SOUTH STATION
EXPANSION

South Station Expansion Project

Appendix 12 - Greenhouse Gas Emissions Technical Report

October 2014

massDOT
Massachusetts Department of Transportation

This Page Intentionally Left Blank

Table of Contents

List of Tables

This Page Intentionally Left Blank

1. Introduction

The Massachusetts Department of Transportation (MassDOT), the Massachusetts Bay Transportation Authority (MBTA), and the National Railroad Passenger Corporation (Amtrak) have for decades identified the expansion of rail capacity at Boston South Station as a crucial transportation need, one that has been articulated in multiple local, regional, state, and Northeast Corridor (NEC)-wide planning documents.[1] In cooperation with the Federal Railroad Administration (FRA), Amtrak, and the MBTA, MassDOT is now pursuing the expansion of South Station to support existing NEC and commuter rail services and to provide for future Amtrak and MBTA service expansions. The current track capacity, layout, and operations of South Station limit the ability to accommodate expanded services. In addition to expanding South Station terminal facilities, the South Station Expansion (SSX) project will also identify a solution to address existing and future intercity and commuter rail service layover needs. The SSX project includes planning, environmental reviews, and preliminary engineering for the five primary elements of the project:

1. **Expand the South Station terminal facilities**, including the addition of up to seven tracks and four platforms and construction of a new passenger concourse and other amenities.
2. **Acquire and demolish the U.S. Postal Service (USPS) General Mail Facility** located on Dorchester Avenue adjacent to South Station, which will provide an approximate 14-acre site on which to expand South Station. (Note that the relocation of the USPS facility will be the subject of a separate environmental review process by others.) Dorchester Avenue will be restored for public and station access.
3. **Create an extension of the Harborwalk along reopened Dorchester Avenue.**
4. **Provide for the possibility of future joint public/private development** adjacent to and over an expanded South Station.
5. **Provide adequate rail vehicle layover space** to address existing and future intercity and commuter rail service needs.

This Greenhouse Gas Emissions Technical Report has been prepared in support of the Draft Environmental Impact Report (Draft EIR) and Environmental Assessment (EA) for the SSX project, in accordance with the Certificate of the Secretary of the Office of Energy and Environmental Affairs (EEA) on the Environmental Notification Form (ENF) for the SSX project (April 19, 2013), the Massachusetts Environmental Policy Act (MEPA) regulations, 301 CMR 11.00 (revised, May 10, 2013), and FRA's Procedures for Considering Environmental Impacts, 64 Federal Register (FR) 101 (26 May 1999), pp. 28545-28556.

2. Summary of Findings

The primary project goal, which is to improve public transportation capacity and performance, will have the effect of reducing greenhouse gas (GHG) emissions. This report quantifies the potential annual GHG emissions from the project, and documents MassDOT's plans to minimize GHG emissions to the maximum extent feasible, consistent with the MEPA Greenhouse Gas Emissions Policy and Protocol (GHG Policy).

[1] Documents citing the need for an expanded South Station include: *Critical Infrastructure Needs on the Northeast Corridor* (2013)*, The Northeast Corridor Infrastructure Master Plan* (2010); *The Amtrak Vision for High-Speed Rail in the Northeast Corridor* (2010)*, A Vision for the Northeast Corridor* (2012), the Massachusetts Department of Transportation *Rail Plan* (2010), the Massachusetts Department of Transportation *Freight Plan* (2010), and the two most recent long range transportation plans of the Boston Region Metropolitan Planning Organization (2007, 2011).

Specifically, this GHG Emissions Technical Report finds:

- The stationary source GHG emissions at South Station will be reduced by approximately 8% for a Build condition incorporating Alternative 1 - Transportation Improvements Only, or by approximately 12% for a Build condition incorporating Alternative 3 – Joint/Private Development Maximum Build;
- Layover facilities will meet Building and Stretch Code requirements through prescriptive energy efficiency measures;
- The technical and economic feasibility of solar (photovoltaic and hot water) installations and of connection to the nearby Veolia district steam system will be evaluated as design progresses;
- Traffic and transit directly associated with the Project will include mitigation that will reduce GHG emissions; and
- The South Station transportation improvements have a regional GHG benefit.

This GHG analysis summarizes the results of the following separate steps:

- Building energy modeling for different build alternatives at South Station. These include Alternative 1, Transportation Improvements Only, and Alternative 3, Joint/Private Development Maximum Build. Because design and mitigation measures would be different for different components of the building, the energy modeling inputs and results are shown separately by space function (South Station Terminal expansion, hotel and multi-family high rise, and mixed-use office/retail);
- Qualitative discussion of stationary source impacts and mitigation measures for the layover facility sites;
- Quantification of GHG impacts associated with water use and wastewater discharge (energy use associated with conveyance and treatment) at the South Station site;
- Draft Tenant Manual description, providing guidelines that encourage tenants to minimize energy use in the joint/private development alternatives;
- Renewable/alternative energy evaluation, summarizing options to reduce GHG impacts through the use of solar, combined heat and power, and other alternatives;
- Quantification of GHG impacts associated with traffic and transit, including reviewing and discussing the results of analysis of three different impact areas:
  - Traffic and transit in the immediate South Station area;
  - Rail travel to and from the layover facility sites; and
  - Regional effects, including impacts on train, subway, and private vehicle commuter traffic.

3. Regulatory Context and Methodology

3.1. MEPA Greenhouse Gas Emissions Policy and Protocol

This submission is subject to review per the MEPA Greenhouse Gas Emissions Policy and Protocol (GHG Policy). The GHG Policy in effect at the time of this DEIR filing is the May 2010 version.

The GHG Policy requires that for certain projects undergoing review by the MEPA Office, GHG emissions be quantified and measures to avoid, minimize, or mitigate such emissions be identified. In addition to quantifying project-related GHG emissions, the GHG Policy requires proponents to quantify the impact of proposed mitigation in terms of energy savings and GHG emissions.

MassDOT consulted with the MEPA Office as well as the Department of Energy Resources (DOER) on November 26th, 2013 to discuss the methodology and mitigation expectations for the SSX project. This analysis follows the specific guidance provided by both MEPA and DOER in that meeting.

The analysis provided in this Technical Report focuses on emissions of carbon dioxide (CO_2). As noted in the GHG Policy, although there are other GHGs, CO_2 is the predominant contributor to global warming. Furthermore, CO_2 is by far the predominant GHG emitted from the types of sources related to the SSX project, and CO_2 emissions can be calculated for these source types with readily-available data.

GHG emissions can be categorized into two groups: (1) emissions related to activities that are stationary on the SSX project sites; and (2) emissions related to transportation. Activities on the site can be further broken down into direct sources and indirect sources. Direct sources include GHG emissions from fuel combustion. Indirect sources include GHG emissions associated with water use, electricity, and other forms of energy that are imported from off-site power plants via the regional electrical grid or local steam distribution system for use on-site.

The *GHG Policy* requires MassDOT to calculate and compare the GHG emissions in two cases, each of which incorporates stationary source and transportation components.

- Case 1 is the baseline from which progress in energy use and GHG emissions reductions for the SSX project is measured. The base case would be a project designed to meet the 8th edition of the Massachusetts Building Code (Code), with amendments, as issued by the Board of Building Regulations and Standards (BBRS). As discussed in the November 2013 meeting, this edition will remain the baseline for all future SSX project energy modeling for GHG Policy compliance.
- Case 2 represents the proposed project, including measures incorporated into the building design that exceed those measures required for compliance with the 8th edition of the Code.

The Policy also requires that MassDOT identify, evaluate, and discuss other measures that could reduce GHG emissions.

3.2. Stretch Code

The Massachusetts Stretch Energy Code Appendix was added to the State Building Code on July 24, 2009 (780 CMR 115.AA). It uses provisions of the International Energy Conservation Code (IECC), but provides a more energy efficient alternative to the standard energy provisions of the code that a municipality may adopt. Boston has elected to include the state's optional Stretch Code into its building requirements, and MassDOT anticipates that a new Stretch Code (SCII) will be proposed, effective mid 2015 or later. Although SCII has not yet been proposed by the BBRS, it is anticipated that it will require energy use of new large buildings to be about 12 to 15% below the baseline of the 2012 IECC requirements. Therefore, since the project is expected to seek building permits following introduction of this code, this analysis targets compliance with the anticipated SCII as a minimum criterion for energy performance. The building energy model results indicate that the project as a whole meets the anticipated SCII requirements (note that the anticipated SCII requirements are on the basis of energy use, not GHG emissions).

For the smaller buildings to be located at the layover facility sites, MassDOT will design, construct, and operate in compliance with the version of the Stretch Code that is in-place at the time when building permits are filed. Stretch Code requirements for the layover facilities would include prescriptive energy efficiency measures, such as steps to reduce thermal bypass and duct leakage.

3.3. GreenDOT Policy Directive & Implementation Plan

In June 2010, MassDOT launched its sustainability initiative with issuance of its GreenDOT Policy Directive. The GreenDOT Policy Directive is designed to support Commonwealth initiatives to promote sustainability, including: the Global Warming Solutions Act; Executive Order 484 – Leading by Example – Clean Energy and Efficient Buildings; and Executive Order 515 – Establishing an Environmental Purchasing Policy. Three goals form the foundation of the GreenDOT Policy: (1) reduce greenhouse gas emissions; (2) promote the healthy transportation modes of walking, bicycling, and public transit; and (3) support smart growth development. On December 12, 2012, MassDOT issued the final GreenDOT Implementation Plan, which includes specific goals and projects to meet the GreenDOT Policy goals.

The following sections describe how the SSX project would meet these GreenDOT Policy goals.

3.3.1. Reduce Greenhouse Gas Emissions

- Based on the 8th edition of the Code, the SSX project would reduce stationary GHG emissions through a variety of construction and operation alternatives aimed at reducing energy use in throughout the SSX project.
- By improving access to transit services, the SSX project would reduce the number of vehicles travelling to and from Boston and other parts of the metropolitan area connected to the MBTA and Amtrak systems.

3.3.2. Promote Healthy Transportation Modes

The project would promote healthy transportation modes through the following:

- Providing secure bicycle parking at South Station, thus encouraging MBTA and Amtrak passengers to commute to the station via bicycle;
- Constructing approximately one-half mile of new bicycle lanes at Dorchester Avenue near the station; and
- Enhancing pedestrian access to the site.

3.3.3. Support Smart Growth Development

The SSX project would provide the needed infrastructure for expanded use of public transit in the years and decades ahead.

The SSX project would further several goals set forth in the GreenDOT Implementation Plan, including the goal to reduce diesel engine idling time, the goal to increase transit system performance statewide, and the goal to design new facilities consistent with MA LEED Plus standards.

4. Project Description

Four sites are under consideration in the SSX project: the South Station site and three layover facility sites consisting of Widett Circle, Beacon Park Yard, and Readville – Yard 2. Figure 1 presents the location of the four SSX project sites.

4.1. South Station Site

The South Station site occupies approximately 49 acres located near Chinatown, the Fort Point Channel, and the South Boston Waterfront/Innovation District. The site includes the following: the South Station Rail Terminal, the South Station Bus Terminal, and the USPS General Mail Facility/South Postal Annex, including that portion of Dorchester Avenue fronting the site and running parallel to the Fort Point Channel. The site extends along a portion of the NEC Main Line to the west, extending past Cove Interlocking, and along a portion of the MBTA's Fairmount Line/Old Colony Railroad to the south, extending just past Broad Interlocking. The site also includes a small park (Rolling Bridge Park), Harborwalk area, and a portion of the Fort Point Channel located at the southern end of the site.

The South Station Terminal area currently consists of 13 tracks, eight platforms and a system of track work (also referred to as interlockings) that allow Amtrak and the MBTA trains to serve the station from the NEC and Framingham/Worcester line from the north/west and the MBTA's Fairmount Line and Old Colony Railroad from the south/east. The future existing condition at the South Station site assumes completion of the South Station Air Rights (SSAR) project, consisting of an approximately 1.8 million sf mixed-use development to be located directly above the railroad tracks at the South Station headhouse.[2]

In addition to the No Build Alternative, there are three Build Alternatives at the South Station site: Alternative 1- Transportation Improvements Only; Alternative 2- Joint/Private Development Minimum Build; and Alternative 3 - Joint/Private Development Maximum Build. The following sections provide a brief description of the build alternatives.

4.1.1. Alternative 1 – Transportation Improvements Only

In Alternative 1, South Station would be expanded onto the adjacent 14-acre USPS property. MassDOT would acquire and demolish the USPS General Mail Facility/South Postal Annex. The existing South Station Terminal, totaling approximately 210,000 sf, would be expanded by approximately 403,000 sf, consisting of an expanded passenger concourse and passenger support services. Capacity improvements would include construction of seven new tracks and four new platforms (including widening of one existing platform), for a total of 20 tracks and 11 platforms. Tower 1 and the approach interlockings would be reconfigured. Alternative 1 would not provide for potential private development at the South Station site, other than the previously-approved SSAR project.[3]

Dorchester Avenue would be restored for public and station access. Restoration of Dorchester Avenue would reconnect Dorchester Avenue to Summer Street as a public way. It would include landscaping and improved pedestrian and cycling connections and facilities (including adjacent sidewalks and crosswalks). Restoration would also include construction of an extension of the Harborwalk along reopened Dorchester Avenue.

4.1.2. Alternative 2 – Joint/Private Development Minimum Build

Alternative 2 would include all of the transportation improvements provided in Alternative 1, as well as provisions for future private development at the South Station site by incorporating appropriate structural foundations into the overall station and track design.

In Alternative 2, the potential for future private development at the South Station site would comply with existing state and local regulations, including existing Chapter 91 regulations regarding building height

[2] The South Station Air Rights Project was approved by the Secretary of the Executive Office of Energy and Environmental Affairs (EEA) in 2006 (EEA No. 3205/9131).
[3] Programming of land resulting from replacement of USPS facility to be determined.

and setback from Fort Point Channel, Fort Point Downtown Municipal Harbor Planning Area requirements, and the Massachusetts Coastal Zone Management program. Future private development could include approximately 660,000 sf of mixed uses consisting of residential, office, and commercial uses, including retail and hotel, located in six separate buildings with open space and plazas (Joint Development [JD] 1-6). Building heights could range up to approximately 12 stories. Approximately 2.01 acres of land fronting Dorchester Avenue would be available for ground floor development; additional construction would occur via air rights over the expanded tracks and platforms. It was estimated that of the total private development, residences would occupy approximately 33% (221,000 sf), office use would occupy approximately 39% (255,000 sf), retail would occupy approximately 12% (79,000 sf), and a hotel would occupy approximately 16% (105,000 sf).[4] Development could include approximately 234 parking spaces, provided in structured underground parking.[5] In addition to the open space provided through the extended Harborwalk, Alternative 2 also would provide additional ground level open space within the joint development parcels.

4.1.3. Alternative 3 – Joint/Private Development Maximum Build

Alternative 3 would include all of the transportation improvement provided in Alternative 1, as well as provisions for future private development at the South Station site by incorporating appropriate structural foundations into the overall station and track design.

As opposed to Alternative 2, Alternative 3 would not be limited to existing building height and setback requirements. In Alternative 3, the maximum potential for future private development at the South Station complex would be limited by the Federal Aviation Administration's (FAA's) maximum building height limit of approximately 290 feet, pursuant to the Terminal Instrument Procedures (TERPS) regulations applicable to Boston Logan International Airport. Alternative 3 would require an amendment to the Municipal Harbor Plan, modifying applicable Chapter 91 regulations. Future private development could include approximately 2 million sf of mixed uses consisting of residential, office, and commercial uses, including retail and hotel uses, located in six separate buildings with open space and plazas (JD 1-6). Building heights could range up to approximately 26 stories. Approximately 2.55 acres of land fronting Dorchester Avenue would be available for ground floor development; additional construction would occur via air rights over the expanded tracks and platforms. It was estimated that of the total private development, residences would occupy approximately 38% (775,000 sf), office use would occupy approximately 45% (917,000 sf), retail would occupy approximately 4% (76,000 sf), and a hotel would occupy approximately 13% (267,000 sf).[6] Development could include approximately 506 parking spaces, provided in underground structured parking.[7] In addition to the open space provided through the extended Harborwalk, Alternative 3 also would provide additional ground level open space within the joint development parcels.

4.2. Layover Facility Sites

4.2.1. Widett Circle Site

Widett Circle totals approximately 29.4 acres and is comprised of two parcels located in the South Boston neighborhood of Boston: Cold Storage and Widett Circle. Both parcels are primarily in private ownership. Widett Circle could provide layover space for up to 30 eight-car train sets. Support facilities would include a crew building, support shed, and power substation, totaling approximately 44,000 sf.

[4] Mixed-use development percentage guidelines were provided by BRA.
[5] Parking ratios were verified by BTD.
[6] Mixed-use development percentage guidelines were provided by BRA.
[7] Parking ratios were verified by BTD.

4.2.2. Beacon Park Yard Site

Beacon Park Yard is located along Cambridge Street in the Allston neighborhood of Boston. It is an industrial-zoned 30-acre site located between the Massachusetts Turnpike Interstate Route 90 (I-90) Allston Toll Plaza and the MBTA Framingham/Worcester Line, and served for many years as a major freight rail yard and intermodal terminal in Boston for CSX Transportation, Inc. (CSXT). Beacon Park Yard could provide layover space for up to 20 eight-car train sets. Support facilities would include a crew building, support shed, and power substation, totaling approximately 31,400 sf.

4.2.3. Readville - Yard 2 Site

The MBTA's Readville - Yard 2 is located in the Readville section of Hyde Park in Boston. Currently, the 17.4 -acre site is a maintenance repair facility and the largest layover yard used by the MBTA for its south side service. Readville – Yard 2 could expand the existing layover facility by up to eight 8-car train sets, for a total layover space of 18 eight-car train sets. Support facilities would include expansion of the existing crew building and support shed, and construction of a power substation, totaling approximately 11,700 sf.

5. Analysis Structure

This GHG analysis summarizes the results of the following separate steps:

- Building Energy Modeling for different cases at South Station. These include Alternatives 1 and 3. Alternative 2 was not specifically modeled because it would generally have impacts in between the other two Alternatives. Because design and mitigation measures are different for different components of the building, the energy modeling inputs and results are shown separately by space function (hotel & multifamily highrise; mixed use office/retail; and South Station headhouse and platform expansion).
- Qualitative discussion of stationary source impacts and mitigation measures for the layover facilities.
- Quantification of GHG impacts associated with water use and wastewater discharge (energy use associated with conveyance and treatment).
- Draft Tenant Manual description, providing guidelines that encourage tenants to minimize energy use in the joint/private development portions of the SSX project.
- Renewable/Alternative Energy Evaluation, summarizing options to reduce GHG impacts through the use of solar, combined heat and power, and other alternatives.
- Quantification of GHG impacts associated with traffic and transit, reviewing and discussion the results of analysis of three different impact areas:
  - Traffic and transit in the immediate South Station area;
  - Rail travel to and from the layover stations; and
  - Regional effects, including impacts on train, subway, and commuter traffic.

Specific commitments to GHG reduction steps are then summarized at the end of the section.

6. Stationary Sources Quantification: South Station

This section reviews the building energy modeling for the terminal expansion and joint/private development at the South Station site. As discussed at a pre-filing meeting with MEPA and DOER on November 26, 2013, the entirety of this analysis focuses on quantifying GHG emissions from

Alternatives 1 and 3. No modeling or analysis is provided for Alternative 2, as the impacts would generally be bounded by the other alternatives.

6.1. Building Energy Model Description

The stationary source estimates of GHG emissions were generated by building energy modeling using eQUEST v3.64. The program is a graphic user interface for the building energy analysis program DOE2, which "uses a description of the building layout, construction, operating schedules, conditioning systems (lighting; heating, ventilation and air conditioning [HVAC]; etc.) and utility rates provided by the user, along with weather data, to perform an hourly simulation of the building and to estimate utility bills."[8]

The SSX project program, as presented in Chapter 3, forms the basis of this analysis. The current preliminary design does not include modifications to, or ventilation connection with, the existing South Station facilities. The building energy modeling for the SSX project was based on separate facilities for heating, lighting, etc. Existing South Station facilities were not modeled.

The following space functions have been included in this assessment: the South Station terminal expansion, hotel, multi-family highrise, and mixed-use office/retail uses. Energy savings would vary significantly by building type. Model inputs are based on best current information; that information is preliminary and subject to change during final design development.

The GHG Policy instructs project proponents to "establish a project baseline condition for each source of GHG emissions required to be quantified" and then "after… calculating estimated GHG emissions associated with the baseline condition in accordance with the methodology outlined above, the proponent should calculate and compare GHG emissions associated with the preferred alternative and other mitigation measures." In accordance with the GHG Policy, and the Secretary's Certificate on the ENF, building energy modeling was performed for the GHG Baseline Case (compliance with code ASHRAE 90.1 – 2010) and the GHG Mitigated Case (including proposed mitigation measures as described in Section 12). The GHG Baseline Case is a hypothetical baseline from which progress in energy use and GHG emissions reductions are measured. The GHG Mitigated Case represents the proposed Project, including measures incorporated into the building shell, along with plumbing MEP systems, lighting design, and other factors that go above and beyond those required for Code compliance.

The emission factors used in the calculation are as follows:

- 11.69 pounds of CO_2 per therm of natural gas used, which is from the U.S. Energy Information Administration Voluntary Reporting of Greenhouse Gases Program;[9]
- 719 pounds of CO_2 per megaWatt hour electricity used, which is the most recent annual average CO_2 emission rate from the 2012 ISO New England Electric Generator Air Emissions Report (January 2014).[10]

6.2. Building Use Energy Conservation Measures

Although different space functions have been assessed, the primary energy conservation measures assumed for this analysis would be applied to each building. Table 1 provides a summary of the energy conservation measures assumed for each use. The following sections describe the HVAC and lighting

[8] EQuest. January 1, 2014. Accessed August 5, 2014. http://www.doe2.com/equest/.
[9] Voluntary Reporting of Greenhouse Gases Program - Emissions Factors. *Voluntary Reporting of Greenhouse Gases Program - Carbon Dioxide Emission Factors.* January 31, 2011. Accessed August 5, 2014. http://www.eia.gov/oiaf/1605/coefficients.html.
[10] ISO New England. *Electric Generator Air Emissions Report.* January 1, 2014. Accessed August 5, 2014. http://www.iso-ne.com/genrtion_resrcs/reports/emission/2012_emissions_report_final_v2.pdf.

systems modeled for each building use at the South Station site. The GHG Baseline Case and the GHG Mitigated Case are described for each space function, and improvements from the baseline are noted.

6.2.1. Terminal Expansion

GHG Baseline Case

For the GHG Baseline Case, an overhead variable air volume (VAV) ventilation system would serve the expansion. Cooling would be provided by 0.4 kilowatt (kW)/ton integrated part-load volume (IPLV) minimum efficient centrifugal chillers tied to a constant primary, variable secondary hydronic loop. Heating would be provided by 80%-efficient natural draft, non-condensing boilers, tied to a common variable speed building hot water loop. Ventilation has been estimated at 14.3 cubic feet per minute (cfm)/person based on ASHRAE 62.1.[11] Variable speed fans would run continuously and fan power is estimated at 1.31 Watts per cfm of supply air. In all zones 50% efficient enthalpy energy recovery units would be required due to high occupant densities. Interior lighting would be limited to 0.77 Watts per square foot with occupancy sensors and code minimum daylighting along the perimeter and top floor skylight areas.

GHG Mitigated Case

For the GHG Mitigated Case, an overhead VAV system would continue to serve the expansion. Cooling would be provided by 0.34 kW/ton IPLV centrifugal magnetic bearing chillers (improved from baseline), tied to a constant primary, variable secondary hydronic loop. Heating would be provided by 96% efficient condensing boilers (improved from baseline), tied to a common variable speed building hot water loop. Ventilation has been estimated at 14.3 cfm/person based on ASHRAE 62.1. Variable speed fans would run continuously and fan power is estimated at 1.31 Watts per cfm of supply air. In all zones 75% efficient enthalpy energy recovery units (improved from baseline) would be required due to high occupant densities. Interior lighting would be limited to 0.62 Watts per square foot (improved from baseline), with occupancy sensors and optimized perimeter daylighting that exceeds code requirements along the perimeter and top floor skylight areas.

6.2.2. Hotel Use

GHG Baseline Case

For the GHG Baseline Case, each heating/cooling zone would be served by 9.3 Energy Efficiency Rating (EER) Packaged Terminal Air Conditioner (PTAC) systems. Heating would be provided by 80% efficient natural draft, non-condensing boilers, tied to a common variable speed building hot water loop. Ventilation has been estimated at 0.11 cfm/sf based on ASHRAE 62.1. Fans would run continuously and fan power would be limited to 0.3 Watts per cfm. Interior lighting would be limited to 1 Watt per square foot with occupancy sensors. Exterior (parking garage) lighting would be limited to 0.25 Watts per square foot. Daylighting controls would not be included since they would not likely be required based on typical window wall ratio's and space characteristics.

GHG Mitigated Case

For the GHG Mitigated Case, fan coil units would serve each zone. Cooling would be provided by 0.34 kW/ton IPLV centrifugal magnetic bearing chillers, tied to a constant primary, variable secondary hydronic loop (improved from baseline). Heating would be provided by 96% efficient condensing boilers

[11] ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) Standards 62.1 and 62.2 are the recognized standards for ventilation system design and acceptable indoor air quality.

(improved from baseline), tied to a common variable speed building hot water loop. Ventilation has been estimated at 0.11 cfm/sf based on ASHRAE 62.1. Fans would run continuously and fan power would be limited to 0.3 Watts per cfm. Interior lighting would be limited to 0.8 Watts per square foot (improved from baseline) with occupancy sensors. Exterior (parking garage) lighting would be limited to 0.17 Watts per square foot (improved from baseline). Daylighting controls have not been included since they would not likely be required based on typical window wall ratio's and space characteristics.

6.2.3. Multi-Family Use

GHG Baseline Case

For the GHG Baseline Case, each heating/cooling zone would be served by 9.3 EER PTAC systems. Heating would be provided by 80% efficient natural draft, non-condensing boilers, tied to a common variable speed building hot water loop. The living units were assumed to be naturally ventilated. Fans would run continuously and fan power would be limited to 0.3 Watts per cfm. Interior lighting would be limited to 0.6 Watts per square foot with occupancy sensors. Exterior (parking garage) lighting would be limited to 0.25 Watts per square foot. Daylighting controls have not been included since they would not likely be required based on typical window wall ratio's and space characteristics.

GHG Mitigated Case

For the GHG Mitigated Case, fan coil units would serve each zone. Cooling would be provided by 0.34 kW/ton IPLV centrifugal magnetic bearing chillers, tied to a constant primary, variable secondary hydronic loop (improved from baseline). Heating would be provided by 96% efficient condensing boilers (improved from baseline), tied to a common variable speed building hot water loop. The living units were assumed to be naturally ventilated. Fans would run based on load and fan power would be limited to 0.3 Watts per cfm. Interior lighting would be limited to 0.48 Watts per square foot with occupancy sensors (improved from baseline). Exterior (parking garage) lighting would be limited to 0.17 Watts per square foot (improved from baseline). Daylighting controls have not been included since they would not likely be required based on typical window wall ratio's and space characteristics.

6.2.4. Office/Retail Use

GHG Baseline Case

For the GHG Baseline Case, an overhead VAV system would serve the upper floor office spaces. Cooling would be provided by 0.4 kW/ton IPLV minimum efficient centrifugal chillers, tied to a constant primary, variable secondary hydronic loop. Heating would be provided by 80% efficient natural draft, non-condensing boilers, tied to a common variable speed building hot water loop. Ventilation has been estimated at 26.6 cfm/person based on ASHRAE 62.1. Variable speed fans would run continuously during occupied hours and fan power is estimated at 1.29 Watts per cfm of supply air. Interior lighting would be limited to 0.9 Watts per square foot with occupancy sensors and code minimum perimeter daylighting.

An overhead packaged single zone air conditioning system would serve the first floor retail spaces. Cooling would be provided by 9.8 EER minimum efficient DX coils. Heating would be provided by 80% efficient gas fired furnaces. Ventilation has been estimated at 25 cfm/person based on ASHRAE 62.1. Constant volume fans would run continuously during occupied hours and fan power is estimated at 1.09 Watts per cfm of supply air. In core retail zones 50% efficient enthalpy energy recovery units would be required. Interior lighting would be limited to 1.4 Watts per square foot with occupancy sensors and code minimum perimeter daylighting.

GHG Mitigated Case

For the GHG Mitigated Case, an overhead VAV system would serve the upper floor office spaces. Cooling would be provided by 0.34 kW/ton IPLV centrifugal magnetic bearing chillers (improved from baseline), tied to a constant primary, variable secondary hydronic loop. Heating would be provided by 96% efficient condensing boilers (improved from baseline), tied to a common variable speed building hot water loop. Ventilation has been estimated at 26.6 cfm/person based on ASHRAE 62.1. Variable speed fans would run continuously during occupied hours and fan power is estimated at 1.29 Watts per cfm of supply air. Interior lighting would be limited to 0.72 Watts per square foot (improved from baseline) with occupancy sensors and optimized perimeter daylighting that exceeds code requirements (improved from baseline).

An overhead packaged single zone air conditioning system would serve the first floor retail spaces. Cooling would be provided by 9.8 EER minimum efficient DX coils. Heating would be provided by 80% efficient gas fired furnaces. Ventilation has been estimated at 25 cfm/person based on ASHRAE 62.1. Constant volume fans would run continuously during occupied hours and fan power is estimated at 1.09 Watts per cfm of supply air. In core retail zones 75% efficient enthalpy energy recovery units (improved from baseline) would be included. Interior lighting would be limited to 1.12 Watts per square foot (improved from baseline). Daylighting would not be required in retail spaces.

Table 1—Proposed Building Energy Conservation Measures

Baseline/Mitigated Energy Conservation Measures	Terminal Expansion	Hotel and Multi-family High-rise	Mixed-use Office/Retail
HVAC: GHG Baseline Case	Standard efficiency boiler/chiller VAV; Minimum efficient (50%) energy recovery	PTACs with standard efficiency boilers	Standard efficiency boiler/chiller VAV; minimum efficient (50%) energy recovery
HVAC: GHG Mitigated Case	High efficiency chillers and condensing boilers with VAV; high efficiency (75%) energy recovery	Fan coils with high efficiency chillers and condensing boilers	High efficiency chillers and condensing boilers with VAV; high efficiency (75%) energy recovery; optimized controls
Lighting: GHG Baseline Case	Code minimum lighting power density and controls	Code minimum lighting power density and controls	Code minimum lighting power density and controls
Lighting: GHG Mitigated Case	Optimized lighting design 20% better than code	Optimized lighting design 20% better than code	Optimized lighting design 20% better than code
Envelope: GHG Baseline Case	Code minimum fenestration (windows and doors)	Code minimum fenestration	Code minimum fenestration
Envelope: GHG Mitigated Case	Higher performing insulated assemblies	Higher performing insulated assemblies	Higher performing insulated assemblies
Process: GHG Baseline Case	---	Standard efficiency equipment	---
Process: GHG Mitigated Case	---	Energy star rated equipment (multi-family only)	---

6.3. GHG Impacts Not Modeled

The GHG reduction measures that cannot be modeled due to the constraints of the modeling software include: tree placement; motion sensor lighting control; operational controls (third-party operator's manual, leak checks, energy management system); refrigerant management; and use of recycled/low-impact materials. Outside of the multi-family residential areas, no credit was taken for proposed improvements in plug loads (through Energy Star appliances, etc.).

As the project is in the preliminary permitting (pre-conceptual) design stage, model inputs perforce do not reflect final design development and are subject to change.

The effects of using renewable or alternative energy sources were not included in the model. As described in Section 9, MassDOT has options to install solar PV, solar hot water, and/or connect to the Veolia district energy system. All of these options will be reviewed further in the design development phase, but none of these options were included in the preliminary permitting design.

The effects of using "plug-ins" were also not included in the model. To reduce diesel locomotive idling, trains parked at the layover sites or at South Station will be connected to station power. This use of "shore power" allows trains to turn off the diesel engines and still have lights, heat, and freeze protection. The primary benefits of plug-ins include noise reduction and local air quality improvement, but some GHG reduction is also realized. The locomotive engine would generate more CO_2 per unit electricity than is generated by plugging in to the regional electric grid. MassDOT has committed to the use of plug-ins, but their placement, sizing, and usage rates have not been finalized. This prevents quantification of the GHG reduction associated with their use.

6.4. Results

6.4.1. Building Energy Modeling Results

The results of the building energy modeling are summarized in Table 2 for Alternative 1 and Table 3 for Alternative 3.

Table 2—Calculated Total Project-Related Stationary Source GHG Emissions, Alternative 1

	Gas Use (MMBtu/year)	Electric Use (MMBtu/year)	Gas CO_2 Emissions (tons/year)	Electric CO_2 Emissions (tons/year)	Total CO_2 Emissions (tons/year)
Terminal Expansion GHG Baseline Case	4,300	20,270	251	2,136	2,387
Terminal Expansion GHG Mitigated Case	2,712	19,299	159	2,033	2,192
Percent Reduction, Alternative 1					8.2 %

Table 3—Calculated Total Project Related Stationary Source GHG Emissions, Alternative 3

	Gas Use (MMBtu/year)	Electric Use (MMBtu/year)	Gas CO_2 Emissions (tons/year)	Electric CO_2 Emissions (tons/year)	Total CO_2 Emissions (tons/year)
Terminal Expansion GHG Baseline Case	4,300	20,270	251	2,136	2,387
Terminal Expansion GHG Mitigated Case	2,712	19,299	159	2,033	2,192
Hotel GHG Baseline Case	10,743	9,222	628	972	1,600
Hotel GHG Mitigated Case	8,899	8,067	520	850	1,370
Residential GHG Baseline Case	6,083	10,345	356	1,090	1,446
Residential GHG Mitigated Case	5,043	10,005	295	1,054	1,349
Office/Retail GHG Baseline Case	14,622	12,782	855	1,347	2,201
Office/Retail GHG Mitigated Case	10,575	11,450	618	1,206	1,825
Total GHG Baseline Case	35,748	52,618	2,089	5,544	7,634
Total GHG Mitigated Case	27,230	48,821	1,592	5,144	6,736
Percent Reduction, Alternative 3					11.8 %

6.4.2. Energy Use Index

The Energy Use Index (EUI) is a measure of annual building site energy use per square foot of conditioned space. The EUI can be a useful tool for setting a separate benchmark for energy use to compare similar projects. Table 4 presents a summary of the EUI for the joint/private development buildings.

The U.S. Energy Information Administration's (EIA's) Commercial Buildings Energy Consumption Survey (CBECS) is "a national sample survey that collects information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures."[12] Per the MEPA scope, this analysis was required to include a comparison of modeled EUI values to relevant CBECS values as a baseline comparison for efficiency. CBECS data can be queried to identify the EUI of comparable facilities to compare against the predicted EUI of the SSX project. The value of this comparison is limited, because often the facilities surveyed for the CBECS data were not directly comparable to a project's facilities, and often the sample size is small, so the CBECS data may not accurately represent an average building of the type described. Furthermore, the CBECS data are more than a decade old and the buildings included are somewhat older still, making comparison to a modern building built to satisfy modern building codes less useful.

CBECS does not include residential data, but similar residential data are available from the EIA Residential Energy Consumption Survey (RECS), with similar limitations.

[12] Commercial Buildings Energy Consumption Survey (CBECS). *About the Commercial Buildings Energy Consumption Survey*. January 1, 2014. Accessed August 5, 2014. http://www.eia.gov/consumption/commercial/about.cfm.

Table 4—Energy Use Index Summary, South Station Site

	Hotel GHG Baseline	Hotel GHG Mitigated	Residential GHG Baseline	Residential GHG Mitigated	Office/ Retail GHG Baseline	Office/ Retail GHG Mitigated	Terminal Expansion GHG Baseline	Terminal Expansion GHG Mitigated
Conditioned Area (sf)	280,000	280,000	280,000	280,000	440,000	440,000	205,000	205,000
Unconditioned Area (sf)	21,800	21,800	21,800	21,800	-	-	200,000	200,000
EUI (kBtu/sf)								
Interior Lighting	10.43	8.35	6.26	5.01	7.18	4.91	18.81	15.05
Exterior Lighting	1.95	1.95	1.95	1.95	0.54	0.54	5.76	4.61
Process Loads	8.07	8.07	18.16	15.13	11.13	11.13	53.15	53.15
Space Heating	25.52	19.31	8.89	5.53	31.76	22.56	18.25	10.50
Space Cooling	7.05	1.63	9.27	2.27	2.82	2.34	7.49	6.65
Heat Rejection	-	0.42	-	0.47	0.38	0.34	0.98	1.00
Pumps	0.19	2.51	0.11	3.71	1.31	1.37	5.10	6.44
Fans	5.25	5.88	1.20	7.20	5.70	5.39	7.59	7.25
Service Hot Water	12.84	12.48	12.84	12.48	1.47	1.47	2.73	2.73
Total EUI	**71.3**	**60.6**	**58.7**	**53.7**	**62.3**	**50.1**	**119.9**	**107.4**

A comparison of CBECS and RECS values is provided in Table 5. The CBECS data are from Table C-10 of the 2003 Survey, and the RECS data are from Table US-1 Part 1 of the 2005 Survey. The CBECS and RECS values cited in this table are provided as Attachment U.

Table 5—Energy Use Index Comparison

End Use Category	GHG Baseline Case EUI, kBtu/sf	GHG Mitigated Case EUI, kBtu/sf	CBECS/RECS Comparison EUI, kBtu/sf	CBECS/RECS Category
Hotel	71.3	60.6	132.1	Lodging
Residential	58.7	53.7	62.4	Apartments 5+ units
Office/Retail	62.3	50.1	73.5 132.1	Retail Office
Terminal Expansion	119.9	107.4	90.8	Public Assembly

There were disparities between the CBECS values and the values used for building energy modeling. The modeling values were determined using information directly related to this project, using new, energy efficient materials and equipment, which paired with the age and imperfect sampling from the CBECS may explain the differences in the values.

Stationary Sources Quantification: Layover Facilities

As is typical for smaller buildings, the layover facilities as described in Section 3.5 of the DEIR would comply with building energy code (and Stretch Code) requirements using prescriptive energy efficiency measures rather than building energy modeling due to the smaller building size and impacts. As described in DOER presentations,[13] prescriptive energy efficiency requirements include detailed minimum standards such as:

- Insulation requirements, including air sealing.
- Windows, heating/cooling equipment, etc., requirements.
- Design controls and details requirements.

The Stretch Code requirement sets the minimum specification and allows some design flexibility to trade one design parameter for another. For example, the current Stretch Code allows for the installation of more efficient heating and cooling equipment, more efficient lighting, or onsite renewable energy generation as a means to meet Stretch Code requirements.

Determining which specific measures would be implemented at the layover facility sites was difficult at this preliminary permitting design stage. Further, prescriptive stretch energy code requirements are in-transition. As noted by the BBRS:[14] “Although the standard "non-stretch" energy provisions of the code will be based on the IECC 2012 as of July 1, 2014, the stretch code will continue to be based on amendments to the IECC2009 (and ASHRAE 90.1-2007 for large commercial buildings) until such a time as the stretch code is updated.” MassDOT will design, construct, and operate the SSX project in compliance with the version of the Stretch Code that is in-place at the time when building permits are filed. The specific measures that will be used to meet the Stretch Code will be determined by the time of filing.

7. Wastewater Quantification

At the South Station site, Alternative 3 would increase the water use and wastewater generation by greater than 300,000 gallons per day (gpd), as presented in the Appendix 8 – *Water and Wastewater Technical Report* for more information. Therefore, consistent with the GHG Policy the potential GHG impacts associated with water and wastewater treatment are calculated here. Other alternatives would have lower water use and wastewater generation rates.

The MEPA Office posts energy usage factors to model GHG emissions associated with energy usage for water or wastewater treatment. As of the filing of this DEIR, the factors for facilities located in the MWRA area are as follows:

- Wastewater Treatment average energy cost = 1.3kWh/1,000 gallons treated.
- Water Treatment average energy cost = 0.2 kWh/1,000 gallons treated.

Using these factors, and ISO New England’s electric generation emissions factor (719 pounds of CO_2 per megawatt-hour of electricity used), the GHG emissions associated with water and wastewater treatment is approximately 82 tons per year for Alternative 3, as shown in Table 6 below.

[13] Finalyson, Ian. *The MA ‘Stretch’ Energy Code 201*. Green Communities Webinar. November 3, 2010.
[14] Massachusetts Department of Public Safety. *Stretch Energy Code – Information*. 2014. Accessed July 28, 2014. http://www.mass.gov/eopss/consumer-prot-and-bus-lic/license-type/csl/stretch-energy-code-information.html.

Table 6—Water and Wastewater Related GHG Emissions, South Station Site

	Water	Wastewater
Alternative 3 use, gpd	453,090	411,900
Energy use, kWh/year	33,076	195,447
CO_2 Emissions, tons/year	11.9	70.3

The layover facility sites would use water and generate wastewater, however the water use and wastewater generation values would be relatively small (<20,000 gpd per site), significantly below than the 300,000 gpd threshold requiring further analysis, and have not been quantified in this analysis.

MassDOT is considering a number of water-saving projects that could reduce the impacts of this project, including but not limited to low-flow or waterless plumbing fixtures throughout the SSX project.

South Station site-related stationary source emissions data, including water and wastewater related GHG emissions, are provided as Attachment T.

8. Draft Tenant Manual

The SSX project is pursuing the opportunity of including joint/private development at the South Station site. Depending on final ownership arrangements, this could include leasing space to tenants. Therefore, certain energy efficiency measures require a level of design that would be performed by the tenants during fit-out. Actual building energy use would depend upon the core and shell design, for which MassDOT is responsible, and also upon what the tenant would add to the building (fit-out) and how the tenant would operate. Tenants would require City of Boston building permits for their fit-out, and would be required to comply with the Stretch Code that the City of Boston has adopted.

The GHG reduction measures that were integrated into the building's core, shell and infrastructure were reviewed and included in the building energy modeling. As instructed in the ENF Certificate, MassDOT has considered measures to educate and create incentives for the tenants to adopt energy efficiency/renewable generation measures.

While MassDOT would not have ultimate control over the tenant's energy use, it is committed to exerting whatever influence it can on commercial tenants to encourage decisions that would maximize the building's energy efficiency. MassDOT would assist tenants to maximize energy efficiency in fit-out by providing a LEED Guide to encourage and assist in meeting the requirements for LEED Certifiable status and to work toward more energy efficient tenant-controlled spaces.

While not directly contributing to GHG reductions, a Tenant Manual provides recommendations and requirements on energy reducing systems and equipment for tenant use and informs the tenant of system limitations imposed by building design. The Tenant Manual would be used as the basis for all third-party lease agreements associated with the SSX project.

The MassDOT Tenant Manual will encourage tenants to minimize energy use. MassDOT has committed to the preparation and implementation of an innovative Tenant Manual containing a set of guidelines that would in some cases require, and in others encourage, tenants to adopt appropriate sustainable design, energy efficiency, water use, water pollution control, and TDM commitments to the extent feasible as part of their respective lease agreements.

The Tenant Manual would require or encourage a commercial tenant to:

- Use variable frequency drives in HVAC distribution systems;
- Reduce lighting power density in office spaces below ASHRAE 90.1-2010 code;
- Design electric wiring and electric systems compatible with the application of building Energy Management Systems and automated lighting controls;
- Use Energy Star rated appliances, if available;
- Participate in the state-wide Green Initiatives Recycling Program;
- Implement recycling of construction waste;
- Promote employee participation to on-site amenities such as ATMs, retail, and restaurants; and
- Promote participation in TDM measures as committed to in Section 4.8 of the DEIR.

9. Renewable/Alternative Energy Evaluation

This section reviews options for onsite energy generation from renewable sources, and options to reduce GHG emissions through the use of alternative energy sources at the South Station site, including onsite electricity generation or the use of district steam. This section applies only to the South Station site, and is not applicable to the layover facility sites.

It may not be feasible to install significant amounts of onsite electric generating capacity at the SSX project. Based on initial contact with the local electricity supplier (NSTAR[15, 16]), the connection to the electrical grid would likely be through spot network vaults rather than through the radial distribution system. Spot network vaults offer more reliable electricity supply, but are not well suited to receive electricity from distributed generation sources. If the SSX project were served by spot network vaults, any interconnected generation source would be limited to 1/15th of the minimum facility load to prevent excess power from flowing into the network and tripping the network protectors in the vault. The connection would also need to use inverter-based equipment. This would preclude the use of all but the smallest onsite Combined Heat and Power (CHP) systems, and would limit solar photovoltaic (PV) and wind-based renewable systems.

9.1. Solar Photovoltaic

Solar photovoltaic (PV) panels create electricity from sunlight; they require undisturbed surface area free from shadows for the collector array, and space for inverters and switchgear.

Project roof space can be used for mechanical equipment, open/habitable space, green roofs, and solar panels. A preliminary feasibility analysis of two potential South Station site build options (Alternatives 1 and 3) would provide roof space that could accommodate a PV system. A shadow impact analysis for the SSX project (presented in Appendix 6- *Coastal Resources Technical Report)* concluded that 70,000 sf of roof space would be suitable for solar panels in Alternative 1, while 25,000 sf would be suitable in Alternative 3 (Alternative 3 requires more rooftop mechanical structures and therefore has less suitable open roof space). The shadow diagrams are provided in Appendix 6 – *Coastal Resources Technical Report.* It was assumed that 50% of the total roof surface for the Build Alternatives could be available for useful panel placement (after allowing for access and maintenance space and roof edge set-backs), providing up to 35,000 sf of useful space in Alternative 1 and up to 12,500 sf of useful space in Alternative 3. For the purposes of this analysis, all useful space was considered to be occupied by the PV panels.

[15] Ruberti, James. NStar. *Electrical Grid*, Personal communication, July 25, 2014.
[16] Feraci, Joseph. NStar. *Electrical Grid*, Personal communication, July 25, 2014.

An array of 35,000 sf was estimated to have an output rating of approximately 420 kW of peak direct current (DC), while an array of 12,500 sf was estimated to have an output rating of approximately 150 kW (peak DC). As previously cited, the connection to the electric distribution grid could preclude or limit onsite electricity generation.

PV Watts, a model developed by the National Renewable Energy Laboratory (NREL) simulates the performance of a PV array based on size, design parameters, geographic location, and historical meteorological data.[17] This model predicts an annual output of approximately 462 MWh in Alternative 1, while the output in Alternative 3 would be approximately 165 MWh. Actual electricity generated could be lower because the model inputs assume an optimal panel tilt, but the panel tilt may need to be reduced to avoid wind shear. Model outputs are provided as Attachment V. Assuming all of that electricity displaces use of electricity from the distribution grid, the potential GHG savings would be 166 tons of CO_2 for Alternative 1, and 59 tons of CO_2 in Alternative 3.

Using a DOER-published model for examining the financial feasibility of PV,[18] MassDOT calculated values for the simple payback period and estimated Return on Equity (ROE) values, which are presented in Table 7. The inputs, assumptions and results of that model are included in Attachment V.

Table 7—Solar PV Investment Summary, South Station Site Joint/Private Development Alternatives

	Alternative 1		Alternative 3	
Ownership	Third Party Owned	MassDOT Owned	Third Party Owned	MassDOT Owned
Return on Equity	5.7%	-0.4%	4.7%	-1.3%
Payback Period (Years)	8 Years	20+ Years	9 Years	20+ Years

This analysis assumes that the panels will not be shadowed by future development during their life cycle. As design develops and actual available roof area can be determined, the designated developer will examine the feasibility of PV. Available financial incentives currently include:

- Federal Tax Credits: The SSX project will be eligible for the federal energy investment tax credit (ITC) program, authorized under 26 USC 48 (section 48). This program offers a 30% tax credit to owners or long-term lessees if performance and quality standards are met.
- Massachusetts Incentives: The Commonwealth of Massachusetts offers Solar Renewable Energy Credits (SRECs) for qualifying solar projects. The SRECs have value through a market based system managed by DOER, wherein the SRECs are purchased by Massachusetts retail electricity suppliers. The SREC program is in-transition, with the original 400 MW cap of the RPS Solar Carve-Out reached and a new program proposed. DOER has now promulgated new regulations to implement the Renewable Portfolio Standard Solar Carve-Out II program, with regulations issued April 25, 2014. The new program will reduce the incentive value over time, and will differentiate between project types. The project type applicable to the SSX project (roof-mounted) was preferred over ground-mounted projects that do not use power onsite. Incentive values are subject to change as the new program is finalized and implemented. The regulations fix an auction price of $257 per megawatt-hour generated starting in 2014, sliding down to $170 per megawatt-hour in 2024 (accounting for SREC factor and usage fee). In the prior RPS Solar Carve-Out program, SRECs were often traded below the minimum auction price, reflecting program uncertainty and transactional costs.

[17] PVWatts Calculator. *PVWatts Calculator*. January 1, 2014. Accessed August 5, 2014. http://pvwatts.nrel.gov/.
[18] Department of Energy Resources. *Simple Solar Finance Model*. Accessed August 5, 2014. http://www.mass.gov/eea/docs/doer/renewables/solar/srec-proj-calc.xls.

The designated developer could consider seeking third-party interest for PV development based on the Power Purchase Agreement (PPA) model. In the PPA model, a third-party PV development company would design, install, own and operate the PV system on MassDOT's building and would sell the output to MassDOT under a long-term PPA, generally at rates below current market rate. Such PV developers are able to take advantage of federal and state tax credits for qualifying projects that MassDOT was unable to take advantage of due to its tax-exempt status.

9.2. Solar Hot Water

Solar hot water heating may be a supplement to a typical gas-fired domestic hot water heating system, sometimes providing hot water directly and other times preheating water that is then brought to normal temperature by a gas-fired boiler. Typically, rooftop space can be dedicated to solar hot water or solar PV (as described in Section 9.3), but not both (some vendors are now offering combination PV & thermal panels). To allow solar hot water generation (which occurs during daylight hours) to match demand (which occurs at all hours with emphasis typically in late evening), solar hot water systems typically include storage tanks.

A recent MEPA filing for an unrelated project[19] used publicly-available tools and calculators to estimate that a solar hot water system in Boston would generate about 1,200 therms of useful heat per year per 1,000 sf of useful panel space. Scaling that estimate to the amount of space available for the SSX project at the South Station site, an array of 35,000 sf (Alternative 1) was estimated to generate about 42,000 therms per year, while an array of 12,500 square feet (Alternative 3) was estimated to generate about 15,000 therms per year. If that heat displaces fuel use in a natural gas-fired boiler, the GHG savings equates to approximately 245 tons of CO_2 for the Alternative 1 case, and 88 tons of CO_2 for Alternative 3.

Solar hot water systems are eligible for the federal energy ITC as described in Section 9.2. The Massachusetts Clean Energy Center currently offers the Commonwealth Solar Hot Water Program (CSHW)[20] Commercial Scale offers financial incentives for solar hot water feasibility studies and construction projects for commercial-scale buildings, and financing options. It is not clear whether funding will be available through the CSHW program at the time of SSX project construction.

9.3. Onsite Combined Heat and Power

A gas-fired Combined Heat and Power (CHP) system can produce electricity and hot water. A CHP has significant efficiency and environmental advantages, as described by MassDEP:

> "In a combined heat and power (CHP) system, the engine or combustion turbine is connected to an electrical generator for electrical power production. The hot exhaust gasses from the engine or combustion turbine are directed through a heat recovery system, such as a boiler, to recover thermal energy for use in heating, cooling, or other uses. This approach eliminates the need for a second combustion unit and therefore eliminates the emissions such a combustion unit would produce. CHP systems make more efficient use of fuel, such as natural gas or fuel oil, than two, separate stand alone, combustion units, one for electricity and one for thermal energy such as steam thus reducing the net emissions of greenhouse gas and other air contaminants."

Electrical interconnection through spot network vaults would prevent any but the smallest CHP systems to be installed for the SSX project. Also, because portions of the joint/private development may be

---

[19] Executive Office of Energy and Environmental Affairs. *Environmental Notification Form: EEA # 15052.* May 15, 2013. http://www.env.state.ma.us/mepa/mepadocs/2013/052213em/nps/enf/15052.pdf.

[20] Massachusetts Clean Energy Center. *Commonwealth Solar Hot Water Commercial Scale.* Accessed July 30, 2014. http://www.masscec.com/solicitations/commonwealth-solar-hot-water-commercial-scale.

separately owned, a single CHP serving the terminal expansion and other elements of the project could complicate future ownership and services contracts.

9.4. District Steam Use

The SSX project has the option to connect to the existing Veolia district energy system. Based on initial contact with Veolia,[21,22] the use of district steam appears feasible. Veolia's Kneeland Street Plant is nearby, and there is a large steam main in Atlantic Avenue, which feeds the Federal Reserve Bank Building. Steam heat from the district energy system could be used for domestic hot water (DHW) production year-round, and for building heat during the heating season. Steam heat can also be used to power steam-driven absorption chillers, used for summertime air conditioning.

Using steam from the district energy system may or may not reduce overall GHG emissions associated with the SSX project. The GHG impacts would be very dependent on the source of the steam, and the extent of the energy losses associated with steam transmission to the SSX project site. Veolia uses both CHP systems and conventional boilers to generate steam in the Boston district energy system. To the extent that high-efficiency CHP systems are used, a very substantial GHG benefit can be realized (because waste heat from electricity generation is turned into useful steam). If low-efficiency boilers were used, the GHG impacts could be higher than using onsite boilers.

9.5. Wind Turbines

Large turbines (greater than 100 kW) are often sited in low-development density areas where a consistent wind resource, unaffected by the built environment, maximizes the payback rate for the installed equipment. This siting strategy also minimizes wind turbulence, a major contributor to reduced performance and longevity of large-scale wind turbines. Areas surrounding the SSX project have several urban/suburban installations of larger turbines, including: the Forbes Park complex in Chelsea; Medford Middle School; and the multiple utility-scale wind turbines in Hull. These projects are sited in relatively open areas where there are no tall buildings in close proximity. Large turbines are typically 200 to 400 feet tall.

For this project, there was no opportunity for large wind turbines on the South Station site because of its proximity to tall buildings. South Station is located within downtown Boston, and large wind turbines are not feasible within this large urban center.

Small turbines (i.e., less than 100 kW) include pole-mounted units in the range of 100 feet tall (hub height; maximum blade tip height is somewhat higher) to modest tower-mounted units up to about 250 feet tall. Similarly, due to the South Station site's proximity to tall buildings, small turbines were not considered for this project.

Building-integrated turbines include very small turbines (generally less than 1 kW to about 5 kW) mounted on building roofs or parapets or otherwise attached to a building. Building-integrated turbines are still in the development phase, with most building-integrated turbines in showplace installations. There a few in the Boston area, including Boston City Hall, Massport Logan Office Center, and the Museum of Science wind turbine lab.

In general, building-integrated turbines are highly susceptible to performance degradation due to turbulent wind regimes around the buildings they are mounted on, as well as nearby structures or topography. In

[21] Silvia, Chris. Veolia. *SSX Veolia Connection*, Personal communication, July 6, 2014.
[22] O'Connell, Ken. Veolia. *SSX Veolia Connection*, Personal communication, July 16, 2014.

spite of some manufacturers' claims that certain building-integrated designs, such as vertical turbines, are less sensitive to building wake turbulence, there is insufficient commercial experience with these units for most developers to have sufficient confidence that all such issues are resolved. A May 2009 article in Environmental Building News indicated that building-integrated turbines are not performing as predicted, have noise and vibration issues, and are a safety and insurance issue.[23] Presentations at the Building Energy 2011 conference in Boston indicated that several types of wind turbines installed at the Museum of Science in Boston and in other southern New England locations have demonstrated similar performance issues.[24] Due to the potential for performance, as well as other issues, building-integrated wind turbines were not deemed to be feasible for the SSX project.

9.6. Ground Source Heat Pumps

Ground-source heat pump (GSHP) technology takes advantage of the near-constant temperature of the earth and groundwater, usually at moderate depths below the surface, to provide a heat sink for heat extracted from a building in summer and a heat source when building heating is required in winter. By using a standard vapor-compression refrigeration cycle that is electrically driven, a GSHP system can, under the right circumstances, reduce the energy required to heat and cool a building and, although electricity is GHG-intensive, possibly result in a GHG emissions reduction as well.

There are two distinct sub-groups of GSHP systems: open loop and closed loop ground coupling. An open loop GSHP system draws in and returns groundwater from one or more wells. A closed loop GSHP system keeps the working fluid in a closed circuit of pipes, relying on heat transfer through the pipe walls to or from the ground and groundwater. In both cases, a large well field was required.

Due to the South Station site's location in a large urban center, there were many competing ground space uses in the area, such as electric and gas lines, along with deep basements, subway lines, underground parking, and the Tip O'Neill Tunnel. Additionally, the majority of the surrounding area is covered by buildings, roads and sidewalks, making the large well field necessary for a GSHP inaccessible. In addition, a well field could also prevent future development of the North South Rail Link project, which MassDOT has committed to not preclude. As a result of all these concerns, GSHPs were not proposed for the SSX project.

10. Quantification: Transportation Sources

Because the SSX project includes significant upgrades that affect regional transportation, assessing the GHG impacts associated with transportation sources exceeds the typical analysis for a project with more localized impacts. This GHG analysis follows the guidance in the MEPA Greenhouse Gas Emissions Policy and Protocol to the extent feasible, but also incorporates specific instructions from MEPA in the ENF Certificate and guidance provided during the pre-filing meeting.

Transportation-related impacts were quantified through three separate analyses:

- Impacts from all transportation sources in the immediate South Station area;
- Locomotive impacts for travel to and from the layover facility sites; and
- Impacts from all transportation sources across a broad region.

---

[23] Wilson, Alex. *The Folly of Building-Integrated Wind.* Environmental Building News, April 29, 2009. Accessed August 5, 2014. http://www2.buildinggreen.com/article/folly-building-integrated-wind.
[24] Northeast Sustainable Energy Association. *Building Energy 2011 Presentations.* 2011. Accessed August 5, 2014. http://www.nesea.org/buildingenergy/bepresentations/.

The assessment of the South Station site most closely follows the guidance in the GHG Policy and Protocol. In this analysis, trips were estimated consistent with the trip generation analysis included in the Appendix 9 – *Traffic Analysis Technical Report* , broken down by vehicle type. The total annual Vehicle Miles Traveled (VMT) was calculated for the road and rail segments in the study area. Then the annual VMT were multiplied by CO_2 emission factors to obtain annual CO_2 emissions (tons/year). For this analysis, U.S EPA emission factors were used for locomotives and MOVES emission factors were used for other vehicle types. The analysis includes a No Build condition, and future (2025 and 2035) Build with Mitigation conditions, for both Alternative 1 and 3. Consistent with the transportation analysis provided in this DEIR (Sections 4.7 and 4.8 and Appendix 9), the transportation improvements were an integral part of the SSX project, and were not analyzed separately. Mitigation measures implemented as part of the Build with Mitigation condition modeling are described in the traffic section of the DEIR (Section 4.8).

The assessment of locomotive impacts traveling to and from the layover facility sites was assessed in a manner similar to the assessment of the South Station area. Different layover site alternatives were presented, and the analysis includes a No Build condition and future (2025 and 2035) Build with Mitigation conditions. The CO_2 emission factors were consistent with the locomotive emission factors for the South Station area.

The assessment of regional impacts was the most effective way to evaluate the impact of transportation mitigation from a project that was designed to improve regional public transportation ridership. This analysis covers a much wider area, using the Central Transportation Planning Staff (CTPS) regional model that includes trips not associated with the SSX project. Therefore, while this regional assessment was the best method to show the SSX project's impacts, the GHG totals cannot be compared to the South Station area and layover trip analyses.

10.1. Localized Emissions

10.1.1. Emissions Inventory Factors

The CO_2 emissions inventory was developed for motor vehicles and buses on affected roadways within the project study area, and railroad locomotives entering, idling, and leaving South Station. The motor vehicle-generated CO_2 emissions were developed using the roadway network and traffic data defined in the project traffic studies, along with appropriate year-dependent and speed-dependent emission factors. A list of the roadway links used in the analysis is presented in Table 8 (a figure locating the roadway links is provided in Section 4.8 of the DEIR). The locomotive-generated CO_2 emissions were developed based on the current and future train schedules and the appropriate U.S. EPA year-specific (i.e., Tier) emission factors for locomotives. The emission inventories were prepared in accordance with U.S. EPA guidelines.[25]

Following guidance in the GHG Policy, the motor vehicle emission factors (expressed as grams of pollutant per vehicle mile) used to estimate the motor vehicle emissions were calculated using the most recently approved version of the U.S. EPA MOVES program (currently MOVES2010b). Emission factors were generated for the "all vehicle categories combined" (the composite emission factor) and for heavy duty diesel vehicles (Intercity buses) separately.

[25] U.S. Environmental Protection Agency, Office of Mobile Sources (now Office of Transportation and Air Quality). *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. Report number EPA-450/4-81-026d (Revised).* Ann Arbor, MI. 1992.

This analysis does not include CO_2 emissions from vehicle idling. Therefore, while the intersection improvements described in Section 7.2 of Appendix 9 - *Traffic Analysis Technical Report* will result in a reduction in GHG emissions, that emission reduction is not quantified through the MOVES program.

Table 8—List of Roadway Links to be Used in the Emissions Inventory Analysis

Link ID No.	Link Description
1	Atlantic Avenue - Kneeland Street to Essex Street
2	Atlantic Avenue - Essex Street to Summer Street
3	Atlantic Avenue - Summer Street to Congress Street
4	Atlantic Avenue - Congress Street to Northern Avenue/Seaport Blvd
5	Summer Street - Atlantic Avenue to Purchase Street
6	Summer Street - Atlantic Avenue to Dorchester Avenue
7	Summer Street - Dorchester Avenue to Haul Road
8	Essex Street - Chauncy Street to Lincoln Street
9	Essex Street - Lincoln Street to Atlantic Avenue
10	A Street - Congress Street to Dorchester Avenue
11	Dorchester Avenue - West 4th St to Old Colony Avenue
12	Dorchester Avenue - West 4th Street to West Broadway
13	Dorchester Avenue - West Broadway to West 2nd Street
14	Dorchester Avenue - Summer Street to West 2nd Street
15	Congress Street - Atlantic Avenue to Purchase Street
16	Congress Street - Atlantic Avenue to Dorchester Avenue
17	Congress Street - A Street to Dorchester Avenue
18	Purchase Street - Seaport Blvd/Northern Avenue to Congress Street
19	Purchase Street - Congress Street to Summer Street
20	Surface Road - Summer Street to Lincoln Street/Essex Street
21	Surface Road - Lincoln Street/Essex Street to Kneeland Street
22	Surface Road - Kneeland Street to I-90 Ramp
23	Lincoln Street - Essex Street to Kneeland Street
24	Lincoln Street - Kneeland Street to Hwy Ramps
25	South Station Connector - Surface Road to Lincoln Street
26	South Station Connector - Lincoln Street to Bus Terminal Entrance/HOV Parking Ramp
27	Kneeland Street - Washington Street to Surface Road
28	Kneeland Street - Surface Road to Lincoln Street
29	Kneeland Street - Lincoln Street to Atlantic Avenue
30	Beach Street - Atlantic Avenue to Surface Road
31	NEW Service Road (Alternative 3 Only)

The F40PH-2C locomotive with a 3,000 horsepower (hp) EMD 16-645E3B engine was chosen as the representative engine for all existing MBTA locomotives. Throttle notch and fuel consumption rates taken from Appendix B of the Locomotive Emission Standards,[26] as shown in Table 9, were used for the MBTA locomotives.

The P42-DC locomotive with a 3,200 hp GE 7FDL engine was chosen to be the representative locomotive for the Amtrak diesel locomotives, and the engine throttle data was taken from Appendix A-2 of Emissions Summary for Other Diesel Emission Sources in and Adjacent to the West Oakland Community,[27] as shown in Table 9—Throttle Notch Data and Fuel Consumption Rate. Because there were no fuel consumption data available for the 7FDL engine, the fuel consumption rate for the GE16 engine (an engine with operational characteristics similar to the 7FDL) were used for Amtrak engines.

Table 9—Throttle Notch Data and Fuel Consumption Rate

	EMD 16-645E3B Engine (Rated Power = 3,000 bhp)		GE 7FDL Engine (Rated Power = 3,200 bhp)	
Throttle Notch Setting	Power in Notch (bhp)	Fuel Rate (lb/hr)	Power in Notch (bhp)	Fuel Rate (lb/hr)
Dynamic Brake	138	126	109	-
Idling	17	279	11	17
1	105	296	179	50
2	363	361	388	86
3	721	432	787	273
4	1030	528	919	368
5	1438	657	1413	532
6	1821	827	2014	680
7	2492	1066	2699	858
8	3070	1186	3200	1082

Source of EMD Data: Appendix B, Locomotive Emission Standards. U.S. EPA, Office of Transportation and Air Quality, EPA-420-R-98-101, April 1998. http://www.epa.gov/otaq/documents/420r98101.pdf
Source of 7FDL Data: Table 1 of the Brunswick Rail Maintenance Facility, Potential Air Quality Impacts of Proposed Facility on Nearby Sensitive Land Uses. Parsons Brinckerhoff, August 2011.
http://www.amtrakdowneaster.com/sites/default/files/Potential%20Air%20Quality%20Impacts.pdf
* Fuel Rate for GE12 Engine from Appendix B, Locomotive Emission Standards. EPA-420-R-98-101, April 1998.

CO_2 emissions were estimated using approved U.S. EPA methodology.[28] CO_2 emissions are dependent on fuel consumption rates and include the following assumptions:

- Diesel fuel density of 3,200 grams per gallon (g/gal)
- Carbon content of fuel of 87% by mass

Based on these factors, a CO_2 emission rate of 10,217 grams per gallon of fuel was calculated for the Build condition, which includes Alternative 1 and Alternative 3.

The South Station average weekday train schedules for the 2012 Existing Conditions, 2035 No Build, and 2035 Build Alternatives were used to calculate locomotive idling and traveling times in the study area. The 2025 and 2035 No Build Alternative train schedules were assumed to be the same. The 2025 and the 2035 train schedules were assumed to be the same for Alternatives 1 and 3. Emissions from the Amtrak

[26] U.S. Environmental Protection Agency. *Locomotive Emission Standards.* April 1998. Accessed August 5, 2014. http://www.epa.gov/otaq/documents/420r98101.pdf.
[27] California Environmental Protection Agency. *Emissions Inventory of Other Diesel Emission Sources in and Adjacent to West Oakland.* Accessed August 5, 2014. http://www.arb.ca.gov/ch/communities/ra/westoakland/documents/partiii_final.pdf.
[28] U.S. Environmental Protection Agency. *Emission Factors for Locomotives.* April 2009. Accessed August 5, 2014. http://www.epa.gov/nonroad/locomotv/420f09025.pdf.

Acela trains were not assessed, as the electric locomotives do not have direct air emissions. All locomotives in the study area were assumed to be either in Idling Mode or Notch-1 setting.

10.1.2. Annual CO_2 Emissions Results by Project Alternative

South Station Site

To quantify potential emissions in compliance with the GHG Policy, Table 10 presents the annual CO_2 emissions in tons per year (tpy) occurring at the South Station site by project alternative. These CO_2 emissions include contributions from motor vehicles and buses on the local roadway network described above; and from train locomotives idling at South Station and moving from and to the Tower 1 interlocking.

Table 10—Project Related CO2 Emissions at South Station by Alternative (tpy)

Alternative	Locomotives	Motor Vehicles	Intercity Buses	Total All Sources
2012 Existing	15,233	11,767	581	27,581
2025 No Build	14,603	12,321	732	27,656
2025 Alternative 1	13,870	12,491	767	27,128
2025 Alternative 3	13,870	12,666	819	27,355
2035 No Build	14,603	12,771	785	28,159
2035 Alternative 1	13,870	13,010	819	27,699
2035 Alternative 3	13,870	13,190	851	27,911

tpy = tons per year

Layover Facility Sites

Table 11 presents the annual CO_2 emissions in tons per year (tpy) occurring in the vicinity of each of the layover facility sites by project alternative. These CO_2 emissions only include contributions from train locomotives idling at each layover facility site and moving from and to the Tower 1 interlocking. It was assumed that there would be no project-related pollutant emissions from motor vehicles, as there would be no measurable increase in motor vehicle traffic due to the SSX project. For informational purposes, Table 11 also includes the number of trains using each layover facility site each day. See Attachment X for calculations. There would be no difference in emissions between 2025 and 2035, and they are combined under the No Build and Alternative 1 or 3 categories.

Table 11—Project Related CO2 Emissions at Layover Facility Sites by Alternative

Alternative	No. of Trains per Day	Idling Trains CO2 (T/Y)	One Way Moving Time (min)	Moving Trains CO2 (T/Y)	Total Idling Plus Moving CO2 (T/Y)
Widett Circle Layover Facility					
2012 Existing	0	0	5	0	0
No Build	0	0	5	0	0
Alternative 1 or 3	30	4,884	5	869	5,753
Beacon Park Yard Layover Facility					
2012 Existing	0	0	11	0	0
No Build	0	0	11	0	0
Alternative 1 or 3	20	3,256	11	1,275	4,531
Readville Yard 2 Layover Facility					
2012 Existing	10	1,628	26	1,507	3,135
No Build	10	1,628	26	1,507	3,135
Alternative 1 or 3	18	2,930	26	2,713	5,643

tpy = tons per year

Net GHG Emissions

The impacts associated with Alternative 1 and Alternative 3 are calculated based on the net difference between the No Build and the Alternative 1/Alternative 3 CO_2 emission rates. These are summarized in Table 12, below.

Table 12—2035 Net Project Related CO2 Emissions by Alternative

	Alternative 1 tons/year	Alternative 3 tons/year
Motor Vehicles near South Station	239	419
Intercity buses near South Station	34	66
Locomotives near South Station	-733	-733
Locomotives to/from Layover Sites	15,927	15,927
Total	15,467	15,679

tpy = tons per year

The results show a net reduction in CO_2 emissions from locomotives in the immediate vicinity of South Station, associated with decreased congestion and idling time on the tracks. The emission totals do not account for the use of plug-ins, which will reduce locomotive idling emissions (while increasing the use of energy from the electric grid). Also, no credit is shown for the GHG reduction associated with traffic intersection improvements (and decreased idling time).

10.2. Regional Emissions

CTPS provided regional CO_2 emissions data to the South Station Expansion project team for each of the modeled alternatives, using the same methodology as for Boston Region MPO's Long Range Transportation Plan's regional air quality conformity determinations, linking the regional travel demand model with mobile emission factors produced by an emissions model, as well as accounting for emissions produced by transit services. Those data show a decrease in region-wide CO_2 emissions associated with the transportation improvements at South Station. Details are provided in Attachment W. Because the study covers a much wider area, and uses a different methodology, these results cannot be directly compared to the South Station-specific GHG emission calculations presented in this Technical Report, but the results do show that the transportation elements of the Project further the goal of GHG emissions.

11. Emissions Summary and Mitigation Measures

11.1. Emissions Summary

Summarizing from Tables 2, 3, 6, and 12, the total potential CO_2 emissions for the analyzed project alternatives are shown in Table 13.

Table 13—2035 Potential GHG Emissions Summary

Parameter	Alternative 1 CO_2 potential emissions (proposed case) tpy	Alternative 3 CO_2 potential emissions (proposed case) tpy
Stationary Source Direct Emissions	159	1,592
Stationary Source Indirect Emissions	2,033	5,144
Water/Wastewater	[not analyzed]	82
South Station area transportation	15,467	15,679

tpy = tons per year

While not directly comparable (because the analysis methodologies are different), the regional analysis of transportation-related CO_2 emissions shows an approximate savings of 46,000 tons/year CO_2 associated with the South Station transportation improvements.

11.2. Stationary Source Mitigation Measures

Building design is in the permitting (pre-conceptual) stage and will continue to evolve. As the SSX project design advances, MassDOT expects that additional technologies described previously, or possibly new technologies developed in the interim period, will be adopted that will further decrease GHG emissions for the project. MassDOT will continue to evaluate energy efficiency measures as the design develops.

Based on the current design, MassDOT is committed to the following mitigation elements (or equivalent measures) for the SSX project or for individual buildings:

11.2.1. Terminal Expansion

Proposed HVAC – High efficiency chillers and condensing boilers with VAV
– High efficiency (75%) energy recovery
Proposed Lighting – Optimized lighting design 20% better than code
Proposed Envelope – Higher performing insulated assemblies

11.2.2. Hotel & Multi-Family Highrise

Proposed HVAC – Fan Coils with high efficiency chillers and condensing boilers
Proposed Lighting – Optimized lighting design 20% better than code
Proposed Envelope – Higher performing insulated assemblies
Proposed Process – Energy star rated equipment (mutli-family only)

11.2.3. Mixed-Use Office/Retail

Proposed HVAC	– High efficiency chillers and condensing boilers with VAV
	– High efficiency (75%) energy recovery
	– Optimized controls
Proposed Lighting	– Optimized lighting design 20% better than code
Proposed Envelope	– Higher performing insulated assemblies

11.2.4. Water Use and Wastewater Generation

Mitigation measures for water use and wastewater generation would include water conservation measures as described in Section 4.9 of the DEIR. Measures would include the use of low-flow plumbing fixtures and providing plantings (at the South Station site) that would require low to no irrigation.

11.3. Mobile Source Mitigation Measures

The SSX project development would include specific transportation mitigation measures as described above for South Station area impacts along with those not quantified in the GHG analyses. These include intersection improvements as described in Section 7.2 of Appendix 9- *Traffic Analysis Technical Report,* and the use of plug-ins to reduce locomotive idling time. These would also include, following further evaluation by MassDOT for consistency with overall policies, preferred parking for hybrid vehicles and electric vehicle charging stations, as well as other transportation enhancements as described in Section 4.8 of this DEIR. Further details of transportation mitigation measures are presented in Appendix 9 - *Traffic Analysis Technical Report.*

11.4. Next Steps

In the detailed design phase, MassDOT will review and implement the following additional measures, if technically and economically feasible:

- Veolia steam network connections; including the use of Veolia steam to power absorption chillers if found to be feasible;
- Solar PV or hot water installations as described in Section 9; and
- Onsite CHP; including CHP serving absorption chillers if found to be feasible.

The use of Solar PV or onsite CHP would require resolution of electrical interconnection issues as described in Section 9.

MassDOT is committed to implementing the energy efficiency and GHG emission reduction measures presented in this analysis; however, MassDOT also must retain design flexibility to allow for changes that will inevitably occur as design progresses. The proposed case includes a comprehensive estimate of the anticipated GHG reductions that can be achieved based on building energy modeling with preliminary design information. If, during the course of design for an individual building, a specific combination of design strategies proves more advantageous from an engineering, economic, or space utilization perspective, the design may vary from what has been described herein. Minimum energy performance standards and associated GHG emission reductions, as shown in Table 1, will be adhered to on an overall project basis.

MassDOT commits to provide a self-certification document to the MEPA Office that is signed by an appropriate professional (e.g., engineer, architect, transportation planner, general contractor) and indicates that all of the required mitigation measures, or their equivalents, have been completed for each phase. The certification will be supported by plans that clearly illustrate what type of GHG mitigation measures have been incorporated into the project. For those measures that are operational in nature, MassDOT will provide an updated plan identifying the measures, the schedule for implementation, and a description of how progress towards achieving the measures will be obtained. The commitment to provide this self-certification is incorporated into the draft Section 61 Findings.

This Page Intentionally Left Blank