CHAPTER 4

AIR QUALITY/GREENHOUSE GAS EMISSIONS

AIR QUALITY ANALYSIS

Introduction

A mesoscale air quality analysis was performed for the Quincy Center Redevelopment Project ("the Project") consistent with MassDEP modeling guidance and using the EPA MOBILE6.2 Mobile Source Emission Factor Model. Mesoscale emissions of volatile organic compounds (VOC) and oxides of nitrogen (NO_x) were calculated for four scenarios: 2012 Existing, 2022 No-Build, 2022 Build, and 2022 Build with Mitigation.

The purpose of controlling VOC and NO_x emissions is to reduce the concentration of ground-level ozone. VOC react with NO_x in the presence of sunlight to create ground-level photochemical oxidants (ozone). Motor vehicles are the predominant source of VOC and NO_x in Massachusetts. The Commonwealth of Massachusetts was classified by the US EPA as a "serious" ozone non-attainment area with regard to the old one-hour ozone standard. Massachusetts was required by the 1990 Clean Air Act Amendments to reduce VOC emissions until attainment of the one-hour Massachusetts and National Ambient Air Quality Standard (NAAQS) for ozone is reached. The Commonwealth developed a State Implementation Plan (SIP) for ozone that showed how these reductions would be achieved. Air monitoring showed that compliance with the one-hour ozone standard has been achieved in most of eastern Massachusetts.

In 1997, the U.S. EPA established a new eight-hour NAAQS for ozone. In April of 2004, the U.S. EPA designated eastern Massachusetts as a moderate nonattainment area with respect to the new eight-hour ozone NAAQS. The U.S. EPA revoked the one-hour ozone standard nationwide in 2005, as part of the implementation of the eight-hour ozone NAAQS. The Commonwealth submitted the required final ozone SIP to the U.S. EPA on January 31, 2008, demonstrating compliance with the 8-hour ozone NAAQS. On March 12, 2008, the U.S. EPA revised the 8-hour ozone standard by reducing it from 0.08 parts of ozone per million parts of air (ppm) to 0.075 ppm. In early 2011, EPA reconsidered the level of the 2008 ozone standard, but in September 2011 EPA decided to not change the 2008 standard. The U.S. EPA will issue final attainment status designations regarding the new standard sometime in the near future. The Commonwealth will then have three years to submit another SIP to demonstrate compliance with the new ozone standard.

Ozone concentrations in the study area are made up of three parts: 1) natural ozone; 2) locally generated ozone; and 3) ozone transported from upwind urban areas. Emissions of VOC and NO_x in the study area have almost no effect on local ozone levels due to their relatively small size and the fact that photochemical reaction times are not rapid enough to form ozone until a parcel of air has been transported a long distance downwind. VOC and NO_x emissions from the urban areas south and west of Massachusetts are the primary determinants of ozone levels in the study area. The VOC and NO_x emissions from the study area are insignificant when compared to emissions from the entire region and urban areas upwind (such as Hartford, and New York City). Effective ozone control measures are national programs such as those setting motor vehicle emission standards and controls on large fuel-burning sources (electric utility plants and industrial boilers).

Mesoscale Study Area

The mesoscale study area used in the EENF air quality analysis has been expanded (Links 18, 19, and 20) to include Burgin Parkway from Hannon Parkway south to Centre Street, consistent with MEPA's request that the traffic study area be expanded to include intersections along this stretch of Burgin parkway:

- Link 1 – Burgin Parkway north of Hannon Parkway
- Link 1a – Burgin Parkway north of Hannon Parkway (2022 Build condition only)
- Link 1b – Burgin Parkway north of Burgin Parkway Access Bridge (2022 Build condition only)
- Link 2 – Hannon Parkway east of Burgin Parkway
- Link 3 – Hannon Parkway east of Parking Way
- Link 4 – Hannon Parkway east of Ross Way
- Link 5 – Hancock Street north of Hannon Parkway
- Link 6 – Hancock Street north of Cliveden Street
- Link 7 – Hancock Street north of Cottage Avenue
- Link 8 – Hancock Street east of Granite Street
- Link 9 – Granite Street east of Ross Way
- Link 10 – Granite Street east of Burgin Parkway
- Link 11 – Parking Way north of Hannon Parkway

- Link 13 – Ross Way north of Cliveden Street
- Link 14 – Ross Way north of Hannon Parkway
- Link 15 – Cliveden Street east of Ross Way
- Link 16 – Burgin Parkway Access Bridge east of Burgin Parkway

- Link 18 – Burgin Parkway north of Quincy Street
- Link 19 – Burgin Parkway north of Penn Street
- Link 20 – Burgin Parkway north of Centre Street

Consistent with the mesoscale analysis done for the EENF, a travel speed of 40 mph was assumed for Burgin Parkway; a travel speed of 30 mph was assumed for Hancock Street, the Hannon Parkway, and Granite Street, and a speed of 25 mph was assigned to all other roadways.

Mesoscale Analysis Methodology

The mesoscale analysis calculated emissions of VOC and NO_x over the study area for four scenarios:

- 2012 Existing
- 2022 No-Build
- 2022 Build
- 2022 Build-With-Mitigation.

The Build scenario calculations were made for the Preferred Building Program. Results for the Alternative Building Program were estimated by scaling the Preferred Building Program results with traffic volume ratios.

The vehicle miles traveled (VMT) for each roadway segment was calculated by multiplying the length of each road segment by the average daily traffic volume on the segment. The VOC and NO_x emissions for each roadway segment were calculated by multiplying the VMT (miles per day) by the MOBILE6.2 predicted VOC and NO_x emission factors in grams per mile. The MOBILE6.2 model output and emission factors are provided in the EENF. Calculations details for the mesoscale air quality analysis are presented in Appendix C.

Predicted Project Impacts

A summary of the results of the mesoscale analysis is presented in Table 4.1. The 2012 Existing VOC mesoscale emissions listed in Table 4.1 are 16.84 kg/day. The mesoscale emissions of VOC for the 2022 No-Build case are predicted to be 10.55 kg/day. This is a 37.4% decrease from the existing mesoscale VOC emissions. For the Preferred Building Program, the mesoscale emissions of VOC for the 2022 Build case are predicted to be 12.12 kg/day. This is a 28.0% decrease from the existing mesoscale VOC emissions. For the Alternative Building Program, the mesoscale emissions of VOC for the 2022 Build case are predicted to be 12.25 kg/day. This is a 27.3% decrease from the existing mesoscale VOC emissions.

The 2012 Existing NO_x mesoscale emissions presented in Table 4.1 are 36.90 kg/day. The mesoscale emissions of NO_x for the 2022 No-Build case are predicted to be 12.18 kg/day. This is a 67.0% decrease from the existing mesoscale NO_x emissions. For the Preferred Building Program, the mesoscale emissions of NO_x for the 2022 Build case are predicted to be 13.99 kg/day. This is a 62.1% decrease from the existing mesoscale NO_x emissions. For the Alternative Building Program, the mesoscale emissions of NO_x for the 2022 Build case are predicted to be 14.15 kg/day. This is a 61.7% decrease from the existing mesoscale NO_x emissions.

The Preferred Building Program has lower VOC and NOx emissions for the 2022Build case than the Alternative Building Program (see Table 4.1).

The MOBILE6.2 model predicts motor vehicle VOC and NO_x emissions to decrease significantly between 2012 and 2022, as new, lower polluting vehicles replace older vehicles on the roadways. The MOBILE6.2 model predicts further declines in VOC and NO_x motor vehicle emission rates between now and 2022 as a result of national motor vehicle emission control programs; these are the most effective mitigation measures for ozone, a regional air pollutant. While each individual project needs to pursue all reasonable mitigation measures for motor vehicle emissions, the net effect of a single project is very small in the context of regional emissions.

Mitigation

The mesoscale analysis results show that the VOC emissions for the 2022 Build case (Preferred Building Program) are predicted to be 12.12 kg/day (14.9%) higher than those for the 2022 No-Build case. Compared to countywide VOC emissions of approximately 62,496 kg/summer day, this represents an increase of approximately 0.003%. NO_x emissions for the 2022 Build case are predicted to be 13.99 kg/day (14.9%) higher than those for the 2022 No-Build case (Preferred Building Program). Compared to countywide NO_x emissions of approximately 70,171 kg/summer day, this represents an increase of approximately 0.003%.

The goal of the mesoscale analysis is to identify all practical and feasible mitigation measures that will help minimize the traffic-related air quality impacts of the proposed project. The Project is within walking distance of Quincy Center Station that provides commuter rail, subway, and bus service. The proponent is committed to a number of Transportation Demand Management (TDM) strategies to reduce employee and customer vehicle trips. The TDM measures are designed to help reduce peak hour and daily vehicle trips through the temporal spreading of the peak hour demand, increased vehicle occupancy rates, and shifting the mode of transportation from single occupancy vehicles to transit. These TDM measures are expected to reduce transportation emissions related to the aggregate of employee, customer, and project-resident trips by 6%. The emissions listed in Table 4.1 for the 2022 Build with Mitigation case assume a 6% reduction. The TDM measures are summarized below and described in detail in Chapter 3:

- *Locate New Buildings Near Transit* – The project is located within walking distance of Quincy Center Station that provides commuter rail, subway, and bus service.

- *Develop Multi-Use Paths To and Through Site* – The project will provide sidewalks, marked crosswalks, pedestrian traffic signals, lighting, and landscaping, to encourage pedestrian travel to and from the site.

- *Size Parking Capacity to Meet, Not Exceed, Local Parking Requirements* – The project's parking capacity is sized to be the minimum amount to meet shared parking requirements for an urban, mixed-use redevelopment project.

- *Provide On-Site Food Service* – The project will provide a wide variety of restaurant and food service options for employees and customers.

- *Provide Bicycle Storage* – The project will provide secure bicycle storage racks throughout the project site.

- *Transportation Coordinator (TC)* – A TC will be provided to manage the TDM program and reach out to residents, business owners, and employees. The TC will provide transit, subway, and bus schedules, and will assist employees and residents in finding carpool/vanpool matches.

- *Roadway and Signalization Improvements to Improve Traffic Flow* – The proponent has proposed roadway and traffic signal improvements. See Chapter 3 for details.

- *Preferential Parking* – The project will provide preferential parking spaces for vanpools and carpools.

- *Tenant Manual* – Through a Tenant Manual, the proponent will encourage tenants to offer their employees these benefits which qualify as TDMs: transit subsidies for commuting or a commuter tax benefit program; flexible work schedules; direct deposit of paychecks; shower facilities for employees to encourage biking to/from work; and a guaranteed ride home for employees who carpool or use transit.

- *No-Idling Truck Zones* – Signs will be posted to require no-idling for trucks parked for more than five minutes.

Compliance with MassDEP Regulations

Any single tenant of the Project that employs more than 250 applicable commuting employees will be subject to MassDEP's Ridesharing Regulation (310 CMR 7.16). The project will comply with the requirements of the MassDEP Idling Regulation (310 CMR 7.11); signs will be posted to in loading docks that no idling is allowed for trucks parked for more than five minutes.

It is not expected that any of the fuel-burning equipment for the Project will require pre-construction air plans approval by MassDEP. Where required, self-certification under the Environmental Results Program (ERP) regulations will be provided to MassDEP, or pre-installation plan approval application will be filed under 310 CMR 7.02.

All demolition and construction activity will comply with the requirements of MassDEP air quality regulations (310 CMR 7.01, 7.09, and 7.10). Construction and demolition will also comply with the MassDEP solid waste ban regulations (310 CMR 19.017). The reduction in the sulfur content of diesel fuel for off-road construction equipment from 500 ppm down to only 15 ppm (ULSD fuel), effective in 2010, has significantly reduced diesel particulate matter emissions, to the point that such emissions are rarely a concern. In selecting contractors for construction, the proponent will give preference to firms that use recently-built equipment with applicable EPA emission limits or that have installed diesel retrofits.

Conclusion

A mesoscale air quality analysis was performed consistent with MassDEP modeling guidance and using the EPA MOBILE6.2 Mobile Source Emission Factor Model. Mesoscale emissions of volatile organic compounds (VOC) and oxides of nitrogen (NO_x) were calculated for four scenarios: 2012 Existing, 2022 No-Build, 2022 Build, and 2022 Build with Mitigation. The mesoscale analysis predicts that the emissions of VOC and NO_x in the project study area for the 2022 Build case will be larger than the emissions for the 2022 No-Build case. Therefore, the Project will mitigate the project's potential air quality impacts by committing to a number of transportation demand management (TDM) strategies and roadway/traffic signal improvements for the project. The TDM measures will improve traffic operations, reduce project generated vehicle trips, and reduce project-related motor vehicle air pollutant emissions.

For the Preferred Building Program, these mitigation measures will reduce 2022 Build VOC emissions by 0.10 kg/day and will reduce 2022 Build NO_x emissions by 0.11 kg/day, both a decrease of 6% in transportation emissions compared to the 2022 Build case. The proposed TDM measures and roadway/traffic signal improvements constitute all reasonable and feasible traffic mitigation measures for a project that is served by public transportation.

For the Alternative Building Program, these mitigation measures will reduce 2022 Build VOC emissions by 0.10 kg/day and will reduce 2022 Build NO_x emissions by 0.12 kg/day, both a decrease of 6% in transportation emissions compared to the 2022 Build case. The proposed TDM measures and roadway/traffic signal improvements constitute all reasonable and feasible traffic mitigation measures for a project that is served by public transportation.

The Preferred Building Program has lower VOC and NOx emissions for the 2022Build case than the Alternative Building Program.

The Commonwealth's State Implementation Plan (SIP) for achieving compliance with the ozone standard includes allowances for increases in VOC and NO_x emissions due to general background growth. The VOC and NO_x emissions related to the Project would be included as part of the Commonwealth's background growth. The mesoscale air quality analysis demonstrates that the project will not have an adverse impact on regional air quality and will be compatible with the Commonwealth's SIP, which will demonstrate how the Commonwealth will achieve attainment of the eight-hour National Ambient Air Quality Standard for ozone.

Table 4.1 Mesoscale Air Quality Emissions Summary				
Study Scenario	VOC (kg/day)	VOC (tons/year)	NOx (kg/day)	NOx (tons/year)
2012 Existing	16.84	6.77	36.90	14.83
2022 No-Build	10.55	4.24	12.18	4.89
2022 Build for the Preferred Building Program	12.12	4.87	13.99	5.62
2022 Build With Mitigation for the Preferred Building Program	12.02	4.83	13.88	5.58
2022 Build for the Alternative Building Program	12.25	4.93	14.15	5.69
2022 Build With Mitigation for the Alternative Building Program	12.15	4.88	14.03	5.64

GREENHOUSE GAS (GHG) ANALYSIS

Introduction

A greenhouse gas (GHG) emissions analysis was performed for the Project consistent with the EEA "Greenhouse Gas Emissions Policy and Protocol" (May 5, 2010) and using the eQUEST energy design software. The Project will build approximately 3.7 million square feet of new, mixed-use space in Quincy Center, of which approximately 3.1 million square feet will be net new space. The Project will replace a significant mass of energy-inefficient commercial buildings in Quincy Center with new structures that embody the low-energy use design inherent to the Massachusetts Stretch Energy Code. This replacement will substantially increase energy efficiency and improve building occupant safety. The Project will adhere to and be consistent with all ten of the Commonwealth's Sustainable Development Principles. The MEPA Scope for this DEIR requires the project to quantify carbon dioxide (CO_2) emissions for two 2022 Full Build scenarios: (1) the Base Case corresponding to the 8th Edition of the Massachusetts Building Code including the 2009 IECC (the "Code"), and (2) the Preferred Alternative, which includes all energy mitigation measures.

The Preferred Alternative energy and emissions calculations were made for the Preferred Building Program. Results for the Alternative Building Program were estimated by scaling the Preferred Building Program results for a different mix of uses.

The Policy requires a project to quantify carbon dioxide (CO_2) emissions and identify measures to avoid, minimize or mitigate such emissions, quantifying the effect of proposed mitigation in terms of emissions reduction and energy savings. The GHG Emissions Policy and Protocol requires quantification of GHG emissions from three sources: direct emissions from on-site stationary sources, indirect emissions from energy generated off-site (electricity), and traffic generated by the project. The project's GHG emissions will include: 1) direct emissions of CO_2 from natural gas combustion for space heating, generating hot water, and cooking of food for sale; 2) indirect emissions of CO_2 from electricity generated off-site and used on-site for lighting, building cooling and ventilation, and refrigeration equipment; and 3) transportation emissions of CO_2 from project traffic.

The project is also subject to the requirements of the Massachusetts Stretch Energy Code ("Stretch Code"), 780 CMR 101-507. Per the EEA "Greenhouse Gas Emissions Policy and Protocol," the Base Case assumes construction compliant with the Code, not the Stretch Code. There is a complex interplay between the requirements of the Code and Stretch Code in this project because: 1) some space will be built with full HVAC systems and lighting by the proponent while other space will be core and shell space in which individual tenants will do the fit-out of mechanical systems and lighting; and 2) the Stretch Code has different requirements for commercial space depending on whether a building has more than 100,000 square feet or not. For the purposes of this GHG analysis and for simplicity, the Preferred Alternative assumes systems built out by the proponent will, at a minimum, satisfy the requirements of the prescriptive option in the Stretch Code (Section 501.1.4) as that set of requirements approximates the energy reduction required for buildings of all sizes. The proponent will assist future building tenants in selecting energy reduction measures as part of their construction and interior fit-out, to ensure all such tenant work fully complies with the Stretch Code.

GHG Analysis Methodology

This analysis of building energy was done with the eQUEST energy design software (version 3.63b, July 2009), which incorporates the U.S. Department of Energy's DOE-2 building energy use model. The calculation of direct and indirect stationary source CO_2 emissions assumed emission rates of 120.6 lb/10^3 cubic feet of natural gas[1] and 828 lb/MWhr.[2] CO_2 emissions produced by project motor vehicle trips were analyzed using the U.S. EPA MOBILE6 emissions factor of 550.4 grams/mile.[3] The eQUEST model assumptions are summarized in Table 4.2 and eQUEST model input files are available to DEP and DOER upon request. Appendix C provides the transportation CO_2 calculations, eQUEST model output, supplemental energy calculations for external electrical loads (refrigeration equipment and outdoor lighting), and a cost analysis for a PV system.

The transportation portion of the GHG analysis calculated emissions of CO_2 for the air quality study area for three scenarios:

- 2022 No-Build
- 2022 Build
- 2022 Build with Mitigation.

The vehicle miles traveled (VMT) for each of the eight roadway segments in the traffic study area was calculated by multiplying the length of each road segment by the average daily traffic (ADT) volume on the segment. The CO_2 emissions for each roadway segment were calculated by multiplying the daily VMT by the MOBILE6.2 predicted CO_2 emission factor of 550.4 grams per mile, approved by MEPA. Transportation CO_2 emissions are summarized in Table 4.3. Appendix C presents the transportation CO_2 emission calculations.

Mitigation measures considered in the GHG analysis are summarized in Tables 4.4 through 4.6 and are discussed in the sections below. Summaries of the eQUEST energy use projections and associated CO_2 emissions for each building in the project, as well as the parking structures and lots, are provided in Tables 4.7 through 4.22. An overall summary of results is presented in Table 4.23 for the Preferred Building Program and in Table 4.24 for the Alternative Building Program.

Figure 4.1 provides a visual depiction of energy use seasonal profiles for the Preferred Building Program and reveals how electricity use peaks in the summer months while use of natural gas peaks in the winter months. The very low thermal load for the project from May through

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[1] U.S. Department of Energy, Energy Information Administration.
[2] ISO New England Inc., 2009 New England Electric Generator Air Emissions Report, Annual Average Emission Rate, Table 5-4, March 2011.
[3] MEPA, "Greenhouse Gas Emissions Policy and Protocol," May 5, 2010, page 9.

October is seen in the graph as the horizontal solid blue line for those six months, which primarily represents gas use for domestic hot water production. This illustrates the fact that the project's constant thermal loads are insufficient to make Combined Heat and Power (CHP) technologies economically feasible. CHP is analyzed in more detail in the next section. The energy efficiencies provided by the Preferred Alternative as compared to the Base Case are easily seen in Figure 4.1 as the gaps between the dashed (Base Case) and solid (Preferred Alternative) lines.

Site Design Mitigation Measures

All reasonable and feasible site design mitigation measure will be adopted by the Project, see Table 4.4. The Project Proponent is committing to the following site design mitigation measures:

- *Sustainable Development Principles* – The Project will preserve open space by redeveloping an existing urban area with a high-density, transit-oriented project that will achieve LEED-ND Silver.
- *Minimize Building Footprints* –The redevelopment project has been designed with taller buildings to allow for well-designed public spaces and parks with landscaping and trees.
- *Minimize Energy Use Through Building Orientation* – The 13 buildings that will comprise the project will each have a façade facing south.
- *Provide Pedestrian Connections to Other Commercial Establishments* – Well-designed sidewalks and public squares will connect the Project to the surrounding Quincy Center urban area and nearby commercial establishments.
- *Design Water Efficient Landscaping* –Water efficient landscaping will be installed to minimize water use. Drought-resistant and native plants will be used in conjunction with Smart Irrigation technology.

Best Management Practices (BMP) for Stormwater Design – The project's stormwater management system will utilize BMPs to collect and treat runoff from impervious surfaces, and will comply with DEP's Stormwater Management Policy and the City's NPDES General permit. Low impact development (LID) techniques will also be employed throughout the site where conditions allow.

Building Design and Operation Mitigation Measures

Consistent with sustainable development principles, the Project will provide significant energy efficiencies in its design. The Project will achieve LEED-ND Silver and all buildings will be LEED-certifiable. All reasonable and feasible building design and operational mitigation measures will be adopted by the proponent, see Table 4.5. The following mitigation measures will be included in the project design and are assumed for the CO_2 emission calculations in Tables 4.7 through 4.24. Building design mitigation measures that were quantified through eQUEST modeling are listed in Table 4.2. Percentage reductions for individual energy efficiency measures listed in Tables 4.7 through 4.20 do not simply sum to the net reduction because when several measures are combined, the reduction of the second measure is applied to a lower base level that includes the reducing effects of the first measure, and so forth.

- *Cool Roofs / Green Roof* – A reflective cool roof will be installed on all buildings. A 40,000 square foot green roof will be installed on Building 5B, the parking structure in Block 5.

- *Centralized Chiller for Large Office Buildings* – Blocks 10 and 11 will have a central chilled water plant with a Coefficient of performance (COP) 15% better than Code.

- *High-Efficiency HVAC Systems* – Energy-STAR rated HVAC units will be used, and Energy Efficiency Ratios (EER) will be 10% above Code. Buildings 10C and 11A HVAC units have Demand Control Ventilation (DCV) controls. High-rise residential and office buildings 3A, 5A/C, 6B/C, 10C, and 11A will have Energy Recovery Ventilation (ERV).

- *High Efficiency Heating* – Heating systems will have efficiency 10% above Code.

- *Seal, Test and Insulate HVAC Supply Ducts* –HVAC supply ducts will be sealed, leak tested, and insulated to reduce energy losses.

- *Energy Management Systems* – The project will employ energy management systems (EMS) to monitor and control the heating, air conditioning, refrigeration and lighting systems for all buildings. Base Case temperatures for occupied and unoccupied times are different and temperature setbacks are show in Table 4.2.

- *Energy Efficient Windows and Building Envelope* – Building envelope insulation will exceed Code for the roof, walls, slab, and fenestration. Roof insulation will be R-25. Wall insulation will be 10% higher than Code. Slab insulation will be R-15 with 2-foot depth. Window type and design will carefully balance Solar Heat Gain Coefficient (SHGC) with Visible Transmittance (VT) to reduce solar gain while admitting natural light. Windows will be double-pane, low-e glass with a U value no higher than 0.29. Window area and design will allow deep penetration of natural light into buildings. Tenants will be encouraged to install daylighting controls.

- *Occupancy Sensors for Lighting* –Occupancy sensors will be used for all spaces not regularly occupied.

- *Energy Efficient Interior Lighting* – Interior light power Density (LPD) will be at least 10% below Code for the retail and office space, and public areas of all buildings. Through a Tenant Manual, tenants will be encouraged to design for LPD 10% below Code.

- *Use Energy STAR Equipment* – Energy STAR appliances for residential units, associated laundry rooms, and kitchens in offices will be used to reduce plug load. Tenants will be encouraged to use Energy STAR rated computers and other equipment.

- *LED Lighting for Parking* - Exterior LPD will be at least 60% below Code through the use of LED lighting for all structured and surface lot parking covering over 1.8 million square feet.

- *High-Efficiency Refrigeration System* – The food markets in Buildings 7A and 8A will have a refrigeration system design that achieves an overall 25% energy savings. While grocery tenants have not yet been identified, most modern supermarkets use some or all of the following design features: 1) High-efficiency compressor rack and condenser fans; 2) Vertical doors used on all refrigerated and freezer food cases; 3) All case doors use LED lights and occupancy sensors; Occupancy sensors turn off lights when aisles are empty; 4) Anti-sweat heater controls. For the 14,060 square foot grocery store in Building 7A, a high efficiency design will lower electrical usage from 965 MWH/yr to 724 MWH/yr. For the 40,155 square foot supermarket in Building 8A, a high efficiency design will lower electrical usage from 1,730 MWH/yr to 1,298 MWH/yr.

- *Electric Sub-Metering* – Sub-metering will be installed for each major tenant.

- *Use Water Conserving Fixtures* – Restrooms will use low-flow faucets in wash sinks activated by motion sensors. Toilets and urinals will be low-flow design (1.3 gpf and 1 pint per flush, respectively), both less than Code.

- *Building Commissioning* – Each building's mechanical systems will undergo commissioning in accordance with the Massachusetts Stretch Code Section 503.2.9.

- *Provide for Storage and Collection of Recyclables in Building Design* – The project will provide adequate space for tenants to recycle materials.

- *Use Building Materials with Recycled Content and Use Low-VOC Content* – Whenever possible, the project will use environmentally friendly building materials, including materials with recycled content, and low-VOC content.

- *Operations Waste Management Program* – Through a Tenant Manual, the proponent will encourage tenants to recycle materials such as bottles, cans, office paper, cardboard, and pallets, and to properly dispose of any hazardous materials such as fluorescent bulbs.

Other building design and operation mitigation measures were considered for the project, and are either still undergoing study or were rejected because they are either technically/financially infeasible or inappropriate for the project:

- *Ground Source Heat Pumps* – Ground source heat pumps are a possibility for the high-rise residential buildings and will be studied further. Due to the amount of utility infrastructure buried beneath the project site, it may not be practical to excavate the large and deep area needed for a ground source heat pump system.

- *Reduce Energy Demand by Using Peak Shaving or Load Shifting Strategies* – These measures are not appropriate for office, retail, supermarket and other tenant spaces that must use power during peak periods.

- *Incorporate Combined Heat and Power (CHP) Technologies into Project* – CHP requires a host for the constant and substantial steam load (waste heat) generated as part of the process. For this reason, CHP is typically found: (1) in heavy manufacturing plants that require substantial process heat; (2) in larger hotels where there is a demand for heat in laundry, domestic hot water for guest rooms and kitchens, and space heating; and (3) in colleges and universities. The energy projected to be used by the project is primarily electricity, used for lighting, ventilation, air conditioning, and appliances. The most likely candidate for CHP in the first phase (Step 1) of the Project is the large office tower Building 11A having a conditioned floor area of 541,221 sf. A detailed cogeneration analysis is presented below assuming 800 kW of microturbines with heat recovery to provide heat and hot water needs for the office building. The next most likely application for CHP would be in the hotel planned in Building 6A as part of the second phase (Step 2) of the project. The proponent will discuss the possibility of CHP with potential hotel tenants at Step 2 in the project.

  A CHP strategy involving more than one building, or buildings built in different phases, is not financially feasible. Given the nature of the project with multiple tenants and different co-developers, the proponent will have no financial guarantees from potential customers at the point in time when capital would be needed for the construction of such a multi-building CHP, and banks would not offer financing without iron-clad guarantees.

  For the feasibility analysis of CHP in Building 11A, the peak and monthly average electrical loads of the office building were calculated by eQUEST as 1,950 kW and 389 kW, respectively. (Both figures assume all energy mitigation measures). To achieve optimal design in terms of electrical and heating loads, an 800-kW cogeneration plant was analyzed that at minimum 40% load provides 320 kW, close to the monthly average electric load. Annual electric use for space cooling is projected by eQUEST to be only 10% of total electric consumption and thus absorption cooling is not economical for this installation because absorption chillers have a capital cost double of that for electric chillers and the office building's cooling load is relatively low due to the excellent insulation in the building envelope.

  The CHP feasibility analysis considered the annual income from Alternative Energy Certificates (AECs) under the State's Alternative Energy Portfolio Standard (APS), as calculated using DOER's APS calculator. Due to the very low heat demand of the building, the energy recovery from the cogeneration system's waste heat is too low for the project to qualify for AECs.

  The local utility National Grid's energy efficiency programs for business provide financial incentives for high-efficiency equipment (e.g., HVAC units, motors) and lighting, but do not subsidize the purchase of a cogeneration plant.[4] The cost of the microturbine installation was calculated as $1,100/kW for equipment, $350/kW for heat recovery, and $798/kW for engineering and installation, yielding a total installed cost of $2,248/kW.[5] With a federal tax credit of $40,000, the cogeneration plant installed cost is $1,758,400 with maintenance

[4] www.nationalgridus.com/masselectric/energyeff/4_new.asp
[5] http://www.wbdg.org/resources/microturbines.php

costing \$0.016/kW-hour. The typical useful life of a commercially available machine ranges from 40,000 to 80,000 hours, or up to 10 years with proper overhaul.[6] Since the microturbines will run near minimum capacity a lot of the time and equivalent full-load run-time will be 4,619 hours/year/turbine (3,695 MWh/year divided by the capacity of 0.8 MW), the feasibility analysis optimistically assumed a 17-year life for the cogeneration plant.

The CHP feasibility analysis was performed using the RETScreen-4 energy model from Natural Resources Canada.[7] Inputs to RETScreen-4 include: electricity and heating demands for the building, obtained from the eQUEST model simulation of the office building; and electric and gas utility rates for commercial customer in Massachusetts.[8] Compared to the rest of the country, both natural gas and electric rates in this State are high. The RETScreen-4 model output along with the DOER Alternative Energy Certificate calculation is given in Appendix C.

The results reveal that total annual cogeneration plant costs (\$813,938) exceed the total annual cost without the cogeneration plant (\$569,623). Thus, the CHP system never pays for itself and is not economically feasible in Building 11A. The primary reason for these results is the high cost of natural gas in Massachusetts, a cost that makes cogeneration very difficult to justify economically. The proponent will discuss the possibility of CHP with potential hotel tenants at Step 2 in the project.

- *On-Site Renewable Energy* – The proponent will set aside space on the roof of buildings in Blocks 4 through 11 for a possible third-party photo-voltaic (PV) installation. The PV cost feasibility analysis presented below begins with an installed cost of \$5.60[9] per rated Watt, the estimated cost of a 200-kW system installed in a single block on a commercial building roof. Due to the lack of firm valuation data for Solar Renewable Energy Certificates ("SREC"), it is not possible to distinguish between the costs for direct store ownership of the system and ownership by a third-party provider. A range of likely costs is presented below.

  The Commonwealth Solar Program ended in 2009 and has been replaced with the SREC program. The following facts were obtained from DOER:[10] (1) SRECs are market-based incentives and should sell between \$300 and \$600 per MWh, less broker fees; (2) An owner can place excess SRECs into an auction account and receive \$285 per MWh (\$300 minus 5% fee); (3) The generator will sell SRECs to a broker or have a contract with one of the retail electric suppliers and try to get the best price; (4) There is no price history as of yet so the only firm price is the default auction price of \$285; (5) Commonwealth Solar Stimulus provides grants for purchase of PV systems by small commercial users up to 200 kW; (6) The first round of funding was over-subscribed and awarded in one day; (7) There will be a

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[6] "The Market for Microturbine Electric Power Generation," August 2010, Forecast International, http://www.forecastinternational.com/samples/F647_CompleteSample.pdf
[7] http://www.retscreen.net/ang/home.php
[8] U.S. Energy Information Administration, Average Price of Electricity to Commercial Customers in Massachusetts (2010) is 14.41 cents per kWh, Average Price of Natural Gas to Commercial Customers in Massachusetts (2009) is \$1.34/therm.
[9] MA DOER, RPS Program, "RPS Solar Carve-Out, Discussion and Analysis of Program Costs," p.2. DOER reports that installed prices in the year 2010 were \$5.60/W.
[10] Personal communications, Natalie Howlett, Renewable Energy project Coordinator, Massachusetts Department of Energy Resources, February 25 and 26, 2010.

second round of CSS awards, but after that SRECs will be the primary financial incentive for PV projects. From this information, we believe it is unlikely that a future commercial PV project will receive CSS funding, and hence the analysis of PV for this project assumes federal and State tax credits along with valuation of SRECs. Since there are no firm estimates of the future value of SRECs, this analysis assumed the possible range of SREC values runs from the guaranteed floor price of $285 up to $570 per MWh (both are net of broker's fee). The SREC value will likely not remain as high as $570 for most of the program's duration[11]; thus the $285 floor price is the more realistic assumption.

For the alternative analysis, a 200 kW system was assumed; this is generally considered the minimum size for a financially feasible third-party vendor PPA.[12] In Massachusetts, a 200 kW PV system, flat-mounted, is projected to generate 206,528 kWh per year,[13] which equates to 85.5 tons per year[14] in GHG emissions reductions. A 200 kW PV system would reduce the annual Preferred Alternative CO_2 emissions (Table 4.22) by 0.7% = 100% * 85.5 / 12,768.9.

The economics of a PV installation were calculated using the DOER Commercial Solar Financial Model updated to reflect the above assumptions. Model output is provided in Appendix C. The cost calculator inputs are as follows:

- PV system size of 200 kW
- System cost of $5.60/Watt
- Annual capacity factor of 11.8% (flush mounted on roof)[15]
- SREC value of $285 (Guaranteed) to $570 (Upper End) / MWh and revenue term 10 years
- An inverter replacement frequency of once every 10 years[16]
- Customer discount rate of 8%

The default customer discount rate in the CS Financial Model is 3%, which is incorrect. The customer discount rate is defined as the interest rate of return that could be earned in an investment in the financial markets with similar risk. At present, a 20-year U.S. Treasury bond pays over 4%; that is the lowest risk investment possible and is not comparable to the risk of investing in a PV system. Corporate bond rates are 6% to 9%, depending on their investment grade. The MTC Calculator uses a customer discount rate of 8%. That rate is reasonable and is used in these PV cost calculations. The calculations assume all current financial incentives: federal tax credits, State tax deductions and SREC values.

[11] Personal communication, Michael Judge, DOER Solar Program Coordinator, May 24, 2010.
[12] Personal communication, Dave Hebert, Gloria Spire Solar, March 3, 2009.
[13] Personal communication, Natalie Howlett, Renewable Energy Project Coordinator, Massachusetts DOER, December 18, 2008. This figure is 4 times 51,632 kWh/year for a 50 kW system.
[14] Annual PV system electrical generation is 206.5 MWh. Multiplying by the ISO New England emission factor of 828 lb CO_2 per MWh and dividing by 2,000 lb/ton yields an annual CO_2 emission reduction of 85.5 tons/year.
[15] Personal communication, Natalie Howlett, Renewable Energy Project Coordinator, Massachusetts DOER, December 18, 2008.
[16] Personal communication, Dave Hebert, Gloria Spire Solar, March 3, 2009.

For the 200-kW system, the calculated Net Present Value of the PV system is -$54,467 for the Guaranteed SREC Price and $171,481 for the Upper End SREC Price. The internal rate of return is 6.3% for the Guaranteed SREC Price and 13.3% for the Upper End SREC Price. The Simple Payback Period is 8 years for the Guaranteed SREC Price and 5 years for the Upper End SREC Price.

Based on market research, almost 90 percent of strong prospects would consider a payback of four years, but acceptance begins to drop rapidly once paybacks reach five years.[17] The Simple Payback also has serious limitations as a measure of cost feasibility and is not used in making business decisions because it ignores inflation, the time value of money and investment risk. Net Present Value (NPV) is the standard financial method for using the time value of money to appraise long-term projects. Used for capital budgeting, and widely throughout economics, NPV measures the excess or shortfall of cash flows, in present value terms, once financing charges are met. If the NPV is positive, an investment may be accepted since it would add value to a project over the long-term. If the NPV is negative, as is the case assuming the Guaranteed SREC Price, the investment should be rejected. The IRR is the annualized effective compound return rate that can be earned on the invested capital, i.e. the yield on the investment. A project is a good investment if its IRR is greater than the rate of return that could be earned by alternate investments of equal risk; in this case the alternate rate of return is the 8% discount rate in the financial model.

In order to have positive financials, the project would need to obtain the upper end of possible SREC values ($570/MWh) for the life of the project, an assumption that DOER considers unlikely.[18] Given the large negative NPV and longer than acceptable payback period for the Guaranteed SREC Price, a PV system is not financially feasible for the project at this time. The proponent will set aside space on the roof of buildings in Block 4 through 11 as "solar ready" with sufficient structural support to accommodate flat-mounted PV system for a possible third-party provider PV installation in the future.

[17] *Assessment of California CHP Market and Policy Options for Increased Penetration*, Final Report, Cosponsors Public Interest Energy Research Program (PIER) and California Energy Commission, July 2005.
[18] Personal communication, Michael Judge, DOER Solar Program Coordinator, May 24, 2010.

Transportation Mitigation Measures

The Project is conveniently located within walking distance of Quincy Center Station that provides commuter rail, subway, and bus service. The Proponents are committed to a number of Transportation Demand Management (TDM) strategies to reduce employee and customer vehicle trips. The TDM measures are designed to help reduce peak hour and daily vehicle trips through the temporal spreading of the peak hour demand, increased vehicle occupancy rates, and shifting the mode of transportation from single occupancy vehicles to transit. These TDM measures are expected to reduce transportation emissions related to the aggregate of employee, customer, and project-resident trips by 6%. The CO_2 emissions listed in Table 4.3 for the 2022 Build with Mitigation case assume a 6% reduction. These TDM measures are summarized below and described in detail in Chapter 3.

- *Locate New Buildings Near Transit*– The project is located within walking distance of Quincy Center Station that provides commuter rail, subway, and bus service.

- *Develop Multi-Use Paths To and Through Site* – The project will provide sidewalks, marked crosswalks, pedestrian traffic signals, lighting, and landscaping, to encourage pedestrian travel to and from the site.

- *Size Parking Capacity to Meet, Not Exceed, Local Parking Requirements* – The project's parking capacity is sized to be the minimum amount to meet typical parking requirements for an urban, mixed-use redevelopment project and is not excessive. The planned parking assumes shared parking savings between multiple uses.

- *Provide On-Site Food Service* – The project will provide a wide variety of restaurant and food service options for employees and customers.

- *Provide Bicycle Storage* – The project will provide secure bicycle storage racks throughout the project site.

- *Transportation Coordinator (TC)* – A TC will be provided to manage the TDM program and reach out to residents, business owners, and employees. The TC will provide transit, subway, and bus schedules, and will assist employees and residents in finding carpool/vanpool matches.

- *Roadway and Signalization Improvements to Improve Traffic Flow* – The proponent has proposed roadway and traffic signal improvements. See Chapter 3 for details.

- *Preferential Parking* – The project will provide preferential parking spaces for vanpools and carpools.

- *Tenant Manual* – Through a Tenant Manual, the Proponents shall require tenants to notify their employees of all available benefits which qualify as TDMs that are offered by the tenant, including but not limited to: transit subsidies for commuting or a commuter tax benefit program; flexible work schedules; direct deposit of paychecks; shower facilities for employees to encourage biking to/from work; and a guaranteed ride home for employees who carpool or use transit.

- *No-Idling Truck Zones* – Signs will be posted to require no-idling for trucks parked for more than five minutes.

The following additional mitigation measure was considered but found not to be appropriate for the Project:

- *Purchase Alternative Fuel and/or Fuel Efficient Vehicles for Fleet* - The Proponents will not maintain an exclusive fleet of vehicles for the Project. This measure is inapplicable to the Project.

Draft Outline for Tenant Manual and Energy Efficiency Guide

As part of the design phase of the Project, the Proponents shall implement a set of tenant guidelines in the Project Tenant Manual and accompanying Energy Efficiency Guide, which either mandate or encourage specific sustainable measures (by providing assistance and/or information for consideration), where applicable, reasonable and/or feasible for specific users. Each tenant and their design team shall be provided a copy of the Tenant Manual and Energy Efficiency Guide upon executing a lease. With respect to the various energy efficiency commitments made within the Tenant Manual, it is assumed at this preliminary stage that the Proponents will be responsible for the construction of the building core and shell, with individual tenants to be responsible for the fit-out of their individual interior spaces, with the Energy Efficiency Guide providing tenants further building information and guidance in this respect.

<u>The Tenant Manual:</u>

The Tenant Manual includes the following requirements that tenants must comply with:

- As allowed by Massachusetts Building and Electrical Code, future building tenants shall be required to fit-out electrical wiring to be compatible with a building's energy management system (EMS) and occupancy controls for lighting.

- In collaboration with tenants, the Proponents shall identify the potential need for electric plug-in stations in the garages to be constructed, and the Proponents shall allocate areas in those garages for such use.

- The Proponents shall provide for individualized tenant control and metering of electricity and natural gas, to the extent practicable and feasible, to help promote increased efficiency.

- Where HVAC units are not provided by the Proponents, the tenant shall be required to use HVAC units with EER values 10% above the Code assumed in this EIR, and any heating systems will be required to achieve an efficiency 10% above the Code used in this EIR.

- As readily available and economically viable, future tenants shall be required to use Energy-STAR rated appliances in residential units and office break-room kitchens.

- The Proponents shall provide to future tenants a list of amenities (such as ATMs, convenience retail stores, restaurants, and food retailers) within walking distance that tenants will be required to pass on to their employees.

- The Proponents shall provide to future building tenants a list of incentives and facilities to promote alternative transportation to the site and reduce single-occupancy vehicle use (such as bicycle storage, preferential parking spaces) that tenants will be required to pass on to their employees.

- The Proponents shall require the tenant to notify their employees of all available TDM measures adopted by the tenant, including but not limited to transit subsidies for commuting or a commuter tax benefit program; flexible work schedules; direct deposit of paychecks; shower facilities for employees to encourage biking to/from work; and a guaranteed ride home for employees who carpool or use transit.

- The Proponents shall, in coordination with the MBTA, create a web site that provides a central resource for tenants and their employees of all local maps, schedules, and station locations with regard to public transit.

The Energy Efficiency Guide:

In addition, the Proponents shall proactively assist future building tenants in selecting energy reduction measures as part of their construction and interior fit-out, to ensure all such tenant work fully complies with the Stretch Energy Code. To accomplish this, at the time a lease is executed, in addition to the Tenant Manual, the Proponents shall provide tenants with an Energy Efficiency Guide that details specific additional design measures that the tenant can take to obtain LEED-equivalent or otherwise more energy-efficient space. The Guide will explain the energy efficiency features already built into the building by the Proponents as well as construction options available for the tenant-controlled space to further reduce energy use. By providing specific energy efficiency information and recommendations in this Guide, tenants will be encouraged to use environmentally-friendly building materials used in the fit-out of their space, and to implement materials recycling in their leased space. Examples of items to be included in the Guide to further encourage tenants to include additional energy efficient design features within their space include:

- Design information regarding interior lighting systems with a Light Power Density (LPD) at least 10% below Code. The Guide shall provide tenants with the specific requirements of the Stretch Energy Code that require LPD be at least 10% below the levels in the Massachusetts Building Code for retail and office uses, and the Guide shall encourage tenants to meet the 10%-below-Code goal for other building uses by providing example fixtures and lighting systems with a very high efficiency.

- Design information relating to interior space with daylighting controls to automatically dim electric lights, taking advantage of the natural light provided through the building's shell. The Guide shall detail specific examples of successful daylighting designs in from other developments and a list of products and vendors that tenants can employ to achieve these daylighting goals.

- Design information relating to Energy Recovery Ventilation (ERV) or Demand Control Ventilation (DCV) systems as it may relate to any tenant build-out HVAC system design. The Guide shall include a list of HVAC products that have ERV and DCV integrated into their design.

- Resources regarding Energy STAR rated computers and other equipment. The Guide shall include a list of or resources that detail typical office equipment that is Energy STAR rated.

Conclusion

A greenhouse gas (GHG) emission analysis was performed consistent with the EEA "Greenhouse Gas Emissions Policy and Protocol" (May 5, 2010) and using the eQUEST energy design software. Carbon dioxide (CO_2) emissions were calculated for two 2022 Full Build scenarios: (1) the Base Case corresponding to the 8^{th} Edition of the Massachusetts Building Code that adopted the 2009 IECC (the "Code"), and (2) the Preferred Alternative, which includes all energy mitigation measures. The Preferred Alternative assumes a comprehensive set of energy efficiency measures that avoid, minimize, and mitigate CO_2 emissions in conformance with the EEA "Greenhouse Gas Emissions Policy and Protocol".

For the <u>Preferred Building Program</u>, the Preferred Alternative will reduce total direct and indirect stationary source CO_2 emissions by 4442.7 tons/year, or 25.8% compared to the Base Case. The energy use of buildings constructed as part of the Project will use 28.6% less energy than is required to meet the State Building Code. Mitigation measures for motor vehicle emissions will reduce include a number of transportation demand management (TDM) strategies and roadway improvements for the project. These measures will reduce project-related motor vehicle CO_2 emissions by 117.3 tons/year, or 6% compared to the Base Case. The net reduction of the project's total CO_2 emissions (stationary source plus transportation) is 4,560.0 tons/year, or 23.8% compared to the Base Case.

For the <u>Alternative Building Program</u>, the Preferred Alternative will reduce total direct and indirect stationary source CO_2 emissions by 4,468.7 tons/year, or 25.7% compared to the Base Case. The energy use of buildings constructed as part of the Project will use 28.4% less energy than is required to meet the State Building Code. Mitigation measures for motor vehicle emissions will reduce include a number of transportation demand management (TDM) strategies and roadway improvements for the project. These measures will reduce project-related motor vehicle CO_2 emissions by 125.2 tons/year, or 6% compared to the Base Case. The net reduction of the project's total CO_2 emissions (stationary source plus transportation) is 4,593.9 tons/year, or 23.6% compared to the Base Case.

The Alternative Building Program has higher electricity and gas use than the Preferred Building Program. As a consequence, the Alternative Building Program total CO_2 emissions are 314.1 tons/year higher than the Preferred Building Program emissions (see Tables 4.23 and 4.24).

Table 4.2 Summary of Equest Model Assumptions		
Energy Efficiency Measure (EEM)	Base Case (Code)[1]	Mitigation Case
Cool Roof	No	Yes, all buildings
Green Roof	No	Yes, Building 5B: 40,195 SF
HVAC Cooling Efficiency for Typical 20-ton Unit	EER 10.0	EER 11.0 (10% above Code), Energy STAR rated units
Office Buildings 10C, 11A Electric Centrifugal Chiller Efficiency	0.576 kW/ton	0.490 kW/ton (15% better than Code)
Heating System Efficiency	80%	90%
Demand Control Ventilation (DCV)	No	Yes, Blocks 10 and 11
Energy Recovery Ventilation (ERV)	No	Yes, Buildings 1C, 3A, 5A/B, 6B/C, 10C, 11A
Cool/Heat Setpoints occupied, unoccupied	72° / 72°, 74° / 70°	75°/68°, 80° / 62° (Commercial) 78° / 64° (Residential)
Roof Insulation (Installed Above Deck)	R-20	R-25
Wall Insulation	R13+R7.5ci	R13+R10ci (10% above Code)
Slab Insulation	None	R-15

[1] Mass. Building Code 8th Edition including 2009 IECC.

Table 4.2 (continued) **Summary of Equest Model Assumptions**		
Energy Efficiency Measure (EEM)	Base Case (Code)[1]	Mitigation Case
Windows Glazing Type	Double Pane, U=0.55, DOE Type 2000	Double Pane, Low-e, U=0.29, SHGC=0.37, VT=0.67 DOE Type 2664
Daylighting Controls	No	Design building envelope for deep natural light penetration. Encourage tenants to use daylighting controls to dim electric lights
Parking Structure and Surface Lot Lighting	150 W/1,000 SF	LED 46 W/1,000 SF
Supermarket Refrigeration System Designed to Reduce Electrical Consumption	No	Yes, by 25%
Light Power Density (Whole Building Method)	Retail 1.5 W/SF Restaurant 1.6 W/SF Office 1.0 W/SF Residential 0.7 W/SF Hotel 1.0 W/SF Health Club 1.0 W/SF Movie Theater 1.2 W/SF	Same, except Retail 1.3 W/SF Office 0.9 W/SF Residential Corridors and Lobbies 10% below Code. Encourage tenants to design for LPD 10% below Code.
Occupancy Controls for Lighting	No	Yes, for all spaces not regularly occupied
Energy STAR Appliances for Residential Units and Kitchens in Offices	No	Yes

[1] Mass. Building Code 8th Edition including 2009 IECC.

Table 4.3 Motor Vehicle CO_2 Air Quality Emissions Summary				
Study Scenario	Total CO_2 (kg/day)	Total CO_2 (tons/year)	Project CO_2 (kg/day)	Project CO_2 (tons/year)
2022 No-Build	32,067	12,890	0	0
2022 Build for the Preferred Building Program	36,841	14,809	4,774.3	1,919.2
2022 Build With Mitigation for the Preferred Building Program	36,549	14,692	4,482.6	1,801.9
2022 Build for the Alternative Building Program	37,264	14,979	5,197.1	2,089.1
2022 Build With Mitigation for the Alternative Building Program	36,952	14,854	4,885.5	1,963.9

Table 4.4
Project Site Design Mitigation Measures

Suggested Mitigation Measure	Part of Project Design	Technically/ Economically Infeasible	Inappropriate to Project Type
Sustainable Development Principles	✓		
Minimize building footprints	✓		
Minimize energy use through building orientation	✓		
Provide pedestrian connections to other commercial establishments	✓		
Design water efficient landscaping	✓		
Best Management Practices (BMP) for stormwater design	✓		

Table 4.5 Building Design And Operation Mitigation Measures			
Suggested Mitigation Measure	Part of Project Design	Technically/ Economically Infeasible	Inappropriate to Project Type
Construct green roof (Block 5)	✓		
High-albedo cool roof	✓		
Energy efficient interior lighting exceeding Code	✓		
High-efficiency HVAC systems 10% above Code. With DCV for buildings 10C and 11A. With ERV for Buildings 3A, 5A, 5C, 6B, 6C, 10C, and 11A	✓		
Central chiller plant for Buildings 10C and 11A	✓		
Reduce energy demand by using peak shaving or load shifting strategies			✓
Energy efficient windows and building envelope with insulation exceeding Code for roof, walls, slab, and windows	✓		
Occupancy sensors for lighting	✓		
Energy Management System	✓		
High-efficiency refrigeration systems	✓		
Seal and leak-test HVAC supply ducts	✓		
LED lighting for parking structures	✓		
Incorporate combined heat and power (CHP) technologies into project		✓	

TABLE 4.5 (continued) **Building Design And Operation Mitigation Measures**			
Suggested Mitigation Measure	Part of Project Design	Technically/ Economically Infeasible	Inappropriate to Project Type
Use water conserving fixtures	✓		
Energy STAR appliances	✓		
Incorporate on-site renewable energy sources into project [1]		✓	
Use building materials with recycled content and low-VOC content	✓		
Provide adequate storage areas for recyclables in building design	✓		
Conduct building mechanical systems commissioning to ensure energy performance	✓		
Operations waste management program (through Tenant Manual)	✓		

[1] The proponent does not consider PV to be economically feasible at this time; however the project will set aside space on the roof for a possible future third-party PV installation.

Table 4.6
Transportation Demand Mitigation Measures

Suggested Mitigation Measure	Part of Project Design	Technically/ Economically Infeasible	Inappropriate to Project Type
Purchase alternative fuel and/or fuel efficient vehicles for fleet			✓
Locate new buildings near transit	✓		
Preferential parking for carpools and vanpools	✓		
Size parking capacity to meet, but not exceed, local parking requirements	✓		
Provide on-site food service	✓		
Provide bicycle storage racks on site	✓		
Appoint a Transportation Coordinator who will distribute ridesharing and transit information	✓		
Roadway and signal improvements to improve flow	✓		
Through a Tenant Manual, the proponent will encourage tenants to offer their employees : transit subsidies for commuting or a commuter tax benefit program; flexible work schedules; direct deposit of paychecks; shower facilities for employees to encourage biking to/from work; and a guaranteed ride home for employees who carpool or use transit.	✓		

Table 4.7

Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 1C

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	62,390	524.98		1,284.40		77.4	217.3	294.8	
Cool Roof		524.32	-0.1%	1,288.80	0.3%	77.7	217.1	294.8	0.0%
ERV on HVAC		513.55	-2.2%	1,284.40	0.0%	77.4	212.6	290.1	-1.6%
Higher Heating Efficiency		524.98	0.0%	1,191.70	-7.2%	71.9	217.3	289.2	-1.9%
Higher Cooling Efficiency		514.50	-2.0%	1,284.40	0.0%	77.4	213.0	290.5	-1.5%
Lower Light Power Density		509.23	-3.0%	1,306.30	1.7%	78.8	210.8	289.6	-1.8%
Energy STAR Appliances		480.43	-8.5%	1,344.00	4.6%	81.0	198.9	279.9	-5.0%
Roof Insulation		524.94	0.0%	1,278.20	-0.5%	77.1	217.3	294.4	-0.1%
Slab Insulation		526.61	0.3%	1,253.90	-2.4%	75.6	218.0	293.6	-0.4%
Energy Management System		515.08	-1.9%	1,007.00	-21.6%	60.7	213.2	274.0	-7.1%
Wall Insulation		525.11	0.0%	1,258.50	-2.0%	75.9	217.4	293.3	-0.5%
Low-e Insulated Window Glass		509.23	-3.0%	1,305.30	1.6%	78.7	210.8	289.5	-1.8%
All Mitigation Measures		410.37	-21.8%	872.37	-32.1%	52.6	169.9	222.5	-24.5%

Table 4.8
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 3A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	299,696	2,178.50		4,094.90		246.9	901.9	1,148.8	
Cool Roof		2,175.60	-0.1%	4,121.80	0.7%	248.5	900.7	1,149.2	0.0%
ERV on HVAC		2,136.40	-1.9%	4,094.90	0.0%	246.9	884.5	1,131.4	-1.5%
Higher Heating Efficiency		2,178.50	0.0%	3,750.20	-8.4%	226.1	901.9	1,128.0	-1.8%
Higher Cooling Efficiency		2,139.90	-1.8%	4,094.90	0.0%	246.9	885.9	1,132.8	-1.4%
Lower Light Power Density		2,127.80	-2.3%	4,171.30	1.9%	251.5	880.9	1,132.4	-1.4%
Energy STAR Appliances		2,003.60	-8.0%	4,330.00	5.7%	261.1	829.5	1,090.6	-5.1%
Roof Insulation		2,178.30	0.0%	4,063.80	-0.8%	245.0	901.8	1,146.9	-0.2%
Slab Insulation		2,183.50	0.2%	3,983.40	-2.7%	240.2	904.0	1,144.2	-0.4%
Energy Management System		2,146.20	-1.5%	2,895.00	-29.3%	174.6	888.5	1,063.1	-7.5%
Wall Insulation		2,179.30	0.0%	3,997.40	-2.4%	241.0	902.2	1,143.3	-0.5%
Low-e Insulated Window Glass		2,033.30	-6.7%	3,433.10	-16.2%	207.0	841.8	1,048.8	-8.7%
All Mitigation Measures		1,727.30	-20.7%	2,376.40	-42.0%	143.3	715.1	858.4	-25.3%

Table 4.9
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 4A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	113,101	816.14		1,383.40		83.4	337.9	421.3	
Cool Roof		814.37	-0.2%	1,397.10	1.0%	84.2	337.1	421.4	0.0%
Higher Heating Efficiency		816.14	0.0%	1,268.90	-8.3%	76.5	337.9	414.4	-1.6%
Higher Cooling Efficiency		801.00	-1.9%	1,383.40	0.0%	83.4	331.6	415.0	-1.5%
Lower Light Power Density		783.05	-4.1%	1,429.40	3.3%	86.2	324.2	410.4	-2.6%
Energy STAR Appliances		751.79	-7.9%	1,471.00	6.3%	88.7	311.2	399.9	-5.1%
Roof Insulation		816.04	0.0%	1,365.20	-1.3%	82.3	337.8	420.2	-0.3%
Slab Insulation		818.41	0.3%	1,339.10	-3.2%	80.7	338.8	419.6	-0.4%
Energy Management System		801.45	-1.8%	1,038.80	-24.9%	62.6	331.8	394.4	-6.4%
Wall Insulation		816.35	0.0%	1,355.10	-2.0%	81.7	338.0	419.7	-0.4%
Low-e Insulated Window Glass		774.41	-5.1%	1,244.90	-10.0%	75.1	320.6	395.7	-6.1%
All Mitigation Measures		662.56	-18.8%	913.48	-34.0%	55.1	274.3	329.4	-21.8%

Table 4.10

Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project

Building 4B

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	191,665	1,408.90		3,485.90		210.2	583.3	793.5	
Cool Roof		1,405.90	-0.2%	3,509.40	0.7%	211.6	582.0	793.7	0.0%
Higher Heating Efficiency		1,408.90	0.0%	3,226.30	-7.4%	194.5	583.3	777.8	-2.0%
Higher Cooling Efficiency		1,381.00	-2.0%	3,485.90	0.0%	210.2	571.7	781.9	-1.5%
Lower Light Power Density		1,345.60	-4.5%	3,580.40	2.7%	215.9	557.1	773.0	-2.6%
Energy STAR Appliances		1,318.30	-6.4%	3,613.30	3.7%	217.9	545.8	763.7	-3.8%
Roof Insulation		1,408.70	0.0%	3,453.70	-0.9%	208.3	583.2	791.5	-0.3%
Slab Insulation		1,412.40	0.2%	3,408.60	-2.2%	205.5	584.7	790.3	-0.4%
Energy Management System		1,381.00	-2.0%	2,826.00	-18.9%	170.4	571.7	742.1	-6.5%
Wall Insulation		1,409.00	0.0%	3,443.10	-1.2%	207.6	583.3	790.9	-0.3%
Low-e Insulated Window Glass		1,341.00	-4.8%	3,257.90	-6.5%	196.5	555.2	751.6	-5.3%
All Mitigation Measures		1,161.30	-17.6%	2,550.30	-26.8%	153.8	480.8	634.6	-20.0%

Table 4.11
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 5A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	295,285	2,083.10		3,200.10		193.0	862.4	1,055.4	
Cool Roof		2,080.70	-0.1%	3,222.90	0.7%	194.3	861.4	1,055.8	0.0%
ERV on HVAC		2,038.90	-2.1%	3,200.10	0.0%	193.0	844.1	1,037.1	-1.7%
Higher Heating Efficiency		2,083.10	0.0%	2,896.50	-9.5%	174.7	862.4	1,037.1	-1.7%
Higher Cooling Efficiency		2,042.60	-1.9%	3,200.10	0.0%	193.0	845.6	1,038.6	-1.6%
Lower Light Power Density		2,020.40	-3.0%	3,288.50	2.8%	198.3	836.4	1,034.7	-2.0%
Energy STAR Appliances		1,911.70	-8.2%	3,402.90	6.3%	205.2	791.4	996.6	-5.6%
Roof Insulation		2,083.10	0.0%	3,173.40	-0.8%	191.4	862.4	1,053.8	-0.2%
Slab Insulation		2,088.40	0.3%	3,102.90	-3.0%	187.1	864.6	1,051.7	-0.4%
Energy Management System		2,044.80	-1.8%	2,351.30	-26.5%	141.8	846.5	988.3	-6.4%
Wall Insulation		2,083.70	0.0%	3,114.20	-2.7%	187.8	862.7	1,050.4	-0.5%
Low-e Insulated Window Glass		1,929.00	-7.4%	2,696.70	-15.7%	162.6	798.6	961.2	-8.9%
All Mitigation Measures		1,643.80	-21.1%	1,878.80	-41.3%	113.3	731.5	844.8	-20.0%

Table 4.12
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 5C

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	251,421	2,197.40		4,770.00		287.6	909.7	1,197.4	
Cool Roof		2,195.40	-0.1%	4,790.00	0.4%	288.8	908.9	1,197.7	0.0%
ERV on HVAC		2,166.00	-1.4%	4,770.00	0.0%	287.6	896.7	1,184.4	-1.1%
Higher Heating Efficiency		2,197.40	0.0%	4,344.20	-8.9%	262.0	909.7	1,171.7	-2.1%
Higher Cooling Efficiency		2,168.60	-1.3%	4,770.00	0.0%	287.6	897.8	1,185.4	-1.0%
Lower Light Power Density		2,192.40	-0.2%	4,780.00	0.2%	288.2	907.7	1,195.9	-0.1%
Energy STAR Appliances		2,117.90	-3.6%	4,910.00	2.9%	296.1	876.8	1,172.9	-2.0%
Roof Insulation		2,197.00	0.0%	4,740.00	-0.6%	285.8	909.6	1,195.4	-0.2%
Slab Insulation		2,200.40	0.1%	4,509.70	-5.5%	271.9	911.0	1,182.9	-1.2%
Energy Management System		2,182.10	-0.7%	3,532.10	-26.0%	213.0	903.4	1,116.4	-6.8%
Wall Insulation		2,196.40	0.0%	4,670.60	-2.1%	281.6	909.3	1,190.9	-0.5%
Low-e Insulated Window Glass		1,951.30	-11.2%	4,027.30	-15.6%	242.8	807.8	1,050.7	-12.3%
All Mitigation Measures		1,722.90	-21.6%	2,704.70	-43.3%	163.1	713.3	876.4	-26.8%

Table 4.13

Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 6A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	195,425	2,434.00		2,437.20		147.0	1,007.7	1,154.6	
Cool Roof		2,426.50	-0.3%	2,462.40	1.0%	148.5	1,004.6	1,153.1	-0.1%
Higher Heating Efficiency		2,434.00	0.0%	2,246.90	-7.8%	135.5	1,007.7	1,143.2	-1.0%
Higher Cooling Efficiency		2,396.80	-1.5%	2,437.20	0.0%	147.0	992.3	1,139.2	-1.3%
Lower Light Power Density		2,420.90	-0.5%	2,454.80	0.7%	148.0	1,002.3	1,150.3	-0.4%
Energy STAR Appliances		2,241.30	-7.9%	2,643.20	8.5%	159.4	927.9	1,087.3	-5.8%
Roof Insulation		2,433.60	0.0%	2,408.40	-1.2%	145.2	1,007.5	1,152.7	-0.2%
Slab Insulation		2,436.00	0.1%	2,394.70	-1.7%	144.4	1,008.5	1,152.9	-0.2%
Energy Management System		2,404.90	-1.2%	1,592.00	-34.7%	96.0	995.6	1,091.6	-5.5%
Wall Insulation		2,433.20	0.0%	2,396.40	-1.7%	144.5	1,007.3	1,151.8	-0.3%
Low-e Insulated Window Glass		2,260.70	-7.1%	2,032.60	-16.6%	122.6	935.9	1,058.5	-8.3%
All Mitigation Measures		2,001.20	-17.8%	1,354.40	-44.4%	81.7	828.5	910.2	-21.2%

Table 4.14
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 6B

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	354,740	3,609.30		7,930.00		478.2	1,494.3	1,972.4	
Cool Roof		3,607.60	0.0%	7,950.00	0.3%	479.4	1,493.5	1,972.9	0.0%
ERV on HVAC		3,555.30	-1.5%	7,930.00	0.0%	478.2	1,471.9	1,950.1	-1.1%
Higher Heating Efficiency		3,609.30	0.0%	7,210.00	-9.1%	434.8	1,494.3	1,929.0	-2.2%
Higher Cooling Efficiency		3,559.70	-1.4%	7,930.00	0.0%	478.2	1,473.7	1,951.9	-1.0%
Lower Light Power Density		3,602.80	-0.2%	7,940.00	0.1%	478.8	1,491.6	1,970.3	-0.1%
Energy STAR Appliances		3,336.40	-7.6%	8,330.00	5.0%	502.3	1,381.3	1,883.6	-4.5%
Roof Insulation		3,609.00	0.0%	7,910.00	-0.3%	477.0	1,494.1	1,971.1	-0.1%
Slab Insulation		3,617.20	0.2%	7,310.00	-7.8%	440.8	1,497.5	1,938.3	-1.7%
Energy Management System		3,586.40	-0.6%	5,740.00	-27.6%	346.1	1,484.8	1,830.9	-7.2%
Wall Insulation		3,607.20	-0.1%	7,710.00	-2.8%	464.9	1,493.4	1,958.3	-0.7%
Low-e Insulated Window Glass		3,111.90	-13.8%	6,280.00	-20.8%	378.7	1,288.3	1,667.0	-15.5%
All Mitigation Measures		2,744.90	-23.9%	3,938.20	-50.3%	237.5	1,136.4	1,373.9	-30.3%

Table 4.15
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 6C

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	159,800	1,129.00		2,125.50		128.2	467.4	595.6	
Cool Roof		1,127.20	-0.2%	2,138.50	0.6%	129.0	466.7	595.6	0.0%
ERV on HVAC		1,104.70	-2.2%	2,125.50	0.0%	128.2	457.3	585.5	-1.7%
Higher Heating Efficiency		1,129.00	0.0%	1,941.20	-8.7%	117.1	467.4	584.5	-1.9%
Higher Cooling Efficiency		1,106.70	-2.0%	2,125.50	0.0%	128.2	458.2	586.3	-1.5%
Lower Light Power Density		1,122.70	-0.6%	2,136.40	0.5%	128.8	464.8	593.6	-0.3%
Energy STAR Appliances		1,028.40	-8.9%	2,258.50	6.3%	136.2	425.8	561.9	-5.6%
Roof Insulation		1,129.10	0.0%	2,109.00	-0.8%	127.2	467.4	594.6	-0.2%
Slab Insulation		1,132.20	0.3%	2,063.00	-2.9%	124.4	468.7	593.1	-0.4%
Energy Management System		1,107.70	-1.9%	1,632.90	-23.2%	98.5	458.6	557.1	-6.5%
Wall Insulation		1,129.40	0.0%	2,077.90	-2.2%	125.3	467.6	592.9	-0.5%
Low-e Insulated Window Glass		1,046.80	-7.3%	1,865.10	-12.3%	112.5	433.4	545.8	-8.3%
All Mitigation Measures		893.30	-20.9%	1,362.10	-35.9%	82.1	369.8	452.0	-24.1%

Table 4.16
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 7A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	275,204	2,830.20		3,310.00		199.6	1,171.7	1,371.3	
Cool Roof		2,831.70	0.1%	3,332.60	0.7%	201.0	1,172.3	1,373.3	0.1%
Higher Heating Efficiency		2,830.20	0.0%	3,066.90	-7.3%	184.9	1,171.7	1,356.6	-1.1%
Higher Cooling Efficiency		2,797.40	-1.2%	3,310.00	0.0%	199.6	1,158.1	1,357.7	-1.0%
Lower Light Power Density		2,797.30	-1.2%	3,361.30	1.5%	202.7	1,158.1	1,360.8	-0.8%
Energy STAR Appliances		2,660.30	-6.0%	3,533.30	6.7%	213.1	1,101.4	1,314.4	-4.1%
Roof Insulation		2,829.90	0.0%	3,268.60	-1.3%	197.1	1,171.6	1,368.7	-0.2%
Slab Insulation		2,835.00	0.2%	3,206.20	-3.1%	193.3	1,173.7	1,367.0	-0.3%
Energy Management System		2,798.00	-1.1%	2,557.80	-22.7%	154.2	1,158.4	1,312.6	-4.3%
Wall Insulation		2,830.40	0.0%	3,248.90	-1.8%	195.9	1,171.8	1,367.7	-0.3%
Low-e Insulated Window Glass		2,745.00	-3.0%	2,986.20	-9.8%	180.1	1,136.4	1,316.5	-4.0%
High Efficiency Refrigeration System		2,589.20	-8.5%	3,310.00	0.0%	199.6	1,071.9	1,271.5	-7.3%
All Mitigation Measures		2,250.80	-20.5%	2,285.80	-30.9%	137.8	931.8	1,069.7	-22.0%

Table 4.17
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 8A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	329,596	5,113.70		13,010.00		784.5	2,117.1	2,901.6	
Cool Roof		5,111.50	0.0%	13,080.00	0.5%	788.7	2,116.2	2,904.9	0.1%
Higher Heating Efficiency		5,113.70	0.0%	11,800.00	-9.3%	711.5	2,117.1	2,828.6	-2.5%
Higher Cooling Efficiency		5,033.20	-1.6%	13,010.00	0.0%	784.5	2,083.7	2,868.2	-1.2%
Lower Light Power Density		4,949.30	-3.2%	13,300.00	2.2%	802.0	2,049.0	2,851.0	-1.7%
Energy STAR Appliances		4,946.50	-3.3%	13,300.00	2.2%	802.0	2,047.9	2,849.8	-1.8%
Roof Insulation		5,112.90	0.0%	12,920.00	-0.7%	779.1	2,116.7	2,895.8	-0.2%
Slab Insulation		5,119.00	0.1%	12,920.00	-0.7%	779.1	2,119.3	2,898.3	-0.1%
Energy Management System		5,005.80	-2.1%	10,150.00	-22.0%	612.0	2,072.4	2,684.4	-7.5%
Wall Insulation		5,113.80	0.0%	12,950.00	-0.5%	780.9	2,117.1	2,898.0	-0.1%
Low-e Insulated Window Glass		5,068.30	-0.9%	12,870.00	-1.1%	776.1	2,098.2	2,874.3	-0.9%
High Efficiency Refrigeration System		4,681.70	-8.4%	13,010.00	0.0%	784.5	1,938.3	2,722.7	-6.2%
All Mitigation Measures		4,134.80	-19.1%	9,510.00	-26.9%	573.5	1,711.8	2,285.3	-21.2%

Table 4.18
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 9A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	108,391	1,211.00		2,555.10		154.1	501.4	655.4	
Cool Roof		1,209.60	-0.1%	2,564.80	0.4%	154.7	500.8	655.4	0.0%
Higher Heating Efficiency		1,211.00	0.0%	2,330.20	-8.8%	140.5	501.4	641.9	-2.1%
Higher Cooling Efficiency		1,184.70	-2.2%	2,555.10	0.0%	154.1	490.5	644.5	-1.7%
Lower Light Power Density		1,163.50	-3.9%	2,622.70	2.6%	158.1	481.7	639.8	-2.4%
Energy STAR Appliances		1,135.00	-6.3%	2,665.60	4.3%	160.7	469.9	630.6	-3.8%
Roof Insulation		1,210.90	0.0%	2,541.60	-0.5%	153.3	501.3	654.6	-0.1%
Slab Insulation		1,213.60	0.2%	2,503.90	-2.0%	151.0	502.4	653.4	-0.3%
Energy Management System		1,181.70	-2.4%	1,871.80	-26.7%	112.9	489.2	602.1	-8.1%
Wall Insulation		1,211.20	0.0%	2,515.20	-1.6%	151.7	501.4	653.1	-0.4%
Low-e Insulated Window Glass		1,145.60	-5.4%	2,329.30	-8.8%	140.5	474.3	614.7	-6.2%
All Mitigation Measures		975.80	-19.4%	1,669.50	-34.7%	100.7	404.0	504.6	-23.0%

Table 4.19

Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project

Building 10C

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	552,182	4,521.20		8,270.00		498.7	1,871.8	2,370.5	
Cool Roof		4,510.60	-0.2%	8,310.00	0.5%	501.1	1,867.4	2,368.5	-0.1%
DCV on HVAC		4,589.60	1.5%	7,380.00	-10.8%	445.0	1,900.1	2,345.1	-1.1%
ERV on HVAC		4,449.60	-1.6%	8,270.00	0.0%	498.7	1,842.1	2,340.8	-1.3%
Higher Heating Efficiency		4,521.20	0.0%	7,460.00	-9.8%	449.8	1,871.8	2,321.6	-2.1%
Higher Cooling Efficiency		4,415.10	-2.3%	8,270.00	0.0%	498.7	1,827.9	2,326.5	-1.9%
Lower Light Power Density		4,410.30	-2.5%	8,380.00	1.3%	505.3	1,825.9	2,331.2	-1.7%
Energy STAR Appliances		4,195.40	-7.2%	8,630.00	4.4%	520.4	1,736.9	2,257.3	-4.8%
Roof Insulation		4,521.30	0.0%	8,210.00	-0.7%	495.1	1,871.8	2,366.9	-0.2%
Slab Insulation		4,535.20	0.3%	8,150.00	-1.5%	491.4	1,877.6	2,369.0	-0.1%
Energy Management System		4,353.80	-3.7%	6,370.00	-23.0%	384.1	1,802.5	2,186.6	-7.8%
Wall Insulation		4,524.20	0.1%	8,130.00	-1.7%	490.2	1,873.0	2,363.3	-0.3%
Low-e Insulated Window Glass		4,268.10	-5.6%	7,040.00	-14.9%	424.5	1,767.0	2,191.5	-7.6%
All Mitigation Measures		3,598.90	-20.4%	4,250.00	-48.6%	256.3	1,489.9	1,746.2	-26.3%

Table 4.20
Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project
Building 11A

Mitigation Measures - eQuest Model Run	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Case	544,311	4,338.90		5,810.00		350.3	1,796.3	2,146.6	
Cool Roof		4,328.70	-0.2%	5,860.00	0.9%	353.4	1,792.1	2,145.4	-0.1%
DCV on HVAC		4,394.10	1.3%	5,080.00	-12.6%	306.3	1,819.2	2,125.5	-1.0%
ERV on HVAC		4,277.90	-1.4%	5,810.00	0.0%	350.3	1,771.1	2,121.4	-1.2%
Higher Heating Efficiency		4,338.90	0.0%	5,220.00	-10.2%	314.8	1,796.3	2,111.1	-1.7%
Higher Cooling Efficiency		4,248.70	-2.1%	5,810.00	0.0%	350.3	1,759.0	2,109.3	-1.7%
Lower Light Power Density		4,182.00	-3.6%	6,010.00	3.4%	362.4	1,731.3	2,093.8	-2.5%
Energy STAR Appliances		3,988.90	-8.1%	6,240.00	7.4%	376.3	1,651.4	2,027.7	-5.5%
Roof Insulation		4,338.90	0.0%	5,750.00	-1.0%	346.7	1,796.3	2,143.0	-0.2%
Slab Insulation		4,352.10	0.3%	5,640.00	-2.9%	340.1	1,801.8	2,141.9	-0.2%
Energy Management System		4,198.10	-3.2%	4,020.00	-30.8%	242.4	1,738.0	1,980.4	-7.7%
Wall Insulation		4,341.80	0.1%	5,680.00	-2.2%	342.5	1,797.5	2,140.0	-0.3%
Low-e Insulated Window Glass		4,101.50	-5.5%	4,590.00	-21.0%	276.8	1,698.0	1,974.8	-8.0%
All Mitigation Measures		3,402.60	-21.6%	2,780.90	-52.1%	167.7	1,408.7	1,576.4	-26.6%

Table 4.21

Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project

Outdoor Lighting for Parking Lots and Structures

Mitigation Measures	SF	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO_2 Emissions (tons/yr)	Electrical CO_2 Emissions (tons/yr)	Total CO_2 Emissions (tons/yr)	CO_2 Emissions Change (%)
Base Code (Code) 150 W/kSF	1,851,817	1,216.6		0.0		0.0	503.7	503.7	
Preferred Alternative - LED Fixtures 46 W/kSF		373.1	-69.3%	0.0	0.0%	0.0	154.5	154.5	-69.3%

Table 4.22

Energy and CO_2 Modeling for the New Quincy Center Redevelopment Project

All Buildings and Outdoor Lighting - Totals

All Buildings - Combined Mitigation	Electrical Usage (MWh/yr)	Electrical Change (%)	Gas Usage (Mcf/yr)	Gas Change (%)	Heating CO2 Emissions (tons/yr)	Electrical CO2 Emissions (tons/yr)	Total CO2 Emissions (tons/yr)	CO2 Emissions Change (%)
Base Case	32,782.8		60,356.5		3,639.5	13,572.1	17,211.6	
Preferred Alternative - All Mitigation Measures	25,452.8	-22.4%	36,161.2	-40.1%	2,180.5	10,588.4	12,768.9	-25.8%

Table 4.23
Greenhouse Gas (CO_2) Emissions Summary for the Preferred Building Alternative (tons/year)

Source	Base Case	Preferred Alternative	Percent Reduction in GHG Emissions
Direct Emissions	3,639.5	2,180.5	40.1%
Indirect Emissions	13,572.1	10,588.4	22.4%
Subtotal Direct and Indirect Emissions	17,211.6	12,768.9	25.8%
Transportation Emissions	1,919.2	1,809.9	6.0%
Total CO_2 Emissions	19,130.8	14,570.8	23.8%

Table 4.24
Greenhouse Gas (CO_2) Emissions Summary for the Alternative Building Alternative (tons/year)

Source	Base Case	Preferred Alternative	Percent Reduction in GHG Emissions
Direct Emissions	3,815.2	2,317.4	39.3%
Indirect Emissions	13,574.5	10,603.6	21.9%
Subtotal Direct and Indirect Emissions	17,389.7	12,921.0	25.7%
Transportation Emissions	2,089.1	1,963.9	6.0%
Total CO_2 Emissions	19,478.8	14,884.9	23.6%

FIGURE 4.1
PROJECT ENERGY USE SEASONAL PROFILES