetts Amendments
- Relevant standards from the Cities of Cambridge, Somerville, and Medford.

9.3.3 The Project Specific Requirements

Traffic control work shall be in accordance with MassDOT Highway Division and Manual on Uniform Traffic Control Devices for Streets and Highways, with Massachusetts Amendments, standards, as well as any locally applicable standards.

The DB Entity shall coordinate with all private developers regarding adjoining roadways between the MBTA Project site and the adjacent private properties to ensure proper signal timing.

The DB Entity shall set up the temporary traffic control staging to perform all roadway, pedestrian route, and bicycle route Work as part of the Project. The temporary traffic control setup shall include reflectorized plastic drums, temporary traffic control signs, temporary impact attenuator, temporary concrete barrier and portable breakaway barricade. The DB Entity shall remove all temporary traffic control items when such associated Work is completed.

9.3.3.1 City of Somerville Intersections

The DB Entity shall coordinate all changes with MassDOT and the City of Somerville to complete the Work including the bridge, roadway, station and TPSS Work per the Somerville agreement.

9.3.3.2 City of Medford Intersections

The DB Entity shall coordinate all changes with MassDOT and the City of Medford to complete the Work including the roadway and pedestrian connection of the bridge, roadway, station and TPSS Work as required. Refer to Section 9.1 for the roadway work to be accomplished at the intersections in the City of Medford.

(a) Broadway & Dexter Street (Magoun Square)

Intersection improvements shall include:

Perform pedestrian signal timing modifications to the traffic signal controller at this intersection.

(b) Broadway & Powder House Boulevard

Intersection improvements shall include:

Perform pedestrian signal timing modifications to the traffic signal controller at this intersection.

(c) College Avenue & Boston Avenue

Intersection improvements shall include:

(i) Mast Arms and signal heads

Provide signal mast arms, poles, foundation, and mounting the proposed signal heads to the mast arms.

(ii) Signal posts and signal heads

Provide all proposed traffic signal posts, pedestrian signal posts and their foundations, as well as the mounting the traffic signal and pedestrian signal heads to the respective posts. Additionally, mount the accessible pedestrian pushbutton assembly and associated regulatory signage to the pedestrian signal posts.

(iii) Pull boxes

Provide all pull boxes and connecting traffic signal equipment to the pull boxes through conduits, and all miscellaneous equipment and material including cables and wiring to provide a fully functional and operational traffic control signal.

(iv) Opticom and Video Detection

Provide video detection cameras for vehicle detection and opticom for emergency vehicle pre-emption.

(d) Boston Avenue & Winthrop Street

Intersection improvements shall include:

Perform pedestrian signal timing modifications to the existing traffic signal controller at this intersection.

(e) Boston Avenue & North Street

Intersection improvements shall include:

(i) Pedestrian Signal Heads

Provide signal heads to existing traffic signal poles.

(ii) Signal Timing Modifications

Perform signal timing modifications to the existing traffic signal controller at this intersection.

(f) College Avenue & George Street

There are no traffic control items identified as required at this intersection by the MBTA; refer to Section 9.1 for the roadway requirements. If the Project design requires any changes to traffic control system, these shall be coordinated with the City.

(g) Mystic Avenue & Main Street / Mystic Valley

There are no traffic control items are required at this intersection; refer to Section 9.1 for the roadway requirements. If the Project design requires any changes to traffic control system, these shall be coordinated with the City.

(h) Main Street & Harvard Street

There are no traffic control items are required at this intersection; refer to Section 9.1 for the roadway requirements. If the Project design requires any changes to traffic control system, these shall be coordinated with the City.

9.3.4 Deliverables

The DB Entity shall submit all design and proposed signal timings to the relevant municipality for approval.

10.1 COMMUTER AND FREIGHT RAIL TRACKWORK

10.1.1 Scope of Work

The DB Entity shall modify approximately 3 miles of the existing commuter rail double track affected by the Project, located between a point approximately 700' south of the Washington Street Bridge in Somerville and Winthrop Street in Medford. The Work includes:

- Design and construction for relocation of existing commuter rail tracks. Finished condition shall be fully welded, destressed, Class 5 track.
- Preservation of freight rail access from the New Hampshire Mainline to the Yard 10 facility, located south of the Washington Street Bridge.
- Demolition and salvage of the existing Willey Track siding between 3rd Avenue in Cambridge and north of Lowell Street in Somerville, including all related connections to the New Hampshire Mainline.
- Demolition and salvage of all special trackwork associated with interlockings at Somerville Junction and McGrath Highway, once retired.
- Demolition and salvage of existing commuter rail mainline track abandoned as a result of construction sequencing.
- Demolition and salvage of all existing tracks within Yard 8.
- Installation of new track to replace retired siding connections and interlockings within the mainline.
- Coordination with all operating railroads that provide service within the corridor including Pan Am Railways, Amtrak, and the MBTA/Commuter Rail Operator.
- Coordination with all other construction work within the corridor, including the New Hampshire Mainline work north of Harvard Street (Tufts Interlocking) and the Yard 10 Improvements.
- Selection and installation of appropriate track structure-based upon Noise and Vibration mitigation requirements of the Environmental Assessment.
- Design and construction of an intertrack fence separating the adjacent commuter/freight and light-rail tracks.
- Procurement and installation of MBTA required corridor signage, such as snow flanger signs at grade crossings. See [Section 12.5](#).
- Design and construction of the track and associated Work shall be completed for the limits of the alignments as shown in [Exhibit 2B.2](#).
- Provide crossovers and turnouts in the number, location, and type as shown in [Exhibit 2B.2](#).
- Design and construction of corridor egress paths in accordance with NFPA 130.
- Design and construction of corridor “egress stairs” shall be completed as shown in [Exhibit 2B.2](#). Stairs shall be galvanized open grated.

10.1.2 Codes, Standards, and Manuals include:

- MBTA Railroad Operations “Commuter Rail Design Standards Manual” (CRDSM)
- MBTA Railroad Operations “Book of Standard Plans, Track and Roadway” (BSP)
- MBTA Railroad Operations, “Track Maintenance Standards”
- MBTA Railroad Operations Directorate, latest version
- MBTA MW-1: Specifications for Construction and Maintenance of Track, latest version
- MBTA Commuter Rail Material Specifications, latest version
- National Fire Protection Association (NFPA) 130: Standard for Fixed Guideway Transit and Passenger Rail Systems

In the event that an element of the design or construction is not addressed by the Technical Provisions or the documents noted above, the appropriate recommended practices of the following reference shall be complied with:

- AREMA, Manual for Railway Engineering and Portfolio of Trackwork Plans

10.1.3 The Project Specific Requirements

The DB Entity shall provide a written log of exceptions to the Technical Provisions for approval by the MBTA.

10.1.3.1 General**(a) Demolition and Salvage**

The DB Entity may reuse track materials that meet the requirements of the Contract Documents. The DB Entity shall coordinate with the MBTA to identify whether any material that is not reused and is scheduled to be removed is salvageable. All material that is identified by the MBTA to be salvaged shall be delivered to the MBTA rail shop at 21 Arlington Avenue, Boston, MA 02129. The DB Entity shall repair and replace with new material any salvaged material damaged or destroyed due to the DB Entity’s negligence. All other material shall become the property of the DB Entity and shall be disposed of off the MBTA’s property.

(b) Track Materials

The proposed track structure shall be comprised of wood ties and ballast. Existing ties, including concrete ties, in the corridor may remain and any ties damaged during construction activities shall be replaced in-kind.

(c) Track Alignment

Design of the track alignment shall accommodate a design speed of 70 miles per hour (mph) for commuter and Amtrak passenger trains and 40 mph for freight trains. Do not preclude a future speed increase to 79 MPH. Meet or exceed the existing corridor design speeds and the speeds shown on the Project Drawings.

(d) Clearances

Meet the requirements of the MBTA Commuter Rail Design Standards Manual (CRDSM) as well as applicable agreements between the MBTA, Pan Am Railways, Amtrak, and DPU for horizontal and vertical clearances. Provide clearance for freight trains on both New Hampshire Mainline tracks.

(e) Freight Rail Connections

Per agreement between the MBTA and Pan Am Railways, the connection from both Yard 8 and Yard 10 to the New Hampshire Mainline can be taken out of service for a period of time in order to facilitate staged construction of the Washington Street Bridge (see Volume 1, Section 2.5). The New Hampshire Mainline shall be connected to the Yard 10 Lead Track through the use of the existing No. 15 turnout north of the Washington Street Bridge in the final condition.

(f) Corridor Walkways and Egress

Provide maintenance walkways on both sides of the Commuter Rail corridor in accordance with MBTA requirements. Provide emergency egress walkways in accordance with NFPA 130 and 7.2 Sitework.

(g) Noise and Vibration Mitigation

The Project Environmental Assessment (EA) evaluates environmental disturbance levels and identifies areas where noise and vibration mitigation are required. The locations of mitigation shown in EA are based on a track alignment that differs from the track alignment contained in Exhibit 2B.2. The DB Entity shall select, design, and construct noise and vibration mitigation methods that meet the requirements of the EA based on the DB Entity’s approved track design.

(h) Track Construction

The DB Entity shall establish a phasing sequence for the track construction. All aspects of phasing including temporary track alignments, proposed service outages, and other operational impacts shall be reviewed and accepted by the operating railroads prior to the start of construction.

(i) Train Control

The track design shall be fully coordinated with the signal systems design to ensure the train control system functions as intended. The DB Entity shall integrate the signal system design and the track design. The track final design plans shall indicate locations of signal equipment to be installed in the track and along the wayside.

10.1.3.2 Track Designation & Stationing

(a) Commuter rail track direction and stationing shall be represented according to Table 10.1-1:

Table 10.1-1 — Commuter Rail Track Designation and Stationing

Branch	Track	Designation
New Hampshire Main Line	Outbound	NH-T1 XXX+XX
	Inbound	NH-T2 XXX+XX

- (b) Engineering stationing shall increase in the outbound direction. Stationing values shall be equated to historical railroad valuation maps. The outbound track (right track (T1) when looking up station) shall be the control track for each line. Each line shall be stationed independently along the centerline of the control (outbound) track. Stationing shall be continuous along the centerline of the control track and shall be the basic control for locating commuter rail system facilities along the route. Independent stationing shall be required on the inbound track when tracks are neither parallel nor concentric, where widened track centers are required around curves, where parallel tracks have independent profiles, or where tracks are in separate structures. Where curvature results in different stationing at the end of a curve, the inbound track stationing shall be equated to the control track stationing at the spiral to tangent (ST) point of whichever track has the spiral which extends the furthest ahead station. Alignment and curve data shall be generated for all tracks.

10.1.3.3 Commuter Rail Horizontal Design Criteria

- (a) Horizontal Design shall be in accordance with the CRDSM, Section I, Chapter 3 Geometric Design Criteria.
- (b) Spiral lengths: use of the formula below for computation of minimum spiral lengths shall require written approval from the MBTA:
- (i) $L_s \geq 1.22 (E_u) V$
- (c) Compound Curve Combining Spirals: Minimum spiral lengths connecting compound curves shall equal or exceed the maximum value computed in the following formulas:
- $L_s (\text{compound}) = 62 (\Delta E_a); V \leq 50 \text{ mph}$
 - $L_s (\text{compound}) = 83 (\Delta E_a); 50 < V \leq 80 \text{ mph}$
 - $L_s (\text{compound}) \geq 1.22 (\Delta E_u) V;$ (Requires written MBTA approval)
 - $L_s (\text{compound}) \geq 1.63 (\Delta E_u) V;$

(d) Accommodation of Freight Rail Traffic

Freight trains will operate on all sections of commuter rail track. Therefore, the following shall apply:

- (i) Actual superelevation value (E_a) on commuter rail track shall be limited to a maximum value of 4" unless prior written approval is obtained from the MBTA.
- (ii) Maximum unbalance superelevation design value (E_u) for freight traffic shall be 3".

10.1.3.4 Commuter Rail Vertical Design Criteria

- (a) Vertical Design shall be in accordance with the CRDSM, Section I, Chapter 3, and Geometric Design Criteria.
- (b) Minimum length of vertical curves shall be the greatest length obtained by the following:

- (i) Commuter Rail Criteria: As determined by Formulas 3.9, 3.10 and 3.11 in the CRDSM.
- (ii) Freight Rail Criteria: As determined by AREMA Chapter 5, Section 3.6 Vertical Curves (2002).

10.1.3.5 Commuter/Freight Rail Vehicle Clearance

(a) General

- (i) Establish clearances in accordance with the CRDSM, Section I, Chapter 6, and Clearance Criteria.
- (ii) Deviation from clearances described in the CRDSM and in this criteria require prior written acceptance by the MBTA.

(b) Track Spacing

- (i) Commuter Rail Track Centers: The minimum horizontal distance between commuter rail track centerlines shall be 13' - 0".
- (ii) Commuter Rail/Light Rail Track Centers: The minimum horizontal distance between commuter rail track and light rail track centerlines shall be 16' - 0" as dictated for this Project by Federal Railway Administration (FRA).
- (iii) Curve Widening: Track centers shall be widened in curves in accordance with the BSP Dig. No. 1018, Standard Track Centers & Side Clearance Increases for Curved Track.
- (iv) Concentric Curves in Multiple Tracks: Multiple tracks shall incorporate concentric curves in accordance with the methodology presented in the CRDSM.

(c) Horizontal Clearance

- (i) Standard Side Clearances: Side clearance shall be in accordance with the CRDSM and the BSP.
- (ii) Increased Side Clearances for Curvature: Side clearances shall be increased in curved track sections in accordance with the CRDSM and the BSP.
- (iii) Freight Railroad Clearance: Provide for Plate F clearance. See AREMA Chapter 28, Figure 28-2-7.
- (iv) Increased side clearance to proposed structures: Side clearances shall be increased by the distances specified in the Technical Provisions section pertaining to each type of proposed structure. For example, refer to the section on Retaining Walls for required distances resulting from retaining wall construction tolerances.

(d) Vertical Clearance

Provide vertical clearances equal or greater than the maximum required by the following:


- (i) Provide minimum clearance of 17'-9" to allow for raising of track during future track surfacing work. Also see BSP Drawing Number 1016.
- (ii) Tracks that are superelevated under overhead structures shall have their overhead clearances increased in accordance with BSP Dwg. No. 1016 and with CRDSM I.6.B.3.
- (iii) Tracks that are in a vertical curve under overhead structures shall have their overhead clearances increased in accordance with CRDSM I.6.B.4.
- (iv) Freight Railroad Clearance: Provide for Plate F clearance. See AREMA Chapter 28, Figure 28-6- 7.

10.1.3.6 Commuter/Freight Rail Trackwork

(a) Roadway

- (i) Roadway design shall be in accordance with the CRDSM, Section I, Chapter 5 Roadway Criteria.
- (ii) Track Roadbed: Track roadbed shall be in accordance with the BSP Dwg. No. 1000, Typical Roadbed Section Double and Single Track on Tangent, and BSP Dwg. No. 1002 Typical Roadbed Section Double and Single Track on Curve.
- (iii) HMA underlayment beneath special trackwork units is not required.
- (iv) Transition ties shall be provided as shown on BSP Dwg. No. 1108.
- (v) Slopes: Slide slopes shall be 2H:1V maximum. Stabilized 1.5H:1V slopes may be used with prior written acceptance of the MBTA where steeper slopes are required to avoid right-of-way impacts or excessive earthwork. The stability of the proposed slopes, and soil conditions, shall be evaluated and evidenced to the satisfaction of the MBTA.
- (vi) Intertrack Fence: Provide intertrack fence to separate the commuter rail track where it is located adjacent to light rail track. Intertrack fence shall be 4'-0" high. See 7.2 Sitework.
- (vii) Right of Way Signs, Posts and Markers shall be provided in accordance with applicable codes and standards.

(b) Trackwork - General

- (i) Trackwork design shall be in accordance with the CRDSM, Section I, Chapter 4 Trackwork Criteria.
- (ii) Rail: New rail shall be 132 RE and shall be head hardened standard AREMA chemistry rail with a minimum Brinell Hardness, HB of 370. See AREMA Chapter 4, Paragraph 2.1.4.2. Existing rail is 132 RE.  [Click here to View RFI #103](#)
- (iii) Track Gauge: Track gauge shall be 4' 8-1/2" measured 5/8" below top of rail on gauge face of the rail.

Rail Welding: Tee rail for tracks 200' outside the limits of special trackwork shall be welded into continuous strings using the electric flash-butt pressure welding process. Thermitite welds shall be used only where it is impractical to perform Pressure Welds (Production Flash Butt Welds) in the following locations: joining continuous welded rail strings, and for inserting insulated plug joints into welded strings.

- (iv) Insulated Joints: Insulated rail joints shall be shop-manufactured per MBTA Standard Drawings per Exhibit 2H.
- (v) Rail Lubricators: Existing rail lubricators shall be refurbished and a certification shall be provided to the MBTA.
- (vi) Mainline track panel length shall be maximized in order to minimize the number of new rail welds. Horizontal and vertical temporary track alignments shall be constructed in accordance with the MBTA MW-1 Specification.

10.2 LIGHT RAIL TRANSIT TRACKWORK

10.2.1 Scope of Work

The Work shall include two branches located north of Science Park station on the project. The Medford Branch shall extend on an elevated structure from the existing East Cambridge Viaduct at Edward H. Land Boulevard northeasterly over the Fitchburg Mainline and through the former Yard 8 to Washington Street in Somerville where the tracks enter the New Hampshire Mainline and continue to north of College Ave (Tufts University) in Medford. The Union Branch shall be a double track spur diverging from the Medford Branch at the Fitchburg Mainline crossing and continuing westerly along the Fitchburg Mainline to Prospect Street in Somerville.

A VMF with storage yard in Cambridge shall be located north of the Commuter Rail Maintenance Facility and shall be connected to both the inbound and outbound Medford and Union Branch tracks.

The Work includes:

- Demolition and salvage of the existing Project tracks between the end of the historic section of the East Cambridge Viaduct and the existing Lechmere Station.
- Design and construction of the Medford and Union Branch mainline tracks, vehicle maintenance and storage facility tracks, and yard lead tracks connecting each inbound and outbound mainline to the storage yard.
- Attendance at the Commuter Rail Track Coordination Meeting and coordination with the attendees (MBTA/Commuter Rail Operator, CSX, Amtrak and Pan Am Railways) to review all near track construction and operational activities including to the New Hampshire Mainline, Fitchburg Mainline, Yard 10, and Valley Track.
- Coordination with all other construction Work within the Corridor, including the New Hampshire Mainline Relocation north of Harvard Street and the Fitchburg Mainline Relocation.
- Selection and installation of appropriate track structure-based Noise and Vibration mitigation methods in accordance with the requirements of the Environmental Assessment.
- Selection and installation of appropriate end of track protection at termini.
- Design and construction of Corridor maintenance walkways and egress paths in accordance with NFPA 130.
- Design and construction of the track and associated Work shall be completed for the limits of the alignments as shown in Exhibit 2B.2.
- Provide crossovers and turnouts in the number, location, and type as shown in Exhibit 2B.2 for light rail transit, yard lead, and VMF trackwork.
- Design and construction of access pads to the System.

10.2.2 Codes, Standards, and Manuals include:

- MBTA Maintenance of Way Division Green Line Light Rail Transit Track Maintenance and Safety Standards (LRTMSS)
- MBTA Maintenance of Way Division – Book of Standard Trackwork Plans (BSTP)
- National Fire Protection Association (NFPA) 130: Standard for Fixed Guideway Transit and Passenger Rail Systems
- MBTA Railroad Operations “Commuter Rail Design Standards Manual” (CRDSM)
- MBTA Commuter Rail Material Specification No. 9251 – Subballast
- MBTA Railroad Operations Book of Standard Plans Dwg. No. 1030

In the event that an element of the track design is not addressed by the Project Specific Requirements or the standards noted above, the appropriate recommended practices of the following references shall comply with:

- Transit Cooperative Research Program (TCRP) Report 155: Track Design Handbook for Light Rail Transit, 2nd Edition
- Transit Cooperative Research Program (TCRP) Report 71: Track Related Research Volume 6: Direct Fixation Track Design, Specification, Research, and Related Material
- The American Railway Engineering and Maintenance of Way Association (AREMA), Manual for Railway Engineering and Portfolio of Trackwork Plans
- ASTM International (ASTM)

10.2.3 Project Specific Requirements

10.2.3.1 General

(a) Demolition

Demolish and salvage track rail, ties, and other track materials (OTM). Salvaged track material shall be stockpiled and delivered to the MBTA. Deliver all salvaged materials to the MBTA Rail Shop located at 21 Arlington Avenue, Boston, MA 02129. All material determined to be non-salvageable by the MBTA, such as railroad ties, track bolts, nuts, washers, spikes, anchors, and lags shall become the property of the DB Entity and shall be disposed of off of the MBTA’s property.

All demolition work shall be performed to prevent damage to materials to be salvaged. Repair, or replace salvaged material that is damaged or destroyed with new material.

(b) Track Materials

The proposed track structure shall be comprised of wood ties and ballast, except within the limits of the Vehicle Maintenance and Storage Facility where the track structure may be ballasted, paved, embedded, or direct fixation. The DB Entity has the option to design and construct a direct fixation track structure for track on the aerial viaduct.

(c) Track Alignment

The track alignment shall be designed to achieve maximum operating speeds and maximize rider comfort. Design the track system to safely support the required design speeds. Coordinate the track design speeds with the system operating speeds determined through the performance simulation and the signal system design, including provisions for overspeed protection.

The design speed for a given horizontal curve shall be determined by its radius, the length of spiral transitions, and the actual and unbalance superelevation values assigned to the curve as described in the Technical Provisions.

The horizontal and vertical track alignment on the historic section of the existing Lechmere viaduct shall be maintained with the exception of a maximum distance of 100' where the existing track shall be realigned to tie into the Work.

(d) Clearances

Clearances between the proposed tracks and bridge structure at the Washington Street Bridge have been approved by the MBTA. The Project shifts the Washington Street Bridge north in order to re-use the existing bridge abutments. The DB Entity shall verify the track alignment is coordinated with the new bridge location and all clearance requirements are satisfied.

(e) Vehicle Maintenance Facility and Storage Yard

The Vehicle Maintenance Facility shall be designed to provide storage space and vehicle services for the existing fleet and newly procured light rail vehicles. The site is divided into two areas: an outdoor storage yard in the west and the Maintenance Facility Building in the east. Space for at least 43 light rail vehicles shall be provided in the outdoor storage yard. Yard lead tracks originating from the mainlines of the Medford and Union Branches shall enter this yard from the west. Yard leads 2 and 3 shall meet at a double crossover prior to entering the yard to provide additional flexibility.

The Vehicle Maintenance Facility Building on the east side of the site shall accommodate 4 double-ended service tracks which shall enter and exit on the building's north-south axis. The service tracks shall originate and terminate on a loop track which shall be located on the outer edge of the site and encircle the building. A long storage track for maintenance of way equipment shall be located on the west side of the loop track. The east and west sides of the yard shall be connected with an arrangement of multiple tracks and crossovers to maximize operational flexibility.

(f) Track Construction

All aspects of near track activities including proposed service outages and other operational impacts shall be reviewed and coordinated with the operating railroads at the Commuter Rail Track Coordination Meeting prior to the start of those activities (See [Volume 1](#)).

(g) Train Control

(h) The track design shall be fully coordinated with the Signal Systems design to ensure the train control system functions as intended. The DB Entity shall integrate the Signal System design

and the track design. The track final design plans shall indicate locations of signal equipment to be installed in the track and along the wayside. Coordination with Other Design Elements

The design shall be coordinated with all guideway elements that interface with the track system including stations, structures, overhead catenary, traction power, communications, signal systems, and drainage.

(i) Future Expansion

The DB Entity’s work shall not prevent future construction of connections from both the Union Square Eastbound and Westbound tracks to the Vehicle Maintenance Facility. See Section 8.7 Viaducts for additional information.

The DB Entity’s work shall not prevent the future extension of light rail tracks to Route 16 on the Medford Branch or to Porter Square on the Union Branch.

10.2.3.2 Light Rail Track Alignment and Vehicle Clearance

(a) General

(i) The DB Entity shall submit a Design Exception Request to the MBTA for each proposed design value that is below a minimum or above a maximum value. The DB Entity shall be solely responsible for acquiring approval from the MBTA, Utility Owners, and Third Parties as may be required. The DB Entity shall obtain approval of all necessary Design Exceptions prior to submission of design and construction documents.

(b) Track Designation and Stationing

(i) Light Rail track direction and stationing shall be represented according to Table 10.2-1.

Table 10.2-1 — Light Rail Track Designation and Stationing

Branch	Track	Designation
Medford	Outbound	MB-EB XXX+XX
	Inbound	MB-WB XXX+XX
Union Square	Outbound	US-EB XXX+XX
	Inbound	US-WB XXX+XX

(ii) Engineering stationing shall increase in the outbound direction. Stationing values shall be equated to the existing stationing placards on the Lechmere Viaduct, starting at Station 177+00. The outbound track (right track (EB) when looking up station) shall be the control track for each line. Each line shall be stationed independently along the centerline of the control track. Stationing shall be continuous along the centerline of the control track and shall be the basic control for locating transit rail system facilities along the route. Independent stationing shall be required on the inbound track when tracks are neither parallel nor concentric; where widened track centers are required around curves, where parallel tracks have independent profiles, or where tracks are in separate structures. Where curvature results in different stationing at the end of a curve, the inbound track

stationing shall be equated to the control track stationing at the spiral to tangent (ST) point of whichever track has the spiral which extends the furthest ahead station. Alignment and curve data shall be generated for all tracks.

(c) Horizontal Track Alignment

(i) General

Unless otherwise approved by MBTA, the horizontal alignment shall consist of tangent sections connected by circular curves with spiral transition curves.

(ii) Tangents

- A. The minimum length of tangent between curved sections (except those within crossover special trackwork units) shall be 60’.
- B. At station platforms the horizontal alignment shall be tangent throughout the entire length of the platform. The tangent shall be extended 45’ beyond both ends of the platform.

(iii) Curves

A. Circular Curves

Circular curves shall be defined by the arc definition of curvature, and specified by their radius in feet. Degree of curve shall be converted to radius using the following formula:

$$R = 5,729.578/D_a$$

Where:

R = radius of curvature in feet

D_a = degree of curvature

Minimum circular curve radii are as follows:

<u>Condition</u>	<u>Radius (feet)</u>
Mainline	275
Yard and Other Non-Revenue Track:	120

Minimum circular curve length shall be 40 ft.

B. Superelevation

Superelevation shall be constant through the circular curve. Superelevation shall be achieved by maintaining the top of the inside rail at the top of rail (TOR) profile and raising the outside rail by an amount equal to the track actual superelevation (E_a). The superelevation transition shall occur linearly at a uniform rate over the length of the spiral curve. For curves without spirals (limited to yard and non-revenue track), superelevation

transitions shall occur at a uniform rate. The length of the transition shall be the minimum spiral length that would have been required for the curve. The transition shall be distributed with 1/3 in the circular curve and 2/3 in the tangent.

Track superelevation shall be based on the following formula:

$$E_q = E_a + E_u = 4.011V^2/R$$

Where:

E_q = total superelevation required to balance the centrifugal force at a given speed in inches (equilibrium)

E_a = actual track superelevation to be constructed in inches

E_u = unbalance superelevation in inches

V = design speed in mph

R = radius of curve in feet

Actual track superelevation (E_a) shall meet the following criteria:

Mainline Track:

Maximum Actual Superelevation shall be 4".

Maximum Unbalance Superelevation shall be 1/2".

Actual track superelevation shall be applied in 1/4" increments.

Ballast Yard tracks intended for 6 MPH operation do not require superelevation.

C. Spiral Curves

Spiral curves shall be provided between circular curves and horizontal tangents, and between adjacent circular curves of varying radius. Spirals shall be Talbot (clothoid) curves as defined by the AREMA Manual for Railway Engineering in which the following relationship pertains:

$$R * L = R_c * L_s$$

Where:

R = radius of curvature at the spiral at any given point between the TS and SC.

L = distance along the spiral from the TS to the given point.

R_c = radius of the circular curve, equal to R at SC.

L_s = length of the spiral curve from TS to SC.

The minimum length of spiral curve shall be the greatest length obtained from the following formulas:

$$L_s = 40E_a$$

$$L_s = 1.10E_aV$$

$$L_s = 0.82 E_u V \text{ (Requires written MBTA approval)}$$

$$L_s = 1.22 E_u V \text{ Minimum}$$

$$\text{Absolute Minimum } L_s = 40'$$

Where:

L_s = length of spiral in feet

E_a = actual superelevation for the circular curve in inches

E_u = unbalanced superelevation for the circular curve in inches

V = design speed in mph

Spirals shall be required on horizontal curves having a radius of less than 10,000'.

Yard and other non-revenue tracks do not require spiral curves if design speeds are 10 mph or less.

D. Reverse Curves

Minimum tangent lengths as specified above shall be maintained between all reverse curves.

E. Compound Curves

Compound circular curves may be used provided that they are connected by a spiral transition curve. The minimum length of spiral transition curve shall be the greatest length obtained from the following formulas:

$$L_s = 40\Delta E_a \text{ Minimum}$$

$$L_s = 1.10\Delta E_a V$$

$$L_s = 0.82 \Delta E_u V \text{ (Requires written MBTA approval)}$$

$$L_s = 1.22 \Delta E_u V \text{ Minimum}$$

$$\text{Absolute Minimum } L_s = 40'$$

Where:

L_s length of spiral in feet

ΔE_a difference of actual superelevation of the circular curves in inches

ΔE_u difference of unbalanced superelevation of the circular curves in inches

V design speed in mph

Yard and other non-revenue tracks with compound curves do not require spiral curves if design speeds are 10 mph or less.

F. Concentric Curves and Track Widening

For mainline multi-track layouts where two or more tracks follow the same general alignment, tracks shall be made concentric through the curves. In cases where track widening is required,

concentric curves shall be created by adjusting the spirals of the inside track to a length where the spiral offset distance (p) relative to the outside track spiral offset distance is increased by an amount equal to the required track center increase, or in cases where no track widening is required, equal to the offset distance of the outside track.

(d) Vertical Track Alignment

(i) General

The vertical alignment shall be composed of constant grade tangent segments connected at their intersection by parabolic curves having a constant rate of change in grade.

The profile grade line in tangent track shall be along the centerline of track between the two running rails and in the plane defined by the top of the two rails. In curved track, the inside (low) rail of the curve shall remain at the profile grade line and the actual superelevation achieved by raising the outer rail above the inner rail.

In areas of curved horizontal alignment where the profile is given for only one track, the grade of the second track shall be adjusted uniformly to accommodate for the differences in length throughout the curve.

(ii) Grades

Grades shall not exceed the maximums specified below:

<u>Condition</u>	<u>Grade</u>
Maximum Sustained Mainline and Yard Lead Grade: Unlimited Length	4.0%
Maximum Sustained Mainline and Yard Lead Grade: up to 2500' Between PVIs	6.0%
Station Platforms: Maximum	0.5%
Yard Tracks: Maximum	0.0%
Yard Storage and Pocket Tracks: Maximum	0.2%
Special Trackwork: Maximum	2.0%

(iii) Vertical Tangents

The minimum length of constant profile grade (vertical tangent) between vertical curves (PVC and/or PVT) shall be 100 ft. At station platforms, a vertical tangent shall extend for 40' beyond the ends of the platform.

(iv) Vertical Curves

Vertical tangents along the track shall be connected with parabolic vertical curves having a constant rate of change of grade.

A. Vertical Curve Lengths

The minimum length of vertical curves allowed shall be determined as follows:

<u>Condition</u>	<u>Length</u>
Minimum Length*	LVC = 100A
Minimum – Crest	LVC = AV ² /25
Minimum – Sag	LVC = AV ² /45

Where:

LVC = length of the vertical curve in feet

A = algebraic difference in the grades in percent ($G_1 - G_2$)

G_1 = percent grade of approaching tangent

G_2 = percent grade of departing tangent

V = design speed in mph

*= Curve lengths less than the result of this equation require written MBTA approval

The minimum equivalent radius of curvature for vertical curves located on mainline tangent track shall not be less than 820' for crests and 1150' for sags. This equivalent radius of curvature can be calculated from the following formula:

$$R_v = LVC/0.01(G_1 - G_2)$$

Where:

R_v = minimum equivalent radius of curvature of a vertical curve in feet.

Minimum vertical curve length and/or design speed may be governed by the overhead contact system (OCS) due to the maximum permissible rate of separation or convergence between the track grade and the contact wire grade. Vertical curve design shall be coordinated with the OCS design to ensure compliance with this limitation.

B. Reverse Vertical Curves

Reverse vertical curves are not permitted.

C. Compound Vertical Curves

Compound or unsymmetrical vertical curves are not permitted.

D. Combined Horizontal and Vertical Curves

Combined horizontal and vertical curves are allowable provided the absolute minimum length of the vertical curve is increased by 1.5 times the required length.

E. Minimum T/R elevation for all VMF Yard tracks is 13.50'.

(e) Special Trackwork

Special trackwork is defined as any type of turnout, crossover or rail crossing. All special trackwork shall be located on horizontal and vertical tangents.

For special trackwork the horizontal and vertical tangent shall extend from the distance specified below preceding the point of switch to the end of the long ties.

The minimum length of tangent track preceding a point of switch shall be 30 ft.

The maximum vertical gradients through special trackwork are given above.

(f) Clearances

(i) General

This section establishes the minimum dimensions required to ensure proper clearances between the light rail vehicles and transit structures or other obstructions and to establish a procedure for determining minimum track center distances. All designs shall meet or exceed the minimum clearance criteria as specified herein.

Designs shall include space for minimum 30" wide maintenance walkways on both sides of the LRT corridor. MBTA written approval shall be obtained on a case by case basis where this condition cannot be met. Maintenance walkways shall not encroach on the Clearance Envelope.

Where emergency walkways are required they shall be a minimum of 30" wide and shall not encroach on the static vehicle envelope per NFPA 130.

(ii) Clearance Envelope

A. The Clearance Envelope (CE) is defined as the space occupied by the Vehicle Dynamic Envelope (VDE) plus the effects of other wayside factors (OWF) including construction and maintenance tolerances for track and various facilities, plus running clearances (RC). This relationship can be expressed as follows:

$$CE = VDE + OWF + RC$$

B. The Clearance Envelope represents the space into which no physical part of the system (other than the light rail vehicle) shall be placed, constructed or protrude. The Clearance Envelope shall be referenced from the centerline of track at the top of rail.

C. The following factors shall be considered in developing the Clearance Envelope.

1. Vehicle Dynamic Envelope Considerations for Determination

Determination of the Vehicle Dynamic Envelope begins with the cross sectional outline of the static vehicle. The dynamic outline of the vehicle is then developed by making allowances for the car body movements that occur when the vehicle is operating on level, tangent track. In addition to car body movements on level, tangent track, the effects of track curvature, superelevation and cross level deviation must also be considered to allow additional room for vehicle overhang on curves, vehicle lean when curves are

superelevated, and vehicle lean due to track cross level deviation on tangents and curves.

2. Dynamic Vehicle Outline

The dynamic outline of the vehicle shall be defined as the extreme car body displacement that can occur for any combination of rotational, lateral and vertical car body movements that occur when the vehicle is operating on level, tangent track. These car body movements are due to truck suspension movements, spring action, allowable wheel and rail wear, and permitted tolerances in vehicle and track construction. The MBTA Maintenance of Way Division Standard Drawing 160, "LRT Track Standard Dynamic Clearance Envelope – Composite LRV" (LRV – light rail vehicle) defines the dynamic vehicle outline to be used for the Project.

3. Vehicle Inswing/Outswing

In addition to the dynamic car body movements described above, car body overhang in horizontal curves also increases the lateral displacement of the dynamic outline relative to the track centerline. For design purposes, both mid-car inswing and end-of-car outswing of the vehicle shall be considered. The amount of mid-car inswing and end-of-car outswing depends primarily on the truck spacing and end overhang of the vehicle and on the radius of track curvature. Mid-car inswing and end-of-car outswing shall be based on the single-articulated MBTA Type 7 Vehicle as shown on MBTA Light Rail Equipment Engineering Drawing, "Data Sheet No. 7 Surface rail Car NOS. 3600 – 3699" Drawing Number 47667 Rev A.

4. Superelevation Effects

The effect of superelevation shall also be accounted for in developing the Vehicle Dynamic Envelope. Superelevation effects shall be limited to the vehicle lean induced by a specified difference in elevation between the two rails of a track and shall be considered independently of other effects on the dynamic outline. In determining superelevation effects, the shape of the dynamic outline shall not be altered. Rather, the dynamic outline shall be rotated about the centerline of the top of the low rail an amount equal to the actual track superelevation.

5. Cross Level Deviation Effects

The effect of cross level deviation shall also be accounted for in developing the Vehicle Dynamic Envelope. Allowable cross level deviation is dependent upon track maintenance requirements set by the MBTA. Cross level deviation effects shall be limited to the vehicle lean induced by the difference in elevation between the two rails of a track and shall be considered independently of other effects on the dynamic outline. In determining cross level deviation effects, the shape of the dynamic outline shall not be altered. Rather, the dynamic outline

shall be rotated about the centerline of the top of the high rail an amount equal to the allowable cross level deviation set by the maintenance practice of the MBTA.

Clearance calculations shall be based on a cross level deviation value of 2-1/8".

D. Vehicle Dynamic Envelope

With the dynamic vehicle outline developed and the effects of track curvature and superelevation determined, the VDE can be calculated.

1. When calculating the VDE for horizontal curves with spirals, the tangent CE shall end 50' before the tangent to spiral (TS) and 50' beyond the ST point. The full curvature CE shall begin 25' prior to the spiral to curve (SC) point and end 25' beyond the curve to spiral (CS) point. The horizontal component of the Vehicle Dynamic Envelope between these two points (i.e., 50' before the TS and 25' before the SC) shall be considered to vary linearly with distance between the two points. Horizontal offsets at intermediate locations shall be calculated by linear interpolation. For simple circular curves, the full curvature CE shall begin 50' prior to the point of curvature (PC) and end 50' beyond the point of tangency (PT).
2. The Clearance Envelope through turnouts shall be calculated based on the centerline radius of the turnout.

E. Other Wayside Factors

1. Other wayside factors (OWF) is the second component of the CE. OWF is the sum of certain construction and maintenance tolerances (CMT) plus a chorded wall construction factor (CW) to account for the effects of chorded wall construction, all where applicable. This relationship can be expressed as follows:

$$OWF = CMT + CW$$

2. The following define other wayside factors and are applicable to and shall be included in the horizontal component of the CE.

Construction and Maintenance Tolerances (CMT)	
Construction tolerance along soldier pile and lagging walls and mechanically stabilized walls	6"
Construction tolerance along all other proposed structures	2"
Construction tolerance at OCS poles or signal equipment	1.5"
Track construction and maintenance tolerance for mainline ballasted track	2.25"
Track construction and maintenance for yard tracks	2.25"
Allowance for acoustical treatment, where required	3"

Chorded Wall Construction Factor (CW)	
Additional width for chorded construction of walls to be added on the outside of curves only	See Figures 10.2-1 & 10.2-2

3. The above dimensions are design values, the applicability of which depends on the type of track construction and the type of structure that the vehicle must clear. The following is a description of the applicability and rationale of these values.

a. Track Construction and Maintenance Tolerances

The combination of several factors such as track misalignment and wheel and track gauge tolerances create the need for this tolerance. Ballasted track demands a greater track misalignment tolerance than either embedded track or direct fixation track would require. Furthermore, a distinction is also made between primary tracks and yard tracks for safety reasons.

b. Construction Tolerances along Proposed Structures

Where the facility adjacent to the trackway is a structure, or part of a structure, the minimum horizontal construction tolerance shall be provided on the assumption that the structure, or part thereof, may be misplaced during construction by a dimension of that magnitude. It is emphasized that the term "structure" as used in this subsection applies to any facility to be constructed alongside the LRT system and above the top of rail.

c. Running Clearances

In addition to the VDE and other wayside factors, the following define the running clearances to be included in the horizontal component of the CE.

Running Clearance (RC)	
Running clearance at OCS poles, signals, signs and other non- structural members	6" Min.
Running clearance along soldier pile and lagging walls and other structures which are normally constructed with liberal construction tolerances.	
Running clearance along cast-in-place, pre-cast, and masonry walls and other structures which are normally constructed with strict construction tolerances	
Running clearance for adjacent light Rail Vehicles (Total between vehicles)	6" Min.

Running clearances are included to provide clear passage for a LRV which has moved to the extreme position within the Dynamic Outline, the minimum horizontal clearance to any structure, or part of a structure, shall always include a horizontal running clearance.

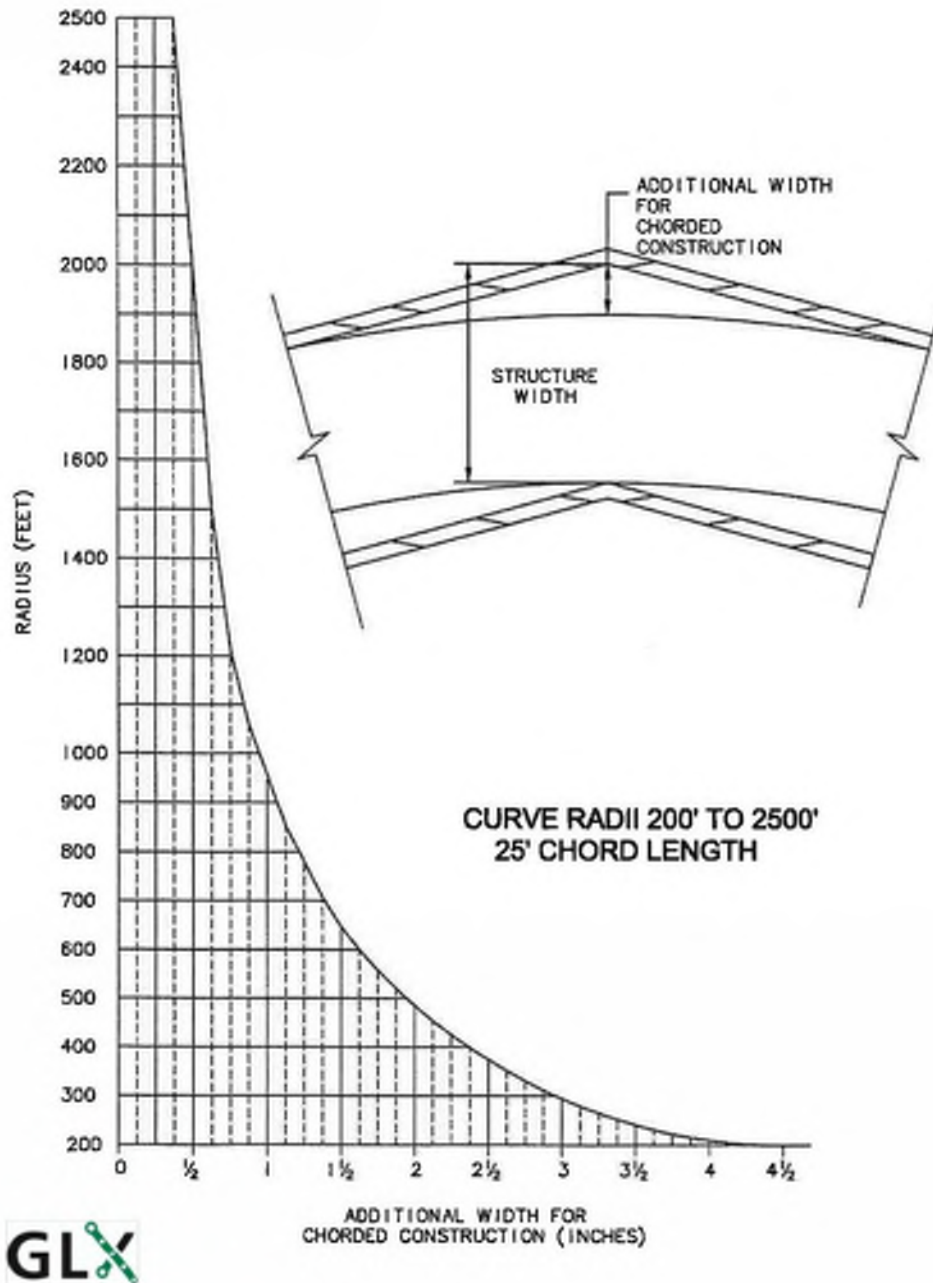


Figure 10.2-1 — Additional Width for Chorded Construction with 25' Chord Length

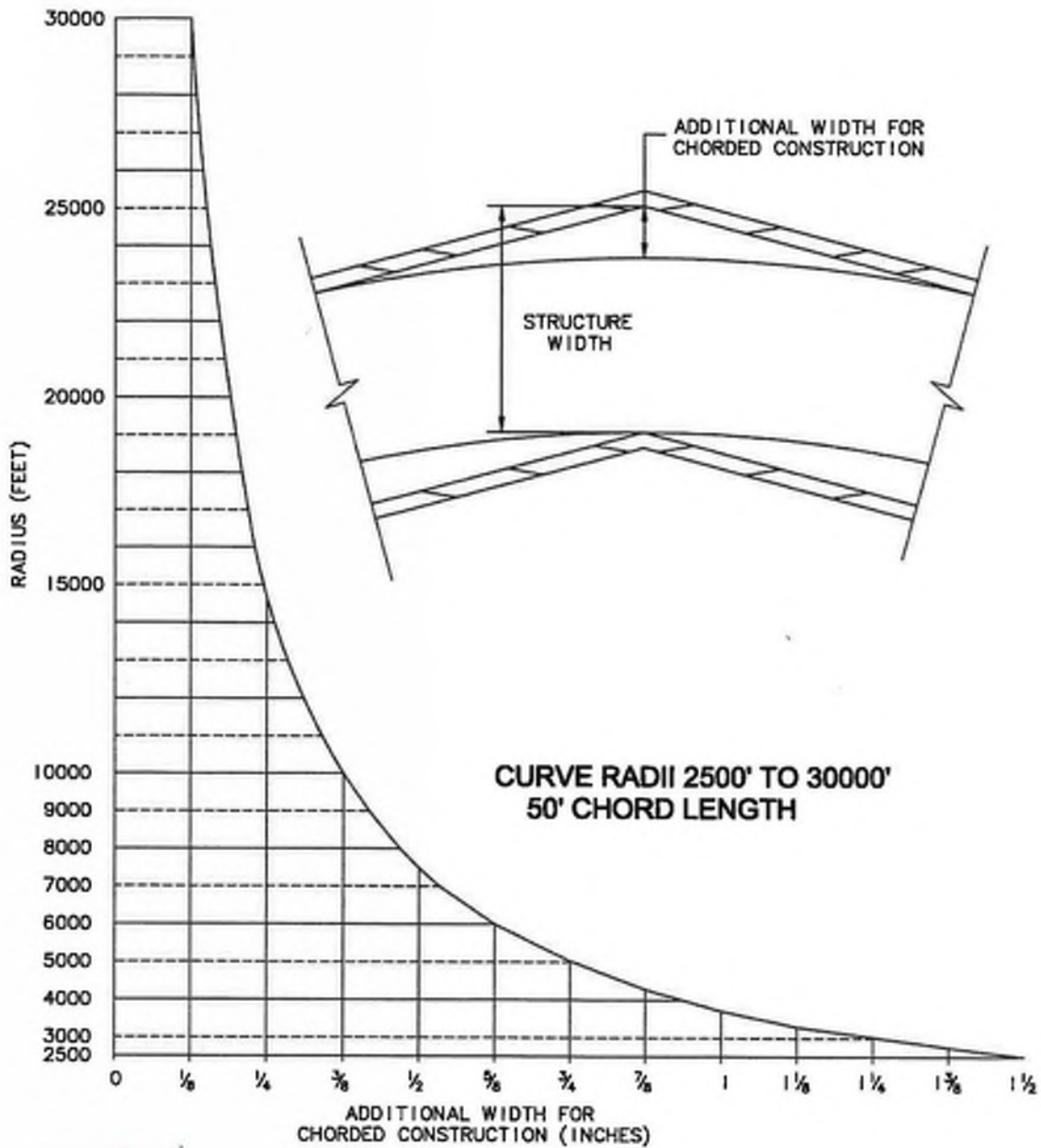


Figure 10.2-2 — Additional Width for Chorded Construction with 50' Chord Length

(iii) Special Clearance Situations

In addition to the CE requirements described above, the following special clearance situations shall be appropriately applied in the design.

A. Vehicle Interface at Station Platforms

The distance from the centerline of the track to the edge of platform shall be 4'-9" for platforms located on tangent track. The distance from centerline of track to the edge of platform for platforms located in curved track shall be modified to account for the effects of vehicle inswing and outswing.

Station platform shall be located 8" above top of rail plane.

Platform construction tolerances shall be coordinated with the station architectural and structural designs to ensure compliance with ADA requirements.

B. Retaining Walls

Where retaining walls are used,

The absolute minimum clearance from the centerline of track to the near face of a retaining wall shall be no less than that required to clear the CE plus the maintenance and emergency exiting width, where required. In areas where the minimum clearance cannot be achieved, a Design Exception shall be submitted for approval of the maximum clearance achievable on the section.

3. Safety Niches

Safety niches shall be provided at all locations where the required walkway clearances are not met over a distance along the track of 20'-0" or greater. Refer to MBTA Standards for additional information.

Maximum distance between niches shall be 20'-0" on center. The dimensions of niches shall be in accordance with the MBTA Commuter Rail Design Standards Manual.

The use of niches requires prior written approval by the MBTA.

(iv) Vertical Clearances to Overhead Structures

A. The following defines vertical clearances from the top of the high rail along any given section of track to the soffit of any overhead structure within the horizontal limits of the Clearance Envelope shall be provided.

Location	Minimum Vertical Clearance
At overhead bridges	15' 0", minimum

- B. Exceptions to the minimum vertical clearances shall be coordinated with the MBTA and OCS designs as required to identify specific local conditions which may affect the clearance.

(v) Track Spacing

Track spacing shall vary depending upon the curvature and the type of construction used for the particular section of line.

- A. The minimum allowable spacing between two exclusive LRT mainline tracks, with equal superelevation and no OCS support poles between them, shall be determined from the following formula:

$$d = \frac{T_t + T_a + 2 (OWF) + RC}{12}$$

Where:

d = minimum allowable spacing between track centerlines, in feet.

T_t = dynamic half width of vehicle towards curve center, in inches

T_a = dynamic half width of vehicle away from curve center, in inches

OWF = other wayside factors, in inches

RC = running clearances, in inches

- B. Along sections where OCS poles are located between track centerlines, the minimum track spacing shall be determined from the following formula:

$$d = \frac{T_t + T_a + 2 (OWF + RC) + P}{12}$$

Where:

d = minimum allowable spacing between track centerlines, in feet.

T_t = dynamic half width of vehicle towards curve center, in inches

T_a = dynamic half width of vehicle away from curve center, in inches

OWF = other wayside factors, in inches

RC = running clearances, in inches

P = OCS pole diameter (including deflection)

10.2.3.3 Light Rail Trackwork

(a) Roadbed

- (i) Roadbed shall be designed in accordance with BSTP Dwg. No. 125 LRT Track Typical Roadbed Section (Tangent), and Dwg. No. 130 LRT Track Typical Roadbed Section (Curved).

- (ii) Subgrade: Subgrade shall be analyzed to determine whether it has both the uniform stability and the strength needed to carry the required loadings. Existing track beds shall be evaluated to determine if subgrade conditions are adequate or if remedial measures shall be required. Provide alternative subgrade designs where standard section cannot be used.
- (iii) Subballast: Minimum subballast depth shall be 8". Subballast material shall be in accordance with the MBTA Commuter Rail Material Specification No. 9251 - Subballast.
- (iv) Asphalt Underlayment: Underlayment is required for all at grade mainline turnouts and special work. Underlayment shall be in accordance with MBTA Railroad Operations Book of Standard Plans Dwg. No. 1030 Asphalt Underlayment at turnouts. Asphalt underlayment shall be required for turnouts located within the VMF Yard.
- (v) Ballast: Ballast shall conform to Section LRT213.103, Ballast of the LRTMSS. Minimum ballast depth shall be 12" minimum below the bottom of tie. A minimum ballast shoulder of 18" from end of tie to top of slope is required. A 12" to 18" shoulder may be used in extenuating circumstances with the prior written approval of MBTA. Ballast shall be AREMA No. 4.
- (vi) Crossties: Timber crossties shall be used for track construction and conform to Section LRT213.109, Crossties of the LRTMSS and with BSTP Dwg. No. 200 Standard Wooden Crosstie, and Dwg. No. 201 Anti-Splitting End Plate for Wooden Cross-Ties.
- (vii) Crosstie Spacing: Spacing shall conform to BSTP Dwg. No 210 Standard Tie Spacing, Usage and Spiking Patterns.
- (viii) Transition ties and approach slabs are required at the ends of all bridges and shall conform to BSTP Dwg. No. 215 Transition Tie Spacing. Approach slabs shall also be used to provide a smooth transition from ballasted track to direct-fixation track and vice versa. Approach slabs shall be installed so that the minimum ballast depth under the ties is 12".
- (ix) Station Platform: A field side rubber crossing panel is required between the station platform and the near rail at all platform locations. Reference Accessible (low-floor) Platform Detail on BSTP Dwg. No. 140 LRT Track Typical Roadbed Section, Double Track with Station Platforms. The detail shall be modified to provide for easy removal and installation of panels to perform track maintenance and as required to coordinate with GLX station platform detail.
- (x) Direct Fixation Track: direct fixation track shall consist of rail, seated on plates/pads, and fastened to second pour reinforced concrete plinths.
- (xi) Embedded Track: embedded track structure shall consist of rail encased in 4000 psi concrete up to top of rail level, with flangeways provided. Design service life shall be minimum 25 years.
- (xii) Paved Track: Paved track shall consist of ballasted track, covered to top of rail level by full-depth rubber panels or bituminous asphalt with rubber rail seal. Flangeways, drainage, and electrical insulation shall be provided. Design service life shall be minimum 25 years.

(b) Rail

- (i) 115 RE section rail conforming to the current AREMA "Specification for Steel Rails" shall be used for all tracks on the LRT system.
- (ii) All new rail shall be head hardened standard AREMA chemistry rail (Head Hardened Rail) with a minimum Brunell Hardness, HB, of 370 (See AREMA Chapter 4, Paragraph 2.1.4.2.).
- (iii) Rail for use in mainline track and yard leads shall be continuously welded. Rail for use in the Vehicle Maintenance & Storage Facility yard shall be jointed.
- (iv) Girder guard rail shall not be acceptable in the VMF Asphalt embedded areas.

(c) Rail Fastenings

- (i) Ballasted, direct fixation, and embedded tracks shall use a fastening system which shall electrically isolate the rail from the tie and the ballast or track concrete.

(d) Restraining Rail

- (i) Track having a centerline radius of less than or equal to 1000', and greater than 100', shall have restraining rail added to the inside running rail.
- (ii) Track having a centerline radius equal to or less than 100' shall have restraining rail added to both running rails.
- (iii) Restraining rail shall be 132 RE installed in accordance with the BSTP and supplemental detail provided by the MBTA. Restraining rail assembly shall extend beyond each end of a guarded simple curve (no spirals) a minimum distance of 10' before the curve and 30' after the curve based on the normal direction of travel. Where the track geometrics include a spiral, the curve guarding shall extend a minimum distance of 10' before the spiral and 30' after the spiral based on the normal direction of travel. Where track is subject to regular bi-directional operations, restraining rail shall extend 30' beyond the end of the simple curve or spiral.
- (iv) The DB Entity shall design curve radii on the Medford Branch and at-grade Union Square Branch tracks to be large enough such that restraining rail is not required outside of special trackwork units.

(e) Emergency Guard Rail

- (i) Two emergency guard rails are required between the running rails in the following locations:
 - Bridge Decks
 - Elevated Structures and Viaducts
 - Adjacent to Station Structures
 - Adjacent to Station Emergency Egress Structures
 - Adjacent to Fill Retaining Walls and Slopes

- Bridge Abutments and Piers
 - On Grades of 3% or greater (regardless of location)
- (ii) Guard Rail shall conform to BSTP Dwg. No. 900 Bridge Guard Installation Details and Dwg. No. 905 Resiliently Fastened Bridge Guard Rail.
- (iii) Emergency guard rail shall extend 100' ahead of the area being protected on the approach end and extend 50' beyond the area being protected on the departure end.
- (f) Track Gauge and Flangeway Width
- (i) Design values for track gauge shall conform to Section LRT213.53, Gauge of the LRTMSS.
- (ii) Flangeway Width shall conform to Section LRT213.54, Flangeway Width of the LRTMSS.
- (g) Corrosion Control/Stray Current Mitigation
- (i) Shall be designed and installed as defined in Section 8.9 Stray Current and Corrosion Control.
- (h) Derails
- (i) Hand thrown sliding block derails are required on all tail tracks and yard leads to prevent out-of-control rail vehicles from inadvertently entering mainline track or fouling adjoining or adjacent tracks.
- (ii) Derails shall be located so as to derail equipment in the direction away from the main track prior to the mainline "fouling" point. Derail installation shall be coordinated with the MBTA Signals and Communication Group for indication and control requirements.
- (i) Lubrication System
- (i) A rail lubrication system approved by the MBTA shall be installed prior to each restrained curve on the mainline and yard lead tracks. For a series of successive curves where the restrained rail is on the same side for each curve, lubricators shall only be installed prior to the first curve in the series. Restrained curves within the Vehicle Maintenance Facility shall be reviewed on a case-by-case basis with the MBTA to assess the appropriateness of lubricators. The lubrication system shall be powered by solar panels. Lubricators installed prior to restraining rail shall apply lubrication to the back of the wheel flange. The lubrication system shall be electrically isolated from the track.
- (j) ROW Access Pads
- (i) ROW access pads shall consist of full-depth pavement and rubber rail seal material extended across both light rail tracks. Pads shall be constructed adjacent to corridor access points to allow Hi-Rail equipment (vehicles with both highway and flanged wheels) to access the tracks. Specifications for Hi-Rail equipment utilized by the MBTA shall be obtained from the MBTA Maintenance of Way Department during the design phase. Corridor access to the pads from outside the ROW shall be provided at the following

streets: Boston Avenue near the TPSS (Medford) and Joy Street (Somerville). Gates in the proposed Right-of-Way fencing shall be provided at each location. Gate openings shall be wide enough to accommodate the turning radius for the MBTA's Hi-rail equipment. Pad length shall be 50 ft. minimum, measured longitudinally along the tracks.

(k) Light Rail Special Trackwork

- (i) Special trackwork shall be designed and constructed in strict accordance with MBTA standards and standard drawings, except as noted within these criteria.
- (ii) Special trackwork shall be located on horizontal and vertical tangents unless otherwise approved by the MBTA.
- (iii) Special trackwork shall be fully guarded, including restraining rail and switch point house top cover guard assemblies.
- (iv) Switch machine timbers shall be made of Azobe Tropical Hardwood Timbers.
- (v) The electric lock switches shown in SYS-GL-0001 (1A and 1B at Red Bridge and 31A and 31B at Magoun) shall be handthrown. All other switches shown in SYS-GL-0001 shall be powered. Refer to Exhibit 2B.1.
- (vi) With the exception of special trackwork and at insulated joint locations all joints in mainline track shall be welded into continuous strings using the electric flash-butt pressure welding process.
- (vii) Frogs in mainline track turnouts shall be designed to have no bolted joints in running surfaces.
- (viii) The mainline crossovers at approx. Sta MB-EB 201+00 and Sta. MB-EB 319+00 are intended to be used for emergency operations only and shall operate via hand throw with electric lock with jump frogs. All other mainline crossovers shall be power operated.
- (ix) Flange bearing frogs are required for all turnouts used for normal train operations.
- (x) Frogs with moving parts, such as spring frogs and movable point frogs, are not allowed on the LRT system.
- (xi) No. 8 turnouts are the minimum size for mainline use.
- (xii) Provisions shall be made during the design of special trackwork for the installation of switch heaters. All switches shall be designed to accommodate switch heaters regardless of the location of the specific installation within the system or the need for switch heaters at that location. Provide switch heaters at all switch locations.
- (xiii) Special trackwork design and location shall be coordinated and confirmed with MBTA Operations, Traction Power, and Signal and Communication Groups.

- (xiv) Double crossovers are allowed provided the straight move track centers are wide enough to allow standard parts to be used and each frog to be a separate casting.
- (xv) Special trackwork shall not be located in the following areas:
 - A. Pedestrian or vehicular crossings.
 - B. Within 200' of a transition between ballasted and direct fixation track.
- (xvi) No. 8 turnout design shall be in accordance with the following table:

NO. 8 TURNOUT DATA		
SWITCH	LENGTH OF SWITCH	26'-0"
	HEEL SPREAD	9 1/8"
	POINT THICKNESS	0'-0"
	SWITCH ANGLE	0° 50' 44"
	HEEL ANGLE	2° 53' 25"
	RADIUS	896.91
FROG	NUMBER	#8
	ANGLE	7° 09' 10"
TURNOUT	ACTUAL LEAD	68'-0"
	CENTERLINE RADIUS	439.96'

- (xvii) No. 10 turnout design shall be in accordance with the following:
 - A. Switch design shall be the same as the No. 8 turnout.
 - B. Lead length shall be 78'-11".

(l) Miscellaneous Track Appurtenances

- (i) Sliding friction or hydraulic Bumping posts shall be installed at the ends of all stub-end tracks. Bumping posts shall be designed to engage the anti-climber of the LRT vehicle and shall be designed to stop 2 fully loaded light rail vehicles traveling at 6 miles per hour. Bumping posts shall be bonded and electrically isolated from the traction power and train control systems.

(m) Tail Tracks

- (i) Tail tracks at College Avenue Station must be of sufficient length to provide storage of at least 6 cars (in married-pairs) on each track beyond the north end of platform without impacting turn-back train operation in the station. Tail tracks at Union Square Station shall be designed to store a minimum of 4 cars (in married pairs) without impacting turn-back train operation in the passenger station.

(n) Storage and Maintenance Yards - Additional Requirements

- (i) Effective length of storage tracks shall be measured from the 11.0' clearance points of converging tracks.
- (ii) Storage length of each single-ended track shall include 30' buffer beyond the length of the LRV to provide space for parking overruns and to prevent hitting end-of-track bumping posts. Storage length of double-ended track shall include 30' buffer beyond the calculated length of stored LRVs on the track to provide space for parking overruns.
- (iii) The minimum yard turnout size shall be 150' curve radius (C.R.), Fully Guarded.
- (iv) Overlapping turnouts may only be used with prior written MBTA approval.
- (v) Yard tracks shall use standard MBTA ballasted track construction with timber cross-ties placed at 24" centers.
- (vi) Walkways are required between vehicle storage tracks and shall be paved. Walkways shall have a 25 year design life with pedestrian loading.
- (vii) Hand thrown sliding block derails are required on shop lead tracks. Derails shall have position indicators.
- (viii) Yard leads shall have a positive grade (yard to mainline direction of travel) to prevent vehicles from inadvertently rolling onto the mainline.
- (ix) Yard grade crossings and shop approaches shall be paved with rubber rail seal.
- (x) Yard track layout and design shall be coordinated with MBTA Operations, Traction Power, Signal and Communications, and Vehicle Groups.

(o) Systems Coordination

- (i) Bonding and cross-bonding for the traction power negative return system shall be coordinated between the track and traction power designs. The locations of insulated joints at interlockings, crossovers, egress crossings, and station platforms shall be coordinated with the track, traction power, and signal designs.

(p) Right of Way Signage

- (i) The DB Entity shall provide track layout drawings to the MBTA at the release for construction stage of track design so that the development of right of way signage design can be initiated. The DB Entity shall coordinate with the MBTA to advance the right of way signage design along with the track design. The DB Entity shall coordinate with the MBTA to allow MBTA personnel or designees to access the right of way to prepare for and carry out the installation of right of way signage.

11.1 TRACTION POWER SYSTEM

11.1.1 Scope of Work

The traction power Work includes a new Traction Power System (TPS) for the System. Traction power shall be supplied by Traction Power Substations (TPSS) that will be located along the Corridor.

The DB Entity shall provide 13.8 kV AC utility infeeds, 13.8 kV AC distribution and 600 V DC traction power distribution. The 13.8 kV AC network shall utilize power supplies from Eversource for the Project.

The 600 V DC traction power system shall be compatible with the existing power system on the existing system. The DB Entity shall provide three new TPSS to connect to the Overhead Contact System (OCS). The TPSS shall be sectioned as shown in [Exhibit 2B.1](#).

The overall design of the TPSS shall be in accordance with MBTA standard specifications (modified as provided in [Exhibit 2A](#)), Eversource utility interface requirements, and industry standards.

The traction power system shall include the equipment listed below. The requirements and functionality of the equipment is prescribed within the detailed specifications:

- AC Switchgear assembly (15 kV Class)
- Rectifier-Transformers
- Rectifiers
- DC Switchgear assembly (800 V Class)
- Bus Ducts
- Negative Equalizer Bus and Drainage Board
- DC Disconnect Switches
- AC and DC Power Cables
- AC circuit breaker control and instrument panel (ACCP)
- Station Battery (including associated charger and accessories)
- Supervisory Equipment (SCADA)
- Substation Automation Equipment (SAS)
- Technical Support Equipment
- Testing and Safety Equipment

The DB Entity may elect to incorporate the following equipment available from the MBTA in its design. Refer to RIDs [Section Volume 1 Exhibit B](#) for further information.

1. 13.8 kV AC switchgear consisting of:
 - a. Two (2) incoming utility line breakers

- b. Two (2) utility metering cubicles
 - c. Two (2) rectifier transformer breakers
 - d. Twelve (12) feeder breakers (spare or unit substation feeds)
 - e. Two (2) bus-tie breakers
 - f. Three (3) ring feeder breakers
 - g. Two (2) auxiliary cubicles
 - h. Associated protection and relaying
 - i. Two (2) MBTA Ground & Test (G&T) devices
 - j. One (1) Eversource Ground & Test (G&T) device.
2. 3 MW Rectifier Transformers - Two
 3. 3 MW Rectifier – Two
 4. 600 V DC switchgear consisting of:
 - a. Two (2) rectifier main breakers (Device 72-R)
 - b. Fourteen (14) feeder breakers (Device 172)
 - c. Associated protection and relaying

11.1.2 Project Specific Requirements

11.1.2.1 Traction Power System Configuration

- a) 13.8 kV Network
 - (i) There shall be three traction power substations (TPSS) on the Project in the locations shown in Exhibit 2B.2:
 - Red Bridge
 - Pearl Street
 - Ball Square
 - (ii) Eversource will provide two independent 13.8kV feeds for Pearl Street TPSS and Red Bridge TPSS. Ball Square TPSS shall be fed by the DB Entity from Pearl Street as indicated in Exhibit 2B.1.
 - (iii) The local utility 13.8 kV infeeds shall be brought to 13.8 kV switchgear within the TPSS. The requirements of the incoming line breakers, metering and associated equipment shall meet the requirements of the local utility company as indicated in the local utility interface requirements.
 - (iv) 13.8 kV shall be distributed to unit substations at passenger stations and within TPSS as indicated within the contract drawings. In addition, two 13.8 kV ring

feeders shall be provided between Pearl Street TPSS and Ball Square TPSS. Each ring feeder shall be provided power from the buses provided from separate utility infeeds.

- (v) DB Entity shall confirm correct cable sizing and rating for the 500 kcmil feeder cable size for each ring feeder circuit and #4/0 AWG cable size for unit substation circuits based on the load on each circuit each operating scenario. All cables on the 13.8 kV network shall be 15 kV rated with 133% insulation.
- (vi) Where more than one ring feeder circuit supplies power to the same facility, i.e. between Pearl St TPSS and Ball Sq TPSS, the circuits shall be routed independently from each other to provide full redundancy in the event of a circuit failure.
- (vii) The method of routing of the 13.8 kV ring feeders shall be determined by the DB Entity.
- (viii) Cable sizes to rectifier transformers shall be as indicated in the Project Definition Plans.
- (ix) DB Entity shall propose the plan for grounding/isolating the cable sheaths of the AC cables to avoid circulating currents.

b) 600 V/650 V DC Traction Power System

The DC traction power system for the Project shall consist of three new traction power substations including all conversion equipment, control, relaying, controls, and associated components to operate the Project. The system includes DC positive feeder cables, negative return cables, supplementary positive and negative cables and DC disconnect switches as required to provide power to the OCS. The system as indicated in Exhibit 2B.1 shall be capable of operating AW3 loaded project and existing system vehicles at five minute headways under normal and single contingency outage scenarios without any detriment to operating service.

- (i) The DC power system shall be separated into electrical sections with section breaks at or near each TPSS. As well as OCS feeder switches, TPSS bypass switches shall be provided to enable a substation to be removed from service while allowing two electrical sections to be joined together. Provisions for an OCS tie switch shall be provided at each end-of-line location (Union Square and Ball Square) to connect the OCS of each track together.
- (ii) Each DC feeder circuit within the substation shall comprise of 2-2000 kcmil feeder cables between circuit breakers and DC feeder disconnect switches. DC positive feeders to the OCS shall comprise 2-1000 kcmil per feeder disconnect switch and interface with the OCS via a trackside disconnect switch. The OCS shall include 2-1000 kcmil supplemental positive cables in parallel with the trolley and messenger wires. These supplemental cables shall be aerially mounted where-ever possible. If installed in a ductbank then the supplemental cable(s) shall be connected to the OCS via pole mounted disconnect switches every 400 ft approximately.
- (iii) Each 2000 kcmil cable may be changed for 2-1000 kcmil if necessary for ease of installation. Where this is proposed, the DB Entity shall ensure that all corresponding equipment, conduits and infrastructure can accommodate the proposed configuration while maintaining design requirements.

- (iv) The 2-1000kcmil supplemental positive cables per track, shall be connected to each other every 500ft approx. to ensure equalization of the electrical circuit.
 - (v) #4/0AWG Conductor taps from the supplemental feeder wires to the respective catenary shall be provide at every 2nd OCS pole or approximately every 250ft.
 - (vi) Separate ductbanks shall be provided for northbound and southbound circuits but may follow the same routing. Eastbound (outbound) and Westbound (inbound) positive feeder cables shall not occupy the same manholes.
 - (vii) Positive feeder cables shall not occupy the same ductbanks or manholes as the negative return cables.
- c) Traction Power Return System
- (i) The traction power return system shall include the running rails and supplemental return cables. The traction power return system shall interface the impedance bonds at the track with the negative return busbar within each TPSS. Each track shall be provided with 2-2000 kcmil returns per track to the TPSS negative busbar. Midway between substations the running rails of each track shall be interconnected via impedance bonds to share the rail return current equally. The tracks at the end of the line shall be connected together via impedance bonds. This shall apply at Union Square and Ball square.
 - (ii) Additionally, a single 2000 kcmil supplemental negative cable shall be provided throughout the Project. This cable shall be shared between the two tracks and interconnected at each TPSS return connection and at each mid-point between substations. The supplemental return cable shall be installed directly on the ballast between the tracks.
- d) Utility Interface
- (i) Eversource is providing two power feeds to the TPSS locations through the agreement with MBTA. Two separate 13.8 kV lines shall be provided to Red Bridge TPSS. The interface shall be as indicated in Specification 16100. Two separate 13.8 kV lines shall be provided to Pearl Street TPSS (Formerly Gilman Square). The interface shall be as indicated in Specification 16100. Cable and ductbank routing shall be coordinated as part of the Contract Documents.
 - (ii) The interface point for supplying and terminating cables between Eversource and the MBTA is the last manhole closest to the substation, but the DB Entity shall provide the ductbank for the entire route on MBTA property. Eversource ductbank requirements shall be as per Eversource specifications.
 - (iii) At each TPSS the incoming line circuit breaker shall be MBTA owned equipment operated by Eversource. Eversource AC switchgear incoming line equipment requirements are included in Exhibit 2A.
 - (iv) The substation equipment shall be laid out to include three exit routes from the area of the AC switchgear. Eversource utility meters shall be located in an accessible area either within the substation or exterior to the substation. The DB Entity shall coordinate the metering location with Eversource.

- (v) The DB Entity shall coordinate a utility isolation point within the utility ductbank route subject to Eversource requirements.
- e) Other TPSS Interfaces
- (i) Building Design
- The TPSS building design requirements are provided in Section 8.8 of these Technical Provisions.
 - The DB Entity shall coordinate all required conduits, floor openings, wall openings for all equipment and components within each substation.
 - TPSS building electrical (lighting, receptacles, heating, HVAC, etc.) shall be designed to coordinate with the placement of the main traction power equipment. Refer to Section 14.
- (ii) Overhead Contact System (OCS)
- DC cable feeders shall be routed out of the substation to OCS structures through DC disconnect switches.
- (iii) Electrical System
- Each TPSS shall be provided with a double ended unit substation fed from 13.8 kV AC switchgear to provide power to building electrical system.
 - The requirements of the unit substation shall be provided by the building electrical design.
- (iv) Grounding System
- Each TPSS shall be provided with a grounding system.
 - Refer to grounding system specifications in Exhibit 2A.1 for details
- (v) Communications
- Each TPSS shall be provided with a communications interface for SCADA.
 - Provide the necessary provisions within the substation to facilitate the connections.
 - Refer to the SCADA system in Section 14.6.
- f) Substation Requirements
- (i) Buildings

Provide all TPSSs as built-in-place TPSS buildings. The building shall be custom built at the site locations identified. A single-story or a double story building may be provided. Where a double story building is to be provided, then all DC equipment (i.e. rectifiers and DC switchgear) shall be on the second floor.

Floor to ceiling space shall be a minimum of 15'-0" to allow for cable trays, bus-ducts and conduits to be routed above equipment.

The TPSS building shall not require the installation of sprinkler systems or windows, but shall require a fire alarm and intrusion detection system.

The TPSS building shall house all the traction power equipment with the exception of rectifier-transformers, which are to be located outside, but adjacent to, the substation building.

The building design shall include mechanical, electrical and plumbing systems within the TPSS building including HVAC, exhaust fans, low voltage AC systems, lighting, unit substations, eye-wash stations, entry access system etc.

Each TPSS shall be provided with a bathroom.

Where cable basements are provided they shall be constructed such that they must minimize building differential settlement to prevent the formation of cracks. Perimeter drains should be installed where feasible. Provision for sumps and sump pumps within the station should be included where necessary. Ductbanks shall drain away from traction power facilities.

Design life shall be 50 years for buildings.

Refer to the TPSS Structures Section 8.8 within these Technical Provisions for details on structural requirements and Section 14 for building features and systems required within each substation.

(ii) Access

Each substation shall be provided building access for the following:

- a) Double door for installation and removal of any/all traction power equipment.
- b) Minimum of two personnel doors.

Loading bay to facilitate the removal or installation of equipment. Loading bay height shall be 4'-0" high, and an access area shall be maintained outside the TPSS. Rollup doors at double doors shall be provide at the loading bay, and shall be a minimum of 10'-0" wide and 12'-0" high.

Double story substations shall be provided with provisions to lift and lower equipment between the two floors. The access hatch(es) shall be sized for the largest piece of equipment. Alternatively, double door or rollup door access to both floors shall be provided.

Design shall include a plan for the installation and potential future removal of the rectifier transformers. The plan shall include the proposed location of the lifting crane and low-loader to ensure adequate space is available.

(iii) Clearances / Layout

The DB Entity shall layout all equipment required within the traction power substations. When developing the layout, the requirements of the National Electrical Code (NEC) shall be adhered to, and the following requirements shall apply:

a) AC Switchgear

1. Front-Provide minimum of 8'-0" unobstructed working clearance.
2. Rear-Provide a minimum of 5'-0" working clearance (NEC Condition #2).
3. Side/Ends-Provide a minimum of 4'-0" for accessibility.
4. Comply with Eversource requirements for emergency exits.

b) DC Switchgear

1. Front-Provide minimum of 6'-0" unobstructed working clearance.
2. Rear-Provide a minimum of 4'-0" working clearance (NEC Condition #2).
3. Side/Ends-Provide a minimum of 4'-0" for accessibility.

Isolate the DC operating equipment (rectifier and DC switchgear) from ground by providing an epoxy insulated floor systems within 6'-0" of the DC switchgear and the rectifiers.

If any rectifiers or portion of the DC switchgear is required to be located within 6'-0" of a wall or a column, ensure that the walls or equipment are shielded using insulating materials to avoid personnel touching both items simultaneously. Where this requirement applies the insulating materials shall extend from floor to ceiling. No grounded equipment (e.g. conduits, receptacles etc.) shall be provided within the isolated area.

Wall and floor space shall also be allowed for the following:

- Equipment access/laydown/storage
- AC circuit breaker testing (including test cabinet)
- DC circuit breaker testing (including test cabinet)
- High-voltage cable testing (including test equipment)
- Spare AC circuit breaker
- Spare DC circuit breaker
- Ground & Test devices (2 x MBTA, 1 x Utility)
- Auxiliary electrical equipment (panelboards, auxiliary transformers etc.)
- Fire Alarm Control Panel (FACP)
- Communications equipment
- Space for a table and chair for the substation maintainer/operator

- Space for a filing cabinet to store maintenance manuals and plans
- Space for a storage cabinet for tools and safety equipment

The main equipment shall be arranged in a symmetrical fashion employing equal cable and busduct lengths to provide equal load sharing under normal operating conditions.

The substation layout shall accommodate the easy removal and installation of major components while the substation is in service.

The layout of each TPSS shall be accepted by the MBTA.

(iv) Equipment

Design life shall be 50 years for buildings and 30 years for equipment.

The equipment requirements including all technical support equipment and spares shall be provided on a per substation basis.

1. AC Switchgear

- DB Entity shall ensure that the AC switchgear provided meets the fault rating of the incoming utility power supply.
- Under the provisions of the Substation Automation System (SAS) the DB Entity shall provide all necessary equipment and material to interconnect the new and MBTA procured equipment into the substation overall design.
- Additional switchgear equipment as required shall need to operate in a similar fashion to that already procured by the MBTA. The AC switchgear at any one substation shall be of one manufacturer.

2. Rectifier Transformers

- The MBTA requires the transformers be oil-filled and located outdoors within a fenced area. Each transformer shall be provided with an oil containment system.
- Space around the transformers shall comply with the requirements of the relevant FM Global property loss data sheet.
- Each rectifier transformer shall be rated for use in conjunction with an associated 3 MW Rectifier. Although interchangeable, each transformer shall be designed along with the rectifier. The paired equipment shall be utilized together wherever possible.
- Under the provisions of the SAS the DB Entity shall provide all necessary equipment and material to interconnect the new and MBTA procured equipment into the substation overall design.
- Refer to section below regarding equipment already procured by MBTA. Two

rectifier transformers have been procured by the MBTA.

3. Rectifiers

- Each rectifier shall be rated 3 MW for use in conjunction with an associated rectifier transformer. Although interchangeable, each rectifier shall be designed along with the rectifier transformer. The paired equipment shall be utilized together wherever possible.
- Under the provisions of the SAS the DB Entity shall provide all necessary equipment and material to interconnect the new and MBTA procured equipment into the substation overall design.
- Refer to section below regarding equipment already procured by MBTA. Two rectifiers have been procured by the MBTA.
- The insulated anchors securing the equipment to the operating floor shall be per MBTA standard details.

4. DC Switchgear

- The DC switchgear shall be able to be operated normally under a switchgear frame alive condition.
- The insulated anchors securing the equipment to the operating floor shall be per MBTA standard details.
- DB Entity shall ensure that the DC switchgear provided meets the fault rating requirements of the MBTA.
- Under the provisions of the SAS the DB Entity shall provide all necessary equipment and material to interconnect the new and MBTA procured equipment into the substation overall design.
- Refer to section below regarding equipment already procured by MBTA. Additional switchgear equipment as required shall need to operate in a similar fashion to that already procured by the MBTA. The DC switchgear at any one substation shall be of one manufacturer.

5. Negative Busbar and Drainage Board

- The MBTA does not utilize negative ground devices within the substations.

6. DC Disconnect Switches

- The MBTA require that each DC feeder circuit is provided with a DC disconnect switch within the TPSS.

7. AC Control Panel (ACCP)

- The MBTA require that a local control panel is provided in the substation for controlling the AC circuit breakers. There shall be two methods of normal

local operation within the substation:

- (i) Via the SAS HMI screen
- (ii) Via the ACCP

This panel shall be also used when locking and tagging out circuit breakers.

- The ACCP shall be located in an accessible position that is away from the AC switchgear such that, in the event of equipment failure, the operator is a safe distance away.
- The layout of the equipment on the ACCP shall match the order of the equipment within the substation.

8. 125 V DC Battery System

- The batteries shall be located within a separate room within the TPSS. The room shall be exhausted to open space outside the substation in the event that the batteries emit toxic gasses.
- The temperature within the battery room shall be controlled to optimize the longevity and reliability of the batteries.
- An OSHA-compliant eye-wash system shall be provided.

9. Substation Automation System (SAS)

- DB Entity shall provide an overall SAS for each TPSS. Where applicable it shall interface with any existing equipment procured by the MBTA. As necessary, equipment shall be provided and installed into any equipment to ensure the SAS is fully operational with the equipment. Information about the equipment procured can be found in the Reference Information Documents.
- The data output from the substation automation control system shall be compatible with the hardware and software at the SCADA Master Station located at Power Control; communication protocol shall be DNP3.

10. AC & DC Busducts

- MBTA preference is for the use of bus-ducts between the rectifier transformers and rectifiers and DC switchgear. The use of cables connections of flexible bus shall be subject to acceptance by the MBTA.

11. SCADA

- The DB Entity shall integrate the new facilities in to the existing operations control center at 45 High Street in Boston.
- Data transmission between the substation and Power Control shall be in DNP3 protocol.

12. AC & DC Ductbanks, Cables and Manholes

- For DC ductbanks containing DC traction power cables, non-metallic conduits (Type RTRC).
- MBTA typical manholes with MBTA manhole covers shall be provided as necessary.

13. Unit Substations

- Each TPSS shall be provided with a double ended unit substation to provide its own auxiliary power and, if required that of an adjacent station. Each double ended unit shall be sized based upon the power requirements.
- Each unit substation shall be provided primary power from the substation 13.8 kV switchgear.
- The requirements of the unit substation shall be provided by the building electrical design.

14. Relay Setting Parameters and Protection Coordination

- The DB Entity is responsible for providing all relay setting parameters and protection coordination of all devices and relays. This includes equipment provided by the MBTA. The DB Entity shall program the relays as necessary to meet the requirements of the Project to provide a fully operational system.

g) Stray Current System Interface

- (i) Refer to Section 8.9 within the Technical Requirements for the Stray current collection system or mitigation scheme required by the Project. DB Entity shall determine the size, capacity and location of this ductbank and pullbox.
- (ii) If a stray current collection system is employed on the system, then the provisions included within the requirements of the negative busbar and drainage board shall be utilized.
- (iii) The stray current system(s) should be connected to the negative return system via the drainage contactors at the negative drainage board.
- (iv) A stray current system ductbank and pullbox shall be provided and routed to an accessible area outside the substation for future connection of any utilities.

11.1.3 Deliverables

11.1.3.1 General (With respect to Work under this Section 11.1 only)

- a) At the completion of each design stage submittal, the DB Entity shall provide a technical presentation to the MBTA and the MBTA's representatives in the form of a Design Conference.
- b) The DB Entity shall conduct a design conference detailed in Exhibit 2A when the

equipment submittals are available. The DB Entity shall deliver these equipment submittals at a time to coincide with design conference.

- c) The DB Entity shall provide a Contract Deliverable Requirements List (CDRL) at the onset of the Project and the list shall include all design submittals, document submittals, product submittals, as-builts, reports and studies.
- d) The DB Entity shall make additional time allowance in the submittal reviews for equipment involving Eversource or other external parties.

11.1.3.2 Studies

- a) Specifications in Exhibit 2A.1 provide the necessary requirements for the studies required.

11.2 OVERHEAD CONTACT SYSTEM - MAINLINE

11.2.1 Scope of Work

The Work includes construction of an overhead contact system (OCS) for LRVs that operate in one, two or three LRV consists.

The Work shall include installation of poles, foundations, feeder cables, pole attachments, catenary wires, balance weights, crossarms, steel structures, bridge supports, bridge protection, surge arrestors, pole identification, disconnect switches, dead-ending the existing OCS at Land Boulevard.

The OCS shall be designed to be compatible with the MBTA LRV electrical and dynamic performance requirements to ensure that the vehicle pantograph maintains contact with the OCS contact wire under all local climatic, environmental, and operating conditions. Pantograph security shall be established by maintaining a minimum contact wire edge distance from the horn of the pantograph under the worst operating condition.

The OCS comprises the following major components:

- a. Catenary wires consisting of 4/0 messenger and 4/0 contact (trolley wire) with flexible, conducting catenary hangers.
- b. Feeder cables from trackside feeder disconnect switches to OCS and also running parallel to the OCS along the Corridor.
- c. Feeder taps running from the parallel feeder cables to the messenger wire.
- d. Supports consisting of cantilever assemblies or cross-span wires.
- e. In-span materials such as hangers, jumpers, insulators, splices and associated hardware.
- f. Mid-point anchors consisting of guy wires, clamps, and down guy assemblies.
- g. Tension lengths with overlaps.
- h. Poles of wide flange shapes or steel tubes poles erected between tracks and on the outside of tracks.
- i. Foundations consisting of drilled shafts, anchor bolts, ground wire connections or direct embedment.
- j. Pole structure guying including terminations and anchors.
- k. Tensioning systems consisting of balance weight assembly with weights and pulleys, and/or constant tension spring type for special applications such as cross-over tracks.
- l. OCS Protection devices such as surge arrestors with grounding.
- m. Sectioning through means of section insulators and manual disconnect switches.

11.2.2 Codes, Standards and Manuals include:

- National Electric Safety Code (NESC)
- Uniform Building Code (UBC)
- American Concrete Institute (ACI)
- American Institute of Steel Construction (AISC)
- American Railway Engineering and Maintenance-of-Way Association (AREMA)
- American Society for Testing and Material International (ASTM)
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronic Engineers (IEEE)
- State and local governing agencies and Public Utility Commissions

11.2.3 The Project Specific Requirements

11.2.3.1 Pantograph Security

A “safe zone” of +/- 6” is required from centerline of pantograph for stagger and offset. MBTA LRV’s have their pantograph located between the truck centers so that the pantograph centerline deviates from the center of the track on curves. The greater the curve radius, the greater the deviation. A pantograph security analysis in accordance with UIC 606-1 shall be performed to determine maximum pole spacing and pulloff spacing to achieve safe operation. The minimum and maximum pantograph operating heights are 12’-6” and 19’-0” respectively. The OCS shall be compatible for pantograph and trolley pole current to accommodate MBTA trolley pole equipped work vehicles and as such, clamp ears shall have hollow hex screws and the spacing of pulloffs shall not exceed twice the square root of the track curve radius. [Click here to View RFI #38](#) [Click here to View RFI #65](#)

11.2.3.2 OCS Components

All OCS components in tension used for the messenger and contact wires and down guys shall not be cast but either forged, formed, machined or drawn to prevent any casting defects including deadends, splices, section insulators, and pole clamps. OCS components shall conform to MBTA standards.

11.2.3.3 Electrical Distribution

Traction power, as described in [Section 11.1](#), is distributed to the OCS through direct current (DC) cables and disconnects switches. In the vicinity of each substation mechanical section insulators shall be provided in the OCS eastbound and westbound catenary wires to create electrical power sections. Track crossover wiring shall also have section insulation to isolate the eastbound/westbound electrical circuits. Section insulators shall be non-bridging and mechanical conforming to MBTA standards. Insulated overlaps shall not be used for section insulation.

Trackside OCS pole mounted, manually operated, DC disconnect switches with a swing angle of 180 degrees conforming to MBTA standards shall be installed on the OCS feeder cable riser poles to allow

isolation of electrical sections at specific locations in the system. They shall be mounted in a non-conducting enclosure and the enclosure shall accommodate the switch in the open and closed positions.

Jumper cables shall be provided for electrical continuity at all special track work locations where it is necessary to have electrical connection in the OCS. At locations where jumper cables are used to provide electrical continuity, such cabling shall provide conductivity that does not reduce the circuit capacity of the catenary wires.

The OCS on the Historic Viaduct section between the North Station incline and Land Boulevard is currently one electrical power section, S-8. The catenary wires for each track over the Historic Viaduct shall be isolated from each other similar to the adjacent electrical sections.

The new catenary is to be connected into the existing catenary at Land Boulevard. The wires shall be connected initially to each other with insulators to isolate the new and existing wires electrically so that the new system can be energized and de-energized without affecting the existing system. It shall be constructed so that test trains can operate through the insulators passing from the existing tracks to the new tracks and new OCS without bridging. Upon complete acceptance of the new system, the catenary wires shall be permanently spliced to the existing wires.

At Land Boulevard, the existing feeder cables in conduit are to be connected to the new aerial feeder cables at the connection of the new viaduct structure through disconnect switches. During construction, the existing catenary and cables along the viaduct shall remain in service. At the end of construction, the new catenary shall be spliced to the existing catenary. The cables in conduit shall be connected to disconnect switches. The disconnect switches shall remain open to isolate the existing system from the extension until such time that the installation has been tested and commissioned and cutover

Electrical warning signs shall be placed on OCS poles indicating the danger from high voltage.

11.2.3.4 Poles and Foundations

The DB Entity shall provide poles to suit the appropriate loading condition and factors of safety with consideration for aesthetic appearance and efficiency. Sizes and types shall be consistent with existing MBTA wide flange poles. If poles are cantilever loaded, maximum deflection shall be 2% of pole length at the point of load application for steel poles. Steel poles shall be designed so that maximum stress under extreme adverse conditions shall not exceed 2/3 of yield strength. Sufficient clearance between the pole face, the pole foundation and LRV's shall be maintained under all circumstances. Steel wide flange and tubular poles shall conform to MBTA standards. Steel poles may be anchor based or direct embedded with concrete foundations. All steel poles shall be electrically grounded by use of either ground rods and cables, direct embedment or steel foundation casing. Surge arrestor grounds shall be independent of pole grounds. [Click here to View RFI #10](#)

OCS poles shall be located at the sides of the LRV tracks except as noted below for the viaduct structure.

OCS poles shall be located between the tracks on the new viaduct structure except at junctions where they may be located at the sides of the track. On single track curves on the viaduct structure, the poles shall be located on the outside of the curve. The design shall preclude mid-span pulloffs on the viaduct.

All poles shall have number tags attached to them providing the route and the pole number. Numbering and tag shall conform to MBTA standards. Route numbers are as follows:

- Medford Branch: 364
- Union Square Branch 365
- Viaduct to split 285

Pole numbers shall be even for inbound poles and odd for outbound poles. Example: 364/1 for outbound towards Medford or 364/2 for inbound towards Boston.

11.2.3.5 Catenary

The DB Entity shall provide a mainline OCS consisting of an auto-tension simple catenary system comprised of two wires; a messenger and a contact wire having a typical system profile height of 48" for a 120' span. The nominal contact wire height shall be 15'-0". The OCS design shall be compatible with the LRV dynamic performance characteristics to ensure that current collection is maintained under all operating conditions. [Click here to View RFI #161](#)

The catenary wires shall be supported from cantilever pipes or span wires (with pulley) insulated from the supporting structures with double insulation implemented. Cantilever assemblies shall be hinged to allow for along-track movement of the catenary wires. Messenger wires shall be suspended under the top cantilever pipe to prevent binding as the cantilever swings along the tracks. Cantilever pipes shall be composed of steel pipe with an insulator at the pole hinge. Configurations shall be typical for those in use on the MBTA system. Span wire shall be 7 strand galvanized guy wire with an insulator typically 3' from the pole. The DB Entity shall provide a standard span wire of 3/8". The second insulator shall be at the energized catenary wire attachment.

The catenary shall be electrically supplemented with parallel feeder cables, in either underground conduits or on poles as required by the traction power system design. Maximum size of aerial feeder cables directly connected to the catenary shall not exceed 1000 kcmil. Feeder taps shall be included at every second cantilever location.

The yard or maintenance facility shall be a single contact wire system (trolley) suspended over the yard track structures and in the facility building and is defined in [Section 11.3](#).

11.2.3.6 Pantograph Security

The pantograph security analysis shall take into account all factors that contribute to displacement of the contact wire with respect to the pantograph. The analysis shall consider varying contact wire heights and the following:

- Conductor dimensions and tensions
- Conductor stagger
- Stagger changes due to along-track conductor movement
- Stagger effect
- Pole deflection due to live loads such as wind and conductor tension change due to temperature change (feeder cables and other ancillary wires)
- OCS erection tolerances
- Vehicle roll and lateral displacement

- Pantograph width
- Pantograph sway
- Track maintenance tolerances
- Wind and no-wind operating tolerances

The results of the study shall include:

- Maximum pole spacing as a function of track curvature
- Conductor blow-off
- Conductor along-track movement and stagger variation
- Maximum tension length to the last in-running steady arm
- Pantograph security as defined per UIC 606-1

11.2.3.7 Conductor Tension Calculations

Conductor tension calculations shall be made for the various equivalent spans as required within the final tension length layout design based upon the following:

- Conductor normal tension at 60° F
- Conductor temperatures
 - Minimum 0°F
 - Maximum 120°F
- Conductor ice loads
 - 1/2" radial ice at 0°F with 40 mph wind

The messenger wire shall be constant tensioned at a tension of 4,000 lbs. The contact wire shall be constant tensioned at 3,000 lbs.

11.2.3.8 Tension Lengths and Overlaps

The OCS shall consist of a number of overlapping tension sections. Each tension section shall be a maximum length considering the constraints of the overhead system design such as along-track movement of the last in-running cantilever, tension loss of the system, and tensioning device travel. Tension lengths shall be terminated at each end by auto tensioning devices of balance weights with pulleys at a 3:1 ratio or fixed terminations at one end as necessary for half tension lengths.

A full tension length shall have two tensioning devices, one on each end and a mid-point anchor midway between the two tensioning devices. A half tension length shall have a fixed termination on one end and a tensioning device on the other. Maximum tension length shall be 3,000 feet. For grades of 1% or greater, the tensioning device shall be at the lower end. Maximum tension lengths shall be determined from:

- Along-track movement of in running cantilevers
- Vertical curves
- Horizontal curves

- Stagger change
- Tensioning device movement
- Tension loss (not to exceed 8%)

Overlaps shall be designed using either point overlaps or spanned overlaps and the contact wire heights at overlaps shall be designed with consideration of the mechanical properties of the OCS. The design shall enable a smooth transition between adjacent contact wires without hard spots or pantograph bounce. The contact wire heights shall be equalized at the overlap so the pantograph rides on both wires. With center pole overlaps, the overlaps shall be staggered along the track to prevent undue fouling of OCS components and tensioning devices.

Balance weights shall be positioned on the downhill side of tension lengths on inclines or other gradients in excess of 1%.

All overlaps and turnout wires shall have jumper cables connecting the messenger and contact wires for electrical equalizing. Mid-span or in span jumpers in the catenary shall be the JRA-1 type shown in Exhibit 2H conforming to the shape and with the components indicated.

11.2.3.9 Catenary Hardware

Catenary hardware shall be utility and industry standard material designed for the intended application. Specific items required by the MBTA for compatibility and operational standardization shall conform to MBTA specifications or specific manufacturer part number as indicated below.

- Messenger Wire - 4/0 19-strand copperweld type EK, MBTA Specification P-178 Specification for 4/0 messenger cable
- Contact Wire - Single AWG 4/0 bronze alloy 80 grooved, and adhering to standard MBTA Specification Section P-102B Specifications for the purchase of grooved bronze trolley wire 80% conductivity
- Catenary Hanger Wires - Stranded alloy 80 flexible wire with identical messenger wire and contact clamps. Wire shall be articulated at the clamp connection and the assembly conforming to MBTA Specification P-160
- Feeder Cable - Aerial Feeder cable shall not be greater than 1000 kcmil and shall conform to MBTA standard specifications for positive cable
- Wire purchase of zinc-coated steel - MBTA Standard P-108B The purchase of zinc-coated steel wire
- Conduits - MBTA Standard P-138E Fiberglass epoxy conduits
- Feeder Switches - MBTA Standard P-150F Feeder insulating switches
- Catenary Hanger - MBTA Standard P-160 Specifications for flexible catenary hanger
- Elastic Arm - MAC Products Elastic Arms part number B0676-03 with adjustable end or approved equal.
- Balance Weights - MBTA Standard P-170 Specification for counter weights. Pulley arrangement shall be 3:1.

- Feed Tap Cable - MBTA Standard P-179 Specification for 4/0 flexible feed tap cable
- Wide Flange Beams - MBTA Specification P-190 Wide flange beams catenary support columns
- Tubular Steel Poles - MBTA Specification P22H Tubular Steel Poles
- Span Spacer - MAC Products Span Spacer Part No. KMA-469 or approved equal
- Crossarms - MBTA Drawings: L-12807-A Special Twisted Brace for Crossarms; B-12774-F for Crossarms Types Q, QA, E, N; SK-614-A 30" Cross Arm Brace or approved equal. Refer to the Project Standard Plans.
- Switch Box Sign - MBTA Drawing A-717-E Porcelain Enamel Sign for Switch Boxes
- Section Insulator-main line - MAC Products section insulator part number B1170-02 or approved equal.
- Clamp Ear - MAC Products Part No. B0348-01 or approved equal.
- Surge Arrestor - Ohio Brass PDV-65, 3 kV or approved equal.
- Bulldog Trolley Wire Splicer, 4/0 - Impulse NC Part No. 16685 or approved equal.

11.2.3.10 Contact Wire Gradients

Where the height of the contact wire must be lowered or raised, it shall correspond to the slope in Table 11.2-1.

Table 11.2-1 — Contact Wire Gradients

LRV Speed	Maximum Slope
60	1:166
50	1:133
40	1:107
30	1:80
20	1:53

11.2.3.11 Safety Factors

The DB Entity shall utilize the safety factors for each element listed in Table 11.2-2.

Table 11.2-2 — Safety Factors

ITEM	SAFETY FACTOR
Messenger Wire	3
Contact Wire	2 (Safety factor at 30% wear)
Catenary Hanger Wires	2
Feeder Cable	2
Guy Wire	2
Pole Foundations	1.5

11.2.3.12 Grounding

OCS poles shall be grounded with a resistance of 25 ohms or less at 68°F. Grounding wires along the right of way shall be hidden and ground rods, if used, shall have below grade connections. All connections to poles, ground rods and other connections shall be by exothermic weld.

Surge arrestors shall have independent ground wires and ground rods from OCS poles. The resistance shall be 5 ohms or less at 68°F. If the arrestor is in a passenger station or area traversed by the public, the ground wire shall be placed in a FRE conduit from below grade to 10 feet above the ground line. Surge arrestors shall be to MBTA standard.

11.3 OVERHEAD CONTACT SYSTEM - TRAIN STORAGE YARD

11.3.1 Scope of Work

The Work includes construction of an overhead contact system (OCS) for LRVs that operate in one, two or three LRV Consists. New construction shall be in the train storage yard in conjunction with civil, structural, and track work from the new corridor into and throughout the new storage yard and maintenance facility building. The OCS shall be tied into the new lines running from the main line to the maintenance facility.

The Work shall include installation of poles, foundations, cables, pole attachments, catenary wires, balance weights, crossarms, steel structures, bridge supports, bridge protection, surge arrestors, pole identification, Maintenance Building OCS including roll up door bridge assemblies, disconnect switches, warning lights, consideration for future OCS build on yard lead viaduct structures, and all else associated with an overhead contact wire system.

The OCS comprises of the following major components:

- a. Contact wires consisting of 4/0 alloy 80 (trolley wire) with span wire and cantilever suspension;
- b. Feeder cables from trackside feeder disconnect switches to;
- c. Feeder taps running from the parallel feeder cables to the contact wire;
- d. Supports consisting of cantilever assemblies or cross-span wires;
- e. In-span materials such as hangers, jumpers, insulators, splices and associated hardware;
- f. Tension lengths with overlapping wires at turnouts;
- g. Poles of wide flange shapes erected between tracks or on the outside of tracks;
- h. Foundations consisting of drilled shafts, anchor bolts, ground wire connections or direct embedment;
- i. Pole structure guying including terminations and anchors;
- j. Tensioning systems consisting of small tension springs for regulating contact wire tensions during elevated temperatures;
- k. OCS Protection devices such as surge arrestors with grounding; and
- l. Sectioning by means of section insulators and manual disconnect switches.

11.3.2 Codes, Standards and Manuals

OCS design shall include the following applicable codes and standards:

- National Electric Safety Code (NESC)
- Uniform Building Code (UBC)
- American Concrete Institute (ACI)
- American Institute of Steel Construction (AISC)
- American Railway Engineering and Maintenance-of-Way Association (AREMA)

- American Society of Testing and Materials International (ASTM)
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronic Engineers (IEEE)
- State and local governing agencies and Public Utility Commissions

11.3.3 The Project Specific Requirements

11.3.3.1 Pantograph Security

A “safe zone” of +/- 6 inches is required from centerline of pantograph for stagger and offset. MBTA LRV’s have their pantograph located between the truck centers at 6’-6” from the center truck so that the pantograph centerline deviates from the center of the track on curves. The greater the curve radius, the greater the deviation. A pantograph security analysis shall be performed to determine maximum pole spacing and pulloff spacing to achieve safe operation. The minimum and maximum pantograph operating heights are 12’-6” and 19’-0” respectively. The OCS shall be compatible for pantograph and trolley pole current to accommodate MBTA trolley pole equipped work vehicles and as such, clamp ears shall have hollow hex screws and the spacing of pulloffs shall not exceed twice the square root of the track curve radius.

11.3.3.2 OCS Components

All OCS components in tension used for the contact wires and down guys shall not be cast but either forged, formed, machined or drawn to prevent any casting defects including deadends, splices, section insulators, and pole clamps. OCS components shall conform to MBTA standards.

11.3.3.3 Electrical Distribution

The DB Entity shall distribute traction power to the VMF from Red Bridge Substation via feeder cables provided by the traction power system. Within the VMF and storage tracks the catenary shall be sectionalized as required by the MBTA to facilitate operations. Section insulators for the yard only shall be non-bridging and mechanical conforming to the MBTA standard section insulator, NO-BO type by Impulse NC or approved equal. Insulated overlaps shall not be used for power section isolation.

Trackside pole mounted, manually operated, DC disconnect switches with a swing angle of 180 degrees conforming to MBTA standards shall be installed on the OCS feeder cable riser poles to allow isolation of electrical sections at specific locations in the system. The switches shall be mounted in a non-conducting enclosure and the enclosure shall accommodate the switch in the open and closed positions. Where disconnect switches are located inside the maintenance facility, the handle of the switch blades shall hang outside of the enclosure when the switch is in the open position and the handle shall be painted bright yellow.

Jumper cables shall be provided for electrical continuity at all special track work locations where it is necessary to have electrical connection in the OCS. At locations where jumper cables are used to provide electrical continuity, such cabling shall provide conductivity that does not reduce the circuit capacity of the catenary wires.

Electrical warning signs shall be placed on OCS poles indicating the danger from high voltage.

11.3.3.4 Poles and Foundations

Poles shall be selected to suit the appropriate loading condition and factors of safety with consideration for aesthetic appearance and efficiency. Sizes and types shall be consistent with existing MBTA wide flange poles. If poles are cantilever loaded, maximum deflection shall be 2% of pole length at the point of load application for steel poles. Steel poles shall be designed so that maximum load under extreme adverse conditions shall not exceed 2/3 of yield strength. Sufficient clearance between the pole face, the pole foundation and LRV's shall be maintained under all circumstances. Steel wide flange and tubular poles shall conform to MBTA standards. Steel poles may be anchor based or direct embedded with concrete foundations. All steel poles shall be electrically grounded by use of either ground rods and cables, direct embedment or steel foundation casing. Surge arrestor grounds shall be independent of pole grounds.

Pullovers on curves shall be spaced by an amount corresponding to twice the square root of the curve radius.

All poles shall have number tags attached to them providing the route and the pole number. Numbering and tag shall conform to MBTA standards. Route number is as follows:

- Yard: 366

Pole numbers shall be sequential as there is no inbound/outbound side.

11.3.3.5 Contact Wire

The Yard OCS shall consist of a variable tension single contact wire system comprised of a contact wire having a typical span length not to exceed 120 ft. span. The nominal contact wire height shall be 16'-0". The OCS design shall include the contact wire, and the pole and structures that support the aerial conductors. The OCS design shall be compatible with the LRV dynamic performance characteristics to ensure that current collection is maintained under all operating conditions.

The contact wires shall be supported from cantilever pipes or span wires insulated from the supporting poles or structures with double insulation implemented. Cantilever assemblies shall be hinged to allow for any along-track movement of the catenary wires. Cantilever pipes shall be composed of steel pipe with an insulator at the pole hinge. Configurations shall be consistent with those in use on the Existing Green Line. Span wire shall be 7 strand galvanized guy wire with an insulator typically 3 feet from the pole. The second insulator is at the energized contact wire suspension assembly. The DB Entity shall provide the MBTA standard span wire of 3/8".

The catenary shall be electrically supplemented with parallel feeder cables where necessary. Maximum size of aerial feeder cable shall not exceed 1000 kcmil.

The DB Entity shall provide a contact wire in the maintenance facility that shall be a single contact wire system (trolley) suspended from elastic hangers attached to a non-conducting fiberglass protection board. The wire in the maintenance facility shall have diode warning lights to indicate whether the wire is dead or alive.

11.3.3.6 Pantograph Security

The pantograph security analysis shall take into account all factors that contribute to displacement of the contact wire with respect to the pantograph. The analysis shall consider varying contact wire heights and the following:

- Conductor dimensions and tensions
- Conductor stagger
- Stagger changes due to along track conductor movement
- Stagger effect
- Pole deflection due to live loads such as wind and conductor tension change due to temperature change (feeder cables and other ancillary wires)
- OCS erection tolerances
- Vehicle roll and lateral displacement
- Pantograph width
- Pantograph sway
- Track maintenance tolerances
- Wind and no-wind operating tolerances

The results of the pantograph security analysis shall include:

- Maximum pole spacing as a function of track curvature
- Conductor blow-off
- Conductor along-track movement and stagger variation
- Maximum tension length to the last in-running steady arm
- Pantograph security

11.3.3.7 Conductor Tension Calculations

Conductor tension calculations shall be made for various equivalent spans based upon the following:

- Conductor normal tension at 60° F
- Conductor temperatures
 - Minimum 0°F
 - Maximum 120°F
- Conductor ice loads
 - 1/2" radial ice at 0°F with 40 mph wind

11.3.3.8 Tension Lengths and Overlaps

The OCS shall consist of a number of tension sections over each track. Each tension section shall be a required length considering the constraints of the overhead system design running from deadend to deadend. Tension lengths shall be terminated at each end by small open spring box design tensioning devices or fixed terminations as necessary with at least one spring per tension length.

The spring shall regulate tension in elevated temperatures to keep sufficient tension on the contact wire to prevent undue sagging. Contact wire shall be tensioned with an initial tension of 2,250 lbs. at 60°F. Tension tables shall be developed for tensioning the contact wire at various temperatures according to the stated temperature range.

Wire crossings at turnouts or track crossings shall be designed with consideration of the mechanical properties of the OCS. The design shall enable a smooth transition between adjacent contact wires without hard spots or pantograph bounce. The contact wire heights shall be equalized at the transition so the pantograph rides under both wires.

All overlaps and turnout wires shall have jumper cables connecting the contact wires for electrical equalizing. Feeder taps shall connect the contact wire to the parallel feeder cables approximately every 250 ft.

11.3.3.9 Catenary Hardware

Catenary hardware shall be utility and industry standard material designed for the intended application. Specific items required by the MBTA for compatibility and operational standardization shall conform to MBTA specifications or specific manufacturer part number as indicated below.

- Contact Wire - Single AWG 4/0 bronze alloy 80 grooved, and adhering to standard MBTA Specification Section P-102B Specifications for the purchase of grooved bronze trolley wire 80% conductivity
- Catenary Hanger Wires - Stranded alloy 80 flexible wire with identical messenger wire and contact clamps. Wire shall be articulated at the clamp connection and the assembly conforming to MBTA Specification P-160
- Feeder Cable - Aerial Feeder cable shall not be greater than 1000 kcmil and shall conform to MBTA Standard specifications for positive cable
- Wire purchase of zinc-coated steel - MBTA Standard P-108B The purchase of zinc-coated steel wire
- Conduits – MBTA Standard P-138E Fiberglass epoxy conduits
- Feeder Switches - MBTA Standard P-150F Feeder insulating switches
- Door Bridge Assembly - Impulse 22460 or approved equal.
- Elastic Arm - MAC Products Elastic Arms part number B0676-03 with adjustable end or approved equal.
- Elastic Hanger - MAC Products part number C1454-01 with insulation block part number E1248-01/D0928-01 or approved equal.

- Feed Tap Cable - MBTA Standard P-179 Specification for 4/0 flexible feed tap cable
- Wide Flange Beams - MBTA Specification P-190 Wide flange beams catenary support columns
- Tubular Steel Poles - MBTA Specification P22H Tubular Steel Poles
- Span Spacer - MAC Products Span Spacer Part No. KMA-469 or approved equal.
- Crossarms - MBTA Drawings: L-12807-A Special Twisted Brace for Crossarms; B-12774-F for Crossarms Types Q, QA, E, N; SK-614-A 30" Cross Arm Brace or approved equal. Refer to the Project Standard Plans.
- Switch Box Sign - MBTA Drawing A-717-E Porcelain Enamel Sign for Switch Boxes
- Section Insulator-Yard - Impulse No-Bo Section Insulator Part No. 17216 (14" underrun) or approved equal.
- Clamp Ear - MAC Products Part No. B0348-01 or approved equal.
- Surge Arrestor - Ohio Brass PDV-65, 3 kV, or approved equal.
- Bulldog Trolley Wire Splicer, 4/0 - Impulse NC Part No. 16685 or approved equal.

11.3.3.10 Contact Wire Gradients

The slope of the contact wire shall not vary excessively from the top of track. Where the height must be lowered or raised, it shall correspond to the slopes in Table 11.3-1.

Table 11.3-1 – Contact Wire Gradients

LRV Speed	Slope
60	1:166
50	1:133
40	1:107
30	1:80
20	1:53

11.3.3.11 Safety Factors

The DB Entity shall utilize the safety factors for each element listed in Table 11.3-2.

Table 11.3-2 – Safety Factors

ITEM	SAFETY FACTOR
Messenger Wire	3
Contact Wire	2 (Safety factor at 30% wear)
Catenary Hanger Wires	2
Feeder Cable	2
Guy Wire	2
Pole Foundations	1.5

11.3.3.12 Grounding

OCS poles shall be grounded with a resistance of 25 ohms or less at 68°F. Grounding wires along the right of way shall be hidden and ground rods, if used, shall have below grade connections. All connections to

poles, ground rods and other connections shall be by exothermic weld.

Surge arrestors shall have independent ground wires and ground rods from OCS poles. The resistance shall be 5 ohms or less at 68°F. If the arrestor is in a passenger station or area traversed by the public, the ground wire shall be placed in a FRE conduit from below grade to 10 feet above the ground line. Surge arrestors shall be to MBTA standard.

11.4 TRAIN CONTROL AND SIGNALING – COMMUTER RAIL TRANSIT SYSTEM

11.4.1 Scope of Work

The Work shall include the coordination of the track Work with signal work to be conducted by the Railroad. Pre-wired signal instrument houses (SIH) and other wayside signal infrastructure will be placed in service by the Railroad in varying stages to coincide with the scheduled track work and track shifts under the DB Contract. The Work shall be coordinated with the Railroad and in consideration of the Railroad operations requirements and staffing constraints. Interface to certain existing systems, installation of new systems, and retirement of other certain existing systems shall be required and coordinated within any Work and schedules submitted for approval as part of the Work.

There is one control point universal interlocking located within the Site (Somerville Junction), which shall be removed/retired as part of the early works and replaced by a new universal interlocking (Tufts) approximately one mile north of Somerville Junction as shown in [Exhibit 2B.2](#).

11.4.2 Codes, Standards and Manuals include:

- American Railway Engineering and Maintenance of Way Association (AREMA) Communications and Signals Manual
- Federal Railroad Administration (FRA) Code of Federal Regulations Part 49 (CFR 49)
- Federal Transportation Administration (FTA)
- Massachusetts Department of Public Utilities (DPU)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Manufacturer’s Association (NEMA)
- Federal Highway Administration (FHWA)
- Manual on Uniform Traffic Control Devices (MUTCD)
- American National Standards Institute (ANSI) standards
- American Society for Testing and Material (ASTM) standards
- American Society for Quality Control (ASQC) standards
- Insulated Power Cable Engineers Association (IPCEA) standards
- Electronic Industries Association (EIA) standards
- Massachusetts Electric Code (MEC)
- National Electric Safety Code (NESC)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories (UL) standards
- MBTA standards, practices, and recommendations

11.5 TRAIN CONTROL AND SIGNALING - LIGHT RAIL TRANSIT SYSTEM

11.5.1 Scope of Work

The Work includes extending the existing system signal system from its current terminus point at Lechmere Station to new terminus points at both College Ave and Union Square, including the yard lead tracks up to, but not including the VMF. The DB Entity shall interface with the existing system signal system. Modification by DB Entity to the existing signal system on the concrete section of the East Cambridge Viaduct will be required.

The Work includes:

- Design, procurement, fabrication and installation of central instrument houses (CIH) to house all signal system control equipment.
- Procurement and installation of all wayside equipment and materials required to interface with the CIH's.
- Design, procurement, fabrication and installation of a switch heater system including separate switch heater cases, heater elements, and all other equipment required to furnish a 600V DC powered switch heating system.
- Demolition of existing wayside signals on the viaduct including associated cable, insulated joints, and CIH equipment.
- Tie-in to existing signal system at Science Park and North Station.
- Complete testing and activation of all systems installed.
- Training of MBTA maintenance, engineering and operating department staffs.
- Design and construct all LRT control and signaling necessary for the Project.

11.5.2 General Requirements

11.5.2.1 Proposed System

The signal system for the extension shall be consistent with the existing automatic block color light signal system using the latest underlying technology and products, while utilizing a combination of vital and non-vital processors to control and indicate the wayside signal components. The signal control system shall be centralized in CIH's located in close proximity to the stations and not distributed along the right-of-way (ROW) in wayside enclosures. The existing Automatic Vehicle Identification (AVI) system shall be extended to include the additional interlockings and movements to the Yard. Route requests shall be available via the AVI system with a pushbutton backup, local control panels within the CIH's, and via remote control from the Operations Control Center (OCC). Physical work at the OCC to be performed by the MBTA with the DB Entity interface and support for testing and activation.

11.5.2.2 College Ave and Union Square Interlockings

College Avenue and Union Square interlockings shall serve as the terminus interlocking for the Medford Branch and Union Square Branch respectively. These interlockings shall be controlled both remotely from OCC and locally from the CIH. Route requests shall be both manual and field automatic.

In field automatic, outbound route selection shall be triggered by occupancy of the outbound approach track circuits to the available platform track. If the approach track becomes unoccupied for more than one minute after request the route shall be cancelled. The preferred move for outbound trains shall be to crossover to the inbound platform if unoccupied. Inbound moves from the platform tracks shall be by wayside push button or automatic train dispatching (ATD) from the OCC. Wayside push buttons shall only be available while in field automatic.

All crossovers shall automatically restore to the normal position after the train has accepted the route and cleared the interlocking.

There shall be remote and local control for an adverse route back to both platform tracks available from the home signal on the inbound track.

AVI indication only sites shall be located on both track circuits west of the platform tracks to indicate a train has entered back into revenue service.

For outbound home signals the platform track shall be occupied for the pushbutton request to be valid.

Sectional release shall be provided on all routes except those where DB Entity demonstrates through their operational analysis there is no operational value.

Switch resequencing logic shall be supplied whereby after three failed attempts to throw and gain correspondence the switches shall be taken out of service, and specific indication supplied to the OCC to alert to this condition.

Non-vital switch and exit blocking shall be provided for all switches and signals to prevent establishment of routes into occupied and/or designated out of service zones. Field automatic shall not be available with any blocks applied.

The OCC shall require constant communication and receipt of indications from the field non-vital processors. In the event communication to OCC from both non-vital processors is lost for more than two minutes, the system shall switch to field automatic for route requests and shall stay in field automatic until communication to OCC is re-established. Once communication is restored, the system shall revert to whichever route requests state it was in before the communication failure occurred. If any blocks are applied field automatic is not available.

College Ave interlocking shall require inbound repeater signals at both platforms if line of sight cannot be achieved between the platforms and the inbound home signals at the crossover.

11.5.2.3 East Somerville Interlocking

East Somerville interlocking shall serve as the Medford Branch entry/exit point to the yard lead tracks and shall also serve as a mid-line automatic turn-back interlocking when required. Automatic turn-back logic

shall be incorporated with a means both locally and remote to enable/disable. This interlocking shall normally operate as an in-line station with trains continuing outbound after passengers disembark. This interlocking shall be controlled both remotely from OCC and locally from the CIH. Route requests shall be both manual and field automatic.

In field automatic, outbound route selection shall be triggered by occupancy of the outbound approach track circuits. The exit from the yard lead track is within the outbound approach to this interlocking and the route request to exit onto the main line shall be by wayside pushbutton. If the approach track becomes unoccupied for more than one minute after request the route shall be cancelled. The logic shall incorporate a first-in first out approach, in that the first train to request a route to the outbound platform from either the main line or yard lead shall be granted. Inbound requests shall be by AVI request with wayside pushbutton backup for either a move inbound towards Lechmere or diverging into the yard lead track.

This interlocking shall incorporate a storage track with routes both into and out of this track via manual route request or field automatic via wayside push button.

When in turn-back mode, all crossovers shall automatically restore to the normal position after the train has accepted the route and cleared the interlocking.

There shall be adverse routes back to both platform tracks available from the home signal on the inbound track and yard entry track via manual route request or field automatic via wayside pushbutton.

AVI indication only sites shall be located at each yard lead and storage track exit point to indicate a train has entered back into revenue service.

A 50' track circuit shall be installed approaching the home signals requiring occupancy for the pushbutton request to be valid. Within station platforms, the platform track shall serve this function.

Sectional release shall be provided on all routes except those where DB Entity demonstrates through their operational analysis there is no operational value.

Switch resequencing logic shall be supplied whereby after three failed attempts to throw and gain correspondence the switches shall be taken out of service, and specific indication supplied to the OCC to alert to this condition.

Non-vital switch and exit blocking shall be provided for all switches and signals to prevent establishment of routes into occupied and/or designated out of service zones. Field automatic shall not be available with any blocks applied.

The OCC requires constant communication and receipt of indications from the field non-vital processors. In the event communication to OCC from both non-vital processors is lost for more than two minutes, the system shall switch to field automatic for route requests and shall stay in field automatic until communication to OCC is re-established. Once communication is restored, the system shall revert to whichever route requests state it was in before the communication failure occurred. If any blocks are applied field automatic is not available.

11.5.2.4 Red Bridge Interlocking

Red Bridge interlocking shall serve as the point where outbound trains shall either continue outbound on the Medford Branch to East Somerville Station, or divert to the Union Branch to Union Square Station. This interlocking shall be controlled both remotely from OCC and locally from the CIH. Route requests shall be both manual and field automatic.

In field automatic outbound trains approaching this interlocking shall be routed to either branch by AVI route request with pushbutton backup. Inbound trains on the Medford Branch shall have routes requested via approach track circuit occupancy. Inbound trains on the Union Branch shall be held at McGrath interlocking until Red Bridge interlocking is able to setup a route for the Union Branch train to depart McGrath and clear through the Red Bridge interlocking, to avoid train having to stop on the steep grade. Wayside push buttons shall only be available while in field automatic.

An AVI indication only site shall be located on the inbound interlocking track west of the switch to indicate a train from the Union Branch has arrived on the Medford Branch.

A 50' track circuit shall be installed approaching the outbound Medford Branch home signal requiring occupancy for the pushbutton request to be valid.

Sectional release shall be provided on all routes except those where DB Entity demonstrates through their operational analysis there is no operational value. Submit to owner any proposed exceptions for approval.

Non-vital switch and exit blocking shall be provided for all switches and signals to prevent establishment of routes into occupied and/or designated out of service zones. Field automatic shall not be available with any blocks applied.

The OCC shall require constant communication and receipt of indications from the field non-vital processors. In the event communication to OCC from both non-vital processors is lost for more than two minutes, the system shall switch to field automatic for route requests and shall stay in field automatic until communication to OCC is re-established. Once communication is restored, the system shall revert to whichever route requests state it was in before the communication failure occurred. If any blocks are applied field automatic is not available.

11.5.2.5 McGrath Interlocking

McGrath interlocking shall serve as the point where all Union Branch trains enter and exit the yard via a single yard lead track. This interlocking shall be controlled both remotely from OCC and locally from the CIH. Route requests shall be both manual and field automatic.

In field automatic inbound trains departing Union Square interlocking shall be routed via AVI route request with wayside pushbutton backup either straight inbound to Red Bridge interlocking and the Medford Branch or diverging into the yard lead. Outbound trains entering the Union Branch via Red Bridge interlocking shall be held at Red Bridge until McGrath interlocking can be cleared for the outbound train departing Red Bridge to avoid the train having to stop on the steep grade. Trains exiting the yard lead track outbound shall have routes cleared via wayside pushbutton request. The logic shall incorporate a first-in first out approach, in that the first train to request a route outbound through McGrath interlocking

from both the main line and yard lead shall be granted. Wayside push buttons shall only be available while in field automatic.

The crossover shall automatically restore to the normal position after the train has accepted the route and cleared the interlocking.

An AVI indication only site shall be located at the yard lead track exit point to indicate a train has entered back into revenue service.

A 50 Ft. track circuit shall be installed approaching the inbound home signal and yard exit signal requiring occupancy for the pushbutton request to be valid.

Sectional release shall be provided on all routes except those where DB Entity demonstrates through their operational analysis there is no operational value. Submit to owner any proposed exceptions for approval.

Non-vital switch and exit blocking shall be provided for all switches and signals to prevent establishment of routes into occupied and/or designated out of service zones. Field automatic shall not be available with any blocks applied.

The OCC requires constant communication and receipt of indications from the field non-vital processors. In the event communication to OCC from both non-vital processors is lost for more than two minutes, the system shall switch to field automatic for route requests and shall stay in field automatic until communication to OCC is re-established. Once communication is restored, the system shall revert to whichever route requests state it was in before the communication failure occurred. If any blocks are applied field automatic is not available.

11.5.2.6 Brickbottom Interlocking

Brickbottom interlocking shall serve as the point where trains crossover from one yard lead track to the other on the Medford Branch yard lead tracks and is also the entry and exit point to the non-signaled yard. This interlocking shall be controlled both remotely from OCC and locally from the CIH. Route requests shall be both manual and field automatic.

Consistent with the main line tracks operation, the Medford Branch yard lead tracks are only signaled for single direction running. In field automatic the outbound signals shall clear routes only to the outbound track, and shall be accomplished via pushbutton request. The inbound towards the yard signals shall be capable of clearing a route to either yard track via pushbutton request, as the limits of this interlocking define the end of signal territory. Wayside push buttons shall only be available while in field automatic.

A 50 Ft. track circuit shall be installed approaching each home signal requiring occupancy for the pushbutton request to be valid.

Sectional release shall be provided on all routes except those where DB Entity demonstrates through their operational analysis there is no operational value. Submit to owner any proposed exceptions for approval.

Non-vital switch and exit blocking shall be provided for all switches and signals to prevent establishment of routes into occupied and/or designated out of service zones. Field automatic shall not be available with any blocks applied.

The OCC requires constant communication and receipt of indications from the field non-vital processors. In the event communication to OCC from both non-vital processors is lost for more than two minutes, the system shall switch to field automatic for route requests and shall stay in field automatic until communication to OCC is re-established. Once communication is restored, the system shall revert to whichever route requests state it was in before the communication failure occurred. If any blocks are applied field automatic is not available.

11.5.3 Codes, Standards and Manuals include:

- American Railway Engineering and Maintenance of Way Association (AREMA) Communications and Signals Manual
- American Public Transit Association (APTA)
- Federal Railroad Administration (FRA) Code of Federal Regulations Part 49 (CFR 49)
- Federal Transportation Administration (FTA)
- Massachusetts Department of Public Utilities (DPU)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Manufacturer's Association (NEMA)
- Federal Highway Administration (FHWA)
- Manual on Uniform Traffic Control Devices (MUTCD)
- American National Standards Institute (ANSI) standards
- American Society for Testing and Material (ASTM) standards
- American Society for Quality Control (ASQC) standards
- Insulated Power Cable Engineers Association (IPCEA) standards
- Electronic Industries Association (EIA) standards
- Massachusetts Electric Code (MEC)
- National Electric Safety Code (NESC)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories (UL) standards
- MBTA Subway Operations Light Rail Rulebook
- MBTA standards, practices, and recommendations

11.5.4 The Project Specific Requirements

11.5.4.1 Functional Requirements

The Automatic Block Signaling (ABS) System shall be designed to control light rail vehicle operations on the mainline and entering and exiting the yard. The system shall be designed in a vital, fail safe manner,

with provisions for making the system operationally efficient, maintainable, cost effective, and upgradeable. The system shall be configured with major subsystems as follows:

(a) Vital Control System

The vital signal system shall be designed, and perform, so as to provide safe movement of all trains and their passengers. The vital system will process and execute all vital functions in accordance with the latest industry standards. The vital system shall include, but not be limited to, all applicable electrical circuits and “hard” wiring, redundant microprocessors, track circuits, line circuits, vital relays and all life/safety components that make up the signal system.

Vital microprocessor interlocking systems (VMIS) shall be used for the design and logic development of the vital signaling systems. The design shall call for furnishing, installing and testing all components and aspects of the redundant VMIS. The VMIS will control and receive indications from wayside signal devices. This shall include but not be limited to all control line and vital safety functions.

Non-vital functions or logic shall not be performed in the VMIS. Non-vital functions will be allowed for communications purposes only between the vital and non-vital processors. The VMIS shall be designed so that all logic and functions can be acceptance tested without influence from the non-vital logic or functions. The non-vital logic shall be disabled or replaced with a test program using the proper I/O and nomenclature to inject requests as needed to initiate the vital logic functions under test.

The vital system shall be designed based upon the closed circuit/loop principles, software diversity, use of proven vital hardware design techniques, and the manufacturer’s safety model to achieve safety for the vital components and system. The use of multiple processors based on voting to achieve safety is acceptable. All vital function inputs and outputs shall use printed circuit boards designed for double-break application, and all vital wiring to the vital processors shall be double broken. All input/output and interface wiring for either VMIS system (normal and standby) shall be designed to be completely isolated so that a failure of any component affecting one of the VMIS units will not impact the other system.

The redundant VMIS units shall execute the same logic/application when in their final configuration to support operations. There shall be no difference between the two systems. It will be acceptable to have different logic/applications running during acceptance testing only.

The power feeds to the redundant VMIS systems shall be isolated and separately fused so that a failure in one unit shall not affect the partner unit. The input/output circuits of each VMIS unit shall be separately fused and isolated so that the failure of either system shall not impact the other.

The redundant VMIS units shall be designed to function in a “hot-standby” manner, with the offline unit taking immediate control without delay and without having to run approach times when required by a failure of the online unit. Each unit shall be clearly labeled “Normal” and “Standby.” The transfer to the partner unit shall be automatic and instantaneous. Transfer of control between normal and standby units shall not compromise the processor controlled and indication functions. These functions shall be designed in a fail-safe mode to prevent the

clearing of signals into a protected section of track. There shall be no preference or default normal state in the transfer logic for normal or standby operation. However, one unit shall be designated as "Normal" and the other as "Standby". Each unit shall provide a "health" status to indicate system availability to support system failover and transfer from the Status and Control panel and OCC. A failover of the VMIS shall not affect the non-vital system.

In addition to the "Normal" and "Standby" units, a third cold standby unit shall be rack installed complete with all (same count) boards specific to the VMIS units installed and running at that installation. The cold standby system shall include microprocessor hardware with application and executive logic preloaded and matching the final configuration of those running in the normal and standby VMIS units. Additionally, the cold standby shall include any boards that have site specific IC chips. The programming of these spare boards shall be fully tested during acceptance testing so that field maintenance personnel can replace a failed executive system board without performing extensive field testing to certify application logic.

VMIS system shall have a proven record (a period of at least five years in revenue service) of implementation and the operation within a 13.8KVAC or higher and 600VDC electrified rail transit environment.

VMIS system shall be proven to be reliable, maintainable, and provides operational flexibility and safety of train movements.

Each VMIS processor (except the cold standby unit) shall perform internal self-diagnostics that will quickly and accurately identify failed boards or vital processes as they occur.

If the non-vital system or OCC link fails, the VMIS shall continue to operate and execute vital logic.

Application logic development shall be done by the DB Entity on a system certified by the VMIS manufacturer using their most recent stable development platform. The application logic development shall be done using a graphical user interface using a standard relay or ladder logic methodology.

An application development and monitoring system suited for field installation shall be provided with each VMIS unit.

Use of manufacturer limited retest processes will be acceptable following proof and demonstration of that process to the MBTA for acceptance.

Site licenses shall be provided to use all furnished system software for the entire MBTA infrastructure without limitation.

100% spare capacity for normal and standby systems for future expansion in application logic shall be provided.

20% spare capacity for all installed I/O for the normal and standby systems for future expansion shall be provided.

All timers other than loss of shunt shall be externally settable or settable in such a way that it does not require the reloading of application logic.

Event recording/data logging of all inputs, outputs, timers, and logic states of variables shall be logged and recorded. The capacity will allow for a minimum of 30 days of data storage before overwriting any data.

The design shall log all maintenance and diagnostic indications for troubleshooting purposes. Diagnostic data shall be displayed in a supplier provided development tool on the Maintainers Computer to assist in the efficiency of troubleshooting and taking corrective action.

All VMIS and associated apparatus shall be rack mounted.

(b) Non-Vital Control System

The non-vital portion of the signal system shall be comprised of various systems to assist in the efficient operation and monitoring of all signal system equipment and all train movements. At a minimum, these systems shall include redundant non-vital processors, redundant signal data networks, diversely routed and redundant signal fiber networks, interfaces with the VMIS units, interfaces with the MBTA Operations Control Center, interfaces with the AVI system, non-vital relays, non-vital event recorders, and support for Local Control and Maintainer Panels.

Redundant non-vital processors shall be used to process all logic functions other than the vital functions that are performed in the VMIS units. The non-vital processors can be microprocessor-based, integrated Vital and Non-Vital Microprocessor Interlocking Systems as long as the vital and non-vital programs can be separately programmed and tested without adversely affecting each other. A fallback position if these requirements cannot be achieved will be use of non-vital PLC (NVPLC) type systems similar to those in use currently by the MBTA. All user control and indications of wayside devices shall be through the non-vital processor systems.

The redundant non-vital systems shall be configured to have the same standby capabilities as the vital system. Each non-vital processor shall be able to be online and working with either vital processor, and vice versa.

The non-vital control system shall be the interface point for communication to the OCC.

The non-vital control system shall be designed and programmed to allow the removal of control from the OCC by emergency release on the local control panel.

The non-vital system shall communicate to the VMIS through a serial or ethernet connection.

The non-vital system shall have event recording for all inputs, outputs, and non-vital functions. All event recorder data shall be recorded, time/date stamped and accessible on the network or via dialup phone line. The non-vital control system event recorder shall have a capacity that will allow for a minimum of 30 days of data storage before overwriting any data.

The non-vital application design shall log all maintenance and diagnostic indications for troubleshooting purposes.

Site licenses shall be provided to use all furnished system software for the entire MBTA infrastructure without limitation.

Application logic development shall be done by the DB Entity on a system certified by the non-vital control system manufacturer using their most recent stable development platform. The application logic development shall be done using a graphical user interface using a standard relay or ladder logic methodology.

All non-vital equipment and associated apparatus shall be rack mounted.

(c) Automatic Vehicle Identification (AVI) System

An Automatic Vehicle Identification (AVI) system shall be provided and integrated into the existing System AVI system and shall be compatible with the onboard AVI equipment. AVI points shall be located as needed for the routing of trains at diverging track locations, at end of line terminals, and at the locations where trains enter and exit from the yard lead tracks. The AVI system shall decode the route number from the vehicle and transmit route requests to the non-vital systems based on the Code Control Box (CCB) settings on the vehicle, and transmit vehicle and route data to the OCC for integration into system data and Dispatcher display.

The AVI selection shall be able to be cancelled and re-routed with a field push-button interface. Pushbutton boxes shall be provided as needed at the appropriate field locations. The pushbutton boxes shall allow the operator to cancel and/or request a route.

The AVI field equipment shall be supported by an uninterruptable power source and shall keep the AVI System online for the same duration that the vital systems within the CIH shall remain online.

11.5.4.2 Train Detection

Occupancy of a rail vehicle in any section of track shall be detected at all times by utilization of track circuits.

All mainline track circuits both within and outside interlocking areas shall be double rail track circuits.

All crossover and turnout tracks shall utilize a separate single rail track circuit for that segment of track.

The minimum length of track circuit shall exceed the inner wheelbase of all Project and Existing System vehicles.

Tracks circuits utilized in the design shall be 100 Hz AC steady energy phase selective track circuits powered by redundant frequency converters located locally in each CIH. Track circuits utilizing vane relays are not allowed.

Track circuits shall have a minimum .06 ohm shunting sensitivity with these requirements met for ballast conditions of 4 ohms per thousand feet or greater.

Track circuits shall be utilized in a fail safe manner whereby a de-energized position of the track relay is interpreted as occupancy of the corresponding track segment.

All double rail track circuits and the signal rail of single rail track circuits shall indicate a broken rail be de-energizing the track circuit.

Polarities shall be organized such that Insulated joint failures shall be detectable and de-energize the adjacent track circuits.

Maximum length of track circuits shall not exceed 1,500 feet without approval of the owner.

11.5.4.3 Block Design

The block design shall interface with the existing signal system adjacent to the extension. The operating headways shall be five (5) minutes on both the Medford and Union Square branches, and two –and-one-half (2/1/2) minutes on the viaduct between North Station and the new junction Interlocking where the extension splits to the Medford and Union Square branches. A minimum recovery buffer of 25 % headway time shall be provided in the design.

The block design shall be based upon a maximum authorized speed of 50 mph except where civil or block design speed restrictions are imposed. Any speed restrictions imposed by the block design, the DB Entity shall be required to attain approval from the MBTA.

Safe Braking Distance (SBD) shall be calculated at a maximum distance a train will travel before the required reduction in speed can be achieved utilizing the safe braking rate and including all the factors described below. The design shall utilize SBD for all safety braking requirements.

All calculations of safe braking distance shall be performed from an initial speed that includes 5 mph of over speed to account for variability in operator control and speed measurement.

The block design shall utilize the following criterion, as shown in Table 11.5-1, developed by the MBTA Signal and Vehicle Engineering Departments for calculating all safe braking requirements, which shall be confirmed by the MBTA:

Block design shall be created in either On Track™ or Rail Sim™. Any alternative means shall be approved by the MBTA.

Table 11.5-1: Block Design Criterion

Item	Value
1. Safe Brake Rate (MPHPS)	1.47 MPHPS
2. Nominal Brake Rate (MPHPS)	2.0 MPHPS
3. Safe Braking Reaction Time (S)	1 Sec
4. Nominal Braking Reaction Time (S)	1 Sec
5. Acceleration Rate (MPHPS)	2.5 mphps
6. Operation during Reaction Time	Coast (acceleration only due to grade)
7. Vehicle Dimensions (FT)	74 feet
8. Operating Consists (Cars)	One, two, and three

Item	Value
9. Vehicle Weights (AW0-AW3)	No. 8 AW0: 86000 lbs No. 8 AW1: 93238 lbs No. 7 AW2: 115608 lbs No. 7 AW3: 126080 lbs
10. Station Dwell Time (S)	30 Seconds
11. Design Headway (S)	75% op Schedule headway 5 Minutes = 225 Sec 2.5 Minutes = 112 Sec
12. Curve Resistance	Not Included in Braking Calculations
13. Davis Formula	Not Included in Braking Calculations

11.5.4.4 Wayside Signals

Color light signals shall be located at the entrance point to each signal block as required by the block design.

Signals shall provide movement authority and provide block occupancy information.

Signals shall all be located on the right hand side of the track governing. Left hand signals shall not be installed without permission of the owner.

All signal layouts shall be equipped with a split base junction box with AAR terminals for terminating signal cables with flex wiring run from base to the signal head units.

All signal units shall be LED type with full light out protection and downgrade of aspects as required.

A red over red (R/R) or yellow over yellow (Y/Y) aspect will require if one unit is dark for the other to turn off and go dark, so as not to display a single red or single yellow aspect when a R/R or Y/Y aspect respectively are called for. Project Definition Plans show current MBTA standard of incandescent bulbs wired in series to achieve this. DB Entity may propose to owner for approval alternative LED technology that can achieve same result.

LED's shall be uniform in shade and density for the respective colors in accordance with the AREMA recommendations for LED signals. LED's shall be secured to the signal head and shall utilize a neoprene gasket to provide water and dust proof seal between the LED and the signal head.

Number plates, hoods, phankills, ladders and mounting hardware shall be supplied as needed. Wall mounted signals shall be supplied with the same features including easily accessible junction boxes and wall mounted ladders.

Signal aspects requiring two light units to be displayed shall be separated to ensure aspect recognition.

Signals shall be designed to be distinct at 1000 feet in advance from a height of seven feet above the top of the rails. Preview of less than 1,000 feet shall require a repeater signal

Signal aspects shall be consistent with the MBTA Rule for Streetcar Motorpersons, Station Personnel, and other employees of the Light Rail Lines as follows:

(a) Interlocking Home Signals

Interlocking home signals shall be placed at the entrance point to every interlocking for each track. Home signals shall be located and designed for normal direction running. However, at the turn-back locations a reverse home signal is provided with routes back to the platform. Where no reverse direction moves are allowed, permanent Red/Red "Z" signals shall be provided at the boundary of the interlocking. Home signals shall be capable of displaying appropriate aspects as listed below in table 11.5-2.

Table 11.5-2: Home Aspects

Home Aspect	Indication
Red/Red	Stop
Vertical Arrow	Proceed on through route
Left Arrow	Proceed on diverging route to the left
Right Arrow	Proceed on diverging route to the right

(b) Automatic Signals

Automatic signals shall be placed at the entrance point to every intermediate block between interlockings. Automatic signals shall be located for normal direction running only. No automatic signals shall be located for reverse direction running. Double berthing Y/Y aspects shall be provided at the entrance to each platform except at turn-back locations. Automatic signals shall be capable of displaying appropriate aspects as listed below in table 11.5-3.

Table 11.5-3: Automatic Aspects

Automatic Aspect	Indication
Red	Stop and proceed after 1 minute at restricted speed (10 MPH) to the next signal
Yellow	Proceed, prepared to stop at the next signal
Green	Proceed at authorized speed
Yellow/Yellow	Come to a complete stop then proceed at restricted speed to an appropriate berth

11.5.4.5 Wayside Pushbuttons

Wayside pushbuttons shall be installed at locations with AVI route selection and shall function as an override to cancel or change a route request. Wayside pushbuttons shall also be installed at locations

without AVI route request as defined in background section E.5.2. Pushbuttons shall work in conjunction with the site-specific application at each location. Pushbuttons shall function as the primary route request where trains enter service from the yard or turn-back stations.

Each pushbutton assembly will consist of a pushbutton box, equipped with recessed buttons, illuminated LED indicators, identification plates and all necessary appurtenances and wiring required to install a fully operational device. The Pushbuttons shall be located and installed at a height that is reachable by the operator from the cab of the Project and Existing System trolley. Pushbuttons shall be rated for low voltage 12/24 VDC operation. The pushbutton box shall be NEMA 4X rated, 14-gauge stainless steel construction. The box shall come equipped with an oil resistant neoprene door gasket and padlock hasp, sized to fit standard MBTA size padlocks.

11.5.4.6 Switch and Lock Movements

Mainline power switch-and-lock movement layouts shall be dual control 110 VDC dual control switch-and-lock movements.

All interlocking power switches shall have an over-switch (OS) track circuit to prevent movement of a powered switch while OS circuit is occupied.

Interlocking power switches shall be controlled by solid-state type switch controllers.

Interlocking power switches shall have a discreet indication of when the switch has been placed in hand operation, and while in this state all signals with routes over the switch shall display their most restrictive aspect.

All complete switch-and-lock movement layouts shall include a junction box, throw rod, insulated swivel, front rod, straps, point lug, lock rod, detector rod, shims, identification plates, required screws, nuts, washers, pins, grease fittings, cotter keys, plates, adjusting brackets, and hardware to mechanically couple the switch-and-lock movement to the switch points and to install the switch layout on timbers.

The switch-and-lock movement layouts to be provided shall be gear driven from the motor. The movements shall have double adjustable type lock, detector rods, and a throw-rod basket. A manual power/hand" selector lever shall be provided. The switch-and-lock movement motors shall be designed for continuous normal operation at 90 to 130 VDC and shall perform intermittent operation at 130 to 150 VDC without sustaining any damage.

All complete hand throw switch-and-lock movements with electric lock layouts shall include a junction box, rod, mounting holes, mounting bolts, wiring inlets, contacts, terminal binding posts, screws, nuts, washers, internal circuit controller heater, and all other necessary appurtenances required for a complete and operational installation. The internal heaters shall have sufficient capacity to prevent adverse effects to the circuit controller and the motor compartment from high moisture and winter conditions. Electrically locked hand-throw crossovers are located at Red Bridge interlocking and just east of Magoun Square Station.

11.5.4.7 Relays

Vital DC relays, shall be of the plug-in type and rack-mounted. They shall have a transparent dust cover made of a non-flammable composition that will not support combustion.

Vital relays, with a nominal operating voltage of 10-16 volts, shall be capable of operating continuously without resultant damage with a minimum voltage range of 7 to 21 volts inclusive applied to their operating circuits.

Biased neutral vital relays shall be designed so that gravity alone will prevent the armature from picking up if they are de-energized or if no current is applied to the coil due to interruption of the normal magnetic circuit. Biased neutral vital relays shall be designed so that up to 50 times working energy applied for two seconds at both normal and reverse polarity will not affect their operating characteristics by more than two percent, and will not pick up their armature on reverse polarity.

Each vital relay shall have a minimum of four dependent front-back contacts, two independent front contacts and one independent back contact. All front contacts shall be silver-to-metalized carbon, except for heavy duty, extra heavy duty, or special application relays. The design shall include two independent spare contacts for future use.

All vital circuits that require multiple relays to meet the design requirements shall be wired in series (cascading).

Vital relays front or back contacts shall be capable of a minimum of five million operations.

Arc suppression for vital relays shall be built into the relay.

Contact arrangements shall be identical for similar types of relays. Exceptions will be made for special function relays only and require approval of the Engineer.

All relays shall come equipped with a mechanical keying device preventing an incorrect relay-type installation.

All vital relays shall provide a test post to allow the relay to be de-energized.

Relay plugboards and all elements necessary for a functioning vital relay shall be of the same manufacturer or as approved by the relay manufacturer.

All relays shall be designed to work in electronic processor environment and shall not generate electromagnetic interference that may disrupt the proper functioning of any electronic systems.

All non-vital relays shall be equipped with a minimum of six front-back contacts. Stationary contacts shall be bifurcated silver, palladium, or approved equal. Movable contacts shall be bifurcated silver, palladium with gold overlay, or approved equal.

All non-vital relays shall be plug-in DC neutral biased or diode-suppressed relays with a nominal operating voltage of 24 volts DC. Where other voltages are required, the relay and application shall be submitted to the Engineer for approval. The non-vital relays shall work reliably when the applied voltage is between 18 volts and 42 volts.

All relays shall be labeled on both the front and back of the relay, as well as on the back (the side the relay does not plug into) of the relay plugboard. All tagging shall not interfere with the operation of the relay or prevent visual inspection.

11.5.4.8 Local Control Panels

Local Control Panels shall be capable of controlling and indicating all signal system functionality at the applicable interlocking locations. There shall be a Local Control Panel for each CIH that has interlocking functionality.

Local Control Panels shall be a hardwired Mosaic tile type panel with LED indications, heavy duty levers and etched labels.

The hardwired panel shall function based on a serial or remote networked parallel I/O from the non-vital system.

The panel shall have levers and indication LEDs to monitor and manage all interlocking functionality.

The panel shall be capable of being completely powered down and disabled when not in use.

The panel shall have a hinged key-lockable glass cover.

11.5.4.9 Maintainers Panels

Maintainers panels shall provide real-time monitoring of subsystems integrated into the signal system provide for the monitoring of at minimum the signal field devices, train locations, communication links, network devices, network connections, vital and non-vital systems, and power systems. There shall be a Maintainers Panel for each CIH installed on the Project.

The Maintainers Panels shall be of the Mosaic tile type with LED indications and etched labels.

Maintainers Panels shall provide indication of all signal system elements up to the adjacent CIH location on either side.

11.5.4.10 Status and Control Panels

Status and Control Panels shall provide real-time system status indications for all critical subsystems supporting operational functionality.

The Status and Control Panel shall also provide control over the online status for the major subsystems, including VMIS and non-vital control system.

The Status and Control Panel shall be a metallic hardwired panel with LED indications, heavy duty levers and etched labels.

The status and control panel shall be rack mounted.

11.5.4.11 Maintenance Computers

Maintenance Computers shall be designed in as an integral part of the processor based systems. There shall be a minimum of two maintenance Computers each with its own monitor, keyboard, and mouse associated with each field location to allow for the simultaneous monitoring of redundant systems or the simultaneous monitoring of the online VMIS and non-vital system

The Maintenance Computers shall have all necessary applications installed for monitoring all processor-based systems. They shall also have all application tools necessary for remote access and management of systems on the same network. Capabilities other than system monitoring shall require authentication.

The Maintenance Computers shall be solid-state hardened equipment designed to function in the harsh environment of an electrified transit system, without requiring a fan for internal cooling.

11.5.4.12 Equipment Housings

Central Instrument Houses (CIH) shall be designed as needed to house all functional signal system elements. CIH's shall be of adequate size to accommodate all signal equipment, plus 20% usable spare capacity for future equipment.

CIH's shall be located in the vicinity of stations, at interlockings, and as needed to avoid cable runs of excessive distances.

Equipment racks shall have standard open frame configuration, shall be shock mounted and isolated from ground. All racks and equipment chassis shall be discretely grounded to the CIH ground bus using ground cable.

CIH's shall include all necessary electrical sources, lighting, HVAC systems, means of cable entry, pre-wired cable racks, and fire suppression systems. The HVAC system shall be a two-part system and shall not use air transfer with the outside as means of cooling or heating.

CIH's shall have a minimum two entry doors that shall both lock.

CIH's shall be installed on foundation piers with cable entry from below.

Junction boxes shall be utilized as needed. Junction boxes shall provide adequate space for triple or double post terminals as needed, terminal boards, cable slack, and all other necessary appurtenances. Insulated "gold" test nuts shall be utilized instead of test links.

No equipment housings shall be placed in Level One areas.

11.5.4.13 Central Instrument House Signal Power

Signal power shall feed all signal equipment and system loads. Signal power shall be isolated and ungrounded through the use of transformers specifically designed for this function.

Two separate 480 VAC single phase power feeds shall be delivered to each CIH from two different substations. If feeds from two substations are not possible, the separate feeds shall come from the same substation on two different sources.

The 480 V AC single-phase signal power shall be delivered to the CIH on separate cables. They shall interface at the CIH on redundant tap adjustable transformers to step the voltage down to 120 V AC.

The 120 V AC ungrounded transformer secondary windings shall feed an automatic transfer switch and a network of manual bypass disconnect switches should the automatic transfer switch require heavy maintenance.

The secondary of the automatic transfer switch and bypass network shall feed the signal power bus that provides power to all signal equipment and functions originating from this CIH.

All signal power feeds and system components shall be consistent across all CIHs for ease of maintenance. The design and sizing of the signal power delivery system shall be based on the design and calculated signal loads originating in the respective CIH's. The CIH with the greatest load shall be used as the basis for the other CIHs.

11.5.4.14 Central Instrument House Utility Power

Power for CIH lighting, utility outlets, HVAC and the fire protection system shall come from a separate dedicated 480 V AC three phase power feed from the closest station.

The 480 V AC feed shall originate on the secondary side of the automatic transfer switch that selects the power source for the stations, unlike the signal power feeds that receive their power directly from the secondary of the transformers.

The 480 V AC utility feed with ground, shall provide power to the CIH utility loads through the required disconnect switches, transformers, breaker panels, etc. The design and sizing of the utility power delivery system shall be based on the design and calculated utility loads in the CIH's. The CIH with the greatest load shall be used as the basis for the other CIH's.

11.5.4.15 Low Voltage Signal System Power

(a) Vital Systems (B12)

All vital systems internal to the CIH shall operate on a 12 V DC battery system (B12). The B12 source shall be ungrounded.

The battery bank shall be of sufficient capacity to support all systems powered by the B12 for a minimum of eight hours. The batteries shall be lead acid based, and shall be sealed for ease of maintenance. The Design shall be supported by calculations that project the entire load that must be supported by the B12 power source, as well as the proper size for all components and cabling.

The batteries shall be charged by redundant battery chargers connected to the batteries in parallel. Each battery charger shall be capable of individually supporting the full system load plus 50% for expansion, in addition to charging a completely discharged battery bank. The chargers, together and individually, shall be capable of supporting the entire load with the batteries disconnected.

The B12 battery chargers shall be powered from the 60 Hz BX120 source. The battery chargers shall be wall or rack mounted.

The batteries and charging system shall be designed so that the batteries and chargers can be isolated through the use of fused disconnect switches for maintenance or replacement.

(b) Non-Vital Systems (B24)

All stand-alone non-vital systems internal to the CIH, if utilized in the design, shall operate on a 24 V DC battery system (B24). The B24 source shall be ungrounded.

The battery bank shall be of sufficient capacity to support all systems powered by the B24 for a minimum of eight hours. The batteries shall be lead acid based, and shall be sealed for ease of maintenance. The Design shall be supported by calculations that project the entire load that must be supported by B24 power source, as well as the proper size for all components and cabling.

The batteries shall be charged by redundant battery chargers connected to the batteries in parallel. Each battery charger shall be capable of individually supporting the full system load plus 50% for expansion, in addition to charging a completely discharged battery bank. The chargers, together and individually, shall be capable of supporting the entire load with the batteries disconnected.

The B24 battery chargers shall be powered from the 60 Hz BX120 source. The battery chargers shall be wall or rack mounted.

The batteries and charging system shall be designed so that the batteries and chargers can be isolated through the use of fused disconnect switches for maintenance or replacement.

(c) Line Battery (LB12)

12 V DC Line battery voltage (LB12) shall be provided to support low voltage functions external to the CIH. Redundant 12V DC power supplies shall generate the LB12. The LB12 source shall be ungrounded.

The LB12 system shall be sized according to the calculated load plus 50% spare capacity for expansion. Additionally, all cable size and fusing shall be determined.

Each power supply shall be capable of individually supporting the full system load plus 50% for expansion

The power supply shall be wall or rack mounted.

11.5.4.16 Operations Control Center Interface

The non-vital systems shall interface directly to the Operations Control Center (OCC) over the OCC Field Network. Communications shall be serial based, using a local terminal server port for each non-vital system to route the data to the OCC Network.

Control functions to be included in the non-vital systems design for OCC interface include:

- (a) Request, canceling, and fleeting of interlocking home signals
- (b) Switch position requests
- (c) Switch and signal blocks
- (d) Mode of operation
- (e) System failover

Indication functions to be included in the non-vital systems design for OCC interface include:

- (a) Track occupancy
- (b) Signal indication
- (c) Switch lock and position
- (d) Alarm indications
- (e) Online system status

Code-Bit Assignment Sheets shall be developed in conjunction with MBTA OCC staff to define all control and indication data bits to be transmitted and received.

Communication protocol between the OCC and non-vital processors shall be Modbus protocol with a direct communication link between the two. Use of third party protocol converters shall not be allowed.

11.5.4.17 Signal Data and OCC Field Networks

A redundant signal data network shall be designed to manage all vital and non-vital communication between the CIHs. A separate OCC Field Network shall be designed to manage communication between the respective CIH and OCC.

The design shall partition the network bandwidth through the use of secure local area networks (S-Lans). The design shall identify all data to be transmitted over the network including origination and destination, frequency, and packet size to determine the necessary bandwidth for each type of data. The data shall be functionally isolated so that a failure that disables one functional path will not degrade the overall functionality of the signal system and its support of service. The redundant path with its data shall support full system functionality.

Network data traffic shall be segmented so that data traffic is not propagated beyond where it is useful for system functionality.

All network equipment diagnostics shall be available at a single designated port on the network. In addition, an indication for signal data network availability shall be provided for display on the Maintainer's panel.

The network shall be designed with centralized management and configuration consoles. These consoles shall be diversely located should the other system lose communication with the network.

For the OCC Field Network, terminal servers shall be utilized at all field locations to interface between the non-vital processor and the data network switch. Terminal servers shall be Lantronix model number EDS2100 or MBTA approved equivalent. The network data switch shall be Moxa model number EDS 510E. No substitutions shall be allowed.

The signal data network and OCC Field Network shall both operate on the fiber optic system detailed in section 11.7 of these Technical Provisions.

11.5.4.18 Train Approach Indicator Lights

Train approach indicator (TAK) lights, and associated equipment and materials, shall be provided and incorporated into the design to alert personnel along the ROW to the presence of an approaching train. Refer to [Exhibit 2H](#) for TAK light design requirements.

The DB Entity shall submit the design of the TAK lighting system as a separate design package that shall be incorporated into the signal system.

11.5.4.19 Station Indicator Lights

There are three types of indicator lights required at stations as follows:

(a) Starter Lights

Lighted "START" signs and bell shall be provided at the inbound end of all turnback platforms.

The Start Sign and Bell logic shall reside within the non-vital system.

When the "START" sign is lighted with the bell ringing, and in conjunction with the applicable wayside signal being clear, it will indicate to the train operator that they should depart the station on their scheduled trip.

The "START" sign and bell work as a function of the OCC schedule dispatch system. They shall not activate until a clear route has been established for the train to proceed.

Pushbutton request to establish a route from the platform westbound shall also activate the bell.

(b) Next Train Lights

Lighted "NEXT TRAIN" signs shall be provided at the inbound end of all turnback platforms.

The "NEXT TRAIN" Sign logic shall reside within the non-vital system.

When the "NEXT TRAIN" sign is lighted it will indicate which platform the outbound train will arrive on.

(c) Bus Hold Lights

At stations that also include a bus station, bus hold lights shall be utilized to provide information to bus drivers when a train is approaching the station to hold for a transfer from the train to the bus.

Bus hold lights shall be lunar white signals placed in clear view of the bus driver when the bus is at the station stop.

Bus hold lights shall be illuminated when a train is approaching the platform to provide adequate time for passenger transfer.

The bus hold logic shall reside within the non-vital system.

11.6 WAYSIDE TELEPHONE SYSTEM

11.6.1 Scope of Work

The Work includes designing, furnishing, and installing telephone instruments and equipment of types specified in Section 16718. Wayside telephones shall be provided along the Corridor at crossovers, signal houses, and in accordance with NFPA 130 requirements. These phones shall allow operators and other workers to communicate directly with the Operations Control Center (OCC).

The wayside telephones shall be located along the MBTA Corridor at crossovers, track access gates, junctions, and signal bungalow locations. A 12 pair minimum cable shall be installed to all phone locations with one pair in each cable supplying dial tone and one pair supplying voltage for the LED signs at the top of the kiosks/masts. The units shall be weather resistant, 2 line telephones with Blue LED lights at the top of the kiosks to identify the wayside telephone locations. The wayside telephones shall be configured with the MBTA Station Centrex System. Station Distribution Panels within the station communication rooms shall be provided to distribute dial tones to the wayside telephones via the 12 pair CAT 6 cables and provide lightning protections to the equipment.

NEMA 4 enclosures shall be provide and mounted to the base of the wayside telephone steel mast where lightning protections and cable terminations are located.

11.6.2 Codes, Standards, and Manuals include:

- American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications
- Americans with Disabilities Act (ADA) Standards including Accessibility Guidelines for Outdoor Developed Areas (36 CFR Part 1195)
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering
- American National Standards Institute (ANSI) Standards
- American Society for Testing and Materials (ASTM) Standards
- BICSI Telecommunications Distribution Methods Manual
- Electronic/Telecommunications Industries Association (EIA/TIA) Standards
- Federal Railroad Association (FRA) Code of Federal Regulations Part 49 (CFR 49)
- Institute of Electrical and Electronic Engineers (IEEE) Standards including C2, C62, 383, 1473, 1477, 1613, 802.X
- Insulated Cable Engineers Association (ICEA) Standards
- Massachusetts Building Code 780 CMR
- Massachusetts Electrical Code (MEC) 527 MR 12.00
- National Television Standards Committee (NTSC) Standards
- National Electrical Manufacturers Association (NEMA) Standards

- National Electrical Contractors Association, Standards of Installation (NECA) Standards
- National Fire Protection Association (NFPA) Standards including NFPA 70, NFPA 72, NFPA 75, NFPA 101
- National Electric Code (NEC) Standards
- Underwriters Laboratories, Inc. (UL) Standards

11.6.3 The Project Specific Requirements

The wayside telephones shall be fed from the local Verizon services at the stations and shall not be part of the MBTA private telephone system. Coordinate with Verizon for proper service at all station locations.

Wayside telephones shall be provided and located along the MBTA Corridor at crossover, track access gates, junctions, and CIH locations, with additional locations as required for a maximum of 500' between wayside telephones.

The wayside telephone system shall be provided throughout MBTA facilities, via the Verizon underground location and 12 pair copper cables that are installed on both the inbound and outbound tracks that shall feed the wayside telephone devices to provide redundancy should one of the cables be damaged. The wayside telephones shall be integrated with Verizon services at stations. Dial tone distribution to wayside telephones shall be performed via 12 pair copper cables.

A 12 pair minimum cable that meets the requirements of NFPA 130 shall be installed to all phone locations with one pair in each cable supplying voltage for the LED signs at the top of the kiosks.

The DB Entity shall provide LED power from distributed DC power from the communication rooms via the 12 pair cable.

The DB Entity shall coordinate with the local Exchange Carrier, Verizon, and configure no more than 3 telephones per Centrex line. The DB Entity shall configure numbers and locations of phones and provide physical locations of the phones to the Transit Police or any MBTA Emergency Services section.

NEMA 4 enclosures shall be provided mounted to the base of the wayside telephone steel mast that provide cable lightning protections at wayside telephone locations.

Wayside telephone housings with blue light indicators shall be provided, securely mounted to the steel masts installed with pre-cast concrete foundations.

All equipment shall be grounded as indicated in the specifications.

11.7 FIBER OPTIC NETWORK

11.7.1 Scope of Work

The DB Entity shall design, furnish, install, connect, test, and place in operation a Fiber Optic Communication System (FOCS) for extending the existing Security Wide Area Network (SWAN) and Wide Area Network (WAN). The IP systems shall operate in a ring with Ethernet Automatic Protection Switching (EAPS) arrangement, with self-healing equipment in event of a fiber break or equipment failure. The DB Entity shall provide all equipment, hardware, and ancillary devices required, which shall conform to Section 16717 in Exhibit 2A.1.

11.7.2 Codes, Standards and Manuals include:

- American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications
- Americans with Disabilities Act (ADA) Standards including Accessibility Guidelines for Outdoor Developed Areas (36 CFR Part 1195)
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering
- American National Standards Institute (ANSI) Standards
- American Society for Testing and Materials (ASTM) Standards
- BICSI Telecommunications Distribution Methods Manual
- Electronic/Telecommunications Industries Association (EIA/TIA) Standards
- Federal Railroad Association (FRA) Code of Federal Regulations Part 49 (CFR 49)
- Institute of Electrical and Electronic Engineers (IEEE) Standards including C2, C62, 383, 1473, 1477, 1613, 802.X
- Insulated Cable Engineers Association (ICEA) Standards
- Massachusetts Building Code 780 CMR
- Massachusetts Electrical Code (MEC) 527 MR 12.00
- National Television Standards Committee (NTSC) Standards
- National Electrical Manufacturers Association (NEMA) Standards
- National Electrical Contractors Association, Standards of Installation (NECA) Standards
- National Fire Protection Association (NFPA) Standards including NFPA 70, NFPA 72, NFPA 75, NFPA 101
- National Electric Code (NEC) Standards
- Underwriters Laboratories, Inc. (UL) Standards

11.7.3 Project Specific Requirements

The DB Entity shall design and furnish a new 10 Gb/s Ethernet fiber optic network for communications. The 10 Gb/s fiber optic network shall interconnect computers and equipment at all stations and facilities and connect to the OCC.

The 10 Gb/s fiber optic network shall interconnect computers and equipment at all stations and facilities and connect to the OCC.

A Fiber Optic cable design and installation consisting of one 96 strand single mode communications cable and innerduct and one 96 strand fiber optic single mode signals cable and innerduct shall interconnect all the stations, Vehicle Maintenance Facility, Transportation Building, and Bungalows. Of the 192 strands, 25% shall be reserved for future expansion.

The Fiber Optic cables shall be run on opposite sides of the Right of Way utilizing the OCS catenary poles where allowed and the new signal trough with the exception of where the cables enter and leave stations.

At the new stations, the cables shall be run inside combined station conduits. The new fiber optic cables shall primarily be installed aerially on the OCS catenary poles and Signal troughs where applicable along the System Corridor. The aerial fiber optic cables shall be attached utilizing messenger cable hanger straps and contain fiber optic storage units at entrance and exit locations for storing cable slack. New Fiber Optic cables shall be installed through existing tunnels complete to the North Station Superstation communications room.

The DB Entity shall utilize the existing fiber optic cable already installed from North Station to the OCC at 45 High Street for the fiber optic cable Work.

The 96 strand communications fiber optic cable shall terminate at the new station communications rooms and at the following existing communications rooms/locations: The Science Park Signal Room, the North Station/Garden Communications Room, and the North Station Superstation Communications Room. All terminations and fusion splicing at fiber distribution / splice panel locations shall be performed as part of the Work. Existing MBTA fiber optic cables shall be used from the North Station Superstation Communications room to 45 High Street to create a complete fiber optic cable network. The new 96 strand fiber optic cables shall provide network connections from the field to the new WAN and SWAN systems at 45 High Street. The Fiber Optic cable plant shall support the Project general purpose network, or "Corporate Network", the switched Ethernet network for the Secure Stations CCTV project (called the Security WAN or "SWAN"), and connectivity for AFC, Public Address, MCS (PLC) and AVAYA VoIP Network System.

A separate Fiber Optic cable shall be installed to support the Signal System. The Signal Fiber optic cable shall be run between Signal bungalows to create a Signals WAN to be used for Vital and non-vital communication PLC and Signal network switches. Additional fiber optic cables shall interconnect signal bungalows and Communication rooms at location where signal bungalows and communication rooms are within the same area. Communications Fiber Optic cables shall demark at stations then separate single mode fiber optic cables and copper cables for communications functions shall be installed to Signals Bungalows and rooms, Traction Power Sub Stations (TPSS) and other sites not located on station platforms. Telephone and security network connections to signal bungalows and rooms shall be via the local communications fiber and copper cables.

The cables shall be physically isolated, with one cable running on the west side of the new light rail infrastructure and the other cable running within the new signal cable troughs. The cables shall provide fully redundant communications capabilities. Traction power substations and the new Vehicle Storage and Maintenance Facility shall be connected to the fiber network. The Maintenance Facility shall have a direct Fiber Distribution Cabinet (FDC) on one of the main Fiber Optic Plant but the TPSS stations shall be connected to the Fiber Optic Plan through the nearest station FDC. Cables shall be mounted on catenary poles as reinforced aerial cable, or as Corridor space permits, as buried cable or run in conduits along the corridor. In areas where trough is provided, the cable shall be installed in trough.

All fiber optic cables along the ROW on messenger, within troughs, and in conduit shall be routed within 1.5" innerduct.

Splicing shall not be allowed on the right of way. A minimum of 50 feet of slack fiber shall be provided for each fiber bundle at all bungalows or termination panels. The slack shall be properly coiled in a means or enclosure designed to properly handle the fiber.

The WAN switch installed at each station shall provide the Station Local Area Network with its redundant Wide Area Network connection. The Designer shall coordinate with the MBTA, the WAN maintenance contractor, and the network design team to ensure all Ethernet nodes are properly configured.

The Station Ethernet switch shall provide an interface for Station Ethernet systems installed under this Project to communicate over the WAN. The Station Ethernet switch is critical to the proper operation of the Automated Fare Collection (AFC) Equipment; and the Hub Monitoring and Control System (HMCS) PLC as these systems shall utilize the Station Ethernet switch to transport data. The Station Ethernet switch shall support data and voice. AFC connections to Fare Vending machines shall be multimode Fiber Optic cable via an additional Ethernet switch, separate from other systems. Refer to H.6 Station and Building Communication systems for additional information.

The Secure Stations Ethernet switch shall connect to the Fiber Optic plant directly and connect to local Ethernet switches with Power over Ethernet supporting all CCTV video connection and traffic at each station. The Secure Stations Ethernet switch at the station shall also connect to the Network Digital Video Recorder servers. The Secure Station Switched Ethernet network shall also provide connectivity and security for the Security Access Control system. The Secure Stations Ethernet switch shall be specified in accordance with current MBTA standard security specifications and guidelines. A secondary switch shall be used as needed to limit Ethernet copper cable lengths to no more than 300 feet.

The general purpose Wide Area Network and Secure Stations Ethernet switches shall be located in each Stations Communications Room. All Fiber Optic connections shall be located in separate Fiber Distribution Cabinets in each Stations Communication Room. An auxiliary communications room or cabinet shall be used to house secondary Ethernet switches for distribution.

The Union Station Branch shall be equipped with two 96 Strand Fiber Optic cables – one for communications and one for signals - providing redundancy, which shall also connect to the main System Fiber Optic plant network at the Communications Room at Lechmere.

Software for the WAN and the SWAN shall be specified by MBTA Communications and installed by the DB Entity as required to configure complete and integrated networks.

The WAN and SWAN systems are described in detail in the MBTA Fiber Optic Cable System Equipment Section 16717 in Exhibit 2A.1.

Subsystem devices, conduits, trays, cables, and other live safety communication installations CANNOT be mounted in close proximity or the train dynamic envelope and passenger emergency egress routes, such as safety walks and emergency exits. For example, subsystem devices, conduits, trays, cables, and other safety communication cannot be mounted anywhere directly above the LRV pantograph.

Subsystem devices, conduits, trays, cables, and other safety communication installations shall not conflict with other tunnel and wayside installations and shall not come closer than 6" to the vehicle dynamic outline at any point in the ROW.

The SWAN network shall utilize Extreme X460 Core switches. The Extreme core switches shall be utilized for compatibility with the existing network elements.

The WAN network shall utilize CISCO WS-3850-24ES-E core switches. CISCO core switches shall be utilized for compatibility with the network elements.

The system is distributed throughout MBTA facilities, via redundant cable routing within the station project limits. The Fiber cables shall be redundantly routed.

LAN Ethernet switches with Power over Ethernet (PoE) supporting all CCTV video, SCADA, etc. connections and at each station. Design Local Networks and PoE hardened Switches for SWAN and WAN connected devices at station and building locations.

DC power for the Core Switches to be powered from -48 VDC power sources and AC power for local switches to be powered from UPS.

All outside main backbone fiber optic cables shall be gel-filled and armored for rodent protection. Sufficient fiber strands shall be provided to support the IP networks plus 25% spares for future expansions. Safety-critical signals shall be backed up by another independent transmission path or means.

The fiber optic cable terminations for the network cables at all stations, signal bungalows, the maintenance facility, and the transportation building shall be as follows:

- Blue and Orange buffer tubes terminated at each station from North Station to College Avenue Station.
- Brown buffer tubes terminated as express (splice through end-to-end) Lechmere Station to Gilman Square Station.
- Slate buffer tubes terminated as express (splice through end-to-end) Lechmere Station to College Avenue Station.
- White buffer tubes unterminated for future use.
- Red buffer tubes terminated as express (splice through end-to-end) from North Station to Lechmere Station.
- Black buffer tubes terminated as express (splice through end-to-end) from North Station to College Avenue Station.

12.1 STATION ARCHITECTURE

12.1.1 Scope of Work

The Work includes the construction of seven center island platform transit stations and the Lechmere Station bus loop. Lechmere Station serves transit traffic from both branches and is an elevated station. The other six stations are on the branch lines and are at-grade stations. These are East Somerville Station, Gilman Square Station, Magoun Square Station, Ball Square Station, College Avenue Station, and Union Square Station.

12.1.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code 780 CMR
- Massachusetts Comprehensive Fire Safety Code, 527 CMR 1.00
- NFPA 130 Standard for Fixed Guideway Transit & Passenger Rail Systems as referenced by 527 CMR
- NFPA 285 Standard Fire Tested Method for Evaluation of Fire Propagation of Exterior Non-Load Bearing Wall Assemblies Containing Combustible Materials
- Massachusetts Architectural Access Board 521 CMR
- Massachusetts Electrical Code 527 CMR 12.00
- International Mechanical Code as amended by 780 CMR 28.00
- Uniform State Plumbing Code 248 CMR
- International Energy Conservation Code as amended by 780 CMR 13.00
- Massachusetts Board of Elevator Regulations 524 CMR
- FM Global Data Sheets
- MBTA Guidelines & Standards
- MBTA Guide to Access
- APTA Guidelines (American Public Transportation Association)
- ADA Standards for Accessible Design
- ADA Standards for Transportation Facilities by US DOT
- Boston Center for Independent Living Agreement (BCIL)
- MBTA Pedal and Park Program Guidelines

Additionally, design of walkways shall implement the principles of Crime Prevention Through Environmental Design (CPTED) as outlined in “Crime Prevention Through Environmental Design: Applications of Architectural Design and Space Management Concepts (2nd ed.)” by Timothy D. Crowe, published by Butterworth, Boston 2000.

12.1.3 The Project Specific Requirements

12.1.3.1 Station Design Considerations

The station design shall:

- Support ease of station maintenance, including:
 - no sealant dependent building joints;
 - light fixtures, fire alarm, speakers maintained from a 10' ladder or permanent designed access apparatus; and
 - light fixtures, fire alarm and speaker devices shall be located so maintenance access does not require ingress to the right of way including train envelope clearances.
- Employ an overall functional design.
- Feature platform elements that are consistent at all stations including the following amenities: audio and visual communication devices, accessible accommodation areas, Customer Assistance Areas, lighting, signage, and shelters.
- Design shall include adequate space for all MEP/FP services required to support the Station, including but not limited to restroom ventilation, elevator machine/control room conditioning, conditioning for any electrical or emergency electrical room(s).
- Provide seating and shelter on the platform and other station public areas.
- Provide weather protection for Customer Assistance Areas, elevators and waiting areas, stairs and ramps exceeding 5%. Coverage shall extend a minimum of 5' beyond of bottom and top landing or stair run or ramp.
- At areas of vertical circulation adjacent to areas with vehicular traffic, offer protection to passengers using impact rated (minimum K4) bollards made out of landscape elements, concrete, steel or masonry. The appearance and quality of construction of the bollards shall be submitted for acceptance by the MBTA.
- Signage to and within the station shall conform to Section 12.5 that is part of this document and shall include employing graphical, size and location standards set by the MBTA.
- Design shall support the vertical relocation of platforms to 14" above Top of Rail (TOR) for future level boarding with the Project and Existing System equipment. The DB Entity shall provide a design that does not preclude the MBTA to perform the following:
 - add 6" of normal concrete weight topping slab over the platforms constructed as part of the Work;
 - add to the sloped walkways that are part of the Work to approach the vertically elevated platforms at a 4.5% maximum running slope;
 - demount the floor mounted shelters, benches and signage without structurally impacting the platform structure constructed as part of the Work;

- sewage flow requirements for Lechmere Station: GFA of interior spaces shall be < 5,333 sqft, and designed such that average daily sanitary sewage flows are no greater than 400 gallons per day as defined by 310 CMR 15.000 (Title 5); and
- exterior building or area lighting, not specific to platform areas, to provide adequate illumination and security where circulation to service room is required.

12.1.4 Physical (Technical) Parameters

The station geometry shall address dimensional criteria to accommodate all users and requirements.

Circulation shall be direct from platform to street and shall minimize turns. The DB Entity shall provide the most direct route from station entrance to platform that accommodates universal access, employing a logical progression of spaces to promote intuitive circulation routes, and openness and transparency in layout and elements to achieve a clear station concept.

A logical progression of space from public space to train car shall be from station entry to circulation areas to platform. Within the circulation to platform, the fare vending machines and toilet rooms shall have direct visible and physical access. Vertical circulation elements such as elevators and stairs shall also accommodate waiting areas and queuing areas and separate them from cross traffic.

For stations with vertical circulation, the station entrance shall have a direct visual connection and path of travel without direction change to the vertical circulation element leading to the platform. The platform shall also have a direct visual connection and path of travel without directional change to the vertical circulation element leading to the station entrance and public way.

The station shall allow for an efficient passenger circulation that provides the least number of vertical and horizontal elements to meet passenger demand per Building Code, accessibility and NFPA 130 emergency egress requirements.

The passenger circulation elements for each of the stations shall adhere to the following criteria which have been established for determining passenger loads:

The capacity review utilized ridership forecasts by the Regional Travel Model administered by Central Transportation Planning Staff (CTPS) and provided 3-hour period data projections for the year 2030. Detailed passenger load forecasts are available in the Project’s Environmental Assessment document.

The 3-hour period data shall be converted to 1-hour periods using a surge factor of 120% and converted to 10-minute (one missed headway) periods using a surge factor of 133%. The 10-minute loads per headway, including boardings, alighting, transfers and line volume shall be used to determine life safety/egress requirements.

Table 12.1-1 — Station Occupancy

Station	3-hour periods	10-minute occupant loads
Lechmere	1,820	954
Union Square	900	204
East Somerville	860	501

Station	3-hour periods	10-minute occupant loads
Gilman Square	780	396
Magoun Square	200	225
Ball Square	370	199
College Ave	510	119

12.1.4.1 Station Entrances

(a) Entrance Size

- (i) Station entrance locations shall be located as shown in Exhibit 2B.2, item 22 of station Concept Plans.
- (ii) The station entrance size shall be determined by public circulation requirement for emergency egress, accessible design, and functional non-emergency efficient passenger circulation.
- (iii) Equipment and associated clearances shall not impinge on public circulation.
- (iv) Public circulation, equipment and amenities shall be organized in a simple functional layout.
- (v) Station shall be recognizable from major approaches by clear sight lines to the entrance and by use of signage.
- (vi) The layout of the station entry shall be coordinated with the fire department of the municipality in which the station resides.
- (vii) Entrances shall not include obstacles or obscured spaces for ease of surveillance and maintenance and unimpeded passenger flow in and out of the station during normal operations and in an emergency.
- (viii) Station entrances shall provide station closure (powered and mechanized) unless otherwise noted on stations plans. A personnel exit door/gate shall be incorporated in the design for emergency egress during off hours.

12.1.4.2 Accessible connections

As part of station circulation, mode transfers shall be provided an accessible route, minimum 8-foot wide and shall connect the station entrance to the elements below, where these are provided:

- Bicycle enclosures;
- Bus stops associated within the same block as platforms, entrances or exits; or in near proximity to the station site as indicated on the design documents;
- RIDE locations ; and
- Sidewalk connections from station entrances as indicated on Contract Documents.

An accessible route shall connect all service rooms to the station or to a public way with a 6-foot minimum wide route.

(a) Public Circulation within the Station

The journey to the platform shall include Horizontal and Vertical Circulation Elements located in the public spaces of the station. Each of the circulation elements defined below shall meet emergency egress and accessibility requirements.

(b) Platforms

Stations shall be designed with single end-loaded platforms. For each station, a single platform shall be centered between tracks, and serve traffic in both directions. The dimension between track centerlines shall determine the maximum available dimensions for the platforms.

- (i) Typical platform length shall be 225' to accommodate a single three-car LRV with 75' per car. Additionally, a future 75' platform extension shall be planned for, resulting in a future 300' long platform (the platform extension is not part of this project). The platform length for Lechmere Station, an elevated station where future extensions could not readily be accommodated, shall be 300' minimum to accommodate two (2) two-car LRVs, as part of this Project. All infrastructure shall be designed and constructed to accommodate potential future platform extension.
- (ii) Platform width shall be set by track alignment and accommodate minimum clearances on the platform.
- (iii) Platform shall be no less than 20 feet wide from outside of tactile edge to outside of tactile edge. Platform width shall comply with code and ADA guidelines and shall take into account train stop positions.
- (iv) For width clearances, a 6-foot minimum clearance shall be required from platform edge to obstructions (i.e. columns and station amenities) along the entire platform length.
- (v) Edge of platform shall be located 4'-9" from centerline of the light rail track.
- (vi) Platform floor elevation shall be designed at 8" above top of rail at the edge. In the future, the platform shall be vertically relocated/lifted to 14" above top of rail (TOR) to accommodate level boarding into the Type 9 LRVs. Platform design shall accommodate this future condition with possible solutions including structural considerations for future thickened slab, or provisions for jacking panels. Platform arrivals of elevators and stairs shall be set at the future 14" elevation above TOR with transition sloped down to the current platform height. The transition slopes shall not exceed 4.5% grade and be constructed to allow for leveling in future renovations.
- (vii) Station cross slope shall be: minimum and preferred 0.45%, maximum 1.9%.
- (viii) Platform drainage shall be directed towards the trackway.
- (ix) A 2-foot wide tactile edge shall be provided along the entire length of the platform.
- (x) Each station shall have an emergency egress that shall provide an accessible way to a point of safety (in the public right-of-way or a safe dispersal area) from the end of the platform. There shall be 36" high metal gates wired to communications systems at the end of the platform preventing unauthorized access to the emergency egress facilities.

- (xi) All platforms shall provide two (2) accessible means of egress to comply with accessibility and life safety requirements.
- (xii) The safe dispersal area shall be designed to provide at least 5 ft² of floor space per occupant using the safe dispersal area, be located at least 50' away from the station, permanently maintained and identified, fenced off to prevent access into the trainway, and provided with a safe and unobstructed path of travel from the station. Access to the safe dispersal areas shall be via a safe and unobstructed path that has a minimum width of 44 inches, and is accessed via a bi-swing door/gate at the end of the platform to prevent unauthorized, non-emergency access. A level landing (minimum 5' in length) shall be provided on the path after the gate. Additionally, at least two accessibility spaces will be provided in the safe dispersal area; each of the spaces will be 30" x 48" minimum, and will be located at least 100' away from the end of the station. The entrance into the accessibility will be via a landing that is level or have a slope not greater than 1:50.

(c) Walkways

Walkways are connecting paths between the different functional areas as, between the public right-of-way, entrance, and platform. The minimum width for accessibility shall be 6 feet clear and unobstructed. The walkway design shall use defensible space criteria to establish passenger safety. Standard waiting and walking spatial criteria shall apply when walkways lead to elevators or bicycle storage outside of the main path of travel.

Sloped walkways shall be provided to all platform access points (ramps, stairs, and elevators) to allow for the future platform height increase.

(d) Track Crossings

- (i) Pedestrian paths shall employ track crossings at right angles to the track direction.
- (ii) A detectable tactile warning shall be provided at both ends of the track crossing.
- (iii) Track crossing shall be of enough distance from the platform to facilitate vertical relocation platforms to 14" above TOR for future level boarding and comply with accessibility requirements.
- (iv) Where track crossings are provided for emergency egress only, the crossings shall include metal gates separating the right of way from public or private ways to prevent unauthorized or unmonitored use. Gates shall open in the direction of egress. These gates shall be wired into station security and communications networks. See Section 7.2 Sitework for detailed information.

(e) Ramps

The DB Entity shall provide exterior ramps for access in two level stations where elevators are not provided and shall follow the requirements including the MBTA Guide to Access. Ramp designs shall

be approved by MBTA's Department of System-wide Accessibility. Required characteristics shall include:

- (i) Ramps shall require roofs systems for weather protection and associated infrastructure. Coverage shall extend a minimum of 5' beyond the bottom and top landing of ramp.
- (ii) The design of the ramps shall use the same material palette as the adjoining station.
- (iii) The slope of ramps shall not exceed 8%.

(f) Stairs

Stair designs shall be submitted for acceptance by the MBTA. Required characteristics shall include:

- (i) There shall be a minimum of one stair per platform when elevators are also provided.
- (ii) Roof weather protection shall include all landings, and extend beyond the top and bottom step by 5' minimum.
- (iii) Risers shall be of uniform height, 7" maximum, closed with perforations, and with yellow contrast/reflective aluminum nosing firmly attached to the stair structure.
- (iv) All treads shall be a uniform depth of 12".

(g) Railings

Railing designs shall be submitted for acceptance by the MBTA. Required characteristics shall include:

- (i) Guard rails shall be picket style guard rail and hand rail assembly consisting of a steel rectangular-bar stock primary frame filled in with a smaller dimensioned field of steel rectangular bar-stock pickets. Posts shall be bar stock primary frame.
- (ii) Guard rail shall be hot dip galvanized, shop primed and painted.
- (iii) Handrails and attachments shall be 1 1/2" diameter heavy wall 316L stainless steel tubing. Handrails shall be continuous.
- (iv) Guard railing attachments to structure shall be galvanized and painted.
- (v) Where dissimilar metals are joined, metal surfaces shall be adequately separated to prevent galvanic action and corrosion.
- (vi) Guard rail posts shall be side mounted (i.e. attached to vertical face of parapet/slab/wall).
- (vii) Child handrails shall be provided at all handrail locations.

(h) Elevators

The DB Entity shall provide elevators in accordance with the MBTA Elevator Standard which include provisions for the design of the elevator shaft and the detailing of the elevator cab and the

performance of the equipment. Elevator designs shall be submitted for acceptance by the MBTA . Required characteristics shall include:

- (i) All elevators shall be accessible.
 - (ii) All elevators shall be heavy duty, electrical traction, Machine Room Less (MRL).
 - (iii) The queuing/discharge space shall be at a minimum of 9' deep clear of partitions or wall, and 5' clear of minimum circulation clearances, located so as to not interfere with the main flow of passengers.
 - (iv) The hoistway and car design shall utilize glazed materials per MBTA Elevator Design Guidelines.
 - (v) Hoistway size shall be determined by product manufacturer's specifications.
 - (vi) Provide elevators return to a designated landing position during a power outage.
 - (vii) Provide Emergency Medical Service (EMS) gurney to be accommodated in the minimum cab size.
 - (viii) Elevator entries shall be covered by minimum 5' overhangs.
 - (ix) Elevator pit waterproofing shall be crystalline type, 4000 psi compressive strength and warranted for five years from date of Substantial Completion.
 - (x) Elevator louvers shall be located to avoid exposure to prevailing winds.
- (i) Area of Rescue Assistance

Areas of Rescue Assistance shall be on a stable firm and slip resistant floor area, 5 feet by 9 feet clear, not encroaching on the main path of egress travel, with ample visibility from several viewpoints, adjacent to elevator doors equipped with a code compliant two-way communication system, lit with minimum 30 fc lighting intensity and signage per [Section 12.5](#). The Area of Rescue Assistance shall be equipped with Stryker Evacuation Chairs or approved equal by the MBTA and signed per applicable per applicable code requirements.

12.1.4.3 Station Elements

(a) General Requirements

The materials exposed to public view or providing weather protection shall be materials designed specifically as a finish and shall be nonporous, durable and resilient to exterior forces including corrosion, weathering and impact. Lifespan of the connections shall meet or exceed the life of the finishes. The lifespan of the connections and finishes shall be no less than 25 years.

The DB Entity shall provide exterior assemblies to avoid interior or exterior corrosion, detrimental contact of dissimilar materials and deleterious reaction to contact with salt. Field welds on structural steel shall not be used. The station materials and finishes shall rely on proven technologies, with a documented successful installation track record of a minimum of 5 years. Station materials shall be noncombustible and weather resistant (including freeze-thaw cycles), mold resistant and detailed to resist anticipated potential vapor and moisture penetration including

direct infiltration, pressure and wind driven infiltration, UV exposure, and vapor migration along gradients.

(b) Exterior Envelope

Requirements shall include:

- (i) Exterior walls shall be an impact resistant material, such as concrete, or precast-concrete, or calcium silicate masonry units intended for outdoor use including integral water repellent to provide corrosion and weather protection. Regarding impact protection, the side of exterior assemblies exposed to public circulation shall be commercial heavy duty, abrasion and indentation resistant to typical impacts from people and intentional abuse with small objects. Applicable tests include: ASTM D4977, ASTM D5420 and ASTM E695.
- (ii) Precast concrete trim locations are window sills, base course and parapet caps at masonry construction exterior walls and curbs at elevator hoistways. Mortar, grout, reinforcement, ties and anchors shall be provided for a complete assembly.
- (iii) Certificate of Compliance for fire rated concrete masonry units shall be determined per ASTM E 119 and submitted to Authority prior to Substantial Completion.
- (iv) Exterior walls shall pass NFPA 285 as a complete assembly when walls utilize metal composite materials (MCM) or high-pressure decorative exterior-grade compact laminates (HPL). This is also required for exterior walls utilizing foam plastics, except for exterior walls of fully sprinklered, one story buildings where foam plastic having a flame spread index of 25 or less, and a smoke developed index of 450 or less, are installed without thermal barriers in or on exterior walls in a thickness not more than 4 inches where the foam plastic is covered by aluminum not less than 0.032 inch-thick, or corrosive-resistant steel not less than 0.016 inch thick.
- (v) Roof materials shall have a documented 25-year service life. Roofs shall have a white or light colored top coat to conform to the MBTA's sustainability policies and goals. The standard roof system of the Work shall be modified bitumen built-up roofing for enclosed rooms and elevator hoistways. Stairs, ramps and bicycle storage areas shall be protected by steel seam roof systems.
- (vi) Roofs shall have tie-offs for all roofs requiring maintenance.
- (vii) Wood/plywood shall not be used in roofing assemblies.
- (viii) Roof drains shall be 30% oversized capacity. Provide overflow scuppers. Heat tracing shall not be accepted as a substitute to oversizing.
- (ix) Provide snow guards for sloped roofs.
- (x) Structural posts shall be elevated 30" or protected to prevent corrosion from snow melting chemicals.
- (xi) All horizontal surfaces shall be sloped to shed water to a drain as required by code. Slope shall not be less than 1%. This requirement includes steel base plates.
- (xii) Equipment and envelope design and installation provided shall comply with MBTA insurance carrier requirements (refer to [Exhibit 21](#) - FM Global Service Guide).

- (xiii) Exposed exterior steel shall be hot-dipped galvanized, primed and painted. Steel plates, shapes and bars shall be ASTM A 36/A 36M. Where used in an exposed to weather application, stainless-steel shall be Type 316L. Aluminum extrusions shall be ASTM B 221, Alloy 6063-T6.

(c) Fenestration and Doors

Requirements shall include:

- (i) Glazing for conditioned spaces shall be double pane insulated glass assemblies in steel or aluminum frames. Mullions shall be thermally broken.
- (ii) Where exposed to direct sun, energy efficient (low “e”) glass shall be used. Flashings shall be either stainless steel or galvanized.
- (iii) Door and window frames shall be painted metal or aluminum.
- (iv) Window and skin penetrating assemblies shall be thermally broken.
- (v) Glazing shall be detailed so that the Corridor and train operation are not impacted by staging of future glass replacement. Glazing, when adjacent to the Corridor, shall be glazed from the interior.
- (vi) Door, lockset and hinge requirements shall be per Section 08711 and coordinated with MBTA Engineering and Maintenance.
- (vii) Doors shall be installed such that they swing open in the direction of egress if the space serves 50 or more people per MSBC.

(d) Interior Elements and Materials General Requirements

The DB Entity shall design and select interior assemblies with attention to avoid interior or exterior corrosion, detrimental contact of dissimilar materials. The station materials and finishes shall rely on proven technologies, with a documented successful installation track record of a minimum of 5 years, and be noncombustible complying with both building code and NFPA standards.

(e) Interior Partitions, Walls and Ceilings

Walls shall be constructed as high impact, with wear resistant finishes and have low moisture absorption rate properties. Back of house areas shall be filled and painted CMU.

All occupiable spaces including operators lounge, bus operations booth and police reporting station, kitchenettes, and toilet rooms shall have acoustical ceilings.

(f) Floors

All floors within the stations shall be cast in place sealed concrete slab. All floors shall include the following characteristics:

- (i) Materials which are consistent throughout their body.

- (ii) Slip resistant ADA compliant finish.
- (iii) Non-stainable transparent sealer finish in support and occupied rooms.
- (iv) Control joints shall be saw cut to prevent uncontrolled surface cracking.
- (v) Colored and/or etched surface treatments are permitted.
- (vi) Minor areas of decorative materials are permitted with MBTA approval.
- (vii) Floor shall not have ponding.
- (viii) Long term cracking shall be reduced through the use of reinforcement.

All occupiable spaces including Operators Lounge, Bus Operations Booth, and Police Reporting Station shall have resilient floor coverings and baseboards over cast in place concrete floors.

Kitchenettes, Restrooms, and Janitor closets shall have durable, easily cleanable, non-porous, through-body floor tiles over the cast in place concrete floors, positively drained to the appropriate plumbing treatment structure.

(g) Platform Shelters

Platform Shelters shall be provided in order to protect transit users from the elements. Platform shelters shall follow MBTA guidelines concerning geometry, height and materials. The shelter layout shall provide two (2) wheelchair areas as per MBTA Guide to Access and shall include seating for a minimum two (2) customers and lighting. There shall be a minimum of three (3) shelters per platform.

(h) Benches

Considerations for bench location and design shall include:

- (i) Benches shall be located near waiting areas, platforms, platform shelters, in paid and unpaid areas - if space permits - and no greater than 200 feet apart within station limits
- (ii) No less than three benches, and protected from the elements, shall be provided per platform.
- (iii) Benches shall have high back and armrests on at least one side of each seat, per accessibility requirements.
- (iv) Benches shall be sloped for drainage.
- (v) A 30-inch by 48-inch clear ground space for a wheelchair shall be provided at all benches on each platform. No armrest shall be adjacent to wheelchair locations for possibility of seat transfer.
- (vi) Armrest elements shall be stainless or galvanized steel elements spaced so as to discourage lounging.
- (vii) Benches shall adhere to MBTA Design Standards.

(i) Customer Assistance Areas (CAAs)

The DB Entity shall provide a minimum of one (1) customer assistance area and bench at each station. CAAs shall be incorporated into platform designs and shall include a call box, a bench, and increased lighting levels, denoted by tactile surface materials. Where required by code, CAAs shall be established as Areas of Rescue Assistance. CAA designs shall be required to be approved by the MBTA.

(j) Trash Receptacles

The DB Entity shall provide one style of trash receptacle for the System platforms. For trash receptacles on the Community Path refer to Section 9. Location and design of trash receptacles considerations shall include:

- (i) Trash receptacles shall be located adjacent to but outside the path of travel, near entrances to stations, at shelters, and at the entrance to pedestrian overpasses.
- (ii) A minimum of two trash receptacles per platform shall be provided.
- (iii) Lechmere Station platform shall have a minimum of 4 trash receptacles.
- (iv) Trash receptacles at platforms shall be blast/explosion proof per MBTA standards.
- (v) The height of a receptacle shall be 3 feet maximum to the opening.
- (vi) Trash receptacle shall be 40-gallon capacity affixed to pavement or a concrete pad with tamper-proof fasteners.
- (vii) Trash receptacles shall be easily accessible for maintenance and vandal proof.
- (viii) When exposed to the weather, trash receptacles shall include a weather-proof cover that keeps the contents dry.
- (ix) One trash receptacle shall be provided at the bicycle enclosure at Lechmere Station.
- (x) Trash receptacles shall adhere to MBTA Design Standards

(k) Bicycle Storage Racks and Enclosure

Location and design considerations of the bike rack enclosures shall include:

- (i) Enclosed and open bike storage shall be provided at all stations, and shall be located away from major circulation.
- (ii) The number of bike spaces, at each station, shall be based on meeting the Environmental Assessment requirements at a minimum. It is encouraged to exceed these capacity minimums, including a 5:2 ratio of long-term (covered and enclosed bike storage) to short-term (open bike rack) spaces at each Station.
- (iii) Bike racks shall be located near station entrances and shall be in unobstructed direct line of sight/visible from entrances or platforms so they can be observed by MBTA personnel or commuters. Refer to sSection 10606 in Exhibit 2A.1.

- (iv) Bike racks shall be made of galvanized steel. Racks shall be a stacked system so two bikes can share the same footprint. More information about rack performance and geometry can be found in the MBTA Pedal and Park Program Guidelines.
- (v) Bicycle enclosures shall be fully accessible, lighted, with fire alarm, camera and communication coverage.
- (vi) Bicycle enclosures shall be covered. At Lechmere Station, the bike enclosure may be covered by the viaduct structure.
- (vii) Provide signage as specified per MBTA standards.
- (viii) Enclosure shall be 1" x 1" diagonal square pattern chain link fence, black vinyl coated, climb resistant.
- (ix) Lighting levels on the interior shall exceed lighting levels around the exterior to allow for unobstructed view into the enclosure from the exterior.
- (x) Each enclosure shall have two entrances; Lechmere station shall have one additional exit.
- (xi) Each entrance shall be card access controlled and with automatic door operators stainless steel hardware.

(l) Sand Storage Bins

All surface stations shall have a minimum of one sand and one salt storage bin each per each station platform. Locations shall be confirmed by the MBTA. Design considerations for sand/storage bins shall include:

- (i) Bins shall be located in areas of the platform that are not on the major paths of travel, away from entrances and boarding areas and outside of the required accessible route, but easily accessible for MBTA maintenance workers.
- (ii) The size of the bin shall be 2'-6" wide, 2'-6" high and 3'-0" long or minimum of 11 cubic feet capacity, covered, lockable, corrosion resistant prefabricated container designed to keep the contents dry.
- (iii) Bins shall be fabricated from molded industrial-duty polyethylene, resistant to degradation from sunlight, oils, saltwater, and chemicals; with stainless-steel hinges.

(m) Bird Deterrents

All horizontal surfaces or areas of potential roosting shall utilize an energy passive bird deterrent strategy including bird slides or other geometrical deterrent, bird spikes, and bird wire.

12.1.4.4 Service Rooms

(a) Employee's Operators Lounge

The Employee's Operators Lounge (EOL) shall be the minimum size as required by the Contract Documents, and not less than 180 SF. The program benchmark is 30 SF per person for an EOL for six MBTA operators. EOL shall be located at College Avenue Station, and Union Station. Union station EOL is by the adjacent developer and out of scope. EOL elements shall be as follows:

- (i) Kitchenette, including 8 linear feet of base and wall cabinets, double tub sink with hot/cold water faucet, food waste disposer, valance lighting over sink, GFI electrical outlet for microwave oven, tankless water heater.
- (ii) Space for table and six chairs, area for lounge seating and convenient electrical outlets suitable for lamps and charging stations.
- (iii) The EOL shall have direct access to or be immediately adjacent to the dedicated toilet rooms. The EOL shall be fully accessible, conforming to ADA, MAAB, and SWA standards and requirements.

(b) Toilet Rooms

Toilet Rooms for employees shall be located at College Avenue, Union Station and Lechmere Station; no public toilet rooms shall be provided. Union Station Toilet rooms are not included in the Work. There shall be two toilet rooms, both fully accessible and compliant to all applicable codes, including ADA, MAAB, and relevant sections of the BCIL. All surfaces shall be non-porous durable, cleanable, stain and water resistant. The plumbing wall shall use ceramic or porcelain tile and conform to the properties listed above from floor to ceiling finish. Toilet rooms shall be heated for occupant comfort and to prevent freezing of pipes. The design shall provide the minimum program requirements:

- Accessible toilet
- Toilet tissue dispenser
- Grab bars
- Accessible sink (including drain pipe protection) and faucet
- Tankless water heater
- Soap dispenser
- Paper towel dispenser
- Hand drier
- Trash receptacle
- Mirror
- Exhaust Fan

(c) Janitor Closets

Janitor Closets shall be located in stations where kitchenettes and/or toilet rooms are located. At Union Station, Janitor Closets shall be provided by the adjacent developer. All surfaces shall be non-porous durable, cleanable, stain and water resistant. The plumbing wall shall use ceramic or porcelain tile and conform to the properties listed above. The design shall provide the minimum program requirements:

- Slop sink and faucet

- Tankless water heater
- Soap dispenser
- Paper towel dispenser
- Trash receptacle
- Shelving storage
- Exhaust fan

(d) Police Reporting Station

The Police Reporting Station shall be provided at Lechmere Station at grade and requirements shall include:

- Access and use shall be fully accessible
- Space and furniture for three workstations with electrical, data and communication access
- Waiting area and seating for 2
- Access to kitchenette
- Visual access to the station entry area
- Direct access to the exterior
- Bullet resistant walls to adjacent spaces, including any fenestrations and doors
- Fully conditioned with local thermostatic control

(e) Bus Operations Booth

The Bus Operations Booth shall be provided at Lechmere Station at grade and requirements shall include:

- Access and use shall be fully accessible
- Space and furniture for one workstation with electrical, data and communication access
- Shelving storage
- Access to kitchenette
- Maximum clear site of vision access of to the bus loop, stops and bus berths
- Fully conditioned with local thermostatic control

(f) Kitchenette

A Kitchenette shall be provided at the Lechmere station for the shared use of the Bus Operations Booth and Police Reporting Station. Requirements shall include:

- 8 linear feet of base with countertop including backsplash and wall cabinets

- double tub sink with hot/cold water faucet
- Food waste disposer
- Valance lighting over sink
- GFI electrical outlet for microwave oven
- Tankless water heater

(g) Starters Booth

Starters booths shall be provided at Union Station and College Station. Requirements for the starters booth shall include:

- Booth use and access shall be fully accessible
- Booth shall be heated, cooled and insulated
- Fenestration shall be insulated glass
- Provide 3 electrical outlets, 1 phone and 1 data outlet
- Provide desk and cabinetry as required by MBTA Operations
- Access doors type, hinge and lockset shall be coordinated with MBTA Engineering and Maintenance

(h) Electrical Room

All electrical rooms shall be sized and laid out according to the electrical service requirements of the station. Adequate space shall be provided to access all equipment. All electrical rooms shall be conditioned to meet the installed equipment's operating temperature range (maximum range 50°F - 78°F). The room shall include an envelope that meets the requirements of the applicable Energy Code, including a continuous air/vapor barrier. The interior surfaces shall be constructed of highly durable finishes and flexible enough to support equipment back boards at any location and position on the walls. Electrical room enclosure fire-resistance shall comply with MSBC.

(i) Communications Room

All communications rooms shall be sized and laid out according to the communication requirements of the station. Adequate space shall be provided to access all equipment and equipment racks. Provisions shall be made to support wire management systems, including cable trays as required for a fully interconnected system of components. All communications rooms shall be conditioned to meet the installed equipment's operating temperature range (maximum range 50°F - 78°F). The room shall include an envelope that (a) meets the requirements of the applicable Energy Code, and (b) includes a continuous air/vapor barrier. The interior surfaces shall be constructed of highly durable finishes and flexible enough to support equipment back boards at any location and position on the walls.

(j) Mechanical Room

All mechanical rooms shall be sized and laid out according to the mechanical service requirements of the station's support spaces, including toilet rooms and operator lounges. Adequate space shall be provided to access all equipment. All mechanical rooms shall be conditioned to meet the installed equipment's operating temperature ranges. The room shall include an envelope that meets the requirements of the applicable Energy Code, including a continuous air/vapor barrier. The interior surfaces shall be constructed of highly durable finishes and flexible enough to support equipment back boards at any location and position on the walls. Mechanical room enclosure fire-resistance shall comply with MSBC.

(k) Elevator Control Room

All elevator control rooms shall be sized and laid out according to the control equipment requirements of the elevator(s) and as required by the elevator manufacturer. Adequate space shall be provided to access the equipment. All elevator control rooms shall be conditioned and ventilated to meet the installed equipment's operating temperature range (maximum range 50°F - 78°F). The room shall include an envelope that meets the requirements of the applicable Energy Code, including a continuous air/vapor barrier. The interior surfaces shall be constructed of highly durable finishes and flexible enough to support equipment back boards at any location and position on the walls. The fire resistance rating of the enclosure shall be rated and vented as required by all applicable codes.

12.1.4.5 Missile Barrier

- (a) Missile barrier protection by a surface with maximum 1" by 1" openings shall be provided at ramp sections, stairs, and public areas (excluding station platforms) running in close proximity to the overhead catenary system, in elevated areas, and as prescribed by MBTA Safety Guidelines and Project Requirements.

12.2 STATION STRUCTURES

12.2.1 Scope of Work

The Work includes the structural design, preparation of structural construction drawings and the construction of seven transit stations - Lechmere Station, East Somerville Station, Gilman Square Station, Magoun Square Station, Ball Square Station, College Ave Station, Union Square Station, the Lechmere bus loop, and their associated platforms, entrances exits, stairs, walkways, ramps and egress structures. The stations shall consist primarily of an island platform and a means of access from the public streets.

12.2.2 Codes, Standards and Manuals include:

- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures
- Massachusetts State Building Code (MBC), referred to below “780 CMR”
- 527 CMR Massachusetts Fire Code
- ASCE 7-10, Minimum Design Loads for Buildings and Other Structures
- AISC Steel Construction Manual 14th Edition
- AISC Design Guide 11: Floor Vibration Due to Human Activity
- AISC Seismic Provisions, as amended by 780 CMR
- ACI-318 Building Code Requirements for Structural Concrete
- ACI 301 Specifications for Structural Concrete
- ACI-530 Building Code Requirements for Masonry Structures
- AWS D1.1 – Structural Welding Code - Steel
- AWS D1.3 – Structural Welding Code – Sheet Steel
- AWS D1.4 – Structural Welding Code – Reinforcing Steel
- AASHTO LRFD Bridge Design Specifications, as supplemented by the FHWA 2010 Drilled Shaft Manual, the latest edition
- AREMA Manual for the Railway Engineering
- FM Global Property Loss Prevention Data Sheets; 1-28 Design Wind Loads, 1-31 Metal Roof Systems, and 1-54 Roof Loads for New Construction
- ASME Safety Code for Elevators and Escalators A17.1

12.2.3 The Project Specific Requirements

12.2.3.1 Design Methodology shall include:

- (a) The Stations Structures design shall be based on the criteria noted and in the applicable standards described herein. Submit any design elements that do not meet the requirements of

these documents in writing to the MBTA for approval. The DB Entity shall maintain a written log of approved exceptions to the Project Requirements.

- (b) Steel Elements – Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD)
- (c) Concrete Elements - Ultimate Strength Method
- (d) Masonry Elements - Allowable Stress Design Method

12.2.3.2 Live loads include:

- (a) Public Spaces - 150 PSF Per MBTA Guide Specifications
- (b) Non- Public Spaces - 50 PSF Per IBC office loading
- (c) Plazas - AASHTO H20 Loading
- (d) Stairs & Corridors - 150 PSF
- (e) Elevator machine rooms - 150 PSF
- (f) Electrical, storage and telecommunications rooms - 250 PSF
- (g) All Other Areas - In accordance with Mass Building Code 780 CMR

12.2.3.3 Superimposed dead loads include:

- (a) Future raising of platforms by 6” for the future higher transit vehicles - 75 psf (equivalent to 6” of normal weight concrete)

12.2.3.4 Train loads include:

- (a) LRV Vertical Loads - 137,000 LBS
- (b) Railroad Vertical Loads - AREMA Cooper 80
- (c) LRV Horizontal Loads - 40% of Single Car Load Applied 2 Feet above the Top of Rail
- (d) Railroad Horizontal Loads - In accordance with AREMA

12.2.3.5 Impact loads include:

- (a) Elevator supports - 100% of the total reaction to the supports

12.2.3.6 Snow loads include:

- (a) In accordance with Mass Building Code 780 CMR

12.2.3.7 Seismic loads include:

- (a) In accordance with Mass Building Code 780 CMR

12.2.3.8 Wind loads include:

- (a) In accordance with Mass Building Code 780 CMR

- (b) In accordance with FM Global (Refer to Exhibit 2I)

12.2.3.9 Load combinations include:

- (a) In accordance with American Society of Civil Engineers (ASCE) 7-10 Chapter 2

12.2.3.10 Maximum deflections include:

- (a) Floor Framing Deflections - Live Load Deflection = $L/360$ Total Load Deflection = $L/240$
- (b) Roof Framing Deflections - Live Load Deflection = $L/240$ Total Load Deflection = $L/180$
- (c) Lateral System Deflections - Wind Load Deflection = $L/400$ and Seismic Load Deflection per ASCE 7, Section 12.12
- (d) Shrinkage and Creep - Account for the long-term effect of concrete shrinkage and creep due to sustained load in deflection calculation

12.2.3.11 Elevators include:

- (a) Serviceability requirements - Per ASME A17.1-10
- (b) Pit Depth – Per elevator standard (Refer to Exhibit 2H)

12.2.3.12 Corrosion controls include:

- (a) Stray Currents - Detail concrete structures reinforcing to comply with Stray Currents detailing requirements for structures within stray currents range
- (b) Corrosion Inhibitor - Provide 3 gallons of Calcium Nitrate corrosion inhibitor (DCI) per cubic yard of concrete in all concrete surfaces exposed to deicing salts or salt water

12.2.3.13 Concrete serviceability include:

- (a) Construction Joints and Control Joints - Provide construction joints and Control Joints to minimize the effect of shrinkage and drying cracks
- (b) Plain concrete - Plain concrete shall not be used in structures exposed to view or the public

12.2.3.14 Protection of Station Supports

The DB Entity shall determine an approach of protection that is appropriate based on the specific types of supports at the stations. All Codes that relate to the design of Transit Stations shall apply to this work. The DB Entity shall design supports to withstand a Light Rail Vehicle Derailment impact using an approach such as the following:

- (a) Safety Walls: Continuous reinforced concrete wall parallel to and integral with the stations or structures support designed to withstand a superimposed impact load based on light rail vehicle equipment and operational characteristics. The Safety Walls are required to extend far enough above the track level at the point where a derailment impact would occur so that the derailment impact occurs at the continuous concrete casement rather than at individual columns. The superimposed impact horizontal load is 55 kip (equivalent to 40% of the weight of one fully

loaded (137,000 pounds) existing System Type 7 car) applied at two feet above the top of rail and distributed over a distance of 10 feet. Include the vertical load from the train's center axles, 48 kips (two single wheel loads 6'-3" apart) as a vehicular surcharge uniform lateral load equivalent to 3'-3" of at-rest soil acting concurrently with the superimposed impact horizontal load. The concrete encasement is also required to fully encase the column base plate and anchor bolts for corrosion protection. See Figure 12.2-1.

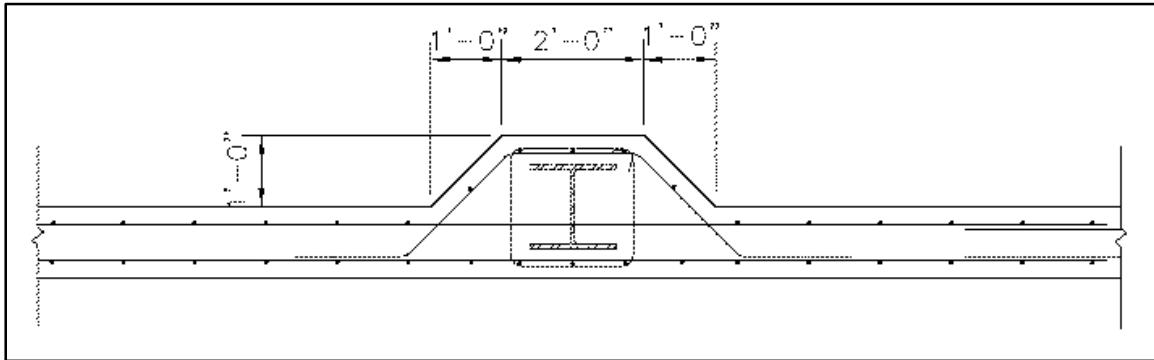


Figure 12.2-1 - Typical Safety Walls for Protection of Stations/Structures Supports

12.2.3.15 Station Specific Technical Requirements

(a) Lechmere Station:

- (i) Two – 36" diameter RCP pipes adjacent to South Exit Structure: The DB Entity shall design and coordinate the station structure around the existing utilities. The DB Entity is required to obtain final approval from the City of Cambridge prior to construction of the station. Protect the two pipe and associated elements during construction at all times including during pile driving, excavation.
- (ii) Platform Structure: The Lechmere viaduct superstructure (portion of the structure above piers) shall be independent from the Lechmere Station platform, in order to minimize structural interactions between the two structures. Final design of the two structures shall take into consideration the future Type 9 LRV, and the requirements for "Level Boarding" between the LRV and platform.
- (iii) Platform vibrations: The DB Entity shall design the Lechmere platform structure such that vibration natural frequency is greater than 4.0 Hz.

(b) East Somerville Station

Community Paths walls: The DB Entity shall provide a waterproofing system such as membrane waterproofing and protection board, crystalline waterproofing (integral additive or surface applied) to the Community Path concrete walls to minimize water infiltration to the Community Path. Extend membrane waterproofing from top of wall foundation to 1'-0" below the finish grade. Provide under slab drains along the length of the Community Path to minimize underground water infiltration.

(c) Pedestrian Walkways

All elevated pedestrian walkway structure, excluding Lechmere Station, shall comply with Section 8.6.

12.3 FARE COLLECTION

12.3.1 Scope of Work

The Work includes the provisions for Fare Vending Machines (FVM) at each of the seven stations.

Methods of fare collection are evolving. It is assumed that at the time of completion of the construction of the seven Stations, entrance gate arrays shall no longer be a part of the fare collection program.

The MBTA is in the process of procuring a new fare collection system for all its service, which is currently named AFC 2.0.

12.3.2 Codes, Standards and Manuals include:

- MAAB 521 CMR

12.3.3 The Project Specific Requirements

12.3.3.1 Fare Vending Machines

MBTA AFC 2.0 to provide FVMs, each typically servicing one to two people per minute, require a queuing area in front of them at minimum 5-foot deep. FVMs to be located in banks or clusters at select locations.

The location of FVMs shall be at the station entrances and Lechmere bus loop (minimum of one on the north side and one on the south side of the loop). These locations shall be adjacent to the accessible route. A FVM and its associated queuing area shall not block the accessible route or path of egress. The functional size of queuing area in front of a FVM cluster is 12' x 5'.

The DB Entity shall request details of the FVM sufficiently in advance to incorporate FVM requirements in the station design.

DB Entity to Provide the following:

- Coverings for rain and snow protection for the FVMs.
- Elevated housekeeping pads at areas with the least likelihood of snow/ice accumulation.

12.3.3.2 Fare Vending Machine Installations

The fare vending machine installations shall be based on MBTA requirements and the AFC 2.0 requirements. FVM installation by the DB Entity shall include the following: a housekeeping pad for a bank of three (3) fare vending machines, power, lighting, closed-circuit television (CCTV), communications, and two six foot benches.

12.4 STATION LIGHTING

12.4.1 Scope of Work

The Work includes the lighting of the seven stations and their surrounding areas. This Work involves lighting for headhouses, platforms, ramps, plazas, walkways, access routes, drive-aisles, bus loops, and all areas where the safety and security of station users, MBTA employees, and MBTA property is a consideration.

The lighting design for stations shall be applied such that economical usage of equipment and energy efficient products are used to meet all requirements. The requirements and selection of equipment shall be coordinated with the requirements outlined in Section 13.5 Building and Building Site Lighting for a consistent approach to lighting throughout the system.

The design of the lighting system includes the following sub-systems:

- a) Station interior lighting,
- b) Station platform lighting,
- c) Site and exterior lighting, including the Lechmere bus loop,
- d) Task lighting for specific applications,
- e) Emergency lighting,
- f) Community Path lighting

12.4.2 Codes, Standards and Manuals include:

- MBTA Design Directive Regarding Platform Lighting Levels
- National Electrical Manufacturers Association
- Illuminating Engineering Society of North America (IESNA), Lighting Handbook, Recommended Practices, and Design Guidelines
- The Massachusetts State Building Code (MSBC)
- American Public Transit Association
- 527 CMR 12.00 Massachusetts Electrical Code
- AASHTO Standard Specifications for Structural Supports
- International Energy Conservation Code

12.4.3 The Project Specific Requirements

12.4.3.1 General Station Lighting Requirements

Lighting equipment shall be vandal-resistant in spaces accessible to patrons or the public.

Luminaire locations shall permit ready accessibility for maintenance and periodic cleaning. “Basis for Design” documentation shall describe how maintenance will be accomplished and any special equipment needed for access to luminaires.

The standardization of lighting levels for similar areas throughout the system is required. Spaces where design requirements are not clearly defined in any of the above listed documents, or spaces where alternate design intent is either suggested or necessary shall be submitted to the MBTA for review and acceptance. Where lighting levels values vary between IESNA and MassDOT documents, the more stringent values shall apply. Lighting for underpasses shall comply with IESNA standards.

Lighting calculations that document the lighting design performance meets the requirements shall be submitted to the MBTA for review and acceptance.

Lighting controls shall be consistent throughout the project, and be provided by same vendor. The selection of lighting equipment (including luminaires) used throughout the project shall be consistent between all the stations (e.g. interior lights at one station are the same make/model as interior lights at the next station), for consistent and simplified maintenance efforts throughout the system.

Lighting controls shall utilize a programmable astronomical timeclock scheduling system for pre-set light levels based on the table as defined below. Preset light levels shall be reviewed and accepted by the MBTA.

Morning	4:00 AM
Open	5:00 AM
Close	1:00AM
Night	1:00 AM to 4:00 AM
Sunset and Sunrise	Per astronomical timeclock

Commissioning of the lighting and lighting controls shall be required, and include aiming of adjustable lighting, and programming of lighting controls.

12.4.3.2 Station Interior Lighting

The interior station lighting shall be LED. A 3500K color temperature shall be used, with an 80+ CRI for all interior lighting. Interior lighting shall be UL Listed for Damp locations, except in cases where a higher rating is required. LEDs shall have a minimum life rating of 50,000 hours with 70% lumen maintenance at 25 degrees Celsius.

Natural light from windows, skylights, and clerestory windows shall be maximized to reduce dependence on light fixtures during daylight hours, and the lighting control system shall control lights accordingly where daylight levels meet or exceed illuminance requirements. Shading methods shall be used where necessary to prevent glare from interfering with employees’ ability to work who are stationed in static locations (e.g. office desks).

Peak luminous intensity from interior light fixtures shall be prevented from being aimed out windows

or skylights to limit light spill to the night sky.

12.4.3.3 Station Platform Lighting

The lighting for the platform lighting shall comply with the MBTA standards through the use of free standing pole mounted lighting, or lighting equipment attached to other structures. Canopies or framework structures constructed solely for the purpose of supporting lighting equipment shall not be permitted. Pole mounted luminaires shall be installed between 16ft and 20ft above grade to maintain a pedestrian scale. Lighting poles for exterior platform lighting applications shall be concrete, heavy duty coated aluminum, or epoxy coated steel poles to maximize service life. Pole shapes at each station shall be same.

A 3000K color temperature shall be used, with an 80+ CRI for platform lighting. Lighting equipment shall be UL listed for wet locations. LED and driver system life shall be rated for 50,000 hours, with 70% lumen maintenance minimum at 25 degrees Celsius.

Platform luminaires shall have a BUG rating not to exceed B4-U0-G2 for Type V distributions, and B3-U0-G2 for Type II, Type III and Type IV distributions. Luminaires shall not exceed 12,000 lumens delivered. Peak luminaire intensity shall not exceed 10,000 candela. Any exterior luminaire located within 10ft or one mounting-height of distance (whichever is greater) of a property line shall be provided with shielding to limit spill light beyond the property boundary.

12.4.3.4 Station Exterior Site Lighting

Lighting controls for all exterior site areas shall turn on exterior luminaires when ambient illuminance levels drop below the design illuminance target or 10 foot-candles at the ground plane, whichever is higher. The lighting control system and luminaires shall accommodate a nighttime set-back of light levels capable of reducing luminaire intensity through dimming up to 80% for energy usage reduction and further light intensity reduction.

The exterior lighting fixtures shall be LED. A 3000K color temperature shall be used, with a 70+ CRI for all exterior lighting. Exterior lighting shall be IP66 rated, and UL listed for wet locations. LEDs shall have a minimum life rating of 50,000 hours with 70% lumen maintenance at 25 degrees Celsius.

Lighting poles for general exterior lighting applications shall be concrete, heavy duty coated aluminum, or epoxy coated steel poles to maximize service life. Pole shapes at each station shall be same. Pole concrete bases shall extend a minimum of 12" above grade. Path and walkway lighting poles shall be pedestrian scale, with a maximum of 15' high, and a minimum of 10' high.

Area lighting poles' height shall be minimum 20' tall to optimize light distribution and coverage and prevent glare.

DB Entity shall closely review the lighting levels and "spill" light with the local Authority Holding Jurisdiction to ensure proper levels for the building location. Luminaires illuminating the building facade shall be shielded from view beyond the site boundary. Luminaires not illuminating the building facade with intensities greater than 10,000 candela shall be shielded or rated as full cut-off per the

IESNA. DB Entity shall avoid any direct illumination onto adjacent properties to limit spill light. Any exterior luminaire located within 10' or one mounting-height of distance (whichever is greater) of a property line shall be provided with shielding to limit spill light beyond the property boundary.

12.4.3.5 Specific Task Lighting

The lighting for specific task areas shall be located and designed to meet task requirements. Additional specific task applications shall be reviewed with the MBTA to verify lighting requirements for those cases.

Lighting at fare vending machines shall comply with requirements and shall use luminaires located to mitigate shadowing on machines, and to provide optimal unobstructed light quality when in use by system patrons.

12.4.3.6 Emergency Lighting

Emergency lighting shall be provided throughout the station and site. Exit lighting fixtures shall be LED.

Sufficient emergency lighting redundancy shall be provided in stairs, ramps, pedestrian overpass, elevator areas and exits, so that the failure of any one unit will not leave any area dark or endanger persons leaving the platform.

Emergency and exit lighting shall be powered by an emergency power source, sized to maintain code required lighting levels for a minimum of 1 hour and 30 minutes. Refer to [Section 14.5](#) for Station and Building Electrical Systems for additional requirements.

12.4.3.7 Community Path Lighting

DB Entity shall provide lighting in compliance with City of Somerville standards and the IESNA Recommendations.

Lighting need not be provided continuously along the entire length of the path, however, lighting shall be provided to meet 1fc horizontal at the walking surface along the community path at key locations, as outlined below:

- Stairs
- Bridges
- Crosswalks
- Underpass locations
- Pathway decision/divergence points
- Changes of grade
- Emergency call boxes
- Other locations considered as potential hazards/obstacles

Areas of special security concerns, including: dense shrubbery/landscaping, light shall extend from 5ft up to 15ft beyond either side of path in these areas, at one third of the design light level at the pathway. At underpass locations, light levels shall be 2-3 times higher than the path lighting outside of the underpass.

Lighting on vertical surfaces within underpasses shall be provided to enhance visibility and security in these locations.

Where lighting is provided for the areas listed above, a minimum of 30ft of path in either direction beyond the specific listed area shall be provided with even illumination.

Poles shall be selected to appear consistent with the existing pathway lighting poles. Use of LED technology on all new poles shall be required, while the aesthetic appearance shall strive to maintain the existing character to the greatest extent possible.

Lighting shall be controlled by a combination photocell and astronomical electronic time clock. System controls shall be set to provide continuous lighting from dusk to dawn.

12.5 STATION SIGNAGE

12.5.1 Scope of Work

The DB Entity shall provide signage and wayfinding elements in accordance with MBTA Standard Design Specifications and the Station Signage Components Manual at the seven new system transit stations and the Lechmere Station bus loop. Signage scope includes all sign types as defined below in section 12.5.3, including MBTA “lollipop” sign, fixed signs(including all metal frames), tactile/Braille signs, regulatory and warning signs and special signs, including project specific signage.

12.5.2 Codes, Standards and Manuals include:

- Massachusetts Architectural Access Board
- MBTA Guide to Access
- ADAAG (ADA Accessibility Guidelines)
- GLX Station Signage Components Manual
- MBTA 2014 Logo Sign Guidelines
- MBTA Standard Design Specifications
- Porcelain Enamel Institute, “*Specifications for Architectural Porcelain Enamel*”

12.5.3 The Project Specific Requirements

Signage shall be provided to identify entrances and exits, location maps, wayfinding, routes, and schedule information to passengers both in the station and in transit. Stations shall be identified as part of the MBTA transit system with the station name and its accessibility provisions.

a) Street Signs

Provide MBTA standard “lollipop” signage, internally illuminated, one at each street entrance to station, mounted on poles in locations unobstructably viewable from the street. For further specifications, description of work, products, submittals and execution, see the following documents:

- GLX Station Signage Components Manual
- MBTA 2014 Logo Sign Guidelines
- Exhibit 2A.1, Section 10428

b) Entrance Signs

Provide the station name and sign frames at the station entrance, in a location clearly visible from the adjacent sidewalks and street intersections. Exiting information to include closest street or plaza as relevant to each station location. For further specifications, description of work, products, submittals, and execution, see the following documents:

- GLX Station Signage Components Manual
- Exhibit 2A.1, Section 10400

- Exhibit 2A.1, Section 10401
- c) Street/ Lobby Signs
- Provide the station main ID signs and frames, including the rapid transit line map, green line map and neighborhood map panels. Additional signs included but not limited to “Do Not Enter” signs, elevator signs, and ADA access signs. For further specifications, description of work, products, submittals and execution, see the following documents:
- GLX Station Signage Components Manual
 - Exhibit 2A.1, Section 10400
 - Exhibit 2A.1, Section 10401
- d) Platform Signs
- Provide freestanding platform station ID signs and frames based on the station requirements and configuration, including maps, and customer assistance panels. Signs shall be visible from inside train cars, considering seated and standing sightlines from passengers. For further specifications, description of work, products, submittals and execution, see the following documents:
- GLX Station Signage Components Manual
 - Exhibit 2A.1, Section 10400
 - Exhibit 2A.1, Section 10401
- Variable Message Signs should also be included. For further specifications, description of work, products and execution, see the following documents:
- Section 14.6
 - Exhibit 2A.1, Section 16742
- e) Track Signs
- Provide track signs and frames, freestanding/mounted to intertrack fence, placed across track – one per train car, based on the station requirements and configuration. Diagrammatic view angles (sight lines) from train are required to determine height of sign. For further specifications, description of work, products, submittals and execution, see the following documents:
- GLX Station Signage Components Manual
 - Exhibit 2A.1, Section 10400
 - Exhibit 2A.1, Section 10401
- f) Tactile/Braille Signs
- Provide tactile/Braille signs for all stations and for all customer-facing station areas. All permanent rooms (including back-of-house rooms), exits, restrooms, and stairs to include tactile/Braille signs as per relevant life safety, building, and ADA codes/guidelines. For further specifications, descriptions of work, products, submittals, and execution, see the following documents:
- GLX Station Signage Components Manual
 - Exhibit 2A.1, Section 10426

g) Regulatory/ Warning Signs

Provide regulatory/warning signs, including: “No smoking”, “Do Not Enter”, “Emergency Exit Only”, “THE RIDE Drop-off/Pick-up”, “Caution Train Crossing”, “Elevator Machine Room”, and “Danger No Passing”. For further specifications, description of work, products, submittals and execution, see the following documents:

- GLX Station Signage Components Manual
- Exhibit 2A.1, Section 10400
- Exhibit 2A.1, Section 10440

h) Bike Cage

Provide regulatory signs for bike parking area/cage. For further specifications, description of work, products, submittals and execution, see the following documents:

- GLX Station Signage Components Manual
- Exhibit 2A.1, Section 10400

i) Busway Signage and Schedule Cases

Provide busway signage, including: bus berth signage, speed limit signs, ‘Do Not Enter Busway’ signs, and schedule cases based on the station requirements and configuration. For further specifications, description of work, products, submittals and execution, see the following documents:

- GLX Station Signage Components Manual
- Exhibit 2A.1, Section 10100
- Exhibit 2A.1, Section 10400

j) Additional Signs

Additional required signs include, Illuminated exit signs (if applicable), area of rescue assistance/area of refuge (if applicable), train operations signage (e.g. first cars stops here), track signage beyond the station, building directory, parking related signs. For further specifications, description of work, products, submittals, and execution, see the following documents:

- Exhibit 2A.1, Section 10424
- Exhibit 2A.1, Section 10400
- Exhibit 2A.1, Section 10440

12.5.4 Overview of Design and Construction Process

12.5.4.1 Preliminary Submission

- a) The DB Entity and MBTA Graphics & Wayfinding (MBTA Wayfinding) shall meet to discuss scope and placement of signage.
- b) Provide base plans to MBTA Wayfinding to identify signage locations.
- c) Provide signage locations on plans for all required signage as described above in Section 12.5.3, as well as sign graphic elevations for review and acceptance by MBTA Wayfinding.

12.5.4.2 Intermediate Submission

- a) Provides plans with MBTA signage included, as well as a sign schedule for MBTA Wayfinding to review. Incorporate any comments from Preliminary Submission review.
- b) Provide structurally engineered site-specific frame designs, and incorporate frames in sign schedule.
- c) Provide elevation/section drawings with signage locations.

12.5.4.3 Pre-Release For Construction Submission

- a) Provide updated plans incorporating comments from intermediate submission review.

13.1 VEHICLE MAINTENANCE FACILITY ARCHITECTURE

13.1.1 Scope of Work

The Work includes the general architectural requirements developed for the Vehicle Maintenance Facility (VMF).

13.1.2 Standards, Codes, and Guidelines include:

- Massachusetts State Building Code 780 CMR
- Massachusetts Comprehensive Fire Safety Code, 527 CMR 1.00
- Massachusetts Architectural Access Board 521 CMR
- ADA Standards for Transportation Facilities by US DOT
- Massachusetts Electrical Code, 527 CMR 12.00
- International Mechanical Code as amended by 780 CMR 28.00
- Uniform State Plumbing Code, 248 CMR
- International Energy Conservation Code as amended by 780 CMR 13.00
- Massachusetts Board of Elevator Regulations, 524 CMR
- FM Global Standards
- MBTA Guidelines & Standards
- MBTA Guide to Access
- APTA Guidelines (American Public Transportation Association)
- Association of American Railroads (AAR)
- NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

13.1.3 The Project Specific Requirements

The VMF shall provide a facility for light duty service and inspection, component change out of the LRVs type 7, 8, and future type 9 LRVs, as well as provisions for future wheel truing. The VMF is an enclosed building that includes: four (4) service tracks, office suite, conference space, locker rooms, restrooms, break spaces, service floor area, storage, and utility rooms. The building shall fully enclose eight (8) - two car paired LRV consists with adequate perimeter (and center cross aisle). The building shall provide adequate space for shop service vehicle egress and accessibility requirements clearances in a fully occupied facility.

The VMF shall be a full time operation facility scheduled to have two (2) 12 hour shifts of twenty-two (22) technician/office employees and one full time cleaner per shift. Total staff in the facility is 23.

13.1.3.1 Exterior Materials

(a) General

The exterior materials to be used on the facility shall be selected based on durability and appearance. The facility exterior substrates shall be low maintenance, durable, and resilient. These finishes exposed to public view or providing weather protection shall be materials designed specifically as a finish and shall be nonporous, durable and resilient to exterior forces including corrosion, weathering and impact. Lifespan of the connections shall meet or exceed the life of the finishes. The connections and finishes lifespan shall not be less than 25 years. Finish materials such as brick, concrete block, pre-cast concrete, and metal siding may be used.

The DB Entity shall provide exterior assemblies with attention to avoid interior or exterior rusting, detrimental contact of dissimilar materials, deleterious reaction to contact with salt, and use of field welded details. The VMF materials and finishes shall rely on proven technologies, with a documented successful installation track record of a minimum of 5 years, and be noncombustible complying with both building code and NFPA standards. In addition, they shall be weather resistant (to freeze-thaw cycles), mold resistant and detailed to resist anticipated potential vapor and moisture penetration including direct infiltration, pressure and wind driven infiltration, UV exposure, and vapor migration along gradients.

(b) Exterior Walls and Roofs

Provide exterior walls that have continuous insulation along entire perimeter of building from 4'-0" below grade and up. The interior and exterior surface of exterior walls from the grade up to a height of 4' shall be an impact resistant material, such as precast concrete, concrete masonry unit; calcium silicate units for outdoor use shall be accepted. All fasteners and clips shall be durable and long lasting grade to protection against corrosion, weather and impact. Above the impact resistant wall surface, there shall be painted metal with integrated insulation, air barrier, moisture barrier and vapor retarder construction. Exterior walls shall pass NFPA 285 as a complete assembly when walls utilize metal composite materials (MCM) or high-pressure decorative exterior-grade compact laminates (HPL). This is also required for exterior walls utilizing foam plastics, except for exterior walls of fully sprinklered, one story buildings where foam plastic having a flame spread index of 25 or less, and a smoke developed index of 450 or less, are installed without thermal barriers in or on exterior walls in a thickness not more than 4 inches where the foam plastic is covered by aluminum not less than 0.032 inch-thick, or corrosive-resistant steel not less than 0.016 inch thick. All metal structure and cladding shall be grounded to collect and return all stray current associated with the electric vehicles. It is a requirement to galvanically separate all dissimilar metals with neoprene gaskets or other similar means of isolation.

Roofs shall be either membrane or painted metal with minimum 25 year life span expectancy. Roof drainage piping shall be conducted internally to the building, with accessible clean-outs, insulated and protected from impact for the bottom eight feet of ground level exposure. Collect and place horizontal and vertical piping in discrete locations to not interfere with shop maintenance operations. Provide roofing in a light-colored material.

Exterior envelope design and installation shall comply with MBTA insurance carrier (FM Global requirements – refer to Exhibit 2I). Design shall be approved by FM Global prior to shop drawing production.

(c) Fenestration and Doors

Provide exterior glazing that is double pane, insulated low “E” coated glass, set in aluminum, thermally broken window frames. Interior glazing shall be tempered and safety laminated, with no portion of glass lower than 30” above the finish floor. Exterior personnel doors shall be painted steel clad, thermally insulated, and thermally gasketed fitted with industrial grade hardware and closers, including kick plates. Flash all exterior doors and windows at all sides with stainless steel or aluminum, durability and appearance to be commensurate with overall wall quality of envelope construction. Window and skin penetrating assemblies shall be thermally broken. LRC and Loading Dock oversized coiling overhead doors shall be high speed, insulated, fitted with camera sensors to automatically open and close doors, hands-free based on approach of vehicle, along with individual override capabilities with individual controls.

13.1.3.2 Interior Elements and Materials

(a) General

The DB Entity shall provide interior assemblies with attention to avoid interior or exterior rusting, detrimental contact of dissimilar materials, deleterious reaction to contact with salt, and use of field welded details. The VMF building materials and finishes shall rely on proven technologies, with a documented successful installation track record of a minimum of 5 years, and be noncombustible complying with both building code and NFPA standards. In addition, they shall be weather resistant (including freeze-thaw cycles), mold resistant, and detailed to resist anticipated potential vapor and moisture penetration including direct infiltration, pressure and wind driven infiltration, UV exposure, and vapor migration along gradients.

(b) Interior Partitions, Walls and Ceilings

Provide walls that are high impact, with wear resistant finishes and have low moisture absorption rate properties. Back of House and work shop related areas, shall be filled and painted CMU. Interior administrative spaces may use light gauge metal framing and gypsum wall board, with a painted finish.

The shop portion of the VMF shall be heated in the winter, and ventilated with outdoor air in the summer. The other occupied and temperature sensitive areas shall be heated in the winter and cooled in the summer. Insulation shall be provided in partitions between these two spaces. The DB Entity shall determine the position and the permeability of the vapor retarder of these partitions based on the final configuration of the layout. Partitions between the shop and occupiable spaces, including the office areas, shall have a STC of 45.

Other required characteristics shall include:

- Wall areas in shops shall have a minimum 8' high concrete or concrete block wainscoting; Shop areas shall not require an architectural ceiling. Shops shall be detailed for industrial use with heavy equipment.
- Finished Hallways shall be constructed of burnished block or other approved finish with maintenance and durability as a primary design consideration. Ceilings shall be resilient acoustical ceiling tile.
- Office areas shall be metal stud and 5/8" gypsum-board construction. Sound insulation shall be provided between adjacent office spaces of STC 35 minimum. Ceilings shall be resilient acoustical ceiling tile.
- Toilet/shower areas shall have ceramic tile floor and tile wall finishes from floor to ceiling. Toilet/shower areas shall have ceiling grids constructed and installed without painted surfaces, designed with maintenance and corrosion protection for humid/wet environments.

(c) Floors

All floors shall include the following characteristics:

- Materials which are consistent throughout their body;
- Slip resistant ADA compliant finish;
- Non-stainable finish;
- Floor shall not have ponding; and
- Long term cracking control of concrete through the use of reinforcement shall be compatible with the overall design life of the building.

All floors within the VMF shall be cast in place concrete with an impregnating concrete sealer and hardener. Colored and/or etched surface treatments are permitted. Safety markings in color and texture in the floor shall delineate "walking areas", "work areas", "equipment areas", and "safety zones." Floors shall have positive drainage to drains or trench drains to the appropriate plumbing treatment structure.

All administrative spaces within the VMF shall have resilient floor coverings and bases over cast in place concrete floors.

Restrooms shall have durable, easily cleanable, non-porous, through-body floor tiles over the cast in place concrete floors, positively drained to the appropriate plumbing drainage structure.

13.1.3.3 Railings

Provide Occupational Safety and Health Administration (OSHA) approved fixed and removable guard rails at all floor openings. Hand rails shall be provided at all stair and ramp locations and conform with the following:

- Hand rails shall be 1 ½" I.D. heavy wall stainless steel tubing.
- Railing systems shall be visually simple with a minimal number of parts and attachments. Post attachments shall attach to the side of slabs, stringers or landings.

- All removable guardrails shall be anodized aluminum.

13.1.3.4 Ramps

Provide ramps in all floor level changes where required by ADA and MAAB. The DB Entity shall conform with the more stringent standard of the MBTA Guide to Access and ADA requirements. Other required characteristics shall include:

- Exterior ramps require roofs systems for weather protection and associated infrastructure, such as lighting. Lighting shall be designed with shielding so as to not impact adjacent structures or properties. Roofs shall cover ramp landings and extend a minimum of 5' beyond the bottom end of the ramp surface.
- The design of the ramps shall use the same material palette as the adjoining floor surface.
- The slope of ramps shall not exceed 8%.

13.1.3.5 Stairs

There shall be a minimum of one stair at all grade changes. Exterior stairs shall be covered including landings.

Risers shall be of uniform height 7 inches maximum, with closed risers, and with contrast/reflective nosing firmly attached to the stair structure.

All treads shall be a uniform width of 11" minimum with a slip resistant tread nosing assembly.

13.1.3.6 Corrosion Control and Safety Grounding

The VMF shall have an equipotential grounding system for all conductive surfaces exposed to human contact. This shall be accomplished through use of a building perimeter ground. The perimeter ground shall be bonded to intermittent ground rods and bonded to the metal structure of the building and reinforcement bars of the concrete. The reinforcing steel of the main shop floor shall be bonded into a grid pattern and all shop conductive surfaces shall be bonded to the grid. The shop track work shall be continuous and bonded to the grid. The shop grid and perimeter ground shall be bonded to the shop transformer ground mat. ~~Insulated rail joints shall be located in the ends of the concrete aprons, which will define the extent of the shop grounding system.~~

DC stray currents are prevalent in the yard and shop area. Accordingly, ferrous pipe shall be coated with an electrical insulating material and tested prior to burial. Some underground services (such as natural gas) may be better served by use of plastic pipe where the code allows. Joints in piping shall require bonding in some locations and insulated joints in others.

13.1.3.7 Vibration and Acoustics

In planning the new facility, vibration and noise-generating equipment including air compressors, wheel truing machine and pumps shall be located away from office areas and acoustically isolated. Vibrating equipment including HVAC mechanical units shall similarly be located and specified with strategies including isolation or mass so that noise and vibration transmission is minimized.

In addition, walls, ceilings and floors in these spaces shall be insulated to further reduce noise transmission to other parts of the facility, STC class of 45.

13.1.3.8 Facility Maintenance

The proposed maintenance procedures shall be accepted by the MBTA to ensure that the new facility provides an efficient work environment. Janitorial closets and other maintenance rooms shall be located on each floor and in locations convenient for users. Floor drains, hose bibs, etc., shall be located for convenience of use.

13.1.3.9 Refuse/Recycling Collection

Refuse collection and recycle bins and dumpsters shall be provided at several locations convenient to work areas as well as to collection vehicles while not infringing on operations or clearances for train vehicle maintenance.

Certain containers shall be provided and designated for recycling purposes, including metal, paper, cardboard, and glass. Provide containers for oil and hydraulic fluid recycling and hazardous waste.

The central location shall include a waste compactor sized to accommodate the need of the Vehicle Maintenance Facility waste and recycling requirements.

13.1.3.10 Functional Requirements & VMF Shop Layout

The shop layout shall conform with the core spatial requirements and be in compliance with applicable design standards and guidelines. The required shop layout characteristics are indicated in the Project Definition Plans and shall include:

- LRV Shop proximity to mainline and storage yard to minimize switching movements and facilitate emergency repairs;
- Run-through tracks in the shop area to provide for efficient flow of LRVs and shall allow entry and exit from either end of the building;
- A maximum of 2 linear car positions in the shop to preclude entrapment of an LRV between others when maintenance and repairs are being performed;
- Grouping related maintenance and servicing activities to simplify supervision and work-flow, and to help minimize the floor space needed for circulation to and from the various interrelated spaces;
- Proximity of support activities shall be incorporated to maximize circulation efficiency;
- Fixed jacks shall be provided for lifting entire LRVs. A bridge crane shall be provided with adequate capacity to lift the heaviest LRV component, an assembled motor truck. The bridge crane shall be so located as to allow a highway flatbed tractor/trailer to position itself under the crane and allow motor trucks and trailer trucks to be loaded for shipment;
- Vehicle hoist with individual rotating lifts shall be provided for exchange, rotation and movement of trucks;
- The daily/routine maintenance pits indicated in MAF-A-2000 shall be a single-level design;

- Services in the pit areas shall include; compressed air outlets at each support column, a 120 VAC duplex receptacle at each column, welder receptacles, floor drains for pit wash down, oil drain for disposing of used gearbox oil, conduits to connect all pits for future addition of other services, radiant heating, exhaust ventilation, provisions for addition of grating, approved railings or chains, stairway access, and provisions for vertical movement of tools and components between the shop floor level and the pit level, as well as platform level. In addition to providing service at this level, the material lift shall also service the pit and maintenance floor;
- Interlocks shall be provided to ensure exclusive operation of the bridge crane or the OCS, but not both for each car position. Operation of the crane shall be allowed in a zone over the unit repair area; and
- Services on the two non-energized tracks shall include compressed air outlets, welder receptacles, 120 VAC duplex receptacles and auxiliary power stations (APS). Each car position (a minimum of eight) shall have one APS for providing auxiliary power to the LRV when the OCS is not energized. APS shall be interlocked with the OCS to ensure mutually exclusive operation.

13.1.3.11 Site and Landscape

Refer to Section 7.5 for treatment of exterior ground for the building and associated yard. Provide number of parking spots as indicated in Project Definition Plans.

13.1.3.12 Sustainability

Refer to Specification 01800, which shall apply to the entire VMF Building and grounds.

13.1.3.13 Room Criteria

- Room: EQUIPMENT STORAGE #101

Dimension Criteria:	Minimum SF shown on VMF Floor Plan Drawing.
Function:	Equipment Storage.
Relationship:	Open access to Service Floor.
Equipment/Furnishings:	As shown on drawing.

Design Features

Floor:	Concrete floor with sealer.
Walls:	Painted CMU.
Ceiling:	14'-0" minimum clear ceiling height. Painted underside of exposed structure.
Secure Area:	Open to Service Floor. Building wide electronic security per <u>Section 14.6</u> .
Plumbing:	None.
Electrical:	General purpose duplex receptacles 120V 20A. Provide power for equipment.
HVAC:	Provide heating and ventilation.

- Room: BREAK ROOM #102

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Enclosed room used as a break area for the maintenance staff assigned to the building.
 Relationship: Direct access to the Service Floor area, adjacent to locker room and restroom.
 Equipment/Furnishings: Counter top, upper and lower cabinets, sink with disposal, microwaves, full-height refrigerator, vending machines, water cooler, tables, chair, and corkboard as shown on drawing.

Design Features

Floor: VCT and resilient base.
 Walls: Painted gypsum wall board on metal stud.
 Window: Operable exterior window, 10'-0" x 3'-0" (min.) glazed area.
 Ceiling: 14'-0" min. clear ceiling height. Suspended acoustic ceiling tile.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: Water and drainage for sink, disposal, dishwasher.
 Electrical: General purpose duplex receptacles 120V 20A.
 Computer and telephone receptacles.
 Ceiling LED lighting, bi-level switching 30fc average.
 Provide power for equipment as required.
 HVAC: Provide heating, cooling and ventilation. Provide residential-duty range hood ducted to the exterior. Separate temperature control.

- Room: PORTER #103

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Floor mounted mop sink and cleaning supply storage.
 Relationship: Connects to the Hallway and near Offices and restrooms.
 Equipment/Furnishings: 8'-0"x1'-0"x3/4" wall mounted plastic laminate shelf on brackets.

Design Features

Floor: Sealed Concrete.
 Walls: Painted CMU.
 Ceiling: 9'-6" minimum ceiling height. Moisture resistant suspended tile ceiling.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: Water and drainage for sink.
 Electrical: General purpose duplex receptacles 120V 20A.
 Ceiling LED lights with moisture resistant prismatic lens 30 FC.

HVAC: Provide positive pressure ventilation and heating with control.

- Room: MEN’S LOCKER/RESTROOM #104

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Men’s Restroom, locker/changing space, and shower.
 Relationship: Adjacent to Break Room and Women’s Locker/Restroom. Obscure sight line to private interior spaces from outer spaces with door fully opened.
 Equipment/Furnishings: Toilet, toilet partitions, toilet paper dispenser, urinal, urinal screens, sinks, mirrors, hands-free hand dryers, soap dispensers, shower, lockers, bench, and robe hook.

Design Features

Floor: Through body colored ceramic tile floor and wall base.
 Walls: Painted moisture resistant gypsum wall board on metal stud framing at non-plumbing walls. Full height ceramic tile on cement wall board, on metal stud at entire shower area, plumbing wet wall and within 2’ of any plumbing fixtures.
 Ceiling: 9’-6” minimum ceiling height. Moisture resistant suspended acoustic ceiling tiles.
 Secure Area: Passage lockset at entry door, latch sets at shower and toilet stall. Building wide electronic security per [Section 14.6](#).
 Plumbing: Toilet, shower, and wash sinks. Floor drain near stalls. Trap primers. Hot and cold water to fixtures. Drainage, waste and vent piping. Locate domestic hot water heater near points of use and in an accessible location.
 Electrical: General purpose duplex receptacles 120V 20A. Ceiling LED lights with moisture resistant prismatic lens 30 FC.
 HVAC: Provide heating cooling and ventilation, exhaust. Heating by convection or radiant independent of air supply.
 Sustainable: Exhaust all locker rooms, showers and toilet rooms via an energy recovery ventilator. Use post-recovery outside air to ventilate occupied spaces. Use ultra-low flow faucets, sanitary fixtures, mixing valves and trim.

- Room: WOMEN’S LOCKER/RESTROOM #105

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Women’s Restroom, locker/changing space, and shower.
 Relationship: Adjacent to Men’s Locker/Restroom and Training Room. Obscure sight line to private interior spaces from outer spaces with door fully opened.

Equipment/Furnishings: Toilets, toilet partition, toilet paper dispensers, sinks, mirrors, hands-free hand dryers, soap dispensers, shower, lockers, bench, sanitary napkin dispensers and disposal, receptacles, and robe hooks.

Design Features

Floor: Through body colored ceramic tile floor and wall base.
 Walls: Painted moisture resistant gypsum wall board on metal stud framing at non-plumbing walls. Full height ceramic tile on cement wall board, on metal stud at entire shower area, plumbing wet wall and within 2' of any plumbing fixtures.
 Ceiling: 9'-6" Clear ceiling height. Moisture resistant suspended acoustic ceiling tile.
 Secure Area: Passage lockset at entry door, latch sets at shower and toilet stalls. Building wide electronic security per Section 14.6.
 Plumbing: Toilets, shower, and wash sinks. Floor drain near stalls, Trap primers. Hot and cold water to fixtures. Drainage, waste, and vent piping. Locate domestic hot water heater near points of use and in an accessible location.
 Electrical: General purpose duplex receptacles 120V 20A. Ceiling LED lights with moisture resistant prismatic.
 HVAC: Provide heating cooling and ventilation exhaust. Heating by convection or radiant, independent of air supply.
 Sustainability: Exhaust all locker rooms, showers, and toilet rooms via an Energy Recovery ventilator. Use post-recovery outside air to ventilate occupied spaces. Use ultra-low flow faucets, sanitary fixtures, mixing valves and trim.

- Room: STORAGE ROOM #106

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Shelving for training material and equipment storage for Training Room.
 Relationship: Direct access to Training Room.
 Equipment/Furnishings: 12'-0" x 1'-0" x 3/4" wall mounted plastic laminate shelf on brackets.

Design Features

Floor: VCT and resilient base.
 Walls: Painted gypsum wall board on metal studs.
 Ceiling: 10'-6" minimum ceiling height. Suspended acoustic tile ceiling.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: None.

Electrical:	General purpose duplex receptacles 120V 20A. Ceiling LED lights with prismatic Lens 30 FC.
HVAC:	Provide heating, cooling and ventilation; cooling and ventilation control may be from the Training Room base system. No individual control is required for cooling. Independent heating, if on an exterior wall, shall be provided.

- Room: Training Room #107

Dimension Criteria:	Minimum SF shown on VMF Floor Plan Drawing.
Function:	Enclosed room for maintenance staff training activities.
Relationship:	Direct access to the Storage Room and Service Floor. Adjacent to Work Room and Locker/Restrooms.
Equipment/Furnishings:	(12) folding chairs, (3) 5'-0"x2'-0" folding tables, 60" wall mounted 1080 DPI, 60Hz (min.) television with wired, AV input and HDMI capability, 12'-0" (min. length) x 2'-0" deep, built-in millwork base cabinet and counter top.

Design Features

Floor:	VCT and resilient base.
Walls:	Painted gypsum wall board on metal studs.
Ceiling:	11'-6" minimum ceiling height. Suspended acoustic ceiling tile.
Secure Area:	Keyed lockset at pair of doors. Building wide electronic security per <u>Section 14.6</u> .
Plumbing:	None.
Electrical:	General purpose duplex receptacles 120V 20A. Ceiling LED lights with prismatic lens 30 FC.
HVAC:	Provide heating, cooling and ventilation. Dedicated system(s) to allow low-level baseline conditioning when unoccupied and boost ventilation and cooling capacity including absorbing latent loads, during high-occupancy training classes. Use energy recovery based on outside air percentage, with CO2 monitoring.

- Room: BREAKROOM #108

Dimension Criteria:	Minimum SF shown on VMF Floor Plan Drawing.
Function:	Enclosed room used as a break area for the administrative staff assigned to the building.
Relationship:	Direct and exclusive access to the Workroom.
Equipment/Furnishings:	8'-0" x 2'-0" Counter space, upper and lower cabinets, sink with disposal, microwave, full-size refrigerator (24 cubic feet minimum), water cooler, (2) 5'-0" x 2'-0" tables, (6) chairs, and 5'-0" x 5'-0" wall mounted cork pin-up board.

Design Features

Floor:	VCT and resilient base.
Walls:	Painted gypsum wall board on metal studs.
Window:	Operable exterior window, 6'-0" x 3'-0" (min.) glazed area. Fixed interior door side lite, 2'-0" wide, height of door.
Ceiling:	9'-6" minimum ceiling height. Suspended acoustic ceiling tile.
Secure Area:	Building wide electronic security per <u>Section 14.6</u> .
Plumbing:	Hot and cold water and drain for sink.
Electrical:	General purpose duplex receptacles 120V 20A. Ceiling LED lights prismatic Lens 30 FC.
HVAC:	Provide heating, cooling and ventilation, individual temperature control.

- Room: OFFICE #109

Dimension Criteria:	Minimum SF shown on VMF Floor Plan Drawing.
Function:	Enclosed office for administrative staff.
Relationship:	Direct access to Work Room, adjacent to Break Room #108, near Entry Vestibule.
Equipment/Furnishings:	Swivel task chair, two (2) guest chairs, L-shaped 5'x5', (long)x 24" deep office desk, 3'-0" deep, double tier, legal size, under counter lockable metal filing cabinet.

Design Features

Floor:	VCT and resilient base.
Walls:	Painted gypsum wall board on metal studs.
Ceiling:	9'-6" minimum ceiling height. Suspended acoustic ceiling tile.
Window:	Operable exterior window, 6'-0" x 3'-0" (min.) glazed area. Fixed interior door side lite, 2'-0" wide, height of door.
Secure:	Keyed lockset at door. Building wide electronic security per <u>Section 14.6</u> .
Plumbing:	None.
Electrical:	General purpose duplex receptacles 120V 20A. Ceiling LED lights with prismatic Lens 30 FC.
HVAC:	Provide heating, cooling and ventilation; individual room temperature control.

- Room: WORK ROOM #110

Dimension Criteria:	Minimum SF shown on VMF Floor Plan Drawing.
Function:	Enclosed shared working admin office space with separate workstation for each occupant.
Relationship:	Access to Office and Breakroom, near vestibule.
Equipment/Furnishings:	12'-0" (min. length) x 2'-0" deep, built-in millwork base cabinet and counter top. Operable window shades.

Design Features

Floor: VCT and resilient base.
 Walls: Painted gypsum wall board on metal stud framing.
 Window: Fixed, 3' (high) x 10' (length) minimum, of equally spaced windows with an optimized direct line of sight to the widest range of the Service Floor and Workshop areas.
 Ceiling: 9'-6" minimum ceiling height. Suspended acoustic ceiling tile. Ceiling LED lights with prismatic lens.
 Secure Area: Keyed lockset at doors. Building wide electronic security per Section 14.6.
 Plumbing: None.
 Electrical: General purpose duplex receptacles 120V 20A.
 HVAC: Provide heating, cooling and ventilation; individual room temperature control.

- Room: ENTRY VESTIBULE #111

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Main entrance, air lock, and controlled space.
 Relationship: Connects to the Hallway and Service area and near Admin Offices.
 Equipment/Furnishings: None.

Design Features

Floor: Minimum SF shown on VMF Floor Plan Drawing.
 Floor: VCT and resilient base.
 Walls: Painted gypsum wall board on metal stud framing.
 Ceiling: 10'-0" minimum clear ceiling height painted gypsum wall board ceiling.
 Secure Area: Secure entry both single doors. Building wide electronic security per Section 14.6.
 Plumbing: None.
 Electrical: General purpose duplex receptacles 120V 20A located per code.
 Ceiling LED lights with prismatic lens 30 FC.
 HVAC: Heating including boost/recovery capacity. Ceiling mounts down blast.

- Room: WORKSHOP AREA #112

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: LRV Truck repair and storage area, including parts and equipment storage.
 Relationship: Connects to the Hallway and direct adjacency to the Work Room and Office.
 Equipment/Furnishings: Coordinate with Equipment List on VMF Floor Plan Drawing. Emergency eye wash station.

Design Features

Floor:	Sealed Concrete with safety markings. All tracks flush floor mounted recessed into concrete floor.
Walls:	Painted CMU and back side of exterior factory finished metal panels.
Ceiling:	Maintain clear unobstructed height from the Service Floor to this space. Allow overhead crane payload transfer from Service Floor. Painted exposed structure. Overhead 7.5 ton crane for LRV Truck movement. LED lighting.
Secure Area:	Open to Service Floor. Building wide electronic security per Section 14.6 .
Plumbing:	Plumbing for emergency eyewash station.
Electrical:	General purpose duplex receptacles 120V 20A located per code. 220V receptacles for portable fans, smoke-eaters, etc.
HVAC:	Provide heating and ventilation, ducted to breathing zone. Spot capture of welding fumes via portable FF&E.

- Room: TRUCK WASH AREA #113

Dimension Criteria:	20'-0" vertical clear from floor, to crane hook. Minimum SF shown on VMF Floor Plan Drawing.
Function:	Area to Wash LRV trucks with high pressure washer.
Relationship:	Adjacent to workshop area.
Equipment/Furnishings:	High pressure washer with remote wash wand with scabbard, push button controls, and hose reels. Soap drum. Access to crane. Coordinate with Equipment List on VMF Floor Plan Drawing.

Design Features

Floor:	Soil, grease, water, slip resistant concrete with integral non-metallic light reflective hardener, and chemical bonded concrete. Includes a large containment sump with grated area. Positive slope to trench drain.
Walls:	Painted CMU. 6-foot-high wall to minimize overspray and allow bridge crane to pass over the space.
Ceiling:	Open and exposed to underside of overall shop ceiling. Watertight LED light fixtures around perimeter.
Secure Area:	Building wide electronic security per Section 14.6 .
Plumbing:	Hose bib attached to power sprayer and require trench drainage. Emergency eyewash station.
Electrical:	Watertight duplex receptacles 120V 20A at select locations. Provide power for power sprayer.
HVAC:	Provide ventilation exhaust drawn from adjacent shop areas, plus local blower fans for drying. Conduct exhausts air to exterior.

- Room: COMPRESSOR ROOM #114

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Compressor and high-pressure wash equipment room.
 Relationship: Direct access to Loading Bay, direct adjacency to Truck Wash and the Lube Room.
 Equipment/Furnishings: House high-pressure washing equipment, Centralized Compressor System and associated equipment/piping.

Design Features

Floor: Sealed Concrete.
 Walls: Painted CMU.
 Ceiling: 12'-0" minimum to underside of painted exposed structure, coordinate with equipment. Impact resistant LED fixtures.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: Fixed high-pressure wash and compressor piping. Primed floor drain.
 Electrical: General purpose duplex receptacles 120V 20A. Power for compressors and pressure wash including disconnects with dry contacts.
 HVAC: Provide ventilation for cooling with priority given to ambient exhaust, direct outside air and if not sufficient to cool the space, mechanical cooling, staged. Monitor temperatures and alarm high and low.

- Room: LUBE ROOM #114

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Vehicle supply and waste lubricant storage room.
 Relationship: Direct adjacency to Loading Bay and parking lot near the central Trash and Recycling area to the North of the building. Locate eyewash station in room, or directly adjacent.
 Equipment/Furnishings: Oil management systems, associated equipment and piping.

Design Features

Floor: Chemically resistant sealer on recessed concrete floor. ~~Curb and ramp at door for flood containment and drum dollies.~~ Click here to View RFI #94
 Walls: Painted CMU.
 Ceiling: 12'-0" minimum to underside of painted exposed structure, coordinate with equipment. Impact resistant LED fixtures.

Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: Eyewash station.
 Electrical: General purpose duplex receptacles 120V 20A.
 HVAC: Provide supply and exhaust ventilation for heat control.

- Room: SHOP OFFICE #116

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Shipping and Receiving Office for a single employee.
 Relationship: Direct access and adjacency to Loading Bay with door and interior sliding window. Direct access and adjacency to exterior (North side of building) with door and operable window.
 Equipment/Furnishings: Swivel task chair. L-shaped 5'x5', (long) x 24" deep office desk. 3'-0" deep, double tier, legal size, under counter lockable metal filing cabinet.

Design Features

Floor: VCT and resilient base.
 Walls: Painted CMU.
 Ceiling: 9'-0" clear ceiling height (min.). Suspended acoustic ceiling tiles and LED lights with prismatic lens.
 Secure Area: Keyed locksets at interior and exterior doors.
 Plumbing: None.
 Electrical: General purpose duplex receptacles 120V 20A.
 HVAC: Provide individual temperature control and positive-pressure outside air ventilation.

- Room: FIRE PROTECTION #117

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Fire Protection equipment, valves and piping utility room.
 Relationship: Direct access to exterior wall for thru-wall Siamese connections as needed. Direct door access to Service Floor.
 Equipment/Furnishings: Fire Protection Equipment.

Design Features

Floor: Sealed Epoxy flooring over concrete slab.
 Walls: Painted CMU.
 Ceiling: 10'-0" Clear ceiling height (min.). Painted exposed underside of structure and LED lights with prismatic lens.
 Secure Area: Keyed lockset at door(s). Building wide electronic security per Section 14.6.
 Plumbing: Floor drain with trap primer.
 Electrical: General purpose duplex receptacles 120V 20A.

HVAC: Provide heating, ventilation. Monitor temperatures and alarm high and low.

- Room: TELEPHONE #118

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Main entrance, air lock, and controlled space.
 Relationship: Connects to the Hallway and near Offices.
 Equipment/Furnishings: Telephone Equipment and associated wiring.

Design Features

Floor: VCT and resilient base.
 Walls: Painted CMU.
 Ceiling: 10'-0" Clear ceiling height (min.). Painted exposed underside of structure and LED lights with prismatic lens.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: None.
 Electrical: General purpose duplex receptacles 120V 20A
 HVAC: Provide dedicated HVAC cooling to 80 degrees F.

- Room: ELECTRICAL ROOM #119

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Primary and central building electrical room.
 Relationship: Connects to the Hallway and near Offices.
 Equipment/Furnishings: Coordinate with Building wide Electrical Requirements.

Design Features

Floor: VCT and resilient base.
 Walls: Painted CMU.
 Ceiling: 10'-0" Clear ceiling height (min.). Painted exposed underside of structure and LED lights with prismatic lens.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: None.
 Electrical: General purpose duplex receptacles 120V 20A.
 HVAC: Provide dedicated HVAC cooling to 80F.

- Room: STORAGE #120

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Storage of equipment and supplies.

Relationship: Direct adjacency to Service Floor and East access road for future exterior loading access.

Equipment/Furnishings: As Scheduled.

Design Features

Floor: VCT and resilient base.

Walls: Painted CMU.

Ceiling: 14'-0" Clear ceiling height (min.). Painted exposed underside of structure and LED lights with prismatic lens.

Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.

Plumbing: None.

Electrical: General purpose duplex receptacles 120V 20A

HVAC: Provide heating, ventilation. Monitor temperatures and alarm high and low.

- Room: PORTER #121

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.

Function: Connects to the Service Floor, direct adjacency to Track 1.

Relationship: Connects to the Hallway and near Offices.

Equipment/Furnishings: As Scheduled.

Design Features

Floor: VCT and resilient base.

Walls: Painted CMU.

Ceiling: 10'-0" clear ceiling height (min.). Suspended acoustic ceiling tile and LED lights with prismatic lens.

Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.

Plumbing: Mop sink and floor drain with trap primer.

Electrical: General purpose duplex receptacles 120V 20A.

HVAC: Provide heating, ventilation. Monitor temperatures and alarm high and low.

- Room: CLEANING STORAGE #122

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.

Function: Main entrance, air lock, and controlled space.

Relationship: Connects to the Service Floor, direct adjacency to Track 1

Equipment/Furnishings: As scheduled.

Design Features

Floor: VCT and resilient base.

Walls: Painted CMU.

Ceiling: 10'-0" clear ceiling height (min.). Suspended acoustic ceiling tile and LED lights with prismatic lens.

Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: Floor drain with trap primer.
 Electrical: General purpose duplex receptacles 120V 20A.
 HVAC: Provide heating, ventilation. Monitor temperatures and alarm high and low.

- Room: STORAGE #124

Dimension Criteria: Minimum SF shown on VMF Floor Plan Drawing.
 Function: Storage of equipment and supplies.
 Relationship: Direct adjacency to Service Floor and East access road for future exterior loading access.
 Equipment/Furnishings: As scheduled.

Design Features

Floor: Sealed concrete.
 Walls: Painted CMU.
 Ceiling: 14'-0" Clear ceiling height (min.). Painted exposed underside of structure and LED lights with prismatic lens.
 Secure Area: Keyed lockset at door. Building wide electronic security per Section 14.6.
 Plumbing: None.
 Electrical: General purpose duplex receptacles 120V 20A.
 HVAC: Provide heating, ventilation. Monitor temperatures and alarm high and low.

- Room: SERVICE FLOOR #125

Dimension Criteria: Clear ceiling height to accommodate service and maintenance of LRVs below, beside, and above; shop design to allow safe maintenance and access with the assigned equipment and power configurations, including roof top operations from gantry, overhead crane and maximum height hoisted LRVs in coinciding relationships. Minimum SF shown on VMF Floor Plan Drawing.
 Function: Main light rail vehicle maintenance area with perimeter and central cross-over aisle access. Tracks 1 & 2 are through building pedestal service bays with a central work area between tracks. Track 3 is a flat service bay with roof top access from elevated gantry and in-ground recessed pit for future wheel truing equipment. Track 4 has two in-ground pits for hoisting equipment. The DB Entity shall provide hoisting equipment for the service bay between columns lines N & R. Both Tracks 3 and 4 have complete and clear 10-ton crane coverage and access above elevated LRVs.

Relationship:	Direct adjacency to all fundamental work spaces. Direct site line to Work Room from all areas of the shop.
Equipment/Furnishings:	Provide and install all equipment as shown on Architectural Floor Plan Drawing, with pneumatic service from centrally piped compressed air system at each work station area, four equally spaced per track mounted to columns. Coordinate eye-wash station locations with overall shop operations and optimal work/safety objectives.
Design Features	
Floor:	Seal concrete with safety markings. Cast in-place concrete stairs to services pits along Tracks 1 & 2. Light weight removable guardrails around open floor pits greater than 8". Stairs and ramps to have fixed stainless steel handrails and guard rails where required.
Walls:	Painted CMU.
Ceiling:	Painted and exposed to underside of structure.
Secure Area:	Keyed locksets at interior and exterior doors. Building wide electronic security per Section 14.6 .
Plumbing:	Full door width recessed trench drains on interior side at all LRV and load Bay service doors with trap primer. Full length recessed trench drains as shown on the VMF Floor Plan Drawing. Eye wash stations.
Electrical:	General purpose duplex receptacles 120V 20A. LED lighting with common cool color temperature lamping throughout. Shielded LED side lighting at Tracks 1 & 2 Service Pits. Through building Catenary DC overhead power with door interlock integration at Tracks 1 & 2. Tracks 3 & 4 do not have indoor overhead catenary power service.
HVAC:	Provide heating, ventilation. Monitor temperatures and alarm high and low.

13.2 VEHICLE MAINTENANCE FACILITY STRUCTURES

13.2.1 Scope of Work

The Work includes one (1) maintenance facility complex located in the city of Somerville which includes the Site, the Vehicle Maintenance Facility (VMF), and the Transportation Building (TB).

13.2.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code, referred to below as “780 CMR”
- ASCE 7, Minimum Design Loads for Buildings and Other Structures
- AREMA Manual for the Railway Engineering
- AISC Steel Construction Manual
- AISC Design Guide 11: Floor Vibration Due to Human Activity
- AISC Seismic Provisions, as amended by 780 CMR
- ACI-318 Building Code Requirements for Structural Concrete
- ACI 301 Specifications for Structural Concrete
- ACI-530 Building Code Requirements for Masonry Structures
- AISI S100 - Specification for the Design of Cold Formed Steel Structural Members
- AWS D1.1 – Structural Welding Code - Steel
- AWS D1.3 – Structural Welding Code – Sheet Steel
- AWS D1.4 – Structural Welding Code – Reinforcing Steel
- MBG 531 – Metal Bar Grating Manual
- AASHTO LRFD Bridge Design Specifications, as supplemented by the FHWA Drilled Shaft Manual, the latest edition
- FM Global Property Loss Prevention Data Sheets; 1-28 Design Wind Loads, 1-31 Metal Roof Systems, and 1-54 Roof Loads for New Construction
- ASME Safety Code for Elevators and Escalators A17.1
- Commuter Rail Material Specifications, MBTA Railroad Operations
- Commuter Rail Design Standards Manual, MBTA Railroad Operations
- Book of Standard Plans – Track and Roadway, MBTA Railroad Operations
- Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures

13.2.3 The Project Specific Requirements

13.2.3.1 Vehicle Maintenance Facility (VMF)

- a) The Vehicle Maintenance Facility shall be a one-story open structure that accommodates LRV service and maintenance, along with associated office spaces. The main floor, where the majority of the maintenance and cleaning activities takes place, shall contain maintenance pits with pedestal track supports providing access to the underside of the vehicles. There shall be a moveable raised roof access platform to service the top portion of the vehicle along Track 3. There shall be two underhung material handling cranes servicing two bays of this facility, Track 4 and the wheel truck servicing zone. Office areas shall be at the ground floor set within a defined area within the shop area.

13.2.3.2 Transportation Building (TB)

- a) The Transportation Building shall be a single level office structure set on a level concrete slab.

13.2.3.3 Design methodology includes:

- a) Steel Elements - Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD) Method
- b) Concrete Elements - Ultimate Strength Method
- c) Masonry Elements - ASD or LRFD Method

13.2.3.4 Live loads include:

- a) Corridor - 100 PSF
- b) Offices - 50 PSF
- c) VMF Main Floor - 250 PSF, 3000 lb concentrated
- d) Mechanical rooms - 100 PSF
- e) Stairways - Max of (150 PSF) or (100PSF with concentrated forces of 300 lb) on the center of tread
- f) All Other Areas - In accordance with Mass Building Code 780 CMR

13.2.3.5 Train loads include:

- a) Transit Vehicle/Train Vertical Loads - Vehicle type 7, 8 and 9

13.2.3.6 Soil loads include:

- a) In accordance with Mass Building Code 780 CMR - Temporary and permanent vertical and horizontal earth pressures, hydrostatic load, vertical and horizontal surcharge load, buoyancy and seismic load per 780 CMR 1610.2

13.2.3.7 Maximum deflections include:

- a) Floor Framing Deflections - Live Load Deflection = $L/360$ Total Load Deflection = $L/240$
- b) Roof Framing Deflections - Live Load Deflection = $L/240$ Total Load Deflection = $L/180$
- c) Lateral System Deflections - Wind Load Deflection = $L/400$ and Seismic Load Deflection per ASCE 7, Section 12.12

13.2.3.8 Corrosion control includes:

- a) Corrosion Inhibitor - Provide Calcium Nitrate corrosion inhibitor per Manufacturer's instructions in all concrete surfaces exposed to deicing salts or salt water

13.2.3.9 Concrete serviceability include:

- a) Construction Joints and Control Joints - Provide construction joints and Control Joints to minimize the effect of shrinkage and drying cracks

13.2.3.10 Post installed anchors include:

- a) The use of Adhesive Post Installed Anchors is prohibited in all applications.

13.2.3.11 LRV Loading

- a) The DB Entity shall design and construct the Vehicle Maintenance Facility to accommodate the Type 7, 8 & 9 LRVs. The loads associated with the LRV (one that accounts for all three types) shall be based on the heaviest empty LRV and a 20 psf loading for maintenance personnel and equipment. Provide the structure for the resulting axle loads (individual wheel loads are $\frac{1}{2}$ the specified axle load) distributed in accordance with the Figure 13.2-1.

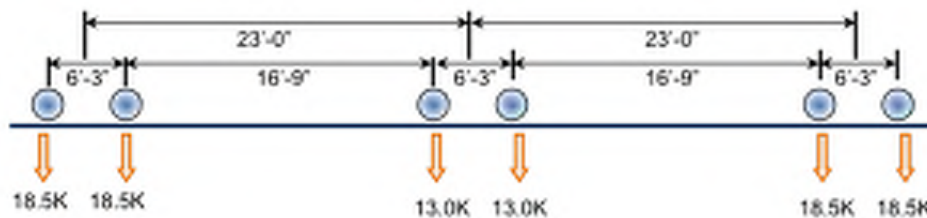


Figure 13.2-1

13.2.3.12 Crane Loads

- a) The DB Entity shall utilize crane and equipment supplier's information for wheel loads, equipment loads, weights of moving parts, and reactions of clamps (if any). Consider construction loads where applicable.
- b) Impact allowance for traveling crane supports, connections and runway beams shall be in accordance with Section 1607.12 of the IBC, unless the crane manufacturer's design specifies higher impact loads. Increase the maximum vertical wheel loads (DL + LL) of the crane by the percentage shown below to determine the induced vertical impact:
 - Monorail cranes: 25%
 - Remote operated bridge cranes: 25%
 - Pendant Operated bridge cranes: 10%
 - Hand-gearred monorail or bridge crane trolley/hoist: 0%
- c) The DB Entity shall provide runway beams for a lateral force equivalent to 20% of the rated

capacity, plus weight of hoist and trolley. Apply this force horizontally to the traction surface of a runway beam and in either direction perpendicular to the runway beams. Calculate the longitudinal force on crane runway beams, except for bridge cranes with hand-gear bridges as 10% of the maximum wheel loads of the crane.

13.3 Vehicle Maintenance Facility Equipment

13.3.1 Scope of Work

The VMF shall include the following services: receiving, daily inspections, light servicing and storage of transit vehicles at the new Somerville facility.

13.3.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code
- AREMA – Manual for Railway Engineering, The American Railway Engineering and Maintenance-of-Way Association
- MBTA Design Standards

13.3.3 The Project Specific Requirements

The DB Entity shall provide the following:

13.3.3.1 VMF Industrial Design Equipment Criteria

The following table describes the purpose of the VMF equipment selection. Required equipment is listed in [Section 13.3.3.2](#).

Element	Purpose of Specified Equipment
Vehicle Inspections	Capable of daily inspection of a minimum of 43 cars stored at the facility.
Vehicle Maintenance	Capable of onsite maintenance and replacement of vehicle trucks and temporary truck storage
Vehicle Cleaning	Support daily interior cleaning of 70 cars
Vehicle Dispatch	Support daily operator dispatch configuration and bay areas
Vehicle Sanding	Provide for receiving and storage of traction sand, which includes sufficient area to store a minimum of 4 pallets unstacked.
Vehicle Fluids	Provide for delivery, dispensing, and waste extraction of lubrication fluids. The quantities are established in sheet MAF-A-1100 in Exhibit 2B.1 as defined by tank sizes.
Vehicle Hoists	Provide capacity for lifting a single LRV, and setting trucks down for replacement. Vehicle hoist located directly adjacent to the truck shop shall be able to rotate trucks to allow direct roll-away of trucks from the vehicle lift area into the truck shop area.

Element	Purpose of Specified Equipment
Shop Cranes	Bridge crane coverages over flat bays and over truck workshop, as specified capacities.
Maintenance Supply Storage	Capacity for storage of specified goods
Vehicle roof maintenance access	Provide access to vehicle roof for maintenance.

13.3.3.2 Vehicle Maintenance Facility Equipment

The DB Entity shall provide the specific equipment as shown on the Project Definition Plans:

Element	REQUIREMENT
Crane, Bridge, 10-Ton	Flat Bay -Full Coverage
Crane, Bridge, 7½ -Ton	Truck Workshop - Full Coverage
Hoist, Married Pair LRV, In-Ground with Body Stands	Capacity for lifting a vehicle married pair and lowering trucks for replacement. Capable of rotating the lowered trucks to allow rolling trucks directly into the truck workshop area.
Hoist, Truck Repair, 15,000 lbs., above-slab	Above-slab, continuously height-adjustable truck hoist capable of lifting the heaviest truck to be used on type 7, 8, and 9 series vehicles to be used for truck maintenance access.
Future LRV roof access	Provide space for MBTA furnished rolling staircases on both sides of the LRV to allow rooftop access and provide extending guardrails to allow movement of personnel on the vehicle rooftop.
Lift, Parts, Two-Floor Stops, 3,000 lbs.	Allow transportation of components on a pallet jack to the pit floor
Compactor, Trash, Stationary, 40 CY	Waste Disposal
Baler, Vertical, Heavy Duty	Recycling Disposal
Washer, Parts, Solvent, 42 Gallon Capacity	Capable of cleaning parts with liquid solvent

Element	REQUIREMENT
Receiver, Waste Oil, 25 gallon	Fluid Collection
Tank, Waste Oil Collection, Integral Transfer Pump, 250 gallon	Fluid Collection
Washer, hi pressure/hot water/detergent, NG	Truck Cleaning
Pump, air piston, 3:1 ratio (Waste Oil)	Fluid Collection
Forklift, electric, Very Narrow Aisle, 4,000 lbs.	Material Handling
Air Compressor, Rotary Screw, 40HP	Centralized Utility
Pallet Jack, 5500 lbs.	Material Handling
Pallet, Spill Containment	Fluid Drum Storage
Platform, work, portable	Provides step-up for workers in pit
Vise, Combination, Swivel Base, 5"	Work Tool
Workbench, severe duty, 6' x 32"	Work Tool
Board, peg, tool	Tool Storage
Shelving unit, 18", 7' high	Tool Storage
Shelving unit, 18", 36" W, 7' High	Parts Storage
Rack, bulk storage, 2x6x6	Parts Storage
Rack, pallet, 8'	Parts Storage
Rack, pallet, 10', with deck	Parts Storage
Rack, pallet, 12', with deck	Parts Storage
Rack, pallet, 16' high bay	Parts Storage
Rack, storage, 72 bin	Parts Storage

13.4 TRANSPORTATION BUILDING

13.4.1 Scope of Work

The Work includes providing a Transportation Building.

The Transportation Building shall be located at the Vehicle Maintenance and Storage Yard for train operators to complete their day-to-day operation of LRVs. This includes line supervision, yard supervision, and operator vehicles. Parking facilities shall be provided on-site for management and operators to park their automobiles for daily use. Multiple operator shifts are required to fulfill the daily System services; this facility shall serve as one of several facilities for LRV operational beginning, shift changes, and rail service closure.

13.4.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code 780 CMR
- Massachusetts Comprehensive Fire Safety Code, 527 CMR 1.00
- Massachusetts Architectural Access Board 521 CMR
- Massachusetts Electrical Code 527 CMR 12.00
- International Mechanical Code as amended by 780 CMR 28.00
- Uniform State Plumbing Code 248 CMR
- International Energy Conservation Code as amended by 780 CMR 13.00
- Massachusetts Board of Elevator Regulations 524 CMR
- FM Global Standard
- MBTA Guidelines & Standards
- MBTA Guide to Access
- APTA Guidelines (American Public Transportation Association)
- ADA Standards for Accessible Design
- ADA Standards for Transportation Facilities by US DOT
- Boston Center for Independent Living Agreement (BCIL)
- NFPA 285 Standard Fire Tested Method for Evaluation of Fire Propagation of Exterior Non-Load Bearing Wall Assemblies Containing Combustible Materials

13.4.3 The Project Specific Requirements

The DB Entity shall provide the specific functional requirements listed below.

13.4.3.1 Transportation Building Program

Table 13.4-1 describes the standards for the Transportation Building.

Table 13.4-1

Area Description	Space Standard	Quantity		Area (sf) Min.	Remarks
		Staff	Spaces		
Transportation Building <ul style="list-style-type: none"> • Vestibule • Office 		2	1 2	35 225	Energy Conservation Workstation
Support Areas <ul style="list-style-type: none"> • Operator’s Lounge • Kitchen * • Restrooms 		30	1 1 2	700 60 50	30 Operators 26 (½ height lockers) Accessible Men’s and Women’s
Subtotal – Transportation Offices and Support Net: Gross Factor (Circulation, Walls)	33%	32		1,070 355	
Total – Transportation Office and Support				1,425	

* In the kitchen, include: sink, microwave, full size refrigerator (minimum of 24 cubic feet), 14 linear feet of countertop, and upper and base cabinets for the length of countertops.

13.4.3.2 General

The DB Entity shall provide exterior and interior assemblies with attention to avoid interior or exterior rusting, detrimental contact of dissimilar materials, deleterious reaction to contact with salt, and use of field welded details. The exterior materials to be used on the facility shall be selected based on durability and appearance. The facility exterior substrate shall be low maintenance durable and resilient. Design life of the connections and finishes shall be not less than 25 years. Other design considerations shall include:

- The material and finish assemblies shall rely on proven technologies, with a documented successful installation track record of a minimum of 5 years.
- The material and finish assemblies shall be noncombustible complying with both building code and NFPA standards.
- The material and finish assemblies shall be weather resistant (including freeze-thaw cycles), mold resistant and detailed to resist anticipated potential vapor and moisture penetration including direct infiltration, pressure and wind driven infiltration and vapor migration along gradients.
- Exterior walls shall pass NFPA 285 as a complete assembly when walls utilize metal composite materials (MCM) or high-pressure decorative exterior-grade compact laminates (HPL). This is also required for exterior walls utilizing foam plastics, except for exterior walls of fully sprinklered, one story buildings where foam plastic having a flame spread index of 25 or less, and a smoke developed index of 450 or less, are installed without thermal barriers in or on exterior walls in a thickness not more than 4 inches where the foam plastic is covered by aluminum not less than 0.032 inch-thick, or corrosive-resistant steel not less than 0.016 inch thick.

- Roof materials shall be selected based on long-term durability and appearance. Roofs shall be cold applied modified bitumen, painted metal or single ply monolithic roof system with a white or light colored top coat to conform to the MBTA's sustainability policies and goals.
- Roofs shall have a minimum twenty-five-year life span expectancy.
- Flashings shall be either stainless steel or galvanized, compatible with selected roof system.
- Equipment and envelope design and installation shall comply with MBTA insurance carrier requirements (FM Global requirements, refer to [Exhibit 2I](#)).

13.4.3.3 Fenestration and Doors

The DB Entity shall provide the following:

- Glazing shall be double pane insulating glass.
- Windows shall be operable.
- Where exposed to direct sun, energy efficient (low "e") glass shall be used. Exterior wall and roof areas shall be insulated to meet current energy codes.
- Flashings shall be either stainless steel or galvanized.
- Door and window frames shall be painted metal or aluminum.
- Window and skin penetrating assemblies shall be thermally broken.
- Coordinate door, lockset and hinge requirements with MBTA.

13.4.3.4 Interior Partitions, Walls and Ceilings

The DB Entity shall provide the following:

- Ceilings shall be durable tile acoustical ceiling, throughout.
- Office partition shall be metal stud and 5/8 inch gypsum-board construction. Sound insulation shall be provided between adjacent spaces of STC 35 minimum.
- Toilet areas shall have ceramic tile floor and wall finishes from floor to ceiling over cement backing board. Sound insulation shall be provided between adjacent spaces of STC 35 minimum. Toilet/shower areas shall have ceiling grids constructed and installed without painted surfaces, designed with maintenance and corrosion protection for humid/wet environments.

13.4.3.5 Floors

All floors shall include the following characteristics:

- Slip resistant ADA compliant finish.
- Non-stainable finish.
- All administrative spaces within the Transportation Building shall have resilient floor coverings and baseboards

- Restrooms shall have durable, easily cleanable, non-porous, through-body floor tiles over substrate for wet areas such as concrete or cement board, pitched to floor drain.

13.4.3.6 Ramps

Ramps shall provide accessible access in all floor level changes where required by ADA and MAAB. The DB Entity shall conform with the more stringent requirement between the MBTA Guide to Access and ADA requirements. Other required characteristics shall include:

- The design of the ramps shall use the same material palette as the adjoining floor surface.
- The slope of ramps shall not exceed 8%.
- Exterior ramps shall be covered including landings. Covers shall extend 5' beyond the end of the ramp surface

13.4.3.7 Stairs

There shall be a minimum of one stair at all grade changes. Stair shall be covered including landings.

Risers shall be of uniform height 7 inches maximum, with closed risers, and with yellow contrast/reflective nosing firmly attached to the stair structure.

All treads shall be a uniform width of 11 inches minimum with a slip resistant tread nosing assembly.

13.4.3.8 Site and Landscape

Refer to [Section 7.5](#).

Provide on-site parking for a minimum of 89 automobile parking spaces for Transportation Building Management and Operators outside of secured fence limits. Provide an accessible path to connect accessible parking spaces with the entry of the building.

13.4.3.9 Interior Fixed Furnishings & Equipment (FF&E)

DB Entity to provide FF&E from acceptable MBTA vendors.

13.4.3.10 Room Criteria

All dimensions indicated shall be minimum requirements. Project Definition Plans indicate the minimum functional layout for the Transportation Building. Unless otherwise noted, refer to Specification 01800 for this building and surrounds.

- Room: EXTERIOR OPEN SPACE

Dimension Criteria:	1,000sf unobstructed, rectangular open space for Operator assembly.
Function:	Operator's Secure Outdoor Paved Seating Area.
Relationship:	Direct adjacency to Transportation Building and parking lot within secure area.

Equipment/Furnishings: None.

Design Features

Floor: Exterior concrete paved area, pitched to drain.
 Walls: Building exterior and back side of security fence.
 Ceiling: None. Open air.
 Secure Area: Security fence adjacency as shown on Maintenance Facility Site Plan.
 Plumbing: 1 Exterior freeze-proof hose bib with locking covers and interior drain valves.
 Electrical: Four exterior GFCI weatherproof receptacles with locking cover, minimum 1 at each entrance and 1 on two opposing sides of the building, 1 serving the outdoor seating area. Shielded exterior lighting at stairs, ramps, landings, and Outdoor Paved Seating Area.
 HVAC: HVAC units serving the Transportation Building shall be located outside of the Operator's Outdoor Paved Seating Area.

- Room: VESTIBULE B201

Dimension Criteria: 5'-0" x 7'-6"
 Function: Main entrance, air lock, and controlled space.
 Relationship: Connects to the Hallway and near Offices.
 Equipment/Furnishings: None.

Design Features

Floor: Door mat, VCT and resilient base.
 Walls: Latex painted gypsum wall board on metal stud.
 Ceiling: 9'-0" clear ceiling height. Painted gypsum wall board ceiling and recessed lights with prismatic lens, 30 FC.
 Secure Area: Secure entry both single doors.
 Plumbing: None.
 Electrical: General purpose duplex receptacle for cleaning machine.
 HVAC: Heating including boost/recovery capacity. Ceiling mount downblast.
 Sustainability:

- Room: HALLWAY B206

Dimension Criteria: 32'-0" x 4'-0"
 Function: Main connecting Hallway.
 Relationship: Main connection from the main entrance vestibule to the Offices, Restrooms, Kitchen and Operators room.
 Equipment/Furnishings: None.

Design Features

Floor: VCT and resilient base.
 Walls: Latex painted gypsum wall board on metal stud.

Ceiling:	9'-0" clear ceiling height. Suspended acoustic ceiling tile and recessed lights with prismatic lens 30 FC.
Window:	Exterior window required.
Secure Area:	None.
Plumbing:	None.
Electrical:	General purpose receptacles for cleaning machine. Locate a maximum of 30 feet apart.
HVAC:	Air conditioning and ventilation, including pressurization OA.

- Room: MANAGER'S OFFICE B207

Dimension Criteria:	11'-9" x 9'-8"
Function:	Office workstation.
Relationship:	Connects to the Hallway, near main entrance Vestibule, Restrooms, Kitchen and Operation.
Equipment/Furnishings:	Task chair. 30" deep work surface. 60"x60" corner office desk. Under counter vertical file cabinet.

Design Features

Floor:	VCT and resilient base.
Walls:	Latex painted gypsum wall board on metal stud.
Ceiling:	9'-0" clear ceiling height. Suspended acoustic ceiling tile and recessed lights with prismatic lens 30 FC.
Window:	Exterior windows required.
Secure Area:	Secure entry single door.
Data & Telephone:	Provide data and telephone receptacles.
Plumbing:	None.
Electrical:	Dedicated circuit quad outlet at the work station. General purpose receptacle on each wall.
HVAC:	Individually controllable HVAC including OA ventilation per code.

- Room: YARD MASTER'S OFFICE B208

Dimension Criteria:	11'-8" x 9'-8"
Function:	Yard Master Office with direct views to the Train Storage Area. Video coverage for all other parts of the VMF site feed to this room, monitor viewing. Transaction counter and window for interaction with Operators.
Relationship:	Connects to the Hallway, near main entrance Vestibule, Restrooms, Kitchen and Operation. Direct adjacency to Train Storage Area with operable window.
Equipment/Furnishings:	Task chair. 60" x 140" corner office desk. Under counter vertical file cabinet. 24" Monitor.

Design Features

Floor:	VCT and resilient base.
Walls:	Latex painted gypsum wall board on metal stud.
Ceiling:	9'-0" clear ceiling height. Suspended acoustic ceiling tile and recessed lights with prismatic lens 30 FC.
Window:	Operable exterior windows to exterior and operable side rolling window with associated transom counter to Hallway.
Secure Area:	Secure entry single door.
Data & Telephone:	Provide data, video feed, and telephone receptacles.
Plumbing:	None.
Electrical:	Dedicated circuit quad outlet at the work station. General purpose receptacle on each wall.
HVAC:	Individually controllable HVAC including OA ventilation.

- Room: MEN'S RESTROOM B202

Dimension Criteria:	6'-6" x 7'-6"
Function:	Restroom for male employees and shared by administrative staff.
Relationship:	Connects to the Hallway and is near Offices and Operators.
Equipment/Furnishings:	Toilet, sink, mirror, hand dryer, grab bars, toilet paper dispenser, wall hooks.

Design Features

Floor:	Porcelain tile with porcelain base with one piece inner corners. Floor to pitch to floor drain.
Walls:	Ceramic tile field with accent horizontal ceramic band to continue 6" below ceiling install on moisture resistance wall board on metal stud.
Ceiling:	9'-0" clear ceiling height. Suspended moisture resistant acoustic tile ceiling and recessed lights with prismatic lens 30 FC.
Secure Area:	Secure entry single door.
Plumbing:	Toilets and wash sinks. Floor drain near toilet, Trap primers. Ultra-low-flow fixtures. Hands-Free trim including dryers. Hot and cold water to fixtures. Drainage, waste and vent piping. Locate domestic hot water heater near points of use and in accessible location.
Electrical:	Receptacle near door for cleaning machine. GFI receptacle over counter. LED task lighting over sink.
HVAC:	Individually controllable HVAC including OA ventilation per code. Exhaust to exterior. No air recirculation within room.
Sustainability:	In addition to the Project-wide sustainability requirements; collect all exhaust air from both toilet rooms and locker

rooms via an energy recovery ventilator (ERV). Use post-recovery outside air to assist ventilation of occupied spaces. Use ultra-low flow plumbing fixtures, metered faucets and HW recirculation. If electric HW heater is used, use a heat pump recovery type. If gas-fired is used, use a condensing type. If location is suitable, solar thermal could be applied.

- Room: WOMEN'S RESTROOM B203

Dimension Criteria: 6'-6"x7'-6"x9'-0"
 Function: Restroom for female employees and shared by administrative staff.
 Relationship: Connects to the Hallway and is near Offices and Operators.
 Equipment/Furnishings: Toilet, sink, mirror, hand dryer, grab bars, toilet paper dispenser, sanitary napkin dispenser, napkin receptacle, wall hooks.

Design Features

Floor: Porcelain tile and porcelain base with one piece inner corners. Floor to pitch to floor drain.
 Walls: Ceramic tile field to continue 6" below ceiling with accent horizontal ceramic band install on moisture resistance wall board on metal stud.
 Ceiling: 9'-0" clear ceiling height. Suspended moisture resistant acoustic ceiling tile and recessed lights with prismatic lens 30 FC.
 Secure Area: Secure entry single door.
 Plumbing: Toilets, and wash sinks as require per code. Floor drain offset near toilet. Trap primers. Hot and cold water to fixtures. Drainage, waste and vent piping Ultra-low-flow fixtures. Hands-Free trim including dryers.
 Electrical: Receptacle near door for cleaning machine. GFI receptacle over counter. Task lighting over sink.
 HVAC: Individually controllable HVAC including OA ventilation. Exhaust to exterior. No air recirculation within room.
 Sustainable: In addition to the Project-wide sustainability requirements; collect all exhaust air from both toilet rooms and locker rooms via an energy recovery ventilator (ERV). Use post-recovery outside air to assist ventilation of occupied spaces. Use ultra-low flow plumbing fixtures, metered faucets and HW recirculation. If electric HW heater is used, use a heat pump recovery type. If gas-fired is used, use a condensing type. If location is suitable, solar thermal could be applied.

- Room: KITCHENETTE B204

Dimension Criteria: Area as shown on drawings.
 Function: Area for storing and preparing food.
 Relationship: Adjacent to Operator's Room and near Offices.

Equipment/Furnishings: Full size refrigerator (24 cubic feet minimum), microwave and water cooler, sink, counter and storage cabinets. Trash and recycle bins.

Design Features

Floor: Heavy Duty VCT and resilient base.
 Walls: Latex painted gypsum wall board on metal stud.
 Ceiling: Suspended acoustic ceiling tile and recessed lights with prismatic lens 30 FC.
 Secure Area: None.
 Plumbing: Water for sink and refrigerator. Drainage, waste and vent for fixtures.
 Electrical: Dedicated outlet for refrigerator. Dedicated outlet for microwave. Two GFI receptacles over counter near sink. Receptacle near door for cleaning machine. Power for hood exhaust fan.
 HVAC: Residential range hood over microwave, ducted to outside including exterior exhaust fan.
 Separate temperature control for heating and cooling.
 Supply air to include outside air.

- Room: OPERATOR’S ROOM B205

Dimension Criteria: 20 SF per seated employee, exclusive of internal circulation
 Function: Enclosed room used as a break area for the operators and administrative staff.
 Relationship: Adjacent to kitchen, near restroom and offices, with door adjacent to Yard.
 Equipment/Furnishings: 13 – 2-Tiered locker equal total 26 lockers
 6 - 30”x72” tables
 Seating for 30 employees
 48”x72” bulletin board

Design Features

Floor: VCT and resilient base.
 Walls: Acrylic latex-painted gypsum Wall board on metal stud.
 Ceiling: 9’-0” clear ceiling height. Suspended acoustic ceiling tile and recessed lights with prismatic lens 30 FC.
 Window: Exterior windows required as shown on Floor Plan drawing.
 Secure Area: Securable exterior door to Yard.
 Plumbing: None.
 Electrical: Receptacles on all walls spaced a maximum of 8 feet apart. Maximum six receptacles per circuit.
 HVAC: Individually controllable HVAC including OA ventilation.

- Room: JANITOR/STORAGE ROOM B210

Dimensions Criteria: Area <62 sqft

- Room: VESTIBULE B209

Dimension Criteria: 5'-0" x 7'-6"
Function: Main entrance, air lock, and controlled space.
Relationship: Connects to the Hallway and near Offices.
Equipment/Furnishings: None.

Design Features

Floor: Door mat, VCT and resilient base.
Walls: Latex painted gypsum wall board on metal stud.
Ceiling: 9'-0" clear ceiling height. Painted gypsum wall board ceiling and recessed lights with prismatic lens, 30 FC.
Secure Area: Secure entry both single doors.
Plumbing: None.
Electrical: General purpose duplex receptacle for cleaning machine.
HVAC: Heating including boost/recovery capacity. Ceiling mount downblast.

13.5 BUILDING AND BUILDING SITE LIGHTING

13.5.1 Scope of Work

The Work includes the lighting of the buildings and their surrounding areas. This Work involves lighting for buildings, sidewalks, parking lots, drive lanes, train yard, train storage area, ramps, plazas, walkways, access routes, and all areas where the safety and security of the building users, MBTA employees, and MBTA property is a consideration.

The lighting design for buildings and site lighting shall be applied such that economical usage of equipment and energy efficient products are used to meet all requirements. The requirements and selection of equipment shall be coordinated with the requirements outlined in [Section 12.4 Station Lighting](#), for a consistent approach to lighting throughout the system.

The design of the lighting system includes the following sub-systems:

- a) Building interior lighting,
- b) Site and outdoor lighting, including the Lechmere Station bus loop,
- c) Task lighting for specific applications,
- d) Emergency lighting.

13.5.2 Codes, Standards and Manuals include:

- MBTA Design Directive-Design Lighting Levels and Fixtures
- National Electrical Manufacturers Association
- Illuminating Engineering Society of North America (IESNA), Lighting Handbook, Recommended Practices, and Design Guidelines
- The Massachusetts State Building Code (MSBC), 780 CMR
- MBTA Design Directive-Design Lighting Levels and Fixtures.
- American Public Transit Association
- Massachusetts Electrical Code, 527 CMR
- AASHTO Standard Specifications for Structural Supports
- International Energy Conservation Code

13.5.3 The Project Specific Requirements

13.5.3.1 General Requirements

Lighting equipment shall be vandal-resistant in spaces accessible to patrons or the public.

Luminaire locations shall permit ready accessibility for maintenance and periodic cleaning. “Basis for Design” documentation shall describe how maintenance will be accomplished and any special equipment needed for access to luminaires.

The standardization of lighting levels for similar areas throughout the system is required. Spaces where design requirements are not clearly defined in any of the above listed documents, or spaces where alternate design intent is either suggested or necessary shall be submitted to the MBTA for review and acceptance. Where lighting levels values vary between IESNA and MassDOT documents, the more stringent values shall apply. Lighting for underpasses shall comply with IESNA standards.

Lighting calculations that document the lighting design performance meets requirements shall be submitted to the MBTA for review and acceptance.

Lighting controls shall be consistent throughout the project, and be provided by same vendor. The selection of lighting equipment (including luminaires) used throughout the project shall be consistent between all the buildings (e.g. interior lights at one building are the same make/model as interior lights at the next building), for consistent and simplified maintenance efforts throughout the system.

Lighting controls shall utilize a programmable astronomical timeclock scheduling system for pre-set light levels based on the table as defined below. Preset light levels shall be confirmed and accepted by the MBTA.

Morning	4:00 AM
Open	5:00 AM
Close	1:00AM
Night	1:00 AM to 4:00 AM
Sunset and Sunrise	Per astronomical timeclock

Commissioning of the lighting and lighting controls shall be required, and include aiming of adjustable lighting, and programming of lighting controls.

13.5.3.2 Building Interior Lighting

The interior building lighting shall be LED. A 3500K color temperature shall be used, with an 80+ CRI for all interior lighting. Interior lighting shall be UL Listed for Damp locations, except in cases where a higher rating is required. LEDs shall have a minimum life rating of 50,000 hours with 70% lumen maintenance at 25 degrees Celsius.

Natural light from windows, skylights, and clerestory windows shall be maximized to reduce dependence on light fixtures during daylight hours, and the lighting control system shall control lights accordingly where daylight levels meet or exceed illuminance requirements. Shading methods shall be used where necessary to prevent glare from interfering with employees’ ability to work who are stationed in static locations (e.g. office desks).

Peak luminous intensity from interior light fixtures shall be prevented from being aimed out windows or skylights to limit light spill to the night sky.

13.5.3.3 Exterior Site Lighting

Lighting controls for all exterior site areas shall turn on exterior luminaires when ambient illuminance levels drop below the design illuminance target, or 10 foot-candles at the ground plane, whichever is higher. The lighting control system and luminaires shall accommodate a nighttime set-back of light levels capable of reducing luminaire intensity through dimming by up to 80% for energy usage reduction and further light intensity reduction.

The exterior lighting fixtures shall be LED. A 3000K color temperature shall be used, with a 70+ CRI for all exterior lighting. Exterior lighting shall be IP66 rated, and UL listed for wet locations. LEDs shall have a minimum life rating of 50,000 hours with 70% lumen maintenance at 25 degrees Celsius.

Lighting poles shall be concrete, heavy duty coated aluminum, or epoxy coated steel poles to maximize service life. Pole shapes at each building shall be same. Pole concrete bases shall extend a minimum of 12" above grade. Path and walkway lighting poles shall be pedestrian scale, with a maximum of 15' high, and a minimum of 10' high.

Yard lighting poles height shall be minimum 20' tall to optimize light distribution and coverage and prevent glare. Yard lighting poles shall be a mechanically lowered type to enable luminaire replacement and maintenance from ground level. Yard lighting luminaires shall have a BUG rating not to exceed B4-U0-G2 for Type V distributions, and B3-U0-G2 for Type II, Type III and Type IV distributions. Any exterior luminaire located within 10ft or one mounting-height of distance (whichever is greater) of a property line shall be provided with shielding and aimed to limit spill light beyond the property boundary.

DB Entity shall closely review the lighting levels and "spill" light with the local Authority Holding Jurisdiction to ensure proper levels for the building location. Luminaires illuminating the building facade shall be shielded from view beyond the site boundary. Luminaires not illuminating the building facade with intensities greater than 10,000 candela shall be shielded or rated as full cut-off per the IESNA. DB Entity shall avoid any direct illumination onto adjacent properties to limit spill light. Any exterior luminaire located within 10ft or one mounting-height of distance (whichever is greater) of a property line shall be provided with shielding to limit spill light beyond the property boundary.

13.5.3.4 Specific Task Lighting

The lighting for specific task areas shall be located and designed to meet task requirements. Refer to VMF and Transportation Building Room Criteria for additional Lighting Criteria on room by room basis for specific requirements.

Pits shall have lights along both sides, which emit light up and down so as to provide sufficient lighting for maintenance tasks.

13.5.3.5 Emergency Lighting

Emergency lighting shall be provided throughout the building. Exit lighting fixtures shall be LED.

Emergency and exit lighting shall be powered by an emergency power source sized to maintain code required lighting levels for a minimum of 1 hour and 30 minutes. Refer to Section 14.5 for Station and Building Electrical Systems for additional requirements.

13.6 BUILDING SIGNAGE

13.6.1 Scope of Work

The DB Entity shall provide signage and wayfinding elements in the Vehicle Maintenance Facility, the Transportation Building, the Lechmere Station bus loop, and the Traction Power Substations. These elements shall be organized in a complete system that conforms to local codes, meets Universal Design rules and are in accordance with MBTA Standard Design Specifications and the MBTA Station Signage Components Manual.

13.6.2 Codes, Standards and Manuals include

- Massachusetts Architectural Access Board
- MBTA's Graphic Standards for typography, locations, mounting details of all signs
- GLX Station Signage Components Manual
- Massachusetts State Building Code (MSBC), 780 CMR
- Massachusetts Comprehensive Fire Safety Code, 527 CMR 1.00

13.6.3 The Project Specific Requirements

- a) Transportation Building and Vehicle Maintenance Facility Tactile Braille Signage Components
All permanent rooms, exits, restrooms, stairs to include Tactile/Braille signs as per relevant life safety, building and ADA codes/guidelines. For further specifications, description of work, products, submittals and execution, see the following documents
 - GLX Station Signage Components Manual
 - Exhibit 2A.1, Section 10426

- b) Regulatory/ Warning Signs
Provide Regulatory/Warning signs, included but not limited to: "No smoking", "Do Not Enter", and "Emergency Exit Only". For further specifications, description of work, products, submittals and execution, see the following documents:
 - GLX Station Signage Components Manual
 - Exhibit 2A.1, Section 10424
 - Exhibit 2A.1, Section 10440
 - Exhibit 2A.1, Section 10400

- c) Additional Signs
Additional required signs include, "Vehicle Maintenance Facility" Exterior Building Sign, Illuminated exit signs (if applicable), area of rescue assistance/area of refuge (if applicable), train

operations signage (e.g. first cars stops here), track signage beyond the station, building directory, parking related signs. For further specifications, description of work, products, submittals and execution, see the following documents:

- Exhibit 2A.1, Section 10424
- Exhibit 2A.1, Section 10440
- Exhibit 2A.1, Section 10400

For an overview of the design and construction process, refer to Section 12.5.

14.1 STATION AND BUILDING SYSTEMS PLUMBING

14.1.1 Scope of Work

The station and building systems plumbing Work includes transit stations, the Lechmere Station bus loop, Vehicle Maintenance Facility (VMF), Transportation Building, Traction Power Substations (TPSS), storm water pump stations, and related structures and functions within these structures which will require plumbing services.

The Work shall include the necessary plumbing services for potable and non-potable water supply, domestic hot water for lavatories, showers and shop use, sanitary drainage waste and vent piping to municipal sewerage connections. Utility natural gas systems and distribution shall be furnished and installed to all appliances requiring same, including venting of combustion products. Work shall include storm water drainage both interior and exterior including clear water waste and all conducted to sub-grade disposal.

All plumbing fixtures, appliances and groups shall be provided with appropriate plumbing connections. The DB Entity is responsible for coordination with Utilities to furnish and install all required services.

14.1.2 Codes, Standards and Manuals include:

- Massachusetts Building Code – 780 CMR State Board of Building Regulations and Standards – Massachusetts Amendments to the International Building Code
- 248 CMR Ch. 4 – Massachusetts Fuel Gas Code
- 248 CMR Ch. 5 – Massachusetts Amendments to NFPA-54
- 248 CMR Ch. 10 – Uniform State Plumbing Code
- 521 CMR – Architectural Access Board
- International Energy Conservation Code (IECC), including Stretch Code provisions per 780 CMR Appendix 115.AA. (Note: All municipalities through which this Project extends, have adopted the Stretch Code.) OSHA-Occupational Safety and Health Administration) 29 CFR (Code of Federal Regulations) 1910.151
- ANSI/ISEA Z358.1 Standard for Eyewash and Emergency Shower Stations
- WaterSense <https://www3.epa.gov/watersense/products/>

14.1.3 The Project Specific Requirements

The Vehicle Maintenance Facility shall include special disposal systems for gasoline, oil and sand separation, as well as a sealed vented tight tank to contain hazardous fluid wastes and medical wastes. The DB Entity shall provide compressed air systems for tool use including vessels, piping, dryers, variable speed compressors and related controls.

Code compliant combination shower and eyewash stations shall be provided in areas within any structure where caustic or corrosive chemicals are used, including TPSS, battery rooms, and the VMF.

Natural gas piping shall be provided including venting of gas trains. Provide solenoid valves and controls for interlocking with carbon monoxide detection systems.

Natural gas piping shall be rigid minimum Sch. 40 carbon steel with malleable iron fittings. The use of corrugated stainless steel tubing (CSST), shall not be used for distribution gas piping. Terminal lengths of CSST with appropriate fittings and not exceeding 36 inches in length, shall be acceptable for terminal connections to gas-fired equipment.

All domestic hot and cold water shall be Type L or Type K ASTM-B88 copper tubing and wrought copper fittings with lead-free solder joints or code-approved compression joints. PEX and other plastic tubing systems with or without metallic fittings, shall not be acceptable.

All domestic water piping shall be insulated in conformance with the Massachusetts Energy Code including the Massachusetts Energy "Stretch Code" as authorized under 780 CMR Appendix 115.AA.

All plumbing and gas or combination plumbing and gas appliances and equipment, fixtures and trim shall be listed in the Accepted Plumbing Products System of the Massachusetts Board of Registration of Plumbers and Gas Fitters, with approval numbers submitted.

All systems shall be within station and building footprints extending to a point ten (10) feet outside the foundation wall.

The Work includes:

- System selection for each application to meet the criteria, for review;
- Design and construction of accepted plumbing systems;
- Vehicle Maintenance Facility (VMF) plumbing systems, which contains several separate functions and systems under one roof, including showers, break room kitchen, compressed air for tools, emergency eyewash stations. Pedal and wrist-operated industrial type stainless steel hand-wash lavatory sinks with soap dispensers shall be provided in shop areas with appropriate primary wastewater separation;
- Transportation Building plumbing systems, which includes operator break rooms, offices, toilets, lockers, and kitchenette;
- Traction Power Sub-Substations (TPSS) plumbing systems, total of three (3). Each includes toilet rooms, custodial/wet closets, battery rooms with emergency eyewash stations, interior floor drains, storm water removal to below grade;
- Station and building plumbing systems with associated occupied spaces, including toilet rooms, custodial closets, kitchen facilities, air conditioning processes, storm water drainage systems conducted to the MBTA storm water system shall all have appropriate plumbing systems, complete;
- Natural gas service to the VMF, Transportation Building, Lechmere Station police and bus dispatch system HVAC equipment requiring gas, as finally determined; and
- Integrate plumbing controls and alarm points via the SCADA/Programmable Logic Controller system, including water leak detection. This work shall be applicable to HVAC, Electrical, Fire

Alarm, Fire Protection and Plumbing trade services and systems, including coordination of specific points, contacts and connections for a complete and operable system.

14.1.3.1 Plumbing General Requirements

The DB Entity shall provide plumbing and drainage in accordance with the requirement of the Massachusetts State Plumbing Code and Fuel Gas Code under 248 CMR, and the requirements of the State Plumbing Inspector.

The plumbing systems shall supply the required quantity of domestic (hot and cold) water for the various fixtures, provide disposal of sanitary waste and storm water.

Refer to Section 12.1 Station Architecture for platform drainage requirements.

Sanitary systems in the VMF shall include application-specific primary sanitary water treatment, separation and containment required by 248 CMR 10.09, due to the presence of oils, grease, gasoline, sand and other substances harmful or hazardous to the building drainage system, the public sewer, sewage treatment plant or other sewage treatment processes.

Sewage flow requirements for Lechmere Station: GFA of interior spaces shall be < 5,333 sqft, and designed such that average daily sanitary sewage flows are no greater than 400 gallons per day as defined by 310 CMR 15.000 (Title 5).

Sewage flow requirements for Red Bridge TPSS: shall be designed such that average daily sanitary sewage flows are no greater than 30 gallons per day as defined by 310 CMR 15.000 (Title 5).

The DB Entity shall provide a complete and operable plumbing system. Exterior frost-proof hose bibbs shall be provided at all facilities with heated and monitored spaces. Hose bibbs are not required at transit stations without heated, monitored spaces.

The DB Entity shall provide compressed air systems for tool use, emergency eyewash stations, natural gas piping and related venting, controls and safety devices at the VMF.

The DB Entity shall provide:

- a) Low-flow water conservation sanitary fixtures that have the WaterSense label;
- b) Urinals shall not exceed 0.5 gpf;
- c) Metered faucets for toilet room lavatories that have the WaterSense label;
- d) Toilet room floor drains; near urinals in Men's Rooms, near and offset from stalls in Women's rooms, all with trap primers;
- e) Conductance of all storm water to below-grade civil storm water systems with backwater valves. Direct-to-grade or rail-bed disposal of storm water is prohibited;

- f) Indirect waste receptors, and independent venting, for disposal of clear condensate from air conditioning, air drying processes, and fire protection systems, and shall only be conducted to storm water system; and
- g) Indirect waste receptors for disposal of laundry washer waste to sanitary including lint traps.

All plumbing and natural gas systems shall be per 248 CMR Chapters 4, 5 and 10, including materials, sizing and practices, many of which are unique to Massachusetts.

Plastic piping such as PEX in its various forms, Polybutylene and others for domestic water piping will not be acceptable. The use of corrugated stainless steel tubing (CSST), for natural gas piping, with the exception of limited-length terminal connections, will not be acceptable.

All plumbing and gas piping shall be rigid materials appropriate to the application as stated in the respective code sections.

Commissioning of the domestic hot water system shall be required.

14.2 STATION AND BUILDING SYSTEMS FIRE PROTECTION

14.2.1 Scope of Work

The station and building systems fire protection Work includes stations, the Lechmere Station bus loop, VMF, transportation building, traction power substations and related structures and functions within structures requiring fire protection for life and property, in conformance with code and insurance underwriter's requirements (FM Global – refer to Exhibit 2I).

The Work consists of design and installation of sprinklers, standpipes, water services, fire pumps, fire department connections, electronic fire alarm monitoring devices and clean-agent systems to protect the various Hazards specific to each facility.

The fire protection Work shall include:

- Stations, in areas used as storage rooms and trash rooms;
- System selection for each application to meet the criteria, for review;
- Design, construction and testing of accepted fire protection systems; and
- Integration of fire protection flow and tamper devices with controls and alarm points via the SCADA/Programmable Logic Controller system, including monitoring and alarming of high and low temperatures, equipment status, inconsistent status alarm, water detection. This work shall be applicable to HVAC, Electrical, Fire Alarm, Fire Protection and Plumbing trade services and systems, including coordination of specific points, contacts and connections for a complete and operable system.

The Project buildings that require Fire Protection include:

- Vehicle Maintenance Facility (VMF) fire protection systems, which includes several separate functions and systems under one roof, with various occupancies and uses, ranging from maintenance, industrial process, storage and office;
- Transportation Building, which includes operator break rooms offices, toilets, lockers, showers.

14.2.2 Codes, Standards and Manuals include:

- Massachusetts Building Code– 780 CMR State Board of Building Regulations and Standards – Massachusetts Amendments to the International Building Code, Chapter 9 FIRE PROTECTION SYSTEMS
- 527 CMR – Massachusetts Fire Prevention Regulations
- 527 CMR 12:00– Massachusetts Electrical Code
- IFC -International Fire Code
- NFPA-13: Standard for the Installation of Sprinkler Systems
- NFPA-14: Standard for the Installation of Standpipe and Hose Systems

- NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 72: National Fire Alarm and Signaling Code
- NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems
- NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
- FM-GLOBAL/ MBTA Insurance Underwriters

14.2.3 The Project Specific Requirements

The DB Entity shall comply with the requirements of the MBTA's insurance underwriter (FM Global – refer to Exhibit 2I). The DB Entity shall coordinate with all Authorities Having Jurisdiction, including conforming to their directives.

14.2.3.1 Fire Protection Design Criteria

The DB Entity shall provide wet sprinklers, dry sprinklers, pre-action and clean agent systems and portable fire extinguishers, including alarmed cabinets, each as appropriate for each zone and hazard category as required by the applicable codes and AHJ requirements.

The DB Entity shall identify all Light, Ordinary, Extra and Special Hazard Categories including sub-groups per NFPA-13 Chapter 5. Identify all barriers and rated partitions, zones and limits. This is especially applicable but not limited to the VMF.

The DB Entity shall provide Wet Sprinkler Systems in all enclosed and heated buildings and structures except as otherwise noted.

The DB Entity shall provide Dry Sprinkler Systems in all enclosed, unheated buildings, structures and portions of structures where freezing temperatures occur.

The DB Entity shall provide Clean Agent Fire Suppression Systems in new Data Rooms and new SCADA Rooms, where water-based systems pose a greater hazard and/or otherwise are not appropriate.

Pump stations and detached starter booths do not require fire suppression.

The design, construction and testing of the fire protection systems for the ancillary facilities shall be subject to the review and approval of the Massachusetts State Fire Marshal's Office and local authorities having jurisdiction (AHJ).

The DB Entity shall provide hydrants as required by NFPA, or more stringent as required by the AHJ and by specific site conditions.

Systems and components common to multiple locations shall be of the same manufacturer or equivalent compatibility or interchangeability, to minimize training, maintenance and inventory of spare parts stock.

14.2.3.2 Sprinkler and Standpipe Systems

The standpipe and sprinkler systems for the buildings and facilities shall conform to the requirements of NFPA 13, NFPA 14, NFPA 130 and the Massachusetts State Building Code. Ancillary Building/Facility

standpipe and sprinkler systems shall include at a minimum, the following components: main water supply; fire department connections; piping from connections and water supply mains to the sprinkler heads; sprinkler heads (including spares); drain lines; electric and electronic monitoring devices, provisions for remote alarm devices; dry and pre-action system air compressors, cabinets and controls; pipe fittings; valves; hangers; inserts; sleeves; and appurtenances as necessary to provide a complete, code compliant, and functional system.

Piping materials shall be appropriate to the location where installed and not less than Schedule 40. Interior heated locations shall be carbon steel pipe and fittings. Exterior locations, even if sheltered, shall be either stainless steel or hot-dipped galvanized pipe and fittings. Dry systems shall be used in all locations subject to freezing temperatures, including interior spaces feeding thereto. All dry system activation valves shall be in areas that are heated to not less than 60 degrees Fahrenheit.

Electric and electronic monitoring devices shall be connected to a local fire alarm system (FAS) panel and be monitored by Operations Command Center (OCC) and the local Fire Department. Supervisory and/or alarm monitoring outputs shall be monitored remotely at the local and remote operations support facilities.

The standpipe hose connections and locations shall be in accordance with NFPA-14, NFPA-130 and shall be approved by each municipality Fire Department. The capacity of the connected water supply shall be adequate for the supply of only the sprinkler portion of the fire protection systems. The use of high-temperature sprinkler heads proximate to heat sources such as radiant tube heaters, is required. All elements of the system shall be UL listed or Factory Mutual Research Corporation (FM-Global) approved.

14.2.3.3 Clean Agent Systems

The DB Entity shall provide clean agent fire suppression systems for communications rooms, server and control rooms. The system shall be provided in accordance with the requirements of NFPA standards 72 and 2001, and the Massachusetts Building Code.

The system shall include discharge nozzles, control panels, extinguishing agent containers, agent releasing panel, detection devices, manual release stations, abort stations, alarm devices, and piping. The clean agent shall be supplied from high pressure storage cylinders that are manifolded. The system shall include reserve cylinders with 100% spare supply of gas and a main to reserve switch to ensure uninterruptible protection. Access to the agent cylinders and agent releasing panel shall not require personnel to enter the protected area. All elements of the system shall be UL listed or Factory Mutual Research Corporation (FM-Global) approved.

Should special conditions exist that shall adversely affect the extinguishing efficiency (such as permanent openings, etc.), additional quantities of the clean agent shall be provided to compensate for these factors. Activation of the clean agent systems shall be by cross zoned smoke detectors installed in the protected space. Activation of a single detector shall result in an alarm but shall not cause a clean agent discharge. Two detectors installed on separate electric circuits shall be activated to cause clean agent discharge. Prior to clean agent discharge, all HVAC systems and fans serving the protected area shall automatically shut down and all HVAC dampers shall be closed. Coordination of the defined volume boundary shall be made by the DB Entity with all disciplines represented for sign-off.

Protected rooms shall be provided with audio/visual alarms and signs to warn occupants of the suppression system operation and the necessity to evacuate the room immediately. Warning and instructions signs to be provided at entrances to, and inside protected areas, and at entrances to clean agent cylinder storage rooms per NFPA 2001. Each clean agent system shall be equipped with a time delay evacuation relay to allow personnel sufficient time for evacuation. The system shall include emergency backup power. Upon loss of the normal power, the system shall automatically transfer to a standby battery. The battery shall be sized for 24 hours of supervision and be capable of discharge and operation of all alarms for 15 minutes at the end of the 24-hour standby period per NFPA 72.

The DB Entity shall provide a minimum of two cabinet-enclosed, self-contained breathing apparatus, each with a 30-minute air supply immediately outside of the rooms protected by the clean agent fire suppression system.

14.2.3.4 Fire Extinguishers

The DB Entity shall provide fire extinguisher cabinet door latches in public areas and shall be alarmed to a continuously monitored location per applicable code requirements including MSBC and NFPA 10.

14.2.3.5 Design Calculations

The DB Entity shall provide design calculations to MBTA in sufficient detail to permit evaluation of the specified plumbing equipment and the systems' designs. Design calculations shall include the following:

- Fire protection hydraulic calculations on electronic spreadsheets, industry software or similar organized form, calculated and sized in conformance with NFPA;
- Fire protection zones including hazard level, system to be used (wet, dry, pre-action, clean-agent);
- Perform hydrant test upon which hydraulic calculations are based; and
- Update all calculations to be current at each review submission including final, to reflect actual room names and numbers, changes in fixture counts and related criteria.

14.2.3.6 Fire Protection Systems Commissioning

The DB Entity shall provide a commissioning plan that consists of individual equipment performance and quality assurance tests, as well as a complete installation testing and commissioning plan that ensures that the system functions and operates as intended and in accordance with all applicable codes and standards. This shall be submitted to the State Fire Marshal and the MBTA for review and acceptance prior to commencement of any testing.

Commissioning shall include HVAC, electrical, plumbing, fire alarm, fire protection and communications/controls systems under both normal and standby power.

14.3 STATION AND BUILDING SYSTEMS – FIRE ALARM

14.3.1 Scope of Work

The station and building systems fire alarm Work includes stations, Vehicle Maintenance Facility (VMF), Transportation Building, Traction Power Substations (TPSS), pump stations, the Lechmere Station bus loop, and functions within structures requiring fire alarm for life safety and property protection, in conformance with code and insurance underwriter's requirements (FM Global requirements, refer to Exhibit 2I).

The system shall be compatible with existing central monitoring systems, including SCADA and BMS/DDC System tie-ins and local fire department notification. The systems shall be interconnected with the Operations Control Center (OCC) as required by NFPA-130. Communication protocol with the OCC shall match existing. The work shall include:

- System selection for each application to meet the criteria.
- Design and construction of fire alarm systems.
- Commissioning and acceptance testing of the fire alarm systems.
- General Facilities and System Descriptions:
 - (a) Vehicle Maintenance Facility (VMF) fire alarm system, which includes several separate functions and systems under one roof, with various occupancies and uses, ranging from maintenance, industrial process, storage and office.
 - (b) Transportation Building, which includes operator break rooms offices, toilets, lockers, showers.
 - (c) Traction Power Sub-Substations, (TPSS) which include transformers, electrical switchgear, capacitor banks, battery room, toilet room and custodial closet.
 - (d) Pump Stations which include a pump section and a control enclosure.
- Fire Alarm Control Panel and digital annunciator for each facility.
- Common Devices for All Facilities as Applicable:
 - (a) Audible/Visual notification appliances.
 - (b) Manual dual-action pull stations with polycarbonate cover with horn.
 - (c) Space smoke and heat detectors furnished and installed in specific spaces.
 - (d) Work includes wiring duct smoke detectors to Fire Alarm System for alarm and monitoring.
 - (e) Carbon monoxide detectors with annunciation and supervisory alarm wherever carbon-based fuel is burned.
- Interface with mechanical systems for fan shutdown and damper operations.

- Power to fire/smoke dampers.
- Interface for elevator recall.
- Monitoring and alarming of high and low temperatures, heat trace status.

14.3.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code (MSBC) – 780 CMR
- Massachusetts Comprehensive Fire Safety Code, 527 CMR 1.00
- Massachusetts Electrical Code, 527 CMR 12.00
- IFC -International Fire Code with Massachusetts amendments.
- NFPA-72
- Owner Operational Standards and Guidelines
- Owner Insurance Underwriters
- NFPA 130

14.3.3 The Project Specific Requirements

14.3.3.1 The DB Entity shall provide a fully addressable fire alarm system which shall transmit alarm outputs to the Owner Operations Center (OCC) at 45 High Street, Boston 02110 for each station and facility. Alarm points transmitted and communication protocol to OCC shall be closely coordinated with MBTA and local fire departments. All new fire alarm systems shall be of the same manufacturer and networked as required to meet applicable codes and standards. Coordination with the OCC and AHJs is required.

14.3.3.2 Manual pull stations shall be dual-action, including protective polycarbonate covers with local alarm. Manual pull stations within a station shall be located on platform and throughout station such that the travel distance from any public area to a device does not exceed 325' unless otherwise approved. The pull stations will be distinctive in color, and indicated by appropriate signs.

14.3.3.3 The facility fire alarm systems shall be Class A, digitally addressable and comprised of a fire alarm control panel, annunciator, manual pull stations, audio-visual notification appliances, heat and smoke detectors, Interlocking with fire protection sprinkler systems, HVAC duct smoke detectors. Annunciator panel location shall be approved by the local authority.

14.3.3.4 An Automatic fire detection via heat or smoke detectors shall be provided in all ancillary spaces in a station.

14.3.3.5 Fire Alarm System Commissioning

- (a) The DB Entity shall provide the commissioning plan that consists of individual equipment performance and quality assurance tests, as well as a complete installation testing and commissioning plan that ensures that the system functions and operates as intended and in accordance with all applicable codes and standards. This shall be submitted to the State Fire

Marshal and MBTA for review and acceptance prior to commencement of any testing. Commissioning shall include HVAC, electrical, plumbing, fire alarm, fire protection and communications/controls systems under both normal and standby power.

14.4 STATION AND BUILDING SYSTEMS HVAC

14.4.1 Scope of Work

The station and building systems HVAC Work includes Stations, Vehicle Maintenance Facility (VMF), Transportation Building, Traction Power Substations, the Lechmere Station bus loop, and related structures and functions within structures requiring heating, ventilating and air conditioning for human comfort and to support processes and equipment functions.

The Work includes:

- System selection for each application to meet the criteria, for review, including calculations;
- Design and construction of accepted HVAC systems;
- Vehicle Maintenance Facility systems, which includes several separate functions and systems under one roof, ranging from industrial, process, storage and office;
- Transportation Building, which includes operator break rooms, offices, toilets, lockers, showers;
- Traction Power Sub-Substations, which include ambient air ventilation, mechanical air conditioning of controls rooms where ambient air temperatures are insufficient for cooling;
- Air conditioning including low-ambient year-round cooling of elevator machine rooms at select stations. Related venting of elevator machine rooms and hoistways per MA Elevator Code;
- Air conditioning including low-ambient year-round cooling of electrical rooms, communications/tel-data rooms, located in select stations, and buildings under this Project;
- Controls systems, both local stand-alone in stations and integrated BACnet® protocol for the VMF and Transportation Building complex; and
- Integration of controls and alarm points via the SCADA/Programmable Logic Controller system, including monitoring and alarming of high and low temperatures, equipment status, inconsistent status alarm, water detection. This work shall be applicable to HVAC, Electrical, Fire Alarm, Fire Protection and Plumbing trade services and systems, including coordination of specific points, contacts and connections for a complete and operable system. All alarm points shall be sent to the MBTA Operations Control Center at 45 High Street, Boston.

14.4.2 Codes, Standards and Manuals include:

- Massachusetts Building Code – 780 CMR State Board of Building Regulations and Standards – Massachusetts Amendments to the International Building Code, including referenced standards.
- IMC - International Mechanical Code
- International Energy Conservation Code (IECC)
- Energy Executive Order #484 Leading by Example – clean energy and Efficient Buildings
- Energy Executive Order #569 Establishing an Integrated Climate Change Strategy for the Commonwealth

- Board of Elevator Regulations, 524 CMR

- MEC -Massachusetts Electrical Code, 527 CMR 12.00
- American Conference of Governmental Industrial Hygienists (ACGIH) Industrial Ventilation Manual.
- ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers), Standards as noted and as applicable to systems selected and implemented by the DB Entity.
- ASHRAE Standard 15, Safety Standard for Refrigeration Systems
- ASHRAE Standard 55 “Thermal Environmental Conditions for Human Occupancy”
- ASHRAE Standard 62 “Ventilation for Acceptable Indoor Air Quality”; 62.1
- ASHRAE Standard 183, “Peak Cooling and Heating Load Calculations in Buildings except Low-Rise Residential Buildings”

14.4.3 The Project Specific Requirements

14.4.3.1 Environmental Requirements

The following ambient outdoor design conditions shall be used and are based upon the Climatic Design Information provided by ASHRAE Handbook, Fundamentals, for Boston’s Logan Airport location. The data assumes 0.4% summer and 99.6% winter, annual frequency of occurrence.

- | | | |
|----|---|----------|
| a) | Summer design dry bulb temperature: | 90.8 °F |
| b) | Summer design wet bulb temperature: | 73.3°F |
| c) | Summer average daily temperature range: | 15.3°F |
| d) | Winter design dry bulb temperature: | 7.4°F |
| e) | Ambient barometric pressure: | 29.7” Hg |

The following indoor design conditions shall be used:

- | | | | |
|----|---------------------------------------|-----------------------------------|--------------------------------------|
| a) | Summer season/air conditioned spaces: | | |
| | i. | Offices, Break Rooms, Booths | 75 °F db, 50% relative humidity (RH) |
| | ii. | Control rooms: | 75 °F db, 50% relative humidity (RH) |
| | iii. | Electrical rooms: | 104 °F db maximum |
| | iv. | Battery rooms: | 88 °F db |
| | v. | Equipment/storage/janitor rooms: | 104 °F db |
| | vi. | Toilets rooms: | Ambient Temperature; Exhausted. |
| b) | Cooling season/ventilated spaces: | | |
| | i. | Pump stations: | 104 °F db |
| | ii. | Traction Power Substations (TPSS) | 104 °F db |
| c) | Heating season: | | |
| | i. | Offices, Break Rooms, Booths | 70 °F db |
| | ii. | Control rooms: | 70 °F db, 25% RH |

iii.	Electrical rooms:	55 °F db
iv.	Battery rooms:	55 °F db
v.	Equipment/storage/janitor rooms:	55 °F db
vi.	Toilets rooms:	70 °F db
vii.	Pump Stations:	55 °F db

14.4.4 Design Calculations

Design calculations shall be provided to MBTA in sufficient detail to permit evaluation of the specified mechanical equipment and the systems' designs. Design calculations shall include the following:

- Room-by-room and space-by-space HVAC calculations;
- Heating, Ventilating and Cooling Calculations shall be performed using ASHRAE Standard 183 RTS algorithms and ASHRAE Standard 62.1 outside air values within recognized commercial calculation software such as Trane Trace, Carrier/UTC "HAP", Elite Software "CHVAC" or equal;
- All calculations shall be submitted to the MBTA for acceptance including input assumptions, building construction heat transfer values, ventilation outside air requirements, critical ventilation zone calculations, design population and activity levels, internal lighting, equipment and power loads; and
- All calculations shall be continuously updated throughout design and construction for any changes to plan layouts and building configurations, with room names and numbers matching the final plan references.

14.4.5 Space Design Requirements

Space design requirements shall include the requirements specified in Table 14.4-1.

Table 14.4-1 – Space Design Requirements

Space Description	Heating	Ventilation (1)	Air Conditioning	Other
Offices, Break Rooms	X	X	X	Individual Control (5) Positive/outflow pressure. (7)
Locker Rooms, Shower Rooms	X	X		(5) Negative/Inflow Pressure (7)
Toilet Rooms	X	X		(5) Negative/Inflow Pressure (7)
Operator and Clerk Booths	X	X	X	
Battery Rooms		X	X	
Electrical Equipment Rooms		X	2	

Space Description	Heating	Ventilation (1)	Air Conditioning	Other
Server and Control Rooms	X		X	Redundant Systems
Fire Pump Room	X	X		
Generator Room	X	X		N.A. if packaged outdoor gen-set.
Janitor Rooms	X	X		Negative/Inflow Pressure (7)
Elevator Machine/Control Rooms	X	X	X	524 CMR 35.00
Elevator Hoistways	(8)	X		Smoke/Heat Vent
Mechanical Equipment Rooms	X	X		
Pump Control/Utility Rooms	X	X		
Pump Stations	X	X		
Traction Power Substations TPSS	X	X	X(2)	(6)
Switchgear Room	X	X	X(2)	
UPS Room	X	X		
Workshop/Storage Room	X	X		

Notes

- Quantity of air changes shall comply with the Massachusetts Building Code requirements, IMC and occupancy either by personnel or equipment within the space.
- Ventilation or air conditioning as required maintaining a maximum temperature of 104 °F within the space.
- The DB Entity shall coordinate with the MBTA to determine and confirm that the MBTA’s Control room systems and equipment can meet the environmental requirements of the DB Entity’s control room equipment that shall be located in the MBTA’s Control room.
- The table above is not intended to be all-inclusive and represents general room types. Final design may not require use of all room types or require additional rooms and functions not listed here. Should final design include rooms, spaces and functions not listed here, all such conditions shall be approved by the MBTA and a supportable equivalent means of environmental control shall be provided.
- The Project has relatively few individual spaces and on different exposures. Individual space zone control shall be provided for each space with appropriate limits on setpoint adjustment, regardless of which final system is provided.
- TPSS facilities shall include toilets, custodial/wet closets and battery storage rooms with emergency eyewash station. Each space shall be provided with exhaust to the exterior. Custodial closets and toilet rooms may be combined. The battery room shall be exhausted separately and shall have hydrogen detection and dedicated filtered outside air ducted to the space, with motorized damper. Each utility space shall be independently heated to minimum 60 degrees F. and toilet rooms heated to a minimum 70 degrees F.
- Office, break room and other regularly occupied spaces shall have their outside air volume provided to ensure a positive/outflow room pressure relative to adjacent spaces. Toilet rooms, locker and shower rooms and janitor closets shall have negative/inflow pressure relative to adjacent spaces. The principle of “clean to less clean” airflow shall be used in system design, control and operation.

8. Elevator hoistways typically would not be heated and not contain wet sprinkler piping or other systems requiring freeze protection.

14.4.6 General Administrative Requirements

14.4.6.1 System Evaluation

The HVAC systems shall comply with the efficiency requirements of the Massachusetts Building Code. Factors of longevity, ease of service, availability of parts, simplicity and cost-effectiveness shall be analyzed, including replacement costs using ASHRAE published median useful equipment life data.

14.4.7 Heating, Ventilating and Air Conditioning (HVAC) System Duct Design

14.4.7.1 General Requirements

Construct sheet metal ducts in the building HVAC system of lock-forming quality galvanized steel with joints that are air tight. Duct gauges and fabrication methods shall comply with the Sheet Metal and Air Conditioning Design Consultant's National Association, Inc. (SMACNA) Duct Construction Standards Metal and Flexible as applicable. Sheet metal shall be 24-gauge minimum thickness with a default minimum construction of 2.0" w.g. positive and negative. The next increment of higher pressure class shall be medium pressure, not less than 6.0" w.g. positive for use in VAV system supply ductwork upstream of terminal boxes. All HVAC ductwork shall meet a minimum Seal Class A/Maximum Leakage Class 3, borne out by random testing. Ductwork shall be insulated after sealing, all per specifications to meet or exceed the energy code.

Provide low pressure ductwork sized by the equal friction method at a friction pressure drop rate of 0.07 inches per 100 feet of duct and with velocities not exceeding 1,500 fpm. Medium pressure ductwork shall be sized by the equal friction method at a friction pressure drop rate of 0.15 inches per 100 feet of duct and with velocities not exceeding 2,500 fpm. Notwithstanding the above sizing criteria, all HVAC systems shall meet IECC requirements for fan horsepower to air volume ratios and shall not exceed a room noise criteria of NC-25 to offices, break rooms, locker-shower rooms, training rooms, police and dispatch rooms. Elbows shall have full centerline radius of at least 1-1/2 times the width of the duct. Where full "1.5 x radius" curves will not fit, use lesser radii elbows with internal radius vanes. Where no radius elbow will fit, mitered elbows shall be provided with single wall turning vanes.

Duct transitions shall have taper ratios of not less than 7:1 expanding, 4:1 contracting and not less than 24 inches long, whichever is greater. Duct transitions connecting to louver plenums shall taper 7:1 regardless of airflow direction.

Special exhaust systems including material handling, process or moisture exhaust, pump stations, kitchens, shower rooms, wash stations and equipment connections shall be provided for appropriate application, duty and longevity, including stainless steel, aluminum and welded construction, intumescent fire-rated ductwork, fire-wrapped ductwork.

Ducted exhaust systems serving any storage rooms containing allowable flammable or volatile substances, shall be provided with intake and extraction points at opposite elevations, high extract for lighter than air vapors and low extract for heavier than air vapors, to maximize cross-flow and incoming air to the breathing zone.

The DB Entity shall use flexible fabric connectors at all motorized air-moving equipment. Connections at inlets of fans shall not be installed directly at the fan inlet, to avoid constricting fan entry flow. Instead, fan inlet flexible connectors shall be installed with a minimum one duct diameter long sheet metal duct joint.

The use of flexible insulated supply duct for final connection to air outlets shall be limited to above accessible lay-in ceilings only and with lengths limited to five feet. Any bends in flexible duct shall be no tighter than a 30-inch centerline radius. Otherwise, all connections to air devices shall be rigid sheet metal.

14.4.7.2 Fire and Smoke Dampers

Fire dampers shall be provided in fire rated partitions or walls at duct and transfer air penetrations. Fire dampers shall be Underwriters Laboratories (UL) listed. Fire dampers shall be the fusible link operating type accepted for the protection of openings in the fire rated walls and partitions. Fire dampers shall be dynamic-rated and shall meet the partition rating as required by code.

Smoke dampers shall be provided in all smoke barriers at duct and transfer air penetrations, shall be UL listed, power-open/fail closed, with smoke detectors and locally installed accessible indicators and key-operated reset switches.

14.4.7.3 Supply, Return and Exhaust Air Registers Grilles and Diffusers

The supply air registers and diffusers shall be selected to provide the required throw and spread with the least amount of draft and noise, not more than 50 fpm terminal velocity at ceiling/partition intersections and not greater than NC-25 in occupied rooms. Registers shall be provided with adjustable and double deflection louvers and opposed-blade adjustable volume dampers. Ceiling diffusers shall be square, rectangular, circular or linear type with adjustable throw opposed-blade adjustable volume dampers (OBDs). These volume dampers shall be key operable through the face of the device.

Exhaust and return air grilles and registers shall be equipped with fixed 35-45 degree angled blades or louvers. Provide filter grilles at fan coil units, fan powered boxes or any other coil-bearing unitary apparatus, to encourage regular filter changes from the space served and to reduce need to access the mechanical unit for this regular task. Filter grilles shall be hinged type with secure clasps, sized for standard filter sizes, 20x20 inch default size to limit inventory and shall accept nominal 2-inch thickness MERV-8 filters. Filter grille velocities shall be 250 fpm maximum at the filter flat face area. Use multiple grilles where required to maintain maximum or lower velocities.

All duct branches serving registers, grilles and diffusers shall have in-duct lockable volume dampers at main duct connections in addition to device-mounted opposed-blade dampers.

14.4.7.4 Louvers

Louvers shall be provided for installation in exterior walls. Louvers shall be double-draining, storm-rated type, designed in accordance with the requirements of Air Movement and Control Association (AMCA) Standard 500-L. Louver blades shall be fabricated from extruded anodized aluminum protected with a weather-resistant fluoropolymer resin protective coating. Louvers shall be provided with bird screens on the interior blade plane. Louvers shall be sized to minimize water penetration, with full airflow intake

velocities through the net free area not to exceed 600 feet per minute. Exhaust velocity through the net free area shall not exceed 700 feet per minute.

Ductwork connecting to louvers shall be designed with bottoms pitched toward the exterior, including plenums at louvers and ductwork connecting to plenums.

The bottom of each plenum shall extend and be flashed over the top of the lowest louver blade and sealed for positive outward drainage. The bottom of each plenum shall extend upward a minimum of six inches as a pan, with no seams on the sides or outer edge. All plenum bases shall be sealed with silicone sealant. All plenums at louvers shall have access doors, minimum 24 x 24 inches.

Ductwork connecting to plenums at louvers shall be designed to minimize high air velocities locally onto or through louver blades. The plenum depth and duct connection sizes shall be such that the entire active louver face shall be within a cone 45 degrees angled from the connecting duct edge. Approaching or exiting duct transitions shall be 7:1 taper where space allows otherwise, SMACNA standards apply.

14.4.7.5 Variable Air Volume Terminals

Variable volume, pressure-independent, single duct, low and medium pressure terminal units shall be provided with a calibrated air volume sensing device, damper, actuator and accessory relays. Where minimum ventilation outside air and supply air requirements exceed minimum space cooling load, hot water reheat coils shall be provided. Sine-Curve Rectifier-controlled electric reheat coils will be considered only upon rigorous energy and lifecycle cost analysis.

Units shall control air volume to within 5 percent of each set point volume. Operation as a system shall include static pressure reset, zone terminal polling, CO₂ demand-controlled ventilation, Air Handling Unit discharge air temperature reset to the most critical zone.

14.4.8 HVAC Systems Piping Design

14.4.8.1 HVAC water piping systems shall be designed and constructed in accordance with ASME Code B31.9, Building Services Piping including hangers, anchors, guides and provision for expansion. The minimum default operating pressure class shall be 150, with greater pressures as required by ASME pressure/temperature limits. Valves shall be per MSS standards, ball valves for piping 2 inches NPS and smaller, butterfly valves for piping larger than 2 inches NPS. Nothing shall prohibit the use of larger ball valves up to 4 inches NPS.

14.4.8.2 HVAC water piping up to 2" NPS shall be ASTM A53 Grade B Sch. 40 carbon steel with screwed malleable iron fittings or ASTM B88 Type L copper with wrought copper fittings and lead-free solder joints.

HVAC water piping larger than 2" NPS shall be ASTM A53 Grade B Sch. 40 carbon steel with forged steel fittings and butt-welded joints.

Condensate drain piping shall be Type L copper with DWV fittings and cleanouts at each change in direction and every 20' or less spacing.

The following shall not be acceptable for HVAC piping systems on this Project, including: Plastic piping including PEX, PE, Polybutylene and similar composites, grooved piping systems.

14.4.9 Heating Systems Design

14.4.9.1 Electric unit heaters shall be provided to heat individual isolated utility spaces including toilet rooms, porter rooms, custodial closets, electric rooms, storage rooms, and fare collection/starter booths to supplement heating by other means. The heaters shall be the industrial type and shall meet all the requirement of the National Electrical Code (NEC). The heaters shall be UL listed. Suitable stationary or rotating air deflectors shall be provided to ensure proper heat distribution. The electric unit heaters shall be provided with a built in or surface mounted high limit thermostat interlocked electrically so the heater cannot be energized unless the fan and fan motor are running. The heaters' operation shall be controlled either by a built in or remote thermostats and have protective devices as required by the Massachusetts Electrical Code. Nothing in this specification shall prohibit application of hydronic heaters in structures equipped with hot water hydronic systems.

14.4.9.2 Regularly occupied spaces such as offices, attended starter and fare collection booths, police reporting station, VMF non-shop personnel areas, shall be heated as part of a comprehensive HVAC system noted elsewhere.

14.4.9.3 The VMF shop spaces shall be served with a combination of suspended indirect high-efficiency gas-fired heating and ventilating units and perimeter low-intensity indirect gas-fired radiant tube heaters under vacuum draw. Direct-fired equipment will not be acceptable. Supply air shall be ducted down to the occupied zone and distributed at or below 10 feet above finished floor elevation. Air supply shall also be directed into roll-over maintenance pits.

14.4.9.4 Coordination of ductwork and heaters with rolling gantry cranes and sprinkler head temperature ratings shall be required.

14.4.10 Ventilation System Design

14.4.10.1 Ventilation systems shall be provided where necessary to maintain the desired environment for equipment operation and maintenance personnel. The system shall consist of air supply and/or exhaust fans and ductwork as required. Ventilation systems shall incorporate duct systems and materials as appropriate and shall consider nearby intake/exhaust areas, neighboring facilities, and maximum sound levels permitted in the area.

14.4.10.2 All air supplied to spaces shall be filtered to no less than MERV-8, for human habitation and to protect equipment.

14.4.10.3 The use of energy recovery ventilators shall be required for ventilating personnel support spaces including VMF non-shop personnel space, police reporting stations and other offices where regular and constant workday occupancy occurs, making use of adjacent locker/shower exhaust. Energy recovery is not required for single-user local toilet rooms where occupancy-based operation is used.

14.4.10.4 Single-user toilet rooms shall be exhausted with ceiling-mounted ECM/DC motor fans using an integral occupancy sensor or light switch interlock with an adjustable post-vacancy time delay. Systems shall be sheet-metal ducted to the exterior with a flexible coupling to the rigid duct. No flexible ductwork shall be used.

14.4.10.5 The VMF shall have roof-mounted high exhaust fans with variable speed control, interlocked with supply units. In summer, open doors shall be used and the fan operation shall be capable of manual

operation by staff. Local spot personnel cooling fans and welding fume “smoke eaters” shall not be part of HVAC work but shall be furnished under FF&E or by the MBTA directly.

14.4.10.6 Ventilation systems serving TPSS facilities for cooling and Pump Station facilities for cooling and humidity control, shall include separate outside air intake provisions, motorized control dampers and controls appropriate to space criteria response. Control interactions shall have enthalpy-based priority staged operation. When outside air alone is insufficient for cooling a space and mechanical cooling is provided for these conditions, the ventilation system shall shut down when its operation would add to the space mechanical cooling load.

14.4.10.7 Fan ratings shall be based from test performed in accordance with the test code of the Air Movement and Control Association (AMCA) and shall bear the AMCA label, with the exception of single-seat toilet room fans, which shall have either the AMCA label or the Home Ventilating Institute (HVI) label.

14.4.11 Air Conditioning/HVAC System Design

14.4.11.1 Provide small, single-space or shared space installations including Electrical, IT or Elevator Machine rooms, typically cooling-only with low outdoor ambient control for year-round cooling to serve equipment requirements. These systems shall be of the “ductless split system” type, inverter-driven and with integral controls. Redundant independent systems shall be provided for IT rooms in an N+1 configuration. Multiple evaporators to a common outdoor condensing unit shall not alone fulfill this requirement. Two (2) such systems shall be provided.

14.4.11.2 “Booth” type occupancies including fare collection and starter booths, shipping/receiving offices and other isolated installations shall be provided with either:

- a. A VRF system with heat pump function, coupled with an electric fan-forced wall heater and ducted outside air supply to and through the evaporator, or
- b. A console floor heat pump unit with outside air capabilities. It is intended to use the heat pump capability for most heating needs and reserve the use of electric resistance heating for colder temperatures, (32 deg. F. and below), or
- c. A “Roof Pod” packaged HVAC system as part of a manufactured booth structure.

14.4.11.3 The use of window air conditioning units will not be acceptable for any application on this Project.

14.4.11.4 Larger “office occupancy” systems serving grouped suites including the VMF non-shop personnel spaces, Lechmere Police Reporting/Bus Operations/Kitchenette suite, shall be provided with multi-zone inverter-driven VRF HVAC system with full heating and cooling capability down to 0 deg. F. with a COP of greater than 1.5. A dedicated minimum outside air system shall be provided, ducting post-recovery outside air to each indoor evaporator. Each room shall have dedicated control. Electric fan-forced wall or ceiling heaters shall be provided at exterior entry doors for rapid recovery.

14.4.11.5 Nothing shall prohibit the use of centrally ducted systems for full HVAC capability and zoning, including condensing gas boilers for heating and VAV terminals for individual zone/room temperature control and integrated or parallel energy recovery ventilation, all to meet or exceed energy code requirements.

14.4.11.6 Door Air Curtains shall be used at non-track roll-up doors to reduce infiltration during prolonged open periods.

14.4.11.7 Ducted central air conditioning units shall operate from the minimum outside air required by code or greater by make-up air requirements, up to 100% outside air for economizer free cooling. Enthalpy comparison control shall be used and the air conditioning equipment shall control and manage low sensible cooling loads at high humidity conditions. The use of passive heat pipe wrap-around coils to provide pre-cooling and proportional reheat shall be used in such conditions.

Variable air volume systems may be used where appropriate and shall be used where required by the energy code. The air conditioning unit cooling capacity shall meet the sensible and total heat requirement for the areas served by the unit. The air conditioning units shall be selected to maintain the space environmental design temperature, humidity, and air change requirements. The units shall be selected to produce the required air volume at the fan total pressure.

14.4.11.8 Air handling units shall include a fan/coil section, mixing box, pre-dehumidification coil, dampers, filters condensate drip pan, and the appurtenances for heating and dehumidification. The air filters shall be replaceable, 4" nominal thickness with an efficiency rating of MERV-8 based upon ASHRAE 52.2. The filter rating shall be based upon a velocity of 500 feet per minute and an initial pressure drop of 0.33 in wg. The air filter material shall have a UL Class 2 rating. Coil casings and drain pans shall be 304 stainless steel, positively pitched for drainage. All drain pans shall have a high overflow port and be instrumented to shut off the cooling process if high water is detected.

14.4.11.9 Condensing units shall be of the air-cooled type, self-contained, complete with casing, fans, heat rejection coils and accessories, ready for full capacity operation. Split packaged units shall be provided with all interconnecting refrigeration piping, electrical power and control wiring between the condenser and the evaporator units. Condensing units shall have coil protection guards and marine environment/seacoast factory package finishes. Where low-ambient operation is required, provide wind baffles, fan speed control, crankcase heaters and head pressure controls to allow full operation down to 0 deg. C. outdoor ambient.

14.4.11.10 Given the relatively short cooling season, the use of air-cooled chillers shall be required for any chilled water application. Water-cooled systems with attendant cooling towers, sumps and condenser or spray water chemical treatment and maintenance will not be acceptable due to higher maintenance requirements.

14.4.12 HVAC Systems Construction

14.4.12.1 The HVAC systems shall be procured, installed and constructed in a complete manner and shall include all components necessary to provide a complete and operable system that is in accordance with the criteria specified in this performance specification. The HVAC systems shall include fans, filters, sound attenuators, air conditioners, air handling units, unit heaters, associated piping, cabling, wiring, conduits, inlets, control systems, equipment, miscellaneous appurtenances, hardware, etc., and other components systems as necessary. The HVAC system shall be installed and constructed with the requirements of other related performance specifications as applicable that are a part of the Contract Documents.

14.4.13 Acoustical and Vibration Isolation Requirements

14.4.14.1 All HVAC systems shall employ appropriate acoustical treatments including spring-neoprene vibration isolation, sound attenuators and flexible duct and pipe connections at motorized equipment.

14.4.14.2 All equipment over one horsepower shall be statically and dynamically balanced to conform to the "smooth" curve on the Rathbone Chart or better.

14.4.14.3 The use of duct lining exposed to the airstream shall not be permissible because of difficulty in cleaning without erosion. Double-wall ductwork with perforated sheet metal inner walls shall be acceptable where lining is to be used.

14.4.14.4 All office-type spaces including lockers and showers, break rooms, training rooms, police and dispatch rooms, shall have their HVAC systems designed to an NC rating not exceeding 25. Repair bays, workshops, support spaces, shall have their HVAC systems designed to an NC rating not exceeding 35. It is understood that the ambient and process noise levels may exceed these limits, but the HVAC systems shall not contribute above the NC levels noted.

14.4.14.5 Municipal noise ordinances limiting noise at the property lines above certain levels and at prescribed hours of the day and night, shall be met. Appropriate shielding, mass, attenuation and direction of discharges shall all be employed to not contribute to ambient noise beyond prescribed limits.

14.4.14 HVAC Systems Commissioning

The commissioning plan shall consist of individual equipment performance and quality assurance tests, as well as a complete installation testing and commissioning plan that ensures that the HVAC systems function and operate as intended. This shall be submitted to the MBTA for review prior to commencement of any testing. A full Testing, Adjusting and Balancing (TAB) report, performed by an entity that is certified by a recognized TAB organization including NEBB, AABC, TABB, NBC, shall be performed and accepted prior to Commissioning. Commissioning shall include HVAC, electrical, plumbing, fire alarm, fire protection and communications/controls systems under both normal and standby power.

14.4.15 Controls and Automation

DB Entity shall provide controls and automation appropriate to each facility to meet requirements of the Massachusetts State Energy Code (IECC as referenced and modified under 780 CMR). The DB Entity shall provide monitoring of other trades' equipment (tight tank, FP/FA etc.).

Controls shall include enthalpy-based economizer free cooling where air systems are used for cooling, staged, coordinated setpoint control to prevent simultaneous heating and cooling in a given zone, scheduling of occupied and unoccupied hours, maintaining reduced temperature set-points and ventilation operation and overall energy use during unoccupied hours. Controls shall provide optimum start times for pre-occupancy recovery of temperatures.

Control system(s) shall monitor equipment status and space conditions, shall allow operator selection of condition ranges and categories including critical and non-critical conditions. The control system(s) shall alarm critical conditions out of range, including low and high temperatures, inconsistent status of equipment/failure.

Exceptions to monitored equipment status shall be stand-alone space heaters of all types, which have integral controls; the spaces they serve shall have their temperatures monitored to alarm potential freezing conditions.

All sprinkler valve rooms, water entry rooms, janitor closets and single-use toilet rooms shall have temperature monitoring and reporting of temperatures below 50 degrees F. (adjustable).

Control system(s) non-critical alarms shall also transmit "soft alarms" including dirty filters, hours of use, preventive maintenance information.

All controls systems alarms and conditions shall be reported, including specific location indicators to the MBTA Operations Control Center at 45 High Street, Boston.

14.5 STATION AND BUILDING SYSTEMS ELECTRICAL

14.5.1 Scope of Work

The station and building systems electrical Work includes seven stations, the Lechmere Station bus loop, a Vehicle Maintenance Facility (VMF), a Transportation Building, two pump stations and three Traction Power Substations (TPSS), and functions within structures requiring electrical power and lighting. The work shall include:

- Providing all work and material required to yield properly operable, code compliant electrical system, which includes lighting and power systems, including unit substations, switchgear, panels and stepdown dry type transformers as required;
- Review all sections of the Project Technical Provisions, including drawings and specifications, for additional requirements;
- Utility metering shall be provided as required by serving utility. CT's and cabinets should be included as required by the utility;
- Service rated main panel or disconnect switch shall be provided in location as approved by serving utility and MBTA;
- Power shall be provided to elevators, fire alarm system, security system, fire protection system and any system or equipment requiring power;
- Provide lighting fixtures as required for the specific application. Lighting controls shall be provided for all areas and be code compliant. Review all proposed control locations with MBTA as part of detailed design reviews;
- Vehicle Maintenance Facility (VMF) electrical power and lighting systems, including power as required for fixed and portable tools, overhead cranes, overhead doors, pit lighting and pit equipment. Review all proposed items with MBTA as part of detailed design review process;
- Transportation Building, including operator break room, offices, toilets, lockers, showers;
- Existing Pump Stations electrical installation;
- Pedestrian bridge lighting and controls;
- Community Path lighting and controls; and
- Traction Power Sub-Substations (TPSS), including lighting. Coordinate the specific requirements with the transportation system.

14.5.2 Codes, Standards and Manuals include:

- MassDOT Design Directive-Design Lighting Levels and Fixtures. Where lighting levels values vary between IES and MassDOT documents, the more stringent values shall apply.
- Massachusetts Building Code – 780 CMR State Board of Building Regulations and Standards – Massachusetts Amendments to the International Building Code
- Massachusetts Electrical Code (MEC) - 527 CMR 12.00

- Illuminating Engineering Society (IES) The Lighting Handbook-10th Edition
- International Building Code (IBC)
- International Energy Conservation Code (IECC)
- Energy Executive Order #484 Leading by Example – clean energy and Efficient Buildings
- Energy Executive Order #569 Establishing an Integrated Climate Change Strategy for the Commonwealth
- Architectural Access Board (ABB) - 521 CMR
- MBTA's Insurance Underwriters
- Underwriters Laboratories (UL)
- City of Somerville's Design Standards for Parks and the Community Path
- All applicable NFPA standards including:
 - NFPA 780
 - NFPA 70
 - NFPA 72
 - NFPA 110

14.5.3 The Project Specific Requirements

The Work includes the following:

- Station 13.8 kV substations with step-down transformers and utilization voltage switchgear;
- Utility services;
- Distribution system, transformers, panelboards, motor controls;
- Grounding systems;
- Lighting, interior and exterior;
- Lighting controls;
- Outlets and receptacles;
- VMF lightning protection system;
- Life Safety Systems, including fire alarm systems, emergency lighting, Uninterruptable Power Supplies (UPS) and distribution;
- Outdoor electrical equipment pedestal enclosures, including power as required;
- Provision for supervisory control and data acquisition (SCADA) requirements;
- Power to passenger information systems (Public Address, Variable Message Signs);

- Power to fare collection systems (Fare Vending Machines);
- Power to all MBTA furnished fixed and portable equipment;
- Power to elevators;
- Power to mechanical, plumbing, and security equipment; and
- All transformers shall be cast coil dry type.

14.5.3.1 Service and utilization services includes:

(a) Electrical power to each station shall consist of the following:

- (i) One-TPSS 13.8 kV feeder. The 13.8 kV feeder shall be provided to each station under the TPSS system work. Coordinate the scope of work at each station.
- (ii) One backup utility service.
- (iii) UPS system for life safety systems.
- (iv) In addition, Lechmere station shall be provided with a natural gas powered emergency generator and/or UPS system for life safety loads, to meet the requirements of the Code.

(b) Electrical power to the VMF and Transportation Building shall be as follows:

- (i) VMF shall be supplied from a metered utility service.
- (ii) VMF shall supply the Transportation Building from a sub-metered feeder.
- (iii) UPS system for life safety systems
- (iv) Natural gas emergency generator

(c) Life safety power for each building and station shall be from a local UPS system.

14.5.3.2 Temporary Power and Lighting

Temporary power and lighting shall be provided for Project facilities, including buildings, structures during the construction period.

14.5.3.3 Design Calculations

Design calculations for the electrical equipment and systems shall be provided to MBTA for acceptance. Design calculations shall include:

- Load calculations for services, distribution, panelboards, and transformers.
- Fault current calculations as a basis for selection of circuit interruption devices and electrical equipment withstand ratings.
- Overcurrent protective device short-circuit study.

- Incoming and feeder wiring selection.
- Relay and overcurrent device settings and coordination curves.
- Arc-flash analysis.
- Voltage drop calculation.

14.5.3.4 Outdoor Pad-Mounted Enclosures

Where pad-mounted outdoor enclosures are provided for electrical service entrance equipment and emergency power supply the following requirements shall apply:

(a) General Enclosures shall be:

- (i) Outdoor NEMA 3R enclosures, steel with baked enamel finish.
- (ii) Pad-mounted on a concrete pad extending minimum of 6" above grade. Pad edges shall be beveled to avoid pooling.
- (iii) Equipment shall be new and UL listed.
- (iv) Enclosure shall contain:
 1. Light and light switch
 2. 120 Volt GFCI receptacle

(b) Service Enclosures:

- (i) Enclosure shall have provisions for passive ventilation to maintain rated equipment and enclosure temperatures at outdoor ambient temperatures.

(c) Emergency System Enclosures:

- (i) Where the enclosure is installed in environment temperature ranging from -5F to 95F, the UPS manufacturer shall provide a temperature controlled enclosure that will maintain the UPS temperature of 77F +/- 5F throughout the range of local environmental temperatures.

14.5.3.5 Emergency Power Systems (Life Safety)

The emergency power systems shall consist of items including UPS units, accessories, panels and wiring as required providing emergency power to the following loads:

- Emergency Egress and EXIT lighting
- Fire Alarm System
- Signal Systems
- Communication and Security Systems
- Local Life Safety Code and AHJ Required Loads

14.5.3.6 Uninterruptible Power Supplies (UPS)

UPS units shall be installed in a 2-hour rated enclosure or room as required by the MEC. Provision shall be made for the required monitoring, control and alarm functions to the SCADA system.

UPS shall be sized to supply the above life safety loads for a period of 90 minutes at full load.

14.5.3.7 Grounding

- Grounding of equipment and systems shall be in strict accordance with the requirements of the MEC.
- A grounding electrode system shall be provided at each building and station. The connection to earth shall be designed so that the system resistance measured shall not exceed 2 ohms.
- Building steel structures shall be grounded at each column base and jumpers provided for, if required, maintaining ground continuity throughout.
- The grounding lugs of exterior lighting poles, bases, and luminaires shall be connected to the system and local grounding conductors.

14.5.3.8 Lightning Protection

A Master Labeled lightning protection system shall be provided for the VMF.

14.5.3.9 Lighting Systems

- The lighting systems, including life safety lighting, shall be fully designed to meet MBTA's and Code requirements.
- The lighting systems shall be designed to be in conformance to IECC power limits.
- The lighting equipment and controls shall be provided to conform to MBTA and IECC requirements.

14.5.3.10 Cable and Containment Systems

- Branch circuits conductors shall be stranded copper with minimum AWG No.12.
- Conduits smaller than 3/4-inch diameter shall not be used.
- Steel conduit and accessories specified shall be zinc coated: Hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M.
- Conduits penetrating exterior walls below grade, at grade floors, or below grade floors shall be sealed to prevent moisture migration.

14.5.3.11 Power Systems and Studies

The following studies shall be performed using data from equipment and cables to be installed.

- (a) Short Circuit Study and Arc Flash Study
 - (i) Arc flash warning signs shall be provided as determined by the study.
- (b) Protective Device Coordination Study.
- (c) A manual transfer switch shall be provided on the supply side of the UPS to allow connection of an MBTA portable generator. Provide a connecting receptacle at a location approved by MBTA. Coordinate the configuration with MBTA.

14.5.3.12 Lechmere Station Emergency Generator

- (a) An outdoor emergency natural gas generator shall be provided for the station.
- (b) Unit shall be located outdoor within weatherproof and acoustic enclosure.
- (c) Unit shall be automatically started and pick up all station loads as a one-step pick-up.
- (d) Unit shall be stand-by rated to support the emergency load of the station plus an additional 25% spare capacity. Voltage rating as determined by station operating voltage analysis.
- (e) Exhaust piping routing and termination shall be closely coordinated with MBTA to ensure proper dispersion of exhaust fumes.

14.5.3.13 Additional Electrical Requirements

Provide the following:

- (a) Pump Stations Electrical Installation - Connect emergency natural gas generators to the pump stations (at Red Bridge and East Somerville Station) electrical system to provide emergency backup power.
- (b) Community Pathway Lighting including:
 - (i) Refer to Section 12.4 Station Lighting.

14.6 COMMUNICATION SYSTEMS

14.6.1 Scope of Work

14.6.1.1 General

The communications systems shall provide the necessary subsystems to support the total operational requirements of the Project. The following subsystems and/or functions shall be considered part of the communications system and its design; including certain requirements related to expanding the subsystems to fulfill future needs:

- Access Control Gates
- Telephone Systems and Instruments
- In-building Public Address System
- Closed Circuit Television (CCTV)
- Station Public Address System
- Variable Message Signs (VMS)
- Access Control
- Passenger/Elevator Emergency Telephone
- SCADA HMCS/PLC System
- Automatic Fare Collection (AFC) Network Conduit and Cable Infrastructure

14.6.1.2 Access Control Gates

DB Entity shall provide access control on all gates to MBTA corridor as part of the Work.

14.6.1.3 Telephone Systems and Instruments

The DB Entity shall provide telephone systems and instruments across the new MBTA stations and buildings including communications equipment, hardware, and ancillary devices required.

14.6.1.4 In-Building Public Address System

The DB Entity shall provide a system for amplifying sound signals from sources such as microphones and telephones and distributing and reproducing them on speakers at the vehicle and transportation building locations.

14.6.1.5 Closed Circuit Television (CCTV)

The DB Entity shall provide an expanded MBTA Closed Circuit Television (CCTV) System at Stations and Yards. The MBTA CCTV system is a real time IP video system utilizing IP based cameras for transmission over the MBTA's IP network. The video is viewed throughout the MBTA system using the Genetec Physical Security Integration Management (PSIM) software client.

14.6.1.6 Station Public Address System

The DB Entity shall provide a complete and operational public address system, that shall integrate with the Variable Message Signs (VMS) in stations.

14.6.1.7 Variable Message Signs (VMS)

The DB Entity shall provide all equipment necessary to form a complete and operational Variable Message Sign system (VMS) at the stations. VMS system shall display information via Light Emitting Diode (LED) scrolling signs located on station platform and other areas.

14.6.1.8 Access Control

The DB Entity shall provide security hardware devices, mounting brackets, power supplies, switches, controls, consoles, and other components of the system as specified, and as required to complete a fully functional Electronic Access Control System (EACS).

The DB Entity shall provide a fully functional IP PoE Call Boxes, IP Gateways, and IP Desktop Master Stations that shall be fully integrated into the Genetec System for camera call-up on the screen of the Genetec Client of the operator answering the phone. The MBTA currently has a Stentofon system and Alphacom server with spare capacity that is integrated into the Lenel and Genetec systems. The DB Entity shall add to the existing system and configure the newly added IP PoE Call Boxes existing IP Gateway, and existing Genetec rules engine to facilitate the automatic camera call up of local CCTV Cameras on answering of the incoming call.

14.6.1.9 Passenger/Elevator Emergency Telephone

The DB Entity shall provide a station Passenger and elevator assistance system. Equipment shall be compatible with the existing passenger assistance systems installed within the MBTA and integrated with the CCTV system.

14.6.1.10 SCADA HMCS/PLC System

The DB Entity shall provide a Communication Programmable Logic Controller (CPLC) for control and monitoring of the Customer Service Agent fare array control panel, pump control systems, fire and security alarms, and miscellaneous items at specified locations. The Work includes development of an automatic monitoring and control system for a complete and fully operable system compatible with the MBTA existing Hub Monitoring and Control System (HMCS).

14.6.1.11 Automatic Fare Collection (AFC) Network Conduit and Cable Infrastructure

The DB Entity shall provide network infrastructure to support the MBTA Fare Vending Machines (FVM) at all station and building locations. The FVM system is described in [Section 12.3](#).

14.6.2 General

Within each communications subsystem, like functions shall be performed by identical units. In no case shall the apparatus or hardware used in one portion of a segment's subsystem be different from that used in another portion to perform the same function under similar operation and environmental conditions.

Modular design shall be employed. Electrical and mechanical components shall be organized in cabinet-mounted plug-in assemblies. The mixing of equipment associated with two subsystems in one plug-in assembly shall not be permitted. Apparatus serving similar functions shall be in the same relative location in all cabinets, wherever practicable.

All communications equipment located in the passenger stations, wayside, Operations Control Center (OCC) and the Yards and Shops shall be powered from un-interruptible power sources or DC back-up battery systems.

All communications equipment shall be clearly stenciled such that the nomenclature is visible from the front with the normal operating covers on the devices.

Ground electrical equipment enclosures in accordance with NFPA 70 requirements.

Cabinets and racks shall be electrically insulated from floor, mounting channels, cabinets, racks, cable trays and the building structures. Each cabinet shall be provided with a ground terminal and connected to a common ground system. Interdependent cabinets and racks may be mechanically and electrically connected to facilitate interconnect wiring.

All communication conduit bends shall be gradual sweeps (factory sweeps) and shall not exceed 180 degrees of bend, for the entire length of the cable run.

Exposed cable trays shall include protective metal covers. Use of exposed trays shall be minimized.

Subsystem Devices of the same system within a station area shall be grouped and routed to an Area-Junction Box. From this Area-Junction Box, all wires of that subsystem shall share an adequately sized common conduit, for wire routing to the designated Communications equipment.

Public Address Conduits generally consist of the following:

- Embedded conduit from the communications room to the speaker zone with interruptions at speaker backboxes or junction boxes.
- An embedded return conduit from the last speaker in a "string" to the communications room.
- Conduits in ancillary areas may be surface mount.
- No other circuits may be shared in a public address conduit.
- All PA conduits shall originate and terminate in the communications room. Minimum size is one inch (1").

CCTV Conduits shall consist of two conduits in parallel, both serving each camera location. All conduits shall be minimum one inch (1"). Conduits shall be routed directly from the junction boxes to the communications room. No other circuits may be shared in a CCTV conduit.

Telephone plant equipment shall be powered from industry-standard negative 48V DC rectifier charges, float battery systems. Public Address, CCTV, and other non-telephone plant shall be powered from Un-Interruptible Power Supplies (UPS).

All communications equipment shall be capable of start-up following a power outage without re-initialization and with full status memory and process recall, with power from battery or from inverter sources.

14.6.3 Codes, Standards and Manuals include:

- American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications
- Americans with Disabilities Act (ADA) Standards including Accessibility Guidelines for Outdoor Developed Areas (36 CFR Part 1195)
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering
- American National Standards Institute (ANSI) Standards
- American Society for Testing and Materials (ASTM) Standards
- BICSI Telecommunications Distribution Methods Manual
- Electronic/Telecommunications Industries Association (EIA/TIA) Standards
- Federal Railroad Association (FRA) Code of Federal Regulations Part 49 (CFR 49)
- Institute of Electrical and Electronic Engineers (IEEE) Standards including C2, C62, 383, 1473, 1477, 1613, 802.X
- Insulated Cable Engineers Association (ICEA) Standards
- Massachusetts Building Code 780 CMR
- Massachusetts Electrical Code (MEC) 527 MR 12.00
- National Television Standards Committee (NTSC) Standards
- National Electrical Manufacturers Association (NEMA) Standards
- National Electrical Contractors Association, Standards of Installation (NECA) Standards
- National Fire Protection Association (NFPA) Standards including NFPA 70, NFPA 72, NFPA 75, NFPA 101
- National Electric Code (NEC) Standards
- Underwriters Laboratories, Inc. (UL) Standards

14.6.4 The Project Specific Requirements

The DB Entity shall coordinate and integrate between all new and existing communications systems.

14.6.4.1 Access Control Gates

a) Existing

The existing MBTA gates are coordinated with the Facility architecture designs and are consistent with existing MBTA Maintenance Facility features and functions. The existing systems are interfaced with existing MBTA head end systems.

The existing Emergency Egress Gates include the following:

- Electric panic hardware (secured side with integrated request-to-exit (REX) switch)
- Gate position switch and armored cable
- Security plate to shroud panic hardware
- Weather resistant junction box with card reader
- Armored cable from junction box to panic hardware
- Conduit on fence and routed to designated access controller
- Chain link fence with 1"X9 gauge mesh at gate and fencing (typical)
- Camera
- VoIP intercom

Existing Vertical Perimeter facility lift gates include the following:

- Chain link fence with 1"X9 gauge mesh at gate and fencing (typical)
- Provide 3-strand barbed wire at top of gate and fencing (typical)
- Provide signal light with LED display integrated into the gate control system for proper sequencing of display. Two aspects shall be displayed.
 - Red: Gate closing, gate opening until clearance point is reached
 - Yellow: Gate fully open to meet clearance requirements
- Vehicle detection loops connected to the gate controller
- Passenger intercom for communication to designated workstation master intercom
- Photo eye safety beam sensors
- Bollards to protect gate controller and intercom
- VoIP Intercom
- Camera

The existing access control portion of the access control & intrusion detection (AC & ID) system is used to control the movement of persons through site areas, facilities, secure areas, buildings, and vehicle parking facilities. The existing requirements of the access control portion of the system, at a minimum, are the following:

- (a) Access to any area in which equipment and/or other items are stored, for which the replacement cost is estimated to exceed \$10,000.00 shall be controlled by card reader.
- (b) Access to any area which is designated as "restricted" by the MBTA is controlled by card reader.
- (c) All card readers which are located "outdoors" i.e., perimeter card readers, parking lot card readers, etc. and any other card reader designated as "intercom required" by the MBTA is equipped with an intercommunication device, which establishes bi-directional communication between these card readers and the remote and local operations control rooms. Card Readers include protocols currently utilized by MBTA's proximity cards.
- (d) All MBTA employee parking facilities are provided with an entrance gate controlled by a card reader. Use passive proximity type cards with photo identification capability, card readers, electromagnetic locks, and electric door strikes.
- (e) The Access Control System components utilized at the stations and facilities interface with and be controlled by the existing MBTA Lenel OnGuard system. The Access Control System utilizes the MBTA Security Ethernet SWAN for communications.

All Lenel controllers, door access equipment, and card readers are Lenel compatible and installed by qualified and certified Lenel technicians.

b) New

The design of the access control gates shall be coordinated with the Facility architecture design, shall be consistent with existing MBTA maintenance facility features and functions and shall be interfaced with existing MBTA head end systems.

Emergency Egress Gates shall include the following:

- Electric panic hardware (secured side with integrated request-to-exit (REX) switch)
- Gate position switch and armored cable
- Security plate to shroud panic hardware
- Weather resistant junction box with card reader
- Armored cable from junction box to panic hardware
- Conduit on fence and routed to designated access controller
- Chain link fence with 1"X9 gauge mesh at gate and fencing (typical)
- Camera
- VoIP intercom

Vertical perimeter facility lift gates shall include the following:

- Chain link fence with 1"X9 gauge mesh at gate and fencing (typical)
- Provide 3-strand barbed wire at top of gate and fencing (typical)
- Provide signal light with LED display integrated into the gate control system for proper sequencing of display. Two aspects shall be displayed.

- Red: Gate closing, gate opening until clearance point is reached
- Yellow: Gate fully open to meet clearance requirements
- Vehicle detection loops connected to the gate controller
- Passenger intercom for communication to designated workstation master intercom
- Photo eye safety beam sensors
- Bollards to protect gate controller and intercom
- VoIP Intercom
- Camera

Experienced fencing installation professionals shall install anti-climb fencing. Elevation of fencing shall conform to the existing ground surface; however, the top line of the fence shall consist of a series of level or uniformly sloping segments of the greatest practical length between points of changing ground slope.

TyMetal gates required for compatibility with access control and model to be like existing MBTA installed gates.

Integrate gate control with Electronic Access control system(EACS). Integrate with the MBTA's existing Electronic Access Control System (EACS)- Lenel, Genetec, and Stentofon systems per spec 16702.

Gates shall continue to operate from generator power or backup source should main power be disrupted.

14.6.4.2 Telephone Systems and Instruments

a) Existing

The existing Passenger Assistance/Information Telephone (PAT) is provided at all existing Green Line stations. The equipment is VoIP and compatible with the existing Passenger Assistance Supervisory Server System located 45 High Street and with the Authority's Customer Call Center located at 10 Park Plaza and all hub locations. Separate call buttons indicate "Emergency 911" and "Customer Information". The audio path between the various stations, the Police Station, and the Customer Call Center is over the SWAN.

The Existing Passenger Emergency Intercom Servers are used and already in place in the MBTA OCC headend and network.

The existing PAT shall provide priority point-to-point telephone service from all station fare collection areas, platforms, and Customer service areas and any other designated public location to the CCTV observers at the OCC and hub locations.

This existing MBTA telephone systems consist of two separate and distinct elements: 1) the Public Switched Network (Verizon Centrex) and 2) the MBTA Voice over IP (VoIP) circuits.

All existing telephone and data cables terminate in the Station Communications Room or Verizon Demarcation rooms on industry standard communications blocks. CAT-6 cable are used to connect each Telephone port to a standard TIA/EIA punch down block cross connect. CAT-6 cable are used to connect

each RJ-45 Ethernet port to a standard Ethernet termination and distribution panel before being connected to the Station Ethernet switch with CAT-6 jumpers.

Digital voice logging recorders exist at vehicle maintenance buildings which provide multiple channel recording of analog and digital Telephone Devices plus time and date data for MBTA employee emergency telephone lines.

The MBTA has an existing AVAYA telephone switch at 45 High Street and 10 Park Plaza that serves the OCC offices, 10 Park Plaza offices, and Ride personal. The AVAYA system provides the following:

- Power over Ethernet (PoE) IP telephones
- DCP digital telephones
- DCP Module that shall support 24 digital telephones
- Analog telephones and trunks
- E1/T1 trunks
- ISDN PRI trunks
- ISDN BRI trunks
- E1/T1 and USP WAN data lines
- On board ports
- USB ports

b) New

This system shall consist of two separate and distinct elements: 1) the Public Switched Network (Verizon Centrex) and 2) the MBTA Voice over IP (VoIP) circuits. Equipment shall be designed to preclude a single point failure from potentially causing loss of all telephone capability. The system design shall utilize VoIP for Customer Information and emergency kiosks and maintenance telephones to meet operational requirements. Maintenance telephones shall use Centrex.

RJ-11 Telephone and RJ-45 Ethernet data cable termination ports shall be installed and tested in each Station room, lobby and platform, and buildings. All telephone and data cable shall be terminated in the station communications room at industry standard communications blocks. CAT-6 cable shall be used to connect each Telephone port to a standard TIA/EIA punch down block cross connect. CAT-6 cable shall be used to connect each RJ-45 Ethernet port to a standard Ethernet termination and distribution panel before being connected to the Station Ethernet switch with CAT-6 jumpers. All CAT-6 cabling shall be tested to 1GBS standards. Surge protection shall be provided on all telephone lines.

Telephones shall be supplied by the DB Entity at points specified by MBTA Communications Section and shall meet MBTA requirements for use suitability (wall mount, table top, hardened, etc.) to include elevator telephones with automatic calling capability to the OCC and Transit Police.

The Avaya G450 Local Survivable Processor (LSP) or latest Avaya model compatible to the G450 gateway is a high-performance converged telephony system that shall be located in the Vehicle Maintenance and Transportation Building, providing all telephony services in one box. The G450 shall provide full support

for legacy DCP and analog telephones. The G350 shall be provided with media modules to Support:

- Power over Ethernet (PoE) IP telephones
- DCP digital telephones
- DCP Module that shall support 24 digital telephones
- Analog telephones and trunks
- E1/T1 trunks
- ISDN PRI trunks
- ISDN BRI trunks
- E1/T1 and USP WAN data lines
- On board ports
- USB ports

The G450 LSP shall be a gateway off the existing Avaya Communication Manager system currently deployed at 45 High St.

The telephone service shall include emergency, maintenance, administrative telephones, served by the MBTA private telephone system. In keeping with MBTA practice, all emergency and patron assistance telephone communications shall be recorded.

Design, furnish, and install a digital voice logging recorder system to be installed at the vehicle maintenance and transportation buildings which shall be designed to provide multiple channel recording of analog and digital Telephone Devices plus time and date data. The equipment furnished under this specification shall be designed for continuous duty operation (i.e., 24 hours per day, 365 days per year) and shall be electrically powered from the Uninterruptible Power System (UPS) which supports this location. The system shall be modular, integrate with the new and existing AVAYA telephone system, and shall accommodate possible future hardware and/or software enhancements.

Utilize an AVAYA G450 LSP or latest compatible model for Transportation and Maintenance buildings. The system shall integrate with the existing 45 High Street IP telephone system.

Provide UPS or back up power source at the building and station communication rooms, telephone service, and devices.

Design, furnish, and install conduit, cable, and telephone wall or desk devices at station locations requiring telephones for MBTA employees.

Design, furnish, and install a standalone digital voice logging system for the VoIP and analog telephones to be designed and furnished for the Maintenance and Transportation buildings.

14.6.4.3 In-Building Public Address System

- a) Existing

The existing Public Address (PA) Systems comply with NFPA 72. The PA subsystem provides effective sound-masking systems which utilizes speakers strategically placed to produce uniformly distributed audio throughout the yards and shops. The systems are defined to provide uniform audio in both tonality and sound level, at 5 feet elevation above the walking area, so that normal moving does not result in 5 dB changes in the sound level.

b) New

The PA subsystem shall comply with NFPA 72 and shall be compliant with listing requirement of the Massachusetts Fire Marshall wherever used as part of a combination fire system. The PA subsystem shall provide effective sound-masking system which utilizes loudspeakers strategically placed to produce uniformly distributed audio throughout the yards and shops. The system shall be defined to provide uniform audio in both tonality and sound level, at 5 feet elevation above the walking area, so that normal moving does not result in 5 dB changes in the sound level.

- (a) Headroom: Sufficient to allow a minimum increase in output of 12 dB, without increase in hum, noise, or total harmonic distortion.
- (b) PA subsystem shall maintain a uniformly distributed sound level at least 10 dB above ambient facility operating noise level measured at 5 ft above floor for indoor locations. The minimum sound level at any point 5 ft. or lower, above the floor sound level shall be:
 - Office areas: 70 dBA minimum
 - Work areas: 78 dBA minimum
- (c) Speakers' frequency response shall be in the range of 150 Hz to 15 KHz.
- (d) Speech Transmission Index (STI) per the NFPA 72 National Fire Alarm and Signaling Code establishes the acoustical guidelines for speech intelligibility of emergency signal system as follows:
 - i.) 90% of STI measurements shall exceed 0.45 throughout building locations where MBTA personal shall be located.

Integrate with phone for paging through phone system for Transportation Building and VMF. An AVAYA LSP requires telephone interface module.

Paging system to be UPS or backup power source fed.

14.6.4.4 Closed Circuit Television (CCTV)

a) Existing

The existing Closed Circuit Television (CCTV) system provides a means of visually monitoring and verifying reported incidents from the MBTA Operations Control Center, Hub Centers, and locations required by the MBTA security Department. The system utilizes Power Over Ethernet (PoE) Cameras strategically located to provide coverage of the public segments of the paid station areas, Bike Storage locations, and selected areas in and around the stations and platforms, elevators, and right of way. Additionally, PoE CCTV cameras provide coverage of the maintenance facility and all controlled access areas including the perimeter of the facility and the storage tracks. The CCTV system utilizes camera types and all system components interface with the current CCTV Surveillance System and Management system provided by

Genetec.

- a) The MBTA Video Surveillance System (VSS) is comprised of the following primary components:
 - (a)Cameras and Video Servers: Provide surveillance views and distribute digital video streams onto the station LAN and security wide area network. (SWAN).
 - (b)Genetec Software
 - (c)All management and storage servers and head end equipment is located at 45 High St. and 10 Park Plaza.
 - (d)Enterprise Monitoring Application: Genetec provides PSIMs functionality, and is the overall user system interface for all security systems.
 - (e)Hub Monitoring Centers: Genetec monitoring applications allow operators to view multiple cameras from anywhere in the system.

MBTA's central Video Surveillance System monitoring entity is the Genetec system, which supports access to live and recorded video streams from cameras, encoders, Digital Video Recorders (DVR) and Network Video Recorders (NVR) connected to the system.

b) New

The Closed Circuit Television (CCTV) system shall be designed and provided as a means of visually monitoring and verifying reported incidents from the MBTA Operations Control Center, Hub Centers, and locations required by the MBTA security Department. Power Over Ethernet (PoE) Cameras shall be located to provide coverage of the public segments of the paid station areas, Bike Storage locations, and selected areas in and around the stations. Additionally, PoE CCTV cameras shall be provided to allow coverage of the maintenance facility and all controlled access areas including the perimeter of the facility and the storage tracks. The CCTV system design shall utilize camera types and all system components which shall interface with the current CCTV Surveillance System and Management system provided by Genetec. The DB Entity shall integrate all CCTV cameras into the NVR and GENETEC. This integration requires the addition of all new devices to the GENETEC maps. The DB Entity is responsible for all licenses associated with the CCTV hardware and system integration. Sharing of video to partner communities shall be accomplished using the Massachusetts video sharing initiative. Camera locations and views design shall be guided by the Secure Stations initiative and by MBTA Security section personnel. Camera locations shall include:

- All access controlled doors
- Fare vending machine locations
- Interior of the Fare Controller location showing the Controller
- Customer Emergency Telephones and Information Telephone kiosks
- Elevator doors and interiors
- Stairs facing the direction of passenger flows
- Platforms including platform ends
- All pedestrian track crossings

- Bike storage and cage areas
- Other locations indicated by Industry Best Practices and MBTA Security and Operations

Storage servers at the MBTA control center (45 High Street) shall be furnished and designed for the cameras to be installed. The storage requirements shall be designed for but not be limited to the following:

- Live streams from the CCTV Cameras shall be streamed at 15 FPS, minimum 720p
- Recording streams shall be streamed at 8 FPS, minimum 720p.
- Storage for 30 days at 8FPS, for all cameras.
- Equipment shall be Network Video Recorder (NVR's) pivot 3 server running Genetec's latest released software.

The CCTV system should be designed for every day safety and security requirements as well as revenue protection, anti-crime and anti-terrorist applications requiring the identification of unknown people and objects depicted within images.

Stations shall generally function unattended. The CCTV subsystem shall provide visual surveillance of designated passenger platform areas, and intersections near platforms, elevators and escalators, and Passenger Emergency Intercoms to aid in safety, security control and assistance to patrons. The subsystem shall provide monitoring capability of all cameras at the OCC and Hub Monitoring Locations. The CCTV subsystem shall provide video recording of all cameras in the System.

Cameras shall be installed to permit monitoring of the cross passages, pedestrian bridges, station areas open to the public, and other appropriate areas on the Right of Way such as interlockings, signal houses, and substations. This excludes the Community Path.

Manual adjustable mounts shall be provided for each camera. Positive position locking shall be provided. Cameras shall be located unobtrusively and at as high an elevation as possible to maximize field of view and reduce vandal access, but low enough to access using an eight-foot ladder. If cameras are located higher than this, fall protection shall be installed per OSHA guidelines.

All PoE CCTV cameras, NVRs, and video encoders installed under this contract shall be integrated and fully functional with the Genetec software. NVR, CCTV, and ancillary equipment shall integrate with Genetec. All Licenses to be included in the installation and activation of any devices to the existing headend by the DB Entity.

The NVR software shall be installed on Pivot3 CCTV Video Server Clusters and shall record all images from CCTV Cameras and CCTV Encoders to the CCTV Video Server Clusters, and it shall connect viewing clients to live or recorded streams. Pivot 3 NVR shall be used for proper integration of the system.

The CCTV system shall utilize the MBTA Security WAN (SWAN) as a means of transmitting IP video to various locations on the WAN and MBTA network for viewing and recording. The system expansion shall incorporate IP fixed cameras, Network Video Recorders (NVRs), the Genetec software, network switches, codecs, and any other hardware or software required to transmit/receive video over an IP network for a complete and functional system.

An IP camera in elevator cab shall utilize IP converters for the Coaxial cable provided by the elevator manufacturer within the elevator travel cables.

Comm. room equipment to be UPS or include battery backup.

14.6.4.5 Station Public Address System

a) Existing

The existing station Public Address Systems are fully integrated, interfaced and work with the Rockwell Collins (Formerly ARINC) PA/VMS Head End hardware and software system installed at the Operations Control Center (OCC), including all local station maintenance and diagnostic functions, both local and remote monitoring. The maintenance functions include but are not limited to: remote monitoring and configuration of public address Digital Signal Processor (DSP), Public Address power amplifiers, preamplifiers, Station Control Units (SCU), and Electronic Signs.

The Station Public Address systems utilize local SCU's configured with AIM PA/VMS software to manage and control all station functions and hardware including microphone paging stations and associated queuing, distribution of emergency announcements, local announcements, OCC announcements, recorded announcements, pre-recorded and assembled messages, and visual display paging.

Separate zones with separate amplifying systems and speaker systems are configured to allow individual or in combination announcements. Passenger station typically have three zones covering; platform inbound, platform outbound, and mezzanine areas.

Automatic gain adjustment of the PA subsystem provides automatic level adjustments based upon ambient noise levels. The controller provides a graduated increase in power output in proportion to the increase in noise level from a preset quiet level. Noise sensing devices for each controlled area are mounted in separate enclosures at each end of the platforms.

Local Microphones are installed on platforms and in mezzanines. Provision are made to reduce output level of speakers in close proximity of local microphones to prevent acoustic feedback.

b) New

The Public Address System shall fully integrate, interface and work with the Rockwell Collins (Formerly ARINC) PA/VMS Head End hardware and software system installed at the Operations Control Center (OCC), including all local station maintenance and diagnostic functions, both local and remote monitoring. The maintenance functions shall include but not be limited to: remote monitoring and configuration of public address Digital Signal Processor (DSP), Public Address power amplifiers, preamplifiers, Station Control Units (SCU), and Electronic Signs.

The Station Public Address System shall be a fully integrated system. The system shall use a local SCU configured with AIM PA/VMS software to manage and control all station functions and hardware including microphone paging stations and associated queuing, distribution of emergency announcements, local announcements, OCC announcements, recorded announcements, pre-recorded and assembled messages, and visual display paging.

Separate zones with separate amplifying systems and speaker systems shall be accessible individually or in combination. Passenger station typically have three zones covering; platform inbound, platform outbound, and mezzanine areas.

Automatic gain adjustment of the PA subsystem shall be provided based upon ambient noise levels. The controller shall provide a graduated increase in power output in proportion to the increase in noise level from a preset quiet level. Noise sensing devices for each controlled area shall be mounted in separate enclosures at each end of the platforms.

Local Microphones shall be installed on platforms and in mezzanines. Provision shall be made to reduce output level of speakers in close proximity of local microphones to prevent acoustic feedback.

The PA subsystem shall comply with NFPA 72 and shall be compliant with listing requirement of the Massachusetts Fire Marshall wherever used as part of a combination fire system. The PA subsystem shall utilize loudspeakers strategically placed to produce uniformly distributed audio throughout the passenger stations. Uniform audio in both tonality and sound level, at 5 feet elevation above the walking area, so that normal moving does not result in 5 dB changes in the sound level.

- (a) Headroom: Sufficient to allow a minimum increase in output of 12 dB, without increase in hum, noise, or total harmonic distortion.
- (b) PA subsystem shall maintain a uniformly distributed sound level at least 10 dB above ambient station operating noise level measured at 5 ft above floor for indoor stations. Outdoor stations shall be not less than 60 dB a plus or minus 30 degrees off Axis, 4 feet above the floor, at vehicle ambient noise level. The minimum sound level at any point 5 ft. or lower, above the floor sound level shall be:
 - Mezzanine: 70 dBA minimum
 - Platform: 78 dBA minimum
- (c) Speakers' frequency response shall be in the range of 150 Hz to 15 KHz.

Speech Transmission Index (STI) per the NFPA 72: 2016 National Fire Alarm and Signaling Code establishes the acoustical guidelines for speech intelligibility of emergency signal system as follows:

- 90% of STI measurements shall exceed 0.45 within the station areas where passengers and employees shall be located.

ARINC headend PA/VMS system with AIM[®] software installed at 45 High Street. The station SCU, DSP, and LED signs shall be compatible with ARINC software and PA/VMS headend.

Comply with Speech Transmission Index (STI) per the NFPA 72 and sound pressure readings for speaker placement.

Install ambient microphones on platforms.

Design, furnish, and install local microphones for MBTA employees at mezzanine and platform locations.

14.6.4.6 Variable Message Signs (VMS)

a) Existing

The existing VMS is controlled from the head end and station SCU Public Address (PA) Control Systems utilizing the MBTA WAN backbone from the existing AIM[®] PA\VMS system installed by ARINC at 45 High St. and at the SCU station communication rooms. The VMS displays text corresponding to PA announcements, and is synchronized with the PA audio announcement.

The Sign locations on the platforms and mezzanine ensure ADA compliance.

Power for VMS system equipment located in the communications room is provided from an uninterruptible communications AC power distribution system.

VMS shall be controlled from the head end and station SCU Public Address (PA) Control System utilizing the MBTA WAN backbone from the existing AIM[®] PA\VMS system installed by ARINC at 45 High St. VMS shall display text corresponding to PA announcements, and shall be synchronized with the PA audio announcement.

b) New

The DB Entity is responsible for turnkey design and installation at each passenger station. This shall include integration into the AIM[®] PA/VMS System located at 45 High St. Existing LED signs are Daktronics. New signs shall be compatible.

Sign locations shall be on platforms and mezzanine to ensure ADA compliance with table 703.5.5 Visual character Height listed within the ADA guidelines and within specification 16742.

Power for VMS system equipment located in the communications room shall be from the uninterruptible communications AC power distribution system.

All signs shall be installed at a height accessible with an eight-foot ladder. If this is not practical, then fall protection shall be designed and provided per OSHA guidelines.

The PA/VMS software shall generate arrival messages as existing on MBTA property. Signs to operate with SCU and PA/VMS headend at 45 High St. LED signs are Daktronics. The system Shall be compatible with the existing systems.

Install signs at mezzanines and platforms to ensure ADA compliance per table 703.5.5 Visual character Height listed within the ADA guidelines.

Provide AC power from the communications room.

14.6.4.7 Access Control

The access control portion of the access control & intrusion detection (AC & ID) system shall be used to control the movement of persons through site areas, facilities, secure areas, buildings, and vehicle parking facilities. Requirements of the access control portion of the system, at a minimum, are the following:

- a) Access to any area in which equipment and/or other items are stored, for which the replacement cost is estimated to exceed \$10,000.00 shall be controlled by card reader. All access controlled areas shall be confirmed by MBTA Safety and Security personnel.
- b) Access to any area which is designated as "restricted" by the MBTA shall be controlled by card reader.
- c) All card readers which are located "outdoors" i.e., perimeter card readers, parking lot card readers, etc. and any other card reader designated as "intercom required" by the MBTA shall be equipped with an intercommunication device, which shall establish bi-directional communication between these card readers and the remote and local operations control rooms. Card Readers shall include protocols utilized currently utilized by MBTA's proximity cards.
- d) All MBTA employee parking facilities shall be provided with an entrance gate controlled by a card reader. Use passive proximity type cards with photo identification capability, card readers, electromagnetic locks, and electric door strikes.
- e) The CCTV System shall provide camera views of all doors which are Access Controlled.
- f) The Access Control System components utilized at the stations and facilities shall interface with and be controlled by the existing MBTA Lenel OnGuard system. The Access Control System shall utilize the MBTA Security Ethernet SWAN for communications.
- g) All Lenel controllers, door access equipment, and card readers shall be Lenel compatible and installed by qualified and certified Lenel technicians. Changes to the existing central systems to configure the field equipment shall also be performed by Lenel certified technicians. The Security Access Control system shall be connected to the Station CCTV LAN and to the Secure Stations Wide Area Network. CCTV system cameras shall monitor all doors where card access control is implemented.

The access control system components provided under this scope of work shall be compatible with the existing EACS System and shall function as an integral part thereof. The Authority's existing EACS system is a Lenel OnGuard ADV-PRO system, providing access control and credential database services. Shall be Lenel OnGuard ADV-Pro compatible.

Provide card readers and door hardware at locations identified above. SRIM, DRIM, and power to be within Comm Room with access control cables direct feed to doors. Coordinate with Architects for proper door hardware.

14.6.4.8 Passenger/Elevator Emergency Telephone

Passenger Assistance/Information Telephone (PAT) shall be provided at all stations. The equipment shall be VoIP and compatible with the existing Passenger Assistance Supervisory Server System located 45 High Street and with the MBTA's Customer Call Center located at 10 Park Plaza and all hub locations. Separate call buttons shall indicate "Emergency 911" and "Customer Information". The audio path between the various stations, the Police Station, and the Customer Call Center shall be over the SWAN.

The PAT shall provide priority point-to-point telephone service from all station fare collection areas, platforms, and Customer service areas and any other designated public location to the CCTV observers at the OCC and hub locations. Instruments/units shall be identical electrically and physically to the existing already on the MBTA property.

CCTV cameras shall be integrated to the IP units to automatically alarm and provide the view of the units activated to the OCC and Hub monitoring locations.

IP Stentofon model is required for compatibility.

The Elevator unit is analog and shall require IP gateway.

Provide LED signs above units powered from the Comm. room that blink when unit is activated.

Provide blue LED light identify customer service /plate location IP call box. Blue LED blinks when activated.

The Location of passenger assistance units shall be at mezzanine and platform locations and Customer Assistance Areas at stations. Locations shall conform to the Americans with Disabilities Act (ADA) standards.

The Passenger Assistance/Information call boxes shall be powered during Station Emergencies The telephone units shall be of a hardened design with a "Police Assistance" LED sign at the top of the call box.

Customer assistance areas designated by the MBTA for Wheelchair base plates shall contain Passenger Assistance/Information Call Boxes with illuminated LED blue lights. Refer to specification 16760 for details.

Access gates shall be provided with call boxes where applicable.

14.6.4.9 SCADA HMCS/PLC System

a) Existing

The MBTA has an existing HMCS that utilizes GE Fanuc PLC with GE HMI headend software. The existing system contains the necessary hardware and software for automatic monitoring of the fire and security alarm systems per the specification 16790 Communications Programmable Logic Controllers. The system consists of a PLC completely wired with all necessary auxiliaries, and PLC programming software. The existing PLC is fully integrated into the software and hardware elements within the existing 45 High Street servers.

b) New

The new CPLC systems shall be compatible with existing HMCS system.

The DB Entity shall design, furnish, install, and test a complete monitoring and control system, that is programmable logic controller (PLC) based, in Communication Rooms (or designated location) to monitor and control various station items. The system shall also contain the necessary hardware and software for automatic monitoring of the fire and security alarm systems, etc. The system shall consist of PLC completely wired with all necessary auxiliaries, and PLC programming software. The full integration of all software and hardware elements into the existing 45 High Street communications pre-processors shall be the sole responsibility of the DB Entity.

The Work also includes the following:

- a) Working drawings indicating the dimensions, weight, and full mounting details of all components.
- b) Furnishing terminal-to-terminal and full inter-connection drawings between components specified.
- c) Programming of PLC and program software documentation as described herein.
- d) Programming of existing human machine interface (HMI) and program software documentation as required by the performance specification described herein at 45 High Street.
- e) Integration of the HMCS PLC I/O modules for remote monitoring and control the fare gate arrays to monitor and control the AFC AC Smart Panels.

Supervision of the PLC system installation: The Manufacturer shall provide the services of a qualified technician who is competent and experienced with the work involved in the installation of the PLC systems of this type. The technician shall, at the site, supervise the PLC and fan control installation and shall be available when any of the work in connection with the PLC system installation is proceeding, to verify that the work is properly performed.

Design and furnish UPS with system.

14.6.4.10 Automatic Fare Collection (AFC) Network Conduit and Cable Infrastructure

Coordinate the installation of the cables and conduits with the AFC2.0 equipment provider.

15.1 GEOTECHNICAL REQUIREMENTS

15.1.1 Scope of Work

The Work includes the geotechnical design and construction of all permanent and temporary structures, including assessing available information, planning and implementing subsurface explorations, geotechnical analysis and reporting, geotechnical instrumentation and monitoring, and protection of existing infrastructure, structures and Utilities in accordance with the requirements.

The MBTA has performed limited subsurface exploration program in the vicinity of the Site. Exploration logs and locations from these previous subsurface explorations are provided in Exhibit 2E. In addition, samples of soil and rock cores obtained during these previous subsurface explorations are available for inspection by the DB Entity. Information from these previous subsurface explorations is provided for reference only. The DB Entity may rely on field measurements and field data contained within Exhibit 2E, but the DB Entity shall not rely on any interpretations, opinions, or conclusions contained within Exhibit 2E.

The DB Entity shall form its own interpretation of the existing geotechnical data and satisfy itself as to the nature and behavior of the ground and sub-soil, the form and nature of the Site, and nature of the Work that may affect its detailed design, construction method, and tools.

15.1.2 Codes, Standards and Manuals include:

- Massachusetts State Building Code
- AREMA Manual for Railway Engineering
- MassDOT LRFD Bridge Manual Part I and Part II
- MassDOT Engineering Directives
- Post-Tensioning Institute (PTI) Recommendations for Pre-stressed Rock and Soil Anchors
- AASHTO LRFD Bridge Design Specifications
- AASHTO LRFD Bridge Construction Specifications
- All appropriate and applicable ASTM Standards
- All appropriate and applicable FHWA Manuals and Standards

15.1.3 The Project Specific Requirements

15.1.3.1 Design Requirements

(a) Foundations

- (i) The DB Entity shall design and construct foundations for the Project in accordance with Section 15.1.3. If driven piles are used, the pile driving criteria for driven piles shall be determined using wave equation analysis and may be verified using pile driving analyzer

testing. The top of foundations, including footings and pile caps, shall be buried a minimum of 2' below ground to protect the foundations from scour.

- (ii) Geotechnical borings shall be drilled in accordance with Table 15.1-2. Borings shall extend below the deepest foundation base at least 10' and a minimum of 3 times the proposed footing width or 3 times the largest dimension of the proposed pile section, whichever is deeper.
 - (iii) The DB Entity shall submit its own calculations demonstrating that the existing foundations provide sufficient resistance to support the design loads. If existing foundations are deemed by the DB Entity to have insufficient capacity, the DB Entity shall modify or remove them at no additional cost to the MBTA.
 - (iv) The selection of representative or "characteristic" geotechnical parameters used to determine foundation capacity shall be based on the results of field and laboratory investigations and in accordance with FHWA Subsurface Investigations - Geotechnical Investigations Reference Manual and AASHTO LRFD Bridge Design Specifications.
- (b) Support of Excavation
- (i) The construction of excavation support systems shall not disturb existing structures or the completed Work. Damage to such structures shall be repaired by the DB Entity at no additional cost to the MBTA.
 - (ii) For excavation support systems left in place, the top 5' below finished grade shall be removed to allow future surface Work. As-built information shall be submitted to MBTA for review and acceptance. As-built information shall include survey locations of the temporary excavation support systems, including coordinates of the endpoints or change in direction, type of the temporary excavation support system, and elevations of top and bottom of the excavation support systems left in place.

(c) Retaining Walls, Slopes, and Embankments

Excavations and embankment design and construction shall be in accordance with the requirements of AREMA and AASHTO as applicable. Refer to [Section 8.1](#) for additional requirements, if relevant, relating to design and construction of retaining walls and slopes.

- (i) The design of retaining walls and slopes shall account for global stability, bearing capacity (where applicable), long-term settlements, and wall deformations in accordance with AASHTO LRFD Bridge Design Specifications. Stability analyses to confirm that all slopes and retaining walls have short term and long term stability sufficient to prevent failure or excessive deformation shall be carried out. Deformations of the slopes or retaining walls (including settlements and lateral movements) shall be determined using appropriate deformation analyses, with representative soil parameters derived from site specific geotechnical investigations and local experience. The estimated range of embankment and wall displacements including settlements and lateral movements shall provide for acceptable structural performance and aesthetics of the embankments and walls.

- (ii) The DB Entity shall ensure the stability of all existing slopes that are affected by the Work.
- (iii) Short and long term deformations of embankments shall not adversely affect the safety, serviceability and durability of the structures and Utilities, including the retaining wall; and any buildings, surface facilities and Utility infrastructure.
- (iv) Long term lateral displacements of the retaining walls shall not adversely affect the safety, serviceability and durability of the structures and Utilities, including the retaining wall; and any buildings, surface facilities and utility infrastructure.
- (v) Any structure components located immediately behind retaining walls, including abutment seats, abutment wingwalls, abutment deck joints, abutment bearings and barriers, shall be designed to accommodate any movements resulting from retaining wall displacements.
- (vi) Silt material specified as “ML” or “MH” material in accordance with the “Unified Soil Classification System” shall not be used in the construction of any structure slopes or approach fills, or in the construction of any embankments supporting the Corridor.

(d) Underpasses

Underpass structures shall be designed for long term earth loads and live loads, and temporary loadings due to staged construction. The Work sequence shall ensure that existing facilities are protected from excavation induced ground deformations or dewatering during construction

(e) Deformation

The DB Entity shall assess ground deformations induced by fill placements, excavations, or change in soil stress, including immediate settlement in granular soils, and both immediate and consolidation (time-dependent) settlements in cohesive soils. The maximum settlement and angular distortion of buildings within the Zone of Influence shall be limited to the category of superficial (cosmetic) damage in accordance with FHWA guidelines. The DB Entity shall perform all required Work, including design, to develop mitigation measures for any existing structures expected to exceed deformation criteria.

(f) Soil Improvement

Any soil improvement systems adopted by the DB Entity shall be in compliance with codes and standards. The DB Entity shall devise and implement pre-production field testing program to demonstrate that the proposed methods and design will provide the ground improvement level required by the DB Entity. The geotechnical design report shall include details of any soil improvement methods being utilized, purpose of the application, test program and field monitoring and verification during construction.

15.1.3.2 Software Requirements

DB Entity shall use a computer program compatible with gINT (version 8 or higher) to develop and maintain an electronic database of subsurface information, including test boring, test pit and probe logs. Subsurface information shall include field and laboratory testing.

Where used, DB Entity shall use fully documented and validated geotechnical engineering software suitable to the design of the Project. The DB Entity shall ensure the most current version of the software is used. When in-house programs or spreadsheets are used, sample output shall be validated and submitted to MBTA.

15.1.3.3 Equipment Requirements

All field and laboratory equipment shall be calibrated as required by the manufacturer.

Standard Penetration Test (SPT) hammers shall be tested for energy efficiency within 12 months prior to use on the Project, and with the energy efficiency ratio reported in the boring logs and boring records. SPT hammers shall consist of fully automatic hammers or the cat-head and rope type. Hand-operated winch driven systems shall not be used.

Laboratories used to analyze and test soil and rock specimens shall be AASHTO-certified for the tests performed and shall have documentation of calibration within the last year for all equipment used for testing.

15.1.3.4 Personnel Requirements

(a) Lead Geotechnical Engineer

The DB Entity shall provide a Lead Geotechnical Engineer who shall be a Professional Engineer licensed in the Commonwealth of Massachusetts. The Lead Geotechnical Engineer shall be in charge of all geotechnical Work, and shall perform or directly oversee all geotechnical Work, and shall sign or co-sign and stamp all geotechnical related design, analysis, reports, released for construction documents, As-Built Plans and other related documents. The Lead Geotechnical Engineer shall have a minimum of 15 years of recent geotechnical experience with explorations, analyses, design, and construction including the following:

- (i) Design and construction of foundations and retaining walls for rail and highway bridge structures of similar magnitude and type that will be used for the Project;
- (ii) Planning and conducting subsurface exploration for railway and roadway structures and facilities including site characterization and development of design soil/rock profiles with relevant properties for geotechnical analysis, design, and construction;
- (iii) Geotechnical design based on LRFD methodology and requirements;
- (iv) Design of foundations and retaining walls for static and dynamic loading;
- (v) Soil-foundation-structure interaction analysis;
- (vi) Design and construction of temporary support of excavation;

(b) Geotechnical Instrumentation Engineer

The DB Entity shall provide a designated geotechnical instrumentation engineer. The geotechnical instrumentation engineer shall be a licensed Professional Engineer in the Commonwealth of

Massachusetts, who has a minimum of a Bachelor of Science degree in civil engineering, and who has at least five years of direct field experience in installation and monitoring of the types of instruments as required.

15.1.3.5 Pre-Construction Condition Survey

A pre-construction condition survey shall be conducted in accordance with the Section 6.

Such surveys shall be carried out for all building structures, bridges, roads, and any other significant surface facilities within the Zone of Influence.

The Zone of Influence shall be determined by the DB Entity for each construction activity to be performed and shall consider the type and proximity of structures within the Zone of Influence. The “Zone of Influence” is defined as:

- (i) Excavations and retaining walls: Extent at which the ground deformations are negligible, and not less than a 1:1 slope from the base of the excavation.
- (ii) Vibrations: Within 140’ of any vibration-producing activity.

Pre-construction condition surveys shall document conditions and determine the nature (i.e., fragile, historic, sensitive, etc.) of all structures within the Zone of Influence in accordance with applicable Laws, Industry Standards, and Project Standards prior to any construction activity. The pre-constructed condition surveys shall each consist of, at a minimum, notes, digital photographs and digital video sufficient to accurately document the preconstruction condition of each structure. All defects shall be noted and recorded.

A pre-construction condition survey report, comprising all pre-constructed survey, along with a log describing the address, date, and viewing orientation of each photo and video segment shall be submitted to MBTA prior to disturbing any area within the Zone of Influence.

15.1.3.6 Geotechnical Instrumentation and Monitoring

Prepare an instrumentation monitoring plan to monitor vibration, accelerations, vertical settlement, and lateral movement of temporary support structures and adjacent ground, and existing structures and infrastructure during construction. The DB Entity shall implement the instrumentation monitoring plan.

- (a) The design and distribution of instrumentation within the DB Entity’s construction monitoring plan shall demonstrate its understanding of the need, purpose and application of each proposed instrumentation type. The DB Entity shall provide, install and maintain the instrumentation and monitor the measurements before, during and after construction up to Contract Final Acceptance.
- (b) The monitoring plan shall consider and include existing structures within the Zone of Influence of DB Entity’s construction activities.
- (c) The Instrumentation and Monitoring Plan shall include Threshold Values and Limiting Values to protect the Work and adjacent property. The “Threshold Value” is defined as level at which corrective measures are required, including procedural modifications that will allow

construction to continue without reaching the specified Limiting Value. Limiting Value is defined as the level at which no further settlement or distortion of the facility being monitored is permitted.

(d) Instrumentation shall include:

- (i) Observation wells and vibrating wire piezometers: Piezometers shall have a range of 50 psi, an over-range rating of twice the rated pressure, $\pm 0.2\%$ full scale accuracy, and 0.025% full scale resolution. Formal baseline readings shall be recorded at least 21 days prior to the start of any construction.
- (ii) Deformation monitoring points (DMPs): shall be used to monitor vertical and/or horizontal deformation of various facilities and ground. DMPs may be read using optical survey methods. Reading accuracy shall be $\pm 0.01'$ and $\pm 0.03'$ for vertical and horizontal readings, respectively. Formal baseline readings shall be recorded at least 21 days prior to any construction, including excavation support wall installation operations.
- (iii) Utility Monitoring Points (UMPs): shall comprise a pipe riser centralized monitoring bar installed at the centerline of the Utility to be monitored. Formal baseline readings shall be recorded at least twenty one (21) days prior to any construction, including excavation support wall installation operations.
- (iv) Tiltmeters: Tiltmeters shall be biaxial. Formal baseline readings shall be recorded at least 21 days prior to any construction including excavation support wall installation operations.
- (v) Inclinerometers in soil and Inclinerometer Probe Extensometers: inclinometers shall have a resolution of 0.0001' per 2', accuracy within 0.025' per 100', and range within 35 degrees from vertical. Extensometers shall have an accuracy of $\pm 0.01'$. Formal baseline readings shall be recorded at least 21 days prior to installation of foundation and/or excavation support wall. Inclinerometers in controlled density fill shall be installed after controlled density filling is complete.
- (vi) Seismographs: Seismographs shall have a range of 0.01" to 8" per second with an accuracy of 5% and no more than a 3 db roll off at the low frequency end, flat frequency response: 2 to 200 Hertz, shall be a three component sensor, and have a fourth channel for air blast monitoring. Formal baseline readings shall be recorded a minimum of seven Days prior to the commencement of any vibration-producing construction activity within 300' of the seismograph location.
- (vii) Vibrating wire strain gages: shall have end blocks arranged for arc welding or bolting to steel, with a minimum center-to-center spacing of 3.6", and shall be fitted with a thermistor. Strain gages shall be installed a minimum of five Days before a gaged strut or brace is used in the excavation support system.

(e) Monitoring Frequency shall be performed in accordance with Table 15.1-1:

Table 15.1-1 – Minimum Requirements for Monitoring Frequency

INSTRUMENT	SCHEDULE
All instruments	(1) Minimum of three readings prior to formal baseline reading with additional readings as necessary to verify that changes resulting from the installation process have ceased. (2) Formal baseline reading. (3) Weekly until any construction of the associated facility. (4) One reading immediately prior to start of construction of the associated facility. Thereafter, the reading frequency shall follow the schedule given below.
Observation Wells and Piezometers	Daily during dewatering or excavation within 200' of observation well location. Weekly after dewatering has stopped or excavation is backfilled, until equilibrium is reached.
Deformation Monitoring Points	One daily reading or every five vertical feet of excavation within 200 horizontal feet of the DMP location until excavation has been backfilled or permanently braced by the completed structure. Thereafter, monthly until completion of contract. Readings shall be taken daily if threshold values are exceeded and until the readings have stabilized to the satisfaction of the MBTA.
Utility Monitoring Points	Same Reading Schedule as Deformation Monitoring Points
Tiltmeters and Convergence Gages	Twice a day during construction activity within 200' of the building limits. Weekly when construction is completed. Thereafter, monthly until end of project.
Inclinometers/Extensometers	Twice a day or one reading every five vertical feet of excavation within 200 horizontal feet of the inclinometer location until excavation has been backfilled or permanently braced by the completed structure. Thereafter, monthly until completion of contract. Readings shall be taken daily if threshold values are exceeded and until the readings have stabilized to the satisfaction of the Geotechnical Instrumentation Engineer.
Seismographs	Continuously with a strip chart recording during vibration-producing construction activities within 300' of seismograph location.
Vibrating Wire Strain Gages	Daily from brace installation until brace removal.

- (f) The DB Entity shall protect all instruments and appurtenant fixtures, leads, connections, and other components of instrumentation systems from damage due to construction operations, weather, traffic, and vandalism. If an instrument is damaged, including an existing instrument installed by others, the DB Entity's instrumentation personnel shall repair or replace the damaged instrument at no additional cost to the MBTA.
- (g) The DB Entity shall collect the monitoring data and shall be recorded in U.S. Customary Units, for example feet, inches, pounds.
- (h) In addition, the DB Entity's Instrumentation and Monitoring Plan shall address the following:
- (i) Construction Vibrations – DB Entity shall monitor vibrations at locations where impact vibrations (e.g., due to pile driving) or large machinery vibrations (e.g., due to movement, compaction) may affect adjacent structures. Vibration monitoring and control

requirements for facilities within the Zone of Influence shall include ground and air-blast vibration threshold and limiting criteria. Include specifications for threshold and limiting vibration criteria and the location of seismograph placement. Address how the DB Entity intends to complete vibration-related activities and provide recommendations for vibration limiting construction methods.

- (ii) Deformation of Facilities – Vertical and lateral deformation of facilities within the Zone of Influence shall be monitored during active construction so that construction procedures can be controlled to prevent damage to adjacent facilities.
- (iii) Contingency Plan – Provide a contingency plan with mitigation measures to be implemented in the event that Threshold Values are exceeded.
- (iv) Communication Plan – Include a plan for communication of instrumentation results to the MBTA and for a process to communicate to the MBTA in cases of emergency.

15.1.4 Deliverables

15.1.4.1 Geotechnical Work Plan

The DB Entity shall prepare a Geotechnical Work Plan (GWP) and submit to MBTA for review and acceptance. The GWP defines the engineering and design approach that the DB Entity will follow with respect to all geotechnical Work to include specifically the plan to develop the foundations, cut and fill slopes, retaining structures, and geotechnical designs for the structures. The GWP shall define the engineering and design approach adopted to develop the necessary geotechnical information for the Project in accordance with the requirements of the Contract Documents. The GWP shall include the following:

- (a) DB Entity's knowledge and understanding of the geotechnical, geologic, hydrogeology and seismic settings of the Site and how the nature and behavior of the soil, rock, groundwater and subsurface conditions will affect the design and methods of construction;
- (b) Narrative addressing, at least, the following:
 - (i) Additional subsurface investigations including field and laboratory testing;
 - (ii) Determination of geotechnical design parameters;
 - (iii) Determination of seismic design parameters, if applicable;
 - (iv) Retaining wall analysis;
 - (v) Slope analysis and design;
 - (vi) Embankment and fill settlement and slope stability analysis; and
 - (vii) Ground improvement or treatment of in-situ soils, if applicable;

- (c) Anticipated methods of analysis and design for foundations, retaining wall and other geotechnical structures;
- (d) Foundation Verification Testing Program, which shall include the following (if applicable):
 - (i) Minimum numbers, and types of static and dynamic load tests for each foundation type, size and subsurface condition;
 - (ii) Minimum percentage and/or numbers of drilled shafts for non-destructive testing, including crosshole sonic logging and thermal integrity profiling; and
 - (iii) Minimum percentage and/or numbers of drilled shafts where shaft base/rock interface coring will be required.
- (e) The Instrumentation and Monitoring Plan and associated programs;
- (f) The Identification of key Project constraints, with description as to how geotechnical Work will proceed to meet these constraints;
- (g) A risk register identifying all major design and construction risks of the geotechnical activities, and describe how these risks are managed and mitigated;
- (h) A narrative describing the approach to quality assurance procedures during design and construction of the geotechnical Work;

15.1.4.2 Geotechnical Exploration Plan

- (a) DB Entity shall prepare a Geotechnical Exploration Plan that identifies the geotechnical exploration tasks for the Project including the following aspects:
 - (i) Exploration plan that identifies previous field explorations accomplished by others, and proposed field exploration to be performed by DB Entity including location, type and depth of field and laboratory testing;
 - (ii) Planned laboratory testing methodologies and schedule including proposed depths, sampling requirements/intervals and special testing procedures;
 - (iii) Planned method of backfilling borings, test pits, etc.; and
 - (iv) Assessment of potential impacts of explorations and construction on existing bridge foundations and Utilities and other nearby structures.
- (b) DB Entity shall submit the draft Geotechnical Exploration Plan for review and comment by MBTA no later than 90 days after issuance of NTP. DB Entity shall schedule a geotechnical exploration review meeting with MBTA within 14 days of the submittal of the draft Geotechnical Exploration Plan to present the geotechnical requirements for the Project, and

the field exploration schedule. DB Entity shall submit the final Geotechnical Exploration Plan for review and comment by MBTA prior to starting any Work.

- (c) The Geotechnical Exploration Plan shall be prepared and signed and sealed by the DB Entity's Lead Geotechnical Engineer. The Geotechnical Exploration Plan shall be integrated with the traffic control and site access plans and shall include details of boring abandonment procedures and a list of all permits required to perform the geotechnical exploration.
- (d) DB Entity shall perform all geotechnical explorations, including in-situ testing, geophysical surveys, and laboratory testing including environmental testing necessary to support the DB Entity's design. All drilling, logging, classification, field testing, and presentation of subsurface information shall be in accordance with ASTM Standards. The DB Entity shall comply with the following geotechnical explorations requirements:
 - (i) Perform soil borings in accordance with Table 15.1-2;
 - (ii) Perform test pits to determine existing footing bearing elevation and bearing stratum as necessary to support the design;
 - (iii) Collect soil and groundwater samples for laboratory testing, supplemented by field tests as required, to inform the design and construction, including testing of soil and groundwater samples for chemical properties and potential environmental contamination;
 - (iv) Perform survey of existing structures to be reused including the top of concrete elevation and horizontal location of the corners of the existing pier caps and footings, and to determine the bearing elevation of the footings;
 - (v) All geotechnical explorations shall be observed by an engineer or geologist representing the DB Entity's Lead Geotechnical Engineer. The field engineer/geologist shall be responsible for logging explorations and keeping records (provided, however, that as between the DB Entity and MBTA, DB Entity is responsible for performance of such portion of the Work); and
 - (vi) Perform vacuum excavation in areas where extensive Utilities are present prior to initiating drilling and sampling.
- (e) DB Entity shall record, maintain, and prepare the database of subsurface information using computer software compatible with gINT. DB Entity shall retain and store all soil and rock samples collected for the Work in a dry secure location provided by the DB Entity for a period of 1 year after Notice of Contract Final Acceptance.
- (f) Table 15.1-2 summarizes the minimum number of total existing and new borings required for various structures. Information from existing borings are provided in Exhibit 2E. It is the sole responsibility of the DB Entity to determine if the existing borings are suitable for use in the Project and the extent to which supplementary explorations are necessary. All boreholes shall be cased during drilling to ensure stability of boreholes. Advancement of the casing shall be

achieved using methods that will not disturb the native soil and ensure that good quality samples can be obtained for subsequent laboratory testing.

Table 15.1-2 – Minimum Requirements for Subsurface Explorations

Geotechnical Feature	Minimum Number of Total Borings
Track Subgrade	In accordance with AREMA requirements
Vehicle Maintenance Facility	Eight (within footprint)
Stations	Six per station
Viaduct piers and abutments	One (1) boring at each caisson and each abutment.
Bridge piers and abutments	In accordance with AASHTO and the MassDOT LRFD Bridge Manual
Retaining walls and Noise Barriers	Two borings at each retaining wall and noise barrier. For walls/barriers more than 200' in length, spacing between borings shall be no greater than 200'. Spacing of borings shall be adequate for design for bearing, settlement, deflections and stability
Traction Power Substations (TPSS) and other Ancillary structures	As required by applicable code.
Embankments and cutting	In accordance with FHWA NHI-01-031 Subsurface Explorations – Geotechnical Site Characterization

- (g) The DB Entity shall keep a continuous and accurate log of the materials encountered and a complete record of the operation of progressing the casing. Where driving is used, a record of the number of blows required to advance the sampling barrel, each 6" in the soil where each sample is taken, shall be kept. Records shall include the following data:
- (i) Dates and times of beginning and completion of Work;
 - (ii) Identifying number and location of exploration including coordinates;
 - (iii) Ground surface elevation at the exploration (referencing NAVD88 datum);
 - (iv) Diameter and description of casing;
 - (v) Total length of each size of casing;
 - (vi) Length of casing extending below ground surface at the completion of the boring;

- (vii) Weight, number of blows, and drop of hammer used to drive casing each successive foot;
 - (viii) Size of drill rods used for sampling;
 - (ix) Elevation of ground water table;
 - (x) Elevation of top of each different material penetrated;
 - (xi) Elevation of the bottom of sampler at start of driving for each sample;
 - (xii) Elevation to which sampler was driven;
 - (xiii) Weight and drop of hammer used to drive sampler, and number of blows required to drive it each 6" for each sample;
 - (xiv) Methods and forces used to push sampler tube when not driven;
 - (xv) Length of sample obtained relative to total sample length;
 - (xvi) Distance from the bottom of sampler to the bottom of the sample when full sample recovery has not been achieved, and any other circumstances of obtaining the sample;
 - (xvii) Stratum represented by the sample;
 - (xviii) Loss or gain of drilling water or mud;
 - (xix) For rock cores, record the core barrel type and diameter, the percent recovery, and the rock quality designation (RQD), drilling time per foot of core, and pressure applied to advance core barrel;
 - (xx) Any sudden dropping of drill rods or other abnormal behavior; and
 - (xxi) Soil classification shall be performed in accordance with the Unified Soil Classification System.
- (h) The DB Entity shall determine the coordinate location and ground surface elevation or mudline elevation for each boring and field exploration position, and shall show the coordinates, station and offset from alignment, and elevation for each individual boring log or exploration record. Coordinates and station and offset shall be referenced to the Project survey control. Elevations shall be referenced to the Project datum and horizontal control system. Boring horizontal coordinates shall be accurate to +/-1.0'; vertical coordinates shall be accurate to +/- 0.5'.

15.1.4.3 Geotechnical Data Report

DB Entity shall prepare a geotechnical data report for the Project. The geotechnical data report must include the following:

- (a) Cover page with the stamp and signature of the Lead Geotechnical Engineer registered in the Commonwealth of Massachusetts
- (b) Introduction with Project Description
- (c) Discussion of Exploration(s) including:
 - (i) Locations and results of borings;
 - (ii) Geophysical testing and other in situ testing;
 - (iii) Chloride content, acidity (PH value) and sulfate content of the surface water, ground water, and/or soil; and
 - (iv) Identify toxicity in soil and presence of other environmentally adverse contaminants.
- (d) Discussion of Results including:
 - (i) Geophysical testing and other in situ testing;
 - (ii) Observations of groundwater monitoring wells;
 - (iii) A detailed description of geological and subsurface conditions (including a description of site stratigraphy);
 - (iv) A description of groundwater conditions; and
 - (v) Results of laboratory tests
- (e) References
- (f) Limitations
- (g) Appendices
 - (i) Site Location Map
 - (ii) Exploration Location Plan (both in paper and in AutoCAD format), geotechnical profile and cross sections (with schematic representation of borings and conditions)
 - (iii) Final boring and test pit logs
 - (iv) Test results
 - Test report of energy efficiency ratio of Standard Penetration Test (SPT) hammer for each drill rig used to drill the bore holes
 - Results of geotechnical in-situ tests, geophysical tests, and laboratory tests performed
 - Digital photo logs of rock core samples with associated rock core information shown

on each digital photo

- Survey of exploration locations, existing foundations including pier cap and footing corners and bearing elevations. Indicate elevation and northing and easting coordinates for structures that are planned for reuse.
- Miscellaneous information – technical reference information, excerpts from other reports and related documents, etc.

(h) DB Entity shall submit the geotechnical data report to the MBTA for review and comment within thirty (30) days of completion of each geotechnical exploration program.

15.1.4.4 Geotechnical Design Reports

DB Entity shall prepare geotechnical design reports for the Project. The geotechnical design reports shall be signed and sealed by the Lead Geotechnical Engineer. The geotechnical design reports shall include a method statement describing the general philosophy and anticipated methods of analysis, design, construction, and construction monitoring. The geotechnical design reports shall include a discussion of the rationale for selection of the proposed construction methods for all geotechnical and foundation aspects of the Project. In the geotechnical design report, the DB Entity shall provide details of equipment and methods proposed for foundation and earthwork construction and demonstrate how they are consistent with the design approach and assumptions. The details presented shall demonstrate compliance with the requirements of the Contract Documents.

Separate design reports shall be prepared for the following:

- (a) Vehicle Maintenance Facility;
- (b) Stations (one report for each);
- (c) Retaining Walls and Noise Barriers (broken up into a minimum of eight (8) along the extension alignment);
- (d) TPSS and other Ancillary Structures (one report for each);
- (e) Bridges (one at each bridge to be reconstructed);
- (f) Viaducts (separate reports for each design section with a minimum of three (3) along the alignment);
- (g) Track Subgrade;
- (h) Utilities
- (i) Community Path; and
- (j) Lechmere Bus Loop

The DB Entity shall define the engineering and design approach followed to develop technically and environmentally acceptable and durable foundations, embankment, cut-and-fill slopes, retaining

structures, track subgrades and geotechnical designs for the Project. The geotechnical design report shall discuss all aspects of the required geotechnical effort, design and analysis, including:

- (i) Description of geology and various ground types and hydrology to be encountered within the Project Site;
- (ii) Assessment of the engineering properties of all soil and rock types, including the expected average and range of soil and rock strengths and deformation properties;
- (iii) Recommended geotechnical design parameters and loading conditions for all soil and rock types for foundation design, including parameters for lateral loading response of soils, retaining wall stability analysis, slope stability analysis, settlement analysis, and rock socket design (where applicable);
- (iv) Design approach and method of analysis to determine seismic response spectra and liquefaction assessment for design earthquakes, if applicable;
- (v) Selection of foundation systems including shallow and deep foundations and the need for ground improvement. This shall include bearing resistances of proposed foundation systems along with anticipated deformations accounting for time-related settlement and lateral deformations;
- (vi) Lateral and vertical earth pressures on structures;
- (vii) Construction impacts and the appropriate mitigations including:
 - Pile driving vibrations and noise;
 - Support of excavation;
 - Groundwater control considerations;
 - Planned field testing programs, including pile and drilled shaft integrity and load testing and ground improvement verification trials;
 - Estimates of corrosion for pile and retaining wall steel structures;
 - Impact on existing structures including buildings, Utilities, and embankments; and mitigation measures to protect these structures.
 - Other items related to soil structure interaction or Site conditions that may affect design or construction.

Geotechnical design reports shall be prepared and signed and sealed by the DB Entity's Lead Geotechnical Engineer. Where the geotechnical design and geotechnical-related as-built construction differ from the information described in the geotechnical design report, the DB Entity shall revise the geotechnical design report to reflect the as-built changes.

15.1.4.5 Geotechnical Instrumentation and Monitoring Plan

The DB Entity shall submit the Instrumentation and Monitoring Plan 120 days prior to start of construction, for review and acceptance by MBTA, and installed before construction. The DB Entity shall implement the instrumentation monitoring plan. The Instrumentation and Monitoring Plan shall include drawings showing the planned location and type of instrumentation, details of instrumentation installation and protection, an instrumentation schedule, quantities, threshold and limiting values to protect Work and property, contingency plans presenting required actions for exceedances of threshold and limiting values, and communication with MBTA.

Geotechnical Instrumentation and Monitoring plan shall be prepared and signed and sealed by the DB Entity's Lead Geotechnical Engineer and Geotechnical Instrumentation Engineer.

15.1.4.6 Pre-Construction Survey Plan

As required in [Section 6](#) – 60 Days prior to undertaking any pre-construction condition surveys.

15.1.4.7 Pre-Construction Survey Report

Prior to undertaking any construction Work.