HARVARD
UNIVERSITY

NOTICE OF PROJECT CHANGE

HARVARD UNIVERSITY'S CAMPUS IN ALLSTON / SCIENCE AND ENGINEERING COMPLEX

SEPTEMBER 15, 2016 | EEA#14069

NOTICE OF PROJECT CHANGE

Harvard University's Campus in Allston / Science and Engineering Complex

Submitted to:

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs

EEA #14069

Submitted by:

Harvard University, through:

Harvard Planning & Project Management

Smith Campus Center

1350 Massachusetts Avenue

Cambridge, MA 02138

In conjunction with:

Behnisch Architekten

&

Epsilon Associates Inc.

Goulston & Storrs

Nitsch Engineering Inc.

Stephen Stimson Associates

Transolar/Klima Engineering

Turner Construction

Van Zelm Engineers

Vanasse Hangen Brustin Inc.

September 15, 2016

TABLE OF CONTENTS

FIGURES

1.0 PROJECT DESCRIPTION

2.0 TRANSPORTATION

3.0 GREENHOUSE GAS ANALYSIS

4.0 STORMWATER

5.0 MITIGATION MEASURES

TABLES

1.0 PROJECT DESCRIPTION

2.0 TRANSPORTATION

3.0 GREENHOUSE GAS ANALYSIS

4.0 STORMWATER

5.0 MITIGATION MEASURES

Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs ■ MEPA Office

For Office Use Only *Executive Office of Environmental Affairs*
MEPA Analyst:
Phone: 617-626-

Notice of Project Change

The information requested on this form must be completed to begin MEPA Review of a NPC in accordance with the provisions of the Massachusetts Environmental Policy Act and its implementing regulations (see 301 CMR 11.10(1)).

EEA # **14069**		
Project Name: **Harvard University's Campus in Allston/Science and Engineering Complex**		
Street Address: **Western Avenue**		
Municipality: **Boston**	Watershed: **Boston Harbor**	
Universal Transverse Mercator Coordinates: **UTM (Zone 19) 324941, 4692250**	Latitude: **42° 21' 46.16" N** Longitude: **71° 7' 33.09" W**	
Estimated commencement date: **3rd Q 2016**	Estimated completion date: **Fall 2020**	
Project Type: **Institutional**	Status of project design: **25% complete**	
Proponent: **Harvard University**		
Street Address: **1350 Mass Avenue**		
Municipality: **Cambridge**	State: **MA**	Zip Code: **02138**
Name of Contact Person: **Susan Radley**		
Firm/Agency: **Harvard University**	Street Address: **1350 Mass Avenue**	
Municipality: **Cambridge**	State: **MA**	Zip Code: **02138**
Phone: **(617) 496-3773**	Fax: **(617) 384-5269**	E-mail: susan_radley@harvard.edu

With this Notice of Project Change, are you requesting:

a Single EIR? (see 301 CMR 11.06(8))	☐Yes ☒No
a Special Review Procedure? (see 301CMR 11.09)	☐Yes ☒No
a Waiver of mandatory EIR? (see 301 CMR 11.11)	☐Yes ☒No
a Phase I Waiver? (see 301 CMR 11.11)	☐Yes ☒No

Which MEPA review threshold(s) does the project meet or exceed (see 301 CMR 11.03)?
None

Which State Agency Permits will the project require?
Mass DEP – Limited Plan Approval Air Permit
MWRA – 8M Permit and Sewer Use Discharge Permit

Identify any financial assistance or land transfer from an Agency of the Commonwealth, including the Agency name and the amount of funding or land area in acres: **Tax Exempt Bond Financing**

PROJECT INFORMATION

In 25 words or less, what is the project change? The project change involves: **a change to the design, program, and phasing of the Science Complex which had been approved via a Phase 1 Waiver in 2007.**
See full project change description beginning on page 3.

Date of publication of availability of the ENF in the Environmental Monitor: (Date: **August 5, 2007**)

Was an EIR required?	☒Yes	☐No; if yes,
was a Draft EIR filed?	☒Yes (Date: January 2014)	☐No
was a Final EIR filed?	☒Yes (Date: August 2014)	☐No
was a Single EIR filed?	☐Yes (Date:)	☒No

Have other NPCs been filed? ☒Yes (Date(s): April 2013) ☐No

If this is a NPC solely for lapse of time (see 301 CMR 11.10(2)) proceed directly to **ATTACHMENTS & SIGNATURES**.

PERMITS / FINANCIAL ASSISTANCE / LAND TRANSFER

List or describe all new or modified state permits, financial assistance, or land transfers not previously reviewed: **dd w/ list of State Agency Actions (e.g., Agency Project, Financial Assistance, Land Transfer, List of Permits) None**

Are you requesting a finding that this project change is insignificant? A change in a Project is ordinarily insignificant if it results solely in an increase in square footage, linear footage, height, depth or other relevant measures of the physical dimensions of the Project of less than 10% over estimates previously reviewed, provided the increase does not meet or exceed any review thresholds. A change in a Project is also ordinarily insignificant if it results solely in an increase in impacts of less than 25% of the level specified in any review threshold, provided that cumulative impacts of the Project do not meet or exceed any review thresholds that were not previously met or exceeded. (see 301 CMR 11.10(6)) ☒**Yes** ☐**No; if yes, provide an explanation of this request in the Project Change Description below.**

As described in more detail in Chapter 1, Project Description, the currently proposed project is similar in scale to the previously approved project but due to a change in program has less parking demand and will generate fewer vehicle trips. In addition, a project of a larger scale was included in the December 2013 DEIR and August 2014 FEIR for Harvard's Campus in Allston so the impacts and mitigation for development of this site have already been reviewed through MEPA.

FOR PROJECTS SUBJECT TO AN EIR

If the project requires the submission of an EIR, are you requesting that a Scope in a previously issued Certificate be rescinded?
☐**Yes** ☒**No; if yes, provide an explanation of this request.**

If the project requires the submission of an EIR, are you requesting a change to a Scope in a previously issued Certificate?
☐**Yes** ☒**No; if yes, provide an explanation of this request**_____**.**

SUMMARY OF PROJECT CHANGE PARAMETERS AND IMPACTS

Summary of Project Size & Environmental Impacts	Previously reviewed	Net Change	Currently Proposed
LAND			
Total site acreage	**8.5**	**+7.1**	**15.6**
Acres of land altered	**0**	**0**	**0**
Acres of impervious area	**8.11**	**+7.1**	**15.2**
Square feet of bordering vegetated wetlands alteration	**0**	**0**	**0**
Square feet of other wetland alteration	**0**	**0**	**0**
Acres of non-water dependent use of tidelands or waterways	**0**	**0**	**0**
STRUCTURES			
Gross square footage **(1)**	**589,000**	**-32,150**	**556,850**
Number of housing units	**0**	**0**	**0**
Maximum height (in feet)	**107**	**0**	**107**
TRANSPORTATION			
Vehicle trips per day	**1,480**	**-910**	**570**
Parking spaces	**500**	**-225**	**275**
WATER/WASTEWATER			
Gallons/day (GPD) of water use	**65,745**	**-295**	**65,450**
GPD water withdrawal	**0**	**0**	**0**
GPD wastewater generation/ treatment	**59,758**	**-258**	**59,500**
Length of water/sewer mains (in miles)	**NA**	**NA**	**NA**

1. With the exception of the District Energy Facility, all square footage numbers in this document refer to gross floor area as defined by the Boston Zoning Code.

Does the project change involve any new or modified:

1. conversion of public parkland or other Article 97 public natural resources to any purpose not in accordance with Article 97? ☐**Yes** ☒**No**
2. release of any conservation restriction, preservation restriction, agricultural preservation restriction, or watershed preservation restriction? ☐**Yes** ☒**No**
3. impacts on Rare Species**?** ☐**Yes** ☒**No**
4. demolition of all or part of any structure, site or district listed in the State Register of Historic Place or the inventory of Historic and Archaeological Assets of the Commonwealth? ☐**Yes** ☒**No**
5. impact upon an Area of Critical Environmental Concern? ☐**Yes** ☒**No**

If you answered 'Yes' to any of these 5 questions, explain below:

PROJECT CHANGE DESCRIPTION (attach additional pages as necessary). The project change description should include:

(a) a brief description of the project as most recently reviewed
(b) a description of material changes to the project as previously reviewed,
(c) if applicable, the significance of the proposed changes, with specific reference to the factors listed 301 CMR 11.10(6), and
(d) measures that the project is taking to avoid damage to the environment or to minimize and mitigate unavoidable environmental impacts. If the change will involve modification of any previously issued Section 61 Finding, include a draft of the modified Section 61 Finding (or it will be required in a Supplemental EIR).

Description of the Project as most Recently Reviewed

In July 2007, Harvard filed an Environmental Notification Form (ENF) outlining a 20-year Master Plan for Harvard's campus in Allston. The 2007 ENF filing also included a Phase I Waiver Request for the proposed Allston Science Complex (the 2007 Science Project). That waiver request was granted by way of a Final Record of Decision issued on October 16, 2007.

Following public review and comment on the ENF, the Secretary issued two Certificates on September 14, 2007, the first outlining the issues to be studied in an Environmental Impact Report (EIR) and the second establishing a Special Review Procedure to guide the MEPA Review of the master plan project.

After a pause, Harvard filed an NPC for the Harvard University's Campus in Allston in April 2013 and subsequently filed a DEIR (December 2013) and FEIR (August 2014). Those filings described a master plan project that was significantly smaller in scope (ten years rather than twenty years), square footage (one million square feet of new development as opposed to four to five million), and geographic area (178 acres rather than 215 acres) than was presented in the ENF filed in 2007.

The 2007 Science Project as proposed in the 2007 Phase I Waiver Request was a new scientific research and education complex of approximately 537,000 gross square feet of above-ground program and amenity space within four building components on an approximately 8.5 acre site. The 2007 Science Project also included approximately 52,000 gross square feet of shared research support facilities below-grade, as well as an underground distributed energy facility, parking for approximately 500 cars (with approximately 350 spaces located within the building and approximately 150 additional spaces located across Western Avenue dedicated to the Science Complex), and loading and mechanical facilities. The 2007 Science Project also included various amenities open to the public, including retail space, an auditorium, and a cafeteria. In addition, the 2007 Science Project's four building components were to surround a central courtyard that

resembled the spatial scale of Harvard's yards and open spaces, and was proposed to be bordered on the west by the proposed Academic Way (a new wide, landscaped pedestrian walkway), to the south by the proposed Rena Street extension, and to the north by Stadium Way. All of these new streets and walkways were to be accessible to the public.

As was described in the ENF and Phase 1 Waiver Request, the 2007 Science Project did not independently trigger any MEPA review thresholds, and, as a stand-alone project (in the absence of state funding), was not subject to MEPA review.

As noted, the Phase 1 Waiver Request was granted in late 2007 by way of a Final Record of Decision and construction on the project began. However, in 2009 in light of significantly changed economic circumstances, Harvard paused construction of the 2007 Science Project and worked to reassess its needs and resources. As described in Chapter 5, Mitigation Measures, although construction on the 2007 Science Project was paused, many of the mitigation measures and benefits outlined in the Final Record of Decision were implemented. These include constructing Ray Mellone Park (a new 1.74 acre public park adjacent to the Honan Library), working with the City of Boston to design and implement bicycle lanes in the project area, and improving sidewalks on North Harvard Street and Western Avenue.

As discussed in more detail in Chapter 1, Project Description, in 2010, Harvard convened an internal Work Team comprised of senior faculty and administrators to advise the University on how the University might proceed in planning for its properties in Allston. In addition, Harvard developed a series of internal planning principles to guide redevelopment of the site of the 2007 Science Project. Following the Work Team recommendations and the development of the planning principles, the University undertook a planning and reprogramming effort that built on the 2007 Science Project but which also included changes, which are discussed below.

Description of the Material Changes to the Project

The Science and Engineering Complex (SEC or Project) consists of the following three components:

1. Construction of a new building at 130-140 Western Avenue (the SEC Building) that will provide laboratories, classrooms, related teaching and research facilities, and ground-floor publicly accessible amenities for Harvard's John A. Paulson School of Engineering and Applied Sciences (SEAS);
2. Renovation of the existing 114 Western Avenue office building for use by SEAS; and
3. Construction of an above-grade district energy facility (DEF) on a parcel of land located on the west side of the proposed "East Drive."

In addition to creating new facilities for SEAS, the Project will include significant publicly accessible open space, new streets, a broad range of streetscape improvements, infrastructure upgrades, and various transportation improvements including parking, transit accommodations, bike facilities, and pedestrian amenities.

The primary changes to the 2007 Science Project include:

- The primary occupant of the SEC Building will be the John A. Paulson School of Engineering and Applied Sciences rather than the Harvard Stem Cell Institute.
- The existing Harvard-owned building at 114 Western Avenue has been added to the project site. The building will be renovated and used for administrative and classroom space for SEAS.

- The district energy facility that had been located in the below-grade portion of the SEC Building has been brought above-grade and will be located on a parcel of land located on the west side of the proposed "East Drive."
- The building program for the SEC Building on the existing building foundation has been reduced from 589,000 SF to 445,350 SF and the overall Project square footage has been reduced from 589,000 square feet to 556,850 square feet.
- The new construction on the SEC Building project site will consist of a single building on the northern portion of the site rather than four separate but connected buildings.
- The southern portion of the SEC Building site is being preserved for future as yet to be determined development and will be landscaped in the interim.
- The western edge of the SEC site – referred to as "Academic Way"- will be a street running between Western Avenue and "Science Drive" rather than a pedestrian path.
- "Science Drive" will connect Rotterdam Street with "Academic Way" rather than end with a turn-around on its western edge.
- The inclusion of SEAS will result in a change of users when compared to the 2007 Science Project with a reduction in faculty/staff and an increase undergraduates and graduate students/researchers.
- The number of parking spaces has been reduced from 500 to 275.
- Parking will be located in two surface lots - the existing lot that serves the building at 114 Western Avenue and a new lot to be constructed south of Rotterdam Street – rather than in the basement of the SEC Building.

Significance of the Proposed Changes

As described in Chapter 1, Project Description, the current Project is similar in scale to the 2007 Science Project but due to a change in program the current Project has a reduced traffic demand and will generate fewer peak hour vehicle trips. In addition, a project of a larger scale was included in the December 2013 DEIR and August 2014 FEIR for Harvard's Campus in Allston so the impacts and mitigation for development of this site have already been reviewed through MEPA.

Mitigation Measures

In November 2015, Harvard submitted an Institutional Master Plan Notification Form (IMPNF)/Notice of Project Change (NPC) to the Boston Redevelopment Authority (BRA) related to the revised project. The IMPNF/NPC submittal began the process of amending the 2013 Institutional Master Plan (IMP) for Harvard University's Allston Campus and revising the project-specific Large Project Review that had been completed for the 2007 Science Project.

On December 23, 2015, the BRA issued the Scoping Determination outlining issues to be studied in an IMP Amendment. The Scoping Determination includes review by the relevant City agencies and departments including the Boston Transportation Department, Boston Water & Sewer Commission, Boston Environment Department, and others. The IMP Amendment was submitted on January 29, 2016 and was approved by the BRA Board on April 14, 2016 and the Boston Zoning Commission on May 18, 2016. Through these reviews under the BRA's IMP review process and Large Project Review process, a series of program-wide and project-specific mitigation measures have been developed.

In addition, as mentioned, the MEPA Office issued a waiver by way of a Final Record of Decision issued on October 16, 2007 for the Allston Science Complex. Although construction on the 2007 Science Project was

paused, many of the mitigation measures and benefits outlined in the Final Record of Decision were implemented. These include constructing Ray Mellone Park (a new 1.74 acre public park adjacent to the Honan Library), working with the City of Boston to design and implement bicycle lanes in the project area, and improving sidewalks on North Harvard Street and Western Avenue.

More information on the Project's mitigation measures is included in Chapter 5, Mitigation Measures.

ATTACHMENTS & SIGNATURES

Attachments:

1. Secretary's most recent Certificate on this project
2. Plan showing most recent previously-reviewed proposed build condition
3. Plan showing currently proposed build condition
4. Original U.S.G.S. map or good quality color copy (8-1/2 x 11 inches or larger) indicating the project location and boundaries
5. List of all agencies and persons to whom the proponent circulated the NPC, in accordance with 301 CMR 11.10(7)

This document includes the following chapters of additional information:

1. Project Description
2. Traffic Analysis
3. GHG Analysis
4. Stormwater Analysis
5. Mitigation Measures

In addition, this document includes the following appendices:

A. Table of Cumulative Impacts
B. Secretary's Certificate on the FEIR
C. Additional Figures (2007 Allston Science Complex Site Plan, Current Site Plan, USGS map)
D. Circulation List
E. Air Quality

Signatures:

8/29/16 — Katherine N. Lapp
Date — Signature of Responsible Officer or Proponent

9/15/16 — Will Donham
Date — Signature of person preparing NPC (if different from above)

Katherine N. Lapp
Name (print or type)

Harvard University
Firm/Agency

Mass Hall, Harvard Yard
Street

Cambridge, MA 02138
Municipality/State/Zip

(617) 495-1524
Phone

Will Donham
Name (print or type)

Harvard Planning and Project Management
Firm/Agency

1350 Mass Avenue
Street

Cambridge, MA 02138
Municipality/State/Zip

(617) 495-1315
Phone

1.0 PROJECT DESCRIPTION

1.1 Project Summary

The Science and Engineering Complex (SEC or Project) consists of the following three components:

1. Construction of a new building at 130-140 Western Avenue (the SEC Building) that will provide laboratories, classrooms, related teaching and research facilities, and ground-floor publicly accessible amenities for Harvard's John A. Paulson School of Engineering and Applied Sciences (SEAS);
2. Renovation of the existing 114 Western Avenue office building for use by SEAS; and
3. Construction of an above-grade district energy facility (DEF) on a parcel of land located on the west side of the proposed "East Drive."

In addition to creating new facilities for SEAS, the Project will include significant publicly accessible open space, new streets, a broad range of streetscape improvements, infrastructure upgrades, and various transportation improvements including parking, transit accommodations, bike facilities, and pedestrian amenities.

1.2 Previously Approved Project

In 2007, the University received approval to construct the Harvard Allston Science Complex (the 2007 Science Project). The 2007 Science Project was the subject of a Phase 1 Waiver Request submitted as part of an Environmental Notification Form (ENF) on July 31, 2007 for Harvard's 20-year Master Plan. The 2007 Science Project received a Phase 1 Waiver in the form of a Final Record of Decision issued by the Secretary of Energy and Environmental Affairs on October 16, 2007.

Below are the key elements of the 2007 Science Project:

- That approved Project consisted of approximately 589,000 square feet of space in four interconnected buildings on an 8.5 acre site.
- Of this, approximately 532,000 square feet was located above-grade and approximately 57,000 square feet was located below-grade.
- The 2007 Science Project was to be constructed in a single phase.
- The 2007 Science Project was to be the home of the Harvard Stem Cell Institute and others, and included primarily research space, but also included an atrium, ground floor retail space, a daycare facility, an auditorium, a district energy facility, and parking, both below-grade and off-site.
- The 2007 Science Project included a large central green open space as well as new streets and pathways around its perimeter.

- The 2007 Science Project included a total of 500 parking spaces, 350 of which were to be located in a below-grade garage.

- Construction of the 2007 Science Project started in late 2007 and resulted in the completion of the foundation and elements of the subsurface component of the Project, but in 2009, the University announced that work on the Project would be paused.

1.3 Planning for Current Project

In 2010, Harvard convened an internal Work Team comprised of senior faculty and administrators to advise the University on how the University might proceed in planning for its properties in Allston. In addition, Harvard developed a series of internal planning principles to guide redevelopment of the site of the 2007 Science Project. These include:

- Maintain the University's leadership in science teaching and research;
- Develop a project that is consistent with the recently approved 2013 Institutional Master Plan (IMP);
- Design a project that continues to include significant permeability both through the site and the building itself;
- Design a project that maintains significant transparency at the street;
- Develop a vibrant public realm;
- Provide significant landscaped open space within the project;
- Comply with City and Harvard's own sustainability guidelines;
- Develop area-wide connectivity with courtyard connections to open space including the future Greenway, Rena Park and Path, as well as adjacent streets;
- Establish building density, massing, and scale consistent with the IMP, with higher density closer to Western Avenue and lower density to the south; and
- Connect with the area's intermodal transportation network.

1.4 Changes to the Project

Following the Work Team recommendations and the development of the planning principles, the University undertook a planning and reprogramming effort that built on the previously approved Project but which also included changes.

Changes to the Project Context

Since the original project was approved in 2007, there have been two important changes in the context of the project.

First, there have been significant changes in the built environment in the area around the site. Commercial activities have increased through the renovation of existing Harvard-owned buildings for use as Stone Hearth Pizza (182 Western Avenue) and SwissBakers (168 Western Avenue). Additional institutional uses have been added through the creation of the Harvard Innovation Lab at 125 Western Avenue and the renovation of 28 Travis Street for Harvard activities. Harvard-related community-oriented uses such as the Ed Portal and the Ceramics Program have been expanded and relocated to 224 Western Avenue

from 175 North Harvard Street. The residential nature of the immediate area has changed with the construction of the Continuum Project in Barry's Corner and the relocation of the Charlesview Apartments to a new site further west on Western Avenue and the demolition of the former Charlesview buildings. In addition, both Continuum and the new Charlesview include ground floor retail space. And finally, the open space character has changed with Harvard's development of Ray Mellone Park to the southwest, the opening of the grove of trees on the former Charlesview site, and the anticipated opening of Rena Park in November 2016. As a result of these activities, the site of the SEC is not carrying the responsibility of a single project, but instead will be a contributor to a range of activities and uses along Western Avenue.

Second, at the time of the permitting of the 2007 Science Project, the University was in the early stages of developing its Institutional Master Plan for its Allston campus. That master planning effort was included in an Institutional Master Plan Notification Form (IMPNF), filed with the Boston Redevelopment Authority (BRA) in early 2007, and an ENF filed with the MEPA Office in July 2007. The 2007 ENF and IMPNF presented a master plan that included both a 20-year plan and a 50-year vision. In response to the 2007 IMPNF, the BRA issued a Scoping Determination outlining the issues to be addressed in the new IMP. Due to the global financial downturn and its severely constraining effects, the University slowed its long-term master planning process and did not then file a new IMP.

Following a period of internal review and external outreach, the University withdrew its 2007 IMPNF and filed a new IMPNF in the Fall of 2012 and a new IMP in 2013. The 2013 IMP, which was approved by the BRA Board in October 2013 and the Boston Zoning Commission in November 2013, provides a Ten-Year Plan and Long-Term Vision for a broader Science and Enterprise district that includes the site of the SEC.

In 2013 and 2014 Harvard University submitted a Draft and Final Environmental Impact Report (EIR) based on the Ten-Year IMP for its campus in Allston. On October 17, 2014 the Secretary issued a Certificate finding that the FEIR "adequately and properly complied with MEPA."

Although the SEC was not technically a Proposed Institutional Project in the 2013 IMP or the 2013 Draft EIR or 2014 Final EIR, it was included in the discussion of planning districts, as well as a background project in the technical analyses. As a result of the development of this planning framework, the SEC can be seen in the context of future development and institutional activities rather than as a stand-alone project as it was in the 2007 permitting process.

Changes to the Project

The primary changes to the 2007 Science Project include:

- The primary building occupant will be the John A. Paulson School of Engineering and Applied Sciences (SEAS) rather than the Harvard Stem Cell Institute.
- The existing adjacent Harvard-owned building at 114 Western Avenue has been added to the Project site. The building will be renovated and used for administrative space for SEAS.
- The inclusion of SEAS will result in a change of users when compared to the 2007 Science Project with a reduction in faculty/staff and an increase undergraduates and graduate students/researchers.
- The energy facility that had been planned in the below-grade level of the SEC Building is being relocated as an approximately 60,000 square foot, above-grade

DEF to be located on a parcel of land on the west side of future "East Drive." This relocation is a design response to the projected impacts of climate change and further study of the Project's climate resiliency strategy.

- The building program on the existing building foundation has been reduced from 589,000 SF to 445,350 SF and the overall Project square footage (including 114 Western the DEF) has been reduced from 589,000 square feet to 556,850 square feet.
- The SEC Building will consist of a single building on the northern portion of the site rather than four separate but connected buildings.
- The southern portion of the site is being preserved for future as yet to be determined institutional development and will be landscaped in the interim.
- The western edge of the site – referred to as "Academic Way"- will be a street running between Western Avenue and "Science Drive" rather than a pedestrian path.
- "Science Drive" will connect Rotterdam Street with "Academic Way" rather than end with a turn-around on its western edge.
- Parking has been reduced from 500 spaces to 275 and will be located in two surface lots - the existing lot that serves the building at 114 Western Avenue and a new lot to be constructed south of Rotterdam Street – rather than in the basement of the building.

Table 1 depicts the comparison of the previously approved 2007 Science Project and the currently proposed Project.

Table 1: Comparison of 2007 Project with Current Project

Dimensions	2007 Project	Current Project
Site Size	8.5 acres	15.6 acres
Project Square Footage	589,000 SF	556,850 SF
Foundation	589,000 SF	445,350 SF
Above-ground	537,000 SF	363,550 SF
Below-grade	52,000 SF	81,800 SF
114 Western Ave	N/A	51,500 SF
DEF	Included in the below-grade level of the project	60,000 SF
Building Height (zoning)	107 feet	Comparable
Parking Spaces	350 on site, 150 off-site	275 on site
LEED Target	Gold	Gold

Note: With the exception of the DEF, all square footage numbers in this document refer to gross floor area as defined by the Boston Zoning Code.

1.5 Project Description

Project Site

As shown in Figure 1, the Project will be located in North Allston on two sites on the southerly side of Western Avenue, east of the intersection of Western Avenue and North Harvard Street, and east of Travis Street.

Since the original Project was approved in 2007, the size of the Project site has increased

from approximately 8.5 acres to approximately 15.6 acres. The increase in size is attributable to the inclusion of the existing Harvard-owned building at 114 Western Avenue and the site of the DEF into the Project.

Building Program and Dimensions

The Science and Engineering Complex Project as a whole is comprised of three components: a single building fronting on Western Avenue, the renovation and reuse of an existing building at 114 Western Avenue, and the DEF. Table 2 provides area calculations of uses within each building.

Table 2: Building Program (Gross Floor Area)

	SEC	114 Western	SUBTOTAL	DEF	TOTAL
Dedicated Laboratory	209,000	0	**209,000**		**209,000**
Admin	8,400	12,200	**20,600**	3,000	**23,600**
Amenities / Retail	31,000	1,700	**32,700**		**32,700**
Atrium / Circulation	122,250	20,800	**143,050**		**143,050**
Teaching Environments	58,200	14,300	**72,500**		**72,500**
Core Layout	16,500	2,500	**19,000**		**19,000**
District Energy Facility				57,000	**57,000**
TOTAL	**445,350**	**51,500**	**496,850**	**60,000**	**556,850**

Note: All square footage numbers refer to gross floor area as defined by the Boston Zoning Code.

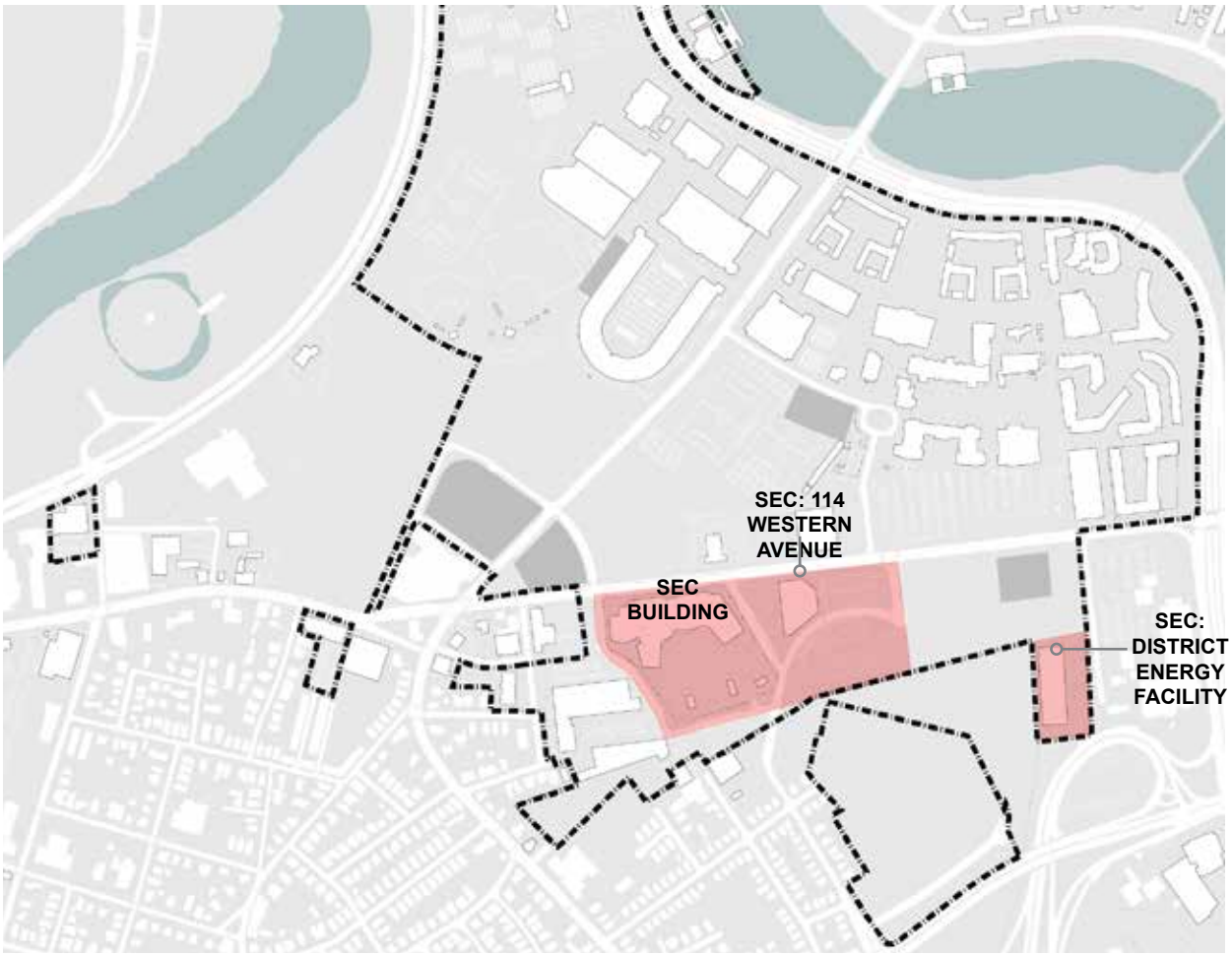


Figure 1: Project Within Proposed IMP Area

SCIENCE AND ENGINEERING COMPLEX

The SEC Building is designed to have ground floor functions that open strategically onto Western Avenue and the central courtyard, two publicly accessible areas that will attract lively pedestrian activities. In addition to the entrance in the center of the building on Western Avenue, there will be building entrances located at the northwest corner (towards Barry's Corner) and northeast corner (facing Harvard Business School).

Consisting of three laboratory "blocks" and an exterior quadrangle, the SEC Building will span up to six floors above-grade, with two additional levels below ground at the courtyard level. The interior of the SEC Building will open to the courtyard, featuring recessed gardens that provide light into the lower floors of the building and accessible terraces with ample greenery and seating.

Research labs will comprise a mix of wet and dry spaces with both open lab research areas and enclosed specialty and core facilities. Research will range from robotics prototyping to materials synthesis. Core facilities may include soft lithography, rheology, motion capture, biological characterization, and machine fabrication shops.

Teaching environments will be focused on active learning spaces and will be located on the lower floors of the building. Program spaces include maker space, design studios, fabrication garages, clubhouse plaza rooms, as well as traditional flat and sloped floor classrooms.

The communal areas in the atrium and the cafeteria/lounges will promote an innovative and interactive educational environment that reinterprets the spatial and social characteristics of Harvard Yard while reflecting Harvard's rich intellectual traditions. Throughout, they are complemented and supported by highly sustainable systems that will continue to inspire and, in turn, attract the best scientists and students to Harvard.

The figures on the following pages depict site/floor plans, elevations, and renderings.

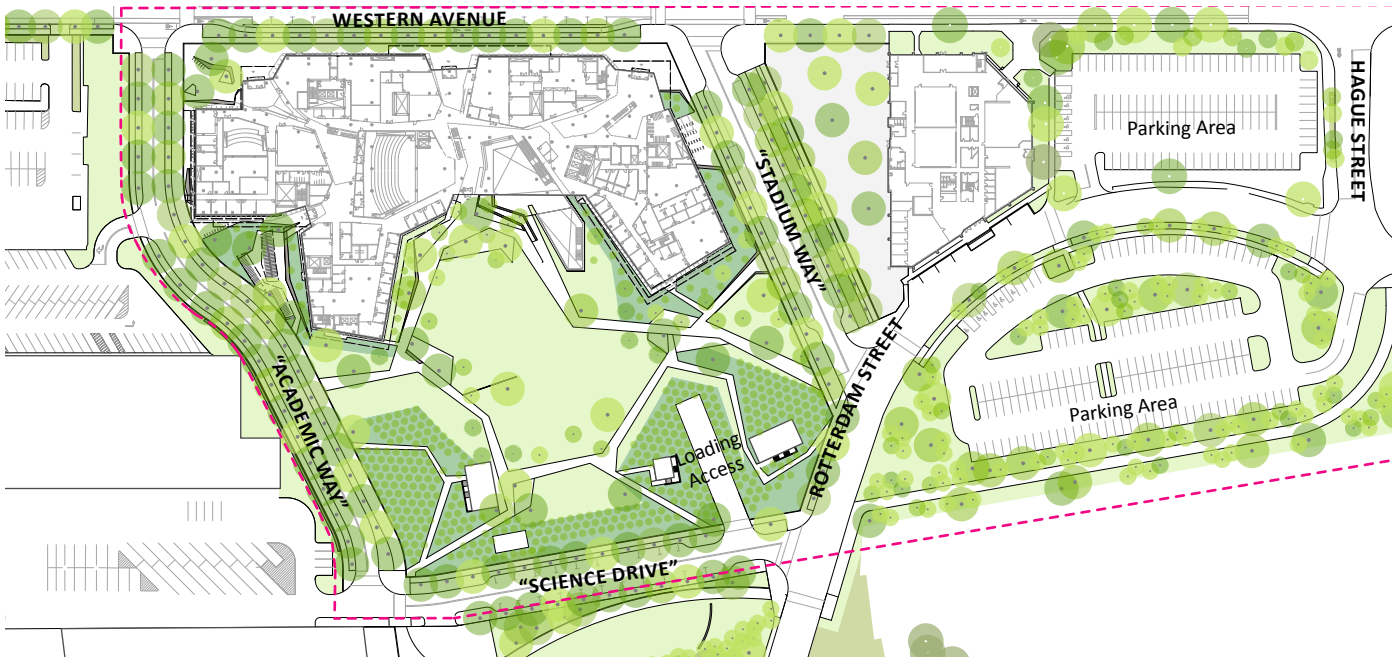
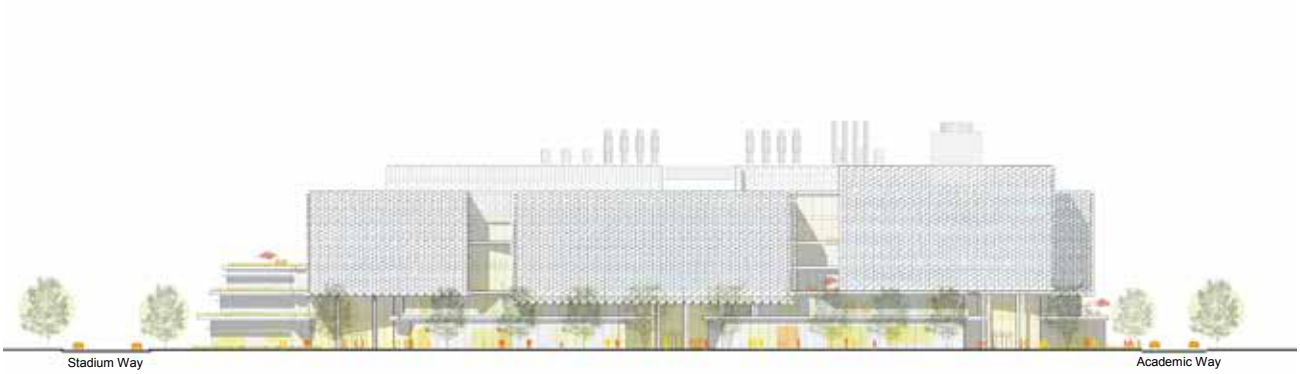


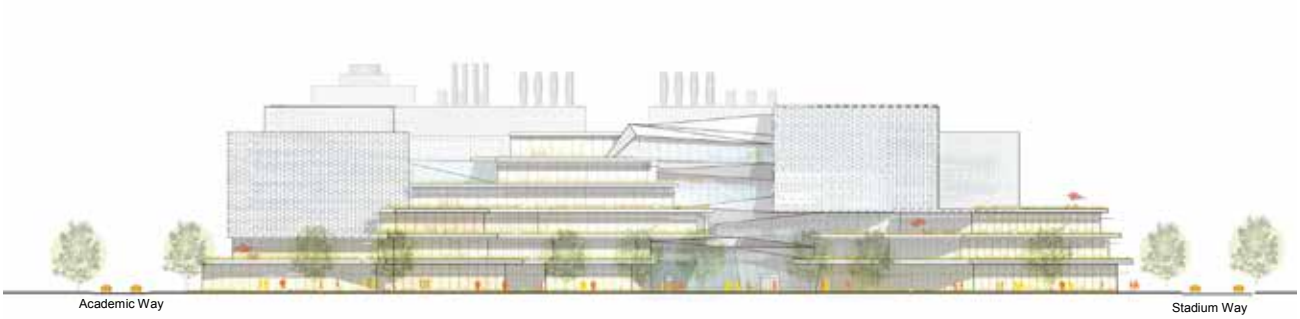
Figure 2: Site Plan

Figure 3: Second Floor Plan

Figure 4: Upper Floor Plan (Typical)

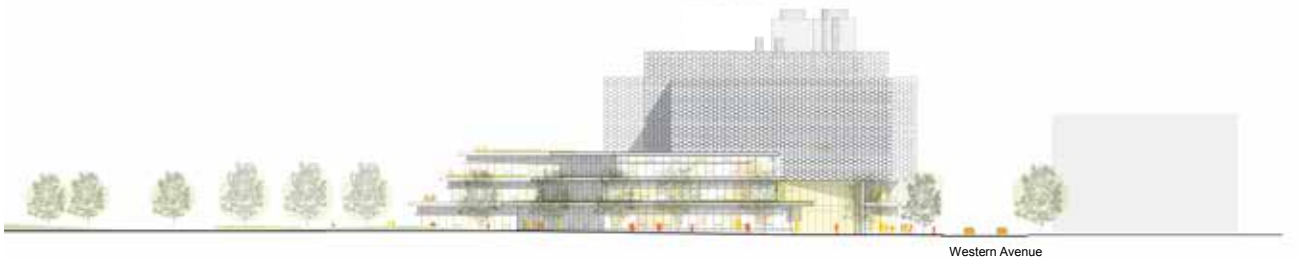


VIEW SOUTH



VIEW NORTH

VIEW EAST



VIEW WEST

Figure 5: Elevations

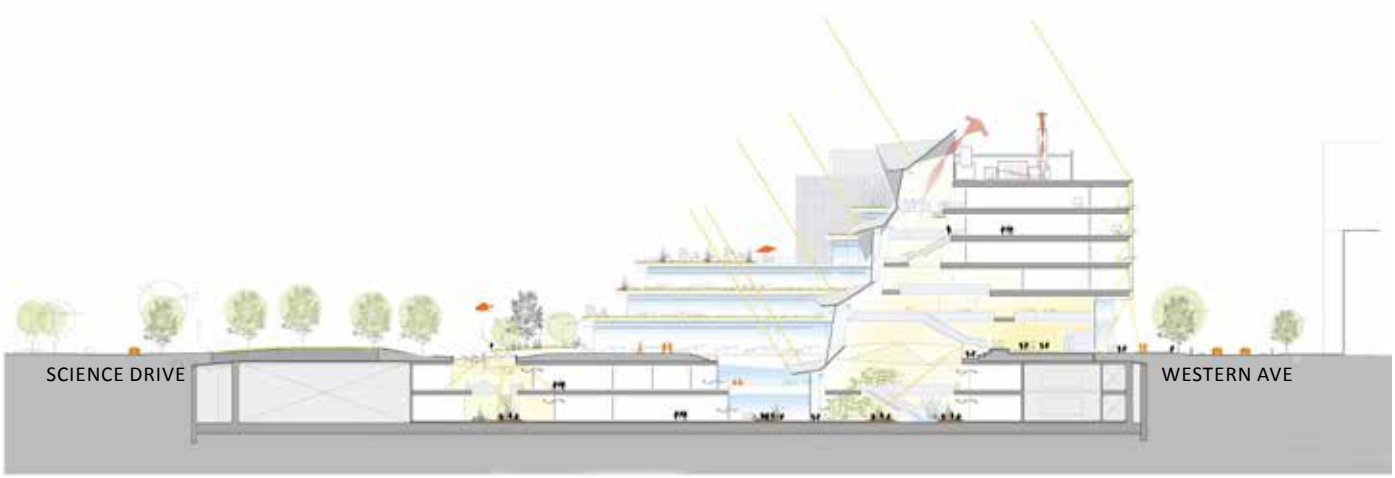


Figure 6: Section

Figure 7: Central Atrium

Figure 8: View from Western Avenue Looking East

Figure 9: View from Western Avenue Looking West

114 WESTERN AVENUE

114 Western Avenue was constructed in 1983 as a three story office building of approximately 79,000 square feet of gross floor area for the Boston-based PBS station, WGBH. 114 Western Avenue was previously connected to 125 Western Avenue via a pedestrian bridge over Western Avenue that was constructed in 1984; the bridge has since been removed. The pedestrian bridge and 114 Western Avenue building were designed by the Waltham-based engineering and architectural services firm Keyes Associates.

As part of the overall Project, the 114 Western Avenue building will be renovated and approximately 51,500 square feet of gross floor area will be used by SEAS. The building will serve as an extension of the SEC at 130-140 Western Avenue. The proposed renovation will house administrative offices, teaching support spaces, and classroom environments for SEAS. A preliminary building program is included in Table 2.

Any remaining un-programmed space within the 114 Western Avenue building will be fit out for future tenants.

In addition to the preliminary program requirements, a number of upgrades and repairs will also be required, including the cleaning and replacement of portions of the façade, life safety upgrades to meet current code (such as new fire alarm and fire protection/sprinkler), and accessibility upgrades (for MAAB compliance).

Figure 10: Existing Conditions - 114 Western Avenue North Facade

DISTRICT ENERGY FACILITY

The planning for the recommencement of the SEC included the inclusion of a facility that will supply hot water for heating, chilled water for cooling, and electricity for building power for the SEC Building. However, on a parallel track, the University was also undertaking additional studies related to climate resiliency and district energy.

The results of these analyses led Harvard to propose the removal of the energy facility from the subsurface level of the SEC Building and the construction of an above-grade district energy facility. This approach will alleviate the significant risks outlined in the resiliency report and serve energy needs for the Ten-Year IMP program as well as future academic buildings, and in the future potentially provide redundant support for some Harvard facilities in Boston currently served by Harvard's Blackstone Plant in Cambridge. Concurrent with the resiliency review, Harvard also recently finalized agreements with CSX Transportation Inc. (CSX) relinquishing control to Harvard of Allston Landing North, subject to some additional near-term environmental remediation of a portion of Allston Landing North. This transaction between CSX and Harvard provides an opportunity for Harvard to propose relocating the DEF from a subsurface location to an above-grade site on the west side of the proposed "East Drive."

After considering several alternative locations, Harvard now proposes to locate the DEF on the west side of the block fronting on the southern extension of the future "East Drive." The location of the southern extension of "East Drive" is consistent with the current MassDOT and BRA planning for roadways between Cambridge Street and Western Avenue that are part of the I-90 Interchange project.

Following are two figures from the BRA-approved IMP Amendment (April 2016). Figure 11 depicts the location of the DEF in the Ten-Year Plan and Figure 12 depicts the location of the DEF in the Long-Term Vision.

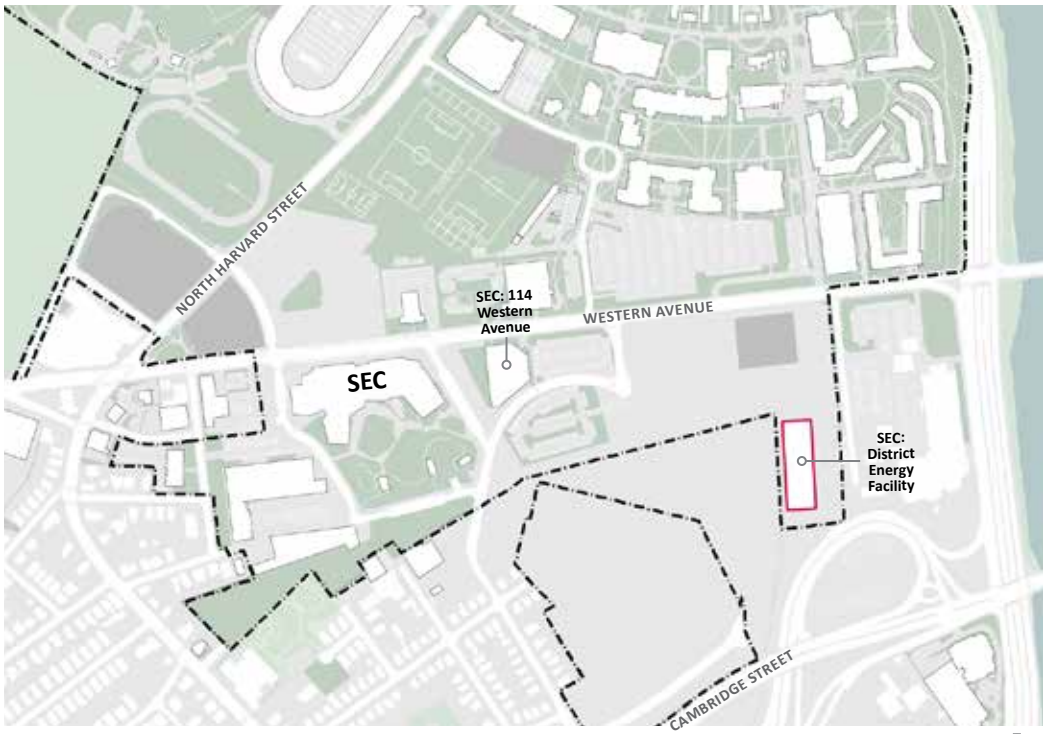


Figure 11: District Energy Facility Location in Ten-Year Plan as Depicted in April 2016 IMP Amendment

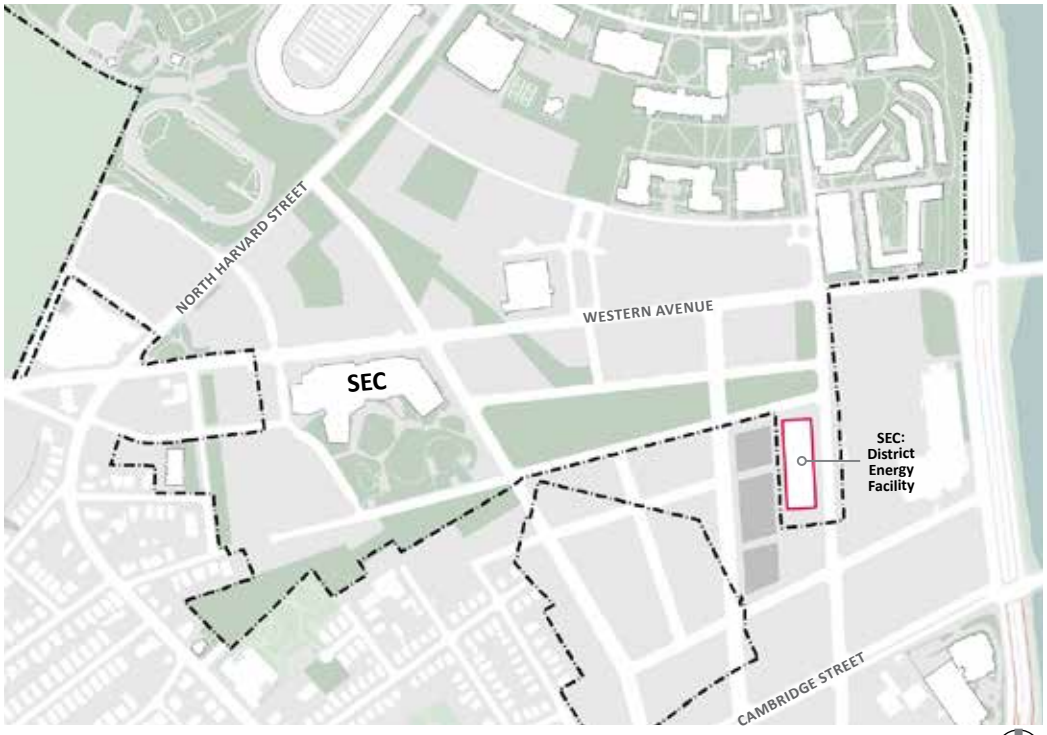


Figure 12: District Energy Facility Location in Long-Term Vision as Depicted in April 2016 IMP Amendment

District Energy Facility Site Selection

The proposed DEF site was selected for the following reasons:

- The site takes advantage of property in Allston Landing North over which Harvard recently gained control;
- The site allows for maximum flexibility in terms of future energy needs, including connections to the Blackstone Plant in Cambridge and accommodating future growth;
- The site is distant from existing residential neighborhoods, respecting neighborhood concerns for proximity of such facilities; and
- The site and building configuration are intended to minimize its impact on the future Greenway.

In addition, the location of this facility is being coordinated with Harvard's own planning about the future Greenway and the future Enterprise Research Campus. The DEF is a permanent support facility and therefore its appearance and siting must complement future development opportunities, including open space, academic buildings, and research and development space. The building is now square in plan and pushed further south to maximize development to the north. The rectangular configuration of the DEF and its siting along "East Drive" are intended to minimize its presence along the future Greenway and to preserve sufficient block depth to accommodate future development.

The DEF will be sited to extend along the western side of the alignment of the future "East Drive" at the southern edge of the extension of "Science Drive." Until "East Drive" is constructed, the building will be reached via an interim access-way south of Western Avenue. The narrow section of the building will face onto "Science Drive," where the building's primary entrance will be located. Fuel delivery along the west and primary loading activity along the south. The primary loading activity will occur within an access-way on the west side of the building. Sufficient block depth will be preserved to accommodate future development to the west of the DEF, providing significant visual screening of the facility. Limited landscape will be provided during the initial years while other development activities progress. In the future, trees will line "East Drive" and "Science Drive" along the building's frontage. The building will be set back from the "East Drive" and "Science Drive" back-of-sidewalk in order to sufficiently provide for foundation plantings. The DEF façade will emphasize transparency along "East Drive" and "Science Drive", showcasing the energy equipment located within it. Mechanical equipment on the roof will be shielded by a screening system around the rooftop perimeter. The building's proximity to the future Greenway will benefit from the natural drainage functions that the Greenway will provide, and will link to the long-term infrastructure corridors which will provide efficient routes for energy that promise to sustain the build-out of the IMP.

Figure 13 depicts a preliminary site plan for the DEF. The design of the facility is evolving and will continue to undergo design review by the BRA.

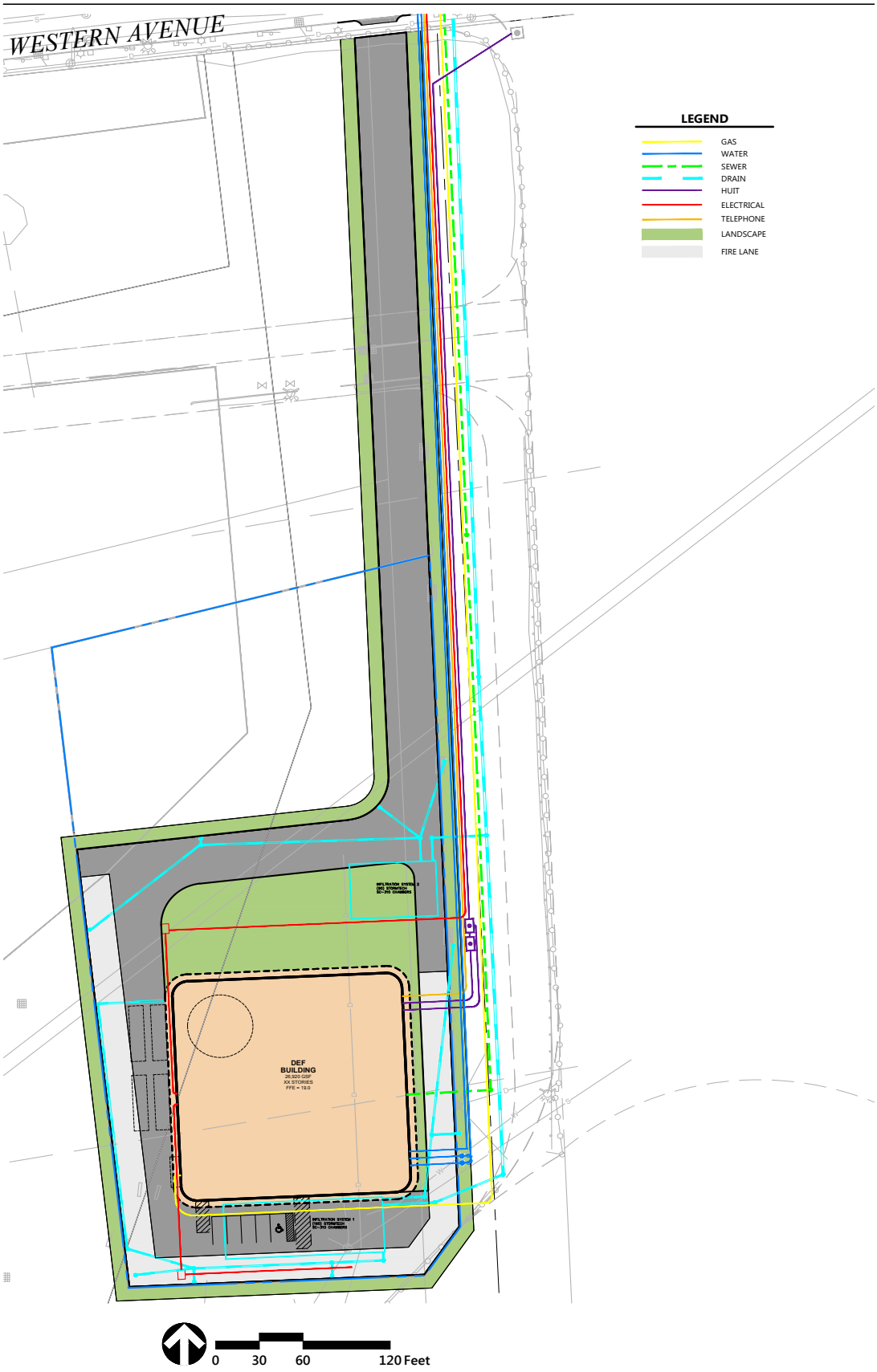


Figure 13: Preliminary Site Plan for the District Energy Facility

District Energy Facility Elements

Serving the SEC Building with an above-grade DEF has the following attributes:

- The DEF will primarily be comprised of district-scale mechanical and electrical spaces that will house energy production and distribution equipment and systems supporting the heating, cooling, and electric distribution needs of future buildings.
- The facility will be up to approximately 60,000 square feet in size, consisting of an approximately 57,000 square foot plant area and approximately 3,000 square feet for a control room, plant office, bathrooms, storage, a training room, and miscellaneous space. (This is comparable in size to the space that had previously been allocated for the energy facility in the subsurface level of the SEC.)
- The building will have a footprint of up to approximately 27,000 square feet and will be approximately 63 feet in height.
- The DEF will have space to expand and serve the heat-energy and chilled water needs for the Ten-Year IMP and future academic buildings and electricity needs for the Ten-Year IMP academic buildings.
- The facility is planned to be constructed at one time, with equipment installed in phases to meet current and near-term needs.
- The building will be resilient to projected storm-surge/climate change flooding impacts (e.g., 4 to 5 feet above-grade, slab-on-grade construction, and hot water distribution rather than steam distribution, which can be vulnerable to extreme flooding events).
- There will be five parking spaces for Harvard and vendor service vehicles.

Figure 14 depicts a conceptual rendering of the DEF as it was presented in the April 2016 IMP Amendment. As noted, the design of the facility is evolving and will continue to undergo design review by the BRA.

Location of viewpoint

Figure 14: District Energy Facility Concept Rendering as Presented in April 2016 IMP Amendment

1.6 Landscape and Public Realm

SEC LANDSCAPE AND PUBLIC REALM IMPROVEMENTS

The central courtyard of the SEC Building site will be a landscaped green space open to the public. Further, the landscape plan has been designed to complement the series of green corridors and open spaces proposed as part of the 2013 IMP, including connections to Rena Park and Ray Mellone Park to the southwest.

The landscape approach provides an opportunity to define a major new outdoor space. It will coordinate with the overall open space master plan for Allston by reinforcing connections from the future Greenway and the SEC open space. There will be a strong pedestrian connection through the SEC Building at grade, linking the pedestrian realm along Western Avenue with the courtyard space.

The landscape design will accommodate a variety of outdoor seating options. The approach will allow for casual gatherings as well as larger formal events. Overall site strategies include study of the potential for future flooding as a result of climate change. The outcomes of this study will be used to support the project's comprehensive climate resiliency strategy.

Figure 15 depicts a rendering of the courtyard and Figure 16 shows the below-grade connections to the exterior.

Figure 15: South Courtyard, Looking Northwest

Figure 16: Below Grade Connection to Exterior

AREA LANDSCAPE SYSTEMS AND THE GREENWAY

Although the Greenway is not technically part of the Project, a number of questions have been asked about the relationship between the Project and the Greenway as it was presented in the 2013 IMP as well as the DEIR and FEIR. The following section outlines the Greenway as envisioned in the 2013 IMP document's Long-Term Vision, as well as in more recent planning.

The first portion of the Greenway to be implemented will be Rena Park in 2016, followed by improvements along "Science Drive" between "Academic Way" and Rotterdam Street to be constructed as part of the Project. As described in the December 2014 Greenway Planning Memo submitted to the BRA, the ultimate timeline for implementation of additional segments is influenced by a number a factors including site control, construction of streets and infrastructure, and the completion of adjacent projects which will improve the safety and security of the area.

Greenway

As described in Harvard's 2013 IMP and as depicted in Figure 17, the Long-Term Vision of this area includes a future Greenway, which is a complex linear working landscape. The Greenway organizes adjacent urban design, infrastructure, sustainability, and open space aspects of the University's Long-Term Vision for the area's development. Contributing to long-term sustainability, the location and shape of the proposed Greenway will build on existing open space, urban design, circulation, and utility and drainage systems.

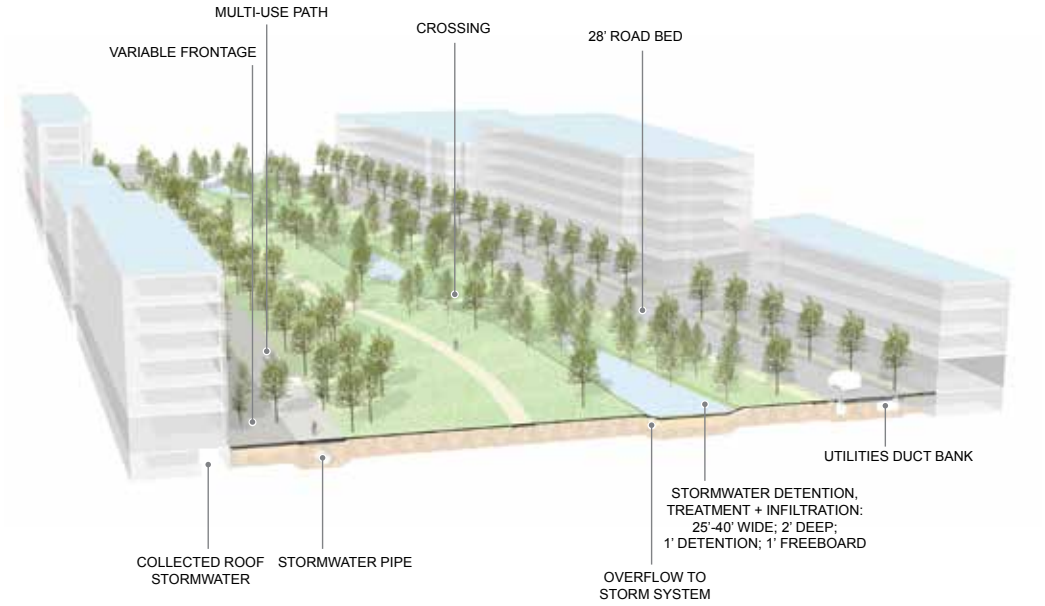


Figure 17: Long-Term Greenway Illustrative Plan and Cross Section (2013 IMP)

Open Space Context and Connections

As shown in Figure 18, in Greenway planning, a number of nearby open spaces have been carefully considered in relation to the area's open space context:

- Charles River Reservation
- Smith Playground
- Barry's Corner Grove
- Rena Park
- Ray Mellone Park
- Hooker-Sorrento Park
- Harvard Business School Central Green

Figure 18: Open Space Network

Greenway Implementation

Like all high-performance urban landscape projects, the Greenway will evolve through adaptation and adjustment over time. Today, except for the upcoming improvements to the proposed Rena Park, the sites that will make up the future Greenway are now primarily paved, displaying degraded urban fill conditions in many areas. The 2013 IMP includes the Greenway in the Long-Term Vision, rather than the Ten-Year Plan because the timeline for full completion of the Greenway relies upon a number of factors.

The first portion of the Greenway to be implemented will be Rena Park in 2016, followed by improvements along "Science Drive" between "Academic Way" and Rotterdam Street to be constructed as part of the Project. Harvard will look for further opportunities to implement portions of the Greenway with future projects as a part of the future Enterprise Research Campus build-out.

A number of ongoing planning processes will need to be resolved in concert with finalization of the Greenway design and implementation strategy. These include the following:

Nearby Building Projects

Segments that comprise the Greenway ideally should be created as buildings are developed along the length of the Greenway. One parcel which is likely to be developed during the Ten-Year IMP is the Hotel and Conference Center. Development of this project would incorporate another piece into the Greenway connection. Similar portions will be created as projects come on-line.

Area-Wide Infrastructure Planning

Planning for infrastructure systems that will serve the future Enterprise Research Campus remains in a preliminary stage. As a result, the final layout and infrastructural functions, such as stormwater retention, utility corridor, and circulation of the Greenway have not yet been fully defined. Collaboration with MassDOT is required as the I-90 Interchange and Western Avenue Bridge projects move forward. Both projects greatly impact the context in which this area is developed through potential new or altered street and river connections.

Environmental Remediation

A portion of the future Greenway will pass through the parcel known as Allston Landing North (also known as the Romar Parcel). This parcel had been encumbered by a perpetual exclusive railroad easement by CSX, but recently CSX relinquished to Harvard these easement rights. In the near-term, CSX still has to complete environmental remediation work at Allston Landing North.

Resiliency Planning

Recent Harvard research regarding the need to anticipate climate change is resulting in ongoing Harvard planning that may bear on the ultimate design of the Greenway.

Planning and Design Considerations

Keeping the many evolving conditions and processes in mind, Greenway planning will unfold as a collaboration between Harvard, the BRA, and the community as decisions are made surrounding the future context for this area.

A number of important design issues shape ongoing Greenway planning. Key considerations include the following:

Greenway Continuity

The currently proposed Greenway configuration establishes the landscape corridor in two sections that are not entirely aligned. The section west of the future "Stadium Way" sits further to the south than does the section to the east of "Stadium Way", impacting ease of navigation and sight lines.

"Stadium Way" Crossing

The Greenway's east-west crossing of "Stadium Way" involves a potentially challenging diagonal movement that also includes an extra crossing of the future "Science Drive."

Greenway Frontage

The Greenway position provides for active building frontage along its southern edge on the future "Science Drive," but its northern edge abuts buildings whose primary face will be on Western Avenue. Establishing an active edge on the north edge of the Greenway is an important urban design consideration.

Transit Interface

Planning for a transit stop on "Stadium Way" in the vicinity of the Greenway is complicated by the Greenway's two-section composition described above, where the Greenway shifts from a more northerly to a more southerly alignment at "Stadium Way."

Eastern Terminus

Establishing a legible terminus at the east end of the Greenway may prove to be challenging due to the busy "East Drive" and Genzyme building beyond.

Western Avenue Corridor

The currently proposed Greenway is only one block south of the Western Avenue corridor, a future focus of pedestrian, bicycle, public realm, and stormwater resources that could be redundant with that of the Greenway.

114 Western Avenue Footprint

The existing 114 Western Avenue building is now part of the Project, and so it is not expected to be removed in the near future. However, a portion of the building is located within the proposed footprint of the Greenway as identified in the 2013 IMP Long-Term Vision.

1.7 Parking and Loading

The Project includes approximately 275 parking spaces to be located in two surface parking lots: 1) the existing parking lot that services 114 Western Avenue; and 2) a new parking lot to be located south of Rotterdam Street. More information on parking, including a discussion of supply and demand, is included in Chapter 2, Transportation.

The SEC Building contains a below grade, 6-bay enclosed loading dock that will serve the various functions of the building. Among other purposes, the loading dock will be used to receive food, furniture, and other regular deliveries, including hazardous materials, as well as to ship out all waste, including hazardous waste, in support of the building's laboratory users. These wastes will be managed to meet standard regulatory protocols governing the handling of such materials.

1.8 Project Sustainability

Science and Engineering Complex

The Science and Engineering Complex will be an exemplary project of integrated sustainability, in both quantitative as well as qualitative terms. In quantitative terms, the SEC Building aspires to achieve, at a minimum, LEED for Building Design and Construction (LEED-BD&C) Version 4 Gold certification, a significant achievement for an energy intensive laboratory building. The SEC Building is being designed to comply with the Harvard Green Building Standards, which is a set of process oriented requirements that go above and beyond those of LEED certification. To achieve these goals the SEC Building will feature high performance envelopes, highly efficient climate, ventilation, and heat recovery systems, and intelligent program zoning to ensure that air circulation, a major contributor to energy use, is minimized while optimizing occupant comfort and safety. The SEC Building will serve as a model of sustainable laboratory operations, integrating facility management and staffing discussions into the design phase to ensure successful long-term operation.

In qualitative terms, the SEC Building will be a model for an approach to sustainability that emphasizes the integration of architectural spaces for communication and collaboration with access to daylight, natural ventilation, and comfort. Collaborative space in a variety of types and scales will be woven into the building in ways that support informal discussion outside of proper laboratory spaces and that optimize opportunities for interdisciplinary interaction. In a building of such considerable scale, the individual should be given considerable control over their environment, to open a window, to raise and lower the lights, to fine-tune temperature, and to occupy spaces appropriate to various tasks and group sizes. Fresh air and daylight will be combined with intelligent programming to create multiple climate zones appropriate to space usage, which link occupants to natural environmental conditions and improve health, productivity, and well-being.

Under LEED, the design team anticipates earning at least 57 points based on the SEC Building design. There are an additional 43 points in the "Maybe" column, and the design team anticipates that many of these credits will be earned in addition to the 57 points listed in the "Yes" column.

114 Western Avenue

Although the existing building at 114 Western Avenue will not undergo major renovations, there will be improvements related to sustainability. The 114 Western Avenue component of the Project is targeting to achieve at a minimum LEED Version 4 Gold certification and it is

being designed to comply with the Harvard Green Building Standards.

DEF Building

Given that the DEF component of the Project is mostly mechanical equipment and Is not occupied most of the time, it is difficult to register such a facility under LEED. The design team is working with the Harvard Green Building Service Office to evaluate sustainability measures that are appropriate for a building like this.

1.9 Project Schedule

The Project schedule calls for modifications to the existing below-grade structure of the SEC Building to begin in the fall of 2016 and construction of the above-grade steel framework of the SEC Building to begin in the spring of 2017. Construction of the DEF is anticipated to begin in early 2017 and renovation of 114 Western Avenue will begin in late 2018. Based on the current schedule, the SEC Building will be occupied in the fall of 2020.

2.0 TRANSPORTATION

2.1 Transportation and Access

The Science and Engineering Complex will replace the previously approved uses that are described in the ENF filed in 2007 for Harvard's Master Plan. The 2007 ENF also included a Phase One Waiver Request for the 2007 Science Project. The current Project is a refinement of the project that was described and analyzed in the Draft and Final EIRs filed in 2013 and 2014 for Harvard University's Campus in Allston.

The 2007 Science Project evaluated the transportation impacts of 589,000 square feet of scientific research and educational space occupied by 1,000 employees. At that time, 114 Western Avenue was assumed to function as a fully occupied commercial space. The Draft and Final EIRs evaluated the transportation impacts of approximately 733,000 square feet of institutional uses on the full foundation site and in a repurposed 114 Western Avenue. The analysis in the Draft and Final EIRs included a preliminary SEC program with approximately 300 faculty/staff and 900 graduate students/researchers affiliated with the School of Engineering and Applied Sciences as well as the transportation demands associated with 390,000 square feet of research and development (R&D) uses on the remainder of the site.

The SEC described in this NPC includes 496,850 square feet of space: 445,350 on the northern portion of the foundation and 51,500 square feet in a repurposed 114 Western Avenue. (As described previously in Chapter 1, the Project also includes a District Energy Facility of approximately 60,000 square feet. However, this facility does not include any full-time staff and has limited traffic impacts.) The analysis in this NPC assumes that the SEC program will accommodate approximately 360 faculty/staff, 1,000 graduate students and researchers, and 600 of the 1,000 SEAS undergraduate students on a daily basis. It also assumes the remaining floor space in 114 Western Avenue will be occupied by an institutional use.

The transportation evaluation presented in this chapter compares the transportation impacts of the SEC to the 2007 Science Project; the 2007 conditions also include 114 Western Avenue as a fully tenanted commercial building. Comparisons are also made to the SEC program that was evaluated in the 2013 IMP analysis.

PROJECT CHARACTERISTICS

The academic nature of the Science and Engineering Complex results in a fundamentally different type of transportation profile as compared to the previously approved 2007 Science Project. In the SEC, faculty/staff and office employees will have similar commuting patterns as the proposed occupants of the 2007 Science Project, but they will be fewer in numbers: approximately 420 as compared to 1,000 in the 2007 Science Project. The addition of the academic component will bring graduate students/researchers and undergraduates to the site. Graduate students/researchers are non-auto oriented and more heavily reliant on transit, Harvard shuttle buses, bicycles, and walking as modes of

travel. Undergraduates are restricted from purchasing parking permits and instead use Harvard shuttle buses, bike or walk to travel on campus. As a result, the SEC will have lower auto use and higher non-auto use as compared to the 2007 Science Project.

The presence of undergraduates at the SEC will generate new pedestrian, bicycle, and shuttle bus trips throughout the day as students move between Cambridge and Allston. Harvard's residential house philosophy strongly encourages on-campus housing for undergraduates for all four years and restricts undergraduates from purchasing a parking permit. In 2015, approximately 98 percent of undergraduates lived in Harvard residences and approximately one-quarter of one percent had a parking permit. Therefore, undergraduate transportation demands will be limited to pedestrian, bicycle, and shuttle bus trips. These connections were anticipated by the 2013 IMP, which provided a planning context to improve pedestrian, bicycle, and shuttle bus systems to accommodate SEC travel demands.

Auto use and parking requirements for the commuting population of the SEC will be lower than the previously approved 2007 Science Project because the SEC commuting population is not as auto-oriented as the population of the 2007 Science Project. As a result, fewer parking spaces will be needed by the SEC. The 2013 IMP also anticipated this change and indicated that the building program for SEAS could be accommodated by expanding the existing surface parking at 114 Western Avenue and that no below grade parking will be required for the initial program.

Site circulation has also changed significantly since the 2007 Science Project. Figure 19 presents the street typologies that were developed for the 2013 IMP. These typologies are based on Boston's Complete Streets Guidelines and provide a framework for future street improvements. The SEC includes streets on all four sides of the site while 2007 Science Project had streets on three sides. Other key differences include the recent implementation of a bike network in the study area and other transportation infrastructure upgrades such as improvements to Barry's Corner and the planned construction of "Academic Way" between North Harvard Street and Western Avenue.

In combination, the reduced reliance on auto use by building users and the planned and implemented transportation network improvements indicate that the traffic impacts of the SEC will be less than the impacts of the previously approved 2007 Science Project. In addition, the analysis indicates that recent, ongoing, planned and proposed improvements to the transit, shuttle, bicycle, and pedestrian systems can accommodate the new SEC demands.

The SEC contains a below grade, six-bay enclosed loading dock that will serve the various functions of the building. Like the 2007 Science Project, the loading dock is a drive-in/drive-out facility. It will use the same driveway on Science Drive that was included in the 2007 Science Project.

Table 3 summarizes key elements of the previously approved 2007 Science Project and the currently proposed Project.

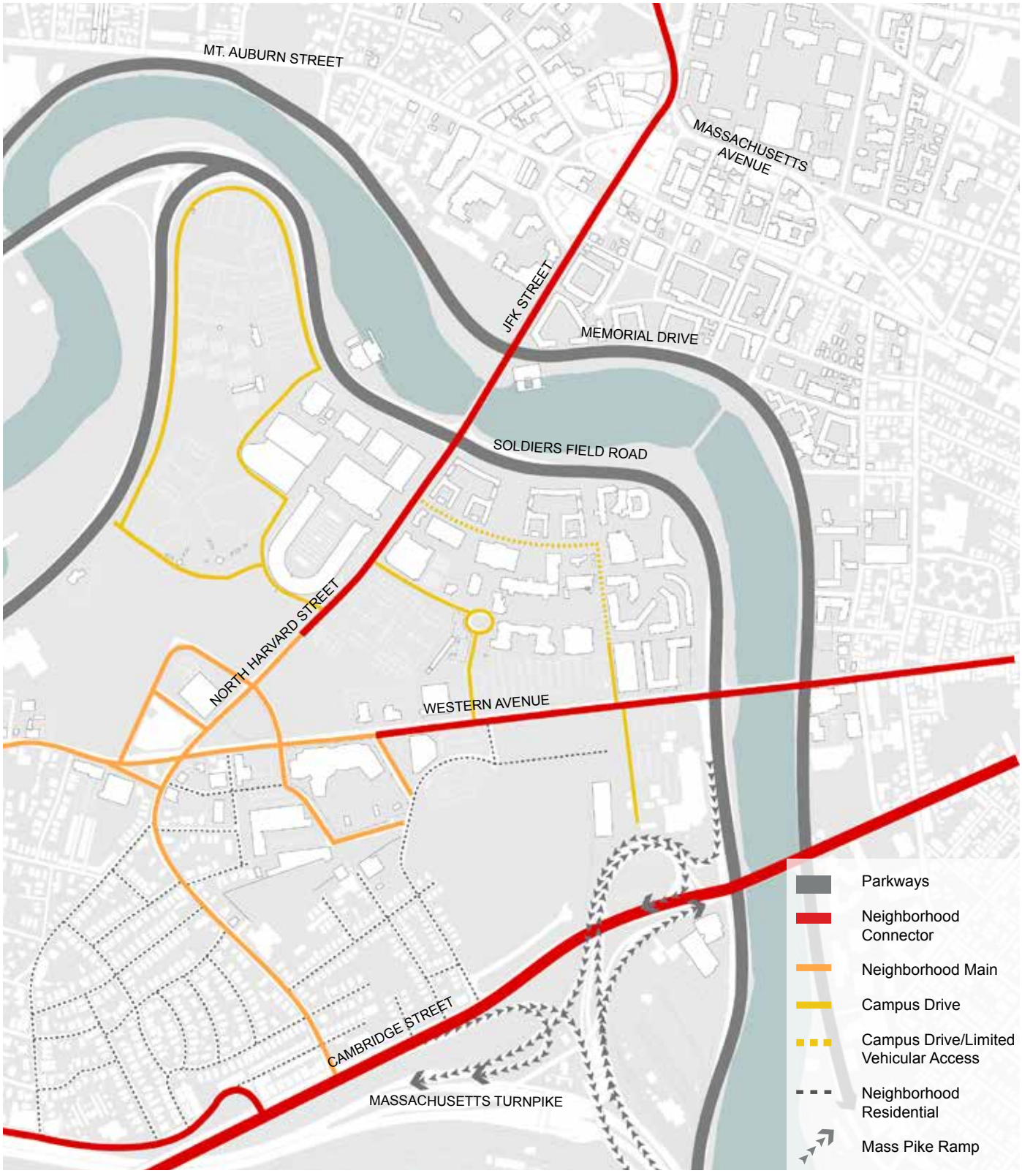


Figure 19: Street Typologies

Table 3: Comparison of Key Transportation Elements

	2007 Science Project	Current Project
BUILDING SQUARE FEET		
Science/SEC Program	589,000 SF	496,850 SF[1]
Office / Other Institutional[2]	79,000 SF[3]	27,500 SF
TOTAL	**668,000 SF**	**524,350 SF**
COMMUTING POPULATION (Approximate Numbers)		
Faculty/Staff	N/A	360
Graduate Students[4]	N/A	1,000
R&D	1,000	N/A
Office[2]	240	N/A
Other Institutional[2]	N/A	60
TOTAL[5]	**1,240**	**1,420**
PARKING		
Existing Surface Spaces	178	178
New Surface Spaces	150 (off-site)	97 (on-site)
New Garage Spaces	350	N/A
TOTAL	**678 TOTAL SPACES**	**275 TOTAL SPACES**
PARKING ACCESS	Parking garage driveways on "Science Drive"	Parking driveways on Rotterdam Street
LOADING	Drive-in/drive-out underground loading docks Driveway on "Science Drive"	Drive-in/drive-out underground loading docks Driveway on "Science Drive"
Site Roadways		
"Stadium Way"	Two-way to "Science Drive" intersection Interim connection to Rotterdam and Windom Streets Long-term connections undetermined	Two-way to "Science Drive" intersection with bike path Interim connection to Rotterdam and Windom Streets Long-term connection to the future reconfigured Allston interchange area (by MassDOT)
"Science Drive"	Two-way with cul-de-sac	Two-way from "Stadium Way" to "Academic Way"
"Academic Way"	Multi-Use pedestrian/bicycle path	Two-way from "Science Drive" to N. Harvard St. with 28 Travis Street driveway

Notes:

All square footage numbers in this document refer to gross floor area as defined by the Boston Zoning Code.

1. Includes 51,500 SF of SEC program in 114 Western Avenue.

2. Assumes three commercial office employees per 1,000 square feet and assumes two employees per 1,000 square feet for "Other Institutional" space in 114 Western Avenue.

3. 114 Western Avenue included as an existing condition that was carried into the analysis of future conditions.

4. Includes SEAS researchers.

5. Does not include undergraduate students.

SITE CIRCULATION

The construction of "Academic Way," "Science Drive," and "Stadium Way" and the enhancements to the sections of Western Avenue in front of the site will improve local circulation and accommodate the multi-modal needs of the SEC. These streets will be designed using Boston's Complete Streets Guidelines. Western Avenue is a public street while the other streets, as well as Rotterdam Street and Hague Street, are private streets owned by Harvard that will be open to public travel.

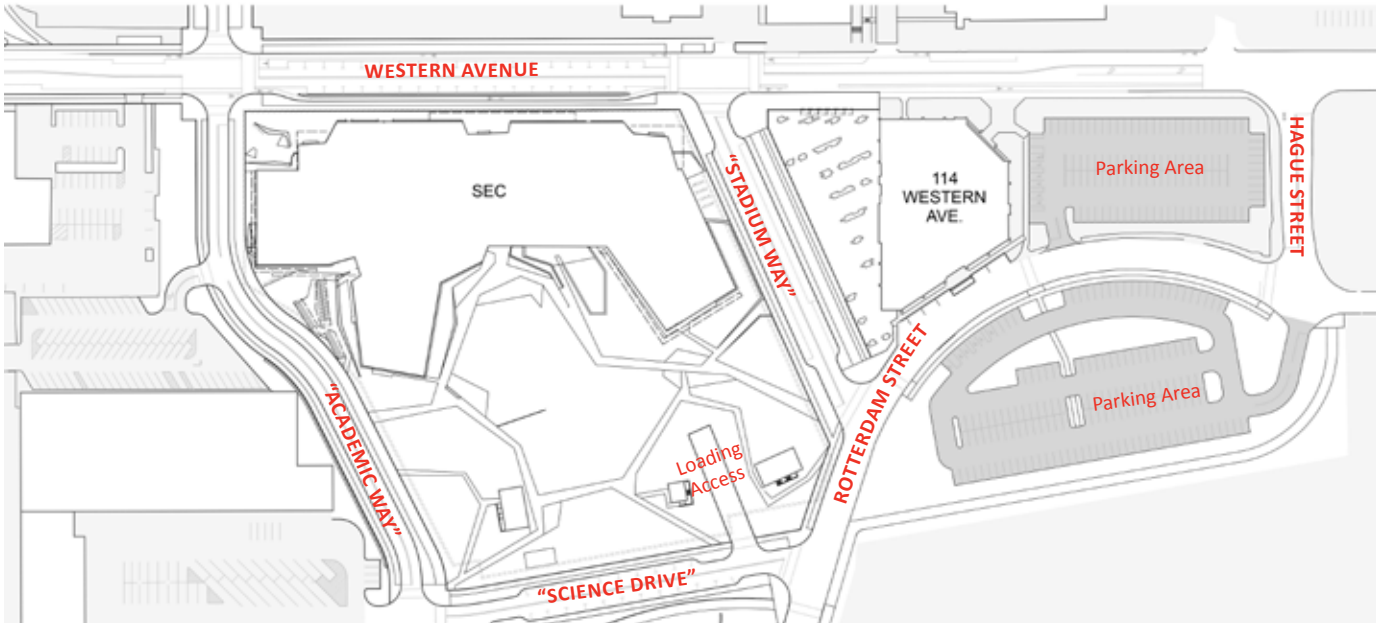


Figure 20: Site Area Circulation

Western Avenue

Western Avenue will be reconstructed in front of the SEC to improve bicycle and pedestrian accommodations and provide on-street parking. This section of the street will have one travel lane and one parking lane in each direction with new cycle tracks in both directions. Figure 20 illustrates the proposed improvements that will formalize the existing eastbound cycle track and create a new westbound cycle track in front of the site. The eastbound track will be relocated onto the space currently occupied by the existing sidewalk. This will create additional street width to restore a parking lane on the north side of the street.

Rotterdam Street/Hague Street

Rotterdam Street and Hague Street are existing two way streets with one travel lane in each direction, sidewalks on either side and no parking. These streets connect Windom Street to Cambridge Street at a signalized intersection. A driveway to access an existing 115-space parking lot at 114 Western Avenue will be retained and the parking lot will be re-purposed for SEC institutional parking. A second lot with 160 spaces will be constructed to the south

of Rotterdam Street with a driveway connection to the intersection of Hague Street and Rotterdam Street.

"Stadium Way"

"Stadium Way" is a two-way street on the eastern side of the SEC between Western Avenue and Rotterdam Street. The street will primarily be used for shuttle bus drop-off and pick-up in support of the SEC. The University will implement a Mobility Hub on the eastern side of the street next to 114 Western Avenue that will include bike parking, a bicycle path and other transportation elements to encourage and support non-auto travel to and from the SEC.

The proposed configuration, which is illustrated in Figure 20, will provide one travel lane and a lane for shuttle bus drop-off/pick-up or on-street parking in each direction with curb extensions and crosswalks at the Western Avenue intersection. An off-road two-way cycle track is proposed along the eastern side of the street. It is anticipated this cycle track will be implemented when the path extends to the south in the future to connect with proposed bicycle improvements in the interchange area.

As illustrated in the 2013 IMP Long-Term Vision, "Stadium Way" will eventually extend from North Harvard Street to Cambridge Street. The construction of "Stadium Way" next to the SEC is the first part of this construction. Further south, MassDOT has undertaken planning and design of the I-90 Allston Interchange Improvement Project that will relocate the I-90 highway alignment, reconfigure the interchange ramps, replace the Cambridge Street bridge over the existing ramps with an at-grade street, and extend Stadium Way to a new West Station.

Harvard is coordinating its planning for "Stadium Way" with the City and MassDOT. As described in the ENF for MassDOT's Allston Interchange Improvement Project, MassDOT will construct Stadium Way to the south of Cambridge Street in its final form. To the north of Cambridge Street, MassDOT proposes to construct a short section of "Stadium Way" between Cambridge Street and North Connector Road as an "interim" roadway. The construction of "Stadium Way" north of Cambridge Street, including the reconfiguration of the "interim" section will be Harvard's responsibility.

"Science Drive"

"Science Drive" is a two-way street on the southern side of the SEC between "Academic Way" and Rotterdam Street. As shown in Figure 20, the SEC Building loading dock driveway will be located on "Science Drive." The current plan includes one travel lane in each direction with a parking lane and a sidewalk on either side of the street. Bicycle accommodations will be provided in the adjacent open space to the south of "Science Drive."

"Science Drive" will also provide the primary access and egress route for buses and trucks traveling to and from the University's fleet management facility at 28 Travis Street. These vehicles will use Rotterdam Street to connect with Western Avenue at the signalized Hague Street intersection. Buses and trucks will be prohibited from traveling on Rotterdam Street and Windom Street to the south of "Science Drive." Existing signage will be updated as necessary at this intersection.

"Academic Way"

"Academic Way" is a two-way street on the western edge of the SEC site between Western Avenue and "Science Drive." This street is in the approximate location of an existing driveway to 28 Travis Street, which is used by the University for fleet management services and other institutional uses. As shown in Figure 20, the current plan includes one travel lane in each direction with a parking lane and a sidewalk on either side of the street.

As shown in Figure 24, a multiuse path is proposed along the eastern side of the street. The proposed multiuse path will provide a convenient connection to bike parking on this side of the SEC while also linking open space at Mellone Park with Smith Field. "Academic Way" will provide connections to the employee and visitor parking lot for 28 Travis Street, as well as providing secondary access to the SEC Building loading docks and bus and the fleet maintenance area at 28 Travis Street.

2.2 Commuting Characteristics

The Science and Engineering Complex is significantly smaller in terms of square feet, trip generation and parking needs than the site conditions that were previously evaluated as part of the 2007 Science Project and the 2013 IMP. Both the 2007 Science Project and the 2013 IMP included significant R&D space which has greater trip generation and parking impacts than the SEC, which is primarily academic in nature. The 2007 Science Project and 2013 IMP also included the full use of the foundation site, while the SEC uses the northern portion of the site and proposes temporary landscaping on the southern portion of the site.

Trip Generation

To assess the impacts of the SEC, person-trip estimates were based on Harvard empirical data regarding peak hour arrival/departure patterns for existing faculty/staff and graduate students on the Allston campus. As shown in Table 4, the SEC generates fewer person-trips than the analysis from the previously approved 2007 Science Project and the 2013 IMP. This difference is primarily associated with the removal of the R&D component from the SEC. It should be noted that to present comparable scenarios, trip generation estimates for a fully occupied 114 Western Avenue have been added to the 2007 Science Project.

Mode Choice

Table 4 presents the peak hour/peak direction mode share estimates that were used in the traffic analysis for the 2007 Science Project, the 2013 IMP, and the current Project. The Boston Transportation Department's (BTD's) Access Boston mode shares were used for the 2007 Science Project mode shares and the research and development and office uses in the 2013 IMP and for the current Project. Academic mode shares for faculty/staff and graduate students/researchers in the 2013 IMP and the SEC are based on empirical data that was available at the time of the analysis. The mode shares in Table 5 were determined by weighting each group's mode share by the percent of the total commuting population represented by that group.

Table 4: Mode Choice

	2007 Science Project[1]	2013 IMP[2]	Current SEC Project[3]
Vehicle	59%	37%	21%
Transit	18%	30%	40%
Bike	23%	33%	29%
Walk			10%
TOTAL	**100%**	**100%**	**100%**

Notes:

1.2007 Science Project mode share is based on BTD's Access Boston mode shares for Area 17. Walk and bike modes were combined for this analysis.

2.Academic is based on empirical data and R&D is based on BTD's Access Boston mode shares. Walk and bike modes were combined for this analysis.

3. Academic is based on empirical data and non-SEAS institutional ("Institutional Other") is based on BTD's Access Boston mode shares for office uses. Undergraduates, who are restricted from purchasing a parking permit, are not included in these estimates.

The vehicle mode choice for the SEC will be significantly lower than the previously approved 2007 Science Project. This reflects the academic nature of the current Project and, in particular, the low level of auto use by graduate student/researchers, who represent 70 percent of the commuting population. As discussed later in this chapter, the lower auto mode share will reduce traffic and parking demands as compared to the 2007 Science Project. In addition, the anticipated SEC auto mode share of 21 percent will support Harvard's commitment to achieve a mode share of 40 percent or less for commuters traveling to the Allston Campus by car, as described in the 2013 IMP. This is below the 50 percent auto mode share goal for commuters that was established for the 2007 Science Project.

Table 5 provides a breakdown of the mode shares by group for the SEC. The mode shares for the faculty/staff and graduate student/researchers are based on survey data from 2014. This data indicated that the SEAS faculty/staff, which represent 25 percent of the overall commuting population, have an auto mode share of approximately 25-35 percent in Cambridge. To be conservative for this IMPNF analysis, it was assumed that the auto mode share for faculty/staff will increase to 60 percent. In contrast, the 2013 IMP used a 75 percent auto mode share for faculty/staff, based on mode share data from 2006.

Table 5: Mode Choice by Group

	Faculty/ Staff[1]	Graduate Students/ Researchers[1]	Institutional Other[2]	"Blended" Mode Shares[3]
Vehicle	60%	5%	59%	21%
Transit	20%	48%	18%	40%
Bike	15%	35%	17%	29%
Walk	5%	12%	6%	10%
Total	100%	100%	100%	**100%**

Notes:

1.Based on 2014 SEAS survey.

2.Based on BTD's Access Boston mode shares for Area 17.

3.Based on 25% faculty/staff; 70% graduate student/researchers; and, 5% "institutional other."

Graduate student/researchers, who represent 70 percent of the overall commuting population, have an auto mode share of three to four percent in Cambridge. This population is strongly oriented towards non-auto use, so the auto mode share was increased slightly to five percent. "Institutional other" will make up five percent of the overall population and will have mode shares based on BTD's Access Boston mode shares for office workers. Additional information is provided in Appendix B.

Vehicle Trips

Table 6 presents the vehicle trip estimates for the 2007 Science Project, 2013 IMP and the SEC. This analysis indicates that the SEC will generate less than half the number of peak hour vehicle trips and less than one-third the daily vehicle trips as both the 2007 Science Project and the assumptions that were included in the detailed traffic analysis of the 2013 IMP. As a result, the SEC will have less impact on intersection operations and level of service than the 2007 Science Project and the 2013 IMP. Mitigation for the SEC will draw upon recommendations from the 2013 IMP.

Table 6: Vehicle Trips

	2007 Science Project[1]	**2013 IMP**	**Current SEC Project[2]**
Weekday Daily	2,050	2,110	570
Weekday AM Peak Hour			
Enter	255	270	115
Exit	55	40	10
Total	310	310	125
Weekday PM Peak Hour			
Enter	35	30	10
Exit	240	280	115
Total	275	310	125

Notes:

1. Includes trip generation estimates for a fully occupied 114 Western Avenue (commercial use) based on peak hour driveway counts.

2. Not including undergraduate trips

Vehicular Trip Distribution

Regional vehicular trip distribution estimates for the 2013 IMP were developed for Harvard-affiliated uses based on 2012 employee zip code data for the Allston Campus provided by Harvard, adjusted for mode to derive automobile trips by town of origin. Each town of origin was assigned to a regional roadway and then to one of the campus gateways serving the study area. Employees assigned to each route were then aggregated to develop a vehicle trip distribution. The more localized trip distribution (i.e., site access) was developed based on the anticipated parking and driveway access locations.

These regional trip distribution patterns are applicable to the SEC and are generally consistent with trip distribution patterns utilized as part of the 2007 Science Project, as shown in Table 7.

Table 7: Vehicle Trip Distribution Comparison

	Trip Distribution	
Roadway (from/to)	**2007 Science Project[1]**	**2013 IMP and Current Project[2]**
Western Ave (from west)	7%	7%
Everett Street (from south)	3%	5%
Cambridge Street (from west)	4%	4%
Harvard Ave (from south)	2%	3%
I-90 East	43%	22%
I-90 West		16%
Soldiers Field Rd (from east)	13%	15%
Western Ave (from east)	5%	4%
North Harvard St (from north)	5%	5%
Route 2 (from west)	18%	19%
TOTAL	**100%**	**100%**

Notes:

1. As presented in Harvard University Allston Science Complex DPIR; June 25, 2007.

2. Based on Harvard 2012 Employee Zip Code Data for the Allston Campus and 2007-2011 American Community Survey 5-Year Estimate Means of Transportation (Mode Share) for home-based work trips; Allston & Cambridge Mode Shares adjusted (2010 DEP Rideshare Survey & 2012 PTDM Survey data used, respectively).

Corridor Traffic Volumes

Vehicular trip generation estimates for the SEC were applied to the roadway network using the trip distribution developed as part of the 2013 IMP. A cordon-level volume comparison of the projected peak hour vehicular traffic along area roadways between the 2007 Science Project, the 2013 IMP, and the SEC is presented Table 8. As shown in Table 8, the SEC is projected to generate significantly fewer or the same number of vehicle trips on the primary corridors serving the site when compared to 2007 Science Project and the 2013 IMP estimates.

Table 8: Cordon-level Peak Hour Vehicular Volume Comparison

	Bi-directional Vehicle Trips		
Roadway Link	**2007 Science Project[1]**	**2013 IMP**	**Current SEC Project**
N. Harvard Street south of Soldiers Field Road			
Weekday Morning	30	75	30
Weekday Evening	35	75	30
Western Avenue west of Spurr Street			
Weekday Morning	60	40	15
Weekday Evening	50	35	15
Western Avenue west of Soldiers Field Road			
Weekday Morning	140	120	50
Weekday Evening	115	115	65
Cambridge Street west of N. Harvard Street			
Weekday Morning	20	20	10
Weekday Evening	20	25	10

Note:

1. Includes trip generation estimates for a fully occupied 114 Western Avenue (commercial use) based on peak hour driveway counts

2.3 Transit

Transit service is provided by the MBTA within the study area as shown in Figure 21. The MBTA operates two bus routes (86 and 66) along North Harvard Street, two bus routes (70 and 70A) along Western Avenue and one bus route (64) along Cambridge Street. In addition to the bus routes, the Harvard Square Station, which is one mile from Barry's Corner, is the most significant regional transit facility near the study area. Red Line service provides access to both local and regional connections. In addition to the Red Line, Harvard Square is a major bus facility that accommodates ten surface bus routes and four trolley-bus services. The Harvard Shuttle complements MBTA transit service by providing a connection between Harvard Square and the Allston Campus.

The SEC is expected to generate approximately 235 transit trips during the morning peak hour and 110 transit trips during the evening peak hour. These morning and evening peak hour trips are made primarily by faculty, staff, graduate students and researchers. The first and last undergraduate classes of the day are anticipated to be scheduled outside commuter peak hours, so the majority of trips made by undergraduates occur during non-peak commuting hours. Additionally, undergraduate students are anticipated to predominantly use the Harvard Shuttle to travel between the Cambridge Campus and Allston Campus.

The 2013 IMP indicated that the Science Project, the Continuum Project and the Ten-Year Plan IMP projects will generate 415 new MBTA transit trips (370 entering and 40 exiting) during the morning peak hour and 330 new transit trips (65 entering and 265 exiting) during the evening peak hour. The new transit trips in the 2013 IMP analysis included transit trips for the Science Project that were comparable to the 2015 SEC Project: 250 (235 entering and 15 existing) during the morning peak hour and 140 new transit trips (15 entering and 125 exiting) during the evening peak hour. The 2013 IMP analysis also indicated that there was sufficient capacity for these trips on the existing bus services. Therefore, it is anticipated that there will be sufficient transit capacity for the SEC peak hour transit trips.

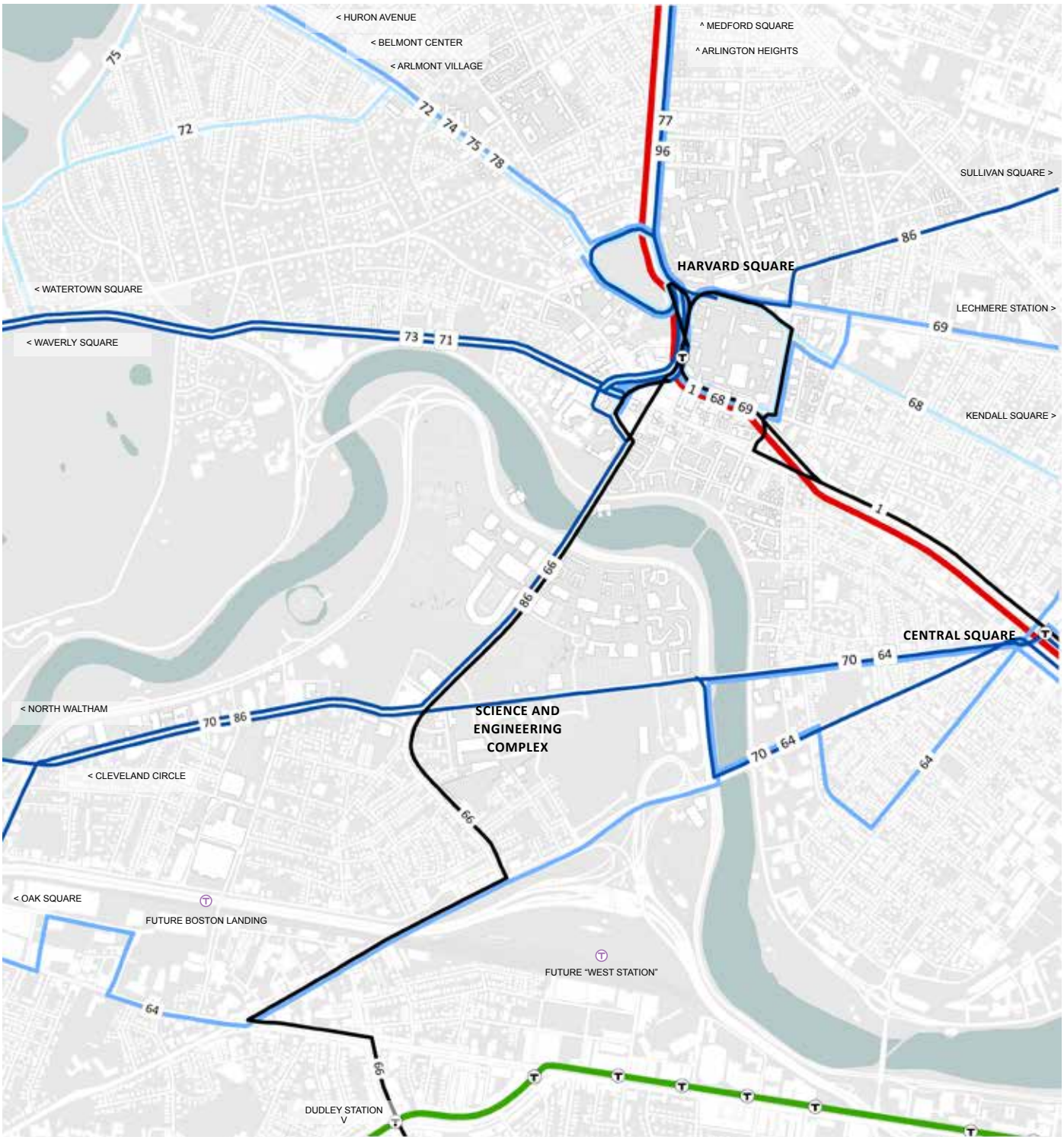


Figure 21: Area Transit

2.4 Shuttle Buses

Figure 22 illustrates the Harvard shuttle bus routes that serve the Allston Campus. The University provides two shuttle services to enhance connectivity between its Allston and Cambridge campuses and to serve the SEC: 1) the Allston Express, which is a one-way loop circumnavigating the Allston and Cambridge campuses: and, 2) the Harvard Square Express that links Harvard Square and Barry's Corner in Allston.

Harvard anticipates modifying and augmenting these two routes to respond to the unique demands of the various SEC populations. This will include diverting the Allston Express to a new stop on Stadium Way and extending the Harvard Square Express to Stadium Way. As part of a Mobility Hub at this location, an outdoor waiting area will be created next to 114 Western Avenue with an indoor waiting area in the SEC. Harvard is also considering other routes that will serve areas of undergraduate activities that are not well connected to the SEC by either the planned shuttle routes or MBTA services, such as student housing locations.

Shuttle bus service to and from the SEC must consider a number of factors that are unique to a campus environment. Levels of service, capacity, and schedule must be responsive to class schedule and peak loading characteristics that vary significantly throughout the day, week and year. Shuttle buses will be specifically purposed to address these types of conditions. In contrast, MBTA bus service runs on fixed routes and schedules that are not compatible with campus access and connectivity needs.

The location and size of shuttle bus stops and MBTA bus stops in Boston and Cambridge are regulated by each municipality. Harvard will continue to coordinate with the municipalities regarding the use of designated stops that also includes, where appropriate, sharing MBTA bus stops. As appropriate, Harvard will coordinate with the MBTA regarding modifications to its network of shuttle routes.

Allston Express

The Allston Express shuttle provides students and staff transportation throughout the year. It is primarily oriented towards providing campus connectivity to a number of locations that are outside the MBTA route structure (e.g., Oxford Street and the River Houses along Memorial Drive). Buses depart from the Cambridge Campus approximately every 15 minutes on weekdays with connections at Harvard Square, Harvard Kennedy School, Harvard Stadium, Harvard Business School (HBS), and Soldiers Field Park Garage. In November 2015, Harvard extended this route to include Barry's Corner.

Headways are adjusted during other times of the year to reflect changes in demand. Harvard has recently extended this route to Barry's Corner with three stops along Western Avenue: One Western, the i-lab and Barry's Corner. Harvard reviewed this change with the Boston Transportation Department prior to implementation. In the future, Harvard anticipates diverting this route to Stadium Way to serve the SEC.

Harvard Square Express

Since November 2015, Harvard has supplemented the Allston Express service with a new shuttle bus route, the Harvard Square Express which travels along North Harvard Street and stops at Barry's Corner and Cotting Hall in Allston and Eliot Street and Harvard Square in Cambridge. The shuttle currently makes three trips per hour from 7:00-10:00 a.m. and 3:00-6:00 p.m., and terminates in the parking lot behind 175 North Harvard Street. In the future, as demand warrants, Harvard anticipates that the service will operate at approximately ten-minute headways.

Harvard anticipates that this route will be extended to Stadium Way and its hours of operation will be increased to support the SEC. The route will use "Academic Way" to make this connection from North Harvard Street. The intent of this route is to provide convenient and reliable connections between the Cambridge and Allston campuses and to connect the SEC and other activities at Barry's Corner with transit routes in Harvard Square. Neighborhood residents and employees of the Continuum Project are able to use the shuttles.

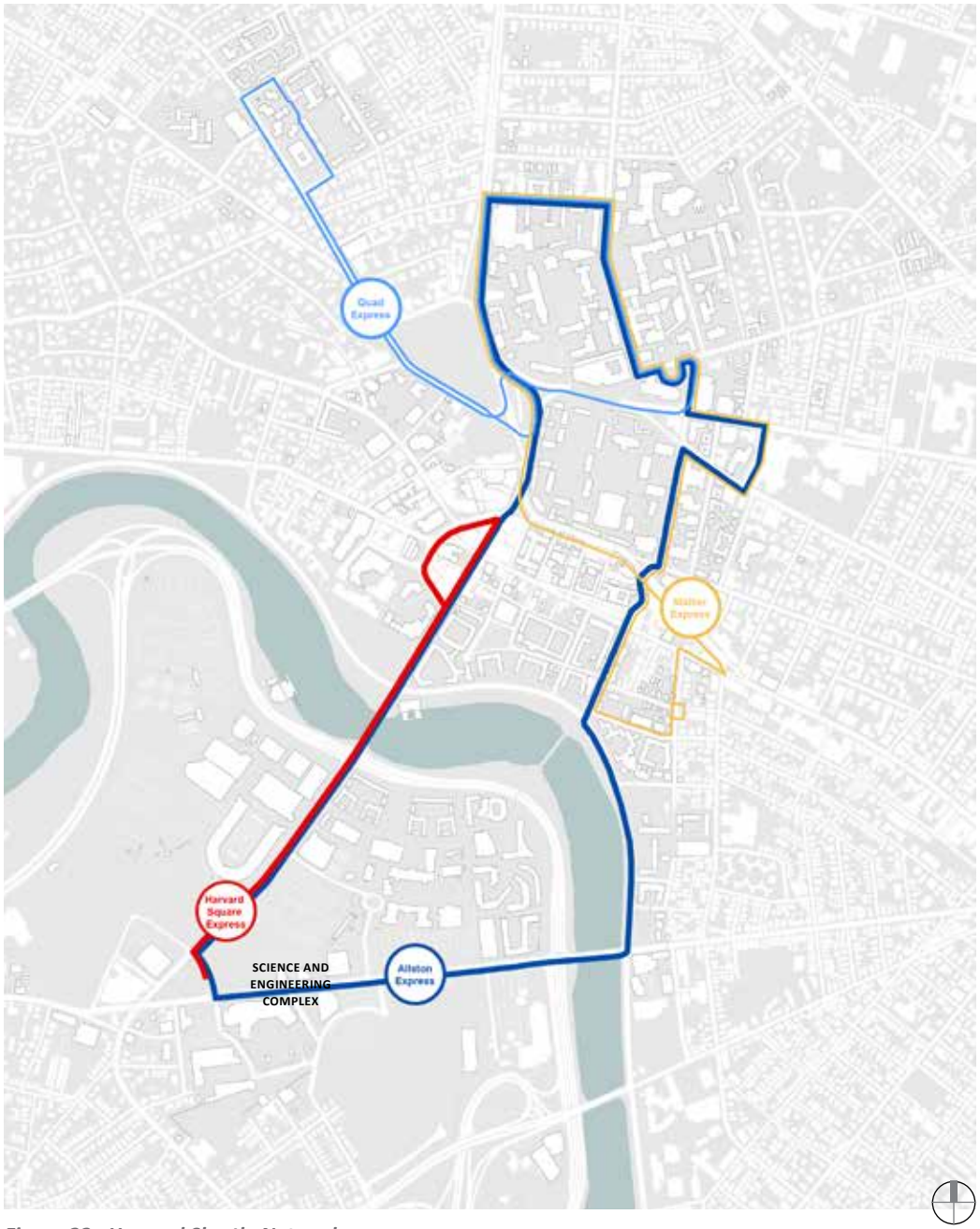


Figure 22: Harvard Shuttle Network

2.5 Bicycles

Bicycles are an important component of the transportation system at Harvard. Harvard provides both covered and uncovered bicycle parking for its employees, students, and visitors on its Allston Campus and is committed to providing covered off-street bike parking and accessible public spaces that are convenient to the SEC building entrance. Harvard has also worked with the City of Boston and the City of Cambridge to sponsor and install four 15-dock Hubway regional bike-share stations in Allston. As demand increases, Harvard is committed to exploring the expansion of the Hubway stations.

In recent years, there has been a significant increase in the number of bike lanes serving Allston. Harvard has collaborated with the City of Boston to install bicycle lanes on North Harvard Street from Soldiers Field Road to Cambridge Street and on Western Avenue from Barry's Corner east to Soldiers Field Road, including a westbound cycle track as shown below. The Paul Dudley White Bicycle Path along the Charles River provide off-road east-west mobility for bicycles and pedestrians from Watertown Square to Museum of Science passing by the study area. Bicycle accommodations on the Anderson Memorial Bridge, the Weeks Bridge, and at Barry's Corner are currently being improved and MassDOT has proposed improvements to the bicycle network serving the area as part of the Allston Interchange project. Figure 23 illustrates the future bicycle network with the SEC.

Future Bicycle Network

Figure 23 illustrates the future bicycle network that will serve the Project when it opens, including recently completed improvements to the Weeks Bridge, the new bike path along South Campus Drive, and the new cycle track on Western Avenue in Cambridge, as well as the bike lanes on the Anderson Bridge that will be completed in 2016. As shown in Figure 23, the Project will:

- Enhance the eastbound cycle track on the southern side of Western Avenue in front of the SEC and create a new westbound cycle track on the northern side of Western Avenue in front of the site that will be buffered from traffic by parking lanes and raised curbs;
- Provide a new multiuse path on Academic Way from North Harvard Street to Science Drive.
- A new multiuse path along the southern edge of the Rotterdam parking lot to connect paths in the area green space with Western Ave..
- Provide right of way for a future new bicycle path next to "Stadium Way" on the block between Rotterdam Street and Western Avenue; and
- Provide secure/covered bicycle parking that will be conveniently located on "Stadium Way" and "Academic Way" near the building entrances.

Prior to recent construction activity on Western Avenue, the existing bicycle infrastructure in front of the site included an eastbound cycle track with floating parking lane and a westbound bike lane. Harvard will work with BTD to refine this design including its transitions to adjacent bike facilities and to explore opportunities to create buffered bike lanes to the east of the site within the existing right of way.

Harvard will also work with BTD to refine the designs for "Academic Way" to provide new bicycle facilities to connect North Harvard Street with the SEC Building and establish a clear bicycle link between Rena Park and the multi-use path along South Campus Drive that leads to Smith Playground.

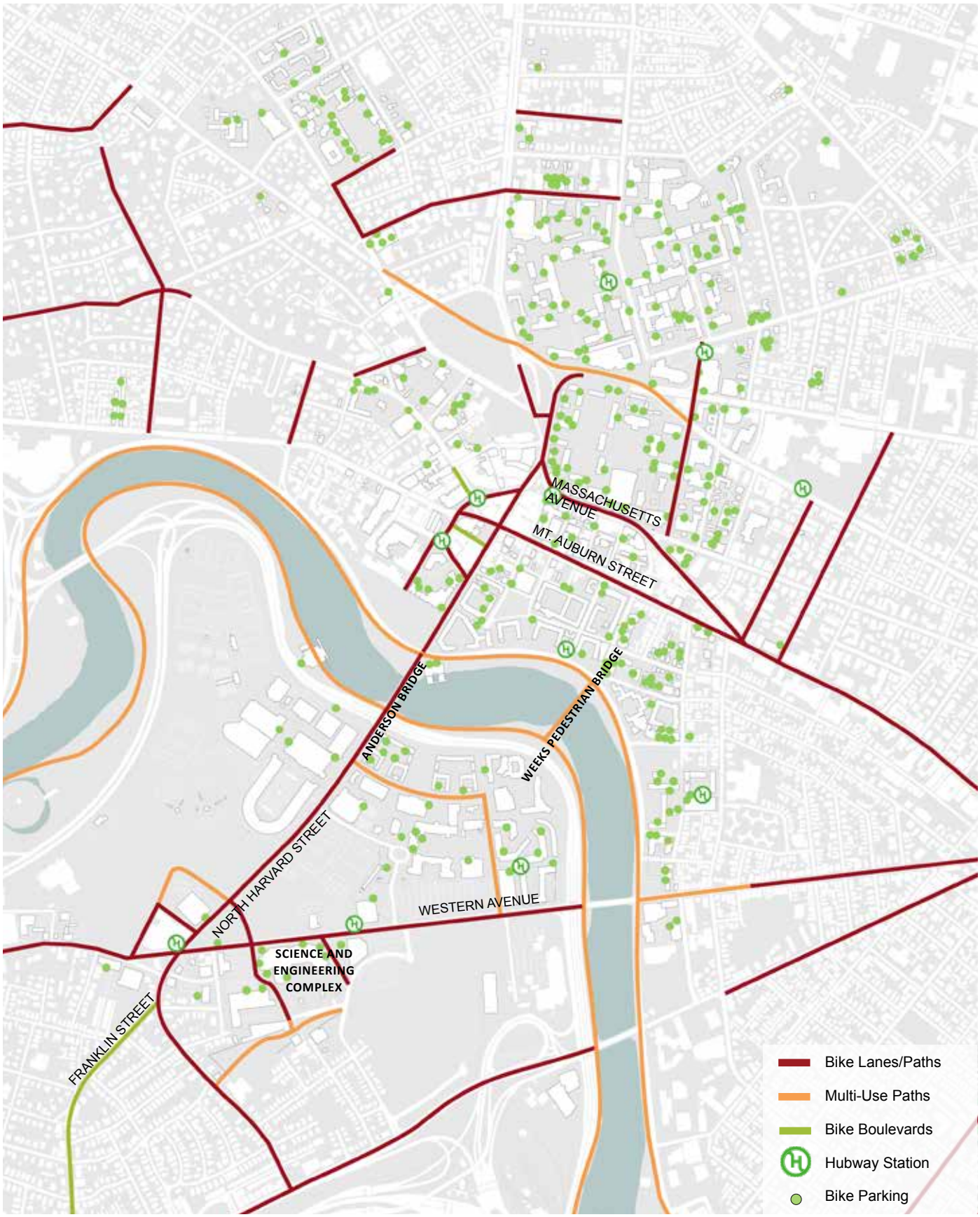


Figure 23: Ten-Year Bicycle Network

SEC Bicycle Accommodations

The mode share analysis indicates that as many as 390 faculty, staff, graduate students and researchers will commute by bicycle to the SEC on a daily basis. An additional 90-100 undergraduates (approximately 15 percent of the daily population) may also bike to the SEC on a daily basis. This is significantly greater than the potential numbers of bicycle commuters for the 2007 Science Project, but less than the 2013 IMP estimate of 1,740 total daily bicycle commuters for the Ten-Year plan including Science.

The SEC includes the accommodation of approximately 400 secure/covered bike parking spaces and approximately 100 outdoor bike parking spaces per Boston's Bike Parking Guidelines. The outdoor bike parking is located along the perimeter of the SEC Building and 114 Western Avenue near building entrances.

The site plan shown in Figure 24 illustrates two locations that have been identified for the secure/covered parking: one along "Academic Way" at the western side of the building and the other in a triangular area next to 114 Western Avenue. These locations are convenient to building entrances. Showers will be located on the ground floor of 114 Western Avenue next to the proposed bike parking area on Level A and Level C of the SEC Building near the eastern elevator core.

Harvard is also investigating opportunities to augment the bike parking at the 114 Western Avenue triangle with other bicycle amenities (e.g., bike repair station, Hubway) as part of a Mobility Hub that will serve the SEC. (The Mobility Hub concept was introduced in the 2013 IMP.) Other mobility options within close proximity to this location will include MBTA bus service, Harvard shuttle services, ZipCars, electric vehicle charging stations, and monitors providing transportation information. The provision and organization of these mobility options will be part of Harvard's commitment to encourage the use of non-vehicular transportation at the Project and the campus development in Allston.

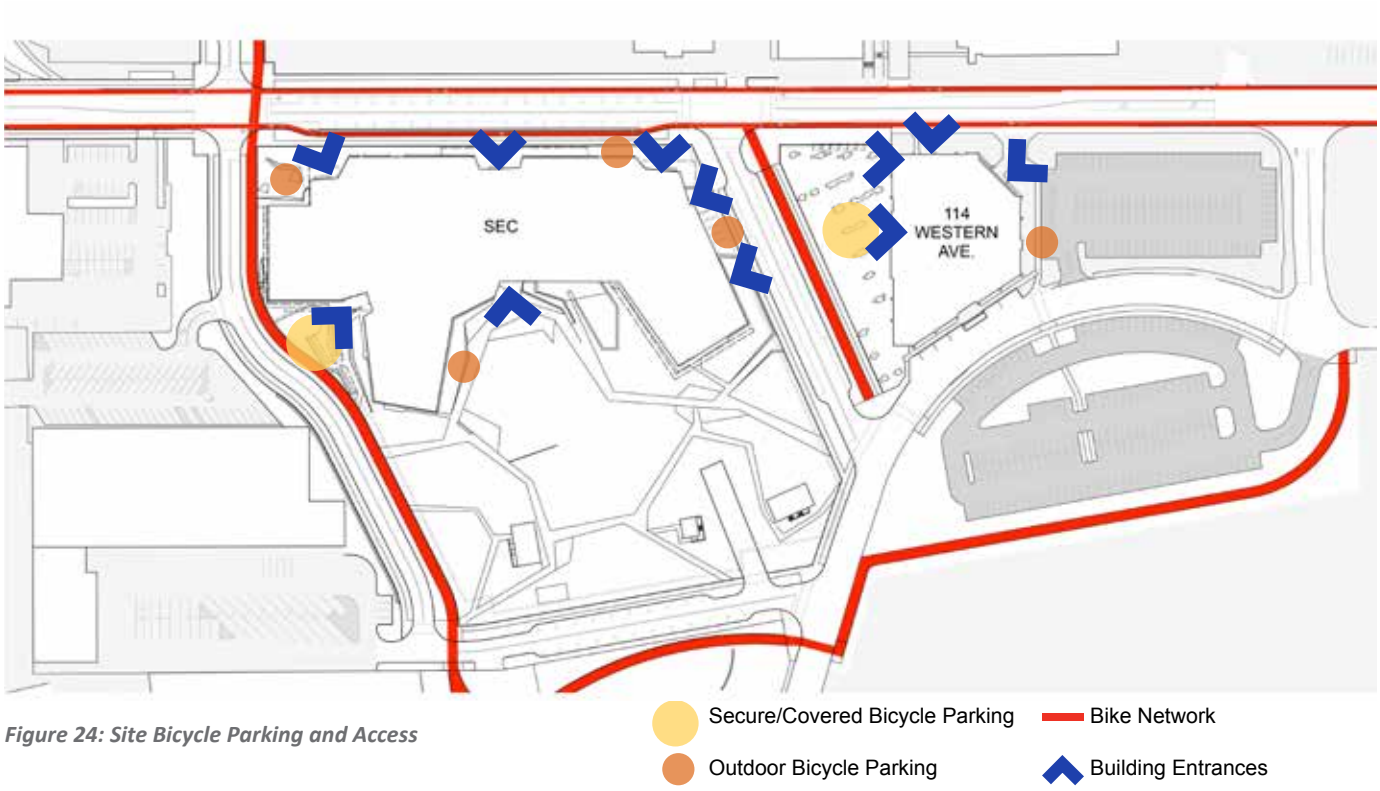


Figure 24: Site Bicycle Parking and Access

2.6 Pedestrians

The shift to academic uses will also increase pedestrian activity as compared to the 2007 Science Project. This will include commuters that will walk to the site and students that will walk to and from the Science and Engineering Complex for class and other academic activities. This level of pedestrian activity was anticipated by the 2013 IMP and is reflected in the design guidelines for streets and paths in the IMP area.

The Allston campus benefits from an extensive network of sidewalks and pedestrian paths that extend across the Charles River and into the Cambridge campus. Recent improvements have been made along these routes. The Department of Conservation and Recreation recently completed improvements to the John Weeks Bridge, making it more accessible and better lit at night. MassDOT is in the process of completing improvements to the Anderson Bridge that will provide better pedestrian crossings at the Memorial Drive and Soldiers Field Road intersections and improved sidewalks on the bridge.

Harvard owns and maintains a network of campus paths within its campus in Allston. These pathways provide internal connections and access to parking facilities as well as links to the system of public sidewalks and paths that are on the periphery of the campus. As part of the Project, Harvard will continue to invest in pedestrian facilities to connect the Project site to existing and planned facilities. As part of the Project, new sidewalks will be constructed on roadways around the perimeter of the site, using Boston's Complete Streets Guidelines. New pedestrian crossings are envisioned at the future intersections of Western Avenue and Academic Way and Western Avenue at Stadium Way as part of the SEC. Harvard will work with BTD to design and implement appropriate pedestrian crossings at these locations.

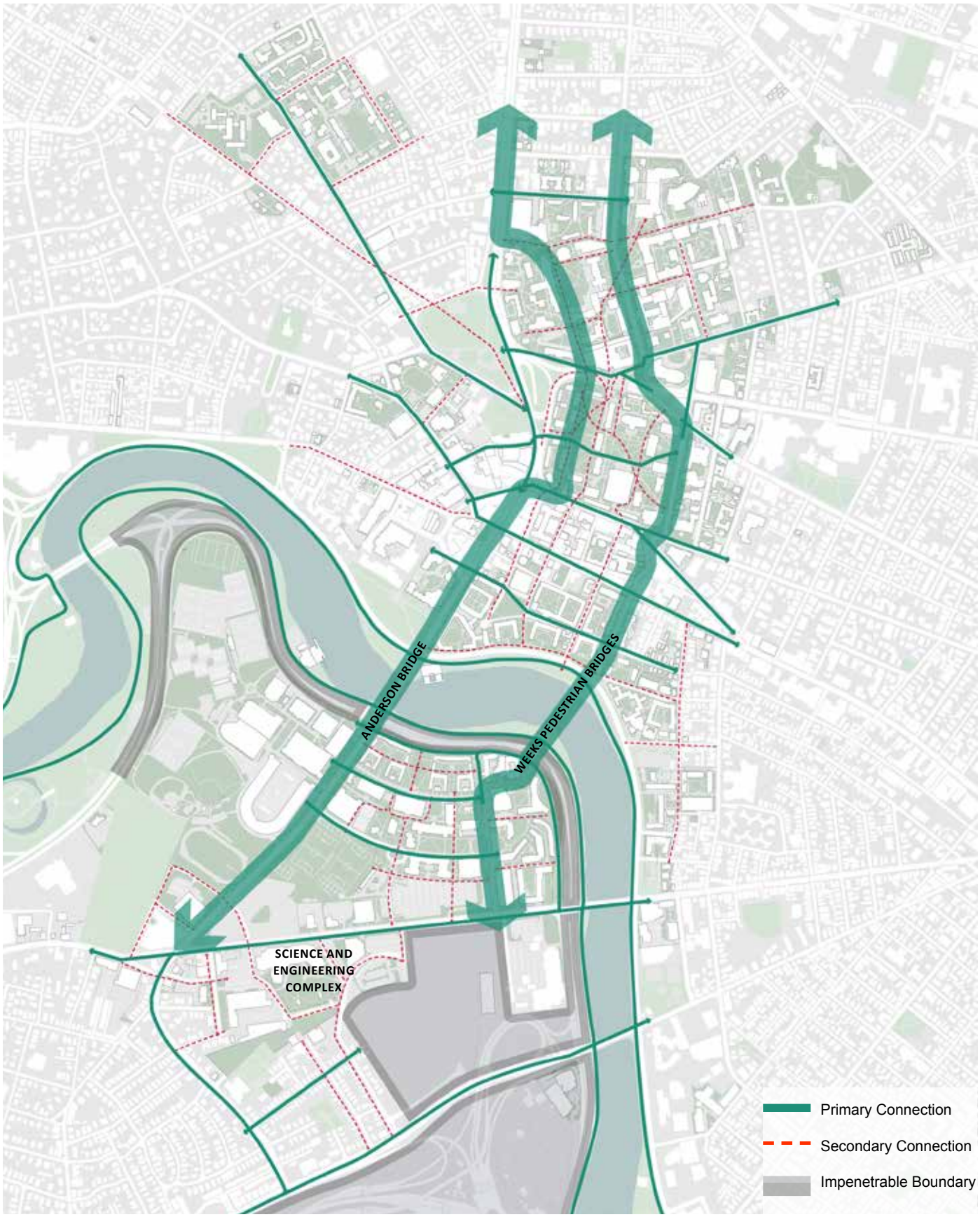


Figure 25: Pedestrian Network

2.7 Parking Management

All University parking is controlled and administered by the Harvard University Parking Office as a University-wide resource with a permitting system and specific parking lot/ garage assignments. Unreserved commuter parking (i.e., valid from 5:00 a.m. to 3:00 a.m. Monday through Friday, and all day on weekends) is available for eligible staff and faculty and currently costs $2,064 per year for surface parking and $2,208 per year for garage parking. Students or other Harvard affiliates living on-campus can obtain Reserved Parking permits (i.e., valid at all times for use by the permit holder) to park for $4,140 per year in garages and $3,900 in surface lots. These parking rates are for FY16. In addition, Harvard provides visitor parking in the Spangler Lot on Western Avenue and at designated multi-space meter locations. Appendix B provides further detail about Harvard's parking management programs.

The 2013 IMP explicitly stated that "No below grade parking is required for the initial program" (i.e. SEC). To accommodate the SEC parking demand, the 2013 IMP proposed to expand the 178 non-institutional surface spaces at 114 Western Avenue to 210 surface spaces by increasing the size of the lot to the east of the 114 Western Avenue building. The current SEC plan will provide the surface parking to the south of 114 Western Avenue to accommodate the Stadium Way alignment and increase the number of spaces from 210 spaces to approximately 275 spaces. As the design of the lot advances, Harvard will investigate the provision of electric charging stations and determine the need to designate other spaces for car-sharing services (e.g., ZipCar), high occupancy vehicles and low emission vehicles.

The new institutional parking supply will support the anticipated demand of 1,420 commuters to the building at a 21 percent auto mode share. Harvard's institutional parking supply was reduced by 90 spaces from 2,642 to 2,552 to construct Klarman Hall. The addition of 275 new institutional spaces for the SEC will increase the institutional parking supply to 2,825 spaces.

2.8 Transportation Demand Management

Harvard has an extensive Transportation Demand Management (TDM) program that is an important tool in managing vehicular travel to the campus. Harvard maintains an extensive CommuterChoice website (www.commuterchoice.harvard.edu) which provides information about these programs. Table 9 provides an overview of Harvard's TDM program that are available for eligible faculty and staff (i.e., working 17.5 hours or more per week).

Harvard is also a member of A Better City Transportation Management Association, which provides TDM services to employees at commercial properties. In addition to its extensive TDM program, Harvard also accommodates transportation demands related to athletic, commencement, and Business School events through police detail traffic control/ management, parking demand management and temporary signage.

Table 9: Overview of CommuterChoice (TDM) Program

Category	TDM Measure
Transit Passes	50 percent subsidy for MBTA monthly passes Pre-tax savings on the purchase of private transit passes and commuter checks is offered as an added bonus for eligible faculty and staff On-line monthly pass sales Participation of 6,700 Harvard affiliates in monthly pass program Eligible affiliates must be a full time benefits eligible employee paid directly through the University and not having a parking pass
Marketing	Transit pass program Public transportation options and Harvard shuttle services Bicycling services such as safe cycling classes, repair clinic, the Hubway bike share, and the departmental bike program Ridesharing options Walking and bicycle maps Links to other references and resources
Bicycle Program	$50 discounted annual membership in the Hubway bike sharing program (normally $85 per year) Reimbursements for bicycle safety training and repair classes for fulltime employees Discounted bike helmets Harvard affiliates bike registration program in conjunction with the Harvard University Police Department Participation in the Bicycle Benefit Act providing bicyclists up to $240/year for bicycle expenses.
Rideshare Programs	Discounted and preferential carpool and vanpool parking in the largest garages and several surface lots 50 percent discount on annual parking permits for carpoolers if they carpool with one other employee, and a 75 percent discount on the cost of their annual parking permit if they travel with three or more people. Carpool partner matching and registration Emergency ride home assistance Zimride, an online ride sharing program that helps Harvard affiliates locate other people with similar commuting patterns or travel needs and facilitates ridesharing. RelayRides program to match people who are willing to lend or borrow vehicles from one another
ZipCar	Discounted annual Zipcar membership ($25/year) to employees. Memberships for an 18+ age group. Parking for 34 ZipCars including 15 in Allston Participation of 10,000+ Harvard affiliates in the program
LEV and Electric Vehicles	Approximately 26 preferred parking spaces are available, with the appropriate permit, for Low Emission Vehicles (LEV) at ten locations on the Cambridge and Allston campuses. Two Electric Vehicle Charging Stations on the Allston Campus at 125 Western Avenue (i-lab)

2.9 Coordination with Other Agencies

MASSDOT COORDINATION

In 2000 and 2003, Harvard purchased what is known as Allston Landing North and Allston Landing South, which includes Beacon Park Yard, from the Massachusetts Turnpike Authority (now MassDOT); MassDOT retained an easement for I-90 and its highway ramps. Since the completion of the 2013 IMP, MassDOT has initiated the I-90 Allston Interchange Improvement Project and filed an ENF with MEPA in October 2014. This project contemplates the reconfiguration of the existing highway alignment and its ramp system, construction of a new West Station, and reintroduction of a rail yard on a portion of the former CSXT rail yard.

MassDOT has worked with Harvard to coordinate its design efforts with the SEC roadway network, which was preliminarily described in the 2013 IMP. Harvard anticipates that the SEC Project will begin construction and be completed before the interchange project. Harvard will continue to coordinate with MassDOT on the I-90 Allston Interchange Improvement Project, including participation on the project Task Force and refinements to the roadway network serving the University's future Enterprise Research Campus between Cambridge Street and Western Avenue.

The I-90 Allston Interchange Project will significantly affect traffic flows into and through the IMP area and on the roadways that serve the SEC. MassDOT will evaluate traffic operations at intersections within the IMP Study Area that were previously identified as having level of service concerns in the 2013 IMP, including intersections along Soldiers Field Road at the Anderson Bridge, the Western Avenue Bridge and the River Street Bridge. Harvard will coordinate with MassDOT regarding the need for future improvements to these intersections as this information becomes available.

Harvard continues to coordinate with MassDOT regarding interim improvements to the intersection of Cambridge Street, the I-90 ramps and the River Street Bridge. MassDOT paused the overall design and engineering efforts to improve the Western Avenue and River Street Bridges. In 2015, MassDOT developed a proposed set of improvements to the intersection of the I-90 off-ramps and Cambridge Street. As an abutter to this intersection, Harvard has coordinated with MassDOT on the design and proposed implementation of these improvements, which began construction in 2016. These improvements, which require the use of a portion of Harvard property, will upgrade the signal equipment, improve vehicular channelization, add new bike lanes and cycle tracks and enhance pedestrian crossings with improved equipment and signal timing plans.

DCR COORDINATION

Harvard has completed its study of potential at-grade crossing of Soldiers Field Road between the Eliot Bridge and Arsenal Street Bridges. The study recommended modifications to the intersection of Everett Street and Soldiers Field Road to provide an at-grade pedestrian/bicycle crossing and enhancements to the existing Telford Street Bridge to make it ADA-compliant, but deferred recommending an at-grade crossing at Smith Field until future conditions were better understood. The remaining $3,350,000 of funds committed by Harvard will be dispersed to DCR through the Boston Redevelopment Authority to prepare engineering plans and implement agreed-upon actions.

As described in the Draft and Final EIRs, Harvard has also worked with the Boston Redevelopment Authority to establish a Flexible Fund Executive Committee to distribute

$5.3 million over ten years for community improvements. The role of the Executive Committee is to evaluate proposals and disperse funds for acceptable projects. DCR is aware of the availability of this funding source.

Harvard had previously coordinated with DCR regarding the development of pedestrian/ bicycle bridge to replace the Sinclair Weeks Bridge over Soldiers Field Road. DCR had worked with the Harvard Business School to identify an appropriate alignment for the bridge that could be integrated into HBS planning for its campus.

2.10 Mitigation

The 2013 IMP identified a menu of enhancements to address the transportation impacts of the various IMP projects. Harvard will implement the following measures that were identified in the 2013 IMP as part of the SEC Project:

- Construction of "Academic Way" from Science Drive to North Harvard Street to relieve traffic congestion in Barry's Corner and provision of new pedestrian and bike connections to SEAS/SEC.
- Signal monitoring improvements at Barry's Corner and along N. Harvard Street to improve management of the traffic signal system along this corridor.
- Enhancements to the Harvard Shuttle system to extend the Allston Express to Barry's Corner.
- Upgrades to Western Avenue to create separated cycle tracks on both sides of the street in front of the SEC.
- Creation of Mobility Hubs at Barry's Corner and SEAS/SEC with Hubway stations, bike parking, ZipCars, MBTA bus stops, and Harvard shuttle stops.
- Consolidation of MBTA bus stops on Western Avenue and North Harvard Street (north of Barry's Corner) to reduce delay, bus bunching and improve service reliability.

The SEC Project does not include changes to DCR-controlled intersections or traffic signals.

2.11 Transportation Monitoring

As part of its Transportation Access Plan Agreement, Harvard provides the Boston Transportation Department with a transportation monitoring and annual report. This report includes the status of the various IMP projects and mitigation commitments, as well as reports commuter survey results for the Allston campus that are based on data from ridesharing surveys that Harvard submits to Massachusetts Department of Environmental Protection on a biennial basis.

The report presents mode share estimates in a format that differentiates faculty and staff from researchers and graduate students. Researchers and graduate students are further differentiated by whether they live at Harvard -owned residences or non-Harvard-owned residences. This analysis indicated that the Allston auto mode share is 26 percent for the 2015 commuting population, which is below the auto mode share goal of 40 percent for IMP projects. This reflects the high percentage (54 percent) of graduate students and researchers in the 2015 Allston campus population. Due to its academic nature, it is anticipated that the SEC auto mode share will be at or below the 2015 auto mode share estimate for the Allston Campus.

3.0 GREENHOUSE GAS ANALYSIS

This section contains a greenhouse gas (GHG) analysis that complies with the MEPA Greenhouse Gas Emissions Policy and Protocol (GHG Policy) of May 2010.

3.1 Introduction and Project Overview

MEPA GREENHOUSE GAS EMISSIONS POLICY AND PROTOCOL

This section addresses GHG emissions generated by operation of the Project and associated traffic, and options that may reduce those emissions in accordance with the MEPA GHG Policy. The GHG Policy requires, for certain projects undergoing review by the MEPA Office and required to prepare an EIR, that GHG emissions be quantified and measures to avoid, minimize, or mitigate such emissions be identified. The GHG Policy requires proponents to quantify the impact of proposed mitigation in terms of energy savings and GHG emissions.

On February 23, 2016, the Proponent met with the MEPA Office and the Department of Energy Resources (DOER) to outline the methodology and mitigation expectations for the Project. This analysis follows the process outlined in that meeting and the follow-up communication.

The analysis provided herein focuses on emissions of carbon dioxide (CO2). As noted in the GHG Policy, although there are other GHGs, CO2 is the predominant contributor to global warming. Furthermore, CO2 is by far the predominant GHG emitted from the types of sources related to this Project, and CO2 emissions can be calculated for these source types with readily available data.

GHG emissions sources can be categorized into two groups: 1) stationary sources or emissions related to activities that are stationary on the site; and 2) mobile sources or 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; and indirect sources include GHG emissions associated with 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 the Proponent to calculate and compare the GHG emissions for two cases, each of which considers stationary source and transportation components.

Stationary Sources

Case 1 is the baseline from which progress in energy use and GHG emissions reductions is measured. Per the GHG Policy, the baseline is a building designed to meet the applicable state building code (Code) that is in effect at the time the ENF is filed. That edition of the Code will remain the baseline for all future development energy modeling for GHG Policy compliance. The baseline is a reference point from which to measure the effectiveness of energy efficiency improvements in the proposed development.

The current Energy Code is the 8th edition, amended to incorporate the building energy provisions of International Energy Conservation Code (IECC) 2012. In accordance with the GHG Policy, this, together with the guidance of the modeling protocol of ASHRAE 90.1 Appendix G, defines the baseline for this GHG analysis.

For the stationary sources component, Case 2 presents the proposed development including GHG mitigation measures anticipated to be incorporated into the building designs.

The City of Boston has elected to include the state's optional Stretch (Energy) Code in its building requirements. Currently, the Stretch Code (SC1) is based on a reduction of energy use from a baseline of IECC 2009 (ASHRAE 90.1-2007).

Very recently, the Board of Building Regulations and Standards (BBRS) proposed a draft of the 9th edition of the Code which would include adoption of IECC 2015, with Massachusetts-specific amendments, and would also include a revision to the Stretch Code (SC2). It is unknown if SC2 will be adopted or what its final form will be. If adopted, it is anticipated that the next version of the Stretch Code would require approximately 12-15% lower energy use than an IECC 2012 baseline. That is the target of the analysis of the SEC Buildings in this GHG analysis.

Although direct comparison between IECC 2012 and 2015 for commercial buildings would depend on the specifics of the use and design of the individual buildings, the U.S. Department of Energy determined that, on a national average basis, IECC 2015 will result in 7.5% lower site energy use than IECC 2012[1], which is less stringent than the Project target of IECC 2012 minus 12-15%.

Mobile Sources

The transportation study (included in the DEIR and FEIR and summarized in Chapter 2.0) includes the entire project area, including Soldiers Field Road, Western Avenue, North Harvard Street, Cambridge Street, and numerous side streets in the vicinity.

Transportation-related emissions for the Baseline case are modeled for the "build without mitigation" condition, which does not include roadway improvements. The analysis was developed using the standard methodology outlined in the current Transportation Impact Assessment (TIA) Guidelines (MassDOT, March 13, 2004). The analysis is based on a study year of 2022.

The transportation analysis for the proposed case includes the effects of any Transportation Demand Management (TDM) program elements as well as any roadway and signalization improvements proposed by the Proponent.

Additional Mitigation

The GHG Policy also requires the Proponent to identify, evaluate, and discuss other measures that could further reduce GHG emissions. Because this Project is in the early stages of planning, many of the GHG mitigation measures cannot be analyzed or committed to at this time. A large part of the description in the remainder of this section is devoted to evaluating and analyzing these additional GHG mitigation measures or potential alternatives.

[1] https://www.energycodes.gov/determinations

PROJECT OVERVIEW

The Project consists of three components:

- The Science and Engineering Complex (the SEC Building), is a planned new construction, approximately 445,350 square foot building. The SEC Building will consist of laboratory and teaching spaces, offices, and administrative space. It will house faculty, scientists, researchers, students, and staff, including undergraduate concentrators and graduate students who are studying applied mathematics, applied physics, computational science and engineering, bioengineering, computer science, electrical engineering, environmental science and engineering, material science, and mechanical engineering.
- Renovation of approximately 51,000 square feet of space in the existing office building at 114 Western Avenue. This building is undergoing a renovation only, with no systems impacted. For this reason, it has been excluded from this GHG analysis.
- The District Energy Facility (DEF) is a planned energy-producing facility, comprised of an approximately 60,000 square foot building housing a combined heat and power (CHP) facility. The DEF will supply hot water for heating, chilled water for cooling, and electricity for building power for the SEC, with size and capacity to serve future buildings as part of Harvard's future expansion in Allston.

Please see section 3.2 for a discussion of the planned DEF. Because the conditioned space inside the DEF is less than 5% of the DEF building, the DEF building itself has been excluded from the stationary source GHG analysis.

The various mitigation measures available for use in a new building development project are identified in Table 10 and are organized into the following subsections: Energy Use Reduction, Energy Generation, and Other Related. Technologies grouped under Energy Use Reduction and Energy Generation are the heart of GHG mitigation measures. Other Related Technologies include additional measures that may indirectly affect GHG emissions, although their primary purpose is to accomplish other goals. For these measures, the GHG emissions reduction potentials are difficult to quantify with any reasonable accuracy and are numerically expected to be a small part of the overall mitigation. They are, therefore, not quantified in this analysis.

This GHG analysis addresses nearly 40 stationary source GHG mitigation measures involving design parameters, technologies, and construction and operating parameters, which are generally referred to herein as "technologies" for convenience. Each of these technologies is discussed in detail in section 3.2.

In Table 10, each building type is represented and the applicability of each technology is characterized as:

- P – included in the design and building energy modeling of the Proposed case;
- A – an alternative that is preliminarily evaluated in this analysis;
- S – to be studied later as building designs progress; or
- X – rejected as a technology that is either not applicable to the use or is deemed to be technically or economically infeasible.

ORGANIZATION OF THE REMAINDER OF THIS SECTION

Sections 3.2 and 3.3 present the designs of each building type of the Project, and for the SEC Building, include:

- a summary of mitigation technologies included in the proposed development;
- modeling description and results or methodology and results of energy use estimation; and
- discussion of mitigation technologies not currently included in the designs and the reasoning behind their exclusion.

Transportation-related GHG emissions and the Project's mitigation measures are analyzed in section 3.4.

Section 3.5 includes a summation of the SEC Building's GHG emissions and a listing of the Proponent's GHG emissions mitigation commitments.

Supporting technical analyses, such as detailed building modeling reports and analyses of certain potential alternatives are provided in Attachment A.

3.2 District Energy Facility

CONCEPT AND DESIGN

The District Energy Facility (DEF) is currently in design development and final plans may change. However, based on extensive experience with District Energy systems on the existing Cambridge and Allston campus, it is reasonable to outline the following expectations and design criteria.

The DEF will provide heating, cooling, and electricity with an N+1 redundancy, along with expansion capability to grow production as demand increases. It will have flexibility to incorporate future technology improvements and additional sources of thermal energy. It will be designed to optimize any necessary trade-offs between maximum overall efficiency and system reliability.

The primary cooling will be via high efficiency medium voltage electrical centrifugal chillers with variable frequency drives (VFDs) on the compressors, chilled water pumps, condenser water pumps, and cooling tower fan motors. Free cooling will be utilized during winter months, using heat exchangers on the condenser water system to supply chilled water without mechanical compression. A thermal energy storage tank and a heat pump chiller are also being considered.

Hot water will be generated via engine based co-gen supplemented by high efficiency boilers. The fuel source will be natural gas with an on-site back up of ultra-low sulfur diesel. The hot water system will be designed to operate at lowest feasible supply temperatures in order to reduce system losses and include the greatest possibility of additional heat recovery options.

The electric district station will be a main switching point between Eversource and the University and will operate at 13,800 volts. It will be designed to utilize grid power in parallel with on-site generation and maximize flexibility regarding supply. It is expected to allow export in cases where the most efficient operation of the facility may produce more power in a specific hour than is needed behind the meter. It will also allow full import during events when on-site generation is offline. It will be designed to island during grid

instability, allowing on-site generation to continue to supply the DEF (and potentially, other university buildings) during an emergency event. Additional standby generation will be incorporated to ensure blackstart capability of the heating side and will be investigated for connection to the cooling side and other campus buildings.

The main inputs for this facility will be electric power from Eversource, natural gas service from National Grid, and water from the Boston Water and Sewer Commission. Fuel oil (in the form of ultra-low sulfur diesel) will be a minor input, primarily used as backup. The main outputs will be a closed loop district chilled water system, and electric distribution feeders.

3.3 Stationary Sources

For purposes of this analysis, the focus of the GHG stationary sources will be the Science and Engineering Complex. Except where indicated, the narrative in this section 3.3, refers to the planned SEC Building.

CURRENT DESIGN AND MITIGATION MEASURES

The various mitigation technologies available for use in a new building development are identified in Table 10 and are organized into the following subsections: Energy Use Reduction, Energy Generation, and Other Related. This section, which describes the mitigation technologies that are included in the design at the present time, is similarly organized.

Energy Use Reduction

Building Orientation

The SEC Building is orientated according to existing street geometry, but the predominant east/west orientation provides a near optimum configuration from an energy use optimization perspective. Further, shading elements on the façades (shading screens, shading fins, and shading wings) are optimized for their individual orientation and redirect sunlight into the building interior.

High Performance Building Envelope

Minimizing the energy intensity of buildings is an important component of the design process. A high-efficiency building shell includes insulation values of walls and roof that exceed Code requirements, while being cost-effective. Glazing that combines functionality and higher insulating properties, while reducing solar heat gain and simultaneously providing adequate natural lighting, adds to the shell's performance.

High-efficiency building envelopes will be utilized. U-factors of roof, walls and glazing, and slab-on-grade floor design will all equal or exceed IECC 2012 standards, as presented in Attachment A.

Green Roof/Podium Areas

Green roof/podium areas will be incorporated into the planned design, reducing cooling loads and site stormwater runoff.

Table 10: GHG Mitigation Technologies

Mitigation Measure/Technology	Building	Remarks
Building Use	Harvard Science and Engineering Complex	
Energy Use Reduction		
Building Orientation	P	
High performance building envelope	P	
Green roof/podium areas	P	
Light or reflective roof	P	
Exterior shading devices	P	
Premium electric motors	P	
Radiant heat	P	
Under-floor air distribution/displacement	P	
Heat or energy recovery	P	
Demand-controlled Ventilation	P	
Room occupancy sensors, lighting	P	
Natural lighting	P	
Daylighting Controls	P	
Reduced LPD interior	P	
High performance lighting, exterior	P	
Energy-Star appliances	P	
Advanced elevators	P	
High efficiency HVAC equipment	P	
Energy Generation		
Cogeneration, CHP	P	Facility will utilize planned cogen. District Energy Facility
District heating/cooling	P	Facility will utilize planned cogen. District Energy Facility
Fuel cell	X	
Solar hot water generation	A	
PV - rooftop	A	
PV- parking lot	S	
3rd Party PV	S	
PV-ready construction	P	
Ground source heat pumps	S	
Wind turbines	X	
Purchased Green Energy	S	Facility will utilize planned cogen. District Energy Facility
Other Related (not quantified)		
LEED target	Gold	
Owner Influence on tenant	S	Food vendor will be held to LEED and SEAS guidelines
Rainwater harvesting	P	
Low flow fixtures, water conservation	P	
Recycling collection areas	P	
Enhanced refrigerant management	P	
Energy management system	P	
Enhanced building commissioning	S	
Construction waste recycling	P	
Recycled content materials	S	
Regional materials	S	

Key:

P = Proposed (Case 2) - included in modeling

A = Examined as alternative - not included in modeling (real numbers discussed in write-up)

S = to be studied at later design phase - no quantitative analysis, potential for inclusion at a later date

X = Not applicable or not feasible

Light or Reflective Roofs

Light or reflective roofing materials will be utilized at the building on roof areas that are not planted. Light concrete pavers with a minimum solar reflective index (SRI) of 29 will be used in the occupied zones. All other non-occupied, non-planted spaces will be a light colored membrane roofing material. Light roofing does not produce a significant energy use reduction in the northeast, as has been demonstrated by modeling in other projects previously submitted to MEPA, but does reduce a building's contribution to the urban heat island effect in the summertime. The Project is located in Boston where the urban heat island effect is of concern.

Exterior Shading Devices

The facade design balances solar shading, thermal insulation, and user experience. For the laboratory facade, the exterior screen is composed of 2'-7.5" by 2'-7.5" shading modules. For the north, east, south, and western facades, each screen is composed of a different module shape which is designed and geometrically optimized to block summer light out and let winter light in. By shading the facade in the summer, peak cooling load is reduced, enabling alternative forms of cooling such as radiant technology. Behind the screen is a curtain wall, which has a higher proportion of glass than a comparable high performance facade due to the shading of the screen. At the garden facades, deep overhangs and fixed horizontal shading elements work together to keep out the high summer sun while still allowing for unrestricted views from the interior spaces.

Premium Electric Motors and Variable Frequency Drives

It is expected that premium motors will be used in the MEP systems and other mechanical equipment such as elevators (where applicable). Variable frequency drives (VFDs) increase the efficiency of motors operating at partial load, and are generally applied to heating, ventilation, and air conditioning (HVAC) and water pump motors greater than 5 horsepower.

Radiant Heat

The building will employ a Radiant Slab System in public areas and overhead radiant panels in office and classroom areas. The radiant slab system is used to provide heating and cooling to large areas such as the Atrium. The Atrium is zoned in roughly 2,000 square foot zones each controlled by a radiant slab manifold. Zones can either be cooling only (interior zones) or heating and cooling (perimeter zones). Medium chilled water (58/64) and hot water (140/110) will be supplied to the respective manifolds which are installed in the zones they serve. For heating and cooling manifolds, a 6-way valve is provided as a switch-over valve which supplies dual temperature (HW or MCHW) to the manifold.

Office and classroom areas will be heated and cooled by overhead radiant panels. These panels will consist of metal ceiling tiles with tubes bonded to them through which hot or chilled water will be circulated to satisfy the heating or cooling requirements of the space. Depending on loads in the space, the panels will comprise from 50 to 75% of the ceiling area.

Underfloor Air Distribution

Air displacement systems are provided for spaces with large occupancies typically lecture halls with raised seating as well as specific spaces within the Atrium where congregation of people will occur. Supply air from the Non-Lab Air System will be used for displacement air systems with a supply air temperature of 58-63 degrees.

The basis of an air displacement system is to deliver neutral temperature air at the occupied zone level. This process compared to traditional overhead system provides for greater human comfort as the air is delivered at an elevated temperature during cooling at the source where it's needed. Generally the amount of supply air can be reduced compared to traditional delivery methods. Air displacement diffusers specially designed for the application are installed in close proximity to the occupant. In the case of auditoriums with raised seating, the space below the seating platform can be used as a supply plenum with air diffusers installed in the platform below each occupant (or every other occupant). In areas such as the atrium, walls or even raised platforms can be used to deliver air at the occupant zone level.

Heat or Energy Recovery

Heat and energy recovery ventilators (HRV and ERV) recover energy from building exhausts, transferring it to the inlet air, and thus minimizing energy losses associated with ventilation. HRVs recover sensible heat, whereas ERVs recover sensible and latent heat.

The building's air systems will employ heat recovery to pre-condition the outside air. The use of enthalpy wheel type heat recovery is not appropriate for this application; an alternate technology consisting of a high efficiency glycol runaround loop with indirect evaporative cooling is proposed (Konvekta). The run-around loop system consists of heat recovery coils within the lab exhaust stream and within the lab and non-lab air handling units to pre-treat incoming outdoor air. Indirect evaporative cooling at the exhaust heat recovery coils will be used to enhance the system effectiveness during warm weather. For building systems consistency, non-lab air handlers will be provided with high efficiency run-around loop heat recovery similar to the lab air systems.

Additionally, air delivered to non-lab spaces (offices, classrooms, etc.) will be returned through the atrium and used as make up air for the laboratory air systems. This approach minimizes ductwork, reduces fan energy use and effectively achieves 100% heat recovery efficiency on the non-lab airflow. The air returned will pass through the Waterwall (described separately) to help purify and humidify it before it is mixed with outside air and used as make-up for the lab air handling units.

Demand-Controlled Ventilation

Demand Controlled Ventilation (DCV) will be employed throughout lab and non-lab spaces to reduce energy consumption. Within laboratories, occupancy sensors, associated with the lighting control system, will index the Lab Air Control System (LAC) to exhaust the design air change rate (ACR) with volumetric control of supply air to maintain required pressure differentials within the lab. Three modes of operation will be maintained; maximum occupied, minimum occupied and unoccupied. Each mode will be assigned specific air change rates based on control banding practices. Spaces with fume hoods would override the ACR based on the hood exhaust rate requirements. The BMS shall index building occupied and un-occupied schedules.

Additional laboratory airflow optimizations include:

- High performance, variable volume, low flow fume hoods.
- Occupancy based auto closing sash and combination vertical/horizontal sash to further reduce fume hood airflow.
- Risk assessment and control banding to optimize airflow in response to the program requirements.

- Use of point source exhaust to achieve local contaminant capture, allowing for lower space air change rates.
- Use of chilled beams to satisfy space cooling/heating loads with required minimum airflow.
- CFD analysis of laboratory airflow to achieve maximum ventilation effectiveness with minimum airflow.

Within non-lab spaces, DCV will be accomplished through the use of occupancy sensors associated with lighting controls and CO2 sensors to index terminals to minimum airflow conditions when possible.

Room Occupancy Sensors

Occupancy sensor switching devices shall be employed in all areas of intermittent use, such as offices, light use storage rooms and janitor closets. All laboratories or other potentially hazardous work areas shall be provided with dual technology sensors to ensure detection of occupants at all times of occupancy. Occupancy sensors in laboratories will be interfaced with the building automation and lighting control systems. Systems shall be designed to ensure that ventilation rates are not affected by lighting overrides if space is occupied.

Natural Lighting

The current design includes glazing and natural lighting appropriate to each space type.

Daylighting Controls

Day lighting and daylight responsive dimming control will be employed to the maximum extent possible throughout the building. It is anticipated that most areas will be provided with photocell controlled LED lighting with dimmable drivers.

Reduced Lighting Power Density

High-performance lighting fixtures such as high-efficiency fluorescent or light-emitting diode (LED) lighting are expected to be used throughout the SEC Building. This reduced lighting will be combined with task lighting to provide sufficient lighting to spaces where work is being performed. Please refer to Appendix A for proposed lighting power density reductions.

High Performance Lighting, Exterior

As LED-based exterior lighting applications broaden, many designers are incorporating this technology into external signs, area lighting, and other uses. Exterior signs and area lighting will be LED-based.

Energy Star Appliances

Energy Star appliances use up to 40% less energy than other models of the same function. Energy Star Appliances will be employed throughout the SEC Building.

Advanced Elevators

All elevators are machine room-less with the exception of Service Elevator 7, a large, high load capacity elevator that requires a machine room due to its size.

High Efficiency Mechanical Equipment

The building will be supplied with hot water and chilled water from the DEF. Where applicable, HVAC systems and equipment will be designed with design ratings and efficiencies that are equal to or better than Code. Please refer to Appendix A for proposed model inputs.

Energy Generation

Cogeneration, CHP

The building will be supplied by a district energy facility that supplies hot water for heating and chilled water for cooling, and includes combined heat and power cogeneration. Please refer to the DEF description in section 3.2 for DEF design information.

District Heating and Cooling

The building will be supplied by a district energy facility powered by Combined Heat and Power cogeneration. Please refer to the DEF description in section 3.2 for DEF design information.

PV-Ready Construction

The SEC Building will be designed as PV-ready (i.e., with appropriate structural capacity and space allocations that make a future PV retrofit possible).

Other Related

LEED Target

At this time, the building is targeting LEED for New Construction Gold.

Rainwater Harvesting

A 75,000 gallon tank will collect rainwater/stormwater for reuse opportunities.

Low Flow Fixtures

The building will employ Ultra Low-Flow water-conserving plumbing fixtures. Electronic type valves will be used.

Recycling Collection Areas

Area will be set aside in appropriate spaces in the SEC Building to participate in separation and recycling of packaging and other recyclable materials.

Enhanced Refrigerant Management

Refrigerant based systems include kitchen freezers/coolers, lab freezers, environmental control room cooling (water cooled compressors) and emergency cooling (condensing unit) will be provided in the SEC Building. This equipment would fall under the parameters of EA Credit 4, Enhanced Refrigerant Management except for those small freezers/cooler with less than 0.5 pounds of refrigerant.

Energy Management System

While not a GHG reduction technology, an Energy Management System (EMS) or Building Management System (BMS) can ensure that a building's systems are installed and operating properly. The Building's BMS is a direct digital system controlling, monitoring and trending building systems. The function of the system is to operate equipment in the most efficient way possible by monitoring conditions (trim and respond) and lower system brake horse power. Metering will be provided on systems noted below providing input to the BMS for energy computations.

- HVAC hydronic systems; HW, Chilled Water,
- HVAC Air Systems; lab air, non-lab air, general exhaust systems
- Power/lighting panels, unit sub stations
- Energy/Btu meter
- Dashboards for demonstrating energy goals and results under consideration

Construction Waste Recycling

Harvard will work with construction managers to outline, develop, and implement a comprehensive construction plan, part of which will involve creating a comprehensive construction waste management plan.

BUILDING ENERGY MODELING

Building energy modeling was performed by TransSolar KlimaEngineering, a recognized leader in climate-responsive high-performance building design. Modeling was conducted using eQuest v3.65.7163, the latest version of this widely recognized and accepted building design model, and followed the protocol of ASHRAE 90.1, Appendix G. Transsolar's model inputs are presented in Attachment A.1. Selected eQuest output tables for each case along with a summary spreadsheet are provided in Attachment A.2.

Methodology

The Baseline cases represent the building built to the standards of IECC 2012 (ASHRAE 90.1-2010) and other parameters as required by Appendix G. The Proposed cases represent the representative buildings with the features described in section 3.3.

The Proposed case building will utilize services from a new District Energy Facility (DEF) including hot water, chilled water and electricity. In accordance with the "District Energy Modelling Guidelines (USGBC)", annual average heating and cooling efficiencies as well as heating, cooling and electricity GHG emissions intensities (MTCDE/MMBtu, MTCDE/ton-hr, and MTCDE/kWh, respectively) were estimated for the new DEF and multiplied accordingly with building heating, cooling and electricity loads from the energy model, post-process. That is, building heating loads are counted on a "steam-meter," cooling loads are counted on a "chilled-water-meter" and electricity on a "electrical-meter" in the energy model, as shown in the BEPS report in Appendix A. In this post-process calculation, the new DEF cogeneration plant efficiency and GHG emissions are captured. Note that the Baseline case is modelled according to ASHRAE 90.1-2010 with Appendix G, which requires natural gas boilers and electric chillers, and therefore, GHG emissions for the Baseline case are calculated with natural gas and Massachusetts grid electricity GHG intensities. The DEF plant performance efficiency assumptions have been included in Appendix A.

Modeling results are summarized in Table 11. Compared to Code-compliant buildings, the Project is expected to decrease GHG emissions by approximately 25%, or approximately 1,381 tons/year.

Energy Use Intensity (EUI) is a measure of annual building energy use per square foot of conditioned space. EUI values for the SEC Building are presented in Table 11. A 25% reduction from Baseline is indicated for the building.

Table 11: SEC Modeling Results

Direct (Natural Gas)[2]	Baseline MMBtu/yr	Proposed MMBtu/yr
Space Heating	26,470	0
Hot Water	1,110	1,109
TOTAL	**27,580**	**1,109**
REDUCTION		**96%**

Indirect (Electricity)	Baseline MWh/yr	Proposed MWh/yr
Space Cooling	940	0
Heat Rejection	50	0
Ventilation Supply Fans	3,690	3,566
Pumps & Auxiliary	540	109
Interior Lighting	1,850	941
Misc. Equipment	3,410	3,412
TOTAL	**10,480**	**8,028**
REDUCTION		**-23%**

District Energy Loads	Baseline MBtu/yr	Proposed MMBtu/yr	Notes
Space Heating (District Hot Water Load)	0	11,825	< from BEPS FM1 Steam Meter
Space Heating (Natural Gas DEF)	0	15,160	< District Hot Water Load / 78% efficiency (Plant Performance Assumption table)
Space Cooling (District Chilled Water Load)	0	19,131	< from BEPS chilled water meter
Space Cooling (Electricity DEF)	0	3,589	< District Chilled Water Load / 5.33 COP (Plant Performance Assumption table)

Total Energy Consumption	Baseline MBtu/yr	Proposed MBtu/yr
	63,338	47,250
		-25%

Energy Use Index	Baseline kBtu/sf-yr	Proposed kBtu/sf-yr
	132.9	99.2
		-25%

GHG Emissions	Baseline tons/yr	Proposed tons/yr
Direct (NG)	1,613	65
Indirect (Electricity)	3,804	2,914
District Energy (NG)	0	725
District Energy (Electricity)	0	332
TOTAL	**5,418**	**4,036**
REDUCTION	**1,381 TONS/YEAR OR -25%**	

CO_2 Emission Factors:			
Natural Gas[2]	117	lbs/MMBtu	
Electricity[3]	726	lbs/MWh	
District Energy Natural Gas	0.0613	MTCDE/MMBTU	< Plant Performance Assumption table, DEF Steam
District Energy Electricity	0.01738	MTCDE/MMBTU	< Plant Performance Assumption table, DEF CHW * 1,000 * 1 Ton-hr/12 MBTU

Notes:

CBECS Table C10, Zone 2

EIA Fuel Emissions Factors, http://www.eia.gov/oiaf/1605/emission_factors.html#emission

Draft 2014 New England Electric Generator Air Emissions Report, Table1.1, 2014 value

MITIGATION STRATEGIES NOT CURRENTLY INCLUDED

The Project will redevelop a brownfield site with significant environmental considerations. While certain mitigation measures may provide GHG benefits, the Proponent must weigh these benefits against any costs associated with potential remediation.

Mitigation technologies not included in the current development fall into three general categories:

- Technologies that may be applicable, but for which an applicability determination must include specifics of proposed building design and use;
- Technologies that are generally considered technically or economically infeasible for use in the SEC Building; and
- "Other Related" technologies that are expected to be used to varying degrees, but for which the GHG emissions effects are not quantified herein.

Energy Generation

Fuel Cells

Fuel cells use methane (natural gas) in an electro-chemical process operating at low temperature to generate electricity. High-grade or low-grade waste heat recovery, or both, can make these units into a CHP technology.

Fuel cells have been used in limited applications for continuous power generation, but they are very expensive. Although the cost has decreased in recent years, it appears to remain well above competing technologies. Even with tax incentives and the potential availability of Alternative Energy Renewable Energy Credits, the cost of fuel cells is considered to be too high for likely application.

Solar Hot Water (SHW)

SHW can be an effective GHG mitigation technique where there is a significant hot water demand. The use of solar thermal is currently under study. The SEC facility is a large building and will have significant domestic hot water loads. The installation of a solar thermal system is an effective way to address these domestic hot water loads with a renewable energy source.

To develop an optimum system type and size, project engineers analyzed eight different collector types (both flat plate and evacuated tube type) in four different system sizes. Performance was modeled using F-chart software. The team found that the evacuated tube type collectors offered slightly greater output but are significantly more expensive. Should the proponent proceed with a solar hot water installation, the following flat plate type collectors would likely be recommended:

- Collector Type: Flat plate, selective surface collectors, nominal 4' x 8', Sun Earth model EC-32
- Collector Array Size: 30 collectors at 32.84 ft2 each, total of 985.2 ft2
- System Type: Glycol drain back
- Storage Volume: 1,500 gallons (three 500-gallon tanks)

If a roof-mounted solar PV system is included in the SEC Building, the installation of a solar thermal system will mean that the two systems will compete for the limited available roof area. The systems have comparable economic performance, but PV systems typically receive greater incentives, making them more attractive on a net cost basis. The availability of Alternative Energy Renewable Energy Credits to solar thermal installations is expected to provide an additional incentive. Solar incentives are difficult to predict for upcoming years. Whether SHW is economically feasible and how it compares with other alternatives will be decided later in design.

Photovoltaic (PV)

PV would compete with Solar Hot Water for roof space, and potentially with CHP for electrical load. The Proponent will evaluate all alternatives when sufficient building design and load information becomes available and will base the economic evaluation on then-current utility costs, incentives and other factors.

Rooftop

The Proponent is considering the use of rooftop PV. However, the Proponent cannot commit to rooftop PV at this time. Further evaluation will occur as design progresses, taking into account available tax incentives, utility rebates (if applicable), cost of electricity, feasibility of net metering, capital costs, the availability and projected value of Solar Renewable Energy Credits, and the financial factors appropriate to the developer.

The total roof area for the SEC Building is approximately 64,500 square feet, although this is broken into many smaller areas due to the presence of roof-top mechanicals, green-roofs, and terrace spaces. Additionally, the available roof space would compete with potential rooftop solar hot water collectors.

Nevertheless, a preliminary performance evaluation was conducted to demonstrate the potential for GHG mitigation presented by rooftop PV. The roof area of the SEC building will likely be partially utilized for HVAC equipment, building vents, emergency equipment, stairwell towers, etc. The remainder may be available for PV or SHW panel arrays. Given the approximately 64,500 square feet of roof area, it is assumed that approximately 32,000 square feet may be available and might accommodate an effective panel area of approximately 19,350 square feet, allowing for maintenance and access spaces, parapet setbacks, etc. This would provide a generation capacity of approximately 232 kW (rated DC). Such an array would produce an average of approximately 307 MWh/yr, offsetting grid-produced electricity and approximately 112 tons/yr of grid GHG emissions. For supporting calculations, see Appendix E - Air Quality.

Photovoltaic (PV) – Parking Lot

At this time, the building design does not include ground or parking lot canopy solar. Both technologies are being considered as design progresses.

Third Party PV

Should the Proponent determine that PV is not economically feasible or desirable to be owner-owned, they may evaluate the use of a third party PV developer. Although the available roof space may be too full with mechanicals to be attractive to most third party developers, that decision will be up to the third party.

PV-ready

As discussed in previously in this section, the SEC Building will be PV-ready.

Ground Source Heat Pumps

The analysis team is hesitant to ground source heat pumps due to several factors. First, it is unknown if existing geologic conditions are suitable to accommodate vertical boreholes, and there is not enough open area to accommodate a horizontal ground heat exchanger. Furthermore, the site is a Brownfield site; as such, the technical feasibility of ground source heat pumps is questionable.

However, ground source heat pumps are being considered for the atrium waterwalls. Waterwalls in the atrium contribute to enhanced occupant comfort by exposing people to the cooling or heating effect from falling water, which can flow down a surface or a mesh. Since waterwalls are operated as moderate temperature heating and cooling devices, comparable to radiant slabs, ground-temperature water may be used for virtually "free" heating and cooling, making use of currently existing geothermal sleeves and providing a refreshing demonstration of technology.

Wind Turbines

Building-integrated wind turbines include small turbines (generally less than 1 kW to about 5 kW) mounted on building roofs or parapets or otherwise attached to a building. In spite of some manufacturers' claims that certain building-integrated designs, such as vertical turbines, are less sensitive to building wake turbulence, there is insufficient experience with these units for most developers to have sufficient confidence that all such issues are resolved.

Larger wind turbines are impractical in this type of urban development.

Purchased Green Energy

Green Energy is a term used to describe electricity generated from renewable resources such a wind and PV. Most utilities offer customers the opportunity to purchase Green Energy for some or all of the customers' needs; rates vary with utility and the class of customer. This Project will be part of a district energy system which will provide efficient local electrical generation. The system will generate only a portion of the required electricity, so it would be possible to purchase green energy. This will be evaluated by Harvard in the future.

Other Related Mitigation Measures

There are a number of additional measures and design features that, while included for a variety of non-GHG reduction reasons, may have the indirect effect of reducing GHG emissions. While many of these are expected to be included in the design and plans for the SEC Building, the GHG impacts are both difficult to quantify with any degree of accuracy and small in comparison to the measures described above. Therefore, GHG reductions related to these measures have not been included in this analysis.

Owner Influence on Tenant

The only tenants will be potential retail or food vendors. These vendors will be subject to LEED and Harvard's guidelines regarding sustainable operations.

Enhanced Building Commissioning

Enhanced building commissioning begins the commissioning process earlier in the design stage, and includes a post-occupancy follow-up visit to ensure that building systems have been operating properly in both the heating and cooling seasons. It is an additional measure to ensure that HVAC, lighting, domestic hot water and renewable energy systems have been installed as designed and perform as expected. It is expected that the Project will pursue this LEED credit, however it is not being committed to at this time.

Recycled Content Materials

The use of recycled-content materials will be encouraged during the procurement stage for the SEC Building. The Proponent desires sustainable design and is encouraging the specification of recycled-content materials wherever practical. Concrete aggregate and cement, wood, glass and glazing products, metals, masonry, and drywall are typically evaluated for cost effectiveness of recycled-content alternatives.

Regional Materials

The Proponent will encourage the specification of regionally-sourced materials wherever possible.

3.4 Mobile Source Emissions

As part of the greenhouse gas evaluation, emissions of carbon dioxide from regional traffic associated with the Project were evaluated.

TRAFFIC GHG ANALYSIS

In accordance with the GHG Policy, GHG emissions were estimated for mobile sources within the transportation study area (see the DEIR and FEIR, as well as Chapter 2.0 of this document, for the transportation analysis). For mobile source GHG emissions, the methodology follows the same methodology that is outlined in MassDEP guidance for mesoscale analyses[1]. The analysis includes a comparison of the future Build conditions to the No-Build condition. If emissions are greater for the Build conditions, reasonable and feasible mitigation measures will be evaluated. The methodology and parameters for the mesoscale analysis follow methodology approved by MassDEP.

The mesoscale analysis performed for the Project predicts the change in regional CO2 emissions due to the Project. The total vehicle pollutant burden was estimated for the 2012 Existing conditions and the No-Build, Build, and Improved Build conditions for year 2022. Traffic conditions are described in more detail in Chapter 2.0.

The EPA's MOVES computer program was adopted in 2013 to supersede Mobile 6.2 for traffic emissions analysis. In April 2014, MassDEP provided the state-specific inputs to be able to run MOVES, completing the transition. MOVES was used to estimate motor vehicle emission factors of CO2 on the roadway network in the Project area. A peak travel day (estimated to be a weekday in March) was used in MOVES. Daily and yearly emission estimates were calculated using the vehicle count data, mileage between intersections, modeled signalized intersection delay times, and emission factors.

The traffic volumes provided in Chapter 2.0 form the basis of the study. Peak hour traffic

[1] MassDEP, Guidelines For Performing Mesoscale Analysis Of Indirect Sources, May 1991.

volumes were provided by the transportation consultant. Estimates of Average Daily Trips (ADT) were made from the peak hour volumes assuming a 10% K-Factor. Average speeds were assumed for all roadways. Distances for the links were estimated with mapping software.

Average per-vehicle idle times were based on delay times reported in the SYNCHRO intersection modeling output reports provided by the transportation consultant to calculate emissions from idling vehicles.

Case 1 represents the difference between the No-Build case and the Build case (i.e., traffic associated with the addition of the Project to the area without any Proponent-proposed mitigation).

Case 2 typically represents the difference between the No-Build case and the Mitigated Build, or Proposed, case

All related calculations, including the 2012 and 2022 emissions estimates, are presented in Appendix E.

TRAFFIC GHG ANALYSIS RESULTS

Table 12 presents the emissions reductions as a result of the intersection improvement described above. Results are presented for the study year 2022.

Table 12: Mobile Source GHG Emissions

		Case 1	Case 2
	Units	2022 Build minus 2022 No-Build	2022 Mitigated Build minus 2022 No-Build
Net VMT	miles/day	4679.5	**4679.5**
Net Delay	hrs/day	378.8	**-78.8**
Roadway GHG	tpy	2747.0	**2747.0**
Intersection GHG	tpy	458.1	**-95.2**
Net GHG Emissions	tpy	3205.1	**2651.7**
Net Change	tpy		**-553.3**
Percent Change	%	-	**-17%**

Case 1 presents the net increase in mobile source GHG emissions due to the Project.
Case 2 indicates a 553.3 tons/year (tpy) (17%) reduction in total greenhouse gases due to traffic improvements. The improvements to signal timing at nearby intersections result in significant reductions in vehicle delay.

TRANSPORTATION DEMAND MANAGEMENT GHG ANALYSIS

As described in more detail in Chapter 2.0, Harvard has an extensive Transportation Demand Management (TDM) program that is an important tool in managing vehicular travel to the campus. Harvard maintains an extensive CommuterChoice website (www.commuterchoice.harvard.edu) which provides information about these programs.

Harvard is also a member of A Better City Transportation Management Association, which provides TDM services to employees at commercial properties. In addition to its extensive TDM program, Harvard also accommodates transportation demands related to athletic, commencement, and Business School events through police detail traffic control/management, parking demand management and temporary signage.

3.5 Summary and Mitigation Commitments

PROJECT GHG SUMMARY

Table 13 presents a composite of the building GHG emissions profiles of the Baseline and Proposed cases. As explained in section 3.5, mobile source emission reductions from siting of the Project have been included in the Baseline and reductions from the TDM program have not been quantified.

Table 13: Project GHG Emissions Summary

	Baseline	Proposed	Difference	
	tons/yr	tons/yr	tons/yr	percent
Stationary Sources	5,418	4,036	9,454	**25%**
Mobile Sources	3,205	3,205	0	**0%**
TOTAL	**8,623**	**7,242**		

PROPONENT'S COMMITMENTS TO GHG REDUCTION

The Proponent's commitments to mitigate Project GHG emissions are indicated in section 3.3. Additional mitigation measures have not been quantified, primarily because the degree of accuracy or the reliability of the quantification method is uncertain.

The design of the SEC Building is early in the overall design process. As the Project proceeds and the design is developed further, the Proponent expects that additional technologies described previously, or possibly new technologies developed in the interim period, will be adopted that will further decrease GHG emissions, but these are not yet ripe for selection. The Proponent will encourage the continued evaluation of energy efficiency and renewable energy measures throughout the life of the Project.

The Proponent is committed to the following mitigation elements for the SEC Building:

- A Combined Heat and Power District Energy Facility;
- High performance building envelopes;
- High-efficiency HVAC equipment;
- Light or reflective roofs;
- Green roofs or podium areas;
- Exterior shading devices;
- Radiant heat;
- Underfloor air distribution;
- Heat recovery;
- Demand controlled ventilation;
- Room occupancy sensors in the appropriate spaces;
- Reduced lighting power densities;
- Energy Star appliances;
- PV-ready construction;
- Rainwater harvesting;
- Low-flow fixtures;
- Recycling collection areas;
- Construction waste recycling;
- A TDM program with elements described in section 3.4.

The Proponent has included in the design of the SEC Building all feasible GHG emissions mitigation in order to avoid, reduce, minimize, or mitigate damage to the environment.

The Proponent is committed to implementing the energy efficiency and GHG emission reduction measures presented in this analysis, but must retain an amount of design flexibility to allow for changes that will inevitably occur as design progresses. If, during the course of design for the SEC building, a specific combination of design strategies proves more advantageous from an engineering, economic, or space utilization perspective, the design of that building may vary from what has been described herein. Energy performance minima and associated GHG emission reductions will be adhered to.

At the completion of the SEC Building, Harvard will submit a self-certification to the MEPA Office, prepared in accordance with the GHG Policy. This certification will identify the GHG mitigation measures incorporated into the SEC Building and will illustrate the degree of GHG reductions from a Baseline case, as Baseline is defined herein, and how such reductions are achieved. Details of the owner's implementation of operational measures will also be included.

3.6 DEF Air Quality

The District Energy Facility (DEF) will include combustion equipment that burns fuel to generate electricity and thermal energy. The air emissions from combustion products are a potential environmental impact; damage to the environment is avoided, minimized, and mitigated through the use of clean fuels, clean combustion practices, and air pollution controls.

Planned air emitting equipment for the DEF, given the current status of design and subject to adjustment, consists of:

- One natural gas fueled cogeneration reciprocating internal combustion engine (RICE) (prime power). The cogeneration RICE is to be rated at approximately 20 MMBtu/hr heat input and 2.6 Mega-Watts (MW) electric power output. Waste heat (hot water) from the cogeneration RICE will be used for district heating and the unit is planned for year-round operation.
- Two condensing boilers for lead heating. The condensing boilers are to be rated at approximately 12 million British thermal units per hour (MMBtu/hr) each and are to be exclusively natural gas fueled and are expected to operate through much of the winter.
- Two flex tube boilers for lag heating. The flex tube boilers are to be rated at approximately 20 MMBtu/hr each and will fire natural gas with ultra-low sulfur diesel (ULSD) backup. They will be used for reliability and for peak winter heating needs.
- Two ULSD fueled RICE standby power generators. The standby RICE units will each be rated at approximately 21 MMBtu/hr heat input and 2.0 MW electric power output. The standby RICE are planned for blackstart operation.
- Cooling towers, using high-efficiency drift eliminators.

Harvard University intends to meet MassDEP top case Best Available Control Technology (BACT) guidelines for the seven combustion sources and permitting exemption requirements for the cooling towers. Harvard University will satisfy BACT through the use of the cleanest available fuels (natural gas and ULSD), clean combustion (specialized burners and tuning to avoid incomplete combustion), and post-combustion catalytic controls for the cogeneration RICE.

The cogeneration RICE will be registered under the MassDEP Environmental Results Program (ERP) for engines, and the standby RICE will be registered under the ERP program for emergency engines. Each individual boiler will go through the MassDEP Limited Plan Approval (LPA) application and approval process. The cooling towers will be below permitting thresholds (per 310 CMR 7.02(2)(b)6.).

The ERP program is a "permit-by-rule" type program. MassDEP air regulations 310 CMR 7.26 set forth stringent design and air emission standards for a variety of air emitting sources. Equipment that can comply with these standards can submit a compliance certification

and registration form, with supporting information, to MassDEP within 60 days of initial operation. The cogeneration RICE and the standby RICE will be designed to comply with the ERP requirements.

The LPA process involves submittal of descriptive information to MassDEP including equipment design information, air emission profiles, and regulatory applicability analyses. The LPA process applies to boilers that fall into a less significant category of maximum design fuel input (less than 30 million Btu/hr for equipment using distillate fuel oil and less than 40 million Btu/hr for equipment using natural gas). Use of BACT is required. The LPA application is due to MassDEP in advance of construction and installation of the subject equipment is not allowed unless an LPA is granted by the agency.

4.0 STORMWATER

The stormwater management approach for the construction of the Science and Engineering Complex Project will be established in compliance with the Boston Water and Sewer Commission (BWSC) standards and the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Policy.

4.1 Site Stormwater Management - SEC Building

The SEC Building is striving to exceed the BWSC requirement for infiltration of 1-inch of rainfall across the impervious area of the site and in support of the Harvard's Green Building Services sustainability goals and the LEED Version 4 Rating System. The Project is using bioretention infiltration as a primary approach to address stormwater quantity and quality leaving the site, with additional use of underground chambers and proprietary stormwater quality structures in order to meet Total Suspended Solids (TSS) removal and phosphorus reduction requirements. A majority of the landscaping is designed with structural soils and profiles to infiltrate and treat stormwater onsite. Infiltration of stormwater through soil and soil media provides treatment by reducing total suspended solids, phosphorus, and other pollutants.

The following analysis depicts calculations based on preliminary design assumptions. These results as currently presented, may change as the site progresses through the design process. However, it should be noted that while the exact results may vary, the overall design goals and project intent will still be met.

The existing site of the SEC Building does not currently contain any Best Management Practices (BMPs) as part of the site closed drainage system. The original site consisted of a paved parking lot. Runoff from the site is collected by a series of catch basins which flows through the closed drainage system, ultimately discharging to the Charles River.

The existing 6.3± acre SEC Building site is approximately 100% impervious. The proposed site improvements will reduce the amount of impervious area by 5.4± acres, a decrease of 85%. The proposed construction of new landscaped areas, green roofs, and porous pavement walkways will help achieve impervious area reduction.

Stormwater runoff from the site flows to the Charles River which has a Total Maximum Daily Load (TMDL) for phosphorus. The SEC Building will align with the Harvard Green Building Services (GBS) stormwater goal to manage (retain and infiltrate/reuse) 1.5-inches of rainfall over the impervious area onsite, therefore exceeding the BWSC one-inch storage and treatment requirement. In order to meet GBS's stormwater goal, the SEC Building will use bioretention basins, porous pavement walkways, a 75,000 gallon stormwater reuse tank, existing underground infiltration chambers, and water quality structures.

Runoff from impervious plazas along the perimeter of the SEC site will flow to porous pavers and trench drains. The porous pavers will be designed with a crushed stone reservoir course below the pavers. A perforated pipe within the stone will collect overflow from the

reservoir course and direct flows to the 75,000 gallon stormwater storage tank within the SEC Building where this stormwater will be reused for the building program.

Runoff from the proposed SEC Building roof and the walkway within the interior of the site will be directed to the bioretention basin system. The bioretention basins are designed to store, infiltrate, and filter the stormwater through the use of soil media. A perforated pipe will collect infiltrated flow from the reservoir course and direct flows to the 75,000 gallon stormwater reuse tanks. The tank is expected to meet the majority of the irrigation and fixture demands for the SEC site. Overflow from the tank will be directed to the existing underground infiltration system which will then direct any remaining overflow to the existing 72-inch drainage main located within "Science Drive."

The required recharge volume for the 1.5-inch rainfall event across the 41,481 square foot (sf) of impervious walkways on site is 5,185 cubic feet (cf). The bioretention basins, 75,000 gallon stormwater tanks, porous pavers, and underground infiltration system will provide a total of 40,825 cf of storage and will provide phosphorus reduction through infiltration. The phosphorus reduction calculations are provided in Table 14 below which exceed the Charles River TMDL reduction of 65%.

Table 14: Weighted Phosphorus Reduction for the Science and Engineering Complex

BMP	Area Being treated (sf)	% Phosphorous reduction
Infiltration System + Green Roofs + Porous Walkways	235,521	97%*
Paved Walkways routed directly to Reuse Tank	41,481	0%
Total SEC Site Impervious Area	276,810	
Weighted Phosphorus Reduction	82.5%	

**Value corresponds to percentage reductions indicated in Appendix F, Attachment 3 (p.35) of the Massachusetts MS4 General Permit for an infiltration depth of 1.5-inches and an infiltration rate of 0.27 inches/hour.*

Table 15 and Table 16 show a comparison of pre- and post-development peak runoff rates and volume for the SEC site taking into account the routing through the bioretention basins, 75,000 gallon stormwater reclaim tank, and underground stormwater infiltration system. The reservoirs beneath the porous pavers are currently not included in these numbers, therefore any future analysis should provide better results than listed.

Table 15: Comparison of Pre- and Post-Development Peak Runoff Rates for the Science and Engineering Complex Site (cubic feet per second)

	2-year storm	10-year storm	25-year storm	100-year storm
Existing Conditions	19.28	27.90	33.42	40.16
Proposed Conditions	0.97	1.62	11.25	29.33
% Reduction	94.97%	94.19%	66.34%	26.97%

Table 16: Comparison of Pre- and Post-Development Volume Runoff for the Science and Engineering Complex Site (cubic feet)

	2-year storm	10-year storm	25-year storm	100-year storm
Existing Conditions	68,433	100,667	121,402	146,753
Proposed Conditions	17,250	42,079	59,547	81,719
% Reduction	74.79%	41.80%	50.95%	44.32%

The proposed stormwater management system will substantially reduce the peak rate and volume of runoff being discharged from site. The proposed design will reduce stormwater rate and runoff volume and will meet or exceed the phosphorous removal requirements for the Charles River, GBS and BWSC.

Figure 26 depicts the BMP Performance for Infiltration with an Infiltration Rate of 0.27in/hr (MA MS4 General Permit, Appendix F, Attachment 3, Page 35).

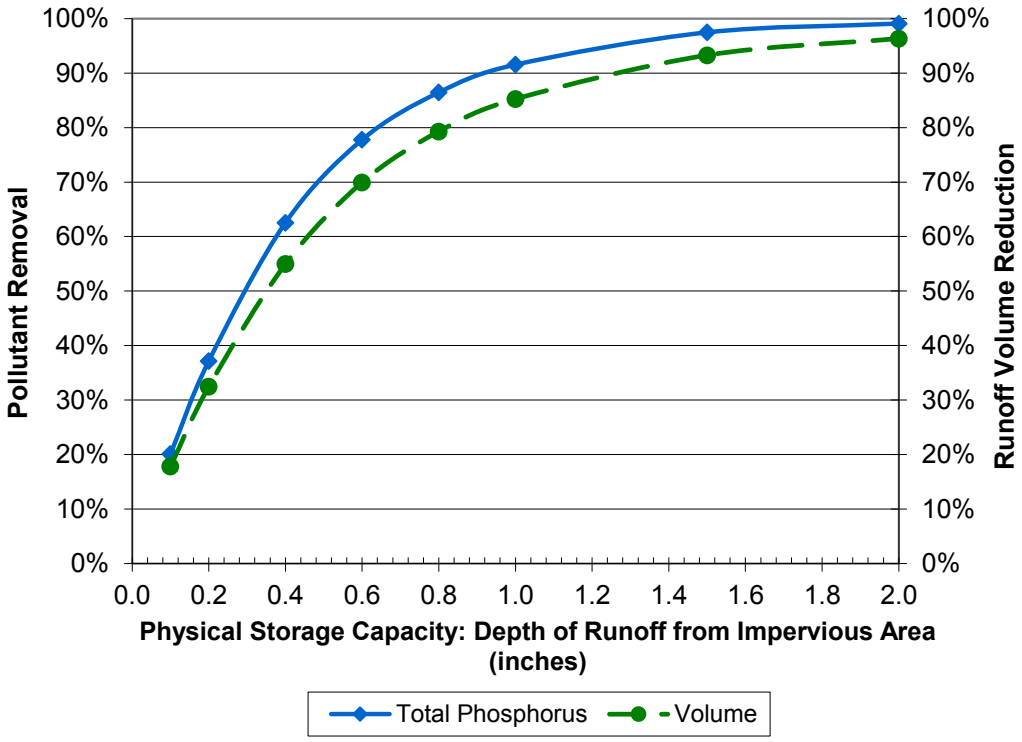


Figure 26: BMP Performance Curve: Infiltration Trench (infiltration rate = 0.27 in/hr)

114 Western Avenue
Existing Conditions

4.2 Site Stormwater Management – 114 Western Avenue

Stormwater runoff from the existing 114 Western Avenue building roof will be collected in a series of underground roof leaders and discharged into a proposed underground infiltration area. The runoff collected from the underground infiltration area will then be directed to the municipal system located within Western Avenue. The existing stormwater service will be dye tested to confirm that the existing building roof drains have been separated from the sewer service. Area drains with sumps will collect runoff from the landscape grounds along the west side of the building and connect into the proposed closed drainage system made up of drain manholes and corrugated plastic pipe.

The stormwater management system for the renovated building will incorporate deep sump catch basins with hoods, area drains with sumps, water quality structures, and infiltration BMPs to collect, treat, and infiltrate stormwater runoff. Low impact development (LID) techniques will be incorporated into the design where feasible. The stormwater management system for the renovated building will meet the requirements for LEED ss credit 6.1, stormwater management – Quantity control and ss credit 6.2, stormwater management – Quality control. Since the system collects and recharges up to the 100-year storm event, thereby treating essentially all storms, this component of the Project may be eligible for an innovation in design point for exemplary performance.

4.3 Site Stormwater Management - DEF

The District Energy Facility will be the first building established in the area to the east of the SEC Building and will need to manage stormwater and provide positive impacts to water quality and collection system capacity as a stand-alone site prior to the development of the future infrastructure system around it.

Goals for the stormwater management system include re-use of stormwater to limit potable water demand, limiting peak runoff leaving the site to below pre-development conditions, and providing infiltration facilities to replenish groundwater. The proposed site will also include more pervious, landscaped areas than the existing condition.

Resiliency planning will guide the drainage approach setting the finished floor above projected flood elevations. The design features of drainage systems (site, interior, and roof) will be designed to accommodate future higher levels of precipitation.

The final design of the site improvements and connections to municipal drainage systems will be reviewed by the BWSC via their Site Plan Review process.

Future DEF Site viewed from MassPike on ramp

Existing Drainage Facilities

The area of the proposed DEF site, including the driveway extending to Western Avenue, is approximately 2.6 acres and is completely impervious. The existing site drainage system served the former industrial use of the site. Site drainage will be directed to existing municipal drainage lines in Western Avenue to the north of the site that flow easterly towards the Charles River.

Design Parameters

The site improvements will include a completely new stormwater management and treatment system to serve the site. The stormwater management system will incorporate on-site detention for limiting peak flows off-site and providing available water for use in the DEF mechanical systems as chiller make-up water.

The BWSC requires all new developments in Boston to provide infiltration facilities, if feasible, to direct stormwater to the groundwater table while limiting drainage contributing to municipal collections systems. Therefore, infiltration facilities in the form of subsurface galleys will be employed to provide detention and infiltration for site areas.

BWSC also requires projects whose runoff is contributory to the Charles River to treat drainage on-site to reduce phosphorus in the runoff. The effectiveness of infiltration for use in treating phosphorous is reliant on underlying soil permeability. This will need to be confirmed by the team geotechnical engineer and the design progresses. If the soils do not support phosphorous treatment, the design will incorporate treatment chambers or filters to meet the required level of treatment.

The proposed design will support the LEED approach being followed by the building as a whole, as well as Harvard's Green Building Standards sustainability goals.

Proposed Drainage Design

The following represents the design approach based on the current understanding of the site and building. The design will continue to evolve through the Design Development process and the final design will be reviewed by BWSC for conformance to their design requirements prior to construction.

The DEF Facility will be placed at the approximate center of the site area and will be the site high point. The building finish floor has been set at elevation 19.5 (Boston City Base). The building is surrounded by a perimeter roadway which will be vary in grade from 18 to 19 somewhat uniformly around the building. This approach will keep the drainage system inverts up as high as they can be in relation to the building to enable positive pipe slope the existing drain in Western Avenue.

Roof drainage will be directed to a storage tank immediately adjacent to the building. The size of this tank has not been finalized, but for the purpose of this study it is anticipated that the capacity to be about 5,000 gallons. Outflow from this tank that is not used from building mechanical make-up water will be directed to an infiltration treatment system adjacent to the building.

Site drainage will be captured in four catchment areas, directed to pre-treatment to manage oils and sediments inherent in roadway and parking area drainage, and then directed to two-site infiltration facilities as shown on the conceptual utility plan. Smaller spaced infiltration/treatment chambers will be located on the site driveway.

All of the site infiltration systems will feature an overflow pipe that will direct drainage to a collector on the east side of the site which will flow to the existing drainage system in Western Avenue via the site driveway.

Phosphorous Removal - Using a combination of pretreatment chambers managing oil and sediments and infiltration systems sized to capture a minimum of an inch of runoff the design will meet BWSC requirements. The design will also meet the 65% phosphorous removal goals of the Charles River TMDL established by the MassDEP.

Based on the current progress design of the DEF facility, Table 17 outlines the pre-development and post-development peak runoff values. Please note that these preliminary numbers do not reflect the capture and reuse of 26,920 sf of roof runoff that will be utilized as mechanical make-up water. This will further reduce off site flows.

Table 17: Comparison of Pre- and Post-Development Peak Runoff Rates for the DEF Site (cubic feet per second)

	2-year storm	10-year storm	25-year storm	100-year storm
Existing Conditions	9.79	15.35	18.90	24.38
Proposed Conditions	9.11	13.77	16.22	21.13
% Reduction	6.9%	10.3%	14.2%	13.33%

5.0 MITIGATION MEASURES

5.1 2007 Project and Cooperation Agreement

As part of the approval of the 2007 Science Project, the University entered into a Cooperation Agreement with the City of Boston. The 2008 Cooperation Agreement outlined an extensive package of community benefits in five areas: public realm, education, housing, workforce development and jobs, and the establishment of the Partnership Fund. Following the decision to pause the 2007 Science Project, the University maintained the commitment to the 2008 Cooperation Agreement. Among the highlights of those continued commitments, Harvard:

- Designed, constructed, and continues to maintain Ray Mellone Park, a 1.74-acre public park located behind the Honan Branch Library;
- Developed, constructed, programmed, and continues to operate the Education Portal (which recently relocated from 175 North Harvard Street to 224 Western Avenue);
- Completed the jobs linkage payments and continues to pay the annual housing linkage payments to the City;
- Worked with the City's Office of Jobs and Community Service to fund the operation the Resource Center and offer workforce development classes; and
- Funded the Partnership Fund, which provides financial resources to neighborhood organizations.

Since the 2008 Cooperation Agreement, Harvard has signed two additional Cooperation Agreements: one for the 28 Travis Street project and one for the 2013 IMP. Collectively, these three agreements build upon each other's commitments and each one was informed by extensive interactions with the community, the City of Boston, and the Harvard-Allston Task Force to ensure an evolution that best serves the entire Allston-Brighton Community.

A full report on the status of the 2008 Cooperation Agreement – and two subsequent Cooperation Agreements – is on the BRA website.

5.2 Current Project

Similarly, as part of the review and approval of the current Project and IMP Amendment, the University proposed a series of mitigation measures and community benefits in the same five areas: public realm, education, housing, workforce development and jobs, and the establishment of the Partnership Fund.

The following section describes the Project's mitigation measures, that is, those transportation, public realm, and construction period measures that are intended to mitigate any potential adverse impacts from the Project.

Transportation-Related Commitments

Pedestrian and Bicycle Access Improvements. Since the approval of the 2007 Science Project, Harvard has collaborated with BTD to add bicycle lanes to North Harvard Street and Western Avenue and has installed "Hubway" bicycle sharing stations at Harvard Business School, the Harvard Innovation Lab, Barry's Corner, and Brighton Mills. In addition, and as part of the Project, Harvard will implement the following additional measures to facilitate walking and bicycling access to the Project:

- Enhance the bicycle facilities on the north and south sides of Western Avenue to the west of and in front of the SEC Building, subject to City of Boston approvals.
- Provide a new multi-use path next to "Academic Way" between North Harvard Street and "Science Drive."
- Extend bicycle and pedestrian paths from Rena Park to Hague Street and Western Avenue.
- Provide sufficient right-of-way to accommodate a future bicycle path next to the new "Stadium Way" on the block between Rotterdam Street and Western Avenue.
- Provide approximately 400 secure/covered bicycle parking spaces and approximately 100 more outdoor bicycle parking spaces that will be located conveniently near the building entrances of the SEC Building and the 114 Western Building.

Transit Improvements. Since the approval of the 2007 Science Project, Harvard has improved transit and shuttle services in Allston. Harvard has worked with the Massachusetts Bay Transportation Authority (MBTA) to recommend and implement improvements to the service in the neighborhood, including the consolidation of MBTA bus stops on Western Avenue and North Harvard Street (north of Barry's Corner) to reduce delay and bus bunching and to improve service reliability. Harvard has also initiated the Harvard Square Express bus between Barry's Corner and Harvard Square in 2015 and extended the Allston Express route to Barry's Corner in 2016. Harvard has opened the two routes of the Harvard Express shuttle system that service Allston to the public.

Harvard will implement the following additional measures to improve transit access to the Project:

- Public Transit: Harvard will work with the MBTA and BTD to locate bus stops as part of the reconstruction of Western Avenue in front of the SEC Building and the 114 Western Building.
- Shuttle Service: Harvard will expand and enhance its shuttle service to the Project. As part of this expansion, the Harvard Square Express and Allston Express shuttle routes will be extended to the SEC Building.
- Mobility Hub. Harvard will create a Mobility Hub between the SEC Building and the 114 Western Building with bicycle parking and adjacent MBTA bus stops and Harvard shuttle stops, as well as connections to nearby Hubway stations, ZipCar spaces, and electric vehicle charging stations.

Transportation Demand Management Program. Harvard has in place a robust Transportation Demand Management (TDM) Program which seeks to lessen the number of new automobile trips generated by the Project. Specifically, the TDM Program shall continue to include:

- MBTA Pass Sales: Harvard will continue its 50 percent discount on MBTA passes and will continue to make such passes available to employees at various locations and on-line, as well as continuing additional cost savings provided by pre-tax payroll deduction.

- Marketing: Harvard will continue to maintain its CommuterChoice website (www.commuterchoice.harvard.edu), which includes information regarding the transit pass program, Harvard shuttle services, maps of pedestrian and bicycle routes and biking-related facilities; advice for visitors regarding public transit; and monthly commuting tips. Harvard will continue to promote its TDM Program in Harvard publications, at kiosks located throughout the Project, at annual commuter fairs, in email updates, and at orientation for new employees.

- Carpool: Harvard will provide some preferential carpool spaces in the parking lots for the Project. In addition, employees can easily register through the CommuterChoice website or with the Commuter Choice office and request information on carpools, vanpools, transit, car sharing, and cycling.

- Bicycle Program: Harvard will continue to provide discounted annual membership in the "Hubway" bicycle sharing program and offer reimbursements for bicycle safety training and repair classes for fulltime employees.

- Transportation Coordinator: Harvard will manage the TDM Program through its existing CommuterChoice program. The CommuterChoice program is an existing resource that is responsible for assisting employees with commuting alternatives and promoting TDM alternatives. The CommuterChoice program will oversee all TDM Programs offered by Harvard to help encourage the use of alternative modes for travel to and from the Project.

Roadway Infrastructure Improvements: Since the approval of the 2007 Science Project, Harvard has installed signal monitoring improvements at Barry's Corner and along North Harvard Street to improve management of the traffic signal system along such corridor. Harvard has also facilitated traffic signal improvements by MassDOT at the intersection of Cambridge Street, River Street Bridge, and Soldiers Field Road. These improvements, which require the use of a portion of Harvard property, will upgrade the signal equipment, improve vehicular channelization, add new bicycle lanes and cycle tracks and enhance pedestrian crossings with improved equipment and signal timing plans. Harvard will construct the following roadway infrastructure improvements as part of the Project:

- A new "Stadium Way" to the east of the SEC Building, a new "Academic Way" to the west of the SEC Building, and a new "Science Drive" to the south of the SEC Building as further detailed in the following section. These roadways shall be open to the public.

- Upgrades to Western Avenue in front of the new SEC Building and the 114 Western Building.

Public Realm Improvements

Harvard will construct an expansive range of on-site and off-site public realm improvements located within and outside the Project Site in connection with the Project.

- Western Avenue Sidewalk and Tree Plantings. Since the approval of the 2007 Science Project, Harvard designed and constructed sidewalk improvements and has planted approximately 150 trees along twelve blocks (3,700 linear feet) of Western Avenue.

- Barry's Corner Improvements. Since the approval of the 2007 Science Project, Harvard

has completed landscaped entrances to the Education Portal, landscaping at the former Citgo station, and improvements to the Grove in front of the former Charlesview site including removing the fence around the site, creating pathways, adding lighting for safety, pruning trees and adding benches. All of this is open to the public.

- Longfellow Path and Rena Path. Under the 2008 Cooperation Agreement, Harvard was to construct new pedestrian connections through the Athletics area ("Longfellow Path") and through the future Rena Park ("Rena Path"). In addition, Harvard was to work with the BRA, the City of Boston, and the Commonwealth of Massachusetts Department of Conservation and Recreation to study the feasibility of a pedestrian crossing of Soldiers Field Road in conjunction with Longfellow Path. Since the initial commitment for Longfellow Path, a number of new planning and development activities have taken place involving new pedestrian routes in order to create new pedestrian permeability in the area west of North Harvard Street. The commitment for Longfellow Path may, with the consent of the BRA, be utilized in a somewhat different fashion than originally intended towards the goal of establishing pedestrian permeability in this area, and that this work may be done in coordination with the ongoing Smith Field Master Plan process led by the Boston Parks and Recreation Department. The commitment to study the feasibility of a pedestrian crossing of Soldiers Field Road has been fulfilled.

- Rena Park. Under the 2008 Cooperation Agreement, Harvard was to fund interim improvements to the area currently called "Rena Park" and fund a design and planning process for the construction of Rena Park. In addition, under the 2008 Cooperation Agreement, Harvard was to construct a new pedestrian connection, referred to as Rena Path, through the future Rena Park. The planning and design process for Rena Park and Rena Path is ongoing, and Harvard has proposed to complete the construction of Rena Park and Rena Path between North Harvard Street and 88 Seattle Street by the end of calendar year 2016.

- Harvard, at its own cost and expense, has replaced a collapsed BWSC-owned storm drain in Rena Park, and the development of Rena Park will follow the replacement of such storm drain. Once constructed, Rena Park and Rena Path shall be open to the public, subject to Harvard's right to restrict public access for security reasons, or for other reasons approved by the BRA.

- Stadium Way, Academic Way and Science Drive. Harvard will construct three new sections of roadway: so-called "Stadium Way" to the east of the SEC Building, so-called "Academic Way" to the west of the SEC Building, and so-called "Science Drive" to connect Rotterdam Street with "Academic Way." Stadium Way shall provide for vehicular access from Western Avenue to Rotterdam Street.

- Western Avenue and North Harvard Street. Harvard has worked with BTD to: 1) improve North Harvard Street by designing bicycle lanes and removing on-street parking on North Harvard Street (north of Barry's Corner); and 2) improve Western Avenue (east of Barry's Corner) by designing and implementing the City of Boston's first cycle track. As part of the Project and consistent with the IMP, Harvard will reconstruct Western Avenue adjacent to the SEC Building, including sidewalks, tree planting, improvements to bicycle accommodations and best practices for stormwater management, subject to City of Boston approvals. Consistent with those improvements and with state, City of Boston, and Harvard University plans for an area-wide network of new streets and new utility infrastructure corridors south of Western Avenue, Harvard will also design and implement improvements to Western Avenue east of the SEC Building and to North Harvard Street north of Barry's Corner as part of future Institutional Master Plan projects that are adjacent to such streets.

- Betterments. Under the 2008 Cooperation Agreement, Harvard was to undertake other significant betterments and landscape improvements to its own properties in the vicinity of the Project site, such as, but not limited to, the replacement and/or the removal of fences and the planting of trees. In accordance with the 2008 Cooperation Agreement, Harvard has improved the following properties: the parking lot at 175 North Harvard Street, Travis Street, and Windom Street. In addition, Harvard has also repainted and improved properties west of Barry's Corner.

Greenhouse Gas Emissions/Air Quality

Greenhouse Gas Emissions

The Proponent has included in the design of the SEC Building all feasible GHG emissions mitigation in order to avoid, reduce, minimize, or mitigate damage to the environment. The Proponent is committed to the following mitigation elements for the SEC Building:

- A Combined Heat and Power District Energy Facility;
- High performance building envelopes;
- High-efficiency HVAC equipment;
- Light or reflective roofs;
- Green roofs or podium areas;
- Exterior shading devices;
- Radiant heat;
- Underfloor air distribution;
- Heat recovery;
- Demand controlled ventilation;
- Room occupancy sensors in the appropriate spaces;
- Reduced lighting power densities;
- Energy Star appliances;
- PV-ready construction;
- Rainwater harvesting;
- Low-flow fixtures;
- Recycling collection areas;
- Construction waste recycling; and
- A Transportation Demand Management program.

Air Quality from the DEF

The Proponent intends to meet MassDEP top case Best Available Control Technology (BACT) guidelines for the seven combustion sources and permitting exemption requirements for the cooling towers. The Proponent will satisfy BACT through the use of the cleanest available fuels (natural gas and ULSD), clean combustion (specialized burners and tuning to

avoid incomplete combustion), and post-combustion catalytic controls for the cogeneration reciprocating internal combustion engine.

Stormwater Management

SEC Building

The SEC Building is striving to exceed the BWSC requirement for infiltration of 1-inch of rainfall across the impervious area of the site and in support of the Harvard's Green Building Services sustainability goals and the LEED Version 4 Rating System. The SEC Building is using bioretention infiltration as a primary approach to address stormwater quantity and quality leaving the site, with additional use of underground chambers and proprietary stormwater quality structures in order to meet Total Suspended Solids (TSS) removal and phosphorus reduction requirements. A majority of the landscaping is designed with structural soils and profiles to infiltrate and treat stormwater onsite. Infiltration of stormwater through soil and soil media provides treatment by reducing total suspended solids, phosphorus, and other pollutants.

DEF

Goals for the stormwater management system for the DEF site include re-use of stormwater to limit potable water demand, limiting peak runoff leaving the site to below pre-development conditions, and providing infiltration facilities to replenish groundwater. The proposed site will also include more pervious, landscaped areas than the existing condition.

Roof drainage will be directed to a storage tank immediately adjacent to the building. The size of this tank has not been finalized, but for the purpose of this study it is anticipated that the capacity to be about 5,000 gallons. Outflow from this tank that is not used from building mechanical make-up water will be directed to an infiltration treatment system adjacent to the building.

Using a combination of pretreatment chambers managing oil and sediments and infiltration systems sized to capture a minimum of an inch of runoff the design will meet BWSC requirements. The design will also meet the 65% phosphorous removal goals of the Charles River TMDL established by the MassDEP**.**

Construction Management Program

Over the past several years, Harvard has worked with the Boston Transportation Department (BTD) to develop Institution-wide guidelines for construction management. A project-specific Construction Management Plan (CMP) based on these guidelines will be submitted to the BTD for review and approval prior to issuance of a building permit. The CMP will identify construction mitigation measures and define truck routes which will help in minimizing the impact of trucks on local streets.

Transportation and Parking

As currently proposed, construction trucks accessing the site will arrive via the Mass. Turnpike to the Soldiers Field Road access road to Western Avenue and will depart using the same roadways. These trucks will be prohibited from using local neighborhood streets to arrive at or depart from the site. The construction team will manage deliveries to the site during morning and afternoon peak hours in a manner that minimizes disruption to traffic flow on adjacent streets. The construction team will provide subcontractors and vendors with Construction Vehicle & Delivery Truck Route Brochures in advance of construction activity. "No Idling" signs will be included at the loading, delivery, pick-up and drop-off areas.

To reduce vehicle trips to and from the construction site, construction workers will be encouraged to use non-auto modes, but recognizing that many workers will choose to drive to the site, the University will provide parking for construction workers at a new parking lot on Rotterdam Street and on the former Charlesview site which will discourage parking on neighborhood streets. The general contractor will work aggressively to ensure that construction workers are well informed of the public and Harvard-owned transportation options serving the area.

Staging

Construction staging and material laydown will occur on site or at construction support areas at the former Charlesview site and/or the east side of the existing foundation on the former Sears site.

Communication

In an effort to have clear, open and up-to-date communications with the neighborhood, the Project will develop a communications plan consistent with other Harvard projects in Allston. A 24-hour hotline will be established upon commencement of construction activity. In addition, when construction commences, a website will provide updates on construction as well as provide Harvard with feedback from the community. A mitigation staff and protocol will be established and be available to address all Project issues. Emergency contacts will be maintained for immediate follow-up on emergency situations. Additionally Harvard will direct the Construction Manager to install community bulletin boards around the perimeter of the site. These bulletin boards will be maintained to provide information on current activity and schedule information.

Rodent Control

Harvard has implemented an extensive rodent inspection monitoring and treatment program that will be carried out before, during, and at the completion of all construction work for the Project.

Work Hours

Typical construction hours will be from 7:00 a.m. to 6:00 p.m., Monday through Friday, with most shifts ordinarily ending at 3:30 p.m. No substantial sound-generating activity will occur before 7:00 a.m. If longer hours, additional shifts, or Saturday work is required, the construction manager will submit a work permit request to the Inspectional Services Department and the Mayor's Office of Neighborhood Services in advance. Notification should occur during normal business hours, Monday through Friday.

Environmental Mitigation During Construction

Harvard and its contractor will employ a number of mitigation measures to minimize any impacts during construction, including:

- Conducting preconstruction surveys on adjacent properties prior to the start of construction based on a predetermined distance from the project;
- Installing noise and dust monitors around the perimeter of the site;
- Using wetting agents on areas of exposed soil on a scheduled basis;
- Evaluating means and methods for performing work at the site for potential vibration impacts on nearby structures and utilities; and
- Segregating materials that may be recycled.

5.3 Proposed Section 61 Findings

MEPA Regulations require that Section 61 Findings be prepared for all required state permits. M.G.L. c. 30, s. 61 requires that "[a]ll authorities of the commonwealth ... review, evaluate, and determine the impact on the natural environment of all works, projects or activities conducted by them and ... use all practicable means and measures to minimize [their] damage to the environment. ... Any determination made by an agency of the commonwealth shall include a finding describing the environmental impact, if any, of the project and a finding that all feasible measures have been taken to avoid or minimize said impact." The finding required by Section 61 "shall be limited to those matters which are within the scope of the environmental impact report, if any, required ... [on a project]." M.G.L. c. 30, s. 62A.

The following state permits are expected to be required for the Project.

Department of Environmental Protection

- Limited Plan Approval

Massachusetts Water Resources Authority

- Sewer Use Discharge Permit
- 8(M) Permit

SECTION 61 FINDING

Project Name: Harvard University's Campus in Allston/Science and Engineering Complex

Project Location: Boston

Project Proponent: Harvard University

EEA Number: 14069

Date Noticed in Monitor: [to be determined]

The potential environmental impacts of the Science and Engineering Complex on Harvard University's Campus in Allston have been characterized and quantified in the DEIR and FEIR for Harvard University's Campus in Allston and the NPC for the Science and Engineering Complex, which are incorporated by reference into this Section 61 Finding. Throughout the planning and environmental review process, the proponent has been working to develop measures to mitigate significant impacts of the projects. With the mitigation proposed and carried out in cooperation with state agencies, the [Agency] finds that there are no significant unmitigated impacts.

The proponent recognizes that the identification of effective mitigation, and implementation of that mitigation throughout the life of the projects, is central to its responsibilities under the Massachusetts Environmental Policy Act (MEPA). The proponent has accordingly prepared the annexed Table of Mitigation that specifies, for each potential state permit category, the mitigation that the proponent will provide.

Now, therefore, [Agency], having reviewed the MEPA filings for Harvard University's Campus in Allston, the mitigation measures already implemented, and those further mitigation measures set forth on the annexed Table of Mitigation Measures, finds pursuant to M.G.L. C. 30, S. 61 that with the implementation of the aforesaid measures, all practicable and feasible means and measures will have been taken to avoid or minimize potential damage from the projects to the environment.

Mitigation Measure	**Timing**	**Cost**
Limited Plan Approval		
Expanding the University's combined heat and power (CHP) facilities through the development of the DEF.	Part of Project design	Part of Project cost
If boilers are used for individual IMP projects, emissions will meet DEP performance standards for boilers.	Part of design of each Project component	Part of Project cost
Installation of the Project's emergency generators will incorporate Best Available Control Technology (BACT).	Part of design of each Project component	Part of Project cost
Sources of pollutants (e.g. boilers, emergency diesel generator) will be properly equipped and maintained.	Part of design of each Project component	Part of Project cost

The design of each Project component will evaluate and include design elements such as high performance building envelopes, High-efficiency HVAC equipment, Light or reflective roofs, Green Roofs or podium areas, Exterior shading devices, Radiant Heat, Underfloor air displacement, Heat recovery, demand controlled ventilation, Room occupancy sensors in the appropriate spaces, Reduced Lighting power densities, Energy Star appliances, PV-ready construction, Rainwater harvesting, and Low-flow fixtures.	Part of design of each Project component	Part of Project cost
Extend the University's extensive TDM program to include the Project	Part of design of each Project component	Part of Project cost
Sewer Use Discharge Permit		
The Project will comply with the mitigation requirements of the BWSC and the policy of the MassDEP to offset any additional wastewater flows by reducing infiltration and inflow (I/I) into sewer systems.	Part of design of each Project component	Part of Project cost
Water conservation methods, such as low-flow fixtures, waterless urinals and grey water systems will be evaluated by the design team for each Project component.	Part of design of each Project component	Part of Project cost
Stormwater management controls for each Project site will be established in compliance with BWSC standards and the DEP's Stormwater Management Standards. They will also be designed to reduce phosphorus and bacteria loads to the Charles River, in accordance with Boston's EPA National Pollutant Discharge Elimination System (NPDES) permit.	Part of design of each Project component	Part of Project cost
As each site goes into final design, detailed stormwater management calculations will be provided to demonstrate compliance with regulatory requirements.	Part of design of each Project component	Part of Project cost
Existing site drainage located within or adjacent to the Project sites will be protected during construction. Specific methods for constructing proposed utilities where they are near to, or connect with, existing water, sewer and drain facilities will be reviewed by BWSC as part of its Site Plan Review process.	Part of design of each Project component	Part of Project cost
8(M) Permit		
Harvard will work with the MWRA to evaluate whether Project components have the potential to impact MWRA easements or property, and will then identify site-specific mitigation measures and file 8(M) Permit application.	Evaluation of potential to impact MWRA facilities will be part of planning of each Project component	Part of Project cost

APPENDIX A

TABLE OF CUMULATIVE IMPACTS

Appendix A: Cumulative Impacts

The MEPA Certificate on the FEIR (dated October 17, 2014) requested that supplemental submittals include an assessment and tabulation of cumulative impacts of the projects included in the FEIR as well as those from other background projects which were approved via other routes (e.g., Notices of Project Change, Requests for Advisory Opinion).

The following table presents key data points from the FEIR, data for the four IMP projects that have undergone review, and data for five other projects that were reviewed outside of the EIR process (including the Science and Engineering Complex, the subject of this Notice of Project Change).

	acreage	new impervious area	square feet (new)	square feet (renovation)	vehicle trips/day	parking spaces	water (net new)	wastewater (net new)
	FEIR							
	178	**(12)**	**1,400,000**	**501,000**	**6,980**	**178**	**146,908**	**133,553**
	IMP Projects in FEIR							
Chao	1.0	-	75,000	-	24	-	26,092	23,720
Klarman	3.7	(0.2)	105,000	-	12	(90)	6,083	5,530
Esteves	0.7	-	-	78,000	-	-	-	-
SFP	4.7	-	-	429,000	-	-	-	-
subtotal	**5.4**	**(0.2)**	**180,000**	**507,000**	**36**	**(90)**	**32,175**	**29,250**
	Other Harvard Projects							
Tata Hall	2.2	1.0	150,000	-	62	-	39,300	18,700
i-lab	2.2	-	-	78,000	50		6,200	6,200
28 Travis	3.7	-	43,750	9,600	-	75	4,900	4,900
Bright	2.2	-	18,500	11,300	-	-	-	-
SEC	15.6	-	505,350	51,500	570	275	65,450	59,500
subtotal	**25.9**	**1.0**	**717,600**	**150,400**	**682**	**350**	**115,850**	**89,300**

APPENDIX B

SECRETARY'S CERTIFICATE ON THE FEIR

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Deval L. Patrick
GOVERNOR

Maeve Vallely Bartlett.
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

October 17, 2014

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
FINAL ENVIRONMENTAL IMPACT REPORT

PROJECT NAME:	Harvard University's Campus in Allston (f/k/a Harvard University – Allston Campus 20-Year Master Plan)
PROJECT MUNICIPALITY:	Boston
PROJECT WATERSHED:	Boston Harbor
EEA NUMBER:	14069
PROJECT PROPONENT:	Harvard University
DATE NOTICED IN THE MONITOR:	September 10, 2014

As Secretary of Energy and Environmental Affairs, I hereby determine that the Final Environmental Impact Report (FEIR) submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (G. L. c. 30, ss. 61-62I) and with its implementing regulations (301 CMR 11.00). The Proponent will be required to submit additional documentation in accordance with the Special Review Procedure (SRP) established for the project (November 20, 2013), as appropriate, and as described in this Certificate.

Project Description

According to the FEIR, the project area includes Harvard's Allston campus located predominantly on land bounded by Soldiers Field Road and Western Avenue, with North Harvard Street separating two distinct areas of the existing campus, the Harvard Business School (HBS) and the athletic area. An Institutional Master Plan (IMP) was reviewed and approved by the Boston Redevelopment Authority (BRA) and Boston Zoning Commission in October and November 2013, respectively.

Harvard has proposed a series of projects to be completed within a ten-year time frame (the Ten-Year Plan) to realize strategic goals in both academic and community development. The specific projects listed in the FEIR include:

Early (2014-2018)

1. **Harvard Business School (HBS), Kresge Hall Replacement/Chao Center** – Replacement of the existing Kresge Hall with a 90,000-sf HBS building to provide a dining facility for HBS's Executive Education program. The building, to be called the Ruth Mulan Chu Chao Center (Chao Center), will also include classroom space, offices for faculty and staff, function rooms, and a kitchen.
2. **Harvard Stadium Addition/Renovation** – Renovation of Harvard Stadium, including an overall reduction in seating from 30,262 to 23,333, improved accessibility features, and a 46,000-sf addition to the westerly side of the stadium to be used for building amenities, club seating, accessibility-related space, and meeting and office space. This project includes approximately 34,200 sf of new interior construction and approximately 130,500 sf of interior renewal.
3. **Renovation of HBS Baker Hall** (to be renamed Esteves Hall) – renovation of the 75,000-sf Baker Hall, which serves as a residential facility for HBS's Executive Education program.
4. **HBS, Burden Hall Replacement** – Replacement of HBS's existing Burden Hall with two buildings totaling 140,000 sf of new space.

Mid Projects (2018-2020)

5. **HBS Faculty and Administrative Office Building** – Construction of a new 110,000-sf faculty and administrative office building to be located on the existing Ohiri Field directly north of the I-lab/Batten Hall.
6. **Gateway Project** – Construction of approximately 300,000-sf of mixed-use space (i.e., ground floor service, retail and/or other institutional uses and programming and upper floor(s) institutional/mixed uses including administrative or academic office space) at the existing Charlesview site on North Harvard Street. Approximately 35,000 to 50,000 sf of space will be retail/active ground floor uses.
7. **Renovation of Soldiers Field Park Housing** – Renovation of the four building, 478-unit, 423,000-sf Soldiers Field Park Housing complex currently used for graduate student housing.

Late Projects (2020-2024)

8. **Athletics Department, Basketball Venue and Institutional/Mixed Use Facility** – Construction of approximately 270,000 to 340,000 sf of mixed use space including: a new 60,000-sf, 3,000-seat basketball venue with locker rooms, athletics offices, and concession areas; approximately 200,000 to 250,000 sf of residential space; and approximately 10,000 to 30,000 sf of retail space.

9. **Hotel and Conference Center** – Construction of a 250,000-sf hotel and conference center including approximately 200 hotel rooms and 30,000-sf of meeting space on the south side of Western Avenue across from the HBS Spangler parking lot.

Small Projects Under Consideration

10. **Batting Cage** – Construction of a 5,000-sf permanent fully enclosed batting cage for baseball and softball located near the existing temporary batting cage between the baseball and softball fields.
11. **Newell Boat House Renovations** – Renovation of Newell Boat House to allow for the replacement of rowing equipment and the modification of space in which the equipment is housed.

The demolition of the existing Charlesview building in Barry's Corner is proposed during the Early Projects phase, while the Harvard Allston Science Project (Science Project) is proposed to be undertaken during the Mid-Project Phase.[1]

The following open space, infrastructure and roadway improvement phasing was outlined in the FEIR:

- Barry's Corner Grove (interim) – Early
- "South Campus Drive" – Early
- "Ivy Lane" – Early
- Rena Park – Early
- "Academic Way" (north of Western Avenue) and narrowing of intersection/elimination of traffic island at Barry's Corner – Mid
- "Academic Way" (south of Western Avenue) – Mid
- "Science Drive" (west of Rotterdam Street) – Mid
- Longfellow Path – Mid
- Rena Path – Mid
- Barry's Corner Grove (completed) – Mid
- Greenway (early phase, eastern segment near Hotel and Conference Center) - Late

A series of non-IMP projects in the Allston area, which are underway or recently completed, are considered background projects to the Ten-Year Plan. These include: the Barry's Corner Residential and Retail Commons, which was reviewed under a separate voluntary MEPA process (EEA No. 15036), 224 Western Avenue (Harvard Ceramics), 28 Travis Street, Bright Hockey Center Addition/Renovation, and HBS Tata Hall. As previously recommended, I strongly encourage Harvard to consider filing voluntarily with the MEPA Office for future Harvard-sponsored projects in Allston that are not within the IMP review area to allow for evaluation of cumulative environmental impacts throughout this neighborhood's transformation. While these projects on their own may not exceed MEPA review thresholds or require State

[1] The Harvard Allston Science Projectreceived a Phase I Waiver in the form of a Final Record of Decision (FROD) on October 16, 2007 to allow construction of the Science Complex in advance of completion of the MEPA review of the Ten-Year Plan projects. Subject to the conditions outlined in the May 10, 2013 Certificate on the NPC, the FROD remains valid for the Science Complex project.

Agency Actions, they are likely related to the overall fabric of the neighborhood and will interact with the projects proposed as part of the Ten-Year Plan.

Jurisdiction and Permitting

This project is subject to MEPA review and required the preparation of a mandatory EIR because it requires State Agency Actions and exceeds several MEPA review thresholds including:

ENF and Mandatory EIR Threshold:

- Generation of 3,000 or more unadjusted new adt on roadways providing access to a single location (301 CMR 11.03(6)(a)(6));

ENF Thresholds:

- New discharge or expansion in discharge to a sewer system of 100,000 or more GPD of sewage, industrial wastewater, or untreated stormwater (301 CMR 11.03(5)(b)(4(a));
- Generation of 2,000 or more new adt on roadways providing access to a single location (301 CMR 11.03(6)(b)(13)); and
- Demolition of all or any exterior part of any Historic Structure listed in or located in any Historic District listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth.

The project, as presented in the FEIR, requires a Non Major Comprehensive Plan Approval from the Massachusetts Department of Environmental Protection (MassDEP), a Construction and Access Permit from the Department of Conservation and Recreation (DCR), a Sewer Use Discharge Permit and 8(m) Permit from the Massachusetts Water Resources Authority (MWRA), and Chapter 254 Review with the Massachusetts Historical Commission (MHC).[2]

Each individual IMP project within the Ten-Year Plan will also be required to undergo additional review by the BRA under the applicable Article 80 provisions of the Boston Zoning Code.[3] As part of the IMP process a program of community benefits were memorialized in a series of agreements between the City of Boston and Harvard. These include a Cooperation Agreement, Institutional Construction Management Plan guidelines, and a Transportation Access Plan Agreement (TAPA).

The project is subject to the MEPA Greenhouse Gas (GHG) Emissions Policy and Protocol. Also, the project will require a National Pollutant Discharge Elimination System (NPDES) Construction General Permit from the United States Environmental Protection Agency (EPA).

[2] Since the filing of the DEIR, MassDEP wastewater regulations have been amended and the project no longer requires a Sewer Connection Permit (BRP WP 74).

[3] The Chao Center and Baker Hall Renovation projects have completed Artide 80 review.

Some portions of the project may receive Financial Assistance in the form of tax-exempt bond financing from the Commonwealth. Because the project is being undertaken with State Financial Assistance, MEPA jurisdiction for this project is broad and extends to all aspects of the project that are likely, directly or indirectly, to cause Damage to the Environment as defined in the MEPA regulations.

Review of the FEIR

The FEIR included a description of each component proposed as part of the Ten-Year Plan. No substantive project changes were identified since the filing of the DEIR. Similar to the DEIR filing, more detail was provided for project elements proposed for commencement very early in the Ten-Year Plan, whereas those projects in middle and later portions of the Ten-Year Plan continued to be described in more conceptual terms.

The FEIR included existing and proposed site plans, architectural drawings and site renderings for the Chao Center and Baker Hall renovation projects. Information provided for the other specific development projects within the Ten-Year Plan was limited to identification of its location within the broader IMP area, approximate building footprints and gross floor areas, proposed uses, building heights, and parking areas. Connections to transit services, water, wastewater, and energy infrastructure, and proximity to parking and open space were provided for the project area. The level of project detail provided in the FEIR is sufficient to identify environmental impacts and mitigation measures associated with the Chao Center and Baker Hall projects. All additional components of the Ten-Year Plan will be required to file Project Commencement Notices (PCNs) in accordance with the SRP.

Land Impacts

The Greenway is proposed as a linear open space south of Western Avenue, extending from Western Avenue to just west of the Charles River, which will both shape the urban landscape and function as an infrastructure corridor. The FEIR included conceptual illustrative cross-sections of the Greenway, identifying key components such as multi-use paths, street connections, stormwater detention and infiltration areas, and utility duct banks. Currently, with the exception of Mellone Park and the pending construction of Rena Park (2014-2015), the future Greenway sites are primarily paved. Before Harvard can obtain control of portions of the proposed Greenway, CSX (the current holder of the exclusive railroad easement encumbering the Allston Landing North area) must complete environmental testing and remediation. This work has commenced, but according to the FEIR, a timeline for completion has not been finalized. Based upon the remediation status and ongoing construction activities, Harvard also identified use of a portion of the future Greenway as a construction support site.

The FEIR reiterated the inclusion of the proposed Greenway as an element of the University's Long-Term Vision rather than a completed component within the Ten-Year Plan due to uncertainty regarding timing of access and control of the land. Harvard proposes to construct segments of the Greenway as buildings are developed along the length of the corridor. The only project located along the Greenway in the Ten-Year Plan is the Hotel and Conference Center (2020 – 2024). The FEIR indicated that as part of the IMP process, land has been reserved for the Greenway and planning has begun for the first piece of connective green space

in the Rena Street corridor between Rena Street and the Science Project. Harvard has made a commitment to work with the City of Boston to develop an implementation schedule for the Greenway. Harvard has also committed to explore interim condition improvements along the Greenway in conjunction with the BRA and Allston Brighton Task Force (Task Force). This planning process is proposed for 2014, with the goal of identifying desirable and feasible elements to increase pedestrian connections consistent with public safety concerns related to ongoing construction and site remediation efforts. I strongly encourage Harvard to coordinate with the Boston Water and Sewer Commission (BWSC), DCR, City of Boston bike advocates, and Task Force members to ensure that interim and final implementation of the Greenway meet the bicycle, pedestrian, stormwater management and open space goals of the community.

Transportation

The Ten-Year Plan projects are estimated to generate approximately 5,300 average daily vehicle trips (adt). The FEIR included a revised and updated transportation study prepared in accordance with the Boston Transportation Department's (BTD) Transportation Access Plan Guidelines (2001) and the BRA Development Review Guidelines (2006). The Study Area was expanded to include the following DCR parkways upstream (north and west) of the Eliot Bridge:

- Gerry's Landing Road;
- Fresh Pond Parkway;
- Soldiers Field Road; and
- Nonantum Road

The transportation study provided a qualitative assessment of traffic flows within these corridors, an assessment of potential traffic volume impacts to the Memorial Drive/Western Avenue and Memorial Drive/ River Street intersections and level-of-service (LOS) analyses at the Gerry's Landing Road/Greenough Boulevard/Memorial Drive and Eliot Bridge/Greenough Boulevard intersections. The transportation study on these additional DCR roadways supplemented the transportation study presented in the DEIR which described 2013 Existing Conditions, a 2022 No-Build Scenario and a 2022 Build Scenario. The transportation study provided estimates of person-trips by mode (i.e., auto, transit, walk/bike) and vehicle trips for the Ten-Year Plan and distributed them through the study area DCR roadways using available Harvard employee zip code data and data from Access Boston for Zone 17 (Allston).

The updated transportation study identified degraded operations (LOS E/F) at the Greenough Boulevard/Eliot Bridge intersection during the weekday evening peak hour in the 2013 Existing Condition. Several approaches were also identified as experiencing LOS E/F conditions with 95th percentile queue lengths exceeding capacity. This same intersection is projected to degrade to LOS E in the 2022 No-Build and 2022 Build Condition during the weekday morning peak hour and continue to operate at LOS F during the weekday evening peak hour under both the 2022 No-Build and 2022 Build Condition. The Greenough Boulevard/Gerry's Landing intersection is projected to degrade from LOS D to LOS E between the 2022 No-Build and 2022 Build Condition during the weekday evening peak hour. Weekday morning peak operations will remain at LOS C under both the 2022 No-Build and 2022 Build Condition.

The transportation study evaluated mitigation options at the Greenough Boulevard/Eliot Bridge, Greenough Boulevard/Gerry's Landing Road at Memorial Drive and Soldiers Field Road/Eliot Bridge intersections. Two mitigation options were analyzed: an actuated option that considers actuating all three signals (no coordination assumed) and a pre-timed/coordinated option that considers coordinating three signals with pre-timed operation. Each option also includes the following signal timing/phasing improvements:

- **Greenough Boulevard at Eliot Bridge**: modified signal phasing to permit Greenough Boulevard southbound through movement with the Eliot Bridge westbound left/Greenough Boulevard northbound right movements.
- **Greenough Boulevard/Gerry's Landing Road at Memorial Drive**: modified pedestrian walk and clearance times (based on current design standards) for the Greenough Boulevard northbound and Memorial Drive westbound crosswalks. Gerry's Landing Road southbound crossing assumed to be separated into two segments.

Both mitigation options improve operations at all three intersections, compared to the 2022 No-Build Condition, with the Pre-Timed/Coordinated option resulting in slightly better operations. Mitigation will require minor equipment and programming modifications. Harvard should discuss the anticipated permitting requirements for these intersection improvements with DCR, including timing for implementation, funding, and construction responsibilities, and whether additional information is necessary to support issuance of Section 61 Findings by DCR.

The Secretary's Certificate on the DEIR requested updated conceptual plans for any proposed transportation improvements within the Ten-Year Plan. The FEIR indicated that the Chao Center and Baker Hall projects do not require the construction of new streets and that the four new streets proposed within the Ten-Year Plan will be coordinated with the City of Boston and constructed consistent with Boston's Complete Streets Guidelines. Roadway/intersection improvements to State-jurisdictional roadways are generally limited to signal timing modifications and signage. However, as discussed later in this Certificate, as part of the PCN process, intersection improvements (physical and/or signal timing) proposed in conjunction with future Ten-Year Plan project must be described in greater detail to ensure their constructability and consistency with multi-modal transportation options and open space opportunities within the project area.

Mode share goals for the Allston Campus were established based on the level of transit infrastructure and commuting population. These parameters are different than Harvard's Cambridge Campus, which is served by both the Red line and bus routes, and results in a large difference in single occupancy vehicle mode shares goals (40 percent to 24.7 percent) for the two campuses. To facilitate achievement of mode share goals, Harvard will extend its existing Allston Express service to Barry's Corner and add a new route, the Harvard Square Express, between Harvard Square and Barry's Corner. As currently proposed, the Allston Express routes will require new stops on campus streets in Allston and the Harvard Express route will include the new planned Barry's Corner shuttle stop on Academic Way and other existing shuttle stops, including one in Harvard Square. Harvard has committed to review the shuttle plan, and

associated stop locations, with the City of Cambridge prior to implementation and revise as appropriate. This shuttle service is free of charge and is available for use by Allston residents and employees of Barry's Corner Residential and Retail Commons. It provides connections between Harvard's campuses, as well as transfers to MBTA services in Harvard Square. The FEIR indicated that MBTA bus routes that serve the IMP Area (including the Route 66 bus) have sufficient capacity to accommodate transit demand associated with the Ten-Year Plan projects. Harvard will continue to work with the MBTA to develop details and designs for physical improvements or enhancements to service operations, as needed. I encourage Harvard to work with the MBTA when preparing the shuttle expansion plans to avoid duplicative parallel transit options in lieu of improvements to existing MBTA service. Harvard should use the results of its proposed mode share monitoring efforts to inform coordination efforts with the MBTA or modifications to its shuttle service to alleviate potential capacity or operational concerns on MBTA services.

Since the filing of the FEIR, MassDOT has committed to numerous improvements to the nearby MassPike, including straightening the curve at the Allston tolls to facilitate electronic tolling and improving safety and traffic operations. MassDOT has also proposed the construction of a new MBTA Commuter Rail station on the Framingham/Worcester Line (to be known as West Station) and is considering use of a portion of the former Beacon Yards area as a layover facility as part of the expansion of service at South Station (EEA #15028). Planning studies and design workgroups are underway for this MassDOT project. Preliminary studies identify opportunities of roadway, pedestrian and bicycle linkages to and through Harvard's Allston campus. Furthermore, these improvements may significantly impact future traffic operations at a number of key intersections and roadways, under the jurisdiction of City of Boston, City of Cambridge, MassDOT and DCR, evaluated as part of the Ten-Year Plan EIR. Therefore, it is critical that Harvard remain an active participant in the planning and design of these MassDOT projects and coordinate its own Ten-Year Plan projects with these proposed changes.

I note the comments from MassDOT regarding capacity and operational issues at the intersections of Western Avenue and Everett Street, Anderson Memorial Bridge and the Soldiers Field Road westbound MassPike off-ramp, Soldiers Field Road eastbound off-ramp at Western Avenue, and Soldiers Field Road westbound off-ramp at River Street. Harvard should meet with MassDOT to discuss short-term and long-term improvements to these intersections to improve traffic operations, particularly in light of proposed changes to the MassPike in the Allston area.

Pedestrian and Bicycle Accommodations

Pedestrian crossings of Soldiers Field Road are provided at three locations within the IMP area: the intersection of North Harvard Street and the Anderson Bridge with the Soldiers Field Road ramps, the intersection of Western Avenue and the Western Avenue Bridge with the Soldiers Field Road ramps, and the Sinclair Weeks footbridge. I note that the Sinclair Weeks footbridge does not meet ADA accessibility standards. According to the FEIR, the MassDOT improvements to the Anderson and Western Avenue Bridges will improve pedestrian crossings by reducing crossing distances and modifying signal timing to create more frequent and longer crossing times. HBS provided $150,000 to DCR to support improvements to the John Weeks

Bridge, including the replacement of stairs with new ramps to enhance accessibility for all users. Modifications of the John Weeks footbridge are underway.

The Charles River Basin Connectivity Study identified potential enhancements to existing or potentially new crossings of Soldiers Field Road at Telford Street, Everett Street and Smith Field. According to the FEIR, Harvard has provided funding for a study of these crossings to improve pedestrian and bicycle access between the Charles River Reservation and adjacent residential neighborhoods and for construction. As part of the Cooperation Agreement signed between Harvard and the City, Harvard has budgeted $150,000 to fund the feasibility phase and $3,350,000 for the implementation phase for a total commitment of $3,500,000. In the feasibility study phase, Harvard will work with DCR and the City of Boston to develop a scope and implement a study of pedestrian and bicycle crossings along Soldiers Field Road between Market Street and the Eliot Bridge. Harvard should specifically discuss the potential impact of at-grade crossings (and associated pedestrian signals) on the operations of nearby DCR intersections. The study will describe existing conditions and evaluate the feasibility of providing at-grade crossings at up to three locations. The findings of the study will be reviewed by DCR, the City of Boston, the Task Force, and the community.

HBS recently removed a wall at the end of Kresge Way to improve connections to the Sinclair Weeks Bridge and its link to the John Weeks Bridge. The FEIR indicated that DCR is evaluating improvements to the Sinclair Weeks Bridge to address ADA requirements. As noted by DCR, funding for these improvements has not been identified. Harvard has committed to continue to work with DCR on this effort. I encourage Harvard to support DCR in efforts to develop a preferred bridge alternative and develop funding opportunities for design and construction.

The FEIR stated that Harvard has been working with the City of Boston and Allston community representatives to fund a program of significant community improvements, several of which would improve pedestrian and bicycle access to the Charles River. The FEIR did not identify specific improvement projects other than evaluation of improved crossings of Soldiers Field Road west of Barry's Corner. Harvard has committed to a public realm flexible fund of $5.3 million over ten years. Specific improvements will be determined by a process led by an Executive Committee comprised of representatives from Harvard, the BRA, Task Force members and perhaps other City agencies. I encourage this Executive Committee to pursue connections consistent with the Charles River Basin Connectivity Study and at existing "gateway" locations to enhance access throughout the IMP Area and beyond, including improvements to the Sinclair Weeks Bridge.

The FEIR indicated that Harvard currently has 1,401 bike parking spaces within the Allston Campus, including 334 covered and secure spaces. The FEIR identified the amount and location of secure-covered, outdoor-covered, and outdoor-open bicycle parking spaces. Secure covered spaces are concentrated near current residential housing. Designated areas for showers and lockers are primarily located at the athletic facility (these facilities are open for use by Harvard Affiliates for a nominal fee). New bicycle parking spaces are proposed in conjunction with four of the Ten-Year Plan projects:

- The HBS Faculty and Administration Office Building – 33 covered spaces and 8 outdoor spaces;
- Mixed Use Facility and Basketball Venue – 134-164 covered spaces and 41-53 outdoor spaces;
- Gateway Project – 86-95 covered spaces and 26-30 outdoor spaces; and
- Hotel and Conference Center – 75 covered spaces and 19 outdoor spaces.

The proposed amount of new bicycle parking was determined based on Boston's *Bicycle Parking Guidelines.* Bicycle parking for the two replacement and three renovation projects are included within the existing parking supply. I encourage Harvard to incorporate sheltered bicycle storage and employee facilities such as changing rooms and showers in each building to further incentivize bicycle use.

Parking

The Ten-Year Plan projects will increase institutional parking supply by 665 parking spaces, for a total of 3,807 spaces. Of these 665 new spaces, 50 are part of a "parking reserve" on the former Charlesview site, 490 spaces are provided to accommodate institutional commuters, affiliate tenants and visitors and 125 spaces are dedicated for use by the hotel and conference center. Parking for the Ten-Year Plan projects was not based on the 59 percent auto mode share for commuters from the BTD guidelines used in the traffic study, but instead was provided consisted with Harvard's mode share goal of 40 percent or less auto use by commuters for its Allston campus. The FEIR included graphics depicting the type and location of parking spaces within the Allston Campus. Off-street parking within the IMP Area is either institutional or private parking; there is no off-street public parking. On-street parking is currently limited to 70 spaces on Western Avenue east of Barry's Corner and on North Harvard Street to the north of Barry's Corner. On-street parking will be expanded in the Ten-Year Plan to include approximately 100 public on-street spaces within the IMP Area and approximately 60-70 on-street spaces controlled by Harvard.

The Harvard University Parking Office controls and administers all Harvard parking as a University-wide resource. It manages the permitting system and specific parking lot/garage assignments. The FEIR identified each type of available parking permit and Fiscal Year 2015 annual fees. Rates vary from as little at $96 for evening commuter permit to $3,588 for tenant garage spaces. Higher costs for tenant rates (e.g., students living on campus) versus parking for faculty and staff (unreserved garage or surface parking) reflect the cost of access to 24-hour a day, 7-day per week parking. Harvard will continue to use a shared parking approach to manage event-related parking demand, as these events typically occur at night and on weekends when commuter parking demand is low.

Harvard's Allston Campus currently includes 14 electric vehicle charging stations (ECS), or 0.5 percent of its parking supply in Allston. The FEIR identified two sources that detail recommended ratios of ECS' to overall parking supply and/or building occupants – LEED version 4 and Article 37 of the Boston Zoning Code. These recommendations range from installing ECS' to serve one percent of the building occupants (Article 37) to two percent of all parking spaces used by the project (LEED). The FEIR did not include a specific commitment by

Harvard to install a determined amount of ECS equipment, but Harvard indicated that it will monitor the demand for ECS and add stations as demand increases or new facilities come online. Preferential parking is provided for low emission (LEV) and fuel-efficient vehicles in designated parking areas on campus, with 14 LEV spaces provided in Allston.

Transportation Demand Management

Harvard has set a mode share goal for the Ten-Year Plan of under 40 percent of commuters traveling to Allston campus by car. The mitigation portion of this Certificate identifies the elements of Harvard's comprehensive Transportation Demand Management (TDM) program to achieve this goal.

The FEIR included a draft Transportation Monitoring Plan to be conducted by Harvard as part of the annual monitoring requirements for its IMP Transportation Access Plan Agreement (TAPA). The elements of this monitoring plan are provided in the mitigation portion of this Certificate. The FEIR does not indicate if monitoring program results and reports will be available to the public or clarify whether it is committed to re-evaluate the expansion of the Harvard Shuttle to serve Harvard's Longwood Campus and/or the proposed MBTA commuter rail station near Everett Street (Boston Landing). The monitoring program should consider which elements of the TDM program applies to which category of potential user (i.e., students, only faculty and staff, etc.) to allow for targeted remedies if mode share goals are not met. I encourage Harvard to modify the draft Transportation Monitoring Plan accordingly.

Water and Wastewater

The Ten-Year Plan project will result in a net increase in average annual water demand of 146,900 gallons per day (gpd) and 133,600 gpd of wastewater generation per MassDEP Title 5 flow guidance. The FEIR included tables identifying water demand and wastewater generation for each element of the Ten-Year Plan, including the total wastewater and water flow reductions attributable to building demolitions (10,950 gpd and 12,045 gpd, respectively). The FEIR also identified net new water and wastewater flows associated with the Science Project and the Barry's Corner Residential and Retail Commons projects (both located outside the IMP Area). These two project will generate an additional 76,790 gpd of wastewater and 84,469 gpd of water demand and will be serviced by the Boston Water and Sewer Commission (BWSC) system serving the IMP Area.

The FEIR included a description and supporting graphic that characterized the existing water supply system and identified ownership of the infrastructure (including MWRA easements within the project area). Harvard used BWSC's hydraulic model of the water system to determine the net impact all project demands on pressures during peak hour demand and on fire protection.

According to the FEIR, Harvard met with BWSC and consulted with MassDEP regarding proposed project compliance with MassDEP's Policy on Managing Infiltration and Inflow in MWRA Community Sewer Systems (BRP 09-01) and with BWSC policy and regulations. To achieve the 4:1 infiltration and inflow (I/I) mitigation goal, Harvard will be required to remove four times the net new wastewater generation of the project from the sewer system directly

tributary to the local MWRA interceptor system in Allston. Based upon net new total wastewater generation estimates, Harvard must identify and remove 534,200 gpd of I/I.

The FEIR described a two-phase I/I reduction plan. The first phase addresses I/I within the wastewater systems owned by Harvard in Allston. This private wastewater system discharges to the BWSC system, thereby contributing to existing combined sewer overflows (CSOs) within the MWRA's Charles River Valley Sewer (CRVS) and the South Charles Relief Sewer (SCRS). Harvard will perform a Sewer System Evaluation Study (SSES) of its sewer system to identify sources of I/I. Inflow sources into Harvard's sewer system found during the SSES, not directly related to the construction for the Ten-Year Plan buildings, will be removed and documentation submitted to BWSC for review and credit as a 1:1 flow offset (i.e., a part of the net flow calculation).

Each project in the Ten-Year Plan will be subject to BWSC review, at which time Harvard will demonstrate adequate I/I mitigation compliance. The I/I mitigation plan will be designed to be paced with the phasing of the overall new development, but may achieve more I/I removal than required for a particular project. According to the FEIR, the BWSC will allow Harvard to "bank" any excess I/I removed during the mitigation process prior to building construction and apply it to offset the wastewater flow contributions as each new building/renovation is completed.

At this time, it is unclear whether the Phase 1 I/I mitigation plan for Harvard's sewer system will result in achieving the 4:1 I/I removal ratio necessary for compliance with MassDEP and BWSC requirements. If these removal requirements cannot be met by Phase 1, Harvard will implement a Phase 2 I/I mitigation plan to remove I/I within the BWSC system to meet any additional mitigation requirements. The FEIR indicated that BWSC plans to undertake a City-wide I/I study starting in 2015 that will provide recommendations for I/I removal in Allston/Brighton. As I/I removal projects are identified in the BWSC system, Harvard will propose projects to meet its obligations to remove I/I for BWSC review and approval.

No allowances were provided in the potable water demand estimates for irrigation or cooling system make-up water. New green space within the project area may require irrigation to supplement rainfall. Harvard will consider rainwater harvesting and storage for irrigation purposes along with the incorporation of drought-tolerant native plant species in landscaping plans. Given the University's requirements for new construction and major renovations to achieve Leadership in Energy and Environmental Design (LEED) Gold certification, a 35% reduction in indoor potable water use is anticipated. Water conservation measures such as low-flow fixtures, waterless urinals and grey water systems are being evaluated by Harvard on a project-by-project basis.

Wetlands, Waterways and Tidelands

The project area does not contain any wetland resource areas regulated under the Massachusetts Wetlands Protection Act. However, portions of the project area do contain filled tidelands potentially subject to M.G.L. Chapter 91 (c.91) (310 CMR 9.00)). According to the FEIR, these tidelands extend landward from the Charles River into the project area and within the footprint of two potential projects (Newell Boathouse renovation and Soldiers Field Park

Housing renovation) and off-site areas associated with minor transportation improvements. The FEIR described historic fill activities and associated licensing for each potential impact area. The FEIR included a graphic identifying the limit of c.91 jurisdiction within the IMP planning area, jurisdictional filled tidelands, and MassDEP historic high and low water marks in relation to the existing Newell Boathouse and Soldiers Field Park Housing structures.

Improvements to Newell Boathouse would likely include an expansion of the building footprint or fill, or include a change in use, and are presumed to require review by MassDEP Waterways as a minor modification or amendment to the existing c.91 License (License no. 2275, September 12, 1889). Harvard should consult with MassDEP to clarify required approvals upon determination of the project's scope.

The existing Soldiers Field Housing project is located, in part, on filled tidelands adjacent to the Charles River upstream of Western Avenue. According to the FEIR, the majority of filled tidelands present at the site are landlocked and exempt from licensing under 310 CMR 9.02 and 310 CMR 9.04 because they are located more than 250 feet landward of the existing flowed tidelands of the Charles River and are separated from the river by Soldiers Field Road – a public way in existence on January 1, 1984. Approximately 40 sf of the existing building is located on jurisdictional filled tidelands. The FEIR indicated that any future alteration of the existing building footprint or change in use within jurisdictional filled tidelands would be subject to c.91 review per 310 CMR 9.05. Harvard has not substantially advanced plans for the Soldiers Field Park Housing site and thus will be required to consult with MassDEP during the planning and design phase to determine permitting/licensing requirements for the project.

Most of the transportation improvements proposed in conjunction with the project are located greater than 250 feet from the existing ordinary high water mark of the Charles River and consist of signal timing and modifications to existing roads that do not represent a structural alteration or change in use requiring a license or permit under 310 CMR 9.05. MassDOT improvements to nearby bridges spanning the Charles River and adjacent intersections are located in areas subject to c.91 jurisdiction. However, these projects are being undertaken by MassDOT outside of the IMP planning area and will not be permitted or designed by Harvard.

Stormwater

The Ten-Year Plan will result in a minor reduction in impervious areas compared to existing conditions (0.8 acres within the 178-acre project area). This does not include the proposed Greenway.

The FEIR included a master planning level stormwater analysis, including calculations, and hydrologic modeling data for the existing and proposed conditions for the Ten-Year Plan projects. Harvard will provide detailed drainage studies for individual projects as part of the BWSC approval process. The stormwater management system will be constructed in compliance with BWSC standards and MassDEP's Stormwater Management Standards (for redevelopment projects). The project intends to meet the BWSC standard to treat one inch of runoff from the proposed impervious area of new development through the use of low-impact development (LID) stormwater management techniques (e.g., vegetated bioretention areas, grassed swales,

porous pavements, etc.) and traditional management measures such as catch basins and particle separators. The drainage system will be designed to meet groundwater recharge and total suspended solids (TSS) removal requirements per MassDEP standards.

The FEIR noted that peak rates of runoff and volumes are anticipated to increase at the Mixed Use/Basketball Facility and the HBS Faculty and Administrative Office project sites. Cumulatively within the IMP Area there will be decrease in peak rates of runoff and volumes to the Charles River. The FEIR indicated that a master planning approach to stormwater management within the IMP Area has been confirmed with MassDEP and BWSC, allowing for a comprehensive view of the project's stormwater discharges to the Charles River, rather than on an individual site basis.

The Ten-Year Plan projects are subject to the Total Maximum Daily Load (TMDL) requirements for phosphorous and pathogens under Boston's anticipated NPDES permit. As noted in the FEIR, BWSC expects that the City will be required to reduce phosphorous to the Charles River by 65 percent. Phosphorous and pathogen reductions will be met by the project through the treatment of the first inch of runoff using rain gardens/bioretention areas, subsurface storage, and porous pavement. The FEIR included a master planning-level analysis to demonstrate that sufficient space is available on each development site to incorporate rain gardens/bioretention areas consistent with TMDL requirements.

The FEIR was responsive to BWSC's comment on the DEIR disagreeing with Harvard's finding that the extension of the 72-inch drain line constructed as part of the Science project through campus (down Western Avenue to a new outfall at the Charles River) will not reduce flooding in the upstream neighborhoods due to existing capacity issues within the upstream neighborhoods. Harvard met with the BWSC to discuss and clarify the drain modeling results. According to the FEIR, at this meeting it was confirmed that the drain model used by Harvard was the same as the model used by BWSC. The FEIR stated that it was agreed that installation of a 72-inch drain would reduce flooding locally on Harvard University property in the Rena Park area, but would not reduce flooding in the upstream neighborhoods (upstream of Coolidge Road and Arden Street) because the drainage systems are undersized and cannot convey flow to the 72-inch drain. Therefore, a new 72-inch drain through the Allston campus would not alleviate upstream flooding due to existing capacity issues, and was not proposed within the timeline of the Ten-Year Plan. However, the BWSC comment letter indicated that in a different meeting held *after* the submission of the FEIR Harvard agreed to fund, design and construct a new drain line from North Harvard Street to the Science Complex, subsequent to BWSC approval.

If the BWSC were to enlarge upstream drain pipes, a larger drain pipe would need to be constructed in either Western Avenue or the Greenway to serve upstream neighborhoods and future Allston campus development in the Ten-Year Plan. Harvard has committed to work with the BWSC to evaluate the drainage needs of this area, including the area north of Ray Mellone Park, throughout the implementation of the Ten-Year Plan. Harvard will plan and size the Greenway to accommodate public and private infrastructure, including preserving a corridor for the construction of a future drain line, if needed.

Greenhouse Gas Emissions

Harvard Energy Systems

The FEIR described the existing Harvard-owned district energy systems serving all or portions of the IMP area including an electric microgrid, a steam distribution network, and a chilled water plant/distribution system. Summaries of each system are as follows:

Electric – the existing microgrid consists of electrical switchgear that receives its supply from NSTAR and a distribution cable that is transformed from 13.8kV to 480/240V at the building level. The primary feeders are interconnected with Harvard's Blackstone CHP facility. The FEIR identified buildings within the Allston campus served by the existing microgrid, those buildings proposed to be served by the existing microgrid (Chao Center, Burden Hall Replacement, HBS Faculty and Administrative Office Building, and Harvard Stadium Addition/Renovation), and those to be served by a future microgrid (Mixed-Use Facility and Basketball Venue, Gateway Project, and the Hotel and Conference Center).[4] To serve portions of the Ten-Year Plan projects (and the new chilled water plant), NSTAR will need to install new 13.8kV electrical feeders from their existing facilities and one or more new Harvard electrical distribution substations will need to be located within one or more area buildings.

Steam/Heat Energy – the existing steam distribution network consists of piping (steam and condensate) running from the Blackstone CHP facility to individual buildings where the heat-energy is typically converted to hot water for distribution/use within the buildings. The FEIR indicated that the following Ten-Year Plan projects are proposed for connection to the existing steam system: Chao Center, Burden Hall Replacement, HBS Faculty and Administrative Office Building, Harvard Stadium Addition/Renovation, Mixed-Use Facility and Basketball Venue, Gateway Project, and the Hotel and Conference Center. Baker Hall renovation and Soldiers Field Park Housing renovations will remain connected to the steam distribution network upon completion.

Chilled Water – electricity is supplied to the district chilled water plant in Allston from the microgrid (interconnected to Blackstone CHP facility). The plant typically provides space conditioning for a number of HBS buildings. The Chao Center, Baker Hall, Burden Hall, and HBS Faculty and Administrative Office Building will be served by the existing system. A new district water chiller plant is proposed in the Science Building to serve the Mixed Use Facility and Basketball Venue, Gateway Project, and Hotel and Conference Center. The new plant will be sized to support future expansion; equipment and the distribution network will be installed in phases/increments over the build out of the Ten-Year Plan projects. The Harvard Stadium Addition/Renovation and Soldiers Field Park Housing renovation projects will be supplied by local (on-site) cooling systems. A new

[4] The Science project will also be served by a future microgrid, but this is not located within the IMP Area.

distribution system will be constructed to facilitate expansion of chilled water within the Allston campus.

Harvard purchases both electricity and natural gas from local distribution companies (e.g., NSTAR and National Grid) and provides service to facilities through direct connections to the utility or through a Harvard-owned distribution network. While the design presented in the FEIR assumed connections to the University's central utility systems in some instances a new building may be constructed out of sequence to the distribution expansion and local-building level production equipment will be used. In this case, provisions will be made to incorporate future connections to the district system when it becomes available.

Chao Center

The FEIR included an updated GHG analysis prepared in accordance with the GHG Policy for the Chao Center. The Policy requires projects to quantify carbon dioxide (CO_2) emissions and identify measures to avoid, minimize or mitigate such emissions. The analysis quantifies the direct and indirect CO_2 emissions associated with the project's energy use (stationary sources) and transportation-related emissions (mobile sources). The GHG analysis evaluated CO_2 emissions for two scenarios as required by the Policy including 1) a Base Case compliant with the 8th edition of the Massachusetts Building Code, which incorporates building energy provisions of the International Energy Conservation Code (IECC 2009) which references American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2007, Appendix G and 2) a Preferred Alternative (i.e., the Design Case) compliant with the Stretch Energy Code (SCI).[5] The analysis used the eQUEST v.3.64 (DOE 2.2 simulation engine) modeling software to perform the GHG analysis. The FEIR was responsive to comments regarding the Chao Center submitted by the Department of Energy Resources (DOER) on the DEIR.

The City of Boston has adopted the Stretch Code subsequent to its designation as a Green Community under the provisions of the *Green Communities Act of 2008*. Therefore, the project will be required to meet the applicable version of the Stretch Code in effect at the time of construction. In municipalities that adopt it, the Stretch Code increases the energy efficiency code requirements for new construction (both residential and commercial) and major residential renovations or additions. The current Stretch Code (SCI) includes a requirement for projects to achieve a 20 percent better energy efficiency than the State's base energy code by either meeting the standard of 20 percent better than ASHRAE 90.1-2007 Appendix G, or by using a prescriptive energy code. The FEIR indicated that SCII may be anticipated to be approximately 27-35 percent more stringent than the 8th edition of the Building Code (IECC 2009, ASHRAE 90.1-2007. As detailed below, the modeling for the Chao Center estimates an energy reduction of approximately 35 percent from the Base Case, indicating that the project may meet or exceed the requirements of SCII as currently envisioned.

[5] The current Stretch Energy Code (SCI) requires energy efficiencies of 20 percent better than ASHRAE 90.1-2007. The SCI requires modeling of base and proposed cases based on the methodology as is defined in ASHRAE 90.1 2007-Appendix G. The Board of Building Regulations and Standards (BBRS) adopted International Energy Conservation Code (IECC) 2012, which became fully effective on July 1, 2014. Accordingly, a revised Stretch Code (SCII) is expected to be proposed by the BBRS. SCII is anticipated to require energy use in new large buildings to be 12 to 15 percent below the baseline of IECC 2012 (ASHRAE 90.1-2010). However, in absence of the adoption of SCII, the BBRS has indicated that SC I remains as the project baseline (i.e., IECC 2009). The Proponent intends to obtain building permits before the SCII is adopted (late 2015) and has therefore selected the 8th edition of the Building Code (and related SCI) for the Base Case in the analysis.

Direct stationary source CO_2 emissions included those emissions from the facility itself, such as boilers, heaters, and internal combustion engines. Indirect stationary source CO_2 emissions were derived from the consumption of electricity, heat or other cooling from off-site sources, such as electrical utility or district heating and cooling systems. Indirect mobile CO_2 emissions included those emissions associated with vehicle use by employees, vendors, customers and others.

The Chao Center will be serviced by several utilities, including electricity, chilled water and steam from the Blackstone CHP facility and natural gas for the kitchen equipment. In addition, approximately 24.9 percent part of the domestic hot water (DHW) requirement (5,395 gpd) will be provided by solar hot water collectors installed elsewhere on campus at a neighboring building (Baker Hall). The Ten-Year Plan projects will meet Harvard's Green Building Standards. One component of these standards is that all new construction and major renovations must meet the LEED-NCv3 Gold certification requirements. Harvard will comply with MassDEP's recently enacted commercial food waste ban.

The FEIR included a summary of modeling inputs (e.g., R-values, U-values, efficiencies, lighting power density, etc.) for energy efficiency measures modeled such as equipment, walls, ceilings, windows, lighting, HVAC units, etc. for both the Base Case and Preferred Alternative. The FEIR identified design changes between the DEIR and FEIR that would alter estimated energy use and GHG emissions. Energy efficiency and GHG reduction measures proposed for the Chao Center are detailed in the mitigation portion of this Certificate.

The FEIR identified several GHG reduction strategies that were evaluated but not incorporated into the project design. These measures include: the use of an on-site ground source heat pump system, use of an on-site condensing boiler system, use of displacement induction units in classrooms, and use of kitchen exhaust hoods with independently modulating dampers. The FEIR provided a discussion of each measure and the reason why it was not selected for inclusion in the Preferred Alternative.

The FEIR included a Mitigation Alternative that evaluated the GHG reduction measures associated with a series of design measures that were not included in the project design due to budgetary limits, space constraints, or poor return on investment. Measures considered as part of the Mitigation Alternative include:

- A ground source heat pump system with an energy efficiency rating (EER) of 21, sized for the cooling load;
- A 90 percent efficient on-site condensing boilers for supplemental space and hot water heating;
- A solar hot water system installed outside the project boundary, offsetting kitchen hot water demand; and
- Use of exhaust hood controls modulating dampers of each hood independently based on ventilation demand.

The FEIR concluded that the Mitigation Alternative results in an overall increase in electricity use, resulting in an energy cost and GHG penalty compared to the Preferred Alternative.

The FEIR also identified a series of GHG reduction commitments that could not be incorporated into the energy modeling. These include, but are not limited to:

- Low-flow and high-efficiency plumbing fixtures;
- A high-efficiency irrigation system for the site and vegetated roof areas;
- Enhanced commissioning services for building energy-related systems;
- Purchase of green power renewable energy credits (RECs) to provide a minimum of 35 percent of the building's electricity from renewable sources for the first two years of building operation; and
- Diversion of as much construction and demolition debris (C&D) from area landfills as possible.

The GHG analysis calculated related emissions for each building energy end-use and respective energy source. Lighting, fans, pumps, chilled water and appliances were assigned a conversion factor for grid-supplied electricity and heating energy (steam) was based on emissions factors for natural gas (and a small amount of No.6 oil) at Harvard's Blackstone CHP facility. These emissions factors are as follows:

- Electricity = 719 lbs CO_2/kWh;
- Steam = 0.0638 short tons CO_2/MMBtu;
- Natural Gas = 0.0584 short tons CO_2/MMBtu.

The GHG analysis for the Chao Center concluded that the Preferred Alternative will exceed the SCI requirement to reduce energy demand by greater than 20 percent (modeling revealed a 35 percent reduction). The Preferred Alternative will reduce project-related stationary source emissions by 292 tons per year (tpy) from the Base Case total emissions of 916 tpy to a Preferred Alternative total of 624 tpy, or a 31.8 percent reduction. I encourage Harvard to review and consider the recommendations provided in the DOER comment letter to further reduce energy demand and GHG emissions associated with the Chao Center.

As noted in the Certificate on the DEIR, Harvard has established Tenant Fit-Out Requirements based on the Harvard Green Building Guidelines and the LEED Green Interior Design and Construction Guidelines for their commercial tenants. Harvard tenants are required to meet established targets, while non-Harvard tenants are strongly encouraged to consider these performance targets when preparing space for occupancy. Harvard also uses Tenant Occupancy Recommendations incorporated into the Service Level Agreement for University Tenants (non-Harvard clients are encouraged to adopt the recommendations) to implement measures that conserve energy, reduce waste, and contribute to a healthy work environment. I strongly encourage Harvard to require non-Harvard tenants to adopt these recommendations as part of their lease agreement to ensure that fit-out of non-Harvard tenant space will be consistent with modeled GHG emissions (mobile and stationary). Harvard, in partnership with the Office for Sustainability, encourages residential tenants to adopt and implement energy reduction measures

through an occupant engagement program. This includes energy efficiency education during orientations and move-ins, Energy Saving Checklists in welcome packet and tenant guides, energy challenges, and energy audits. Third-party tenants who develop on Harvard-owned land subject to long-term leases will be required to sign agreements that include language committing the project to a high level of sustainability such as compliance with the City of Boston's Article 37 sustainability initiative and Harvard's Green Building Standards (achieve at least LEED Gold Certification and participate in Level 1 Integrated Design).

Mobile Source Emissions

The FEIR did not include a specific mobile source GHG emissions analysis, as the Chao Center does not generate significant traffic impacts because it is a replacement project. Mobile source emissions estimates were provided as part of the DEIR and are reiterated herein.

Indirect mobile source emissions were analyzed using the EPA MOBILE 6.2 Mobile Source Emission Factor Model. Average vehicle idling times were based on delay times reported in the SYNCHRO intersection modeling output reports prepared as part of the traffic study. Existing 2012 study area CO_2 emissions were estimated at 25,837.7 tpy, while 2022 No-Build study area CO_2 emissions were estimated at 29,631.5 tpy. Mobile source analysis traffic (volumes, delays, speeds) and emission factor data were developed for the adjusted: i) 2022 No-Build Case, ii) 2022 Build Case, and iii) 2022 Mitigated Build Case. The 2022 Mitigated Build Case includes traffic signal timing and phasing improvements but no physical roadway modifications. No credit was taken for the anticipated reduction in trips and vehicle miles traveled due to the proposed TDM program. Under the 2022 Build Case, the project will contribute an estimated 1,045 tpy of CO_2. The indirect mobile emissions analysis estimated that under the 2022 Mitigated Build Case, CO_2 emissions attributable to the project subsequent to the implementation of the proposed traffic mitigation measures would be reduced by 224 tpy, for a project total contribution of 821 tpy, or a 21 percent overall reduction.

Direct mobile source emissions from fleet vehicles associated with the Ten-Year Plan projects were also evaluated. Fleet vehicles are used on the Allston campus for building and grounds maintenance, mail, recycling, and campus security. Many of these vehicles already include GHG reduction attributes either through the use of biodiesel, hybrid, or electric vehicles. Harvard does not anticipate increasing its vehicle fleet to address campus expansion, with the exception of the proposed shuttle bus route between Barry's Corner and Harvard Square, which is scheduled for 2016. The DEIR presented assumptions about service frequency and length, estimating a total of 89,000 VMT per year at a minimum. The DEIR evaluated potential GHG emissions associated with this shuttle route using standard diesel buses and B20 biodiesel. Use of B20 biodiesel buses would reduce CO_2 emissions from 2,258 tpy to 1,834 tpy, a reduction of 424 tpy.

Climate Change Adaptation

As directed by the Certificate on the DEIR, Harvard reviewed EOEEA's *Climate Change Adaptation Report* (September 2011) and identified changes in air and sea surface temperature, precipitation, and sea level rise as key climate change-related impacts to the Allston campus. Harvard has proposed to adopt climate change adaptation procedural guidelines and climate

change resilience strategies for the development of the Allston campus. Part of this process includes conducting an Allston campus-wide vulnerability assessment and adaptation plan. According to the FEIR, the vulnerability and resiliency assessment is underway and being conducted in coordination with the Cities of Cambridge and Boston, as well as other organizations in the Commonwealth (i.e., infrastructure, transportation, buildings, etc.). Based upon the results of these assessments, Harvard will develop climate change preparedness policies and standards for the entire Harvard campus, individual campuses within Harvard, internal campus districts, individual buildings and infrastructure. The assessment includes buildings occupied by Harvard and commercial properties owned by Harvard; resulting plans should apply to these properties as well. Harvard should provide the MEPA office with a copy of the vulnerability assessment, or if it contains proprietary information, a summary document, upon its completion.

Because the vulnerability assessment and adaptation plan are underway, proposed climate change resiliency measures described in the FEIR were generally limited to the incorporation of sustainable design measures into the Chao Center and Baker Hall renovations. Many of these measures provide climate change resiliency functions through the decrease in stormwater runoff, increases in pervious area, reductions in urban heat island effect, and reduced energy demand. I note the Chao Center basement-level utilities will be mounted on concrete pads to be protected from flooding, with the majority of the building equipped with sump pumps. Harvard is also considering the use of submersible switchgear. The FEIR described the climate resiliency features of the campus district energy system and electric microgrid. In addition to being designed to withstand typical failure scenarios, the system is designed with black start and island capability, allowing it to function through a total loss of utility supply. New on-site renewable energy capabilities incorporated into the Ten-Year Plan are proposed for integration into the microgrid, providing additional energy resiliency.

Historic and Archaeological Resources

Harvard will file Project Notification Forms (PNFs) with the MHC for each individual project that may impact historic resources and for which there is any associated State Financial Assistance or licensing in accordance with M.G.L. c.9, ss.26-27C and 950 CMR 71.00. Harvard will work cooperatively with MHC and the Boston Landmarks Commission (BLC), as required, to ensure that potential impacts to historic resources are considered and appropriately mitigated. Planning principles established for the Ten-Year Plan address the historic sensitivity and architectural diversity of the existing campus and indicate that plans should incorporate historical references, maintain view corridors and feature and preserve landmarks. For projects that involve demolition of structures that are 50 years or older, an Article 85 application will be filed with the BLC in accordance with the City of Boston's Demolition Delay Ordinance. As recommended by the MHC, I encourage Harvard to commence the MHC PNF process early in the planning stages of Ten-Year Plan projects that will impact known historic resources (e.g., renovations to Harvard Stadium).

A PNF and Article 85 application were submitted to MHC for the Chao Center project in August 2013. The MHC determined that Kresge Hall meets the criteria of eligibility for listing in the State and National Registers of Historic Places as a contributing element of the HBS

campus. The MHC further determined that the demolition of Kresge Hall to facilitate the construction of the Chao Center constitutes an adverse effect pursuant to 950 CMR 71.05. Subsequent to consultation between Harvard and MHC, MHC concluded that there were no prudent and feasible measures or alternative which would eliminate the need for demolition of Kresge Hall. Therefore, the MHC and Harvard entered into a Memorandum of Agreement (MOA) to mitigate the adverse effect to historic resources. As described in the FEIR, the MOA included the following mitigation measures:

- *Photodocumentation*: prior to demolition, Kresge Hall was photographed with high-quality digital photography with documentation retained in the HBS archives within Baker Library, along with the original architectural plans. A copy of the photographs were provided to the BLC on compact disc;
- *New Construction*: the Chao Center was designed to be sensitive to the historic McKim, Mead & White legacy campus adjacent to the project site, with project plans shared with the MHC and BLC after completion of the BRA review process;
- *Archaeology*: an archaeological survey of the four projects within the Ten-Year Plan located on the HBS campus (Kresge Hall, Burden Hall, Baker Hall, and Ohiri Field).

According to the FEIR, the reconnaissance archaeology survey is underway and being conducted by the Public Archaeology Laboratory Inc. (PAL) (State Archaeologist's Permit No. 3452). The survey included a walkover and ground inspection of the study areas and review of geotechnical data and historical background materials. According to the MHC comment letter, MHC concurs with the findings presented in a draft archaeological report submitted by PAL. It recommends that professional archaeologists examine future additional soil borings for the Burden Hall replacement site and the northeast quadrant of Ohiri Field. The PCNs submitted for these projects should summarize the findings of additional archaeological investigations, the results of additional review in accordance with MHC regulations, and identify measures taken to avoid impacts to archaeological resources, as applicable.

Hazardous Waste

The FEIR provided an update on the status of study and reporting requirements in accordance with the Massachusetts Contingency Plan (MCP) (310 CMR 40.0000) for property at 100 Western Avenue (CSX Allston Landing North MCP Site). According to the FEIR, the Phase II Comprehensive Site Assessment Report and a separate Phase III Remedial Action Plan and Completion Statement Report were submitted to MassDEP on behalf of CSX Transportation on March 28, 2014. The final Phase IV Remedy Implementation Plan was submitted on July 25, 2014.

The FEIR indicated that, with the exception of a portion of property located at 115 Cambridge Street (aka Sears Lot) which is part of the CSX Allston Landing North MCP Site, there are no planned site assessments or remedial actions per the MCP at the proposed Construction Staging Area (CSA).

As noted previously in the DEIR, there is potential for additional regulated sites to be encountered during construction, as this area of Allston was filled with "urban fill" consisting of coal, ash, debris and other materials. Urban fill, along with the past industrial use of the property, may result in the discovery of compounds regulated under the MCP above reportable concentrations. Additionally there are current sources of contamination to groundwater in the IMP Area from upgradient sources. To mitigate potential soil and groundwater contamination impacts, Harvard construction projects take into account the likely need for urban fill disposal, construction dewatering treatment, building design changes, and underdrain groundwater treatment. Harvard will conduct pre-characterization studies prior to the start of construction to assess potential remediation requirements. As determined by Harvard's Licensed Site Professional (LSP), remediation will be implemented to achieve a condition of No-Significant Risk. Potential construction techniques to achieve this status may include the use of vapor barriers and sub-slab depressurization systems, treatment of both construction dewatering and permanent building dewatering before discharge, and locating stormwater infiltration basins away from areas of known groundwater contamination.

Construction Period

Harvard will develop an institutional Construction Management Plan (CMP) to coordinate the preparation and implementation of the individual project CMPs. Specific categories of principles and approaches to construction management that will guide the CMPs and construction period mitigation include communication; construction work hours; public safety, staging and access; construction worker transportation; construction truck routes and deliveries; construction employment; environmental mitigation; stormwater management; air quality; noise; construction waste; protection of utilities; and rodent control.

The main route for construction truck access will be via the Massachusetts Turnpike to the Soldiers Field Road access road to Western Avenue. Trucks will be prohibited from using local neighborhood streets to arrive or depart from the site. For projects that will impact greater than one acre, a Stormwater Pollution Prevention Plan (SWPPP) will be prepared in accordance with NPDES Construction General Permit requirements. Erosion control measures, such as siltation control fencing, construction entrance/exit stations, and catch basin inserts will be used near soil stockpiles, on-site storage and staging areas, debris and recycling stockpiles, cut and fill slopes, and other stripped and graded areas. Construction period dewatering will be conducted in accordance with MWRA, MassDEP, EPA, DCR and BWSC regulations, with appropriate dewatering permits obtained, as necessary. Harvard will conduct construction activities in accordance with BWSC's *Stormwater Best Management Practices: Guidance Document* January 2013 and Harvard's Environmental Health and Safety and Mitigation standards.

The FEIR provided minimal existing conditions data on the proposed CSA, a potential centralized area for construction-related uses, including truck layover, materials storage, worker parking, and temporary support structures. Harvard indicated that it intends to formalize use of the CSA with the Boston Transportation Department (BTD) through the City of Boston's Construction Management Plan (CMP) guidelines and/or one or more TAPAs and CMPs. Access to the CSA will be addressed in the CMP for each IMP project. The Chao Center and Baker Hall projects are not expected to require use of the CSA, as they will use their existing

sites to accommodate construction staging equipment. Harvard will continue to work with CSX on CSX's ongoing remediation work north and east of the proposed CSA, as this work will dictate the future access and egress points to the CSA.

The FEIR indicated that the potential North Allston Haul Road is a component of the CSA that is not required in the early stages of the Ten-Year Plan project. Harvard intends to continue investigating the feasibility of this potential connection, but did not identify its location or its potential benefits or conflicts with adjacent uses. Given proposed infrastructure and potential redevelopment opportunities in the area by Harvard, MassDOT and other entities, it is unclear if the North Allston Haul Road would facilitate or restrict construction access to these potential projects. If this alternative means of access is pursued, a PCN should be filed (either in conjunction with other projects or as a separate PCN) to identify potential environmental impacts of the haul road, permitting requirements and compliance with applicable regulatory performance standards.

Harvard intends to use the City of Boston's CMP process, which includes participation in regular meetings of a Construction Subcommittee of the Harvard-Allston Task Force to coordinate and manage traffic-related construction period impacts. Additional coordination meetings with MassDOT are proposed to address potential construction-period traffic conflicts with nearby MassDOT Accelerated Bridge Program (ABP) projects.

The FEIR did not include a conceptual plan clarifying pedestrian and bicycle routes during each Ten-Year Plan project to demonstrate the maintenance of sufficient pedestrian and bicycle routes within and through the project area and neighborhood to key destinations such as MBTA bus stops, Harvard's Cambridge Campus, public parks and open space (including the Paul Dudley White Bike Path), and neighborhood uses along Western Avenue and North Harvard Street. The Chao Center and Baker Hall projects are infill projects within the HBS campus, and will not require significant detours of pedestrian and bicycle routes on a broader scale. However, as noted in the FEIR, Harvard will clarify pedestrian and bicycle routes in each PCN demonstrating the maintenance of sufficient pedestrian and bicycle routes within and through the project area and neighborhood. Finally, as part of the institutional CMP, Harvard will site staging areas in a manner that minimizes impacts to pedestrian, bike and vehicular flow in the neighborhood and are coordinated with other construction activity in the immediate area.

The project will comply with MassDEP's Solid Waste and Air Pollution Control regulations, pursuant to M.G.L. c.40, §54. Construction work will comply with the City of Boston's Noise Ordinance. Harvard requires contractors to meet Tier 3 and Tier 4 emissions standards for non-road construction equipment. If specific equipment does not meet those standards, the contractor is required to retrofit the equipment using after-engine emissions controls such as oxidation catalysts or diesel particulate filters to meet the standard. Harvard requires contractors to develop a Waste Management Plan identifying the types and volumes of C&D material, and solid waste expected to be recycled, reused, and disposed during the course of the project; method(s) of collection and transportation of materials off-site; and the facilities where the materials will be process and/or disposed.

Mitigation

The FEIR included draft Section 61 Findings for use by State Agencies. These draft Section 61 Findings should be revised in response to this Certificate and provided to State Agencies to assist in the permitting process and issuance of final Section 61 Findings. The FEIR also included a list of measures proposed to mitigate the environmental impacts associated with the Ten-Year Plan projects and listed various community benefits memorialized in the Cooperation Agreement with the Task Force and the BRA. The FEIR provided a general mitigation implementation schedule (early, mid, late-projects) for open space/infrastructure, roadway improvements.

The following mitigation measures have been proposed in accordance with the Ten-Year Plan projects:

Land

- Harvard will work with the City of Boston and the Task Force to develop an implementation schedule for the Greenway on both an interim and permanent basis.
- Harvard will allocate, over a ten-year term and in accordance with the Cooperative Agreement with the Task Force and the BRA, $9,750,000 towards public realm improvements, $5,350,000 of which will be allocated to the Public Realm Flexible Fund.

Transportation

General

- The Ten-Year Plan includes a series of transportation improvements that will benefit the broader IMP Area. These include:
  - The construction of "Academic Way" and "Science Drive";
  - Design of "Stadium Way" to the 25% design stage within 24 months of the effective date of the IMP.
  - Traffic signal improvements in Barry's Corner and new traffic signals on "Academic Way";
  - New pedestrian paths, enhanced crossings, and upgraded sidewalks;
  - Extension of the City of Boston's Complete Streets guidelines to include campus streets as part of an integrated street network.
  - Construction of five Mobility Hubs in Allston to be located on one or two MBTA bus routes and/or Harvard shuttle routes. Mobility hubs will also include a combination of Hubway stations, electric car charging stations, car sharing services (e.g. Zipcar) and taxi stands.
  - Provision of additional ECS equipment based on monitoring for increased demand and/or as new facilities come online.
  - Upgraded shuttle bus service between Barry's Corner and Harvard Square. This shuttle service is free of charge, is available for use by Allston residents and employees of Barry's Corner Residential and Retail Commons, and provides connections between Harvard's campuses, as well as transfers to

MBTA services in Harvard Square. Harvard will review the shuttle plan, and associated stop locations, with the City of Cambridge prior to implementation and revise as appropriate; and

- Consolidation of MBTA bus stops. Harvard will continue to work with the MBTA to develop details and designs for physical improvements or enhancements to service operations, as needed.

Roadway and Intersection Improvements

- Diversion of traffic flows around Barry's Corner and improved pedestrian crossings through the construction of "Academic Way.";
- Completion of a traffic signal warrant analysis for "Academic Way" at Western Avenue intersection prior to installation to confirm that warrant(s) are fully met;
- Signal optimization and coordination of the Barry's Corner traffic signal with the proposed new traffic signal at "Academic Way" and North Harvard Street. This includes upgrading communications and video monitoring equipment at this location.
- Interconnection of traffic signals along North Harvard Street and provision of communication improvements to link the North Harvard Street intersections ("Academic Way" to Cambridge Street) and Cambridge Street (Windom Street to Harvard Avenue) to the City of Boston's Traffic Management Center.
- Implementation of a "No Left Turn" restriction at the Western Avenue eastbound approach of the Western Avenue at Everett Street intersection in the AM and PM peak hours.
- Implementation of signal timing modifications at the Soldiers Field Road at Eliot Bridge intersection;
- Implementation of signal timing modifications at the Western Avenue at Hague Street and Batten Way intersection;
- Installation of video detection equipment at the Cambridge Street at Franklin Street and Harvard Avenue intersections; and
- Implementation of signal equipment and programming modifications at the Greenough Boulevard/Eliot Bridge, Greenough Boulevard/Gerry's Landing Road at Memorial Drive and Soldiers Field Road/Eliot Bridge intersections to coordinate the three signals with pre-timed operation and the following signal timing/phasing improvements:
  - *Greenough Boulevard at Eliot Bridge*: modified signal phasing to permit Greenough Boulevard southbound through movement with the Eliot Bridge westbound left/Greenough Boulevard northbound right movements.
  - *Greenough Boulevard/Gerry's Landing Road at Memorial Drive*: modified pedestrian walk and clearance times (based on current design standards) for the Greenough Boulevard northbound and Memorial Drive westbound crosswalks. Gerry's Landing Road southbound crossing assumed to be separated into two segments.

Pedestrian and Bicycle Accommodations

- Creation of a new multi-use path along "South Campus Drive" that will accommodate pedestrians and bikes. The path will create a new off-street cycling route around Barry's Corner with access to Smith Field. This enhancement is proposed in conjunction with the Barry's Corner Retail and Residential Commons Project.
- Construction of pedestrian and bicycle facilities on "Academic Way" that will link Rena Park with Smith Field.
- Provide additional covered and uncovered secure bicycle parking in conjunction with the HBS Faculty and Administration Office Building, Mixed Use Facility and Basketball Venue, Gateway and Hotel and Conference Center projects.
- Upgrades to Barry's Corner, including the intersection geometry improvements, removal of the existing pedestrian island, and improvements to the existing grove of trees to enhance and promote public use of the space.
- Construction of new multi-use paths in Rena Park that will create a gateway to the park and the future Greenway;
- Upgrades to Western Avenue including sidewalk reconstruction and formalization of the existing cycle track.
- Expansion of the Hubway stations as demand increases.
- Signal timing adjustments at North Harvard Street at Franklin Street and Kingsley Street to reduce delay and provide acceptable LOS for all users.
- Funding ($3.5 million total) study and implementation of potential enhancements to existing or potentially new crossings of Soldiers Field Road at Telford Street, Everett Street and Smith Field as identified in the Charles River Basin Connectivity Study.
- Continuing to work collaboratively with DCR to evaluate and implement improvements to the Sinclair Weeks Bridge.

Transportation Demand Management

- Implementation and expansion of Harvard's Commuter Choice TDM program. This program includes:
  - 50 percent subsidies for MBTA monthly passes;
  - Pre-tax savings on the purchase of private transit passes and commuter checks for eligible faculty and staff;
  - Online monthly pass sales;
  - Marketing efforts that focus on the transit pass program, public transportation options and Harvard shuttle services, bicycling services such as safe cycling classes, repair clinics, the Hubway, departmental bike programs, ridesharing options, walking and bicycle maps, and links to other references or resources;
  - $50 discounted annual membership to the Hubway bike sharing program;
  - Discounted bike helmets;
  - Bike registration with the Harvard University Police Department;
  - Participation in the Bicycle Benefit Act providing bicyclists with up to $240/year for bicycle expenses;

- Discounted and preferential carpool and vanpool parking in the largest garages and several surface lots;
- Carpool partner matching and registration;
- Emergency ride home assistance;
- Zimride, an online ride sharing program that helps Harvard affiliates locate other people with similar commuting patterns or travel needs to facilitate ridesharing;
- RelayRides program to match people who are willing to lend or borrow vehicles from one another;
- Discounted Zipcar membership ($25/year) for employees;
- Parking for 28 Zipcars including five spaces in Allston;

Transportation Monitoring Program

- As part of its annual IMP TAPA reporting requirement, Harvard will conduct a monitoring program that addresses the following areas of study.
  - Annual Survey
    - Survey commuters on an annual basis to estimate an Allston campus mode share and to identify factors that affect mode choice
  - Parking Management
    - Report the number and location of institutional parking spaces in Allston
    - Report the amount of monthly parking permit fees (i.e., rate schedule)
  - Transit Pass Program
    - Report the status of Harvard's MBTA monthly pass subsidy program.
    - Report the number of participants in the transit pass program.
    - Describe other supporting program elements including pre-tax savings on purchase of private transit passes and commuter checks and Emergency Ride Home program.
  - Ridesharing
    - Report the number and location of preferential carpool spaces and vanpool spaces.
    - Report the level of participation in carpool and vanpool programs.
    - Describe carpool and vanpool program elements including carpool partner matching and carpool registration, discounts, subsidies, preferential parking, and participation in programs such as Zimride.
  - Car-Sharing
    - Report the number and location of car-sharing services.
    - Describe Zipcar membership accounts.
  - Electric Vehicles and Low Emissions Vehicles
    - Report the number and location of EV charging stations and LEV spaces.
    - Report the number of EV and LEV permits.
  - Bicycles
    - Report the number and location of covered and uncovered bicycle parking, the location of bike repair stations, and the location of Hubway stations.
    - Describe participation in the Hubway bike share program and membership fees, discounts, and subsidies.

    - Describe bicycle programs including reimbursements for the purchase, repair, maintenance, and storage of bicycles, departmental bike program, discounts for bicycle helmets, bike registration program, and information dissemination.
  - Walking
    - Describe walk-to-work programs and information distribution.
  - Shuttle Services
    - Describe routes, stops and schedule.
    - Report annual ridership levels.
    - Describe information dissemination including online tracking and phone applications.
  - Outreach and participation
    - Describe outreach programs
    - Describe participation in local, regional and national programs and events.
- Harvard will work with BTD to complete the final monitoring program.

Air Quality

- Harvard will construct infrastructure and traffic management improvements to minimize the potential impacts of the project to the transportation system (i.e. intersection, signal timing, and roadway improvements) and a TDM program to reduce volatile organic compound (VOC) emissions by 0.6 tpy and nitrogen oxides (NOx) emissions by 0.2 tpy from the 2022 Build Condition to 2022 Build with Mitigation Condition.
- The project will conform with the Clean Air Act Amendments, as it does not create a new violation of the NAAQS, an increase in the frequency or severity of any existing violations, nor a delay in the attainment of the NAAQS.

Greenhouse Gas Emissions

- Harvard will implement general, master planning-level, GHG reductions including:
  - All Ten-Year Plan projects will meet Harvard's Green Building Standards. One component of these standards is that all new construction and major renovations must meet the LEED-NCv3 Gold certification requirements.
  - Complying with the recently enacted MassDEP commercial food waste ban.
  - Expanding CHP facilities at Blackstone – and potentially elsewhere;
  - Utilizing and expanding the comprehensive TDM program;
  - Working with BTD to on traffic operations improvements to reduce traffic delays and idling;
  - Establishing Tenant Fit-Out Requirements based on the Harvard Green Building Guidelines and the LEED Green Interior Design and Construction Guidelines for commercial tenants. Harvard tenants are required to meet established targets, while non-Harvard clients are strongly encouraged to consider these performance targets when preparing space for occupancy;
  - Incorporating Tenant Occupancy Recommendations into the Service Level Agreement for University Tenants (non-Harvard clients are encouraged to adopt the

recommendations) to implement measures that conserve energy, reduce waste, and contribute to a healthy work environment;
- Requiring third-party tenants who develop on Harvard-owned land subject to long-term leases to sign agreements that include language committing the project to a high level of sustainability such as compliance with the City of Boston's Article 37 sustainability initiative and Harvard's Green Building Standards (achieve at least LEED Gold Certification and participate in Level 1 Integrated Design).
- Replacing or augmenting fleet vehicles with alternative fueled vehicles; and
- Developing an urban tree canopy consistent with project design guidelines.

Stationary Sources

Baker Hall
- Complete renovations of the major energy consuming systems to meet the prescriptive requirements of the 8th edition of the Massachusetts Energy Code (2009 IECC). Renovations include upgrades to reduce domestic hot water demand, higher-efficiency windows and insulation, new fan coils with ECM motors, new control valves, new higher-efficiency motors for pumps and fans, use of mechanical ventilation and heat recovery, installation of a modern Energy Management System, and reduced lighting power densities.

Chao Center
- Implementation of the following key energy measures:
  - A high performance envelope with additional roof insulation (R-31), wall insulation (R-21), and low-e IGU glazing units with argon gas;
  - A low energy lighting system with approximately 31 percent lighting power density reduction over ASHRAE 90.1-2007 (through the use of LED and fluorescent lighting fixtures) plus the incorporation of daylight and vacancy controls;
  - Use of 66 percent efficient enthalpy wheels recovering energy from all outside air units except for the kitchen makeup air unit;
  - Use of chilled beams in offices, classrooms, and project rooms and hydronic perimeter radiation system decoupling cooling and heating demand from fan use;
  - Use of variable flow air and water systems with premium efficiency circulator pumps, night setbacks and temperature resets;
  - Use of demand control ventilation (DCV) in most spaces and dedicated exhaust makeup air units delivering tempered outside air to the variable flow kitchen, bakery, and servery exhaust hoods;
  - Installation of energy star equipment for the kitchen, bakery, servery, and office appliances;
  - Installation of a rooftop-mounted 67 kW photovoltaic (PV) array with an annual generation capacity of 75,430 kWh/year, or approximately three percent of the building's proposed annual energy use. The PV system will offset approximately 27 tpy GHG emissions.
  - Use of solar hot water collectors from the neighboring Baker Hall to provide 24.9 percent of the domestic hot water (DHW) requirement (5,395 gpd).

- The Preferred Alternative will exceed the SCI requirement to reduce energy demand by greater than 20 percent (modeling projected a 35 percent reduction). The Preferred Alternative will reduce project-related stationary source emissions by 292 tons per year (tpy) from the Base Case total emissions of 916 tpy to a Preferred Alternative total of 624 tpy, or a 31.8 percent reduction.

Mobile Sources

- Indirect mobile source emissions for the Ten-Year Plan projects are estimated to be reduced by 224 tpy in the 2022 Mitigated Build Case from the 2022 Build Case (821 tpy and 1,045 tpy, respectively). The 2022 Mitigated Build Case includes traffic signal timing and phasing improvements but no physical roadway modifications. No credit was taken for the anticipated reduction in trips and vehicle miles traveled due to the proposed TDM program.
- Direct mobile source emissions from fleet vehicles associated with the establishment and expansion of the shuttle route were projected at 1,834 tpy (buses using B20 biodiesel) versus standard diesel buses (2,258 tpy), a reduction of 424 tpy.
- Use of a variety of biodiesel, hybrid, or electric vehicles fleet vehicles for building and grounds maintenance, mail, recycling, and campus security.

General

- A self-certification will be provided to the MEPA office upon completion of each element within the Ten-Year Plan project signed by an appropriate professional (e.g. civil engineer, traffic engineer, architect, general contractor) indicating that all of the GHG mitigation measures, or equivalent measures that are designed to collectively achieve the proposed stationary source GHG emission reduction committed to in the FEIR or the applicable PCN, have been incorporated into the project.

Water and Wastewater

- The project will comply with MassDEP's Policy on Managing Infiltration and Inflow in MWRA Community Sewer Systems (BRP 09-01) and with BWSC policy and regulations;
- Harvard will implement an I/I reduction plan to meet the 4:1 infiltration and inflow (I/I reduction goal, estimated at removal of approximately 543,200 gpd of I/I;
    - Harvard will perform a Sewer System Evaluation Study (SSES) of its private sewer system to identify sources of I/I (Phase 1);
    - Inflow sources into Harvard's sewer system found during the SSES, not directly related to the construction for the Ten-Year Plan buildings, will be removed and documentation submitted to BWSC for review and credit as a 1:1 flow offset (i.e., a part of the net flow calculation);
    - If I/I reduction requirements cannot be met by Phase 1, Harvard will implement a Phase 2 I/I mitigation plan to remove I/I within the BWSC system to meet any additional mitigation requirements;
    - Each project in the Ten-Year Plan will be subject to BWSC review, at which time Harvard will demonstrate adequate I/I mitigation compliance.

- Harvard will implement water conservation measures such as low-flow fixtures, waterless urinals and grey water systems to meet the LEED Gold certification 35% reduction in indoor potable water use standard;
- Harvard will seek to limit potable water use for irrigation purposes and use native drought-tolerant landscaping to reduce irrigation demand.

Stormwater

- The stormwater management system will be constructed in compliance with BWSC standards and MassDEP's Stormwater Management Standards (for redevelopment projects).
- The project will meet the BWSC standard to treat one inch of runoff from the proposed impervious area of new development and meet groundwater recharge and total suspended solids (TSS) removal requirements per MassDEP standards.
- The project will incorporate the following stormwater management BMPs: vegetated bioretention areas, grassed swales, porous pavements, catch basins and particle separators.
- The project will meet the TMDL requirements for phosphorous and pathogens under Boston's anticipated NPDES permit (65 percent) through the use of rain gardens/bioretention areas, subsurface storage, and porous pavement.
- Harvard will design, fund and construct a new storm drain between North Harvard Street and the Science Project site, subject to BWSC permit approval, in 2015.
- Harvard will work with the BWSC to evaluate the drainage needs of upstream neighborhoods including the area north of Ray Mellone Park, and potential construction of a new storm drain down Western Avenue or within the Greenway to the Charles River throughout the implementation of the Ten-Year Plan.
- The Greenway will be designed and sized to accommodate public and private infrastructure, including preserving a corridor for the construction of a 72-inch or larger future drain line, if needed.
- Harvard will continue to investigate the use of green infrastructure elements such as: vegetated bioretention areas/rain gardens, subsurface storage and infiltration, green roofs, permeable pavers in plaza areas, porous asphalt in roadway/parking spaces, pervious concrete walkways, and rainwater harvesting systems to manage stormwater runoff during each individual project design phase.

Climate Change Adaptation

- Harvard will adopt climate change adaptation procedural guidelines and climate change resilience strategies for the development of the Allston campus.
- Harvard will conduct an Allston campus-wide vulnerability assessment and adaptation plan in coordination with the Cities of Cambridge and Boston, as well as other organizations in the Commonwealth (i.e., infrastructure, transportation, buildings, etc.).
- Harvard will use the results of the vulnerability assessment to develop climate change preparedness policies and standards for the entire Harvard campus, individual campuses within Harvard, internal campus districts, individual buildings and infrastructure.

- The Chao Center basement-level utilities will be mounted on concrete pads to be protected from flooding, with the majority of the building equipped with sump pumps. Harvard is also considering the use of submersible switchgear.
- The campus district energy system and electric microgrid provide climate resiliency by being designed to withstand typical failure scenarios, to black start and island, and allowing it to operate through any total loss of utility supply.
- New on-site renewable energy capabilities incorporated into the Ten-Year Plan are proposed for integration into the microgrid, providing additional power resiliency for the campus.

Historic and Archaeological Resources

- Harvard will file PNFs with MHC for each individual project within the Ten-Year Plan that may impact historic resources and for which there is any associated State Financial Assistance or licensing in accordance with M.G.L. c.9, ss.26-27C and 950 CMR 71.00.
- Harvard will work cooperatively with MHC and BLC, as required, to ensure that potential impacts to historic resources are considered and appropriately mitigated.
- Harvard has established planning principles in the Ten-Year Plan to address the historic sensitivity and architectural diversity of the existing campus.
- Projects that involve demolition of structures that are 50 years or older will file an Article 85 application with the BLC in accordance with the City of Boston's Demolition Delay Ordinance.
- Harvard entered into an MOA to mitigate the adverse effect to historic resource associated with the proposed construction of Chao Center pursuance to 950 CMR 71.05. The MOA included the following mitigation measures:
    - Photodocumentation: prior to demolition, Kresge Hall was photographed with high-quality digital photography with documentation retained in the HBS archives within Baker Library, along with the original architectural plans. A copy of the photographs were provided to the BLC on compact disc;
    - New Construction: the Chao Center was designed to be sensitive to the historic McKim, Mead & White legacy campus adjacent to the project site, with project plans shared with the MHC and BLC after completion of the BRA review process;
    - Archaeology: an archaeological survey of the four projects within the Ten-Year Plan located on the HBS campus (Kresge Hall, Burden Hall, Baker Hall, and Ohiri Field).

Construction Period Impacts

- Harvard will conduct pre-characterization studies prior to the start of construction to assess potential remediation requirements. As determined by Harvard's Licensed Site Professional (LSP), remediation will be implemented to achieve a condition of No-Significant Risk. Potential construction techniques to achieve this status may include the use of vapor barriers and sub-slab depressurization systems, treatment of both construction dewatering and permanent building dewatering before discharge, and

locating stormwater infiltration basins away from areas of known groundwater contamination.

- Harvard will develop an institutional Construction Management Plan (CMP) to coordinate the preparation and implementation of the individual project CMPs.
- Harvard will prepare a SWPPP in accordance with NPDES Construction General Permit requirements for projects that will impact greater than one acre.
- Harvard will use erosion control measures, such as siltation control fencing, construction entrance/exit stations, and catch basin inserts, near soil stockpiles, on-site storage and staging areas, debris and recycling stockpiles, cut and fill slopes, and other stripped and graded areas.
- Construction period dewatering will be conducted in accordance with MWRA, MassDEP, EPA, DCR and BWSC regulations, with appropriate dewatering permits obtained, as necessary.
- Harvard will conduct construction activities in accordance with BWSC's *Stormwater Best Management Practices: Guidance Document* January 2013 and Harvard's Environmental Health and Safety and Mitigation standards.
- The project will comply with MassDEP's Solid Waste and Air Pollution Control regulations, pursuant to M.G.L. c.40, §54.
- Construction work will comply with the City of Boston's Noise Ordinance.
- Contractors will be required to meet Tier 3 and Tier 4 emissions standards for non-road construction equipment. If specific equipment does not meet those standards, the contractor is required to retrofit the equipment using after-engine emissions controls such as oxidation catalysts or diesel particulate filters to meet the standard.
- Contractors will be required to develop a Waste Management Plan identifying the types and volumes of construction and demolition material, and solid waste expected to be recycled, reused, and disposed during the course of the project; method(s) of collection and transportation of materials off-site; and the facilities where the materials will be process and/or disposed.
- Construction period traffic impacts will be coordinated and managed through the City of Boston's CMP process, which includes participation in regular meetings of a Construction Subcommittee of the Task Force. Harvard will participate in additional coordination meetings with MassDOT to address potential construction-period traffic conflicts with nearby MassDOT Accelerated Bridge Program (ABP) projects.
- Staging areas will be sited in a manner that minimizes impacts to pedestrian, bike and vehicular flow in the neighborhood and are coordinated with other construction activity in the immediate area.

Project Commencement Notices and Interim Update

Future project review is subject to the terms and conditions agreed upon in the SRP. As noted previously, PCNs will be required for each component of the Ten-Year Plan other than the Chao Center and Baker Hall projects. PCNs may address one or more projects within the Ten-Year Plan depending upon project design advancement and construction scheduling. The PCN's should be prepared in accordance with the SRP, as modified by this Certificate.

The SRP requires the preparation and submission of an Interim Update upon the five-year anniversary of the issuance of this Certificate (October 17, 2019). This document is expected to include an update on the status of area-wide infrastructure improvements (e.g., the Greenway, Longfellow Path, etc.) and individual development projects within the Allston Campus area and a description of any significant changes to the Allston Campus Ten-Year Plan projects from that described in the FEIR. The Interim Update should provide an assessment of cumulative impacts associated with projects completed to date and compare impacts to those disclosed in the FEIR. It should also update the status of all mitigation commitments identified in the Section 61 Findings for the Allston Campus and all individual projects to date and provide information in response to the requirement that the Proponent monitor the effectiveness of TDM measures applied to achieve a 50% mode share for single occupancy vehicles for the Science Complex. If the results of the monitoring indicate that the 50% mode share target has not been achieved, Harvard must commit to additional mitigation measures in the Interim Update.

Given the complexity of the Ten-Year Plan, its potential cumulative environmental impact, and ongoing project coordination and review with the City of Boston, State Agencies and the Task Force, each PCN would benefit from providing a discussion of the broader project context. This discussion, similar to that requested as part of the Interim Update, would provide a clear understanding of individual project relationships to the environmental impacts disclosed as part of the FEIR, proposed mitigation measures, and its context within the framework of projects proposed by others near the IMP Area. I encourage Harvard to provide this level of information in each PCN.

The FEIR includes a commitment to provide additional information in the PCNs to allow for review and evaluation of elements of the Ten-Year Plan that were not advanced or applicable to the Chao Center and Baker Hall projects. Specifically, each PCN should (as applicable):

- Describe the project programming and relationship to the Ten-Year Plan.
- Tabulate project-related traffic generation, water demand, wastewater generation, vehicle and bicycle parking (including ECS equipment and dedicated LEV spaces), and impervious area and compare to the overall data provided for each category as part of the Ten-Year Plan EIR. Subsequent PCNs should compare impacts to the overall Ten-Year Plan project and PCNs reviewed prior to submission to allow for an assessment of cumulative project impacts.
- Provide project site plans that clearly identify access roadways and internal driveways (and associated widths, lane configurations, etc.), transit connections (public and Harvard shuttle), pedestrian and bicycle accommodations, accessible public open space, surface and structured parking, and stormwater, wastewater, and water supply infrastructure.
- Include sufficiently detailed conceptual plans (preferably 80-scale) for any proposed roadway improvements (MassDOT, DCR, City of Cambridge or BTD) in order to verify the feasibility of constructing such improvements. The conceptual plans should show proposed lane widths and offsets, layout lines and jurisdictions, and the land uses (including access drives and loading areas) adjacent to areas where improvements are proposed. These conceptual plans should demonstrate that improvements are consistent with a Complete Streets design approach.

- Provide information about potential water and wastewater infrastructure extensions or relocation needs, identify I/I mitigation projects and estimated removal volumes to demonstrate ongoing compliance with MassDEP and BWSC requirements, and describe selected water conservation measures and project-site level rainwater harvesting and storage opportunities for the proposed project.
- Provide detailed drainage studies/calculations to ensure compliance with applicable stormwater management standards and TMDLs. The PCNs should identify stormwater BMPs, including the incorporation of green infrastructure elements, and construction-related dewatering requirements. If projects within the Ten-Year Plan will tie into stormwater infrastructure within the Greenway, the PCN must identify the connection and describe associated improvements to the Greenway to control and convey stormwater flows.
- Provide an update on Harvard's collaboration with DCR, MassDEP and the City of Boston during the advancement of stormwater system design to ensure that the potential impact of additional stormwater flows to the Charles River will meet applicable water quality standards. Each PCN should provide a status report on Harvard's ongoing collaboration with the BWSC to evaluate the drainage needs of the IMP Area and upstream neighborhoods and identify any improvements within the Ten-Year Plan as they affect design and implementation of the master plan stormwater management system and Greenway proposal.
- Include a GHG analysis (both stationary and mobile sources, as applicable) in compliance with the GHG Policy and as noted below:
    - Recommendations made by DOER during the DEIR and FEIR review processes should apply to all future GHG analyses submitted in accordance with the SRP. Harvard should make note of these suggestions to ensure that future filings are sufficiently complete to allow for a meaningful assessment of GHG reduction measures. I encourage Harvard to meet with MEPA and DOER staff prior to the preparation of these GHG analyses to discuss methodology, applicable code requirements, etc.
    - Evaluate renewable energy sources (i.e., PV, SHW, ground source heat pumps, etc.) on a case-by-case basis for each Ten-Year Plan project. Harvard is a Licensed Retail Supplier of electricity in Massachusetts and has certain requirements under the Renewable Portfolio Standard (RPS). Harvard's current obligation is 15.1 percent, an amount that is scheduled to increase one percent per year through 2020. It is anticipated that additional renewable energy sources will be required as part of the Ten-Year Plan to meet Harvard's RPS obligations.
    - Evaluate the potential for building-specific CHP units during their design on a case-by-case basis if it is not economical to connect some buildings in the Ten-Year Plan to the Blackstone CHP facility.
    - Provide a renewable energy analysis that describes potential renewable energy sources (i.e., system size/type, potential energy generation outputs, etc.) and estimated GHG emissions reductions.
    - Provide new information on the University's energy supply, to the extent that it is revised. Additionally, upon such time that a Ten-Year Plan project will connect to the proposed future chilled water or electric microgrid expanded

service areas, the PCN (or 5-year Interim update, whichever comes first based upon system design status) should provide sufficient detail describing the these systems and how they will be integrated into the Allston campus to meet its energy demand requirements.

- PCNs for the Newell Boathouse improvements and the Soldiers Field Housing project should demonstrate project compliance with applicable c.91 performance standards and regulations.
- PCNs for those components of the Ten-Year Plan with potential impacts to historic resources should provide a discussion of proposed mitigation measures to mitigate historic impacts (if identified by MHC per 950 CMR 71.00).
- PCNs for the Burden Hall replacement and HBS Faculty and Administrative Office projects should summarize the findings of additional archaeological investigations, the results of additional review in accordance with MHC regulations, and identify measures taken to avoid impacts to archaeological resources, as applicable.
- Discuss the findings of the climate change vulnerability assessment as they pertain to the proposed project and describe the applicable climate change preparedness measures to be implemented as part of building/site design and operations. Specifically, each PCN should provide supporting data justifying the selection of proposed critical infrastructure elevations and describe how the design of building entry and exit points, roadways, public and private on-site utilities, and first floor uses and materials selection have considered potential climate change impacts. The PCNs should identify site elements designed to reduce the impact of extreme heat events and limit the potential impact of more frequent and intense storm precipitation.
- The PCN for the first component of the Ten-Year Plan proposing to use the CSA must include existing conditions data on the CSA (i.e., area, impervious area, stormwater management, hazardous materials, etc.) and describe how this area will be used to support construction of the project and future components of the Ten-Year Plan. This should include a discussion of how the CSA will be accessed by construction-related traffic, estimated construction-related traffic trips, parking for construction workers and equipment, and how it relates to truck traffic routes and intersection operations studied as part of the EIR process. Finally, the PCN should identify BMPs to be used by contractors in the CSA to ensure effective stormwater and hazardous materials management consistent with applicable Federal, State and local laws and regulations.
- Discuss how the project will be constructed consistent with the institutional CMP and the specific CMP developed for the project.
- Demonstrate the maintenance of sufficient pedestrian and bicycle routes within and through the project area and neighborhood pedestrian and bicycle routes during the construction period.
- Provide a status report on the planning, funding or implementation of area-wide infrastructure improvements identified in the EIR or proposed in conjunction with the allocation of funds from the Public Realm Flexible Fund established by the Cooperation Agreement.
- Identify which mitigation measures proposed as part of the Ten-Year Plan EIR will be implemented in conjunction with the project.

Interim Update

As noted previously, the project will be required to file an Interim Update by October 17, 2019. In addition to the guidance provided by the SRP for content, the Interim Update should specifically address the following:

- Provide the results of post-occupancy traffic monitoring, including the operations at DCR and MassDOT intersections assessed as part of the EIR's traffic study. If predicted LOS goals are not being met, the Interim Update should include a commitment to address these deficiencies.
- Harvard should provide an update on the specific timing of proposed mitigation measures, preferably tied to the construction of certain projects within the Ten-Year Plan. I note that many of these improvements are associated with local City of Boston roadways or private campus driveways. The Interim Update should provide copies of City of Boston approvals for improvements to these roadways and intersections.
- Provide an update on BWSC and Harvard drainage improvements within the Allston neighborhood; specifically the status of planning and design of the 72-inch drainage pipe between the Science Project and the Charles River.
- Discuss Harvard's success at meeting its 40 percent auto mode share goal. The Interim Update should include a breakdown of mode share trips by auto, transit, walk and bicycle. The Interim Update should discuss how the TDM program applies to user type (students, faculty, and staff) and provide an analysis of parking space use to determine if parking is being maximized to the extent practicable. If goals are not being met, Harvard must identify and commit to implement additional mitigation measures. The Interim Update should include the most recent annual TDM monitoring report required as part of the IMP TAPA as supporting documentation.
- Report on the status of the study and implementation of improved pedestrian and bicycle crossings at Soldiers Field Road and the establishment of Longfellow Path.
- Report on the status and results of ongoing collaboration between Harvard and the Department of Conservation and Recreation (DCR) in the planning and reconstruction of the Anderson Bridge, Sinclair Weeks Bridge, Western Avenue Bridge and River Street Bridge to optimize pedestrian and bicycle functionality, amenity, and safety.
- Report on the status of planning and implementation of both interim and permanent improvements to the Greenway.
- Provide a status report on the planning, funding or implementation of area-wide infrastructure improvements identified in the EIR or proposed in conjunction with the allocation of funds from the Public Realm Flexible Fund established by the Cooperation Agreement.
- Report on the status of CSX's remediation efforts in the Allston Landing North Area and the proposed CSA.
- Discuss the relationship of the Ten-Year Plan projects, including roadway, bicycle and pedestrian accommodations, to the proposed changes in the Allston Landing North area, including but not limited to, MassDOT's proposal to straighten the MassPike at the Allston Brighton tolls and construct a new MBTA Commuter Rail station. The Interim Update should review the Ten-Year Plan projects in the context

of the most recently available planning documents prepared in conjunction with the reconfiguration of the MassPike and potential changes to the local roadway network. Connections to this large area of potential redevelopment and transit access will play an important role in meeting the mode share goals established by Harvard. The Interim Update should include a discussion of Harvard's collaboration with MassDOT on these efforts.

Conclusion

Based on a review of the FEIR, comment letters and consultation with State Agencies, I find that the FEIR adequately and properly complies with MEPA and its implementing regulations. The Chao Center and Baker Hall renovation projects may proceed to permitting, as applicable. Additional MEPA project review will be guided by the SRP, as modified in this Certificate. State Agencies should forward copies of the final Section 61 Findings to the MEPA Office for publication in accordance with 301 CMR 11.12.

October 17, 2014
Date

Maeve Vallely Bartlett

Comments received:

10/01/2014	Boston Water and Sewer Commission
10/09/2014	Massachusetts Water Resources Authority
10/09/2014	Massachusetts Historical Commission
10/10/2014	Massachusetts Department of Environmental Protection – Northeast Regional Office (MassDEP – NERO)
10/10/2014	Massachusetts Department of Transportation
10/10/2014	Charles River Watershed Association and Metropolitan Area Planning Council (joint letter)
10/10/2014	WalkBoston
10/14/2014	Department of Energy Resources
10/14/2014	Department of Conservation and Recreation

MVB/HSJ/hsj

APPENDIX C

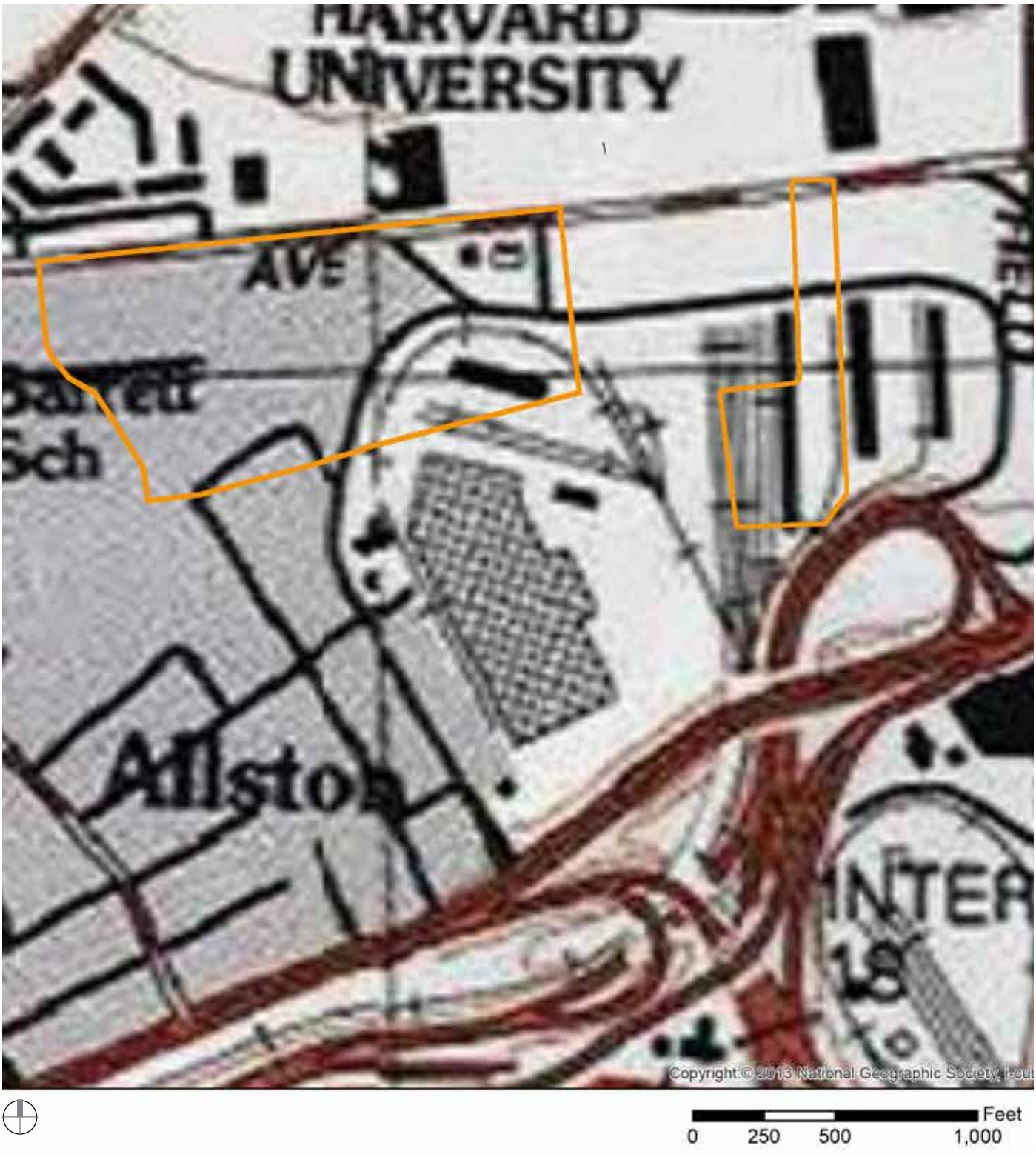
ADDITIONAL FIGURES

Figure 1: 2007 Science Complex Site Plan

Source:
Stephen Stimson Associates Landscape Architects

Figure 3-2
Landscape Site Plan

Figure 2: USGS Map



Source: ArcGIS Online - USA Topo Basemap

"The map includes the National Park Service (NPS) Natural Earth physical map at 1.24km per pixel for the world at small scales, i-cubed eTOPO 1:250,000-scale maps for the contiguous United States at medium scales, and National Geographic TOPO! 1:100,000 and 1:24,000-scale maps (1:250,000 and 1:63,000 in Alaska) for the United States at large scales. The TOPO! maps are seamless, scanned images of United States Geological Survey (USGS) paper topographic maps."

Figure 3: Current Site Plan Overview

Figure 4: Science & Engineering Complex (SEC) Site Plan

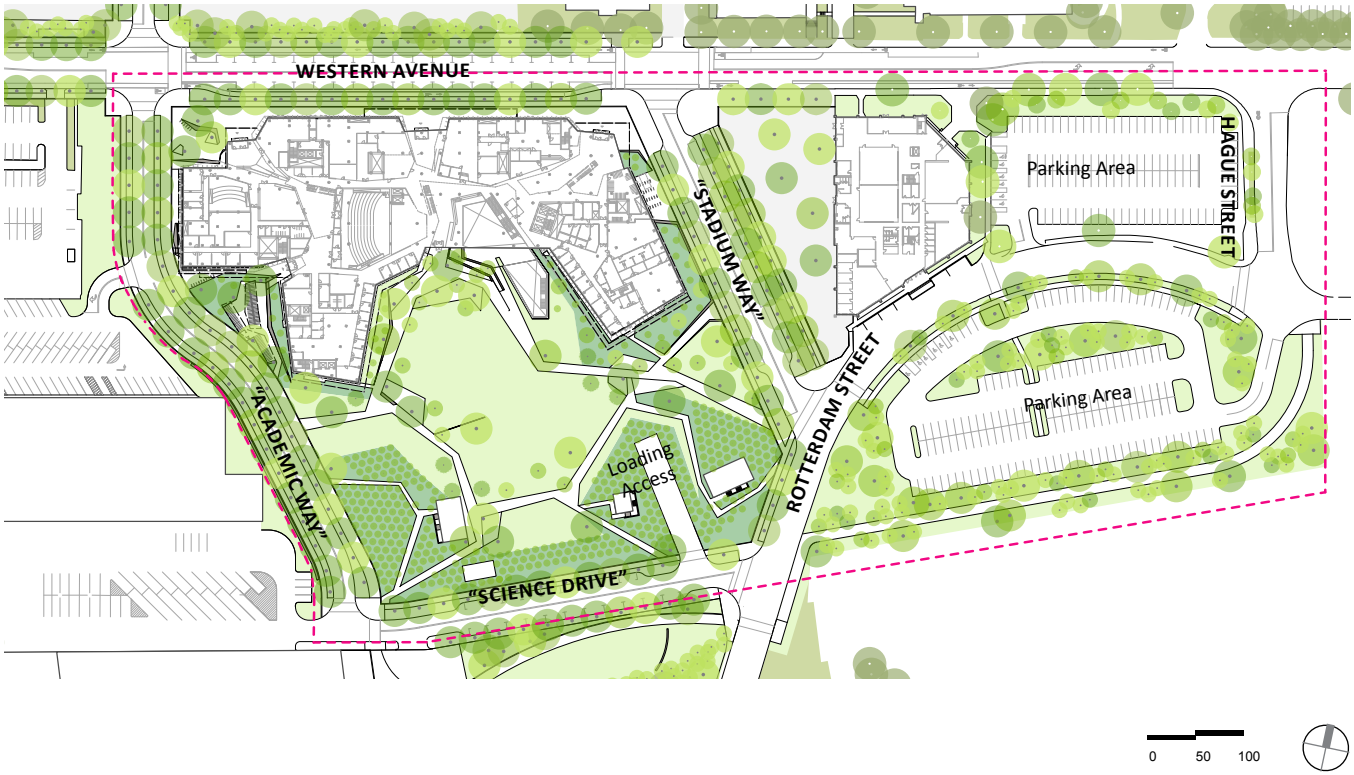
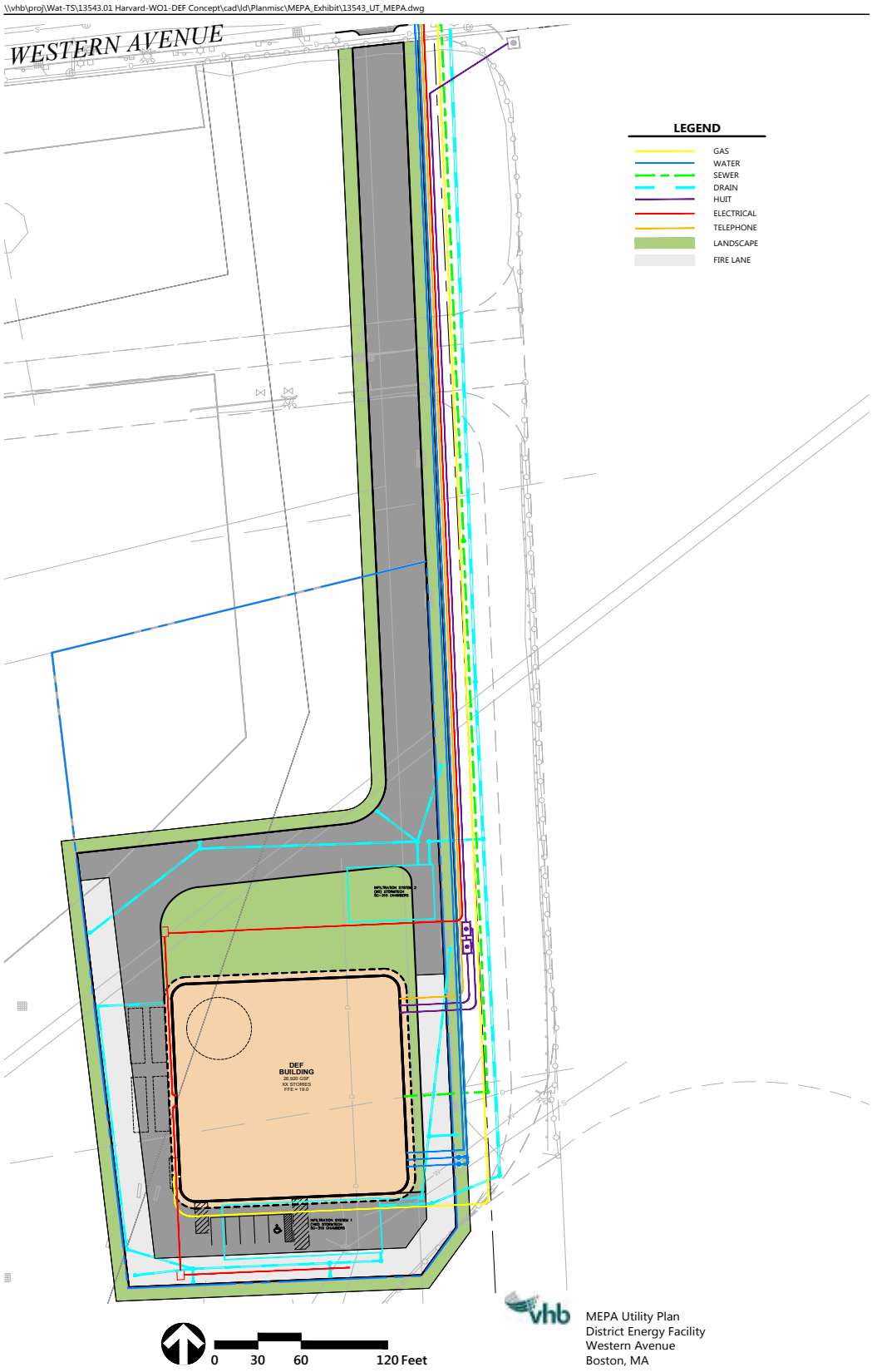


Figure 5: District Energy Facility (DEF) Site Plan



APPENDIX D

CIRCULATION LIST

Executive Office of Environmental Affairs
MEPA Office, EOEA #14069
Attn: Holly Johnson, MEPA Analyst
100 Cambridge Street, Suite 900
Boston, MA 02114

Department of Environmental Protection
Northeast Regional Office
Attn: MEPA Coordinator
205B Lowell Street
Wilmington, MA 01887

MassDOT
Public/Private Development Unit
Attn: MEPA Coordinator
10 Park Plaza
Boston, MA 02116

MassDOT
District #6
Attn: MEPA Coordinator
185 Kneeland Street
Boston, MA 02111

Massachusetts Historical Commission
Attn: Brona Simon
The Massachusetts Archives Building
220 Morrissey Boulevard
Boston, MA 02125

Massachusetts Department of Conservation and Recreation
Attn: Rick Corsi
251 Causeway Street
Boston, MA 02114

Division of Energy Resources
Attn: Paul Ormond
100 Cambridge Street, 10th floor
Boston, MA 02114

Massachusetts Bay Transit Authority
Attn: Andrew Brennan
10 Park Plaza, 6th Floor
Boston, MA 02216-3966

Massachusetts Water Resource Authority
Attn: Marianne Connolly
100 First Avenue
Charlestown Navy Yard
Boston, MA 02129

Metropolitan Area Planning Council
Attn: Marc Draisen
60 Temple Place
Boston, MA 02111

Boston Redevelopment Authority
Attn: Gerald Autler
1 City Hall Plaza, 9th Floor
Boston, MA 02201

Boston Environment Department
Attn: Austin Blackmon
1 City Hall Plaza, Room 805
Boston, MA 02201

Boston City Council
Attn: Mark Ciommo
1 City Hall Plaza, 5th Floor
Boston, MA 02201

Boston Water & Sewer Commission
Attn: John Sullivan
980 Harrison Avenue
Boston, MA 02119

Cambridge Department of Community Development
Attn: Iram Farooq
344 Broadway
Cambridge, MA. 02139

Cambridge City Manager
Attn: Richard C. Rossi
Cambridge City Hall
795 Massachusetts Ave.
Cambridge, MA 02139

Sal N. DiDomenico
State Senator
State House
Room 218
Boston, MA 02133

Kevin G. Honan
State Representative, 17th Suffolk
Commonwealth of Massachusetts
The General Court
State House
Boston, MA 02133-1053

Michael J. Moran
State Representative, 18th Suffolk
Commonwealth of Massachusetts
The General Court
State House
Boston, MA 02133-1053

Allston Brighton CDC
Attn: Carol Ridge Martinez
20 Linden Street, Suite 288
Allston, MA 02134

Cambridge Bicycle Committee
Attn: Jonathan Adams
344 Broadway
Cambridge, MA 02139

Charles River Watershed Association
Attn: Pallavi Mande
190 Park Road
Weston, MA 02493

Conservation Law Foundation
Attn: Bradley Campbell
62 Summer Street
Boston, MA 02110-1016

LivableStreets Alliance
Attn: Stacy Thompson
70 Pacific Street
Cambridge, MA 02139

MassBike Metro Boston Chapter
Attn: Richard Fries
171 Milk Street, Suite 33
Boston, MA 02109

WalkBoston
Attn: Wendy Landman
Old City Hall
45 School Street
Boston, MA 02108

Paula Alexander
226 North Harvard Street
Allston, MA 02134

Tamara Bonn
84 Franklin Street
Allston, MA 02134

John Cusack
35 Windom Street
Allston, MA 02134

John Eskew
15 Athol Street
Allston, MA 02134

Stevan Goldin
33 Rockport Road
Gloucester, MA

Mike Hanlon
290 North Harvard Street
Allston, MA 02134

Rosie Hanlon
172 Chiswick Road
Brighton, MA 02135

Stephen Kaiser
191 Hamilton Street
Cambridge, MA 02139

Harry Mattison
28 Mansfield Street
Allston, MA 02134

Tim McHale
102 Litchfield Street
Brighton, MA 02135

Herbert Nolan
Solomon Fund, Inc.
10 Laurel Ave., Suite 200
Wellesley, MA 02481

Michael Pahre
76 Foster Street
Brighton, MA 02135

Karen Smith
70 Athol Street
Allston, MA 02134

Rita Vaidya
15 Athol Street
Allston, MA 02134

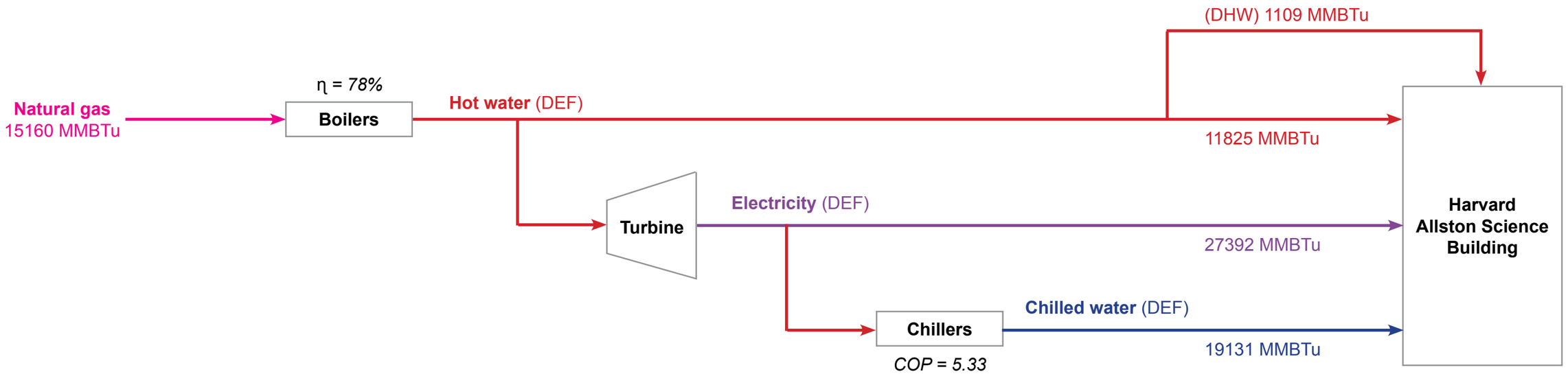
Brent Whalen
332 North Harvard Street
Allston, MA 02134

APPENDIX E

AIR QUALITY

APPENDIX E

1. Trigeneration Diagram



Proposed energy strategy

Total Energy Consumption = 47,250 MMBTu		**GHG Emissions = 4035 tons / year**	
DEF Electricity	27,392 MMBTu (all other end-uses)	DEF Chilled water	19,131 MMBTU x 0.01738 = 332 tons
	3,589 MMBTu (space cooling)	DEF Hot water	11,825 MMBTU x 0.0613 = 724 tons
DEF Natural gas	15,160 MMBTu (space heating)	Grid Electricity	27,392 MMBTU x 0.1022 = 2,914 tons
Grid Natural gas	1109 MMBTU (DHW)	Grid Natural gas	1109 MMBTU x 0.0586 = 65 tons

APPENDIX E

2. Energy Modeling Assumptions and Methodology

Allston Science and Engineering Complex

Summary of energy model for GHG analysis

10 March 2016

Executive Summary

This memo summarizes the results and major inputs of the energy model, constructed based on architectural plans that reflect an approved program (November 13, 2015 set), as well as those façade and mechanical design properties that have been coordinated within the design team so far, and serves as the SD phase model for MEPA compliance.

General Information

Software: eQuest 3-65 build 7163

Number of Buildings Modeled: 1

Proposed Case Energy Model
File Name: Harvard_SD.pd2
Relevant Runs: "Parametric Run #3"

Baseline Case Energy Model
File Name: Harvard_SD_2_BaseVAV.pd2
Relevant Runs: "Parametric Run #4"

Pre-processing tools

Thermal zone area summary tool – summarizes area take-offs and space tags from Design Review mark-ups, which are shown in Appendix. This ensures that all variations in space type, façade type, orientation and schedules are reflected in the energy model, while still allowing for time-efficient changes as design progresses. Note that this is the reason that the energy model 3D view does not "look" like the actual building design.

Post-processing tools

Consolidated Report Tables – includes GHG emissions factors, utility rates and equipment efficiency. This table is the final step in calculating total building energy consumption.

Additional calculations

PV Potential spreadsheet – estimate of electricity generation potential from various areas for PV panels under consideration.

newyork@transsolar.com
220 East 23rd Street Suite 403
New York, NY 10012 USA
t +1 212 219 2255
LL EO

Energy Model Description, Assumptions, and Inputs

All energy models were completed in eQuest v3.65 based on the in-progress schematic design architectural plans as of November 13, 2015. Thermal zoning plans are provided in the appendix. The following pages include tables that summarize the critical inputs and assumptions.

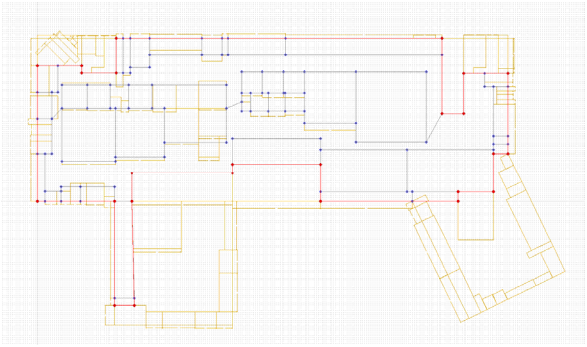


Figure 1: Thermal zoning for typical above-grade floor

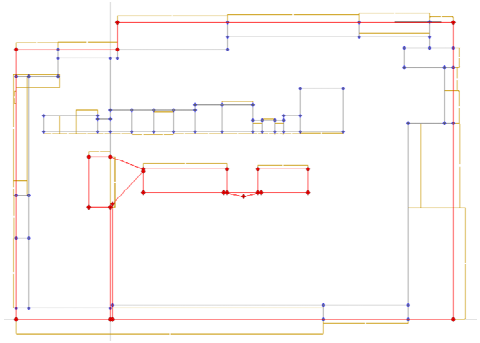


Figure 2: Thermal zoning for below-grade floor

Table 1: Area distribution per space type – in progress

Major Space Class	Area (SF)	
Offices	86538	18%
Write-Up	54640	11%
Meeting / Conference	19354	4%
Computational	23655	5%
Labs	128567	27%
Class / Lecture	17762	4%
Lobby / Atrium	59544	12%
Corridor	54033	11%
All other spaces	32364	7%
Total GSF	476456	

Baseline Model

The current Massachusetts building code requires that all new commercial construction must comply with the IECC 2012 commercial provisions or ASHRAE 90.1-2010. Therefore, the Baseline model to comply via the performance rating method is defined by ASHRAE 90.1-2010 with Appendix G.

Description of mechanical systems

The basic concept for the building air systems (both lab and non-lab) is to provide dedicated outside air to all areas of the building in sufficient quantities to satisfy the ventilation and latent heat rejection requirements of the various areas. The ventilation air will satisfy the latent removal and some component of the space sensible load, but will not be the primary means of providing sensible cooling. Sensible cooling will be provided through the use of non-condensing space cooling devices which will typically consist of active chilled beams for lab areas, and active or passive chilled beams, radiant ceilings, radiant floor slabs or fan coil units for non-lab areas. In areas which may utilize active slab for heating and cooling, careful control will be necessary to avoid the risk of condensation during economizer mode, where a higher dewpoint could be introduced via natural ventilation. Fan coil units with latent removal capabilities may be employed in areas with high latent loads.

The air systems will employ heat recovery to pre-condition the outside air. The use of enthalpy wheel type heat recovery is not appropriate for this application; an alternate technology consisting of a high efficiency glycol run-around loop with indirect evaporative cooling is proposed (Konvekta). The run-around loop system consists of heat recovery coils within the lab exhaust stream and within the lab and non-lab air handling units to pre-treat incoming outdoor air. Indirect evaporative cooling at the exhaust heat recovery coils will be used to enhance the system effectiveness during warm weather. For building systems consistency, non-lab air handlers will be provided with high efficiency run-around loop heat recovery similar to the lab air systems.

Description of plant

The Proposed case building will utilize services from a new District Energy Facility (DEF) including hot water, chilled water and electricity. In accordance with the "District Energy Modelling Guidelines (USGBC)", annual average heating and cooling efficiencies as well as heating, cooling and electricity GHG emissions intensities (MTCDE/MMBtu, MTCDE/Ton-hr, and MTCDE/kWh, respectively) were estimated for the new DEF and multiplied accordingly with building heating, cooling and electricity loads from the energy model, post-process. That is, building heating loads are counted on a "steam-meter", cooling loads are counted on a "chilled-water-meter" and electricity on a "electrical-meter" in the energy model, as shown in the BEPS report. In this post-process calculation, the new DEF cogeneration plant efficiency and GHG emissions are captured. Note that the Baseline case is modelled according to ASHRAE 90.1-2010 with Appendix G, which requires natural gas boilers and electric chillers, and therefore, GHG emissions for the Baseline case are calculated with natural gas and Massachusetts grid electricity GHG intensities.

newyork@transsolar.com
220 East 23rd Street Suite 403
New York, NY 10012 USA
t +1 212 219 2255
LL EO

Table 2: Model Inputs

	ASHRAE 90.1-2010 Appendix G	Proposed Design
HVAC System Type	Labs: One 100% outside air system with reheat Non-labs: VAV system with reheat	Labs: One 100% outside air VAV system with reheat; chilled beams Non-labs: 100% DOAS with Radiant
Heat Recovery	50% sensible effectiveness	80% sensible effectiveness
Fan Power	Labs: 6 ACH at all times, 11" w.c. Non-labs: (per ASHRAE 62.1-2010) offices: 5 cfm OA/person class: 7.5 cfm OA/person	Labs: 6 ACH at all times, 11" w.c. Non-labs: offices: 16 cfm OA/person class: 16 cfm OA/person
Airside Economizer	OA temperature max 70°F	Non-lab Unit: OA temperature max 70°F
Supply Air Temperature	Reset between 55 - 60 °F based on OA DB	Reset between 55 - 60 °F based on OA DB
NonLab Space Temperature Setpoints	76 °F Cooling setpoint 7am - 6pm 70 °F Heating setpoint 7am - 6pm 82 °F Cooling setpoint 6pm - 7am 64 °F Heating setpoint 6pm - 7am	76 °F Cooling setpoint 7am - 6pm 70 °F Heating setpoint 7am - 6pm 82 °F Cooling setpoint 6pm - 7am 64 °F Heating setpoint 6pm - 7am
Lab Space Temperature Setpoints	76 °F Cooling setpoint 7am - 6pm 70 °F Heating setpoint 7am - 6pm 78 °F Cooling setpoint 6pm - 7am 68 °F Heating setpoint 6pm - 7am	76 °F Cooling setpoint 7am - 6pm 70 °F Heating setpoint 7am - 6pm 78 °F Cooling setpoint 6pm - 7am 68 °F Heating setpoint 6pm - 7am
Heating Source	ASHRAE Baseline boilers per LEED district energy modeling guidelines Option 2	Virtual plant representing steam from new ESF central cogen plant per LEED district energy modeling guidelines Option 2
Heating Efficiency	Design efficiency 80%	78% annual average heating efficiency (provided by Harvard E&U)
HW Loop	Supply 180 °F, DT 50 °F	Supply 180 °F, DT 50 °F
Cooling Source	ASHRAE Baseline chillers per LEED district energy modeling guidelines Option 2	Virtual plant representing chilled water from new ESF central cogen plant per LEED district energy modeling guidelines Option 2
Chiller Efficiency	Design COP 6.1	5.33 annual average cooling COP (provided by Harvard E&U)
CHW Loop	supply 44 °F, DT 12 °F	supply 44 °F, DT 10 °F
Pumps	Variable flow: HW 12 W/gpm, CHW 17 W/gpm	Variable flow: HW 11 W/gpm, CHW 11 W/gpm

Table 3: Weekday schedules – All cases

Weekdays	Non Lab Equipment Schedule	NonLab Lighting Schedule	Whole Building Occupancy Schedule	Lab Equipment Schedule	Lab Lighting Schedule
7am to 8am	30%	42%	23%	100%	42%
8am to 9am	40%	90%	90%	100%	90%
9am to 10am	50%	90%	90%	100%	90%
10am to 11am	50%	90%	90%	100%	90%
11am to 12pm	50%	90%	78%	100%	90%
12pm to 1pm	40%	90%	78%	100%	90%
1pm to 2pm	50%	90%	80%	100%	90%
2pm to 3pm	50%	90%	80%	100%	90%
3pm to 4pm	50%	71%	71%	100%	71%
4pm to 5pm	50%	61%	41%	100%	61%
5pm to 6pm	40%	50%	21%	100%	50%
6pm to 7pm	30%	68%	39%	100%	68%
7pm to 8pm	30%	68%	39%	100%	68%
8pm to 9pm	20%	67%	29%	50%	67%
9pm to 10pm	20%	29%	10%	50%	29%
10pm to 11pm	20%	10%	5%	50%	20%
11pm to 7am	20%	5%	0%	50%	20%

Table 4: Weekend schedules – All cases

Weekends	NonLab Equipment Schedule	NonLab Lighting Schedule	Whole Building Occupancy Schedule	Lab Equipment Schedule	Lab Lighting Schedule
7am to 8am	30%	5%	3%	50%	20%
8am to 9am	40%	5%	0%	50%	20%
9am to 10am	40%	5%	5%	50%	20%
10am to 11am	40%	5%	5%	50%	20%
11am to 12pm	40%	5%	2%	50%	20%
12pm to 1pm	30%	5%	2%	50%	20%
1pm to 2pm	30%	5%	5%	50%	20%
2pm to 3pm	30%	5%	5%	50%	20%
3pm to 4pm	30%	5%	5%	50%	20%
4pm to 5pm	30%	5%	4%	50%	20%
5pm to 6pm	20%	5%	2%	50%	20%
6pm to 7pm	20%	5%	1%	50%	20%
7pm to 8pm	20%	5%	1%	50%	20%
8pm to 9pm	20%	5%	1%	50%	20%
9pm to 10pm	20%	5%	1%	50%	20%
10pm to 11pm	20%	5%	1%	50%	20%
11pm to 7am	20%	5%	1%	50%	20%

APPENDIX E

3. Plant Performance Assumptions

Allston Science and Engineering Complex

Plant Performance Assumptions

10 March 2016

	ASHRAE Baseline		Proposed Design	
Heating CO_2 (MTCDE/MMBTU)	FY2014, Nat Gas	0.0532	FY2016, ESF steam	0.0613
Electric CO_2 (MTCDE/kWh)	Mass Grid 2006	0.00041	FY2016, ESF electricity	0.000316
Cooling CO_2 (MTCDE/Ton-hr)	Not applicable		FY2016, ESF CHW	0.00020856
Heating ($/MMBTU)	FY2016, Blackstone Steam*	37.77	FY2016, Blackstone Steam*	37.77
Electric ($/kWh)	FY2016, Blackstone Elec*	0.162	FY2016, Blackstone Elec*	0.162
Heating efficiency	80% per ASHRAE 90.1-2010 App G (design)		FY2016, new ESF	78% (annual avg)
Cooling efficiency	6.1 COP per ASHRAE 90.1-2010 App G (design)		FY2016, new ESF	5.33 COP (annual avg)

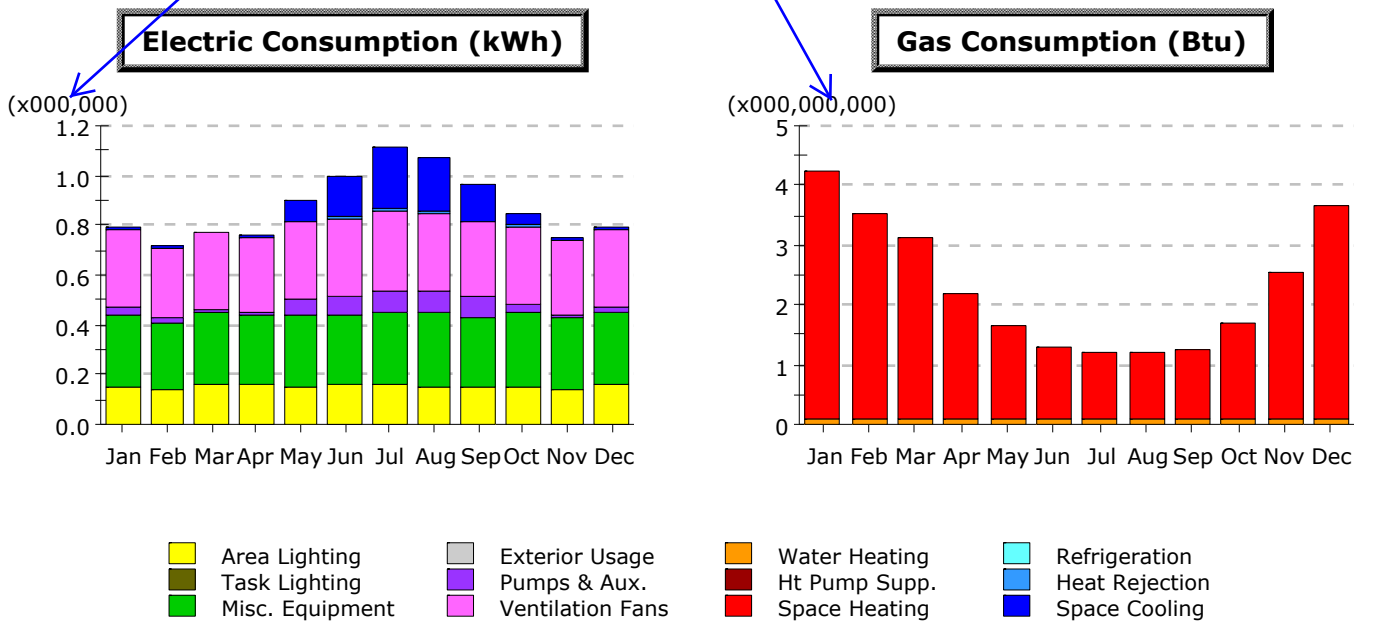
* Ideally, we would use natural gas and electric utility rates for the new ESF central plant, per the District Energy System Modeling Guidelines to apply rates according to the actual energy sources used in the upstream DES.

newyork@transsolar.com
220 East 23rd Street Suite 403
New York, NY 10012 USA
t +1 212 219 2255
LL EO

APPENDIX E

4. Base Case Modeling Monthly Output and BEPS Report

Note: units could not be adjusted in eQuest to match units shown in Proposed Monthly results



Electric Consumption (kWh x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.01	0.01	0.00	0.01	0.09	0.17	0.24	0.21	0.14	0.05	0.01	0.01	0.94
Heat Reject.	0.00	-	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.05
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.31	0.28	0.31	0.30	0.31	0.31	0.32	0.32	0.30	0.31	0.30	0.31	3.69
Pumps & Aux.	0.03	0.02	0.01	0.01	0.06	0.08	0.09	0.09	0.08	0.04	0.01	0.02	0.54
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.29	0.26	0.29	0.28	0.29	0.28	0.29	0.29	0.28	0.29	0.28	0.29	3.41
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.15	0.14	0.16	0.16	0.15	0.16	0.16	0.16	0.15	0.16	0.14	0.16	1.85
Total	0.80	0.71	0.78	0.76	0.90	1.00	1.11	1.07	0.96	0.85	0.75	0.79	10.47

Gas Consumption (Btu x000,000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	4.16	3.42	3.03	2.06	1.55	1.20	1.12	1.13	1.18	1.60	2.46	3.55	26.47
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.10	0.09	0.11	0.10	0.09	0.09	0.09	0.08	0.08	0.09	0.08	0.10	1.11
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4.26	3.52	3.14	2.17	1.64	1.29	1.21	1.22	1.26	1.68	2.54	3.65	27.58

Base Case

REPORT- BEPS Building Energy Performance WEATHER FILE- Boston MA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	6299.1	0.0	11644.2	0.0	3219.0	157.5	1834.2	12594.5	0.0	0.0	0.0	0.0	35748.6
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	26465.3	0.0	0.0	0.0	0.0	0.0	0.0	1109.9	0.0	27575.2
MBTU	6299.1	0.0	11644.2	26465.3	3219.0	157.5	1834.2	12594.5	0.0	0.0	1109.9	0.0	63323.8

TOTAL SITE ENERGY 63323.76 MBTU 142.6 KBTU/SQFT-YR GROSS-AREA 142.6 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 134821.11 MBTU 303.6 KBTU/SQFT-YR GROSS-AREA 303.6 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.12
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 273

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

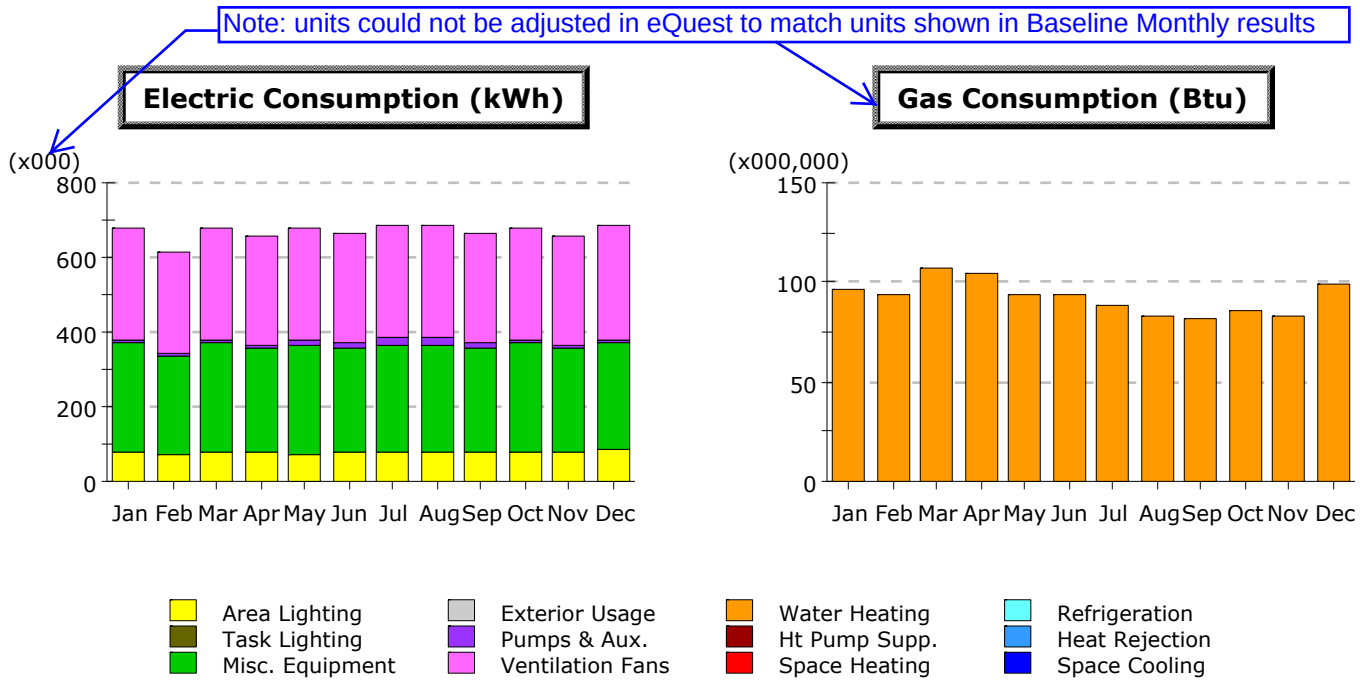
APPENDIX E

5. Proposed Case Modeling Monthly Output and BEPS Report

Proposed Design Case (6 ACH)

Project/Run: Harvard_SD - 3 Run Date/Time: 01/11/16 @ 09:45

Note: units could not be adjusted in eQuest to match units shown in Baseline Monthly results



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	303.0	273.6	302.4	292.5	303.0	293.2	303.6	303.4	292.9	302.6	293.1	302.6	3,566.0
Pumps & Aux.	5.4	4.9	5.5	5.7	9.9	13.2	16.8	15.5	12.5	8.0	5.8	5.5	108.6
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	292.1	262.2	288.3	277.9	292.1	277.9	288.7	290.1	279.8	290.5	283.4	288.5	3,411.8
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	79.8	73.1	81.9	79.8	73.9	77.3	78.5	76.8	77.5	79.8	76.1	86.3	940.8
Total	680.4	613.7	678.3	655.9	678.9	661.7	687.6	685.8	662.6	680.9	658.4	683.0	8,027.2

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	96.9	93.3	106.9	104.6	93.3	93.1	89.0	83.1	82.0	85.3	83.2	98.6	1,109.3
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	96.9	93.3	106.9	104.6	93.3	93.1	89.0	83.1	82.0	85.3	83.2	98.6	1,109.3

Proposed Case

REPORT- BEPS Building Energy Performance WEATHER FILE- Boston MA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	3211.0	0.0	11644.2	0.0	0.0	0.0	370.7	12170.5	0.0	0.0	0.0	0.0	27396.5
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1109.3	0.0	1109.3
Stea STEAM													
MBTU	0.0	0.0	0.0	11824.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11824.8
Chil CHILLED-WATER													
MBTU	0.0	0.0	0.0	0.0	19130.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19130.7
MBTU	3211.0	0.0	11644.2	11824.8	19130.7	0.0	370.7	12170.5	0.0	0.0	1109.3	0.0	59461.3

TOTAL SITE ENERGY 59461.25 MBTU 133.9 KBTU/SQFT-YR GROSS-AREA 133.9 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 115760.52 MBTU 260.7 KBTU/SQFT-YR GROSS-AREA 260.7 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 2.85
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 106
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 144

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

APPENDIX E

6. Rooftop Solar Analysis

Preliminary PV Potential - Harverd SEC

Problem:

Estimate annual output of potential PV array for Washington Village

Given:

Total roof area	64,500	sf
CO_2 coversion [1]	730	lbs/MWh

Air Emissions Report, Table1.1, 2013 value

Assumptions:

Available roof area[1]	50%	32,250	sf
panel area[2]	60%	19,350	sf
W/sf	12		
Arrangement			
tilt	20	deg	
azimouth	180	deg true	

[1] available area allows for skylights and HVAC equipment, breaking up the

[2] panel area allows for set-backs from roof edge, and maintenance and row

Calculation:

Array size	232	kW peak DC	
Annual generation	306.5	MWh	(see PVWatts output)

Annual GHG reduction **111.9** **tons**

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at http://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

306,472 kWh per Year *

System output may range from 294,152 to 317,628kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Energy Value ($)
January	2.71	17,064	2,544
February	3.67	20,773	3,097
March	4.49	27,383	4,083
April	5.01	29,012	4,326
May	5.75	32,956	4,914
June	6.03	32,389	4,829
July	6.13	33,814	5,042
August	5.83	32,302	4,816
September	4.93	26,938	4,016
October	4.09	23,883	3,561
November	2.61	15,403	2,297
December	2.35	14,555	2,170
Annual	**4.47**	**306,472**	**$ 45,695**

Location and Station Identification

Requested Location	allston, ma
Weather Data Source	(TMY2) BOSTON, MA 6.0 mi
Latitude	42.37° N
Longitude	71.03° W

PV System Specifications *(Residential)*

DC System Size	232 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

Initial Economic Comparison

Average Cost of Electricity Purchased from Utility	0.15 $/kWh
Initial Cost	3.30 $/Wdc
Cost of Electricity Generated by System	0.20 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.