



Massachusetts Port Authority
One Harborside Drive, Suite 200S
East Boston, MA 02128-2909
Telephone: 617-568-5000
www.massport.com

July 31, 2020

The Honorable Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environmental Affairs

ATTN: MEPA Office

Erin Flaherty, EEA No. 16168
100 Cambridge Street, Suite 900,
Boston, Massachusetts 02114

Re: Framingham Logan Express Expansion Project Single EIR, Framingham, MA. EEA No. 16168

Dear Secretary Theoharides and Director Kim:

On behalf of the Massachusetts Port Authority (Massport), we are pleased to submit for your review this *Single Environmental Impact Report (SEIR)* for the expansion of the existing Framingham Logan Express facility. As outlined in the *Expanded Environmental Notification Form (EENF)* and the *Logan Airport Environmental Status and Planning Report (ESPR, EEA #3247)*, Massport's Logan Express network is a centerpiece of our High Occupancy Vehicle (HOV) strategy for passenger and employee ground access in and out of Logan Airport. Logan Express is the seventh largest transit system in the Commonwealth and is critical to reducing vehicle trips, congestion, and greenhouse gas emissions throughout its market area. The Framingham Logan Express service has been very effective in serving the MetroWest area and in 2019 was estimated to have eliminated over 450,000 annual trips along the Massachusetts Turnpike (I-90) in the highly congested corridor between the Framingham area and Logan Airport. While activity at Boston Logan International Airport has been dramatically reduced due to the ongoing COVID-19 worldwide pandemic, a return to historic passenger levels can reasonably be expected. With that recovery and longer-term growth, traffic congestion in an around Boston and the western suburbs is expected to return. Over time, with the increased capacity at an expanded Framingham Logan Express parking garage, we expect that the annual number of avoided trips would exceed 1 million.

As described in the EENF, the original Logan Express facility at this location was constructed in 1995; that facility was replaced in 2015 with the current integrated terminal and four-level garage structure totaling 1,082 parking spaces. Massport's current plan is to expand the garage within the existing footprint to its maximum structural capacity of seven levels. This expansion was envisioned during the 2014 MEPA review process (EEA #15144) which described that the garage foundations were designed to allow for the construction of additional parking levels in the future. Within the existing footprint and structural capacity, a total of 998 additional spaces will be added. Even with the additional spaces, during peak travel periods Massport expects to continue operation of the adjacent 565-space overflow parking lot along Flutie Pass. When the overflow lot is in use,

Massport's Logan Express buses will continue to directly service that lot so that patrons do not need to walk between the overflow lot and the main terminal.

By building out this facility and adding to Massport's system-wide Logan Express HOV capacity, we estimate that use of overall Logan Express network of facilities will be able to double from nearly 2 million annual users in 2019 to over 4 million annual users. This translates to a very significant reduction in regional vehicle miles travelled (VMT) and associated vehicle emissions. The greenhouse gas (GHG) analyses demonstrate that by expanding the garage to provide an additional 998 parking spaces and expanded services, the project will result in a reduction of GHG emissions by over 7,200 tons per year (CO₂e) compared to the existing condition— this is the equivalent of eliminating emissions from the annual energy usage of over 750 homes.

In addition to the primary project benefit of taking vehicle trips off the road, Massport will be adding a new solar PV array along the south-facing building façade; this new array will offset 100% of the additional energy demand of the new parking levels and some of the energy demand for the existing facility. Although there will be some temporary disturbance around the building perimeter to facilitate a crane moving around the garage during construction, the project will remain within the footprint of the existing garage structure and avoid the adjacent wetlands. Since filing of the EENF, Massport has continued to coordinate with the City of Framingham; recently the Framingham Conservation Commission issued their approval of the project.

Massport would like to acknowledge that this SEIR was filed during the ongoing COVID-19 worldwide pandemic. As a result of this situation, a number of the underlying capacity issues that led Massport to propose expansion of the Framingham Logan Express Garage are not as pressing as they were when the EENF was filed in early March. Flights in and out of Logan Airport are dramatically reduced and passenger levels dropped by over 90% in spring 2020. Although we have recently observed some increases in passenger demand, there are presently far fewer passengers and employees travelling to and from Logan and there is less roadway congestion both in Boston and the metropolitan area. In addition, in the near-term, the public's propensity to use HOV transportation services like buses, rapid transit and commuter rail, has also been significantly affected by concerns about COVID-19.

Within that context, Massport continues to evaluate and plan for the recovery of air passenger activity and remains committed to implementing the broad range of ground access strategies that were outlined in the February 2020 Expanded ENF including expansion of Logan Express services. The schedule for those improvements has, however, been adjusted due to the current conditions. At the time of the EENF filing, Massport's plan was to commence construction on the Framingham Logan Express Garage Expansion in 2020. At this time, we expect that construction of the additional garage levels will be delayed for at least 12 months.

Consistent with the Secretary's Certificate on the EENF, this Single EIR focuses on detailing project changes since the EENF, evaluating additional energy efficiency and renewable energy options, updating the traffic analyses and responding to the two comments filed on the EENF.

We would appreciate your placing Notice of the Single EIR in the August 10, 2020 edition of the *Environmental Monitor*. Based on that date, comments would be due by September 10th to be followed by the Secretary's Certificate on September 17, 2020. The document will be available for download and review on Massport's website at <https://www.massport.com/massport/about-massport/project-environmental-filings/logan-airport/>.

We look forward to discussing these important HOV improvements with you and the MEPA Office staff. I can be reached at 617-568-3524 or via email at sdalzell@massport.com to answer any project questions you may have.

Sincerely,

Massachusetts Port Authority



Stewart Dalzell, Deputy Director
Environmental Planning and Permitting

Attachments

Cc: MEPA Distribution List (SEIR Appendix D)
Framingham Mayor Yvonne Spicer
State Senator Karen Spilka
State Representative Carmine Gentile
State Representative Maria Robinson
State Representative Jack Lewis
MA Department of Energy Resources
AIR, Inc.
J. Barrera, M. Hadley, H. Morrison, T. Monfared, A. Coppola/Massport



July 31, 2020

Massport Logan Express Framingham Garage Expansion

**SINGLE ENVIRONMENTAL IMPACT
REPORT (EEA No. 16168)**

Submitted to:

Executive Office of Energy
& Environmental Affairs
MEPA Office
100 Cambridge Street – Suite 900
Boston, MA 02114

Prepared for:

Massachusetts Port Authority
One Harborside Drive – Suite 200S
Boston, MA 02128

Prepared by:

Stantec Consulting Services, Inc.
226 Causeway Street – 6th Floor
Boston, MA 02114

**MASSPORT – LOGAN EXPRESS FRAMINGHAM GARAGE EXPANSION
SINGLE ENVIRONMENTAL IMPACT REPORT**

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1.0 INTRODUCTION AND BACKGROUND

The Massachusetts Port Authority (Massport) is planning to expand the existing Logan Express parking garage facility in the City of Framingham. The garage is located near the Massachusetts Turnpike (I-90) at the corner of Burr Street and Shoppers World Drive. See Figure 1 - USGS map and Figure 2 – Project Site and Offsite Parking.

Throughout 2019, the demand for parking spaces at the Logan Express Framingham facility exceeded supply 11 months of the year. Massport proposes to increase the capacity of the Framingham Logan Express garage by adding three additional levels on top of the existing four-level garage. The additional 998 parking spaces would expand garage capacity from the existing 1,082 spaces to 2,080 spaces. The vertical expansion would be contained within the existing garage footprint; no additional land would be used for the Project. As part of this plan, Massport also anticipates continued lease of 565 overflow parking spaces at the nearby AMC Theatres along Flutie Pass.

This Single EIR (SEIR) was filed during the ongoing COVID-19 worldwide pandemic. As a result, a number of the underlying issues that led Massport to propose expansion of the Framingham Logan Express Garage have temporarily changed. Flights in and out of Logan are dramatically reduced and passenger levels dropped over 90% in spring 2020. As a result, while passenger numbers are beginning a slow recovery, there are far fewer passengers and employees travelling to and from Logan and there is far less roadway congestion both in Boston and the metropolitan area. In addition, the public's interest in using High Occupancy Vehicle (HOV) transportation services like buses, rapid transit and commuter rail, has also been significantly affected by concerns about COVID-19.

Within that context, Massport continues to evaluate and plan for the recovery of air passenger activity and remains committed to implementing the broad range of ground access strategies that were outlined in the March 2020 Expanded ENF, including expansion of Logan Express services. The schedule for those improvements has, however, been adjusted due to the current conditions. At the time of the EENF filing, Massport's plan was to commence construction on the Framingham Logan Express Garage Expansion in 2020. At this time, we expect that the proposed garage expansion will be delayed for at least 12 months. Massport will provide an update on the schedule in the forthcoming Logan Environmental Data Report to be filed in late 2020.

1.1 LOGAN EXPRESS SERVICE

Logan Express is a high-occupancy vehicle (HOV) transit service offered by Massport, transporting passengers by bus between each of its five satellite locations in Braintree, Framingham, Woburn, Peabody, and Boston (Back Bay), and Boston- Logan

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International Airport (Logan Airport). The Logan Express system provided HOV bus service to and from Logan Airport for more than 2.1 million passengers and employees in 2019. At each of the four suburban facilities, including Framingham, users can park their vehicles at relatively low cost and travel directly to Logan Airport's passenger terminals using the Logan Express bus service. Some suburban users of the Logan Express bus service are also dropped off/picked up at the facility and do not use the parking facilities provided. The Back Bay Logan Express is an urban facility which does not offer parking.

As described in the *Expanded Environmental Notification Form* filed for the project in March 2020 and Massport's recent Environmental Status and Planning Report (ESPR, EEA No. 3247) for Logan Airport, Massport has a comprehensive, multi-pronged trip reduction strategy to diversify and enhance ground transportation options for passengers and employees traveling to and from Logan Airport. The trip reduction strategy is designed to offer passengers traveling to and from Logan Airport with a choice of HOV, transit, and shared-ride options that are convenient and reliable, and that reduce environmental and community impacts.

This project is one important element of Massport's comprehensive diverse trip reduction strategy, that has a goal to double ridership on the Logan Express system from 2 million to 4 million annual passengers over the next 10 years. By shifting more passengers and employees to Logan Express, Massport can reduce vehicle miles traveled (VMT), regional and local roadway congestion, and air emissions.

Responding to the strong regional and national economies, passenger levels at Logan Airport increased more than 25 percent between 2015 to 2019 from 33.8 million to 42.5 million annual passengers. Since the garage opened in 2015, ridership at Massport's Framingham Logan Express facility has grown at an even faster rate, increasing 43 percent from 431,000 riders in 2015 to 616,200 riders in 2019.

Massport estimates that in 2019 the Logan Express service in Framingham resulted in the avoidance of approximately 480,000 vehicle trips on the Logan Airport gateway entrances/exits including the Sumner and Callahan Tunnels and the Williams Tunnel (I-90), resulting in a reduction in CO₂E of approximately 4,630 tons per year.

While the continuing worldwide COVID-19 pandemic has drastically reduced air travel, Massport expects passenger activity to recover to pre-pandemic levels over time and the conditions precipitating the need for more Framingham Logan Express parking to return.

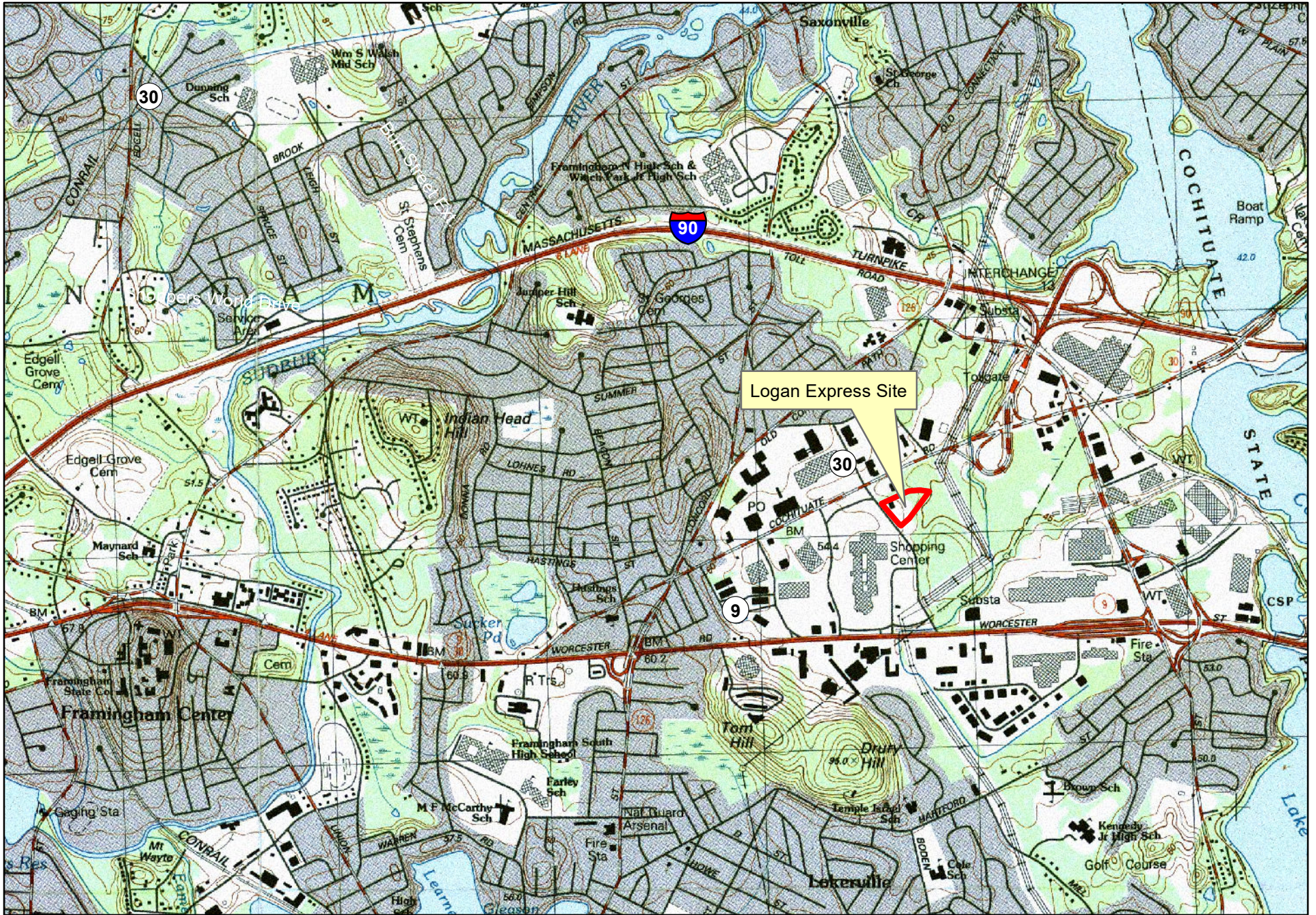
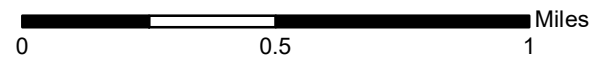


Figure 1: USGS Topographic Map (1:24,000)

Massport Logan Express Garage Expansion
Framingham, MA

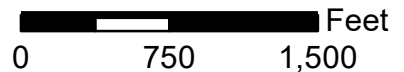


Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, (data current to October 2013).
2015 Orthophotography.



Figure 2 - Project Site & Offsite Parking

Massport Logan Express Garage Expansion
 Framingham, MA



2.0 PROJECT DESCRIPTION AND BACKGROUND

This section describes the proposed expansion of the Logan Express Garage in Framingham, other Massport Logan Express facility improvements, and planned improvements to Logan Airport High-Occupancy Vehicle access.

2.1 PROJECT DESCRIPTION

Massport is planning to expand the existing Logan Express parking garage facility in the City of Framingham. The garage is located near the Massachusetts Turnpike (I-90) at the corner of Burr Street and Shoppers World Drive (Figures 1 and 2).

The Framingham Logan Express facility garage was constructed in 2015. Almost immediately following opening of the new garage, the facility began to fill to capacity during peak travel periods. This growth in ridership at Framingham occurred ahead of forecast for that site and demonstrated the latent regional demand for a convenient, reasonable cost and well-run HOV facility.

Massport proposes to increase the capacity of the Framingham Logan Express garage by adding three additional levels on top of the existing four-level garage. The additional 998 parking spaces would expand garage capacity from the existing 1,082 spaces to 2,080 spaces. The vertical expansion would be contained within the existing garage footprint; no additional land would be used for the Project. As part of this plan, Massport also anticipates continued lease of 565 overflow parking spaces at the nearby AMC Theatres along Flutie Pass.

The sections below describe additional measures Massport intends to implement to ensure safe and continuous access to the Logan Express service and HOV vehicles.

2.1.1 Planned Improvements to Logan Express

Massport's overall HOV strategy includes the following recent and future Logan Express improvements:

- Increase Braintree Logan Express service from two to three trips per hour (This increase was implemented in 2019 but has been temporarily suspended).
- Advance planning for added parking capacity at the LEX Braintree site that is nearing capacity.
- Provide security line priority status to Logan Express Back Bay riders (implemented in 2019, but the Back Bay service has been temporarily suspended).
- Execute a sustained marketing campaign to support the Logan Express strategy and increase ridership.

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- Implement Logan Express electronic ticketing.
- Open a new urban Logan Express site in Boston at North Station (Initially planned for mid-2020, but now temporarily deferred).
- Evaluate new Logan Express suburban locations, with a plan to open at least one new site (temporarily deferred).
- Explore Ride Apps (Uber/Lyft, etc.) to provide 'last mile' connections to/from LEX facilities.
- Continue to monitor parking capacity at all Logan Express sites.

2.1.2 Improvements to High-Occupancy Vehicle Access

Massport's overall HOV strategy includes the following access improvements:

- Massport has partnered with the MBTA to promote its Silver Line access to the Airport. Massport's financial support of the MBTA Silver Line has included Airport route subsidization (including paying for free boarding at the Airport), the prior purchase of eight MBTA Silver Line buses, and the purchase of eight more MBTA Silver Line buses in the future as passenger numbers recover.
- Consolidation of Logan Airport Ride App services to promote ride sharing and reduced trips.
- Operating two early morning Sunrise Shuttle services that serve East Boston, Winthrop, and Revere employees before the MBTA Blue Line service starts.
- Continuing to provide free, clean-fuel shuttle bus service for passengers between the MBTA Blue Line Airport Station, the Water Transportation dock, and all terminals.

2.2 PROJECT SITE AND CONTEXT

The Logan Express Framingham facility parcel is 4.63 acres, of which approximately 3.14 acres are impervious, including the terminal building, parking garage, limited surface parking and driveways. The existing garage is approximately 382,700 gross square feet (GSF). This facility includes parking decks, bus loading and waiting areas, a ticket office, a vending area, restrooms, and utility space.

Figure 3 presents an aerial-based map of the site that highlights the existing garage, access roads, wetland resource areas; impervious areas; and sidewalks. The site is owned and operated by Massport and there are no easements.

The garage facility is located within the highly developed Massachusetts Turnpike (I-90)/Route 30/Route 9 corridor in the Framingham/ Natick area. Nearby land uses

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include the Shoppers World Plaza, REI store, the AMC Premium Cinema, Liberty Mutual office building, Home Goods/Target stores, Natick Mall and numerous other retail, restaurant and commercial buildings and associated surface parking lots.

To meet growing customer demand for HOV service to Logan Airport, particularly during peak travel periods, Massport currently leases an additional 565 parking spaces from adjacent property owners, including 490 spaces along Flutie Pass at AMC Theatres and 75 spaces at the former Fran's Florist (Figure 2). Over the past several years, during peak travel periods, Massport has had access for up to 132 additional parking spaces at the adjacent Shopper's World parking area. Thus, a total of 697 overflow parking spaces are currently available for Logan Express Framingham customers. Upon expansion of the garage, Massport intends to continue use of up to 565 parking spaces at the AMC lot, but discontinue use of the Shopper's World overflow parking.

2.3 MEPA HISTORY

Massport initiated Logan Express service from the Framingham area in the mid-1980s, focusing on selected peak travel periods. In 1994, Massport formalized this service with the opening of a small terminal building and associated surface parking lot of 374 spaces at the current location. Within a few years, as demand for the service grew, Massport seasonally leased existing parking spaces from adjacent retail business in Shopper's World to meet peak parking demand. In 2001, Massport secured approvals for additional/structured parking at this site (EEA#12412), but following the events of September 11, 2001, that garage was not constructed.

After several years of economic recovery and sustained growth in ridership, demand once again exceeded the original surface lot and small terminal. An Environmental Notification Form (ENF) was filed by Massport in December 2013 for the construction of a five-level, 1,500-space garage (EEA#15144) to replace the existing surface parking lot and terminal at this location. On February 28, 2014, the Secretary determined that the preparation an Environmental Impact Report (EIR) was not required and that the project could advance to the permitting phase.

The new four-level garage was constructed and opened in 2015 with 1,037 parking spaces (with an additional 45 surface spaces for valet and short-term parking. The garage was designed to allow for future vertical expansion to seven levels to provide Massport the ability to meet demand for HOV bus service if Logan Express ridership continued to grow.

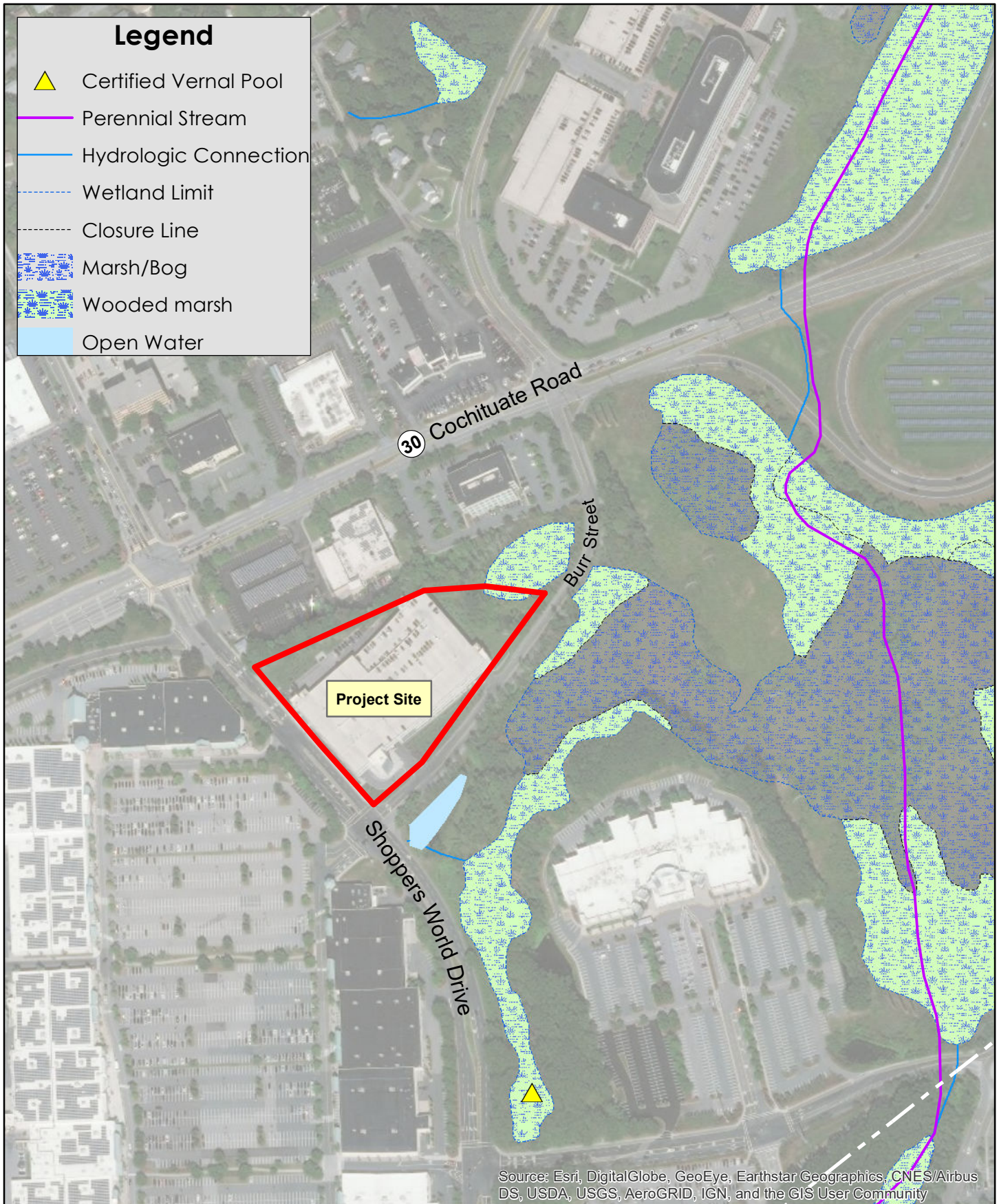


Figure 3 - DEP Wetlands

Massport Logan Express Garage Expansion
Framingham, MA



Map Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, (data current to October 2013).
2015 Orthophotography.

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As outlined in that ENF, Massport intended to discontinue the use of overflow parking areas with the opening of the new garage. However, once the new parking garage was opened in 2015, it was almost immediately regularly filled to capacity because of continued growth in passenger levels at Logan Airport, the attractiveness of the LEX service, and Massport's strong emphasis on HOV travel. For this reason, it became necessary to continue periodic use of the overflow lots from the opening of the garage in 2015 through early 2020. (Note that due to the recent reduction of trips from the LEX Framingham facility due to the COVID-19 pandemic, the AMC overflow parking lot is currently closed for LEX customer use).

On March 2, 2020, Massport filed an Expanded ENF (EENF) with the MEPA Office. The purpose of the EENF was initiate MEPA review of the additional 998 parking spaces and to formally acknowledge the planned continued use of the 565 overflow parking spaces at the AMC Theatres lot along Flutie Pass. While the additional garage spaces alone did not trigger a requirement for a mandatory *Environmental Impact Report (EIR)*, formal acknowledgment of the continued use of the 565 overflow spaces met the EIR requirements.

The EENF included a waiver request to support Massport's request to file a Single EIR, rather than a Draft and Final EIR, pursuant to Section 11.06(8) of the MEPA regulations. On April 17, 2020, the Secretary issued the EENF Certificate stating that 'this project requires the submission of an Environmental Impact Report (EIR)'. The Certificate also included the Secretary's approval of Massport's Single EIR waiver request, to be prepared "in accordance with the Scope included in this Certificate". This Single EIR is submitted in response to the Secretary's requirement.

2.4 CHANGES TO THE PROJECT SINCE THE EXPANDED ENF

The proposed Project remains consistent with the project outlined in the March 2020 EENF. As noted in Section 1.0, the COVID-19 worldwide pandemic has had a substantial impact on Massport operations including a dramatic reduction in the number of daily flights and an approximately 90% reduction in passenger levels in spring 2020. Even more dramatic ridership reductions were experienced on the Logan Express buses during the early months of the pandemic.

Within that context, Massport continues to evaluate and plan for the recovery of air passenger activity and remains committed to implementing the broad range of ground access and trip reduction strategies that were outlined in the March 2020 Expanded ENF including expansion of Logan Express services. The schedule for those improvements has, however, been adjusted due to the continuing passenger reductions. At the time of the EENF filing, Massport's plan was to commence construction on the Framingham Logan Express Garage Expansion in 2020. At this time, we expect that the proposed garage expansion will be delayed for at least 12 months.

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Massport will provide an update on the schedule in the forthcoming *Logan Environmental Data Report* (EEA No. 3247) to be filed in late 2020.

2.5 PROJECT REGULATORY REQUIREMENTS

A list of required permits, financial assistance, land transfer, and any required federal environmental permits are provided in Table 1. Massport will fund this project. There will be no land transfers.

The expansion of the capacity of the LEX Framingham garage is a key element in Massport's HOV initiatives. Massport had planned to complete design and commence construction during 2020. However, given the disruptions to the airline industry due to the COVID-19 pandemic, Massport is currently re-evaluating the schedule of all ongoing design and construction projects to best match Massport priorities, projected ridership, and available funding.

Table 1 List of Permits and Approvals

Permit / Approval	Agency/Board	Status
Local		
Order of Conditions (OOC)	Framingham Conservation Commission	Hearing Closed May 20, 2020. OOC issued June 2, 2020.
State		
State Building Permit State Plumbing Permit	Office of Public Safety	Prior to Construction

3.0 ALTERNATIVES

Project build alternatives were limited based on several factors:

- The existing building footprint, access drives, and temporary parking spaces maximize existing site coverage without intruding into adjacent wetlands; and
- The garage foundations were originally constructed to support a maximum of seven levels which is the current proposal.

The EENF discussed both horizontal expansion which would have required permanent alteration of several wetland resource areas and a reduced vertical expansion which would not have meet the project need for increased HOV ridership, reduced VMTs and reduced local and regional emissions. Accordingly, neither of those alternatives are carried forward into this Single EIR.

Similarly, a no-build alternative would also not meet the project need for increased HOV ridership, reduced VMTs and reduced local and regional emissions. Section 3.1 provides an overview of the Preferred Alternative followed by Section 3.2 which provides a brief discussion of the No-Build Alternative.

3.1 PREFERRED ALTERNATIVE

Consistent with the original description in the 2013 ENF and as updated in the 2020 EENF, Massport plans to add three additional levels to the existing four-level parking garage. This vertical expansion will increase the capacity of the garage by 998 parking spaces, from the existing 1,082 spaces to 2,080 spaces. Massport intends to continue to lease 565 existing parking spaces along the adjacent Flutie Pass for use on an as-needed basis during peak travel periods. Periodic use of overflow parking at Shopper's World would be discontinued upon opening of the new garage levels. The capacity of the existing and proposed garage, by level, is provided in Table 2.

Note: the data presented in the following paragraphs related to GHG emissions and traffic volumes for the 2029/2030 future build year were prepared to support the EENF during February 2020. Since then, the COVID-19 worldwide pandemic has had a substantial impact on Massport operations; including a dramatic reduction in the number of daily flights and a nearly 90% reduction in passenger levels in the spring of 2020. However, Massport believes that passenger volumes levels will recover in the upcoming years and that these projections remain valid.

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Table 2 LEX Framingham Garage Parking Capacity

Garage Level	Existing Garage	Proposed Garage¹
<i>Short Term & Valet</i>	45	40
<i>Ground Level</i>	176	175
<i>2nd Level</i>	216	213
<i>3rd Level</i>	341	337
<i>4th Level (Roof of Existing)</i>	304	337
<i>New 5th Level</i>	0	337
<i>New 6th Level</i>	0	337
<i>New Roof Level</i>	0	304
Garage Total	1,082	2,080
Increase in Garage Parking Spaces		998
Leased Parking Spaces	697	565 ²

¹ Parking space capacity is reduced on lower levels due to new electrical equipment rooms and improvements to the vehicle travel lanes.

² With the completion of the garage expansion, remote parking at Shopper’s World will be discontinued.

Massport forecasts that by 2030 expanding the parking capacity at the Logan Express service in Framingham by 998 spaces and the continued use of the overflow parking spaces, as needed, will annually eliminate 1,100,000 vehicle trips on the Logan Airport gateway entrances/exits including the Sumner and Callahan Tunnels and the Williams Tunnel (I-90). By 2029, these avoided trips would result in a reduction of 11,605 tons per year in GHG (as measured in CO₂E). This is 62% more (7,261 tons of CO₂E) than the Future No-Build Alternative (which includes continued use of the existing 1,082 space garage with 565-space overflow parking, as needed). This would more than double the existing annual number of avoided trips between MetroWest and Logan Airport that result from Massport’s operation of the Framingham Logan Express facility.

The 2019 Traffic Impact and Access Study (recently updated and provided as Appendix B) determined that, on an average weekday, in the future-build year (2029) the proposed garage will add approximately 1,496 vehicle trips to the surrounding road network. During the weekday morning peak hours, approximately 88 vehicle trips (45 in and 43 out) will be added to the surrounding road network, while during the evening peak hour approximately 117 (58 in and 59 out) vehicle trips will be added.

Based on those assumptions, approximately half of the trips will be drop-off/pick-up and bus movements trips with the remaining half of the trips will be for long-term parking at the garage. From a traffic operations perspective, the differences between the No-Build and Build Alternative’s effect on local traffic operations are relatively minor. Site bus operations should improve with the proposed reconfiguration of the facility, with reduced pedestrian/vehicle conflicts.

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In line with Massport's authority-wide sustainability planning, as part of the expansion project, Massport will implement several new elements to the garage to enhance efficiency, reduce electricity demand and facility-wide emissions. These new measures are described below.

3.1.1 Facility and Bus Service Improvements

In addition to the added parking spaces and overall trip reduction, Massport is evaluating the following facility and bus service improvements at LEX Framingham:

Service Improvements

- Increase bus frequency from two to three times hourly (to be initiated upon resumption of suitable passenger demand post COVID-19 recovery).
- Initiate E-ticketing for improved customer convenience and speed up boarding.

Facility Improvements

Modifications to terminal building to simplify and speed up passenger loading and unloading, including:

- Clear signage directing vehicles picking up passengers to short-term lot.
- Potential new garage automated parking guidance system to direct persons to available parking spaces.
- Addition of two new elevators providing service to all garage levels. Existing elevators shall provide service to existing levels only.
- Expansion of security closed circuit television system.
- Passenger assistance call boxes on all new levels.
- Ticketing kiosks at overflow parking lot.
- Enhanced signage regarding overflow lot operations, bus schedules and directions to garage.

Environmental Enhancements

Massport will design and construct the facility in accordance with their Sustainability and Resiliency Design Guidelines (SRDG). Environmental initiatives for the garage and terminal facility to be included in the design of the facility include:

- Solar photovoltaic power panels on garage façade
- High efficiency LED lighting

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- Electric Vehicle (EV) Charging Stations/Alternative fuel vehicle priority parking locations. Currently, there are two dual charging stations installed, serving four EV parking spaces. Once the Project is complete, this number will be increased to six installed EV parking spaces. Additional conduit and infrastructure will be placed for two additional parking spaces, bringing the future building's EV capacity to six installed spaces and two EV-ready spaces.
- Bike Racks
- Water saving restroom fixtures
- Roof runoff from the new facility will continue to be directed to the existing stormwater system on the site, while the runoff from the interior levels of the garage will be directed to the sewer system. Stormwater pollutants will be minimized as the roof parking will be only be used during peak operation, and snow-melting machines will be utilized in place of de-icing chemicals.

3.2 OTHER ALTERNATIVE CONSIDERED

In response to the Secretary's Certificate on the EENF, Massport evaluated the possibility of relocating the existing overflow parking along Flutie Pass to a location closer to the garage facility. As illustrated on Figure 2, the overflow lot at the AMC Theatres is approximately 1,300 feet away from the terminal and garage. As discussed below, shifting this overflow parking lot to a location closer to the garage is not practicable.

Massport recently extended the lease for the 490-space AMC lot along Flutie Pass through 2030, with an option for an additional 10-year extension. As part of this plan, Massport also entered into an agreement to upgrade the adjacent 75-space parking at the former "Fran's Flowers" garden facility. Together, these connected lots have a capacity of 565 spaces. As noted earlier, with the completion of the garage expansion project, Massport will no longer use the temporary overflow spaces at Shopper's World.

To clarify the current operation of the LEX Framingham overflow parking spaces, users are directed to use the overflow parking at the AMC Theater along Flutie Pass (Lot 4) when the main parking garage at the terminal building is full. Users of the overflow parking must currently park in short term parking at the main terminal building, purchase their Logan Express bus ticket in the building and then drive to Lot 4. Users who park in the overflow lot then wait for a Logan Express bus that originates from the terminal building to pick them up and then departs towards Logan Airport. Similarly, the Logan Express bus that originates at Logan Airport will make a stop at the overflow Lot 4 to discharge users before arriving at its final destination at the main Logan Express terminal building. Passengers disembarking at Lot 4 will have purchased their bus ticket either at Logan Airport or from the bus driver. They currently do not pay for parking at Lot 4.

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The Logan Express buses serve the overflow parking lot at the same frequency as the main facility. The overflow lot is equipped with a shelter to allow passengers to be weather protected. Although there are sidewalks between the overflow lot and the main terminal, passengers are discouraged from walking between the two parking areas. With frequent bus service and revenue control, there is no need to visit the main terminal once parked at the overflow lot. Massport has not experienced many user complaints regarding use of the overflow lot and does not see the that the location of the remote lot as a disincentive for use of the Framingham Logan Express service. Massport will add revenue control and security cameras and continue to monitor use of the overflow lot.

3.2.1 Alignment with Regional Bus Routes

A comment received on the EENF suggested that the distance between the Metro West Regional Transit Authority's (MWRTA) bus stop at the AMC overflow lot and the garage was a barrier to higher use of this Logan Express facility. As illustrated on Figure 2, the overflow lot is approximately 1,300 feet away from the terminal and garage. Parking industry standards generally suggest that the walkable limit is approximately 1,000 feet.

Massport has recently contacted the MWRTA. While several the MWRTA services are temporarily reduced or suspended due to the ongoing COVID-19 pandemic, Massport and the MWRTA have agreed to coordinate on a more regular basis as activity levels and the use of public transportation services recover. This coordination will include determining if relocation of this bus stop or adding an additional bus stop at the LEX Framingham terminal building would best serve MWRTA customers and be compatible with LEX operations. The feasibility of aligning the timing and frequency of their respective bus schedules would also be considered.

4.0 TRANSPORTATION

An updated Transportation Impact Analysis (TIA) has been prepared that addresses all information requested within the Secretary's Certificate. The updated TIA is provided as Appendix B. New information provided in the TIA includes the following:

- States that considering the dampening effect of the COVID-19 on existing Logan Airport passenger levels and vehicular traffic volumes, the future (2029) build traffic levels reported most likely represent a conservative estimate of traffic conditions.
- Clarifies the current operation of the overflow lots at the LEX Framingham in which users are directed to use Lot 4 (the AMC lot) when the main parking garage at the Framingham Logan Express terminal building is fully occupied. Users of Lot 4 must currently park in short term parking at the main terminal building, purchase their Logan Express bus ticket in the building and then drive to Lot 4. Users who park in Lot 4 wait for a Logan Express bus, that originates from the main Framingham Logan Express terminal building, to pick them up, and then depart towards Logan Airport. Similarly, the Logan Express bus that originates at Logan Airport will make a stop at Lot 4 to discharge users before arriving at its final destination at the main Framingham Logan Express terminal building.
- Clarifies that the trips to the overflow lots were incorporated into existing conditions traffic counts.
- Confirms that there are currently two bikes racks (16 bike storage spaces) inside the garage. Observations indicate that these spaces are not heavily used (1-2 bicycles). If usage of the bike racks increases in the future, space exists to add additional bike racks.

5.0 GREENHOUSE GAS EMISSIONS

An initial Greenhouse Gas (GHG) analysis was presented in the Expanded Environmental Notification Form (EENF). The initial analysis addressed the GHG emissions that would be generated by operation of the Project, and options that may reduce those emissions in accordance with the MEPA GHG Policy.

The GHG analysis presented in the EENF focused 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 structures and equipment that are stationary on the site; and (2) mobile sources, or emissions related to transportation. Stationary sources can be further broken down into direct sources and indirect sources; direct sources include GHG emissions from on-site 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 for use on-site.

As discussed in previous filings, the Project consists of 3 levels of parking garage to be constructed on top of an existing parking garage. The Project is unconditioned (the garage parking levels are neither heated nor cooled). The stationary source analysis is limited to lighting and proposed on-site photovoltaics (PV). The EENF Certificate included comments from Massachusetts Environmental Policy Act (MEPA) Office and the Department of Energy Resources (DOER). In this continuation of the GHG analysis, MEPA and DOER comments are addressed.

5.1 ON SITE PHOTOVOLTAIC (PV)

5.1.1 Proposed Design

The proposed Project includes the addition of Solar PV on the façade of the building. Simulations were run on numerous scenarios for the façade PV. Solar modeling was performed using PVsyst v.6.8.6 using Metonorm data. This modeling was further updated using National Renewables Energy Laboratory (NREL) data. Based on the options modeled, Massport has chosen the Base Option, four hundred and four JinkiSolar (or equivalent) panels. This system will have an estimated production of 159 MWh/year and will offset an estimated 54 tons of GHG annually. Please refer to Appendix 3 for an updated PV Report.

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5.1.2 Canopy PV

A solar canopy was also considered for the top level of the proposed Project. The proposed building height is 69.31 feet, measured from grade plane to the top of the highest parking deck surface. Chapter 2 of 780 CMR defines a "high-rise building" as "a building more than 70 feet in height above grade plane." This height threshold is also used in MGL Chapter 148 - Fire Prevention, Section 26A, which states, "Every building or structure of more than seventy feet in height above the mean grade shall be protected with an adequate system of automatic sprinklers in accordance with the provisions of the state building code...". When this issue was discussed with the State Building Inspector, he advised the design team that the height of any structural framework supporting a rooftop solar PV system would be included in the determination of the building height.

The height of the building with the solar PV structural assembly installed would be approximately 80.8 feet. As the garage would be greater than 70-foot in height, the design team confirmed that adding such a structural assembly to the rooftop would classify the parking garage as a high-rise building, thus triggering the requirement to install fire suppression throughout the entire garage building, including retrofitting existing levels that are not part of the proposed project.

An in-depth structural analysis has not been performed to determine if the existing structure can support a rooftop solar PV array, or if modifications to the existing structure would be required to support the array. However, for the purpose of this alternative analysis, it was assumed that garage structure would be capable of supporting a rooftop solar PV array.

The design team evaluated the potential benefit of a canopy PV system. The canopy system could be owned, installed, and maintained by Massport. Alternatively, the system could be owned, installed, and maintained by a third party through a power purchase agreement (PPA). The PPA scenario was further evaluated as it is more financially favorable.

An approximate 40,320 sf canopy could be built on the top level of the garage (refer to Appendix C-2 for a preliminary canopy area study). A PV system of this size could be capable of generating approximately 488 MWh of electricity annually. Assuming this on-site electricity replaces the purchase of electricity at \$0.18 per kWh, the canopy system could save Massport approximately \$87,900 annually. In a PPA arrangement, the property owner does not benefit from State or Federal incentives. The design team received an estimate of \$4.3 million dollars to install the required fire suppression system throughout the existing and proposed garage.

Given these assumptions, that a 40,320 sf canopy solar PV system built on the garage roof would save Massport approximately \$87,900 annually, but that the addition of this

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solar PV canopy system would trigger the requirement to install a \$4.3 million fire suppression system, the pay-back period for the installation of a third-party owned solar PV canopy system would be approximately 48 years.

Given the long payback period, the solar PV canopy system has been deemed infeasible at this time. As detailed above, Massport has already committed to adding Solar PV on the façade of building instead of the roof.

5.2 STATIONARY SOURCES

5.2.1 Lighting Summary

The lighting design and lighting power reduction remain unchanged from the EENF. The Project proposes highly efficient lighting that will incorporate motion sensors and ambient light sensors to achieve an estimated 75% reduction below Massachusetts Energy Code requirements. Analysis of the energy use for the proposed lighting shows that 783.9 kilowatt-hours (kWh) are saved daily compared to Massachusetts Energy Code standards for the building which equates to approximately 286 MegaWatt-hours (MWh) of saved energy annually. At a carbon dioxide emission factor of 682 pounds per Megawatt-hour (lb/MWh)¹, the 286 MWh per year reduction in energy use accounts for a 97.5 ton per year reduction in GHG emissions compared to baseline. Please refer to Appendix C-3 for the Lighting Report.

5.2.2 Overall Facility Stationary Sources

As detailed above, lighting is the Project's only stationary source of GHG emissions. The estimated annual lighting consumption for the Project is 97.1 MWh. The existing facility uses approximately 580 MWh of electricity annually through lighting, heating and cooling the terminal building, and electric-powered equipment. When the Project is complete, the facility is estimated to consume approximately 677 MWh of electricity annually. This equates to approximately 231 tons of CO₂ annually.

5.2.3 Electric Vehicle Charging Stations

Massport has carefully considered the current electric vehicle (EV) demand at their parking facilities to determine the need for additional EV capacity. Currently, there are two dual charging stations installed, serving four EV parking spaces. Once the Project is complete, this number will be increased to six installed EV parking spaces. Additional conduit and infrastructure will be placed for two additional parking spaces, bring the future building's EV capacity to six installed spaces and two EV-ready spaces.

¹ 2017 ISO New England Electric Generator Air Emissions Report, Table 1-1 (https://www.iso-ne.com/static-assets/documents/2019/04/2017_emissions_report.pdf)

5.3 MOBILE SOURCES

The mobile source analysis performed in the EENF remains valid and unchanged. A minor transcription error has been corrected from the EENF, resulting in an increased GHG reduction commitment. Table 3 summarizes the Project's mobile source emissions.

Table 3 Project GHG Mobile Source Emissions Summary

	Baseline 2029 No-Build	Proposed 2029 Preferred- Build	Difference	
	tons/yr	tons/yr	tons/yr	percent change
Mobile Sources	8,738	1,677	-7,061	-80.8%

While the local traffic GHG emissions are expected to increase by approximately 199 tons annually due to the proposed Project's three new levels of parking, the Project's reduction in GHG emissions due to the reduced trips to Logan airport is estimated to be 7,260 tons annually. As a result of overall vehicle trip reduction, the proposed Project's net CO2 emissions are -7,061 tons per year.

5.4 SUMMARY AND MITIGATION COMMITMENTS

The proposed project will include a reduced lighting density that will decrease energy by approximately 75% over a code baseline. In addition, the Project will include a PV installation that will generate approximately 59 MWh/year. Finally, the Project's nearly 1000 new parking spaces will eventually lead to avoiding approximately 1.1 million trips between Framingham and Logan Airport.

Table 4 presents the building GHG emissions for the Baseline and Proposed cases.

Table 4 Project GHG Emissions Summary

	Baseline	Proposed	Difference	
		tons/yr		Percent Change
Stationary Sources (lighting)	130.7	33.1	-97.5	-74.7%
Façade Photovoltaics	na	-54	-54	na
Mobile Sources	8,738	1,677	-7,061	-80.8%

5.4.1 Massport's Commitments to GHG Reduction

Massport's project commitments to GHG reduction and overall environmental stewardship remain unchanged from the EENF. Throughout this chapter, Massport's commitments to mitigate Project GHG emissions are described. As facility design develops, Massport expects that additional technologies described previously, or possibly new technologies developed in the interim period, may be adopted that will further decrease GHG emissions. Massport will encourage the continued evaluation of energy efficiency and renewable energy measures throughout the life of the Project.

Massport is committed to the following building mitigation elements for the Project:

- Reduced lighting power densities;
- Façade PV installation; and
- Addition of two electric vehicle charging stations with two additional EV-ready spaces.

Massport 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 design of the building, a specific combination of design strategies proves more advantageous from an engineering, economic, or space utilization perspective, then the design of the building may vary from what has been described herein. Energy performance minima and associated GHG emission reductions will be adhered to.

Upon completion of the garage additions, Massport 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 building and will illustrate the degree of GHG reduction from a Baseline case, as Baseline is defined herein, and how such reductions are achieved. Details of Massport's implementation of operational measures will also be included.

6.0 CONSTRUCTION PERIOD

Prior to construction Massport will work with the selected construction contractor to develop a Construction Management Plan that identifies specific measures to be implemented during construction, including the following:

- Safe and uninterrupted movement of vehicles, pedestrians, and bicyclists.
- Identifies storage and staging areas for construction materials (preliminary staging down areas are identified on Figure 4).
- Identifies preferred construction vehicle access routes to the Project site (preliminary construction access route identified on Figure 5)
- Measures to control potential construction-related air quality and noise impact.
- Measures to control potential negative impact to wetlands, water quality, and stormwater management (compliance also through adherence with the Order of Conditions issued for the Project by the Framingham Conservation Commission).
- Notification and construction protocols to be implemented if contamination is encountered at the site during construction
- Measures to ensure safe and continues access to portions of the garage to remain open for LEX parking

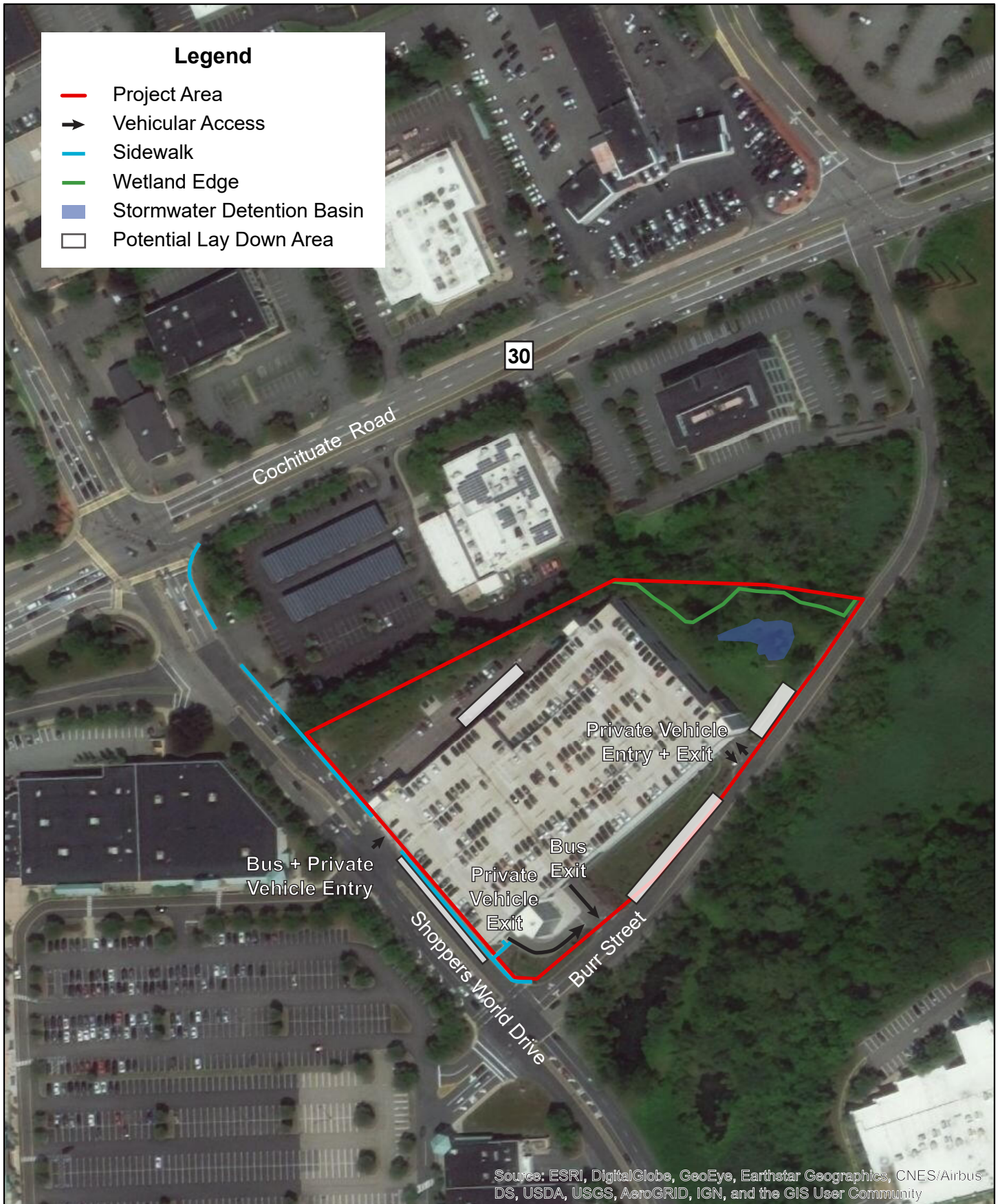
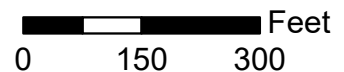


Figure 4 - Project Site - Access and Lay Down Areas

Massport Logan Express Garage Expansion
 Framingham, MA



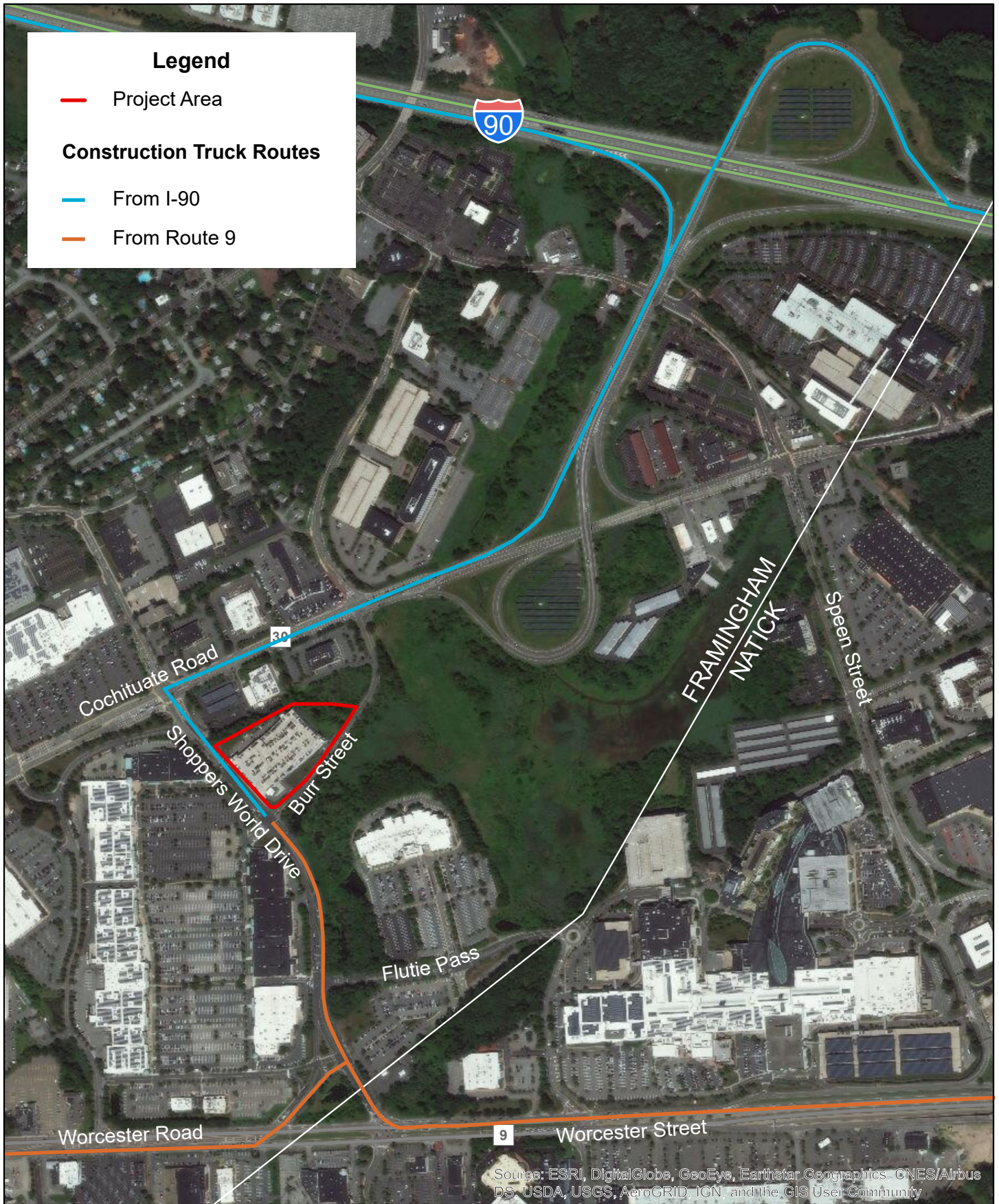
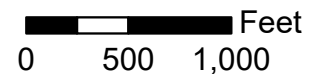


Figure 5: Construction Truck Routes

Massport Logan Express Garage Expansion
Framingham, MA



7.0 MITIGATION AND DRAFT SECTION 61 FINDINGS

7.1 INTRODUCTION

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 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."

Massport recognizes that the identification of effective mitigation, and implementation of that mitigation throughout the life of the Project, is central to its responsibilities under the Massachusetts Environmental Policy Act (MEPA).

Table 5 describes the measures to be implemented by Massport to mitigate the effects of the Project related to the required state actions, other measures, and the schedule for implementation. All mitigation will be the responsibility of Massport. Table 1 (Section 2.5) provides a list of all required local, state, and federal approvals.

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7.2 DRAFT SECTION 61 FINDING

Project Name: Logan Express Garage Expansion
Project Location: 11 Burr Street, Framingham, MA
Project Proponent: Massachusetts Port Authority
EEA Number: 16168

The potential environmental impacts of the Project have been characterized and quantified in the Expanded ENF dated March 2, 2020 and the Single EIR dated July 31, 2020, which are incorporated by reference into this Section 61 Finding. Throughout the planning and environmental review process, Massport has been working to develop measures to maximize the environmental benefits of additional HOV services and mitigate the temporary construction impacts.

Massport finds that: (a) the selection and implementation of the Project's Preferred Alternative and assessment of environmental impacts associated with the Project are properly and adequately described and evaluated in the EENF and Single EIR; (b) the description of the environmental impacts set forth in these documents is adopted as a specific finding herein; and (c) by implementing the environmentally beneficial measures and mitigation measures set forth in the EENF and Single EIR, all practicable means and measures will be taken to minimize damage to the environment. In making this finding, Massport has considered reasonably foreseeable climate change impacts and effects, including greenhouse gas emissions and potential sea level rise.

Massport further finds and determines that the improvements constituting the Preferred Alternative for the Project, as set forth in the EENF and Single EIR, will enhance the operation of Logan Airport, reduce regional roadway congestion and associated vehicle emissions, and better serve the traveling public.

Massport hereby makes the findings set forth below in accordance with M. G. L. c.30, § 61, and hereby authorizes and directs the CEO/Executive Director to implement the measures described herein.

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7.2.1 Project Summary

Logan Express is a high-occupancy vehicle (HOV) transit service offered by Massport, transporting passengers by bus between each of its five satellite locations in Braintree, Framingham, Woburn, Peabody, and Boston (Back Bay), and Boston- Logan International Airport (Logan Airport). The Logan Express system in Framingham provided HOV bus service to and from Logan Airport for more than 616,200 riders in 2019. Throughout 2019, the demand for parking spaces at the Logan Express Framingham facility exceeded supply 11 months of the year.

The Project involves the expansion of the existing Logan Express parking garage facility located at 11 Burr Street in the City of Framingham. Massport proposes to increase the capacity of the Framingham Logan Express garage by adding three additional levels on top of the existing four-level garage. The new levels were envisioned when the garage was initially approved in 2013 and constructed in 2015. The additional 998 parking spaces would expand garage capacity from the existing 1,082 spaces to 2,080 spaces. The vertical expansion would be contained within the existing garage footprint; no additional land would be used for the Project. As part of this plan, Massport also anticipates continued lease of 565 overflow parking spaces at the nearby AMC Theatres along Flutie Pass.

7.2.2 Facility Sustainability and Resiliency Enhancements

Massport will design and construct the facility in accordance with their Sustainability and Resiliency Design Guidelines (SRDG). Environmental initiatives for the garage and terminal facility to be included in the design of the facility include:

- Solar photovoltaic power panels on garage façade
- High efficiency LED lighting
- Electric Vehicle (EV) Charging Stations/Alternative fuel vehicle priority parking locations. Currently, there are two dual charging stations installed, serving four EV parking spaces. Once the Project is complete, this number will be increased to six installed EV parking spaces. Additional conduit and infrastructure will be placed for two additional parking spaces, bringing the future building's EV capacity to six installed spaces and two EV-ready spaces.
- Bike Racks
- Water saving restroom fixtures

Roof runoff from the new facility will continue to be directed to the existing stormwater system on the site, while the runoff from the interior levels of the garage will be directed to the sewer system. Stormwater pollutants will be minimized as the roof parking will be

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only be used during peak operation, and snow-melting machines will be utilized in place of de-icing chemicals.

7.2.3 Project Benefits

As demonstrated by its purpose, the implementation of the Project itself is an environmentally beneficial measure. As described below, the Project and its associated program elements will increase HOV travel to Logan Airport for customers and employees, reduce VMT, improve regional air quality, and improve the passenger experience by adding 998 parking spaces to the existing Logan Express parking garage in Framingham entirely within the Massport property footprint. Except for the temporary construction impacts described below, no significant adverse environmental impacts resulting from the implementation of the Project have been identified.

The following sections describe facility and bus service improvements that will be implemented in conjunction with the Project, and the greenhouse gas emissions reductions benefits that will result from Project implementation.

7.2.3.1 Facility and Bus Service Improvements

In line with Massport's Authority-wide sustainability planning, as part of the expansion project, Massport will implement several new elements to the garage to enhance efficiency, reduce electricity demand and facility-wide emissions. These new measures are described below.

In addition to the added parking spaces and overall trip reduction, Massport is evaluating the following facility and bus service improvements at LEX Framingham:

Service Improvements

- Increase bus frequency from two to three times hourly (to be initiated upon resumption of suitable passenger demand post COVID-19 recovery).
- Initiate E-ticketing for improved customer convenience and to speed up boarding.

Facility Improvements

Modifications to terminal building to simplify and speed up passenger loading and unloading, including:

- Clear signage directing vehicles picking up passengers to short-term lot.
- Potential new garage automated parking guidance system to direct persons to available parking spaces.

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- Addition of two new elevators providing service to all garage levels. Existing elevators shall provide service to existing levels only.
- Expansion of security closed circuit television system.
- Passenger assistance call boxes on all new levels.
- Ticketing kiosks at overflow parking lot.
- Enhanced signage regarding overflow lot operations, bus schedules and directions to garage.

7.2.3.2 Surface Transportation and Greenhouse Gas Emissions Benefits

Massport forecasts that by 2030 expanding the parking capacity at the Logan Express service in Framingham by 998 spaces and the continued use of the overflow parking spaces, as needed, will annually eliminate 1,100,000 vehicle trips on the Logan Airport gateway entrances/exits including the Sumner and Callahan Tunnels and the Williams Tunnel (I-90). By 2029, these avoided trips would result in a reduction of 11,605 tons per year in GHG (as measured in CO₂E). This is 62% more (7,261 tons of CO₂E) than the Future No-Build Alternative (which includes continued use of the existing 1,082 space garage with 565-space overflow parking, as needed). This would more than double the existing annual number of avoided trips between MetroWest and Logan Airport that result from Massport's operation of the Framingham Logan Express facility.

7.2.4 Construction Period Management

Prior to construction, Massport will work with the selected construction contractor to develop a Construction Management Plan that identifies specific measures to be implemented during construction, including the following:

- Safe and uninterrupted movement of vehicles, pedestrians, and bicyclists.
- Identifies storage and staging areas for construction materials.
- Identifies preferred construction vehicle access routes to the Project site.
- Measures to control potential construction-related air quality and noise impact.
- Measures to control potential negative impact to wetlands, water quality, and stormwater management (compliance also through adherence with the Order of Conditions issued for the Project by the Framingham Conservation Commission).
- Notification and construction protocols to be implemented if contamination is encountered at the site during construction

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- Measures to ensure safe and continuous access to portions of the garage to remain open for LEX parking

7.2.5 Timing and Responsibility of Implementation

All measures will be implemented according to the Project's construction schedule. Construction of this garage is expected to begin no earlier than 2021. Non-construction mitigation measures will be implemented as part of the design or operation of the Project elements. Table 5 (below) provides a summary of the mitigation commitments. Massport will be responsible for implementing all mitigation measures.

Table 5 Summary of Mitigation Commitments

Mitigation	Schedule	Estimated Cost	Responsible Party
Greenhouse Gas Emissions			
Reduced Power Densities	Concurrent with garage construction	Part of overall garage construction cost	Massport
Façade Solar PV Installation	Concurrent with garage construction	\$676,000	Massport
Addition of two electric vehicle charging stations with two additional spaces EV-ready	Concurrent with garage construction	\$13,000	Massport
Construction Period Mitigation Measures			
Safe and uninterrupted movement of vehicles, pedestrians, and bicyclists.	During construction	Part of overall garage construction cost	Massport
Identifies preferred construction vehicle access routes to the Project site	During construction	Part of overall garage construction cost	Massport
Measures to control potential construction-related air quality and noise impact.	During construction	Part of overall garage construction cost	Massport
Measures to control potential impact to wetlands, water quality, and stormwater management (compliance also through adherence with the Order of Conditions issued for the Project by the Framingham Conservation Commission).	During construction	Part of overall garage construction cost	Massport

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Mitigation	Schedule	Estimated Cost	Responsible Party
Notification and construction protocols to be implemented if contamination is encountered at the site during construction	During construction	Part of overall garage construction cost	Massport

8.0 RESPONSE TO COMMENTS

8.1 ANNOTATED MEPA EENF CERTIFICATE AND COMMENT LETTERS

This section provides a copy of the MEPA Certificate on the Expanded ENF and both comment letters. Each comment has been annotated with an identifying comment number. Responses to each comment are provided in the following section.



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

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Kathleen A. Theoharides
SECRETARY

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

April 17, 2020

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

PROJECT NAME	: Logan Express Framingham – Garage Expansion
PROJECT MUNICIPALITY	: Framingham
PROJECT WATERSHED	: SuAsCo
EEA NUMBER	: 16168
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: March 11, 2020

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G. L. c. 30, ss. 61-62I) and Section 11.06 of the MEPA regulations (301 CMR 11.00), I have reviewed the Expanded Environmental Notification Form (EENF) and hereby determine that this project **requires** the submission of an Environmental Impact Report (EIR). The EENF was submitted to support the Proponent's request to file a Single EIR, rather than a Draft and Final EIR, pursuant to Section 11.06(8) of the MEPA regulations. The Proponent should submit a Single EIR in accordance with the Scope included in this Certificate.

Project Description

The project involves increasing the capacity of the Massachusetts Port Authority's (Massport) existing Logan Express Parking Garage in Framingham. Logan Express is a transit service offered by Massport which transports passengers by bus between each of its five satellite locations in Peabody, Woburn, Framingham, Braintree and Boston (Back Bay), and Logan Airport. At each of the four suburban facilities, including Framingham, users are able to park their vehicles for a fee and take the Logan Express bus directly to Logan Airport's four passenger terminals. Some users of the Logan Express bus service are also dropped off/picked up at the facility and do not use the parking facilities. The Logan Express system currently carries

approximately 2 million passengers annually and is a component of Massport's overall trip reduction and high occupancy vehicle (HOV) strategy. This project will contribute to Massport's goal of increasing HOV mode share to Logan Airport by 40 percent by 2027 as part of MassPort's commitment to reduce roadway congestion and associated greenhouse gas (GHG) emissions.

The existing four-level garage at the Framingham Logan Express facility has a capacity of 1,082 spaces on site, in addition to approximately 697 overflow spaces at nearby commercial properties (total of 1,779 spaces). The project proposes to construct an additional three levels of parking (998 new parking spaces) on the existing four-level garage for a total of 2,080 spaces on-site, while continuing to lease 565 of the currently available 697 overflow parking spaces off-site (total of 2,645 spaces). The project is proposed to meet existing and future demand of air passenger and employees seeking access to Logan Airport. Since the Framingham garage opened in 2015, annual ridership has exceeded projected demand and has increased by 147,000 trips per year (34.1 percent) between 2015-2018.

As described in Massport's recent Environmental Status and Planning Report (ESPR) (EEA#3247) for Logan Airport, Massport has a comprehensive vehicle trip reduction strategy to diversify and enhance ground transportation options for passengers and employees traveling to and from Logan Airport. To improve accessibility to the Airport as well as to relieve on-Airport roadway congestion, Massport proposes to enhance HOV and Logan Express facilities, implement on-Airport roadway and Massachusetts Bay Transportation Authority (MBTA) Blue Line/intra-terminal connectivity projects, construct a consolidated transportation network company (TNC, such as Uber and Lyft) drop-off and pick-up area, and construct new parking facilities, which will help reduce the number of drop-off/pick-up trips. Massport's plan includes doubling Logan Express annual ridership from 2 million to 4 million which will be advanced through this project.

MEPA Review History

An ENF (EEA#12412) was filed in 2001 proposing to construct a 1,081-space parking garage at the project site. A Certificate was issued on February 23, 2001 determining that no further MEPA review was required. However, the project was not constructed and a second ENF (EEA#15144) was filed in 2014 due to lapse of time. The project consisted of the construction of a bus terminal and five-story parking garage with 1,500 parking spaces which would replace an existing surface parking lot (374 spaces) at the facility and consolidate off-site overflow parking (500 spaces) used when Massport's lot was full. The Certificate indicated that if sufficient funding was not available for a five-level garage, a four-level garage accommodating 1,100 parking spaces would be constructed. As described in the Certificate, at the time of project design and permitting, a future vertical expansion was contemplated; therefore, the garage was designed to structurally support up to seven levels of parking. The purpose of the project was to add parking capacity and consolidate remote overflow lot operations into a single new garage facility. Upon discontinuation of the 500 off-site overflow spaces leased by Massport, the project would result in an additional 626 net New spaces to accommodate projected future demand (1,500 total spaces).

A Certificate on the second ENF (EEA# 15144) was issued on February 28, 2014 which determined no further MEPA review was required. Massport subsequently constructed a four-level parking garage accommodating 1,082 parking spaces with the plan to phase out use of overflow spaces leased off-site. However, once the parking garage was opened in 2015, it was almost immediately filled to capacity due to the convenience of the service and growth in passenger levels at Logan Airport. Therefore, Massport has continued to operate the overflow lots since the opening of the garage and use of the 500 off-site spaces were not taken out of service and up to an additional 197 off-site were periodically used during high demand periods. Because use of the off-site overflow spaces was not contemplated at the time MEPA review previously concluded, approximately 565 off-site spaces which will continue to be utilized, are considered New, in addition to the 998 New spaces to be offered through vertical expansion of the parking garage (1,563 total).

Project Site

The 4.63-acre project site consists of the existing Logan Express Facility which includes the four-level, 382,700 sf parking garage with 1,082 parking spaces, bus terminal, ticket office, waiting area, vending area and restrooms. Approximately 3.14 acres of the project site is impervious, the remainder of the site consists of lawn and landscaping around the building perimeter, storm drainage infrastructure, and forested upland and wetlands.

Massport currently leases an additional 697 parking spaces from adjacent property owners including 490 spaces at the AMC Theatres parking lot, 75 spaces at Fran's Florist and up to 132 additional parking spaces at the Shopper's World parking lot. Use of the 132 spaces at the Shopper's World is expected to end upon the opening of the garage expansion, leaving a total of 565 overflow spaces available off-site.

Environmental Impacts and Mitigation

Potential environmental impacts associated with the project include the generation of 1,496 new adt (4,800 adt total); construction of 998 new parking spaces (2,645 total); increase in water demand by 440 gallons per day (gpd) (890 gpd total); and increase in wastewater generation by 400 gpd (805 gpd total). As described below, the project is anticipated to have environmental benefits overall due to the reduction in vehicle miles traveled to and from Logan Airport and a net reduction of associated GHG emissions of 7,061 tons per year (tpy) (net of the marginal increase in emissions associated with increased traffic in the project vicinity).

The ENF identifies the following measures to avoid, minimize, and mitigate project impacts: avoiding construction period impacts to wetlands, use of sediment and erosion controls during construction and implementation of energy efficiency measures within the parking garage including the provision of a solar array.

Jurisdiction and Permitting

The project is undergoing MEPA review and is subject to a mandatory EIR pursuant to 301 CMR 11.03(6)(a)(7) of the MEPA regulations because it involves Agency Action and

involves the construction of 1,000 or more new parking spaces at a single location. The project also exceeds the ENF threshold at 11.03(6)(b)(14) because it will generate 1,000 or more new adt and create 150 or more new parking spaces at a single location. The project is being undertaken by Massport. The project is subject to the MEPA Greenhouse Gas Policy and Protocol (GHG Policy).

The project requires an Order of Conditions from the Framingham Conservation Commission due to temporary impacts proposed to the 100-ft buffer zone to Bordering Vegetated Wetlands (BVW) during the construction period. In the case of an appeal, the project may require a Superseding Order of Conditions from the Massachusetts Department of Environmental Protection (MassDEP).

Because the project is being undertaken by Massport, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Single EIR Request

Massport requested that it be allowed to file a Single EIR in lieu of a Draft and Final EIR. The MEPA regulations indicate a Single EIR may be allowed, provided I find that the EENF:

- a) describes and analyzes all aspects of the project and all feasible alternatives, regardless of any jurisdictional or other limitation that may apply to the Scope;
- b) provides a detailed baseline in relation to which potential environmental impacts and mitigation measures can be assessed; and,
- c) demonstrates that the planning and design of the Project use all feasible means to avoid potential environmental impacts.

Massport submitted an EENF to satisfy the requirements for a Single EIR and, as required, the EENF was subject to an extended comment period which closed on April 10, 2020. The EENF provided a detailed project description, a baseline for evaluating environmental impacts and a comprehensive alternatives analysis. The EENF identified how the project is designed to achieve consistency with regulatory standards and measures to avoid, minimize and mitigate project impacts.

Review of the EENF

The EENF included a description of the proposed project and described the history of the project. The EENF provided supporting graphics and updated conceptual site plans that identified existing and proposed conditions, access roads and internal driveways. The EENF included an analysis of the project's transportation impacts including impacts on nearby roadway intersections. The EENF identified all federal, State, and local permits and approvals required for the project and discussed how the project will be developed in a manner consistent with applicable regulatory standards and requirements.

Comments from Air Inc. are supportive of the project and encourage Massport to further develop HOV ridership through additional coordination with regional transportation authorities including through providing terminal service for other buses, and to explore the feasibility of incorporating Bus Rapid Transit (BRT) into the Logan Express system.

Alternatives Analysis

The project involves the vertical expansion of an existing facility. Therefore, the alternatives analysis was limited to a No-Build Alternative, a Two-level Garage Expansion and a Three-level Garage Expansion (Preferred Alternative). Under the No-Build Alternative, there would be no expansion of the existing parking facility to meet existing and future demand. The existing facility and overflow parking has reached its capacity. Under the 2029 No-Build condition, the facility would reduce annual vehicle trips to Logan gateway roads by 450,000 trips. As described in the EENF, this alternative was dismissed because it would result in a lower reduction in regional vehicle miles traveled (VMT) and associated reduction vehicle emissions as compared to the Preferred Alternative. Due to the constrained parking at Logan Airport, parking demand is likely to be met by increased pick-up and drop-off at Logan Airport, which would result in doubling of travel miles for each trip.

Massport evaluated two other alternatives for increasing HOV ridership to Logan Airport through the vertical expansion of the garage by two levels (661 new spaces) and through the vertical expansion of the garage by three levels (998 new spaces) (Preferred Alternative). Massport evaluated both of these alternatives based on their ability to meet the project purpose, potential impact on wetland resources, traffic conditions, and number of avoided trips to Logan Airport and associated GHG emissions reductions.

The Two-level garage expansion would result in 1,164 new adt and one to six seconds of additional delay at key area intersections. This alternative would result in 960,000 annual reduction in trips on Logan Airport gateway roads and would reduce GHG emissions in 2029 by 9,935 tpy. The Preferred Alternative would result in 1,496 new adt and one to nine seconds of additional delay at key study area intersections. The Preferred Alternative is anticipated to reduce trips on Logan gateway roads by 1,100,000 annually in 2029 and reduce GHG emissions by 11,605 tpy. Both the two-story and three-story expansion alternatives would require temporary impacts to the buffer zone to BVW during the construction period. The Preferred Alternative was chosen because it will eliminate approximately 140,000 more annual trips from Logan's gateway roadways and an additional 1,670 tpy of GHG emissions.

Traffic and Transportation

The EENF included a Transportation Impact Assessment (TIA) prepared in general conformance with the current MassDOT/Executive Office of Energy and Environmental Affairs (EEA) *Transportation Impact Assessment Guidelines* which included an assessment of the transportation impacts of the project. The TIA evaluated traffic conditions within a study area encompassing the project site and surrounding roadways and used a 10-year planning horizon.

According to the TIA, actual traffic count data were used as the basis of the trip generation estimates rather than trip generation report rates established by the Institute of

Transportation Engineers (ITE). The ITE trip generation rates apply to typical commuter Park-Ride lots associated with public transportation services, which were not considered by Massport to be applicable to the ridership characteristics of the Logan Express since Logan Express carries both employees and airline passengers throughout the day. Total trip generation was comprised of two distinct components including trips associated with users of the permanent parking spaces at the facility and trips associated with Logan Express passengers being dropped off and picked up at the facility by the Logan Express Buses, personal automobiles, taxis and Transportation Network Company (TNC) vehicles. To account for future pick up and drop offs, the existing daily and peak hour trips to the drop off areas were increased by 25 percent to reflect Massport's projections for growth of passenger traffic at Logan Airport and expected increase in frequency of Logan Express bus service, from two buses per hour per direction to three buses per hour per direction. The 25 percent growth rate is also reflective of the availability of some capacity in the current Logan Express service to accept additional passengers, as many of the buses are not currently fully occupied throughout the day. The TIA also relied on Massport's usage data for both bus passengers and parking facilities.

Turning Movement Counts (TMC) were collected at 23 locations and traffic volume data was collected by Automatic Traffic Recorders (ATR) at 11 additional locations. According to the EENF, the existing Logan Express facility generates 3,304 average daily trips (adt). The project is expected to generate an additional 1,496 adt, including 88 new trips during the morning peak hour and 117 new trips during the evening peak hour. The TIA compared LOS at the study area intersections under existing conditions and 2029 No-Build and 2029 Build conditions. At several study area intersections, the increase in delay downgraded the level of service by a letter grade as discussed below.

At the intersection of Cochituate Road/Whittier Street, the expected increase in delay is 6 seconds during the afternoon peak period. At the intersection of Cochituate Road/Burr Street the expected increase in delay is 9 seconds during the afternoon peak period. According to the EENF, the anticipated increases in delay are not considered significant and therefore, no roadway improvements or traffic signal timing adjustments at the study area intersections are proposed.

The purpose of the project is to reduce or shorten vehicle trips by passengers and employees of Logan Airport. The project itself serves as a Transportation Demand Management (TDM) measure allowing employees of Logan Airport to drive a relatively short distance to the Logan Express facility and utilize a HOV vehicle (i.e. the bus) to access Logan Airport. Therefore, it can be presumed that traffic delays and congestion would likely occur *elsewhere*—i.e., outside the study area along travel routes to, and in the vicinity of, the Airport—under no build or reduced build scenarios.

Climate Change

Executive Order 569: Establishing an Integrated Climate Change Strategy for the Commonwealth (EO 569; the Order) was issued on September 16, 2016. EO 569 recognizes the serious threat presented by climate change and directs Executive Branch agencies to develop and implement an integrated strategy to combat climate change and prepare for its impacts. The

Order seeks to ensure that Massachusetts will meet GHG emissions reduction goals established under the Global Warming Solution Act of 2008 (GWSA) and will work to prepare state government and cities and towns for the impacts of climate change. In accordance with M.G.L. c. 30, section 61, the reasonably foreseeable climate change impacts of a project, including additional GHG emissions, and effects, such as climate change, are within the subject matter of any required Agency Action. As such, Massport should evaluate and consider these issues when identifying potential impacts and measures to avoid, minimize, and mitigate said impacts.

Greenhouse Gas Emissions

The DEIR included a GHG analysis based on the MEPA Greenhouse Gas Policy and Protocol (“the Policy”). The Policy requires projects to quantify carbon dioxide (CO₂) emissions and identify measures to avoid, minimize and mitigate such emissions. The analysis quantified the direct and indirect CO₂ emissions associated with the project's energy use (stationary sources) and transportation-related emissions (mobile sources). The DEIR outlined and committed to mitigation measures to reduce GHG emissions.

The stationary source GHG analysis evaluated CO₂ emissions for the Base Case and the Preferred Alternative. The Base Case was designed to meet the minimum energy requirements of the 10th Edition of the Massachusetts Building Code (the Base Code). The garage facility is not a conditioned space, therefore it is not subject to specific energy requirements. Stationary source emissions were modeled on lighting power density requirements for parking garages based on IECC 2018 Table C405.3.2(2).

The overall stationary source CO₂ emissions for lighting the additional three floors were estimated at 131 tons per year (tpy) under the Base Case scenario (maximum allowable lighting density). The mitigation measures included in the Proposed Case will reduce GHG emissions to 25 tpy, a reduction of 106 tpy (approximately 81 percent) due to the use of high efficiency LED lighting. The estimates of GHG emissions were calculated using the CO₂ emission factors of 682 pounds per megawatt-hour for grid electricity published by the Independent System Operator-New England (ISO-NE) in the 2016 ISO New England Electric Generator Air Emissions Report.¹

The Project includes the addition of Solar PV on the façade of the Logan Express facility. A solar canopy was considered. However, in discussions with the City of Framingham, it was determined that the construction of a solar canopy above the top level of the parking garage would trigger fire protection requirements that would significantly increase project costs by requiring fire suppression throughout the entire garage building, including retrofitting existing garage levels. An additional concern is the potential for the added height of a solar canopy to cast a shadow on the offsite PV panels at the adjacent REI property. Therefore, the project proposes to add Solar PV on the façade of the parking facility instead of the roof. The system would generate 163.5 MWh annually which equates to 55.8 tpy of GHG emissions reductions associated electricity use offsets.

¹ Revised GHG emissions estimate calculations were e-mailed to the MEPA Office on 04/13/2020 which identified an 81% reduction of GHG emissions.

Mobile Sources

The EENF analyzed the project's mobile-source CO₂ emissions using the EPA's MOVES emissions model and data from the traffic study. The MOVES model calculates emissions factors for vehicles expressed in a volume per distance travelled. Total emissions of vehicles are estimated by applying Vehicle Miles Travelled (VMT) data to vehicles in the study area and emissions from idling vehicles. The analysis calculated GHG emissions under the Existing 2019, No Build 2029 and Build 2029 scenarios. Regional GHG emissions from mobile sources are expected to increase from 13,082 tpy under No Build 2029 conditions to 13,282 tpy under Build 2029 conditions, representing an increase of 199 tpy (2 percent) due to project-related vehicle trips in the study area. However, the reduction of private passenger vehicle trips created by the Logan Express service results in a net reduction of GHG emissions as described below.

At capacity, it is estimated that approximately 450,000 trips to and from Logan from Metro-West are removed from the Mass Pike I-90 based on the existing capacity of the Logan Express. With a three-level expansion, it is estimated that a total of 1.1 Million trips will be saved annually, which is 650,000 trips more than the existing annual savings. As a result of the round trips to Logan removed from the region, it is expected that in 2029 with no expansion, GHG emissions would be reduced by 4,344 tons. The Preferred Alternative will reduce emissions by 11,605 tons, a further reduction of 7,260 tons over the No-Build case. When calculated net of the increase in emissions (199 tpy) associated with project related trips in the vicinity of the parking garage itself, the project will result in a net reduction of 7,061 tpy over the base case.

Shadow Analysis

A shade analysis was performed to evaluate the impacts of the shadows cast by the proposed parking garage modifications at Framingham Logan Express. In particular, the study focused on the impacts of the shadows on the adjacent lot of land, which is owned by Recreational Equipment Incorporated (REI) and contains solar photovoltaic (PV) panels in the parking lot and on the building's roof. The objective of the study was to determine if and how the proposed parking garage modifications would negatively impact the panels' sun exposure. The solar analysis indicates that the proposed modifications to the parking garage will not negatively impact the sun exposure of the solar panels during the spring, summer, and fall seasons. The expanded garage will obstruct sun exposure to approximately 10% of REI's rooftop solar panels for two- to four-hours in the morning during November and December. However, the EENF notes that this is a period of relatively low solar power generation. Thus, the environmental benefits from the renewable energy generation by REI will not be materially reduced.

Construction Period

The project identifies approximately 7,675 sf of temporary impacts to the 100-ft buffer zone to BVW located along the northeast corner of the project site associated with construction staging. The project will include sedimentation and erosion controls during the construction period to protect nearby resource areas. The project site is regulated under M.G.L. c.21E and the

Massachusetts Contingency Plan (MCP; 310 CMR 40.0000). The EENF identified two Release Tracking Numbers (RTNs) associated with the project site, two RTNs which abut the site and one RTN in close proximity to the site. The EENF notes that Massport requires construction contractors to recycle all construction and demolition (C&D) waste generated by their projects.

Conclusion

The EENF documented the project's impacts and measures to avoid, minimize, and mitigate impacts. It documented baseline environmental conditions, included an alternatives analysis and identified measures to avoid, minimize and mitigate environmental impacts. The project will contribute to significant GHG emission reductions by increasing HOV ridership to Logan Airport through the expansion of an existing facility associated with minimal environmental impacts. Based on a review of the EENF, consultations with State Agencies and review of comment letters, I have determined that the Proponent can submit a Single EIR in lieu of a Draft and Final EIR. The Proponent should submit a Single EIR that provides updated project information and analyses as specified in the Scope below.

SCOPE

General

The Single EIR should follow Section 11.07 of the MEPA regulations for outline and content, as modified by this Scope. The Single EIR should identify and describe any changes to the project since the filing of the EENF and provide an update on State, local and federal permitting.

MEPA-1

Project Description and Permitting

The DEIR should describe the project and identify any changes to the project since the filing of the EENF. It should include updated site plans for existing and post-development conditions. Conceptual plans should be legible and provided at a reasonable scale. Plans should clearly identify: all major project components (existing and proposed buildings, access roads, etc.); public areas; wetland resource areas; impervious areas; ownership of parcels including easements; pedestrian and bicycle accommodations; and stormwater and utility infrastructure.

MEPA-2

The DEIR should provide a brief description and analysis of all applicable statutory and regulatory standards and requirements, and describe how the project will meet those standards. It should include a list of required State Permits, Financial Assistance, or other State or local approvals and provide an update on the status of each.

MEPA-3

Alternatives Analysis

The Single EIR should expand on the alternatives analysis provided in the EENF to include an option which consolidates overflow parking at nearby commercial properties at the Logan Express Facility or provide parking at areas closer to the existing facility. If this alternative is not feasible, the Single EIR should explain why. The Single EIR should explore

MEPA-4

MEPA-5

ways to bridge connections to local bus routes and public transportation including the provision of space for regional bus services including the MetroWest Regional Transit Authority's Route 1 bus stop. The Single EIR should also address the feasibility of implementing BRT with Framingham Logan Express operations.

Transportation

The Single EIR should include an updated TIA that reflects changes to the project since the EENF was filed. The Single EIR should clarify the number of bicycle storage spaces at the existing facility. The Single EIR should clarify if the trips to the overflow lots have been incorporated into existing conditions. The Single EIR should clarify how customers are transported from overflow lots to the Logan Express bus terminal and describe how these trips will be impacted over the 10-year planning horizon including whether associated mobile source emissions are considered.

MEPA-6

MEPA-7

The Single EIR should provide supporting data and calculations for projected use of the parking facility and identify to what extent the Framingham Logan Express facility will contribute to Massport's ground transportation improvement strategy, including proposed improvements at other Logan Express facilities. The Single EIR should describe a monitoring plan developed to confirm the projections described in the EENF, and should discuss what, if any, adjustments to Airport growth projections may be anticipated as part of MassPort's Environmental Data Report due in 2020 and how this may impact assumptions of VMT reductions and associated emissions benefits described in the EENF.

MEPA-8

MEPA-9

GHG Emissions

The Single EIR should include a revised GHG analysis which responds to the DOER's comment letter. The GHG analysis should quantify the existing GHG emissions associated with the existing facility including the ticketing office and existing garage space to provide a better representation of baseline conditions and how the proposed solar array will reduce overall stationary GHG emissions of the facility. The Single EIR should provide a summary of both stationary and mobile GHG emissions. The Single EIR should confirm the proposed type and size of the solar array that Massport will install and quantify associated GHG emissions reductions.

MEPA-10

MEPA-11

Construction Period

The Single EIR should describe potential construction period impacts (including but not limited to traffic management, materials management, parking, air quality and noise impacts, and other items as they related to the construction period) and outline feasible measures that can be implemented to eliminate or minimize these impacts in a draft CMP. The draft CMP should identify truck traffic routes associated with construction traffic, staging areas, and how safe pedestrian, bicycle and vehicle access around the project site for customers of the Logan Express facility will be maintained throughout the construction period. The Single EIR should also address notification and construction protocols to be implemented if contamination is encountered at the site during construction and potential construction-period dewatering

MEPA-12

MEPA-13

activities and related permitting requirements. The Single EIR should clarify whether any earthwork is required for the garage expansion.

Mitigation and Draft Section 61 Findings

MEPA-14

The Single EIR should include a section that identifies proposed mitigation measures and provides draft Section 61 Findings for each Agency Action. It should include a comprehensive list of mitigation measures that are consistent with mitigation measures identified in other sections of the Single EIR. It should contain clear commitments to implement these mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation, and contain a schedule for implementation.

In order to ensure that all GHG emissions reduction measures adopted by the Proponent as the Preferred Alternative are actually constructed or performed by the Proponent, the GHG Policy requires proponents to provide a self-certification to the MEPA Office indicating that all of the required mitigation measures, or their equivalent, have been completed. If “equivalent” measures are completed, I encourage the Proponent to commit to an equivalent GHG reduction expressed in volumetric terms (e.g., tpy) and not just a percentage. In addition, if GHG commitments cannot be achieved, any changes to such commitments must be included in the GHG self-certifications. The commitment to provide this self-certification in the manner outlined above should be incorporated into the draft Section 61 Findings included in the Single EIR.

MEPA-15

Responses to Comments

The FEIR should contain a copy of this Certificate and a copy of each comment letter received. In order to ensure that the issues raised by commenters are addressed, the Single EIR should include direct responses to comments to the extent that they are within MEPA jurisdiction. This directive is not intended, and shall not be construed, to enlarge the scope of the Single EIR beyond what has been expressly identified in this certificate.

Circulation

The Proponent should circulate the Single EIR to those parties who commented on the ENF to any State and municipal agencies from which the Proponent will seek permits or approvals, and to any parties specified in section 11.16 of the MEPA regulations. The Proponent may circulate copies of the Single EIR to commenters other than State Agencies in a digital format (e.g., CD-ROM, USB drive) or post to an online website. However, the Proponent should make available a reasonable number of hard copies to accommodate those without convenient access to a computer to be distributed upon request on a first come, first served basis. The Proponent should send a letter accompanying the digital copy or identifying the web address of the online version of the Single EIR indicating that hard copies are available upon request, noting relevant comment deadlines, and appropriate addresses for submission of comments. The Single EIR submitted to the MEPA office should include a digital copy of the complete document. A

copy of the Single EIR should be made available for review in the local Framingham Public Library.²

April 17, 2020

Date

K. Theoharides

Kathleen A. Theoharides

Comments received:

04/12/2020	Air INC.
04/15/2029	DOER

KAT/EFF/eff

² Requirements for hard copy distribution or mailings will be suspended during the Commonwealth's COVID-19 response. Please consult the MEPA website for further details on interim procedures during this emergency period: <https://www.mass.gov/orgs/massachusetts-environmental-policy-act-office>.



COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF
ENERGY AND ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENERGY RESOURCES
100 CAMBRIDGE ST., SUITE 1020
BOSTON, MA 02114
Telephone: 617-626-7300
Facsimile: 617-727-0030

Charles D. Baker
Governor

Karyn E. Polito
Lt. Governor

**Kathleen A.
Theoharides**
Secretary

Patrick C. Woodcock
Commissioner

15 April 2020

Kathleen Theoharides, Secretary
Executive Office of Energy & Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02114
Attn: MEPA Unit

RE: Logan Express Garage, Framingham, Massachusetts, EEA #16168

Cc: Maggie McCarey, Director of Energy Efficiency, Department of Energy Resources
Patrick Woodcock, Commissioner, Department of Energy Resources

Dear Secretary Theoharides:

We've reviewed the Expanded Environmental Notification Form (EENF) for the above project. The proposed project includes adding several stories of new structured parking over an existing, approximately 100,000-sf footprint parking garage.

Executive Summary

In summary, we recommend the following:

- The project should provide additional information about rooftop solar PV and potentially reexamine this option as it would improve PV mitigation by x7 or x8. **DOER-1**
- The project should provide additional information about EV charging stations and EV charging station readiness and potentially add EV commitments. **DOER-2**

Current Mitigation Commitments

Current mitigation commitments are as follows:

- 167-kW of façade-mounted solar PV, anticipated to produce about 163 to 190 MWhrs/yr

Logan Express Garage, EEA #16168
Framingham, Massachusetts

- A 75% reduction in lighting power consumption.

Solar PV Systems

Current mitigation includes 167-kW of façade-mounted PV, estimated to produce 163 to 190 MWhrs/yr which would offset 55-65 tons per year.

The submission describes choosing the façade PV over rooftop to avoid two potential issues:

1. Addition of rooftop PV to the top of the structure would trigger the need to upgrade entire structure's fire suppression system.
2. Addition of rooftop PV would potentially shade the adjacent, existing rooftop PV system at the REI building.

Issue 2 is readily solved by setting back the rooftop PV from the edge of the parking garage. Rooftop-mounted PV would provide about **x7 or x8 more** emission reductions than the currently planned façade system, including a set-back to avoid REI building shading. With set-back, the rooftop could accommodate about 90,000-sf of solar, generating about 1,300 MWhrs/yr, offsetting about 440 tons/yr.

The DOER is looking to understand more about issue 1. Specifically:

- a. What fire code section(s) causes the upgrade requirement and how are these requirements being applied to this project?
- b. What are the estimated costs of such an upgrade, and how would that cost addition change the proforma of a PV system?

Logan Express Garage, EEA #16168
Framingham, Massachusetts

EV Charging Stations

The submission does not describe EV charging station options. Grants may be available through Massachusetts DEP “MassEVIP” program (<https://www.mass.gov/how-to/apply-for-massevip-public-access-charging-incentives>). The DOER is looking to understand more about existing station and potential for more, as follows:

- a. How many EV charging stations currently exist at this facility?
- b. How many spaces are currently “EV-ready” at this facility?
- c. What commitments can be made to increase EV charging stations and/or EV readiness?
- d. Are there any funding/grant opportunities?

Sincerely,



Paul F. Ormond, P.E.
Energy Efficiency Engineer
Massachusetts Department of Energy Resources



Brendan Place
Clean Energy Engineer
Massachusetts Department of Energy Resources



April 9, 2020

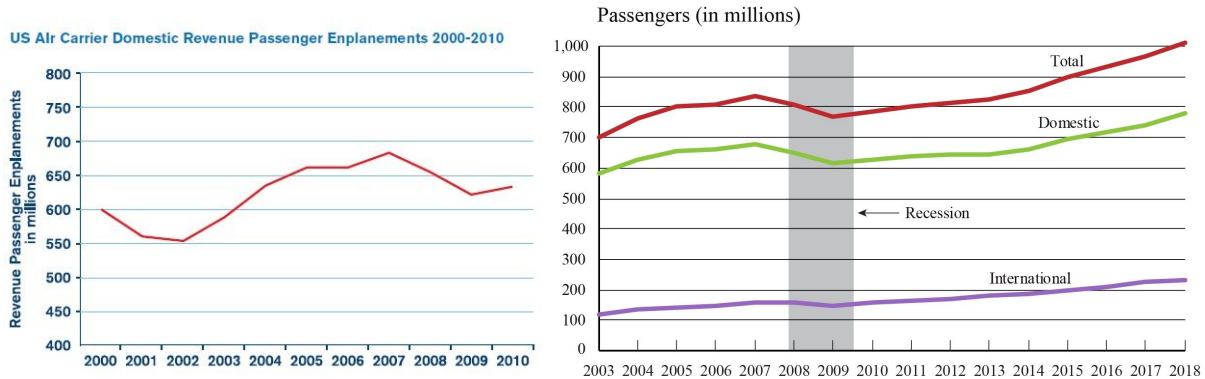
The Honorable Kathleen A. Theoharides,
Secretary Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900,
Boston, Massachusetts 02114

Re: Framingham Logan Express Expansion Project, Framingham, MA

Dear Secretary Theoharides,
Airport Impact Relief, Incorporated (AIR, Inc.) thanks you for the opportunity to comment on the
Massport Logan Express Framingham Garage Expansion EENF.

AIR, Inc.'s coalition of residents, communities, non-profit organizations, transportation, open
space, air quality, public health, and airport experts supports forward thinking airport planning
and policies which reduce and mitigate environmental air quality, noise, and traffic congestion
impacts. We regard Massport's current efforts to increase use of HOV modes of ground access
to Logan through investment in improvements at Logan Express's Framingham parking facilities
described in the Massport Logan Express Framingham Garage Expansion EENF as timely and
important, and support this project.

AIR-1



The sharp downturn in air travel resulting from COVID 19 will provide a window of respite from
the worst of these impacts. But the historical perspective on airport growth shows that past
downturns in 2002 due to the September 11th attacks and in 2008 after the most recent
recession were followed by steady recovery periods and attainment of new all-time high levels
of air travel. Boston and New England's economic and cultural assets position Logan Airport,
already one of the fastest growing origin and destination airports in the country, to recover from

the COVID 19 downturn more quickly than most. Thus, while the historic high passenger volume levels at Logan of roughly 43.5 million passengers (attained in 2019) may not be attained in 2020 or 2021, the trend at Logan indicates that these levels will continue to grow at faster than the average rate. Recent trends suggest that these levels could reach into the 60 - 70 million range within the 10 - 20 year timeframe, and the 80 - 90 million in the 30 - 40 year horizon. Therefore, it is essential that projects such as the Framingham parking expansion are advanced and expanded upon.

AIR, Inc.'s comments submitted for [2017 ESPR](#) and [2016 EDR](#) call for use of high growth scenarios in impact mitigation and policy strategies. The improvements in the Logan Express service suggested in the EENF are a pivotal component to mitigating traffic congestion by capturing additional HOV mode share. Adding 998 spaces to the existing 1082 structured parking spaces at Framingham Logan Express will produce a 92% increase in available parking at this remote HOV terminal. This additional capacity will assure the availability of parking to users of Logan Express Framingham and support an increase in selection of this already popular service. The move from 30 minute headways, to 20 minutes will produce a 33% increase in availability at the Logan Express Framingham facility. Reducing trip headways will also provide valuable user experience benefits: reducing the risk of crowding and fear of scarcity of seats, and creating a perception of a high frequency of service and the Port Authority's commitment.

Even with the addition of 998 spaces, the EENF states that based upon 2019 planning projections, the Framingham facility was expected to be overcapacity upon opening. With AIR, Inc.'s high growth, long term perspective, along with offering support for Massport's Logan Express Framingham Garage Expansion EENF, we ask that EEA encourage Massport to follow this shorter term HOV planning immediately with longer reaching strategies to create capacity well above the gains detailed in the EENF.

AIR-2

Table 5-1 Logan Airport Gateways: Annual Average Daily Traffic, 2000, 2010–2017

Year	AADT		AWDT		AWEDT		Annual Air Passengers	
	Volume	Percent Change	Volume	Percent Change	Volume	Percent Change	Level of Activity	Percent Change
2000	95,058	3.8%	101,446	3.9%	78,358	2.1%	27,412,926	--
2010	94,179	4.9%	98,968	5.5%	82,595	4.5%	27,428,962	--
2011	99,449	5.6%	104,863	6.0%	85,879	4.0%	28,907,938	5.4%
2012 ¹	99,281	(0.2%)	104,439	(0.4%)	86,494	0.7%	29,235,643	1.1%
2013	102,771	3.5%	107,656	3.1%	90,822	5.0%	30,218,970	3.4%
2014	108,172	5.3%	113,564	5.5%	94,881	4.5%	31,634,445	4.7%
2015	113,623	5.0%	119,288	5.0%	99,415	4.8%	33,449,580	5.7%
2016	119,750	5.4%	125,715	5.4%	104,456	5.1%	36,288,042	8.5%
2017	124,646	4.1%	130,601	3.9%	109,723	5.0%	38,412,419	5.9%

Source: Massport.

ESPR 2017 reported average weekday daily traffic volumes at Logan of over 130,000 daily trips. Even with Massport's recently refined HOV calculations, which reclassify taxi and

transportation network company (TNC) trips with more than one traveler as HOV trips, setting Logan's current HOV mode share at 40%, this volume of traffic has inundated our roadway system contributing to Boston's recent notoriety as the most congested city in the United States. Using the lower growth scenario of 50 million passengers by 2032 (+/-30 months) and at the 40% HOV level, an additional 4 million passengers (10,700 more per day) can be expected to use single occupancy vehicle (SOV) passenger car modes to access Logan. If the proposed increases in Logan Express and other ground access strategies at Logan successfully divert 2 million SOV trips within the coming years, daily SOV Logan ground access congestion will grow by 5,000 trips per day. In the more likely 60 million passenger scenario, an additional 8 million annual SOV (22,000 more per day) trips would still occur, and in the 80 million scenario in the 30 - 40 year horizon, 20 million more annual SOV trips (55,000 more per day) can be anticipated.

We ask that the Secretary build upon the directives for growth-commensurate policy included in its ESPR 2017 certificate by providing specific direction in her approval of this EENF as to how Massport should work to further develop community and stakeholder group dialogues around strategies to leverage more out of Logan Express by:

AIR-3

1. Investigating ways to integrate Logan Express facilities and service with regional bus transit services
2. Engaging in exploratory discussions with MBTA and other regional transit and community stakeholder groups to assess opportunities to enhance Logan Express service with BRT elements
3. Further developing Logan Express as remote airport terminals by exploring the feasibility and user experience of baggage check-through, ticketing kiosks, rental car service, and other conveniences and amenities at Logan Express locations
4. Development of Logan Express facilities not only as remote airport terminals, but as regional bus transit connector hubs serving downtown as well as other regional destinations and airports

RE other bus transit systems

The Framingham Logan Express location could capture additional trips from the MetroWest Regional Transit Authority's Route 1 bus stop located at the Flutie Pass overflow lot if this bus station was aligned with the Logan Express location. While the Transportation Research Board of the [National Academies' Airport Passenger Terminal Planning and Design Guidebook \(pg 232\)](#) recommends that maximum passenger walking distances be limited to under 1,000 feet, the MWRTA Route 1 Flutie Pass stop is currently 1,300 feet from the Logan Express Framingham facility. The walk between the separate facilities along Shoppers World Drive and Flutie Pass also involves two at grade street crossings, clearly exceeding air travel convenience standards and posing an obstacle to potential transfers. The physical alignment (co-location) of these two bus transit facilities would reduce the inconvenience cost of Logan Express for

travellers transferring from the regional bus network and improve the user experience, effectively extending HOV access to Logan to the entire Route 1 service area.

Frequency of MWRTA Route 1 service to Flutie Pass is also an issue. While Route 1 provides 19 daily weekday trips to the Macy's bus shelter at the Natick Mall between 5:52 AM and 8:35 PM, it only offers two early morning weekday connections at 5:49 AM and 6:11 AM to the Flutie Pass outdoor stop just .6 miles away from the Flutie Pass stop.



AIR, Inc. believes that significant additional cost reduction / user experience benefits could be gained at minimal cost by aligning this regional bus transit with this Logan Express location, and adjusting the frequency and timing of regional transit service to provide regular service.

AIR-4

Recent price adjustments to the Back Bay Logan Express service revealed cost sensitivities which should be amplified in more economy-minded traveller classes. At \$7 per day parking and \$22 round trip fares, 2 budget conscious adult travellers

through Logan could avoid \$93 in added expenses on a 7 day trip by making drop off and pickup with a family member or a friend. To further offset the perceived cost of this extended HOV service option which is likely to be more heavily utilized by budget-conscious travellers at this time, Massport should also consider offering free transfers onto Logan Express for riders with valid MWRTA tickets.

AIR-5

AIR, Inc. hopes that the Secretary will encourage Massport to use its mixed logit program to model demand for this and other potential perceived cost and user experience adjustment opportunities.

AIR-6

RE BRT

AIR, Inc. has engaged in discussions with the Institute for Transportation and Development Policy (ITDP) which has extensive bus rapid transit planning expertise and has recently completed successful trials employing certain [BRT elements into MBTA bus service](#). We believe that numerous opportunities exist to improve the Logan Express user experience by applying BRT elements to the service. Given the urgency to relieve airport congestion, today's Logan Express planning should include assessments of future BRT service features such as level

AIR-7

boarding, dedicated or on the shoulder travel lanes, improved fare collections, and traffic signal priority.

RE further developing Logan Express via additional air travel amenities

Improving remote terminal to airport baggage handling strategies is one of the key elements recommended in the Federal Transit Administration's [Improving Public Transportation to Large Airports](#) report by the National Research Council's Transportation Research Board.

Uninterrupted baggage transfer from Logan Express facilities through to destination airports would offer a significant convenience benefit for travellers by removing the hardship of lifting, dragging, attending to, and stowing luggage.

AIR-8

Seamless baggage handling systems used at [Swiss](#) airports allow travellers to check luggage from home right through to destination airports. In this system, transportation personnel tag the bags with and load them into bus or train cargo holds, unload them at the airport, and place them into the airport's internal security screening and baggage handling system. Advances such as Radio Frequency Identification (RFID) have emerged and can optimize the baggage handling process further. Logan Express should innovate baggage handling to improve the competitive positioning of airport bus service vs SOV modes.

AIR-9

Likewise, we feel it is important for Massport to investigate any and all enhancements which would support improved user experience for or increased use of Logan Express. Thus, improved amenities at Logan Express concourses, and even exploration of rental car services should be considered. Why would travelers want to drive a rental vehicle from Logan, fighting unfamiliar Boston traffic, when they could transfer to a free Logan Express shuttle and pick up their rental car in Framingham?

AIR-10

Massport should also consider upgrading buses and providing separate employee transportation options to improve and preserve capacity on Logan Express vehicles.

AIR-11

RE Logan Express as Regional bus transit hubs

With roadway capacity limited and unlikely to expand, AIR, Inc. believes that Massport must adopt defensive congestion management strategies. By seeking to reduce competing traffic volumes such as inbound morning north shore commuter traffic, the Port Authority can preserve roadway capacity for Logan-bound SOV and HOV trips. While we advocate a broad range of defensive measures including support for MBTA Blue Line extension to Lynn, the Red to Blue Connector, and expanded ferry transportation, the needed improvements to the Logan Express system and its facilities could offer potential benefits to other regional transit systems. Massport should explore its options and opportunities to provide terminal space for other bus transit services at its suburban facilities.

AIR-12

AIR-13

AIR, Inc. support for Massport's plans to market Logan Express more aggressively

We believe that Massport must create better options for travellers and position them properly within the airport transportation market. With this, we believe, not only will come a significant increase in ridership, but also an important reexamination of the service by prospective users. It is of vital importance that potential users be met with an appealing offer - one which essentially out-competes single occupancy modes of travel. If and when it makes sense for SOV ground access mode passengers to give Logan Express a try, the service will need the capacity to deliver.

AIR-14

AIR, Inc. support for Massport's request for allowance of a single EIR

It is imperative, even considering what will likely be a multi-year slow-down in air passenger travel, that the Port Authority proceed as quickly as possible in the improvement of the Logan Express HOV system. Massport's proposed parking enhancements are a critical component of this improvement.

AIR-15

Again, AIR, Inc. is happy to provide our complete support for Massport's Framingham Logan Express Expansion Project. We also see a need to use this respite to plan aggressive expansion of this and all present and future Logan Express facilities to address future major passenger expansion at Logan. We are eager to support collaboration between the Port Authority and transit and community stakeholders in this work.

Sincerely,



Chris Marchi
Vice President
Airport Impact Relief, Incorporated (AIR, Inc.)

8.2 INTRODUCTION

This Section provides responses to the Secretary’s Certificate on the EENF and the two comment letters that were received on the EENF that was filed with the MEPA Office on March 2, 2020. The letters have been reproduced and individual comments coded in the margins. Responses to the comments follow each individual letter and can be matched using the comment code numbers. Table 8-1 lists the Certificate, letters received and the comment identifier.

Table 8-1 Certificate and Comment Letters

Certificate of the Secretary of Energy and Environmental Affairs	MEPA
Massachusetts Department of Energy Resources	DOER
Airport Impact Relief, Inc.	AIR, Inc.

8.2.1 MEPA EENF Certificate

MEPA-1 The Single EIR should follow Section 11.07 of the MEPA regulations for outline and content, as modified by this Scope. The Single EIR should identify and describe any change to the project since the filing of the EENF and provide an update on state, local, and federal permitting.

Response: Section 2.4 of the SEIR identifies and describes changes to the project since the filing of the EENF and Section 2.5 provides an update on state, local, and federal permitting.

As noted in Section 1.1, the COVID-19 worldwide pandemic has had a substantial on Massport operations; including a dramatic reduction in the number of daily flights and a nearly 90% reduction in passenger levels during spring 2020.

Within that context, Massport continues to evaluate and plan for the recovery of air passenger activity and remains committed to implementing the broad range of ground access strategies that were outlined in the March 2020 Expanded ENF including expansion of Logan Express services. The schedule for those improvements, however, continue to be adjusted due to the current conditions. At the time of the EENF filing, Massport’s plan was to commence construction on the Framingham Logan Express Garage

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Expansion in 2020. At this time, we expect that construction of the additional garage levels will be delayed for at least 12 months; Massport will provide an update on the schedule in the forthcoming Logan Environmental Data Report to be filed in late 2020.

MEPA-2 **The SEIR should describe the project and identify any changes to the project since the filing of the EENF. It should include updated site plans for existing and post-development conditions. Conceptual plans should be legible and provided at a reasonable scale. Plans should clearly identify: all major project components (existing and proposed buildings, access roads, etc.); public areas; wetland resource areas; impervious areas; ownership of parcels including easements; pedestrian and bicycle accommodations; and stormwater and utility infrastructure.**

Response: Section 2.0 of the SEIR describes the project. The proposed Project remains consistent with the project outlined in the March 2020 EENF. See the response to MEPA-1 for a summary of the effect of the COVID-1 pandemic on Massport operations and the timing on Project construction.

The SEIR includes site plans for existing and post-development conditions, identifying all major project components at a legible and a reasonable scale.

MEPA-3 **The SEIR should provide a brief description and analysis of all applicable statutory and regulatory standards and requirements and describe how the project will meet those standards. It should include a list of required State Permits, Financial Assistance, or other State or local approvals and provide an update on the status of each.**

Response: Section 2.5 of the SEIR provides a description of all applicable statutory and regulatory requirements for the project. A list of required State Permits, Financial Assistance, or other State or local approvals, and their current status, is also provided.

MEPA-4 **The Single EIR should expand on the alternative analysis provided in the EENF to include an option which consolidates overflow parking at nearby commercial properties at the Logan Express Facility or provide parking areas closer to the existing facility. If this alternative is not feasible, the Single EIR should explain why.**

Response: Section 3.0 of the SEIR provides an expanded alternative analysis which provides additional detail on the operation of the Logan Express

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parking garage and overflow parking lots. The alternatives analysis examines the feasibility of consolidating overflow parking at nearby commercial properties closer to the garage.

The overflow lot is served by the Logan Express buses and users of the overflow lot are not expected (or encouraged) to walk between the lot and the terminal building. This lot is under extended lease by Massport and it is not feasible or necessary to be relocated.

MEPA-5 The Single EIR should explore ways to bridge connections to local bus routes and public transportation including the provision of space for regional bus services including the MetroWest Regional Transit Authority's Route 1 bus stop. The Single EIR should also address the feasibility of implementing BRT with Framingham Logan Express operations.

Response: Where opportunities exist, Massport has cooperated with public and private bus operators to allow pick-up and drop off services at its Logan Express locations. As an example, in the past, Peter Pan Bus Lines included the Framingham LEX site in its routes, but that service concluded several years ago.

Massport's priority for Logan Express is to provide parking capacity for Logan-bound passengers and therefore use of that limited capacity is not provided for other bus services that do not provide service for Logan Airport passengers or employees.

As described in Section 3.2, during development of this SEIR, Massport contacted the MetroWest Regional Transportation Authority (MWRTA), based in Framingham, MA. While several the MWRTA services are temporarily reduced or suspended due to the ongoing COVID-19 pandemic, we have agreed to coordinate on a more regular basis as activity levels and the use of public transportation services resume.

Section 3.2 of the SEIR provides an expanded alternative analysis which provides additional detail on the feasibility of the Logan Express garage in Framingham serving as a connection for local bus routes or other local public transportation services.

To the extent that bus rapid transit (BRT) and/or bus priority lanes become available along I-90 between the Framingham Logan Express facility and

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Logan Airport, Massport would work to make use of those facilities to further grow HOV ridership.

- MEPA-6 The Single EIR should include an updated TIA that reflects changes to the project since the EENF was filed. The Single EIR should clarify the number of bicycle storage spaces at the existing facility.**

Response: Section 4.0 of the SEIR provides an updated TIA that reflects changes to the project since the EENF. The garage currently has two bicycle racks inside the garage with a combined capacity to store 16 bicycles. Massport will continue to monitor use of the bicycle racks to determine the demand for any additional bicycle storage capacity.

- MEPA-7 The Single EIR should clarify if the trips to the overflow lots have been incorporated into existing conditions. The Single EIR should clarify how customers are transported from overflow lots to the Logan Express bus terminal and describe how these trips will be impacted over the 10-year planning horizon including whether associated mobile source emissions are considered.**

Response: Section 4.0 of the SEIR provides greater detail regarding operations at the Logan Express facility in Framingham. Specifically, this section confirms that the trips to the overflow lots have been incorporated into the existing conditions traffic analysis and describes operations for customers using the overflow parking lots, and the potential effect of these operations on mobile source operations.

- MEPA-8 The Single EIR should provide supporting data and calculations for projected use of the parking facility and identify to what extent the Framingham Logan Express facility will contribute to Massport's ground transportation improvement strategy, including proposed improvements to other Logan Express facilities.**

Response: The Framingham Logan Express site has had capacity issues since its opening. When calculating the need for parking at Framingham, Massport first calculated the amount of parking needed to deal with 2019 demand levels.

To calculate future demand, Massport used its mode choice model driven by responses to the 2019 Logan Ground Access Survey to determine the capacity needs for the Logan Express system, including Framingham. The

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lack of capacity at current levels was contributing to latent demand at Framingham. Massport expects that the addition of more parking capacity combined with additional passenger volume would result in an increase in ridership at Framingham of up to 10% at a 50M passenger level.

This modeling was done in 2019. Since then, the COVID-19 worldwide pandemic has had a substantial impact on Massport operations; including a dramatic reduction in the number of daily flights and a nearly 90% reduction in passenger levels in spring 2020 (98% reduction in Logan Express demand in April 2020). However, Massport believes that as passenger volumes levels recover in the upcoming years our projections related to future passenger volumes remain valid.

MEPA-9 The Single EIR should describe a monitoring plan developed to confirm the projections described in the EENF, and should discuss what, if any, adjustments to Airport growth projections may be anticipated as part of Massport’s Environmental Data Report due in 2020 and how this may impact assumptions of VMT reductions and associated emissions benefits described in the EENF.

Response: Massport will continue to closely monitor the recovery of passenger volumes at Framingham as well as all Massport Logan Express location. Currently, services at Framingham, Braintree and Woburn are operating for the same number hours per day, but buses are generally running on a reduced hourly schedule throughout the day. Note that the Peabody and Back Bay Logan Express operations are currently suspended.

As of the date of this SEIR preparation, passenger levels at Framingham were averaging less than 10% of the available seat capacity of 2,100 seats per day. Based on available information, Massport expects to be maintaining this reduced service schedule through mid-2020. The 2018/2019 Logan EDR will provide an update on Logan Express services when filed in late 2020. Massport will continue to monitor passenger demand and intends to add additional service as air passenger demand increases. Again, all modeling was done at a 50M passenger demand level and Massport reports passenger levels annually.

MEPA-10 The Single EIR should include a revised GHG analysis which responds to the DOER’s comment letter. The GHG analysis should quantify the existing GHG emissions associated with the existing facility including the ticketing office and existing storage space to provide a better representation of baseline

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conditions and how the proposed solar array will reduce overall stationary GHG emissions of the facility. The Single EIR should provide a summary of both stationary and mobile GHG emissions.

Response: Section 5.0 of the SEIR provides a revised GHG analysis which responds to DOER's comment letter. The GHG analysis also quantifies GHG emissions associated with the existing facility to provide a better representation of baseline conditions and how the proposed solar array will reduce overall stationary GHG emissions of the facility.

MEPA-11 The Single EIR should confirm the proposed type and size of the solar array that Massport will install and quantify associated GHG emissions reductions.

Response: Section 5.0 of the SEIR confirms the type and size of the solar PV array that Massport will install on the garage façade and quantifies the associated GHG emissions reductions. As described, the planned façade solar array will provide more power than is required to serve the additional garage levels.

MEPA-12 The Single EIR should describe potential construction period impacts (including but not limited to traffic management, materials management, parking, air quality and noise impacts, and other items as they related to the construction period) and outline feasible measures that can be implemented to eliminate or minimize these impacts in a draft CMP. The draft CMP should identify truck routes associated with construction traffic, staging areas, and how safe pedestrian, bicycle, and vehicle access around the project site for customers of the Logan Express facility will be maintained throughout the construction period.

Response: Prior to construction Massport will work with the selected construction contractor to develop a Construction Management Plan that identifies specific measures to be implemented during construction. The CMP will provide details on methods to be employed to manage potential construction period impacts including traffic management, materials management, parking, air quality, wetland, and noise impacts.

MEPA-13 The FEIR should also address notification and construction protocols to be implemented if contamination is encountered at the site during construction and potential construction period dewatering activities and related permitting requirements. The Single EIR should clarify whether any earthwork is required for the garage expansion.

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Response: The Construction Management Plan will provide the construction period protocols to be implemented if contamination is encountered at the site during construction and potential construction period dewatering activities.

MEPA-14 The Single EIR should include a section that identifies proposed mitigation measures and provides draft section 61 measures for each Agency Action

Response: Section 7.0 of the SEIR provides a Draft Section 61 Finding that identifies proposed mitigation measures.

MEPA-15 The FEIR should include a commitment to provide a self-certification to the MEPA Office at the completion of the project.

Response: Massport commits to provide to the MEPA office a self-certification at the completion of the project.

8.2.2 Agency Comment Letters

DEPARTMENT OF ENERGY RESOURCES (DOER)

DOER-1 The project should provide additional information about rooftop solar PV and potentially reexamine this option as it would improve PV mitigation by x7 or x8.

Response: Section 5.1 of the SEIR provides additional information about rooftop solar PV. A solar PV canopy was considered for the top level of the proposed Project. However, the result of the analysis, as described in Section 5.1.2, was that given the long payback period, a PV Canopy system on the garage roof has been deemed infeasible at this time. Massport has committed to adding Solar PV on the façade of building instead of the roof. This façade solar PV system will have an estimated production of 159 MWh/year and will offset an estimated 54 tons of GHG annually.

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DOER-2 **The project should provide additional information about EV charging stations and EV charging station readiness and potentially add EV commitments.**

Response: Massport has carefully considered the current electric vehicle (EV) demand at their parking facilities to determine the need for additional EV capacity. Currently, there are two dual charging stations installed, serving four EV parking spaces. Once the Project is complete, this number will be increased to six installed EV parking spaces. Additional conduit and infrastructure will be placed for two additional parking spaces, bring the future building's EV capacity to six installed spaces and two EV-ready spaces.

8.2.3 Other Comment Letters

AIRPORT IMPACT RELIEF, LLC (AIR)

AIR-1 **We regard Massport's current efforts to increase use of HOV modes of ground access to Logan through investment in improvements at Logan Express's Framingham parking facilities described in the Massport Logan Express Framingham Garage Expansion EENF as timely and important and support this project.**

Response: Acknowledged

AIR-2 **With AIR, Inc.'s high growth, long term perspective, along with offering support for Massport's Logan Express Framingham Garage Expansion EENF, we ask that EEA encourage Massport to follow this shorter term HOV planning immediately with longer reaching strategies to create capacity well above the gains detailed in the EENF.**

Response: Section 2.1.1 and 2.1.2 of the SEIR describe the numerous initiatives Massport is implementing to improve access to the Logan Express system and HOV vehicles.

AIR-3 **We ask that the Secretary build upon the directives for growth-commensurate policy included in its ESPR 2017 certificate by providing specific direction in her approval of this EENF as to how Massport should work to further develop community and stakeholder group dialogues around strategies to leverage more out of Logan Express by:**

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a. Investigating ways to integrate Logan Express facilities and services with regional bus transit services;

Response: Framingham is not part of the MBTA service area and therefore, this Logan Express facility would not be integrated with MBTA service. Massport has reached out to the MetroWest Regional Transportation Authority (MWRTA), based in Framingham, MA. While several the MWRTA services are temporarily reduced or suspended due to the ongoing COVID-19 pandemic, we have agreed to coordinate on a more regular basis as activity levels and the use of public transportation services resume.

b. Engaging in exploratory discussions with MBTA and other regional transit and community stakeholder groups to assess opportunities to enhance Logan Express service with BRT elements;

Response: Framingham is not part of the MBTA service area. Massport has contacted the MetroWest Regional Transportation Authority (MWRTA), based in Framingham, MA and plans additional future coordination.

c. Further developing Logan Express as remote airport terminal by exploring the feasibility and user experience of baggage check-through, ticketing kiosks, rental car service, and other conveniences and amenities at Logan Express locations; and

Response: Massport explored initial steps to having one or more of the four suburban Logan Express sites provide baggage check-through services. Once passenger numbers recover to as level capable of supporting those additional services (and operating costs), Massport would re-initiate development of an implementation plan.

d. Development of Logan Express facilities not only as remote airport terminals, but as regional bus transit connector hubs serving downtown as well as other regional destinations and airports.

Response: Massport continues to prioritize Logan Express parking capacity for Logan-bound passengers. That limited Logan Express parking capacity is not able to support other bus services that do not provide feeder service for Logan Airport passengers or

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employees. Massport would, however, welcome other Logan bound transit services.

AIR-4 AIR, Inc. believes that significant additional cost reduction / user experience benefits could be gained at minimal cost by aligning this regional bus transit with this Logan Express location and adjusting the frequency and timing of regional transit service to provide regular service.

Response: Massport's priority for Logan Express is to provide parking capacity for Logan-bound passengers and therefore use of that limited capacity is not provided for other bus services that do not provide feeder service for Logan Airport passengers or employees. Massport has reached out to the MetroWest Regional Transportation Authority regarding the possibility of connecting their Route 1 with the Framingham Logan Express.

As noted above, a number of the MWRTA services are temporarily reduced or suspended due to the ongoing COVID-19 pandemic, however, Massport has agreed to coordinate with MWRTA on a more regular basis as activity levels and the use of public transportation services resume.

AIR-5 To further offset the perceived cost of this extended HOV service option which is likely to be more heavily utilized by budget-conscious travelers at this time, Massport should also consider offering free transfers onto Logan Express for riders with valid MWRTA tickets.

Response: Massport will consider the possibility of some type of incentive for public transportation users as passenger demand recovers.

AIR-6 AIR, Inc. hopes that the Secretary will encourage Massport to use its mixed logit program to model demand for this and other potential perceived cost and user experience adjustment opportunities.

Response: Massport continues to use modeling tools developed by Massport to support our effort to double Logan Express ridership at by the time Logan Airport reaches 50M passengers.

AIR-7 We believe that numerous opportunities exist to improve the Logan Express user experience by applying BRT elements to the service. Given the urgency to relieve airport congestion, today's Logan Express planning should include assessments of future BRT service features such as level

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boarding, dedicated or on the shoulder travel lanes, improved fare collections, and traffic signal priority.

Response: To the extent that bus rapid transit (BRT) and/or bus priority facilities become available between the Framingham Logan Express facility and Logan Airport, Massport would work to make use of those facilities to further grow HOV ridership. Those elements would most likely be on I-90, which is under MassDOT control. Massport and MassDOT work together on transportation improvements often and will continue to do so. Massport is pursuing e-ticketing to enhance the Logan Express user experience.

AIR-8 Uninterrupted baggage transfer from Logan Express facilities through to destination airports would offer a significant convenience benefit for travelers by removing the hardship of lifting, dragging, attending to, and stowing luggage.

Response: Massport explored initial steps to having one or more of the four suburban Logan Express sites provide baggage check-through services. Once passenger numbers recover to a level capable of supporting those additional services (and operating costs), Massport would re-initiate development of an implementation plan.

AIR-9 Logan Express should innovate baggage handling to improve the competitive positioning of airport bus service vs SOV modes.

Response: Massport explored initial steps to having one or more of the four suburban Logan Express sites provide baggage check-through services. Once passenger numbers recover to a level capable of supporting those additional services (and operating costs), Massport would re-initiate development of an implementation plan.

AIR-10 Likewise, we feel it is important for Massport to investigate any and all enhancements which would support improved user experience for or increased use of Logan Express. Thus, improved amenities at Logan Express concourses, and even exploration of rental car services should be considered.

Response: Massport has continuously upgraded and improved its Logan Express system to include upgraded facilities, modern buses, improved/expanded parking and adjustment of bus fares and parking rates, all with the goal of expanding use of Logan Express consistent with

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our goal of doubling annual ridership. This project is a prime example of that commitment.

AIR-11 Massport should also consider upgrading buses and providing separate employee transportation options to improve and preserve capacity on Logan Express vehicles.

Response: Currently, the bus schedules are designed to handle passenger and employee loads. In the case of Braintree, multiple early morning buses are operated to fully meet ridership peaks. The Framingham Logan Express has a much lower employee ridership base. Massport will continue to review and adjust bus schedules to meet ridership demand.

AIR-12 With roadway capacity limited and unlikely to expand, AIR, Inc. believes that Massport must adopt defensive congestion management strategies. By seeking to reduce competing traffic volumes such as inbound morning north shore commuter traffic, the Port Authority can preserve roadway capacity for Logan-bound SOV and HOV trips. While we advocate a broad range of defensive measures including support for MBTA Blue Line extension to Lynn, the Red to Blue Connector, and expanded ferry transportation, the needed improvements to the Logan Express system and its facilities could offer potential benefits to other regional transit systems.

Response: The Massachusetts Turnpike (I-90) is owned and operated by MassDOT. Massport and MassDOT work together on regional transportation/HOV improvements and will continue to do so.

AIR-13 Massport should explore its options and opportunities to provide terminal space for other bus transit services at its suburban facilities.

Response: Massport continues to prioritize Logan Express parking capacity for Logan-bound passengers. That limited Logan Express parking capacity is not able to support other bus services that do not provide feeder service for Logan Airport passengers or employees. Massport would, however, welcome other Logan bound transit services.

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AIR-14 **We believe that Massport must create better options for travelers and position them properly within the airport transportation market. With this, we believe, not only will come a significant increase in ridership, but also an important reexamination of the service by prospective users. It is of vital importance that potential users be met with an appealing offer - one which essentially out-competes single occupancy modes of travel.**

Response: Massport has continuously upgraded and improved its Logan Express system to include upgraded facilities, modern buses, Wi-Fi, improved/expand parking and adjustment of bus fares and parking rates, all with the goal of expanding use of Logan Express consistent with our goal of doubling annual ridership. Our stated goal is to implement changes that encourage a doubling of Logan Express system ridership. This project is a prime example of that commitment.

AIR-15 **It is imperative, even considering what will likely be a multi-year slow-down in air passenger travel, that the Port Authority proceed as quickly as possible in the improvement of the Logan Express HOV system. Massport's proposed parking enhancements are a critical component of this improvement.**

Response: Acknowledged

APPENDIX A

MEPA EENF Certificate and Comment Letters – See Section 8

APPENDIX B

Transportation Impact Assessment (revised May 2020)

The following TIA appendices are available upon request:

Appendix A – Traffic Count Data

Appendix B – Crash Rate Worksheets

Appendix C – Trip Generation Calculations

Appendix D – Intersection Capacity Analysis Worksheets



**Traffic Impact and Access Study
Proposed Expansion of the
Framingham Logan Express
Parking Garage**

May 21, 2020

Prepared for:

Massachusetts Port Authority



Prepared by:

Stantec Consulting Services Inc.
Burlington, Massachusetts

**TRAFFIC IMPACT & ACCESS STUDY
 PROPOSED EXPANSION OF THE
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 MAY 21, 2020**

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APPENDIX C - TRIP GENERATION CALCULATIONS
APPENDIX D - INTERSECTION CAPACITY ANALYSIS WORKSHEETS



1.0 INTRODUCTION

1.1 OVERVIEW

The Massachusetts Port Authority (Massport) is proposing improvements to the existing Logan Express parking garage and terminal facility (LEXF) in the City of Framingham that is located in close proximity to the Massachusetts Turnpike (I-90) at the corner of Burr Street and Shoppers World Drive (Figure 1). Massport completed improvements to this facility in the summer of 2015. Over the past several years, as passenger levels at Boston-Logan International Airport have continued to expand, ridership at Massport's Framingham Logan Express facility has likewise expanded.

Logan Express is a transit service offered by Massport, transporting passengers by bus between each of its five satellite locations in Peabody, Woburn, Framingham, Braintree and Boston (Back Bay), and Logan Airport. At each of the four suburban facilities, including Framingham, users are able to park their personal vehicles at relatively low cost and take the Logan Express bus directly to Logan Airport's four passenger terminals. Some users of the Logan Express bus service are also dropped off/picked up at the facility and do not use the parking facilities. The Logan Express system currently carries approximately 2 million annual passengers and is a component of Massport's overall trip reduction and high occupancy vehicle (HOV) strategy.

To meet this existing and projected demand, Massport is proposing to increase the parking capacity to provide 2,080 parking spaces at this facility. Construction of an expansion to the existing garage and integrated terminal building will add to Massport's HOV capacity for passengers and employees.

This study evaluates the impacts that the proposed expansion of the LEXF parking supply will have on traffic volumes in study area. To address potential traffic impacts of the proposed expansion, an extensive data collection effort was undertaken. Stantec coordinated with Massport staff to identify changes in the project area and project goals. New intersection traffic turning movement counts and automatic traffic recorder counts were performed in Framingham and Natick, where the intersections are likely to be affected by the LEXF expansion.

In addition to traffic related data, historical crash trends in the study area were identified for the most recent available four-year period of 2015-2018 and crash analyses were conducted using MassDOT crash rate calculation procedures.

Traffic estimates from several future development projects permitted/approved but not yet occupied in Framingham and Natick were obtained and added onto the background traffic growth projections to establish future year analysis projections to represent year 2029 Build and No-Build conditions.

Lastly, projections were made of year 2029 (Build) traffic volumes and operating conditions with the proposed expansion of the LEXF parking garage by 998 parking spaces and increased frequency of Logan Express bus service. Expansion of the LEXF can be accomplished without adversely affecting the



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local roadway network, while providing a significant reduction in annual trips between Framingham and Boston along a severely congested corridor.



1.2 PURPOSE AND NEED

The purpose of this project is to expand reliable and convenient access for HOV service to Boston Logan International Airport Logan for passengers and employees in the MetroWest/Framingham area. Currently, the Framingham Logan Express garage consists of 1,082 parking spaces, and existing demand can exceed that capacity during Logan Airport's peak travelling periods.

Massport's Ground Transportation Plan calls for an increase in HOV usage to Logan Airport to reduce congestion around Logan Airport and the regional highway system leading to the airport and to lower greenhouse gas (GHG) emissions. In order to satisfy these goals, Massport continues to heavily promote the use of its five Logan Express sites, which includes the Framingham Logan Express facility, through means including the proposed increase in parking capacity at the Framingham site. Since the construction of the Framingham Logan Express parking garage in 2015, parking demand has steadily increased, and demand now exceeds capacity at the new garage much of the time. Demand is such that Massport continues to use proximate overflow surface parking lots. As Logan Airport continues to grow to meet forecast regional demand, implementation of the Ground Transportation Plan, which includes the need for enhanced HOV services, will become all the more critical. Further expansion of the garage at the existing Framingham Logan Express site allows Massport to help meet the growing regional HOV demand and, as a result, lower GHG emissions.



2.0 EXISTING TRANSPORTATION CONDITIONS

2.1 PROJECT BACKGROUND

At the present time, the main Framingham Logan Express (LEXF) terminal building is served by a 1,082 parking space garage, integrated with the Logan Express bus terminal and constructed by Massport in 2015. Logan Express buses can stage simultaneously in one lane on the east side of the LEXF terminal on the ground level of the garage with a lane available for bypass and a similar setup for curbside passenger drop off/pick up on the west side. Buses flow in a clockwise direction, entering from Shoppers World Drive, stopping and discharging/embarking passengers and exit the facility onto Burr Street. The existing parking garage also includes 16 interior bicycle parking spaces in the garage and is not expected to change under the proposed garage expansion. There is space in the garage for additional bicycle parking, should future demand patterns change.

To meet growing customer demand for HOV service to Logan Airport, particularly during peak travel periods, Massport currently leases an additional 565 parking spaces from adjacent property owners, including 490 spaces at AMC Theatres, 75 spaces at Fran's Florist. During peak travel periods, up to 132 additional parking spaces can be accessed at the Shopper's World parking area. Thus, a total of 697 overflow parking spaces are available for Logan Express Framingham customers.

These overflow parking lots are located within a quarter mile walking distance of the existing LEXF terminal. Massport has indicated that the two overflow lots are used frequently. Figure 2 shows the full LEXF parking system.

The Logan Express primary overflow surface lot (Lot 4) is located on the south side of Flutie Pass (across the roadway from the AMC movie theatre) and 565 existing parking spaces are leased by Massport at this location (AMC Overflow Lot). Under existing conditions, users are directed to use Lot 4 when the main parking garage at the Framingham Logan Express terminal building is fully occupied. Users of Lot 4 must currently park in short term parking at the main terminal building, purchase their Logan Express bus ticket in the building and then drive to Lot 4. Users who park in Lot 4 wait for a Logan Express bus, that originates from the main Framingham Logan Express terminal building, to pick them up, and then depart towards Logan Airport. Similarly, the Logan Express bus that originates at Logan Airport will make a stop at Lot 4 to discharge users before arriving at its final destination at the main Framingham Logan Express terminal building. The second overflow lot is located at the Shoppers World shopping complex. The parking spaces at this location are not leased by Massport. Rather, Massport pays on a per parking space basis only when these existing Shoppers World parking spaces are used by Logan Express customers. Use of spaces at Shoppers World is expected to end upon the opening of the new garage levels.

Once the proposed expansion of the existing garage is complete, Massport intends to continue to lease the 565 existing parking spaces along Flutie Pass for use on an as-needed basis during peak travel periods. Logan Express buses will continue to service the surface lot in the same manner as they are today, as long as the lot is in use. Improvements are proposed at the AMC Overflow lot so that users will



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be able to purchase tickets at the Lot and will not have to stop at the main terminal building first to purchase tickets. Within the planning horizon of this study, it is expected that frequency of Logan Express bus service will increase from two buses per hour per direction to three buses per hour per direction. Use of overflow parking at Shopper's World would be discontinued upon opening of the new garage levels.



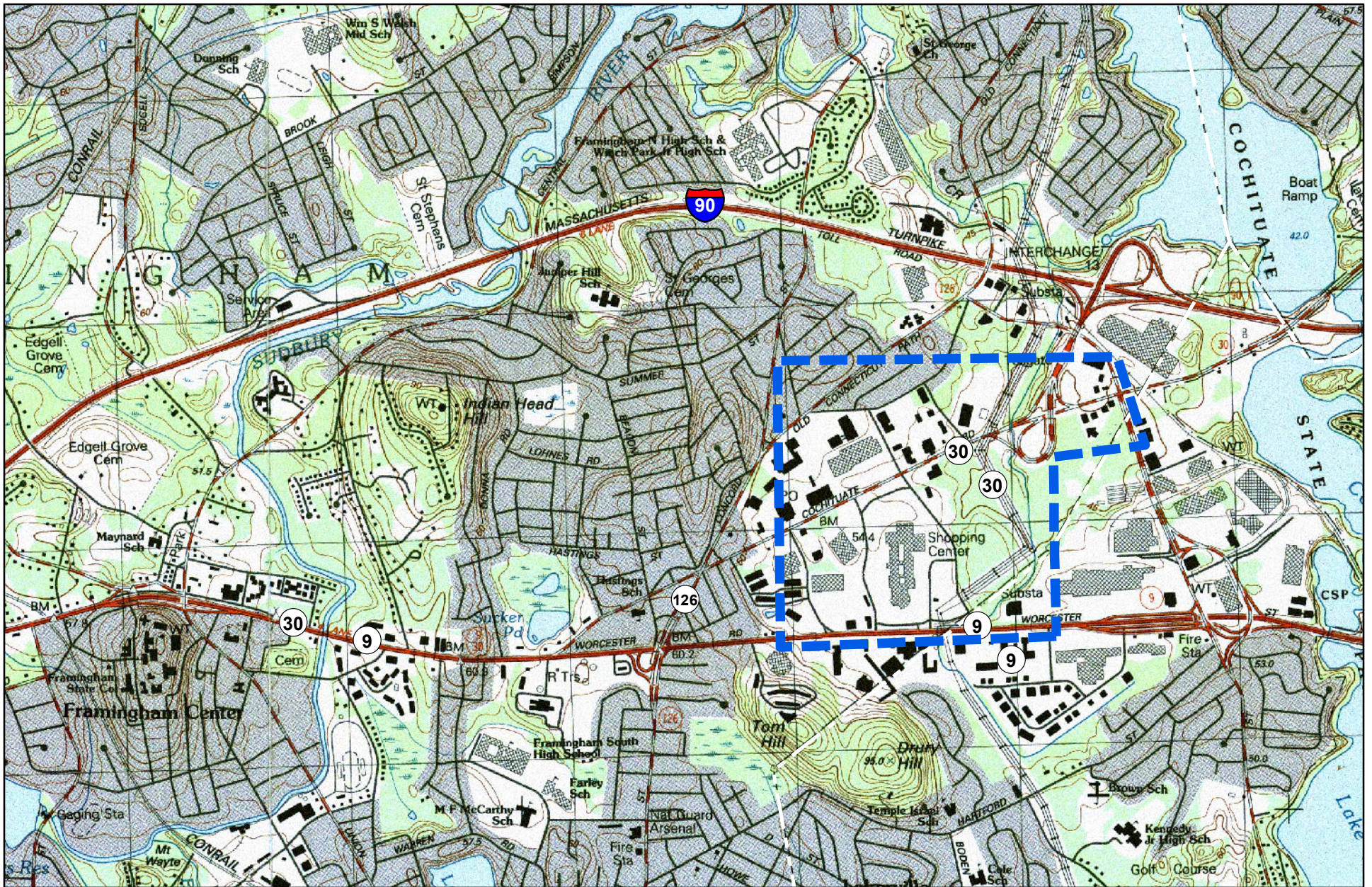
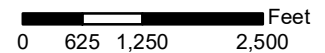


Figure 1 - Study Area Locus Map

Logan Express - Framingham
 May 2020



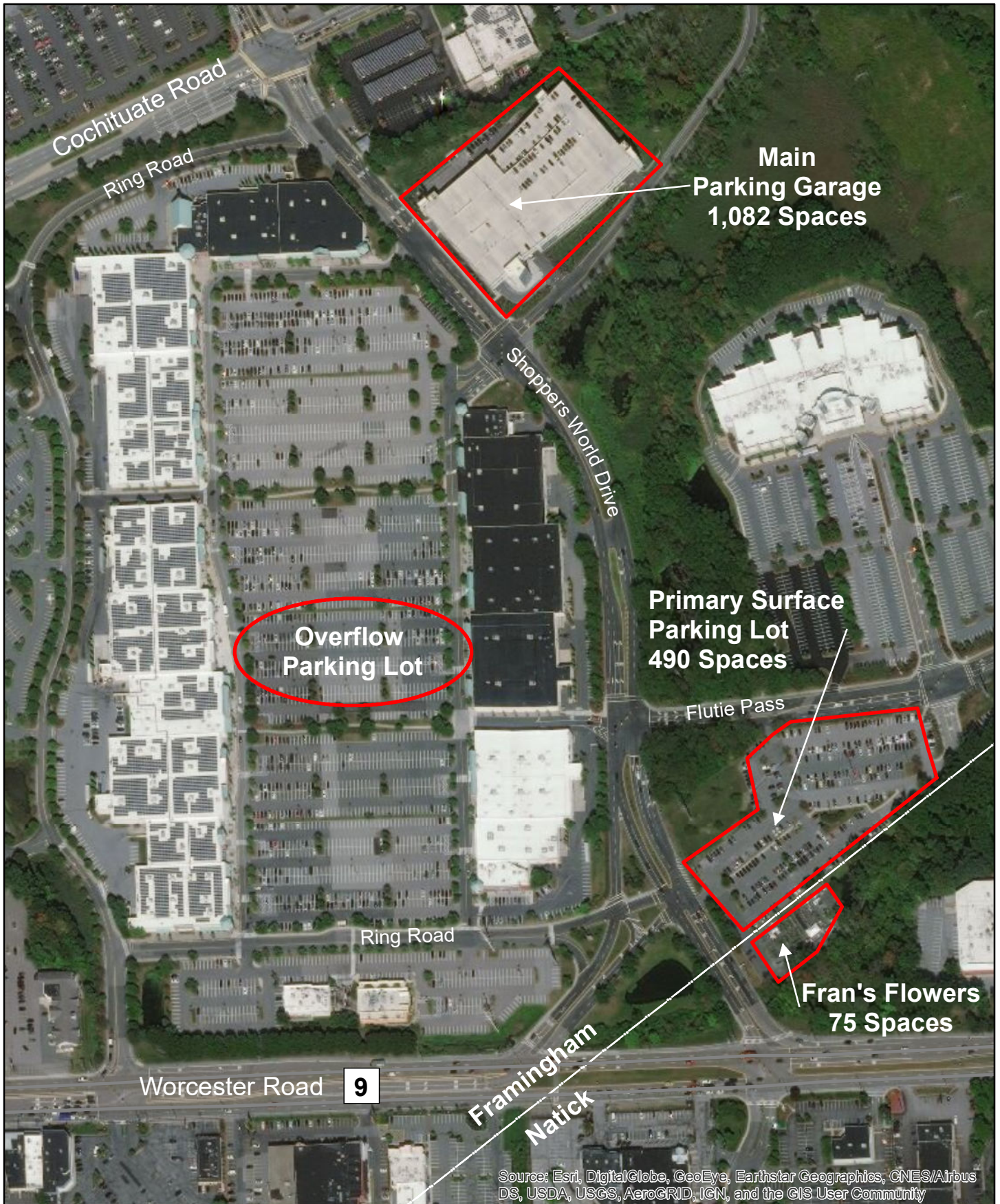
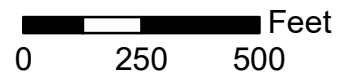


Figure 2 - Parking Systems

Logan Express - Framingham
May 2020



2.2 EXISTING ROADWAY CONDITIONS

2.2.1 Framingham Logan Express Access

The LEXF site is conveniently located close to three regionally significant east-west corridors – the Massachusetts Turnpike (Interstate 90), Cochituate Road (State Route 30), and Worcester Road (State Route 9). It is located just east and adjacent to the Shoppers World retail commercial area far from sensitive residential areas in the northeast quadrant of the intersection of Shoppers World Drive at Burr Street. Three driveways provide existing access/egress to the site. An entrance only driveway is provided via a four-legged unsignalized intersection on Shoppers World Drive approximately 300 feet north of its signalized intersection with Burr Street. The LEXF driveway on Shoppers World Drive accommodates entering traffic only. Shoppers World Drive is median divided and generally consists of two travel lanes in each direction with auxiliary lanes at intersections. A median opening with a left-turn access lane approximately 55 feet in length allows for southbound traffic on Shoppers World Drive to enter the site. This driveway serves as the Logan Express bus entrance, as well as the entrance for vehicles picking up and dropping off at the facility.

An exit-only driveway is located off Burr Street, approximately 130 feet east of Shoppers World Drive. The approach serves as a single wide lane for both right and left turning movements. This driveway serves exiting Logan Express buses and exiting vehicles picking up and dropping off at the facility.

A two-way driveway is located off Burr Street, approximately 410 feet east of Shoppers World Drive. The approach consists of a single shared lane for left and right turning exiting vehicles, and a lane for entering vehicles. This driveway serves vehicles entering and exiting the facility to park in the Logan Express facility's parking areas.

Entry into the AMC Overflow Lot is provided via two driveways off Flutie Pass. Entry to the Fran's Flowers Overflow Lot will also be off Flutie Pass, as Massport plans to implement changes to the lot and the existing entrance driveway to Fran's Flowers from Shoppers World Drive will be closed. Traffic exits the AMC and Fran's Flowers Overflow lots via the traffic signal at the four-way signalized intersection of Burr Street/AMC Theatre Driveway/AMC Overflow Lot.

Bus traffic enters the LEXF site via Shoppers World Drive and exits via the western Burr Street driveway.

2.2.2 Cochituate Road (Route 30)

Cochituate Road (State Route 30) is a generally northeast-southwest-oriented arterial roadway that traverses several eastern Massachusetts communities. While a state-numbered route, Cochituate Road is under the jurisdiction of the City of Framingham. Its posted speed limit is 30 miles per hour. Through the study area, Cochituate Road is median divided, has two through lanes in each direction, and is bounded mainly by commercial land uses. At critical signalized intersections, Cochituate Road widens to provide left and right turning lanes. Within the study area, its four intersections with Speen Street, Burr Street, Whittier Street/Shoppers World Drive, Shoppers World Way /Ring Road are all under traffic signal-control and all located in the City of Framingham.



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From east to west:

At Speen Street, the westbound Cochituate Road approach has three lanes including two through lanes and exclusive left turn lane. The southbound Speen Street approach to the intersection has four lanes striped to provide an exclusive left-turn lane, two through lanes and an exclusive right turn lane. The eastbound Cochituate Road approach has four lanes including exclusive left- and right turn lanes, a through lane and a shared through/right lane. The northbound Speen Street approach has four lanes including a double left turn lane, and two through lanes.

At Burr Street, the westbound Cochituate Road approach has three lanes including a right-turn only lane and two through lanes. Westbound left turns are not permitted from Cochituate Road to Burr Street. The southbound Burr Street approach to the intersection has two lanes striped - an exclusive left-turn lane and a shared left/through/right turn lane. The eastbound Cochituate Road approach has three lanes including an exclusive left-turn lane, a through lane, and a shared through/right lane. The northbound Burr Street approach has a shared through/left-turn lane and a channelized exclusive right-turn lane.

At Whittier Street and Shoppers World Drive, the westbound Cochituate Road approach consists of three lanes including an exclusive left-turn lane, a through lane, and a shared through/right lane. The existing southbound Whittier Street approach includes an exclusive left-turn lane, a shared through/left lane, a through lane and an exclusive right-turn lane. The eastbound Cochituate Road approach provides an exclusive left-turn lane, two through lanes and two exclusive right-turn lanes separated from the through movements by a channelization island. The northbound Shoppers World Drive approach is median-divided and provides a shared left-through lane, a through lane and an exclusive right-turn lane.

At Shoppers World Way and Ring Road, the westbound Cochituate Road approach consists of an exclusive left-turn lane, two through lanes and an exclusive right-turn lane. The southbound Shoppers World Way approach provides three approach lanes including an exclusive left-turn lane, a shared left/through lane, and an exclusive right-turn only lane separated by a channelization island. The eastbound Cochituate Road approach is similar to the westbound approach as it also provides exclusive left and right-turn lanes and two through lanes. The northbound approach has three lanes including two exclusive left-turn lanes and a shared through/right lane and is median divided.

2.2.3 Worcester Road (Route 9)

Worcester Road (State Route 9) is a generally east-west oriented arterial roadway that traverses most of the Commonwealth. Worcester Road is a significant east-west regional roadway between eastern and central Massachusetts. Worcester Road is under the jurisdiction of the MassDOT.



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Through the study area, Worcester Road is median divided, typically provides three through lanes in each direction, and has commercial land uses adjacent to it. Its posted speed limit is 40 miles per hour through the study area. Worcester Road has been widened at critical intersections to provide auxiliary lanes for heavy turning movements. Worcester Road also forms the southern boundary of a large commercial area in the City of Framingham and Town of Natick known as the 'Golden Triangle'. The other two boundaries of the Golden Triangle are Speen Street to the east and Cochituate Road/Concord Street/Old Connecticut Path to the north and west. Within the study area, Worcester Road has signalized intersections at Natick Mall Road, Shoppers World Drive, the Ring Road West Couplet, and Ring Road.

Again, from east to west:

At the intersection with Natick Mall Road and Dean Road, the westbound Worcester Road approach provides four lanes, including an exclusive left-turn lane, two through lanes, and one shared through-right turn lane. The southbound Natick Mall Road approach intersects Worcester road at a skew to the west to foster left turn movements out of the Natick Mall heading eastbound on Worcester Road. The southbound Natick Mall Road approach is median divided and provides two exclusive left turn lanes and a channelized right turn lane. The eastbound Worcester Road approach has four lanes including three through lanes and a channelized right turn lane. Eastbound left turns are not permitted and are geometrically constrained. The northbound Dean Road approach has three lanes, including two exclusive left-turn lanes and a channelized right-turn lane. Through traffic from Dean Road to Natick Mall Road is prohibited.

At its intersection with Shoppers World Drive, the westbound Worcester Road approach provides five lanes including an exclusive right-turn lane, three through lanes, and an exclusive left-turn lane. The southbound Shoppers World Drive approach intersects Worcester Road at a skew to the west to foster left turn movements out of Shoppers World heading eastbound on Worcester Road. The southbound Shoppers World Drive approach is median divided and provides an exclusive left-turn lane and a shared through left-turn lane. The eastbound Worcester Road approach has three lanes including two through lanes and a shared through/right lane. Eastbound left turns are not permitted and are geometrically constrained, as they are provided at the West Couplet intersection just upstream of this intersection. The northbound approach of the Michael's/La-Z-Boy plaza driveway has two lanes, including exclusive left- and right-turn lanes.

The Ring Road West Couplet intersects Worcester Road at an acute angle to foster right-turn lane movements westbound to Worcester Road and eastbound left-turn lane movements from Worcester Road to the Ring Road West Couplet and Shoppers World. The westbound Worcester Road approach has three through lanes (with left and right turns prohibited). The southbound Ring Road West Couplet has two right-turn lanes only (with left and through movements prohibited). Eastbound Worcester Road has a double left-turn lane and three through lanes. The signal operation permits pedestrian crossings of the east leg of the intersection.

At its intersection with the Ring Road and a private driveway to the south serving commercial developments (Verizon/Bed, Bath & Beyond), the westbound Worcester Road approach provides three through lanes, a double left-turn lane, and an exclusive right-turn lane. The southbound Shoppers World



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West Driveway approach is median divided and restricted to right turns out only in one signal-controlled right-turn lane. The eastbound Worcester Road approach has a double left-turn lane, two through lanes, and a shared through/right-turn lane. The northbound approach from a private commercial drive is also median-divided and includes a driveway wide enough for two lanes but is unmarked.

2.2.4 Shopper's World Drive

Shoppers World Drive provides a north-south connection between Worcester and Cochituate Roads, or State Routes 9 and 30 respectively. It has two through lanes in each direction, is median-divided and provides direct access to the LEXF facility and several Shoppers World adjacent land uses. Shoppers World Drive is privately-owned and maintained by Shoppers World.

Within the study area, Shoppers World Drive has five signalized intersections, two of which intersect public roads (Cochituate and Worcester roads) and were described previously. The other three signalized intersections are with private roads on the Shoppers World site -- i.e., the Burr Street, Flutie Pass, and the West Couplet Ring Road/Shoppers World Drive split. Auxiliary turn lanes are provided at each of these intersections, as described below.

From north to south:

At its intersection with Burr Street, the westbound Burr Street approach provides two lanes including a shared through/left lane and a shared through/right lane. The southbound Shoppers World Drive approach provides four lanes, including two through lanes, as well as exclusive left and right-turn lanes. An unnamed eastbound Shoppers World driveway approaches this intersection in three lanes including a shared through/left lane, a through lane, and an exclusive right-turn lane. The northbound Shoppers World Drive approach has three approach lanes including an exclusive left-turn lane, a through lane, and a shared through/right-turn lane.

At its intersection with Flutie Pass, the westbound Flutie Pass approach provides three lanes, with two exclusive left turn lanes and an exclusive right turn lane. The southbound Shoppers World Drive approach provides four lanes, including two through lanes and two exclusive left turn lanes. An unnamed eastbound Shoppers World driveway approaches this intersection in three lanes including an exclusive left turn lane, a through lane, and a channelized right turn lane. The northbound Shoppers World Drive approach has three approach lanes including two through lanes and two exclusive right-turn lanes.

At its intersection with the Ring Road West Couplet, the southbound approach of the Shoppers World Drive has four lanes; two are exclusive right-turn lanes channelized by a median toward the Ring Road West Couplet (ultimately travelling westbound on Route 9) and two are southbound through lanes. The eastbound Ring Road West Couplet approach to the intersection is median divided and has three lanes comprised of an exclusive left-turn lane to an east-west Shoppers World distributor driveway, an exclusive left-turn lane to the Shoppers World Drive, and a shared left/right lane to Shoppers World Drive. The northbound Shoppers World Drive approach also has three lanes including an exclusive left-turn lane to the east-west Shoppers World distributor driveway, and two through lanes.



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2.2.5 Burr Street

Burr Street is undivided adjacent to the LEXF facility and has two lanes in each direction. At its intersection with the Shoppers World Drive, Burr Street is striped for one lane in each direction to the east of the LEXF facility exit driveway. Primarily commercial uses and open space/wetlands abut Burr Street.

2.2.6 Shopper's World Roadways

Shoppers World provides several internal driveways including Shoppers World Drive and the Ring Road that serve primarily adjacent retail/commercial users. These roadways located between Worcester Road (Route 9) Cochituate Road (Route 30) were constructed to minimize the need for Shoppers World users to make U-turns and left turns onto the regional highway system. The circular roads provide the same advantage for use of the LEXF facility.

2.3 EXISTING TRAFFIC VOLUMES

Traffic volume data was collected during October 2019. Two types of traffic counts were performed, automatic traffic recorder (ATR) counts and manual turning movement counts (TMC). Refer to Figure 3 for the locations where automatic and manual counts were performed.

2.3.1 Automatic Traffic Recorder Counts

Automatic traffic recorder counts were performed over a two-day period on October 16-17th 2019 on a Wednesday and Thursday at four driveways to obtain a two-day record of activity at the LEXF site. The four locations included:

- The LEXF entrance off Shoppers World Drive – serving entering buses and drop-off and pick ups;
- The LEXF exit to Burr Street – serving exiting buses and drop-off and pick ups;
- The LEXF entrance/exit to Burr Street – serving entering/exiting vehicles to parking areas; and

Additionally, automatic traffic recorder counts were performed at:

- Burr Street south of Cochituate Road (Route 30)
- Shoppers World Drive south of Burr Street
- Cochituate Road west of Burr Street
- AMC Overflow Lot south of Flutie Pass
- Fran's Flowers Overflow Lot east of Shoppers World Drive
- Flutie Pass east of AMC Overflow Lot
- Whittier Street north of Cochituate Road
- Ring Road south of Cochituate Road



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Rounded and seasonally adjusted average weekday traffic volumes are provided on Figure 4. According to MassDOT's seasonal factors data, traffic volumes collected during the month of October are historically approximately 6% higher than average annual conditions, and therefore, traffic volumes in this study were not adjusted, in order to present a conservative approach to the study.

2.3.2 Manual Turning Movement/Vehicle Classification Counts

Morning and afternoon peak hour turning movement counts were performed at 23 intersections between 6-9 AM and 4-6 PM on a typical weekday, which are the typical commuter peak hours and when roadways typically carry the highest volumes. All TMCs were conducted on Thursday October 17, 2019, with the exception of the intersection of Ring Road at Shoppers World Drive, which was conducted on Tuesday October 29, 2019, due to an issue with the counting apparatus. From the data collected, the typical morning commuter peak hour in the study area occurs from 8:00-9:00 AM, while the typical afternoon commuter peak hour occurs from 5:00-6:00 PM. Traffic volume counts include truck and automobile turning movements as well as pedestrians and bicycles. Manual count locations included:

- Burr Street at Cochituate Road (Route 30)
- Whittier Street and Shoppers World Drive at Cochituate Road (Route 30)
- Shoppers World Way at Cochituate Road (Route 30) at and Ring Road
- Ring Road at Ring Road (north)
- Ring Road at Shoppers Word Drive (north)
- Burr Street at Shoppers World Drive
- Shoppers World Drive at Flutie Pass
- Ring Road at Shoppers World Drive (south)
- Worcester Road (Route 9) at Shoppers World Drive
- Worcester Road (Route 9) at the Ring Road West Couplet
- Worcester Road (Route 9) at Ring Road (west)
- Ring Road at Ring Road (south)
- Ring Road at Shoppers World Interior Driveway
- Shoppers World Drive at Logan Express Driveway and Shopper's World Interior Driveway
- Burr Street at Logan Express West Driveway
- Speen Street at Cochituate Road (Route 30)
- Route 30 at TJX Driveway
- Speen Street at TJX Driveway
- Whittier Street at Colonial Shopping Center Overflow Lot
- Flutie Pass at AMC Lots
- Newbury Street at Old Connecticut Path
- Burr Street at Logan Express East Driveway
- Worcester Road (Route 9) at Natick Mall Road

The existing traffic count data, both the daily traffic volume count data and the peak hour intersection turning movement count data at all locations include, amongst many destinations in the study area, traffic going to and leaving the AMC Overflow parking lot. Therefore, the baseline (existing) traffic counts throughout the study area, including the morning and afternoon peak hour turning movement intersection



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traffic count data that are used in the intersection operations analysis, account for the use of the AMC Overflow parking lot. It is worthwhile to note that the traffic data collection at the AMC Overflow lot indicates that peak usage of the parking lot on weekdays is during the mid-day hours.

Existing morning and afternoon peak hour turning movement volumes at the 23 intersections are summarized on Figures 5 and 6.



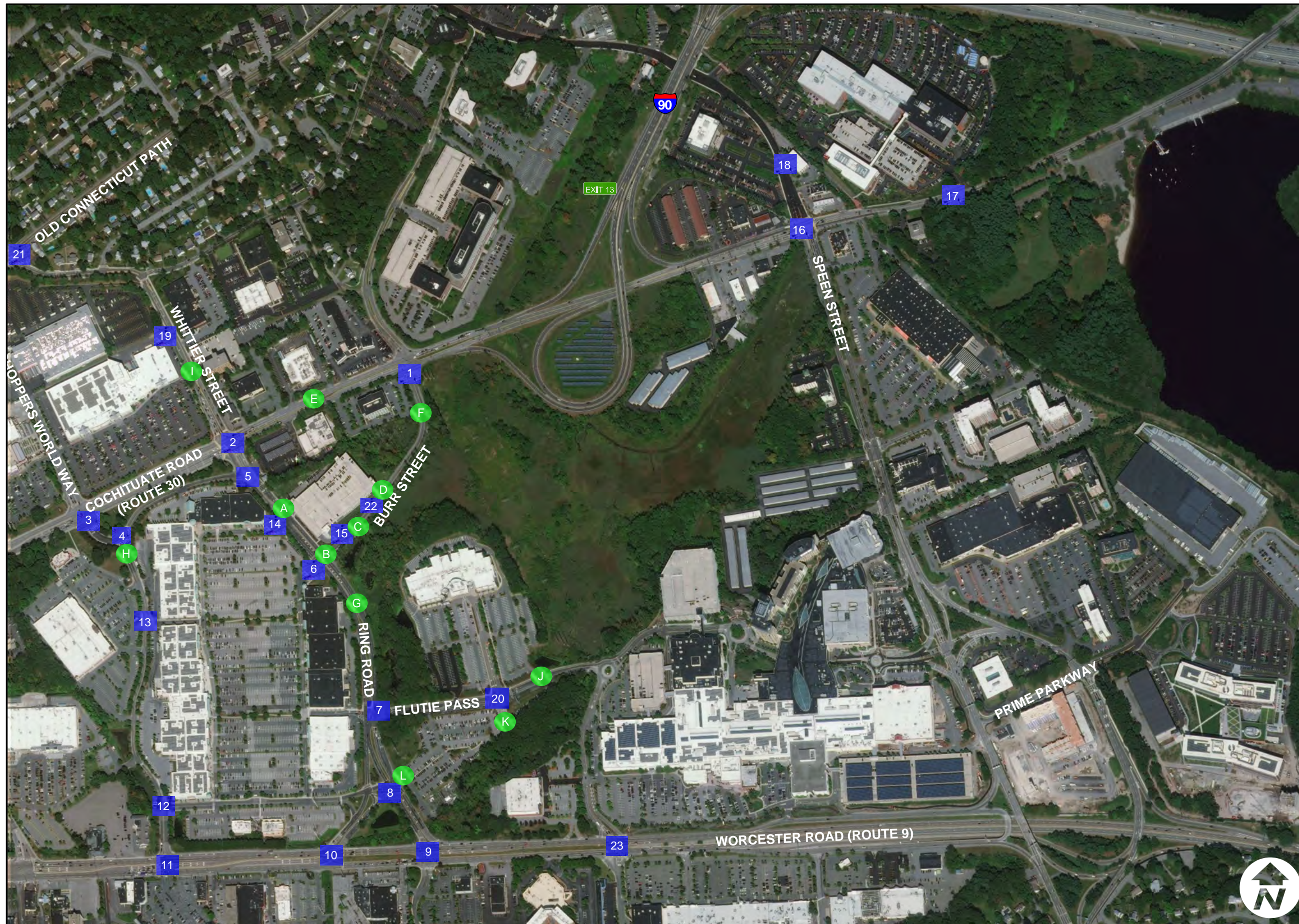
**Traffic Count Locations
Framingham Logan Express
Garage Expansion
(9/30/19)**

Turning Movement Counts (TMC)

1. Burr Street at Cochituate Road/Route 30
2. Whittier Street and Ring Road at Cochituate Road/Route 30
3. Shopper's World Way and Ring Road at Cochituate Road/Route 30
4. Ring Road at Ring Road (west)
5. Ring Road at Ring Road (east)
6. Burr Street at Ring Road
7. Ring Road at Flutie Pass
8. Ring Road at Ring Road (southeast)
9. Worcester Road/Route 9 at Ring Road (east)
10. Worcester Road/Route 9 at Ring Road (central)
11. Worcester Road/Route 9 at Ring Road (west)
12. Ring Road at Shopper's World Driveway (1)
13. Ring Road at Shopper's World Driveway (2)
14. Ring Road at Logan Express Driveway and Shopper's World Driveway
15. Burr Street at Logan Express Driveway
16. Speen Street at Cochituate Road (Route 30)
17. Route 30 at TJX Driveway
18. Speen Street at TJX Driveway
19. Whittier Street at Colonial Shopping Center Overflow Lot
20. Flutie Pass at Overflow Lot
21. Whittier Street at Old Connecticut Path
22. Burr Street at Logan Express Driveway
23. Worcester Road/Route 9 at Natick Mall Driveway

Automatic Traffic Recorder (ATR)

- A. Logan Express Entrance from Ring Road
- B. Logan Express Drop-Off
- C. Logan Express Exit on to Burr Street
- D. Logan Express Entrance/Exit on to Burr Street
- E. Cochituate Road (Route 30)
- F. Burr Street
- G. Ring Road (south of Burr Street)
- H. Ring Road (nrth of Kohl's Driveway)
- I. Whittier Street
- J. Flutie Pass
- K. Logan Express Overflow Lot Burr Street Entrance/Exit
- L. Logan Express Overflow Lot Ring Road Entrance/Exit



LEGEND # Turning Movement Counts (TMC) X Automatic Traffic Recorder (ATR)

Figure 3 - Traffic Count Locations
Logan Express - Framingham
May 2020

0 250 500 Feet



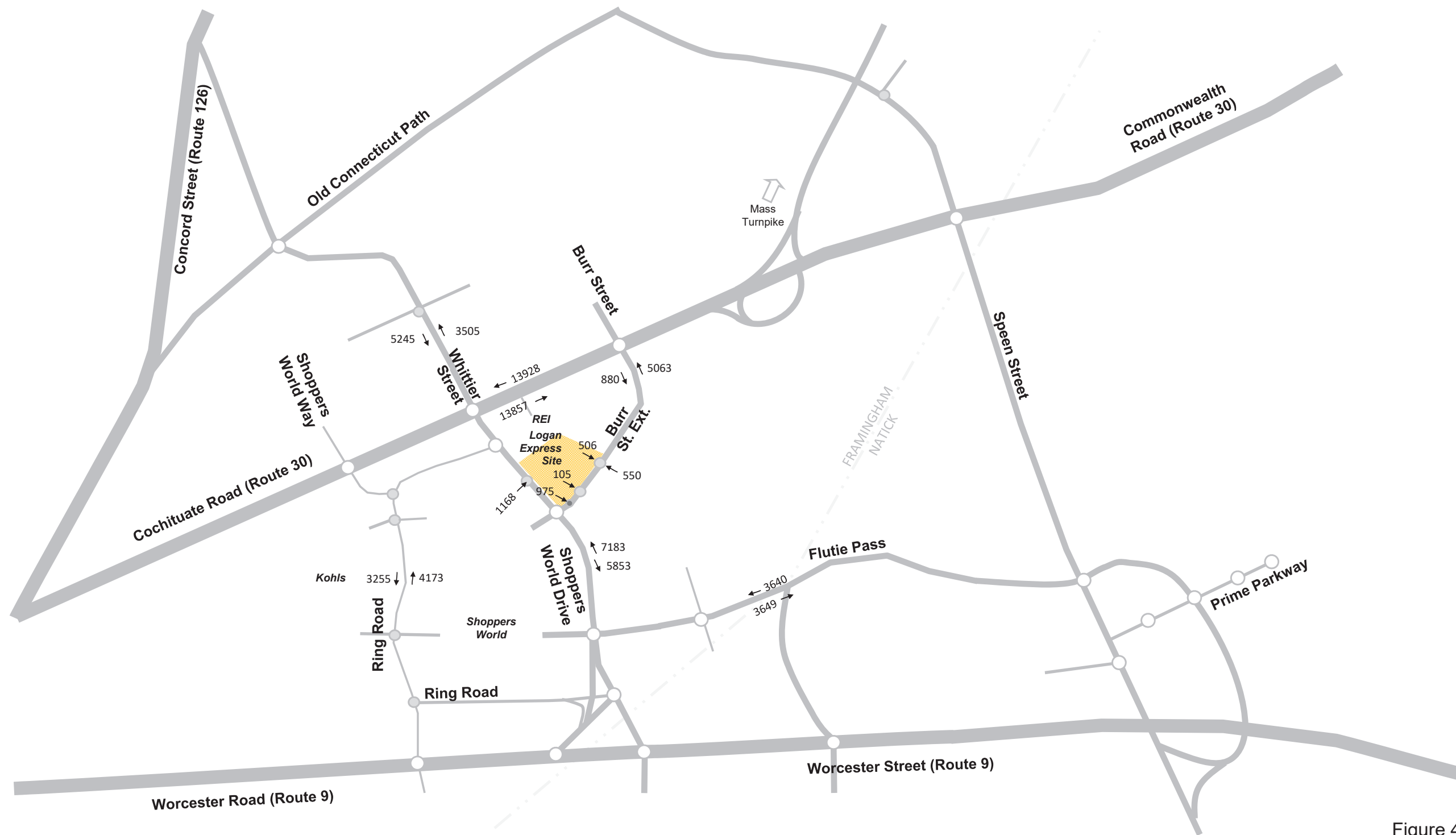


Figure 4



Schematic Diagram:
Not to Scale



2019 ADT Traffic Volumes
Logan Express – Framingham
May 2020





Figure 6



Schematic Diagram:
Not to Scale



2019 Existing PM Peak Hour Traffic Movement Volumes

Logan Express – Framingham
May 2020

2.4 CRASH HISTORY

Stantec used data from the MassDOT Crash Data Portal to obtain study area crash data from 2015-2018, the latest four-year crash data period available in the Portal. Crash data includes only reported crashes with greater than \$1,000 in property damage. This particular study area presents substantial crash tabulation difficulties because much of the area is on private property and precise locations are more difficult to identify, as many of the driveways are unmarked or referenced by different names (e.g., Shoppers World Drive is sometimes referred to as the North-South Connector and Ring Road). The average statewide / (MassDOT District 3) crash rates are 0.78 / (0.89) crashes per million entering vehicles for signalized intersections and 0.57 / (0.61) crashes per million entering vehicles at unsignalized intersections. Table 1 summarizes LEXF study area crash data from 2015 to 2018. Details are contained in the Technical Appendix to this report.



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Table 1 - Study Area Crash Data Summary – 2015-2018

Intersection	Number of Crashes ¹		Number by Severity			Number by Crash Type ¹				Calculated Crash Rate ²
	Av./Year	4 Yr. Total	PDO ³	INJ ⁴	Not Reported	Angle	Rear End	Sideswipe	Other	2015-2018
Cochituate Road (Route 30) at Burr Street	7	28	15	12	1	11	11	4	2	0.52
Cochituate Road (Route 30) at Whittier and Shoppers World Drive	9.75	39	25	13	1	14	13	7	5	0.82 ⁵
Route 30 at Shoppers World Way and Ring Road	0.75	3	2	1	-	-	1	-	1	0.08
Shoppers World Drive at Burr Street	2	8	5	3	-	7	-	1	-	0.30
Shoppers World Drive at Worcester Road (Route 9) East	15.5	62	53	9	-	16	29	1 11	6	0.87 ⁵
Shoppers World Drive at Worcester Road (Route 9) West	13.5	54	37	10	7	16	8	15	15	0.93 ⁵
Worcester Street (Route 9) at Natick Mall Road	18.75	75	65	10	-	23	24	21	7	0.93 ⁵
Worcester Road (Route 9) at Ring Road West	6.25	25	16	9	-	8	5	7	5	0.37
Speen Street at Cochituate Road (Route 30)	15.75	63	50	11	2	23	20	14	6	0.91 ⁵
Shoppers World Drive at Flutie Pass	2.5	10	6	4	-	3	2	4	1	0.44

1. Reported crashes as summarized by the Massachusetts Department of Transportation from Registry of Motor Vehicles statistics. Data excludes unreported crashes with less than \$1,000 in damage.
2. Crash rate in accordance with Crash Rate calculation procedures
3. PDO – Accident involving Property Damage Only
4. INJ – Accident involving personal injuries.
5. Intersection exceeds average statewide or District 3 crash rate.



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Five of the study area signalized intersections exceeded statewide or District 3 crash rates for signalized intersections. In order of severity, they are:

- Worcester Road (Route 9) at Shopper's World Drive (west)
With 54 total reported crashes, this intersection has a relatively high occurrence of sideswipe and rear end collisions that contribute to the 0.93 crashes per million entering vehicles calculated for the four-year reporting period.
- Worcester Street (Route 9) at Natick Mall Road
With 75 total reported crashes, this intersection is the first signal on Route 9 westbound for over two miles, so sudden stops may contribute to the 0.93 crashes per million entering vehicles during the four-year reporting period.
- Speen Street at Cochituate Road (Route 30)
With 63 total reported crashes, this intersection also has a relatively high occurrence of angle and rear end collisions on Worcester Road (Route 9) that is contributing to its 0.91 crashes per million entering vehicles during the three-year reporting period.
- Cochituate Road (Route 30) at Whittier Street/Shopper's World Drive
With 39 total reported crashes, has an occurrence of angle and rear end crashes that contributes to the 0.82 crashes per million entering vehicles rate calculated for the four-year reporting period. Again, while exceeding the statewide crash rate, the calculated rate is lower than the District 3 average crash rate of 0.89 crashes per million entering vehicles.
- Worcester Road (Route 9) at Shopper's World Drive (east)
With 62 total reported crashes, this intersection has a relatively high occurrence of rear end collisions and 0.87 crashes per million entering vehicles rate calculated for the four-year reporting period. While exceeding the statewide crash rate, the calculated rate is lower than the District 3 average crash rate of 0.89 crashes per million entering vehicles.

The Massachusetts Department of Transportation – Highway Division (MassDOT) maintains a database of High Crash Locations in Massachusetts. The database uses crash information from the Massachusetts Registry of Motor Vehicles (RMV). Crash clusters are identified where the total number of "equivalent property damage only" (EPDO) crashes is within the top 5% in the region. EPDO is a methodology of weighting crashes by severity (fatal, injury or property damage only), so that the raw number of crashes is not the determining criteria. An examination of the database reveals that there are no crash clusters within the study area, based on year 2014-2016 crash data.



3.0 FUTURE TRAFFIC VOLUMES

Future traffic conditions within the study area were forecast to gain an understanding of the traffic impacts of the project on the adjacent transportation network. Traffic growth within the study area is a function of expected land development, economic activity, changes in demographics, and changes in travel patterns.

3.1 FUTURE NO-BUILD CONDITIONS

In order to evaluate traffic impacts associated with the proposed expansion of the proposed LEXF garage, future No-Build Condition traffic volumes were examined to provide a baseline condition for comparison. No-Build Condition vehicular traffic volumes are those that are expected to use the roadway network in the future, assuming the proposed expansion of the proposed LEXF garage does not occur. No-Build Condition traffic volumes will be projected for the year 2029 based on traffic volumes collected in 2019.

Future No-Build Condition traffic volume projections generally consist of background growth, and traffic generated from specific proposed development projects in the study area.

3.1.1 General Background Growth

Typically, general background growth is a function of population growth, future land development, increased economic activity, and changes in travel patterns. After consideration of the characteristics of the general land use in the region, and review of recent traffic impact studies for development projects in the surrounding area, it was determined that a background growth rate of 1% per year should be used to grow the existing traffic volumes. This background growth rate accounts for all background traffic growth, including external growth and growth due to unspecified developments in the area.

3.1.2 Specific Planned Development Projects

To assess Year 2029 traffic conditions in the area, future infrastructure and private development project information was obtained from the City of Framingham and the Town of Natick.

On the basis of the information obtained, Table 2 below summarizes a list of private land development projects and their associated projected morning and afternoon peak hour trip generation, which were in some cases calculated based on the information provided in permitting documents for their respective development project. A map of the study area with the locations of the approved background developments is provided in Figure 7. The anticipated trips generated for each of these developments were distributed on the study area roadways in order to estimate future traffic conditions. These projects have been approved and are expected to affect future traffic conditions in the vicinity of the LEXF site.



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**Table 2 - Study Area Approved Background Development Projects
 Projected AM/PM Peak Hour Trip Generation**

Development	Type	Size	AM Entering	AM Exiting	PM Entering	PM Exiting
236 Cochituate Road, Framingham	Medical Office	5,070 sf	12	4	5	14
TJX – 770 & 740 Cochituate Road, Framingham	Corporate Conference Center	54,000 sf	191	26	38	184
85 Worcester Road, Framingham	Marijuana Dispensary	5,700 sf	36	35	74	73
655 Cochituate Road, Framingham	Marijuana Dispensary	7,370 sf	43	34	80	81
Cloverleaf West Apartments 321 Speen Street, Natick	Residential	124 units	12	33	34	21

The resulting year 2029 Future No-Build peak hour traffic volumes were developed through the application of the one percent annual growth rate for a ten-year period to existing peak hour traffic volumes and the addition of traffic associated with specific area development projects. Figures 8 & 9 display the year 2029 Future No-Build traffic volumes for the morning and afternoon peak hours, respectively.



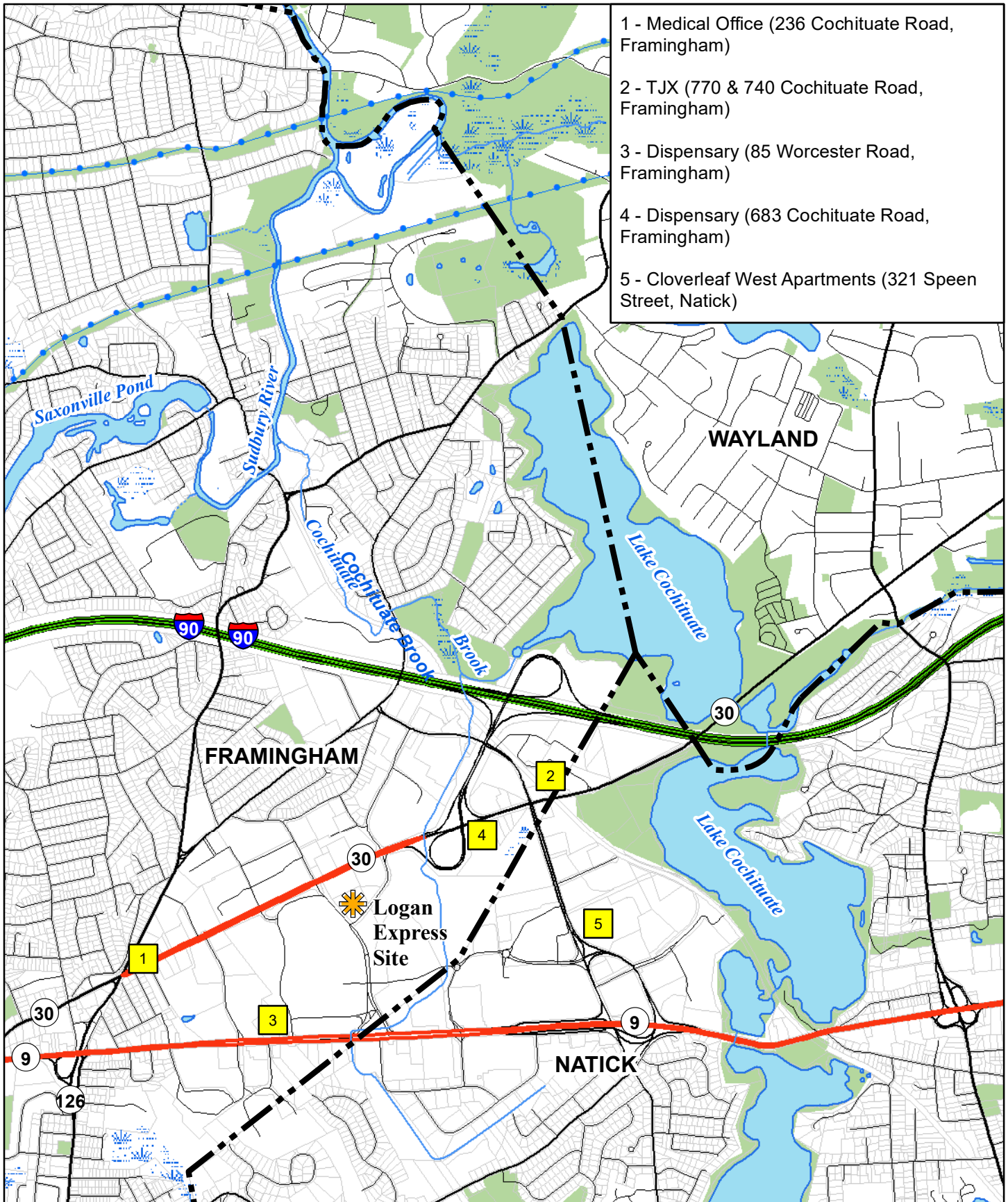


Figure 7 - Logan Express Study
Approved Developments Projects

Logan Express - Framingham

0 1,900 3,800 Feet





Figure 8



Schematic Diagram:
Not to Scale



2029 No-Build AM Peak Hour Traffic Movement Volumes

Logan Express – Framingham
May 2020



Figure 9



Schematic Diagram:
Not to Scale



2029 No-Build PM Peak Hour Traffic Movement Volumes

Logan Express – Framingham
May 2020

3.2 BUILD CONDITIONS

In order to evaluate the effect of the proposed LEXF garage expansion on traffic operations in the study area, vehicle trips associated with the proposed expansion are projected, distributed, and assigned to the adjacent roadway network. These incremental vehicle trips are added to the No-Build Condition traffic volumes to form the Build Condition traffic volume networks for the morning and afternoon peak hours.

3.2.1 Project Generated Traffic

The estimate of trips generated due to the expansion of the existing LEXF Garage is based upon 48-hour automatic traffic recorder count data obtained at driveways to the LEXF facility during the October 2019 count program. The use of the *ITE Trip Generation*¹ methodology, specifically Land Use Code 090 (Park and Ride Lot with Bus or Light Rail), to estimate trip generation is not assumed to be applicable, as the ITE methodology is associated with typical commuter park-ride lots for public transportation services that are typically used by daily commuters.

The custom trip generation used in this study is based upon the following:

- The total trip generation of the LEXF facility consists of two distinct components: trips associated with users of the permanent parking spaces at the facility and trips associated with Logan Express passengers being dropped off and picked up at the facility by the Logan Express Buses, personal automobiles, taxis and Transportation Network Company (TNC) vehicles.
- The trips associated with the users of the permanent parking spaces at the LEXF facility are generated at a different rate with a different independent variable than the trips associated with the pick-ups and drop offs.
- Using existing traffic volumes counted at the LEXF driveway to the permanent parking areas, peak hour and daily trip rates per parking space provided was developed.
- Similarly, using existing traffic volumes counted at the LEXF driveway to the drop off-area, existing daily and peak hour trips to the drop off areas were calculated.
- In order to calculate the trips associated with the proposed expansion of the LEXF facility the existing daily and peak hour trip rate per parking space was applied to the proposed 998 new parking spaces.
- Additionally, in order to account for pick ups and drop offs in the future, the existing daily and peak hour trips to the drop off areas were increased by 25 percent to reflect Massport's projections for growth of passenger traffic at Logan Airport and expected increase in frequency of Logan Express bus service, from two buses per hour per direction to three buses per hour per direction. The 25 percent growth rate is also reflective of the availability of some capacity in the current Logan Express service to accept additional passengers, as many of the buses are not currently fully occupied throughout the day.

Applying the two trip making scenarios of the expanded facility, on a typical weekday, the LEXF garage expansion is expected to add approximately **1,496** vehicle trips per day to the local roadway network, and

¹ Institute of Transportation Engineers, Trip Generation, 10th Edition, 2017.



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88 and 117 total trips during the morning and afternoon peak hours, respectively. Table 3 shows the details of the project trip generation.

Table 3 – Project Trip Generation

Trip Source	Weekday			Weekday AM			Weekday PM		
	Total	Enter	Exit	Total	Enter	Exit	Total	Enter	Exit
Parking (998 Additional Spaces)	961	500	461	70	35	35	96	47	49
Pick up/Drop off	535	294	241	18	10	8	21	11	10
Total New Trips	1,496	794	702	88	45	43	117	58	59

The existing traffic volume data collection program was completed with the existing Logan Express overflow parking lots in use. If the overflow lots are used in the future (after the proposed garage expansion is in operation), it is expected that these trips to the overflow lots are already captured in the baseline (existing) traffic volume data collection throughout the study area.

3.2.2 Trip Distribution and Assignment

The following forms the basis of the expected trip distribution pattern of the trips associated with the proposed expansion of the LEXF garage:

- Existing ground traffic count turning movements at the LEXF site;
- Results of the LEXF drop-off/pick-up and long term parking license plate surveys conducted as part of the 2014 traffic study (*Traffic Impact Access Study, Framingham Logan Express Parking Garage, January 2014*, prepared by Fay, Spofford & Thorndike), that evaluated the impacts of the construction of the current LEXF facility.

A comparison of these two trip distribution patterns indicates that the expected LEXF trip distribution patterns after construction and occupation of the proposed expansion is likely to be similar to the distribution patterns found during the 2014 study and confirmed by turning movements at the existing Logan Express driveways. Generally, traffic to and from the LEXF facility disperses relatively quickly, as approximately half the new trips are expected to travel to and from the north on the Shoppers World Drive and half to and from the Route 9 intersections. To summarize, the assumed trip distribution pattern based on the initial study in 2014, and confirmed by the current site driveway counts is as follows:

- Approximately **36%** to and from the east on Cochituate Road (southbound traffic via the Shoppers World Driveway and north eastbound traffic via Burr Street);
- **13%** to and from the north via Whittier Street;
- **31%** to and from the east on Route 9 via Shoppers World Driveway and
- **13%** to and from the west of Route 9 via Shoppers World Driveway and the West Couplet/Ring Road.



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- 7% to and from the west on Cochituate Road (southbound traffic via Shoppers World Driveway).

The trips expected to be generated by the proposed expansion, as detailed earlier in Table 3, were assigned to study area intersections using the trip distribution patterns outlined above. Year 2029 Build morning and afternoon peak hour traffic volumes, which consist of the addition of peak hour project generated traffic to the year 2029 No Build traffic volumes, are displayed in Figures 10 & 11, respectively.





Figure 10



Schematic Diagram:
Not to Scale



2029 Build AM Peak Hour Traffic Movement Volumes

Logan Express – Framingham
May 2020



Figure 11



Schematic Diagram:
Not to Scale



2029 Build PM Peak Hour Traffic Movement Volumes

Logan Express – Framingham
May 2020

4.0 TRAFFIC IMPACT ANALYSIS

4.1 CAPACITY ANALYSIS

Measuring existing traffic volumes and projecting future traffic volumes quantifies traffic flow within a study area. To assess quality of flow, capacity analyses were conducted for study area intersections for the Existing, Future No-Build, and Future Build Conditions. The capacity analyses provide a standardized indication of the ability of the intersections to accommodate traffic demands placed upon it.

4.1.1 Level of Service Criteria

A primary result of capacity analyses is the assignment of Level of Service (LOS) to traffic facilities under various traffic flow conditions. Analyses were conducted using methods defined in the *Highway Capacity Manual, 6th Edition* (TRB, 2016) which provides methodologies for signalized and unsignalized intersections. The Level of Service is conceptually defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists.

A Level of Service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. In doing so, Level of Service provides an index to quality of traffic flow.

Six Levels of Service are defined for each type of facility. They are given letter designations, from A to F, with LOS A representing the best operating conditions and LOS F representing the worst. Since the Level of Service of a traffic facility is a function of traffic flows placed upon it, an intersection may operate at a wide range of Levels of Service, depending on the time of day, day of week, or period of year.

The average delay per vehicle approaching an intersection is used to quantify the Level of Service at a particular intersection. This is discussed briefly below, and LOS designations are defined in *Tables 4 & 5*. Average delay measures the mean stopped delay experienced by vehicles entering an intersection during the design period. Average delay is measured for each individual turning movement that must yield the right of way, and for the intersection as a whole (including through vehicles that experience no delay).

Table 4 – Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (Seconds/Vehicle)
A	0 – 10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F	>50

Source: Highway Capacity Manual, 6th Edition, TRB



Table 5 – Level of Service Criteria for Signalized Intersections

Level of Service	Average Control Delay (Seconds/Vehicle)
A	≤10
B	>10 – 20
C	>20 – 35
D	>35 – 55
E	>55 – 80
F	≥80

Source: Highway Capacity Manual, 6th Edition, TRB

4.2 OPERATING CONDITIONS

The Synchro traffic analysis software package (Version 10) was employed to evaluate operating conditions at the study intersections. This software uses methodology based on the Highway Capacity Manual (HCM) 6th Edition to conduct the analyses and is widely accepted for use by public agencies.

Under the HCM, the overall LOS for a STOP controlled intersection is not defined. Instead of the overall LOS, it is customary to instead report the LOS of the minor movements (i.e. side street or left turn) at the intersection. Since the methodology does not provide a means of reporting the overall LOS of a STOP controlled intersection, it is therefore important to note that even though the LOS for the minor movement is reported, it is not wholly representative of the overall performance of the intersection. In this report, LOS of the study intersections is reported on *Tables 6, 7, and 8*. Intersection capacity analyses were evaluated for 2019 Existing, 2029 No-Build, and 2029 Build Conditions. Capacity Analysis worksheets can be found in *Appendix D*.



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**Table 6 - Existing Level of Service and Delay¹
2019 AM (PM) Peak Hour (1 hour)**

Intersection	Average Total Delay (seconds/vehicle)	Volume to Capacity Ratio (v/c)	Level-of Service (LOS)
Signalized			
Shoppers World Way/Cochituate Road (Route 30) /Ring Road	14 (27)	0.59 (0.88)	B (C)
Whittier St/Shoppers World Drive/Cochituate Road (Route 30)	19(89)	0.75 (1.00+)	B (F)
Burr Street/ Cochituate Road (Route 30)	37 (161)	1.00+ (1.00+)	D (F)
Shoppers World Drive/Burr Street	13 (19)	0.54 (0.69)	B (B)
Shoppers World Drive/Flutie Pass	12 (19)	0.18 (0.55)	B (A)
Worcester Road (Route 9)/Shoppers World Drive/Michael's Driveway	12 (19)	0.71 (0.90)	B (B)
Shoppers World Drive/Ring Road West Couplet	12 (16)	0.32 (0.45)	B (B)
Worcester Road (Route 9)/Ring Road West Couplet	3 (5)	0.39 (0.51)	A (A)
Worcester Road (Route 9)/West Driveway/Bed Bath Drive	20 (24)	0.82 (0.84)	C (C)
Speen Street at Cochituate Road (Rte. 30)	36(64)	0.89 (1.00+)	D (E)
Worcester Road (Route 9)/Natick Mall Road	33(55)	1.00+ (1.00+)	C (E)
Unsignalized			
Shoppers World Drive /FLE Driveway ²	EB 12 (EB 18)	0.02 (0.17)	B (C)
Burr Street/FLE West Driveway ²	SB 10 (SB 11)	0.12 (0.15)	A (B)
Burr Street/FLE East Driveway ²	EB 9(EB 10)	0.04 (0.08)	A (B)

¹ Reported results from Synchro 10 analysis. Levels of Service are from A-F, where A is the best and F the worst. Seconds of delay rounded to nearest second during the highest 15-minute period of the AM or PM peak hours and represents total control delay per motorist including acceleration, deceleration, and stop delays. V/C (volume to capacity) is for the worst individual traffic movement in the intersection.

² Worst unsignalized intersection approach is reported.



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From Table 6, none of the Study Area intersections operate worse than LOS D during the morning peak hour. However, during the afternoon peak hour, two Cochituate Road intersections – with Burr Street and Whittier Street/Shoppers World Drive -- operate with congestion at LOS F, while the intersections of Cochituate Road at Speen Street and Worcester Road at Natick Mall Road operate at LOS E, and all other intersections remain above LOS D in the afternoon peak hour.

During both the morning and afternoon peak hours, the unsignalized driveway intersections of the LEXF site driveway with Shoppers World Drive and Burr Street operate at LOS A-C. Similarly, the signalized intersection of the Burr Street and Shoppers World Drive is operating at LOS B.

**Table 7 - Projected No Build Level of Service and Delay¹
2029 AM (PM) Peak Hour (1 hour)**

Intersection	Average Total Delay (seconds/vehicle)	Volume to Capacity Ratio (v/c)	Level-of-Service (LOS)
Signalized			
Shoppers World Way/Cochituate Road (Route 30) /Ring Road	16 (30)	0.64 (0.98)	B (C)
Whittier St/Shoppers World Drive/Cochituate Road (Route 30)	20 (110)	0.81 (1.00+)	B (F)
Burr Street/ Cochituate Road (Route 30)	55 (208)	1.00+ (1.00+)	E (F)
Shoppers World Drive/Burr Street	13 (19)	0.57 (0.73)	B (B)
Shoppers World Drive/Flutie Pass	12 (20)	0.20 (0.58)	B (B)
Worcester Road (Route 9)/Shoppers World Drive/Michael's Driveway	14 (22)	0.75 (0.98)	B (C)
Shoppers World Drive/Ring Road West Couplet	13 (16)	0.36 (0.48)	B (B)
Worcester Road (Route 9)/Ring Road West Couplet	4 (6)	0.44 (0.58)	A (A)
Worcester Road (Route 9)/West Driveway/Bed Bath Drive	24 (31)	0.92 (0.97)	C (C)
Speen Street at Cochituate Road (Rte. 30)	49(112)	1.00+(1.00+)	D (F)
Worcester Road (Route 9)/Natick Mall Road	56(89)	1.00+(1.00+)	E (F)
Unsignalized			
Shoppers World Drive /FLE Driveway ²	EB 12 (EB 20)	0.02 (0.20)	B (C)
Burr Street/FLE West Driveway ²	SB 10 (SB 12)	0.13 (0.18)	B (B)
Burr Street/FLE East Driveway ²	EB 9 (EB 11)	0.05 (0.09)	A (B)

¹ Reported results from Synchro 10 analysis. Levels of Service from A-F, where A is the best and F the worst. Seconds of delay rounded to nearest second during the highest 15-minute period of the AM or PM peak hours and represents total control delay per motorist including acceleration, deceleration, and stop delays. V/C (volume to capacity) is for the worst individual traffic movement in the intersection.

² FLE – Framingham Logan Express. Worst unsignalized intersection approach is reported



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As depicted on Table 7, traffic operational levels of service by the year 2029 at the intersections studied are expected to be very similar to the year 2019 existing levels of service identified on Table 6 previously.

Table 7 results indicate nearly the same levels of service and delays are expected during the year 2029 No-Build when compared to year 2019 existing conditions, for the intersections between Route 9 and Route 30, with some expected minor increases in delays and volume to capacity ratios. Slightly larger increases in delay and volume to capacity ratios are expected to be found at the study intersections along Route 9 and Route 30 due to background development projects by others along those roadways.

**Table 8 - Projected Build Level of Service and Delay¹
2029 AM (PM) Peak Hour (1 hour)**

Intersection	Average Total Delay (seconds/vehicle)	Volume to Capacity Ratio (v/c)	Level-of-Service (LOS)
Signalized			
Shoppers World Way/Cochituate Road (Route 30) /Ring Road	16 (30)	0.64 (0.98)	B (C)
Whittier St/Shoppers World Drive/Cochituate Road (Route 30)	21 (116)	0.85 (1.00+)	C (F)
Burr Street/ Cochituate Road (Route 30)	57 (217)	1.00+ (1.00+)	E (F)
Shoppers World Drive/Burr Street	15 (22)	0.64 (0.76)	B (C)
Shoppers World Drive/Flutie Pass	12 (20)	0.20 (0.58)	B (B)
Worcester Road (Route 9)/Shoppers World Drive/Michael's Driveway	14 (23)	0.76 (1.00+)	B (C)
Shoppers World Drive/Ring Road West Couplet	13 (16)	0.37 (0.50)	B (B)
Worcester Road (Route 9)/Ring Road West Couplet	4 (6)	0.44 (0.59)	A (A)
Worcester Road (Route 9)/West Driveway/Bed Bath Drive	24 (32)	0.92 (0.98)	C (C)
Speen Street at Cochituate Road (Rte. 30)	49 (113)	1.00+(1.00+)	D (F)
Worcester Road (Route 9)/Natick Mall Road	57(91)	1.00+(1.00+)	E (F)
Unsignalized			
Shoppers World Drive /FLE Driveway ²	EB 12 (EB 22)	0.02 (0.23)	B (C)
Burr Street/FLE West Driveway ²	SB 11 (SB 13)	0.17 (0.25)	B (B)
Burr Street/FLE East Driveway ²	EB 10 (EB 13)	0.13 (0.23)	B (B)

¹ Reported results from Synchro 10 analysis. Levels of Service from A-F, where A is the best and F the worst. Seconds of delay rounded to nearest second during the highest 15-minute period of the AM or PM peak hours and represents total control delay per motorist including acceleration, deceleration, and stop delays. V/C (volume to capacity) is for the worst individual traffic movement in the intersection.

² FLE – Framingham Logan Express. Worst unsignalized intersection approach is reported



**TRAFFIC IMPACT & ACCESS STUDY
PROPOSED EXPANSION OF THE
FRAMINGHAM LOGAN EXPRESS GARAGE
MAY 21, 2020**

Under 2029 Build conditions shown on Table 8, the assumed trip distribution pattern is expected to dissipate the impact of the garage to fewer than 60 peak hour trips through all of the intersections analyzed except t - the signalized intersection of Burr Street at Shoppers World Drive and the two unsignalized LEXF site driveway intersections on Burr Street.

At Study Area intersections, trips are expected to increase due to the proposed expansion of the LEXF facility (including increases to the parking capacity and increases in passenger pick up/drop off), but their projected levels of service are not expected to vary greatly when compared to the 2029 No-Build scenario. At most of the intersections, the expected increase in delay, if any at all, is 1 or 2 seconds, when compared to the No-Build condition. In some instances, even though the increase in delay was just one second, the increase in delay crossed the threshold into a different level of service letter grade. At the intersection of Cochituate Road/Whittier Street, the expected increase in delay is 6 seconds during the afternoon peak period. At the intersection of Cochituate Road/Burr Street the expected increase in delay is 9 seconds during the afternoon peak period. These anticipated increases in delay are typically considered to be small and the change to the experience of an individual driver is not expected to be notable. As such, it is not anticipated that improvements to the roadway or traffic signal timings at the study area intersections are needed as a result of the Project.



5.0 CONCLUSION

Using standard traffic engineering practices, this Traffic Impact Study has:

- Reviewed existing traffic and roadway conditions in the vicinity of the proposed project site, including an extensive data collection program
- Determined background traffic growth for the study area between 2019 and 2029, due to specific background development projects and due to general background growth
- Estimated and distributed the additional traffic that is expected to be generated by the proposed Logan Express Garage Expansion
- Presented an evaluation of traffic impacts due to the implementation of the proposed expansion

This study shows that:

- On a daily basis, the proposed expansion of the garage is expected to add approximately 1,496 vehicle trips to the surrounding road network. During the morning peak hour, approximately 88 vehicle trips (45 in and 43 out) are expected to be added, while during the afternoon peak hour, approximately 117 (58 in and 59 out) vehicle trips are expected to be added
- From a traffic operations perspective, the differences between the year 2029 No-Build and Build local traffic operations are relatively minor. At most of the intersections, the expected increase in delay, if any at all, is 1 or 2 seconds, when compared to the No-Build condition. At the intersection of Cochituate Road/Whittier Street, the expected increase in delay is 6 seconds during the afternoon peak period. At the intersection of Cochituate Road/Burr Street the expected increase in delay is 9 seconds during the afternoon peak period. These anticipated increases in delay are typically considered to be small and the change to the experience of an individual driver is not expected to be notable.

This study indicates that the roadways and intersections can accommodate the construction of the proposed expansion. It is not anticipated that improvements to the roadway or traffic signal timings at the study area intersections are needed as a result of the Project.

This study was undertaken in the fall of 2019, including the traffic data collection and traffic operations analysis, prior to the emergence of the COVID-19 pandemic. COVID-19 is expected to have a lasting effect on economic conditions within the 10 year planning horizon of this study and, as a result, baseline (existing) traffic volumes may not rebound to the levels shown in this study. Similarly, the traffic operations analysis results as presented in the study for existing, no-build and build conditions may not be realized due to the anticipated lower baseline traffic volumes.



APPENDIX C-1

Greenhouse Gas Emissions Analysis - Solar Modeling at Framingham Logan Express Parking Garage



March 5, 2020
File: 179410001

Stantec Inc
65 Network Drive, 2nd Floor Burlington MA 01803

Attention: Katie Raymond, PE, LEED AP
3 Mill & Main Place, Suite
250 Maynard, MA 01754

Dear Katie,

Reference: Solar Modeling at Framingham Logan Express Parking Garage

The solar modelling to the parking garage for the Base, Option A, B & C has been performed using PVsyst v.6.8.6 on March 4 & 5th, 2020 using NREL data. Building PV orientation was at an Azimuth of S41°E with four outputs generated. All options use a fixed 90° Tilt with varying number of modules and types for each option. A summary of the simulations was run is as follows.

Item	Base	Option A	Option B	Option C
Qty of JinkoSolar 330M-60L Modules (330W: Short PV)	N/A	202	88	96
Qty of JinkoSolar 410M-72HL-V (410W: Regular PV)	404	303	360	356
Total System DC Available (kW)	165.64	190.89	176.64	177.64
Qty of Sunny Tri-power String Inverter (33.3kW)	5			
Total System AC Available (kW)	166.5			
Average Overbuild	0.995	1.146	1.061	1.067
Specific Production (kWh/kWp/Year)	961	907	904	919
Average Performance Ratio (%)	81.31	76.55	76.31	77.58
Near Shadings Losses (%)	-4.52	-5.27	-5.25	-4.40
Electrical Shadings Loss (%)	-0.35	-2.15	-1.07	-0.33
Soiling Loss (%)	-2.42			
Energy Injected to Grid (MWh) (For first year – Solar typical depreciates at a rate of 0.4%/yr.	159.16	173.08	159.62	163.211
Order of Production Output	4	1	3	2

Currently, Option A appears to provide the highest return on energy yield. As with all three of Options A through C, due to the distributed nature of the secondary module type, there will be longer cable runs between the short modules. Option A does, however, have closer apparent distances between module types.

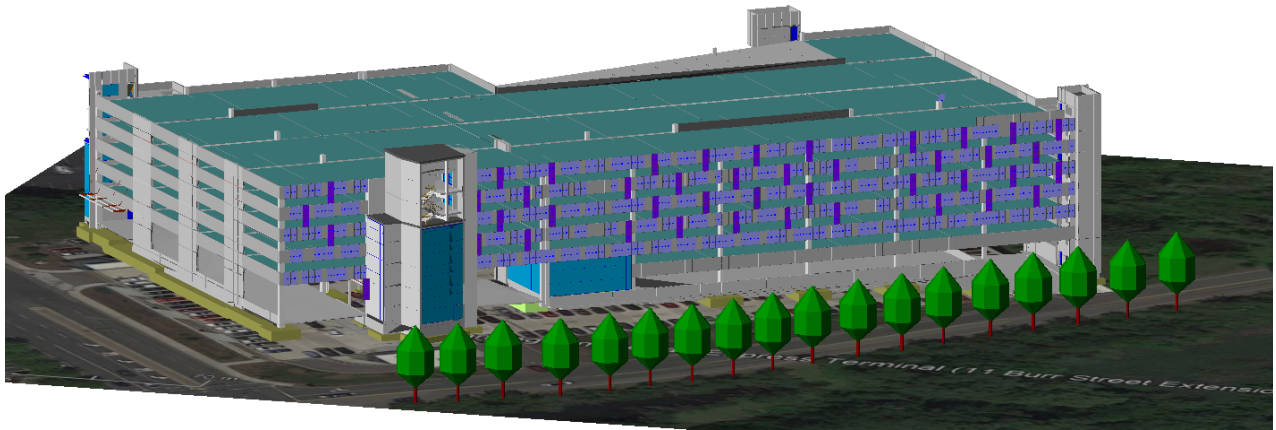
Base Option:



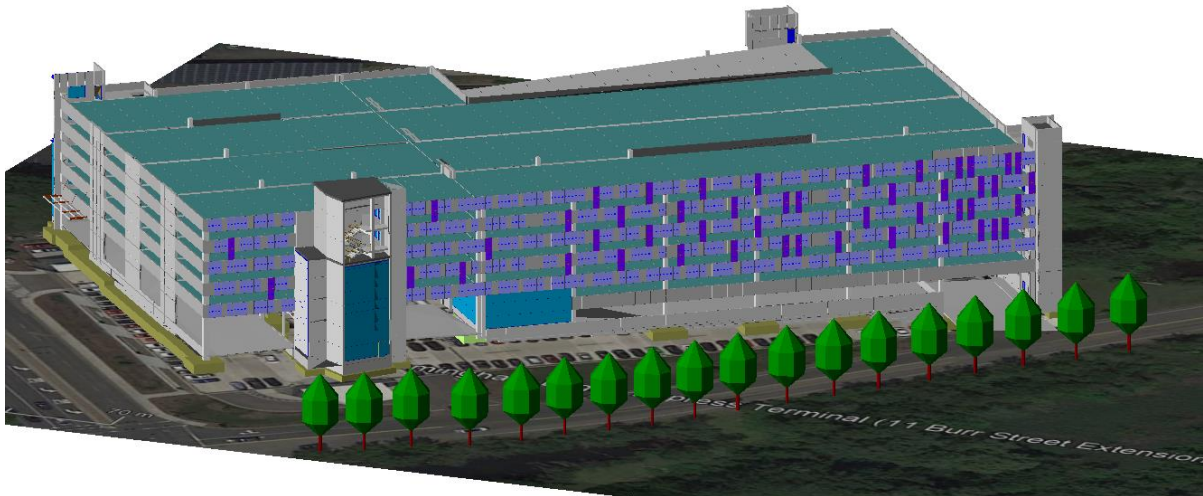
Option A:



Option B:



Option C:



Please see the attached PVsyst reports following this memo for full parameters on how these scenarios were modelled.

Regards,

Daniel Kraemer CTech
Project Manager: Controls, Power - Ontario

Phone: 519 585 7433
Fax: 519 579 6733
dan.kraemer@stantec.com

Attachment: ana_Framington_Garage_PVsyst_Base_90degTilt_EnergyModelResults_05.03.2020.pdf,
ana_Framington_Garage_PVsyst_OptionA_90degTilt_EnergyModelResults_05.03.2020.pdf,
ana_Framington_Garage_PVsyst_OptionB_90degTilt_EnergyModelResults_05.03.2020.pdf,
ana_Framington_Garage_PVsyst_OptionC_90degTilt_EnergyModelResults_05.03.2020.pdf
c. Jeff Cohen



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Project : Framington_Garage

Geographical Site Lokerville Country **United States**

Situation Latitude 42.30° N Longitude -71.39° W

Time defined as Legal Time Time zone UT-5 Altitude 50 m

Monthly albedo values

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Albedo	0.26	0.29	0.24	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.27

Meteo data: Lokerville NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016 - TMY

Simulation variant : Base_90DegTilt

Simulation date 05/03/20 08h53
Simulation for the 1st year of operation

Simulation parameters System type **SE Facade**

Collector Plane Orientation Tilt 90° Azimuth -41°

Models used Transposition Perez Diffuse Imported

Horizon Average Height 0.8°

Near Shadings According to strings Electrical effect 80 %

User's needs : Unlimited load (grid)

PV Arrays Characteristics (5 kinds of array defined)

PV module Si-mono Model **JKM 410M-72HL-V**
Custom parameters definition Manufacturer Jinkosolar

Sub-array "8_String"

Number of PV modules	In series	8 modules	In parallel	12 strings
Total number of PV modules	Nb. modules	96	Unit Nom. Power	410 Wp
Array global power	Nominal (STC)	39.4 kWp	At operating cond.	40.4 kWp (20°C)
Array operating characteristics (50°C)	U mpp	335 V	I mpp	121 A

Sub-array "11_String"

Number of PV modules	In series	11 modules	In parallel	8 strings
Total number of PV modules	Nb. modules	88	Unit Nom. Power	410 Wp
Array global power	Nominal (STC)	36.1 kWp	At operating cond.	37.0 kWp (20°C)
Array operating characteristics (50°C)	U mpp	460 V	I mpp	81 A

Sub-array "13_String"

Number of PV modules	In series	13 modules	In parallel	4 strings
Total number of PV modules	Nb. modules	52	Unit Nom. Power	410 Wp
Array global power	Nominal (STC)	21.32 kWp	At operating cond.	21.89 kWp (20°C)
Array operating characteristics (50°C)	U mpp	544 V	I mpp	40 A

Sub-array "14_String"

Number of PV modules	In series	14 modules	In parallel	6 strings
Total number of PV modules	Nb. modules	84	Unit Nom. Power	410 Wp
Array global power	Nominal (STC)	34.4 kWp	At operating cond.	35.4 kWp (20°C)
Array operating characteristics (50°C)	U mpp	585 V	I mpp	60 A

Sub-array "14_String_2"

Number of PV modules	In series	14 modules	In parallel	6 strings
Total number of PV modules	Nb. modules	84	Unit Nom. Power	410 Wp
Array global power	Nominal (STC)	34.4 kWp	At operating cond.	35.4 kWp (20°C)
Array operating characteristics (50°C)	U mpp	585 V	I mpp	60 A



1599 State Route 34, Suite 3, Wall Township, NJ 07727

By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Total	Arrays global power	Nominal (STC)	166 kWp		Total	404 modules
		Module area	813 m²		Cell area	733 m ²
Inverter		Model	Sunny Tripower33-US-10 (480 VAC)			
Custom parameters definition		Manufacturer	SMA			
Characteristics		Operating Voltage	300-800 V	Unit Nom. Power	33.3 kWac	
Sub-array "8_String"		Nb. of inverters	1 units	Total Power	33 kWac	
				Pnom ratio	1.18	
Sub-array "11_String"		Nb. of inverters	1 units	Total Power	33 kWac	
				Pnom ratio	1.08	
Sub-array "13_String"		Nb. of inverters	1 units	Total Power	33 kWac	
				Pnom ratio	0.64	
Sub-array "14_String"		Nb. of inverters	1 units	Total Power	33 kWac	
				Pnom ratio	1.03	
Sub-array "14_String_2"		Nb. of inverters	1 units	Total Power	33 kWac	
				Pnom ratio	1.03	
Total		Nb. of inverters	5	Total Power	167 kWac	

PV Array loss factors

Array Soiling Losses

Average loss Fraction 2.4 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
3.1%	1.4%	3.1%	1.5%	3.1%	1.5%	3.1%	3.1%	3.0%	1.6%	3.0%	1.6%

Thermal Loss factor

Uc (const) 26.0 W/m²KUv (wind) 1.2 W/m²K / m/s

Wiring Ohmic Loss

Array#1 54 mOhm

Loss Fraction 2.0 % at STC

Array#2 112 mOhm

Loss Fraction 2.0 % at STC

Array#3 265 mOhm

Loss Fraction 2.0 % at STC

Array#4 190 mOhm

Loss Fraction 2.0 % at STC

Array#5 190 mOhm

Loss Fraction 2.0 % at STC

Global

Loss Fraction 2.0 % at STC

LID - Light Induced Degradation

Loss Fraction 1.4 %

Module Quality Loss

Loss Fraction -0.8 %

Module Mismatch Losses

Loss Fraction 1.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.10 %

Module average degradation

Year no 1

Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.995	0.982	0.933	0.879	0.765	0.545	0.000

Spectral correction

FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
Monocrystalline Si	0.85914	-0.02088	-0.0058853	0.12029	0.026814	-0.001781

System loss factors

AC wire loss inverter to transfo

Inverter voltage 480 Vac tri

Wires: 3x95.0 mm² 71 m

Loss Fraction 1.0 % at STC

External transformer

Iron loss (24H connexion) 165 W

Loss Fraction 0.1 % at STC

Resistive/Inductive losses 14.0 mOhm

Loss Fraction 1.0 % at STC

Unavailability of the system

3.0 days, 3 periods

Time fraction 0.8 %

Auxiliaries loss

constant (fans) 130 W

... from Power thresh. 0.0 kW



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Horizon definition

Project : Framington_Garage
Simulation variant : Base_90DegTilt
Simulation for the 1st year of operation

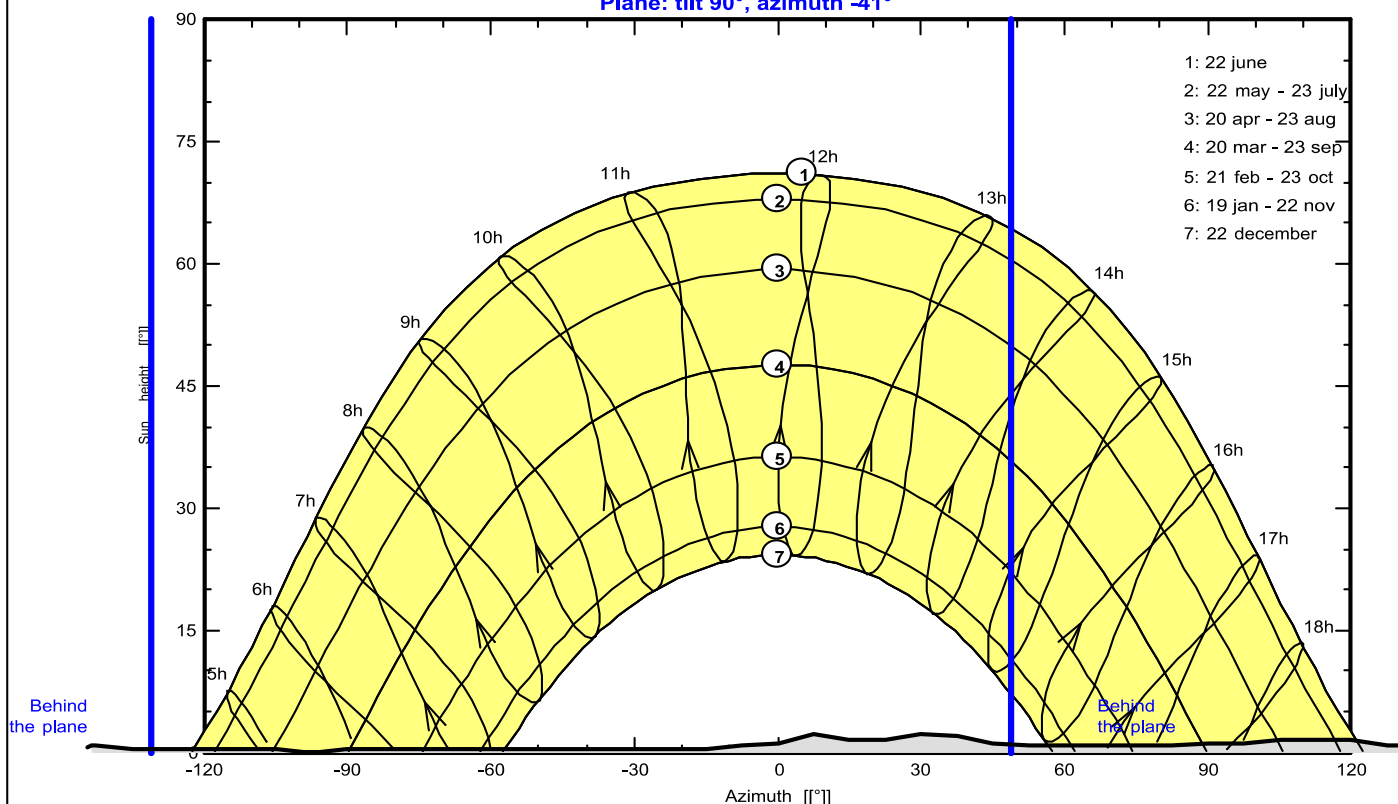
Main system parameters	System type	SE Facade		
Horizon	Average Height	0.8°		
Near Shadings	According to strings	Electrical effect	80 %	
PV Field Orientation	tilt	azimuth	-41°	
PV modules	Model	JKM 410M-72HL-V	Pnom	410 Wp
PV Array	Nb. of modules	404	Pnom total	166 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom	33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total	167 kW ac
User's needs	Unlimited load (grid)			

Horizon	Average Height	0.8°	Diffuse Factor	0.99
	Albedo Factor	100 %	Albedo Fraction	0.97

Height [°]	0.4	0.4	0.0	0.4	0.8	0.4	0.4	0.0	0.4	0.4
Azimuth [°]	-180	-165	-158	-150	-143	-135	-105	-98	-90	-15
Height [°]	0.8	1.1	2.3	1.5	1.5	2.3	1.9	1.1	0.8	0.8
Azimuth [°]	-8	0	8	15	23	30	38	45	53	83
Height [°]	1.1	1.1	1.5	1.5	0.8	1.1	0.8	0.8	0.4	0.4
Azimuth [°]	90	98	105	120	128	135	143	150	158	180

Horizon from PVGIS website API, Lat=42°18'15", Long=-71°23'35", Alt=53m

Plane: tilt 90°, azimuth -41°





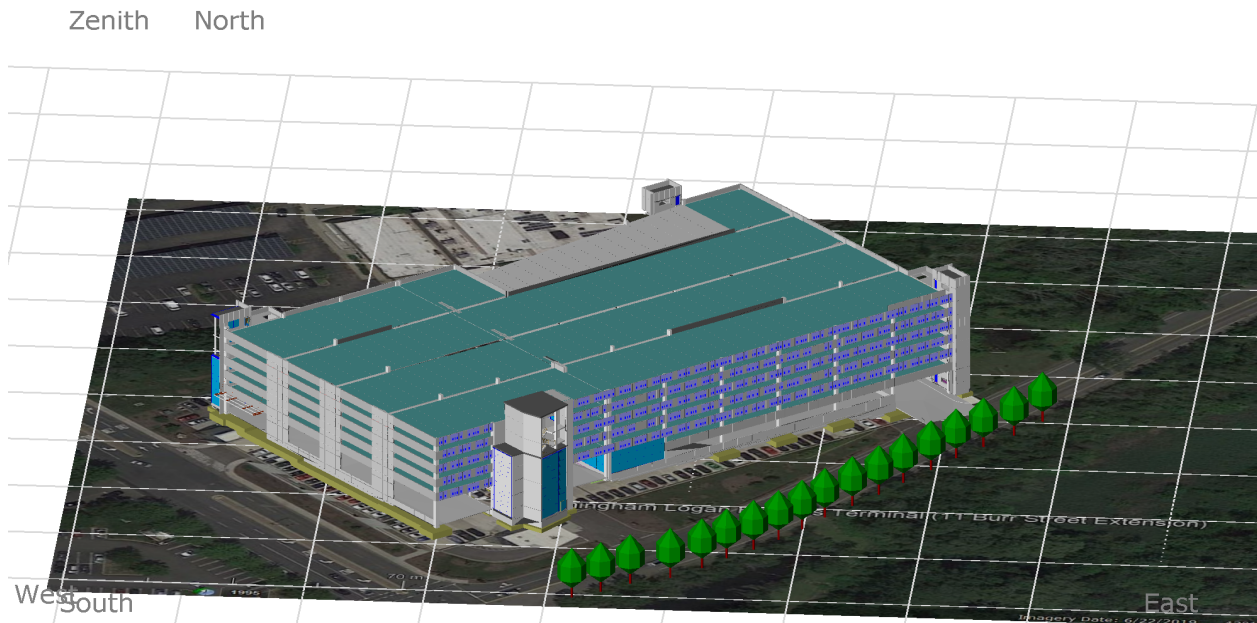
1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Near shading definition

Project : Framington_Garage
Simulation variant : Base_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	Pnom	410 Wp
PV Array	Nb. of modules	Pnom total	166 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom
Inverter pack	Nb. of units	Pnom total	167 kW ac
User's needs	Unlimited load (grid)		

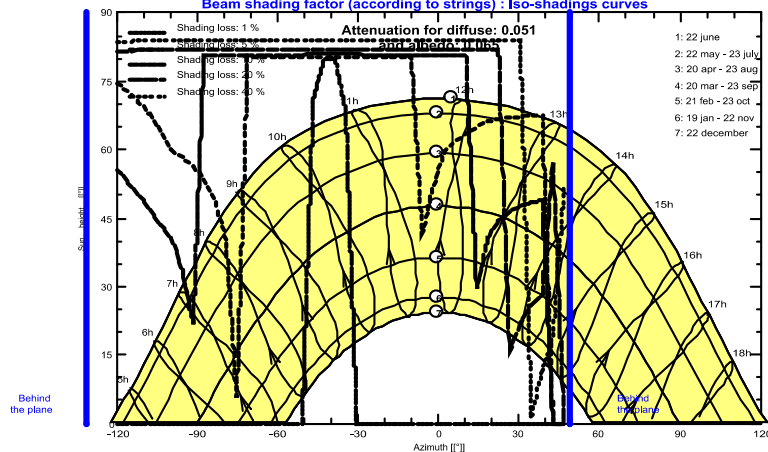
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Framington_Garage

Beam shading factor (according to strings) : Iso-shadings curves





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By: Daniel Kraemer

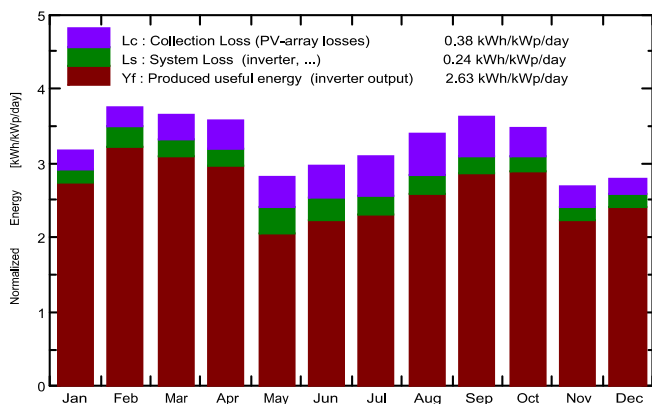
Grid-Connected System: Main results

Project : Framington_Garage
Simulation variant : Base_90DegTilt
Simulation for the 1st year of operation

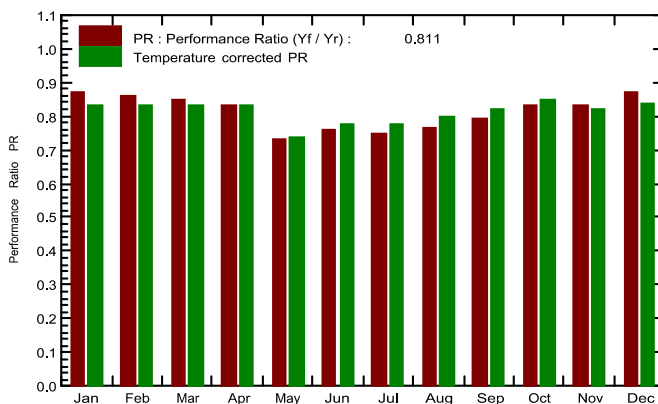
Main system parameters	System type	SE Facade
Horizon	Average Height	0.8°
Near Shadings	According to strings	Electrical effect 80 %
PV Field Orientation	tilt	90°
PV modules	Model	JKM 410M-72HL-V
PV Array	Nb. of modules	404
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom 410 Wp
Inverter pack	Nb. of units	5.0
User's needs	Unlimited load (grid)	Pnom total 166 kWp Pnom 33.3 kW ac Pnom total 167 kW ac

Main simulation results
System Production **Produced Energy 159160 kWh/year** Specific prod. 961 kWh/kWp/year
Performance Ratio PR 81.13 %

Normalized productions (per installed kWp): Nominal power 166 kWp



Performance Ratio PR and Weather corrected PR



Base_90DegTilt
Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR
January	60.9	21.92	-3.95	97.9	88.8	15005	14066	0.867
February	83.8	28.96	-1.63	105.4	97.3	16197	14957	0.857
March	122.8	44.18	1.01	113.2	103.0	17045	15931	0.849
April	155.7	52.88	7.67	107.0	97.9	15852	14713	0.830
May	166.5	69.85	13.77	87.0	77.3	12361	10526	0.731
June	177.0	74.06	17.85	89.0	79.9	12614	11159	0.757
July	191.5	75.26	21.37	95.7	84.8	13188	11844	0.747
August	172.2	63.93	21.01	105.0	93.8	14542	13267	0.763
September	134.3	43.50	17.09	109.0	99.1	15429	14289	0.791
October	95.3	33.33	11.29	107.9	100.3	15926	14863	0.831
November	58.1	22.66	5.47	80.8	73.1	11970	11113	0.831
December	51.0	20.04	-2.60	86.3	78.9	13271	12431	0.870
Year	1469.0	550.58	9.08	1184.3	1074.2	173398	159160	0.811

Legends: GlobHor Horizontal global irradiation
DiffHor Horizontal diffuse irradiation
T_Amb T amb.
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings
EArray Effective energy at the output of the array
E_Grid Energy injected into grid
PR Performance Ratio



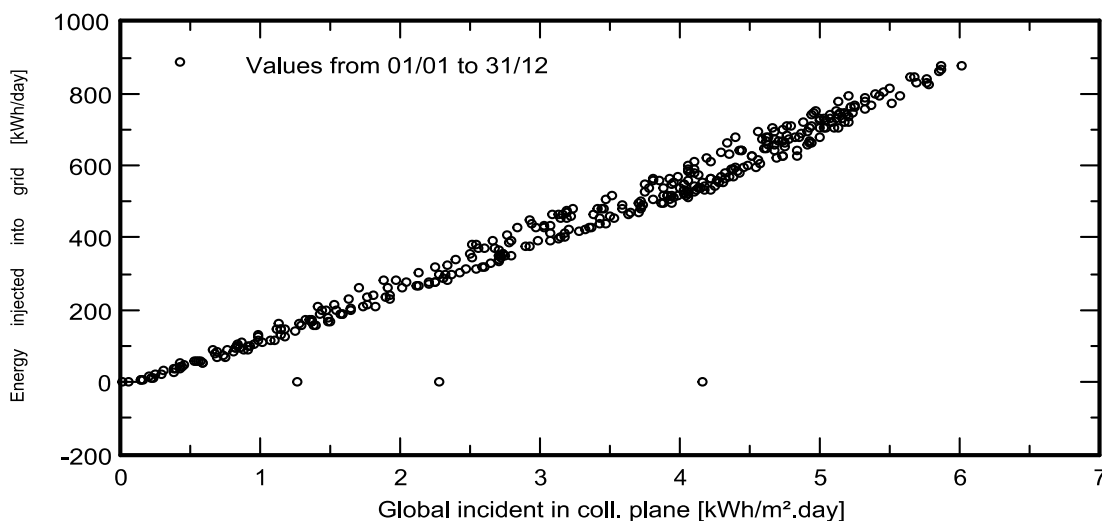
1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Special graphs

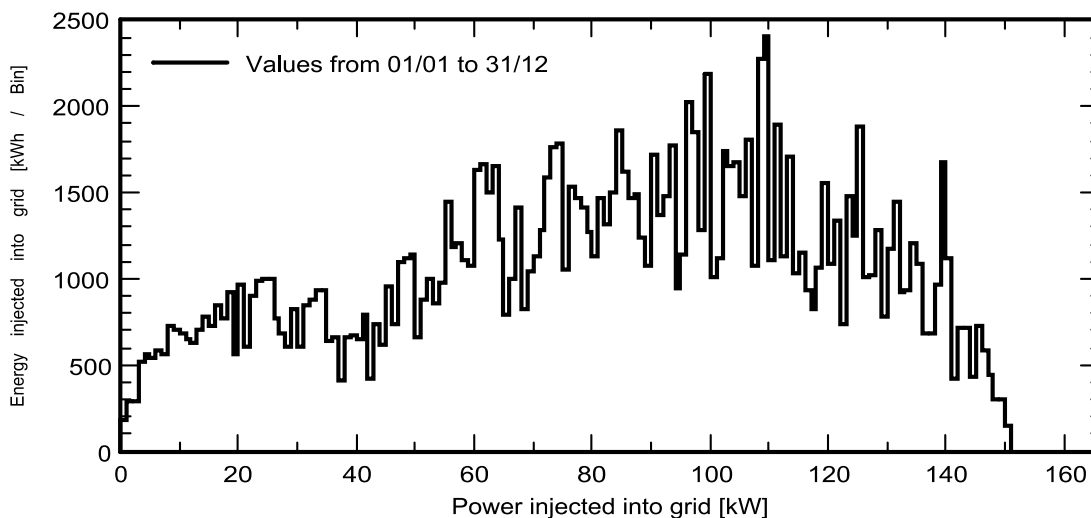
Project : Framington_Garage
Simulation variant : Base_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade
Horizon	Average Height	0.8°
Near Shadings	According to strings	Electrical effect 80 %
PV Field Orientation	tilt 90°	azimuth -41°
PV modules	Model JKM 410M-72HL-V	Pnom 410 Wp
PV Array	Nb. of modules 404	Pnom total 166 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom 33.3 kW ac
Inverter pack	Nb. of units 5.0	Pnom total 167 kW ac
User's needs	Unlimited load (grid)	

Daily Input/Output diagram



System Output Power Distribution



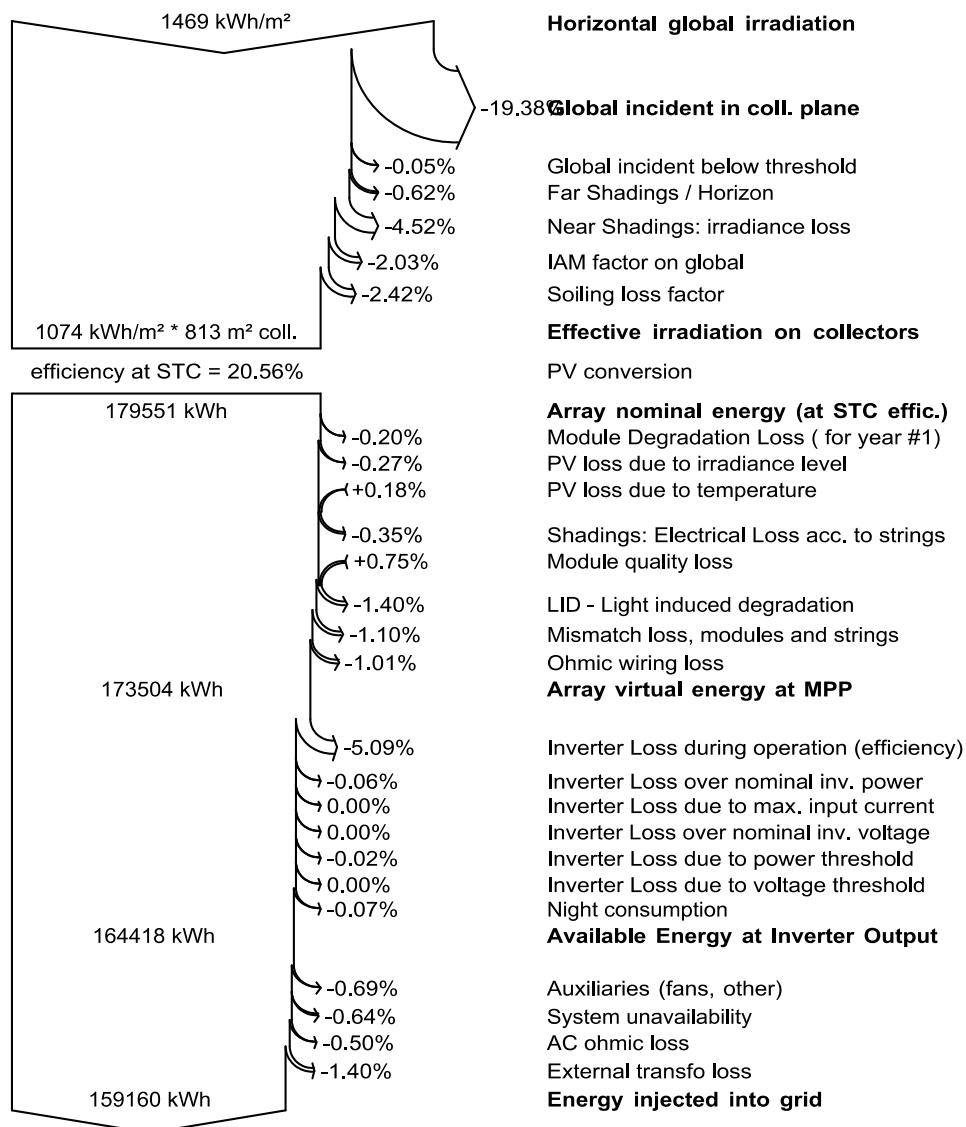


Grid-Connected System: Loss diagram

Project : Framington_Garage
Simulation variant : Base_90DegTilt
 Simulation for the 1st year of operation

Main system parameters	System type	SE Facade
Horizon	Average Height	0.8°
Near Shadings	According to strings	Electrical effect 80 %
PV Field Orientation	tilt 90°	azimuth -41°
PV modules	Model JKM 410M-72HL-V	Pnom 410 Wp
PV Array	Nb. of modules 404	Pnom total 166 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom 33.3 kW ac
Inverter pack	Nb. of units 5.0	Pnom total 167 kW ac
User's needs	Unlimited load (grid)	

Loss diagram over the whole year





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: P50 - P90 evaluation

Project : Framington_Garage
Simulation variant : Base_90DegTilt
 Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	Pnom	410 Wp
PV Array	Nb. of modules	Pnom total	166 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom
Inverter pack	Nb. of units	Pnom total	167 kW ac
User's needs	Unlimited load (grid)		

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

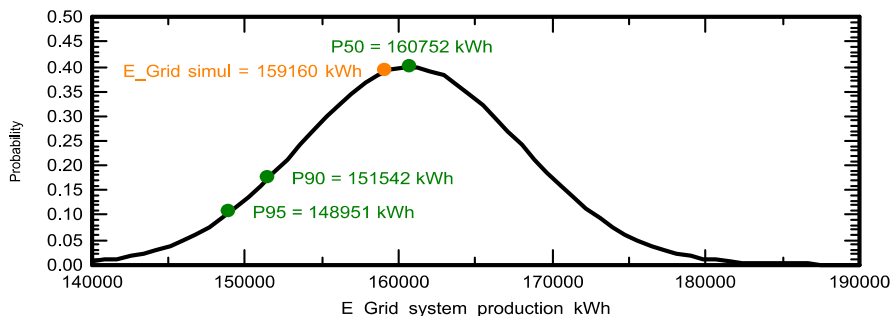
Meteo data source	NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016		
Meteo data	Kind	TMY, multi-year	
Specified Deviation	Climate change	1.0 %	
Year-to-year variability	Variance	4.1 %	

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	4.5 %	(quadratic sum)

Annual production probability	Variability	7182 kWh
	P50	160752 kWh
	P90	151542 kWh
	P95	148951 kWh

Probability distribution





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Project : Framington_Garage

Geographical Site Lokerville Country **United States**

Situation Latitude 42.30° N Longitude -71.39° W

Time defined as Legal Time Time zone UT-5 Altitude 50 m

Monthly albedo values

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Albedo	0.26	0.29	0.24	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.27

Meteo data: Lokerville NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016 - TMY

Simulation variant : OptionA_90DegTilt

Simulation date 05/03/20 08h55
Simulation for the 1st year of operation

Simulation parameters System type **SE Facade**

Collector Plane Orientation Tilt 90° Azimuth -41°

Models used Transposition Perez Diffuse Imported

Horizon Average Height 0.8°

Near Shadings According to strings Electrical effect 80 %

User's needs : Unlimited load (grid)

PV Arrays Characteristics (4 kinds of array defined)

Sub-array "Module_1_10Str"	Si-mono	Model	JKM 410M-72HL-V	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	10 modules	In parallel 16 strings
Total number of PV modules		Nb. modules	160	Unit Nom. Power 410 Wp
Array global power		Nominal (STC)	65.6 kWp	At operating cond. 67.4 kWp (20°C)
Array operating characteristics (50°C)		U mpp	418 V	I mpp 161 A
Sub-array "Module_1_11Str"	Si-mono	Model	JKM 410M-72HL-V	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	11 modules	In parallel 13 strings
Total number of PV modules		Nb. modules	143	Unit Nom. Power 410 Wp
Array global power		Nominal (STC)	58.6 kWp	At operating cond. 60.2 kWp (20°C)
Array operating characteristics (50°C)		U mpp	460 V	I mpp 131 A
Sub-array "Module_2_13Str"	Si-mono	Model	JKM 330M-60L	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	13 modules	In parallel 8 strings
Total number of PV modules		Nb. modules	104	Unit Nom. Power 330 Wp
Array global power		Nominal (STC)	34.3 kWp	At operating cond. 35.0 kWp (20°C)
Array operating characteristics (50°C)		U mpp	453 V	I mpp 77 A
Sub-array "Module_2_14Str"	Si-mono	Model	JKM 330M-60L	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	14 modules	In parallel 7 strings
Total number of PV modules		Nb. modules	98	Unit Nom. Power 330 Wp
Array global power		Nominal (STC)	32.3 kWp	At operating cond. 33.0 kWp (20°C)
Array operating characteristics (50°C)		U mpp	488 V	I mpp 68 A



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Total	Arrays global power	Nominal (STC)	191 kWp	Total	505 modules
		Module area	945 m²	Cell area	837 m ²
Inverter		Model	Sunny Tripower33-US-10 (480 VAC)		
Custom parameters definition		Manufacturer	SMA		
Characteristics		Operating Voltage	300-800 V	Unit Nom. Power	33.3 kWac
Sub-array "Module_1_10Str"		Nb. of inverters	8 * MPPT 21 %	Total Power	56 kWac
				Pnom ratio	1.17
Sub-array "Module_1_11Str"		Nb. of inverters	12 * MPPT 11 %	Total Power	45 kWac
				Pnom ratio	1.31
Sub-array "Module_2_13Str"		Nb. of inverters	5 * MPPT 22 %	Total Power	37 kWac
				Pnom ratio	0.93
Sub-array "Module_2_14Str"		Nb. of inverters	7 * MPPT 13 %	Total Power	30 kWac
				Pnom ratio	1.08
Total		Nb. of inverters	5	Total Power	167 kWac

PV Array loss factors

Array Soiling Losses

Average loss Fraction 2.4 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
3.1%	1.4%	3.1%	1.5%	3.1%	1.5%	3.1%	3.1%	3.0%	1.6%	3.0%	1.6%

Thermal Loss factor

Uc (const) 26.0 W/m²K

Uv (wind) 1.2 W/m²K / m/s

Wiring Ohmic Loss

Array#1 51 mOhm

Loss Fraction 2.0 % at STC

Array#2 69 mOhm

Loss Fraction 2.0 % at STC

Array#3 115 mOhm

Loss Fraction 2.0 % at STC

Array#4 141 mOhm

Loss Fraction 2.0 % at STC

Global

Loss Fraction 2.0 % at STC

LID - Light Induced Degradation

Loss Fraction 1.4 %

Module Quality Loss

Loss Fraction -0.8 %

Module Mismatch Losses

Loss Fraction 1.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.10 %

Module average degradation

Year no 1

Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.995	0.982	0.933	0.879	0.765	0.545	0.000

Spectral correction

FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
Monocrystalline Si	0.85914	-0.02088	-0.0058853	0.12029	0.026814	-0.001781

System loss factors

AC wire loss inverter to transfo

Inverter voltage 480 Vac tri

Wires: 3x95.0 mm² 61 m

Loss Fraction 1.0 % at STC

External transformer

Iron loss (24H connexion) 190 W

Loss Fraction 0.1 % at STC

Resistive/Inductive losses 12.1 mOhm

Loss Fraction 1.0 % at STC

Unavailability of the system

3.0 days, 3 periods

Time fraction 0.8 %

Auxiliaries loss

constant (fans) 130 W

... from Power thresh. 0.0 kW

Night auxiliaries consumption 130 W



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Horizon definition

Project : Framington_Garage
Simulation variant : OptionA_90DegTilt
Simulation for the 1st year of operation

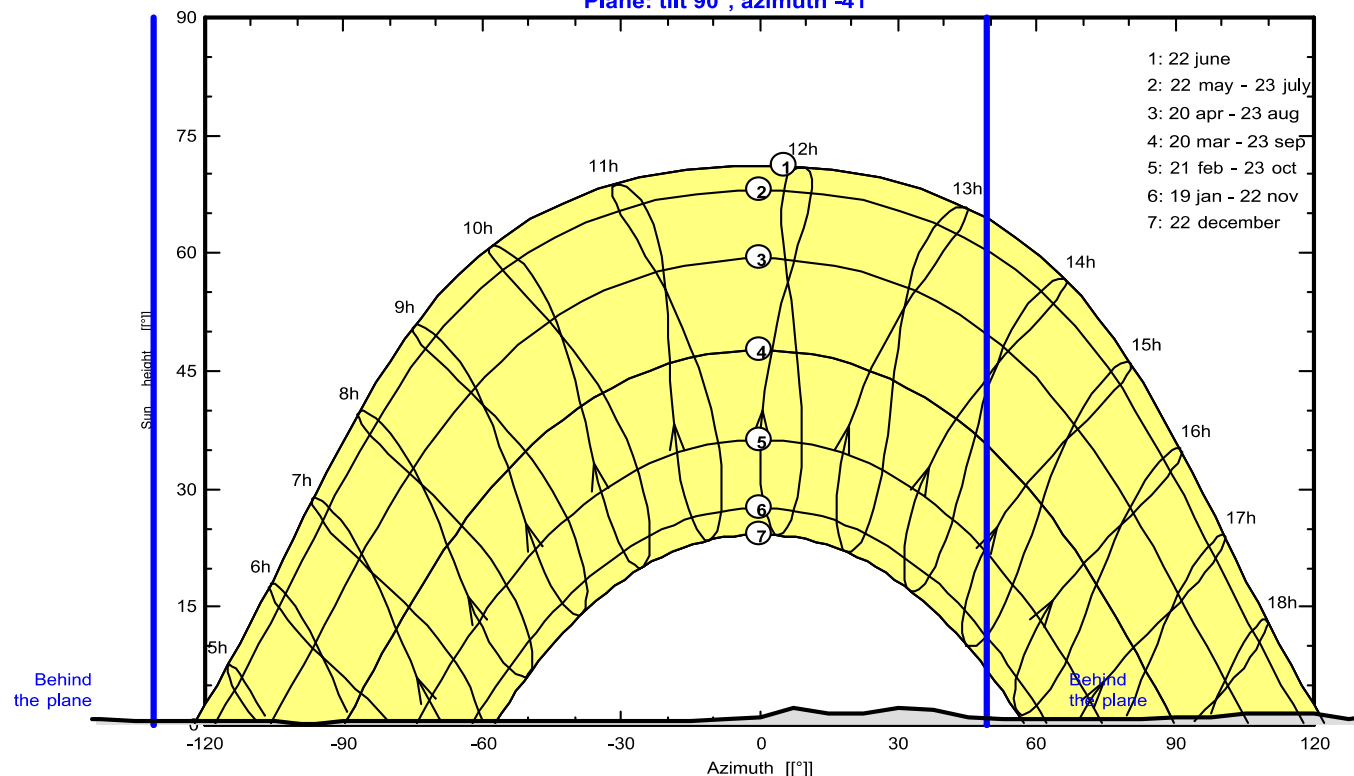
Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	JKM 410M-72HL-V	Pnom 410 Wp
PV modules	Model	JKM 330M-60L	Pnom 330 Wp
PV Array	Nb. of modules	505	Pnom total 191 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total 167 kW ac
User's needs	Unlimited load (grid)		

Horizon	Average Height	0.8°	Diffuse Factor	0.99
	Albedo Factor	100 %	Albedo Fraction	0.97

Height [°]	0.4	0.4	0.0	0.4	0.8	0.4	0.4	0.0	0.4	0.4
Azimuth [°]	-180	-165	-158	-150	-143	-135	-105	-98	-90	-15
Height [°]	0.8	1.1	2.3	1.5	1.5	2.3	1.9	1.1	0.8	0.8
Azimuth [°]	-8	0	8	15	23	30	38	45	53	83
Height [°]	1.1	1.1	1.5	1.5	0.8	1.1	0.8	0.8	0.4	0.4
Azimuth [°]	90	98	105	120	128	135	143	150	158	180

Horizon from PVGIS website API, Lat=42°18'15', Long=-71°23'35', Alt=53m

Plane: tilt 90°, azimuth -41°





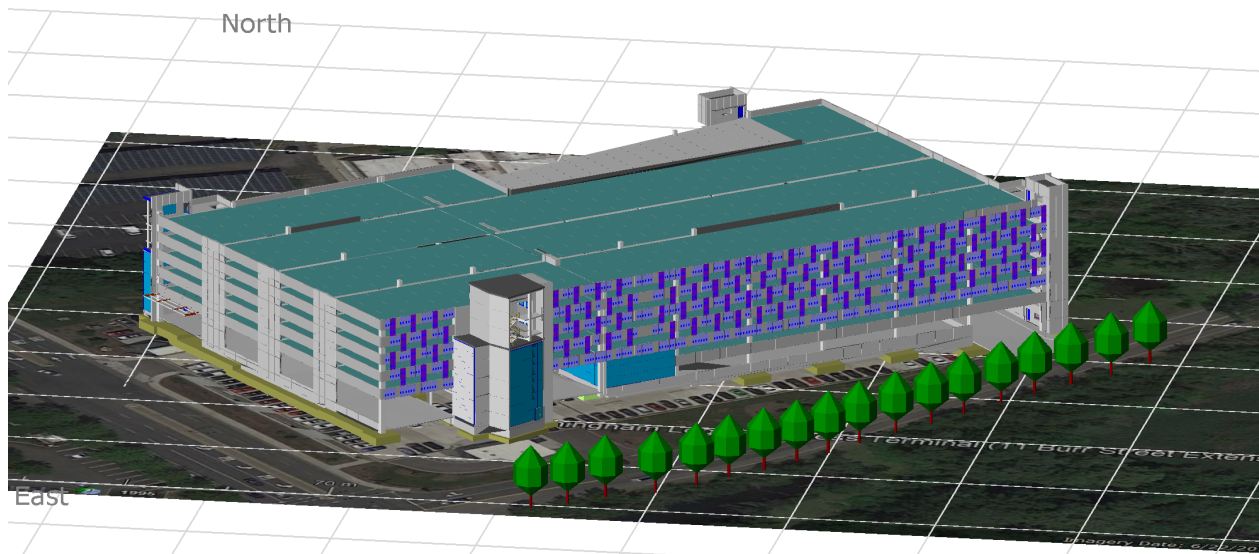
1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Near shading definition

Project : Framington_Garage
Simulation variant : OptionA_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	JKM 410M-72HL-V	Pnom 410 Wp
PV modules	Model	JKM 330M-60L	Pnom 330 Wp
PV Array	Nb. of modules	505	Pnom total 191 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total 167 kW ac
User's needs	Unlimited load (grid)		

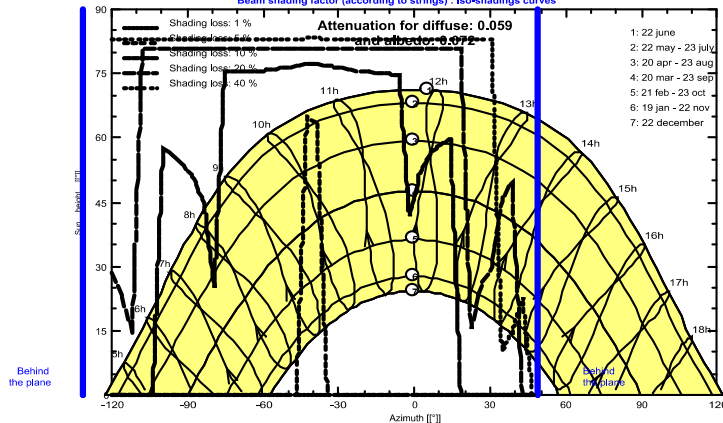
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Framington_Garage

Beam shading factor (according to strings) : Iso-shadings curves





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By: Daniel Kraemer

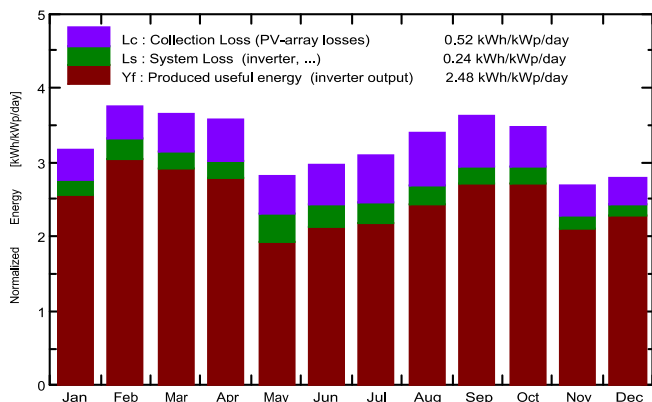
Grid-Connected System: Main results

Project : Framington_Garage
Simulation variant : OptionA_90DegTilt
Simulation for the 1st year of operation

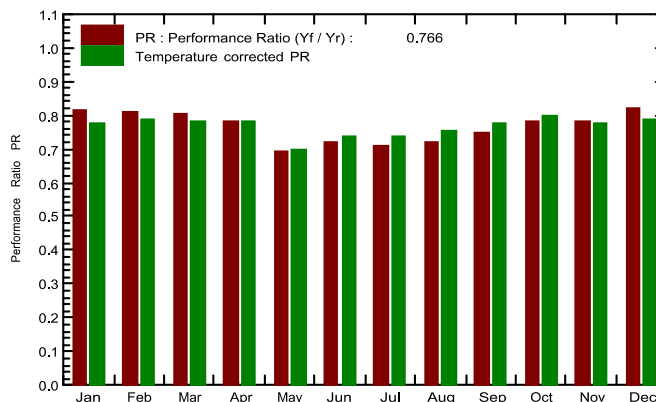
Main system parameters	System type	SE Facade
Horizon	Average Height	0.8°
Near Shadings	According to strings	Electrical effect 80 %
PV Field Orientation	tilt	90° azimuth -41°
PV modules	Model	JKM 410M-72HL-V Pnom 410 Wp
PV modules	Model	JKM 330M-60L Pnom 330 Wp
PV Array	Nb. of modules	505 Pnom total 191 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0 Pnom total 167 kW ac
User's needs	Unlimited load (grid)	

Main simulation results
System Production **Produced Energy 173067 kWh/year** Specific prod. 907 kWh/kWp/year
Performance Ratio PR **76.55 %**

Normalized productions (per installed kWp): Nominal power 191 kWp



Performance Ratio PR and Weather corrected PR



OptionA_90DegTilt
Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR
January	60.9	21.92	-3.95	97.9	87.9	16330	15229	0.815
February	83.8	28.96	-1.63	105.4	96.2	17685	16265	0.809
March	122.8	44.18	1.01	113.2	101.9	18612	17297	0.800
April	155.7	52.88	7.67	107.0	96.7	17310	15962	0.781
May	166.5	69.85	13.77	87.0	76.3	13601	11467	0.691
June	177.0	74.06	17.85	89.0	78.9	13900	12190	0.717
July	191.5	75.26	21.37	95.7	83.7	14527	12949	0.709
August	172.2	63.93	21.01	105.0	92.6	15946	14464	0.721
September	134.3	43.50	17.09	109.0	97.9	16852	15535	0.747
October	95.3	33.33	11.29	107.9	99.2	17365	16136	0.783
November	58.1	22.66	5.47	80.8	72.3	13068	12070	0.783
December	51.0	20.04	-2.60	86.3	78.1	14483	13504	0.820
Year	1469.0	550.58	9.08	1184.3	1061.7	189678	173067	0.766

Legends: GlobHor Horizontal global irradiation
DiffHor Horizontal diffuse irradiation
T_Amb T amb,
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings
EArray Effective energy at the output of the array
E_Grid Energy injected into grid
PR Performance Ratio



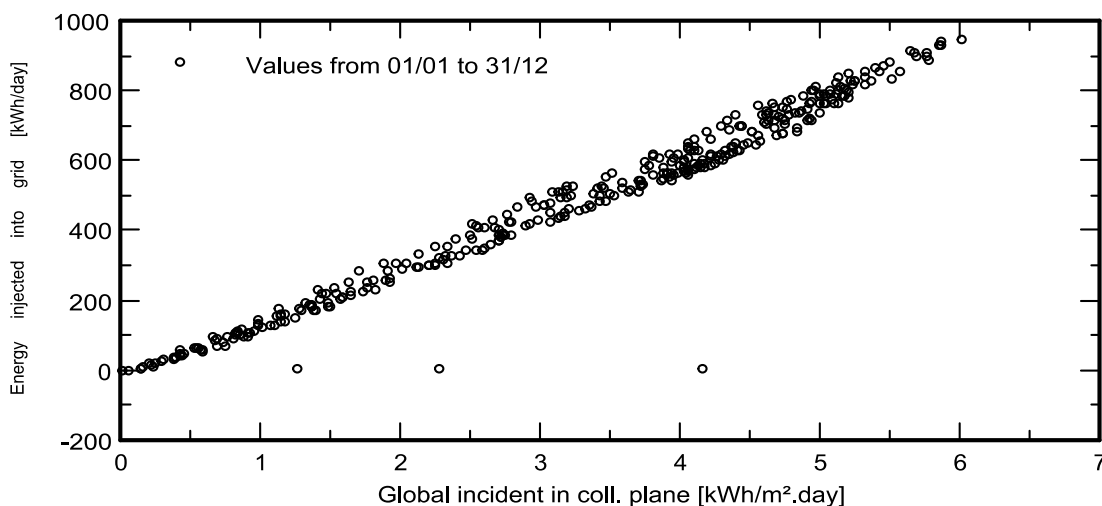
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By: Daniel Kraemer

Grid-Connected System: Special graphs

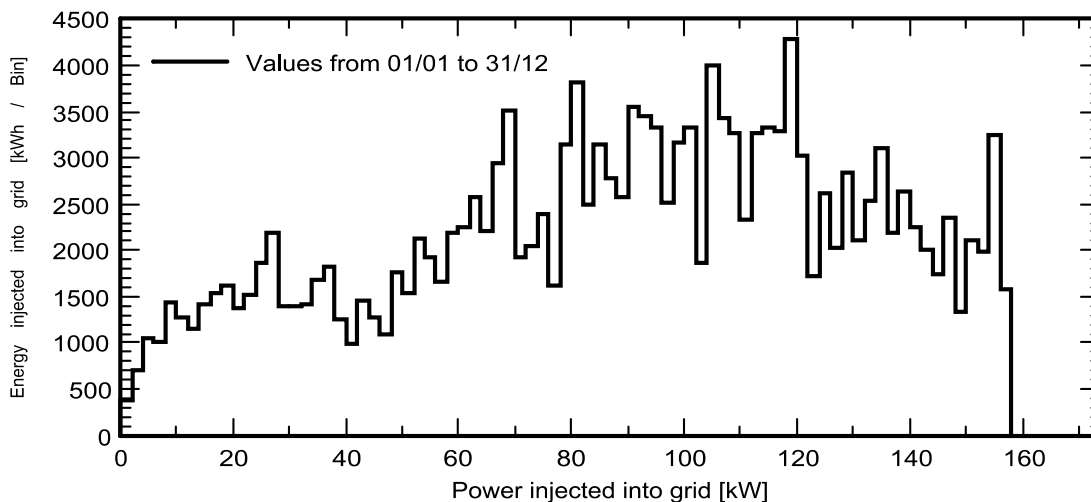
Project : Framington_Garage
Simulation variant : OptionA_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings		Electrical effect 80 %
PV Field Orientation	tilt	90°	azimuth -41°
PV modules	Model	JKM 410M-72HL-V	Pnom 410 Wp
PV modules	Model	JKM 330M-60L	Pnom 330 Wp
PV Array	Nb. of modules	505	Pnom total 191 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total 167 kW ac
User's needs	Unlimited load (grid)		

Daily Input/Output diagram



System Output Power Distribution





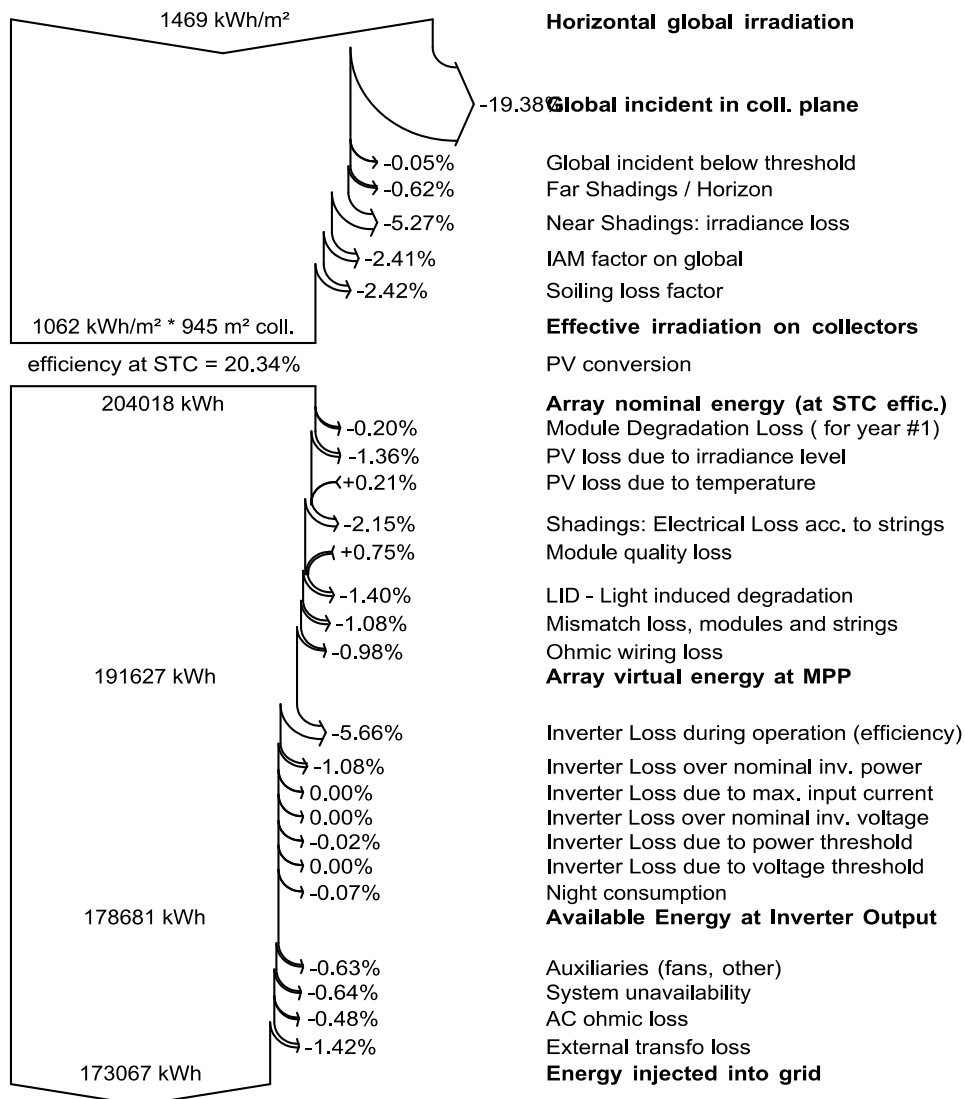
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By: Daniel Kraemer

Grid-Connected System: Loss diagram

Project : Framington_Garage
Simulation variant : OptionA_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	JKM 410M-72HL-V	Pnom 410 Wp
PV modules	Model	JKM 330M-60L	Pnom 330 Wp
PV Array	Nb. of modules	505	Pnom total 191 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total 167 kW ac
User's needs	Unlimited load (grid)		

Loss diagram over the whole year





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: P50 - P90 evaluation

Project : Framington_Garage
Simulation variant : OptionA_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade		
Horizon	Average Height	0.8°		
Near Shadings	According to strings	Electrical effect	80 %	
PV Field Orientation	tilt	azimuth	-41°	
PV modules	Model	JKM 410M-72HL-V	Pnom	410 Wp
PV modules	Model	JKM 330M-60L	Pnom	330 Wp
PV Array	Nb. of modules	505	Pnom total	191 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom	33.3 kW ac	
Inverter pack	Nb. of units	5.0	Pnom total	167 kW ac
User's needs	Unlimited load (grid)			

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

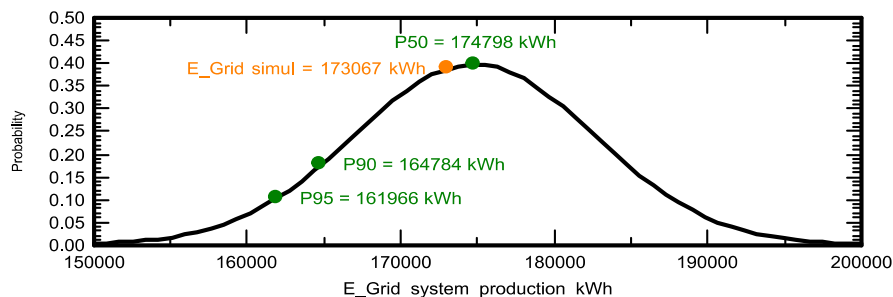
Meteo data source	NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016		
Meteo data	Kind	Monthly averages	TMY Multi-year average
Specified Deviation	Climate change	1.0 %	
Year-to-year variability	Variance	4.1 %	

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	4.5 %	(quadratic sum)

Annual production probability	Variability	7810 kWh
	P50	174798 kWh
	P90	164784 kWh
	P95	161966 kWh

Probability distribution





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Project : Framington_Garage

Geographical Site Lokerville Country **United States**

Situation Latitude 42.30° N Longitude -71.39° W

Time defined as Legal Time Time zone UT-5 Altitude 50 m

Monthly albedo values

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Albedo	0.26	0.29	0.24	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.27

Meteo data: Lokerville NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016 - TMY

Simulation variant : OptionB_90DegTilt

Simulation date 05/03/20 09h43

Simulation for the 1st year of operation

Simulation parameters System type **SE Facade**

Collector Plane Orientation Tilt 90° Azimuth -41°

Sheds configuration Nb. of sheds 454
Sheds spacing 4.01 m Collector width 1.97 m

Shading limit angle Limit profile angle 26.2° Ground cov. Ratio (GCR) 49.2 %

Models used Transposition Perez Diffuse Imported

Horizon Average Height 0.8°

Near Shadings According to strings Electrical effect 80 %

User's needs : Unlimited load (grid)

PV Arrays Characteristics (4 kinds of array defined)

Sub-array "Module_1_8Str" Si-mono Model **JKM 410M-72HL-V**
Custom parameters definition Manufacturer Jinkosolar
Number of PV modules In series 8 modules In parallel 10 strings
Total number of PV modules Nb. modules 80 Unit Nom. Power 410 Wp
Array global power Nominal (STC) **32.8 kWp** At operating cond. 33.7 kWp (20°C)
Array operating characteristics (50°C) U mpp 335 V I mpp 101 A

Sub-array "Module_1_9Str" Si-mono Model **JKM 410M-72HL-V**
Custom parameters definition Manufacturer Jinkosolar
Number of PV modules In series 9 modules In parallel 20 strings
Total number of PV modules Nb. modules 180 Unit Nom. Power 410 Wp
Array global power Nominal (STC) **73.8 kWp** At operating cond. 75.8 kWp (20°C)
Array operating characteristics (50°C) U mpp 376 V I mpp 201 A

Sub-array "Module_1_10Str" Si-mono Model **JKM 410M-72HL-V**
Custom parameters definition Manufacturer Jinkosolar
Number of PV modules In series 10 modules In parallel 10 strings
Total number of PV modules Nb. modules 100 Unit Nom. Power 410 Wp
Array global power Nominal (STC) **41.0 kWp** At operating cond. 42.1 kWp (20°C)
Array operating characteristics (50°C) U mpp 418 V I mpp 101 A



1599 State Route 34, Suite 3, Wall Township, NJ 07727

By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Sub-array "Module_2_11Str"	Si-mono	Model	JKM 330M-60L		
Custom parameters definition		Manufacturer	Jinkosolar		
Number of PV modules		In series	11 modules	In parallel	8 strings
Total number of PV modules		Nb. modules	88	Unit Nom. Power	330 Wp
Array global power		Nominal (STC)	29.04 kWp	At operating cond.	29.65 kWp (20°C)
Array operating characteristics (50°C)		U mpp	383 V	I mpp	77 A
Total	Arrays global power	Nominal (STC)	177 kWp	Total	448 modules
		Module area	870 m²	Cell area	779 m ²

Inverter		Model	Sunny Tripower33-US-10 (480 VAC)		
Custom parameters definition		Manufacturer	SMA		
Characteristics		Operating Voltage	300-800 V	Unit Nom. Power	33.3 kWac
Sub-array "Module_1_8Str"	Nb. of inverters	5 * MPPT 21 %	Total Power	35 kWac	
			Pnom ratio	0.94	
Sub-array "Module_1_9Str"	Nb. of inverters	16 * MPPT 11 %	Total Power	60 kWac	
			Pnom ratio	1.23	
Sub-array "Module_1_10Str"	Nb. of inverters	10 * MPPT 11 %	Total Power	37 kWac	
			Pnom ratio	1.10	
Sub-array "Module_2_11Str"	Nb. of inverters	1 units	Total Power	33 kWac	
			Pnom ratio	0.87	
Total	Nb. of inverters	5 (0.0 unused)	Total Power	166 kWac	

PV Array loss factors

Array Soiling Losses

Average loss Fraction 2.4 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
3.1%	1.4%	3.1%	1.5%	3.1%	1.5%	3.1%	3.1%	3.0%	1.6%	3.0%	1.6%

Thermal Loss factor	Uc (const)	26.0 W/m ² K	Uv (wind)	1.2 W/m ² K / m/s
Wiring Ohmic Loss	Array#1	65 mOhm	Loss Fraction	2.0 % at STC
	Array#2	37 mOhm	Loss Fraction	2.0 % at STC
	Array#3	82 mOhm	Loss Fraction	2.0 % at STC
	Array#4	97 mOhm	Loss Fraction	2.0 % at STC
	Global		Loss Fraction	2.0 % at STC
LID - Light Induced Degradation			Loss Fraction	1.4 %
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Module average degradation	Year no	1	Loss factor	0.4 %/year
Mismatch due to degradation	Imp RMS dispersion	0.4 %/year	Vmp RMS dispersion	0.4 %/year
Incidence effect (IAM): User defined profile				

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.995	0.982	0.933	0.879	0.765	0.545	0.000

Spectral correction

FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
Monocrystalline Si	0.85914	-0.02088	-0.0058853	0.12029	0.026814	-0.001781

System loss factors

AC wire loss inverter to transfo	Inverter voltage	480 Vac tri		
	Wires: 3x95.0 mm ²	66 m	Loss Fraction	1.0 % at STC
External transformer	Iron loss (24H connexion)	176 W	Loss Fraction	0.1 % at STC
	Resistive/Inductive losses	13.1 mOhm	Loss Fraction	1.0 % at STC



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Unavailability of the system	3.0 days, 3 periods	Time fraction	0.8 %
Auxiliaries loss	constant (fans) 130 W	... from Power thresh.	0.0 kW
	Night auxiliaries consumption	130 W	



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Horizon definition

Project : Framington_Garage
Simulation variant : OptionB_90DegTilt
Simulation for the 1st year of operation

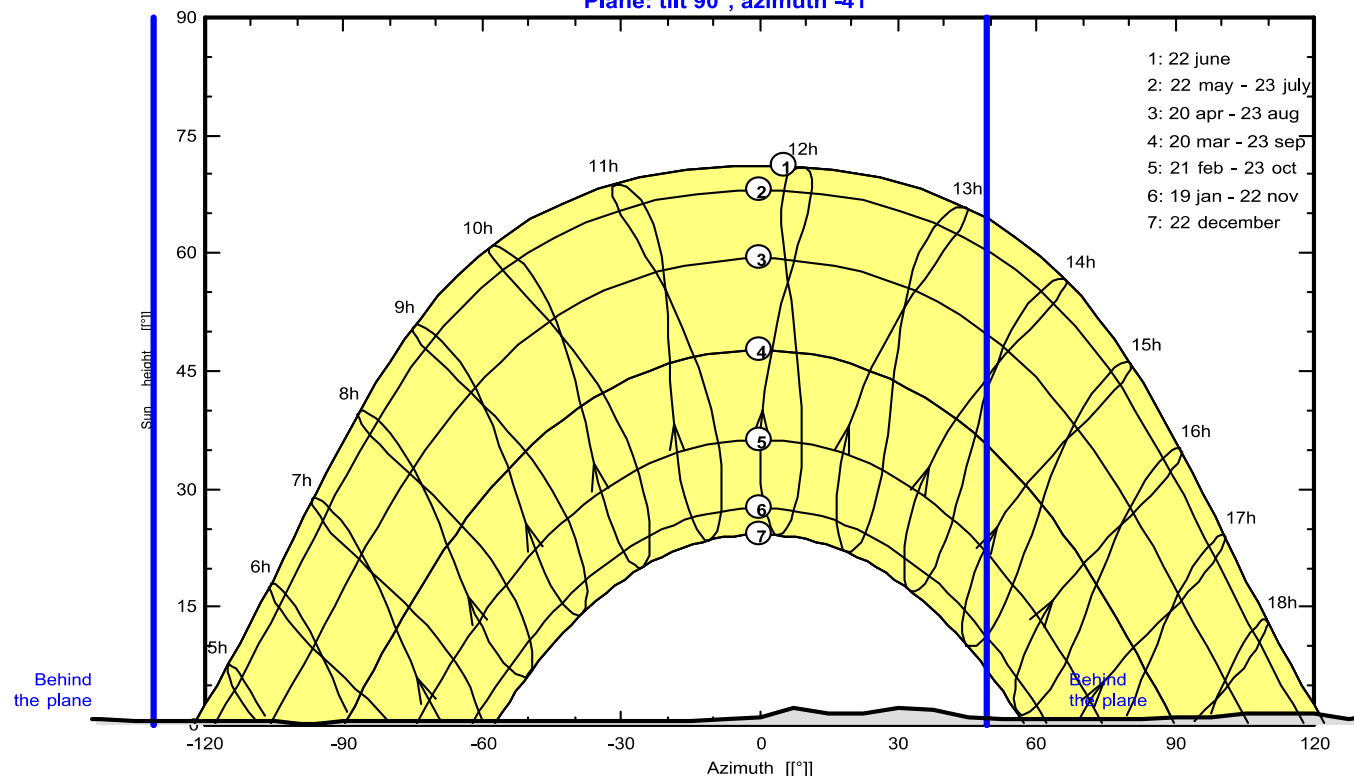
Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	JKM 410M-72HL-V	Pnom 410 Wp
PV modules	Model	JKM 330M-60L	Pnom 330 Wp
PV Array	Nb. of modules	448	Pnom total 177 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total 166 kW ac
User's needs	Unlimited load (grid)		

Horizon	Average Height	0.8°	Diffuse Factor	0.99
	Albedo Factor	100 %	Albedo Fraction	0.97

Height [°]	0.4	0.4	0.0	0.4	0.8	0.4	0.4	0.0	0.4	0.4
Azimuth [°]	-180	-165	-158	-150	-143	-135	-105	-98	-90	-15
Height [°]	0.8	1.1	2.3	1.5	1.5	2.3	1.9	1.1	0.8	0.8
Azimuth [°]	-8	0	8	15	23	30	38	45	53	83
Height [°]	1.1	1.1	1.5	1.5	0.8	1.1	0.8	0.8	0.4	0.4
Azimuth [°]	90	98	105	120	128	135	143	150	158	180

Horizon from PVGIS website API, Lat=42°18'15', Long=-71°23'35', Alt=53m

Plane: tilt 90°, azimuth -41°



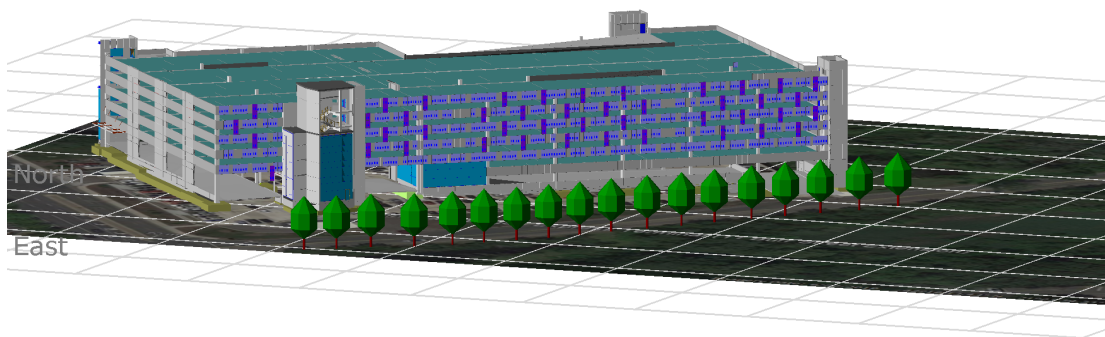


Grid-Connected System: Near shading definition

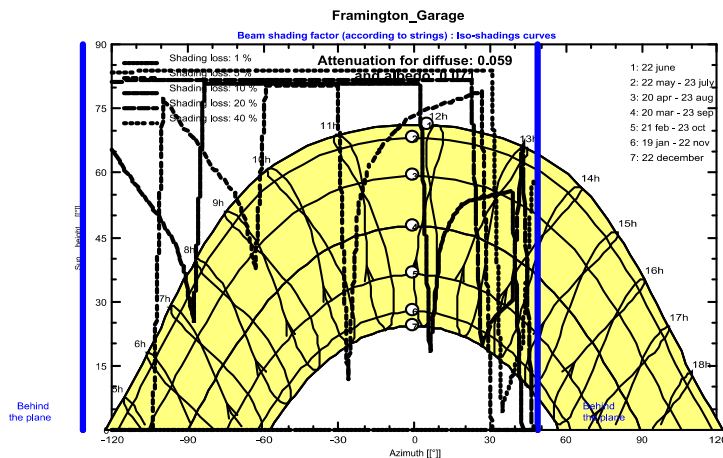
Project : Framington_Garage
Simulation variant : OptionB_90DegTilt
 Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
PV Field Orientation	tilt	azimuth	-41°
PV modules	Model	JKM 410M-72HL-V	Pnom 410 Wp
PV modules	Model	JKM 330M-60L	Pnom 330 Wp
PV Array	Nb. of modules	448	Pnom total 177 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)		Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0	Pnom total 166 kW ac
User's needs	Unlimited load (grid)		

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

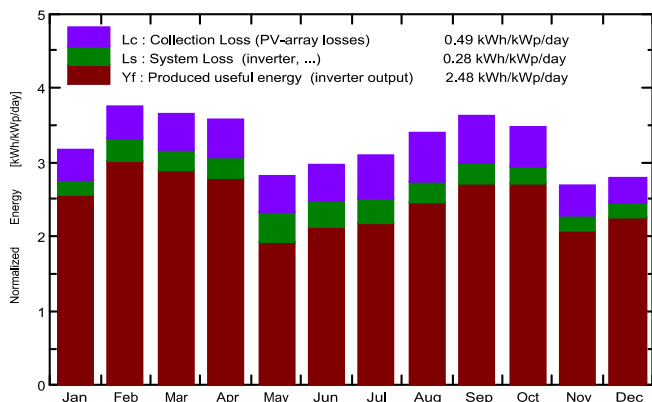
Grid-Connected System: Main results

Project : Framington_Garage
Simulation variant : OptionB_90DegTilt
Simulation for the 1st year of operation

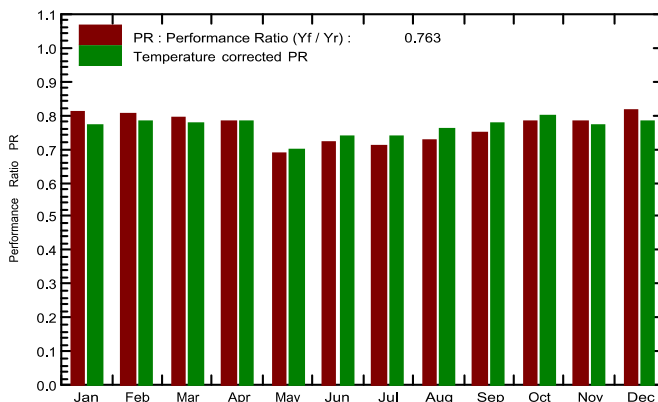
Main system parameters	System type	SE Facade
Horizon	Average Height	0.8°
Near Shadings	According to strings	Electrical effect 80 %
PV Field Orientation	tilt	90° azimuth -41°
PV modules	Model	JKM 410M-72HL-V Pnom 410 Wp
PV modules	Model	JKM 330M-60L Pnom 330 Wp
PV Array	Nb. of modules	448 Pnom total 177 kWp
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom 33.3 kW ac
Inverter pack	Nb. of units	5.0 Pnom total 166 kW ac
User's needs	Unlimited load (grid)	

Main simulation results
System Production **Produced Energy 159629 kWh/year** Specific prod. 904 kWh/kWp/year
Performance Ratio PR **76.31 %**

Normalized productions (per installed kWp): Nominal power 177 kWp



Performance Ratio PR and Weather corrected PR



OptionB_90DegTilt
Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR
January	60.9	21.92	-3.95	97.9	87.9	15148	13992	0.809
February	83.8	28.96	-1.63	105.4	96.4	16383	14944	0.803
March	122.8	44.18	1.01	113.2	102.1	17293	15891	0.794
April	155.7	52.88	7.67	107.0	97.0	16230	14765	0.781
May	166.5	69.85	13.77	87.0	76.6	12842	10568	0.688
June	177.0	74.06	17.85	89.0	79.2	13143	11275	0.717
July	191.5	75.26	21.37	95.7	84.0	13740	11983	0.709
August	172.2	63.93	21.01	105.0	92.9	15071	13437	0.724
September	134.3	43.50	17.09	109.0	98.2	15806	14395	0.748
October	95.3	33.33	11.29	107.9	99.3	16166	14872	0.780
November	58.1	22.66	5.47	80.8	72.4	12154	11100	0.778
December	51.0	20.04	-2.60	86.3	78.2	13430	12406	0.814
Year	1469.0	550.58	9.08	1184.3	1064.1	177407	159629	0.763

Legends: GlobHor Horizontal global irradiation
DiffHor Horizontal diffuse irradiation
T_Amb T_amb
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings
EArray Effective energy at the output of the array
E_Grid Energy injected into grid
PR Performance Ratio



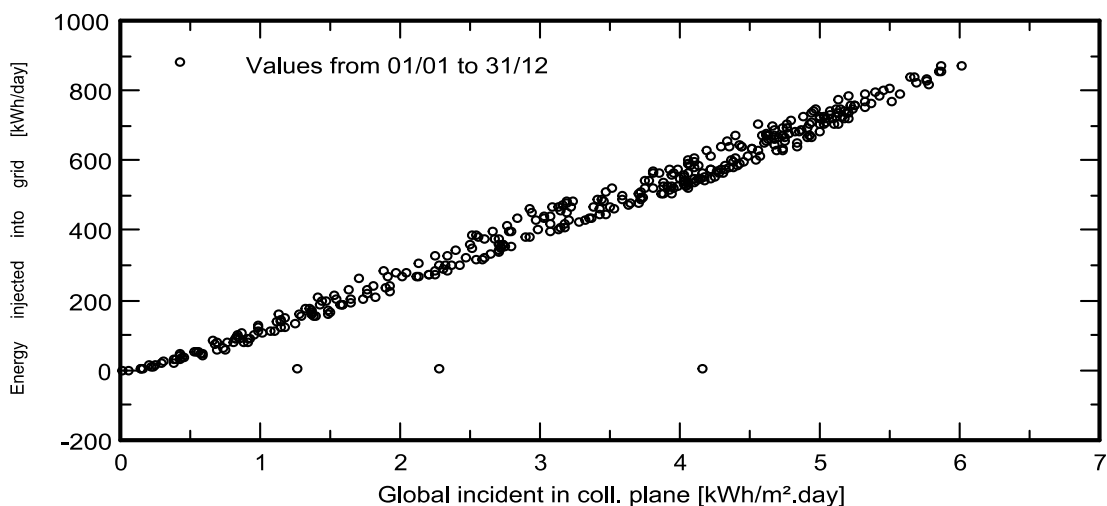
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By: Daniel Kraemer

Grid-Connected System: Special graphs

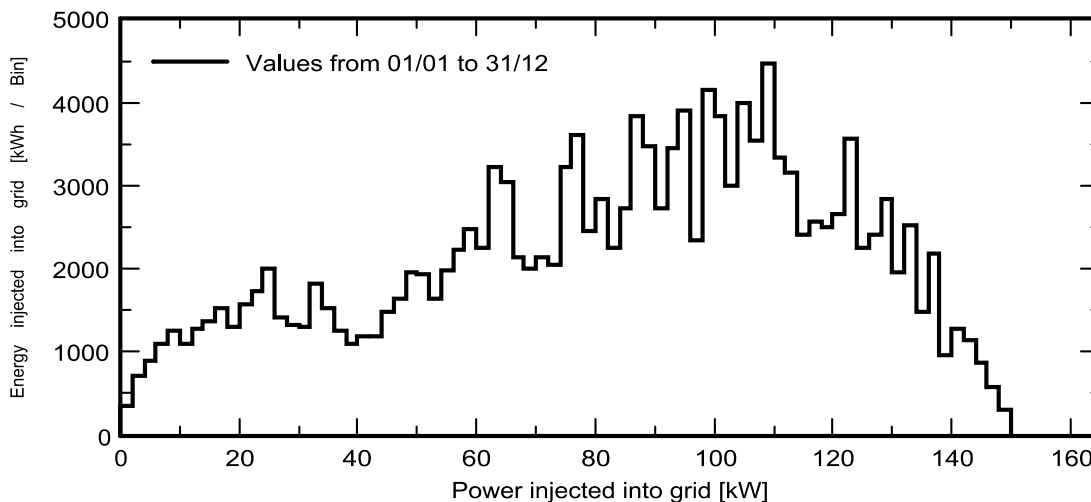
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Simulation variant : OptionB_90DegTilt
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Inverter pack	Nb. of units	5.0	Pnom total 166 kW ac
User's needs	Unlimited load (grid)		

Daily Input/Output diagram



System Output Power Distribution



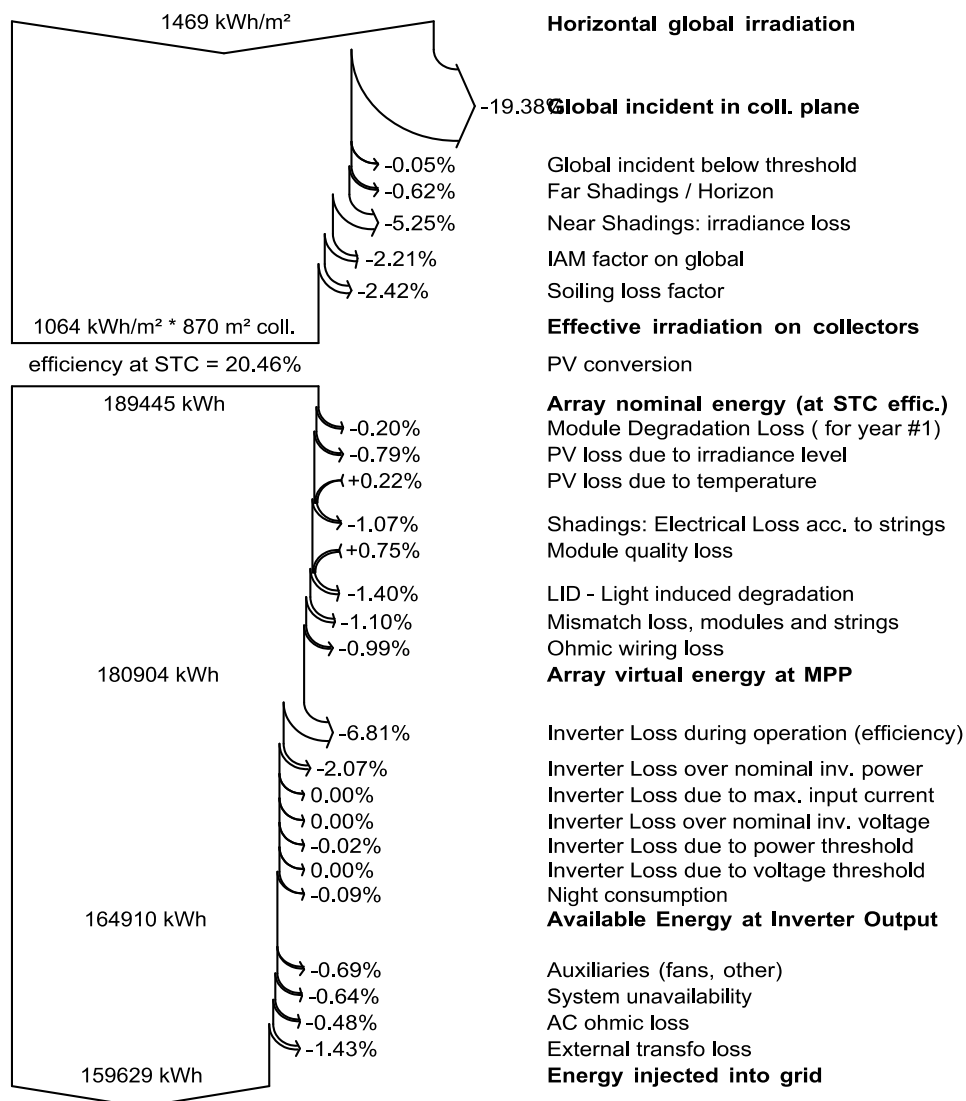


Grid-Connected System: Loss diagram

Project : Framington_Garage
Simulation variant : OptionB_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade	
Horizon	Average Height	0.8°	
Near Shadings	According to strings	Electrical effect	80 %
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Inverter pack	Nb. of units	5.0	Pnom total 166 kW ac
User's needs	Unlimited load (grid)		

Loss diagram over the whole year





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: P50 - P90 evaluation

Project : Framington_Garage
Simulation variant : OptionB_90DegTilt
Simulation for the 1st year of operation

Main system parameters	System type	SE Facade		
Horizon	Average Height	0.8°		
Near Shadings	According to strings	Electrical effect	80 %	
PV Field Orientation	tilt	azimuth	-41°	
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Inverter pack	Nb. of units	5.0	Pnom total	166 kW ac
User's needs	Unlimited load (grid)			

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

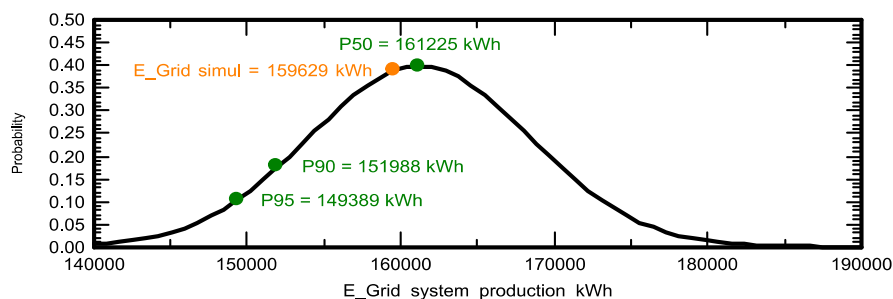
Meteo data source	NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016		
Meteo data	Kind	Monthly averages	TMY Multi-year average
Specified Deviation	Climate change	1.0 %	
Year-to-year variability	Variance	4.1 %	

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	4.5 %	(quadratic sum)

Annual production probability	Variability	7204 kWh
	P50	161225 kWh
	P90	151988 kWh
	P95	149389 kWh

Probability distribution





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Project : Framington_Garage

Geographical Site Lokerville Country **United States**

Situation Latitude 42.30° N Longitude -71.39° W

Time defined as Legal Time Time zone UT-5 Altitude 50 m

Monthly albedo values

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Albedo	0.26	0.29	0.24	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.27

Meteo data: Lokerville NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016 - TMY

Simulation variant : OptionC_90DegTilt

Simulation date 05/03/20 10h14
Simulation for the 1st year of operation

Simulation parameters System type **SE Facade**

Collector Plane Orientation Tilt 90° Azimuth -41°

Models used Transposition Perez Diffuse Imported

Horizon Average Height 0.8°

Near Shadings According to strings Electrical effect 80 %

User's needs : Unlimited load (grid)

PV Arrays Characteristics (4 kinds of array defined)

Sub-array "Module_1_8Str"	Si-mono	Model	JKM 410M-72HL-V	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	8 modules	In parallel 12 strings
Total number of PV modules		Nb. modules	96	Unit Nom. Power 410 Wp
Array global power		Nominal (STC)	39.4 kWp	At operating cond. 40.4 kWp (20°C)
Array operating characteristics (50°C)		U mpp	335 V	I mpp 121 A
Sub-array "Module_1_9Str"	Si-mono	Model	JKM 410M-72HL-V	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	9 modules	In parallel 20 strings
Total number of PV modules		Nb. modules	180	Unit Nom. Power 410 Wp
Array global power		Nominal (STC)	73.8 kWp	At operating cond. 75.8 kWp (20°C)
Array operating characteristics (50°C)		U mpp	376 V	I mpp 201 A
Sub-array "Module_1_10Str"	Si-mono	Model	JKM 410M-72HL-V	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	10 modules	In parallel 8 strings
Total number of PV modules		Nb. modules	80	Unit Nom. Power 410 Wp
Array global power		Nominal (STC)	32.8 kWp	At operating cond. 33.7 kWp (20°C)
Array operating characteristics (50°C)		U mpp	418 V	I mpp 81 A
Sub-array "Module_2_11Str"	Si-mono	Model	JKM 330M-60L	
Custom parameters definition		Manufacturer	Jinkosolar	
Number of PV modules		In series	12 modules	In parallel 8 strings
Total number of PV modules		Nb. modules	96	Unit Nom. Power 330 Wp
Array global power		Nominal (STC)	31.7 kWp	At operating cond. 32.3 kWp (20°C)
Array operating characteristics (50°C)		U mpp	418 V	I mpp 77 A



1599 State Route 34, Suite 3, Wall Township, NJ 07727

By: Daniel Kraemer

Grid-Connected System: Simulation parameters

Total	Arrays global power	Nominal (STC)	178 kWp	Total	452 modules
		Module area	875 m²	Cell area	783 m ²
Inverter		Model	Sunny Tripower33-US-10 (480 VAC)		
Custom parameters definition		Manufacturer	SMA		
Characteristics		Operating Voltage	300-800 V	Unit Nom. Power	33.3 kWac
Sub-array "Module_1_8Str"		Nb. of inverters	6 * MPPT 21 %	Total Power	42 kWac
				Pnom ratio	0.94
Sub-array "Module_1_9Str"		Nb. of inverters	16 * MPPT 11 %	Total Power	60 kWac
				Pnom ratio	1.23
Sub-array "Module_1_10Str"		Nb. of inverters	8 * MPPT 11 %	Total Power	30 kWac
				Pnom ratio	1.10
Sub-array "Module_2_11Str"		Nb. of inverters	1 units	Total Power	33 kWac
				Pnom ratio	0.95
Total		Nb. of inverters	5 (0.0 unused)	Total Power	165 kWac

PV Array loss factors

Array Soiling Losses

Average loss Fraction 2.4 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
3.1%	1.4%	3.1%	1.5%	3.1%	1.5%	3.1%	3.1%	3.0%	1.6%	3.0%	1.6%

Thermal Loss factor

Uc (const) 26.0 W/m²KUv (wind) 1.2 W/m²K / m/s

Wiring Ohmic Loss

Array#1 54 mOhm

Loss Fraction 2.0 % at STC

Array#2 37 mOhm

Loss Fraction 2.0 % at STC

Array#3 102 mOhm

Loss Fraction 2.0 % at STC

Array#4 106 mOhm

Loss Fraction 2.0 % at STC

Global

Loss Fraction 2.0 % at STC

LID - Light Induced Degradation

Loss Fraction 1.4 %

Module Quality Loss

Loss Fraction -0.8 %

Module Mismatch Losses

Loss Fraction 1.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.10 %

Module average degradation

Year no 1

Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.995	0.982	0.933	0.879	0.765	0.545	0.000

Spectral correction

FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
Monocrystalline Si	0.85914	-0.02088	-0.0058853	0.12029	0.026814	-0.001781

System loss factors

AC wire loss inverter to transfo

Inverter voltage 480 Vac tri

Wires: 3x95.0 mm² 66 m

Loss Fraction 1.0 % at STC

External transformer

Iron loss (24H connexion) 177 W

Loss Fraction 0.1 % at STC

Resistive/Inductive losses 13.0 mOhm

Loss Fraction 1.0 % at STC

Unavailability of the system

3.0 days, 3 periods

Time fraction 0.8 %

Auxiliaries loss

constant (fans) 130 W

... from Power thresh. 0.0 kW

Night auxiliaries consumption 130 W



1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Horizon definition

Project : Framington_Garage
Simulation variant : OptionC_90DegTilt
Simulation for the 1st year of operation

Main system parameters

Horizon

System type **SE Facade**
Average Height 0.8°

Near Shadings

According to strings	Electrical effect	80 %
PV Field Orientation	tilt	90°
PV modules	Model	JKM 410M-72HL-V
PV modules	Model	JKM 330M-60L
PV Array	Nb. of modules	452
Inverter	Sunny Tripower33-US-10 (480 VAC)	Pnom
Inverter pack	Nb. of units	5.0
User's needs	Unlimited load (grid)	

azimuth -41°

Pnom 410 Wp

Pnom 330 Wp

Pnom total **178 kWp**

Pnom 33.3 kW ac

Pnom total **165 kW ac**

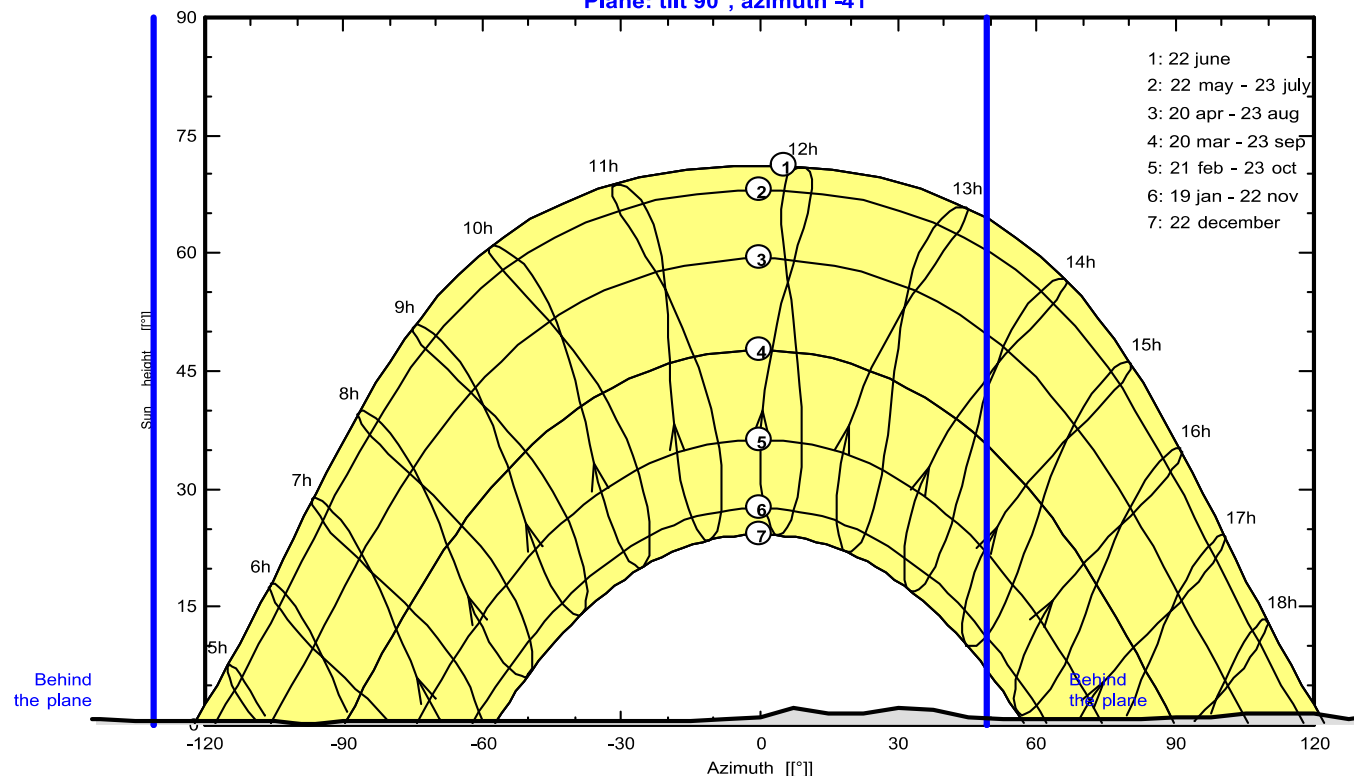
Horizon

Average Height 0.8°
Albedo Factor 100 %
Diffuse Factor 0.99
Albedo Fraction 0.97

Height [°]	0.4	0.4	0.0	0.4	0.8	0.4	0.4	0.0	0.4	0.4
Azimuth [°]	-180	-165	-158	-150	-143	-135	-105	-98	-90	-15
Height [°]	0.8	1.1	2.3	1.5	1.5	2.3	1.9	1.1	0.8	0.8
Azimuth [°]	-8	0	8	15	23	30	38	45	53	83
Height [°]	1.1	1.1	1.5	1.5	0.8	1.1	0.8	0.8	0.4	0.4
Azimuth [°]	90	98	105	120	128	135	143	150	158	180

Horizon from PVGIS website API, Lat=42°18'15', Long=-71°23'35', Alt=53m

Plane: tilt 90°, azimuth -41°





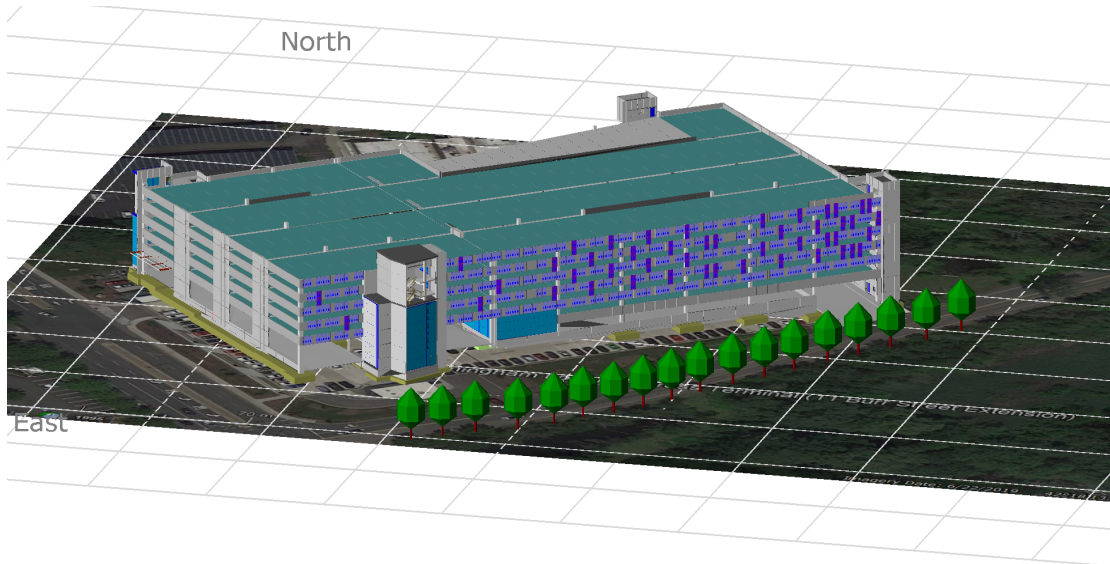
1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: Near shading definition

Project : Framington_Garage
Simulation variant : OptionC_90DegTilt
Simulation for the 1st year of operation

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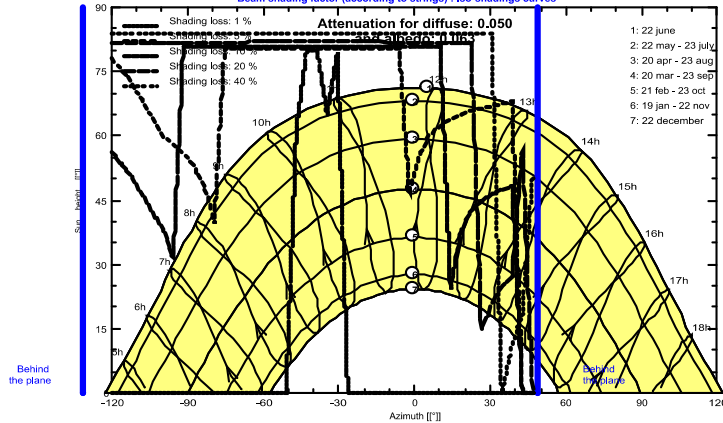
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Framington_Garage

Beam shading factor (according to strings) : Iso-shadings curves





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By: Daniel Kraemer

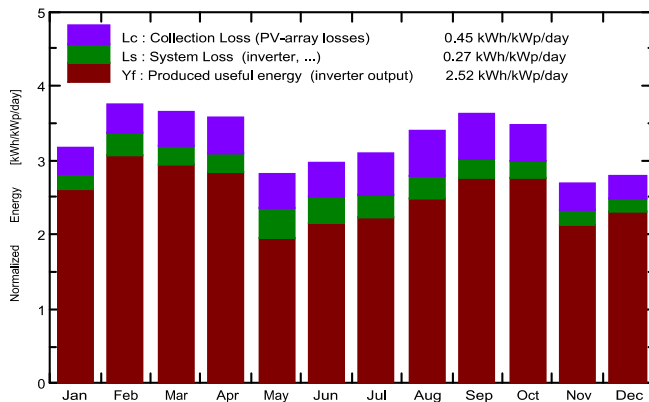
Grid-Connected System: Main results

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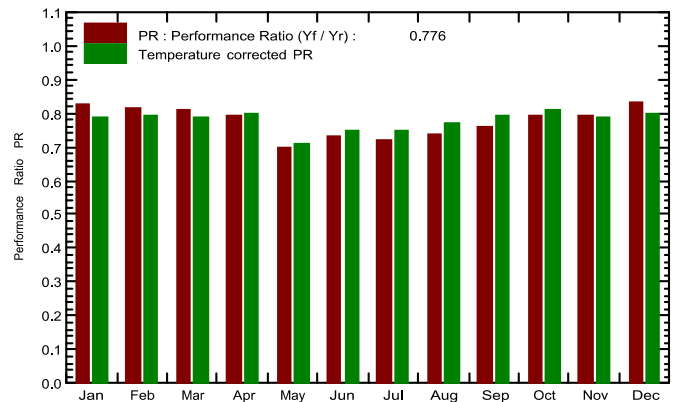
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Main simulation results			
System Production	Produced Energy	163211 kWh/year	Specific prod. 919 kWh/kWp/year
	Performance Ratio PR	77.58 %	

Normalized productions (per installed kWp): Nominal power 178 kWp



Performance Ratio PR and Weather corrected PR



OptionC_90DegTilt
Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR
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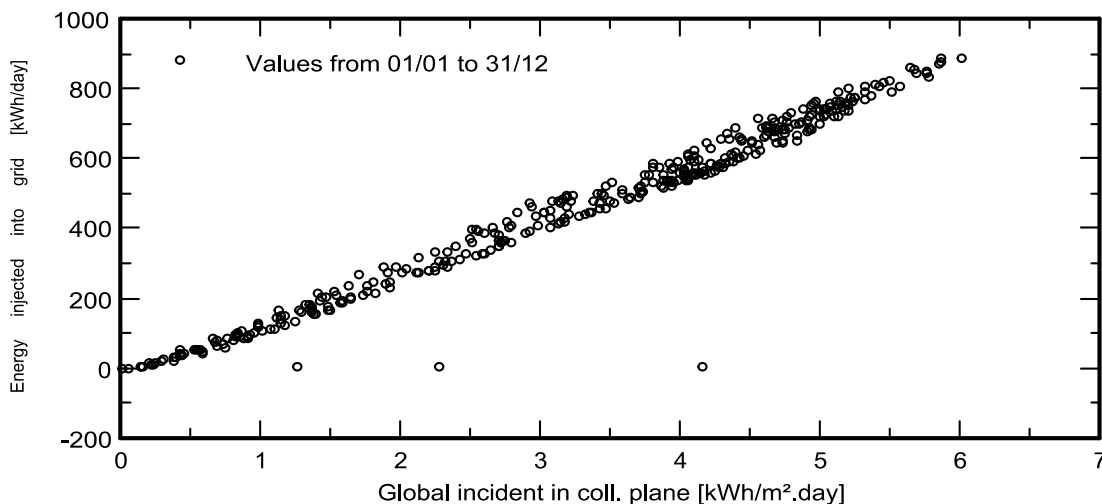
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Grid-Connected System: Special graphs

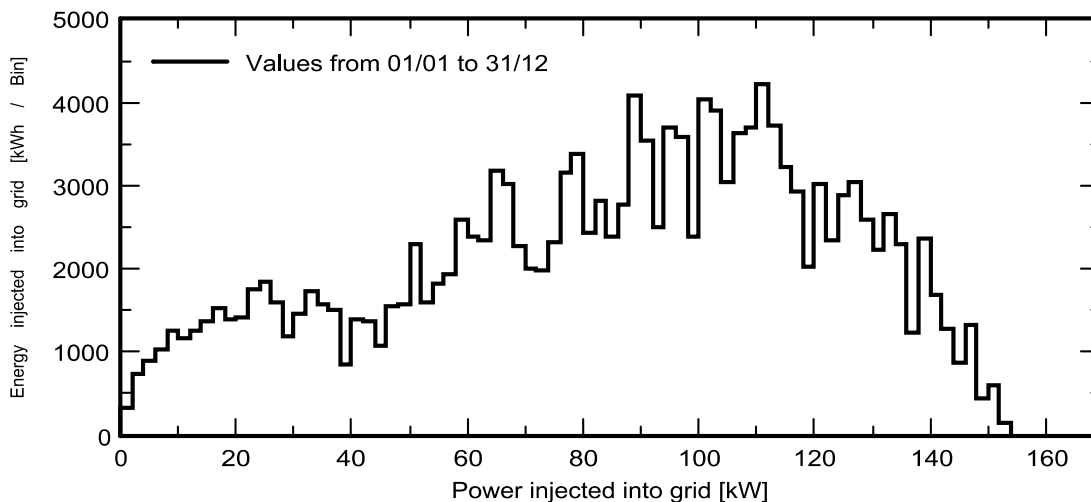
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Daily Input/Output diagram



System Output Power Distribution



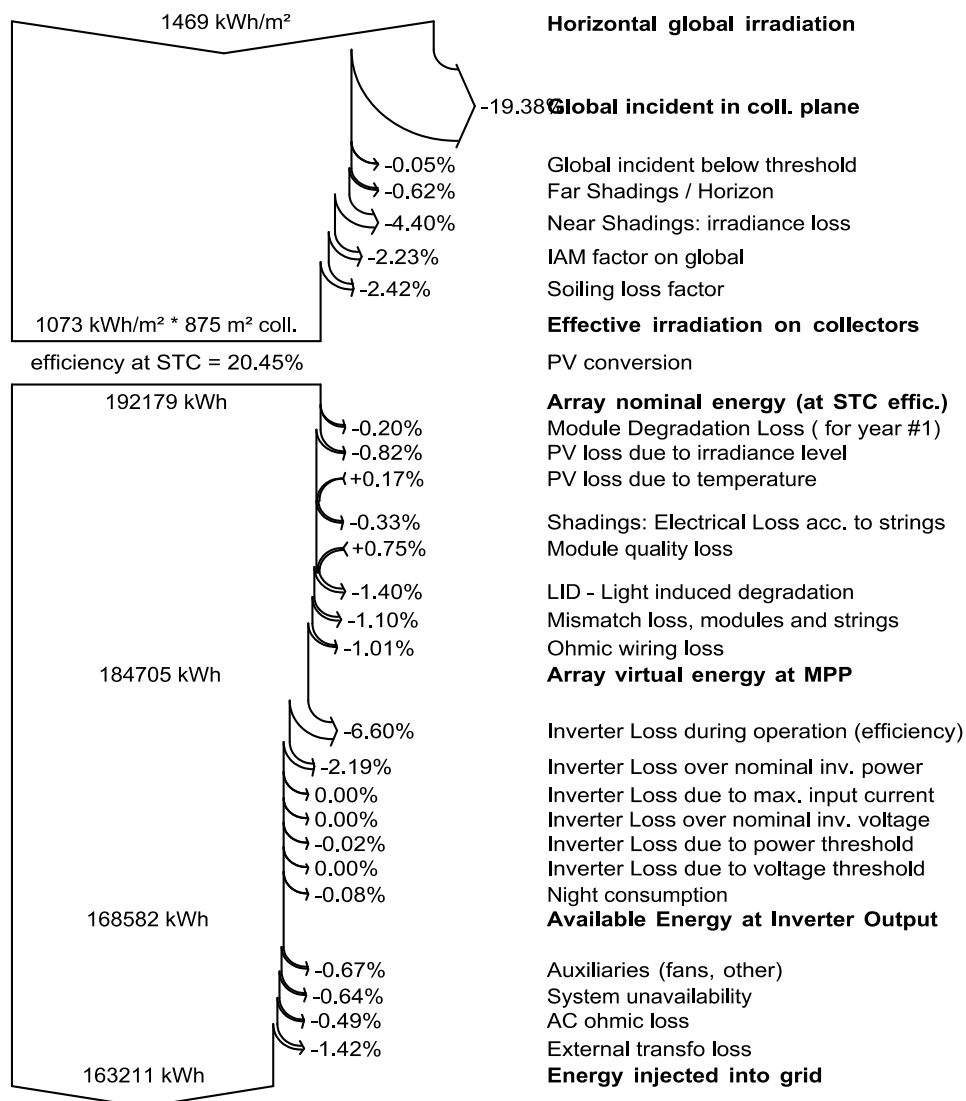


Grid-Connected System: Loss diagram

Project : Framington_Garage
Simulation variant : OptionC_90DegTilt
Simulation for the 1st year of operation

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Loss diagram over the whole year





1599 State Route 34, Suite 3, Wall Township, NJ 07727
By: Daniel Kraemer

Grid-Connected System: P50 - P90 evaluation

Project : Framington_Garage
Simulation variant : OptionC_90DegTilt
Simulation for the 1st year of operation

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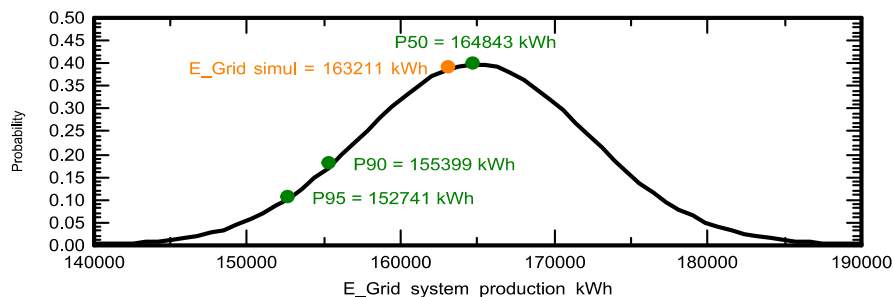
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Global variability (meteo + system)	Variance	4.5 %	(quadratic sum)

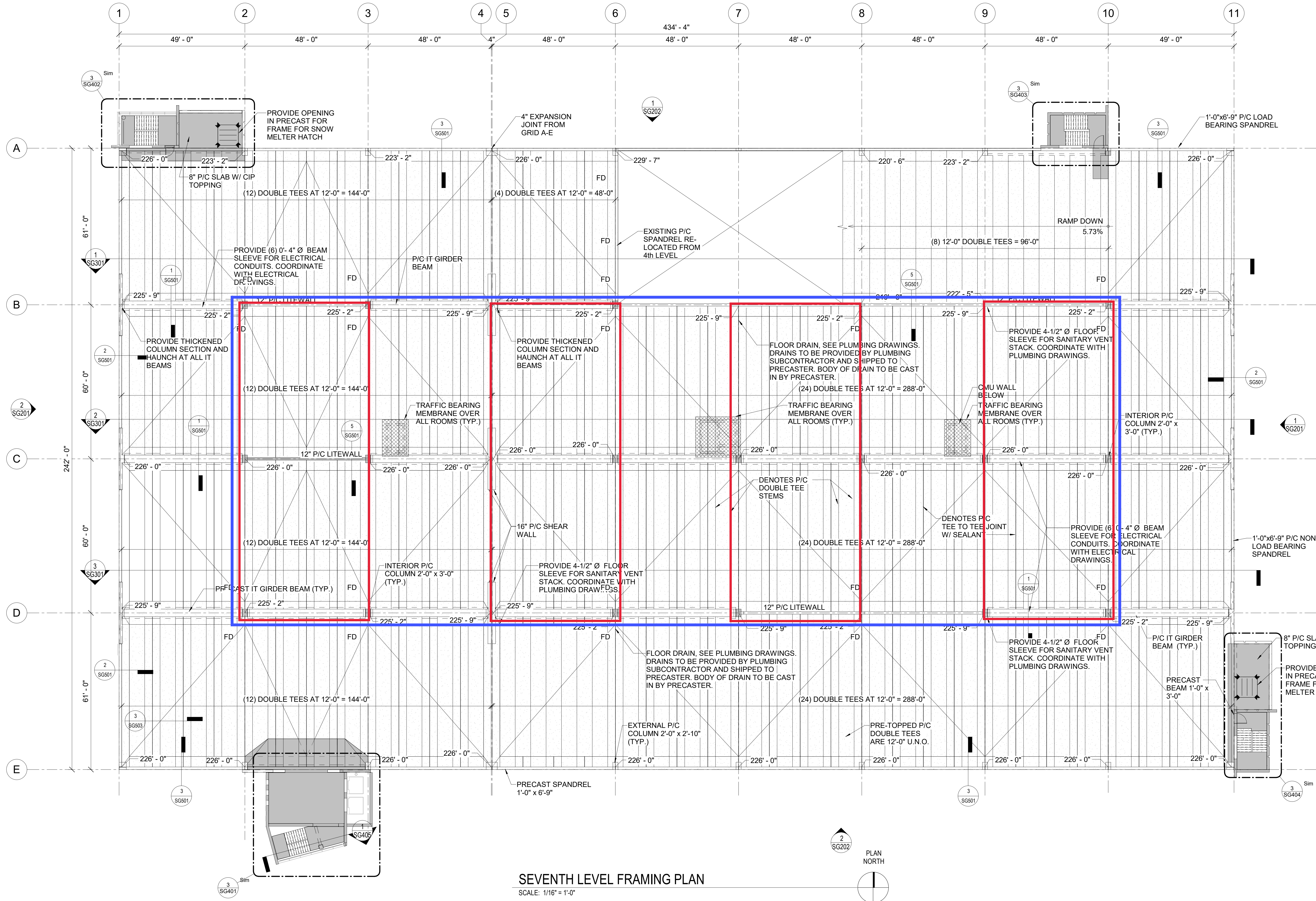
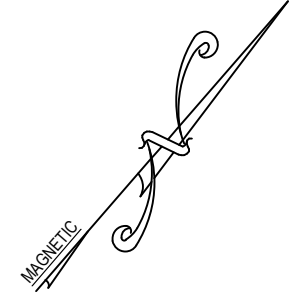
Annual production probability	Variability	7365 kWh
	P50	164843 kWh
	P90	155399 kWh
	P95	152741 kWh

Probability distribution



APPENDIX C-2

Greenhouse Gas Emissions Analysis - Solar PV Canopy Area



MASSACHUSETTS PORT AUTHORITY
EAST BOSTON, MASSACHUSETTS 02128

PROJECT LOCATION:
FRAMINGHAM LOGAN EXPRESS
GARAGE EXPANSION
FRAMINGHAM, MASSACHUSETTS

MPA CONTRACT NO.: L1629-C1 LOCATION CODE: 2950

PROJECT SUBMISSION PHASE:
60%

REGISTRATION STAMP:
FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

KEY PLAN:

REVISIONS:

REV. NO.	DATE	DESCRIPTION	BY

PRIMARY:
Stantec Architecture and Engineering P.C.
65 Network Drive, Second Floor
Burlington, MA. 01803-4542
Tel:(781) 221-1000
www.Stantec.com

CONSULTANT:
DESMAN, Inc.
18 Tremont Street, Suite 300
Boston, MA. 02108
Tel:(617) 778-9882
www.desman.com

PROJECT NUMBER AND TITLE:
L1629-C1
FRAMINGHAM LOGAN EXPRESS
GARAGE EXPANSION

SHEET TITLE:
GARAGE SEVENTH LEVEL FRAMING PLAN

DISCIPLINE:
STRUCTURAL

DESIGN BY: HJE DRAWN BY: WTF CHECKED BY: WJW APPROVED BY: WJW

SCALE: AS NOTED DATE: MARCH 2020

DRAWING NUMBER: SHEET OF

SG108



APPENDIX C-3
**Greenhouse Gas Emissions Analysis -
Lighting Report**



Stantec Inc
65 Network Drive, 2nd Floor
Burlington MA 01803

February 4, 2020
File: 179410001

Attention: Katie Raymond, PE, LEED AP
3 Mill & Main Place, Suite 250
Maynard, MA 01754

Dear Katie,

Reference: Greenhouse Gas Study for Proposed Lighting at Framingham Logan Express Parking Garage

The greenhouse gas impact of the proposed lighting for the three new levels of the parking garage has been calculated. The calculated lighting loads, power density and energy consumed are compared to the maximum allowable by the energy code. The energy code referenced is the Massachusetts Energy Code (International Energy Conservation Code 2018, Table C405.3.2(2)).

Proposed Lighting uses 29 kilowatts less than required by energy code.

Proposed Lighting is 66.5% below energy code requirements.

Energy usage is 75% below allowable energy code since garage luminaires are equipped with motion sensors and ambient light sensors to dim when no occupancy is detected for 10 minutes and turn off when daylight is sufficient.

783.9 kWh are saved per day over allowable energy code which equates to 286.1 MWh annually.

Attached is the associated calculation.

Regards,

Dan Hallahan

Daniel Hallahan, PE, LC, LEED AP

Phone: 617 792 3431
Email: daniel.hallahan@stantec.com

Attachment: Greenhouse Gas Study for Proposed Lighting on the 3 New Levels
c. Jeff Cohen
hd \\us1552-f01\shared_projects\179410517\documents\letters\greenhouse_gas_lighting_letter.docx

**Framingham Garage Expansion
Greenhouse Gas Study for Proposed Lighting on the 3 New Levels**

Calculated By: Dan Hallahan
Checked by: DJS
Date: 2/4/2020

LIGHTING POWER

Lighting Watts - Forth Level Proposed (Reference As-built DWG EG107)
-110 Type V Fixtures @ 33-Watts Each = 3630-Watts

Lighting Watts - Fifth Level Proposed (Reference As-built DWG EG107)
-110 Type V Fixtures @ 33-Watts Each = 3630-Watts

Lighting Watts - Sixth Level Proposed (Reference As-built DWG EG107)
-104 Type V Fixtures @ 33-Watts Each = 3432-Watts
-30 Type CD Fixtures @ 122-Watts Each = 3660-Watts
-6 Type VD Fixtures @ 50-Watts Each = 300-Watts
Sixth Level Total: 7392 -Watts

Total Lighting Wattage Proposed for the forth, fifth and sixth levels is 14652 Watts

LIGHTING POWER DENSITY

Garage Parking Levels Measure 240' x 434' = 104160 SqFt per floor
With 3 new floors, the total new square footage is 312480 SqFt

Proposed Lighting Power Density = $14652W/312480 \text{ SqFt} = 0.047 \text{ W/SqFt}$
Per Massachusetts Energy Code (IECC 2018, Table C405.3.2(2)), Lighting Power Density allowed is 0.14 W/SqFt

Lighting Wattage Allowed is $0.14 \text{ W/SqFt} \times 312480 \text{ SqFt} = 43747\text{-Watts}$
Proposed Lighting uses 29095 Watts lower than required by energy code.
Proposed Lighting is 66.5% below energy code requirements.

LIGHTING ENERGY

Type V luminaires are equipped with motion sensors and ambient light sensors to dim when no occupancy is detected for 10 minutes and turn off when daylight is sufficient.

25% of Type V luminaires will be 'off' for 10 hours per day because of daylight at perimeter
25% of Type V luminaires will be 'off' for 5 hours per day because of daylight near perimeter (2nd row in)
50% of Type V luminaires will be 'off' for 0 hours per day because of daylight - interior
When powered, 50% of the time, the V luminaires will be dimming to 40% power.
So, Each V luminaire will operate an average of 20.25 hours per day.
With dimming, that is reduced to the equivalent full power of 14.175 hours per day per V fixture

Type CD luminaires are designed for portal lighting to counter the cave effect from entering the garage from bright sunlight to relatively dark interior and will operate only during daytime - 12 hours per day.

Type VD luminaires are equipt with motion sensors to dim when no occupancy is detected for 10 minutes & operate 24 hours per day.
50% of the time, the VD luminaires will be dimming to 40% power.
With dimming, that is reduced to the equivalent full power of 16.8 hours per day per VD fixture

Power from all type V luminaires is 10.7kW, which operates for an average equivalent of 20.25 hours per day consuming 216.7 kWh per day.
Power from all type CD luminaires is 3.7kW, which operates for an average equivalent of 12 hours per day consuming 44.4 kWh per day.
Power from all type VD luminaires is 0.3kW, which operates for an average equivalent of 16.8 hours per day consuming 5 kWh per day.

Total energy usage for the three new levels: 266.1 kWh per day
Total energy usage allowed by energy code without controls is: 1050 kWh per day
Energy usage is 75% below allowable energy code.

783.9 kWh are saved per day over allowable energy code or 62.4 gallons of gasoline saved per day for the three new interior levels.
783.9 kWh per day is 286.1 MWh annually which equates to 223 Tons of Carbon Dioxide Equivalent, or 2.7 tanker trucks worth of gasoline saved per year.

In addition to the energy savings on the new floors, on the existing 3rd floor, 30 Type CD luminaires will be removed.
These luminaires have been used for transitional lighting from bright roof level to relatively dark interior.

Third floor power savings: 30 Type CD Fixtures are being removed from the 3rd level @ 122-Watts Each = -3660-Watts
Power from these type CD luminaires is 3.7kW, which operates for an average equivalent of 12 hours per day consuming 44.4 kWh per day.

So, in addition to the 783.9 kWh saved on the new floors, 44.4 kWh will be saved on the third floor for a total of 828.3 kWh saved per day or 302 MWh annually.

APPENDIX D

Distribution List

Agency	Contact
Executive Office of Energy and Environmental Affairs	MEPA Office 100 Cambridge Street, Suite 900 Boston, MA 02114 E-Mail: MEPA@mass.gov
State Senator Karen Spilka	Honorable Karen Spilka Massachusetts State House 24 Beacon Street, Room 332 Boston, MA 02133 E-Mail: Karen.Spilka@masenate.gov
State Representative Carmine Gentile	Honorable Carmine Gentile Massachusetts State House 24 Beacon Street, Room 167 Boston, MA 02133 E-Mail: carmine.gentile@mahouse.gov
State Representative Maria Robinson	Honorable Maria Robinson Massachusetts State House 24 Beacon Street, Room 22 Boston, MA 02133 E-Mail: maria.robinson@mahouse.gov
State Representative Jack Lewis	Honorable Jack Lewis Massachusetts State House 24 Beacon Street, Room 43 Boston, MA 02133 E-Mail: Jack.Lewis@mahouse.gov
Department of Environmental Protection Boston Office	Commissioner's Office One Winter Street Boston, MA 024108 E-Mail: helena.boccardo@mass.gov
Department of Environmental Protection Northeast Regional Office	Attn: MEPA Coordinator 205 Lowell Street Wilmington, MA 01887 E-Mail: john.d.viola@mass.gov
Massachusetts Department of Transportation (MassDOT) Highway Division	Public / Private Development Unit 10 Park Plaza, Suite 4150 Boston, MA 02116 E-Mail: lionel.lucien@dot.state.ma.us
Massachusetts Department of Transportation District 3 Office	Attn: MEPA Coordinator 403 Belmont Street Worcester, MA 01604 E-Mail: lori.shattuck@dot.state.ma.us
Massachusetts Historical Commission (MHC)	The MA Archives Building 220 Morrissey Boulevard Boston, MA 02125 E-Mail: Brona.Simon@state.ma.us

Metropolitan Area Planning Council (MAPC)	<p>MAPC 60 Temple Place, 6th Floor Boston, MA 02111 E-Mail: mdraisen@mapc.org mpillsbury@mapc.org</p>
Massachusetts Water Resources Authority (MWRA)	<p>Massachusetts Water Resources Authority Charlestown Navy Yard, 100 First Avenue Boston, MA 02129 E-Mail: katherine.ronan@mwra.com</p>
Department of Energy Resources	<p>Department of Energy Resources Attn: MEPA Coordinator 100 Cambridge Street, 10th Floor Boston, MA 02114 E-Mail: paul.ormond@mass.gov brendan.place@mass.gov</p>
Framingham Mayor Yvonne Spicer	<p>Honorable Yvonne Spicer Framingham City Hall 150 Concord Street Framingham, MA 01702 E-Mail: mayor@framinghamma.gov</p>
Framingham Planning Department	<p>150 Concord Street, Room B2 Framingham, MA 01702 E-Mail: eo@framinghamma.gov</p>
Framingham City Council	<p>150 Concord Street Framingham, MA 01702 E-Mail: gking@framinghamma.gov jgalliardt@framinghamma.gov</p>
Framingham Conservation Committee	<p>150 Concord Street, Room 213 Framingham, MA 01702 E-Mail: rdm@framinghamma.gov jniro@framinghamma.gov</p>
Framingham Health Department	<p>150 Concord Street Framingham, MA 01702 E-Mail: ssw@framinghamma.gov</p>
Framingham City Clerk	<p>150 Concord Street, Room 105 Framingham, MA 01702 E-Mail: cityclerk@framinghamma.gov</p>
Natick Town Administrator	<p>Town of Natick c/o Melissa Malone, Town Administrator Natick Town Hall, 2nd Floor 13 East Central Street Natick, MA 01760 E-Mail: mmalone@natickma.org</p>

REI Senior Corporate Counsel	Wilma Wallace, Vice President, General Counsel and Corporate Secretary REI Corporation 6750 South 228 th Street Kent WA 98032 E-Mail: wwallace@rei.com
Garry Holmes R.W. Holmes Realty Co. Inc.	R.W Holmes Realty Co. Inc. 321 Commonwealth Road, Suite 202 Wayland, MA, E-Mail: gholmes@rwholmes.com
AIR, Inc. East Boston	Gail Miller, President AIR, Inc. 232 Orient Avenue East Boston, MA 02128
MetroWest Regional Transit Authority	Ed Carr, Authority Administrator MetroWest Regional Transit Authority 15 Blandin Avenue Framingham, MA 01702 E-mail: ed@mrta.com