DRAFT ENVIRONMENTAL IMPACT REPORT

Highland Science Center

Needham Heights, Massachusetts

PROPONENT

557 Highland, LLC c/o The Bulfinch Companies, Inc.
116 Huntington Avenue, Suite 600
Boston, Massachusetts 02116

SUBMITTED TO

Massachusetts Environmental Policy Act Office (MEPA)
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

July 2022

SUBMITTED BY

VHB
99 High Street, 10th Floor
Boston, Massachusetts 02110

IN ASSOCIATION WITH

Acentech Incorporated
AHA Consulting Engineers, Inc.
Dain, Torpy, Le Ray, Wiest & Garner, P.C.
Frieze Cramer Rosen & Huber LLP
John Moriarty & Associates, Inc.
McPhail Associates, LLC
Paul Finger Associates, Inc.
Robert T. Smart, Jr., Esq.
Simpson Gumpertz & Heger, Inc.
Stantec Architecture

DocuSign Envelope ID: 0B305B97-D8BB-4BDE-83EA-6E561388BBC8

July 15, 2022

Beth Card, Secretary
Executive Office of Energy and Environmental Affairs
Attn: Tori Kim, MEPA Director
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

Re: Draft Environmental Impact Report
Highland Science Center (a/k/a Highland Innovation Center)
557 Highland Avenue, Needham, MA

Dear Secretary Card:

557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc. (the "Proponent"), is pleased to submit this Draft Environmental Impact Report ("DEIR") for the redevelopment of 557 Highland Avenue (the "Project Site") in Needham, Massachusetts. A new state-of-the-art laboratory and office building will be constructed to promote future growth of life science and research uses, to be known as the Highland Science Center (the "Project"). An Environmental Notification Form (ENF) for the Project was submitted on March 31, 2022.

The Proponent is proposing up to an approximately 531,000-SF office/laboratory/research and development building complex on the site of the former Muzi Ford and Chevy Dealerships. The new buildings, varying in height from 3-5 stories, and associated landscape and hardscape improvements, including a fitness trail, are intended to attract office, research and development and life science tenants, with ancillary retail, café, daycare, and fitness amenities, subject to market demand. The Project will include up to an approximately 310,000-SF below-grade parking garage and a five-story, approximately 297,000-SF stand-alone parking garage.

The Project will repurpose an underutilized site and result in a number of public benefits, such as improved stormwater management, improved open space along Highland Avenue, enhanced pedestrian accessibility, ground level activation with retail and community space at the corner of Gould Street and Highland Avenue, new construction and permanent jobs in Needham, and substantial additional annual tax revenue to support Needham's educational and recreational programs, housing initiatives, and community/open spaces.

DocuSign Envelope ID: 0B305B97-D8BB-4BDE-83EA-6E561388BBC8

We look forward to working with you and your staff during your review of the Project. We anticipate that the DEIR will be noticed in the July 22, 2022 edition of the Environmental Monitor. If you have any questions or if any additional information would be helpful, please do not hesitate to contact me.

Thank you.

Sincerely,
557 Highland, LLC

DocuSigned by:

By: _____
061B9585B2F8420...
Robert A. Schlager
Duly authorized

Highland Science Center

Needham, MA

SUBMITTED TO **The Executive Office of Energy and Environmental Affairs**
MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114

PROPONENT **557 Highland, LLC,**
an affiliate of The Bulfinch Companies, Inc.
116 Huntington Ave., Suite 600
Boston, MA 02116

PREPARED BY **VHB**
99 High Street, 10th Floor
Boston, MA 02110

IN ASSOCIATION WITH
Acentech Incorporated
AHA Consulting Engineers, Inc.
Dain, Torpy, Le Ray, Wiest & Garner, P.C.
Frieze Cramer Rosen & Huber, LLP
John Moriarty & Associates
McPhail Associates, LLC
Paul Finger Associates, Inc.
Robert T. Smart, r., Esq.
Simpson Gumpertz & Heger, Inc.
Stantec, Inc.

July 2022

Table of Contents

1 Project Description 1-1

1.1 Project Overview 1-1
1.2 Site Context and Existing Conditions 1-1
1.3 Summary of Changes Since ENF 1-2
1.3.1 Design Changes 1-2
1.3.2 Transportation Changes 1-2
1.4 Project Description 1-4
1.4.1 Development Program 1-5
1.4.2 Description of Project Components, Uses 1-5
1.4.3 Description of Overall Design Approach 1-5
1.4.4 Description of Site/Public Realm Improvements and Open Space 1-6
1.4.4 Description of Site Access/Circulation and Parking 1-6
1.5 Project Schedule 1-7
1.6 Summary of Public Benefits 1-7
1.7 Regulatory Compliance 1-8

2 Alternatives Analysis 2-1

2.1 Project Alternatives 2-1
2.2 No-Build Alternative 2-1
2.3 As-of-Right Build 2-2
2.4 Residential Build 2-2
2.5 Preferred Alternative 2-2
2.6 Impact Comparison Table (VHB/Civil) 2-3
2.7 Public Space Alternatives 2-3

3 Environmental Justice and Public Health 3-1

3.1 Key Findings and Benefits 3-1
3.2 Environmental Justice Populations 3-1
3.3 Opportunities for LEP Populations 3-4
3.3.1 Public Involvement Plan 3-4
3.4 Public Health 3-4
3.4.1 Environmental Impacts 3-5
3.4.2 Vulnerable Health EJ Criteria 3-6
3.4.3 DPH EJ Tool 3-6
3.4.4 EPA EJ Screen 3-7
3.4.5 Public Health Permits 3-9

4 Stormwater and Water/Wastewater 4-1

4.1 Key Benefits and Findings 4-1
4.2 Stormwater 4-1
4.2.1 Stormwater Permits and Compliance 4-1
4.2.2 Stormwater Management System 4-2
4.2.3 Future Climate Conditions 4-3
4.2.4 Climate Resilience 4-3
4.3 Water/Wastewater 4-3
4.3.1 Water/Wastewater Permits and Compliance 4-3
4.3.2 Water/Wastewater Analysis 4-3

5 Traffic and Transportation 5-1

5.1 Key Findings and Benefits 5-3
5.2 Proposed Transportation Changes from ENF 5-5
5.2.1 Gould Street Improvements 5-5
A graphic of the revised Gould Street roadway improvements is provided in Figure 5.1. 5-5
5.2.2 Additional Off-Site Improvements 5-5
5.2.3 Electric Vehicle Charging Stations 5-6
5.2.4 Bicycle Parking 5-6
5.2.5 Transportation Monitoring Program 5-6
5.3 Coordination with State/Local Agencies 5-6
5.4 Additional Transportation Impact Assessments 5-7
5.4.1 Existing Site-Generated Trips 5-7
5.4.2 Safety Review 5-8
5.4.3 Queue Analysis 5-10
5.4.4 Access to MBTA Bus Route 59 5-11
5.4.5 Bicycle Demand and Parking 5-11
5.4.6 On-Site Parking 5-13
5.5 Mitigation 5-13
5.5.1 Additional Intersection Mitigation 5-15
5.5.2 Conceptual Roadway Plans 5-24
5.5.3 Gould Street Bicycle and Pedestrian Enhancements 5-25
5.5.4 Noanett Road Improvements 5-25
5.5.5 Hunting Road Radar-Embedded Speed Limit Signs 5-26
5.5.6 Highland Avenue Bicycle Accommodations 5-26
5.6 Transportation Demand Management 5-26
5.6.1 Shuttle and Transit Connection 5-27
5.6.2 Electric Vehicle Charging 5-28
5.6.3 Emergency Ride Home 5-28
5.6.4 Carpool Assistance 5-28
5.6.5 Desired TDM Goals 5-28
5.7 Transportation Monitoring Program 5-29
5.7.1 On-Site Parking Facility Traffic Monitoring 5-29
5.7.2 Intersection and Roadway Traffic Monitoring 5-29

5.7.3 Travel Survey....5-30
5.7.4 Transportation Monitoring Program Results....5-30

6 Solid and Hazardous Waste.... 6-1

6.1 Project Site Background....6-1
6.2 Key Findings and Benefits....6-2
6.3 Regulatory Context....6-2
6.4 Contamination....6-3
6.5 Measures to Protect Public Health....6-3

7 Climate Change.... 7-1

7.1 Key Findings and Benefits....7-1
7.2 Regulatory Context....7-1
7.2.1 MEPA Greenhouse Gas Policy and Protocol....7-1
7.2.2 Massachusetts Stretch Energy Code....7-2
7.3 Adaptation and Resiliency....7-2
7.3.1 Measures to Increase Resilience....7-2
7.3.2 Resilient Massachusetts Action Team....7-3
7.3.3 Flexible Adaptation Strategies....7-3
7.3.4 Community Resilience Workshop....7-3
7.4 Greenhouse Gas Emissions....7-4
7.4.1 Stationary Source Assessment....7-4
7.4.2 Mobile Source Assessment....7-8

8 Construction Period Impacts.... 8-1

8.1 Key Findings and Benefits....8-1
8.2 Noise....8-1
8.3 Air Quality....8-2
8.4 Water Quality....8-3
8.5 Traffic....8-3
8.6 Construction and Demolition Debris....8-3
8.7 Contaminated Material....8-4
8.8 Stormwater Pollution Prevention Plan....8-4
8.9 Dewatering Activities....8-4

9 Mitigation and Draft Section 61 Findings.... 9-1

9.1 Mitigation Measures....9-1
9.2 Draft Section 61 Findings....9-5
9.2.1 MassDOT Access Permit....9-5
9.3 GHG Self-Certification....9-10

10 Response to Comments 10-1

10.1 ENF Certificate 10-1
Letter 1: Greenman-Pedersen, Inc 10-30
Letter 2: Town of Needham 10-37
Letter 3: Massachusetts Water Resources Authority 10-38
Letter 4: Massachusetts Department of Energy Resources 10-40
Letter 5: Charles River Watershed Association 10-45
Letter 6: Massachusetts Department of Transportation 10-47
Letter 7: Massachusetts Department of Environmental Protection 10-50

List of Appendices

Appendix A – Distribution List

Appendix B – RMAT and EJ

Appendix C – Infrastructure

Appendix D – Transportation

Appendix E – GHG Assessment

Appendix F – ENF Certificate and Comment Letters

Appendix G – Plans and Elevations

List of Tables

Table No.	Description	Page
Table 1-1	Proposed Development Program	1-4
Table 1-2	Anticipated Project Permits and Approvals	1-8
Table 2-1	Project Alternatives	2-1
Table 2-2	Quantitative Analysis of Impacts from Project Alternatives	2-3
Table 5-1	Comparison of Empirical and ITE Trips for Existing Site Uses	5-7
Table 5-2	Weave Segment Capacity Analysis Summary	5-9
Table 5-3	Proposed Bicycle Parking Spaces	5-12
Table 5-4	Signalized Intersection Capacity Analysis Summary – Highland Avenue at Gould Street / Hunting Road and Gould Street at Site Driveway	5-17
Table 5-5	Signalized Intersection Capacity Analysis Summary – Highland Avenue at West Street	5-19
Table 5-6	Signalized Intersection Capacity Analysis Summary – Highland Avenue at Webster Street	5-20
Table 5-7	Signalized Intersection Capacity Analysis Summary – Highland Avenue at 1st Avenue	5-21
Table 5-8	Signalized Intersection Capacity Analysis Summary – Hunting Road at Kendrick Street	5-22

Table 5-9 Central Avenue Traffic Signal Warrants Analysis Summary 5-23
Table 7-1 Lab/Office Key Model Assumptions 7-6
Table 7-2 Building Stationary Source CO2 Emissions 7-7
Table 7-3 Solar Feasibility Assessment Results 7-8
Table 7-4 Mesoscale Analysis Results 7-11
Table 7-5 Mitigation Analysis Results 7-12

List of Figures

Figure No.	Description	Page
1.1	Project Site Location	
1.2	Project Site Context	
1.3	Existing Conditions	
1.4a	Aerial Site Photo - Prior to Demolition	
1.4b	Aerial Site Photo - After Demolition	
1.5	Proposed Site Plan	
1.6a	Proposed Highland Ave. Rendering	
1.6b	Proposed Gould St. Rendering	
1.6c	Proposed Highway Rendering	
1.6d	Proposed Entry Rendering	
1.6e	Proposed Highland-Gould Rendering	
1.7a	Proposed Garage Plan	
1.7b	Proposed Ground Floor Plan	
1.7c	Proposed Second Floor Plan	
1.7d	Proposed Third Floor Plan	
1.7e	Proposed Fourth Floor Plan	
1.7f	Proposed Fifth Floor Plan	
1.7g	Proposed Roof/Penthouse Plan	
1.8a	Proposed Building Sections	
1.8b	Proposed Building Sections	
1.9a	Proposed Building Elevations	
1.9b	Proposed Building Elevations	
3.1	Environmental Justice	
4.1	Existing Infrastructure	
4.2	Proposed Infrastructure	

4.3 LID, BMPS, Green Infrastructure

4.4 Conceptual Utility Plan

4.5 Conceptual Drainage Plan

5.1 Gould Street Concept Plan

1

Project Description

557 Highland Avenue, LLC, an affiliate of The Bulfinch Companies, Inc., (the "Proponent") is pleased to submit this Draft Environmental Impact Report (DEIR) for the redevelopment of 557 Highland Avenue (the "Project Site") in Needham, Massachusetts. A new state-of-the-art laboratory and office building will be constructed to promote future growth of life science and research uses, to be known as the Highland Science Center (the "Project"). This chapter provides an overview of existing conditions, the Project, and its anticipated public benefits. This chapter also identifies the state and local permits and approvals that are anticipated to be required.

As described and analyzed in this DEIR, the Project represents the largest life sciences project that the Proponent believes is reasonably achievable at the Project Site under the Town of Needham's recently-adopted Highland Commercial 1 zoning regulations. The DEIR assumes that the Planning Board will, by special permit, grant certain dimensional relief allowed by the recent rezoning. The Proponent also has asked the Planning Board for a special permit reducing the number of required parking spaces. The DEIR does not assume that this reduction in the number of required parking spaces will be granted, because the increase in parking spaces and corresponding vehicle trips are the MEPA review thresholds applicable to the Project. This conservative approach ensures that the traffic mitigation measures discussed and committed to during the MEPA process will be adequate whether or not the requested parking relief is granted.

1.1 Project Overview

An Environmental Notification Form (ENF) for the Project was filed March 31, 2022, and published in the Environmental Monitor on April 8, 2022. The ENF comment period ended on April 28, 2022, and the ENF Certificate was issued on May 9, 2022. The Proponent has sought to incorporate and address in this DEIR the requests and feedback provided in the ENF Certificate and public comments on the ENF. Refer to Chapter 10, *Response to Comments,* to see individual responses to comments from agencies, organizations, and members of the public.

In advance of this filing, the Proponent and Project team met with and received feedback from multiple State and local agencies, elected officials, community stakeholders, and members of the general public. The process of discussion and input remains active as the Proponent continues to plan for and advance the Project.

1.2 Site Context and Existing Conditions

The Project Site consists of 9.27 acres of land, and is bordered by Highland Avenue to the south, Interstate 95/Route 128 to the east, Gould Street to the west, and a private way and commercial buildings/impervious surface parking lots to the north. Refer to Figure 1.1 for a site location map. The Project Site is located directly off Interstate 95/Route 128, adjacent to off-ramp Exit 35C and along a commercial corridor on Highland Avenue.

The existing site consists almost entirely of impervious surface that previously served as a car dealership and an unaffiliated carwash with approximately 532 parking spaces. Current access to the Project Site is provided primarily on Gould Street, with a gated entrance on Highland Avenue. Refer to Figure 1.2 for Project Site context, and Figure 1.3 for an existing conditions plan.

1.3 Summary of Changes Since ENF

1.3.1 Design Changes

Since filing the ENF, the Proponent's Project team has had seven open meetings with members of the community (via Zoom) and met with all the main Town of Needham departments for their input. The Project has undergone further development and modifications in response to comments received in these meetings. The form of the south building has been kinked to break down the overall length of the south facade, provide more open space, and soften the overall massing at the corner of Highland Avenue and Gould Street where the Project will include a retail plaza. The landscape architect continues to develop the site plan with an effort to add more native yet diverse landscape plantings, including adding more mature trees around the south building to buffer it from the roads. Meadow grasses and groundcover will be used instead of the previously proposed utilized in lieu of bluegrass lawn areas to minimize the need for irrigation. The fitness / walking path has been moved closer to the south building along Highland Ave providing more separation and landscape screening between pedestrians and vehicles. The community open space along Gould Street has been furth developed and a multi-purpose green space incorporated into the Project that could be utilized for a pickleball court during the spring, summer and fall months and an ice skating rink during the winter. An exterior pavilion is also envisioned for this space. The walking and exercise trail and retention pond, as public amenities at the Project have been further developed. The loading dock and entry to the below grade parking garage on the north building have been relocated to the north facade facing the free-standing garage. This change will provide an active use façade with windows facing Gould Street and enhance the pedestrian connection between the free-standing garage and main entry of the atrium.

1.3.2 Transportation Changes

The ENF included a full Traffic Impact and Access (TIA) study developed based on MassDOT TIA guidelines. The following sections outline the transportation-specific changes to the Project since the filing of the ENF.

1.3.2.1 Gould Street Improvements

To provide more family-friendly bicycle accommodations on Gould Street, the Proponent has modified the proposed mitigation on Gould Street to include bi-directional separated bicycle lanes at sidewalk level on the east side of Gould Street between Highland Avenue and just north of TV Place. A new crosswalk across Gould Street at the location of the abandoned railroad right-of-way will be installed so pedestrians and southbound bicyclists can cross Gould Street to access the sidewalk and bi-directional separated bicycle lanes on the east side of Gould Street. The proposed crosswalk will be equipped with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers. To accommodate southbound bicyclists who may want to continue on-road and not cross Gould Street, a four-foot-wide unmarked bicycle-accommodating shoulder will be provided on the southbound (west) side of Gould Street. Under the concept presented in the ENF, all bicyclists would have traveled in on-road bicycle lanes directly next to vehicle traffic.

To provide enhanced pedestrian accommodations, the Proponent will reconstruct the sidewalk on the west side of Gould Street between Highland Avenue and Noanett Road. This will provide a safer accommodation for pedestrians walking in that area.

In addition, the revised concept eliminates the Gould Street dedicated northbound right-turn lane into TV Place and the dedicated southbound right-turn lane onto Highland Avenue. Gould Street at the intersection with Highland Avenue now will be widened to four lanes, rather than the previously-proposed five lanes. These changes were made based on feedback from the Town of Needham and members of the public, to reduce the amount of pavement and the lengths of associated crosswalks. Although these turn lanes were included in the initial concept design, the lanes are not required to provide an adequate level of operations for vehicles. Intersection traffic analyses for the new concept are included in Section 5.5.1.1 of Chapter 5, *Traffic and Transportation*.

1.3.2.2 Additional Off-Site Improvements

The Proponent has also committed to the following off-Site roadway improvement measures in addition to those proposed in the ENF:

- Traffic signal timing modifications at four additional intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street.
- Improvements at Noanett Road to improve pedestrian accommodations and deter cut-through traffic on the local residential roadway, including signs indicating no cut-through traffic, information dissemination, and funding for police enforcement.
- Installation of two radar-embedded speed limit signs on Hunting Road to encourage lower vehicle speeds.

1.3.2.3 Electric Vehicle Charging Stations

The ENF stated that the Project will include parking facilities equipped with electric vehicle (EV) charging stations, but it did not specify the number of EV charging stations that would be provided. The Proponent is now committed to providing approximately 25-percent of the parking spaces in each parking area (the stand-alone parking garage, the surface lot, and the

underground garage) with EV parking stations, with consideration as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions.

1.3.2.4 Bicycle Parking

In the ENF, the Project was proposed to include up to 89 bicycle parking spaces. Based on community feedback, the number of bicycle parking spaces has been increased. The Project is now proposed to include up to 104 secure indoor and bicycle parking spaces for tenants'employees and up to 50 outdoor bicycle parking spaces on public bicycle racks for visitors and customers for a total of up to 154 bicycle parking spaces on-Site.

1.3.2.5 Transportation Monitoring Program

The Transportation Monitoring Program has been revised based on feedback from MassDOT and the Town of Needham's peer reviewer. The monitoring program has been expanded to include an annual travel survey of employees and patrons, 48-hour traffic volume counts on TV Place and on the Project Site driveway, capacity and queue analyses for four study area intersections, and a commitment to review/adjust the TDM program and add additional measures if the Project Site generates more trips than expected. Full details of the revised Transportation Monitoring Program are provided in Section 5.7 of Chapter 5, *Traffic and Transportation*.

1.4 Project Description

The Proponent is proposing to build a new office/laboratory building complex on the site of the former Muzi Ford and Chevrolet Dealership. The Project will feature an office/laboratory research facility with below-grade parking and a stand-alone parking structure. The new building and landscape improvements are intended to attract office and life science tenants, with ancillary retail, café, daycare, and fitness amenities, subject to market demand.

1.4.1 Development Program

Refer to Table 1-1 below for a summary of the proposed uses for the Project.

Table 1-1 Proposed Development Program

Use	Size	Quantity	Height
Project Site	9.27 acres	NA	NA
Building Information			
Office	260,500 SF	NA	70 feet
Lab/Research and Development	260,500 SF	NA	70 feet
Retail	10,000 SF	NA	NA
Total Square Feet	**531,000[1] SF**	**NA**	**42-70 feet**
Free standing parking garage	297,000 SF		55'[2]
Below grade parking	310,000[3] SF		NA

NA Not Applicable
SF Square Feet
1 Per Needham Zoning, the parking garage is not included in total SF.
2 Five stories above-grade, and two stories below-grade.
3 There will be two below-grade parking levels beneath the buildings that will be 155,000 SF each.

1.4.2 Description of Project, Components and Uses

The office/lab buildings will total up to 531,000 square feet (SF) with a floor area ratio (FAR) of 1.31 and range in height from 42 feet to 70 feet in height as allowed by Special Permit. Each building will have two levels of below-grade parking serving the primary tenants of the building.

In addition to the below-grade parking, a stand-alone garage structure will be built to a height of 55 feet with a maximum floorplate of 42,500 SF, as allowed by Special Permit. In total, the stand-alone garage and below-grade parking will provide up to 1,770 parking spaces for the users of the building, as required by local zoning.

Refer to Figure 1.5 for a proposed site plan.

1.4.3 Description of Overall Design Approach

The building arrangement conforms with the dimensional guidelines adopted as part of the recent rezoning of the Project Site and adjacent properties to the north, across TV Place. The office/lab buildings are conceived as one structure articulated as three distinct parts:

- **South Building** – a three-story building located primarily along Highland Avenue. The massing is kinked and pulls away from the corner at Gould Street, creating a scale that is recognizable and related to the adjacent context;
- **North Building** – a five-story building that is set back from Highland Avenue and Gould Street by 200 feet and extends toward the Southbound Exit 35C from I-95/Route 128.
- **Atrium** – a two-story atrium that connects the South Building and the North Building and provides the main entry for the buildings. The atrium will allow opportunities to bring daylight into the deeper sections of the floorplates and allow for internal connections

between the South Building and the North Building. Visually, the atrium will create a break within the massing ensuring visual interest and clarity of each of the parts.

Tucked into the deepest part of the Project Site will be a five-story parking garage. The structure will be set back 200 feet off Highland Avenue, near the Southbound Exit 35C from I-95/Route 128, and will have primary frontage along TV Place. Internal vehicular drives, and bicycle and pedestrian paths will connect the garage to the office/laboratory buildings and provide connections to the primary site entry along Gould Street.

1.4.4 Description of Site/Public Realm Improvements and Open Space

As a former auto dealership and car wash, the Project Site is primarily paved impervious surface. The Project Site's landscaping is essentially limited to a row of trees along Gould Street that wraps the corner and extends approximately 200 feet along Highland Avenue.

In addition, a small water feature with Muzi signage occupied the corner at the intersection of Highland Avenue and Gould Street. Highland Avenue is currently being upgraded by the Massachusetts Department of Transportation (MassDOT) and functions as a primary entrance into the Town of Needham for residents and visitors. As envisioned by the Needham Master Plan, the Project will create a substantial landscape buffer surrounding the Project Site to enhance the arrival experience and complement the development.

Open space improvements are proposed primarily at the southeast and northeast portions of the Project Site, including a 10-foot-wide fitness/walking path around the perimeter of the Project Site. Bicycle lanes will be incorporated into the circulation system to encourage tenants' employees to utilize alternative transportation methods. The Project consists of two office/lab structures with a central enclosed atrium that will contain flexible space. Project amenities may include café, fitness, daycare, collaboration space, and conference center for the tenants of the development. In addition, a portion of the South Building at the corner of Highland Avenue and Gould Street has been dedicated to community-based retail and will also include a hardscape and softscape plaza space for the retail tenants to offer outdoor seating.

1.4.5 Description of Site Access/Circulation and Parking

Primary access to the Project Site will be from a newly signalized intersection on Gould Street and a secondary entrance on TV Place. These entrances will be connected by a loop road and wide pedestrian sidewalks and will include dedicated bicycle lanes. A free-standing parking structure will be located near the secondary entrance off of TV Place and below-grade parking will be accessed from the loop road on the north side of the North Building. Primary entrances to the South Building and North Building will be centrally located in the atrium courtyard to enhance both the tenant and visitor arrival experience. Extensive softscape and hardscape treatments are planned for the courtyard. A surface parking lot with approximately 30 spaces for visitors and customers will be located in close proximity to the entrance of the buildings in the southwest portion of the Project Site. This parking lot will primarily serve visitors to the retail space.

1.5 Project Schedule

Construction is expected to commence in April 2023. The garage will be constructed first, and will take approximately six months to complete, during which time, excavation and backfill for the South Building foundation will occur. The North Building foundation will be constructed after the garage is erected. Project construction is expected to be completed on or about December 2025.

1.6 Summary of Public Benefits

The Project will repurpose an underutilized site with a state-of-the-art environmentally-friendly development. Benefits to the Town of Needham will include:

Environmental Benefits

- Improved water quality and stormwater management; and
- Improved open space along Highland Avenue;

Economic/Public Benefits

- Provide 300 temporary construction jobs for approximately three years, associated with construction of the garage, office/lab buildings, hardscape, and landscaping;
- Provide approximately 1,250 permanent jobs at full occupancy, with employees working on staggered schedules;
- Substantial additional annual tax revenue in excess of $5 million, which will support the Town of Needham's educational and recreational programs, housing initiatives, community and open spaces, and other Town priorities.
- Enhanced pedestrian accessibility/elimination of curb cut along Highland Avenue;
- Ground level activation with retail and community space at the corner of Gould Street and Highland Avenue; and
- Potential for community and education connections in both construction trades and life science studies;

Transportation Benefits

- Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway;
- Geometric improvements and signal timing and equipment improvements at the intersection of Highland Avenue at Gould Street/Hunting Road;
- Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements;
- Geometric improvements at the intersection of Gould Street at TV Place;
- Design and installation of bi-directional sidewalk-level separated bicycle facilities on the east side of Gould Street between Highland Avenue and just north of TV Place;

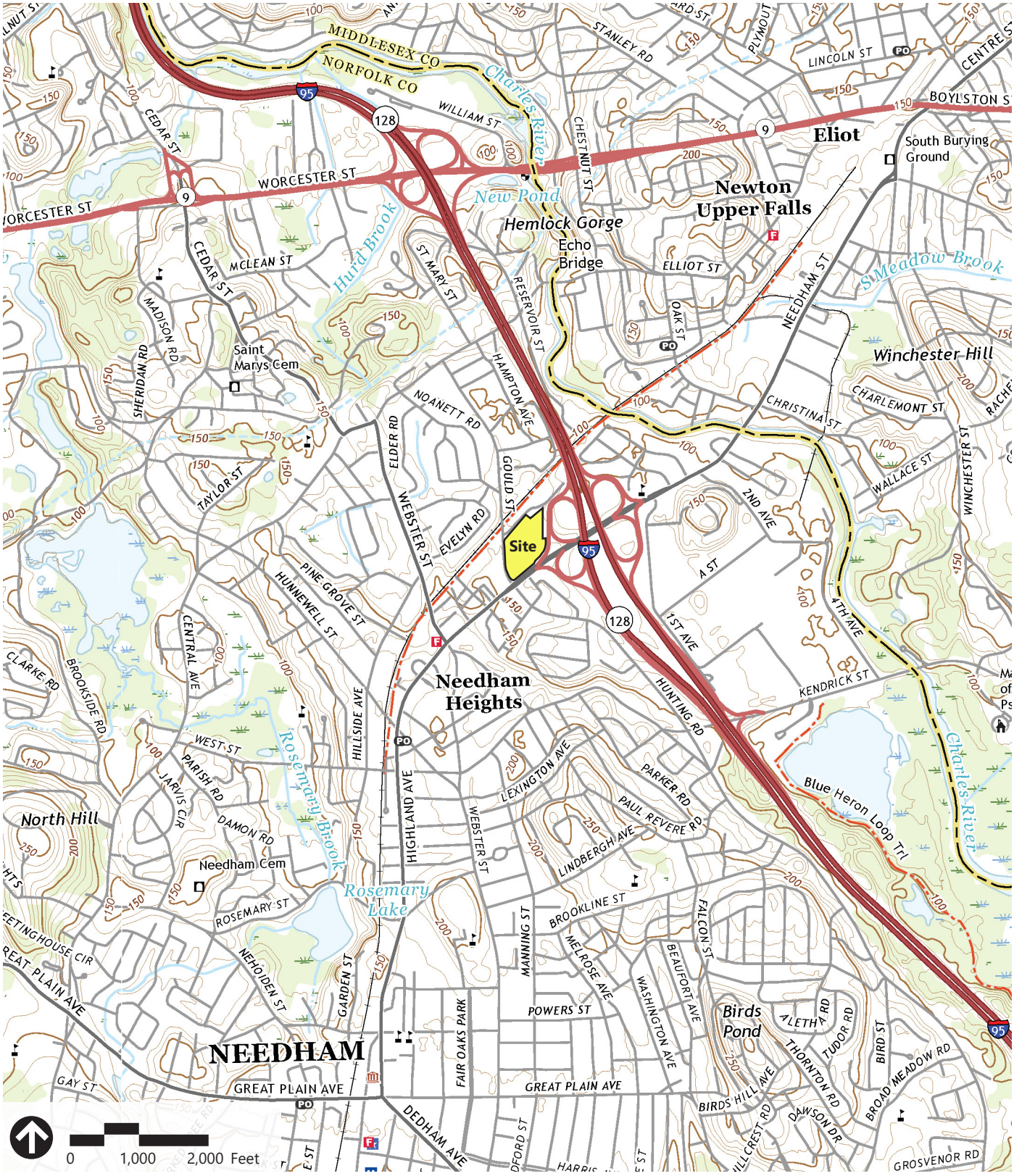
- Addition of shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately ½ mile between just north of TV Place and Central Avenue;
- Sidewalk improvements along the west side of Gould Street between Highland Avenue and Noanett Road;
- A new crosswalk for pedestrians and bicyclists across Gould Street at the location of the abandoned railroad right-of-way with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers;
- Traffic signal timing modifications at four additional intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street;
- Improvements at Noanett Road to improve pedestrian accommodations and deter cut-through traffic on the local residential roadway, including signs indicating no cut-through traffic, information dissemination, and funding for police enforcement;
- Installation of two radar-embedded speed limit signs on Hunting Road to encourage lower vehicle speeds;
- Design and construction of an approximately 0.5-mile walking/fitness path around the Site that will be open to all members of the public;
- Implementation and operation of a shuttle service between the Site and nearby transit station(s) to provide a connection to the MBTA Green Line D Branch and/or MBTA commuter rail. Shuttle vehicle will be an electric vehicle (EV); and
- Coordination with the Town of Needham to support additional funding for a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site into a shared use path that would connect to Needham Heights to the south.

1.7 Regulatory Compliance

Table 1-2 lists the permits and approvals from federal, state, and local governmental agencies, that are anticipated to be required by the Project. It is possible that only some of the permits and approvals identified below will be required, and also that there are other permits and approvals which will be identified in the course of approval of the Project. The Project will not require any extraordinary relief, e.g., variances. Needham requires site plan approval for any project creating more than 10,000 SF of new gross floor area. The requested special permits for dimensional relief are expressly contemplated and allowed in the recently-adopted rezoning of the Project Site and adjacent properties.

Table 1-2 Anticipated Project Permits and Approvals

Agency	Permit/Approval
Town of Needham	
Needham Planning Board	Special permit Site Plan Approval
Design Review Board	Sign Permit (if necessary)
Commonwealth of Massachusetts	
Executive Office of Energy and Environmental Affairs	Massachusetts Environmental Policy Act (MEPA) Review
Massachusetts Department of Environmental Protection/ Environmental Protection Agency	NPDES General Permit
Massachusetts Department of Transportation	Indirect access permit Permit to modify highway layout
Federal	
Federal Aviation Administration	Notice of Proposed Construction/Alteration



Source: VHB, USGS (2021)

Figure 1.1

Project Site Location

Highland Science Center
Needham, Massachusetts

Source: VHB, World Topo Map, Bing aerial

Figure 1.2

Site Context

Highland Science Center
Needham, Massachusetts

Source: VHB, Bing aerial

Figure 1.3

Existing Conditions

Highland Science Center
Needham, Massachusetts

Source: Google Earth

Figure 1.4a

Figure Title: Aerial Site Photo - Prior to Demolition

Highland Science Center
Needham, Massachusetts

Source: Bulfinch

Figure 1.4b

Figure Title: Aerial Site Photo - After Demolition

Highland Science Center
Needham, Massachusetts

Source:

pfa Landscape Architects · Planners
Civil Engineers · Wetland Scientists
PAUL FINGER ASSOCIATES

Figure 1.5

Figure Title: Proposed Site Plan

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6a

Figure Title: Proposed Highland Ave. Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6b

Figure Title: Proposed Gould St. Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6c

Figure Title: Proposed Highway Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6d

Figure Title: Proposed Entry Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6e

Figure Title: Proposed Highland-Gould Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6a

Figure Title: Proposed Highland Ave. Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6b

Figure Title: Proposed Gould St. Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6c

Figure Title: Proposed Highway Rendering

Highland Science Center
Needham, Massachusetts

Source:

Stantec

Figure 1.6d

Figure Title: Proposed Entry Rendering

Highland Science Center
Needham, Massachusetts

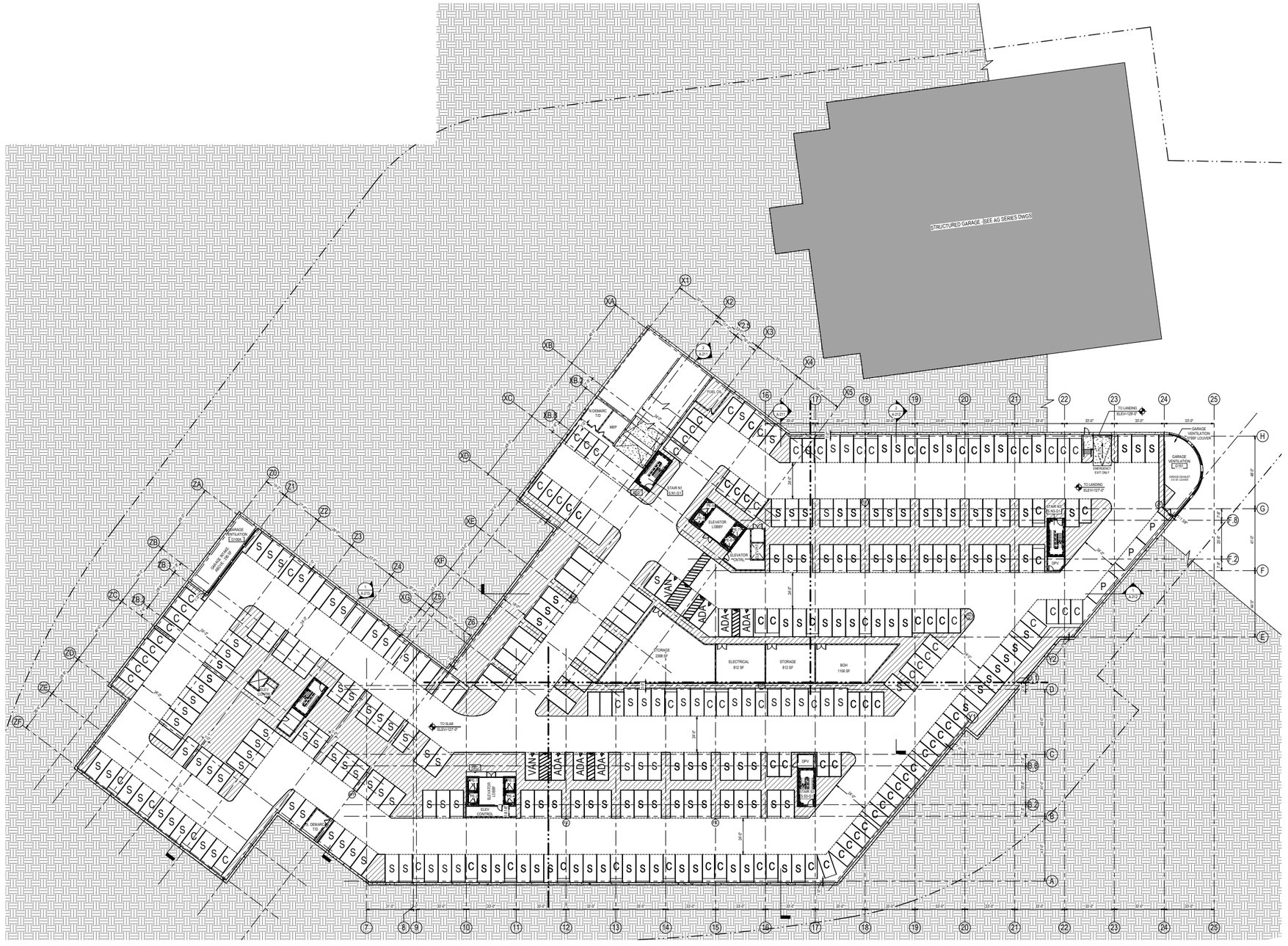
Source:

Stantec

Figure 1.6e

Figure Title: Proposed Highland-Gould Rendering

Highland Science Center
Needham, Massachusetts



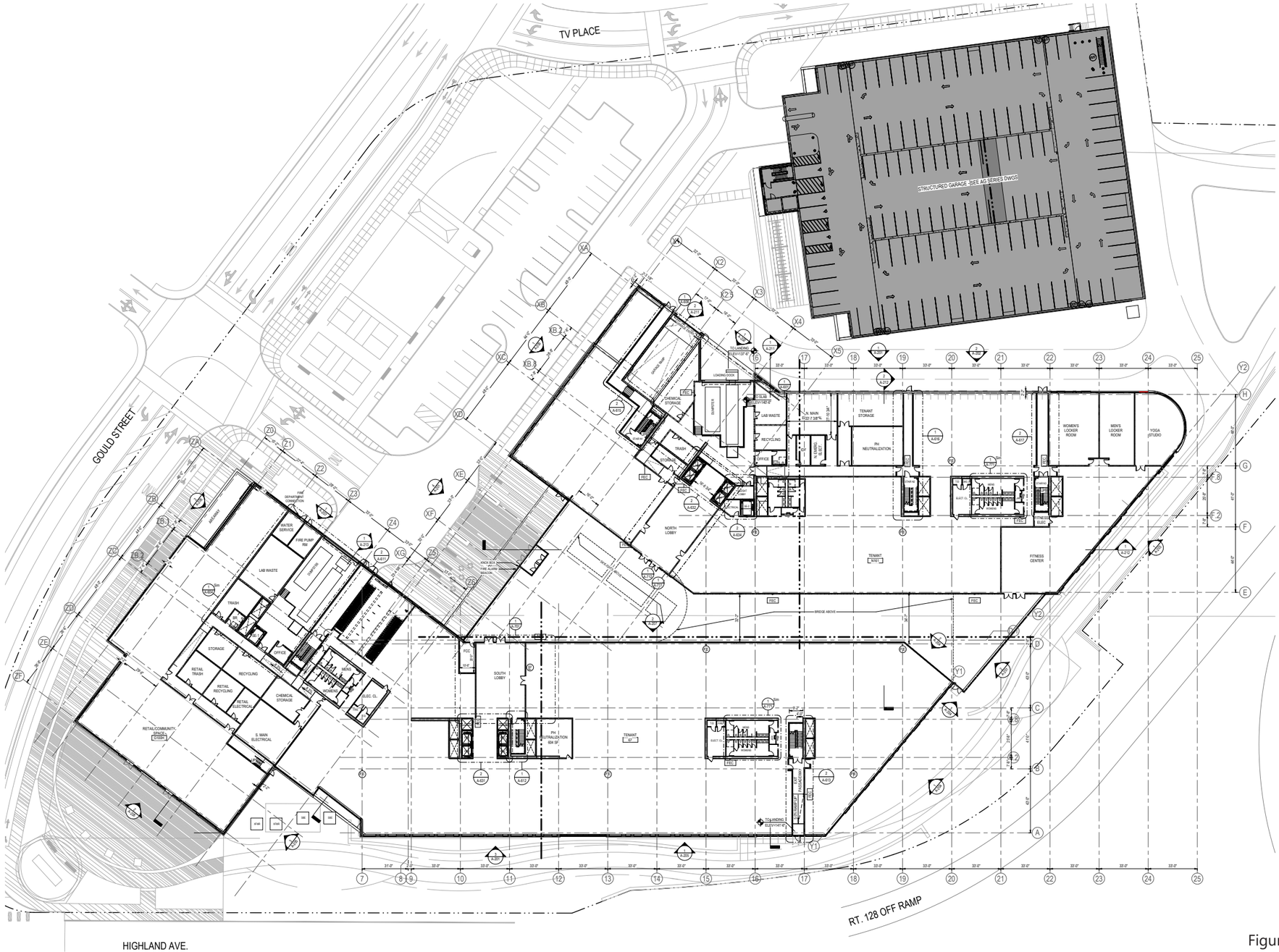
Source:

Stantec

Figure 1.7a

Figure Title: Proposed Garage Plan

Highland Science Center
Needham, Massachusetts



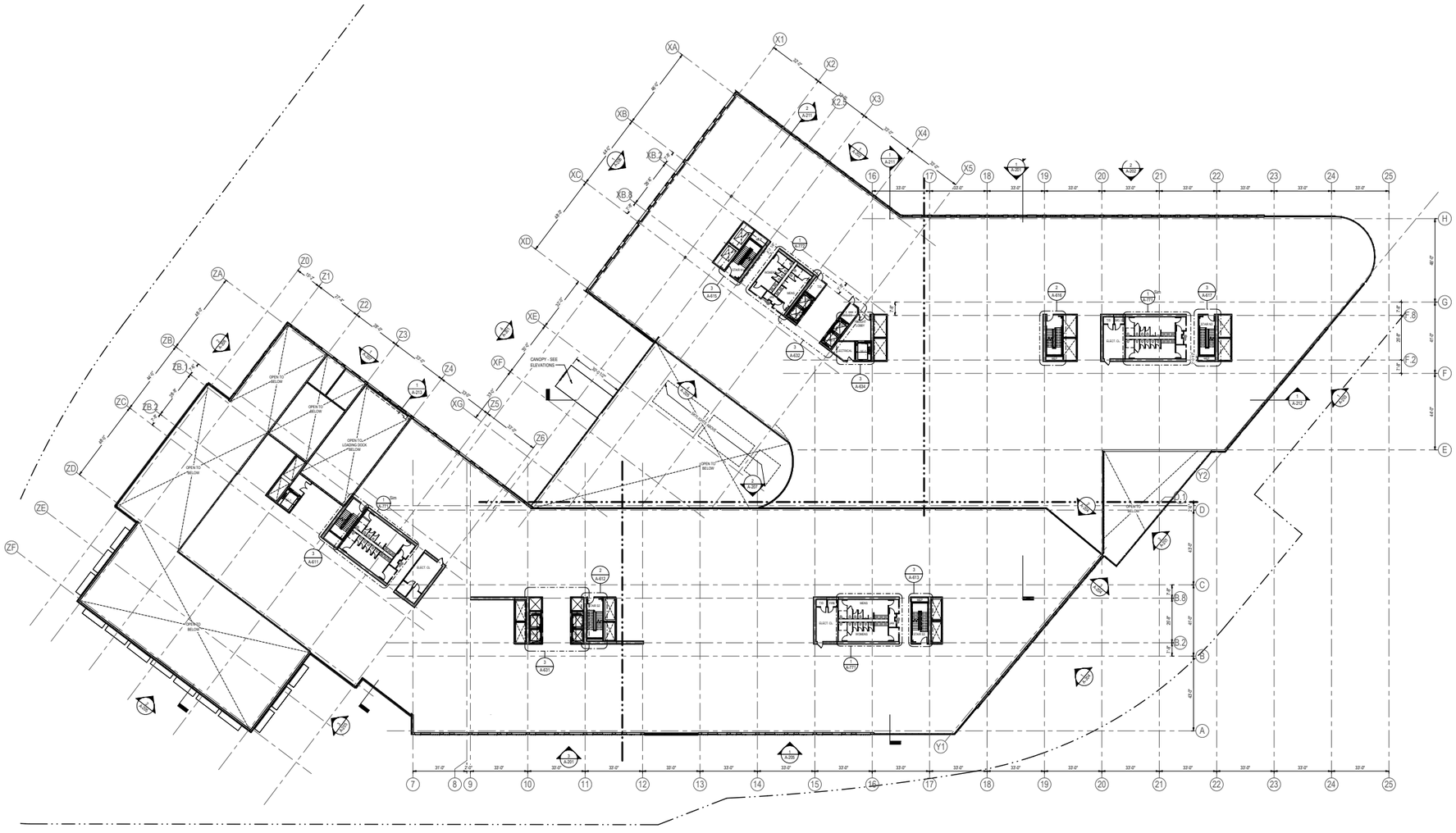
Source:

Stantec

Figure 1.7b

Figure Title: Proposed Ground Floor Plan

Highland Science Center
Needham, Massachusetts



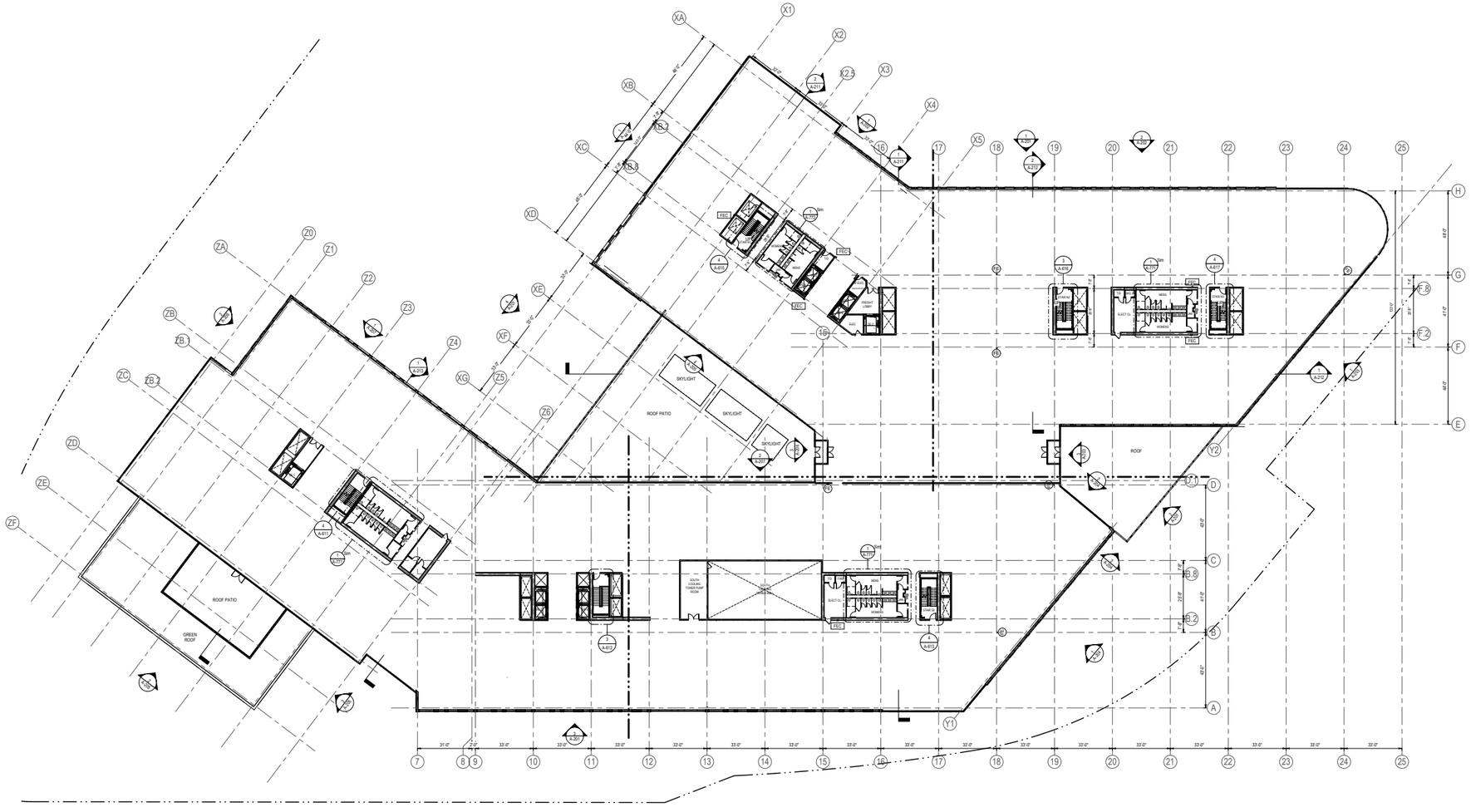
Source:

Stantec

Figure 1.7c

Figure Title: Proposed Second Floor Plan

Highland Science Center
Needham, Massachusetts



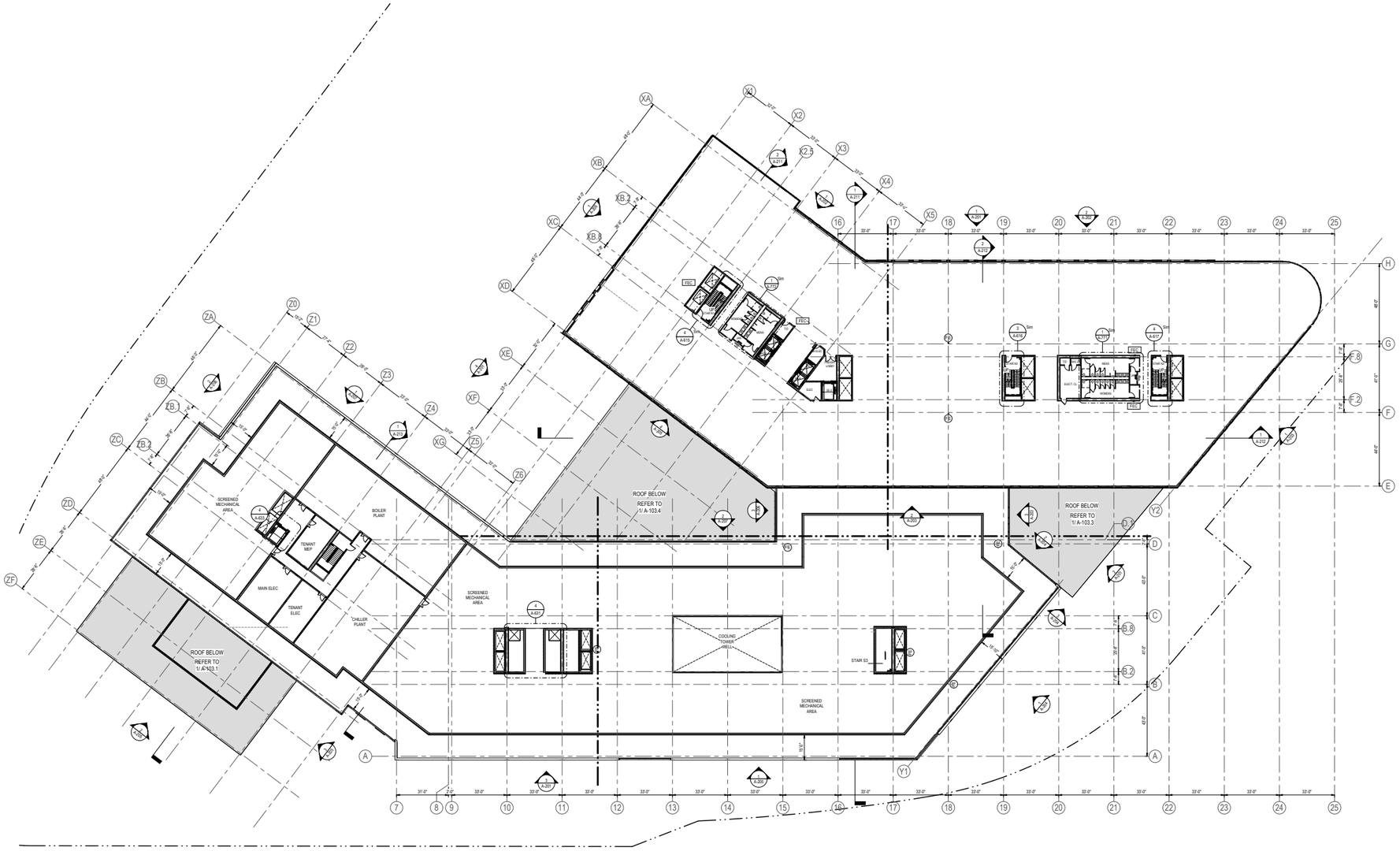
Source:

Stantec

Figure 1.7d

Figure Title: Proposed Third Floor Plan

Highland Science Center
Needham, Massachusetts



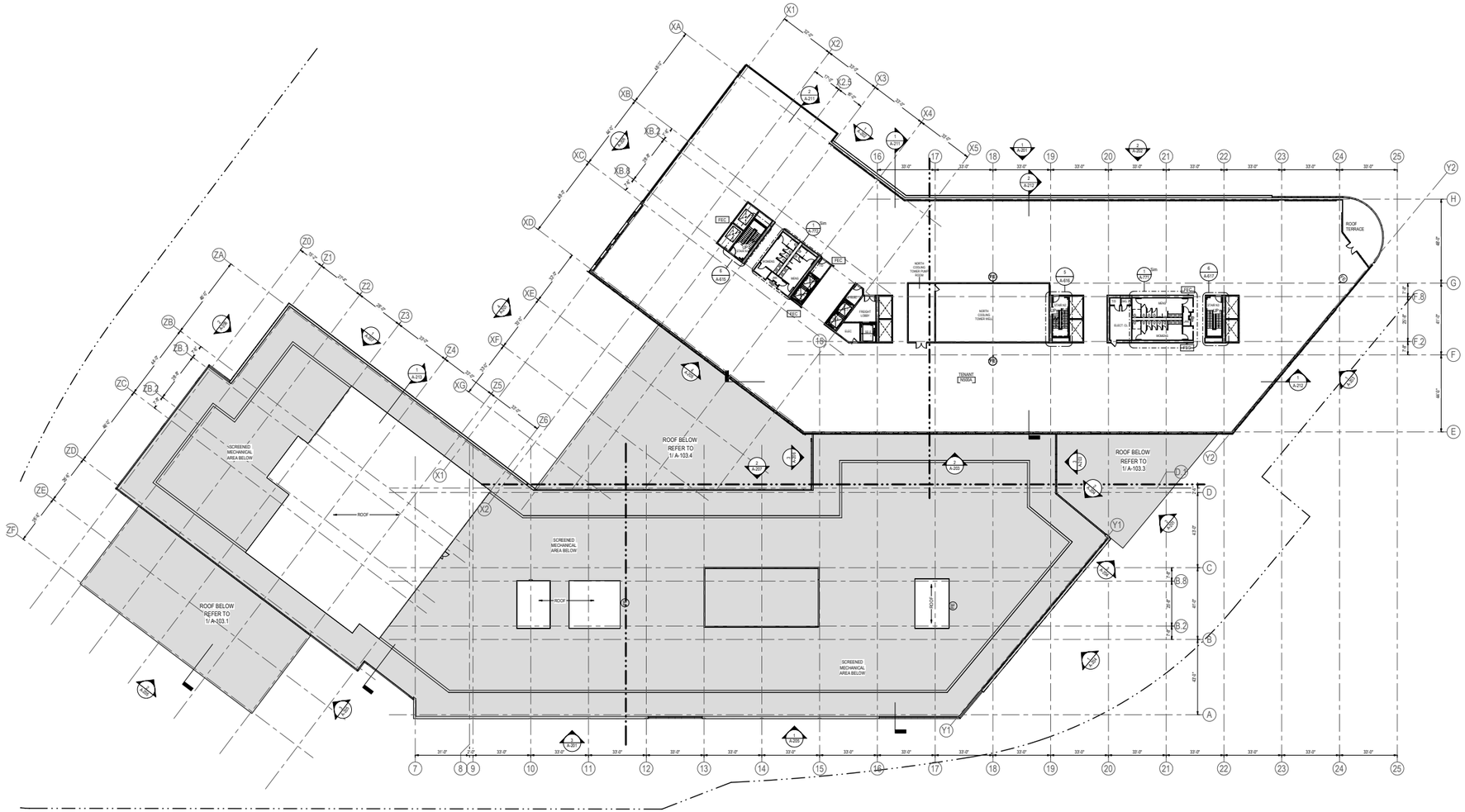
Source:

Stantec

Figure 1.7e

Figure Title: Proposed Fourth Floor Plan

Highland Science Center
Needham, Massachusetts



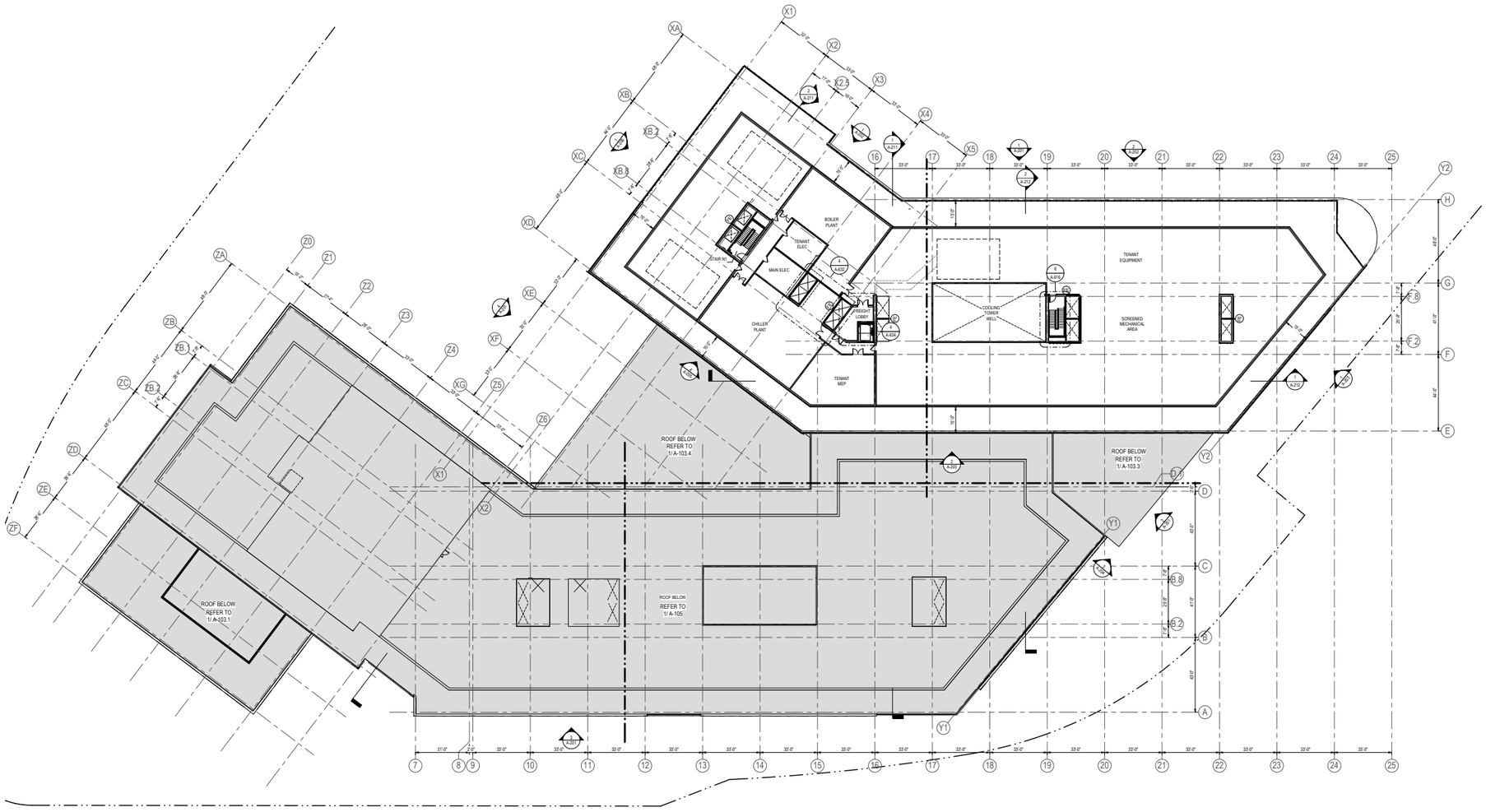
Source:

Stantec

Figure 1.7f

Figure Title: Proposed Fifth Floor Plan

Highland Science Center
Needham, Massachusetts



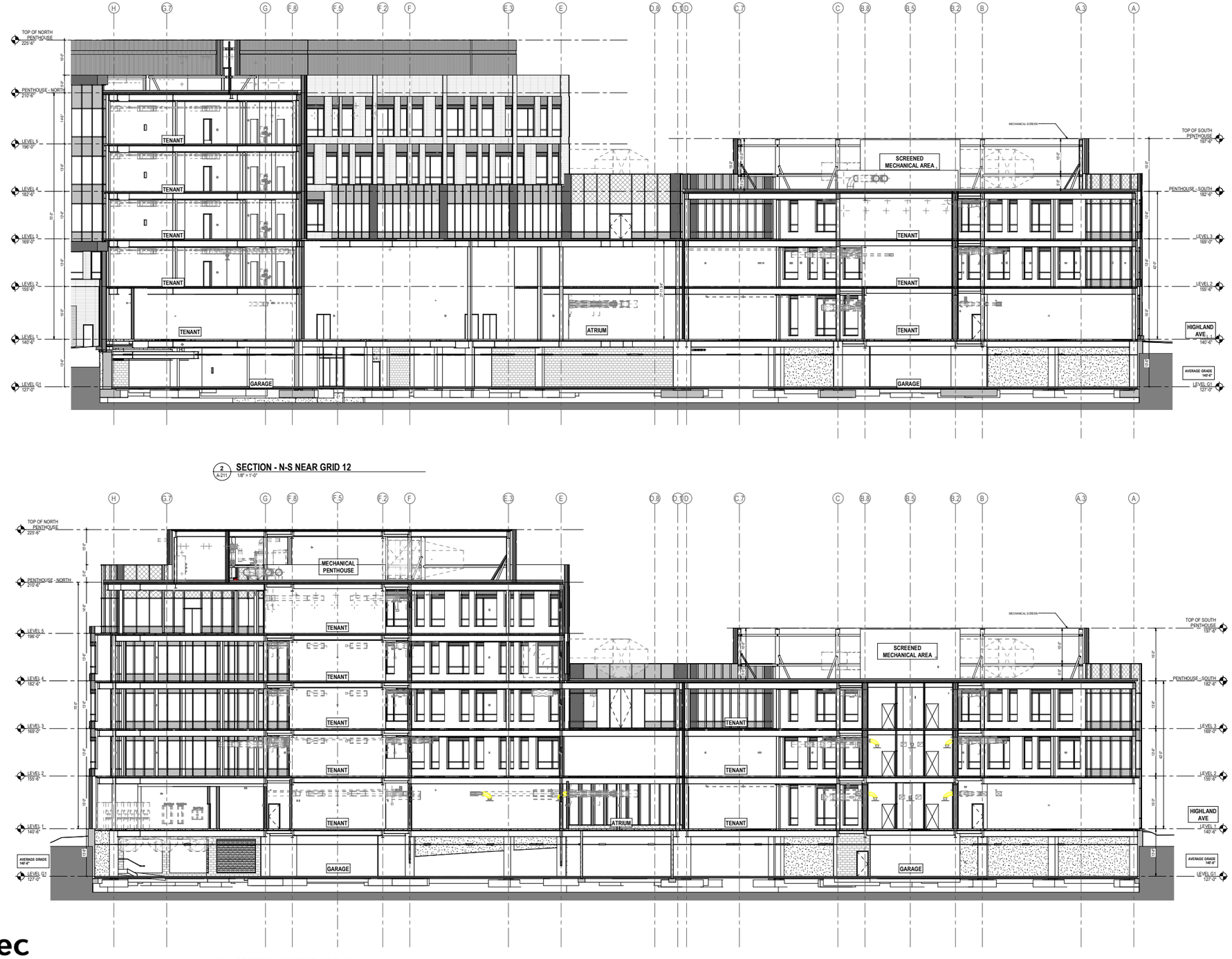
Source:

Stantec

Figure 1.7g

Figure Title: Proposed Roof/Penthouse Plan

Highland Science Center
Needham, Massachusetts



2 A-211 SECTION - N-S NEAR GRID 12
1/8" = 1'-0"

1 A-211 SECTION - N-S NEAR GRID 16
1/8" = 1'-0"

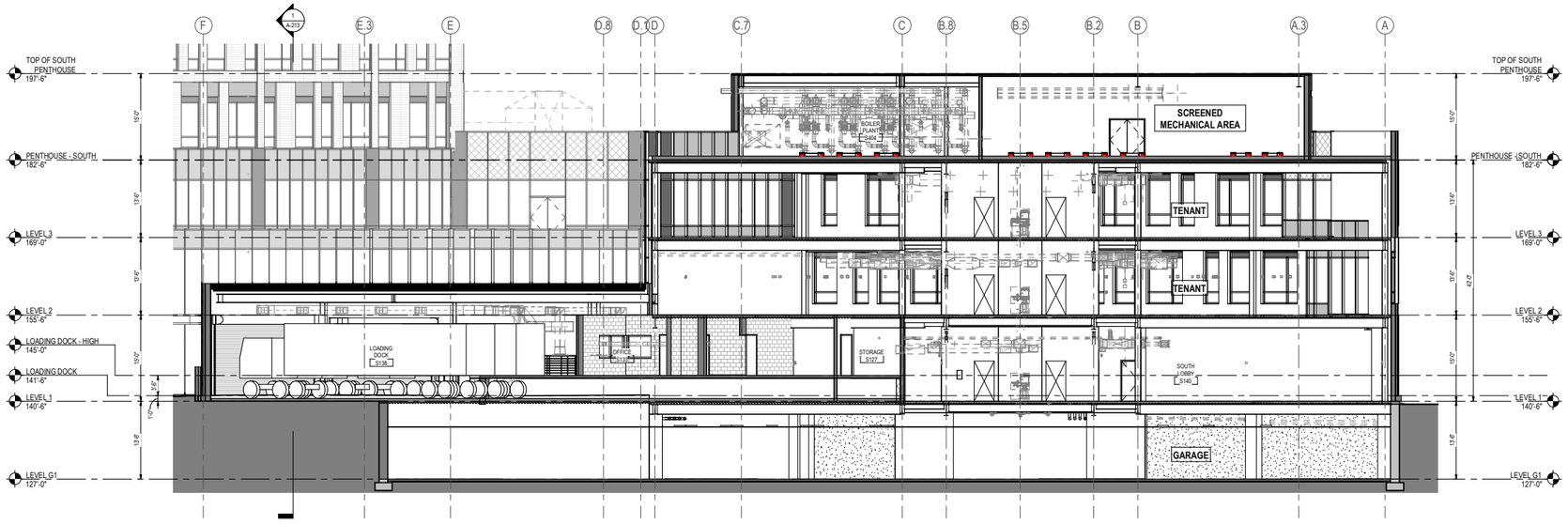
Source:

Stantec

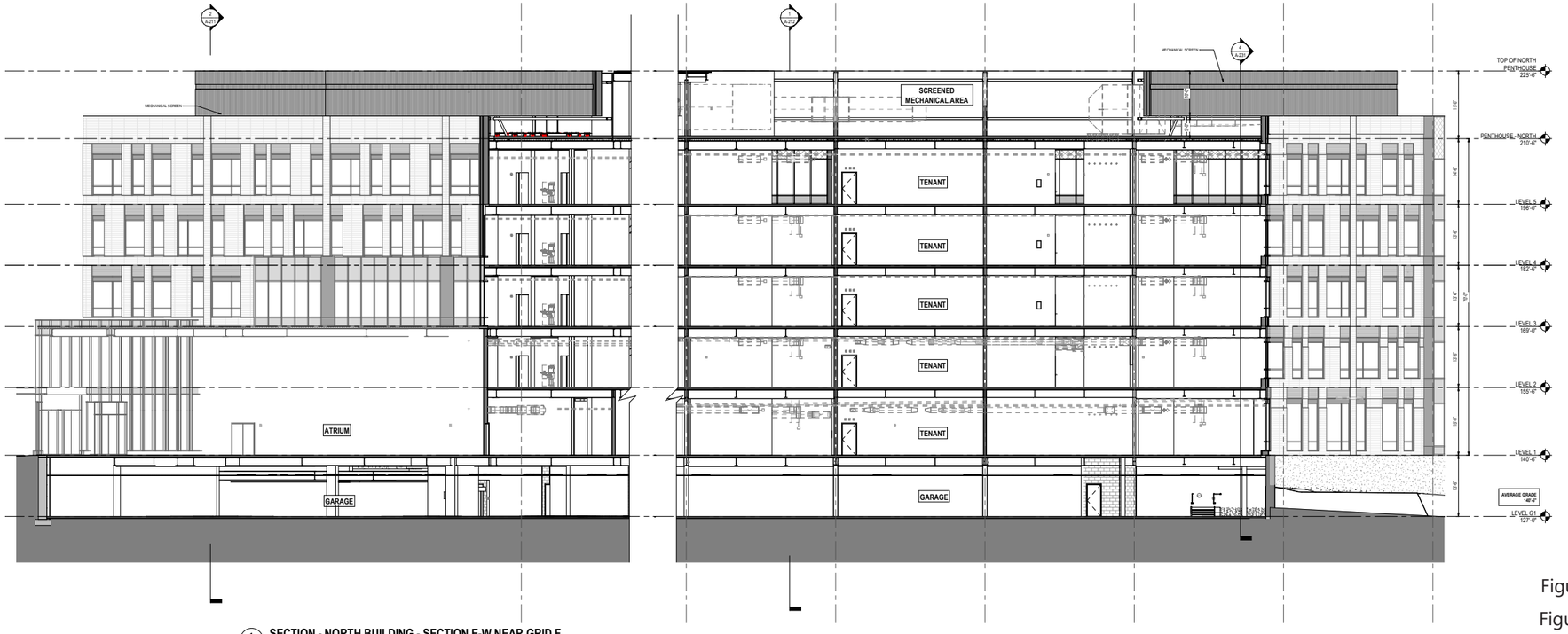
Figure 1.8a

Figure Title: Proposed Building Sections

Highland Science Center
Needham, Massachusetts



1 A-213 **SECTION - SOUTH BUILDING - SECTION N-S NEAR GRID 5**
1/8" = 1'-0"



1 A-213 **SECTION - NORTH BUILDING - SECTION E-W NEAR GRID F**
1/8" = 1'-0"

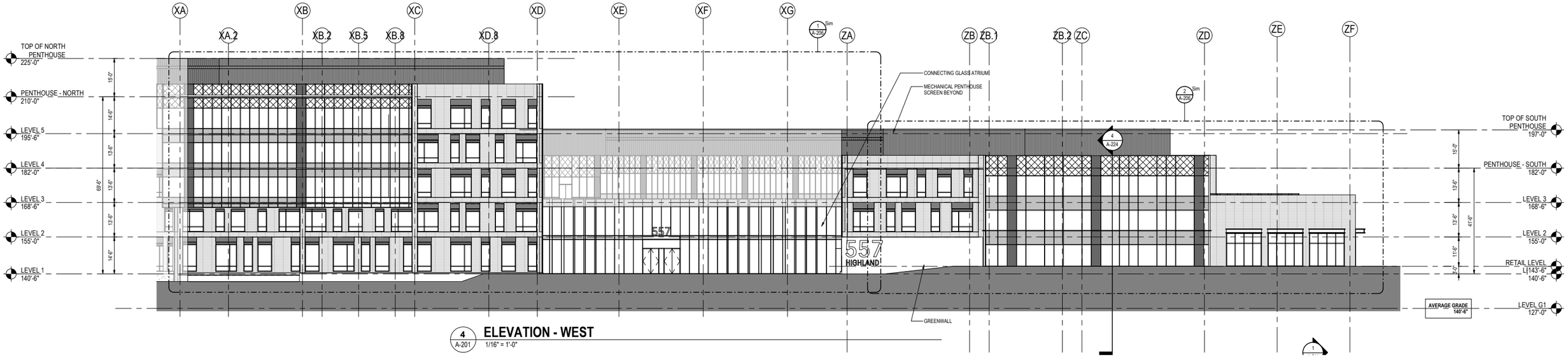
Source:

Stantec

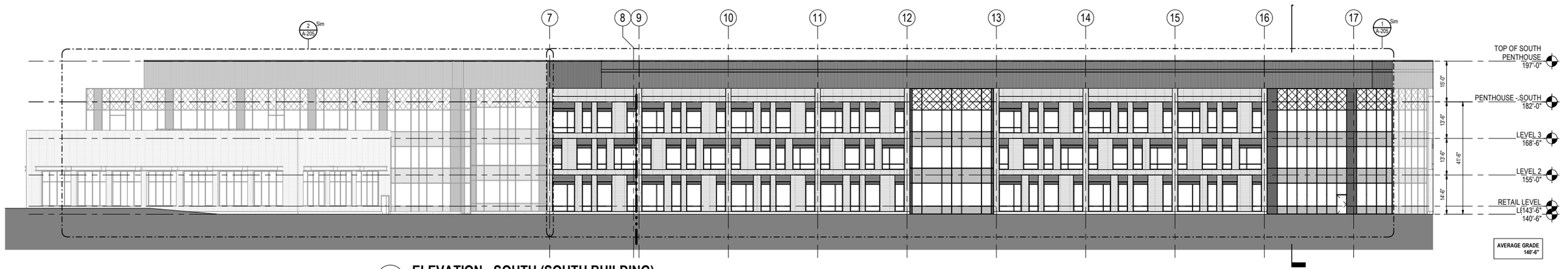
Figure 1.8b

Figure Title: Proposed Building Sections

Highland Science Center
Needham, Massachusetts



4 A-201 **ELEVATION - WEST**
1/16" = 1'-0"



3 A-201 **ELEVATION - SOUTH (SOUTH BUILDING)**
1/16" = 1'-0"

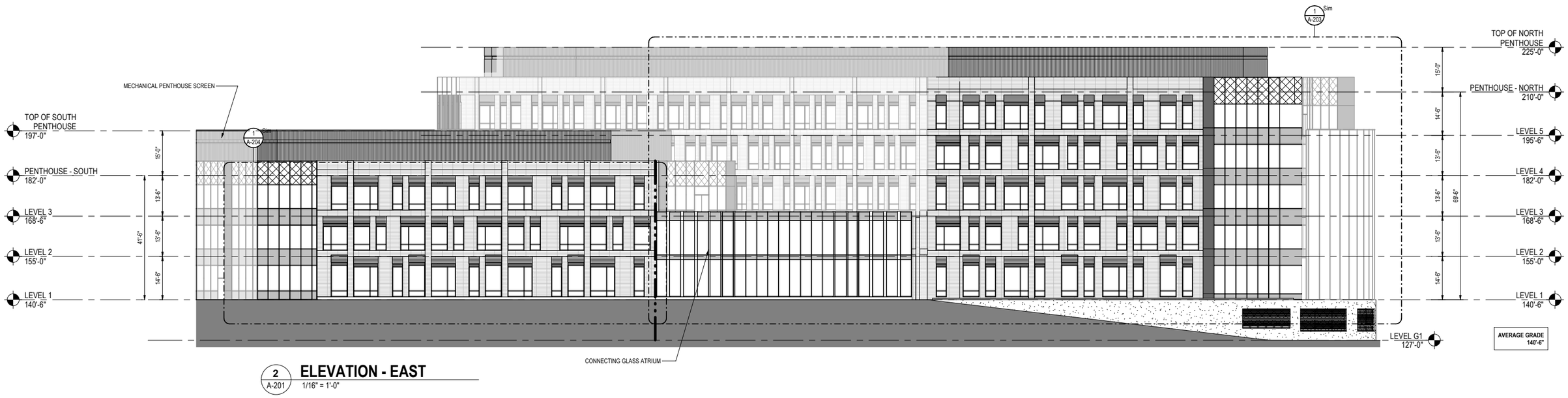
Source:

Stantec

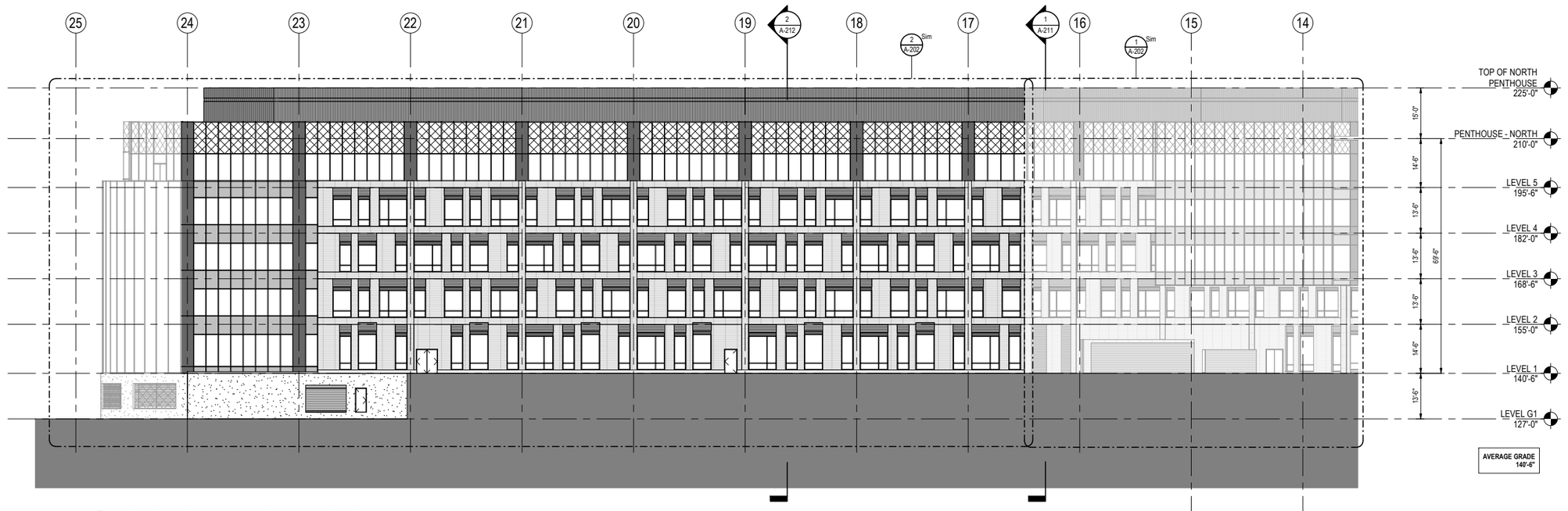
Figure 1.9a

Figure Title: Proposed Building Elevations

Highland Science Center
Needham, Massachusetts



2 A-201 **ELEVATION - EAST**
1/16" = 1'-0"



1 A-201 **ELEVATION - NORTH (NORTH BUILDING)**
1/16" = 1'-0"

Source:

Stantec

Figure 1.9b

Figure Title: Proposed Building Elevations

Highland Science Center
Needham, Massachusetts

2

Alternatives Analysis

This section provides a description and evaluation of project alternatives that were considered in the site design process to work toward the project goals and intentions of the Proponent.

2.1 Project Alternatives

Table 2-1 below compares the project alternatives. No alternative additional land uses have been or are being considered due to the Proponent's development objectives.

Table 2-1 Project Alternatives

	No-Build Alternative	As-of-Right Build Alternative	Residential Build Alternative	Preferred Alternative
Lab/Research & Development	-0-	242,359 GSF	-0-	260,500 GSF
Office	39,750 GSF[1]	161,573 GSF	-0-	260,500 GSF
Retail	-0-	-0-	-0-	10,000 SF
Residential	-0-	-0-	404,000 GSF (167 units)	-0-
Total	**39,750 GSF**	**403,933 GSF**	**404,000 GSF**	**531,000 GSF**

Note: All building areas are provided in Gross Square Feet (GSF), as defined in the applicable zoning codes.
SF Square Feet
1 Represents the two former automobile dealership and car wash buildings.

2.2 No-Build Alternative

The No-Build Alternative would maintain the existing conditions at the Project Site, leaving in place extensive paving and the remnants of the two former, two-story car dealership buildings and the car wash that occupied in total approximately 39,750 SF. Although the No-Build Alternative would not result in any new impacts, the existing uses are dated, and do not provide space for the growing demand for laboratory and research and development uses within Greater Boston's life science cluster. Further, the existing site conditions consist of an entirely impervious surface parking lot from which untreated stormwater sheet flows offsite. The No-Build Alternative would also eliminate the Proponent's ability to provide the inherent benefits including increased tax revenue and creation of new jobs.

The No-Build Alternative is not considered a viable option for the Project Site. However, it will be used to establish the existing and future No-Build "baseline" conditions for the technical analyses presented herein.

2.3 As-of-Right Build

The As-of-Right Build Alternative that was initially considered would construct up to approximately 403,933 SF of office/laboratory/research and development uses in one building, and approximately 1,346 structured above-grade parking spaces. The As-of-Right Build Alternative was ultimately not chosen due to its inability to meet the Proponent's desired development program. This alternative proposed a building of greater height and that would have exceeded the Town of Needham's height restrictions for the Site. Further constraints of this alternative on the site include the recently adopted zoning limitations on the massing and placement of the parking garage.

2.4 Residential Build

The Residential Build Alternative was initially considered to construct up to 167 dwelling units, along with 251 parking spaces. The Residential Build alternative was not chosen because it was not economically viable, given the cost for acquisition of the land and abatement/removal of hazardous materials associated with the former automobile service/repair facilities, car wash, and other commercial operations dating back to the 1940s. This alternative also would not generate anywhere near the tax revenue that the Town of Needham anticipated when it created the Highway Commercial 1 Zoning District encompassing the Project Site. Based on the total building inclusive of the land and parking garage, real estate taxes would expect to be in excess of $5 million annually. Needham amended its Zoning By-Laws in 2016 to create a Mixed-Use Overlay District, to encourage multifamily residential development elsewhere, by itself or in combination with retail and office uses. This overlay district covers, the Mixed-Use 128 Zoning District and the northern portion of the Highland Commercial – 128 District. The land costs in the Mixed-Use Overlay District are significantly less than the costs for land in the Highway Commercial 1 District, which immediately abuts Route I-95/Route 128. In May 2021, Needham approved the zoning amendment which created the Highway Commercial 1 District encompassing the Project Site. This amendment allows, by Special Permit, the construction of residential buildings.

2.5 Preferred Alternative

The Preferred Alternative, or the Project, as described in the Section 1.2, includes approximately 521,000 SF of office/lab uses set in two buildings with approximately 10,000 SF of retail uses, and up to approximately 1,770 structured parking spaces. Real estate taxes would expect to be in excess of $5 million. The current real estate taxes are $270,000; the Preferred Alternative would result in an approximately 11-fold increase of annual real estate taxes. The redevelopment of the Project Site will create the opportunity to develop state-of-the-art components with desirable floor-plate layouts that will attract new tenants that will further strengthen Greater Boston's robust life-science cluster.

2.6 Impact Comparison Table

Table 2-2 Quantitative Analysis of Impacts from Project Alternatives

Impact Category	No-Build Alternative	As-of-Right Build Alternative	Residential Build Alternative	Preferred Alternative
Land (VHB/Civil)				
New Land Alteration	0	0	0	0 SF
New Impervious Area	0	(3.4) Ac	(3.2) Ac	(1.8) Ac
Tree Clearing	0	0	0	0
Water and Wastewater (VHB/Civil)				
Water Use	25,358 GPD	113,000 GPD	98,736 GPD	129,172 GPD
Wastewater Generation	23,053 GPD	44,231 GPD	89,760 GPD	54,554 GPD
Transportation and Parking (VHB/Transportation)				
New Daily Vehicle Trips (Unadjusted)	520	4,360	752	6,050
New Daily Vehicle Trips (Adjusted) [a]	-367	3,473	-135	5,005
New Parking [b]	-399	814	-281	1,238

Ac = acres
GPD = gallons per day
adt = average daily trips
a Previous land uses of car wash and car dealership observed to generate approximately 887 daily trips (based on counts conducted by VHB in July 2021).
b Existing Site contains 532 parking spaces, of which up to 100 were used by employees and customers and the rest were used to support new and used car inventory.

2.7 Public Space Alternatives

Multiple design iterations for the Project Site's public areas have been considered and presented for feedback at the recent community meetings and to the Planning Board. The design along Gould Street was initially planned as an open lawn area which could be used as a park by nearby residents. The Project Team then reviewed options for providing one or more pickleball courts, community gardens and pavilions of multiple sizes, and considered the reduction of surface parking areas to accommodate these at the Project. The latter reduces the impervious parking area on the Project, but the pickleball and pavilion areas will remain impervious so that they can be converted into ice-skating in the winter. The surface parking lot has been reduced from 44 spaces to 30 spaces to provide additional room for the community open space along Gould Street. Many of the public hardscape areas of the Project Site will utilize permeable pavers or stabilized grass to continue to allow surface infiltration to the extent possible.

3

Environmental Justice and Public Health

This section provides an assessment of the Project's potential impacts on surrounding Environmental Justice (EJ) populations. Following MEPA's interim EJ guidelines, this assessment utilized a mapping tool developed by the Massachusetts Executive Office of Energy and Environmental Affairs ("EEA") and the Massachusetts Department of Public Health to identify EJ populations in proximity to the Project Site, including the demographics of such populations. In addition to discussing the potential impacts of the Project on the identified EJ populations, this assessment also considers off-site sources that could result in a cumulative negative environmental impact on the surrounding EJ populations.

3.1 Key Findings and Benefits

- The Project is not located within 1-mile of an Environmental Justice Community;
- There are no Vulnerable Health Criteria standards met at the Census Tract level in proximity to the Project Site;
- The Proponent distributed an updated Project Fact Sheet to CBOs translated in Chinese; and
- The Project will mitigate the impacts of heat island effect through reduced impervious surface.

3.2 Environmental Justice Populations

EEA defines EJ as "the equal protection and meaningful involvement of all people and communities" regarding environmental issues, including the equitable allocation of benefits and burdens. The EJ Policy builds upon Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which "directs federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law."

In accordance with the EJ Policy, the Proponent consulted the EEA Massachusetts 2020 Environmental Justice Populations Map to identify potential EJ populations, as defined under the EJ Policy, that are within a 1- or 5-mile radius of the Project Site. Figure 3.1 presents the 1- and 5-mile radii of the Project Site, as shown on the EJ Population Map.

The EJ Population Map is derived from the 2020 U.S. Census (for EJ block groups) and 2015 American Community Survey 5-Year Estimates (for English isolation criteria).

The MEPA regulations define EJ Populations as:

a. A neighborhood that meets one or more of the following criteria:

i. The annual median household income is not more than 65 per cent of the statewide annual median household income;

ii. Minorities comprise 40 percent or more of the population;

iii. 25 percent or more of households lack English language proficiency; or

iv. Minorities comprise 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income; or

b. A geographic portion of a neighborhood designated by the Secretary as an environmental justice population in accordance with law.

The Environmental Justice tool has been utilized and demonstrates that this Project is not within 1-mile of any EJ community. The Project will not exceed any air quality thresholds or cause impacts outside of the 1-mile radius. Refer to Figure 3.1 for a map of EJ Populations within a 1-mile and 5-mile radius.

Within five miles of the Project Site, the following EJ Populations are found:

Minority

- Block Group 5, Census Tract 4044, Norfolk County
- Block Group 6, Census Tract 1301, Suffolk County
- Block Group 1, Census Tract 4025, Norfolk County
- Block Group 1, Census Tract 4024, Norfolk County
- Block Group 4, Census Tract 4021.02, Norfolk County
- Block Group 2, Census Tract 1304.06, Suffolk County
- Block Group 3, Census Tract 1304.04, Suffolk County
- Block Group 1, Census Tract 1304.04, Suffolk County
- Block Group 5, Census Tract 1304.02, Suffolk County
- Block Group 4, Census Tract 1303, Suffolk County
- Block Group 2, Census Tract 1105.01, Suffolk County
- Block Group 6, Census Tract 1301, Suffolk County
- Block Group 1, Census Tract 1106.07, Suffolk County
- Block Group 2, Census Tract 1106.01, Suffolk County
- Block Group 3, Census Tract 1105.02, Suffolk County
- Block Group 1, Census Tract 1301, Suffolk County
- Block Group 2, Census Tract 1301, Suffolk County
- Block Group 3, Census Tract 4012, Norfolk County
- Block Group 4, Census Tract 4012, Norfolk County
- Block Group 2, Census Tract 4012, Norfolk County

- Block Group 1, Census Tract 4012, Norfolk County
- Block Group 1, Census Tract 4011, Norfolk County
- Block Group 3, Census Tract 4006, Norfolk County
- Block Group 2, Census Tract 4011, Norfolk County
- Block Group 2, Census Tract 3738, Middlesex County
- Block Group 1, Census Tract 3740, Middlesex County
- Block Group 2, Census Tract 4006, Norfolk County
- Block Group 2, Census Tract 4.02, Suffolk County
- Block Group 3, Census Tract 4.02, Suffolk County
- Block Group 2, Census Tract 2.02, Suffolk County
- Block Group 1, Census Tract 5.03, Suffolk County
- Block Group 2, Census Tract 3.02, Suffolk County
- Block Group 2, Census Tract 2.02, Suffolk County
- Block Group 1, Census Tract 3.02, Suffolk County
- Block Group 2, Census Tract 2.01, Suffolk County
- Block Group 4, Census Tract 2.01, Suffolk County
- Block Group 4, Census Tract 3.01, Suffolk County
- Block Group 3, Census Tract 3.01, Suffolk County
- Block Group 2, Census Tract 3731, Middlesex County
- Block Group 1, Census Tract 3.01, Suffolk County
- Block Group 1, Census Tract 3731, Middlesex County
- Block Group 5, Census Tract 3731, Middlesex County
- Block Group 4, Census Tract 3704, Middlesex County
- Block Group 4, Census Tract 3701.02, Middlesex County
- Block Group 1, Census Tract 3701.02, Middlesex County
- Block Group 3, Census Tract 3746, Middlesex County
- Block Group 2, Census Tract 3686, Middlesex County
- Block Group 5, Census Tract 3686, Middlesex County
- Block Group 1, Census Tract 3686, Middlesex County
- Block Group 1, Census Tract 3687, Middlesex County
- Block Group 1, Census Tract 3685, Middlesex County
- Block Group 3, Census Tract 3685, Middlesex County
- Block Group 2, Census Tract 3684, Middlesex County
- Block Group 3, Census Tract 3684, Middlesex County
- Block Group 2, Census Tract 4041, Norfolk County

Income

- Block Group 2, Census Tract 1304.02, Suffolk County

Minority and Income

- Block Group 2, Census Tract 3687, Middlesex County
- Block Group 1, Census Tract 3684, Middlesex County
- Block Group 3, Census Tract 3686, Middlesex County
- Block Group 1, Census Tract 1401.06, Suffolk County

Minority and English Isolation

- Block Group 3, Census Tract 1304.06, Suffolk County

Minority, Income, and English Isolation

- Block Group 4, Census Tract 4.01, Suffolk County
- Block Group 2, Census Tract 5.04, Suffolk County
- Block Group 2, Census Tract 1401.06, Suffolk County

3.3 Opportunities for Limited English Proficient Populations

During the ENF filing stage, the Proponent found that Chinese is spoken within a one-mile radius of the Project Site, and translated the Public Notice into Chinese. The Proponent will prepare, translate into Chinese, and distribute an updated Project Fact Sheet that will contain a summary of the Project, along with details on how to contact the Proponent and submit comments to the MEPA Office.

3.3.1 Public Involvement Plan

The Proponent is continuing community outreach as the Project progresses. To supplement the outreach already conducted, the Proponent has and will continue to use various resources to conduct a meaningful information campaign. On July 14th, 2022, the Proponent circulated a Project Fact Sheet to Community Based Organizations, providing Project details and information on how to provide comments as well as Proponent contact information.

3.4 Public Health

The Proponent utilized the Department of Public Health Tool and the U.S. EPA's "EJ Screen" [1] to shed light on the extent to which the area's EJ populations may already experience public health burdens that may result from environmental pollution.[2] This information was considered along with Project information to assess the Project's potential impact on public health.

1 United States Environmental Protection Agency. 2022 version. EJScreen. Retrieved: 06/02/22 from https://ejscreen.epa.gov/mapper/

2 EJScreen was developed by EPA to highlight places that may be candidates for further review, analysis, or outreach to support the agency's environmental justice work. The EPA notes that the environmental indicators are only screening-level proxies for actual exposures or health risks, and that screening-level results do not, by themselves, determine the existence or absence of environmental justice concerns in a given location; do not provide a risk assessment; and have other significant limitations. EJ Screen is not designed to take into account quantifiable cumulative or synergistic effects. https://www.epa.gov/ejscreen/purposes-and-uses-ejscreen Accessed 05/28/22.

3.4.1 Environmental Impacts

Climate

As indicated in the Resilience Massachusetts Action Team (RMAT) Report, included in Appendix B, the primary climate change impacts on the nearby EJ populations are related to urban flooding and extreme heat. The Project has been designed to mitigate these impacts. The Project's stormwater management systems will not exacerbate the risk of urban flooding, and in fact will dramatically improve existing conditions. Stormwater runoff from the Project will comply with requirements for redevelopment activities as set forth in the Massachusetts Stormwater Handbook. While the impacts of climate change tend to affect EJ populations more severely than non-EJ populations, the Project does not exacerbate such impacts.

The Project is being designed to help mitigate the impacts of climate change. A combination of vegetation and high-albedo paving and roofing surfaces will be used to prevent the Project from increasing the Project Site's contribution to the heat island effect.

Transportation

As discussed in the ENF, the Project is expected to generate approximately 5,005 net new average daily trips during the weekday. Of these trips, approximately 583 are expected during the morning peak hour, and 565 during the evening peak hour.

A sidewalk is currently provided along Highland Avenue for pedestrian and bicycle use, and the Project includes improvements to the sidewalk adjacent to the Project Site and along the west side of Gould Street from Highland Avenue north to Noanett Road.

To mitigate traffic-related impacts (and associated mobile source GHG emissions), the Project will implement the measures listed in Chapter 9, *Mitigation and Draft Section 61 Findings*. The Project is not anticipated to generate a significant number of diesel truck trips during daily operations.

Infrastructure

The Project will include several measures to reduce the threat of urban flooding from extreme precipitation. The Proponent is reviewing the proposed stormwater management system's ability to handle larger future storm events. The rainfall-runoff response of the Project Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, 25, and 100 years. The results of the analysis show that there is no increase in peak discharge rates between the existing and proposed conditions. The proposed improvements to the water and wastewater systems will be permitted and designed in conformance with Sewer Discharge Permit requirements, 360 C.M.R. 10.016 and State Plumbing Code. Sewer Use Discharge permit(s) for laboratory wastewater and/or industrial process wastewater will be obtained if and when leases are signed with tenants requiring those permits and all discharge will be in compliance with those regulations. For more information on wastewater, refer to Chapter 4, *Stormwater and Water/Wastewater*.

Construction Period Impacts

Impacts associated with the Project construction activities are typically related to truck traffic, air quality, noise, stormwater runoff, solid waste, and vibration. The Proponent will develop a detailed Construction Management Plan that will address and identify controls for impacts related to access and transportation, fugitive dust, anti-idling measures, noise, hazardous materials handling, and construction work hours.

3.4.2 Vulnerable Health EJ Criteria

Using the Department of Public Health EJ Tool, the Proponent analyzed the health criteria of census tracts and municipalities in proximity to the Project Site. There are no census tracts in proximity to the site that exhibit Vulnerable Health Criteria. The following municipalities are within a five-mile radius of the Project Site.

Health Criteria	Heart Attack	Low Birth Weight	Elevated Blood Lead Prevalence	Pediatric Asthma ED Visits
Town of Needham	Statistically significantly lower	Statistically significantly lower	Statistically significantly lower	Statistically significantly lower
Town of Newton	Statistically significantly lower	Not statistically significantly different	Statistically significantly lower	Statistically significantly lower
Town of Wellesley	Statistically significantly lower	Not statistically significantly different	Statistically significantly lower	Statistically significantly lower

3.4.3 DPH EJ Tool

The MA DPH EJ Tool indicates that the following facilities/ infrastructure are mapped in EJ communities within one mile of the Project Site. Please note the Project will not impact or exacerbate any of the identified hazards. Rather, the Project will remediate historic releases to the environment of oil and hazardous materials at the Project Site.

- MassDEP major air and waste facilities – 8
- M.G.L. c. 21E sites – 6
- "Tier II" toxics use reporting facilities – 9
- MassDEP sites with AULs – 3
- MassDEP groundwater discharge permits – 0
- Wastewater treatment plants – 0
- MassDEP public water suppliers – 0
- Underground storage tanks – 9
- EPA facilities – 0
- Road infrastructure – Mass Rt 128, I-95
- MBTA bus and rapid transit – Route 59 Webster St @ Hillside Ave, Webster St @ Elder St; Commuter Rail Needham Branch

- Other transportation infrastructure – N/A
- Regional transit agencies - MBTA
- Energy generation and supply – N/A

3.4.4 EPA EJ Screen

The Project team also consulted the U.S. EPA's "EJ Screen," which provides a percentile ranking by census block group, compared against statewide averages, for 12 environmental indicators. The Buffer Report generated by this tool (see Appendix B) indicates the following for the area within the Project Buffer Area:

1. 84th percentile for $PM_{2.5}$
2. 45th percentile for Ozone
3. 68th percentile for NATA Diesel PM
4. 99th percentile for NATA Cancer Risk (cancer risk from inhalation of air toxics)
5. 81st percentile for NATA Respiratory HI (air toxics respiratory hazard index)
6. 86th percentile for Traffic Proximity (count of vehicles per day at major roads divided by the distance)
7. 48th percentile for Lead Paint Indicator (percent of housing built before 1960)
8. 52nd percentile for Superfund Proximity (count of National Priorities List/Superfund sites divided by the distance)
9. 27th percentile for RMP Proximity (count of facilities with Risk Management Plans divided by the distance)
10. 75th percentile for Hazardous Waste Proximity (count of transfer, storage, and disposal facilities (TSDF) divided by the distance)
11. 85th percentile for Underground Storage Tanks (USTs)
12. 43rd percentile for Wastewater Discharge Indicator (toxicity-weighted concentration/meter)

For comparison, the City of Boston as a whole is at or above the 80th percentile for 8 out of these 12 environmental indicators. The following environmental indicators are above the 80th percentile of the statewide average for the Project Buffer Area,[3] signifying a potential existing environmental burden for the area's EJ populations.

1. **PM 2.5** – This indicator calculates the average concentration of fine inhalable particles in the air over a period of three years. The National Ambient Air Quality Standard (NAAQS) for PM 2.5 is 12 µg/m3. The value for this variable in the Project Buffer Area is below that

3 According to the EJ Screen Technical Documentation (September 2019, p. 27), a relatively high percentile means the value is relatively uncommon. However, a high percentile is not necessarily a real concern from a health or legal perspective. To understand the actual health or other implications of any screening results requires looking at the actual data and the indicator represents, and also looking at other relevant data if available. Besides the percentile, other important considerations in interpreting any screening results include the following: whether and to what extent the environmental data shows values above any relevant health-based or legal threshold; the significance of any such thresholds, or the magnitude and severity of the health or other impacts of the given environmental concern, nationally or locally; and the degree of any disparity between various groups, in exposures to the relevant environmental pollutants.

standard at 7.5 µg/m3. A high percentile is calculated because Boston is in an attainment area, and concentrations of PM 2.5 are lower than the national average in general.

Common sources of PM 2.5 emissions include power plants and industrial facilities. People with heart or lung disease, older adults, and children are considered at greater risk from particles than other people. Long-term exposure to particles is associated with reduced lung function and the development of chronic bronchitis, while short term exposure can aggravate lung disease, causing asthma attacks and acute bronchitis, and may also increase susceptibility to respiratory infections.

2. **NATA Cancer Risk** – This indicator represents the probability of contracting cancer over the course of a lifetime (70 years), assuming continuous exposure to point, nonpoint and mobile sources, biogenics, and fires. This indicator characterizes cancer risk based on estimates of inhalation exposure concentrations determined at the census tract level. This approach is used only to determine geographic patterns of risks within counties, and not to pinpoint specific risk values for each census tract. While the EPA is reasonably confident that the patterns (*i.e.,* relatively higher levels of risk within a county) represent actual differences in overall average population risks within the county, they are less confident that the assessment pinpoints the exact locations where higher risks exist, or that the assessment captures the highest risks in a county.

   The value for this indicator in the Project Buffer Area is 30, while the average in the USA is 29.

3. **NATA Respiratory HI** – This indicator is an estimate of chronic noncancer hazards for multiple air toxins. An HI value less than or equal to 1 indicates that the exposure is not likely to result in adverse noncancer effects. An HI value greater than 1, however, does not necessarily suggest a likelihood of adverse health effects and cannot be interpreted as a statistical probability of adverse effects occurring.

   The HI value for the Project Buffer Area is .3, therefore adverse noncancer effects are not likely.

4. **Traffic Proximity** – This indicator consists of a count of vehicles (AADT, avg. annual daily traffic) at major roads within 500 meters, divided by distance in meters as calculated from 2019 U.S. Department of Transportation traffic data. Proximity to roads can provide access to jobs, health care, food, recreational opportunities, and other benefits. However, proximity to motor vehicle traffic is associated with increased exposures to ambient noise, toxic gases and particulate matter including diesel particulates. Any indicator of residential proximity addresses exposures relevant to the residences within a block group and would not capture most exposures that occur away from the home, such as at work, at school or during a commute.

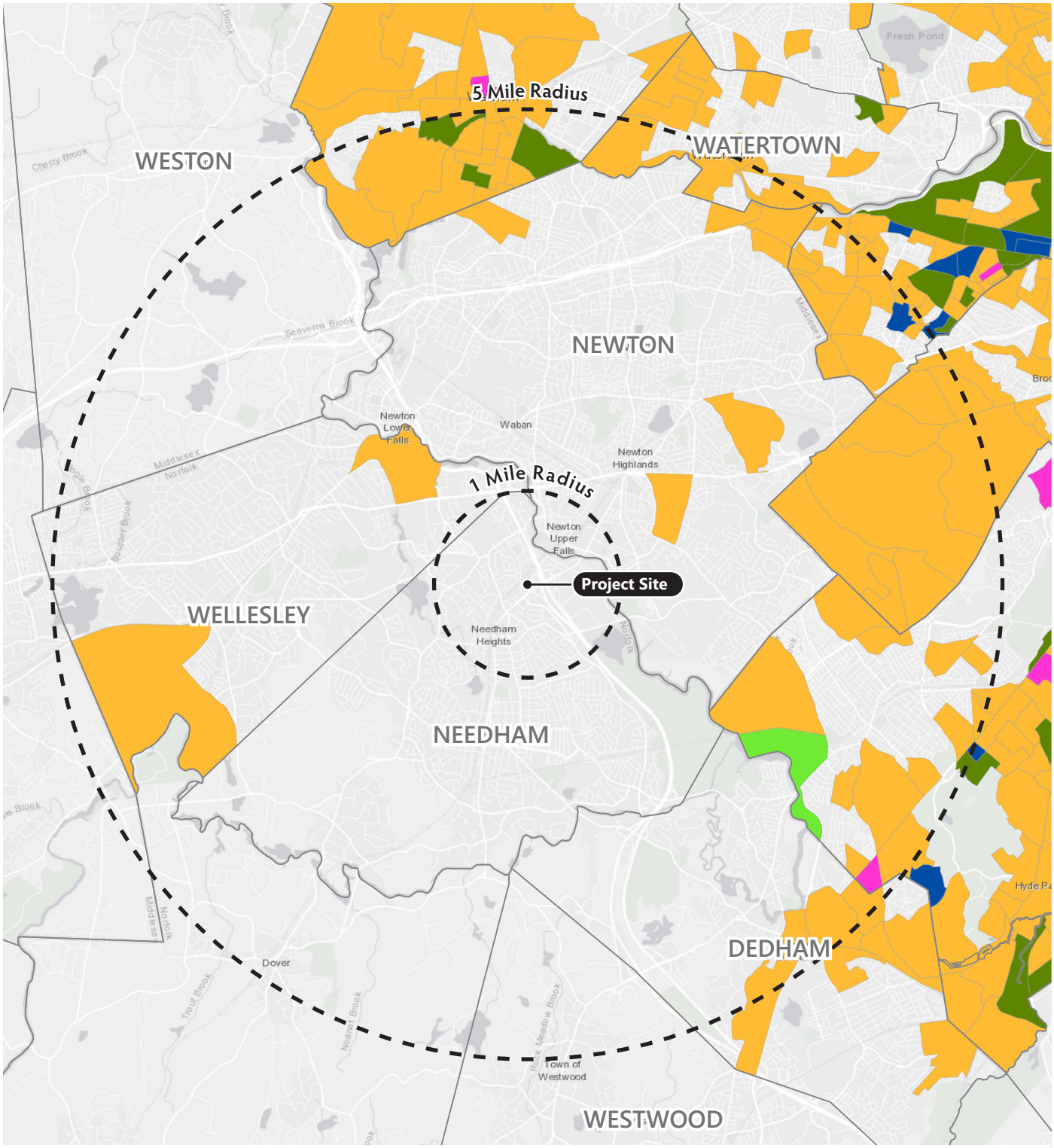
   The value for this indicator in the Project Buffer Area is 3700, while the state average is 2100, and the USA average is 710.

5. **USTs** – This indicator represents the density of Underground Storage Tanks within a geographic area. USTs can threaten public health if the fluids they hold leak out into the soil and groundwater.

   Due to the density of the Project Site's urban location, there are more proximate USTs (6.5/km2) than the state average (3.1/km2) . The Proponent has removed USTs from the Project Site associated with former uses.

3.4.5 Public Health Permits

No permits for the Project contain performance standards intended to protect public health.



, , Feet

Source: The Environmental Justice Map Viewer, an interactive map that uses population data from the 2 2 Census, based upon three demographic criteria developed by the states Executive Office off Energy and Environmental Affairs EEA, to show which Census Tract Bloc groups are classified as EJ populations .

- Income
- Minority
- Minority and Income
- Minority and English Isolation
- Minority, Income and English Isolation

Prepared By: VHB, Inc.

3.1 Environmental Justice Populations
Highland Science Center
Needham, Massachusetts

4

Stormwater and Water/Wastewater

This section describes the proposed improvements to the stormwater management system, including compliance with the appropriate permitting requirements, treatment and pollution control measures, and best management practices in connection with existing drainage infrastructure.

This section also addresses the projected water and wastewater demands, improvements to the existing systems, and compliance with regulations and efforts to eliminate infiltration and inflow.

4.1 Key Benefits and Findings

Key findings associated with stormwater management and water/wastewater include the following:

- The proposed improvements to the stormwater management system include no new untreated discharges or erosion to wetlands.
- The proposed improvements will result in attenuation of peak rates and treatment of stormwater recharge to meet water quality requirements.
- A surface detention basin will be included as part of the stormwater management system, ultimately meeting the requirements of the Town of Needham and Massachusetts Stormwater Management Standards.
- No stormwater discharges will mix with wastewater flows, eliminating wastewater infiltration and inflow on the site.
- The Project will utilize 129,172 gallons per day (GPD) of water and discharge 54,554 GPD.

4.2 Stormwater

4.2.1 Stormwater Permits and Compliance

The Project will comply with the Town of Needham Stormwater By-Law and Regulations that regulate stormwater treatment and water pollution control measures and maintain functional operation of stormwater management systems. The Project and associated improvements to the stormwater management system also will comply with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification

Regulations (314 CMR 9.00). This includes ensuring that there are no new untreated discharges or erosion to wetlands, attenuation of peak rates, stormwater recharge, treatment of impervious stormwater runoff to meet water quality requirements, considering land uses with higher potential pollutant loads, pollution prevention and erosion control requirements, an operation and maintenance plan (O&M), as well as prohibition of illicit discharges.

The topography and existing drainage conditions of the site generally grade East, with most of the site draining towards a swale located adjacent to the I-95/Route 128 off-ramp that eventually connects to the MassDOT drainage system. As these drainage patterns will be generally maintained, the Project also requires compliance with MassDOT Stormwater Management Standards and will require a MassDOT Access Permit.

Refer to Figure 4.1 for the Existing Drainage Conditions and to Figure 4.2 for the Proposed Drainage Conditions. The stormwater management report is attached in full in Appendix C.

4.2.2 Stormwater Management System

Low Impact Development (LID) techniques and Best Management Practices (BMPs) will be included into the proposed stormwater management system to meet the intended goals of the Town of Needham's stormwater regulations. These techniques include an approximate 1.8-Acre reduction of impervious area from the existing condition and a proposed surface detention basin to reduce peak runoff rates. In general, stormwater from the proposed paved surfaces will be collected in deep-sump and hooded catch basins and routed through a proprietary media filter unit. Stormwater from the proposed building and garage roof areas will be routed through proprietary hydrodynamic water quality units, to the surface basin, and then through a proprietary media filter unit. Treated stormwater will be discharged to the existing design point via a stone level spreader. Green infrastructure practices will be considered by the development team for incorporation into the landscape and building architecture design as feasible. Refer to Figure D.3 for a plan showing the approximate locations of BMPs proposed for the site.

For additional detail and calculations of the system, the full stormwater report is attached in Appendix C.

4.2.2.1 Water Quality and Discharge

The proposed improvements to the stormwater management system include new structures and drainage pipes, water quality units, media filters, and a surface detention basin.

Due to poor soil quality, infiltration rates are below the minimum requirement of MassDEP. However, the Project results in a net decrease in impervious coverage when compared to the existing conditions, eliminating the need for recharge, and significantly reducing peak runoff rates and volumes from the Site. The proposed stormwater management system has also been designed to provide 80% TSS removal from all proposed impervious surfaces. Additionally, the proposed media filters have been sized to provide at least 65% removal of total phosphorus, which meets the EPA's total maximum daily loads (TMDL) removal target for commercial land use for the Charles River watershed. Further analysis of the capacity of the stormwater management system and how specific stormwater management measures will be designed in conformance with the phosphorus and pathogen TMDL.

4.2.3 Future Climate Conditions

The proposed improvements to the stormwater management system have been informed by the results of an RMAT Climate Resilience Design Standards Tool Project Report, to ensure capacity and compliance despite projected changes in future climate conditions. The RMAT results are included in Appendix B. The results show a high exposure to extreme precipitation. In order to mitigate for these impacts, the site has been designed with a significant reduction in impervious area compared to the existing condition, First Floor Elevation of the buildings have been raised compared to the existing site grades, and the proposed stormwater management system has been designed to manage storms much greater than the current 100 year storm (approximately 9.5" storm without detention pond overflow).

4.2.4 Climate Resilience

The proposed design will incorporate climate resilience into the design for stormwater management and the overall site landscape. Existing impervious area will be reduced significantly as part of the proposed improvements. As the existing conditions featured minimal vegetation and trees, an increase in vegetation and trees included as part of the Project will be excepted to further develop the Site's climate resilience.

4.3 Water/Wastewater

4.3.1 Water/Wastewater Permits and Compliance

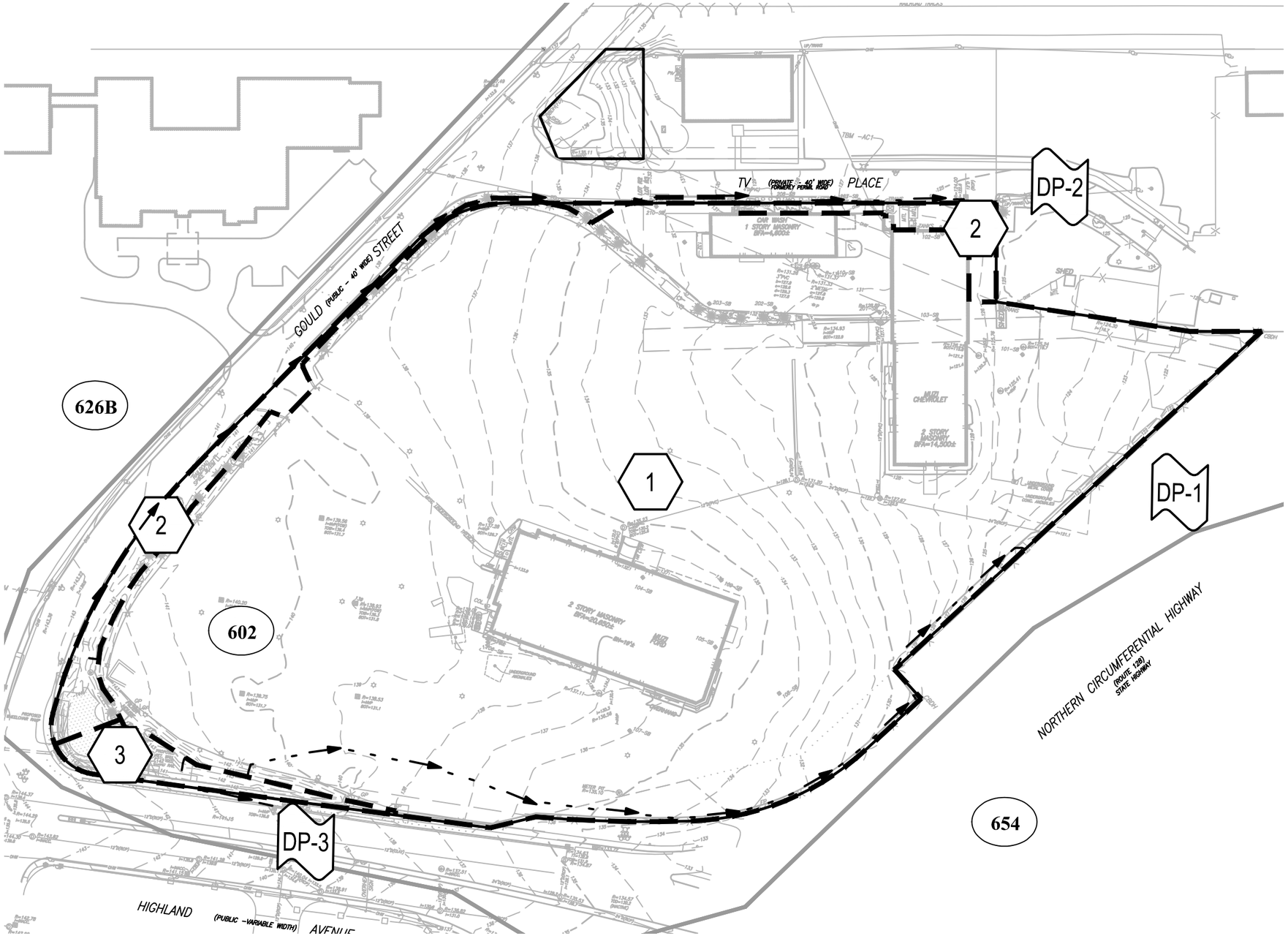
The proposed improvements to the water and wastewater systems will be permitted and designed in conformance with Sewer Discharge Permit requirements, 360 C.M.R. 10.016 and State Plumbing Code. Sewer Use Discharge permit(s) for laboratory wastewater and/or industrial process wastewater will be obtained if and when leases are signed with tenants requiring those permits.

4.3.2 Water/Wastewater Analysis

This separation of stormwater and wastewater discharges is in conformance with the Town of Needham's efforts to eliminate infiltration and inflow practices. As such, wastewater backups and surcharges are not expected to be impacted by major storm events. Appropriate payments will be made to cover the fees associated with offsetting the increase in sewer flow on the municipal system. Based on recent projects in the Town the assumed mitigation fee is $8.00/gallon for every gallon of sewer increase times 4 (removal rate).

Measures will also be implemented for efficient use and recycling of water onsite, to mitigate the overall water demand. The measures include but are not limited to water recycling for irrigation, chiller water, and greywater flushing, as determined feasible by the development team while still in compliance with the appropriate regulations.

\\vhb\gbl\proj\Boston\15306.00\cad\ld\Eng\Stormwater\15306.00 - EX Drainage.dwg



Legend

SYMBOLS

- X — DESIGN POINT
- X — DRAINAGE AREA DESIGNATION
- X — POND

LINETYPES

- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL TYPE BOUNDARY

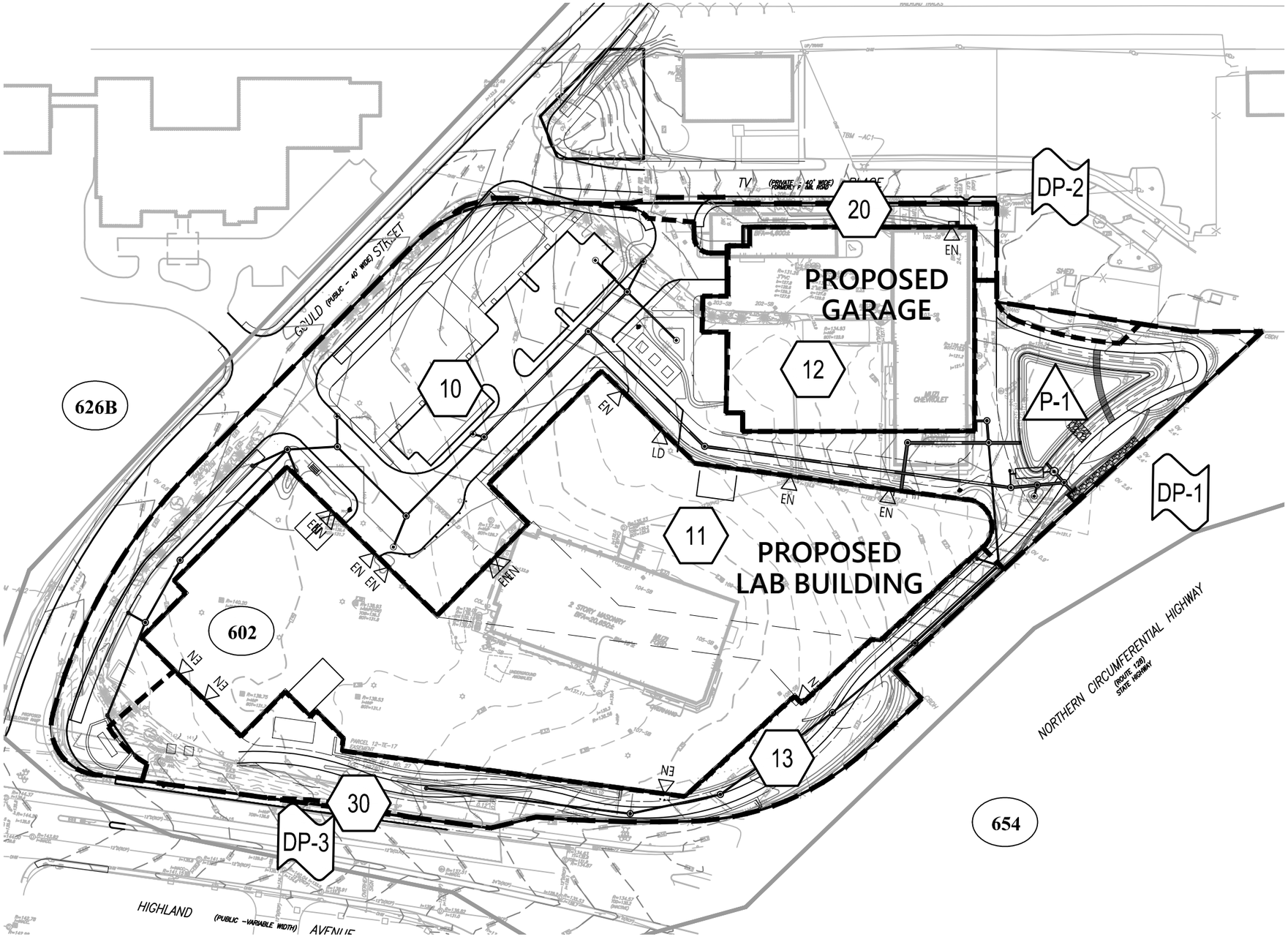
SCS SOIL CLASSIFICATIONS

602	URBAN LAND, 0 TO 15 PERCENT SLOPES
628B	MERRIMAC-URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES, HSG A
654	UDORTHENTS, LOAMY, HSG A

0 50 100 200Feet

Figure 4.1
Existing Drainage Conditions

Highland Science Center
Needham, Massachusetts



Legend

SYMBOLS

- X — **DESIGN POINT**
- X — **DRAINAGE AREA DESIGNATION**
- X — **POND**

LINETYPES

- **DRAINAGE AREA BOUNDARY**
- **TIME OF CONCENTRATION FLOW LINE**
- **SOIL TYPE BOUNDARY**

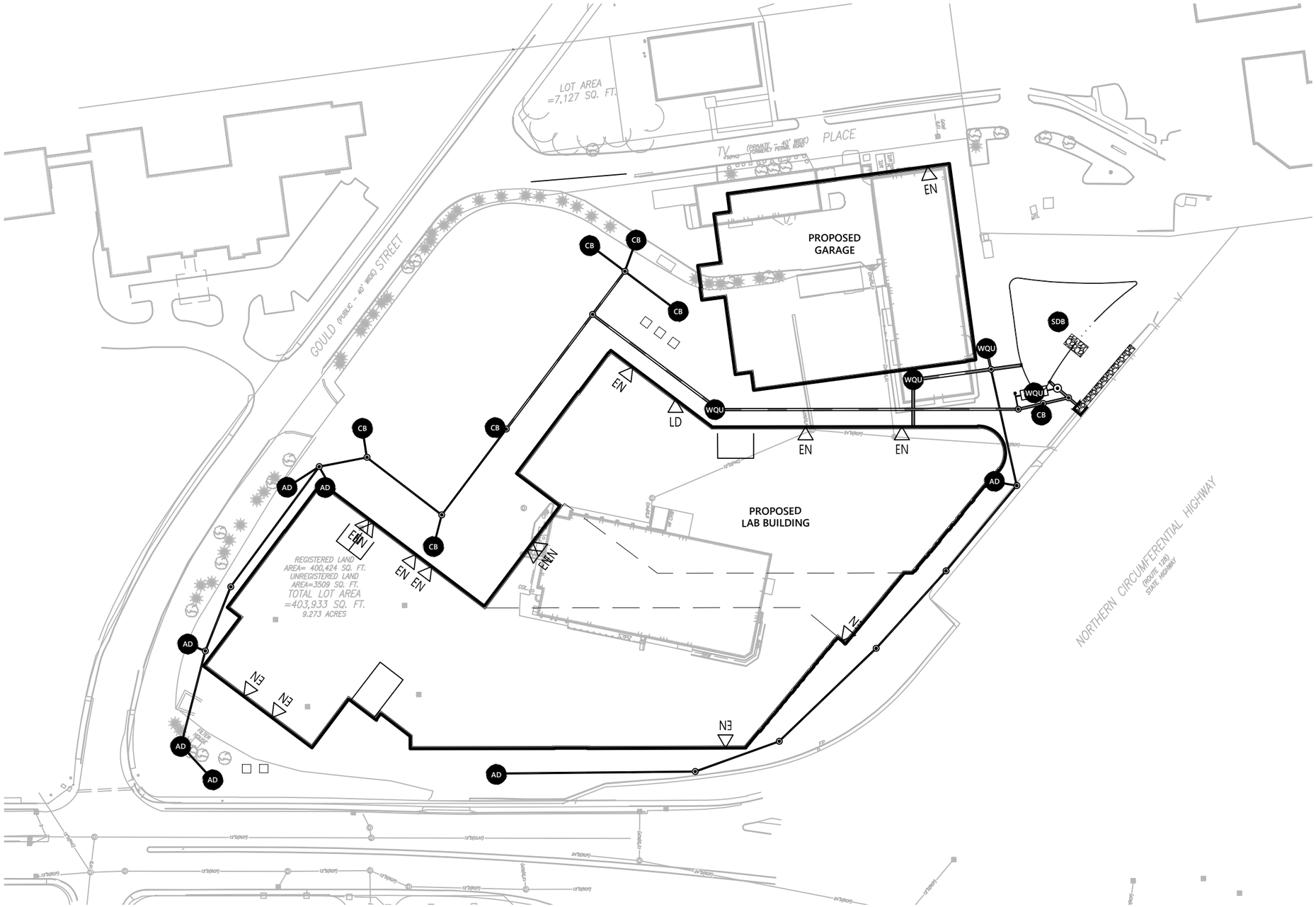
SCS SOIL CLASSIFICATIONS

602	**URBAN LAND**
628B	**MERRIMAC-URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES, HSG A**
654	**UDORTHENTS, LOAMY, HSG A**

Figure 4.2
Proposed Drainage Conditions

Highland Science Center
Needham, Massachusetts

\\vhb\gbl\proj\Boston\15306.00\cad\ld\Eng\Stormwater\BMP\15306.00-BMP_RD.dwg



Legend

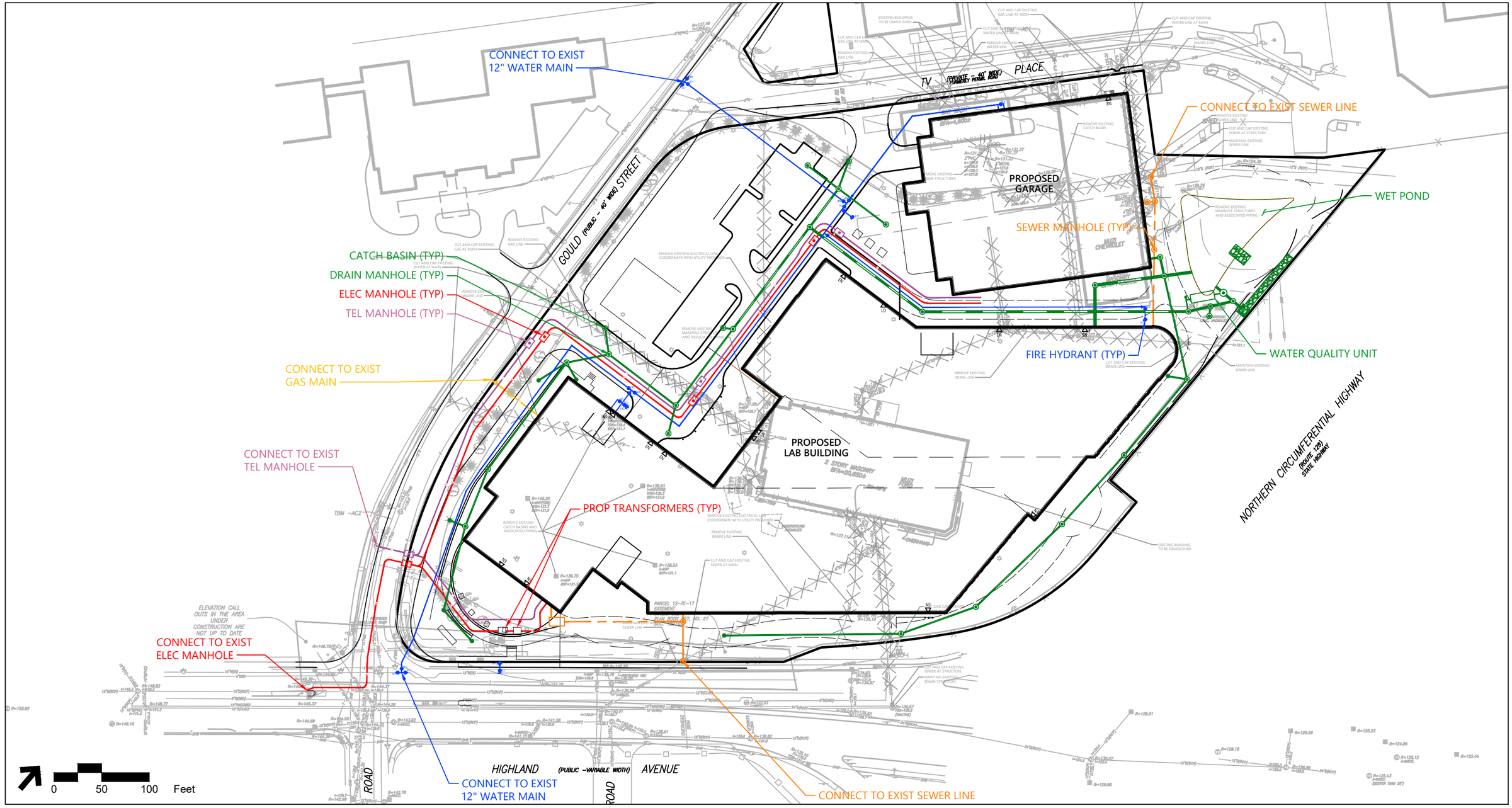
- CB — Catch Basin
- AD — Area Drain
- WQU — Water Quality Unit
- SDB — Surface Detention Basin

0 50 100 200Feet

Figure 4.3

BMP Locations

Highland Science Center
Needham, Massachusetts



8"S → 030: Sanitary Sewer / Force Main

12"D → 104: Storm Drain

12"W 160: Water Distribution / Fire Protection

E 001: Electric (All Phases), OHW, UPs, Signal

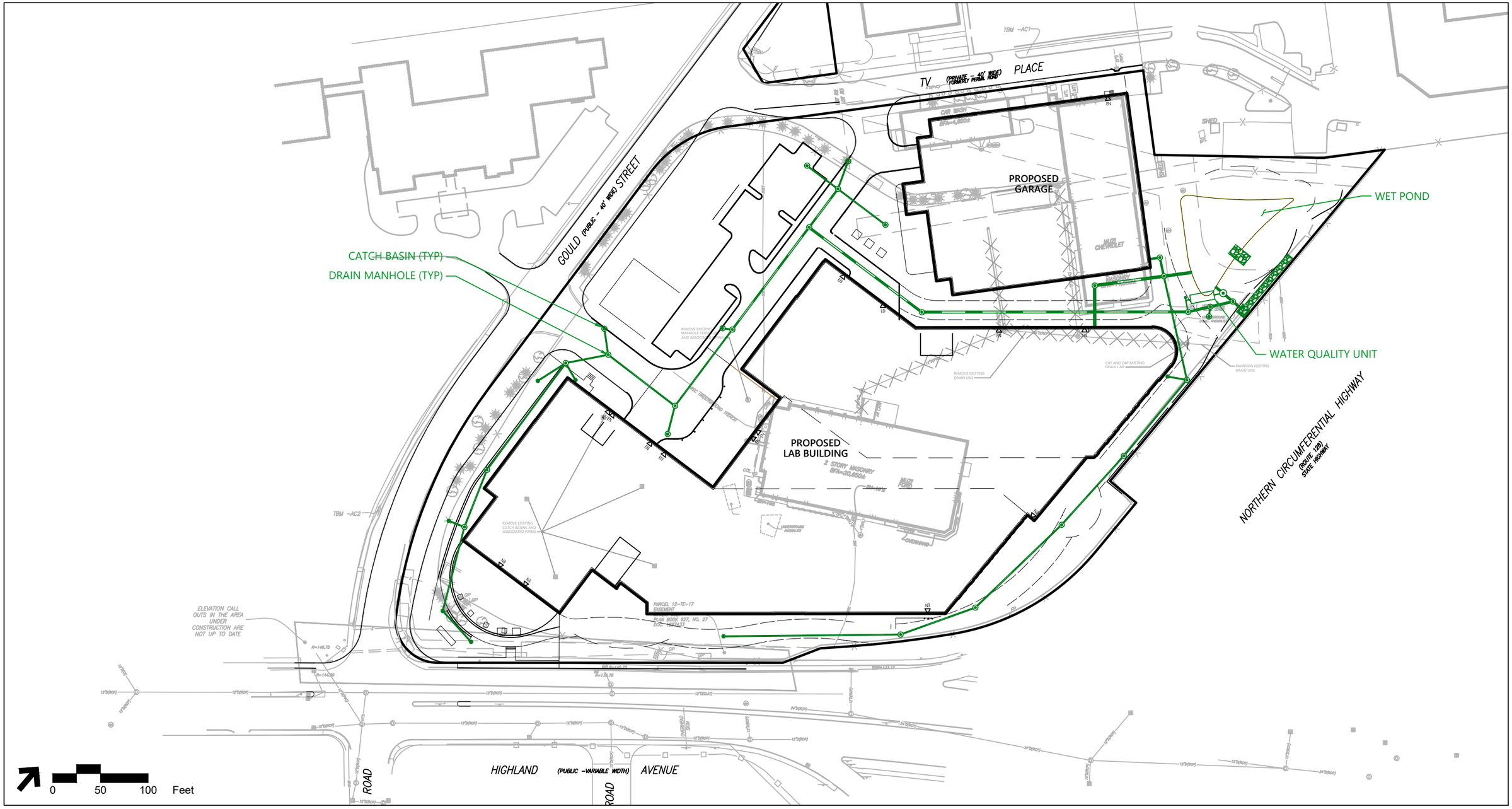
T 233: Telecommunications / Fiber / CATV

G 040: Gas / Oil

Figure 4.4

Conceptual Utility Plan

Highland Science Center
Needham, Massachusetts



12"D → 104: Storm Drain

Figure 4.5
Conceptual Drainage Plan

Highland Science Center
Needham, Massachusetts

5

Traffic and Transportation

As requested in the scoping section of the Secretary's Certificate on the ENF, this chapter provides responses to the 'Traffic and Transportation' comments . Comments received from MassDOT in their comment letter are the primary driver of the content included in this chapter. Comment letters received from the Town of Needham, their transportation peer reviewer, and others are also addressed. A full traffic impact and access (TIA) study developed based on MassDOT TIA guidelines was included as Chapter 2 of the ENF (referred to throughout this chapter as the "TIA"). For reference, the TIA included in the ENF as Chapter 2 is also included in Appendix D of this DEIR.

The TIA evaluated the Project's potential traffic impacts. The Project includes up to 531,000 SF of rentable space, with approximately 260,500 SF of office space, approximately 260,500 SF of research and development space, and approximately 10,000 SF of retail space (the "Project"). The Project will also accommodate a maximum of 1,770 off-street parking spaces.[1] The parcel of land was formerly occupied for several decades by a car dealership and car wash.

No major changes to the proposed building program or the proposed parking supply have been made since the filing of the ENF. Therefore, the evaluation and summary of the Project's transportation elements and quantified impacts presented in the TIA remain unchanged from the TIA included in the ENF. This chapter includes an update to the proposed mitigation package and the supplemental information requested in the ENF Certificate.

The following responses to the 'Traffic and Transportation' section of the Scope of the ENF Certificate are included in this chapter (with references to DEIR sections in **bold**):

› Continue consultation with the Town, the MBTA, and appropriate MassDOT units, including PPDU, Traffic Operations, and the District 6 Office during the preparation of the DEIR for the Project. **(Section 5.3)**

[1] The Proponent is seeking a special permit from the Needham Planning Board to reduce the required number of parking spaces to ~1,408. This DEIR conservatively assumes that the requested relief may not be granted. The analysis, proposed mitigation measures, and responses to comments assume that 1,770 spaces will be provided. To the extent that the number of parking spaces is reduced, there will be a corresponding reduction in associated average daily vehicle trips, increasing the effectiveness of proposed traffic mitigation measures.

- Ensure more accurate data for the existing site-generated trips are incorporated to the extent warranted. **(Section 5.4.1)**
- Document any additional analysis and mitigation measures related to collision history. **(Sections 5.4.2.1 and 5.451)**
- Include analysis of existing and proposed weave conditions on Highland Avenue to ensure that increased traffic volumes do not lead to degraded safety conditions in the area of the Highland Avenue/I-95 interchange. **(Section 5.4.2.2)**
- Include analysis of queuing at study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area. **(Section 5.4.3)**
- Determine the feasibility of additional MBTA Bus Route 59 service closer to the Project Site. **(Section 5.4.4)**
- Include an assessment of the potential bicycle parking demand that could be generated by the Project and the adequacy of the number of bicycle parking spaces provided to accommodate this demand. **(Section 5.4.5)**
- Provide an update on the potential reduction in parking and how that may contribute to an associated reduction in impervious area. **(Section 5.4.6)**
- Consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of the intersection of Highland Avenue at Hunting Road/Gould Street. **(Section 5.5.1.1)**
- Include sufficiently detailed conceptual plans (minimum of 80-scale) for any proposed roadway improvements. **(Section 5.5.2)**
- Consider coordinating with District 6 to install adequate bicycle and pedestrian infrastructure on Highland Avenue at the I-95 interchange. **(Section 5.5.6)**
- Demonstrate a strong commitment to implementing TDM measures to the greatest extent feasible to reduce SOV travel to and from the Site. **(Section 5.6)**
- Clarify the Proponent's commitment to EV charging (number of spaces) and describe how it will be implemented on the Site. **(Section 5.6.2)**
- Provide additional information on how carpool assistance and emergency ride home services will be provided, as well as what incentive program may be implemented. **(Sections 5.6.3 and 5.6.4)**
- Quantify the anticipated mode share that is expected for the Project both with and without TDM measures. **(Section 5.6.5)**
- Include a draft transportation monitoring program (TMP) commitment and discuss how the Proponent intends to implement the monitoring program. **(Section 5.7)**
- Describe the methodology used to estimate the effectiveness of TDM measures. **(Section 5.7.3)**
- Discuss what measures the Proponent plans to take if traffic counts for the Project are shown to be higher than anticipated and if TDM and other mitigation measures prove less effective than expected. **(Section 5.7.4)**

5.1 Key Findings and Benefits

This section provides the Summary of Findings and Transportation Mitigation that was included in the TIA, with the revised/additional transportation mitigation incorporated. This revised list is based upon input received at multiple community meetings as well as input and guidance received from the Town of Needham.

The Project will result in additional trips generated to and from the Project Site. These new trips can be expected to produce some localized impacts on the surrounding transportation infrastructure. The Proponent has developed a comprehensive series of improvement actions to address existing operating conditions and constraints and to mitigate future new impacts. Generally, the Project will adopt and incorporate nearly all of the transportation improvements that were identified in the Traffic Study commissioned by the Town of Needham in support of their recent rezoning effort for the area, even though that study contemplated the redevelopment of the adjacent Channel 5 (WCVB) properties for which there are no current plans. The improvements and the proposed mitigation program are intended to offset the Project's impacts and to provide improved transportation infrastructure to the surrounding area for all users, thereby supporting significantly improved area mobility. The Proponent is also committed to implementing an extensive travel demand management (TDM) program in connection with the Project's development and operation. A summary of key findings and mitigation and improvement actions are described below:

- The net-new traffic generated by the Project is estimated to total 5,005 net new weekday daily trips, 583 trips during the morning peak hour (515 entering and 68 exiting), and 565 trips during the evening peak hour (92 entering and 473 exiting).
- The Proponent is committed to funding the design and construction of key mitigation and improvement measures, including:
  - Installation of bi-directional separated bicycle accommodations at sidewalk level on the east side of Gould Street between Highland Avenue and just north of TV Place.
  - Addition of shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately ½ mile between just north of TV Place and Central Avenue.
  - Sidewalk improvements along the west side of Gould Street between Highland Avenue and Noanett Road.
  - Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway.
  - Geometric improvements and signal timing and equipment improvements at the intersection of Highland Avenue at Gould Street/Hunting Road, including widening this section of Gould Street to four lanes..
  - Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements.
  - Geometric improvements at the intersection of Gould Street at TV Place.
  - A new crosswalk for pedestrians and bicyclists across Gould Street at the location of the abandoned railroad right-of-way with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers.

  - Traffic signal timing modifications at four additional intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street.
  - Improvements at Noanett Road to improve pedestrian accommodations and deter cut-through traffic on the local residential roadway, including signs indicating no cut through traffic, information dissemination, and funding for police enforcement.
  - Installation of two radar-embedded speed limit signs on Hunting Road to encourage lower vehicle speeds.
- The Proponent will implement a shuttle service between the Site and nearby transit stations to provide a connection to the greater MBTA transit network for employees and visitors who wish to take transit to/from the Site. This shuttle service will be operated using EVs.
- The Proponent will work with the Town of Needham to support additional funding for a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site and the Channel 5 (WCVB) property into a shared use path that would connect to Needham Heights to the south.
- The Project includes significant pedestrian and open space amenities, including new sidewalks and accessible crossings adjacent to the Project Site and at key off-site locations (as noted above). An approximately 0.5-mile fitness/walking path around the Project Site with landscaping, lighting, and other public amenities will be included and will be open to the general public.
- Connections to the future bicycle accommodations on Highland Avenue that will extend toward Newton to the east and toward Needham Heights to the west.
- Up to 104 secure indoor bicycle parking spaces will be provided on-Site for employees and up to 50 outdoor bicycle parking spaces will be provided on public bicycle racks for a total of up to 154 bicycle parking spaces on-Site.
- The maximum proposed parking supply of 1,770 parking spaces conforms to local zoning requirements for the Site (one parking space per 300 SF), which results in an increase of 1,238 net-new spaces over the 532 parking spaces previously provided on Site. However, the Proponent is requesting a lower parking ratio of one parking space per 360 SF as part of the Special Permit process with the Town of Needham. The parking demand will be accommodated primarily in a stand-alone structured parking garage to be located on the northeast portion of the site adjacent to TV Place. Additional parking will be provided below-grade under each building and in a small surface parking lot intended to be used by visitors and patrons.
- Approximately 25 percent of the parking spaces in each parking area will be equipped with Electric Vehicle charging stations, with consideration being given as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions.
- The Project will include dedicated off-street loading bays interior to the buildings to ensure that loading and service operations will not impact traffic operations or pedestrian flow on adjacent streets and will not be visible or audible to neighbors.
- The Proponent will implement a wide array of TDM measures to incentivize reduced single occupant driving and increased use of alternative forms of transportation to access the workplace.

› The Proponent is committed to a robust transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network.

5.2 Proposed Transportation Changes from ENF

Although the Project size, general layout, and amount of parking has not changed since the filing of the ENF, the proposed mitigation package has been revised for the DEIR filing based on feedback from the community, the Town of Needham, and the Town's peer reviewer.

5.2.1 Gould Street Improvements

To provide more family-friendly bicycle accommodations on Gould Street, the Proponent has modified the proposed mitigation on Gould Street to include bi-directional separated bicycle lanes at sidewalk level on the east side of Gould Street between Highland Avenue and just north of TV Place. A new crosswalk across Gould Street at the location of the abandoned railroad right-of-way will be installed so pedestrians and southbound bicyclists can cross Gould Street to access the sidewalk and bi-directional separated bicycle lanes on the east side of Gould Street. The proposed crosswalk will be equipped with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers. To accommodate southbound bicyclists who may want to continue on-road and not cross Gould Street, a four-foot-wide unmarked bicycle-accommodating shoulder will be provided on the southbound side of Gould Street. Under the concept presented in the ENF, all bicyclists would have traveled in on-road bicycle lanes directly next to vehicle traffic.

To provide enhanced pedestrian accommodations, the Proponent will also reconstruct the sidewalk on the west side of Gould Street between Highland Avenue and Noanett Road. This will provide a safer accommodation for pedestrians walking between Highland Avenue and the residential neighborhoods along Noanett Road.

In addition, the revised concept eliminates the Gould Street dedicated northbound right-turn lane into TV Place and the dedicated southbound right-turn lane onto Highland Avenue based on feedback from the Town of Needham to reduce the lengths of the associated crosswalks and the amount of pavement. While these turn lanes were included in the initial concept design, the lanes are not required to provide an adequate level of operations for vehicles. Intersection traffic analyses for the new concept are included in Section 5.5.1.1.

5.2.2 A graphic of the revised Gould Street roadway improvements is provided in Figure 5.1.Additional Off-Site Improvements

The Proponent has also committed to the following off-Site roadway improvement measures in addition to those proposed in the ENF:

› Traffic signal timing modifications at four additional intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street.

- Improvements at Noanett Road to improve pedestrian accommodations and deter cut-through traffic on the local residential roadway, including signs indicating no cut-through traffic, information dissemination, and funding for police enforcement.
- Installation of two radar-embedded speed limit signs on Hunting Road to encourage lower vehicle speeds.

5.2.3 Electric Vehicle Charging Stations

The ENF stated that the Project will include parking facilities that will be equipped with electric vehicle (EV) charging stations, but it did not specify the number of EV charging stations that would be provided. The Proponent is now committed to providing approximately 25 percent of the parking spaces in each parking area (the stand-alone parking garage, the surface lot, and the underground garage) with EV parking stations, with consideration being given as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions.

5.2.4 Bicycle Parking

In the ENF, the Project was proposed to include up to 89 bicycle parking spaces. Based on community feedback, the number of bicycle parking spaces has been increased. The Project is now proposed to include up to 104 secure, indoor bicycle parking spaces for tenant's employees and up to 50 outdoor bicycle parking spaces on public bicycle racks for visitors and customers for a total of up to 154 bicycle parking spaces on-Site.

5.2.5 Transportation Monitoring Program

The Transportation Monitoring Program has been revised based on feedback from MassDOT and the Town of Needham's peer reviewer. The monitoring program has been expanded to include an annual travel survey of employees and patrons, 48-hour traffic volume counts on TV Place and on the Project Site driveway, capacity and queue analyses for four study area intersections, and a commitment to review/adjust the TDM program and add additional measures if the Project Site generates more trips than expected. Full details of the revised Transportation Monitoring Program are provided in Section 5.7.

5.3 Coordination with State/Local Agencies

The Proponent continues to coordinate with state and local agencies as the Project develops. For instance, a MEPA site consultation was held on April 20 (virtual) and 22 (on-site), 2022, and a Development Review Team meeting was held with the Town of Needham on April 26, 2022. Two public hearings have been held thus far with the Needham Planning Board on June 7 and July 7, 2022. Additional communications have also occurred between the Proponent and local and state agencies to ensure that all parties are up to date on the details of the Project.

Continued coordination with local and state agencies is expected as the Project advances. Specifically, coordination with MassDOT and the Town of Needham will occur as the

proposed off-Site mitigation improvements move from the conceptual to the design phase to ensure that they tie in with the existing and proposed transportation network.

The Project will require at least two permits from MassDOT prior to the development of the Project. One permit will be for the change-in-use of the property as the property directly abuts a state highway (Route 128/I-95) and because the project will generate more than 3,000 daily vehicle trips. A separate MassDOT access permit will be required for the construction of any off-site roadway improvements within the state highway layout, which includes the southern end of Gould Street. The Proponent will coordinate with MassDOT as necessary during the preparation of the permitting documents.

5.4 Additional Transportation Impact Assessments

The TIA submitted with the ENF and included in Appendix D includes information on existing safety analyses, intersection capacity under existing and future conditions, and proposed Project mitigation as outlined in the Transportation Scoping Letter. The analyses provided in the TIA are still applicable, as no changes have been made to the proposed Project description or trip generation. However, several additional transportation impact assessments have been requested by MassDOT and/or by the Town of Needham's peer reviewer. The following sections provide the additional requested transportation assessments.

5.4.1 Existing Site-Generated Trips

Due to a lack of data for traffic volume entering and exiting the existing Site driveways prior to the beginning of the pandemic, the existing site-generated trips were counted on July 14, 2021. Although this represents a condition during the COVID-19 pandemic, the counts were conducted after the Commonwealth was beginning to enter a "new normal" phase and after the emergency order was rescinded.

To determine if the site-generated trips observed in July 2021 align with the trip generation levels expected from a general car wash and car dealership, the empirical counts have been compared against the expected rates from the Institute of Transportation Engineers (ITE). Table 5-1 provides a comparison of the empirical rates for the previous uses and the ITE-generated rates (based on data provided in the ITE Trip Generation Manual). The ITE worksheets for the previous uses on-Site are included in Appendix D.

Table 5-1 Comparison of Empirical and ITE Trips for Existing Site Uses

	Empirical Counts (July 2021) [a]			ITE Trip Generation		
	Car Dealership	Car Wash	Total	Car Dealership [b]	Car Wash [c]	Total
Weekday Daily						
Enter	233	177	**410**	489	n/a	**n/a**
Exit	300	177	**477**	489	n/a	**n/a**
Total	533	354	**887**	978	n/a	**n/a**
Weekday Morning						
Enter	27	10	**37**	40	n/a	**n/a**
Exit	19	5	**24**	34	n/a	**n/a**
Total	46	15	**61**	75	n/a	**n/a**
Weekday Evening						
Enter	8	21	**29**	42	27	**69**
Exit	33	24	**57**	50	27	**77**
Total	41	45	**86**	92	54	**146**

a Based on actual counts by VHB in July 2021.
b Based on ITE LUC 840 (Automobile Car Sales (New)), using regression equation for daily trips and peak hour of generator trips.
c Based on ITE LUC 948 (Automated Car Wash), using average rates for weekday evening peak hour of generator trips. No data provided for daily or weekday morning peak hour trips.

As shown in the table above, the empirical counts conducted in July 2021 are measurably lower than what would be expected based on ITE rates. The summer is generally a slower time for the previous uses on Site, especially for a car wash that commonly is busiest in the Winter and early Spring. Because the ITE trip rates are based on data collected at sites across the country over several decades and most-likely from different times of the year, it is not surprising that the empirical volumes do not exactly match the ITE-projected volumes and variation between the two sets of data is generally to be expected.

Although July 2021 empirical data may represent a slightly lower volume of existing Site-generated trips than the Project Site may have generated on an average non-summer weekday prior to the pandemic, no adjustments have been made to the trip generation or the analyses presented in the TIA. Because the Project Site-generated volumes presented in the TIA include a credit for the trips currently generated by the Project Site, using the lower empirical data provides a more conservative analysis for the trip generation and intersection operational analyses. Therefore, no changes have been made to the analyses to take further credit for the higher volume of trips that the Project Site may have generated by the previous uses on-Site.

5.4.2 Safety Review

The TIA included a detailed crash analysis for each study area intersection based on the most recent five years of available data (2015-2019). The following sections provide further safety analyses, including collision diagrams at certain study area intersections and weaving

analyses on Highland Avenue at the Route 128/I-95 interchange. None of the study area intersections are identified as 2017-2019 HSIP high-crash locations.

5.4.2.1 Collision Diagrams

Based on a review of the crash data presented in the TIA, the following five study area intersections either have a crash rate above the district average or experienced an average of three or more crashes per year:

- Highland Avenue at West Street
- Highland Avenue at Gould Street / Hunting Road
- Highland Avenue at 1st Avenue
- Highland Avenue at 2nd Avenue
- Hunting Road at Kendrick Street

Several of these intersections are currently being reconstructed or have recently been reconstructed in connection with ongoing roadway improvements being led by MassDOT. The intersections of Highland Avenue at Gould Street/Hunting Road and Highland Avenue at 2nd Avenue are both currently being reconstructed as part of the MassDOT roadway improvements. The intersection of Highland Avenue at 1st Avenue was reconstructed in 2018. Because the crash data reviewed was between 2015 and 2019, these improvements are expected to address some of the safety concerns and are not reflected in the crash data.

Collision diagrams have been developed at the identified intersections above, except for the intersections of Highland Avenue at 1st Avenue and 2nd Avenue, as the crash data does not reflect roadway improvements and the project-related impacts are smaller at those two intersections. The collision diagrams are included in Appendix D.

As shown in the collision diagrams, angle crashes were most prevalent at the three intersections studied. At the Highland Avenue and West Street intersection, there were 6 angle crashes and 3 side-swipe, same direction crashes occurred at the intersection and 2 crashes involved bicyclists. At the Highland Avenue and Gould Street/Hunting Road intersection, there were 6 angle and 4 side-swipe, same direction crashes occurred. At the Hunting Road and Kendrick Street intersection , there were 7 angle crashes occurred.

The high prevalence of angle crashes may indicate conflicts between turning vehicles and through vehicles. This could be caused by drivers becoming frustrated with congestion and trying to turn when there are insufficient gaps in opposing traffic. Section 5.5.1 presents the proposed mitigation at these three intersections, which includes signal timing modifications to improve operations and reduce congestion.

5.4.2.2 Weaving Analyses

Weaving analyses based on methodology from the Highway Capacity Manual (HCM) were conducted on Highland Avenue at the Route 128/I-95 interchange and presented previously in the ENF. For informational purposes, the weaving analyses results are presented below as well.

Weaving segment analyses were conducted at the following ramp junction locations:

- Highland Avenue Eastbound between the I-95 Southbound Exit 35C Off-Ramp and the Route 128/I-95 Northbound On-Ramp
- Highland Avenue Westbound between the Route 128/I-95 Northbound Off-Ramp and the I-95 Southbound On-Ramp

Analyses were conducted during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. A summary of the weave segment analyses is presented in Table 5-2 and the detailed analysis worksheets are provided in Appendix D.

Table 5-2 Weave Segment Capacity Analysis Summary

	2022 Existing Conditions			2029 No Build Conditions			2029 Build Conditions		
Location/Period	v/c[a]	Density[b]	LOS[c]	Demand	Density	LOS	Demand	Density	LOS
Highland Avenue EB between Route 128/I-95 SB Off-Ramp and I-95 NB On-Ramp									
Weekday Morning	0.53	18.5	B	0.66	24.3	C	0.66	24.7	C
Weekday Evening	0.30	10.2	A	0.38	13.0	B	0.44	15.2	B
Highland Avenue WB between Route 128/I-95 NB Off-Ramp and Route 128/I-95 SB On-Ramp									
Weekday Morning	0.22	6.5	A	0.26	7.9	A	0.34	10.1	A
Weekday Evening	0.31	10.9	A	0.38	13.9	B	0.40	14.3	B

a volume-to-capacity ratio
b density, in passenger cars per mile per lane
c level of service

As shown in Table 5-2, the weaving locations for the interchange of Highland Avenue at the Route 128/ I-95 are expected to operate at LOS C or better during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. The addition of Site-generated traffic is not expected to result in a degrade in level of service for either Highland Avenue weaving location.

5.4.3 Queue Analysis

To understand the queueing impacts of operations at each study area intersection under the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions, queue diagrams have been developed for the weekday morning and weekday evening peak hours. The queue diagrams for each study area intersection are provided in Appendix D.

As shown in the queue diagrams, the addition of the Project-generated vehicle trips is expected to result in minimal changes in queue lengths at most of the study area intersections. For intersections where there is a noticeable impact in queue caused by the Project, mitigation has been proposed to offset those impacts.

While the maximum queues on the Highland Avenue westbound approach are expected to extend beyond the I-95 southbound off-ramp under the 2029 Build Conditions with mitigation during both peak hours, this situation is expected to occur as well under the 2029 No Build Conditions without the Project. Because the Route 128/I-95 southbound off-ramp

is over 1,500 feet in length, any queue on the Route 128/I-95 southbound off-ramp is not expected to spill back onto the Route 128/I-95 southbound mainline. In addition, the queues on Highland Avenue westbound are not expected to extend back far enough in the 2029 Build Condition to impact the weaving operations between the Route 128/I-95 northbound off-ramp and the Route 128/I-95 southbound on-ramp, which as reported in the previous section are expected to operate at LOS B or better.

5.4.4 Access to MBTA Bus Route 59

As noted in the TIA, the closest MBTA bus stop to the Site for MBTA Route 59 is nearly a half-mile away on Webster Street. Since the publication of the ENF, the MBTA released a draft plan of the Bus Network Redesign in May 2022. The Bus Network Redesign is a full review and overhaul of all bus routes operated by the MBTA with the goal of creating a better experience for current and future bus riders. The MBTA spent several years developing the draft Bus Network Redesign plan based on demographics, employment districts, traffic congestion, and travel patterns. As shown in the draft plan of the Bus Network Redesign, Route 59 is proposed to maintain its existing alignment through Needham while eliminating different variations of the route through Newton to simplify operations. Route 59 is expected to operate every 60 minutes or less between at least 6:00 AM and 7:00 PM, seven days a week.

The Proponent was requested in the ENF certificate to review the feasibility of providing additional MBTA Bus Route 59 service closer to the Project Site. Because currently proposed, Route 59 will not travel closer to the Project Site than it does under existing conditions and will continue to operate along Webster Street and Central Avenue. As one of the goals of the Bus Network Redesign is to simplify operations, it is unlikely that a new variation of Route 59 would be supported that stops at the Project Site for some routes and continues to serve the residential areas along Webster Street and Central Avenue for other routes. If Route 59 was revised to directly serve the Project Site, it would no longer provide access to the residential areas along Webster Street and Central Avenue. However, prior to the submittal of the FEIR, the Proponent will contact the MBTA to understand if there are opportunities to modify bus access in the area to better support transit connectivity.

To maintain transit service to the residential areas along Webster Street and Central Avenue while also providing transit connection to the Project Site, the Proponent is committed to providing a dedicated EV shuttle service that will run between the Project Site and nearby public transportation stations, such as the commuter rail at Needham Heights and the Green Line D Branch at Newton Highlands. This will provide a direct connection between the Project Site and the public transportation network throughout greater Boston without negatively impacting transit service to the existing residential areas in Needham served by MBTA Route 59.

5.4.5 Bicycle Demand and Parking

The Project will provide covered and secured bicycle parking spaces within its buildings and outdoor bicycle racks near building entrances for Project visitors. Specifically, the Project will include up to 104 secure indoor bicycle parking spaces on-Site for tenant's employees and 50 outdoor bicycle parking spaces on public bicycle racks for visitors and customers to the Site for a total of up to 154 bicycle parking spaces on-Site.

As presented in the TIA, the trip generation estimates were developed assuming 100 percent of the Site-generated traffic would use private vehicles to access the Site. This was a conservative analysis used to identify the "worst-case" scenario of vehicular impacts that the Site could generate. The actual percentage of employees commuting by private vehicle will be less than 100 percent.

To determine if the proposed bicycle parking supply is sufficient for the anticipated bicycle demand, data from the US Census Bureau was reviewed to determine the existing mode share characteristics for employees who commute to workplaces in the Town of Needham. Based on the data, approximately one percent of all existing employees who commute to workplaces in the Town of Needham do so by bicycle (the existing mode share data is included in Appendix D). With the proposed TDM program and the investment in pedestrian and bicycle infrastructure for the Project, the percentage of employees arriving and departing by alternative modes of transportation, including by bicycle, at the Project Site is expected to exceed the rates for existing workplaces in the Town of Needham. For the purposes of determining if the proposed bicycle parking supply is sufficient for the anticipated bicycle demand for the Project Site, a conservative five percent bicycle mode share has been assumed.

Table 5-3 summarizes the proposed bicycle parking demand for the Project Site based on the trip generation presented in the TIA.

Table 5-3 Proposed Bicycle Parking Spaces

Period	Vehicle Trips [a]	Bike Mode Share Estimate [b]	Bike Trip Estimate [c]	Proposed Bicycle Parking		
				Long-term Spaces	Short-term Spaces	Total Bike Spaces
Weekday Daily						
Enter	2,536	5% enter	**127**	104	50	**154**
Exit	2,469	5% exit	124			

a Total Net New Vehicle Trips expected to be generated by the Project, as presented in Table 2-5 of the TIA.
b Conservative bicycle mode share of five percent based on area projects.
c Estimated daily bike trips generated by the Project assuming a five percent bike share.

Using a conservative estimated bicycle trip rate, a maximum of 127 entering bicycle trips would be expected to be generated by the Project over the course of an average weekday. As shown in Table 5-3, up to 154 bicycle parking spaces will be provided on-Site. Because the total number of bicycle parking spaces on-Site will exceed the maximum daily bicycle trips generated by the Project Site, the bicycle parking supply is expected to be sufficient for the anticipated bicycle parking demand. This is true without considering that not all bicyclists will be on-Site at the same time and thus not all bicyclists will need their own dedicated bicycle parking spaces.

In addition, the Proponent will monitor the actual level of bicycle demand on-Site once the Project opens. If it is determined that the bicycle mode share exceeds the five percent assumed in the bicycle parking demand and additional bicycle parking is required, the Proponent will install additional bicycle parking spaces on-Site.

5.4.6 On-Site Parking

As stated in the ENF, the Project will be supported by a maximum of 1,770 off-street parking spaces, which corresponds to a minimum of one space per 300 SF of development as required by Town of Needham zoning. Since the filing of the ENF, the configuration of the surface parking lot proposed to be constructed on the southwest corner of the Site has been revised slightly. Under the plan shown in the ENF, the surface parking lot was proposed to consist of approximately 44 parking spaces. Under the revised plan for the southwest corner of the Site, the surface parking lot will consist of approximately 30 parking spaces. The elimination of 14 surface parking spaces will provide additional room for community open space along Gould Street. The community open space may consist of lawn space, seasonal amenities such as pickleball courts in the Summer and ice skating in the winter, or other community amenities. The exact use of the open community space will be determined based on coordination with nearby residents and the Town of Needham.

Although 1,770 parking spaces is the maximum number of spaces that will be provided, the Proponent is seeking a reduction in parking as part of the Special Permit process with the Town of Needham. The maximum of 1,770 parking spaces is based on Town of Needham zoning requirements of one parking space per 300 SF. A part of the Special Permit process the Proponent is requesting a higher parking ratio of one parking space per 360 SF. If granted by the Town of Needham, the reduction in parking spaces would result in the elimination of one level of parking from beneath the buildings and would not impact the amount of impervious area on-Site.

The one space per 300 SF zoning requirement is based on an expected employee density of 3.33 employees per 1,000 SF for traditional office space. However, R&D uses typical have a lower employee per square foot density than office uses due to the square footage needed for lab space. Based on a review of employee density for existing R&D spaces in Cambridge, the average employee density for R&D space is approximately 2.46 employees per 1,000 SF.[2] Also, the one parking space per 300 SF ratio assumes that each employee will commute alone via private vehicle. In reality, some employees will commute via carpool, walking, biking, or public transit. The Proponent will encourage the use of alternative commuting modes beyond single occupancy vehicles with the implementation of a TDM program and a shuttle connection to nearby transit stations. Therefore, it is likely that the Project Site will require fewer parking spaces than required by zoning.

5.5 Mitigation

As described in the TIA, the Proponent is committed to a robust mitigation package to offset the Project-related impacts to the transportation network and to improve multimodal travel within the study area. Specifically, the Proponent is committed to the following transportation mitigation items:

› Installation of bi-directional separated bicycle accommodations at sidewalk level on the east side of Gould Street between Highland Avenue and just north of TV Place.

2 Calculations by VHB based on 2018 PTDM Monitoring Reports provided by the City of Cambridge for four existing R&D facilities located at 7 Cambridge Center, 610 Main Street, Tech Square, and Binney Street.

- Addition of shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately ½ mile between just north of TV Place and Central Avenue.
- Sidewalk improvements along the west side of Gould Street between Highland Avenue and Noanett Road.
- Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway.
- Geometric improvements and signal timing and equipment improvements at the intersection of Highland Avenue at Gould Street / Hunting Road.
- Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements.
- Geometric improvements at the intersection of Gould Street at TV Place.
- A new crosswalk for pedestrians and bicyclists across Gould Street at the location of the abandoned railroad right-of-way with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers.
- Traffic signal timing modifications at four additional intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street.
- Improvements at Noanett Road to improve pedestrian accommodations and deter cut-through traffic on the local residential roadway, including signs indicating no cut-through traffic, information dissemination, and funding for police enforcement.
- Installation of radar-embedded speed limit signs on Hunting Road as a means to slow traffic.
- Implementation of a shuttle service between the Project Site and nearby transit stations to provide a connection to the greater MBTA transit network for employees and visitors who wish to take transit to/from the Project Site. This shuttle service will be operated using EV technology.
- Coordination with the Town of Needham to support additional funding for a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site and the Channel 5 (WCVB) property into a shared use path that would connect to Needham Heights to the south.
- Construction of an approximately 0.5-mile walking/fitness path around the Project Site with landscaping, lighting, and other public amenities will be included and will be open to all members of the general public.

Full details of the mitigation items are provided below or in the TIA. In addition, the Proponent will provide a robust traffic demand management (TDM) plan that will help to reduce the use of single occupant driving to and from the Project Site, including providing a dedicated shuttle service between the Project Site and nearby public transit nodes.

At the request of MassDOT and the Town of Needham, additional mitigation items have been reviewed at several study area intersections since the submittal of the ENF. The following sections describe the additional off-Site mitigation that the Proponent is proposing in addition to the mitigation included in the TIA.

5.5.1 Additional Intersection Mitigation

The Proponent has done a further assessment of Project-related impacts at several study area intersections identified by the Town of Needham's peer reviewer and has reviewed operations to determine if mitigation could be proposed to improve operations or to address safety issues. Specifically, the Proponent reviewed the following intersections identified by the Town of Needham's peer reviewer as having poor operations for at least one movement under the 2029 Build Conditions:

- Highland Avenue at Gould Street / Hunting Road
- Highland Avenue at West Street
- Highland Avenue at Webster Street
- Highland Avenue at 1st Avenue
- Hunting Road at Kendrick Street
- Central Avenue at Cedar Street and Webster Street

The intersections of Highland Avenue at Webster Street and Highland Avenue at Gould Street/ Hunting Road are currently under reconstruction by MassDOT, and the intersection of Highland Avenue at 1st Avenue was reconstructed by MassDOT in 2018. These improvements are reflected in the 2029 No Build and 2029 Build Conditions presented in the TIA. While some of the improvements at these intersections are intended to improve vehicle operations, the roadway reconstruction also include a strong emphasis on improving pedestrian and bicycle accommodations along the corridor. This results in some small tradeoffs in vehicle capacity to better accommodate pedestrians and bicyclists, such as the introduction of leading pedestrian intervals to facilitate pedestrians crossing the intersections.

The following sections describe the additional review conducted and proposed mitigation at the identified study area intersections. For the five signalized intersections listed below, the Proponent is proposing to fund the design and implementation of signal timing modifications during the identified weekday peak hours. The signal timing modifications will also include a review of the clearance intervals to determine if the yellow and/or all-red times should be adjusted to improve safety operations.

5.5.1.1 Highland Avenue at Gould Street / Hunting Road

As discussed in the TIA, the Proponent is proposing improvements at the intersection of Highland Avenue at Gould Street/Hunting Road that will include widening the cross-section of Gould Street to accommodate additional vehicle turn lanes and revising the traffic signal timings and equipment to accommodate the revised Gould Street cross-section. The Project mitigation was developed based on conceptual improvements that were proposed in a 2020 traffic memorandum developed as part of the rezoning of the Project Site.[3] A figure of the concept plan from the 2020 traffic study supporting the rezoning of the Site is included in Appendix D for reference.

3 Traffic Impact Study, Muzi Motors Redevelopment, Greenman-Pederson, Inc. November 20, 2020

The Town of Needham's peer reviewer noted that even with the mitigation measures proposed by the Proponent, the Hunting Road northbound movement will operate over capacity at level-of-service (LOS) F during the weekday morning and evening peak hours under 2029 Build with Mitigation Conditions. The Highland Avenue eastbound left-turn movement will also operate at LOS F during the weekday morning peak hour. The Proponent was requested to consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of this intersection.

While expanding the Hunting Road cross-section would provide additional capacity at the intersection, an additional northbound lane cannot be implemented without taking significant private property outside of the right-of-way. This would have a major impact on the property at 580 Highland Avenue and could require the razing of the existing house on that property. Therefore, to limit the right-of-way impacts, no expansion of Hunting Road is proposed.

To improve operations on the Hunting Road approach, the proposed signal cycle lengths and/or phase splits during the weekday morning and weekday evening peak hours were further reviewed and adjusted from what was proposed in the TIA. Because the new signalized intersection of Gould Street at the Project Site driveway is proposed to be coordinated with the signal at Highland Avenue at Gould Street/Hunting Road, timing adjustments at one intersection will also impact operations at the second intersection.

As noted previously, based on feedback from the community and from the Town of Needham, the Proponent has revised the design for the proposed Gould Street improvements. The new concept plan includes bi-directional separated bicycle facilities at sidewalk level on the east side of Gould Street to provide a family-friendly bicycle accommodation. In addition, the new concept plan eliminates the dedicated southbound right-turn lane from Gould Street to Highland Avenue and the dedicated northbound right-turn lane from Gould Street to TV Place to reduce the amount of pavement. The removal of the dedicated southbound right-turn lane also has the added benefit of shortening the pedestrian crossing. The wider Gould Street cross-section was proposed in the 2020 traffic study to support the rezoning of the site based on the "worst-case" scenario for the full buildout of the site and the adjacent Channel 5 (WCVB) property, which included up to 130,000 SF of retail space.

Table 5-4 summarizes the intersection capacity analyses at the intersections of Highland Avenue at Gould Street/Hunting Road and Gould Street at the Project Site driveway during the weekday morning and weekday evening peak hours with the revised southbound geometry and the revised signal timings in place. The intersection capacity worksheets are included in Appendix D. The elimination of the Gould Street northbound right-turn lane onto TV Place is not expected to impact operations as the northbound approach is under free-flow conditions.

As shown in the table below, the southbound shared through/right-turn lane is expected to operate at acceptable levels of service without providing dedicated through and right-turn lanes and queues are not expected to spill back to the upstream intersection at the Site driveway. The shared lane is expected to operate at LOS E during the weekday morning peak hour and LOS D during the weekday evening peak hour with volume-to-capacity ratios of less than 0.80 during both peak hours.

During the weekday morning peak hour, while the Hunting Road northbound left-turn/through movements and the Highland Avenue eastbound left-turn movements are still expected to operate at LOS F under the 2029 Build Conditions with the proposed mitigation, the amount of delay and volume-to-capacity ratios are expected to be better than or similar to operations under the 2029 No Build Conditions and the overall intersection delay is expected to be slightly better than under the 2029 No Build Conditions. During the weekday evening peak hour, the Hunting Road northbound left-turn/through movement is expected to operate at LOS E with the proposed mitigation, which is similar to operations for movements on the other approaches. The intersection of Gould Street at the Project Site driveway is expected to operate at overall LOS C or better under the 2029 Build Conditions with mitigation.

Table 5-4 Signalized Intersection Capacity Analysis Summary – Highland Avenue at Gould Street / Hunting Road and Gould Street at Site Driveway

Location / Movement	2029 No-Build Condition					2029 Build without Mitigation					2029 Build with Mitigation				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at Gould Street and Hunting Road															
Weekday Morning															
Highland Ave EB L	1.04	>120	F	~93	#234	>1.20	>120	F	~190	#353	0.96	115.7	F	153	#330
Highland Ave EB T/R	0.86	40.2	D	364	#512	0.79	36.6	D	364	#512	0.66	30.2	C	363	503
Highland Ave WB L	0.58	58.6	E	36	83	0.61	65.3	E	38	83	0.42	61.4	E	42	83
Highland Ave WB T/R	0.94	52.1	D	362	#545	1.15	117.8	F	~616	#841	0.97	54.3	D	587	#797
Hunting Rd NB L/T	0.96	89.0	F	206	#434	1.13	>120	F	~263	#480	0.96	96.8	F	265	#433
Hunting Rd NB R	0.48	39.8	D	48	102	0.51	44.0	D	52	102	0.53	46.1	D	93	136
Gould St SB L	0.82	64.8	E	145	#281	0.91	84.5	F	182	#347	0.70	71.7	E	136	180
Gould St SB L/T/R	0.78	59.4	E	137	#264	0.88	77.3	E	175	#335	-	-	-	-	-
Gould St SB T/R	-	-	-	-	-	-	-	-	-	-	0.57	72.7	E	107	166
Overall	**0.98**	**55.1**	**E**			**1.20**	**100.2**	**F**			**0.95**	**55.5**	**E**	**-**	**-**
Weekday Evening															
Highland Ave EB L	>1.20	>120	F	19	57	>1.20	>120	F	27	72	0.60	58.2	E	24	57
Highland Ave EB T/R	0.81	42.3	D	287	440	0.81	42.4	D	290	442	0.74	32.8	C	252	#373
Highland Ave WB L	0.86	83.3	F	100	194	0.87	84.5	F	101	196	0.78	61.6	E	89	#182
Highland Ave WB T/R	1.00	61.7	E	~535	#774	1.07	84.0	F	~599	#861	1.02	61.3	E	~527	#702
Hunting Rd NB L/T	0.56	51.4	D	66	127	0.58	52.2	D	70	134	0.73	61.0	E	65	#126
Hunting Rd NB R	0.10	35.7	D	4	24	0.10	35.7	D	4	24	0.07	34.2	C	0	5
Gould St SB L	0.91	61.1	E	295	#574	>1.20	>120	F	~681	#1051	0.97	61.6	E	310	#376
Gould St SB L/T/R	0.88	56.9	E	284	#554	>1.20	>120	F	~653	#1022	-	-	-	-	-
Gould St SB T/R	-	-	-	-	-	-	-	-	-	-	0.76	45.5	D	228	#239
Overall	**1.03**	**59.5**	**E**			**>1.20**	**>120**	**F**			**1.05**	**52.9**	**D**	**-**	**-**
Gould Street at Wingate Driveway / Project Site Driveway															
Weekday Morning															
Wingate Dwy EB L/T/R											0.01	61.9	E	0	0
Site Dwy WB L											0.50	65.0	E	46	90
Site Dwy WB L/T/R											0.29	62.1	E	25	68
Gould St NB L/T	*Intersection unsignalized under 2029 No Build Conditions without Mitigation*					*Intersection unsignalized under 2029 Build Conditions without Mitigation*					0.57	5.0	A	153	m273
Gould St NB R											0.31	4.0	A	22	m78
Gould St SB L											0.08	3.1	A	3	24
Gould St SB T/R											0.15	3.0	A	20	88
Overall											**0.54**	**7.8**	**A**		
Weekday Evening															
Wingate Dwy EB L/T/R											0.03	43.4	D	0	12
Site Dwy WB L											0.75	44.2	D	174	187
Site Dwy WB L/T/R											0.70	41.6	D	163	176
Gould St NB L/T	*Intersection unsignalized under 2029 No Build Conditions without Mitigation*					*Intersection unsignalized under 2029 Build Conditions without Mitigation*					0.31	10.7	B	56	m252
Gould St NB R											0.07	13.2	B	1	m30
Gould St SB L											0.03	8.8	A	4	21
Gould St SB T/R											0.37	11.4	B	124	270
Overall											**0.44**	**21.8**	**C**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

As noted in the TIA, construction is currently ongoing on the MassDOT Needham-Newton corridor project to improve safety and pedestrian/bicycle accommodations along Highland Avenue, including at the intersection with Gould Street/Hunting Road. The Project includes geometric and signal improvements along the corridor and new sidewalks and separated bicycle lanes. The roadway redesign project has been in the works for many years and has gone through several rounds of public comments to reach the current construction plan. The MassDOT reconstruction project does not include a significant enhancement of capacity at the intersections along Highland Avenue, as the design prioritizes safety and active transportation enhancements over additional vehicle capacity and several movements are expected to operate at LOS F with the roadway project in place. Since the 2029 No Build Conditions reflect the completed MassDOT roadway design at the intersection of Highland Avenue at Gould Street/Hunting Road, the proposed mitigation at the intersection has been designed to accommodate the additional Site-generated traffic while operating similarly to the 2029 No Build Conditions, which reflects the MassDOT vision of the corridor.

5.5.1.2 Highland Avenue at West Street

The Town of Needham's peer reviewer noted that the Highland Avenue southbound approach to West Street will operate over capacity with long delays during the weekday evening peak hour under 2029 Build Conditions, with an increase in delay of 22 seconds per vehicle generated by the Project. The Proponent was requested to investigate measures to mitigate this impact to operations. In addition, this intersection has been identified as having a crash rate higher than the MassDOT district average.

The Proponent has reviewed the signal timings at the intersection of Highland Avenue at West Street during the weekday evening peak hour and determined that if the following signal timing adjustments were made, operations would improve for the southbound approach without adversely impacting movements on the other approaches:

- Increase cycle length to 125 seconds
- Provide the following splits for each movement:
  - 51 seconds for the West Street eastbound/westbound approaches, with a 17 second leading eastbound left-turn phase
  - 54 seconds for the Highland Avenue northbound/southbound approaches
  - 20 seconds for exclusive pedestrian crossings

Table 5-5 summarizes the intersection capacity analyses at the intersection of Highland Avenue at West Street during the weekday evening peak hour with the revised signal timings in place. The intersection capacity worksheets are included in Appendix D.

Table 5-5 Signalized Intersection Capacity Analysis Summary – Highland Avenue at West Street

	2029 No-Build Condition					2029 Build without Mitigation					2029 Build with Mitigation				
Location / Movement	**v/c [a]**	**Del [b]**	**LOS [c]**	**50 Q [d]**	**95 Q [e]**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**
Highland Avenue at West Street															
Weekday Evening															
West St EB L	0.60	26.2	C	70	154	0.61	26.7	C	73	159	0.64	31.4	C	87	178
West St EB T/R	0.46	20.9	C	123	251	0.46	20.9	C	123	251	0.48	24.9	C	148	281
West St WB L	0.36	30.7	C	35	88	0.36	30.7	C	35	88	0.39	36.2	D	42	98
West St WB T/R	0.66	36.3	D	117	229	0.66	36.3	D	117	229	0.71	44.3	D	140	256
Highland Ave NB L/T/R	0.82	28.1	C	225	#664	0.83	29.0	C	229	#675	0.78	26.2	C	254	#669
Highland Ave SB L/T/R	0.97	50.7	D	320	#889	1.05	72.0	E	369	#978	0.98	53.4	D	408	#994
Overall	**0.81**	**35.3**	**D**			**0.85**	**43.3**	**D**			**0.84**	**38.4**	**D**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.

As shown in the table above, modifying the signal timings at this location would reduce the delay for the Highland Avenue southbound movements from 72 seconds to 53 seconds, which nearly offsets the increase in delay caused by the additional Site-generated traffic through the intersection. With the modified signal timings, the overall intersection delay of 38 seconds under the 2029 Build Conditions would be similar to the overall intersection delay of 35 seconds under the 2029 No Build Conditions without the Project in place. In addition, the signal timing adjustments results in volume-to-capacity ratios of less than 1.00 for all movements.

5.5.1.3 Highland Avenue at Webster Street

The Town of Needham's peer reviewer noted that the Highland Avenue eastbound through/right-turn movement at the intersection with Webster Street will operate over capacity during the weekday morning peak hour under 2029 Build Conditions, with an increase in delay of 26 seconds per vehicle generated by the Project. The Proponent was requested to investigate measures to mitigate this impact to operations.

The Proponent has reviewed the signal timings at the intersection of Highland Avenue at Webster Street during the weekday morning peak hour and determined that if the following signal timing adjustments were made, operations would improve for the eastbound approach without adversely impacting movements on the other approaches:

- Increase cycle length to 130 seconds
- Provide the following splits for each movement:
  - 65 seconds for the Highland Avenue eastbound/westbound approaches, with a 16 second leading westbound left-turn phase
  - 28 seconds for exclusive pedestrian crossings
  - 37 seconds for the Webster Avenue northbound/southbound approaches

Table 5-6 summarizes the intersection capacity analyses at the intersection of Highland Avenue at Webster Street during the weekday morning peak hour with the revised signal

timings in place. It should be noted that the changes in operation are relative to future conditions with the MassDOT roadway improvement project in place. The intersection capacity worksheets are included in Appendix D.

Table 5-6 Signalized Intersection Capacity Analysis Summary – Highland Avenue at Webster Street

	2029 No-Build Condition					2029 Build without Mitigation					2029 Build with Mitigation				
Location / Movement	**v/c [a]**	**Del [b]**	**LOS [c]**	**50 Q [d]**	**95 Q [e]**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**
Highland Ave at Webster Street															
Weekday Morning															
Highland Ave EB L	0.14	22.7	C	13	50	0.14	22.7	C	13	50	0.12	22.1	C	14	52
Highland Ave EB T/R	1.00	67.6	E	290	#745	1.08	93.4	F	330	#830	0.92	49.1	D	366	#861
Highland Ave WB L	0.55	20.9	C	32	109	0.55	21.5	C	32	109	0.63	27.0	C	39	#152
Highland Ave WB T/R	0.64	18.5	B	180	473	0.64	18.6	B	182	480	0.61	19.1	B	223	531
Webster St NB L/T	0.90	56.0	E	189	#471	0.90	56.0	E	189	#471	0.86	54.6	D	223	#474
Webster St NB R	0.40	24.4	C	25	122	0.40	24.4	C	25	122	0.47	30.2	C	51	177
Webster St SB L/T/R	>1.20	35.0	D	69	#160	>1.20	35.0	D	69	#160	>1.20	39.1	D	82	164
Overall	**0.91**	**39.2**	**D**			**0.95**	**46.3**	**D**			**0.87**	**36.8**	**D**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.

As shown in the table above, modifying the signal timings at this location would reduce the delay for the Highland Avenue eastbound through/right movements from 93 seconds to 49 seconds, which more than offsets the increase in delay caused by the additional Site-generated traffic through the intersection. With the modified signal timings, the overall intersection delay of 37 seconds under the 2029 Build Conditions would be lower than the overall intersection delay of 39 seconds under the 2029 No Build Conditions without the Project in place.

5.5.1.4 Highland Avenue at 1st Avenue

The Town of Needham's peer reviewer noted that the Highland Avenue westbound left/through movement at the intersection with 1st Avenue will be well over capacity during the weekday evening peak hour under both 2029 No Build and Build Conditions. The Proponent was requested to consider measures to reduce delay and improve operations at this location.

The Proponent has reviewed the signal timings at the intersection of Highland Avenue at 1st Avenue during the weekday evening peak hour and determined that if the following signal timing adjustments were made, operations would improve for the westbound approach without adversely impacting movements on the other approaches:

- Increase cycle length to 115 seconds
- Provide the following splits for each movement:
  - 50 seconds for the Highland Avenue eastbound/westbound approaches, with 3 second leading pedestrian intervals

- 29 seconds for the southbound driveway approach and the crosswalk across Highland Avenue
- 36 seconds for the 1st Avenue northbound approach

Table 5-7 summarizes the intersection capacity analyses at the intersection of Highland Avenue at 1st Avenue during the weekday evening peak hour with the revised signal timings in place. The intersection capacity worksheets are included in Appendix D.

Table 5-7 Signalized Intersection Capacity Analysis Summary – Highland Avenue at 1st Avenue

	2029 No-Build Condition					2029 Build without Mitigation					2029 Build with Mitigation				
Location / Movement	**v/c [a]**	**Del [b]**	**LOS [c]**	**50 Q [d]**	**95 Q [e]**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**
Highland Avenue at 1st Avenue															
Weekday Evening															
Highland Ave EB L/T	0.65	23.6	C	192	#418	0.68	24.2	C	203	#444	0.58	22.0	C	231	427
Highland Ave EB R	0.19	2.4	A	0	12	0.19	2.4	A	0	12	0.19	2.7	A	0	24
Highland Ave WB L/T	>1.20	>120	F	~626	#975	>1.20	>120	F	~630	#980	1.08	76.8	E	~651	#1090
1st Ave NB L	0.69	27.3	C	222	296	0.69	27.3	C	222	296	0.82	46.4	D	291	#532
1st Ave NB L/T/R	0.55	23.9	C	144	216	0.55	23.9	C	144	216	0.68	37.6	D	207	#396
Driveway SB L/T/R	0.10	44.5	D	2	15	0.10	44.5	D	2	15	0.06	52.1	D	3	13
Overall	**0.99**	**81.5**	**F**			**0.99**	**82.0**	**F**			**0.95**	**50.1**	**D**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

As shown in the table above, modifying the signal timings at this location would reduce the delay for the Highland Avenue eastbound through/right movements from over 120 seconds to 77 seconds, which is better than the operations under the 2029 No Build Conditions without the Project in place. The overall intersection level of service would improve from LOS F to LOS D with the signal timing adjustments.

5.5.1.5 Hunting Road at Kendrick Street

The Town of Needham's peer reviewer noted that the Hunting Road northbound approach to Kendrick Street will be well over capacity during the weekday morning peak hour under 2029 No Build and Build Conditions. The Proponent was requested to consider measures to reduce delay and improve operations at this location.

The Proponent has reviewed the signal timings at the intersection of Hunting Road at Kendrick Street during the weekday morning peak hour and determined that if the following signal timing adjustments were made, operations would improve for the northbound approach without adversely impacting movements on the other approaches:

› Maintain cycle length of 90 seconds
› Provide the following splits for each movement:
  - 29 seconds for the Kendrick Street eastbound/westbound approaches, with a 12 second leading westbound left-turn phase

- 37 seconds for the Hunting Road northbound/southbound approaches, with an 11 second lagging southbound left-turn phase
- 24 seconds for exclusive pedestrian crossings

Table 5-8 summarizes the intersection capacity analyses at the intersection of Hunting Road at Kendrick Street during the weekday morning peak hour with the revised signal timings in place. The intersection capacity worksheets are included in Appendix D.

Table 5-8 Signalized Intersection Capacity Analysis Summary – Hunting Road at Kendrick Street

	2029 No-Build Condition					2029 Build without Mitigation					2029 Build with Mitigation				
Location / Movement	**v/c [a]**	**Del [b]**	**LOS [c]**	**50 Q [d]**	**95 Q [e]**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**	**v/c**	**Del**	**LOS**	**50 Q**	**95 Q**
Hunting Road at Kendrick Street															
Weekday Morning															
Kendrick St EB L/T/R	0.43	19.5	B	109	#252	0.43	19.6	B	110	#253	0.49	23.5	C	124	#298
Kendrick St WB L	0.23	11.0	B	20	71	0.23	11.0	B	20	71	0.26	13.6	B	23	77
Kendrick St WB T/R	0.31	12.4	B	72	213	0.33	12.7	B	78	227	0.37	15.8	B	93	249
Hunting Rd NB T/R	>1.20	>120	F	~285	#461	>1.20	>120	F	~285	#461	0.93	60.3	E	219	#386
Hunting Rd NB R	0.39	0.7	A	0	0	0.39	0.7	A	0	0	0.39	0.7	A	0	0
Hunting Rd SB L	0.42	38.0	D	32	65	0.45	38.2	D	34	69	0.39	34.1	C	31	63
Hunting Rd SB T/R	0.14	24.3	C	28	60	0.14	24.3	C	27	60	0.11	20.8	C	24	54
Overall	**0.68**	**41.7**	**D**			**0.68**	**42.1**	**D**			**0.67**	**22.3**	**C**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

As shown in the table above, modifying the signal timings at this location would reduce the delay for the Hunting Road northbound movements from over 120 seconds to 60 seconds, which is better than the operations under the 2029 No Build Conditions without the Project in place. The overall intersection level of service would improve from LOS D to LOS C with the signal timing adjustments.

The traffic signal at this intersection is coordinated with the intersection of Kendrick Street at the Route 128/I-95 Southbound Ramps to the east, which was not included as a study area intersection in the TIA. It will be confirmed that modifying the splits at the Hunting Road at Kendrick Street intersection will not adversely impact operations at the adjacent signalized intersection before implementing the signal timing adjustments

5.5.1.6 Central Avenue at Cedar Street and Webster Street

The Town of Needham's peer reviewer noted that the Webster Street and Cedar Street approaches to Central Avenue are expected to operate well over capacity with long delays and queues under 2029 No-Build and Build conditions, particularly during the weekday AM peak hour. The Proponent was requested to conduct a signal warrant analysis to assess whether a warrant for installation of traffic signal will be met at either of these locations. Central Avenue, Cedar Street, and Webster Street are all under local Town jurisdiction.

As requested, signal warrant analyses have been conducted at the intersections of Central Avenue at Cedar Street and Central Avenue at Webster Street. The warrants have been conducted for the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions. The warrants are based on peak hour data projected throughout the day based on the hourly distribution of traffic at a nearby MassDOT count station on Highland Avenue. Table 5-9 presents the results of the signal warrant analyses and the warrant analysis worksheets are included in Appendix D.

Table 5-9 Central Avenue Traffic Signal Warrants Analysis Summary

Location	Condition	Warrant 1 (8-Hour) Met	Warrant 2 (4-Hour) Met	Warrant 3 (Peak Hour) Met
Central Avenue at Cedar Street	2022 Existing	Yes	Yes	No
	2029 No Build	Yes	Yes	No
	2029 Build	Yes	Yes	Yes
Central Avenue at Webster Street	2022 Existing	Yes	No	No
	2029 No Build	Yes	Yes	No
	2029 Build	Yes	Yes	No

Note: Based on 85th-percentile speeds under 40 miles per hour, per posted speed limits on Central Avenue

As shown in the table above, signals at both intersections along Central Avenue are warranted by at least one warrant under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. The addition of Site-generated traffic does not trigger an intersection from not having a traffic signal being warranted to warranting a traffic signal.

Because both intersections warrant signals under Existing and No Build Conditions and because less than 10 percent of the Project-generated trips are expected to travel through these two intersections per the TIA, the Proponent is not proposing to signalize either of these intersections. Mitigation for the proposed Project is focused on locations that are expected to carry a higher proportion of Site-generated traffic. However, the signal warrants conducted provide information to the Town of Needham that a signal is warranted at each of these locations. In addition, the Proponent is proposing to fund the installation of a traffic signal at the intersection of Central Avenue at Gould Street, which is expected to help operations at these two unsignalized intersections by creating additional gaps in the traffic flow along Central Avenue that will help create additional opportunities for vehicles turning onto and off-of Central Avenue.

5.5.2 Conceptual Roadway Plans

As noted previously, the Proponent is proposing to expand the cross section of Gould Street between Highland Avenue and TV Place and to install new traffic signals at the intersections of Gould Street at the Project Site driveway and Central Avenue at Gould Street. Detailed conceptual roadway improvement plans have been developed for these locations to verify the feasibility of constructing such improvements. The plans show the proposed lane widths and offsets, layout lines and jurisdictions, and adjacent land uses. The conceptual plans are included in Appendix D.

5.5.3 Gould Street Bicycle and Pedestrian Enhancements

As stated in the TIA, mitigation along Gould Street includes improved pedestrian accommodations along the Site frontage and new bicycle accommodations along the corridor. Based on feedback from the local neighborhood and the Town of Needham, the proposed bicycle and pedestrian enhancements have been revised since the filing of the ENF to provide better accommodations for all users. The Proponent is committed to funding the design and construction of the following improvements:

- Bi-directional sidewalk-level separated bicycle facilities on the east side of Gould Street along the Site frontage between Highland Avenue and just north of TV Place
- Shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately ½ mile between just north of TV Place and Central Avenue
- Sidewalk improvements along the west side of Gould Street between Highland Avenue and Noanett Road.
- A new pedestrian facility on the east side of Gould Street along the Site frontage between Highland Avenue and just north of TV Place
- A new crosswalk for pedestrians and bicyclists across Gould Street at the location of the abandoned railroad right-of-way with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers.
- A four-foot-wide on-road unmarked bicycle-accommodating shoulder on the southbound side of Gould Street to accommodate southbound bicyclists who may want to continue on-road and not cross Gould Street to access the bi-directional sidewalk-level separated bicycle lanes on the east side of Gould Street.

The Proponent will coordinate with the Town of Needham and MassDOT to ensure that the proposed accommodations tie into facilities on adjoining roadways, including the new bicycle facilities currently under construction by MassDOT on Highland Avenue.

5.5.4 Noanett Road Improvements

Based on feedback from the local community, the Proponent will include mitigation measures to discourage drivers from using Noanett Road as a cut-through to access Central Avenue and to improve pedestrian accommodations. Specifically, the Proponent is proposing the following measures:

- Reconfiguring the sidewalk ramps on the northwest and southwest corners of the intersection of Noanett Road and Gould Street to be ADA accessible and striping of a crosswalk across the Noanett Road approach to Gould Street
- Installing “No Cut-Through Traffic” signs limiting access to residents only between the hours of 7:00-10:00 AM and 3:00-6:00 PM .
- Commissioning a police detail stationed in an unmarked cruiser, who will issue citations to violators upon opening of the Project for the first three months and at other such intervals from time to time, as required
- Installing “Blind Driveway” and “Slow Children” signs as needed

As Noanett Road and Gould Street are under local jurisdiction, the Proponent will coordinate with the Town of Needham on the implementation of the proposed improvements.

5.5.5 Hunting Road Radar-Embedded Speed Limit Signs

Based on feedback from the local community, the Proponent will also include mitigation measures to address vehicle speeding concerns on Hunting Road. The Proponent will fund the installation of two radar-embedded speed limit signs to encourage lower vehicle speeds. The speed limit signs will display the speed limit and the speed of the approaching driver, informing the driver if they are exceeding the speed limit. The specific locations of the two radar-embedded speed limit signs will be based on coordination with the local neighborhood and the Town of Needham.

5.5.6 Highland Avenue Bicycle Accommodations

Portions of Highland Avenue within the study area are currently under construction as part of the MassDOT Needham-Newton Corridor Project (MassDOT Project No. 606635). As part of this project, new raised bicycle lanes will be constructed in each direction along Highland Avenue between Webster Street and just east of Gould Street / Hunting Road and between Wexford Street and the Charles River.

The segment of Highland Avenue within the Route 128/I-95 interchange (including the bridge over Route 128/I-95) was recently rebuilt and reconstructed as part of the Route 128/I-95 add-a-lane project. Construction was completed in 2018 and included significant improvements to the pedestrian and bicycle accommodations, including new sidewalks and buffered bicycle lanes on each side of Highland Avenue. The buffered bicycle lanes in each direction are separated from the general-purpose travel lanes on Highland Avenue by a painted buffer 2-4 feet in width which provides greater separation between vehicles and bicyclists than provided by traditional bicycle lanes. In addition, pedestrian and bicycle crossings were provided across all the interstate on-ramps and off-ramps, with signage and pavement markings included to enhance the visibility of the crossing pedestrians and bicyclists, with green paint used for the bicycle crossings.

The Proponent will coordinate with MassDOT to ensure the proposed pedestrian/bicycle improvements along Gould Street will tie into the accommodations along Highland Avenue. As the design for Highland Avenue went through many years of review and coordination, the Proponent will respect MassDOT's recent and ongoing work on Highland Avenue and enhance the connections between Highland Avenue, the Site, and the nearby residential areas.

5.6 Transportation Demand Management

The Proponent is committed to providing a robust Transportation Demand Management (TDM) program to reduce single occupant driving and increase the use of alternative forms of transportation to access the workplace. As described in the TIA, the proposed TDM plan will include the following measures:

- Providing an Employee Transportation Advisor who will coordinate with the local Transportation Management Association
- Provide up to 104 secure, covered bicycle parking spaces for Tenant's employees and up to 50 public bicycle spaces for visitors and patrons (for a total of 154 bicycle parking spaces on-Site)
- Providing EV shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line)
- Provide EV charging stations at 25 percent of all parking spaces located on-Site
- Requiring tenants to provide a 50 percent transit pass subsidy for their employees
- Carpool assistance and incentives
- Emergency ride home
- Bicycling/walking incentives and amenities
- Provide on-site locker rooms and showers for employees
- Offer on-site amenities for employees to reduce midday trip making
- Telecommuting and compressed workweeks, when feasible
- Display in the Main Lobby transportation-related information for tenants' employees and visitors
- Promotional efforts

In addition, the Proponent is committed to joining the 128 Business Council, which is the local Transportation Management Association (TMA) for the area.

The following sections provide additional details on specific items of the TDM plan, as requested by MassDOT and the Town of Needham's peer reviewer.

5.6.1 Shuttle and Transit Connection

The Proponent is committed to providing shuttle service between the Project Site and nearby transit stations, using a fully EV-operable vehicle. The Site is located approximately two miles from the nearest Green Line D Branch station at Newton Highlands and less than a mile from the nearest commuter rail station at Needham Heights. The shuttle service will travel between the Project Site and both transit stations, providing a connection to the greater MBTA transit network for employees and visitors who wish to take transit to/from the Project Site. This will allow commuters who live closer to Boston to easily access the Project Site without the need to use a private vehicle.

As described in Section 5.4.4, the nearest MBTA Bus Route 59 stop to the Project Site is approximately 0.5 miles from the Project Site. Rerouting the Route 59 bus to directly serve the Project Site, service would cut service to the residential neighborhoods along Webster Street and Central Avenue. By providing a dedicated shuttle between the Project Site and nearby transit nodes, the Project Site can be directly connected with the MBTA transit system without impacting the bus service for the residential neighborhoods along Webster Street and Central Avenue.

5.6.2 Electric Vehicle Charging

To promote the use of electric vehicles and to accommodate a future increase in electric vehicles on the roadway, the Project Site will be equipped with EV charging stations. Approximately 25 percent of the parking spaces in each parking area (the parking garage, the surface lot, and the underground garage) will be equipped with electric vehicle parking stations, with consideration as to how increased electric vehicle capacity can be implemented in the future as warranted by demand and market conditions.

5.6.3 Emergency Ride Home

Tenant's employees will be able to take advantage of the 128 Business Council's emergency ride home program. This program provides commuters who use alternative transportation with a guaranteed ride home in the event of an emergency. To use this program, employees can be reimbursed for a taxi or ride-share ride for trips within 10 miles of the Project Site or be reimbursed for the cost of a rental car for trips more than 10 miles away from the Project Site.[4]

5.6.4 Carpool Assistance

The Proponent will have an on-Site Employee Transportation Coordinator. Part of the job of the Employee Transportation Coordinator may be to assist in helping employees coordinate carpools, such as by creating a database of employees interested in carpooling and linking them with other employees interested in carpooling who live in the same direction. The Employee Transportation Coordinator may also provide incentives such as raffles with small prizes and other events to promote carpooling and commuting via transit, walking, and biking.

5.6.5 Desired TDM Goals

The Proponent is committed to implementing the TDM measures to the greatest extent feasible to reduce single-occupancy vehicle travel to and from the Project Site. The Proponent will use the 128 Business Council as a resource when implementing the TDM measures as the 128 Business Council has many years of experience with TDM plans as a Transportation Management Association.

As presented in the TIA, the trip generation estimates were developed assuming 100 percent of the Site-generated traffic would use private vehicles to access the Project Site. This was a conservative analysis used to identify the "worst-case" scenario of vehicular impacts that the Site could generate. With the proposed TDM program, the investment in pedestrian and bicycle infrastructure, and the dedicated shuttle between the Site and nearby transit stations, the Proponent is committed to ensuring that the percentage of Project Site-generated traffic using private vehicles is less than 100 percent. With the future of hybrid work schedules and

4 Additional details of the emergency ride home program can be found on the 128 Business Council's website at the link below: https://128bc.org/resources/emergency-ride-home/

employees working from home, it is also likely that not all employees who work on-Site will commute to the workplace five days a week.

Data from the US Census Bureau was reviewed to determine the actual mode share characteristics for employees who commute to workplaces in the Town of Needham. Based on the data, approximately 95 percent of all employees who commute to workplaces in the Town of Needham do so via private automobile while two percent use public transit and three percent walk or bike. With the strong TDM program and mitigation measures, the percentage of employees that take alternative forms of transportation is anticipated to be higher than that generated by other workplaces within the Town of Needham. The existing mode share data is included in Appendix D.

The success of the TDM plan will be measured based on the results of the transportation monitoring program, as outlined in the following section. The Proponent will use the results of the transportation monitoring program to review the current TDM program and decide if any adjustments are necessary to further engage the employees and patrons of the Project Site to encourage the use of walking/biking, carpooling, and public transportation.

5.7 Transportation Monitoring Program

The Proponent is committed to a strong transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network. Based on feedback from MassDOT and the Town of Needham's peer reviewer, the transportation monitoring program has been revised to include additional data collection and commitments.

The transportation monitoring program will begin six months after full occupancy of the proposed development and continue for a period of five years. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham. Details of the transportation monitoring program are provided in the following sections.

5.7.1 On-Site Parking Facility Traffic Monitoring

The actual number of weekday morning peak hour, weekday evening peak hour, and weekday daily vehicle trips generated by the Project will be measured using simultaneous automatic traffic recorder (ATR) counts or via a parking revenue control system at each parking entrance/exit for a continuous 24-hour period on a typical weekday.

These volumes entering and exiting each parking facility will be compared against the estimated Project-generated vehicle trips presented in this report to determine if the Project Site is generating trips at a rate higher or lower than what was projected.

5.7.2 Intersection and Roadway Traffic Monitoring

The traffic monitoring program will include collecting weekday morning and weekday evening peak period turning movement counts on a non-holiday week, during midweek

days at the following study area intersections that represent the key vehicular gateways to the Project Site and are the focus of the proposed roadway mitigation:

- Central Avenue at Gould Street
- Gould Street at TV Place
- Gould Street at the Project Site driveway
- Highland Avenue at Gould Street / Hunting Road

The traffic monitoring program will also include collecting continuous 48-hour ATR counts at the following locations:

- Gould Street north of Highland Avenue
- Site driveway east of Gould Street
- TV Place east of Gould Street

If the results of the monitoring study indicate that the actual traffic increase generated by the Project exceeds the traffic projections contained within the TIA by 10 percent or more, the Proponent will work with the Town of Needham and MassDOT to determine if the monitoring program should be expanded, and if so, which additional intersections should be included.

5.7.2.1 Operational Analyses

The traffic monitoring program will include capacity and queue analyses during the weekday morning and weekday evening peak hours at the four intersections identified in the previous section. The results of the operational analyses will be summarized in tabular form and compared against the projected operational results presented in the TIA.

5.7.3 Travel Survey

The proposed transportation monitoring program will include an annual travel survey of tenants' employees and patrons of the Project Site. The survey will be conducted by the Proponent and will include details on the modes of transportation that tenants' employees and patrons use to access the Project Site as well as the effectiveness of the proposed TDM programs. The survey will also ask about hybrid work schedules to determine how frequently employees commute to the Project Site versus working from home. .

5.7.4 Transportation Monitoring Program Results

Based on the results of the transportation monitoring program, the Proponent will evaluate the TDM program to see if any adjustments are necessary to further engage the tenant's employees and patrons of the Project Site to encourage the use of walking/biking, carpooling, and public transportation. If the transportation monitoring program indicates that the actual traffic increase generated by the Project exceeds the traffic projections contained within the TIA by 10 percent or more, the Proponent will increase funding for the TDM program and add more measures to try and reduce the share of single occupancy vehicles accessing the Project Site. The Proponent will coordinate with the Town of Needham and MassDOT to determine potential additional TDM measures that could be implemented

if the actual Site-generated volumes exceeds the projections in the TIA by 10 percent or more.

\\vhb.com\gbl\proj\Boston\15306.00\cad\te\planmisc\Concepts\Alt 5\15306.00 - Concept - alt5 - 2way CT & Walk East - v4.dwg

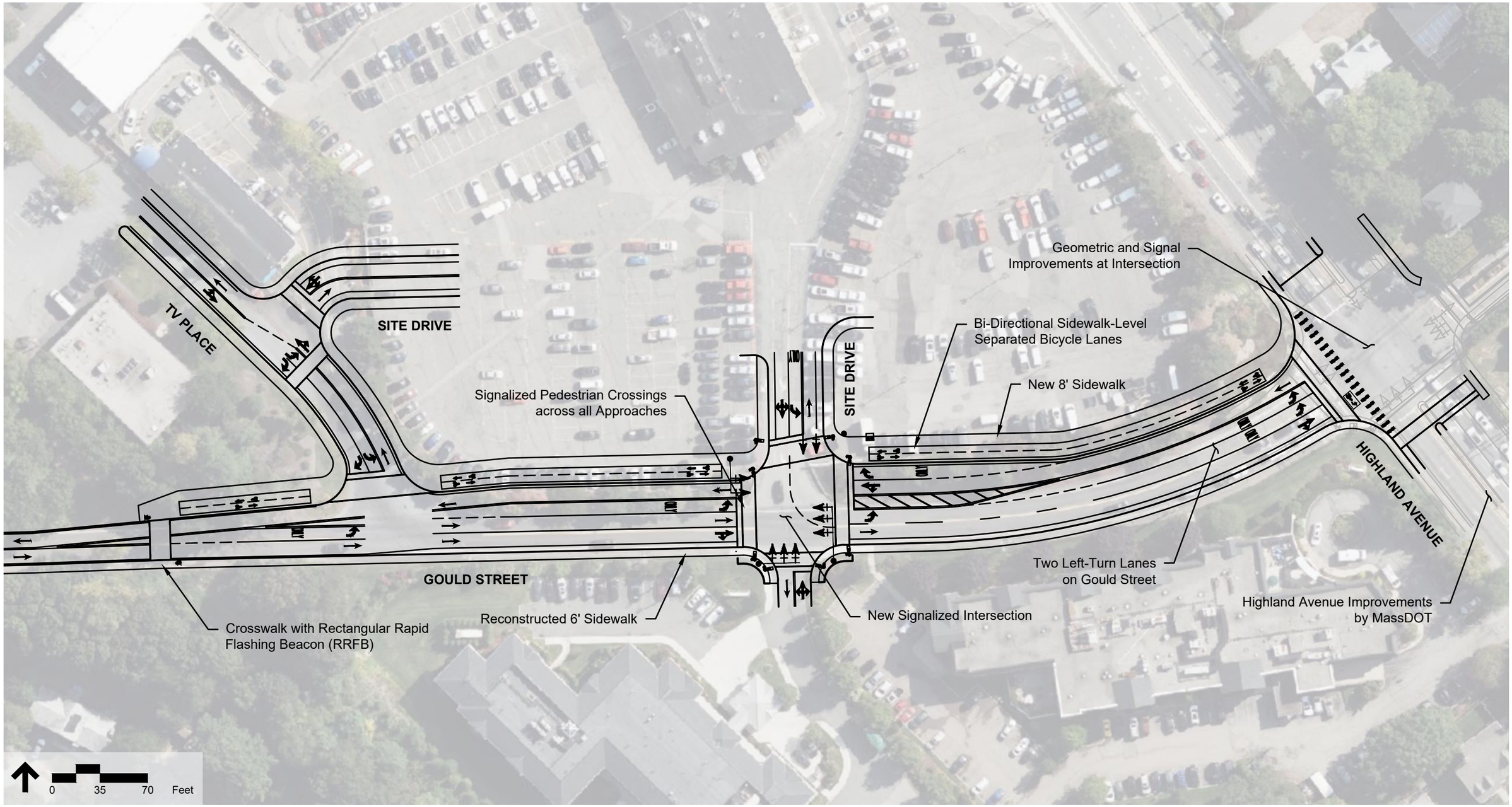


Figure 5.1

Proposed Gould Street
Roadway Improvements

Highland Science Center
Needham, Massachusetts

6

Solid and Hazardous Waste

This chapter provides responses to comments related to solid and hazardous waste.

6.1 Project Site Background

Over the past approximately 70 years, the Project Site had been occupied by the Muzi automotive dealerships (Muzi Ford and Muzi Chevrolet). The dealerships' complex consisted of two 2-story buildings containing showrooms and service bays, a body repair shop and a single-story former car wash. Decommissioning of the automotive service facilities and car wash was performed in phases beginning in November and December 2021. The abatement of hazardous building materials was completed in January 2022 after which the former buildings were demolished, and the site was leveled.

Subsurface assessment activities indicate that historical site filling as well as oil and hazardous materials that were used during operation of the automotive dealerships have affected localized areas of soil at the Project Site. As a result, release conditions have been identified in soil at portions of the Project Site to which Release Tracking Numbers (RTNs) 3-36733, 3-37285 and 3-37373 were assigned by the Massachusetts Department of Environmental Protection ("DEP").

RTN 3-36733 pertains to Reportable Concentrations of naphthalene, 1,4-dichlorobenzene and 2-methylnaphthalene that were detected in soil by the previous owner along the perimeter of the former car wash building that formerly occupied the northern portion of the Project Site. Based upon the results of a Method 3 Risk Characterization, the former owner submitted a Permanent Solution Statement with No Conditions to the DEP in August 2021.

RTN 3-37285 pertains to gasoline contamination that was encountered in soil during the decommissioning of an underground storage tank (UST) in January 2022. Under the provisions of a DEP approved Immediate Response Action (IRA) Plan, approximately 1,000 cubic yards of contaminated soil were excavated and removed off-site. Based upon the response actions that were completed at the Project Site in conjunction with the results of soil testing, an IRA Completion report was submitted to the DEP in May 2022.

More recently RTN 3-37373 was assigned to the Project Site due to Reportable Concentrations of total metals (arsenic, antimony, cadmium, chromium, lead, mercury, and zinc); polychlorinated biphenyls (PCBs); polycyclic aromatic hydrocarbons (PAH), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs); and petroleum hydrocarbons that were detected during soil pre-characterization assessment activities.

6.2 Key Findings and Benefits

- Release conditions have been identified at portions of the Project Site to which RTNs 3-36733, 3-37285 and 3-37373 were assigned by the DEP.
- Based upon the results of subsurface assessment activities, the contaminants of concern in soil are considered to be petroleum hydrocarbons, PAHs, PCBs, VOCs, antimony, arsenic, cadmium, lead, mercury and zinc. Although the affected soil is located above the surface of groundwater, an additional assessment will be performed to evaluate a potential release in groundwater.
- It is anticipated that a majority of the contaminated soil will be excavated and removed off-site to facilitate construction of the below grade levels and foundations of the proposed buildings. Soil remaining at the site which may be affected by residual levels of the contaminants of concern will either be covered by the proposed building footprints or by clean fill material that is overlain by hardscaping and/or landscaping.
- The remedial actions that will be completed during construction will result in a Condition of No Significant Risk and a Permanent Solution for the identified release conditions at the Project Site.

6.3 Regulatory Context

Abatement and disposal of hazardous materials (or hazardous waste), if encountered, will be performed under the provisions of MGL c.21, OSHA, and the Massachusetts Contingency Plan (MCP) by specialty contractors who are experienced and licensed in handling materials of this nature.

It is currently anticipated that construction of the Project and Project Site improvements will require off-site removal of excess soil, resulting primarily from the construction of the below grade parking levels and foundation system. The Proponent has retained a Licensed Site Professional (LSP) to manage the environmental aspects of the Project, including proper management and/or removal of soil encountered during construction. Removal of excess excavated soil will be conducted in accordance with the DEP's current regulations and policies.

In accordance with the provisions of section 310 CMR 40.0444 of the MCP, a Release Abatement Measure (RAM) Plan will be prepared and submitted to DEP prior to non-exploratory earthwork activities, such as bulk excavation or utility installation. The RAM Plan will outline requirements for the management and handling of site soils affected by the above-described release conditions.

As further discussed below, chemical testing of soil samples has been performed to facilitate reuse/disposal of the soils off-site depending on the acceptance criteria of specific facilities. The soils transported off-site will be reused/disposed of in accordance with the MCP and other regulatory requirements. Disposal of materials will be tracked via Material Shipping Records, Bills of Lading and/or other methods, as required to document their proper and legal disposal.

Although groundwater is not anticipated to be encountered during site excavation activities, procurement of temporary groundwater dewatering discharge permits from the EPA, DEP, Town of Needham, and/or the Massachusetts Water Resource Area (MWRA) may be

required for pumping and off-site discharge of groundwater. If on-site recharge is not feasible and off-site discharge is required, the appropriate dewatering discharge permits will be obtained.

6.4 Contamination

A series of subsurface explorations have been completed across the Project Site to pre-characterize soils for off-site removal in anticipation of the planned redevelopment. The explorations were performed in a grid pattern consisting of 80 cells in which soil samples were obtained continuously to a depth ranging from approximately 25 to 30 feet below ground surface. As part of the subsurface exploration programs, over 350 composite and discrete soil samples were submitted for total MCP-14 metals, total petroleum hydrocarbons (TPH), extractable petroleum hydrocarbons (EPH), volatile petroleum hydrocarbons (VPH), VOCs, SVOCs, PCBs, pH, reactivity, ignitability, conductivity, and toxicity characteristic leaching procedure (TCLP).

In summary, portions of soil at the Project Site have been affected by concentrations of petroleum hydrocarbons, PAHs, PCBs, VOCs, antimony, arsenic, cadmium, lead, mercury and zinc which exceed the applicable MCP RCS-1 reporting thresholds.

Upon completion of construction, any affected soil that may remain in- place at the Project Site and will be addressed in Permanent Solution Statement to be prepared for the Project Site.

Groundwater is located at depths ranging from approximately 25 to 30 feet below ground surface. Based upon the scope of construction it is not anticipated that groundwater will be encountered during excavation activities.

Although soil testing indicates that the contaminated soil is located above the surface of groundwater, sampling and analysis of groundwater will be performed to evaluate a potential release in groundwater.

6.5 Measures to Protect Public Health

Remedial actions will be implemented as part of Project construction. A Release Abatement Measure Plan will be prepared and implemented in accordance with 310 CMR 40.0442(3) of the MCP and DEP Policy #WSC-00-425 “Construction of Buildings in Contaminated Areas” to address the requirements for construction within the release site. The RAM Plan will include provisions for the excavation, management and off-site removal of contaminated soil. As part of the RAM Plan, a Risk Characterization will be prepared to evaluate risks to current and future human receptors (i.e., workers, nearby residents and future site occupants) that may be exposed to levels of contaminants when the fill material is uncovered and/or excavated or to materials that may remain at the Project Site after construction. The results of the testing will also be utilized to prepare an Environmental Monitoring Plan to mitigate potential exposure to the surrounding public from dust particulates and volatile organic compounds during construction.

Construction period access to the Project Site will be restricted to the personnel involved in construction and/or remediation activities. Project activities will be conducted in accordance with OSHA regulations, a Soil Management Plan, and a site-specific Health and Safety Plan to be developed for use by site workers and to protect the general public.

The excavation and management of contaminated soil will be performed under the supervision of the Proponent's LSP. To prevent exposures to the general public during excavation, monitoring for dust and VOCs will be performed. Mitigation measures may include spraying dry soils with water or a surfactant agent prior to excavation, covering stockpiles with polyethylene, limiting the excavation area, street sweeping or ceasing excavation operations during high wind conditions.

Construction for the proposed buildings' foundations and below grade floor levels will result in the excavation and off-site removal of a majority of the contaminated soil. Contaminated soil remaining at the Project Site upon completion of construction will be covered by either the footprints of the proposed buildings or by clean fill material that is overlain by hardscaping and/or landscaping. A potential vapor intrusion pathway will be eliminated by the below grade levels of ventilated parking that will occupy the entire footprints of the proposed buildings. As a result, a Condition of No Significant Risk will exist, and a Permanent Solution will be achieved for the Project Site.

7

Climate Change

This chapter provides responses to comments related to climate change adaptation and resilience and sustainability.

7.1 Key Findings and Benefits

The Project will include several benefits related to climate change.

- Improved water quality and stormwater management;
- Improved open space along Highland Avenue and Gould Street;
- Decrease in impervious surface and implementation of permeable pavers to reduce impacts related to urban flooding and heat island effect;
- The Project will utilize the LEED v4 BD+C rating system for the Core and Shell building components
- The proposed lab/office building will have hybrid heating systems and have a high-performance building enclosure–which would result in an estimated 48 percent energy usage savings and in a reduction by approximately 36 percent in stationary source GHG emissions compared to a code-baseline design.
- The Proponent will implement roadway improvements and a comprehensive TDM program to reduce mobile source GHG emissions relative to the baseline, including installing EV parking with charging stations.

7.2 Regulatory Context

7.2.1 MEPA Greenhouse Gas Policy and Protocol

The Executive Office of Energy and Environmental Affairs (EEA) has developed the "MEPA GHG Policy," which requires project proponents to identify and describe feasible measures to minimize both mobile and stationary source GHG emissions generated by their proposed project(s). Mobile sources include vehicles traveling to and from a project. Stationary sources include on-site boilers, heaters, and/or internal combustion engines (direct sources) as well as the consumption of energy in the form of electricity (indirect sources). Greenhouse gases include several air pollutants, such as carbon dioxide (CO_2), methane, hydrofluorocarbons, and perfluorocarbons. The MEPA GHG Policy calls for the evaluation of CO_2 emissions for a land development project because CO_2 is the predominant man-made contributor to global warming. This evaluation uses the terms CO_2 and GHG interchangeably.

The MEPA GHG Policy states that all projects undergoing MEPA review requiring the submission of an Environmental Impact Report (EIR) must quantify the project's GHG emissions and identify measures to avoid, minimize, or mitigate such emissions. In addition to quantifying project related GHG emissions, the MEPA GHG Policy requires proponents to quantify the effectiveness of proposed improvements in terms of energy savings, and therefore, potential emissions reductions. The goal of the MEPA GHG Policy is to identify and implement measures to minimize or reduce the total GHG emissions anticipated to be generated by that respective project.

7.2.2 Massachusetts Stretch Energy Code

As part of the Green Communities Act of 2008, Massachusetts developed an elective building code, known as the "Stretch Energy Code," that gives cities and towns the ability to choose stronger energy performance in buildings than otherwise required under the state building code. Codified by the Board of Building Regulations and Standards as 780 CMR Appendix 115.AA of the 9th edition Massachusetts Building Code, the Stretch Energy Code is an appendix to the Massachusetts Building Code, based on further amendments to the International Energy Conservation Code (IECC). The Stretch Energy Code increases the energy efficiency code requirements for new construction and major residential renovations or additions in municipalities that adopt it. Needham adopted the Stretch Energy Code in 2019.

The Project buildings are subject to the November 2020 Energy Code. A baseline model incorporating the November 2020 Energy Code has been considered and is included in the following analysis. The Stretch Energy Code requires a 10 percent improvement in energy usage over this baseline model. The Base Case described herein includes three Section C406 measures and other energy conservation measures, as required. The buildings also meet the requirements of the November 2020 Energy Code envelope backstop (Section C402.1.5).

7.3 Adaptation and Resiliency

In accordance with the *MEPA Interim Protocol on Climate Change Adaptation and Resiliency*, this section describes methods of mitigation to offset the impacts related to climate change. Specifically, measures to reduce the impacts of land alteration and GHG emissions are discussed.

7.3.1 Measures to Increase Resilience

To combat future climate risks, the Project will include measures to reduce the threat of urban flooding from extreme precipitation. Mitigation measures include increased open space, tree planting, permeable surfaces, and an overall decrease in impervious surfaces. Further, the on-site retention pond will slow the rate of water release from the Project Site. In running the RMAT tool, the project is noted as at-risk for extreme participation events. The on-site pond and stormwater system handle the 9.5" storm without overflowing the on-site system. The 9.5" storm is an increase in over 16% from the current 100-year storm which shows the site is designed to reduce the threat of extreme participation events in the future.

7.3.2 Resilient Massachusetts Action Team

Based on the Resilience Massachusetts Action Team (RMAT) tool, the Project is not exposed to Sea Level Rise/Storm Surge or Extreme Precipitation-Riverine Flooding but has a high risk of Extreme Precipitation-Urban Flooding and a high risk of Extreme Heat. The overall Project is scored as Moderate.

To reduce the effects from Extreme Heat events, the Proponent is developing appropriate strategies for a changing climate in the near term, as well as planning for a longer-term adaptation strategy over the course of the Project's life span. Such strategies include decreasing the total impervious surface of the Project Site and adding natural barriers to Extreme Heat, including trees and landscaping throughout the Project Site. Because the current site is an almost entirely impervious surface parking lot, the Project will significantly improve the existing conditions.

The Project received a high exposure to Extreme Precipitation because the maximum annual daily rainfall for the Project exceeds 10 inches within the overall Project's useful life and the existing impervious area of the Project Site is greater than 50%. The Project Site does not have a history of flooding, and impervious surface will be reduced.

The Recommended Planning Horizon for this Project is 2070, with a 10-year (10%) Recommended Return Period.

Rainfall volumes used for this analysis are based on the Natural Resources Conservation Service (NRCS) Tyle III, 24-hour storm and NOAA Atlas 14 precipitation depths for the Project Site.

7.3.3 Flexible Adaptation Strategies

The Proponent will take steps to reduce potential impacts related to precipitation-based flooding during future storm events, as well as negative impacts from the urban heat island effect through the proposed Project Site design. The proposed design takes into consideration the need for adaptation and can accommodate future design changes as necessary.

7.3.4 Community Resilience Workshop

The Town of Needham held a Community Resilience Workshop in May 2020 to create a dialogue on addressing future climate risks.

The Project's resilience strategy aligns well with the goals set forth in the workshop. The report demonstrates that the Town of Needham identifies flooding, severe storms, drought, and heat waves, as the greatest climate threats. To reduce the impacts of these events, the Town outlines strategies for resilience. Respondents were asked to provide their three highest climate priorities for the Town of Needham. The top three responses were Water Infrastructure, Stormwater, and Tree and Forest Management. The Project incorporates several resilience measures that will address future climate risks related to these items as discussed above in Section 7.3.1.

7.4 Greenhouse Gas Emissions

The GHG emissions assessment is composed of two components: the stationary source assessment from buildings' energy use and the mobile source assessment from vehicles trips generated by the Project.

7.4.1 Stationary Source Assessment

The following presents the results of the stationary source GHG emissions assessment, in accordance with the MEPA GHG Policy. The stationary source analysis reflects the most recent design plans for the buildings as of this filing. The proposed buildings have been designed to meet the requirements of the MEPA GHG Policy by incorporating reasonable and feasible energy conservation measures to reduce energy consumption. The proposed buildings will also meet the requirements of the Stretch Energy Code and incorporate sustainable and high-performance building design, including energy conservation measures.

7.4.1.1 Methodology

To provide for energy efficiency and reduced stationary source GHG emissions, the Proponent has evaluated the following key planning and design criteria:

- Methods to reduce overall energy demand through improved envelope construction;
- Methods to reduce overall energy demand through appropriate design and sizing of systems; and
- Methods to incorporate cost-effective energy-optimizing systems.

The buildings were modeled with the proposed building geometry, HVAC system type, occupancy schedule, and ventilation rates as defined by the current design plans.

Direct stationary source CO_2 emissions include those emissions from the facility itself, such as boilers, heaters, and internal combustion engines. Indirect stationary source CO_2 emissions are derived from the consumption of electricity, heat, or cooling from off-site sources, such as electrical utility or district heating and cooling systems. The direct and indirect stationary source CO_2 emissions from the proposed building sources are calculated through an energy and GHG analysis procedure that combines the energy model with Excel spreadsheets for pre and post-processing based on assumptions for the Project's building elements, such as (but not limited to) the specific type of use(s) and users of the buildings, building configuration and architecture type, building envelope (walls/windows), interior fit-out (where known), and HVAC equipment efficiency ratings.

The GHG mitigation measures can be divided into the buildings' construction materials, architecture, and the heating and cooling processes. The following sections present the proposed building improvements (and their correlating energy modeling parameters for reference, where applicable) that are assumed to be included as part of the Project for the purpose of this analysis. The specific proposed improvements will likely be subject to design modifications as necessary to achieve the GHG emissions reduction based on the final building program, tenants and design.

Energy Model and Analysis Conditions

The energy analysis was conducted using eQUEST v3.65. eQUEST uses the DOE2 simulation engine to estimate annual energy consumption by simulating a year of building operations based on a typical weather year and user inputs. The model estimates each building's electricity and gas usage based on building design and system assumptions using Appendix G of ASHRAE 90.1-2013.[1] The amount of consumed energy is then converted into the amount of CO_2 emitted using the standardized conversion factors.[2] CO_2 emissions were quantified for (1) the Base Case corresponding to the minimum requirements of ASHRAE 90.1-2013 with Massachusetts's amendments and (2) the Design Case, which includes all energy saving measures that were deemed to be reasonable and feasible. The stationary source assessment calculated CO_2 emissions for the following build conditions:

- **Build Condition with MA Building Code (the "Base Case"):** The Project assuming typical construction materials and building equipment/systems that meet the minimum requirements of the November 2020 energy code. This baseline is established by the energy code as being defined by ASHRAE 90.1–2013 according to the November 2020 energy code. Additionally, the Base Case adopts Section C406.1 energy conservation measures per the Stretch Code.
- **Build Condition with Energy Conservation Measures (the "Design Case"):** The Project assuming building design and system improvements that meet the MEPA GHG Policy. Based on the current design and preliminary building modeling results, the Project will meet the MEPA GHG Policy requirement for energy reduction savings and the Stretch Energy Code.

7.4.1.2 Energy Model Results and GHG Emissions

As described in Chapter 1, *Project Description*, the Project includes the construction of two lab/office buildings with a stand-alone parking garage in Needham. The lab/office buildings have a modeled area of 520,000 sf. The modeled parking garage area is 480,000 sf. The modeling was conducted using a 60 percent lab and 40 percent office split.

The Proponent must carefully consider the Project's rooftop equipment as a local Town of Needham zoning ordinance limits to 25 percent the total roof area that may be covered by structures not used for human occupancy to a maximum of 25 percent of the total roof area. The Needham ordinance specifically states that these structures include chimneys, heating, ventilating or air-conditioning equipment, solar or photovoltaic panels, elevator housings, skylights, cupolas, spires and the like. Due to this limitation, the Proponent did not initially include a heat pump system in the mechanical design of the heating plant. After reviewing the feasibility of such systems and comments from DOER, the Proponent has made space for the heat pump chiller in the current design while trying to stay at the 25 percent area limit. This inclusion has limited the Proponent's ability to consider other measures, such as solar arrays on the roof and has required the Proponent to move other equipment off of the roof. The Proponent will continue to assess the feasibility of the heat pump chiller given the space

1 American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ASHRAE 90.1-2013-Energy Standard for Buildings Except Low-Rise Residential Buildings, Appendix G, 2013.

2 Electricity converted using 654 lbs CO2 per MWh (2020 ISO New England Electric Generator Air Emissions Report). Natural Gas converted using 117 lbs CO2 per MMBtu (US Energy Information Administration).

limitations as the design progresses and more information about rooftop equipment is known.

The following presents the energy modeling analysis for the new lab/office buildings. The Section C406 measures included in the Base Case for lab/office buildings are more efficient HVAC per C406.2, lighting power density reduction per C406.3, and reduced air infiltration per C406.9. Table 7-1 provides a summary of the proposed building improvements assumed for the lab/office buildings. Key energy savings features include a high-efficiency envelope complying with the backstop requirement, improved HVAC equipment with hybrid space heating, heat pump water heating, reduced air infiltration and an improved energy recovery system. Further information on the energy modeling and envelope compliance calculations is provided in Appendix E. The energy modeling report in Appendix E was conducted before the decision was made to implement a hybrid heating system. As such the energy modeling report in Appendix E, presents a previous design as the "Proposed Design" and the now proposed design as the "Hybrid Alternative."

Table 7-1 Lab/Office Key Model Assumptions

Building Component	Base Case[1]	Design Case
Building Usage and Size	Office/Lab Building (520,000 sf); Parking Garage (480,000 sf)	
Building Exterior Envelope (Construction Assemblies)		
Roof Assembly	R 30 ci above deck: U-0.032	R-40 ci; U-0.0.25
Wall Assembly	Steel framed with R-11 cavity and R-14 c.i. with U-factor of 0.064	Steel framed with R-19 cavity and R-15 c.i. (U-0.041) & insulated spandrel glass (U-0.125) with weighted average U-factor of 0.067
Window -to-Wall Ratio	38%	38%
Windows and Glazing	Metal framing U-0.38	Metal framing U-0.30
Solar Heat Gain Coefficient	0.40	0.40
Air Infiltration	0.4 cfm/sf (Reduced per C406.1-8)	0.4 cfm/sf (Reduced per C406.1-8)
HVAC Systems and Controls		
HVAC System (Air-Side)	System 7, VAV System with Reheat	Lab: Chilled water/Hot water AHUs (100% OA system) Office: 4 Pipe Fan Coil System with a DOAS (from 100% OA units)
HVAC System (Water-Side)	3 water-cooled centrifugal chillers & 2 natural draft boilers	Three, 900 tons Water cooled centrifugal chillers, Three, 750 tons centrifugal chillers & one HP Chiller (120F supply T) designed per 25% of the heating load & eight, 4000 MBH condensing boilers
Chiller Efficiencies	6.9 COP per Table C403.3.2(7) (Improved per C406.1-1)	Chillers with COP of 6.9 HP Chiller 2.45 COP @ 30F ambient T
Boiler Efficiencies	90.2% per Table C403.3.2(5) (Improved per C406.1-1)	95%, Boiler
Energy Recovery	Modeled per Section 6.5.7.2 (b)	High efficiency ERV with 79% Effectiveness
Service Hot Water		
HW System Type	Electric Resistance	Heat Pump, UEF: 3.45
Interior Loads		

Building Component	Base Case[1]	Design Case
Lighting LPD (W/SF)	0.58 Office / 1.2 Lab / 0.162 Garage (Reduced per C406.1-2)	0.58 Office / 1.2 Lab / 0.162 Garage
Lighting Controls	Daylighting per Code	Daylighting per Code
Equipment	Lab: 7 W/SF; Office: 0.75 W/SF	Lab: 7 W/SF; Office: 0.75 W/SF

1 Base Case represents ASHRAE 90.1-2013 conditions with additional efficiency measures under the November 2020 energy code.

The total estimated annual electricity and natural gas consumption, and associated emissions for the Project are presented in Table 7-2. Under the Base Case, the CO_2 emissions are 11,058 tpy. With the currently proposed building design and system improvements, the estimated energy use reduction for the Project is 48.3 percent, which equates to a 36.5 percent (4,034 tpy) reduction in stationary source CO_2 emissions when compared to the Base Case. The proposed design reduces natural gas consumption by 93.7 percent from the Base Case and has a fossil fuel use intensity of 9.4 kBtu/sf-yr.

Table 7-2 Building Stationary Source CO_2 Emissions

	Energy Consumption			CO_2 Emissions		
	Electricity (MWh/yr)	Natural Gas (MMBtu/yr)	Total (MMBtu/yr)	Electricity (tons/yr)	Natural Gas (tons/yr)	Total (tons/yr)
Base Case[1]	19,977	77,351	145,513	6,533	4,525	11,058
Design Case	20,602	4,898	75,192	6,737	287	7,023
End-Use Savings	-625	72,453	70,321	-204	4,239	4,034
Percent Savings			**48.3%**			**36.5%**

tons/yr = short tons per year
MWh = Megawatt hour
MMBtu = million British Thermal Units
1. Base Case represents ASRAE 90.1-2013 conditions with additional efficiency measures under the November 2020 energy code.

7.4.1.3 Thermal Energy Demand Intensity and Envelope

Thermal Energy Demand Intensity (TEDI) describes the annual heating required by a building for space conditioning and for conditioning of ventilation air, estimated by using an energy model, normalized per square feet of area of conditioned space. It is reported in the units of kBtu/sf-yr. At the request of DOER, the Proponent has performed a TEDI analysis for the Project buildings. This analysis is presented in Appendix E. Under the Base Case, the heating TEDI was estimated to be 123.96 kBtu/sf-yr. The Proposed Design heating TEDI is estimated to be 12.39 kBtu/sf-yr, representing a 90 percent reduction.

The energy analysis indicates that the proposed high-performance envelope with 38 percent window to wall ratio, thermally broken windows, low glazing system U-value, high performing opaque spandrels with insulation of R-8, and high-performance heat recovery system have resulted in significant reduction in heating (and cooling) TEDI. As a result, occupant comfort has been increased, building resiliency has been improved and peak demands have been reduced significantly compared to the Baseline model. The proposed design is in line with DOER's request for a high-quality envelope, as it is above code, considers thermal bridging, uses highly-insulated curtainwall/spandrel and reduces air infiltration.

7.4.1.4 On-Site Renewable Energy

Solar photovoltaics produce electricity without generating GHG emissions, potentially offsetting some of the anticipated stationary source emissions associated with the buildings. The Proponent is exploring the opportunity to locate solar arrays on the roof of the standalone parking garage and roofs of the buildings' penthouses. Table 7-3 summarizes the feasibility assessment conducted for these areas. The estimated payback for the solar array was 8.2 years. Further information on the solar assessment is presented in Appendix E.

Table 7-3 Solar Feasibility Assessment Results

Area	System Size (kW)	Annual Production (kWh)	GHG Reduction (tons)
Building Penthouses	200	216,000	71
Parking Garage Roof	507	600,000	196

As discussed above, the Needham zoning code limits to 25 percent of the roof area the amount of mechanical equipment, penthouses and other structures on each building's roof. This limit also applies to solar arrays and places those arrays in contention with other rooftop equipment. The zoning code also limits the heights of rooftop structures, again including solar arrays, to 15 feet above the roof elevation. Given the need screen rooftop equipment, solar arrays would be limited to the penthouse roofs and still need to remain below the 15-foot limit. The Proponent is in the process of determining if solar arrays on the parking garage are allowed under the local zoning code, as the garage is already at the maximum allowed height and any solar array would likely exceed the maximum allowed height.

Given these limitations and the conceptual nature of the current design, the Proponent will commit to making these areas solar-ready. A solar-ready roof is one which is designed with the appropriate structural capacity and electrical infrastructure to support a solar PV installation if deemed feasible at a future date. When the limitations imposed by the zoning code are clarified, the Proponent will further investigate the feasibility of installing these solar arrays.

7.4.2 Mobile Source Assessment

This section presents the results of the mesoscale air quality analysis, in accordance with the MassDEP May 1991 *Guidelines for Performing Mesoscale Analysis of Indirect Sources* (the "Guidelines") and mobile source greenhouse gas (GHG) emissions assessment, in accordance with the *MEPA Greenhouse Gas Emissions Policy and Protocol* (the "MEPA GHG Policy"). The purpose of the mesoscale air quality analysis is to demonstrate there are measures that will reduce the Project-related volatile organic compounds (VOCs) and nitrogen oxides (NOx) emitted in the Project area and to determine consistency with the State Implementation Plan (SIP). The mobile source GHG emissions assessment builds off that analysis to determine the projected mobile source carbon dioxide equivalent (CO_{2e}) emissions associated with Project-generated traffic; thus, they are presented together herein.

7.4.2.1 MassDEP Guidelines for Mesoscale Analysis

According to the Guidelines[3], a mesoscale (regional) air quality analysis is required for commercial development projects that would result in 3,000 or more average daily vehicle trips. The purpose of the mesoscale air quality analysis is to estimate the area-wide emissions of VOC and NO_X emissions during a typical day in the peak ozone season (summer), consistent with the requirements of the State Implementation Plan (SIP). The mesoscale analysis evaluates the change in VOC and NO_X emissions from the average daily traffic volumes and vehicle emission rates. To demonstrate compliance with the SIP criteria, the air quality study must show the Project's change in daily (24-hour period) VOC and NO_X emissions.

MassDEP has established guidelines that define the modeling and review criteria for air quality studies prepared under MEPA. These guidelines recommend that mesoscale analyses be prepared for proposed development projects to determine the change in Project-related ozone precursor emissions. The predominant source of ozone precursor emissions anticipated from the Project is emissions from Project-related traffic. Ozone is not directly emitted by motor vehicles but is generated when VOC and NO_X emissions from motor vehicles, stationary sources, and area sources react in the atmosphere with sunlight and heat. Project-related ozone impacts are determined by assessing the changes in VOC and NO_X emissions of motor vehicles. MassDEP criteria require that proposed development projects include all reasonable and feasible emission reduction mitigation measures if the ozone emissions from the Build Condition are greater than the No-Build Condition.

7.4.2.2 Methodology

Needham is in Norfolk County which is in attainment for all National Ambient Air Quality Standards (NAAQS) criteria pollutants except for the 8-hour (1997 Revoked) and 1-hour (1979 Revoked) Ozone standards. As such, the air quality analysis calculated emission inventories of the two pollutants that contribute to the violation of the Ozone NAAQS from mobile sources: VOC and NO_X. Other criteria pollutants are not of concern for the area and are not required to be quantified.

The mesoscale analysis evaluates the change in emissions with and without the Project: specifically, daily (24-hour period) VOC and NO_X emissions from the average daily traffic volumes and vehicle emission rates.

The mesoscale air quality analysis utilizes developed traffic data (volumes, speeds, and roadway geometry) and emission factor data for Existing, No-Build, Build, and Build with Mitigation Conditions. The mesoscale study area includes all links studied by the traffic analysis. Some of the major roadways that were included in the mesoscale analysis include Highland Avenue, Webster Street, Central Avenue, and Gould Street. The mesoscale traffic and emission factor data were incorporated into the emission calculations to evaluate the changes in VOC and NO_X emissions.

Mobile source GHG emissions are based upon the traffic volumes, the distance vehicles travel and GHG emission rates. The mobile source emissions are calculated by performing a mesoscale

3 Guidelines for Performing Mesoscale Analysis of Indirect Sources, Massachusetts Department of Environmental Protection, May 1991

analysis to evaluate the changes in CO_{2e} emissions for the existing and future conditions within the traffic study area. The GHG mobile source analysis estimates the area-wide CO_{2e} emissions from vehicle traffic for a period of one year. Mobile source emissions were calculated by performing an annual GHG emissions mesoscale analysis to evaluate the estimated change in CO_{2e} emissions for the existing and future conditions within the study area.

Emission Factor Modeling

EPA's Office of Transportation and Air Quality (OTAQ) has developed the Motor Vehicle Emission Simulator (MOVES).[4] MOVES3 is EPA's motor vehicle emissions model for state and local agencies to estimate VOCs, NO_X, $CO_{2e,}$ and other emissions from cars, trucks, buses, and motorcycles.

All the vehicle emission factors used in the mesoscale analysis were obtained using EPA's MOVES3 emissions model. MOVES3 calculates emission factors from motor vehicles in mass per distance format (often grams per mile) for existing and future conditions and applies these factors to Vehicle Miles Travelled (VMT) data to obtain emissions inventories. The emissions calculated for this air quality assessment include Tier 3 emission standards, which is an EPA program that sets new vehicle emissions standards, including lowering the sulfur content of gasoline, heavy-duty engine, and the second phase of light-duty vehicle GHG regulations. It also includes Massachusetts-specific conditions, such as the state vehicle registration age distribution and the statewide Inspection and Maintenance (I/M) Program. These stringent emissions regulation programs often result in lower emissions inventories with the passage of time when comparing similar scenarios.

The MOVES3 model was run at a Project-level to obtain emission factors for each link of the mesoscale analysis. The model was set to calculate the emissions burden by choosing to model emissions processes that are specifically related to on-road travel. Links were created that used the appropriate speeds and grades for each roadway segment.

Traffic Data

The air quality study used traffic data (volumes) developed for each analysis condition. The mesoscale analysis uses typical daily peak and off-peak traffic volumes for the ozone summer season. The VMT data used in the air quality analysis were developed based on the traffic data analyzed in Chapter 5, *Traffic and Transportation*.

7.4.2.3 Existing Air Emissions

The mesoscale analysis calculated the existing VOC and NO_X emissions for the Project inventory. These emissions, estimated to be 45.3 kilograms per day (kg/day) of VOCs and 24.2 kg/day of $NO_{X,}$ establish an Existing Condition to which future emissions can be compared. The mobile source CO_{2e} emissions were estimated to be 16,656 short tons per year (tpy).

4 MOVES3 (Motor Vehicles Emission Simulator), January 2021, US EPA, Office of Mobile Sources, Ann Arbor, MI.

7.4.2.4 Future Air Emissions

Future Project-related emission calculations are based upon changes in traffic and emission factor data. The traffic data includes traffic volumes that were used to calculate VMT on the study network. The emission factor data included emission reduction programs, shifts in vehicle populations, and other factors. Under the No-Build Condition, VOC emissions were estimated to be 34.9 kg/day and NO_X emissions were estimated to be 15.0 kg/day. Mobile source CO_{2e} emissions were estimated to be 18,658 tpy.

Under the Build Condition, as presented in Table 7-4, the VOC emissions are estimated to 41.0 kg/day and the NO_X emissions are estimated to be 20.8 kg/day. Mobile source CO_{2e} emissions were estimated to be 23,352 tpy. The Build emissions inventory was developed by considering the effects of the Project generated trips on the No-Build network. The SIP and MEPA GHG Policy require that proposed projects with VOC, NO_X, and mobile source CO_{2e} emissions under the Build Condition that are greater than the No-Build Condition include all reasonable and feasible emission reduction measures.

Table 7-4 Mesoscale Analysis Results

Pollutant	Existing Conditions	No-Build Conditions	Build Conditions	Project-Related Emissions[1]
Volatile Organic Compounds (kg/day)	45.3	34.9	41.0	6.1
Oxides of Nitrogen (kg/day)	24.2	15.0	20.8	5.8
Mobile Source Carbon Dioxide (tpy)	16,656	18,658	25,352	6,694

1 Represents the difference in emissions between the Build and No-Build Conditions

7.4.2.5 Proposed Mitigation Measures

A transportation mitigation program has been developed to mitigate impacts of Project-related traffic. The Proponent has incorporated multiple demand reduction measures to mitigate the impacts of the Build Condition. The Proponent is also proposing roadway improvement measures (signal improvements and/or geometric changes) at eight off-site intersections. The roadway improvement measures are expected to provide a 4.1 kg/day reduction of VOCs, a 5.5 kg/day reduction of NO_X and 6,279 tpy reduction of GHG. Delay savings at multiple intersections are the primary contributor to air emissions reductions from roadway improvements. The proposed improvements would mean these intersections would operate better than they do in the No-Build condition, resulting in the Project-related emission being nearly offset.

The Proponent is committed to implementing a TDM program tailored to the use. A full description of the TDM program and the proposed monitoring program is detailed in Chapter 5, *Traffic and Transportation*. Implementation of the TDM program is expected to improve air quality in the study area by promoting the use of alternative forms of transportation over the use of single-occupant motor vehicle ("SOV") trips to the Project Site. This modal shift results in lower Project-related vehicles miles traveled (VMT) which consequentially reduces indirect Project emissions. Previous estimates of similar TDM programs have ranged on the order of a two percent reduction in VMT, which is assumed to

result in comparable pollutant emission savings. Assuming a two percent reduction, the TDM plan is expected to provide a 0.1 kg/day reduction of VOCs, a 0.1 kg/day reduction of NO_X and a 134 tpy reduction of mobile source CO_{2e} emissions.

These savings result in Project-related emissions of 1.9 kg/day of VOCs, 0.2 kg/day of NO_X and 281 tpy of mobile source CO_{2e} emissions. A summary of the mitigation emissions reduction is shown in Table 7-5.

Table 7-5 Mitigation Analysis Results

Pollutant	Project-related Emissions[1]	Savings Due to TDM Measures[2]	Savings Due to Roadway Improvements	Mitigated Project-related Reduction
Volatile Organic Compounds (kg/day)	6.1	-0.1	-4.1	1.9
Oxides of Nitrogen (kg/day)	5.8	-0.1	-5.5	0.2
Mobile Source Carbon Dioxide (tpy)	6,694	-134	-6,279	281

1 Represents the difference in pollutant emissions between the Build and No-Build Conditions.
2 Mitigation from TDM Measures.

7.4.2.6 Electric Vehicles

The Project will provide preferred parking for electric vehicles at charging stations. To promote the use of electric vehicles and to accommodate a future increase in electric vehicles on the roadway, the Project Site will be equipped with electric vehicle parking stations. Approximately 25-percent of the parking spaces in each parking area (the stand alone parking garage, the surface lot, and the underground garage) will be equipped with EV chargers, with consideration as to how increased electric vehicle capacity can be implemented in the future as warranted by demand and market conditions. Tenants, employees or visitors will be able to charge their electric vehicles, which will also help the Proponent continue its commitment to clean energy and alternative transportation solutions. Fully electric vehicles do not have any tailpipe emissions (such as NOx or particulates-both of which contribute to respiratory illness) and emit practically no engine heat, thereby helping to reduce the high temperature in congested corridors.

8

Construction Period Impacts

As required by the Secretary's Certificate on the ENF, this chapter describes the Project's construction period. Impacts associated with the Project are temporary in nature, and are related to truck traffic, air (dust), noise, stormwater runoff, and solid waste. The Proponent will develop a detailed Construction Management Plan (CMP), which will reflect the input of the regulatory authorities having jurisdiction over such plans. The CMP will include detailed information on construction activities, specific construction mitigation measures, vehicle routing, work hours, and staging to minimize impact on the surrounding neighborhood.

8.1 Key Findings and Benefits

- Construction period impacts on the local transportation system, including access points, truck routes, and hours of construction and deliveries, will be minimized through coordination with the Town of Needham.
- During the construction period, the Project will include installation of erosion and sedimentation controls to protect against discharge of any sediment material into on-site or off-site drainage systems.
- The Proponent will implement a comprehensive Construction Waste Management Plan (CWMP) for this Project.
- The Proponent will contractually require the construction contractors to adhere to all applicable regulations regarding control of construction vehicle emissions.
- Contaminated soil will be excavated and removed off-site during construction of the Project.
- A CMP will be developed with input from the Town of Needham and other appropriate agencies.

8.2 Noise

Construction period activities may temporarily increase nearby sound levels due to the intermittent use of heavy machinery. The Project will generate typical sound levels from construction activities, including foundation construction, truck movements, heavy equipment operations, and general construction activities. At this time, blasting activities are not anticipated over the course of the Project. Construction activities will occur primarily during standard work hours, Monday through Saturday).

The Proponent will implement mitigation measures to reduce or minimize noise from construction activities. A CMP will be developed with input from the Town of Needham and other appropriate agencies. The CMP will address noise impacts and mitigation.

Specific construction period noise mitigation measures may include the following:

- The Project specifications will require that construction equipment will be required to have installed and properly operating appropriate noise muffler systems;
- The Project specifications will require that construction vehicles and equipment will be required to maintain their original engine noise control equipment;
- All construction activities will typically be limited to normal working hours and off-hour work would be minimized, to the extent practicable;
- Appropriate traffic management techniques will be implemented during the construction period including proper operation and maintenance, and prohibition of excessive idling of construction equipment engines, as required by MassDEP regulation 310 CMR 7.11;
- Mitigation of roadway traffic noise impacts;
- Work hours and relevant noise generating activities will be reviewed further with the Town of Needham to outline those construction activities which may occur prior to 7:00 AM and after 7:00 PM, Monday through Saturday, as well as those activities which may occur during overnight hours (if necessary);
- Quieter-type (manually adjustable or ambient-sensitive) backup alarms on construction vehicles will be required;
- Additional noise control options will be evaluated during the design process for effectiveness and feasibility; and

Appropriate operational specifications and performance standards will be incorporated into the construction contract documents.

8.3 Air Quality

The Proponent will contractually require the construction contractors to adhere to all applicable regulations regarding control of construction vehicle emissions. This will include, but not be limited to, the use Ultra-Low-Sulfur Diesel ("ULSD") fuel for all off-road diesel-powered construction equipment, maintenance of all motor vehicles, machinery, and equipment associated with construction activities and proper fitting of equipment with mufflers or other regulatory-required emissions control devices. Additionally, construction specifications will require that all diesel equipment used on-site will be fitted with after-engine emission controls, such as diesel oxidation catalysts or diesel particulate filters. The Proponent will work with the contractor to promote the use of ULSD fuel for on-road diesel-powered construction vehicles.

Most heavy equipment on the Project Site will be less than three years old and comply with the Tier 4 requirements. If any of the equipment is older than three years, it will be fitted with the required DOCs or DPFs. All equipment used on the Project Site is logged. The Proponent is committed to including these measures in the requirements for bidding and

review for compliance on site as equipment arrives and will also hire a company to monitor air quality during the demolition.

8.4 Water Quality

During the construction period, the Project will include installation of erosion and sedimentation controls to protect against discharge of any sediment material into on-site off-site drainage systems. Additionally, in accordance with EPA requirements, a construction phase Stormwater Pollution Prevention Plan (SWPPP) will be developed to prevent impacts on nearby resource areas from the construction, as well as the operation of the Project.

Erosion and sedimentation controls, including silt fence and hay bales, will be installed along appropriate downgrade portions of the perimeter of the excavated areas to prevent construction materials from contaminating the storm drainage system.

8.5 Traffic

Construction period impacts on the local transportation system, including access points, truck routes, and hours of construction and deliveries, will be minimized by coordination with the Town of Needham. Construction workers will be encouraged to carpool/vanpool. Staging areas will be coordinated with the Proponent, Contactor, and the Town of Needham to minimize impacts to the movement of vehicles and pedestrians in the area. Secure on-site storage for tools and materials will be provided in order to minimize the number of construction-related trips and vehicles that access the Project Site. Police details will be used as necessary to facilitate access to the Project Site for construction vehicles and to maintain safe and efficient passage for pedestrians and motor vehicles on public roadways.

8.6 Construction and Demolition Debris

The Proponent will be entering into a contract with a waste disposal firm that will include detailed requirements for disposal, separation, processing, re-use and recycling. All disposal will be conducted in compliance with all local, State, and Federal regulations. Any disposal will include specific requirements and procedures for segregation, reprocessing, reuse, and recycling of materials whenever possible. The contractor/construction manager will be responsible for ensuring that debris will be disposed of at appropriately designated licensed solid waste disposal facilities as defined by Massachusetts General Laws.

During soil excavation and removal, the Proponent will have a Licensed Site Professional evaluating and monitoring the progress of the Project daily. The Proponent will ensure that the waste removal and disposal during construction will be in conformance with the Town of Needham and MassDEP regulations for solid and hazardous waste disposal.

The Project Proponent complied with the MassDEP Asbestos Regulations (310 CMR 7.15) for the demolition of the former Muzi automobile dealership and carwash structures.

The Proponent will implement a comprehensive Construction Waste Management Plan (CWMP) for this Project. This plan will maximize the diversion of demolition and construction

waste from landfill disposal and support resource reclamation. The overall goal is to divert up to 75 percent of construction waste and here is an overview of key program elements:

- Sorting of all waste on-site to recover, reuse and recycle all salvageable materials;
- Separate containers on-site for recyclable materials (i.e., Wood, Metal, Concrete, Cardboard/Paper);
- Designated onsite person(s) for consistent implementation of the waste management plan; and
- Waste Diversion Reporting to monitor results and impacts;

8.7 Contaminated Material

Contaminated soil will be excavated and removed off-site during construction of the Project. To prevent exposures to the general public during excavation, monitoring for dust and VOCs will be performed. Upon completion of excavation activities, a Condition of No Significant Risk will exist and a Permanent Solution for the identified release conditions at the Project Site will be achieved.

8.8 Stormwater Pollution Prevention Plan

This project disturbs more than one acre of land and will require a Construction General Permit (CGP) and a SWPPP. During construction, the Project will provide and maintain all temporary erosion and sedimentation control measures required by the engineer to control soil erosion and water pollution for the Project Site and to adjacent properties. All erosion control measures will be established at the beginning of construction and maintained during the entire construction period. Dewatering (if required) will be managed on site in accordance with the CGP. If dewatering off site is required a Remediation General Permit (RGP) will be applied for and all dewatering activities off site shall meet the applicable conditions of the permit.

The installation and maintenance of silt fencing, berms, ditches, sedimentation basins, construction exits, fiber mats, catch basin filters, straw, netting, gravel, trenches, mulches, grasses, slope drains, and other approved erosion control devices or methods, needed to protect any areas on- or off-site in accordance with the SWPPP, will be developed by the Contractor, which is required by the EPA or its locally designated agency.

8.9 Dewatering Activities

In consideration of the observed depth of the groundwater below the existing ground surface, it is anticipated that the dewatering of groundwater encountered during foundation excavation may be performed by means of localized sumping. Therefore, groundwater interception and drainage by means of strategically located sump pumps are recommended to provide a workable excavation surface.

Pumped groundwater will be recharged on-site to the greatest extent possible. However, based on the extent of the proposed commercial building and garage footprints across the Project Site, on-site recharge of collected groundwater may not be feasible during periods of

heavy precipitation. Therefore, dewatering and off-site discharge into nearby storm drains may be required during excavation of the foundations and preparation of the lowest-level slab.

Groundwater samples have been taken from the Project Site for lab analysis to prepare and submit an RGP Notice of Intent for Temporary Construction Dewatering Discharge to the DEP and US EPA and to prepare a dewatering submittal describing the dewatering system and treatment processes.

9

Mitigation and Draft Section 61 Findings

This chapter provides an overview of the measures proposed to mitigate the impacts of the Project along with draft Section 61 findings.

9.1 Mitigation Measures

The Proponent, where practicable, will mitigation or compensate for unavoidable impacts. This section provides a summary of impacts from the Project and mitigation required for implementation of the Project. Table 9-1 below summarizes the proposed mitigation commitments.

Table 9-1 Summary of Mitigation Measures

Category	Mitigation Measure	Responsible Party	Cost Estimate	Schedule/Status
Greenhouse Gas Emissions				
	The proposed lab/office buildings will have high-performance building enclosure and mechanical systems–which would result in an estimated 48 percent energy usage savings and resulting in a reduction of approximately 36 percent in stationary source GHG emissions compared to a code-baseline design.	Proponent	-	Design/Construction
	The Proponent will implement roadway improvements and a comprehensive TDM program to reduce mobile source GHG emissions relative to the baseline, including installing EV parking with charging stations.	Proponent	-	Design/Construction
Land Alteration				
	Plant trees in excess of local requirement.	Proponent		Design/Construction
	Maintain minimum open space in excess of local zoning requirement	Proponent		Design/Construction
Water Quality/Stormwater				
	65% phosphorus removal	Proponent		Design/Construction
	80% TSS removal	Proponent		Design/Construction
Water/Wastewater Generation				
	Maintain water and sanitary sewer within the development limits.	Proponent	TBD	Confirmed during design phase
Construction Period Impacts				
	Noise	Contractor	-	Construction
	› The CMP specifications will require that construction equipment will be required to have installed and properly operating appropriate noise muffler systems.			

Table 9-1 Summary of Mitigation Measures

Category	Mitigation Measure	Responsible Party	Cost Estimate	Schedule/Status
	› The CMP specifications will require that construction vehicles and equipment will be required to maintain their original engine noise control equipment. › All construction activities will typically be limited to normal working hours and off-hour work would be minimized, to the extent practicable. › Appropriate traffic management techniques implemented during the construction period will mitigate roadway traffic noise impacts. › Proper operation and maintenance, and prohibition of excessive idling of construction equipment engines, will be implemented as required by MassDEP regulation 310 CMR 7.11. › Work hours and relevant noise generating activities will be reviewed further with the Town of Needham to outline those construction activities which may occur prior to 7:00 AM and after 7:00 PM, Monday through Saturday, as well as those activities which may occur during overnight hours (if necessary). › Quieter-type (manually adjustable or ambient-sensitive) backup alarms on construction vehicles will be required. › Additional noise control options will be evaluated during the design process for effectiveness and feasibility. › Appropriate operational specifications and performance standards will be incorporated into the construction contract documents.			
	Air Quality › Tire cleaning areas at construction vehicle entrances and exits. › If required, water sprays during excavation, stockpiling, and loading of demolition and soil materials for removal. › Site watering as required to mitigate wind erosion. › Street sweeping of adjacent local roadways to address potential sediment accumulation. › Secure covering of piles of excavated materials. › Properly secured covers on truck cargos during materials transport. › Minimization of the free drop height of excavated or aggregate material during earthwork operations.	Contractor	-	Construction
	Water Quality – Installation of erosion and sedimentation controls along appropriate downgrade portions of the perimeter of the excavated areas to prevent construction materials from contaminating the storm drainage system.			
	Debris › All disposal will be conducted in compliance with local, State, and Federal regulations, and will include specific requirements and procedures for segregation, reprocessing, reuse, and recycling of materials whenever possible. › A Licensed Site Professional will evaluate and monitor progress of the Project daily during soil excavation and removal. › The Project complied with the MassDEP Asbestos Regulations before the demolition of the former structures The Proponent will implement a comprehensive Construction Waste Management Plan, which will maximize the diversion of demolition and	Contractor	-	Construction

Table 9-1 Summary of Mitigation Measures

Category	Mitigation Measure	Responsible Party	Cost Estimate	Schedule/Status
	construction waste from landfill disposal and support resource reclamation.			
	Traffic › Access points, truck routes, and hours of construction and deliveries will be minimized. › Construction workers will be encouraged to carpool/vanpool. › Staging areas will be coordinated with the Proponent, Contractor, and the Town of Needham to minimize impacts to the movement of vehicles that access the Project Site.	Contractor	-	Construction
	Stormwater Pollution Prevention › Installation and maintenance of silt fencing, berms, ditches, sedimentation basins, construction exits, fiber mats, catch basin filters, straw, netting, gravel, trenches, mulches, grasses, slope drains, and other approved erosion control devices or methods.	Contractor	-	Construction
Traffic/Transportation				
	Highland Avenue at Gould Street / Hunting Road Intersection Improvements: Geometric improvements and signal timing and equipment improvements at the intersection, including the expansion of the Gould Street southbound approach to include two left-turn lanes and one shared through/right-turn lane. Pedestrian infrastructure, including ramps crosswalks and sidewalks will be ADA-compliant. Bi-directional separated bicycle lanes will be provided at the east side of Gould Street.	Proponent	$500,000 to $1,000,000	Prior to Occupancy
	Central Avenue at Gould Street Intersection Improvements: Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements. Pedestrian infrastructure, including ramps crosswalks and sidewalks will be ADA-compliant.	Proponent	$500,000 to $1,000,000	Prior to Occupancy
	Gould Street at Site Driveway / Wingate Driveway Intersection Improvements: Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway. Expansion of the Gould Street cross-section to include two southbound through lanes and turn lanes into the Project Site driveway. Pedestrian infrastructure, including ramps, crosswalks and sidewalks will be ADA-compliant. Bi-directional separated bicycle lanes will be provided on the east side of Gould Street.	Proponent	$500,000 to $1,000,000	Prior to Occupancy
	Gould Street at TV Place Intersection Improvements: Geometric improvements.	Proponent	$200,000 to $500,000	Prior to Occupancy
	Gould Street Bicycle Accommodations: Design and installation of bicycle accommodations in each direction of Gould Street, including bi-directional sidewalk-level separated bicycle lanes on the east side of Gould Street along the Project Site frontage between Highland Avenue and just north of TV Place and shared lane markings and signage between just north of TV Place and Central Avenue.	Proponent	$150,000 to $300,000	Prior to Occupancy
	Gould Street Pedestrian Improvements: Reconstruction of the sidewalk on the west side of Gould Street between Highland Avenue and Noanett Road and construction of a new pedestrian facility at the east side of Gould Street along the Project Site frontage between Highland Avenue and just north of TV Place. Installation of a crosswalk across Gould Street at the location of the abandoned	Proponent	$150,000 to $300,000	Prior to Occupancy

Table 9-1 Summary of Mitigation Measures

Category	Mitigation Measure	Responsible Party	Cost Estimate	Schedule/Status
	railroad right-of-way with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers.			
	Noanett Road Traffic Calming and Pedestrian Improvements: Reconfiguring the sidewalk ramps on the northwest and southwest corners of the intersection of Noanett Road and Gould Street to be ADA accessible and striping of a crosswalk across the Noanett Road approach to Gould Street. Installation of signage to deter cut-through traffic during the peak hours.	Proponent	$40,000 to $70,000	Prior to Occupancy
	Hunting Road Radar-Embedded Speed Limit Signs: Installation of two radar-embedded speed limit signs on Hunting Road to encourage lower vehicle speeds.	Proponent	$20,000 to $40,000	Prior to Occupancy
	Intersection Signal Timing Modifications: Design and implementation of signal timing modifications during certain peak hours at four intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street.	Proponent	$40,000 to $70,000	Prior to Occupancy
	Shared-Use Path Feasibility Study: Coordination with the Town of Needham to support additional funding for a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site into a shared use path that would connect to Needham Heights to the south.	Proponent	TBD	Prior to Occupancy
	On-Site Walking/Fitness Path: Design and construction of an approximately 0.5-mile walking/fitness path around the Project Site that will be open to all members of the public.	Proponent	TBD	Prior to Occupancy
	Transit Connector Shuttle Service: Implementation and operation of a shuttle service between the Project Site and nearby transit station(s) to provide a connection to the MBTA Green Line D Branch at Newton Highlands and MBTA commuter rail at Needham Heights. Shuttle vehicle will be an electric vehicle (EV).	Proponent	TBD	During Occupancy
	Transportation Demand Management Plan: Implementation of a comprehensive TDM program, as outlined in the Draft Section 61.	Proponent	TBD	During Occupancy
Solid and Hazardous Waste				
	Contaminated soil will be excavated and removed off-site during construction of the Project. To prevent exposures to the general public during excavation, monitoring for dust and VOCs will be performed. Upon completion of excavation activities, a Condition of No Significant Risk will exist and a Permanent Solution for the identified release conditions at the Project Site will be achieved.	Proponent	$2,900,000-$4,000,000 (Trans. & Disp., MCP Compliance)	During Construction

9.2 Draft Section 61 Findings

9.2.1 MassDOT Access Permit

DRAFT ONLY

July 31, 2022

J. Lionel Lucien, P.E.
Manager - Public/Private Development Unit
Massachusetts Department of Transportation, Highway Division - Boston
10 Park Plaza, Room 4150
Boston, MA 02116

Re: EEA No. 16456 – 557 Highland Avenue. Needham, Massachusetts

These findings for 557 Highland Avenue redevelopment (the "Project"), have been prepared in accordance with the provisions of M.G.L. c. 30, Section 61 and 301 CMR 11.00. On _____, the Secretary of Energy and Environmental Affairs issued a decision stating that the Project's Final Environmental Impact Report ("FEIR"), _____, adequately and properly complied with the Massachusetts Environmental Policy Act ("MEPA") and its implementing regulations.

9.2.1.1 Project Description

The Project will include up to 531,000 square feet (SF) of rentable space, with approximately 260,500 SF of office space, approximately 260,500 SF of research and development space, and approximately 10,000 SF of retail space. The Project will also accommodate up to 1,770 off-street parking spaces (or a minimum of one space per 300 SF, as required by Town of Needham zoning regulations). In addition, the Project Site will include new public amenities, including a 0.5-mile walking/fitness path around the perimeter of the Project Site and a new community open space along Gould Street. The parcel of land was formerly occupied for several decades by a car dealership and car wash.

To support the additional traffic generated by the Project, the Proponent is proposing infrastructure improvements surrounding the Project Site. Specifically, the Proponent is proposing vehicular, bicycle, and pedestrian enhancements to Gould Street along the Project Site frontage and enhancements to the intersections of Highland Avenue at Gould Street/Hunting Road and Central Avenue at Gould Street.

The Traffic Impact and Access (TIA) study previously prepared quantifies existing and future traffic conditions with and without the Project. Based on the analysis of the future traffic conditions, the major impacts of the Project are expected to be mitigated by the proposed roadway reconstruction.

9.2.1.2 Summary of Project Impacts

Based on projections made in the TIA, the project is anticipated to generate 584 new vehicle trips (515 entering and 68 exiting) during the weekday morning peak hour and 565 new

vehicle trips (92 entering and 473 exiting) during the weekday evening peak hour. As presented in the TIA, the trip generation estimates were developed assuming 100-percent of the Site-generated traffic would use private vehicles to access the Project Site. This was a conservative analysis used to identify the "worst-case" scenario of vehicular impacts that the Project Site could generate. The actual percentage of Project Site-generated traffic traveling by private vehicle is expected to be less than 100-percent with the proposed mitigation and TDM plan that is outlined in the following sections.

9.2.1.3 Mitigation Measures

The following recommendations summarize the roadway improvements within the study area necessary to provide safe and efficient access. Detailed traffic analyses indicate that some of the study area intersections currently experience significant delays during the peak periods. Without the implementation of any improvement measures at these locations, delays and congestion would worsen with or without the proposed development in place.

The following Improvements are proposed as part of this Project to mitigate the Project's traffic impacts, as well as to accommodate future background growth, alleviate existing deficiencies, and enhance the pedestrian and bicycle accommodations in the area:

- **Highland Avenue at Gould Street / Hunting Road Intersection Improvements:** Geometric improvements and signal timing and equipment improvements at the intersection, including the expansion of the Gould Street southbound approach to include two left-turn lanes and one shared through/right-turn lane. Pedestrian infrastructure, including ramps, crosswalks and sidewalks will be ADA-compliant. Bi-directional separated bicycle lanes will be provided at the east side of Gould Street.
- **Central Avenue at Gould Street Intersection Improvements:** Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements. Pedestrian infrastructure, including ramps crosswalks and sidewalks will be ADA-compliant.
- **Gould Street at Site Driveway / Wingate Driveway Intersection Improvements:** Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway. Expansion of the Gould Street cross-section to include two southbound through lanes and turn lanes into the Project Site driveway. Pedestrian infrastructure, including ramps crosswalks and sidewalks will be ADA-compliant. Bi-directional separated bicycle lanes will be provided on the east side of Gould Street.
- **Gould Street at TV Place Intersection Improvements:** Geometric improvements.
- **Gould Street Bicycle Accommodations:** Design and installation of bicycle accommodations in each direction of Gould Street, including bi-directional sidewalk-level separated bicycle lanes on the east side of Gould Street along the Project Site frontage between Highland Avenue and just north of TV Place and shared lane markings and signage between just north of TV Place and Central Avenue.
- **Gould Street Pedestrian Improvements:** Reconstruction of the sidewalk on the west side of Gould Street between Highland Avenue and Noanett Road and construction of a new pedestrian facility at the east side of Gould Street along the Project Site frontage between

Highland Avenue and just north of TV Place. Installation of a crosswalk across Gould Street at the location of the abandoned railroad right-of-way with either an LED warning sign or a rapid rectangular flashing beacon (RRFB) to alert drivers.

- **Noanett Road Traffic Calming and Pedestrian Improvements:** Reconfiguring the sidewalk ramps on the northwest and southwest corners of the intersection of Noanett Road and Gould Street to be ADA accessible and striping of a crosswalk across the Noanett Road approach to Gould Street. Installation of signage to deter cut-through traffic during the peak hours.
- **Hunting Road Radar-Embedded Speed Limit Signs:** Installation of two radar-embedded speed limit signs on Hunting Road to encourage lower vehicle speeds.
- **Intersection Signal Timing Modifications:** Design and implementation of signal timing modifications during certain peak hours at four intersections: Highland Avenue at West Street, Highland Avenue at Webster Street, Highland Avenue at 1st Avenue, and Hunting Road at Kendrick Street.
- **Shared-Use Path Feasibility Study:** Coordination with the Town of Needham to support additional funding for a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site into a shared use path that would connect to Needham Heights to the south.
- **On-Site Walking/Fitness Path:** Design and construction of an approximately 0.5-mile walking/fitness path around the Project Site that will be open to all members of the public.
- **Transit Connector Shuttle Service:** Implementation and operation of a shuttle service between the Project Site and nearby transit station(s) to provide a connection to the MBTA Green Line D Branch at Newton Highlands and the MBTA commuter rail at Needham Heights. Shuttle vehicle will be an electric vehicle (EV).

9.2.1.4 Construction Period

A Construction Management Plan will be developed in coordination with and approved by MassDOT.

9.2.1.5 Transportation Demand Management (TDM)

The Proponent is committed to providing a robust transportation demand management (TDM) program to reduce single occupant driving and increase the use of alternative forms of transportation to access the workplace. As described in the TIA, the proposed TDM plan will include the following measures:

- Providing an Employee Transportation Advisor who will coordinate with the local Transportation Management Association
- Provide up to 114 secure covered and bicycle parking spaces and up to 50 public bicycle parking spaces for a total of up to 154 bicycle parking spaces on-site.
- Providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line)

- Provide electric vehicle charging stations at 25-percent of all parking spaces located on-Site
- Requiring tenants to provide a 50 percent transit pass subsidy for their employees
- Carpool assistance and incentives
- Emergency ride home
- Bicycling/walking incentives and amenities
- Provide on-site locker rooms and showers for employees
- Offer on-site amenities for employees to reduce midday trip making
- Telecommuting and compressed workweeks, when feasible
- Display in the Main Lobby transportation-related information for tenants' employees and visitors
- Promotional efforts

In addition, the Proponent is committed to joining the 128 Business Council, which is the local Transportation Management Association (TMA) for the area.

Shuttle Service

The Proponent will provide shuttle service between the Project Site and nearby transit stations, using a fully EV-operable vehicle. The Project Site is located approximately two miles from the nearest Green Line D Branch station at Newton Highlands and less than a mile from the nearest commuter rail station at Needham Heights. The shuttle will travel between the Project Site and both transit stations, providing a connection to the greater MBTA transit network for employees and visitors who wish to take transit to/from the Project Site. This will allow commuters who live closer to Boston to easily access the Project Site without the need to use a private vehicle.

9.2.1.6 Transportation Monitoring Program

The Proponent is committed to a strong transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network. The transportation monitoring program will begin six months after full occupancy of the proposed development and continue for a period of five years. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham. Details of the transportation monitoring program are provided in the following sections.

On-Site Parking Facility Traffic Monitoring

The actual number of weekday morning peak hour, weekday evening peak hour, and weekday daily vehicle trips generated by the Project will be measured using simultaneous automatic traffic recorder (ATR) counts at each parking entrance/exit for a continuous 24-hour period on a typical weekday.

These volumes entering and exiting each parking facility will be compared against the estimated Project-generated vehicle trips presented in this report to determine if the Project Site is generating trips at a rate higher or lower than what was projected.

Intersection and Roadway Traffic Monitoring

The traffic monitoring program will include collecting weekday morning and weekday evening peak period turning movement counts on a non-holiday week, during midweek days at the following study area intersections that represent the key vehicular gateways to the Project Site and are the focus of the proposed roadway mitigation:

- Central Avenue at Gould Street
- Gould Street at TV Place
- Gould Street at the Project Site driveway
- Highland Avenue at Gould Street/Hunting Road

The traffic monitoring program will include capacity and queue analyses during the weekday morning and weekday evening peak hours at the four intersections identified above. The results of the operational analyses will be summarized in tabular form and compared against the projected operational results presented in the TIA.

In addition to peak period turning movement counts at the identified intersections above, the traffic monitoring program will include collecting continuous 48-hour ATR counts at the following locations:

- Gould Street north of Highland Avenue
- Site driveway east of Gould Street
- TV Place east of Gould Street

If the results of the monitoring study indicate that the actual traffic increase generated by the Project exceeds the traffic projections contained within the TIA by ten percent or more, the Proponent will work with the Town of Needham and MassDOT to determine if the monitoring program should be expanded, and if so, which additional intersections should be included.

Travel Survey

The proposed transportation monitoring program will include an annual travel survey of tenants' employees and patrons of the Project Site. The survey will be conducted by the Proponent and will include details on the modes of transportation that tenants' employees and patrons use to access the Project Site as well as the effectiveness of the proposed TDM programs. The survey will also ask about hybrid work schedules to determine how frequently employees commute to the Project Site versus working from home. The results of the survey will be used to review the current TDM program and decide if any adjustments are necessary to further engage the tenants' employees and patrons of the Project Site to encourage the use of walking/biking, carpooling, and public transportation.

Transportation Monitoring Program Results

Based on the results of the transportation monitoring program, the Proponent will evaluate the TDM program to see if any adjustments are necessary to further engage the tenant's employees and patrons of the Project Site to encourage the use of walking/biking, carpooling, and public transportation. If the transportation monitoring program indicates that the actual traffic increase generated by the Project exceeds the traffic projections contained within the TIA by ten percent or more, the Proponent will increase funding for the TDM program and add more measures to try and reduce the share of single occupancy vehicles accessing the Project Site, and coordinate with the Town of Needham and MassDOT to determine potential additional TDM measures that could be implemented.

9.3 GHG Self-Certification

In accordance with the MEPA GHG Policy, the Proponent will provide Self-Certifications to the MEPA Office signed by an appropriate professional following completion of construction of each building to demonstrate that all the required mitigation measures, or their equivalent, have been completed. A draft Letter of Commitment for the future GHG Self-Certifications for the Project is provided below.

D R A F T

Secretary Bethany A. Card
Executive Office of Energy & Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

ATTN: Director Tori Kim, MEPA Office

Re: Letter of Commitment for Greenhouse Gas Emissions Self-Certification
EA No. 16546 – Highland Innovation Center, Needham, MA

On behalf of 557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc. ((the "Proponent"), VHB has prepared a summary of the estimated reduction in overall energy use and stationary source Greenhouse Gas ("GHG") emissions for the Highland Innovation Center project in Needham (the "Project").

In accordance with the current MEPA Greenhouse Gas Emissions Policy and Protocol (the "GHG Policy") dated May 2010, the stationary source GHG assessment was provided to the MEPA Office as part of the Draft Environmental Impact Report (the "DEIR"). The design case assumed building design and system improvements that would result in energy reductions, in accordance with the GHG Policy.

Building energy modeling based on early stages of design estimate that the assumed energy conservation measures across the full build-out of the Project could reduce overall energy usage by 48 percent resulting in a 36 percent reduction in stationary source CO_2 emissions

when compared to the baseline case. The following table presents the estimated energy savings and CO_2 emissions reductions by building.

	Energy Consumption			CO_2 Emissions		
	Electricity (MWh/yr)	**Natural Gas (MMBtu/yr)**	**Total (MMBtu/yr)**	**Electricity (tons/yr)**	**Natural Gas (tons/yr)**	**Total (tons/yr)**
Base Case[1]	19,977	77,351	145,513	6,533	4,525	11,058
Hybrid Alternative	20,602	4,898	75,192	6,737	287	7,023
End-Use Savings	-625	72,453	70,321	-204	4,239	4,034
Percent Savings			**48.3%**			**36.5%**

tons/yr = short tons per year
MWh = Megawatt hour
MMBtu = million British Thermal Units
1. Base Case represents ASRAE 90.1-2013 conditions with additional efficiency measures under the November 2020 energy code.

The building energy model results of the estimated energy usage savings and associated stationary source GHG emissions reductions presented above are preliminary based on current building design. Following completion of construction of each building, the Proponent will submit a Self-Certification to the MEPA Office, signed by an appropriate professional, which identifies the as-built energy conservation measures and documents the associated stationary source GHG emissions reductions from the baseline case.

If you have any questions, please contact me via e mail at ssaquib@vhb.com.

Very truly yours,

VANASSE HANGEN BRUSTLIN, INC.

Samhita Saquib, Senior Environmental Planner

10

Response to Comments

This chapter includes responses to the ENF Certificate issued May 9, 2022 and to comment letters submitted during the ENF review period. Copies of the ENF Certificate and each comment letter are included in Appendix A. The ENF Certificate is assigned a letter and all other comment letters are assigned a number, as listed below in Table 10-1. Each individual comment is assigned a comment code that corresponds to the comment delineations on the Certificate and each comment letter for reference. The responses provided herein aim to refer to specific sections of the DEIR for further information, where appropriate.

Table 10-1 List of ENF Comment Letters

Letter No.	Commenter	Affiliation	Date Received
C	Beth Card	Massachusetts Office of Energy and Environmental Affairs	May 9, 2022
1	Rebecca L. Brown	Greenman-Pedersen, Inc.	April 25, 2022
2	Kate Fitzpatrick	Town of Needham	April 26, 2022
3	Rebecca Weidman	Massachusetts Water Resources Authority	April 28, 2022
4	Paul F Ormond	Massachusetts Department of Energy Resources	May 6, 2022
5	Heather Miller	Charles River Watershed Association	April 28, 2022
6	J. Lionel Lucien	Massachusetts Department of Transportation	April 28, 2022
7	John D. Viola	Massachusetts Department of Environmental Protection	April 28, 2022

10.1 ENF Certificate

Comment C.1

The DEIR should describe the project and identify any changes since the filing of the ENF.

Response

Refer to Section 1.3 of Chapter 1, *Project Description* for a summary of changes since the ENF.

Comment C.2

It should identify and describe state, federal, and local permitting and review requirements associated with the project and provide an update on the status of each of these pending actions.

Response

Refer to Section 1.7 of Chapter 1, *Project Description*, for a list of federal, state, and local permits.

Comment C.3

The DEIR should include a description and analysis of applicable statutory and regulatory standards and requirements, and a discussion of the project's consistency with those standards.

Response

Refer to Section 1.7 of Chapter 1, *Project Description.*

Comment C.4

It should confirm that the height of any proposed buildings will comply with the Massachusetts Port Authority's (Massport) Logan Airspace Map and any related FAA requirements.

Response

The height of all buildings will comply with all state and federal aviation requirements. Specifically with regard to Massport's Airspace Composite Map, the Project Site falls significantly outside of the Composite Map's outer perimeter.

Comment C.5

The DEIR should include detailed site plans for existing and post-development conditions at a legible scale. Plans should clearly identify buildings, interior and exterior public areas, impervious areas, transportation improvements, pedestrian and bicycle accommodations, and stormwater and utility infrastructure.

Response

Detailed site plans are included in Chapter 1, *Project Description,* and in Appendix G. Conceptual plans for the off-site roadway improvements are referenced in Section 5.5.2 of Chapter 5, *Traffic and Transportation*, and are included in Appendix D.

Comment C.6

The DEIR should provide detailed plans, sections, and elevations to accurately depict existing and proposed conditions, including proposed above- and below-ground structures and on- and offsite open space and resiliency and other mitigation measures.

Response

Refer to figures in Chapter 1, *Project Description,* and Appendix G.

Comment C.7

The information and analyses identified in this Scope should be addressed within the main body of the DEIR and not in appendices. In general, appendices should be used only to provide raw data, such as drainage calculations, traffic counts, capacity analyses and energy modelling, that is otherwise adequately summarized with text, tables, and figures within the main body of the DEIR. Information provided in appendices should be indexed with page numbers and separated by tabs, or, if provided in electronic format, include links to individual sections. Any references in the DEIR to materials provided in an appendix should include specific page numbers to facilitate review.

Response

Information and analyses identified in the Certificate have been addressed within the main body of the DEIR.

Comment C.8

The ENF does not include the impacts (i.e., traffic, water/wastewater, etc.) of this alternative as compared to the Preferred Alternative. The DEIR should include an analysis of the impacts of each alternative as compared with the Preferred Alternative, preferably in table format.

Response

Refer to Section 2.6 of Chapter 2, *Alternatives Analysis,* for a quantitative analysis of impacts of Project Alternatives.

Comment C.9

The DEIR should clarify if an all residential development is an allowed use and therefore a viable alternative.

Response

Refer to Section 2.4 of Chapter 2, *Alternatives Analysis.* In May 2021, the Town of Needham approved the zoning amendment, which created the Highway Commercial 1 District encompassing the Project Site. This amendment allows, by Special Permit, the construction of residential buildings.

Comment C.10

During the MEPA remote consultation session, the Proponent acknowledged community concerns regarding the proposed public amenity spaces. The DEIR should outline alternatives considered for auxiliary programing within the public spaces on the project and how these alternatives are expected to impact traffic and impervious area creation at the site (i.e., parking demand).

Response

Refer to Section 2.7 of Chapter 2, *Alternatives Analysis,* for a discussion of public space alternatives.

Comment C.11

Accordingly, the project should undertake efforts to provide meaningful opportunities for LEP populations to participate in review of the project, but the project is not required to analyze impacts on EJ populations in accordance with new regulations and protocols that took effect on January 1, 2022.

Response

The Proponent will provide a translated Project Fact Sheet to CBOs and offer translation services to LEP populations, if requested.

Comment C.12

The DEIR should address how the public involvement plan will facilitate meaningful participation in review of the project by LEP populations located within the identified DGA. A translated project fact sheet on the project website should be a minimum outreach measure.

Response

Refer to Section 3.3, Chapter 3, *Environmental Justice and Public Health*.

Comment C.13

In accordance with St. 2021, c. 8, s. 57, the DEIR should include a separate section on "Public Health," and discuss any known or reasonably foreseeable public health consequences that may result from the environmental impacts of the project. Particular focus should be given to any impacts that may materially exacerbate "vulnerable health EJ criteria," in accordance with the MEPA Interim Protocol for Analysis of EJ Impacts. In addition, other publicly available data, including through the DPH EJ Tool, should be surveyed to assess the public health conditions in the immediate vicinity of the project site, in accordance with 301 CMR 11.07(6)(g)10. Any project impacts that could materially exacerbate such conditions, including industrial/laboratory wastewater discharge and 21E cleanup, should be analyzed.

Response

Refer to Section 3.4, Chapter 3, *Environmental Justice and Public Health*, for a discussion on public health. This section also includes a description of environmental impacts and vulnerable health criteria.

Comment C.14

To the extent any required Permits for the project contain performance standards intended to protect public health, the DEIR should contain a specific discussion of such standards and how the project intends to meet or exceed them.

Response

Refer to Section 3.4.5, Chapter 3, *Environmental Justice and Public Health*, for a discussion on permits related to public health.

Comment C.15

The DEIR should list stormwater related permits required by the project and detail compliance with associated permit regulations.

Response

The Project requires compliance with the Needham Stormwater Bylaws and Regulations, in addition to MassDEP Stormwater Management Standards. Needham adheres to the NPDES program with the goal of maintaining a productive system with high quality discharge. There is also an access permit required by MassDOT, because stormwater from the site flows, and will continue to flow, to a swale on the adjacent MassDOT SHLO. Refer to Section 4.2.1 of Chapter 4*, Stormwater and Water/Wastewater* for additional information.

Comment C.16

The Proponent has stated that the capacity for onsite infiltration is limited based on prior soil contamination; however, the Proponent should continue to consider Low Impact Development (LID) and green infrastructure (GI) measures where feasible.

Response

The Project utilizes multiple environmentally sensitive and low impact development (LID) techniques. The proposed stormwater design includes a 1.8-acre reduction of impervious area and a surface detention basin, reducing peak runoff rates. Additionally, stormwater from the proposed paved surfaces will be collected in deep-sump and hooded catch basins and routed through a proprietary media filter unit. Stormwater from the proposed buildings and garage roofs is routed through a proprietary hydrodynamic water quality unit, to the surface basin, and then through a proprietary media filter unit. Refer to Section 4.2.2 of Chapter 4, *Stormwater and Water/Wastewater* for additional details about the Project's use of low impact development and green infrastructure measures.

Comment C.17

The DEIR should provide more detail on the components of the stormwater management system and analyze how the system will be designed to meet the Town's Stormwater Bylaw and Regulations and/or the MassDEP Stormwater Management Standards to improve water quality and reduce pre development peak discharge rates and volumes

Response

The stormwater management system will be designed to meet the quality, discharge rate and volume requirements of Needham's Stormwater Bylaws and Regulations, and the MassDEP Stormwater Management Standards. These standards include no new untreated discharges or erosion to wetlands, attenuation of peak rates, stormwater recharge, treatment of impervious stormwater runoff to meet water quality requirements, considering land uses with higher potential pollutant loads (LUHPPLs), pollution prevention and erosion control requirements, and an operation and maintenance plan (O&M), as well as prohibition of illicit discharges. In relation to meeting Needham Stormwater Bylaws and Regulations, supporting documentation demonstrating compliance has been provided in the technical appendices of the stormwater management report. Refer to Section 4.2 of Chapter 4, *Stormwater and Water/Wastewater* for further analysis of how the stormwater management system will be designed to meet the Town's Stormwater Bylaws and Regulations and the MassDEP Stormwater Management Standards.

Comment C.18

It should include a plan showing the location of BMPs, LID and GI measures.

Response

Refer to Section 4.2.2 of Chapter 4, *Stormwater and Water/Wastewater* for plans showing location of BMPs, LID and GI measures.

Comment C.19

The DEIR should provide analysis of the capacity of the stormwater management system under future climate conditions, as described below. It should provide a detailed description of how specific stormwater management measures, such as infiltration, will be designed in conformance with the phosphorous and pathogen Total Maximum Daily Loads (TMDL) established for the Charles River.

Response

Due to poor soil quality, infiltration rates are below the minimum requirement of MassDEP. However, the project results in a net decrease in impervious coverage when compared to the existing conditions, eliminating the need for recharge. The proposed stormwater management system has been designed to provide 80% TSS removal from all proposed impervious surfaces. Additionally, the proposed media filters have been sized to provide at least 65% removal of total phosphorus, which meets the EPA's TMDL removal target for

commercial land use. Further analysis of the capacity of the stormwater management system and how specific stormwater management measures will be designed in conformance with the phosphorus and pathogen total maximum daily loads (TMDL) established for the Charles River Watershed can be found in Section 4.2 of Chapter 4, *Stormwater and Water/Wastewater*.

Comment C.20

The DEIR should discuss any permit requirements that would be imposed by MassDOT for use of its drainage systems, and how pollutant loading, and runoff would be managed if connecting to MassDOT infrastructure.

Response

The only applicable permit required by MassDOT is an access permit. More details can be found in Section 4.2.1 of Chapter 4, *Stormwater and Water/Wastewater*. Pollutant loading will be managed through a treatment train of BMPs designed to provide 80% TSS removal from all proposed impervious surfaces. Due to the Project's location inside the Charles River Watershed, the Project will provide at least 65% removal of total phosphorus, meeting the EPA's TMDL removal target for commercial land use. Additional information regarding how pollutant loading, and runoff would be mitigated can be found in Section 4.2.2.1 of Chapter 4, *Stormwater and Water/Wastewater*.

Comment C.21

The Proponent should also address comments from the MWRA comment letter which describes the prohibition on discharge of groundwater and stormwater into the sanitary sewer system given the site's access to separate sewer and stormwater drain systems.

Response

The proposed stormwater systems will not discharge stormwater to the sanitary sewer system because there is a separate drainage system. The new system will minimize illicit discharge and satisfy all requirements of the MWRA. More information regarding how the Project will address comments from the MWRA can be found in *Section 4.2.2.1 of* Chapter 4, *Stormwater and Water/Wastewater*.

Comment C.22

The DEIR should address comments from the Charles River Watershed Association (CRWA) regarding impervious area and stormwater management, water quality, trees and vegetation, and climate resilience.

Response

The DEIR addresses comments from the *Charles River Watershed Association (CRWA)* and satisfies concerns regarding impervious area, stormwater management, water quality, trees

and vegetation, and climate resilience. More information can be found in Section 4.2.4 of Chapter 4, *Stormwater and Water/Wastewater*.

Comment C.23

The Proponent should continue consultation with the Town, the MBTA, and appropriate MassDOT units, including PPDU, Traffic Operations, and the District 6 Office during the preparation of the DEIR for the project.

Response

The Proponent continues to coordinate with state and local agencies as the Project develops. Details of coordination with state and local agencies is included in Section 5.3 of Chapter 5, *Traffic and Transportation*.

Comment C.24

While the use of the lower existing site-generated trips will result in a more conservative (higher) estimate of the net increase in trips generated by the project, the Proponent should consult with MassDOT and the Town to ensure that more accurate data are incorporated to the extent warranted.

Response

The Proponent has compared the empirical trips observed at the Project Site driveways in July 2021 with the projected trips rates based on data from the Institute of Transportation Engineers (ITE) for the previous uses on the Project Site. While the empirical trips are less than the estimated ITE trip rates for the uses on-Site, the data is in the same general range. Because the ITE trip rates are based on data collected at sites across the country over several decades and most-likely from different times of the year, it is not surprising that the empirical volumes do not exactly match the ITE-projected volumes and variation between the two sets of data is generally to be expected. Because the Site-generated volumes presented in the TIA include a credit for the trips currently generated by the Project Site, using the lower empirical data provides a conservative analysis for the trip generation and intersection operational analyses.

Further details on the existing site-generated trips are provided in Section 5.4.1 of Chapter 5, *Traffic and Transportation*.

Comment C.25

The DEIR should describe changes made to the TIA, if any, including any changes in assumption about the project's trip generation and associated mitigation.

Response

No changes have been made to the TIA regarding the Project's trip generation. Based on comments from MassDOT, the Town of Needham's peer reviewer, and local residents,

additional mitigation is now proposed at several locations, including signal timing modifications at four additional intersections, improvements at Noanett Road to improve pedestrian accommodations and deter cut-through traffic on the local residential roadway, and improvements on Hunting Road to reduce vehicle speeding. The proponent is also committed to reconstructing the existing sidewalk on the west side of Gould Street from Highland Avenue to Noanett Road and providing bi-directional separated bicycle accommodations on the east side of Gould Street along the Project Site-frontage. In addition, the Gould Street dedicated northbound right-turn lane into TV Place and the dedicated southbound right-turn lane onto Highland Avenue have been removed from the proposed improvement plan based on feedback from the Town of Needham to reduce the amount of pavement.

Details of the additional Project mitigation is provided in Section 5.2 of Chapter 5, *Traffic and Transportation*.

Comment C.26

As requested in comments from GPI, the DEIR should consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of this intersection.

Response

While expanding the Hunting Road cross-section would provide additional capacity at the intersection, an additional northbound lane cannot be implemented without taking significant property outside of the right-of-way. This would have a major impact on the property at 580 Highland Avenue and could require the razing of the existing house on that property. Therefore, to limit the right-of-way impacts, no expansion of Hunting Road is proposed.

To improve operations on the Hunting Road approach, the proposed signal cycle lengths and/or phase splits during the weekday morning and weekday evening peak hours were further reviewed and adjusted from what was proposed in the TIA. The proposed mitigation now results in operations on the northbound Hunting Road approach similar to those under the 2029 No Build Conditions.

Details of the proposed intersection improvements and a summary of the intersection capacity analyses with the revised signal timings are provided in Section 5.5.1.1 of Chapter 5, *Traffic and Transportation*.

Comment C.27

As recommended by MassDOT, the DEIR should include analysis of queuing at study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area.

Response

To understand the queueing impacts of operations at each study area intersection under the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions, queue diagrams have been developed for the weekday morning and weekday evening peak hours. The queue diagrams for each study area intersection are provided in Appendix D and are discussed and analyzed in Section 5.4.3 of Chapter 5, *Traffic and Transportation*.

Comment C.28

As requested by MassDOT, the DEIR should include analysis of existing and proposed weave conditions on Highland Avenue to ensure that increased traffic volumes do not lead to degraded safety conditions in the area of the Highland Avenue/I-95 interchange.

Response

An analysis of existing and proposed weave conditions on Highland Avenue at the Route 128/ I-95 interchange is included in Section 5.4.2.2 of Chapter 5, *Traffic and Transportation*. As the analyses show, the weaving segments are expected to operate at LOS C or better under the 2029 No Build and 2029 Build Conditions, and no segment is expected to experience a degradation in level of service due to the additional Site-generated trips.

Comment C.29

In the comment letter prepared on behalf of the Town, GPI requests additional information related to collision history including collision diagrams for any locations that experience an average of more than 3 crashes per year or a crash rate higher than the state or district-wide average per MassDOT guidelines. GPI comments also state that the Proponent should investigate measures to improve safety and mitigate collision occurrence in any location where five or more crashes of a similar type occurred over the analysis period. The DEIR should document any additional analysis and mitigation measures.

Response

Additional information related to collision history, including collision diagrams at the intersections of Highland Avenue at West Street, Highland Avenue at Gould Street / Hunting Road, and Hunting Road at Kendrick Street, is presented in Section 5.4.2.1 of Chapter 5, *Traffic and Transportation*. Proposed mitigation at these three intersections includes signal modifications, which will include a review of the clearance intervals to determine if the yellow and/or all-red times should be adjusted to improve safety operations. Details on the proposed mitigation are included in Section 5.5.1 of Chapter 5, *Traffic and Transportation*.

Comment C.30

The Proponent should consider coordination with MBTA in order to determine the feasibility of additional MBTA Bus Route 59 service closer to the project site and include feasible options in the DEIR.

Response

Prior to the submittal of the FEIR, the Proponent will contact the MBTA to understand if there are opportunities to modify bus access in the area to better support transit connectivity. However, after the publication of the ENF, the MBTA released a draft plan of the Bus Network Redesign in May 2022. As currently proposed, Route 59 will not travel closer to the Project Site than it does under existing conditions and will continue to operate along Webster Street and Central Avenue. As one of the goals of the Bus Network Redesign is to simplify operations, it is unlikely that a new variation of Route 59 would be supported that stops at the Project Site for some routes and continues to serve the residential areas along Webster Street and Central Avenue for other routes. If Route 59 was revised to directly serve the Project Site, it would no longer provide access to the residential areas along Webster Street and Central Avenue.

To maintain transit service to the residential areas along Webster Street and Central Avenue while also providing transit connection to the Project Site, the Proponent is committed to providing a dedicated EV shuttle service that will run between the Project Site and nearby public transportation stations, such as the commuter rail at Needham Heights and the Green Line D Branch at Newton Highlands. This will provide a direct connection between the Project Site and the public transportation network throughout greater Boston without negatively impacting transit service to the existing residential areas in Needham served by Route 59.

Additional details on the MBTA Bus Network Redesign and the feasibility of rerouting the MBTA Bus Route 59 are provided in Section 5.4.4 of Chapter 5, *Traffic and Transportation*.

Comment C.31

As stated in the Town's comments, the DEIR should include an assessment of the potential bicycle parking demand that could be generated by the project and the adequacy of the number of bicycle parking spaces provided to accommodate this demand including the number of spaces to be accommodated inside (secured) versus outside.

Response

The Project will include up to 104 secure indoor bicycle parking spaces on-Site for tenants' employees and up to 50 outdoor bicycle parking spaces on public bicycle racks for visitors and customers for a total of up to 154 bicycle parking spaces on-Site. An assessment of the potential bicycle parking demand that the Project might generate, indicates that the on-Site bicycle parking supply will be more than adequate. In addition, the Proponent will monitor the actual level of bicycle demand on-Site once the Project opens and will install additional bicycle parking spaces on-Site if additional bicycle parking is required.

Further details on the potential bicycle parking demand and the number of bicycle parking spaces proposed to be provided on-Site are provided in Section 5.4.5 of Chapter 5, *Traffic and Transportation*.

Comment C.32

The Proponent has indicated they intend to seek a reduction in parking as part of the Special Permit process with the Town. The DEIR should provide an update on the potential reduction and how that may contribute to an associated reduction in impervious area.

Response

An update on the potential parking reduction and how that may contribute to an associated reduction in impervious area is provided in Section 5.4.6 of Chapter 5, *Traffic and Transportation*. Since the submittal of the ENF, the Project Site plan has been revised to reduce the size of the surface parking lot from approximately 44 parking spaces to approximately 30 parking spaces. The 14 space reduction in surface parking will provide additional room for community open space along Gould Street. Any additional reduction in parking on-Site would occur in the underground parking garage below the buildings and would not impact the amount of impervious area on-site.

Comment C.33

MassDOT requests that the Proponent consider coordinating with District 6 to install adequate bicycle and pedestrian infrastructure on Highland Avenue at the I-95 interchange to connect with proposed Complete Streets improvements to be installed under the MassDOT Project.

Response

The segment of Highland Avenue within the Route 128/ I-95 interchange (including the bridge over Route 128/I-95) was recently rebuilt and reconstructed as part of the Route 128/I-95 add-a-lane project. Construction was completed in 2018 and included significant improvements to the pedestrian and bicycle accommodations, including new sidewalks and buffered bicycle lanes on each side of Highland Avenue. The buffered bicycle lanes in each direction are separated from the general-purpose travel lanes on Highland Avenue by a painted buffer 2-4 feet in width which provides greater separation between vehicles and bicyclists than provided by traditional bicycle lanes. In addition, pedestrian and bicycle crossings were provided across all the interstate on-ramps and off-ramps, with signage and pavement markings included to enhance the visibility of the crossing pedestrians and bicyclists, with green paint used for the bicycle crossings.

The Proponent will coordinate with MassDOT to ensure the proposed improvements along Gould Street will tie into the bicycle and pedestrian accommodations along Highland Avenue. As the design for Highland Avenue went through many years of review and coordination, the Proponent will respect the recent and ongoing work on Highland Avenue and enhance the connections between Highland Avenue, the Project Site, and the nearby residential areas.

Details on the proposed Highland Avenue bicycle accommodations are provided in Section 5.5.6 of Chapter 5, *Traffic and Transportation*.

Comment C.34

The DEIR should include sufficiently detailed conceptual plans (minimum of 80-scale) for any proposed roadway improvements including the proposed signalization, geometric improvements, and bicycle lanes to verify the feasibility of constructing such improvements. These plans should clearly show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed.

Response

Detailed conceptual plans (at 80-scale) for the proposed roadway improvements have been developed that include the proposed signalization, geometric improvements, and bicycle lanes to verify the feasibility of constructing such improvements. These plans also show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed. The conceptual plans are referenced in Section 5.5.2 of Chapter 5, *Traffic and Transportation*, and are included in Appendix D.

Comment C.35

The DEIR should provide additional information on how carpool assistance and emergency ride home services will be provided, as well as what incentive program may be implemented.

Response

Additional information on emergency ride home services is provided in Section 5.6.3 of Chapter 5, *Traffic and Transportation*, and additional information on carpool assistance and what incentive program may be implemented is provided in Section 5.6.4 of Chapter 5, *Traffic and Transportation*. The Project is expected to partake in the emergency ride home services currently provided by the 128 Business Council. Carpool assistance for employees on-Site will be coordinated by the Employee Transportation Coordinator.

Comment C.36

In addition to providing shuttle service to nearby commuter rail and Green Line services, the Proponent should explore the possibility of extending bus service to the site as requested by the Town.

Response

Refer to the response to Comment C.30. Additional details on the feasibility of rerouting the MBTA Bus Route 59 to service the Site are provided in Section 5.4.4 of Chapter 5, *Traffic and Transportation*.

Comment C.37

Given the high number of new vehicular trips anticipated from the project, the DEIR should demonstrate a strong commitment to implementing TDM measures to the greatest extent feasible to reduce SOV travel to and from the site.

Response

The Proponent is strongly committed to implementing the TDM measures to the greatest extent feasible to reduce single-occupancy vehicle travel to and from the Project Site. Section 5.6 of Chapter 5, *Traffic and Transportation*, provides details on the TDM measures that the Proponent intends to implement, including the implementation of direct shuttle service between the Project Site and nearby transition stations to facilitate the use of public transit to access the Project Site.

Comment C.38

The DEIR should quantify the anticipated mode share that is expected for the project (both with and without TDM measures) and demonstrate that the project will take all feasible measures to encourage non-vehicular travel to and from the site.

Response

The trip generation estimates were developed assuming 100-percent of the Site-generated traffic would use private vehicles to access the Project Site. This was a conservative analysis used to identify the "worst-case" scenario of impacts that the Project Site could generate. With the TDM program, the investment in pedestrian and bicycle infrastructure, and the dedicated EV shuttle between the Project Site and nearby transit stations, the Proponent is committed to ensuring that the percentage of Site-generated traffic using private vehicles is less than 100-percent. With the future of hybrid work schedules and employees working from home, it also is likely that not all tenant employees will commute to the workplace five days a week.

Data from the US Census Bureau shows that approximately 95-percent of all employees who commute to workplaces in the Town of Needham do so via private automobile, that two percent use public transit and that three percent walk or bike. With the strong TDM program and mitigation measures outlines that the Proponent is committed to implementing at the Project Site, the percentage of employees that take alternative forms of transportation to the Project Site is anticipated to be higher than the average for other workplaces within the Town of Needham.

Details on the desired TDM goals are provided in Section 5.6.5 of Chapter 5, *Traffic and Transportation*.

Comment C.39

The DEIR should describe the methodology used to estimate the effectiveness of TDM measures and should discuss what measures the Proponent intends to take if the TDM program proves to be less effective than anticipated as shown through monitoring efforts.

Response

The proposed transportation monitoring program will include an annual travel survey of tenants' employees and patrons of the Project Site. The survey will be conducted by the Proponent and will include details on the mode of transportation tenants' employees and

patrons use to access the Project Site as well as the effectiveness of the proposed TDM programs. The survey will also ask about hybrid work schedules to determine how frequently tenants' employees commute to the Project Site versus working from home. The results of the survey will be used to review the current TDM program and decide if any revisions are necessary to further engage the employees and patrons of the Project Site to encourage the use of walking/biking, carpooling, and public transportation.

If the transportation monitoring program indicates that the actual traffic increase generated by the Project exceeds the traffic projections contained within the TIA by ten percent or more, the Proponent will increase funding for the TDM program, add more measures to attempt to reduce the share of single occupancy vehicles accessing the Project Site and coordinate with the Town of Needham and MassDOT to determine potential additional TDM measures that could be implemented.

Details on the Transportation Monitoring Program travel survey and results are provided in Section 5.7.3 and Section 5.7.4 of Chapter 5, *Traffic and Transportation*.

Comment C.40

The DEIR should maximize opportunities to make the site EV-ready and install EV charging wherever feasible.

Response

To promote the use of electric vehicles and to accommodate a future increase in electric vehicles on the roadway, the Project Site will be equipped with electric vehicle charging stations. Approximately 25-percent of the parking spaces in each parking area (the stand-alone parking garage, the surface lot, and the underground garage) will be equipped with Level 2 electric vehicle charging stations, with consideration as to how increased electric vehicle capacity can be implemented in the future as warranted by demand and market conditions.

Details of the electric vehicle charging facilities on Site are outlined in Section 5.6.2 of Chapter 5, *Traffic and Transportation,* and in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.41

The DEIR should clarify the Proponent's commitment to EV charging (number of spaces) and describe how it will be implemented on the site.

Response

Refer to the response to Comment C.40. Details of the electric vehicle charging facilities on Site are outlined in Section 5.6.2 of Chapter 5, *Traffic and Transportation,* and in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.42

The DEIR should include a draft transportation monitoring program (TMP) commitment. The goals of the monitoring program will be to evaluate the assumptions made in the DEIR and the adequacy of the mitigation measures, as well as to determine the effectiveness of the TDM program.

Response

A draft transportation monitoring program (TMP) commitment is included in Section 5.7 of Chapter 5, *Traffic and Transportation*. The TMP will evaluate the trip generation assumptions made in the TIA and the adequacy of the mitigation measures, as well as help determine the effectiveness of the TDM program.

Comment C.43

As described in MassDOT's comment letter, the Proponent will be required to conduct the TMP for a period of five years, beginning six months after occupancy of the full-build project. It should include:

• Simultaneous automatic traffic recorder (ATR) counts at each parking entrance for a continuous 24-hour period on a typical weekday;

• Travel survey of employees and patrons at the site;

• Weekday AM and PM peak hour turning movement counts (TMCs) and operations analysis at study area intersections, and;

• Updates on efficacy of the TDM program.

Response

Details of the transportation monitoring program (TMP) are included in Section 5.7 of Chapter 5, *Traffic and Transportation*. The TMP will begin six months after occupancy of the proposed development and continue for a period of five years. It will include ATR counts at each parking entrance for a continuous 24-hour period on a typical weekday, a travel survey of tenants' employees and patrons at the Project Site, weekday morning and evening peak hour turning movement counts and operations analyses at specific study area intersections, and updates on the efficacy of the TDM program. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham.

Comment C.44

The DEIR should discuss in detail how the Proponent intends to implement the monitoring program, and what measures it plans to take if traffic counts for the project are shown to be higher than anticipated, and if TDM and other mitigation measures prove less effective than expected.

Response

Refer to response to comment C.43.

Comment C.45

To ensure that the project's new wastewater flow does not increase surcharging and overflows in large storms, the Proponent should fully offset the project's wastewater flows with I/I removal in accordance with Town's policies and regulations.

Response

The new wastewater flow resulting from the proposed improvements will not increase surcharging and overflows in large storms. Refer to Section 4.3.2 of Chapter 4*, Stormwater and Water/Wastewater*, for information regarding the project's wastewater flow. The Proponent will comply with the Town of Needham's I/I removal policies and regulations.

Comment C.46

The DEIR should describe how the Proponent will assist the Town's efforts of removing infiltration and inflow (I/I) from the municipal collection system.

Response

Refer to Section 4.3.2 of Chapter 4*, Stormwater and Water/Wastewater*, for information regarding offsets to the Project's wastewater flows with I/I removal.

Comment C.47

A Sewer Use Discharge Permit is required prior to discharging laboratory wastewater and/or industrial process wastewater from any laboratory and commercial space associated with the project into the MWRA sanitary sewer system. Any gas/oil separators in parking garages associated with the project must comply with 360 C.M.R. 10.016 and State Plumbing Code and their installation may not be back filled until inspected and approved by MWRA and the Local Plumbing Inspector. The DEIR should describe measures that the Proponent will take to comply with the above permits.

Response

Refer to Section 4.3.1 of Chapter 4*, Stormwater and Water/Wastewater,* for information regarding compliance with Sewer Use Discharge Permit requirements, 360 C.M.R. 10.016 and State Plumbing Code.

Comment C.48

According to the ENF, the project is being designed to minimize demands on the Town's water supply and to minimize sanitary sewer discharges. As described above, a cistern integrated into the standalone garage will store captured stormwater, for use in irrigation, as makeup water for the HVAC cooling towers, and elsewhere in the buildings. Within the buildings, water will be

recycled to the extent feasible, with graywater used for flushing toilets and urinals. The building's water faucets, toilets, urinals, and other water fixtures use high-efficiency, low-flow designs. The DEIR should further describe all measures that will be implemented as the project design progresses.

Response

Refer to Section 4.3.2 of Chapter 4*, Stormwater and Water/Wastewater*, for a discussion on proposed design components for water harvesting and recycling.

Comment C.49

Comments from MassDEP state that excavating, removing and/or disposing of contaminated soil, pumping of contaminated groundwater, or working in contaminated media must be done under the provisions of M.G.L. c. 21E and all other applicable federal, state, and local laws, regulations, and bylaws.

Response

The Proponent will perform any excavation, removal and/or disposal of contaminated soil, pumping of contaminated groundwater, or work in contaminated media under the provisions of M.G.L. c. 21E and all other applicable federal, state, and local laws, regulations, and bylaws. Refer to Section 6.3 of Chapter 6, *Solid and Hazardous Waste*.

Comment C.50

If contamination at the site is known or suspected, the appropriate tests should be conducted well in advance of the start of construction and professional environmental consulting services should be readily available to provide technical guidance.

Response

The Proponent has retained a Licensed Site Professional to manage the environmental aspects of the Project and will prepare and submit a Release Abatement Measure (RAM) Plan prior to non-exploratory earthwork activities. A series of subsurface exploration programs have been completed across the Project Site to pre-characterize in-situ soil for off-site removal, also submitting over 350 soil samples for testing. Refer to Sections 6.3 and 6.4 of *Chapter 6, Solid and Hazardous Waste*.

Comment C.51

If dewatering activities are to occur at a site with contaminated groundwater, or in proximity to contaminated groundwater where dewatering can draw in the contamination, a plan must be in place to properly manage the groundwater. As is already the case, an LSP must be employed or engaged to manage, supervise or actually perform the necessary response actions at the site.

Response

The Proponent has retained a Licensed Site Professional to manage the environmental aspects of the Project. Although it is not anticipated that groundwater will be encountered during excavation activities, an additional assessment will be performed to evaluate a potential release in groundwater. Refer to Section 6.3 *of Chapter 6, Solid and Hazardous Waste.*

Comment C.52

MassDEP comments state further investigation of subsurface conditions is expected to continue, and the results provided to MassDEP in the next scheduled submittal due in May of 2022. The DEIR should contain the results of ongoing analysis and describe measures to protect public health.

Response

The proponent will continue to investigate subsurface conditions and provide results to MassDEP in compliance with the MCP. For information regarding remedial actions and measures to protect public health, refer to Section 6.5 of Chapter 6*, Solid and Hazardous Waste.*

Comment C.53

The DEIR should continue to identify opportunities to increase resilience through enhancement of the site, including increased open space and permeable surfaces.

Response

The proposed site improvements will increase the percentage of open space and implement permeable surfaces on the Project Site, including porous pavement, so as to increase resilience. Refer to Section 4.2.4 of Chapter 4*, Stormwater and Water/Wastewater*.

Comment C.54

Effective April 25, 2022, the MA Resilience Design Tool now provides rainfall volumes associated with a 24-hour storm for multiple storm scenarios and planning horizons for projects subject to extreme precipitation risks. The DEIR should consult these volumes for the 10-year, 25-year and 50-year storm in 2070 in assessing the efficacy of the stormwater design in attenuating peak runoff and pollutant loading. Estimates can be provided in lieu of exact calculations, to the extent stormwater design is not advanced enough by the time of the DEIR.

Response

Refer to Section 4.2.3 of Chapter 4*, Stormwater and Water/Wastewater*, for consultations with the MA Resilience Design Tool for the estimates regarding the efficacy of the specified storm events.

Comment C.55

To the extent the project is unable to accommodate future year storm scenarios, the DEIR should discuss whether the project has engaged in flexible adaptative strategies, and whether current designs allow for future upgrades to be made to adapt to climate change.

Response

The proposed improvements and stormwater management system are expected to accommodate future year storm scenarios while allowing for future upgrades adaptable to climate change. Refer to Section 4.2.3 of Chapter 4*, Stormwater and Water/Wastewater*.

Comment C.56

I encourage the Proponent to consult the data available from the Town, including the findings of its Community Resilience Building Workshop (May 2020) and additional reports it may have prepared, and the resilientMA.org website to develop climate change scenarios for the site and identify potential adaptation measures.

Response

Refer to Section 7.3.4, Chapter 7, *Climate Change*, for a discussion on the Needham Community Resilience Building Workshop. The RMAT Tool was utilized by the Proponent and discussed in Section 7.3.2, Chapter 7, *Climate Change*.

Comment C.57

The Policy requires Proponents to quantify carbon dioxide (CO2) emissions and identify measures to avoid, minimize or mitigate such emissions. The analysis should quantify the direct and indirect CO2 emissions of the project's energy use (stationary sources) and transportation-related emissions (mobile sources).

Response

The Proponent has presented a stationary and mobile source GHG emissions assessment per the MEPA GHG Policy in Section 7.4 of Chapter 7, *Climate Change*.

Comment C.58

The DEIR should include a GHG analysis that calculates and compares GHG emissions associated with a 1) Base Case that conforms to the 9th Edition of the Massachusetts Building Code, which references the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2013 and the International Energy Conservation Code (IECC) 2015, and 2) a Preferred Alternative that achieves greater reductions in GHG emissions.

Response

The Proponent has modeled the two requested alternatives in the stationary source GHG assessment as presented in Section 7.4.1 of Chapter 7, *Climate Change*.

Comment C.59

The Town has adopted the Massachusetts Stretch Energy Code (SC). Therefore, the project will be required to meet the applicable version of the SC in effect at the time of construction.

Response

The proposed design complies with the Stretch Energy Code.

Comment C.60

The Stretch Code requires a 10% energy performance improvement over ASHRAE 90.1-2013-Appendix G plus Massachusetts amendments including C402.1.5 (envelope), C405.3 and C405.4 (lighting), C405.10 (EV charging), and C406 (three additional efficiency measures). The analysis should include the three C406 additional efficiency measures in their Baseline.

Response

The proposed design complies with the Stretch Energy Code and the energy modeling includes three additional C406 measures as requested. The energy modeling is summarized in Section 7.4.1 of Chapter 7, *Climate Change*.

Comment C.61

The DEIR should present an evaluation of mitigation measures identified in DOER's comment letter. In particular, the feasibility of each of the mitigation measures outlined below should be assessed for each of the major project elements, and if feasible, GHG emissions reduction potential associated with major mitigation elements should be evaluated to assess the relative benefits of each measure.

Response

The Proponent has evaluated the mitigation measures identified in DOER's comment letter. The results of these evaluations are presented in Section 7.4.1 of Chapter 7, *Climate Change* and in Appendix E. Where measures were not found to be feasible, the reasoning is presented.

Comment C.62

The DEIR should explain, in reasonable detail, why certain measures that could provide significant GHG reductions were not selected – either because it is not applicable to the project or is deemed technically or financially infeasible.

Response

Refer to the response to Comment C.61.

Comment C.63

If financially infeasible, the DEIR should describe the cost effectiveness metrics that were used to evaluate feasibility, whether energy savings that would accrue to future tenants were considered, and what "payback period" the Proponent would deem to be reasonable given the financial constraints identified. It should include a review of available financial incentives potentially available for the project, as described in DOER's comment letter.

Response

Refer to the response to Comment C.61.

Comment C.64

At a minimum, the DEIR should consider the following GHG mitigation measures:

- *Building design and construction practices that result in low heating and cooling TEDI by:*
  - *o Maintaining envelope integrity with framed, insulated walls with continuous insulation*
  - *o Thermally broken windows and other components to eliminate thermal bridges*
  - *o Minimizing glass curtain wall assemblies and excessive windows*
  - *o Low air-infiltration, confirmed with in-building air-infiltration testing*
  - *o Energy recovery*
  - *o Management of solar heat gains*
- *Efficient electrification of space heating including:*
  - *o For highly ventilated lab/office: low temperature, hydronic space heating with heat-input provided by hybrid, in-building, central plant consisting of air-to-water heat pump (primary) and gas boilers (secondary)*
  - *o For not highly ventilated space: low temperature, hydronic space heating with heat-input provided by in-building central plant consisting of air-to-water heat pump, or, air source heat pump (ASHP)/variable refrigerant flow (VRF)*
- *Efficient electrification of water heating where feasible*
- *Extensive rooftop solar-readiness*
- *EV ready parking spaces*

Response

The Proponent has committed to the majority of the measures identified in the comment letter. The buildings are designed to reduce TEDI, use hybrid systems for space heating, and heat pumps for water heating. The buildings are also designed for solar readiness and EV charging stations. The measures included in the Proposed design are presented in Section 7.4.1 of Chapter 7, *Climate Change*.

Comment C.65

The GHG analysis should include an evaluation of potential GHG emissions associated with mobile emissions sources.

Response

The Proponent has presented a mobile source GHG emissions in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.66

The DEIR should follow the guidance provided in the GHG Policy for Indirect Emissions from Transportation to determine mobile emissions for Existing Conditions, Build Conditions, and Build Conditions with Mitigation

Response

Refer to the response to Comment C.65. The analysis follows the requested guidance and methodology.

Comment C.67

The Proponent should thoroughly explore means to reduce overall SOV trips.

Response

The Proponent is committed to a comprehensive TDM program that will reduce SOV trips, which is outlined in Section 5.6 of Chapter 5, *Traffic and Transportation*. The corresponding GHG mitigation is presented in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.68

The DEIR should also review measures to promote the use of low-emissions vehicles, including installing EV charging stations and providing designated parking spaces for these vehicles.

Response

The Proponent will commit to installing EV charging stations at the Project Site as outlined in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.69

The DEIR should present Existing Conditions, a future No Build scenario, Build scenario with project impacts included, and Build with Mitigation showing the effect of TDM measures and any roadway improvements implemented by the project

Response

The Proponent has presented a mobile source GHG emissions in Section 7.4.2 of Chapter 7, Climate Change. The analysis follows the requested methodology and conditions.

Comment C.70

The analysis should document the reductions in GHG emissions associated with the mitigation.

Response

The Proponent will implement multiple measures to reduce mobile source GHG emissions. The corresponding GHG mitigation is presented in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.71

The DEIR should explain how TDM measures will be monitored and adjusted over time and provide a methodology for quantifying emission reductions impacts rather than an assumed percentage reduction.

Response

The Proponent is committed to an extensive Transportation Monitoring Program (as described in Section 5.7 of Chapter 5, *Traffic and Transportation*) that will monitor and adjust TDM measures to insure their effectiveness. The Proponent has assessed potential GHG reductions associated with the TDM program in Section 7.4.2 of Chapter 7, *Climate Change*.

Comment C.72

The Proponent should conduct an indirect source review analysis in accordance with MassDEP Guidelines for Performing Mesoscale Analysis of Indirect Sources. The purpose of the analysis is to determine whether and to what extent the project will increase the amount of volatile organic compounds (VOC) and nitrogen oxides (NOx) emitted in the project area as compared to existing and future no-build conditions, and to discuss mitigation measures as appropriate. The analysis should model emissions under No Build and Build conditions. If the analysis demonstrates that emissions under future Build conditions are greater than under the No Build scenario, mitigation measures must be provided, including a TDM Program.

Response

The Proponent has presented a mobile source air quality assessment in Section 7.4.2 of Chapter 7, *Climate Change*. The analysis follows the requested guidance and methodology.

Comment C.73

The DEIR should include a commitment to provide a GHG self-certification to the MEPA Office upon construction of the project. It should be signed by an appropriate professional (e.g., engineer, architect, transportation planner, general contractor) indicating that all of the GHG

mitigation measures, or equivalent measures that are designed to collectively achieve identified reductions in stationary source GHG emission and transportation-related measures, have been incorporated into the project.

Response

The Proponent has provided a draft Self-Certification in Section 8.3 of Chapter 8, *Mitigation and Draft Section 61 Findings*, reflecting the GHG emissions analysis presented in this DEIR filing.

Comment C.74

If equivalent measures are adopted, the project is encouraged to commit to achieving the same level of GHG emissions (i.e., "carbon footprint") identified in the Preferred Alternative expressed as a volumetric measure (tpy) in addition to a percentage GHG reduction from Base Case.

Response

The Proponent will reduce emissions by the percentage reduction presented herein, as required by the MEPA GHG Policy.

Comment C.75

The DEIR should describe all construction-period impacts and mitigation relative to noise, air quality, water quality, and traffic.

Response

Refer to Chapter 8, *Construction Period Impacts*, for a discussion of impacts and mitigation related to noise, air, water quality, and traffic.

Comment C.76

It should confirm that the project will require its construction contractors to use Ultra Low Sulfur Diesel fuel, and discuss the use of after-engine emissions controls, such as oxidation catalysts or diesel particulate filters.

Response

The Proponent will require its construction contractors to use Ultra Low Sulfur Diesel fuel and engine emissions control measures where feasible.

Comment C.77

The DEIR should provide more information regarding the project's generation, handling, recycling, and disposal of construction and demolition debris (C&D) and identify measures to reduce solid waste generated by the project.

Response

Refer to Section 8.6, Chapter 8, *Construction Period Impacts,* for information related to the handling, recycling, and disposal of construction and demolition debris.

Comment C.78

I encourage the Proponent to commit to C&D recycling activities as a sustainable measure for the project.

Response

Any disposal will include specific requirements and procedures for segregation, reprocessing, reuse, and recycling of materials whenever possible. The construction manager will be responsible for ensuring that debris will be disposed of at appropriately designated licensed solid waste disposal facilities as defined by Massachusetts General Laws.

Comment C.79

The DEIR should describe how any contaminated material encountered during construction will be managed in accordance with M.G.L. c. 21E and the MCP.

Response

Refer to Section 8.7, Chapter 8, *Construction Period Impacts*, for a discussion on contaminated material.

Comment C.80

The project will be required to develop a Stormwater Pollution Prevention Plan (SWPP) in accordance with its NPDES CGP to manage stormwater during the construction period.

Response

A Stormwater Pollution Prevention Plan will be developed in accordance with the NPDES CGP to manage stormwater during the construction period.

Comment C.81

The DEIR should describe stormwater management measures that will be implemented during construction.

Response

Refer to Section 4.2.2, Chapter 4*, Stormwater and Water/Wastewater*, for stormwater management measurements that will be implemented during construction in compliance with local and state stormwater requirements.

Comment C.82

It should describe potential construction period dewatering activities and identify mitigation measures in compliance with those required for contaminated sites.

Response

Although groundwater is not anticipated to be encountered during site excavation activities, procurement of temporary groundwater dewatering discharge permits from the EPA, MassDEP, Town of Needham, and/or the Massachusetts Water Resource Authority (MWRA) may be required for pumping and off-site discharge of groundwater. If on-site recharge is not feasible and off-site discharge is required, the appropriate dewatering discharge permits will be obtained. Refer to Section 6.4.3, Chapter 6*, Solid and Hazardous Waste*.

Comment C.83

All construction-period mitigation measures should be listed in the draft Section 61 Findings.

Response

Mitigation of construction impacts are discussed in Table 9-1, Summary of Mitigation Measures and construction period mitigation measures are listed in the draft MassDOT Section 61 Findings.

Comment C.84

The DEIR should include a separate chapter summarizing all proposed mitigation measures including construction-period measures. This chapter should also include a comprehensive list of all commitments made by the Proponent to avoid, minimize and mitigate the environmental and related public health impacts of the project.

Response

Refer to Chapter 9, *Mitigation and Draft Section 61 Findings*, for proposed mitigation measures of the Project.

Comment C.85

The filing 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.

Response

Refer to Chapter 9, *Mitigation and Draft Section 61 Findings*, for proposed mitigation measures of the Project, estimated costs, responsible parties, and scheduling.

Comment C.86

The list of commitments should be provided in a tabular format organized by subject matter (traffic, water/wastewater, GHG, etc.) and identify the Agency Action or Permit associated with each category of impact.

Response

Comment noted. Refer to Table 9-1, Chapter 9, *Mitigation and Draft Section 61 Findings*.

Comment C.87

Draft Section 61 Findings should be separately included for each Agency Action to be taken on the project.

Response

Comment noted. Refer to Sections 9.2 and 9.3, Chapter 9, *Mitigation and Draft Section 61 Findings.*

Comment C.88

The filing should clearly indicate which mitigation measures will be constructed or implemented based upon project phasing to ensure that adequate measures are in place to mitigate impacts associated with each development phase.

Response

Comment noted. Refer to Chapter 9, *Mitigation and Draft Section 61 Findings.*

Comment C.89

To ensure that all GHG emissions reduction measures adopted by the Proponent as the Preferred Alternative are constructed or performed by the Proponent, the Secretary 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. The commitment to provide this self-certification in the manner outlined above should be incorporated into the draft Section 61 Findings included in the DEIR.

Response

Refer to the response to Comment C.73.

Comment C.90

The DEIR should contain a copy of this Certificate and a copy of each comment letter received. To ensure that the issues raised by commenters are addressed, the DEIR should include direct responses to comments to the extent that they are within MEPA jurisdiction.

Response

Refer to Appendix F for a copy of the Certificate and all comment letters. This chapter addresses all comments.

Comment C.91

The Proponent should circulate the DEIR to those parties who commented on the ENF, to any State Agencies from which the Proponent will seek permits or approvals, and to any parties specified in section 11.16 of the MEPA regulations.

Response

Comment noted. Refer to the DEIR Distribution List in Appendix A.

Comment C.92

The Proponent must make a reasonable number of hard copies available to accommodate those without convenient access to a computer and distribute these upon request on a first come, first-served basis.

Response

The Proponent will provide hard copies at the Needham Public Library and on a first come first-served basis.

Comment C.93

A copy of the DEIR should be made available for review in the Needham Public Library.

Response

The DEIR will be delivered to the Needham Public Library.

Letter 1: Greenman-Pedersen, Inc.

Comment 1.1

It should be noted that MassDOT will require a minimum of two permits for this development. One permit will be for the change-in-use of the property as the property directly abuts land owned by the Commonwealth of Massachusetts (Interstate 95 / Route 128) and the project will generate more than 2,000 daily vehicle trips. A separate MassDOT access permit will be required for the construction of any off-site roadway improvements within the SHLO.

Response

The Proponent will prepare two permits for MassDOT, one for the change-in-use of the Project Site as the Project Site directly abuts land a state highway and a separate access permit for the construction of any off-site roadway improvements within the state highway layout (SHLO).

Comment 1.2

The Applicant should provide additional information on how carpool assistance and emergency ride home services will be provided, as well as what incentive program may be implemented.

Response

Additional information on emergency ride home services is provided in Section 5.6.3, Chapter 5, *Traffic and Transportation*, and additional information on carpool assistance and what incentive program may be implemented is provided in Section 5.6.4 of Chapter 5, *Traffic and Transportation*. The Project is expected to partake in the emergency ride home services currently provided by the 128 Business Council and carpool assistance for employees on-Site will be coordinated by the Employee Transportation Coordinator.

Comment 1.3

In addition to providing shuttle service to nearby commuter rail and Green Line services, the Applicant should explore the possibility of extending bus service to the site.

Response

Refer to the response to Comment C.30.

Additional details on the MBTA Bus Network Redesign and the feasibility of rerouting the MBTA Bus Route 59 are provided in Section 5.4.4, Chapter 5, *Traffic and Transportation*.

Comment 1.4

In Section 1.B on page 21 of the ENF Form, the Applicant has stated that no permits will be required related to roadways or other transportation facilities. However, a MassDOT access permit will be required for the construction of off-site roadway improvements within the SHLO.

Therefore, the Applicant should complete the Transportation Facility Impacts section of the ENF Form.

Response

Refer to the response to Comment 1.1.

Comment 1.5

The capacity and queue analysis summarized in Table 2-15 of the ENF indicates that even with the mitigation measures proposed by the Applicant, the Hunting Road northbound movement will operate over capacity at level-of-service (LOS) F during the weekday AM and PM peak hours under 2029 Build with Mitigation conditions. The Highland Avenue eastbound left-turn movement will also operate at LOS F during the weekday AM peak hour. Therefore, the Applicant should consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of this intersection.

Response

Refer to the response to Comment C.26.

Comment 1.6

Section 2.3.4.1 of the ENF notes that a total of 89 bicycle parking spaces will be provided indoors and outdoors, but no description is given on how many spaces will be indoors and how many will be outdoors. The study also does not contain any assessment of the potential bicycle parking demand that could be generated and the adequacy of the number of bicycle parking spaces provided to accommodate this demand.

Response

Refer to the response to Comment C.31. Further details on the potential bicycle parking demand and the number of bicycle parking spaces proposed to be provided on-Site are provided in Section 5.4.5, Chapter 5, *Traffic and Transportation*.

Comment 1.7

In addition, per MassDOT guidelines, collision diagrams should be prepared for any locations that experience an average of more than 3 crashes per year or a crash rate higher than the state or district-wide average.

Response

Collision diagrams have been developed for the intersections of Highland Avenue at West Street, Highland Avenue at Gould Street/Hunting Road, and Hunting Road at Kendrick Street. The collision diagrams are presented in Section 5.4.2.1, Chapter 5, *Traffic and Transportation*, and are included in Appendix D.

Comment 1.8

The Applicant should calculate the crash rates for all study area intersections and prepare collision diagrams, as necessary, to identify collision patterns at the study area intersections.

Response

Calculated crash rates for all study area intersections were included in the bottom row of Table 2-2 of the ENF. As discussed in the response to comment 1.7, collision diagrams have been developed for the intersections of Highland Avenue at West Street, Highland Avenue at Gould Street/Hunting Road, and Hunting Road at Kendrick Street. The collision diagrams are presented in Section 5.4.2.1, Chapter 5, *Traffic and Transportation*, and are included in Appendix D.

Comment 1.9

For any location where 5 or more crashes of a similar type occurred over the analysis period, the Applicant should investigate measures to improve safety and mitigate collision occurrence.

Response

For the three intersections where collision diagrams have been developed (Highland Avenue at West Street, Highland Avenue at Gould Street/Hunting Road, and Hunting Road at Kendrick Street), the Proponent is proposing signal timing modifications to improve operations. As part of the signal timing modifications, the clearance intervals will be reviewed to determine if the yellow and/or all-red times should be adjusted to improve safety operations. The Proponent is also improving significant roadway and intersection improvements at the intersections of Central Avenue at Gould Street, Highland Avenue at Gould Street/Hunting Road, Gould Street at the Project Site driveway, and Gould Street at TV Place that will help improve safety conditions at each intersection. Details on the proposed Project transportation mitigation are included in Section 5.5, Chapter 5, *Traffic and Transportation*.

Comment 1.10

According to Table 2-9, the Highland Avenue southbound approach to West Street will operate over capacity with long delays during the weekday PM peak hour under 2029 Build conditions, with an increase in delay of 22 seconds per vehicle generated by the project. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

Response

The Proponent has reviewed the signal timings at the intersection of Highland Avenue at West Street during the weekday evening peak hour and determined that signal timing adjustments can be made to improve operations for the southbound approach without adversely impacting movements on the other approaches. Details of the proposed timing adjustments and a summary of the intersection capacity analyses with the revised signal

timings at this intersection are provided in Section 5.5.1.2, Chapter 5, *Traffic and Transportation*.

Comment 1.11

The Highland Avenue eastbound through/right-turn movement at the intersection with Webster Street will operate over capacity during the weekday AM peak hour under 2029 Build conditions, with an increase in delay of 26 seconds per vehicle generated by the project. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

Response

The Proponent has reviewed the signal timings at the intersection of Highland Avenue at Webster Street during the weekday morning peak hour and determined that signal timing adjustments can be made to improve operations for the eastbound approach without adversely impacting movements on the other approaches. Details of the proposed timing adjustments and a summary of the intersection capacity analyses with the revised signal timings at this intersection are provided in Section 5.5.1.3, Chapter 5, *Traffic and Transportation*.

Comment 1.12

Although not heavily impacted by project-generated traffic, the Highland Avenue westbound left/through movement at the intersection with 1st Avenue will be well over capacity during the weekday PM peak hour under both 2029 No-Build and Build conditions. GPI recommends the Applicant consider measures to reduce delay and improve operations at this location.

Response

The Proponent has reviewed the signal timings at the intersection of Highland Avenue at 1st Avenue during the weekday evening peak hour and determined that signal timing adjustments can be made to improve operations for the westbound approach without adversely impacting movements on the other approaches. Details of the proposed timing adjustments and a summary of the intersection capacity analyses with the revised signal timings at this intersection are provided in Section 5.5.1.4, Chapter 5, *Traffic and Transportation*.

Comment 1.13

Similarly, the Hunting Road northbound approach to Kendrick Street will be well over capacity during the weekday AM peak hour under 2029 No-Build and Build conditions. GPI recommends the Applicant consider options reducing delay and improving operations at this location.

Response

The Proponent has reviewed the signal timings at the intersection of Hunting Road at Kendrick Street during the weekday morning peak hour and determined that signal timing adjustments can be made to improve operations for the northbound approach without adversely impacting movements on the other approaches. Details of the proposed timing adjustments and a summary of the intersection capacity analyses with the revised signal timings at this intersection are provided in Section 5.5.1.5, Chapter 5, *Traffic and Transportation*.

Comment 1.14

The Webster Street and Cedar Street approaches to Central Avenue are expected to operate well over capacity with long delays and queues under 2029 No-Build and Build conditions, particularly during the weekday AM peak hour. The Applicant should investigate options for improving the operations of these intersections, including conducting a signal warrant analysis to assess whether a warrant for installation of traffic signal will be met at either of these locations.

Response

The Proponent has conducted signal warrant analyses at the intersections of Central Avenue at Cedar Street and Central Avenue at Webster Street. The warrants have been conducted for the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions. At both intersections, signals are warranted by at least one warrant under the 2022 Existing, 2029 No Build, and 2029 Build Conditions and the addition of Site-generated traffic does not trigger an intersection from not having a traffic signal being warranted to warranting a traffic signal.

Because both intersections warrant signals under Existing and No Build Conditions and since less than 10-percent of the Project-generated trips are expected to travel through these two intersections per the TIA, the Proponent is not proposing to signalize either of these intersections. However, the Proponent is proposing to fund the installation of a traffic signal at the intersection of Central Avenue at Gould Street, which is expected to also help operations at these two unsignalized intersections by creating additional gaps in the traffic flow along Central Avenue that will help create additional opportunities for vehicles turning onto and off-of Central Avenue.

Details on the traffic signal warrant analyses conducted at these two intersections are provided in Section 5.5.1.6, Chapter 5, *Traffic and Transportation*.

Comment 1.15

As noted in Comment 7, even with the proposed mitigation at the Highland Avenue / Gould Street / Hunting Road intersection, some movements will continue operating at LOS F under 2029 Build with Mitigation conditions. Therefore, the Applicant should investigate the feasibility of providing additional capacity at this location to accommodate 2029 Build traffic volumes.

Response

Refer to the response to Comment C.26.

Comment 1.16

Section 2.7.3 of the ENF describes a transportation monitoring program that will be conducted post-occupancy to monitor parking occupancy and traffic operations at four of the study area intersections, including the site driveway. The Applicant should also provide monitoring of the effectiveness of the proposed TDM program in encouraging walking/biking, carpooling, and public transportation travel to/from the site.

Response

Refer to the response to Comment C.39.

Comment 1.17

However, should the result of the monitoring study indicate that the actual traffic increase generated by the project exceeds the traffic projections contained within the ENF by ten percent or more, the study area for the monitoring program should be expanded to include additional locations to verify that the project's impacts does not create any operation deficiencies at nearby locations.

Response

Refer to the response to Comment C.39.Comment 1.18

In addition, the monitoring programs should include a capacity and queue analysis to verify the operations of each of the study area intersections under post-occupancy conditions.

Response

The proposed transportation monitoring program will include capacity and queue analyses to verify the operations of the monitoring study area intersections under post-occupancy conditions. Details on the proposed operational analyses for the transportation monitoring program are provided in Section 5.7.2.1, Chapter 5, *Traffic and Transportation*.

Comment 1.19

The monitoring program should also include the collection of daily traffic volumes on TV Place and the Project Site driveway to verify the daily traffic generated by the project.

Response

The proposed transportation monitoring program will include simultaneous automatic traffic recorder (ATR) counts at the Project Site driveway and on TV Place for a continuous 48-hour period during a typical week. Details on the proposed intersection and roadway traffic monitoring program are provided in Section 5.7.2, Chapter 5, *Traffic and Transportation*.

Letter 2: Town of Needham

Comment 2.1

We expect the developer to work with the Town in providing an alteration/taking plan and recordings for a new Road Right of Way layout on Gould Street and for optimizing the traffic signals at Highland Avenue and Gould Street.

Response

The Proponent will work with the Town to optimize the traffic signals at Highland Avenue and Gould Street, and at other intersections. If the redesign of Gould Street requires expanding the right of way onto the Project Site, the Proponent will provide the Town with an alteration/taking plan and otherwise assist the Town in completing the takings/acceptance process.

Comment 2.2

We are seeking clarification for the facility's proposed water use of 129,172 gallons per day (GPD) while the wastewater design flow generation is 54,554 GPD.

Response

The discrepancy in water use in comparison to wastewater flow is due to evapotranspiration and use of water in mechanical equipment anticipated for lab use. Refer to Section 4.3.2 of *Chapter 4, Water/Wastewater Analysis*.

Comment 2.3

We expect to work with the developer on determining the optimum water loop design. The current proposal shows a 10-inch water connection to the site off a 12-inch main on Gould Street and a connection to an existing 8-inch water main on TV Place. The additional loop connection may be more optimum if connected from Highland Avenue in front of the development instead of, or an addition to the 8-inch on TV Place connection.

Response

The developer will continue to work with the Town of Needham DPW and water department for optimal water connection. The design has been revised to show a loop from the 12-inch feed on Highland Avenue to the 12" feed on Gould Street with the building feeds pulling from that proposed loop.

Letter 3: Massachusetts Water Resources Authority

Comment 3.1

To ensure that the Project's new wastewater flow does not increase surcharging and overflows in large storms, the Proponent should fully offset the Project's wastewater flows with infiltration and inflow ("I/I") removal in accordance with Town of Needham's policies and regulations.

Response

The new wastewater flow resulting from the proposed improvements will not increase surcharging and overflows in large storms. Refer to Section 4.3.2, *Chapter 4,* for information regarding the Project's wastewater flow.

Comment 3.2

Additionally, the Charles River is surrounded by Environmental Justice Populations. The proponent should carefully analyze ways to offset the additional wastewater generated by this development to limit/eliminate potential impacts that additional flow to the sewer may have on CSOs to the Charles River and associated downstream communities.

Response

The proponent has provided an assessment of the Project's potential impacts on Environmental Justice (EJ) populations surrounding the Charles River as detailed in section 3.4.1 in *Chapter 3, Environmental Justice and Public Health*.

Comment 3.3

MWRA prohibits the discharge of groundwater and stormwater into the sanitary sewer system, pursuant to 360 C.M.R. 10.023(1) except in a combined sewer area when permitted by the Authority and the local community. The Project site has access to separate sewer and storm drain systems. Therefore, the discharge of groundwater or stormwater to the sanitary sewer system associated with this Project is prohibited.

Response

The proposed improvements to the drainage and sanitary sewer systems on Site will not incorporate any illicit discharge of groundwater or stormwater into the sanitary sewer system, pursuant to 360 C.M.R. 10.023(1). Refer to *Chapter 4, Stormwater and Water/Wastewater*, for more information.

Comment 3.4

A Sewer Use Discharge Permit is required prior to discharging industrial process or laboratory wastewater from office, laboratory, or commercial space associated with the Project into the MWRA sanitary sewer system. For assistance in obtaining this permit, a representative of the

proposed office and laboratory space should contact Stephen Buczko, Industrial Coordinator, in the TRAC Department at (617) 305-5619 or Stephen.Buczko@mwra.com.

Response

Refer to Section 4.3.1, Chapter 4, *Stormwater and Water/Wastewater*, for information regarding compliance with Sewer Use Discharge Permit requirements, 360 C.M.R. 10.016 and State Plumbing Code**.**

Comment 3.5

Completed Sewer Use Discharge Application forms and attachments should be submitted via standard mail tov Stephen Buczko, MWRA, Industrial Coordinator, MWRA, TRAC, 2 Griffin Way, Chelsea, MA 02150 and via email to TRACPermits@mwra.com.

Response

The Proponent will submit Sewer Use Discharge Application forms and attachments on completion to Stephen Buczko as indicated.

Comment 3.6

Any gas/oil separators in parking garages associated with the Project must comply with 360 C.M.R. 10.016 and State Plumbing Code.

Response

Proposed gas/oil separator(s) in parking garages associated with the Project will comply with 360 C.M.R. 10.016 and State Plumbing Code.

Comment 3.7

Installation of gas/oil separator(s) may not be back filled until inspected and approved by the MWRA and the Local Plumbing Inspector. For assistance in obtaining an inspection, the Proponent should contact Michael J. Quercio, Source Coordinator, in the TRAC Department at (617) 305-5645 or Michael.Quercio@mwra.com

Response

Installation of gas/oil separator(s) will not be back filled until inspected and approved by the MWRA and the local Town of Needham Plumbing Inspector.

Comment 3.8

Additionally, due to the proximity of planned MWRA infrastructure to the Project site, MWRA requests coordination with the Proponent during design and construction.

Response

The Proponent will coordinate with MWRA during design and construction of the Project.

Letter 4: Massachusetts Department of Energy Resources

Comment 4.1

Separately, develop two UA analysis tables, as follows:

a. One table that shows how the baseline complies with Table 5.5-5 of ASHRAE 90.1 2013 Appendix G plus Massachusetts Amendment C401.2.4. Fenestration limits will vary depending upon building type.

b. A second table that shows how the proposed complies with 2018 IECC Tables C- 402.1.3, C402.1.4, and C-402.4. Fenestration limit should be 30% when calculating minimum performance requirements for all building types.

Response

The Proponent has performed the building envelope requirement calculations and confirmed that the proposed envelope complies with the energy code. The envelope requirement calculations are presented in Appendix E.

Comment 4.2

A combination of high-performing, thermally broken envelope, heat recovery, and solar gain management should be used throughout with an aim toward reducing heating TEDI. Strategies to achieve this include:

a. Above code-threshold envelope (vertical walls, windows, roofs and exposed lower level floors). Priority should be given to increasing continuous insulation and framed insulated wall sections. Distinguish between R value of batt and R value of continuous insulation. Continuous insulation necessarily means insulation that is uninterrupted by hangers, studs, etc. Indicate planned wall assembly U value and wall construction type (mass, wood,metal stud, etc). Confirm that the relationship between R-value and assembly U-factor conform to Appendix A of the Code.

b. Account for thermal bridges in assemblies and components with calculating U values. Use thermal bridge free assemblies and components to thermally break:

i. Hangers, girts, ties, and brick shelfs

ii. Intersections between balconies and vertical walls

iii. Intersections between the floor and vertical walls

iv. Transitions from wall to window

v. Parapets

vi. Vertical wall to vertical wall transitions (where the wall "turns") Consult https://thermalenvelope.ca/catalogue/ for pre-solved clear wall thermal bridge and linear thermal bridge values.

c. *Minimize glass curtain wall/spandrel systems as much as possible. Avoid these systems where possible, as these are the lowest performing wall systems.*

d. *If curtain wall systems are used, evaluate systems having opaque "spandrel" portion between R-4 through R-10. Opaque spandrel systems with performance better than R-10 are not recommended as there are significant difficulties to achieve performance higher than this in practice. Consult https://thermalenvelope.ca/catalogue/ for pre-solved opaque curtain wall performance values.*

e. *If curtain wall systems are used, evaluate using at least R-4 vision glass.*

f. *For all wall sections, use the thermal comfort tool to help evaluate reduction/elimination of perimeter heating systems. https://www.payette.com/glazing-and-winter-comfort-tool/*

g. *Reduce air infiltration to at least 0.4 cfm at 75 Pa. In-building field tests are recommended to confirm air-infiltration.*

h. *Incorporate ventilation energy recovery. High performing energy recovery is essential to achieving low TEDI.*

i. *Manage solar gains with external shading and/or low solar heat gain coefficient (SHGC).*

Response

The Proponent is proposing high performing building envelopes that incorporates the majority of the recommendations listed. The building envelopes are above-code, with high performing curtain wall, reduced air infiltration and energy recovery. The design will aim to eliminate thermal bridges as much as possible, using the Interactive Thermal Bridging Tools described. No perimeter heating is currently proposed. TEDI has been significantly reduced (by 90%) by the designed high performance energy recovery system. SHGC is designed to 0.4 to reduce solar heating during cooling hours but benefit from free heat gain during heating season.

Comment 4.3

At a minimum, develop the following scenario for the highly ventilated lab/office portions of the project:

a. *Improved envelope described above and inclusion of energy recovery to achieve heating TEDI reduction;*

b. Air infiltration of 0.4 cfm/sf at 75 Pa;

c. Downsize the HVAC as much as possible, including evaluating perimeter heating downsizing and/or elimination;

d. Near elimination of use of gas or other fossil fuels with EUIff goal of 5 to 10 kBtu/sf-yr or less using following strategy:

i. Ventilation incorporating dedicated outside air systems and energy recovery;

ii. Energy recovery of concurrent heating and cooling with heat recovery chillers or similar approach;

iii. In-building, centrally-located hybrid efficient electric space heating (air to water heat pump sized at 25 to 50% peak heating capacity as priority backed-up with 95% efficient gas boiler sized at 100% peak, connected to 120. thermal distribution hot water loop);

e. External shading and improved solar heat gain coefficient windows to control space cooling loads;

f. Conduct sub-scenarios with and without air source heat pump water heating.

Response

The Proponent has incorporated the above strategies into their proposed design so an alternative model was not run. The Proponent has reduced TEDI, air infiltration, and HVAC sizing. Fossil fuel use intensity is within the stated range. A heat pump chiller sized for 25 percent of the heating load is included to electrify a portion of the space heating requirements. Heat Pump water heating is also proposed. The SHGC value is optimized to 0.4 to control cooling load.

Comment 4.4

At a minimum, develop the following scenario for office, retail, and other normally ventilated portions of the project:

a. Improved envelope described above and inclusion of energy recovery to achieve heating TEDI reduction;

b. Air infiltration of 0.4 cfm/sf at 75 Pa;

c. Downsize the HVAC as much as possible, including evaluating perimeter heating downsizing and/or elimination;

d. Elimination of use of gas or other fossil fuels with EUIff goal of 0 kBtu/sf-yr or less using following strategy:

i. Ventilation incorporating dedicated outside air systems and energy recovery;

ii. Energy recovery of concurrent heating and cooling with heat recovery chillers or similar approach;

iii. Electric air source heat pump/VRF heating/cooling systems.

e. External shading and improved solar heat gain coefficient windows to control space cooling loads;

f. Conduct sub-scenarios with and without air source heat pump water heating.

Response

The majority of the listed mitigation measures are similar to the previous comment and have been included in the proposed design. The retail spaces are not tenanted so their exact use is not yet known. Nonetheless, the space and water heating in the retail spaces will be electrified.

Comment 4.5

Evaluate incentives, including:

g. Estimate of Alternative Energy Credits;

h. Estimates of MassSave® incentives, based on meeting with utility.

Response

The Proponent is committed to the systems for which these incentives are meant to encourage including the use of heat pumps for heating and an improved building envelope to reduce energy consumption. The Proponent will make full use of these incentives to re-coup some of the additional costs that is required to implement these items.

Comment 4.6

Evaluate rooftop solar PV readiness. This should include building roof plans showing location of PV readiness areas and location of roof HVAC equipment and other appurtenances. Provide table showing areas needed for code required PV readiness and proposed, above-code PV readiness.

Response

The Proponent has conducted a rooftop feasibility assessment and is committed to providing solar-ready roof areas on the buildings' penthouses and the stand-alone parking garage. More information about the solar assessment is presented in Section 7.4.1 of Chapter 7, *Climate Change*.

Comment 4.7

Maximize EV-ready parking spaces, target 100% EV Readiness. Clarify commitments to installed EV charging station and EV ready spaces.

Response

The Proponent will commit to installing EV charging stations at the Project Site as outlined in Section 7.4.2, Chapter 7, *Climate Change*. Approximately 25-percent of the parking spaces in each parking area (the stand-alone parking garage, the surface lot, and the underground garage) will be equipped with electric vehicle charging stations, with consideration as to how increased electric vehicle capacity can be implemented in the future as warranted by demand and market conditions.

Comment 4.8

Compare model results total and individual end uses with representative, prototype buildings developed by Pacific Northwest National Labs/Department of Energy found at the link below. Provide a summary explaining potential differences.

https://www.energycodes.gov/sites/default/files/documents/BECP_901_2013_Progress_Indicator_0_0.pdf

http://www.energycodes.gov/sites/default/files/documents/2013EndUseTables.zip

https://www.energycodes.gov/commercial-energy-cost-savings-analysis

Response

Lab spaces are not included in the provided databases. The Proponent has compared the proposed design to benchmark lab data in Appendix E.

Comment 4.9

Include a table similar to the example below. For "code value" ensure that the value incorporates any improved efficiency per requirements of Section C406.1 of the Massachusetts' amendments.

Response

A table similar to that requested is presented in both Section 7.4.1, Chapter 7, *Climate Change* and in Appendix E.

Letter 5: Charles River Watershed Association

Comment 5.1

Existing impervious area should be reduced wherever possible and where impossible due to necessary uses, impervious cover impacts should be mitigated through modern stormwater management.

Response

The Project reduces existing impervious cover by 1.8 acres. The proposed stormwater design also implements a train of BMPs that are designed to provide an 80% TSS removal of stormwater runoff from impervious surfaces. More information regarding reduction of impervious area and water quality can be found in Section 4.2.2.1, Chapter 4*, Stormwater and Water/Wastewater*.

Comment 5.2

Green infrastructure should be extensively incorporated into the building, parking lots, and other paved areas to treat stormwater generated by impervious surfaces and provide cooling benefits for the community.

Response

The proposed stormwater design has deep-sump and hooded catch basins which collect stormwater from proposed paved surfaces and route it through a proprietary media filter unit. Stormwater collected from the proposed building and garage roofs is routed through proprietary hydrodynamic water units, to the surface basin, and then through a proprietary media filter unit. More information regarding the Projects use of green infrastructure can be found in Section 4.2.2, Chapter 4, *Stormwater and Water/Wastewater*.

Comment 5.3

Under the nutrient TMDL, significant reductions in phosphorus loading are required in order to meet water quality standards—there is no "room" for any additional phosphorus loading to the Charles River. The pre- and post-development annual phosphorus load from the site should be provided, along with calculations showing that the project complies with the phosphorus TMDL.

Response

The proposed stormwater management system has media filters sized to provide a minimum of 65% removal of total phosphorus, meeting the EPA's TMDL removal target for commercial land use. Further information regarding the reduction of phosphorus loading can be found in Section 4.2.2.1, Chapter 4, *Stormwater and Water/Wastewater*.

Comment 5.4

The project must also address the discharge of bacteria to the Charles River.

Response

The discharge of bacteria into the Charles River is addressed in Section 4.2.2.1 of Chapter 4, *Stormwater and Water/Wastewater*.

Comment 5.5

Under Stormwater Handbook Standard 10 – Prohibition of Illicit Discharges, for any sewer and storm drain infrastructure remaining on site, we would expect the proponent to confirm the condition and separation of stormwater utilities, and that there are no illicit connections.

Response

The Project will have separate sewer and drain systems. The new sewer system will minimize any illicit discharge and meet the expectations of the CRWA. More information regarding the design and impact of the sewer and drain systems can be found in Section 4.2.2, Chapter 4, *Stormwater and Water/Wastewater*.

Comment 5.6

We recommend that native trees and shrubs be planted within proposed landscaped areas and along proposed roadways wherever possible.

Response

The Project's landscape architect is continuing to develop the Project's landscaping plans with an effort to add native yet diverse landscape plantings including adding more mature trees around the buildings. This is discussed in Chapter 1*, Project Description*.

Letter 6: Massachusetts Department of Transportation

Comment 6.1

In the DEIR, the Proponent should include analysis of queuing at study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area.

Response

To understand the queueing impacts of operations at each study area intersection under the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions, queue diagrams have been developed for the weekday morning and weekday evening peak hours. The queue diagrams for each study area intersection are provided in Appendix D and are discussed and analyzed in Section 5.4.3, Chapter 5, *Traffic and Transportation*.

Comment 6.2

In the DEIR, the Proponent should include analysis of existing and proposed weave conditions on Highland Avenue to ensure that increased traffic volumes do not lead to degraded safety conditions in the area of the Highland Avenue/I-95 interchange.

Response

An analysis of existing and proposed weave conditions on Highland Avenue at the Route 128/I-95 interchange is included in Section 5.4.2.2, Chapter 5, *Traffic and Transportation*. As the analyses show, the weaving segments are expected to operate at LOS C or better under the 2029 No Build and 2029 Build Conditions, and no segment is expected to experience a degradation in level of service due to the additional Site-generated trips.

Comment 6.3

MassDOT requests that the Proponent consider coordinating with District 6 to install adequate bicycle and pedestrian infrastructure on Highland Avenue at the I-95 interchange to connect with proposed Complete Streets improvements to be installed under MassDOT Project #606635.

Response

Refer to the response to Comment C.33. Details on the proposed Highland Avenue bicycle accommodations are provided in Section 5.5.6, Chapter 5, *Traffic and Transportation*.

Comment 6.4

The DEIR should include sufficiently detailed conceptual plans (minimum of 80- scale) for any proposed roadway improvements including the proposed signalization geometric improvements, and bicycle lanes to verify the feasibility of constructing such improvements.

These plans should clearly show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed.

Response

Detailed conceptual plans (at 80-scale) for the proposed roadway improvements have been developed that include the proposed signalization, geometric improvements, and bicycle lanes to verify the feasibility of constructing such improvements. These plans also show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed. The conceptual plans are referenced in Section 5.5.2, Chapter 5, *Traffic and Transportation*, and are included in Appendix D.

Comment 6.5

The Proponent should also consider coordination with MBTA in order to determine the feasibility of additional MBTA Bus Route 59 service closer to the Project site.

Response

Refer to the response to Comment C.30. Additional details on the MBTA Bus Network Redesign and the feasibility of rerouting the MBTA Bus Route 59 are provided in Section 5.4.4, Chapter 5, *Traffic and Transportation*.

Comment 6.6

The Proponent should continue consultation with the Town of Needham, the MBTA, and appropriate MassDOT units, including PPDU, Traffic Operations, and the District 6 Office during the preparation of the DEIR for the Project.

Response

The Proponent continues to coordinate with state and local agencies as the Project develops. Details of coordination with state and local agencies is included in Section 5.3, Chapter 5, *Traffic and Transportation*.

Comment 6.7

Additionally, the Proponent should include a Draft Section 61 Finding in the DEIR that summarizes the proposed mitigation plan and the monitoring program.

Response

A Draft Section 61 Finding that summarizes the proposed mitigation plan and the monitoring program is included in Chapter 9, *Mitigation and Draft Section 61 Findings*.

Comment 6.8

If you have any questions regarding these comments, please contact Curtis.B.Wiemann@dot.state.ma.us.

Response

No response is necessary.

Letter 7: Massachusetts Department of Environmental Protection

Comment 7.1

Response actions pursuant to RTN 3-37285 are expected to continue at the site of the proposed project. Pursuant to section 40.0560(2)(b) of the MCP, a Phase I Site Assessment report for RTN 3-37285 must be submitted to MassDEP by January 21, 2023.

Response

The Proponent has retained a LSP to prepare submittal reports as required under 310 CMR 40.0000, the MCP. If a Permanent Solution has not yet been achieved, a Phase I Initial Site Investigation Report and Tier Classification will be submitted to the MassDEP by January 21, 2023.

Comment 7.2

Additionally, immediate Response Action Status Reports must continue to be submitted to MassDEP in accordance with the requirements of section 310 CMR 40.0425 of the MCP, until an Immediate Response Action Completion Statement is submitted to MassDEP.

Response

An Immediate Response Action Completion Report for RTN 3-37285 was submitted to the MassDEP on May 26, 2022

Comment 7.3

The project proponent is advised that excavating, removing and/or disposing of contaminated soil, pumping of contaminated groundwater, or working in contaminated media must be done under the provisions of M.G.L. c. 21E and all other applicable federal, state, and local laws, regulations, and bylaws.

Response

Excavation and off-site disposal of contaminated soil will be performed under the provisions of M.G.L. c. 21E, OSHA, and the MCP. In accordance with the provisions of 310 CMR 40.0444 of the MCP, a Release Abatement Measure (RAM) Plan will be prepared and submitted to the DEP prior to non-exploratory earthwork activities, such as bulk excavation or utility installation. The RAM Plan will outline requirements for the management and handling of site soils affected by the above-described release conditions. The soils transported off-site will be legally reused/disposed of in accordance with the MCP and other regulatory requirements. Disposal of materials will be tracked via Material Shipping Records, Bills of Lading and/or other methods, as required to document their proper and legal disposal.

Although groundwater is not anticipated to be encountered during site excavation activities, procurement of temporary groundwater dewatering discharge permits from the EPA,

MassDEP, Town of Needham, and/or the Massachusetts Water Resource Area (MWRA) may be required for pumping and off-site discharge of groundwater. If on-site recharge is not feasible and off-site discharge is required, the appropriate dewatering discharge permits will be obtained.

Comment 7.4

If contamination at the site is known or suspected, the appropriate tests should be conducted well in advance of the start of construction and professional environmental consulting services should be readily available to provide technical guidance.

Response

A series of subsurface exploration programs have been completed across the Project site to pre-characterize in-situ soil for off-site removal in anticipation of the planned redevelopment. The explorations were performed in a grid formation consisting of 80 cells in which soil samples were obtained continuously to a depth ranging from approximately 25 to 30 feet below ground surface. As part of the subsurface exploration programs, over 350 composite and discrete soil samples were submitted for total MCP-14 metals, total petroleum hydrocarbons (TPH), extractable petroleum hydrocarbons (EPH), volatile petroleum hydrocarbons (VPH), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), PCBs, pH, reactivity, ignitability, conductivity, and toxicity characteristic leaching procedure (TCLP).

Comment 7.5

If dewatering activities are to occur at a site with contaminated groundwater, or in proximity to contaminated groundwater where dewatering can draw in the contamination, a plan must be in place to properly manage the groundwater.

Response

Groundwater is located at depths ranging from approximately 25 to 30 feet below ground surface. Based upon the scope of construction it is not anticipated that groundwater will be encountered during excavation activities.

Although soil testing indicates that the contaminated soil is located above the surface of groundwater, sampling and analysis of groundwater will be performed to evaluate a potential release in groundwater.

Comment 7.6

A Licensed Site Professional (LSP) must be employed or engaged to manage, supervise or actually perform the necessary response actions at the site.

Response

The Proponent has retained a LSP to manage the environmental aspects of the Project, including proper management and/or removal of soil encountered during construction. Removal of excess excavated soil will be conducted in accordance with MassDEP's current policies and regulations.

Comment 7.7

Dust and/or vapor monitoring and controls are often necessary for large-scale projects in contaminated areas. The need to conduct real-time air monitoring for contaminated dust and to implement dust suppression must be determined prior to excavation of soils, especially those contaminated with compounds such as metals and PCBs. An evaluation of contaminant concentrations in soil should be completed to determine the concentration of contaminated dust that could pose a risk to health of on-site workers and nearby human receptors. If this dust concentration, or action level, is reached during excavation, dust suppression should be implemented as needed, or earthwork should be halted.

Response

The Release Abatement Measure (RAM) Plan will include provisions for the excavation, management and off-site removal of contaminated soil. As part of the RAM Plan, a Risk Characterization will be prepared to evaluate risks to workers and nearby residents that may be exposed to levels of contaminants once the fill material is uncovered and/or excavated. The results of the Risk Characterization will also be utilized to prepare an Environmental Monitoring Plan to mitigate potential exposure to the surrounding public from dust particulates and volatile organic compounds during construction.

The excavation and management of contaminated soil will be performed under the monitoring of the Proponent's LSP. To prevent exposures to the general public during excavation, monitoring for dust and VOCs will be performed. Based upon the results of a focused Risk Assessment, a time weighted average dust monitoring action level will be established for the Project Site. If during construction an exceedance of the dust monitoring action level is detected, mitigative measures will be implemented which may include spraying dry soils with water or a surfactant agent prior to excavation, covering stockpiles with polyethylene sheeting, limiting the excavation area, street sweeping or ceasing excavation operations during high wind conditions.

Comment 7.8

If capping of contaminated soil is needed to achieve a level of No Significant Risk, MassDEP recommends the following capping design criteria. In unpaved areas, a minimum of three feet of clean soil should be placed over the contaminated soil. This protective layer of clean soil should be separated from the underlying contaminated soil by a geotextile or combination of materials, which will provide both a brightly colored visual marker and a permeable fabric to separate the clean soil from the contaminated soil. In paved areas, a minimum one-foot cap consisting of clean soil, road base and the pavement layer should be placed over the contaminated soil. Similar to unpaved areas, the contaminated soil should be separated from

the clean soil or road base using a visual marker and geotextile. In such cases, an Activity and Use Limitation (AUL), prepared in accordance with 310 CMR 40.1012 would be necessary to identify the maintenance requirements of the cap. It should also be noted that a cap constructed as an Immediate Response Action or as a Release Abatement Measure will not be considered a Permanent Solution until a Phase III completed in accordance with 310 CMR 40.0850 demonstrates the lack of a feasible alternative, as required by 310 CMR 40.0414(7) and 40.0442(4).

Response

The results of soil testing that have been completed to-date will be utilized to prepare a Risk Characterization to evaluate exposure risks associated with future unrestricted use of the Project Site. The Risk Characterization will determine if capping of the existing fill material and implementation of an AUL is necessary to achieve and maintain a Condition of No Significant Risk at the Project Site. The Risk Characterization will also evaluate Background pursuant to the applicable DEP guidance prepared for historical fill material and fill material containing coal ash and cinders.

Comment 7.9

Parties constructing and/or renovating buildings in contaminated areas should consider whether chemical or petroleum vapors in subsurface soils and/or groundwater could impact the indoor air quality of the buildings. All relevant site data, such as contaminant concentrations in soil and groundwater, depth to groundwater, and soil gas concentrations should be evaluated to determine the potential for indoor air impacts to existing or proposed building structures. Particular attention should be paid to the vapor intrusion pathway for sites with elevated levels of chlorinated volatile organic compounds such as tetrachloroethylene (PCE) and trichloroethylene (TCE).

Response

The planned redevelopment of the Project Site includes the construction of multi-story commercial buildings, the footprints of which are underlain by a ventilated parking garage. The ventilated parking garage will eliminate the potential for vapor intrusion into a majority of the overlying occupied spaces. The laboratory analysis of soil samples that has been performed to date has not detected a release of chlorinated volatile organic compounds.

Comment 7.10

Construction activities conducted at a disposal site shall not prevent or impede the implementation of likely assessment or remedial response actions at the site. Construction of structures at a contaminated site may be conducted as a Release Abatement Measure if assessment and remedial activities prescribed at 310 CMR 40.0442(3) are completed within and adjacent to the footprint of the proposed structure prior to or concurrent with the construction activities.

Response

Remedial actions will be implemented as part of the Project's construction. A Release Abatement Measure (RAM) Plan will be prepared and implemented in accordance with 310 CMR 40.0442(3) of the MCP and DEP Policy #WSC-00-425 "Construction of Buildings in Contaminated Areas" to address the requirements for construction of structures within the release site. The RAM Plan will include provisions for the excavation, management and off-site removal of contaminated soil. As part of the RAM Plan, a Risk Characterization will be prepared to evaluate risks to future human receptors (i,.e., workers, nearby residents and future site occupants) that may be exposed to levels of contaminants that may remain at the site after construction.

Comment 7.11

Excavation of contaminated soils to construct clean utility corridors should be conducted for all new utility installations.

Response

A majority of the contaminated soil is localized to within the footprint of the proposed stand-alone garage building. The analysis of soil samples that have been collected outside the footprints of the proposed building has not detected levels that would pose a Significant Risk to utility or construction workers. However, if encountered within utility corridors, the contaminated soil will be excavated and replaced with clean soil.

Comment 7.12

The project proponent is advised that in cases where proposed activities would not be consistent with a level of No Significant Risk and/or an existing AUL, additional cleanup and the amendment or termination of the initial AUL and implementation of a revised AUL would be necessary before the proposed activities could occur

Response

The Proponent understands these requirements and will take the suggested action if necessary.

Comment 7.13

MassDEP encourages the Proponent to review the plan to identify project management and operational practices that will assist the Commonwealth in meeting its material management goals.

Response

The Proponent will explore opportunities for waste reduction and recycling assistance

Comment 7.14

Many construction and demolition materials are currently banned from disposal or transfer for disposal in Massachusetts (https://www.mass.gov/guides/massdep-waste-disposal-bans). Therefore, MassDEP encourages the Proponent to make a significant commitment to construction and demolition (C&D) waste recycling activities as a sustainable measure for the project and to assist in complying with waste ban requirements.

Response

The Project Construction Manager will implement a waste management plan to divert Project-related construction waste material from landfills through recycling and salvaging where practicable. Any construction waste will be handled in a manner consistent with all applicable local, state, and federal regulations.

Comment 7.15

In accordance with 310 CMR 16.03(2)(b), ABC can be crushed on-site with a 30-day notification to MassDEP. However, the asphalt is limited to weathered bituminous concrete (no roofing asphalt), and the brick and concrete must be uncoated or not impregnated with materials such as roofing epoxy. If the brick and concrete are not clean, the material is defined as C&D waste and requires either a Beneficial Use Determination (BUD) or a Site Assignment and permit before it can be crushed.

Response

The Proponent understands these requirements and will take the suggested action if necessary.

Comment 7.16

Pursuant to the requirements of 310 CMR 7.02 of the Air Pollution Control regulations, if the ABC crushing activities are projected to result in the emission of one ton or more of particulate matter or other pollutant to the ambient air per year, and/or if the crushing equipment employs a diesel oil fired engine with an energy input capacity of three million or more British thermal units per hour for either mechanical or electrical power which will remain on-site for twelve or more months, then a plan application must be submitted to MassDEP for written approval prior to installation and operation of the crushing equipment.

Response

The Project will comply.

Comment 7.17

Pursuant to 310 CMR 7.15 the removal of asbestos from the buildings must adhere to the special safeguards defined in the Air Pollution Control regulations.

Response

The Proponent complied with the MassDEP Asbestos Regulations (310 CMR 7.15) in connection with the demolition of the former Muzi car dealership and car wash buildings (the only buildings on Site).

Comment 7.18

An asbestos survey to identify all asbestos containing materials (ACM) shall be conducted by a Massachusetts Department of Labor Standards certified Asbestos Inspector.

Response

Refer to the response to Comment 7.17.

Comment 7.19

All identified ACM shall be abated prior to demolition activities.

Response

Refer to the response to Comment 7.17.

Comment 7.20

The Proponent is required to submit to MassDEP an Asbestos Removal Notification (Form AQ04 (ANF-001)) at least 10 working days prior to initiating work for any project involving asbestos abatement, removal, or disposal.

Response

Refer to the response to Comment 7.17.

Comment 7.21

If any ACM will need to be abated through non-traditional abatement methods, the Proponent must apply for and obtain approval from MassDEP, through Application BWP AQ36 - Application for Non-Traditional Asbestos Abatement Work Practice Approval.

Response

Refer to the response to Comment 7.17.

Comment 7.22

Pursuant to 310 CMR 7.09, for any Construction and Demolition, except in a residential building with fewer than 20 units, the Proponent is required to submit to MassDEP a Construction/Demolition Notification (Form BWP AQ06) at least 10 working days prior to initiating work.

Response

The Proponent complied with this regulation in connection with the demolition of the former Muzi car dealership and car wash buildings (the only buildings on Site).

Comment 7.23

The Proponent is advised that asbestos containing waste materials (ACWM) are a special waste as defined in the Solid Waste Management regulations.

Response

Understood.

Response to Comments..... 1

10.1 ENF Certificate..... 1

Letter 1: Greenman-Pedersen, Inc..... 30

Letter 2: Town of Needham..... 37

Letter 3: Massachusetts Water Resources Authority..... 38

Letter 4: Massachusetts Department of Energy Resources..... 40

Letter 5: Charles River Watershed Association..... 45

Letter 6: Massachusetts Department of Transportation..... 47

Letter 7: Massachusetts Department of Environmental Protection..... 50

A

MEPA Distribution List

Below is a list of state and municipal agencies from whom the Proponent will seek permits or approvals and other parties as specified in 301 CMR 11.16. These are the parties to whom the DEIR is required to be circulated.

State and Regional Agencies and Officials

Secretary Beth Card
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114
mepa@mass.gov
tori.kim@state.ma.us

Massachusetts Department of Transportation
Public/Private Development Unit
Attn: J. Lionel Lucien
10 Park Plaza Suite #4150
Boston, MA 02116
MassDOTPPDU@dot.state.ma.us
Curtis.B.Wiemann@dot.state.ma.us
Lionel.Lucien@dot.state.ma.us

Department of Environmental Protection
Attn: Commissioner's Office
One Winter Street
Boston, MA 02108
helena.boccadoro@mass.gov

DEP/Northeast Regional Office
Attn: MEPA Coordinator
205B Lowell Street
Wilmington, MA 01887
john.d.viola@mass.gov

Massachusetts Historical Commission
Attn: Brona Simon
The MA Archives Building
220 Morrissey Boulevard
Boston, MA 02125
brona.simon@state.ma.us

Massachusetts DOT District #6
Attn: MEPA Coordinator
185 Kneeland Street
Boston, MA 02111
michael.garrity@dot.state.ma.us

Metropolitan Area Planning Council
Attn: Executive Director
60 Temple Place
Boston, MA 02111
mpillsbury@mapc.org
afelix@mapc.org

Massachusetts Water Resources Authority
Attn: MEPA Coordinator
100 First Avenue
Charlestown Navy Yard
Boston, MA 02129
katherine.ronan@mwra.com

MEPA Office
Attn: EEA EJ Director
100 Cambridge Street, Suite 900
Boston, MA 02144

Department of Energy Resources
Attn: MEPA Coordinator
100 Cambridge Street, 10th floor
Boston, MA 02114

MEPA-EJ@mass.gov

paul.ormond@mass.gov
Maggie.McCarey@mass.gov

Town of Needham

Planning Department
Attn: Director of Planning
Public Services Administration Building
500 Dedham Avenue
Needham, MA 02492
lnewman@needhamma.gov

Select Board
Attn: Chair
Needham Town Hall
1471 Highland Avenue
Needham, MA 02492
selectboard@needhamma.gov

Public Health Department
Attn: Director of Public Health
178 Rosemary Street
Needham, MA 02494
healthdepartment@needhamma.gov

Conservation Commission
Attn: Chair (Charles River Room)
Public Services Administration Building
500 Dedham Avenue
Needham, MA 02492
conservation@needhamma.gov

Needham Public Library
1139 Highland Avenue
Needham Heights, MA 02494
neemail1@minlib.net

ENF Commenters

Greenman–Pedersen, Inc.
Rebecca L. Brown

Charles River Watershed Association
Heather Miller
hmiller@crwa.org

Town of Needham - Town Manager
Attn: Kate Fitzpatrick

Community Based Organizations

Mass Rivers Alliance	Neighbor to Neighbor
Environment Massachusetts	Unitarian Universalist Mass Action Network
Clean Water Action	Sierra Club MA
Appalachian Mountain Club	Mass Audubon
The Trust for Public Land	Browning the GreenSpace
E4TheFuture Mass Land Trust Coalition	Ocean River Institute Mass Climate Action Network (MCAN)
Conservation Law Foundation	Community Action Works
Healthcare without Harm	Charles River Watershed Assoc.
The Trustees of Reservations	Environmental League of MA

Tribal Organizations

Chaubunagungamaug Nipmuck Indian Council	Massachusetts Commission on Indian Affairs (MCIA)
Chappaquiddick Tribe of the Wampanoag Nation, Whale Clan	Wampanoag Tribe of Gay Head (Aquinnah)
Nipmuc Nation (Hassanamisco Nipmucs)	Herring Pond Wampanoag Tribe
Mashpee Wampanoag Tribe	North American Indian Center of Boston
Pocassett Wampanoag Tribe	Massachusetts Tribe at Ponkapoag
	Stockbridge-Munsee Tribe

APPENDIX B: Environmental Justice and RMAT

- EPA EJ Screen
- Project Fact Sheet
  - English
  - Chinese
- RMAT Report

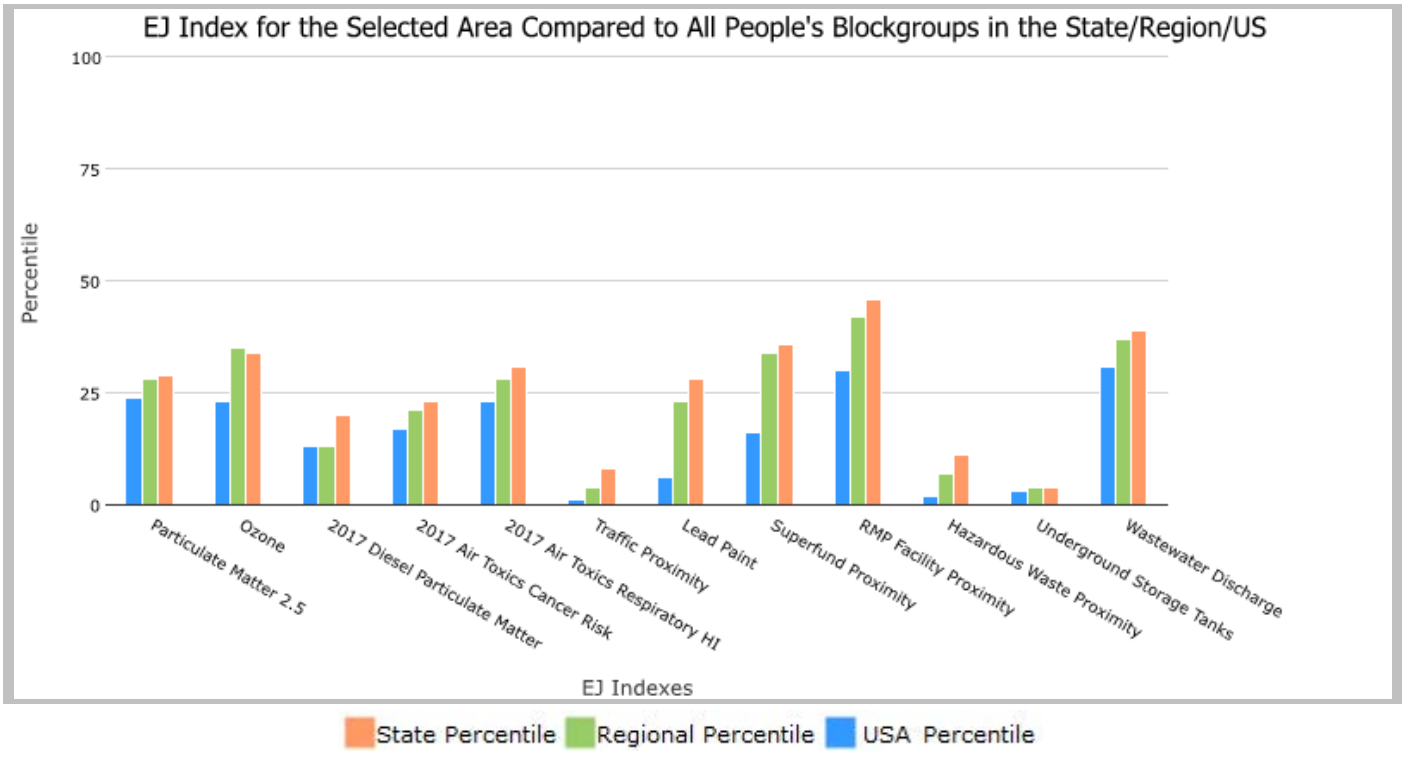
EJScreen Report (Version 2.0)

1 mile Ring around the Area, MASSACHUSETTS, EPA Region 1

Approximate Population: 13,728

Input Area (sq. miles): 3.60

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
Environmental Justice Indexes			
EJ Index for Particulate Matter 2.5	29	28	24
EJ Index for Ozone	34	35	23
EJ Index for 2017 Diesel Particulate Matter*	20	13	13
EJ Index for 2017 Air Toxics Cancer Risk*	23	21	17
EJ Index for 2017 Air Toxics Respiratory HI*	31	28	23
EJ Index for Traffic Proximity	8	4	1
EJ Index for Lead Paint	28	23	6
EJ Index for Superfund Proximity	36	34	16
EJ Index for RMP Facility Proximity	46	42	30
EJ Index for Hazardous Waste Proximity	11	7	2
EJ Index for Underground Storage Tanks	4	4	3
EJ Index for Wastewater Discharge	39	37	31



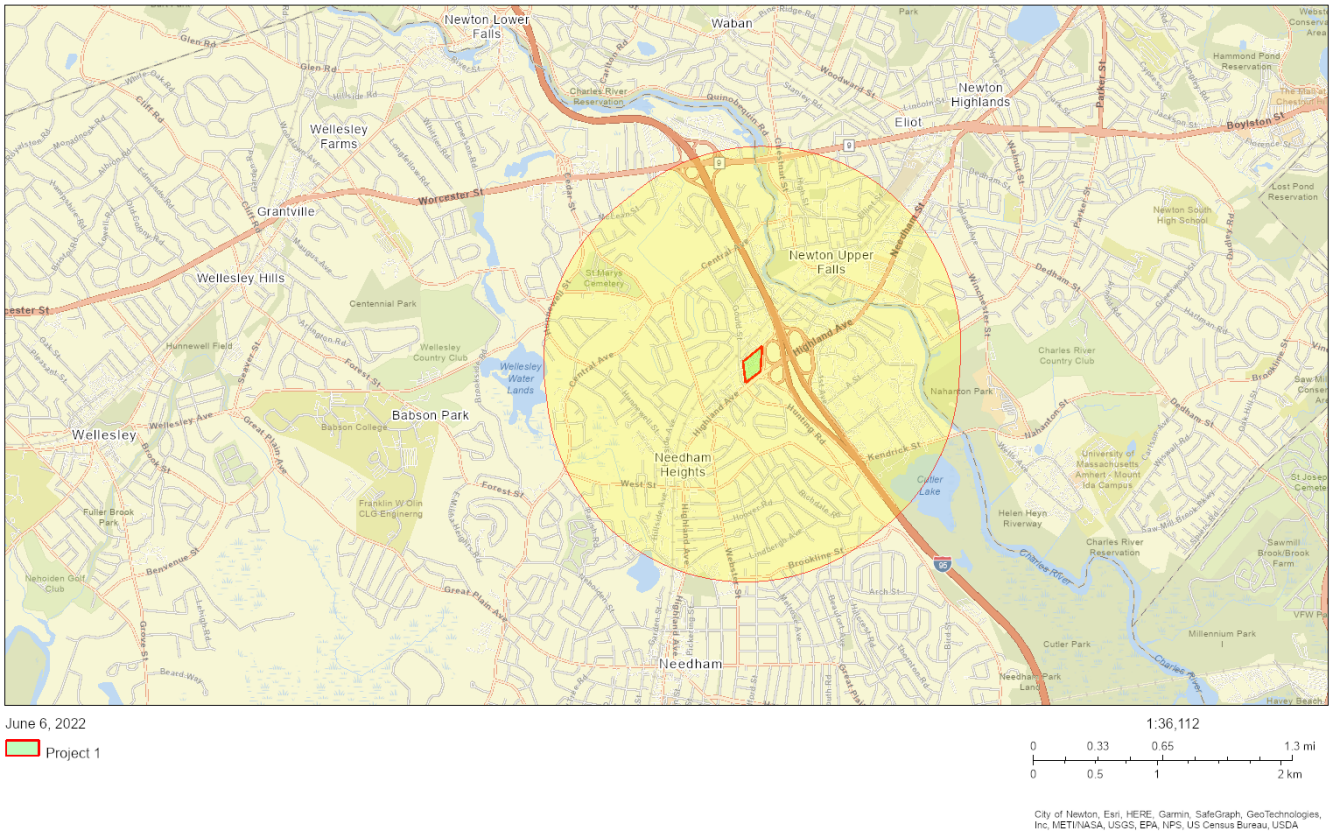
This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

EJScreen Report (Version 2.0)

1 mile Ring around the Area, MASSACHUSETTS, EPA Region 1

Approximate Population: 13,728

Input Area (sq. miles): 3.60



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	3

EJScreen Report (Version 2.0)

1 mile Ring around the Area, MASSACHUSETTS, EPA Region 1

Approximate Population: 13,728

Input Area (sq. miles): 3.60

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Pollution and Sources							
Particulate Matter 2.5 (µg/m^3)	7.5	6.78	84	6.68	79	8.74	21
Ozone (ppb)	39.2	39.5	45	39.8	43	42.6	28
2017 Diesel Particulate Matter* (µg/m^3)	0.316	0.295	68	0.227	80-90th	0.295	60-70th
2017 Air Toxics Cancer Risk* (lifetime risk per million)	30	24	99	23	95-100th	29	80-90th
2017 Air Toxics Respiratory HI*	0.3	0.3	81	0.28	90-95th	0.36	<50th
Traffic Proximity (daily traffic count/distance to road)	3700	2100	86	1300	92	710	96
Lead Paint (% Pre-1960 Housing)	0.48	0.49	48	0.44	57	0.28	76
Superfund Proximity (site count/km distance)	0.09	0.17	52	0.15	53	0.13	63
RMP Facility Proximity (facility count/km distance)	0.16	0.7	27	0.6	35	0.75	29
Hazardous Waste Proximity (facility count/km distance)	5.2	5.2	75	3.8	79	2.2	88
Underground Storage Tanks (count/km^2)	6.5	3.1	85	3	85	3.9	82
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.00043	0.21	43	0.4	46	12	42
Socioeconomic Indicators							
Demographic Index	18%	25%	50	24%	52	36%	27
People of Color	27%	28%	61	25%	67	40%	45
Low Income	9%	22%	26	23%	23	31%	13
Unemployment Rate	5%	5%	59	5%	59	5%	55
Linguistically Isolated	5%	6%	66	5%	73	5%	71
Less Than High School Education	3%	9%	28	9%	25	12%	18
Under Age 5	6%	5%	67	5%	69	6%	57
Over Age 64	17%	16%	60	17%	56	16%	64

*Diesel particular matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's 2017 Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

For additional information, see: www.epa.gov/environmentaljustice

EJScreen is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJScreen documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJScreen outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

Highland Science Center
Project Fact Sheet

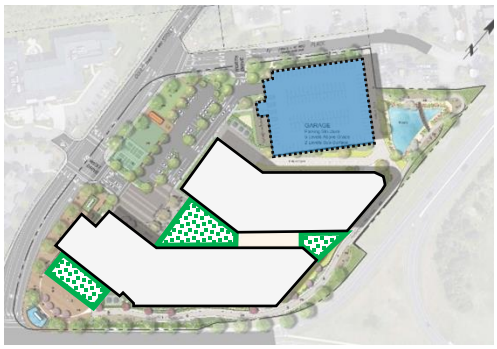
Project Summary

557 Highland Avenue, LLC, is proposing the construction of a laboratory and office building with ancillary retail of 531,300 square feet (SF) and an above ground parking garage in Needham, Massachusetts. The Project is located at 557 Highland Avenue, on the former site of the Muzi Ford/Chevrolet Car Dealership and car wash facilities.

Project Site

The Project is located on 9.27 acres of land adjacent to Highland Avenue and I-95. The Project Site is located along a commercial and residential corridor within the Highway Commercial 1 zone.

Site Plan



The Project will consist of two buildings with an atrium entrance, a standalone parking garage, and overall site improvements including green infrastructure and a stormwater pond.

Project Benefits

The Project will provide inherent benefits to the Town of Needham:

- 1,250 new permanent jobs and 300 temporary construction jobs
- Generate additional property tax, sales tax and income tax for the Town of Needham and Commonwealth of Massachusetts
- Support growing lab industry in Greater Boston
- Provide comprehensive site planning and sustainable design features
- Mitigation of traffic and environmental impacts
- Reduced impervious surface
- Tree plantings
- Walkway around the perimeter of the Site
- Geometric and traffic signal improvements at surrounding intersections.
- New family friendly bicycle accommodations

Potential Impacts

The Project will provide significant mitigation for impacts related to traffic, and air quality.

- Generate approximately 5,005 new weekday trips
- Utilize approximately 129,172 gallons per day (GPD) of water and discharge 54,554 GPD
- Total energy consumption of 75,192 million British Thermal Units per year (MMBtu)
- Total CO_2 emissions of 7,023 tons per year
- Intermittent increase in nearby sound levels during the construction of the Project

Mitigation Measures include:

- Implementation of a comprehensive TDM Program to reduce GHG emissions
- Direction connection with an EV shuttle to nearby MBTA Green Line and Commuter Rail transit stations
- EV charging parking spaces (25 percent of all spaces)
- On-site stormwater retention and infiltration
- Use of recycled materials
- Native landscaping throughout site to reduce heat island effect
- Maintenance of water and sanitary sewer within the development limits
- Implementation of noise and dust control measures
- Installation of erosion and sedimentation controls
- Implementation of a comprehensive Construction Waste Management Plan to support resource reclamation
- Highland Avenue at Gould Street / Hunting Road Intersection Improvements
- New traffic signal and intersection improvements at Central Avenue at Gould Street
- New traffic signal and intersection improvements at Gould Street at Site Driveway / Wingate Driveway
- Gould Street at TV Place Intersection Improvements
- Bi-directional sidewalk-level separated bicycle lanes on the east side of Gould Street
- Reconstructed sidewalk on the west side of Gould Street between Highland Avenue and Noanett Road
- New crosswalk across Gould Street with rapid rectangular flashing beacon (RRFB)
- Traffic calming and pedestrian improvements at Noanett Road
- Hunting Road Radar-Embedded Speed Limit Signs
- Intersection signal timing modifications at four additional locations

Ways to Provide Input

Submit comments on the DEIR through the following:

MEPA Online Portal

The Project will be available on the Environmental Monitor on July 22nd.
Visit: https://eeaonline.eea.state.ma.us/EEA/MEPA-eMonitor/home to submit comments by August 22nd, 2022. DEIR decisions will be released on August 29th, 2022.

Email

Contact: Jennifer.Hughes@mass.gov for any questions or comments related to the Project.

Mail

Secretary of Energy and Environmental Affairs, Executive Office of Energy and Environmental Affairs (EEA), Attn: MEPA Office, Jennifer Hughes, EEA No. 16546, 100 Cambridge Street, Suite 900, Boston MA 02114

Additional Information

If you would like to request additional information from the Project Team to learn more about the filing, email ssaquib@vhb.com. Translation services can be provided upon request.

高地科学中心
项目概况

项目总结

557 Highland Avenue，LLC 公司计划在马萨诸塞州尼德姆镇建造一幢实验室和办公大楼，附带 531300 平方英尺的零售区和一个地上停车场。本项目位于高地大道 557 号，是穆兹福特（Muzi Ford）/雪佛兰汽车经销商和洗车设施的旧址。

项目场地

本项目占地面积 9.27 英亩，毗邻高地大道和 95 号州际公路。本项目场地位于公路商业 1 区内的商业和住宅走廊沿线。

场地图

本项目将包括两幢带有中庭入口的建筑，一个独立的停车场，以及包括绿色基础设施和一个雨水池在内的整体场地改善工程。

项目效益

本项目将为尼德姆镇带来以下固有的效益：

- 1250 个新的长期工作岗位和 300 个临时建筑工作岗位
- 为尼德姆镇和马萨诸塞州州带来额外的财产税、销售税和所得税
- 支持大波士顿地区不断增长的实验室产业
- 提供全面的场地规划和可持续设计功能
- 缓解交通和环境影响
- 减少不透水表面
- 植树
- 项目场地周围的步行道
- 周边交叉路口的几何改善和交通信号改善
- 新的家庭友好型自行车停放/骑行

潜在影响

本项目将显著缓解与交通和空气质量相关的影响。

- 产生约 5005 次新的工作日车辆出行
- 每天使用约 129172 加仑的水，排放 54554 加仑的废水
- 每年总能耗为 751.92 亿英热单位（MMBtu）
- 每年二氧化碳排放总量为 7023 吨
- 在本项目施工期间，附近的噪音水平会间歇性增大

缓解措施包括：

- 实施全面的交通需求管理（TDM）计划以减少温室气体排放
- 与附近的 MBTA 绿线和通勤铁路交通站的电动班车直接连接
- 电动汽车充电车位（占所有车位的 25%）
- 场地内雨水保留和渗透
- 使用回收材料
- 在整个场地设计本土景观，以减少热岛效应
- 维护开发项目范围内的供水和下水道
- 实施噪音和灰尘控制措施
- 安装侵蚀和沉淀控制装置
- 实施全面的建筑废物管理计划，支持资源回收
- 古尔德街/亨廷路交叉路口的高地大道改善措施
- 古尔德街、中央大道处的新交通信号和交叉路口改善措施
- 场地车道/温盖特车道、古尔德街处的新交通信号和交叉路口改善措施
- 古尔德街与 TV 广场交叉路口改善措施
- 古尔德街东侧与人行道齐平的双向分隔自行车道
- 在高地大道和诺安特路之间的古尔德街西侧重建人行道
- 穿过古尔德街的新人行横道，配有快速矩形闪光信号灯（RRFB）
- 诺安特路的交通疏导和行人改善措施
- 亨廷路雷达嵌入式限速标志
- 在另外四个地点进行交叉路口信号灯时间修改

提供意见的方式

通过以下方式提交关于 DEIR 的意见：

MEPA 在线门户网站

本项目将于 7 月 22 日在《环境监测》（Environmental Monitor）上公布。请访问：https://eeaonline.eea.state.ma.us/EEA/MEPA-eMonitor/home，在 2022 年 8 月 22 日之前提交意见。DEIR 决定将于 2022 年 8 月 29 日公布。

电子邮件

联系方式：如有与本项目有关的任何疑问或意见，请联系 Jennifer.Hughes@mass.gov。

邮寄

能源和环境事务部长，能源和环境事务执委会办公室 (EEA)，收件人：MEPA Office, Jennifer Hughes, EEA No. 16546, 100 Cambridge Street, Suite 900, Boston MA 02114

其他信息

如果您希望向项目团队索取更多信息，以便详细了解项目备案情况，请发电子邮件至 ssaquib@vhb.com。可应要求提供翻译服务。

RMAT Climate Resilience Design Standards Tool Project Report

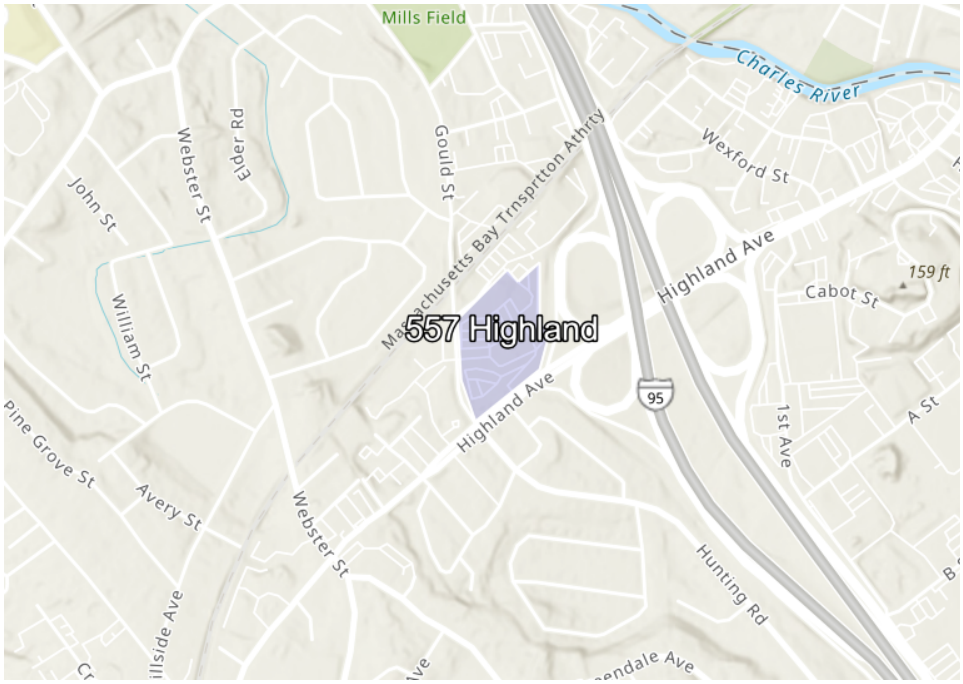
557 Highland
Date Created: 3/3/2022 1:29:10 PM Created By: MKarasik [Download]

Project Summary

Link to Project

Estimated Construction Cost: $50000000.00
End of Life Year: 2073
Project within mapped Environmental Justice population: No

Ecosystem Benefits	Scores
Project Score	Moderate
Exposure	**Scores**
Sea Level Rise/Storm Surge	Not Exposed
Extreme Precipitation - Urban Flooding	High Exposure
Extreme Precipitation - Riverine Flooding	Not Exposed
Extreme Heat	High Exposure



Asset Summary

Number of Assets: 1

Asset Risk	Sea Level Rise/Storm Surge	Extreme Precipitation - Urban Flooding	Extreme Precipitation - Riverine Flooding	Extreme Heat
Lab/Office Building	Low Risk	High Risk	Low Risk	High Risk

Project Outputs

	Target Planning Horizon	Intermediate Planning Horizon	Percentile	Return Period	Tier
Sea Level Rise/Storm Surge					
Lab/Office Building					
Extreme Precipitation					
Lab/Office Building	2070			10-yr (10%)	Tier 2
Extreme Heat					
Lab/Office Building	2070		50th		Tier 2

Scoring Rationale - Exposure

Sea Level Rise/Storm Surge

This project received a "Not Exposed" because of the following:

- Not located within the predicted mean high water shoreline by 2030
- No historic coastal flooding at project site
- Not located within the Massachusetts Coast Flood Risk Model (MC-FRM)

Extreme Precipitation - Urban Flooding

This project received a "High Exposure" because of the following:

- Maximum annual daily rainfall exceeds 10 inches within the overall project's useful life
- Existing impervious area of the project site is greater than 50%
- No historic flooding at project site

- No increase to impervious area

Extreme Precipitation - Riverine Flooding

This project received a "Not Exposed" because of the following:

- No historic riverine flooding at project site
- The project is not within a mapped FEMA floodplain [outside of the Massachusetts Coast Flood Risk Model (MC-FRM)]
- Project is more than 500ft from a waterbody
- Project is not likely susceptible to riverine erosion

Extreme Heat

This project received a "High Exposure" because of the following:

- 30+ days increase in days over 90 deg. F within project's useful life
- Not located within 100 ft of existing water body
- Existing impervious area of the project site is greater than 50%
- No increase to the impervious area of the project site
- No tree removal

Scoring Rationale - Asset Risk Scoring

Asset - Lab/Office Building
Primary asset criticality factors influencing risk ratings for this asset:

- Asset can be inaccessible/inoperable more than a week after natural hazard event without consequences
- Less than 1,000 people would be directly affected by the loss/inoperability of the asset
- Some alternative programs and/or services are available to support the community
- Cost to replace is between $30 million and $100 million
- Spills and/or releases of hazardous materials would be relatively easy to clean up

Project Design Standards Output

Asset: Lab/Office Building — Building/Facility

Sea Level Rise/Storm Surge — Low Risk

Applicable Design Criteria

Tidal Benchmarks: No
Stillwater Elevation: No
Design Flood Elevation (DFE): No
Wave Heights: No
Duration of Flooding: No
Design Flood Velocity: No
Wave Forces: No
Scour or Erosion: No

Extreme Precipitation — High Risk

Target Planning Horizon: 2070
Return Period: 10-yr (10%)

Applicable Design Criteria

Tiered Methodology: Tier 2 (Link)

Total Precipitation Depth for 24-hour Design Storms: Yes
Peak Intensity for 24-hour Design Storms: Yes
Riverine Peak Discharge: No
Riverine Peak Flood Elevation: No
Duration of Flooding for Design Storm: Yes
Flood Pathways: No

Extreme Heat — High Risk

Target Planning Horizon: 2070
Percentile: 50th Percentile

Applicable Design Criteria

Tiered Methodology: Tier 2 (Link)

Annual/Summer/Winter Average Temperature: Yes
Heat Index: Yes
Days Per Year With Max Temperature > 95°F: Yes
Days Per Year With Max Temperature > 90°F: Yes
Days Per Year With Max Temperature < 32°F: Yes
Number of Heat Waves Per Year: Yes
Average Heat Wave Duration (Days): Yes
Cooling Degree Days (Base = 65°F): Yes
Heating Degree Days (Base = 65°F): Yes
Growing Degree Days: No

Project Inputs

Core Project Information

Name:	557 Highland
Given the expected useful life of the project, through what year do you estimate the project to last (i.e. before a major reconstruction/renovation)?	2073
Location of Project:	Needham
Estimated Capital Cost:	$50,000,000
Who is the Submitting Entity?	Private Other VHB Elizabeth Grob (egrob@vhb.com)
Is this project being submitted as part of a state grant application?	No
Which grant program?	
What stage are you in your project lifecycle?	Permitting
Is climate resiliency a core objective of this project?	Yes
Is this project being submitted as part of the state capital planning process?	No
Is this project being submitted as part of a regulatory review process or permitting?	Yes
Brief Project Description:	The Project is being submitted to the MEPA office as an ENF. The Proponent is proposing to build a new ground up lab/office building complex on the former site of the Muzi Ford and Chevy Dealership at 557 Highland Ave., Needham, Massachusetts. The Project ., will feature an office / lab research facility with below grade parking in addition to a stand-alone parking structure. As envisioned by the Needham Master Plan, the proposed development will contain a substantial landscape buffer surrounding the site to enhance the arrival experience of motorists and compliment the development. Open space improvements are proposed within the southeast and northeast portions of the site including perimeter walking paths around the site.

Project Submission Comments:

Project Ecosystem Benefits

Factors Influencing Output

- ✓ Project provides flood protection through nature-based solutions
- ✓ Project reduces storm damage
- ✓ Project promotes decarbonization
- ✓ Project filters stormwater using green infrastructure
- ✓ Project provides recreation
- ✓ Project provides oxygen production
- ✓ Project improves air quality

Factors to Improve Output

- ✓ Protect public water supply by reducing the risk of contamination, pollution, and/or runoff of surface and groundwater sources used for human consumption
- ✓ Incorporate green infrastructure or nature-based solutions that recharge groundwater
- ✓ Incorporate nature-based solutions that improve water quality
- ✓ Incorporate nature-based solutions that sequester carbon carbon
- ✓ Increase biodiversity, protect critical habitat for species, manage invasive populations, and/or provide connectivity to other habitats
- ✓ Preserve, enhance, and/or restore coastal shellfish habitats
- ✓ Incorporate vegetation that provides pollinator habitat
- ✓ Identify opportunities to remediate existing sources of pollution
- ✓ Identify opportunities to prevent pollutants from impacting ecosystems
- ✓ Incorporate education and/or protect cultural resources as part of your project

Is the primary purpose of this project ecological restoration?

No

Project Benefits	
Provides flood protection through nature-based solutions	Yes
Reduces storm damage	Yes
Recharges groundwater	No
Protects public water supply	No
Filters stormwater using green infrastructure	Yes
Improves water quality	No
Promotes decarbonization	Yes
Enables carbon sequestration	No
Provides oxygen production	Yes
Improves air quality	Yes
Prevents pollution	No
Remediates existing sources of pollution	No
Protects fisheries, wildlife, and plant habitat	No
Protects land containing shellfish	No
Provides pollinator habitat	No
Provides recreation	Yes
Provides cultural resources/education	No

Project Climate Exposure	
Is the primary purpose of this project ecological restoration?	No
Does the project site have a history of coastal flooding?	No
Does the project site have a history of flooding during extreme precipitation events (unrelated to water/sewer damages)?	No
Does the project site have a history of riverine flooding?	No
Does the project result in a net increase in impervious area of the site?	No
Are existing trees being removed as part of the proposed project?	No

Project Assets

Asset: Lab/Office Building
Asset Type: Typically Occupied
Asset Sub-Type: Laboratory
Construction Type: New Construction
Construction Year: 2023
Useful Life: 50

Identify the length of time the asset can be inaccessible/inoperable without significant consequences.
Building may be inaccessible/inoperable more than a week after natural hazard event without consequences

Identify the geographic area directly affected by permanent loss or significant inoperability of the building/facility.
Impacts limited to site only

Identify the population directly served that would be affected by the permanent loss of use or inoperability of the building/facility.
Less than 1,000 people

Identify if the building/facility is located within an environmental justice community or provides services to vulnerable populations.
The building is not located in an environmental justice community and does not provide services to vulnerable populations

If the building/facility became inoperable for longer than acceptable in Question 1, how, if at all, would it be expected to impact people's health and safety?
Inoperability of the building/facility would not be expected to result in injuries

If there are hazardous materials in your building/facility, what are the extent of impacts related to spills/releases of these materials?
Spills and/or releases of hazardous materials would be relatively easy to clean up

If the building/facility became inoperable for longer than acceptable in Question 1, what are the impacts on other facilities, assets, and/or infrastructure?
Minor – Inoperability will not likely affect other facilities, assets, or buildings

If this building/facility was damaged beyond repair, how much would it approximately cost to replace?
Between $30 million and $100 million

Is this a recreational facility which can be vacated during a natural hazard event?
No

If the building/facility became inoperable for longer than acceptable in Question 1, what are the public and/or social services impacts?
Some alternative programs and/or services are available to support the community

If the building/facility became inoperable for longer than acceptable in Question 1, what are the environmental impacts related to natural resources?
No impact on surrounding natural resources is expected

If the building/facility became inoperable for longer than acceptable in Question 1, what are the impacts to government services (i.e. the building is not able to serve or operate its intended users or function)?
Loss of building is not expected to reduce the ability to maintain government services.

If the building/facility became inoperable for longer than acceptable in Question 1, what are the impacts to loss of confidence in government (i.e. the building is not able to serve or operate its intended users or function)?
No Impact

Report Comments

N/A

APPENDIX C: Infrastructure

- Stormwater Management Report

STORMWATER REPORT

Highland Innovation Center

557 Highland Avenue
Needham, Massachusetts

PREPARED FOR

Bulfinch

116 Huntington Avenue
Suite 600
Boston, MA 02116
781.707.4000

PREPARED BY

vhb

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

MARCH, 2022

Table of Contents

Stormwater Report Narrative **4**

Project Description 4
Site Description 4
Existing Drainage Conditions 4
Proposed Drainage Conditions 5
Environmentally Sensitive and Low Impact Development (LID) Techniques 6

Regulatory Compliance **10**

Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards 10
Standard 1: No New Untreated Discharges or Erosion to Wetlands 10
Standard 2: Peak Rate Attenuation 10
Standard 3: Stormwater Recharge 11
Standard 4: Water Quality 11
Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs) 12
Standard 6: Critical Areas 12
Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable 12
Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls 12
Standard 9: Operation and Maintenance Plan 12
Standard 10: Prohibition of Illicit Discharges 12
Local Municipal Rules and Regulations 13

Appendices

Appendix A: Standard 1 Computations and Supporting Information 1
Appendix B: Standard 2 Computations and Supporting Information 1
Appendix C: Standard 3 Computations and Supporting Documentation 1
Appendix D: Standard 4 Computations and Supporting Information 1
Appendix E: Standard 8 Supporting Information 1

List of Tables

Table No.	Description	Page
Table 1	Existing Conditions Hydrologic Data	5
Table 2	Proposed Conditions Hydrologic Data	5
Table 3	Peak Discharge Rates (cfs*)	11

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00). This report also demonstrates compliance with the Town of Needham Stormwater By-Law.

Project Description

The Applicant, Bulfinch, is proposing to construct a Research & Development and Office building at 557 Highland Avenue (the Project). As proposed, the Project consists of 422,400 square feet of building space, ancillary landscape improvements, surface parking, structured parking, and utility improvements to support this use.

The Project will entail the construction of approximately 1,408 total parking spaces and a portion of the site is considered a Land Use with Higher Potential Pollutant Loads (LUHPPL).

Site Description

The Project Site is a 9.27-acre parcel of land (the Site) located at 577 Highland Ave in Needham, Massachusetts (see Figure 1). The Site lies within the surface watershed of Charles River and is bounded by TV Place to the north, Highland Ave to the south, Interstate 95 to the east, and Gould Street to the west. See Figure 1, Site Locus Map.

According to the National Resources Conservation Service (NRCS), surface soils on the Site consist of Urban Land and do not have an associated Hydrologic Soil Group (HSG). For the purposes of this stormwater report, surface soils have conservatively been assumed to be HSG D. Based on the soil evaluation included in Appendix C, the Site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour).

Existing Drainage Conditions

Under existing conditions, the Site is developed, consisting of existing building and surface parking which result in nearly complete impervious coverage. The Site generally pitches from east to west, with the majority of the site draining towards a swale located adjacent to the Route 95/128 off-ramp. Figure 2 illustrates the existing drainage patterns on the Site. Currently, the Site

is divided into 3 drainage areas as stormwater runoff flows to 3 Design Points, which have been identified as MassDOT Drainage Swale, TV Place Closed Drainage, and Highland Avenue Closed Drainage. Table 1 below provides a summary of the existing conditions hydrologic data.

Table 1 Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
1 – Main Site	MassDOT Drainage Swale	DP-1	8.74	97	5.3
2 – Gould/TV Place Landscaping	TV Place Closed Drainage	DP-2	0.40	88	7.8
3 – Highland Ave Landscaping	Highland Ave Closed Drainage	DP-3	0.15	81	5.0

Proposed Drainage Conditions

Figure 3 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into 6 drainage areas that discharge treated stormwater to the 3 existing Design Points. Table 2 below provides a summary of the proposed conditions hydrologic data.

Table 2 Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
10 – Parking Lot and Drives	MassDOT Drainage Swale	DP-1	3.48	90	5.0
11 – Building	Bioretention Basin	DP-1	3.54	98	5.0
12 – Garage	MassDOT Drainage Swale	DP-1	0.95	98	5.0
13 – South of Building	Bioretention Basin	DP-1	1.06	84	5.0
20 – Overland to TV Place	TV Place Closed Drainage	DP-2	0.26	87	5.0
30 – Overland to Highland Ave	Highland Ave Closed Drainage	DP-3	0.01	80	5.0

The site design integrates a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. Because portions of the Site are considered a LUHPPL, the proposed stormwater management system has been designed to treat the one inch Water Quality Volume for those areas. The proposed stormwater

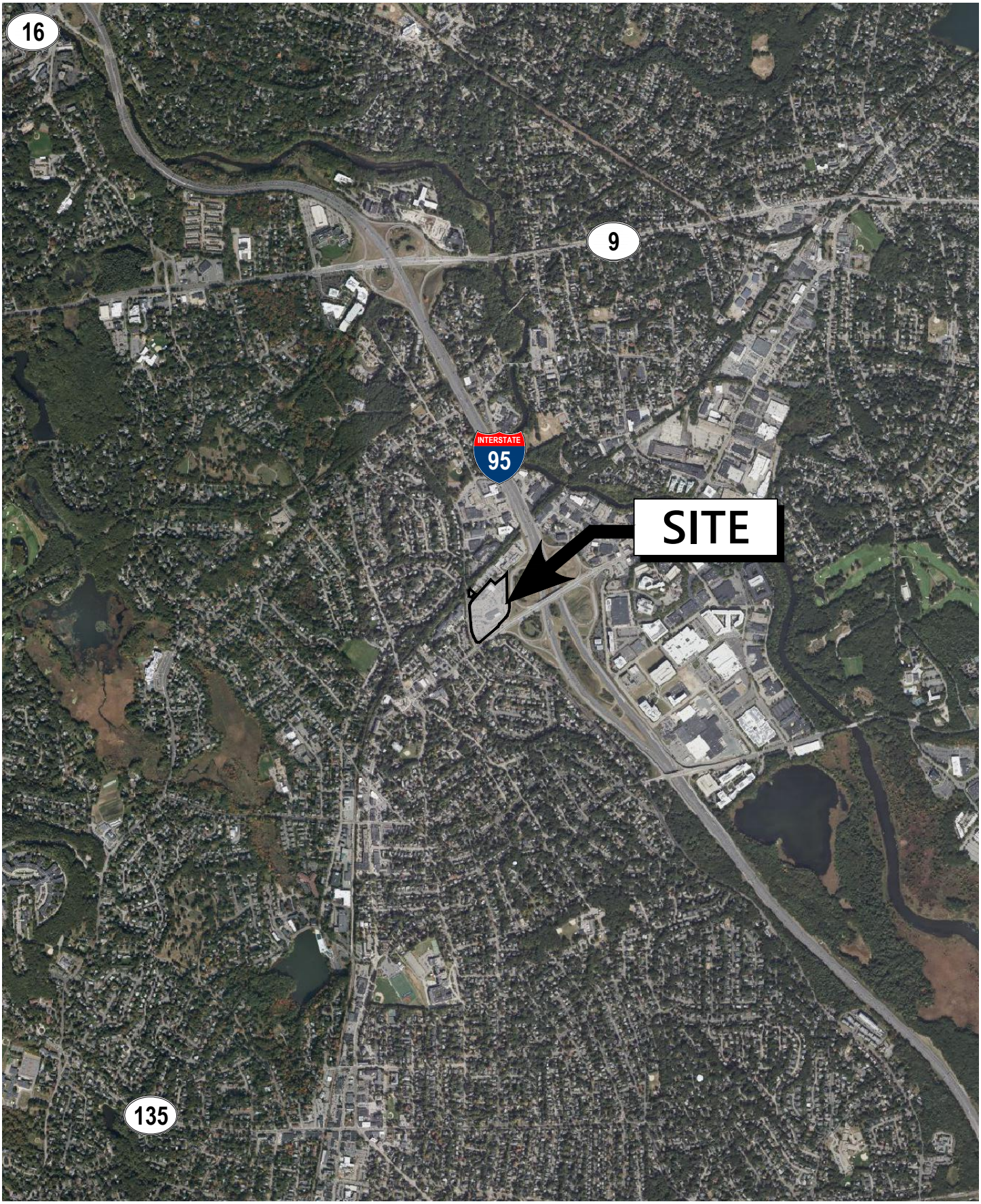
management system has been designed to treat the half inch Water Quality Volume for the remainder of the Site.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include a 1.8-Acre reduction of impervious area and a proposed surface detention basin to reduce peak runoff rates. In general, stormwater from the proposed paved surfaces is collected in deep-sump and hooded catch basins and routed through a proprietary media filter unit. Stormwater from the proposed building and garage roof areas is routed through proprietary hydrodynamic water quality units, to the surface basin, and then through a proprietary media filter unit. Treated stormwater is discharged to the existing design point DP-1 via a stone level spreader.

Figure 1 Site Locus Map

\\vhb\gbl\proj\Boston\15306.00\cad\ld\Eng\Appendix Drawings\Site Locus Map.dwg



0 1,000 2,000 Feet

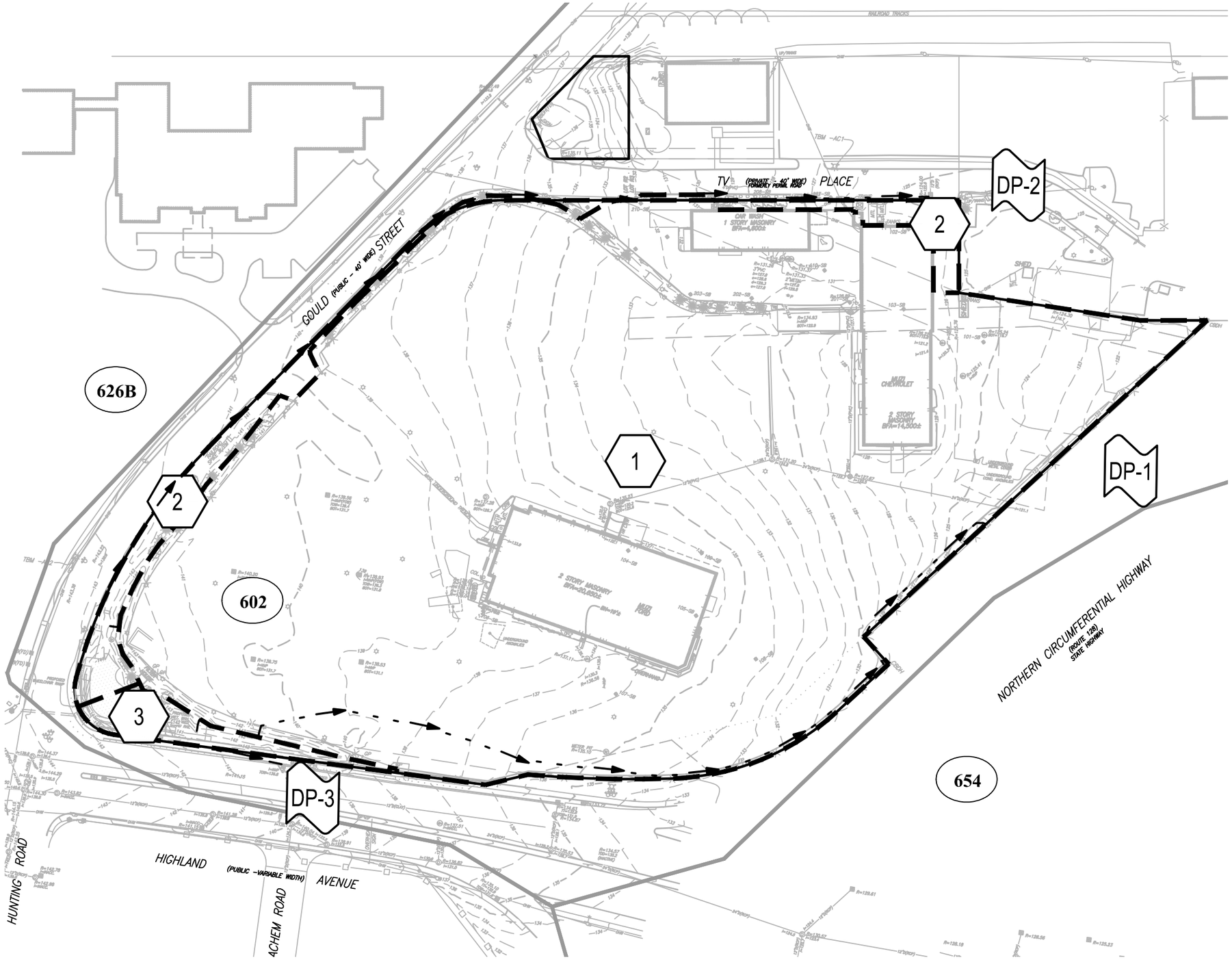
Site Locus Map

577 Highland Avenue
Needham, MA

Figure 1

March 2022

Figure 2 Existing Drainage Area



Legend

SYMBOLS

- X — **DESIGN POINT**
- X — **DRAINAGE AREA DESIGNATION**
- X — **POND**

LINETYPES

- **DRAINAGE AREA BOUNDARY**
- **TIME OF CONCENTRATION FLOW LINE**
- **SOIL TYPE BOUNDARY**

SCS SOIL CLASSIFICATIONS

602	**URBAN LAND, 0 TO 15 PERCENT SLOPES**
628B	**MERRIMAC-URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES, HSG A**
654	**UDORTHENTS, LOAMY, HSG A**

0 50 100 Feet

Existing Drainage Conditions

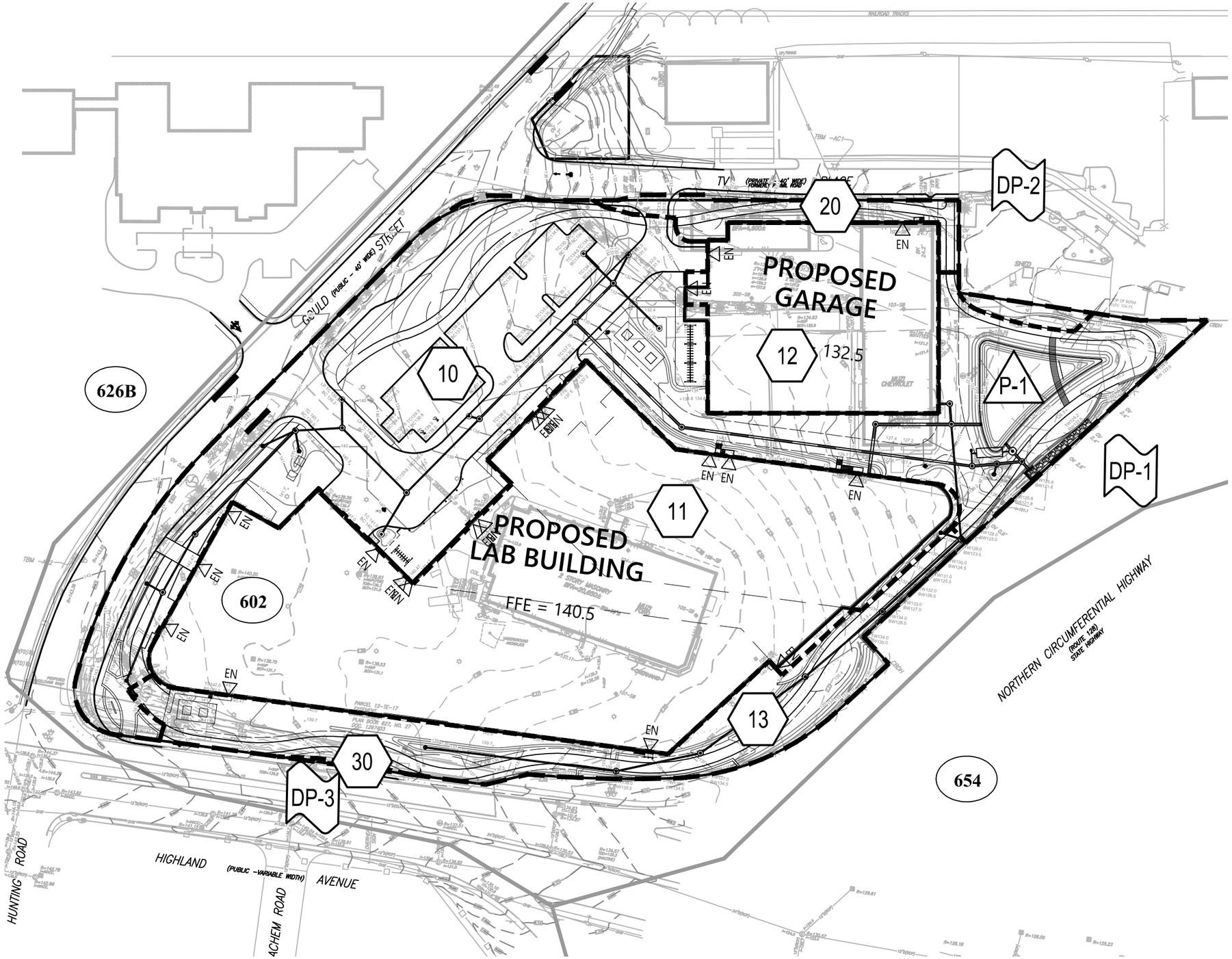
557 Highland Avenue
Needham, MA

Figure 2

March 2022

Figure 3 Proposed Drainage Area

\\vhb\gbl\proj\Boston\15306.00\cad\ld\Eng\Stormwater\15306.00 - PR Drainage.dwg



Legend

SYMBOLS

- X — **DESIGN POINT**
- X — **DRAINAGE AREA DESIGNATION**
- X — **POND**

LINETYPES

- **DRAINAGE AREA BOUNDARY**
- **TIME OF CONCENTRATION FLOW LINE**
- **SOIL TYPE BOUNDARY**

SCS SOIL CLASSIFICATIONS

602	**URBAN LAND**
628B	**MERRIMAC-URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES, HSG A**
654	**UDORTHENTS, LOAMY, HSG A**

0 50 100 Feet

Proposed Drainage Conditions

557 Highland Avenue
Needham, MA

Figure 3

March 2022

Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with headwalls and stone protection to dissipate discharge velocities. Overflows from BMP's that impound stormwater have been designed with stone material to protect downgradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, 25, and 100 years. The results of the analysis, as summarized in Table 3 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Table 3 Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	25-year	100-year
Design Point: 1				
Existing	28.4	45.2	55.6	71.7
Proposed	20.4	36.4	46.0	59.0
Design Point: 2				
Existing	0.9	1.6	2.1	2.8
Proposed	0.6	1.2	1.5	2.0
Design Point: 3				
Existing	0.3	0.6	0.8	1.1
Proposed	0.0	0.0	0.0	0.0

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3.

The project represents a net decrease in impervious coverage compared to the existing condition. Therefore, there is no Required Recharge Volume in accordance with the Stormwater Handbook.

Additionally, geotechnical exploration performed by the Project's Geotechnical Engineer indicated existing onsite soils with infiltration rates of 0.014 – 0.070 inches/hour, which are well below the minimum required to infiltrate per the MassDEP Stormwater Handbook. Accordingly, stormwater infiltration is not technically feasible on the Site and no infiltration BMPs are proposed.

Soil evaluation is included in Appendix C.

Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide 80% TSS removal of stormwater runoff from all proposed impervious surfaces.

The Project Site is located within the watershed of the Charles River, which is regulated under Total Maximum Daily Loads (TMDLs) for nutrients and pathogens. The proposed media filters have been sized to provide at least 65% removal of Total Phosphorus, which meets the EPA's TMDL removal target for commercial land use.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

Portions of the Project Site are subject to greater than 1,000 vehicle trips per day and are therefore considered a LUHPPL. Accordingly, the stormwater system has been designed with suitable BMPs sized to treat the 1 inch Water Quality Volume for those portions of the Site. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix D.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff from LUHPPLs, see Appendix D.

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project has been designed to comply with all ten of the Stormwater Management Standards.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb approximately 9 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included in Appendix E.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included in Appendix D as part of the Long Term Pollution Prevention Plan.

Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures remaining from previous development which are part of the redevelopment area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the site not

included in the redevelopment project area. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.

Local Municipal Rules and Regulations

Due to the low-permeability soils onsite, infiltration of the 1-inch rainfall depth over impervious areas is not feasible as noted under Standard 3, above. The proposed stormwater management system has otherwise been designed in accordance with the Needham Stormwater By-Law and MassDEP standards as outlined in the preceding sections. Supporting documentation demonstrating compliance has been provided in the Technical Appendices to this report.

Appendix A: Standard 1 Computations and Supporting Information

› Flow/Velocity calculations for basin overflow swale and level spreader

Velocity Over Overflow Weirs

Project Name: 557 Highland Avenue **Proj. No.:** 15306.00
Date: March 2022
Project Location: Needham, MA **Calculated by:** DMK
Checked by:

Detention Basin Spillway Flows and Velocities

Storage Area	Elev of Weir (feet)	Peak Water Surface Elevation (feet) 2-year	25-year	100-year	Overflows over Weir 2-year	25-year	100-year	Overflow Q (cfs) 2-year	25-year	100-year	Overflow V (ft/s) 2-year	25-year	100-year
P1	126.25	125.70	126.24	126.54	**no**	**no**	**yes**	-	-	4.7	-	-	1.7

The maximum weir overflow velocity for the detention basin is 1.3 fps during the 100-year event.
This velocity is not typically erosive to vegetative cover in good condition.
The spillway of the detention basin has been designed with stone material to protect down gradient areas from erosion as a conservative measure.

Level Spreader Flows and Velocities

Design Point	25-Year Peak Flow (cfs)	Maximum Flow Depth (in)	Level Spreader Length (ft)	Overflow V (ft/s)
DP-1	46.0	2.0	70	3.9

The maximum weir overflow velocity for the detention basin is 3.9 fps during the 25-year event.
This velocity is not typically erosive to vegetative cover in good condition.

Permissible Velocities for Vegetated Spillways [1]

Vegetative Cover	Permissible Velocity [2] (ft/s) Erosion Resistant Soils [3] Slope of Exit Channel 0-5%	5-10%	Easily Erodible Soils [4] Slope of Exit Channel 0-5%	5-10%
Bermuda Grass Bahiagrass	8	7	6	5
Buffalograss Kentucky Bluegrass Smooth Bromegrass Tall Fescue Reed Canary Grass	7	6	5	4
Sod Forming Grass-Legume Mixtures	5	4	4	3
Lespedeza Weeping Lovegrass Yellow Bluestem Native Grass Mixtures	3.5	3.5	2.5	2.5

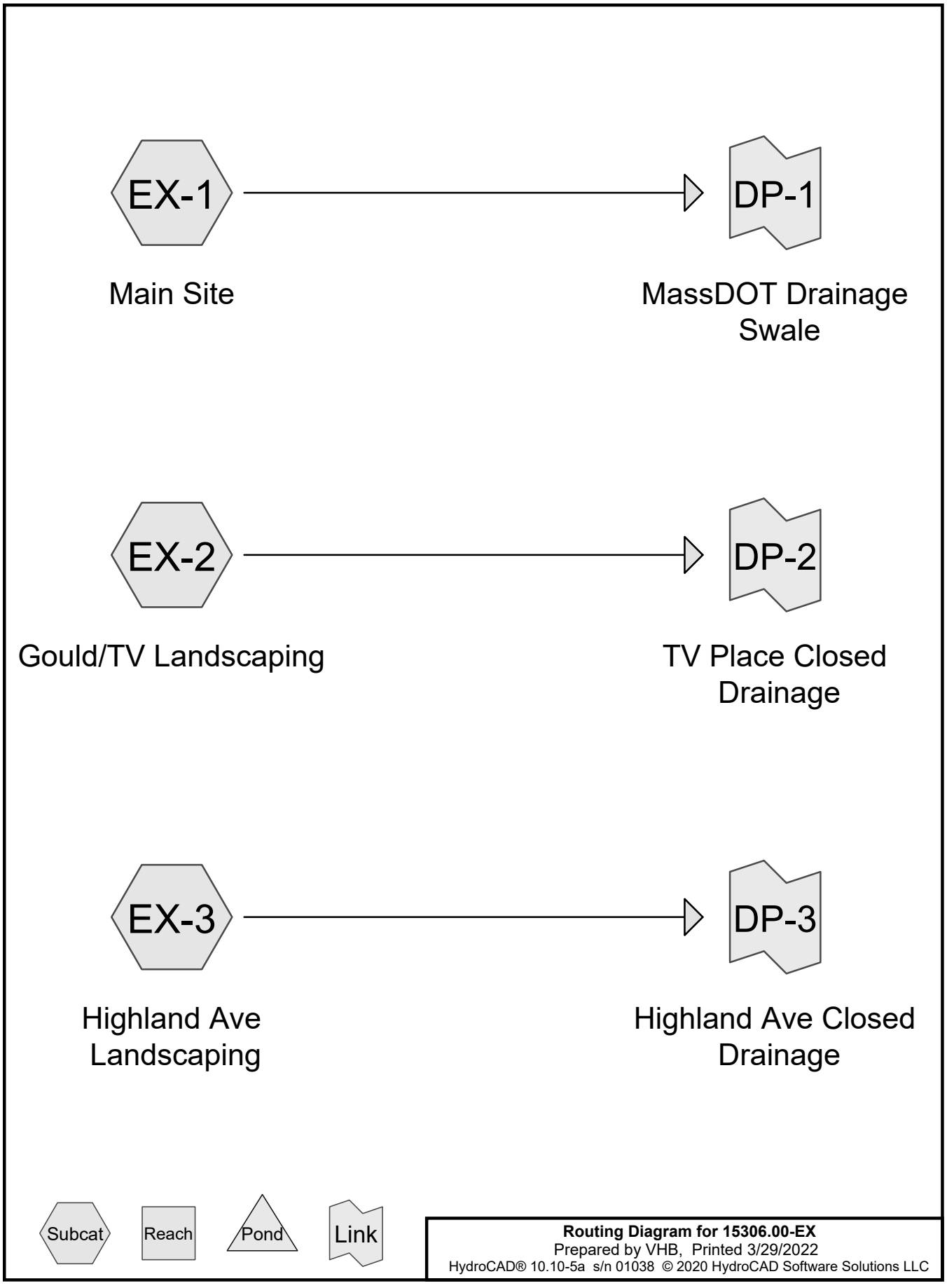
[1] SCS-TP-61
[2] Increase values 25 percent when the anticipated average use of the spillway is not more frequent than once in 10 years.
[3] Those with a high clay content and high plasticity. Typical soil textures are silty clay, sandy clay, and clay.
[4] Those with a high content of fine sand or silty and lower plasticity or non-plastic. Typical soil textures are fine sand, silt, sandy loam, and silty loam.

Source - USDA-SCS Engineering Field Manual

Appendix B: Standard 2 Computations and Supporting Information

The rainfall-runoff response of the Site under existing and proposed conditions was evaluated for storm events with recurrence intervals of 2, 10, 25 and 100-years. Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm and NOAA Atlas 14 precipitation depths for the site: 3.31, 5.19, 6.36, and 8.17 inches, respectively. Runoff coefficients for the pre- and post-development conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. Drainage areas used in the analyses were described in previous sections and shown on Figures 2 and 3. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

HydroCAD Analysis: Existing Conditions



Routing Diagram for 15306.00-EX
Prepared by VHB, Printed 3/29/2022
HydroCAD® 10.10-5a s/n 01038 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
32,880	80	>75% Grass cover, Good, HSG D (EX-1, EX-2, EX-3)
332,070	98	Paved parking, HSG D (EX-1, EX-2, EX-3)
39,750	98	Roofs, HSG D (EX-1)
404,700	**97**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=2.97"
Flow Length=855' Tc=5.3 min CN=97 Runoff=28.4 cfs 94,084 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=2.10"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=0.9 cfs 3,025 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=1.56"
Flow Length=110' Tc=5.0 min CN=81 Runoff=0.3 cfs 869 cf

Link DP-1: MassDOT Drainage Swale Inflow=28.4 cfs 94,084 cf
Primary=28.4 cfs 94,084 cf

Link DP-2: TV Place Closed Drainage Inflow=0.9 cfs 3,025 cf
Primary=0.9 cfs 3,025 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.3 cfs 869 cf
Primary=0.3 cfs 869 cf

Total Runoff Area = 404,700 sf Runoff Volume = 97,978 cf Average Runoff Depth = 2.91"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 28.4 cfs @ 12.07 hrs, Volume= 94,084 cf, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 0.9 cfs @ 12.11 hrs, Volume= 3,025 cf, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 0.3 cfs @ 12.08 hrs, Volume= 869 cf, Depth= 1.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 2.97" for 2-Year event
Inflow = 28.4 cfs @ 12.07 hrs, Volume= 94,084 cf
Primary = 28.4 cfs @ 12.07 hrs, Volume= 94,084 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 2.10" for 2-Year event
Inflow = 0.9 cfs @ 12.11 hrs, Volume= 3,025 cf
Primary = 0.9 cfs @ 12.11 hrs, Volume= 3,025 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 1.56" for 2-Year event
Inflow = 0.3 cfs @ 12.08 hrs, Volume= 869 cf
Primary = 0.3 cfs @ 12.08 hrs, Volume= 869 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=4.84"
Flow Length=855' Tc=5.3 min CN=97 Runoff=45.2 cfs 153,429 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=3.85"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=1.6 cfs 5,556 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=3.15"
Flow Length=110' Tc=5.0 min CN=81 Runoff=0.6 cfs 1,761 cf

Link DP-1: MassDOT Drainage Swale Inflow=45.2 cfs 153,429 cf
Primary=45.2 cfs 153,429 cf

Link DP-2: TV Place Closed Drainage Inflow=1.6 cfs 5,556 cf
Primary=1.6 cfs 5,556 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.6 cfs 1,761 cf
Primary=0.6 cfs 1,761 cf

Total Runoff Area = 404,700 sf Runoff Volume = 160,746 cf Average Runoff Depth = 4.77"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 45.2 cfs @ 12.07 hrs, Volume= 153,429 cf, Depth= 4.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 1.6 cfs @ 12.11 hrs, Volume= 5,556 cf, Depth= 3.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 0.6 cfs @ 12.07 hrs, Volume= 1,761 cf, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 4.84" for 10-Year event
Inflow = 45.2 cfs @ 12.07 hrs, Volume= 153,429 cf
Primary = 45.2 cfs @ 12.07 hrs, Volume= 153,429 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 3.85" for 10-Year event
Inflow = 1.6 cfs @ 12.11 hrs, Volume= 5,556 cf
Primary = 1.6 cfs @ 12.11 hrs, Volume= 5,556 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 3.15" for 10-Year event
Inflow = 0.6 cfs @ 12.07 hrs, Volume= 1,761 cf
Primary = 0.6 cfs @ 12.07 hrs, Volume= 1,761 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=6.00"
Flow Length=855' Tc=5.3 min CN=97 Runoff=55.6 cfs 190,446 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=4.97"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=2.1 cfs 7,178 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=4.21"
Flow Length=110' Tc=5.0 min CN=81 Runoff=0.8 cfs 2,352 cf

Link DP-1: MassDOT Drainage Swale Inflow=55.6 cfs 190,446 cf
Primary=55.6 cfs 190,446 cf

Link DP-2: TV Place Closed Drainage Inflow=2.1 cfs 7,178 cf
Primary=2.1 cfs 7,178 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.8 cfs 2,352 cf
Primary=0.8 cfs 2,352 cf

Total Runoff Area = 404,700 sf Runoff Volume = 199,976 cf Average Runoff Depth = 5.93"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 55.6 cfs @ 12.07 hrs, Volume= 190,446 cf, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 2.1 cfs @ 12.11 hrs, Volume= 7,178 cf, Depth= 4.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 0.8 cfs @ 12.07 hrs, Volume= 2,352 cf, Depth= 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 6.00" for 25-Year event
Inflow = 55.6 cfs @ 12.07 hrs, Volume= 190,446 cf
Primary = 55.6 cfs @ 12.07 hrs, Volume= 190,446 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 4.97" for 25-Year event
Inflow = 2.1 cfs @ 12.11 hrs, Volume= 7,178 cf
Primary = 2.1 cfs @ 12.11 hrs, Volume= 7,178 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 4.21" for 25-Year event
Inflow = 0.8 cfs @ 12.07 hrs, Volume= 2,352 cf
Primary = 0.8 cfs @ 12.07 hrs, Volume= 2,352 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Main Site Runoff Area=380,680 sf 95.71% Impervious Runoff Depth=7.81"
Flow Length=855' Tc=5.3 min CN=97 Runoff=71.7 cfs 247,767 cf

Subcatchment EX-2: Gould/TV Runoff Area=17,320 sf 41.86% Impervious Runoff Depth=6.73"
Flow Length=1,025' Tc=7.8 min CN=88 Runoff=2.8 cfs 9,720 cf

Subcatchment EX-3: Highland Ave Runoff Area=6,700 sf 3.28% Impervious Runoff Depth=5.90"
Flow Length=110' Tc=5.0 min CN=81 Runoff=1.1 cfs 3,296 cf

Link DP-1: MassDOT Drainage Swale Inflow=71.7 cfs 247,767 cf
Primary=71.7 cfs 247,767 cf

Link DP-2: TV Place Closed Drainage Inflow=2.8 cfs 9,720 cf
Primary=2.8 cfs 9,720 cf

Link DP-3: Highland Ave Closed Drainage Inflow=1.1 cfs 3,296 cf
Primary=1.1 cfs 3,296 cf

Total Runoff Area = 404,700 sf Runoff Volume = 260,782 cf Average Runoff Depth = 7.73"
8.12% Pervious = 32,880 sf 91.88% Impervious = 371,820 sf

Summary for Subcatchment EX-1: Main Site

Runoff = 71.7 cfs @ 12.07 hrs, Volume= 247,767 cf, Depth= 7.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
324,600	98	Paved parking, HSG D
39,750	98	Roofs, HSG D
16,330	80	>75% Grass cover, Good, HSG D
380,680	97	Weighted Average
16,330		4.29% Pervious Area
364,350		95.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	11	0.1820	0.27		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
4.6	844	0.0230	3.08		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
5.3	855	Total			

Summary for Subcatchment EX-2: Gould/TV Landscaping

Runoff = 2.8 cfs @ 12.11 hrs, Volume= 9,720 cf, Depth= 6.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
7,250	98	Paved parking, HSG D
10,070	80	>75% Grass cover, Good, HSG D
17,320	88	Weighted Average
10,070		58.14% Pervious Area
7,250		41.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	24	0.0830	0.23		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
6.1	1,001	0.0180	2.72		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
7.8	1,025	Total			

Summary for Subcatchment EX-3: Highland Ave Landscaping

Runoff = 1.1 cfs @ 12.07 hrs, Volume= 3,296 cf, Depth= 5.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
220	98	Paved parking, HSG D
6,480	80	>75% Grass cover, Good, HSG D
6,700	81	Weighted Average
6,480		96.72% Pervious Area
220		3.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	24	0.1670	0.30		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.31"
0.6	86	0.0120	2.22		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
1.9	110	Total, Increased to minimum Tc = 5.0 min			

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 380,680 sf, 95.71% Impervious, Inflow Depth = 7.81" for 100-Year event
Inflow = 71.7 cfs @ 12.07 hrs, Volume= 247,767 cf
Primary = 71.7 cfs @ 12.07 hrs, Volume= 247,767 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 17,320 sf, 41.86% Impervious, Inflow Depth = 6.73" for 100-Year event
Inflow = 2.8 cfs @ 12.11 hrs, Volume= 9,720 cf
Primary = 2.8 cfs @ 12.11 hrs, Volume= 9,720 cf, Atten= 0%, Lag= 0.0 min

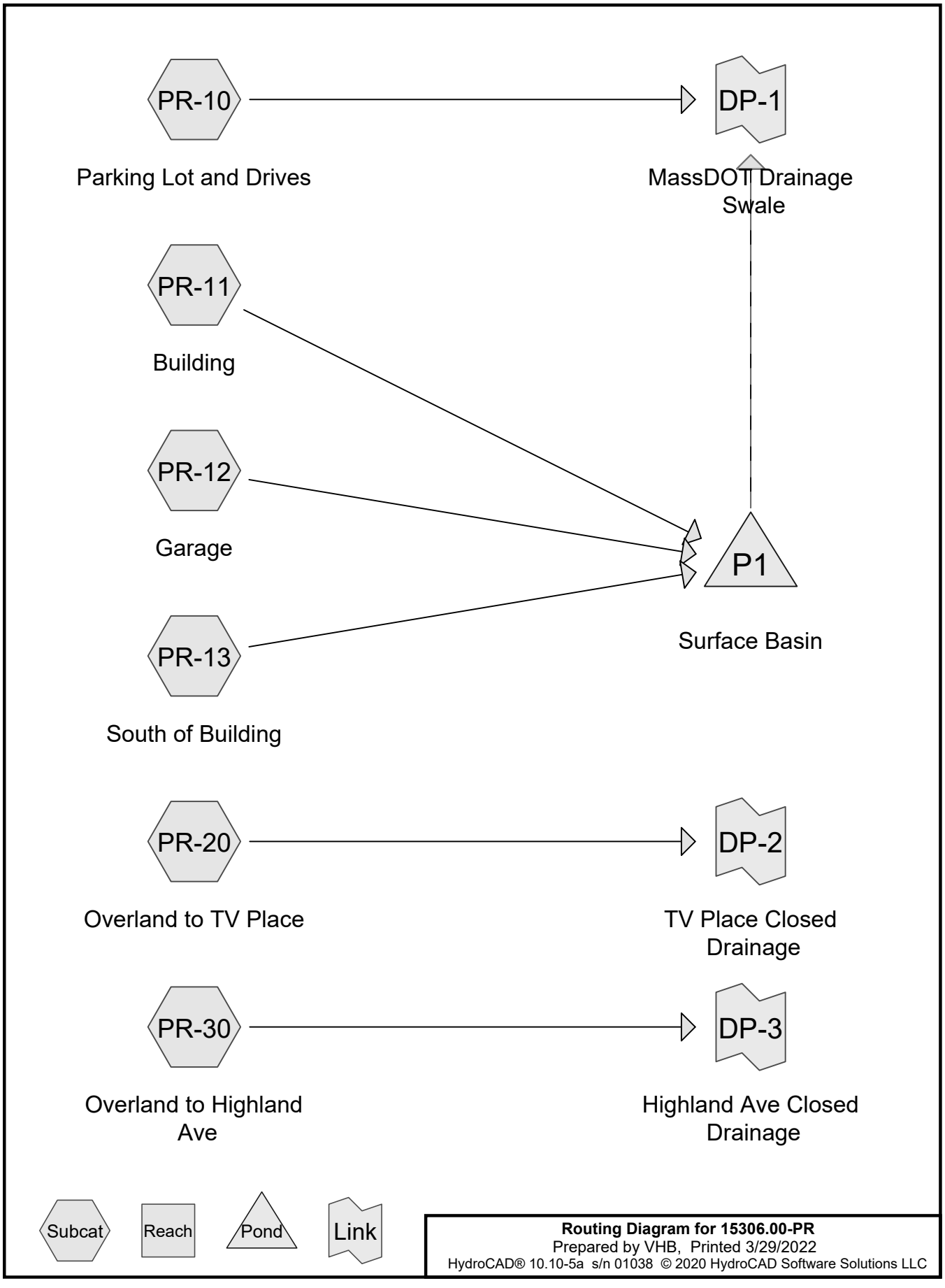
Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 6,700 sf, 3.28% Impervious, Inflow Depth = 5.90" for 100-Year event
Inflow = 1.1 cfs @ 12.07 hrs, Volume= 3,296 cf
Primary = 1.1 cfs @ 12.07 hrs, Volume= 3,296 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

HydroCAD Analysis: Proposed Conditions



Routing Diagram for 15306.00-PR
Prepared by VHB, Printed 3/29/2022
HydroCAD® 10.10-5a s/n 01038 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
108,450	80	>75% Grass cover, Good, HSG D (PR-10, PR-13, PR-20, PR-30)
3,850	96	Gravel surface, HSG D (PR-10, PR-13, PR-20)
96,800	98	Paved parking, HSG D (PR-10, PR-13, PR-20)
195,600	98	Roofs, HSG D (PR-11, PR-12)
404,700	**93**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=2.27"
Tc=5.0 min CN=90 Runoff=9.5 cfs 28,649 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=3.08"
Tc=5.0 min CN=98 Runoff=11.8 cfs 39,553 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=3.08"
Tc=5.0 min CN=98 Runoff=3.2 cfs 10,603 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=1.77"
Tc=5.0 min CN=84 Runoff=2.3 cfs 6,804 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=2.01"
Tc=5.0 min CN=87 Runoff=0.6 cfs 1,912 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=1.49"
Tc=5.0 min CN=80 Runoff=0.0 cfs 37 cf

Pond P1: Surface Basin Peak Elev=125.70' Storage=14,946 cf Inflow=17.2 cfs 56,960 cf
Primary=11.1 cfs 19,729 cf Secondary=0.0 cfs 0 cf Tertiary=1.2 cfs 36,909 cf Outflow=12.4 cfs 56,639 cf

Link DP-1: MassDOT Drainage Swale Inflow=20.4 cfs 85,287 cf
Primary=20.4 cfs 85,287 cf

Link DP-2: TV Place Closed Drainage Inflow=0.6 cfs 1,912 cf
Primary=0.6 cfs 1,912 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 37 cf
Primary=0.0 cfs 37 cf

Total Runoff Area = 404,700 sf Runoff Volume = 87,558 cf Average Runoff Depth = 2.60"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 9.5 cfs @ 12.07 hrs, Volume= 28,649 cf, Depth= 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 11.8 cfs @ 12.07 hrs, Volume= 39,553 cf, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 3.2 cfs @ 12.07 hrs, Volume= 10,603 cf, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 2.3 cfs @ 12.08 hrs, Volume= 6,804 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 0.6 cfs @ 12.07 hrs, Volume= 1,912 cf, Depth= 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.08 hrs, Volume= 37 cf, Depth= 1.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.31"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 2.83" for 2-Year event
Inflow = 17.2 cfs @ 12.07 hrs, Volume= 56,960 cf
Outflow = 12.4 cfs @ 12.14 hrs, Volume= 56,639 cf, Atten= 28%, Lag= 4.2 min
Primary = 11.1 cfs @ 12.14 hrs, Volume= 19,729 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Tertiary = 1.2 cfs @ 12.14 hrs, Volume= 36,909 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 125.70' @ 12.14 hrs Surf.Area= 8,835 sf Storage= 14,946 cf

Plug-Flow detention time= 102.0 min calculated for 56,623 cf (99% of inflow)
Center-of-Mass det. time= 98.4 min (861.8 - 763.4)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=11.1 cfs @ 12.14 hrs HW=125.70' (Free Discharge)
↑**1=Culvert** (Passes 11.1 cfs of 24.8 cfs potential flow)
↑**2=Sharp-Crested Rectangular Weir**(Weir Controls 11.1 cfs @ 2.73 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=123.75' (Free Discharge)
↑**3=Broad-Crested Rectangular Weir**(Controls 0.0 cfs)

Tertiary OutFlow Max=1.2 cfs @ 12.14 hrs HW=125.70' (Free Discharge)
↑**4=Culvert** (Inlet Controls 1.2 cfs @ 6.27 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 2.60" for 2-Year event
Inflow = 20.4 cfs @ 12.10 hrs, Volume= 85,287 cf
Primary = 20.4 cfs @ 12.10 hrs, Volume= 85,287 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 2.01" for 2-Year event
Inflow = 0.6 cfs @ 12.07 hrs, Volume= 1,912 cf
Primary = 0.6 cfs @ 12.07 hrs, Volume= 1,912 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 1.49" for 2-Year event
Inflow = 0.0 cfs @ 12.08 hrs, Volume= 37 cf
Primary = 0.0 cfs @ 12.08 hrs, Volume= 37 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=4.06"
Tc=5.0 min CN=90 Runoff=16.5 cfs 51,221 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=4.95"
Tc=5.0 min CN=98 Runoff=18.6 cfs 63,665 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=4.95"
Tc=5.0 min CN=98 Runoff=5.0 cfs 17,067 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=3.44"
Tc=5.0 min CN=84 Runoff=4.4 cfs 13,205 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=3.75"
Tc=5.0 min CN=87 Runoff=1.2 cfs 3,559 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=3.06"
Tc=5.0 min CN=80 Runoff=0.0 cfs 76 cf

Pond P1: Surface Basin Peak Elev=126.05' Storage=18,171 cf Inflow=28.0 cfs 93,937 cf
Primary=20.4 cfs 44,547 cf Secondary=0.0 cfs 0 cf Tertiary=1.4 cfs 49,046 cf Outflow=21.8 cfs 93,593 cf

Link DP-1: MassDOT Drainage Swale Inflow=36.4 cfs 144,813 cf
Primary=36.4 cfs 144,813 cf

Link DP-2: TV Place Closed Drainage Inflow=1.2 cfs 3,559 cf
Primary=1.2 cfs 3,559 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 76 cf
Primary=0.0 cfs 76 cf

Total Runoff Area = 404,700 sf Runoff Volume = 148,793 cf Average Runoff Depth = 4.41"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 16.5 cfs @ 12.07 hrs, Volume= 51,221 cf, Depth= 4.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 18.6 cfs @ 12.07 hrs, Volume= 63,665 cf, Depth= 4.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 5.0 cfs @ 12.07 hrs, Volume= 17,067 cf, Depth= 4.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 4.4 cfs @ 12.07 hrs, Volume= 13,205 cf, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 1.2 cfs @ 12.07 hrs, Volume= 3,559 cf, Depth= 3.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.07 hrs, Volume= 76 cf, Depth= 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.19"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 4.67" for 10-Year event
Inflow = 28.0 cfs @ 12.07 hrs, Volume= 93,937 cf
Outflow = 21.8 cfs @ 12.13 hrs, Volume= 93,593 cf, Atten= 22%, Lag= 3.6 min
Primary = 20.4 cfs @ 12.13 hrs, Volume= 44,547 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Tertiary = 1.4 cfs @ 12.13 hrs, Volume= 49,046 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 126.05' @ 12.13 hrs Surf.Area= 9,266 sf Storage= 18,171 cf

Plug-Flow detention time= 82.3 min calculated for 93,593 cf (100% of inflow)
Center-of-Mass det. time= 79.8 min (834.9 - 755.1)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=20.4 cfs @ 12.13 hrs HW=126.05' (Free Discharge)
↑**1=Culvert** (Passes 20.4 cfs of 26.4 cfs potential flow)
↑**2=Sharp-Crested Rectangular Weir** (Weir Controls 20.4 cfs @ 3.35 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=123.75' (Free Discharge)
↑**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Tertiary OutFlow Max=1.4 cfs @ 12.13 hrs HW=126.05' (Free Discharge)
↑**4=Culvert** (Inlet Controls 1.4 cfs @ 6.90 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 4.42" for 10-Year event
Inflow = 36.4 cfs @ 12.10 hrs, Volume= 144,813 cf
Primary = 36.4 cfs @ 12.10 hrs, Volume= 144,813 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 3.75" for 10-Year event
Inflow = 1.2 cfs @ 12.07 hrs, Volume= 3,559 cf
Primary = 1.2 cfs @ 12.07 hrs, Volume= 3,559 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 3.06" for 10-Year event
Inflow = 0.0 cfs @ 12.07 hrs, Volume= 76 cf
Primary = 0.0 cfs @ 12.07 hrs, Volume= 76 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=5.20"
Tc=5.0 min CN=90 Runoff=20.8 cfs 65,569 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=6.12"
Tc=5.0 min CN=98 Runoff=22.9 cfs 78,687 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=6.12"
Tc=5.0 min CN=98 Runoff=6.1 cfs 21,094 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=4.53"
Tc=5.0 min CN=84 Runoff=5.7 cfs 17,382 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=4.86"
Tc=5.0 min CN=87 Runoff=1.5 cfs 4,619 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=4.11"
Tc=5.0 min CN=80 Runoff=0.0 cfs 103 cf

Pond P1: Surface Basin Peak Elev=126.24' Storage=19,936 cf Inflow=34.7 cfs 117,162 cf
Primary=26.0 cfs 61,624 cf Secondary=0.0 cfs 0 cf Tertiary=1.4 cfs 55,182 cf Outflow=27.4 cfs 116,807 cf

Link DP-1: MassDOT Drainage Swale Inflow=46.0 cfs 182,375 cf
Primary=46.0 cfs 182,375 cf

Link DP-2: TV Place Closed Drainage Inflow=1.5 cfs 4,619 cf
Primary=1.5 cfs 4,619 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 103 cf
Primary=0.0 cfs 103 cf

Total Runoff Area = 404,700 sf Runoff Volume = 187,453 cf Average Runoff Depth = 5.56"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 20.8 cfs @ 12.07 hrs, Volume= 65,569 cf, Depth= 5.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 22.9 cfs @ 12.07 hrs, Volume= 78,687 cf, Depth= 6.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 6.1 cfs @ 12.07 hrs, Volume= 21,094 cf, Depth= 6.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 5.7 cfs @ 12.07 hrs, Volume= 17,382 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 1.5 cfs @ 12.07 hrs, Volume= 4,619 cf, Depth= 4.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.07 hrs, Volume= 103 cf, Depth= 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.36"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 5.82" for 25-Year event
Inflow = 34.7 cfs @ 12.07 hrs, Volume= 117,162 cf
Outflow = 27.4 cfs @ 12.13 hrs, Volume= 116,807 cf, Atten= 21%, Lag= 3.5 min
Primary = 26.0 cfs @ 12.13 hrs, Volume= 61,624 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf
Tertiary = 1.4 cfs @ 12.13 hrs, Volume= 55,182 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 126.24' @ 12.13 hrs Surf.Area= 9,505 sf Storage= 19,936 cf

Plug-Flow detention time= 74.6 min calculated for 116,807 cf (100% of inflow)
Center-of-Mass det. time= 72.6 min (824.4 - 751.8)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=26.0 cfs @ 12.13 hrs HW=126.24' (Free Discharge)
└**1=Culvert** (Passes 26.0 cfs of 27.2 cfs potential flow)
└**2=Sharp-Crested Rectangular Weir**(Weir Controls 26.0 cfs @ 3.64 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=123.75' (Free Discharge)
└**3=Broad-Crested Rectangular Weir**(Controls 0.0 cfs)

Tertiary OutFlow Max=1.4 cfs @ 12.13 hrs HW=126.24' (Free Discharge)
└**4=Culvert** (Inlet Controls 1.4 cfs @ 7.21 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 5.57" for 25-Year event
Inflow = 46.0 cfs @ 12.10 hrs, Volume= 182,375 cf
Primary = 46.0 cfs @ 12.10 hrs, Volume= 182,375 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 4.86" for 25-Year event
Inflow = 1.5 cfs @ 12.07 hrs, Volume= 4,619 cf
Primary = 1.5 cfs @ 12.07 hrs, Volume= 4,619 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 4.11" for 25-Year event
Inflow = 0.0 cfs @ 12.07 hrs, Volume= 103 cf
Primary = 0.0 cfs @ 12.07 hrs, Volume= 103 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-10: Parking Lot and Runoff Area=151,400 sf 56.01% Impervious Runoff Depth=6.97"
Tc=5.0 min CN=90 Runoff=27.5 cfs 87,975 cf

Subcatchment PR-11: Building Runoff Area=154,250 sf 100.00% Impervious Runoff Depth=7.93"
Tc=5.0 min CN=98 Runoff=29.4 cfs 101,935 cf

Subcatchment PR-12: Garage Runoff Area=41,350 sf 100.00% Impervious Runoff Depth=7.93"
Tc=5.0 min CN=98 Runoff=7.9 cfs 27,326 cf

Subcatchment PR-13: South of Building Runoff Area=46,000 sf 18.48% Impervious Runoff Depth=6.26"
Tc=5.0 min CN=84 Runoff=7.8 cfs 23,991 cf

Subcatchment PR-20: Overland to TV Place Runoff Area=11,400 sf 30.70% Impervious Runoff Depth=6.62"
Tc=5.0 min CN=87 Runoff=2.0 cfs 6,285 cf

Subcatchment PR-30: Overland to Highland Runoff Area=300 sf 0.00% Impervious Runoff Depth=5.78"
Tc=5.0 min CN=80 Runoff=0.0 cfs 145 cf

Pond P1: Surface Basin Peak Elev=126.54' Storage=22,887 cf Inflow=45.1 cfs 153,252 cf
Primary=28.5 cfs 88,016 cf Secondary=4.7 cfs 1,715 cf Tertiary=1.5 cfs 63,147 cf Outflow=34.7 cfs 152,877 cf

Link DP-1: MassDOT Drainage Swale Inflow=59.0 cfs 240,853 cf
Primary=59.0 cfs 240,853 cf

Link DP-2: TV Place Closed Drainage Inflow=2.0 cfs 6,285 cf
Primary=2.0 cfs 6,285 cf

Link DP-3: Highland Ave Closed Drainage Inflow=0.0 cfs 145 cf
Primary=0.0 cfs 145 cf

Total Runoff Area = 404,700 sf Runoff Volume = 247,656 cf Average Runoff Depth = 7.34"
27.75% Pervious = 112,300 sf 72.25% Impervious = 292,400 sf

Summary for Subcatchment PR-10: Parking Lot and Drives

Runoff = 27.5 cfs @ 12.07 hrs, Volume= 87,975 cf, Depth= 6.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
84,800	98	Paved parking, HSG D
64,650	80	>75% Grass cover, Good, HSG D
1,950	96	Gravel surface, HSG D
151,400	90	Weighted Average
66,600		43.99% Pervious Area
84,800		56.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Base**

Summary for Subcatchment PR-11: Building

Runoff = 29.4 cfs @ 12.07 hrs, Volume= 101,935 cf, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
154,250	98	Roofs, HSG D
154,250		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-12: Garage

Runoff = 7.9 cfs @ 12.07 hrs, Volume= 27,326 cf, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
41,350	98	Roofs, HSG D
41,350		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-13: South of Building

Runoff = 7.8 cfs @ 12.07 hrs, Volume= 23,991 cf, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
1,150	96	Gravel surface, HSG D
29,350	80	>75% Grass cover, Good, HSG D
7,000	80	>75% Grass cover, Good, HSG D
8,500	98	Paved parking, HSG D
46,000	84	Weighted Average
37,500		81.52% Pervious Area
8,500		18.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-20: Overland to TV Place

Runoff = 2.0 cfs @ 12.07 hrs, Volume= 6,285 cf, Depth= 6.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
750	96	Gravel surface, HSG D
7,150	80	>75% Grass cover, Good, HSG D
3,500	98	Paved parking, HSG D
11,400	87	Weighted Average
7,900		69.30% Pervious Area
3,500		30.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment PR-30: Overland to Highland Ave

Runoff = 0.0 cfs @ 12.07 hrs, Volume= 145 cf, Depth= 5.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.17"

Area (sf)	CN	Description
300	80	>75% Grass cover, Good, HSG D
300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond P1: Surface Basin

Inflow Area = 241,600 sf, 84.48% Impervious, Inflow Depth = 7.61" for 100-Year event
Inflow = 45.1 cfs @ 12.07 hrs, Volume= 153,252 cf
Outflow = 34.7 cfs @ 12.13 hrs, Volume= 152,877 cf, Atten= 23%, Lag= 3.7 min
Primary = 28.5 cfs @ 12.13 hrs, Volume= 88,016 cf
Secondary = 4.7 cfs @ 12.13 hrs, Volume= 1,715 cf
Tertiary = 1.5 cfs @ 12.13 hrs, Volume= 63,147 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 126.54' @ 12.13 hrs Surf.Area= 9,890 sf Storage= 22,887 cf

Plug-Flow detention time= 66.1 min calculated for 152,877 cf (100% of inflow)
Center-of-Mass det. time= 64.5 min (812.5 - 748.1)

Volume	Invert	Avail.Storage	Storage Description
#1	123.75'	24,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
123.75	6,450	0	0
124.00	6,850	1,663	1,663
125.00	8,000	7,425	9,088
126.00	9,200	8,600	17,688
126.75	10,150	7,256	24,944

Device	Routing	Invert	Outlet Devices
#1	Primary	122.00'	**24.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 122.00' / 121.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	125.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	126.25'	**12.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#4	Tertiary	123.75'	**6.0" Round Culvert** L= 10.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.75' / 123.65' S= 0.0100 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 0.20 sf

Primary OutFlow Max=28.5 cfs @ 12.13 hrs HW=126.54' (Free Discharge)
└**1=Culvert** (Inlet Controls 28.5 cfs @ 9.06 fps)
└**2=Sharp-Crested Rectangular Weir** (Passes 28.5 cfs of 35.7 cfs potential flow)

Secondary OutFlow Max=4.7 cfs @ 12.13 hrs HW=126.54' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Weir Controls 4.7 cfs @ 1.32 fps)

Tertiary OutFlow Max=1.5 cfs @ 12.13 hrs HW=126.54' (Free Discharge)
└**4=Culvert** (Inlet Controls 1.5 cfs @ 7.68 fps)

Summary for Link DP-1: MassDOT Drainage Swale

Inflow Area = 393,000 sf, 73.51% Impervious, Inflow Depth > 7.35" for 100-Year event
Inflow = 59.0 cfs @ 12.09 hrs, Volume= 240,853 cf
Primary = 59.0 cfs @ 12.09 hrs, Volume= 240,853 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-2: TV Place Closed Drainage

Inflow Area = 11,400 sf, 30.70% Impervious, Inflow Depth = 6.62" for 100-Year event
Inflow = 2.0 cfs @ 12.07 hrs, Volume= 6,285 cf
Primary = 2.0 cfs @ 12.07 hrs, Volume= 6,285 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Link DP-3: Highland Ave Closed Drainage

Inflow Area = 300 sf, 0.00% Impervious, Inflow Depth = 5.78" for 100-Year event
Inflow = 0.0 cfs @ 12.07 hrs, Volume= 145 cf
Primary = 0.0 cfs @ 12.07 hrs, Volume= 145 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Appendix C: Standard 3 Computations and Supporting Documentation

› Soil Evaluation in accordance with Volume 3, Chapter 1 of the Handbook

Soil Evaluation and Analysis

Memorandum

Date:	March 18, 2022
Recipient:	The Bulfinch Companies, Inc.
Attention:	Mr. Robert Schlager
Copy:	Mr. Thomas Urtz (Stantec)
	Mr. Daniel Keches, P.E. (VHB)
Sender:	Nathan Davis, PhD, P.E.; Brendan A. O'Neil, P.E.
Project:	557 Highland Avenue
Project No:	7307.2.01
Subject:	Preliminary Evaluation of Soil Hydraulic Conductivity

This memorandum provides a summary of our preliminary evaluation of the estimated hydraulic conductivity of fill material in the general vicinity of two (2) proposed locations for groundwater infiltration systems for the proposed development to be located at 557 Highland Avenue in Needham, Massachusetts. The purpose of this evaluation is to assess the feasibility of installing stormwater recharge systems for the proposed development as well as to provide infiltration rates to be used for initial sizing of the systems.

Existing Site Conditions

The subject site occupies an approximate 9.3-acre plan area bounded by Highland Avenue to the south, Gould Street to the West, Interstate 95 and associated ramps to the east, and commercial properties to the north. Formerly, the site was occupied by three (3) buildings: a 2-story masonry car dealership and garage occupying an approximately 20,650 square-foot plan area located near the center of the site; a 2-story masonry car dealership and garage occupying an approximately 14,500 square-foot plan area located near the northeastern corner of the site; and a single-story masonry car wash along the northern property line. These buildings have recently been demolished and the site is currently occupied by paved parking areas, with landscaped areas along Gould Street and Highland Avenue, a depressed drainage swale/water feature located at the southwestern corner of the site, and leveled soil in the areas of the former buildings.

Proposed Construction

The current scope of proposed development is understood to consist of a 3- to 5-story lab, office and retail building, a 6-story garage, and a surface parking area. The proposed lab, office and retail building is understood to be an L-shaped building, with the 3-story portion parallel to Highland Avenue and occupying a plan area of approximately 70,442 square feet, and the 5-story portion extending away from Highland Avenue and occupying a plan area of approximately 54,670 square feet. The two portions of the building are understood to be connected via an approximately 4,355-square-foot atrium overlying an approximately

20,361-square-foot plaza. It is understood that the entire building is proposed to be underlain by a 2-level below-grade garage with lowest level slab at approximately Elevation +112.5 that occupies a plan area of approximately 146,023 square feet. The garage is understood to contain 6 above-grade levels of parking along with 2 below-grade levels and occupy a plan are of approximately 41,824 square feet. The proposed garage lowest-level slab elevation is not currently known, but it is anticipated to be at approximately Elevation +110 based on the proposed site grades surrounding the garage.

Exploration Program

The following subsurface explorations were completed at the project site under contract to McPhail:

- Twenty-three (23) borings, completed during the period of December 30, 2021 through January 24, 2022 by Carr Dee Corp. of Medford, MA.
- Sixty-seven (67) geoprobes, completed during the period of December 20, 2021 through January 6, 2022 by Geosearch of Sterling, MA.

Subsurface Conditions

Underlying the surface treatments on-site, the explorations encountered a deposit of fill that extends to a depth of up to 38 feet below ground surface. The fill material was observed to be highly variable, consisting of a mixture of silt, sand, and gravel and containing varying amounts of brick, ash, cinders, and rubber. Portions of the fill deposit were observed to contain numerous boulders ranging up to approximately 6 feet in largest dimension. Underlying the fill material, successive deposits of organic material, alluvium, glacial outwash, glacial till, and bedrock were encountered in the explorations. The alluvial deposit was observed to be interbedded with deposit of organic silt. Explorations performed to depths of up to 64 feet below ground surface in the central portion of the site did not encounter a bedrock deposit. Bedrock, or refusal on suspected bedrock was encountered in the southwestern and northern portions of the site at depths ranging from 14.5 to 22.5 feet below ground surface.

Evaluation of Soil Hydraulic Conductivity

At the completion of the exploration program, soil samples obtained from the borings and geoprobes were returned to our laboratory for more detailed classification, analysis, and testing. The laboratory testing consisted of sieve analyses to determine the soil gradations to confirm the visual classifications and to estimate the coefficient of hydraulic conductivity for site soils. Laboratory test procedures were in general accordance with applicable ASTM Standards.

Using the above-referenced laboratory-derived grain-size distributions, the coefficient of hydraulic conductivity of the fill was estimated using the Kozeny-Carman formula. This method involves the use of additional parameters such as void ratio and particle shape,

which are estimated from the boring data and the representative soil samples. The results from the Kozeny-Carman formula were then compared with referenced infiltration rates (Rawls rates) based on the USDA textural classification.

The results of the Kozeny-Carman formula applied using the grain-size distributions obtained from laboratory analysis indicate a coefficient of hydraulic conductivity in the fill layer at the depths indicated ranging from about $1.9x10^{-5}$ to $6.1x10^{-5}$ cm/s. The Rawls rates estimated from the USDA textural classifications range from $6.4x10^{-5}$ to $1.2x10^{-4}$ cm/s. In consideration of the above, as well as the presence of numerous boulders, shallow bedrock along the edges of the site and varying amounts of rubber encountered in the boreholes, a coefficient of hydraulic conductivity of $5x10^{-5}$ cm/s is recommended for evaluation of recharge into the fill layer.

It should be noted that the fill layer is heterogeneous in composition and variable in density, thus, it is anticipated that the coefficient of hydraulic conductivity in this layer will be highly variable, and the results of the permeability testing may not be representative of the entire deposit. In addition, it should be noted that a relatively thin organic layer is intermittently present on the subject site which may lower the effective hydraulic conductivity of the overlying fill layer where present.

We trust that the above information is sufficient for your present requirements. Should you have any questions concerning the information presented herein, please contact us.

\\mcphail-fs2\mcphail\Working Documents\Jobs\7307 - 557 Highland\Correspondences\7307_Preliminary_Permeability_Evaluation_031722.docx

GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERS
2269 Massachusetts Avenue
Cambridge, Massachusetts 02140
(617) 868-1420

Appendix D: Standard 4 Computations and Supporting Information

- Operation and Maintenance Plan
- Water Quality Volume Calculations
- TSS Removal Worksheets
- Water Quality Unit Sizing Calculations

Operations and Maintenance Plan

557 Highland Avenue

Needham, MA

PREPARED FOR

Bulfinch

116 Huntington Avenue
Suite 600
Boston, MA 02116
781.707.4000

PREPARED BY

vhb

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

MARCH, 20220

A Source Control

A comprehensive source control program will be implemented at the Project Site, which includes the following components:

- Regular pavement sweeping in the private ways
- Catch basin cleaning
- Clearing litter from the parking area, islands, and perimeter landscape areas
- Enclosure and regular maintenance of all dumpsters
- Spill Prevention training

B Spill Prevention

Spill prevention equipment and training will be provided by the property management company.

B.1 Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

Facility Manager (name): _____

Facility Manager (phone): _____

Construction Manager (name) : _____

Construction Manager (phone): _____

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

B.2 Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (DEP). and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.

Emergency Notification Phone Numbers

1. FACILITY MANAGER		
Name:	Phone:	
	Beeper/Cell:	
	Home Phone:	
Alternate Contact:	Phone:	
	Beeper/Cell:	
	Home Phone:	
2. FIRE & POLICE DEPARTMENT	Emergency:	911
3. CLEANUP CONTRACTOR		
Address:	Phone:	
4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)	Emergency:	888-304-1133
5. NATIONAL RESPONSE CENTER	Phone:	800-424-8802
Alternate: U.S. Environmental Protection Agency	Business:	617-918-1111
6. MUNICIPAL HEALTH DEPARTMENT	Phone:	781-455-7940
Municipal Conservation Commission:	Phone:	781-455-7550

Hazardous Waste & Oil Spill Report

Date: _____ **Time:** _____ **AM / PM**

Exact location (Transformer #): _____

Type of equipment: _____ **Make:** _____ **Size:** _____

S / N: _____ **Weather Conditions:** _____

On or near water? ☐ Yes ☐ No **If yes, name of body of water:** _____

Type of chemical / oil spilled: _____

Amount of chemical / oil spilled: _____

Cause of spill: _____

Measures taken to contain or clean up spill: _____

Amount of chemical / oil recovered: _____ **Method:** _____

Material collected as a result of cleanup:

_____ drums containing _____

_____ drums containing _____

_____ drums containing _____

Location and method of debris disposal: _____

Name and address of any person, firm, or corporation suffering charges: _____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: _____

Spill reported by General Office by: _____ **Time:** _____ **AM / PM**

Spill reported to DEP / National Response Center by: _____

DEP Date: _____ **Time:** _____ **AM / PM** **Inspector:** _____

NRC Date: _____ **Time:** _____ **AM / PM** **Inspector:** _____

Additional comments: _____

B.3 Assessment – Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department: 911

Municipality Health Department 781-455-7940

Municipality Conservation Commission: 781-455-7550

Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies	Quantity	Recommended Suppliers
› Sorbent Pillows/"Pigs"	2	http://www.newpig.com Item # KIT276 — mobile container with two pigs
› Sorbent Boom/Sock	25 feet	http://www.forestry-suppliers.com
› Sorbent Pads	50	
› Lite-Dri® Absorbent	5 pounds	
› Shovel	1	Item # 33934 — Shovel (or equivalent)
› Pry Bar	1	Item # 43210 — Manhole cover pick (or equivalent)
› Goggles	1 pair	Item # 23334 — Goggles (or equivalent)
› Gloves – Heavy	1 pair	Item # 90926 — Gloves (or equivalent)

C Snow Management

- Snow storage areas will be managed to prevent blockage of storm drain catch basins and stormwater drainage swales. Snow combined with sand and debris may block a storm drainage system, diminishing the capacity of the system and causing localized flooding.
- Sand and debris deposited on vegetated or paved areas shall be cleared from the site and properly disposed of at the end of the snow season, no later than May 15.
- Snow shall not be dumped into any waterbody, pond, or wetland resource area.

D Maintenance of Stormwater Management Systems

D.1 Pavement Systems

D.1.1 Standard Asphalt Pavement

- Sweep or vacuum standard asphalt pavement areas at least four times per year with a rotary brush or vacuum sweeper and properly dispose of removed material.
- Recommended sweeping schedule:
- Oct/Nov
- Feb/Mar
- Apr/May
- Aug/Sep
- More frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.

D.2 Structural Stormwater Management Devices

D.2.1 Catch Basins

The proper removal of sediments and associated pollutants and trash occurs only when catch basin inlets and sumps are cleaned out regularly. The more frequent the cleaning, the less likely sediments will be re-suspended and subsequently discharged. In addition, frequent cleaning also results in more volume available for future deposition and enhances the overall performance. As noted in the pavement Operation and Maintenance (O&M) section, more frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.

Catch basins are constructed with sumps (minimum 4 feet) and hooded outlets to trap debris, sediments, and floating contaminants. Disposal of all sediments must be in accordance with applicable local, state, and federal guidelines.

Inspections and Cleaning

- All catch basins shall be inspected at least four times per year and cleaned a minimum of at least once per year.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

D.2.2 Structural Water Quality Devices

The stormwater drainage system has structural water quality devices and media filters. These include Contech CDS units, JellyFish and StormFilter units, which efficiently remove sediment and hydrocarbons from stormwater runoff.

- Inspect devices monthly for the first three months after construction.
- After initial three month period, all water quality units are to be inspected at least four times per year and cleaned a minimum of at least once per year (when sediment reaches 8" in depth).
- Maintain and replace media filters in accordance with manufacturer's recommendations.
- Follow manufacturer instructions and contact manufacturer if system is malfunctioning.

D.2.3 Stormwater Outfalls

- Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect outfalls annually after initial three month period.
- Annual inspections should be supplemented after large storms, when washouts may occur.
- Maintain vegetation around outfalls to prevent blockages at the outfall.
- Maintain rip rap pad below each outfall and replace any washouts.
- Remove and dispose of any trash or debris at the outfall.

D.2.4 Roof Drain Leaders

- Perform routine roof inspections quarterly.
- Keep roofs clean and free of debris.

- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.
- Clean inlets twice per year or as necessary.

D.3 Vegetated Stormwater Management Devices

D.3.1 Surface Detention Basins

There is a surface detention ponds on the Site. The detention pond is a partially vegetated basin that are designed to detain roadway and rooftop runoff. The maintenance of the detention basins may affect the functioning of stormwater management practices. This includes the condition of the side slope vegetation and the sediment deposits in the bottom of the ponds.

Initial Post-construction Inspection

- Basin should be inspected after every major storm for the first few months to ensure proper stabilization and function.

Long-term Maintenance

- The grass on the sideslopes and in the buffer areas should be mowed, and grass clippings, organic matter, and accumulated trash and debris removed, at least twice during the growing season.
- Eroded or barren spots should be reseeded immediately after inspection to prevent additional erosion and accumulation of sediment.
- Deep tilling can be used to break up a clogged surface area.
- Sediment should be removed from the basin as necessary. Removal procedures should not take place until the floor of the basin is thoroughly dry.

Inspections and Cleaning

- Detention basin should be inspected at least twice a year to ensure proper stabilization and function.
- Light equipment, which will not compact the underlying soil, should be used to remove the top layer.

D.3.2 Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of the stormwater management system. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings and proper aeration of soils.

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.

- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.
- Annual application of compost amendments and aeration are recommended.

Water Quality Volume Calculations

Water Quality Volume Calculations

Project	557 Highland Ave	**Project #**	15306.00
Calculated by	SRD	**Date**	3/15/2022
Checked by	DMK	**Date**	3/15/2022

DETENTION BASIN P1

Runoff from subcatchment areas 11, 12, 13

Water Quality Storm Runoff Depth	(in)	0.5
Total Impervious Area	(ft^2)	204,100

BASIN WQV:

Required Volume:

Runoff Depth to be Treated (in)	Required Volume (ft^3)
0.5	**8,504**

Provided Volume:

Elevation	Area (ft^2)	Cumulative Volume (ft^3)
123.75	6,450	0
124.00	6,850	1,663
125.00	8,000	**9,088**

TSS Removal Worksheets

TSS Removal Calculation Worksheet

VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**557 Highland Ave**	Sheet:	**1 of 2**
Project Number:	**15306.00**	Date:	**3/15/2022**
Location:	**Needham, MA**	Computed by:	**SRD**
Discharge Point:	**DP-1**	Checked by:	**DMK**
Drainage Area(s):	**10**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D E)
Deep Sump and Hooded Catch Basin	**25%**	**1.00**	**0.25**	**0.75**
Media Filter	**80%**	**0.75**	**0.60**	**0.15**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data.

** Equals remaining load from previous BMP (E)

*** Contech Jellyfish sizing calculation gives a TSS removal rate of 80%. Refer to attached calculations.

Treatment Train TSS Removal = **85%**

TSS Removal Calculation Worksheet

VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
(617) 924-1770

Project Name:	**557 Highland Ave**	Sheet:	**2 of 2**
Project Number:	**15306.00**	Date:	**3/15/2022**
Location:	**Needham, MA**	Computed by:	**SRD**
Discharge Point:	**DP-1**	Checked by:	**DMK**
Drainage Area(s):	**11, 12**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D E)
Water Quality Unit	**80%**	**1.00**	**0.80**	**0.20**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data.
** Equals remaining load from previous BMP (E)
*** Contech CDS unit sizing calculation gives TSS removal rates of 81-83%. Refer to attached calculations.

Treatment Train TSS Removal = **80%**

Water Quality Unit Sizing

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

557 HIGHLAND AVE
NEEDHAM, MA

Area	0.95 ac	Unit Site Designation	WQU-203
Weighted C	0.9	Rainfall Station #	69
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.02	0.02	10.1
0.04	9.6%	19.8%	0.03	0.03	9.5
0.06	9.4%	29.3%	0.05	0.05	9.2
0.08	7.7%	37.0%	0.07	0.07	7.4
0.10	8.6%	45.6%	0.09	0.09	8.1
0.12	6.3%	51.9%	0.10	0.10	5.9
0.14	4.7%	56.5%	0.12	0.12	4.3
0.16	4.6%	61.2%	0.14	0.14	4.2
0.18	3.5%	64.7%	0.15	0.15	3.2
0.20	4.3%	69.1%	0.17	0.17	3.9
0.25	8.0%	77.1%	0.21	0.21	6.9
0.30	5.6%	82.7%	0.26	0.26	4.7
0.35	4.4%	87.0%	0.30	0.30	3.5
0.40	2.5%	89.5%	0.34	0.34	2.0
0.45	2.5%	92.1%	0.38	0.38	1.9
0.50	1.4%	93.5%	0.43	0.43	1.0
0.75	5.0%	98.5%	0.64	0.64	2.9
1.00	1.0%	99.5%	0.85	0.85	0.4
1.50	0.0%	99.5%	1.28	1.00	0.0
2.00	0.0%	99.5%	1.71	1.00	0.0
3.00	0.5%	100.0%	2.56	1.00	0.1
					89.2
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.3%
				Predicted Net Annual Load Removal Efficiency =	**82.7%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

557 HIGHLAND AVE
NEEDHAM, MA

Area	3.54 ac	Unit Site Designation	WQU-204
Weighted C	0.9	Rainfall Station #	69
t_c	5 min		
CDS Model	2020-5	CDS Treatment Capacity	**2.2 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.06	0.06	10.2
0.04	9.6%	19.8%	0.13	0.13	9.5
0.06	9.4%	29.3%	0.19	0.19	9.2
0.08	7.7%	37.0%	0.25	0.25	7.4
0.10	8.6%	45.6%	0.32	0.32	8.1
0.12	6.3%	51.9%	0.38	0.38	5.9
0.14	4.7%	56.5%	0.45	0.45	4.3
0.16	4.6%	61.2%	0.51	0.51	4.2
0.18	3.5%	64.7%	0.57	0.57	3.2
0.20	4.3%	69.1%	0.64	0.64	3.8
0.25	8.0%	77.1%	0.80	0.80	6.7
0.30	5.6%	82.7%	0.96	0.96	4.5
0.35	4.4%	87.0%	1.12	1.12	3.4
0.40	2.5%	89.5%	1.27	1.27	1.9
0.45	2.5%	92.1%	1.43	1.43	1.8
0.50	1.4%	93.5%	1.59	1.59	0.9
0.75	5.0%	98.5%	2.39	2.20	2.5
1.00	1.0%	99.5%	3.19	2.20	0.4
1.50	0.0%	99.5%	4.78	2.20	0.0
2.00	0.0%	99.5%	6.37	2.20	0.0
3.00	0.5%	100.0%	9.56	2.20	0.1
					87.8
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	92.5%
				Predicted Net Annual Load Removal Efficiency =	**81.4%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH Stormwater Solutions Inc. Engineer: JBS
Date Prepared: **3/25/2022**

Site Information

Project Name	**557 Highland Ave -** WQU-108	
Project State	**MA**	
Project City	**Needham**	
Total Drainage Area, Ad	**1.95**	ac
Post Development Impervious Area, Ai	**1.95**	ac
Pervious Area, Ap	**0.00**	ac
% Impervious	**100%**	
Runoff Coefficient, Rc	**0.95**	

Mass Loading Calculations

Mean Annual Rainfall, P	**49.0**	in
Agency Required % Removal	**80%**	
Percent Runoff Capture	**90%**	
Mean Annual Runoff, Vt	**296,554**	ft^3
Event Mean Concentration of Pollutant, EMC	**75**	mg/l
Annual Mass Load, M total	**1388**	lbs

Filter System

Filtration Brand	**Jelly Fish**	
Cartridge Length	**54**	in

Jelly Fish Sizing

Mass to be Captured by System	**1110**	lbs
Water Quality Flow	**1.44**	cfs

Method to Use **FLOW BASED**

Summary			
Flow	Treatment Flow Rate	1.60	cfs
	Required Size	**JFPD0806-8-2**	

Determining Number of Cartridges for Systems Downstream of Detention

CONTECH Stormwater Solutions Inc. Engineer:	JBS	
Date	3/28/2022	
Site Information		
Project Name	557 Highland Ave - WQU-131	
Project State	MA	
Project Location	Needham	
Drainage Area, Ad	9.02	ac
Impervious Area, Ai	6.63	ac
Pervious Area, Ap	2.39	
% Impervious	74	%
Runoff Coefficient, Rc	0.71	
Upstream Detention System		
Peak release rate from detention, $Q_{release\ peak}$	0.60	cfs
Treatment release rate from detention, $Q_{release\ treat}$	0.60	cfs
Detention pretreatment credit (from removal efficiency calcs)	50%	
Mass loading calculations		
Mean Annual Rainfall, P	49	in
Agency required % removal	80%	
Percent Runoff Capture	90%	
Mean Annual Runoff, V_t	1,027,717	ft^3
Event Mean Concentration of Pollutant, EMC	60	mg/l
Annual Mass Load, M_{total}	3847.17	lbs
Water Quality Volume		
90% Rainfall Depth	0.50	in
Volume to be treated	0.267	ac-ft
Volume to be treated by filters	11652.1185	ft^3
Filter System		
Filtration brand	StormFilter	
Cartridge height	18	in
Specific Flow Rate	1.67	gpm/ft^2
Number of cartridges - mass loading		
Mass removed by pretreatment system, M_{pre}	1923.58	lbs
Mass load to filters after pretreatment, M_{pass1}	1923.58	lbs
Mass to be captured by filters, M_{filter}	1538.87	lbs
Allowable Cartridge Flow rate, Q_{cart}	12.53	
Mass load per cartridge, M_{cart} (lbs)	27.00	lbs
Number of Cartridges required, N_{mass}	57	
Treatment Capacity	1.59	cfs
Determine Critical Sizing Value		
Number of Cartridges using $Q_{release\ treat}$, N_{flow}	22	
Method to Use:	MASS-LOADING	

SUMMARY

Treatment Flow Rate, cfs	1.59
Cartridge Flow Rate, gpm	12.5
Number of Cartridges	57

CONTECH ENGINEERED SOLUTIONS

Estimated Filtration Practice Phosphorus Reduction

Date Prepared: **3/28/2022**

Site Information

Project Name	**557 Highland Ave -** WQU-131	
Project City	**Needham**	
Project State	**MA**	
System Designation	**StormFilter**	
Total Drainage Area, Ad	**9.02**	ac
Post Development Impervious Area, Ai	**6.63**	ac
Pervious Area, Ap	**2.39**	ac
% Impervious	**74%**	
Runoff Coefficient, Rc	**0.71**	
Calculated Phosphorus Load*	**10.19**	lb/yr
*Per Table 1-1 Attachment 1 to Appendix F	**1.13**	lb/ac/yr (Commercial)

Results

Contech Treatment Practice	**StormFilter**	
Filtration Practice Efficiency**	**86**	%
Calculated Phosphorus Reduction	**8.77**	lb/yr

ATTACHMENT 1 TO APPENDIX F

Method to Calculate Baseline Phosphorus Load (Baseline), Phosphorus Reduction Requirements and Phosphorus load increases due to development (P_{DEVinc})

The methods and annual phosphorus load export rates presented in Attachments 1, 2 and 3 are for the purpose of measuring load reductions for various stormwater BMPs treating runoff from different site conditions (i.e. impervious or pervious) and land uses (e.g. commercial, industrial, residential). The estimates of annual phosphorus load and load reductions due to BMPs are intended for use by the permittee to measure compliance with its Phosphorus Reduction Requirement under the permit.

This attachment provides the method to calculate a baseline phosphorus load discharging in stormwater for the impaired municipalities subject to Lakes and Ponds TMDL. A complete list of municipalities subject to these TMDLs is presented in Appendix F, Table F-6. This method shall be used to calculate the following annual phosphorus loads:

1) Baseline Phosphorus Load for Permittees
2) Phosphorus Reduction Requirement

This attachment also provides the method to calculate stormwater phosphorus load increases due to development for the municipalities subject to the Charles River TMDL requirements and the Lakes & Ponds TMDL requirements:

3) Phosphorus Load Increases due to Development

The **Baseline Phosphorus Load** is a measure of the annual phosphorus load discharging in stormwater from the impervious and pervious areas of the impaired Lake Phosphorus Control Plan (LPCP) Area.

The **Baseline Phosphorus Pounds Reduction** referred to as the permittee's **Phosphorus Reduction Requirement** represents the required reduction in annual phosphorus load in stormwater to meet the WLA for the impaired watershed. The percent phosphorus reduction for each watershed (identified in Appendix F, Table F-6) is applied to the Baseline Phosphorus Load to calculate the Phosphorus Pounds Reduction.

The **Phosphorus load increases due to development (P_{DEVinc})** is the stormwater phosphorus load increases due to development over the previous reporting period and incurred to date. Increases in stormwater phosphorus load from development will increase the permittee's baseline phosphorus load and therefore, the phosphorus reduction requirement.

Examples are provided to illustrate use of the methods. Table 1-1 below provides annual composite phosphorus load export rates (PLERs) by land use category for the Baseline Load and Phosphorus Reduction Requirement calculations. The permittee shall select the land use category that most closely represents the actual use of the watershed. For watersheds with institutional type uses, such as government properties, hospitals, and schools, the permittee shall use the commercial land use category for the purpose of calculating phosphorus loads. Table 1-2 provides annual PLERs by land use category for impervious and pervious areas. The permittee shall select the land use category that most closely represents the actual use of the watershed. For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value. If the HSG is not known, assume HSG C conditions for the phosphorus load export rate. For watersheds with

institutional type uses, such as government properties, hospitals, and schools, the permittee shall use the commercial/industrial land use category for the purpose of calculating phosphorus loads. Table 1-3 provides a crosswalk table of land use codes between Tables 1-1 and 1-2 and the codes used by MassGIS.

The composite PLERs in Table 1-1 to be used for calculating Baseline Phosphorus Load are based on the specified directly connected impervious area (DCIA). If the permittee determines through mapping and site investigations that the overall DCIA for the collective area for each land use category is different than the corresponding values in Table 1-1, then the permittee is encouraged to submit this information in its annual report and request EPA to recalculate the composite PLERs for the permittees to use in refining the Baseline Phosphorus Load calculation for the LPCP.

(1) Baseline Phosphorus Load: The permittee shall calculate the **Baseline Phosphorus Load** by the following procedure:

1) Determine the total area (acre) associated with the impaired watershed;

2) Sort the total area associated with the watershed into land use categories;

3) Calculate the annual phosphorus load associated with each land use category by multiplying the total area of land use by the appropriate land use-based composite phosphorus load export rate provided in Table 1-1; and

4) Determine the Baseline Phosphorus Load by summing the land use loads.

Example 1-1 to determine Baseline Phosphorus Load:
Watershed A is 18.0 acres, with 11.0 acres of industrial area (e.g. access drives, buildings, and parking lots), 3.0 acres of medium-density residential and 4.0 acres of unmanaged wooded area.

The **Baseline Phosphorus Load** = (Baseline P Load $_{IND}$) + (Baseline P Load $_{MDR}$) + (Baseline P Load $_{FOR}$)

Where:
Baseline P Load $_{IND}$ = (TA_{IND}) x (PLER for industrial use (Table 1-1))
= 11.0 acre x 1.27 lbs/acre/year
= 14.0 lbs P/year

Baseline P Load $_{MDR}$ = (TA_{MDR}) x (PLER for medium density residential (Table 1-1))
= 3.0 acre x 0.49 lbs/acre/year
= 1.5 lbs P/year

Baseline P Load $_{FOR}$ = (TA_{FOR}) x (PLER for forest (Table 1-1))
= 4.0 acre x 0.12 lbs/acre/year
= 0.5 lbs P/year

Baseline Phosphorus Load = 14.0 lbs P/year + 1.5 lbs P/year + 0.5 lbs P/year
= **16.0 lbs P/year**

(2) Baseline Phosphorus Pounds Reduction (Phosphorus Reduction Requirement): The Baselines Phosphorus Reduction requirement is the amount of reduction in annual phosphorus load (in pounds) that the permittee is required to achieve in the Watershed. The permittee shall calculate the **Phosphorus Reduction Requirement** by multiplying the **Baseline Phosphorus Load** by the applicable percent phosphorus reduction for that watershed specified in Table F-6 (Appendix F).

Example 1-2 to determine Watershed Phosphorus Reduction Requirement:
Table F-6 identifies Watershed A's percent phosphorus reduction as 45%; therefore the Watershed Phosphorus Reduction Requirement is:

Phosphorus Reduction Requirement = (Baseline Phosphorus Load) x (0.45)
= (16.0 lbs P/year) x (0.45)
= **7.2 lbs P/year**

(3) Phosphorus load increases due to development (P_{DEVinc}): To estimate the increases in stormwater phosphorus load due to development in the Watershed (either PCP or LPCP Area), the permittee will use the following procedure:

1) Determine the total area of development by land use category and calculate the baseline load from that area using the composite PLERs in Table 1-1;

2) Distribute the total development area into impervious and pervious subareas by land use category;

3) Calculate the phosphorus load due to development (P_{DEV}) for each land use-based impervious and pervious subarea by multiplying the subarea by the appropriate phosphorus load export rate provided in Table 1-2; and

4) Determine the phosphorus load increase (P_{DEVinc}) by subtracting the baseline phosphorus load from the increased phosphorus load due to development.

Note: If structural BMPs are installed as part of new development, the P_{DEVinc} will be reduced by the amount of BMP load treated by that BMP as calculated in Attachment 3.

Example 1-3 to determine Phosphorus Load Increases: For the same 15.11 acre Watershed A as specified in Example 1-1, a permittee has tracked development in the LPCP Area in the last year that resulted in 1.5 acres of medium density residential area and 0.5 acres of forest land being converted to high density residential impervious area as detailed below. The undeveloped MDR area is pervious area, HSG C soil and the undeveloped forest area is pervious, HSG B soil.

Land Use Category	Baseline Area (acres)	(lbs P/acre/yr)*	Baseline area unchanged (acres)	P export rate (lbs P/acre/yr)**	Developed Area converted to HDR IA (acres)	P export rate (lbs P/acre/yr)**
Industrial	11.0	1.27	No change	--	No change	--
MDR	3.0	0.49	1.5	0.21	1.5	2.32

Forest	4.0	0.12	3.5	0.12	0.5	2.32

*From Table 1-1; ** From Table 1-2

The phosphorus load increase is calculated as:

Baseline Load = (Baseline P Load $_{IND}$) +
(Baseline P Load $_{MDR}$) +
(Baseline P Load $_{FOR}$)
= **16.0 lb/year** (determined in Example 1-1)

P_{DEV} = $(TA_{IND} \times PLER_{IND})+(IA_{HDR} \times PLER_{HDR})+(PA_{MDR} \times PLER_{MDR})+(PA_{FOR} \times PLER_{For})$
= (11.0 acres * 1.27) + (2.0 acres * 2.32) + (1.5 acres * 0.21) + (3.5 * 0.12)
= **19.0 lbs P/year**

$\mathbf{P_{DEVinc}}$ = P_{DEV} – Baseline Load
= 19.0 – 16.0
= **3.0 lbs/year**

Table 1-1. Annual composite phosphorus load export rates

Land Cover	Representative DCIA, %	Composite PLERs, lb/ac/yr	Composite PLERs, kg/ha/yr
Commercial	**57**	**1.13**	**1.27**
Industrial	**67**	**1.27**	**1.42**
High Density Residential	**36**	**1.04**	**1.16**
Medium Density Residential	**16**	**0.49**	**0.55**
Low Density Residential	**11**	**0.30**	**0.34**
Freeway	**44**	**0.73**	**0.82**
Open Space	**8**	**0.26**	**0.29**
Agriculture	**0.4**	**0.45**	**0.50**
Forest	**0.1**	**0.12**	**0.13**

Table 1-2: Proposed average annual distinct P Load export rates for use in estimating P Load reduction credits the MA MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	P Load Export Rate, lbs/acre/year	P Load Export Rate, kg/ha/yr
Commercial (Com) and Industrial (Ind)	Directly connected impervious	1.78	2.0
	Pervious	See* DevPERV	See* DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.32	2.6
	Pervious	See* DevPERV	See* DevPERV
Medium -Density Residential (MDR)	Directly connected impervious	1.96	2.2
	Pervious	See* DevPERV	See* DevPERV
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	1.34	1.5
	Pervious	See* DevPERV	See* DevPERV
Forest (For)	Directly connected impervious	1.52	1.7
	Pervious	0.13	0.13
Open Land (Open)	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (Ag)	Directly connected impervious	1.52	1.7
	Pervious	0.45	0.5
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group A	Pervious	0.03	0.03
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group B	Pervious	0.12	0.13
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Pervious	0.21	0.24
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C/D	Pervious	0.29	0.33
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D	Pervious	0.37	0.41

Table 1-3: Crosswalk of MassGIS land-use categories to land-use groups for P Load Calculations

Mass GIS Land Use LU_CODE	Description	Land Use group for calculating P Load - 2013/14 MA MS4
1	Crop Land	Agriculture
2	Pasture (active)	Agriculture
3	Forest	Forest
4	Wetland	Forest
5	Mining	Industrial
6	Open Land includes inactive pasture	open land
7	Participation Recreation	open land
8	spectator recreation	open land
9	Water Based Recreation	open land
10	Multi-Family Residential	High Density Residential
11	High Density Residential	High Density Residential
12	Medium Density Residential	Medium Density Residential
13	Low Density Residential	Low Density Residential
14	Saltwater Wetland	Water
15	Commercial	Commercial
16	Industrial	Industrial
17	Urban Open	open land
18	Transportation	Highway
19	Waste Disposal	Industrial
20	Water	Water
23	cranberry bog	Agriculture
24	Powerline	open land
25	Saltwater Sandy Beach	open land
26	Golf Course	Agriculture
29	Marina	Commercial
31	Urban Public	Commercial
34	Cemetery	open land
35	Orchard	Forest
36	Nursery	Agriculture
37	Forested Wetland	Forest
38	Very Low Density residential	Low Density Residential
39	Junkyards	Industrial
40	Brush land/Successional	Forest

Appendix E: Standard 8 Supporting Information

- List of recommended Construction Period BMPs
- Recommended construction period maintenance checklist

Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Straw Bale Barriers

Straw bale barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Bales will be set at least four inches into the existing ground to minimize undercutting by runoff.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, straw bale barriers will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and straw bale barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with straw bale barriers (where appropriate) or silt sacks throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a

sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.

- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.

- Damaged or deteriorated items will be repaired immediately after identification.

- The underside of straw bales should be kept in close contact with the earth and reset as necessary.

- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.

- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be re-graded and stabilized as necessary.

Merrimack College – Campus Parking Improvements, North Andover, Massachusetts
Construction Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by:
Straw Bales/Silt Fencing	In accordance with NPDES CGP			• Accumulated sediment • Separation of straw bales with the earth and each other • Damaged or broken straw bales/ silt fence	☐yes ☐no		
Gravel Construction Entrance	In accordance with NPDES CGP			• Accumulated sediment • Tracking of sediment outside limit of work	☐yes ☐no		
Catch Basin Protection	In accordance with NPDES CGP			• Accumulated sediment within silt sacks • Rips or torn silt sacks	☐yes ☐no		
Diversion Channels	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments	☐yes ☐no		
Temporary Sedimentation Basins	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments • Accumulation of sediment	☐yes ☐no		
Vegetated Slope Stabilization	In accordance with NPDES CGP			• Cracking, • Erosion	☐yes ☐no		

Stormwater Control Manager _____

Appendix D: Transportation

- Traffic Impact and Access Study (ENF Chapter 2)
- Existing Site Trip Generation Calculations
- Collision Diagrams
- Weave Segment Capacity Analysis Worksheet
- Queue Diagrams
- Existing Town of Needham Mode Share Data
- GPI 2020 Gould Street Improvement Concept Plan
- Intersection Capacity Analysis Worksheets
- Traffic Signal Warrant Analysis Worksheets
- Conceptual Roadway Improvement Plans

2

Transportation

VHB has evaluated the potential traffic impacts associated with the proposed development at 557 Highland Avenue in Needham, Massachusetts (the "Site"). The proposed development Project includes up to 531,000 SF of rentable space, with approximately 260,500 SF of office space, approximately 260,500 SF of research and development space, and approximately 10,000 SF of retail space. The Project will also accommodate up to 1,770 off-street parking spaces (or a minimum of 1 space/300 SF as required by Town of Needham zoning regulations). The parcel of land was formerly occupied for several decades by a car dealership and car wash.

The Project is consistent with local redevelopment goals for the area as previously studied by the Town of Needham's Department of Planning and Community Development. To support the rezoning effort, a Traffic Study commissioned by the Town of Needham was completed by GPI in November 2020.[1] That study considered rezoning the Muzi Motors and WCVB/Channel 5 properties from Industrial 1 to Highway Commercial 1 while providing a maximum floor area ratio of 1.35. This rezoning was formally codified in the creation of a new use district called Highway Commercial 1 and a corresponding zoning map amendment, which were adopted by Needham Town Meeting on May 3, 2021.

This Transportation Impact and Access Study (TIAS) provides an evaluation and summary of the Project's transportation elements and quantified impacts. It includes an analysis of estimated trip generation characteristics and describes anticipated parking conditions, loading and service activities, drop-off amenities, and other important transportation mitigation and improvement actions that will be provided in connection with the Project. The purposes of these analyses are to:

- Describe the transportation-related characteristics of the Project;
- Quantify the transportation impacts of the Project;
- Develop and clearly commit to a set of mitigation strategies and traffic improvement measures that will help to lessen the transportation effects of the Project, and
- Demonstrate that these transportation mitigation efforts will serve as exceptional public benefits as they relate to transportation issues.

The sections below provide an overview of the Project and a summary of the TIAS findings. Subsequent sections provide a more detailed discussion of estimated traffic generation of

1 Traffic Impact Study, Muzi Motors Redevelopment, Greenman-Pederson, Inc. November 20, 2020

the Project. The final section presents a detailed summary of transportation mitigation and improvement actions that the Proponent is committed to implementing in connection with the Project. Note that this mitigation plan is reflective of those actions that have been delineated by the Town of Needham in connection with its own recent evaluation supporting rezoning of this site and other adjacent sites.

2.1 Summary of Findings and Transportation Mitigation

The Project will result in additional trips generated to and from the Project Site. These new trips can be expected to produce some localized impacts on the surrounding transportation infrastructure. The Proponent has developed a comprehensive series of improvement actions to address existing operating conditions and constraints and to help mitigate future new impacts. Generally, the Project will adopt and incorporate nearly all transportation improvements that were delineated in the Traffic Study commissioned by the Town of Needham in support of their recent rezoning effort for the area. The improvements and the proposed mitigation program are intended to offset the Project's impacts and to provide improved transportation infrastructure to the surrounding area for all users supporting significantly improved area mobility. The Proponent is also committed to implementing an extensive travel demand management (TDM) program in connection with the Project's development and operation. A summary of key findings and mitigation and improvement actions are described below:

- The net-new traffic generated by the Project is estimated to total 583 trips during the morning peak hour (515 entering and 68 exiting), and 565 trips during the evening peak hour (92 entering and 473 exiting).
- The Project will generate 5,005 net new weekday daily trips – or approximately 44% fewer trips than that estimated by GPI's traffic study supporting the recent Town of Needham rezoning effort.
- The Proponent is committed to funding the design and construction of key mitigation and improvement measures, including:
  - Installation of on-road bicycle lanes in each direction of Gould Street between Highland Avenue and just north of TV Place
  - Addition of shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately ½ mile between just north of TV Place and Central Avenue.
  - Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and the main Project Site driveway opposite the Wingate Driveway.
  - Geometric improvements at the intersection of Highland Avenue at Gould Street / Hunting Road
  - Design and installation of a fully-actuated traffic signal at the intersection of Gould Street and Central Avenue, including associated geometry improvements
  - Geometric improvements at the intersection of Gould Street at TV Place including turn lanes into and out of TV Place

- The Proponent will work with the Town of Needham to fund a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site and the Channel 5 property into a shared use path that would connect with Needham Heights to the south and the Charles River to the north.
- The Project includes significant pedestrian and open space amenities, including new sidewalks and accessible crossings adjacent to the site and at key off-site locations (as noted above). An approximately 0.5-mile walking path around the Project Site with landscaping, lighting, and other public amenities will be included and will be open to all members of the general public.
- Connections to the future bicycle accommodations on Highland Avenue that will extend toward Newton to the east and toward Needham Heights to the west.
- Up to 89 bicycle parking spaces will be provided consisting of covered bicycle storage/long-term bicycle parking on-site and outdoor public bike racks/short-term bicycle parking.
- The Project Proponent will explore and look to implement shuttle connectivity through its future proactive involvement in the Route 128 Business Council to improve public transportation access and accessibility to the Project Site.
- On-site parking will be more than adequate to accommodate the expected employee and visitor demands of the Project. The proposed parking ratio conforms to local zoning requirements for the site (1 parking space/300 SF), which produces an estimated parking need of up to 1,770 spaces (an increase of 1,238 net-new spaces over the 532 parking spaces previously provided on Site). This parking demand will be accommodated primarily in a structured parking garage to be located on the northeast portion of the site adjacent to TV Place. Additional below-grade parking will be provided under each building, and in a surface parking lot intended to be used by visitors.
- Parking facilities will be equipped with Electric Vehicle charging stations, with consideration as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions.
- The Project will include dedicated off-street loading docks to ensure that loading and service operations are handled internal to the buildings and will not impact traffic operations or pedestrian flow on adjacent streets.
- The Proponent will implement a wide array of TDM measures to incentivize reduced single occupant driving and increased use of alternative forms of transportation to access the workplace. Key TDM actions to be implemented in connection with the Project include:
  - Providing an Employee Transportation Advisor who will coordinate with the 128 Business Council;
  - Exploring the feasibility of providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line)
  - 50 percent transit pass subsidy to be offered by future tenants to their employees;
  - Carpool assistance and incentives;
  - Emergency ride home;
  - Bicycling/walking incentives and amenities;
  - Telecommuting and compressed workweeks, when feasible;

- Display in the Main Lobby transportation-related information for employees and visitors; and
- Promotional efforts.

› The Proponent is also committed to a robust transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network. The monitoring program will include the annual collection of traffic counts and parking garage activity by employees and visitors to the Project Site. The transportation monitoring program will begin six months after full occupancy of the proposed development and continue for a period of five years. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham.

2.2 Study Methodology

This Transportation Study has been performed in conformance with the Massachusetts Executive Office of Energy and Environmental Affairs (EEA)/Executive Office of Transportation (EOT) guidelines. Prior to completing this study, VHB completed a Traffic Scoping Letter (TSL) process with MassDOT to get buy-in on the many facets of the traffic study. That TSL was submitted to MassDOT on November 2, 2021. MassDOT issued an approved scope to the Proponent on February 2, 2022. This study is reflective of the approved scope. TSL materials and related MassDOT correspondence are included in Appendix C for reference. VHB also held preliminary consultation with Town of Needham transportation staff on traffic study requirements and that input is reflected within this Study.

VHB prepared the traffic assessment in three stages. The first stage involved an assessment of existing traffic conditions within the Project study area, including: an inventory of existing roadway geometry; observations of traffic flow, including daily and peak period traffic counts; a summary of existing public transit facilities in the area; and a review of vehicular crash data.

The second stage of the study established the framework for evaluating the transportation impacts of the Project. Specific travel demand forecasts for the Project were assessed along with future traffic demands on the study area roadways due to projected background traffic growth and other proposed area developments that may occur independent of the Project. The year 2029, a seven-year time horizon, was selected as the design year for analysis for the preparation of this traffic impact and access assessment in accordance with the standard industry practices in Massachusetts.

The third and final stage of the study discusses possible measures to improve existing and future traffic operations in the area and offsetting the traffic-related impacts associated with the Project.

2.2.1 Analysis Conditions

This study contains transportation analyses conducted under the following three conditions during the weekday morning and weekday evening peak hours:

› 2022 Existing Conditions
› 2029 No Build Conditions

› 2029 Build Conditions

The 2022 Existing Conditions analyses provide a snapshot of conditions today in the study area. The 2022 Existing Conditions have been conducted based on pre-COVID-19 conditions, and do not take into account the change in travel patterns caused by the COVID-19 pandemic. The 2029 No Build Conditions and 2029 Build Conditions analyses provide a picture of what transportation conditions will look like in the study area in the future with and without the Project in place. These three analyses allow for a comparison of the Project's impact on the transportation network and help to determine what transportation mitigation measures are necessary to offset the impacts of the Project.

2.3 Project Description

A detailed review of the proposed building program and Site access plan was conducted as part of this evaluation and is described in the following sections. Included in the review of the Project Site access plan are descriptions of the proposed pedestrian accommodations, bicycle accommodations, loading and delivery activities, and parking supply.

2.3.1 Building Program

The development proposal for the Project Site includes up to 531,000 SF of rentable space, consisting of the following uses:

› Approximately 260,500 SF of office space;

› Approximately 260,500 SF of research and development space; and

› Approximately 10,000 SF of retail.

The building is conceived as one structure articulated as three distinct parts. The first part, the "South Building", is a three-story building located along Highland Avenue and extending toward Gould Street, creating a scale that is recognizable and related to the adjacent context. The second part, "the North Building", is a five-story building that is set back from Highland Avenue and Gould Street by 200 feet and extends toward the Southbound Exit 35C from I-95/Route 128. The third part is a two-story atrium connecting the South Building and the North Building that provides the main entry for the buildings. The atrium will allow opportunities to bring daylight into the deeper sections of the floorplate and allow for internal connections between the South Building and the North Building. Visually, the atrium will create a break within the massing ensuring visual interest and clarity of each of the parts. A five-story parking garage will be located north of the North Building, closest to TV Place.

The Project will create new office and lab space at a highly visible location adjacent to Exit 35C on I-95/Route 128. Under existing conditions, the Project Site consists of a former car dealership and car wash. Both the car dealership and car wash ceased operation in late 2021.

The previous uses of a car dealership and a car wash were frequented throughout the day, as opposed to most of the traffic entering and exiting during the peak hours, as is typical of office and lab uses. Of note, car washes are generally the busiest during the weekends when people are most likely to get their vehicles washed. The former car wash on-Site typically handled up to 18,000 car washes per month, based on review of sales data and conversation

with the former operator. This level of activity translates to about 600 washes/day during peak months (which tend to be during the winter).

The Project will have most traffic entering and exiting during the weekday morning and evening peak hours, meaning that the impacts on the roadway network will be less on the weekends. The Project will match existing office and lab uses located along the I-95/Route 128 corridor, and with the proposed mitigation described in detail in this study, the roadway network will be able to accommodate the Project-generated trips during the busiest weekday peak hours.

2.3.2 Site Access

2.3.2.1 Existing Site Access

The Project Site is located along Highland Avenue and Gould Street in Needham, Massachusetts. The Project Site is bounded by Highland Avenue to the south, TV Place to the north, Gould Street to the west, and the I-95/Route 128 Exit 35C southbound off-ramp to the east. Access to the Project Site is currently provided by two driveways off Gould Street and one driveway off Highland Avenue. The northern driveway off Gould Street, referred to as TV Place, provided access to the car wash and an egress from the car dealership. TV Place also provides access to an office building and the Channel 5 studios, which are not included in the Project Site and will remain in place with access from TV Place. The southern driveway off Gould Street provides the main access to the car dealership. The driveway off Highland Avenue is for limited use by the dealership and is gated.

A Site location map is provided in Figure 2.1.

2.3.2.2 Project Site Access

The Project will include office, research and development, and retail space within newly constructed buildings and a stand-alone parking garage. Existing driveways off Gould Street will remain in place and a full connection will be provided between TV Place and the Project Site. There will be no curb cuts along Highland Avenue with the existing, gated driveway being eliminated.

An internal roadway within the Project Site will connect between the Gould Street driveway and TV Place. This internal roadway will provide connections to the above-ground parking garage, the parking garages located below each building, a small surface parking lot, and all loading and service areas.

Figure 2.2 illustrates the site plan and external access points for the Project and includes the garage and loading access points.

2.3.3 Pedestrian Accommodations

As part of the Project, new sidewalks will be provided along the proposed internal street. The internal sidewalks will connect to the sidewalk on the west side of Gould Street at the proposed signalized intersection of Gould Street at the Project Site driveway/Wingate driveway. The signalized intersection will include pedestrian phasing and will have ADA-

compliant crosswalks across all four approaches, providing a protected pedestrian crossing of Gould Street that does not currently exist. In addition, a new sidewalk will be provided along the Project Site frontage on the east side of Gould Street where none exists today.

A key aspect of the Project will be the new perimeter path and open spaces. An approximately 0.5-mile walking path will be constructed to circulate around the Project Site with landscaping, lighting, and other public amenities. The walking path will be open to the public and will be used by both employees and visitors to the Project Site and by nearby neighbors. Connections to the walking path will be provided to Highland Avenue and Gould Street.

2.3.4 Bicycle Accommodations

The Project Site will be designed to encourage workers and visitors to travel via bicycle. The internal street network will consist of a low-speed street that will allow for shared bicycle and vehicular traffic. Bicycle lanes will be provided on both Project Site driveways to provide dedicated access for bicyclists. Bicycle racks will be placed in visible, convenient locations on Site for visitors and customers and secure, indoor bicycle spaces will be provided for employees.

The Project Site is adjacent to Highland Avenue, which is currently the subject of a MassDOT construction project that will provide continuous dedicated bicycle facilities for approximately two miles along Highland Avenue and Needham Street between Webster Street in Needham and Route 9 in Newton. Most of the corridor will be constructed with separated bicycle lanes. Located directly on Highland Avenue, the Project Site will have strong bicycle connections with Needham Heights to the southwest and Newton to the northeast.

As mitigation for the Project, the Proponent is proposing to install bicycle lanes in both directions along Gould Street between Highland Avenue and the former MBTA railroad ROW just north of TV Place. Between the former MBTA railroad ROW and Central Avenue, a distance of approximately ½ mile, the Proponent will fund the installation of shared lane pavement markings and signage in each direction. These improvements will provide a new north-south bicycle corridor within this area of Needham and will improve bicycle connectivity to the Project Site with connections to bicycle lanes on TV Place and the Project Site driveway.

In addition, the Proponent will work with the Town of Needham to fund a study of the feasibility of converting the former MBTA railroad ROW north of the Project Site and the Channel 5 property into a shared use path that would connect with Needham Heights in the south and the Charles River in the north.

2.3.4.1 Bicycle Parking

The Project's potential bicycle parking needs will be accommodated through the provision of secured bicycle parking within the Project building and/or building garages and by outdoor bicycle racks throughout the Site. Approximately 89 bicycle spaces will be provided in outdoor bicycle racks located throughout the Site and in indoor/secure locations.

In addition to designated bicycle parking spaces, a bicycle maintenance station will be available on-site for tenants' employees.

2.3.5 Loading and Deliveries

A service and loading dock location will be provided for the Project Site in the North Building and South Building. The service and loading dock will be accessed via a dedicated driveway off of the internal circulating roadway.

The exact number and timing of deliveries will vary depending on the nature of the various retail establishments, in addition to standard office delivery activity. Retail delivery activity typically occurs during morning hours so as not to interfere with the operation of the business. Due to the smaller sizes of the retail uses, most deliveries likely will be made by smaller, single-unit trucks. These trucks can easily be accommodated and should typically only be on Site for a short time.

2.3.6 Vehicle Parking

The Project will include up to 1,770 off-street parking spaces (or a minimum of 1 space/300 SF as required by zoning). The site was formerly occupied by a car dealership and car wash for many years that contained approximately 532 parking spaces[2]. Taking into account the previous parking on Site that will be removed, the Project will include construction of up to 1,238 net new parking spaces. The existing Site plan showing the number of parking spaces provided for the car dealership and the car wash is included in Appendix C.

2.3.6.1 Vehicle Parking Demand

Zoning requirements for the Town of Needham require a minimum of one parking space per 300 square feet, which results in an expected employee density for the Project Site of 3.33 employees per 1,000 SF (assuming each parking space corresponds to one employee). However, R&D uses typical have a lower employee per square foot density than office uses due to the square footage needed for lab space. Based on a review of employee density for existing R&D spaces in Cambridge, the average employee density for R&D space is approximately 2.46 employees per 1,000 SF[3].

In addition, the one parking space per 300 SF ratio assumes that each employee will commute alone via private vehicle. In reality, some employees will commute via carpool, walking, biking, or public transit.The Proponent will encourage the use of alternative commuting modes beyond single occupancy vehicles with the implementation of the TDM program outlined in this report. Therefore, it is likely that the Project Site will generate fewer occupied parking spaces than required by zoning.

Table 2-1 provides a summary of the anticipated parking demand for the Project Site.

2 The 532 previous parking spaces on Site include spaces that were used to support new and used car inventory. It is estimated that up to 100 parking spaces were used primarily by employees and customers.

3 Calculations by VHB based on 2018 PTDM Monitoring Reports provided by the City of Cambridge for four existing R&D facilities located at 7 Cambridge Center, 610 Main Street, Tech Square, and Binney Street.

Table 2-1 Parking Generation Calculations

Use	SF	Employee/Patron Density [a]	Reduction for non-SOV [b]	Parking Demand
Office	260,500	3.33/ksf	0.92	799 spaces
R&D	260,500	2.46/ksf	0.92	590 spaces
Retail	10,000	3.33/ksf	0.92	31 spaces
Total				**1,420 spaces**

a Based on Town of Needham zoning requirements for office and retail and data from existing R&D uses in Cambridge for R&D.

b Estimated 8-percent reduction in required parking spaces to account for incentivized modes of transportation beyond single occupancy vehicles (SOV).

As shown in Table 2-1, the actual vehicle parking demand for the Project Site may be around 1,420 parking spaces. With a requirement of up to 1,770 parking spaces proposed on-Site, there will be adequate parking provided for the Project Site.

The parking calculations above do not consider changes in travel patterns caused by the COVID-19 pandemic. With the rise in popularity of employees working from home either full time or on certain days of the week, it is likely that not all employees for the office and R&D uses will be on-Site all at the same time. Therefore, the future parking demand may be lower than what is reported in Table 2-1.

2.4 Existing Conditions

Evaluation of the transportation impacts associated with the Project requires an understanding of the existing transportation conditions in the study area including: an inventory of the traffic control, roadway, driveway, and intersection geometry in the study area; the collection of peak hour traffic volumes; a review of existing bicycle and pedestrian accommodations in the study area; a summary of public transit options in the area; and a review of recent crash history. Each of these elements is described in detail below.

2.4.1 Study Area

Based on VHB's knowledge of the area transportation network and the operational characteristics of the Project, as well as input from the Town of Needham and MassDOT, a study area comprising of the following intersections in Needham and their approach roadways were selected for review (see Figure 2.3):

1. Central Avenue at Cedar Street
2. Central Avenue at Webster Street
3. Central Avenue at Gould Street
4. Central Avenue at Hampton Avenue
5. Central Avenue at River Park Street
6. Gould Street at Ellis Street
7. Gould Street at Kearney Road
8. Gould Street at Station Road

9. Gould Street at Noanett Road
10. Gould Street at TV Place
11. Gould Street at Muzi Ford/Wingate Residences driveways
12. Highland Avenue at West Street
13. Highland Avenue at Hunnewell Street
14. Highland Avenue at Webster Street
15. Highland Avenue at Gould Street / Hunting Road
16. Highland Avenue at I-95 SB Ramps
17. Highland Avenue at I-95 NB Ramps
18. Highland Avenue at 1st Avenue
19. Highland Avenue at 2nd Avenue
20. Kendrick Street at Hunting Road

The Project Site is located in the Needham Heights neighborhood less than ¼ mile from the Newton town line. The Project Site is directly served by Highland Avenue and Gould Street. Highland Avenue connects the Project Site to the Needham Heights neighborhood to the southwest and to I-95/Route 128 and Newton in the northeast. The nearest transit stop to the Project Site is Needham Heights on the Needham Branch of the MBTA commuter rail, approximately 0.8 miles southwest of the Project Site.

2.4.2 Roadway Network

Descriptions of the study area roadways and intersections are provided below, including descriptions of the existing lane configurations, traffic control at the study intersections, and the roadway jurisdiction in this area.

MassDOT is currently reconstructing portions of Highland Avenue.[4] The reconstruction project will enhance bicycle and pedestrian accommodations along the corridor and improve traffic flow. In addition, the MassDOT project will change the lane geometry at several intersections. A functional design report for the reconstruction project was submitted in August 2017 and construction on the project is underway. The roadway and intersection descriptions below are based on existing conditions as of early 2022 and do not take into consideration this ongoing corridor reconstruction project. Full details of the reconstruction project are included later in this TIA.

2.4.2.1 Study Area Roadways

Highland Avenue

Highland Avenue begins at Great Plain Avenue in the south and turns into Needham Street at the Newton City Line to the north. Within the study area, Highland Avenue is under MassDOT jurisdiction east of Webster Street, *i.e.,* adjacent to the Project Site, and under local

4 Functional Design Report, Reconstruction of Highland Avenue, Needham Street, and Charles River Bridge; MassDOT Project No. 606635; Submitted by Stantec Consulting Services, Inc.; August 2017.

jurisdiction west of Webster Street. The roadway within the study area is classified as a principal urban arterial west of I-95/Route 128 and as a minor urban arterial east of I-95/Route 128. Highland Avenue runs in a generally northeast/southwest direction within the study area. Highland Avenue generally consists of two travel lanes in each direction between Gould Street and 2nd Avenue and one travel lane in each direction west of Gould Street and east of 2nd Avenue. There is no posted speed limit within the study area along Highland Avenue. Sidewalks are provided on both sides of the roadway and crosswalks are provided at major intersections. Land use around Highland Avenue is mainly commercial.

Gould Street

Gould Street runs from Central Avenue in the north and turns into Hunting Road once it crosses Highland Avenue to the south. It is classified as an urban minor arterial roadway under local jurisdiction. Gould Street runs in a generally north/south direction and consists of one travel lane in each direction. There is no posted speed limit along Gould Street. Sidewalks are provided along one side of the road, along the western side in proximity to the Project Site. Land use along Gould Street is primarily commercial and residential.

2.4.2.2 Study Area Intersections

1: Central Avenue at Cedar Street

Central Avenue and Cedar Street form a three-way unsignalized intersection. Central Avenue runs east/west and Cedar Street intersects from a southbound approach. Each approach to the intersection consists of a single general-purpose lane.

The southbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on all sides of the intersection. Crosswalks are provided across the southbound approach of Cedar Street and across the westbound approach of Central Avenue. Land use around the intersection is residential.

2: Central Avenue at Webster Street

Central Avenue and Webster Street form a three-way unsignalized intersection. Central Avenue runs east/west and Webster Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane. An island separates the approach and exit lanes along Webster Street.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on the northern, western, and eastern sides of the intersection. Crosswalks are provided across the southbound approach of Webster Street. Land use around the intersection is residential.

3: Central Avenue at Gould Street

Central Avenue and Gould Street form a three-way unsignalized intersection. Central Avenue runs east/west and Gould Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on all sides of the intersection. Crosswalks are provided across the northbound approach of Gould Street and across the westbound approach of Central Avenue. Land use around the intersection is residential.

4: Central Avenue at Hampton Avenue

Central Avenue and Hampton Street form a three-way unsignalized intersection. Central Avenue runs east/west and Hampton Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on all sides of the intersection. Crosswalks are provided across the northbound approach of Hampton Street and across the westbound approach of Central Avenue. Land use around the intersection is residential.

5: Central Avenue at River Park Street

Central Avenue and River Park Street form a three-way unsignalized intersection. Central Avenue runs east/west and River Park Street intersects from a northbound approach. Each approach to the intersection consists of a single general-purpose lane.

The northbound approach operates under STOP control while the eastbound and westbound approaches are free flowing. Sidewalks are provided on the eastern and western sides of the intersection and no crosswalks are provided. Land use around the intersection is residential.

6: Gould Street at Ellis Street

Gould Street and Ellis Street form a three-way unsignalized intersection. Gould Street runs north/south, and Ellis Street intersects from a westbound approach. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is mostly commercial with some residential buildings on the western side.

7: Gould Street at Kearney Road

Gould Street and Kearney Road form a three-way unsignalized intersection. Gould Street runs north/south and Kearney Road intersects from a westbound approach. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is commercial.

8: Gould Street at Station Road

Gould Street and Station Road form a three-way unsignalized intersection. Gould Street runs north/south and Station Road intersects from a westbound approach. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is commercial.

9: Gould Street at Noanett Road

Gould Street and Noanett Road form a four-way unsignalized intersection with a commercial driveway to the east. Gould Street runs north/south and Noanett Road intersects from an eastbound approach. Each approach to the intersection consists of a single general-purpose lane.

The eastbound and westbound approaches operate under STOP control while the northbound and southbound approaches are free-flowing. Crosswalks are not provided at this intersection. The land uses around the intersection are commercial and residential.

10: Gould Street at TV Place

Gould Street and TV Place form a three-way unsignalized intersection. Gould Street runs north/south and TV Place intersects from a westbound approach. TV Place is a private way and connects to the Project Site as well as the WCVB Channel 5 studios and an office building. Each approach to the intersection consists of a single general-purpose lane.

The westbound approach operates under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of the intersection. Crosswalks are not provided at this intersection. The land use around the intersection is commercial.

11: Gould Street at Muzi Ford/Wingate Res.

Gould Street intersects with the entrances of two establishments, the former Muzi Ford dealership and Wingate Residence, and forms a four-way unsignalized intersection. Gould Street runs north/south and the Muzi Ford entrance intersects from a westbound approach while the entrance of Wingate Residence intersects from an eastbound approach. Each approach to the intersection consists of a single general-purpose lane.

The eastbound and westbound approaches operate under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on the western side of this intersection. The land use around the intersection is commercial.

12: Highland Avenue at West Street

Highland Avenue and West Street form a four-way signalized intersection. Highland Avenue runs north/south and West Street runs east/west. The southbound and northbound approach of Highland Avenue to the intersection consists of a single general-purpose lane

with adjacent parking provided. The eastbound and westbound approach of West Street to the intersection consists of a left-turn lane and a shared through/right-turn lane.

All approaches to the intersection are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided across all approaches to the intersection. The land use around the intersection is commercial.

13: Highland Avenue at Hunnewell Street

Highland Avenue and Hunnewell Street form a four-way unsignalized intersection. Highland Avenue runs north/south and Hunnewell Street runs southeast/northwest. Each approach to the intersection consists of a single general-purpose lane.

The northwest bound and southeast bound approaches operate under STOP control while the northbound and southbound approaches are free flowing. Sidewalks are provided on all sides of the intersection and crosswalks are provided at the eastbound and westbound approach and through the middle of the intersection across Highland Avenue. The land use around the intersection is commercial and residential.

14: Highland Avenue at Webster Street

Highland Avenue and Webster Street form a four-way signalized intersection. Highland Avenue runs east/west and Webster Street runs north/south. The eastbound and westbound approach of Highland Avenue to the intersection consists of a left-turn lane and shared through/right-turn lane. The northbound approach of Webster Street consists of a shared through/left-turn lane and right-turn lane. The southbound approach of Webster Street consists of a shared through/left-turn lane and a shared through/right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on all sides of this intersection. The land uses around the intersection are commercial and residential.

15: Highland Avenue at Gould Street/Hunting Road

Highland Avenue and Gould Street/Hunting Road form a four-way signalized intersection. Highland Avenue runs east/west and Gould Street/Hunting Road runs north/south. The eastbound and westbound approach of Highland Avenue to the intersection consists of a left-turn lane and two through lanes. The northbound approach of Hunting Road consists of a shared through/left-turn lane and right-turn lane. The southbound approach of Gould Street consists of a left-turn lane and a shared left/through/right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on all sides of this intersection. The land uses around the intersection are commercial and residential.

16: Highland Avenue at I-95 SB Ramps

Highland Avenue and I-95 SB on and off ramps have an unsignalized interchange with merging and diverging lanes along Highland Avenue. Highland Avenue runs east/west and the ramps run parallel. The eastbound and westbound travel lanes of Highland Avenue consist of two travel lanes and one merge/diverge lane. All four I-95 SB ramps consist of one lane.

Sidewalks are provided along Highland Avenue and crosswalks are provided across each of the I-95 SB ramps.

17: Highland Avenue at I-95 NB Ramps

Highland Avenue and I-95 NB have an unsignalized and signalized interchange with merging and diverging lanes along Highland Avenue. Highland Avenue runs east/west and the ramps run parallel. The eastbound and westbound travel lanes of Highland Avenue consist of two travel lanes and one merge/diverge lane. All four I-95 NB ramps consist of one lane except for the off-ramp to Highland Avenue eastbound which consists of 2 lanes.

All approaches are unsignalized, except for the off-ramp to Highland Avenue eastbound which is signalized with Highland Avenue. Sidewalks are provided along Highland Avenue and crosswalks are provided across each of the I-95 NB ramps.

18: Highland Avenue at 1st Avenue

Highland Avenue and 1st Avenue form a four-way signalized intersection. Highland Avenue runs east/west and 1st Avenue approaches the intersection from a northbound approach with a commercial driveway approaching from the north. No left turns are permitted from Highland Avenue. The eastbound approach of Highland Avenue consists of two through lanes, a right-turn lane, and a bike lane. The westbound approach of Highland Avenue to the intersection consists of two through lanes and a bike lane. The northbound approach of 1st Avenue consists of a left-turn and a shared left/through/right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on the northern, southern, and eastern sides of this intersection. The land use around the intersection is commercial.

19: Highland Avenue at 2nd Avenue

Highland Avenue and 2nd Avenue form a four-way signalized intersection with a commercial driveway to the north. Highland Avenue runs east/west and 2nd Avenue approaches the intersection from a northbound approach. The eastbound and westbound approaches of Highland Avenue to the intersection consist of a shared through/left-turn lane and a shared through/right-turn lane. The northbound approach of 2nd Avenue consists of a left-turn lane, shared through/left-turn lane and a right turn lane. The southbound approach consists of a shared through/left-turn lane and a right turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on all approaches to the intersection. The land use around the intersection is commercial.

20: Kendrick Street at Hunting Road

Kendrick Street and Hunting Road form a four-way signalized intersection. Kendrick Street runs east/west and Hunting Road runs north/south. The eastbound approach of Kendrick Street to the intersection consists of a shared through/left-turn lane and a shared through/right-turn lane. The westbound approach of Kendrick Street consists of a left-turn lane and a shared through/right-turn lane. The southbound approaches of Hunting Road

consist of a shared right-turn/through lane and a left-turn lane. The northbound approach of Hunting Road consists of a left-turn/through lane and a channelized right-turn lane.

All approaches are signalized. Sidewalks are provided on all sides of the intersection and a crosswalk is provided on the northern, southern, and western sides of this intersection. The land use around the intersection is residential.

2.4.3 Existing Traffic Volumes

Traffic volumes were collected during the weekday morning and weekday evening peak periods at each of the study area intersections. Due to the current coronavirus (COVID-19) pandemic, traffic volumes may not represent normal travel conditions along Massachusetts roadways. In accordance with MassDOT guidelines, traffic counts collected after March 13, 2020 may not be representative of typical traffic volumes and 2019 data should be considered as existing traffic volumes.[5] Based on MassDOT guidance, VHB identified traffic counts conducted prior to the start of the COVID-19 pandemic at most of the study area intersections. At locations where pre-pandemic counts were not available, new traffic counts were conducted in July 2021 and adjusted to represent "pre-pandemic" conditions based on traffic volumes at nearby intersections. The following section documents the initial data collection, the review of adjustment data, and a summary of the 2022 Existing Condition traffic volumes.

2.4.3.1 Data Collection

Weekday morning and weekday evening turning movement counts for the study area intersections were gathered from several sources, including recently published traffic studies in the area. Based on MassDOT guidance, an emphasis was placed on identifying traffic counts that were conducted prior to the start of the COVID-19 pandemic, between 2014 and 2020. Specifically, data from the following traffic studies were used to develop the existing traffic volumes:

- Traffic Impact Study, Muzi Motors Redevelopment, GPI, November 2020
- Draft Environmental Impact Report, The Northland Newton Development, VHB, August 2020
- Traffic Impact Study, 100-110 West Street, McMahon Associates, April 2020
- Route 128 Add-a-Lane Post Construction Study, McMahon Associates, November 2019
- Functional Design Report, Reconstruction of Highland Avenue, Needham Street, and Charles River Bridge, Stantec, August 2017

For locations where pre-pandemic counts were not available, new traffic counts were conducted by VHB in July 2021. All traffic count data is included in Appendix C.

2.4.3.2 Traffic Volume Adjustment

Based on MassDOT's guidance on traffic count data, the existing volumes were adjusted, if necessary, for both seasonality and annual growth rates.

The traffic data collected for the study area was obtained during the months of January, February, April, June, July, October, and December. To quantify the seasonal variation of traffic volumes in the area, the MassDOT statewide traffic data 2019 weekday seasonal

5 MassDOT Guidance on Traffic Count Data. Apr 2020.

factors were reviewed based on the roadway classification of the approach to each intersection. For locations where the counts were conducted in months that have traffic volumes slightly lower than average month conditions, each movement was adjusted accordingly to represent average conditions. To provide a conservative analysis, no downward adjustments were made for locations where the counts were conducted in months that have traffic volumes higher than average month conditions. The seasonal adjustment factors are included in Appendix C.

The traffic counts were conducted between 2015 and 2021. As stated previously, MassDOT considers volumes from 2019 to represent "Existing" Conditions. For the counts conducted between 2015 and 2018, the MassDOT Yearly Growth Rates were reviewed based on the roadway classification of the approach to each roadway. Based on those growth rates, the counts conducted between 2015 and 2018 were adjusted accordingly to represent 2019 conditions. The MassDOT yearly growth rate factors are included in Appendix C.

To provide a similar analysis to the Traffic Impact Study completed by GPI in November 2020 to support the rezoning of the Project Site, the volumes used from that study have not been adjusted for seasonal adjustment or annual growth. As stated in the GPI study, the volumes presented in the report have already been adjusted for seasonality. In addition, as stated in that study, a comparison of traffic data between 2015 and 2019 showed that volumes decreased in that period at the intersection of Highland Avenue at Gould Street/ Hunting Road. Therefore, the volumes presented in the GPI study related to the Town of Needham rezoning were not adjusted upward to account for an annual growth rate.

To provide a conservative analysis, traffic volumes were balanced between adjacent intersections where no cross streets intersect the traffic stream. To be consistent with MassDOT's guidance that 2019 volumes represent Existing Conditions, the traffic volumes conducted in 2021 were balanced with adjacent intersections where traffic counts were conducted prior to the start of the COVID-19 pandemic.

2.4.3.3 2022 Existing Conditions Traffic Volumes

The 2022 Existing Conditions were developed by applying the adjustment factors described above to the counts conducted between 2015 and 2021. Based on MassDOT guidance, the 2022 Existing Conditions represent a pre-pandemic condition and do not take into account any shift in travel patterns caused by the pandemic. The resulting 2022 Existing Conditions weekday morning and weekday evening peak hour traffic volumes are shown in Figures 2.4, and 2.5, respectively.

2.4.4 Public Transportation

Public transportation in Needham is provided by the Massachusetts Bay Transportation Authority (MBTA). The proposed development is indirectly served by one MBTA bus route: Bus Route #59. Additional service within close proximity of the Project Site includes the D Branch of the Green Line and the Needham Line of the commuter rail. Figure 2.6 displays the existing public transportation services provided in the study area. Descriptions of each transit service is provided below, and detailed maps and schedules can be found in Appendix C. The descriptions and analyses of transit services in the area are based on pre-COVID-19 conditions and do not include any temporary changes in service due to COVID-19.

- Bus Route 59 travels between Watertown Square in Watertown and Needham Junction in Needham via Newton. The nearest stops to the Project Site are at the intersections of Hillside Avenue and Webster Street and Central Avenue at Gould Street, both approximately a half mile from the Project Site. Bus Route 59 runs seven days a week and during peak periods has a frequency of approximately 30-40 minutes. Bus Route 59 provides connections to the D Branch of the Green Line at Newton Highlands, to the Needham Line of the commuter rail at Needham Highlands, Needham Center, and Needham Junction, and to the Worcester Line of the MBTA Commuter Rail at Newtonville.
- The D branch of the Green Line connects Newton with Brookline and Boston and travels from Riverside in Newton to Government Center in Downtown Boston. The nearest stop to the Project Site on the D branch of the Green Line is Eliot, approximately two miles northeast of the Project Site on Route 9. Service is provided seven days a week and runs approximately every eight minutes during peak hours.
- The Needham Line of the MBTA Commuter Rail travels between Needham Heights and Back Bay Station and South Station in Boston. The nearest stop to the Project Site is Needham Heights, approximately 0.7 miles southwest of the Project Site on Highland Avenue. Service is provided six days a week, Monday through Saturday; during peak periods, service is provided every 30-50 minutes in peak directions.

2.4.4.1 Private Shuttle Service

In addition to the MBTA, a private shuttle service is provided in the area by the 128 Business Council. The 128 Business Council operates the Needham Shuttle between the Newton Highlands MBTA Station on the Green Line and different companies in and around the Needham Crossing area that are Council members. The Needham Shuttle runs Monday through Friday and makes seven trips during the weekday morning and weekday evening peak periods. Service is provided approximately every hour between 6:30 AM and 9:22 AM and between 3:15 PM and 6:25 PM. Fares are free for employees who work at member companies and are $4 per ride for non-members. The current nearest stop to the Project Site is at 200 A Street, approximately 3,000 feet east of the Project Site.

2.4.5 Active Transportation Infrastructure

2.4.5.1 Pedestrian Environment

Varying levels of pedestrian accommodations are provided throughout the study area and are representative of the level of pedestrian accommodations throughout Needham. Sidewalks are provided on both sides of all major roadways in the study area, except along the east side of Gould Street between Highland Avenue and Beech Street where the sidewalk terminates in front of the Project Site. Crosswalks are provided at all signalized intersections. At the study area, signalized intersections with pedestrian accommodations provide pedestrian signals for all crosswalks. Crosswalk ramps are provided for most crosswalk approaches, and tactical warning strips are provided on some, but not all, crosswalk ramps.

Significant enhancements to the pedestrian network within the study area are proposed independent of the Project in the next several years.

2.4.5.2 Bicycle Amenities

Existing dedicated bicycle facilities in the study area are limited. On-street bicycle lanes are provided on both sides of Highland Avenue between Wexford Street and Gould Street/ Hunting Road, on Hunting Road south of Highland Avenue, and on a section of Kendrick Street between Hunting Road and 3rd Avenue. No dedicated on-road bicycle facilities are provided on any of the other study area roadways.

A graphic illustrating the existing pedestrian and bicycle network in the vicinity of the Project Site is provided in Figure 2.7.

2.4.6 Crash History

A detailed crash analysis was conducted to identify potential vehicle accident trends and/or roadway deficiencies in the traffic study area. The most current vehicle accident data for the traffic study area intersections were obtained from MassDOT for the years 2015 to 2019. The MassDOT database comprises crash data from the Massachusetts Registry of Motor Vehicles (RMV) Division primarily for use in traffic studies and safety evaluations. Data files are provided for an entire city or town for an entire year, though it is possible that some crash records may be omitted either due to individual crashes not being reported, or the municipality's crash records not being provided in a compatible format for RMV use. A summary of the vehicle accident history for the study intersections based on the available RMV data is presented in Table 2-2 and the detailed crash data is provided in Appendix C for reference.

Crash rates are calculated based on the number of accidents at an intersection and the volume of traffic traveling through that intersection on a daily basis. Rates that exceed MassDOT's average for accidents at intersections in the MassDOT district in which the town or city is located could indicate safety or geometric issues for a particular intersection. For the study area, the calculated crash rates were compared to MassDOT's District 6 average, as Needham is located in District 6. In District 6, the average crash rate is 0.71 for signalized intersections and 0.52 for unsignalized intersections. These rates imply that, on average, 0.71 accidents occurred per million vehicles entering signalized intersections throughout District 6 and 0.52 accidents occurred per million vehicles entering unsignalized intersections in District 6. The locations of some accidents cannot be precisely determined from the database. These locations typically involve interchange intersections. Additionally, some accidents may have occurred but were either not reported or not included in the database, and therefore not considered.

Table 2-2 Vehicular Crash Summary (2015-2019)

Year	1. Central Ave at Cedar St	2. Central Ave at Webster St	3. Central Ave at Gould St	4. Central Ave at Hampton Ave	5. Central Ave at River Park	6. Gould St at Ellis St	7. Gould St at Kearney Rd
2015	1	1	3	0	2	0	0
2016	0	0	0	0	1	1	0
2017	2	0	6	0	0	0	0
2018	1	0	3	0	0	1	0
2019	0	0	2	1	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Average	0.80	0.20	2.80	0.20	0.60	0.40	0.00
Collision Type							
Angle	0	1	12	0	0	2	0
Front to Front	0	0	0	0	0	0	0
Head-on	0	0	0	0	0	0	0
Rear-end	2	0	2	1	2	0	0
Rear-to-Rear	0	0	0	0	0	0	0
Sideswipe, opp. direction	0	0	0	0	0	0	0
Sideswipe, same dir.	0	0	0	0	0	0	0
Single vehicle crash	2	0	0	0	1	0	0
Unknown/Not reported	0	0	0	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Crash Severity							
Fatal injury	0	0	0	0	0	0	0
Non-fatal injury	0	0	2	1	0	0	0
Property damage only	4	1	11	0	3	2	0
Unknown/Not Reported	0	0	1	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Time of Day							
Weekday, 7 AM - 9 AM	0	0	1	0	0	0	0
Weekday, 4 PM - 6 PM	0	0	5	0	0	0	0
Saturday, 11 AM - 2 PM	0	0	1	0	0	1	0
Weekday, other time	3	1	6	1	3	1	0
Weekend, other time	1	0	1	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Pavement Conditions							
Dry	4	1	11	0	1	1	0
Wet	0	0	1	0	1	0	0
Snow	0	0	1	0	1	1	0
Slush	0	0	0	0	0	0	0
Ice	0	0	0	0	0	0	0
Not reported	0	0	1	1	0	0	0
Other	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0
Total	**4**	**1**	**14**	**1**	**3**	**2**	**0**
Non Motorist (Bike, Ped)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MassDOT Crash Rates	**0.22**	**0.04**	**0.46**	**0.04**	**0.11**	**0.26**	**0.00**

Table 2-2 Vehicular Crash Summary (2015-2019) (cont.)

Year	8. Gould St at Station Rd	9. Gould St at Noanett Rd	10. Gould St at TV Place	11. Gould St at Muzi Ford/ Wingate Driveway	12. Highland Ave at West St	13. Highland Ave at Hunnewell St	14. Highland Ave at Webster St
2015	0	0	0	0	6	1	2
2016	0	0	0	0	3	1	3
2017	0	0	0	0	5	1	0
2018	0	0	0	2	3	3	2
2019	0	0	0	0	5	2	2
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Average	0.00	0.00	0.00	0.40	4.40	1.60	1.80
Collision Type							
Angle	0	0	0	0	8	5	1
Front to Front	0	0	0	0	0	0	0
Head-on	0	0	0	1	1	0	0
Rear-end	0	0	0	1	4	2	6
Rear-to-Rear	0	0	0	0	0	0	0
Sideswipe, opp. direction	0	0	0	0	0	0	0
Sideswipe, same dir.	0	0	0	0	6	0	0
Single vehicle crash	0	0	0	0	3	1	2
Unknown/Not reported	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Crash Severity							
Fatal injury	0	0	0	0	0	0	0
Non-fatal injury	0	0	0	1	2	0	3
Property damage only	0	0	0	0	19	8	6
Unknown/Not Reported	0	0	0	1	1	0	0
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Time of Day							
Weekday, 7 AM - 9 AM	0	0	0	1	2	1	0
Weekday, 4 PM - 6 PM	0	0	0	0	3	2	0
Saturday, 11 AM - 2 PM	0	0	0	1	0	1	0
Weekday, other time	0	0	0	0	13	2	5
Weekend, other time	0	0	0	0	4	2	4
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Pavement Conditions							
Dry	0	0	0	2	18	7	4
Wet	0	0	0	0	3	1	4
Snow	0	0	0	0	0	0	0
Slush	0	0	0	0	0	0	0
Ice	0	0	0	0	0	0	0
Not reported	0	0	0	0	1	0	0
Other	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	1
Total	**0**	**0**	**0**	**2**	**22**	**8**	**9**
Non Motorist (Bike, Ped)	**0**	**0**	**0**	**0**	**3**	**0**	**1**
MassDOT Crash Rates	**0.00**	**0.00**	**0.00**	**0.11**	**0.86**	**0.35**	**0.29**

Table 2-2 Vehicular Crash Summary (2015-2019) (cont.)

Year	15. Highland Ave at Gould St/ Hunting Rd	16. Highland Ave at I-95 SB Ramps	17. Highland Ave at I-95 NB Ramps	18.Highland Ave at 1st Ave	19. Highland Ave at 2nd Ave	20. Hunting Rd at Kendrick St
2015	5	0	8	1	4	5
2016	6	1	2	8	7	3
2017	4	3	2	4	4	3
2018	4	0	1	3	9	4
2019	5	2	0	8	9	5
Total	**24**	**6**	**13**	**24**	**33**	**20**
Average	4.80	1.20	2.60	4.80	6.60	4.00
Collision Type						
Angle	6	0	0	6	9	9
Front to Front	0	0	0	0	0	0
Head-on	0	0	0	0	2	0
Rear-end	6	5	12	7	6	4
Rear-to-Rear	0	0	0	0	1	0
Sideswipe, opp. direction	0	0	0	0	2	0
Sideswipe, same dir.	8	0	0	9	7	2
Single vehicle crash	2	1	1	1	5	4
Unknown/Not reported	2	0	0	1	1	1
Total	**24**	**6**	**13**	**24**	**33**	**20**
Crash Severity						
Fatal injury	0	0	0	0	0	0
Non-fatal injury	4	1	4	4	2	5
Property damage only	18	5	9	20	31	14
Unknown/Not Reported	2	0	0	0	0	1
Total	**24**	**6**	**13**	**24**	**33**	**20**
Time of Day						
Weekday, 7 AM - 9 AM	3	4	3	8	5	2
Weekday, 4 PM - 6 PM	4	0	1	1	2	1
Saturday, 11 AM - 2 PM	1	0	1	0	1	0
Weekday, other time	12	1	5	13	22	12
Weekend, other time	4	1	3	2	3	5
Total	**24**	**6**	**13**	**24**	**33**	**20**
Pavement Conditions						
Dry	17	5	13	20	24	14
Wet	6	0	0	2	7	3
Snow	0	0	0	0	0	0
Slush	0	0	0	0	0	1
Ice	0	0	0	0	0	1
Not reported	0	1	0	2	0	1
Other	1	0	0	0	1	0
Unknown	0	0	0	0	1	0
Total	**24**	**6**	**13**	**24**	**33**	**20**
Non Motorist (Bike, Ped)	**0**	**0**	**0**	**0**	**2**	**2**
MassDOT Crash Rates	**0.44**	**0.10**	**0.20**	**0.41**	**0.64**	**0.63**

As shown in Table 2-2, the accident data indicates that the intersection of Highland Avenue at West Street is the only study area intersection above the district crash rate averages.

The majority of crashes throughout the study area were angle crashes and rear-end crashes occurring on dry pavement resulting in property damage only. Based on the MassDOT records, there were no fatal accidents that occurred within the study area during the five-year period studied. The intersection that saw the highest number of crashes involving pedestrians or bicycles was the intersection of Highland Avenue at West Street, which saw three crashes involving pedestrians or bicyclists over the five-year period.

Several of the study area intersections have been reconstructed in recent years or are expected to be reconstructed in future years as part of the MassDOT roadway reconstruction project. These improvements are not reflected in the crash data presented in Table 2-2 and will address some of the existing safety concerns. The intersections of Highland Avenue at the I-95 Northbound and Southbound Ramps were reconstructed in 2017 and the intersection of Highland Avenue at 1st Avenue was reconstructed in 2018. In addition, several other study area intersections on Highland Avenue are expected to be reconstructed within the next few years. However, all the crash data presented above is from 2015-2019 and does not fully reflect these recent or future improvements.

2.4.6.1 Highway Safety Improvement Program

In addition to calculating the crash rate, study area intersections also were reviewed in the MassDOT's Highway Safety Improvement Program (HSIP) database. An HSIP-eligible cluster is one in which the total number of "equivalent property damage only"[6] crashes in the area is within the top 5 percent of all clusters in that region. Being HSIP-eligible makes the location eligible for FHWA and MassDOT funds to address the identified safety issues at these locations.

None of the study area intersections are potential HSIP-eligible clusters based on the most recently available data at the time of the HSIP review.

2.5 Future Conditions

Traffic volumes in the study area were projected to the year 2029, reflecting a typical seven-year traffic-planning horizon as required by MassDOT. Independent of the Project, volumes on the roadway network under year 2029 No Build Condition were assumed to include existing traffic and new traffic resulting from background traffic. Anticipated Site-generated traffic volumes were added to the 2029 No Build Condition traffic volumes to reflect the 2029 Build Condition in the study area.

2.5.1 2029 No Build Condition

Traffic volumes in the study area were projected to a seven-year traffic-planning horizon. Independent of the Project, volumes on the roadway network under the future 2029 No Build- condition were assumed to include existing traffic and new traffic resulting from

6 "Equivalent property damage only" is a method of combining the number of crashes with the severity of the crashes based on a weighted scale. Crashes involving property damage only are reported at a minimal level of importance, while collisions involving personal injury (or fatalities) are weighted more heavily.

background traffic growth. Under the Build condition, Project generated traffic volumes were added to the No-Build volumes to reflect the Build conditions within the Project study area.

2.5.1.1 Background Traffic Growth

Traffic growth on area roadways is a function of the expected land development, economic activity, and changes in demographics. Several methods can be used to estimate this growth. A procedure frequently employed is to estimate an annual percentage increase and apply that increase to study area traffic volumes. An alternative procedure is to identify estimated traffic generated by planned new major developments that would be expected to impact the Project study area roadways. For the purpose of this assessment, both methods were considered.

Historic Traffic Growth

Historic traffic data and previously submitted traffic studies in the vicinity of the Project Site were reviewed to determine an appropriate growth rate. Based on this research and correspondence with the Town of Needham, a growth rate of 1.0 percent was determined to be appropriate for this study. This growth rate is consistent with the Traffic Impact Study prepared by GPI to support the rezoning of the Project Site, which was submitted in November 2020, and overlaps with a majority of the study area.

Project-Specific Growth

In addition to accounting for background growth, the traffic associated with other planned and/or approved developments near the Project Site was also considered. Based on research by VHB and discussions with the Town of Needham, it was determined that there are several planned development projects within the vicinity of the study area that would need to be considered as part of the future traffic conditions, independent of the Project. The planned/approved projects are described below in detail and the traffic volumes associated with them have been included in the No-Build and Build conditions. The associated traffic volumes are included in Appendix C.

- **100 West Street** – This project involves the conversion of a former mill building into 83 assisted living units and 72 independent senior living units. Projected traffic volumes expected to be generated by this project were obtained from the published traffic study submitted as part of the permitting process for the project.
- **Newton Northland Development** – This project involves the redevelopment of 22.6 acres of land on the corner of Needham Street and Oak Street in Newton, Massachusetts. The project will include approximately 1.4 million SF of development including 193,200 SF of office space, 115,100 SF of retail/commercial space, and 800 residential units. Projected traffic volumes expected to be generated by this project were obtained from the published traffic study submitted as part of the permitting process for the project.
- **Boston Children's Hospital at Founders Park** – This project involves the full build-out of the Founders Park development by Boston Children's Hospital. The project will include an approximately 224,000 SF pediatric ambulatory center and 228,000 SF of office space for the hospital. Projected traffic volumes expected to be generated by this project were obtained from the published traffic study submitted as part of the permitting process for the project.

› **589 Highland Avenue** – This project involves the conversion of 142-bed nursing home into 50 independent living units at the existing Wingate at Needham development. Based on a review of estimated trip generation for the existing and proposed uses, the project is expected to result in a net decrease in trips. Therefore, this project is mentioned for reference purposes only and no trips were added or removed from the roadway network to provide a conservative analysis.

2.5.1.2 Roadway Improvements

In assessing future traffic conditions, proposed and recently completed roadway improvements within the study area were considered. Based on research by VHB and discussions with the Town of Needham and MassDOT, there is one project that may affect traffic volumes within the seven-year horizon and was incorporated into the No-Build and Build condition traffic analyses. The proposed roadway improvement project is described in detail below:

› **Needham-Newton Corridor Project** – This project involves the redesign of Highland Avenue, Needham Street, and Winchester Street in Needham and Newton (MassDOT Project No. 606635). The project involves reconstruction of portions of these three roadways to improve traffic operations, safety, and multimodal accommodations and includes three different segments: Highland Avenue from Webster Street to the I-95 Southbound ramps, Highland Avenue from Wexford Street to Needham Street just west of Oak Street (including the bridge over the Charles River), and Needham Street from just east of Oak Street to Winchester Street at the Route 9 Eastbound ramps. The project will involve the following improvements:

- New traffic signals at the intersections of Needham Street at Charlemont Street, Winchester Street at Route 9 EB Service Road, and Winchester Street at Route 9 WB Service Road;
- Updated signal timings throughout the corridor to include leading pedestrian intervals and adaptive signal timing technology;
- Raised bike lanes / multiuse off-road paths throughout the corridor;
- Reconstructed sidewalks;
- Seven additional crosswalks: four at signalized intersections and three unsignalized with Rectangular Rapid Flashing Beacons along Needham Street south of Industrial Place, north of Jaconnet Street, and south of Easy Street;
- Additional left-turn lanes along Highland Avenue at unsignalized intersections east of I-95/Rt 128; and
- Construction of cantilevered shared use paths on both sides of the bridge over the Charles River to allow for two northbound travel lanes and one southbound travel lane on the bridge.

2.5.1.3 No-Build Traffic Volumes

The 2029 No-Build traffic volumes were developed using a growth rate of 1.0 percent per year and adding in the background projects and roadway improvement projects described above. The resulting 2029 No-Build weekday morning and weekday evening peak hour traffic volume networks are illustrated in Figures 2.8 and 2.9, respectively.

2.5.2 2029 Build Condition

The rate at which any proposed development generates traffic is dependent upon the size, location, and concentration of surrounding developments. As described previously, the Project comprises office, research & development, and retail uses. The ITE *Trip Generation Manual*[7] categorizes these land uses and provides weekday daily, weekday morning, and weekday evening peak hour unadjusted vehicle trip generation estimates for each use. The trip generation estimates for the proposed uses were projected using the following Land Use Codes:

- LUC 710 – General Office Building
- LUC 760 – Research and Development Center
- LUC 822 – Retail Plaza (<40,000 SF)

2.5.2.1 Project Trip Generation

Estimating future conditions volumes for the Project Site involved a review of the existing development on those parcels, along with the additional trip generation expected from the Project. Adjustments for the site-generated traffic were made based on internal capture rates and pass-by trips.

Existing Site-Generated Traffic

The Site currently is occupied by a former car dealership and car wash. Prior to the closure of these businesses in the Fall of 2021, counts of the Project Site were conducted by VHB in July 2021.

Table 2-3 summarizes the traffic counts for the existing uses on-Site. The count sheets are included in Appendix C.

Table 2-3 Existing Site-Generated Trips

	Existing Site Trips [a]
Weekday Daily	
Enter	410
Exit	477
Total	887
Weekday Morning	
Enter	37
Exit	24
Total	61
Weekday Evening	
Enter	29
Exit	57
Total	86

a Based on actual counts by VHB in July 2021.

7 Trip Generation Manual, 11th Edition, Institute of Transportation Engineers, Washington, D.C., 2021.

As shown in Table 2-3, the existing Site with a car dealership and car wash generated approximately 887 vehicle trips (410 entering/ 477 exiting) over the course of a typical weekday in July 2021, with approximately 61 vehicle trips (37 entering/ 24 exiting) during the weekday morning peak hour and 86 vehicle trips (29 entering/ 57 exiting) during the weekday evening peak hour.

As stated previously, the former uses also likely generated similar, or higher, volumes on weekends. Specifically, car washes are generally busier on weekends than on weekdays because people are more likely to get their vehicles washed on weekends. However, because the Project will consist of mostly office and lab space, the Project Site in the future will generate most trips during the weekday peak periods. Therefore, this study focuses on the roadway impacts of the Project Site-generated trips during an average weekday during traditional morning and evening peak commuter periods.

In addition, trips generated by the car wash were likely to vary by season based on demand, with volumes typically highest in the Winter and lowest in the Summer. Because the existing traffic counts were conducted in July, the Project Site-generated volumes presented in Table 2-3 may represent below-average conditions for the former uses.

The former Wash World typically handled up to 18,000 car washes per month, based on review of sales data and conversation with the former operator. This level of activity translates to about 600 washes/day during peak months (which tend to be during the winter). However, to provide a conservative analysis of the impacts of the Project, and in particular to conservatively assess appropriate infrastructure improvements that will be needed along both Gould Street and Highland Avenue, the existing site-generated trips counted in July 2021 were not adjusted to account for the seasonality of trips generated by the former car wash.

Unadjusted Project-Generated Traffic

The proposed development will consist of a mixture of office, lab, and supporting retail uses. Specifically, the Project is proposed to include approximately 260,500 SF of office space, 260,500 SF of lab space, and approximately 10,000 SF of supporting retail uses. Traffic associated with the office space was estimated using ITE LUC 710, traffic associated with the lab space was estimated using ITE LUC 760, and traffic associated with the retail uses was estimated with ITE LUC 822.

The retail uses are expected to be smaller businesses catering to the employees on-site and nearby residential neighbors. Potential uses will include small eating establishments, coffee shops, or convenience store uses. While these do not fit the exact description of a traditional ITE "Strip Retail Plaza," retail traffic was estimated using this land use code, which results in an overly conservative (likely high) estimate of traffic associated with this specific use. The unadjusted vehicle trip estimates are presented in Table 2-4, and trip generation worksheets are included in Appendix C.

Table 2-4 Project Trip Generation – ITE Unadjusted Vehicle Trips

	Office [a]	R&D [b]	Retail [c]	Total Unadjusted Vehicle Trips
Weekday Daily				
Enter	1,335	1,387	326	**3,048**
Exit	1,335	1,387	326	**3,048**
Total	2,669	2,775	652	**6,096**
Weekday Morning				
Enter	336	210	17	**563**
Exit	46	46	12	**104**
Total	381	256	29	**667**
Weekday Evening				
Enter	62	39	39	**140**
Exit	305	205	39	**549**
Total	368	244	78	**689**

a Based on ITE LUC 710 (General Office Building) for 260,500 SF
b Based on ITE LUC 760 (Research and Development Center) for 260,500 SF
c Based on ITE LUC 822 (Strip Retail Plaza (<40,000 sf)) for 10,000 SF

Internal Capture Trips

Because the proposed development is a mixed-use project, the trip generation characteristics of the Project Site will be different from a single-use project. Some of the traffic to be generated by the proposed development will be contained on the Project Site as "internal" or "shared vehicle" trips. For example, workers at the office space on site may patronize the retail uses during lunch or after work. While these shared trips represent new traffic to the individual uses, they would not show up as new vehicle trips on the surrounding roadway network.

As described in the ITE Trip Generation Handbook:

> *because of the complementary nature of these land uses, some trips are made among the on-site uses. This capture of trips internal to the Site has the net effect of reducing vehicle trip generation between the overall development Site and the external street system (compared to the total number of trips generated by comparable land uses developed individually on stand-alone sites) an internal capture rate can generally be defined as the percentage of total person trips generated by a site that are made entirely within the site. The trip origin, destination, and travel path are all within the site.*

Based on the methodology outlined in the ITE Trip Generation Handbook, internal capture rates were applied to the gross person trips. The internal capture rate calculations are included in Appendix C.

Mode Share

It is expected that visitors and commuters to the Project Site will use a variety of transportation options, including private vehicles, walking, bicycling, and public transportation. The Project is connected to the rest of Needham with sidewalks, and the roadway improvements along Highland Avenue will include separated bicycle facilities providing a connection between the Project Site and Newton. While public transit is provided within Needham, the nearest public transit to the Project Site is located approximately 0.5 miles north, with MBTA bus route 59 traveling on Central Avenue.

To provide a conservative analysis and to account for the lack of public transit immediately serving the Project Site, no mode share credits are applied to the trip generation estimates and the Project-generated trips assume that 100-percent of the Project Site traffic will access the Project Site via private vehicles.

Pass-By Trips

While the ITE rates provide estimates for all the traffic associated with each land use, not all of the traffic generated by the Project will be new to the area roadways. A portion of the vehicle-trips generated by the retail land use will likely be drawn from the traffic volume roadways adjacent to the Project Site. For example, someone traveling on Gould Street may choose to deviate from their original travel path to visit the Project Site retail, before heading back to continue to their final destination. For this evaluation, ITE pass-by rates for LUC 821 (Shopping Plaza) were utilized for the retail trip generation and applied to existing trips on Gould Street. Specifically, 40 percent of the Project Site trip generation was assumed to be drawn from the surrounding roadway network during the weekday evening peak hour, as outlined in the ITE Trip Generation Manual. All other time periods studied assume a 25 percent pass-by rate.

Project-Generated Trips

As described above, internal capture credit and pass-by credit for the Project was applied to the unadjusted new vehicle trips presented in Table 2-4 to develop the net trips expected to be generated by the Project Site. Table 2-5 presents the Project-generated net new trips.

Table 2-5 Project-Generated Trips

	Adjusted Vehicle Trips [a]				Pass-By [b]	Existing Site Trips [c]	Total Net New Vehicle Trips
	Office	R&D	Retail	Total			
Weekday Daily							
Enter	1,330	1,382	313	**3,025**	(-79)	(-410)	**2,536**
Exit	1,328	1,381	316	**3,025**	(-79)	(-477)	**2,469**
Total	2,658	2,763	629	**6,050**	(-158)	(-887)	**5,005**
Weekday Morning							
Enter	334	209	11	**554**	(-2)	(-37)	**515**
Exit	42	44	9	**94**	(-2)	(-24)	**68**
Total	376	253	20	**649**	(-4)	(-61)	**584**
Weekday Evening							
Enter	62	39	36	**136**	(-15)	(-29)	**92**
Exit	303	204	38	**545**	(-15)	(-57)	**473**
Total	365	242	74	**681**	(-30)	(-86)	**565**

a Includes adjustments for internal capture between retail and office/lab uses.
b Pass-by includes trips for the retail uses already traveling on the roadway network under Existing Conditions.
c Existing Site-Generated trips based on empirical counts conducted by VHB in July 2021.

As shown in Table 2-5, the Project is expected to generate a total of 6,050 daily trips during an average weekday and 649 and 681 new vehicle trips during the respective weekday morning and weekday evening peak hours. However, these totals include traffic already being generated by the Project Site under existing conditions as well as pass-by trips currently on the roadway network. After considering this existing traffic generation and pass-by, the Project will result in an additional 5,005 vehicle trips (2,536 entering/ 2,469 exiting) over the course of a typical weekday, with approximately 584 vehicle trips (515 entering/68 exiting) during the weekday morning peak hour and 565 vehicle trips (92 entering/473 exiting) during the weekday evening peak hour.

Rideshare Trip Generation

In the past decade, a rapidly increasing mode of transportation has been the use of transportation network companies (TNCs), such as Uber and Lyft. That said, it is difficult from a trip generation perspective to estimate the total number of TNC users on any given day. Many riders use TNCs for shopping or entertainment purposes and alternate TNC trips with transit and private vehicle trips. In addition, because the popularity of TNCs is a relatively new phenomenon, ITE does not provide any hard data on the effects of TNCs on trip generation.

It is expected that during the peak hours analyzed, the primary reason for travel to and from the Project Site will be for commuting between people's homes and workplaces. It is likely that a higher percentage of TNC trips will be made during off-peak hours when people are more likely to be traveling for non-work activities. In addition, in the build year 2029 it is unknown what share of trips will be done via TNCs. Seven years prior to 2022 TNCs were just starting to have a notable presence in the Boston area and today they are a regular feature

on all area roadways. As such, it would be challenging to forecast the share of TNC trips seven years into the future due to changing travel patterns and technology. Therefore, a separate TNC mode share percentage has not been developed and it is included in the vehicle mode shares presented in the previous sections.

Comparison to Previous Zoning Traffic Study

As noted previously, GPI prepared a Traffic Impact Study in November 2020 to support the rezoning of the Project Site. In that study, a trip generation analysis was conducted estimating the number of new trips that could be generated by the Muzi site and the adjacent Channel 5 site. A comparison of the trip generation presented in the 2020 traffic study with the currently proposed trip generation is provided below in Table 2-6.

Table 2-6 Trip Generation Comparison for Previous Zoning Traffic Study

	Currently Proposed Project [a]	Rezoning Assessment [b]	Difference
Weekday Daily			
Enter	**2,536**	4,494	**(-1,958)**
Exit	**2,469**	4,494	**(-2,025)**
Total	**5,005**	8,988	**(-3,983)**
Weekday Morning			
Enter	**515**	625	**(-110)**
Exit	**68**	-5	**+73**
Total	**583**	620	**(-37)**
Weekday Evening			
Enter	**92**	126	**(-34)**
Exit	**473**	743	**(-270)**
Total	**565**	869	**(-304)**

a Total Net New Vehicle Trips as reported in Table 2-5.
b New Primary Trips for the "No Residential" trip generation alternative (Table 2), Traffic Impact Study to support rezoning of the Muzi site, GPI, November 2020.

As shown in Table 2-6, the current Project is expected to generate significantly less traffic than what was estimated in the 2020 traffic study supporting the rezoning effort. During the weekday morning and weekday evening peak hours, the Project is expected to generate approximately 37 and 204 fewer trips, respectively, than what was analyzed in the 2020 rezoning memo. Overall, the Project trip generation is estimated to be over 40 percent lower than that estimated during the rezoning effort.[8]

Project Trip Distribution

The directional distribution of the traffic approaching and departing the Project Site is a function of population densities, the location of employment opportunities, existing travel

8 The traffic study prepared by GPI to support the rezoning of the site assumed redevelopment of both the Muzi parcel and the Channel 5 parcel. The current Project does not include the Channel 5 parcel, and trips generated by the Channel 5 studios are assumed to remain on the network in the 2029 Build Conditions.

patterns, and the efficiency of the roadway system. Trips made to and from the proposed office/laboratory spaces during the peak hours are expected to be predominantly home-to-work and work-to-home trips in the morning and evening peak hours, respectively. Accordingly, the trip distribution for the office/laboratory portions of the proposed development has been derived based on Journey-to-Work data for the City of Needham with the 2010 U.S. Census data. The retail-generated trips are expected to follow trip distribution patterns similar to the office and lab uses.

Table 2-7 and Figure 2.10 illustrate the trip distribution. Detailed trip distribution calculations are provided in Appendix C.

Table 2-7 Trip Distribution Summary

Travel Route	Direction	Trips
I-95 North	North	32%
I-95 South	South	32%
Needham Street	East	7%
Highland Avenue	West	7%
Central Street	East	7%
Central Street	West	5%
Kendrick Street	East	4%
Cedar Street	North	3%
West Street	West	3%
Total		100%

Source: 2010 US Census Data

Vehicles will be able to access the Project Site via Gould Street from both the main driveway across from the Wingate driveway and from TV Place. The trip distribution calculations assume that of the Project Site-generated trips accessing the Project Site to/from the south on Gould Street, 80-percent will use the main Project Site driveway and 20-percent will use TV Place. Conversely, of the Project Site-generated trips accessing the Project Site to/from the north on Gould Street, it is assumed that 20-percent will use the main Project Site driveway and 80-percent will use TV Place to access the Project Site.

2.5.2.2 Project Trip Assignment

The Project-related traffic volumes for the Build Condition are assigned to the study area roadway network based on the trip distribution patterns shown in Table 2-7. The assigned volumes are then added to the 2029 No-Build peak hour traffic volume networks to develop the 2029 Build Condition for the weekday morning and weekday evening peak hour traffic volume networks, respectively. The site-generated trip traffic volume networks for the morning and evening peak periods are shown in Figures 2.11 and 2.12.

The 2029 Build Condition traffic volumes are shown in Figures 2.13 and 2.14 for the weekday morning and weekday evening, respectively.

2.6 Transportation Operations Analyses

Measuring existing traffic volumes and projecting future traffic volumes quantifies traffic flow within the study area. To assess the quality of flow, roadway capacity analyses were conducted with respect to Existing and projected No-Build and Build traffic volumes for both weekday morning and weekday evening peak hours. Capacity analyses provide an indication of how well the roadway facilities can serve the traffic demands placed upon them. Roadway operating conditions are classified by calculated levels of service.

2.6.1 Intersection Capacity Analyses

Consistent with MassDOT guidelines, Synchro 10 software was used to model LOS operations at the Project Study Area intersections. Both signalized and unsignalized intersection capacity analyses were conducted under 2022 Existing, 2029 No-Build, and 2029 Build conditions.

2.6.1.1 Level-of-Service Criteria

The evaluation criteria used to analyze area intersections in this traffic study are based on the Highway Capacity Manual (HCM).[9] The term 'Level of Service' (LOS) denotes the different operating conditions that occur on a given roadway segment under various traffic volume loads. It is a qualitative measure that considers a number of factors including roadway geometry, speed, travel delay and freedom to maneuver. LOS provides an index to the operational qualities of a roadway segment or an intersection. LOS designations range from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions.

In addition to LOS, two other measures of effectiveness are typically used to quantify the traffic operations at intersections; volume-to-capacity ratio (v/c) and delay (expressed in seconds per vehicle). For example, an existing v/c ratio of 0.90 for an intersection indicates that the intersection is operating at 90 percent of its available capacity. A delay of 15 seconds for a particular vehicular movement or approach indicates that vehicles on the movement or approach will experience an average additional travel time of 15 seconds. For a given LOS letter designation there may be a wide range of values for both v/c ratios and delay. Comparison of intersection capacity results therefore requires that, in addition to the LOS, the other measures of effectiveness should also be considered.

The LOS designations, which are based on delay, are reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of all traffic entering the intersection and the LOS designation is for overall conditions at the intersection. For unsignalized intersections, however, the analysis assumes that traffic on the mainline is not affected by traffic on the side streets. Thus, the LOS designation is for the critical movement exiting the side street and for the conflicting movement on the mainline, which is generally the left turn from the mainline into a side street or driveway. Table 2-8 shows the LOS criteria for both signalized intersections and unsignalized intersections.

9 Transportation Research Board, Highway Capacity Manual, 6th Edition, Washington, D.C., 2016.

Table 2-8 Intersection Level-of-Service Criteria

Level of Service	Signalized Intersection Delay	Unsignalized Intersection Delay
A	0 to 10 seconds	0 to 10 seconds
B	10 to 20 seconds	10 to 15 seconds
C	20 to 35 seconds	15 to 25 seconds
D	35 to 55 seconds	25 to 35 seconds
E	55 to 80 seconds	35 to 50 seconds
F	Greater than 80 seconds	Greater than 50 seconds

Source: Highway Capacity Manual, 6th Edition.

The analytical methodologies typically used for unsignalized intersections use conservative analysis parameters, such as long critical gaps. Actual field observations indicate that drivers on minor streets generally accept shorter gaps in traffic than those used in the analysis procedures and therefore experience less delay than reported by the analysis software. The analysis methodologies also do not fully take into account the beneficial grouping effects caused by nearby signalized intersections. The net effect of these analysis procedures is the over-estimation of calculated delays at unsignalized intersections in the study area. Cautious judgment should therefore be exercised when interpreting the capacity analysis results at unsignalized intersections.

2.6.1.2 Signalized Intersection Capacity Analyses

Table 2-9 summarizes the intersection capacity analyses for the signalized study area intersections and the capacity analysis worksheets are included in Appendix C.

Table 2-9 Signalized Intersection Capacity Analysis Summary

	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
Location / Movement	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at West Street															
Weekday Morning															
West St EB L	0.62	28.3	C	83	#210	0.83	50.7	D	105	#225	0.89	61.0	E	114	#258
West St EB T/R	0.36	21.6	C	102	236	0.42	27.5	C	128	252	0.42	27.5	C	128	252
West St WB L	0.16	30.6	C	19	58	0.20	35.9	D	25	65	0.20	35.9	D	25	65
West St WB T/R	0.69	39.4	D	141	286	0.78	51.1	D	176	313	0.78	51.1	D	176	313
Highland Ave NB L/T/R	0.82	29.0	C	265	#648	0.88	33.7	C	367	#842	0.92	40.3	D	407	#913
Highland Ave SB L/T/R	0.58	19.6	B	150	376	0.59	19.3	B	183	439	0.60	19.7	B	189	453
Overall	**0.73**	**27.4**	**C**	-	-	**0.83**	**34.1**	**C**	-	-	**0.88**	**37.9**	**D**	-	-
Weekday Evening															
West St EB L	0.54	25.1	C	64	142	0.60	26.2	C	70	154	0.61	26.7	C	73	159
West St EB T/R	0.43	20.8	C	110	228	0.46	20.9	C	123	251	0.46	20.9	C	123	251
West St WB L	0.35	30.9	C	33	84	0.36	30.7	C	35	88	0.36	30.7	C	35	88
West St WB T/R	0.65	36.0	D	108	213	0.66	36.3	D	117	229	0.66	36.3	D	117	229
Highland Ave NB L/T/R	0.71	21.9	C	175	#547	0.82	28.1	C	225	#664	0.83	29.0	C	229	#675
Highland Ave SB L/T/R	0.83	28.3	C	236	#726	0.97	50.7	D	320	#889	1.05	72.0	E	369	#978
Overall	**0.72**	**26.2**	**C**	-	-	**0.81**	**35.3**	**D**	-	-	**0.85**	**43.3**	**D**	-	-
Highland Ave at Webster Street															
Weekday Morning															
Highland Ave EB L	0.11	12.1	B	7	22	0.14	22.7	C	13	50	0.14	22.7	C	13	50
Highland Ave EB T/R	0.79	22.3	C	138	#236	1.00	67.6	E	290	#745	1.08	93.4	F	330	#830
Highland Ave WB L	0.43	9.8	A	20	40	0.55	20.9	C	32	109	0.55	21.5	C	32	109
Highland Ave WB T/R	0.56	9.7	A	102	167	0.64	18.5	B	180	473	0.64	18.6	B	182	480
Webster St NB L/T	0.66	19.4	B	105	#204	0.90	56.0	E	189	#471	0.90	56.0	E	189	#471
Webster St NB R	0.41	12.7	B	45	105	0.40	24.4	C	25	122	0.40	24.4	C	25	122
Webster St SB L/T/R	0.38	15.1	B	36	66	>1.20	35.0	D	69	#160	>1.20	35.0	D	69	#160
Overall	**0.75**	**15.3**	**B**	-	-	**0.91**	**39.2**	**D**	-	-	**0.95**	**46.3**	**D**	-	-
Weekday Evening															
Highland Ave EB L	0.18	14.2	B	10	32	0.21	26.0	C	19	67	0.22	26.2	C	20	68
Highland Ave EB T/R	0.79	24.2	C	125	#275	0.88	47.0	D	260	#656	0.90	49.4	D	268	#673
Highland Ave WB L	0.86	28.2	C	51	#171	0.88	44.0	D	109	#399	0.90	48.7	D	115	#409
Highland Ave WB T/R	0.63	11.0	B	117	229	0.69	19.1	B	231	#672	0.74	20.6	C	257	#750
Webster St NB L/T	0.32	14.5	B	39	75	0.56	36.9	D	83	191	0.56	36.9	D	83	191
Webster St NB R	0.23	10.1	B	30	56	0.33	22.7	C	62	162	0.33	22.7	C	62	162
Webster St SB L/T/R	0.51	15.6	B	62	96	0.80	44.1	D	134	#271	0.80	44.1	D	134	#271
Overall	**0.77**	**17.3**	**B**	-	-	**0.85**	**35.1**	**D**	-	-	**0.87**	**36.4**	**D**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

Table 2-9 Signalized Intersection Capacity Analysis Summary (cont.)

	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
Location / Movement	v/c[a]	Del[b]	LOS[c]	50 Q[d]	95 Q[e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at Gould Street and Hunting Road															
Weekday Morning															
Highland Ave EB L	1.14	>120	F	~68	#235	1.04	>120	F	~93	#234	>1.20	>120	F	~190	#353
Highland Ave EB T/R	0.72	28.0	C	232	413	0.86	40.2	D	364	#512	0.79	36.6	D	364	#512
Highland Ave WB L	0.51	45.8	D	23	72	0.58	58.6	E	36	83	0.61	65.3	E	38	83
Highland Ave WB T/R	0.79	31.1	C	220	410	0.94	52.1	D	362	#545	1.15	117.8	F	~616	#841
Hunting Rd NB L/T	0.79	47.5	D	137	#395	0.96	89.0	F	206	#434	1.13	>120	F	~263	#480
Hunting Rd NB R	0.15	28.9	C	0	46	0.48	39.8	D	48	102	0.51	44.0	D	52	102
Gould St SB L	0.71	45.6	D	96	#246	0.82	64.8	E	145	#281	0.91	84.5	F	182	#347
Gould St SB SB L/T/R	0.67	43.4	D	91	#224	0.78	59.4	E	137	#264	0.88	77.3	E	175	#335
Overall	**0.77**	**38.8**	**D**	-	-	**0.98**	**55.1**	**E**	-	-	**1.20**	**100.2**	**F**	-	-
Weekday Evening															
Highland Ave EB L	0.47	45.1	D	15	40	>1.20	>120	F	19	57	>1.20	>120	F	27	72
Highland Ave EB T/R	0.57	24.8	C	173	242	0.81	42.30	D	287	440	0.81	42.40	D	290	442
Highland Ave WB L	0.53	37.2	D	67	120	0.86	83.30	F	100	194	0.87	84.50	F	101	196
Highland Ave WB T/R	0.70	21.5	C	206	368	1.00	61.70	E	~535	#774	1.07	84.00	F	~599	#861
Hunting Rd NB L/T	0.94	112.1	F	52	#130	0.56	51.40	D	66	127	0.58	52.20	D	70	134
Hunting Rd NB R	0.05	28.9	C	0	23	0.10	35.70	D	4	24	0.10	35.70	D	4	24
Gould St SB L	1.09	109.8	F	~262	#393	0.91	61.10	E	295	#574	>1.20	>120	F	~681	#1051
Gould St SB SB L/T/R	1.05	96.0	F	~244	#377	0.88	56.90	E	284	#554	>1.20	>120	F	~653	#1022
Overall	**0.86**	**47.2**	**D**	-	-	**1.03**	**59.50**	**E**	-	-	**>1.20**	**>120**	**F**	-	-
Highland Avenue at I-95 NB Ramps															
Weekday Morning															
Highland Ave EB T	0.68	8.3	A	165	232	0.75	9.3	A	268	327	0.75	9.2	A	270	328
I-95 Off Ramp NB R	0.54	23.3	C	53	118	1.03	85.2	F	~146	#371	1.04	87.8	F	~151	#380
Overall	**0.65**	**9.6**	**A**	-	-	**0.80**	**21.1**	**C**	-	-	**0.80**	**21.4**	**C**	-	-
Weekday Evening															
Highland Ave EB T	0.47	5.6	A	50	89	0.56	7.3	A	75	129	0.55	7.0	A	82	138
I-95 Off Ramp NB R	0.42	13.7	B	16	44	0.44	15.0	B	30	70	0.46	16.6	B	33	77
Overall	**0.46**	**6.4**	**A**	-	-	**0.53**	**8.1**	**A**	-	-	**0.52**	**8.0**	**A**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

Table 2-9 Signalized Intersection Capacity Analysis Summary (cont.)

	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
Location / Movement	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at 1st Avenue															
Weekday Morning															
Highland Ave EB L/T	0.57	12.4	B	181	#470	0.77	21.2	C	~607	#802	0.77	21.3	C	~611	#806
Highland Ave EB R	0.44	5.2	A	0	35	0.70	8.6	A	11	#103	0.70	8.6	A	11	#103
Highland Ave WB L/T	0.41	8.3	A	55	226	0.55	16.2	B	193	337	0.57	16.5	B	203	354
1st Ave NB L	0.45	38.5	D	49	91	0.44	32.8	C	73	140	0.44	32.8	C	73	140
1st Ave NB L/T/R	0.06	36.1	D	0	18	0.13	30.4	C	7	58	0.13	30.4	C	7	58
Driveway SB L/T/R	0.19	39.3	D	15	10	0.19	39.3	D	15	10	0.19	39.3	D	15	10
Overall	**0.55**	**11.3**	**B**	-	-	**0.74**	**17.0**	**B**	-	-	**0.74**	**17.2**	**B**	-	-
Weekday Evening															
Highland Ave EB L/T	0.43	13.0	B	101	273	0.65	23.6	C	192	#418	0.68	24.2	C	203	#444
Highland Ave EB R	0.11	3.0	A	0	10	0.19	2.4	A	0	12	0.19	2.4	A	0	12
Highland Ave WB L/T	0.81	17.2	B	163	#674	>1.20	>120	F	~626	#975	>1.20	>120	F	~630	#980
1st Ave NB L	0.74	41.3	D	149	210	0.69	27.3	C	222	296	0.69	27.3	C	222	296
1st Ave NB L/T/R	0.47	32.7	C	71	134	0.55	23.9	C	144	216	0.55	23.9	C	144	216
Driveway SB L/T/R	0.10	44.5	D	2	15	0.10	44.5	D	2	15	0.10	44.5	D	2	15
Overall	**0.79**	**18.6**	**B**	-	-	**0.99**	**81.5**	**F**	-	-	**0.99**	**82.0**	**F**	-	-
Highland Avenue at 2nd Avenue															
Weekday Morning															
Highland Ave EB L	-	-	-	-	-	0.02	9.5	A	1	11	0.02	9.0	A	1	11
Highland Ave EB T/R	-	-	-	-	-	0.61	14.3	B	201	485	0.59	13.6	B	203	488
Highland Ave EB L/T/R	0.47	6.2	A	42	143	-	-	-	-	-	-	-	-	-	-
Highland Ave WB L/T/R	>1.20	15.5	B	184	#383	>1.20	24.6	C	157	#672	>1.20	27.9	C	164	#731
2nd Ave NB L	0.41	38.2	D	49	91	0.41	36.6	D	52	126	0.43	39.1	D	52	126
2nd Ave NB L/T	0.42	38.3	D	51	93	0.42	36.6	D	53	127	0.44	39.2	D	53	127
2nd Ave NB R	0.10	36.3	D	0	27	0.11	30.2	C	0	57	0.11	32.6	C	0	57
Driveway SB L/T	0.38	44.2	D	17	32	0.29	41.1	D	16	36	0.29	43.2	D	16	36
Driveway SB R	0.00	42.3	D	0	0	0.00	39.9	D	0	0	0.00	41.9	D	0	0
Overall	**0.76**	**15.1**	**B**	-	-	**0.62**	**21.6**	**C**	-	-	**0.61**	**23.0**	**C**	-	-
Weekday Evening															
Highland Ave EB L	-	-	-	-	-	0.06	15.1	B	4	22	0.06	15.1	B	4	22
Highland Ave EB T/R	-	-	-	-	-	0.53	19.3	B	179	389	0.56	19.6	B	190	412
Highland Ave EB L/T/R	0.40	4.9	A	129	34	-	-	-	-	-	-	-	-	-	-
Highland Ave WB L/T/R	0.74	19.4	B	220	#420	0.90	26.9	C	211	#722	0.92	29.3	C	213	#733
2nd Ave NB L	0.69	40.4	D	125	187	0.73	43.3	D	135	268	0.73	43.3	D	135	268
2nd Ave NB L/T	0.68	40.2	D	125	187	0.72	42.7	D	134	266	0.72	42.7	D	134	266
2nd Ave NB R	0.15	31.9	C	0	56	0.38	30.0	C	44	142	0.40	30.2	C	48	148
Driveway SB L/T	0.59	44.5	D	53	74	0.55	43.0	D	52	91	0.55	43.0	D	52	91
Driveway SB R	0.02	38.9	D	0	0	0.02	38.8	D	0	0	0.02	38.8	D	0	0
Overall	**0.78**	**21.4**	**C**	-	-	**0.95**	**28.2**	**C**	-	-	**0.02**	**38.8**	**C**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

Table 2-9 Signalized Intersection Capacity Analysis Summary (cont.)

Location / Movement	2022 Existing Condition					2029 No-Build Condition					2029 Build Condition				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Greendale Avenue and Kendrick Street at Hunting Road															
Weekday Morning															
Kendrick St EB L/T/R	0.42	21.0	C	102	#226	0.43	19.5	B	109	#252	0.43	19.6	B	110	#253
Kendrick St WB L	0.22	12.2	B	19	68	0.23	11.0	B	20	71	0.23	11.0	B	20	71
Kendrick St WB T/R	0.30	13.7	B	66	195	0.31	12.4	B	72	213	0.33	12.7	B	78	227
Hunting Rd NB T/R	>1.20	>120	F	~390	#579	>1.20	>120	F	~285	#461	>1.20	>120	F	~285	#461
Hunting Rd NB R	0.36	0.6	A	0	0	0.39	0.7	A	0	0	0.39	0.7	A	0	0
Hunting Rd SB L	0.37	37.2	D	29	62	0.42	38.0	D	32	65	0.45	38.2	D	34	69
Hunting Rd SB T/R	0.12	23.0	C	25	57	0.14	24.3	C	28	60	0.14	24.3	C	27	60
Overall	**0.72**	**66.5**	**E**	-	-	**0.68**	**41.7**	**D**	-	-	**0.68**	**42.1**	**D**	-	-
Weekday Evening															
Kendrick St EB L/T/R	0.43	31.2	C	59	86	0.57	36.3	D	68	97	0.57	36.5	D	68	97
Kendrick St WB L	0.53	7.8	A	115	180	0.58	9.0	A	126	196	0.58	9.2	A	126	196
Kendrick St WB T/R	0.37	7.0	A	100	157	0.41	7.8	A	112	174	0.42	8.0	A	113	176
Hunting Rd NB T/R	0.61	38.1	D	58	100	0.58	35.2	D	64	109	0.58	35.2	D	64	109
Hunting Rd NB R	0.10	0.10	A	0	0	0.10	0.10	A	0	0	0.10	0.1	A	0	0
Hunting Rd SB L	0.25	24.4	C	24	54	0.26	23.5	C	26	57	0.33	23.7	C	34	71
Hunting Rd SB T/R	0.44	26.2	C	77	136	0.46	25.4	C	87	150	0.45	25.2	C	87	150
Overall	**0.61**	**15.4**	**B**	-	-	**0.65**	**16.5**	**B**	-	-	**0.65**	**16.6**	**B**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

As shown in Table 2-9, the following signalized intersections are expected to see a degrade in overall LOS between the 2029 No-Build Conditions and the 2029 Build Conditions:

› Highland Avenue at West Street – LOS C to LOS D during the weekday morning peak period (increase in overall delay of 4 seconds).

› Highland Avenue at Gould Street/Hunting Road – LOS E to LOS F during the weekday morning and weekday evening peak periods (increase in overall delay of greater than 30 seconds).

All other intersections and time periods are expected to see the overall LOS maintained from the 2029 No-Build Condition to the 2029 Build Conditions.

To offset the impacts of the additional Project-generated trips at the intersection of Highland Avenue at Gould Street / Hunting Road, the proponent is proposing geometric and signal timing mitigation. Details of the proposed mitigation are described later in this report.

2.6.1.3 Unsignalized Intersection Capacity Analyses

Table 2-10 summarizes the intersection capacity analyses for the unsignalized study area intersections and the capacity analysis worksheets are included in Appendix C.

Table 2-10 Unsignalized Intersection Capacity Analysis Summary

	2022 Existing Condition				2029 No-Build Condition				2029 Build Condition			
Location / Movement	**v/c [a]**	**Del [b]**	**LOS [c]**	**95 Q [d]**	**v/c**	**Del**	**LOS**	**95 Q**	**v/c**	**Del**	**LOS**	**95 Q**
Central Avenue at Cedar Street												
Weekday Morning												
Cedar St SB L/R	>1.20	>120	F	759	>1.20	>120	F	926	>1.20	>120	F	1027
Weekday Evening												
Cedar St SB L/R	0.69	43.9	E	116	0.83	64.7	F	162	0.90	81.6	F	188
Central Avenue at Webster Street												
Weekday Morning												
Webster St NB L/R	>1.20	>120	F	434	>1.20	>120	F	554	>1.20	>120	F	587
Weekday Evening												
Webster St NB L/R	0.86	76.2	F	166	1.12	>120	F	254	>1.20	>120	F	281
Central Avenue at Gould Street												
Weekday Morning												
Gould St NB L/R	0.99	100.1	F	227	>1.20	>120	F	327	>1.20	>120	F	428
Weekday Evening												
Gould St NB L/R	>1.20	>120	F	662	>1.20	>120	F	828	>1.20	Err [e]	F	Err
Central Avenue at Hampton Avenue												
Weekday Morning												
Hampton Ave NB L/R	0.08	17.3	C	7	0.09	18.7	C	8	0.10	19.0	C	8
Weekday Evening												
Hampton Ave NB L/R	0.18	18.0	C	16	0.21	19.5	C	19	0.22	20.5	C	20
Central Avenue at River Park Street												
Weekday Morning												
River Park St NB L/R	0.02	17.7	C	2	0.03	19.2	C	2	0.03	19.6	C	2
Weekday Evening												
River Park St NB L/R	0.00	11.8	B	0	0.00	12.2	B	0	0.00	12.6	B	0
Gould Street at Ellis Street / Driveway												
Weekday Morning												
Driveway EB L/T/R	0.04	18.4	C	3	0.04	20.5	C	3	0.05	23.5	C	4
Ellis St WB L/T/R	0.07	16.6	C	6	0.08	18.3	C	6	0.09	20.6	C	7
Weekday Evening												
Driveway EB L/T/R	0.01	16.6	C	1	0.01	18.1	C	1	0.02	20.5	C	1
Ellis St WB L/T/R	0.21	19.1	C	20	0.26	21.9	C	25	0.31	26.1	D	31

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 95th percentile queue, in feet.
e Movement beyond capacity, no results reported.

Table 2-10 Unsignalized Intersection Capacity Analysis Summary (cont.)

	2022 Existing Condition				2029 No-Build Condition				2029 Build Condition			
Location / Movement	v/c [a]	Del [b]	LOS [c]	95 Q [d]	v/c	Del	LOS	95 Q	v/c	Del	LOS	95 Q
Gould Street at Kearney Road												
Weekday Morning												
Kearney Rd WB L/R	0.15	17.4	C	13	0.17	19.2	C	15	0.19	21.8	C	17
Weekday Evening												
Kearney Rd WB L/R	0.38	20.7	C	43	0.44	24.6	C	54	0.51	30.0	D	67
Gould Street at Station Road												
Weekday Morning												
Station Rd WB L/R	0.02	15.9	C	1	0.02	17.3	C	2	0.02	19.0	C	2
Weekday Evening												
Station Rd WB L/R	0.18	15.6	C	17	0.20	17.0	C	19	0.23	19.0	C	22
Gould Street at Noanett Street and Driveway												
Weekday Morning												
Driveway WB L/T/R	0.04	23.4	C	3	0.05	26.8	D	4	0.05	30.2	D	4
Weekday Evening												
Driveway WB L/T/R	0.35	23.5	C	38	0.40	27.8	D	45	0.46	33.9	D	55
Gould Street at TV Place												
Weekday Morning												
TV Place WB L/R	0.14	18.4	C	12	0.15	20.5	C	13	0.36	32.0	D	39
Weekday Evening												
TV Place WB L/R	0.17	19.3	C	15	0.19	21.7	C	17	0.88	72.7	F	183
Gould Street at Muzi Fold Driveway and Wingate Res. Driveway												
Weekday Morning												
Muzi Ford WB L	0.14	31.4	D	12	0.17	37.5	E	14	1.15	>120	F	152
Weekday Evening												
Muzi Ford WB L	0.20	26.9	D	19	0.24	31.2	D	22	>1.20	Err [e]	F	Err
Highland Avenue at Hunnewell Street												
Weekday Morning												
Hunnewell St EB L/T//R	>1.20	>120	F	314	>1.20	Err [e]	F	Err	>120	Err [e]	F	Err
Weekday Evening												
Hunnewell St EB L/T//R	1.01	118.2	F	220	>1.20	>120	F	383	>1.20	>120	F	433

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 95th percentile queue, in feet.
e Movement beyond capacity, no results reported.

As shown in Table 2-10, the critical movements at the majority of the unsignalized study area intersections currently operate at acceptable levels of service, with a few key exceptions. These conditions generally are expected to continue under the future 2029 conditions with and without the addition of site-generated traffic.

Examples of unsignalized movements that are expected to operate at LOS F (delay greater than 50 seconds) under 2029 No Build Conditions and 2029 Build Conditions include:

› Cedar Street southbound approach to Central Avenue during the weekday morning and weekday evening peak periods.

- Webster Street northbound approach to Central Avenue during the weekday morning and weekday evening peak periods.
- Gould Street northbound approach to Central Avenue during the weekday morning and weekday evening peak periods.
- Hunnewell Street eastbound approach to Highland Avenue during the weekday morning and weekday evening peak periods.

Unsignalized Site Driveway Operations

At the unsignalized Project Site driveway and TV Place, operations are expected to operate at poor conditions. The Project Site driveway is expected to operate at LOS F with v/c ratios greater than 1.00 during both the weekday morning and weekday evening peak period. The TV Place approach is expected to operate at LOS F with a v/c ratio of 0.88 during the weekday evening peak period.

To improve operations at the Project Site driveway that will improve the LOS and reduce the v/c ratios to lower than 1.00, the Proponent is proposing mitigation that includes adding a traffic signal to the intersection. To improve operations at TV Place, the Proponent is proposing mitigation that includes dedicated left-turn and right-turn lanes. Details of the proposed mitigation are described later in this report.

2.6.2 Ramp Junction Capacity Analyses

At the interchange of Highland Avenue at I-95, the intersection generally does not operate as a standard signalized or unsignalized intersection. Traffic enters and exits the interstate ramps through merge, diverge, and weaving movements, similar to traffic operations on an interstate. Therefore, the conflicting movements have been analyzed using methodology for merge, diverge, and weaving conflicts.

The one exception to this is the junction of the I-95 northbound ramp with Highland Avenue eastbound. At this intersection, both approaches are signalized. Therefore, results for that ramp junction are summarized previously in the signalized intersection capacity analyses.

2.6.2.1 Level-of-Service Criteria

The capacity analyses conducted include merge/diverge analyses and weave analyses. Each analysis is based on procedures presented in the Highway Capacity Manual (HCM).

A merge or diverge segment is defined as a location that involves the interaction between freeway mainline through traffic and traffic merging from or diverging to ramps. The analyses for merge and diverge segments takes into account geometric and operational factors such as the length and taper of the acceleration/deceleration lanes, free-flow vehicle speed along the mainline and on the ramps themselves, and the number of vehicles in the right-most (or left-most for left exits) two lanes of the mainline. The focus of the analysis is at the ramp junction with the mainline where entering vehicles attempt to find gaps in the adjacent traffic stream. The action of this merging traffic creates vehicle turbulence along the mainline which can affect freeway operations. The converse of this action is the diverge movement which forces exiting vehicles to shift in advance and occupy the correct travel

lane in order to exit the freeway causing temporary instability as the vehicles shift lanes and decelerate. According to the HCM, the influence area for both of these movements is approximately 1,500 feet before the diverge areas and beyond the merge areas (including acceleration and deceleration lanes).

A weaving segment is defined as a location that involves the interaction between two or more crossing traffic streams traveling in the same direction. A common weaving segment is formed by a one-lane freeway on-ramp followed by a one-lane freeway off-ramp, with the two connected by an auxiliary lane, which describes the geometry of Highland Avenue in both directions between the I-95 northbound and southbound ramps. The analysis for a weaving segment takes into account geometric and operational factors such as the length of the weaving section, free-flow vehicle speed along the mainline facility, and the number of vehicles in the weaving lanes. The focus of the analysis is within the weaving segment itself, where vehicles must attempt to find gaps and also accelerate or decelerate as they traverse the weaving segment.

Table 2-11 shows the level-of-service criteria for basic merge/diverge and weaving segments.

Table 2-11 Level-of-Service Criteria for Highway Capacity Analyses

Level of Service	Merge/Diverge Segment Density Range [a]	Weaving Segment Density Range [b]
A	0 to 10 pc/mi/ln	0 to 12 pc/mi/ln
B	10 to 20 pc/mi/ln	12 to 24 pc/mi/ln
C	20 to 28 pc/mi/ln	24 to 32 pc/mi/ln
D	28 to 35 pc/mi/ln	32 to 36 pc/mi/ln
E	Greater than 35 pc/mi/ln	36 to 40 pc/mi/ln
F	Demand Exceeds Capacity	Greater than 40 pc/mi/ln

Source: Highway Capacity Manual, Washington, D.C., 2016.
Note: Criteria measured in vehicle density (passenger car/mile/lane).
a Merge/Diverge density range (HCM, Exhibit 14-3).
b Weaving segment density range for multilane highways or C-D Roads (HCM, Exhibit 13-6).

2.6.2.2 Merge/Diverge Segment Analyses

Merge and diverge segment analyses were conducted at the following three ramp junction locations:

- Highland Avenue Eastbound at the I-95 Southbound On-Ramp (diverge location)
- Highland Avenue Westbound at the I-95 Northbound On-Ramp (diverge location)
- Highland Avenue Westbound at the I-95 Southbound Off-Ramp (merge location)

Analyses were conducted during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. A summary of the merge and diverge segment analyses are presented in Table 2-12 and the detailed analysis worksheets are provided in Appendix C.

Table 2-12 Merge/Diverge Capacity Analysis Summary

	2022 Existing Conditions		2029 No Build Conditions		2029 Build Conditions	
Location/Period	**Density[a]**	**LOS[b]**	**Density**	**LOS**	**Density**	**LOS**
Highland Avenue EB at I-95 SB On-Ramp *(Diverge Movement)*						
Weekday Morning	13.5	B	15.6	B	15.8	B
Weekday Evening	11.6	B	13.0	B	14.7	B
Highland Avenue WB at I-95 NB On-Ramp *(Diverge Movement)*						
Weekday Morning	9.8	A	10.8	B	11.2	B
Weekday Evening	13.5	B	16.2	B	16.3	B
Highland Avenue WB at I-95 SB Off-Ramp *(Merge Movement)*						
Weekday Morning	12.1	B	13.3	B	16.4	B
Weekday Evening	14.4	B	16.0	B	16.5	B

a density in ramp influence area, in passenger cars per mile per lane
b level of service

As shown in Table 2-12, the merge and diverge locations for the interchange of Highland Avenue at I-95 are expected to operate at LOS B or better during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions.

2.6.2.3 Weave Segment Analyses

Weaving segment analyses were conducted at the following two ramp junction locations:

› Highland Avenue Eastbound between the I-95 Southbound Off-Ramp and the I-95 Northbound On-Ramp

› Highland Avenue Westbound between the I-95 Northbound Off-Ramp and the I-95 Southbound On-Ramp

Analyses were conducted during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. A summary of the weave segment analyses is presented in Table 2-13 and the detailed analysis worksheets are provided in Appendix C.

Table 2-13 Weave Segment Capacity Analysis Summary

	2022 Existing Conditions			2029 No Build Conditions			2029 Build Conditions		
Location/Period	v/c[a]	Density[b]	LOS[c]	Demand	Density	LOS	Demand	Density	LOS
Highland Avenue EB between I-95 SB Off-Ramp and I-95 NB On-Ramp									
Weekday Morning	0.53	18.5	B	0.66	24.3	C	0.66	24.7	C
Weekday Evening	0.30	10.2	A	0.38	13.0	B	0.44	15.2	B
Highland Avenue WB between I-95 NB Off-Ramp and I-95 SB On-Ramp									
Weekday Morning	0.22	6.5	A	0.26	7.9	A	0.34	10.1	A
Weekday Evening	0.31	10.9	A	0.38	13.9	B	0.40	14.3	B

a volume to capacity ratio
b density, in passenger cars per mile per lane
c level of service

As shown in Table 2-13, the weaving locations for the interchange of Highland Avenue at I-95 are expected to operate at LOS C or better during the weekday morning and weekday evening peak hours under the 2022 Existing, 2029 No Build, and 2029 Build Conditions.

2.6.3 Signal Warrant Analysis

To determine the feasibility of potential mitigation measures, signal warrant analyses were conducted at two intersections: Central Avenue at Gould Street and Gould Street at the Project Site driveway / Wingate Driveway. Signalization of both intersections was proposed as mitigation for redevelopment of the Muzi site in the traffic memo conducted by GPI in 2020.

2.6.3.1 Warrant Analysis Summary

The Federal Highway Administration (FHWA) has established criteria for evaluating the need for traffic signal control at an intersection. Several warrants, published in the Manual on Uniform Traffic Control Devices (MUTCD),[10] provide guidelines for determining the need for a signal based on such factors as traffic volume, pedestrian volume, progressive movement of traffic, vehicular delay, and others. While satisfaction of one or more of these warrants alone does not necessarily justify installation of a traffic signal, warrants in combination with capacity analysis, crash analysis, and a study of intersection safety provide valuable criteria for evaluating the need for a traffic signal.

There are nine warrants defined in the MUTCD. The warrants consider the roadway geometry, traffic volume entering the intersection, travel speeds, pedestrian activity, and special considerations such as proximity to schools and active railroad grade crossings. Even if these warrants are satisfied, other considerations such as traffic flow progression, sight distance, and physical constraints must be considered before pursuing traffic signal control.

10 Manual on Uniform Traffic Control Devices, 2009 Edition; U.S. Department of Transportation Federal Highway Administration, Washington DC, December 2009.

Traffic volumes were evaluated for the following three volume-based warrants:

- **Warrant 1 (Eight Hour Vehicular Volume)** – Warrant 1 is based on any eight hours of a day where the traffic entering the intersection reaches a threshold that warrants considering signal control.
- **Warrant 2 (Four Hour Vehicular Volume)** – Warrant 2 is for any four hours of a day.
- **Warrant 3 (Peak Hour)** – Warrant 3 is for the peak hour of any given day.

The signal warrant analysis was conducted based on the 2022 Existing Conditions, 2029 No Build Conditions, and 2029 Build Conditions for the intersection of Central Avenue at Gould Street and based on the 2029 Build Conditions for the intersection of Gould Street at the Project Site driveway / Wingate driveway. The daily distribution of site-generated volumes was based on the Institute of Transportation Engineers (ITE) Trip Generation Manual, and the daily distribution of existing and future roadway traffic was based on the proportion of peak hour traffic experienced throughout the rest of the day at a nearby MassDOT count station on Highland Avenue. Calculations projecting the hourly volumes at each intersection are included in Appendix C.

Table 2-14 presents the results of the three-traffic volume-based warrant analyses at the intersections of Central Avenue at Gould Street and Gould Street at the Project Site driveway / Wingate driveway. The signal warrant analysis worksheets are provided in Appendix C.

Table 2-14 Traffic Signal Warrants Analysis Summary

Location	Condition	Warrant 1 (8-Hour) Met	Warrant 2 (4-Hour) Met	Warrant 3 (Peak Hour) Met
Central Avenue at Gould Street	2022 Existing	Yes	Yes	No
	2029 No Build	Yes	Yes	Yes
	2029 Build	Yes	Yes	Yes
Gould Street at the Project Site driveway/ Wingate Driveway	2022 Existing	n/a	n/a	n/a
	2029 No Build	n/a	n/a	n/a
	2029 Build	Yes	Yes	Yes

Note: Based on 85th-percentile speeds under 40 miles per hour.

As shown in Table 2-14, all the volume-based warrants are met at the intersection of Central Avenue at Gould Street under all conditions, except for the peak hour warrant under 2022 Existing Conditions, and all the volume-based warrants are met at the intersection of Gould Street at the Project Site driveway / Wingate driveway under the 2029 Build Conditions.

In addition to the three warrants described above, there are six other traffic signal warrants outlined in the MUTCD. While none of the six additional warrants are met at this intersection, the warrants are listed below with the reasoning why they do not apply at this location:

- **Warrant 4 (Pedestrian Volume)** – This warrant is not applicable because the current number of pedestrians at either location does not meet the minimum number of pedestrians required to meet any of the cases for Warrant 4.
- **Warrant 5 (School Crossing)** – This warrant is not applicable because there are not established school crossings across Central Avenue or Gould Street in these locations.

- **Warrant 6 (Coordinated Signal System)** – This warrant is not applicable because Central Avenue and Gould Street do not currently contain a coordinated traffic signal system with spacing of 1,000 feet.
- **Warrant 7 (Crash Experience)** – Warrant 7 is satisfied when five collisions correctable by signalization occur over the most recent 12 months. A review of crash data determines that this warrant is not applicable at either location because less than five total crashes occurred over the most recent 12-month period with data available.
- **Warrant 8 (Roadway Network)** – This warrant is not applicable because the study intersections are not the common intersection of two major routes.
- **Warrant 9 (Intersection Near a Grade Crossing)** – This warrant is not applicable because the intersections are not near active grade crossings.

2.7 Transportation Mitigation

In general, the Project will have a minor impact at most study area intersections on the operations or safety of the roadway network. This is reflected in the operational analyses presented previously in this study. The following section discusses actions that the Project Proponent will implement to limit the Project's impacts to the roadway system and to enhance the overall transportation network in the area, including off-site roadway mitigation and a robust transportation demand management system.

2.7.1 Off-Site Roadway Mitigation

To mitigate the impacts of the Project and to improve the overall transportation network, the Proponent is proposing improved pedestrian and bicycle accommodations as well as roadway improvements at four intersections: Central Avenue at Gould Street, Gould Street at the Project Site driveway / Wingate driveway, Highland Avenue at Gould Street / Hunting Street, and Gould Street at TV Place. The mitigation proposed is based on the proposed mitigation from the traffic study completed by GPI in 2020 to assist in the rezoning of the Project Site. Details of the proposed pedestrian and bicycle improvements as well as the mitigation proposed at each intersection are provided below.

2.7.1.1 Proposed Pedestrian and Bicycle Improvements

Gould Street Bicycle Accommodations

The Proponent is proposing to add on-road bicycle accommodations along Gould Street to create a new north-south bicycle network within this area of Needham and connect Mills Field and the commercial and residential uses on Gould Street with the under-construction bicycle accommodations along Highland Avenue and the existing bicycle lanes in each direction on Hunting Road. The bicycle accommodations will consist of on-road bicycle lanes in each direction for approximately 900 feet between Highland Avenue and the former MBTA railroad ROW just north of TV Place. Between the former MBTA railroad ROW and Central Avenue, a distance of approximately ½ mile, the Proponent will fund the installation of shared lane pavement markings and signage in each direction. The design of the on-road bicycle accommodations will be coordinated with the Town of Needham.

Shared-Use Path Planning Study

North of the Project Site and the Channel 5 property is a former MBTA railroad ROW. There are long-term plans to convert this right-of-way into a shared-use path that would connect to the regional pedestrian and bicycle network of Eastern Massachusetts. To the north, the path would cross I-95/Route 128 and the Charles River and connect to the existing Upper Falls Greenway in Newton. To the south, the path would connect to the existing Bay Colony Rail Trail via Needham Heights and Needham Center. This would create a continuous off-road pedestrian and bicycle facility that would one day extend between Newton, Needham, Dover, and Medfield.

While there are long-term plans to create this shared-use path network, there is currently no funding for the part of the project between the Charles River and Needham Heights. The Proponent is proposing to coordinate with the Town of Needham to fund a study evaluating the feasibility of converting the former railroad ROW into a shared-use path between the Charles River and the commuter rail at Needham Heights. As part of the proposed improvements along Gould Street, the Proponent will include a crosswalk at the location of the future shared-use path.

2.7.1.2 Proposed Intersection Improvements

Central Avenue at Gould Street

Based on the analyses presented previously, without mitigation, the Gould Street approach is expected to operate at LOS F during the weekday morning and weekday evening peak hours under all scenarios, with v/c ratios greater than 1.00. The addition of Site traffic in the 2029 Build Condition will increase the delay on the Gould Street approach, as approximately 15-percent of Site-generated traffic is expected to travel through this intersection. Also as reported previously, this location meets the volume-based traffic signal warrants under the 2022 Existing, 2029 No Build, and 2029 Build Conditions. With mitigation, Gould Street is proposed to operate at LOS D or E with a v/c ratio under 1.00.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to fund the installation of a traffic signal at the intersection of Central Avenue at Gould Street. The traffic signal is proposed to be actuated-uncoordinated and include an exclusive pedestrian phase. The geometry of the intersection is proposed to be maintained on the Central Avenue eastbound and Gould Street northbound approaches with one general purpose lane in each direction while the geometry of the Central Avenue westbound approach is proposed to consist of a dedicated left-turn lane and a dedicated through lane. The westbound approach is anticipated to be restriped to provide a dedicated left-turn lane by narrowing the existing travel lanes and without changing the curb lines. Crosswalks will be provided across all approaches.

Although the installation of a traffic signal at this location will not require altering the curb line of the roadway, some minor right-of-way impacts may be necessary to locate signal equipment and to provide ADA-compliant sidewalk ramps at each crosswalk.

Figure 2.15 provides an illustration of the proposed intersection improvement concept. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

Gould Street at Site Driveway / Wingate Driveway

Based on the analyses presented previously, without mitigation, the Project Site driveway approach is expected to operate at LOS F during the weekday morning and weekday evening peak hours under the 2029 Build Condition, with v/c ratios greater than 1.00. Also as reported previously, this location meets all three volume-based traffic signal warrants under 2029 Build Conditions. In addition, there are no pedestrian facilities at this intersection, except for the sidewalk on the west side of Gould Street. With mitigation, the Project Site driveway during the weekday evening hour is proposed to operate at LOS D with a v/c ratio of 0.75 or lower and dedicated pedestrian and bicycle facilities will be provided.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to fund the installation of a traffic signal at the intersection of Gould Street at the Project Site Driveway / Wingate driveway. A traffic signal at this location will help employees and visitors access the Project Site via vehicle and will also improve pedestrian and bicycle connectivity to the Project Site by providing a protected crossing across Gould Street. The traffic signal is proposed to be actuated and coordinated with the signal at the intersection of Highland Avenue at Gould Street / Hunting Road, as the two traffic signals will be less than 400 feet apart.

As outlined in the GPI Traffic Impact Study, Gould Street is proposed to be expanded to a five-lane cross section. The northbound approach will consist of a shared left-turn/through lane and a dedicated right-turn lane and the southbound approach will consist of a dedicated left-turn lane, a dedicated through lane, and a shared through/right-turn lane. The geometry of the Wingate driveway eastbound approach is proposed to be maintained with one general purpose lane. The Project Site driveway approach is proposed to consist of a dedicated left-turn lane and a shared left-turn/through/right-turn lane. One inbound lane into the Project Site is proposed. Crosswalks will be provided across all approaches and bicycle lanes will be provided in each direction on Gould Street and on the Project Site driveway.

To accommodate the expanded cross-section on Gould Street, the roadway will need to be expanded by up to 32 feet. Any expansion of the roadway is expected to occur to the east into the Project Site and the western curb line along the Wingate frontage will be maintained.

Figure 2.16 provides an illustration of the proposed improvements along Gould Street and at this intersection. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

Highland Avenue at Gould Street / Hunting Road

Based on the analyses presented previously, without mitigation, the intersection of Highland Avenue at Gould Street / Hunting Road is expected to operate at overall LOS F during the weekday morning and weekday evening peak hours under the 2029 Build Condition. The Gould Street southbound and Highland Avenue westbound approaches are expected to be impacted the greatest by the additional Site-generated traffic under the 2029 Build Conditions, with both approaches operating at LOS F with v/c ratios greater than 1.00. With mitigation, the intersection is expected to improve to overall LOS D during both peak hours.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to fund geometric improvements at this location that include the addition of a second dedicated southbound left turn lane as well as a dedicated southbound right-turn lane. Without mitigation, the southbound approach consists of a dedicated left-turn lane and a shared left/through/right-turn lane. Under the proposed mitigation, the southbound approach will consist of two dedicated left-turn lanes, a dedicated through lane, and a dedicated right-turn lane. This will provide additional capacity for the Project Site-generated traffic accessing I-95 and Needham Heights while minimizing the impacts for other drivers on the roadway. Bicycle lanes in each direction are also proposed on Gould Street.

In addition, the signal timings at this intersection are proposed to be modified to provide adequate green time for each approach. As part of the improvements, the signal is proposed to be coordinated with the signal at the intersection of Gould Street at the Project Site driveway / Wingate driveway, as the two traffic signals will be less than 400 feet apart.

Highland Avenue is currently being reconstructed as part of the Needham-Newton Corridor Project and will include improved pedestrian and bicycle accommodations. The proposed bicycle lanes on Gould Street will connect to the Highland Avenue bicycle accommodations at this intersection providing access toward Newton to the east and toward Needham Heights to the west. The Proponent will work with MassDOT to coordinate how the proposed improvements on Gould Street will tie into the roadway improvements on Highland Avenue as well as any changes needed to the signal equipment.

Figure 2.16 provides an illustration of the proposed improvements along Gould Street and at this intersection. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

Gould Street at TV Place

Based on the analyses presented previously, without mitigation, the TV Place single-lane approach to Gould Street is expected to operate at LOS D during the weekday morning and LOS F during the weekday evening peak hours under the 2029 Build Condition, with queues up to 185 feet. There are also no pedestrian or bicycle accommodations at this intersection, except for the sidewalk on the west side of Gould Street.

As recommended in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site, the Proponent is proposing to provide turn lanes on TV Place and on Gould Street. TV Place is proposed to consist of a dedicated left-turn lane and a dedicated right-turn lane. Gould Street northbound is proposed to consist of a through lane and a dedicated right-turn lane and Gould Street southbound is proposed to consist of a through lane and a dedicated left-turn lane. This will help traffic entering and exiting the Project Site and other businesses on TV Place by providing additional storage space for vehicles turning into and out of TV Place. In addition, a new crosswalk is proposed across TV Place and bicycle lanes are proposed in both directions on Gould Street and TV Place. The crosswalk will be ADA compliant and will connect with the proposed pedestrian facility along the Project Site frontage on the east side of Gould Street and the south side of TV Place.

To accommodate the expanded cross-sections on TV Place and Gould Street, the curb-to-curb width on each roadway will need to be widened. It is expected that roadway widening will take place into the Project Site east of Gould Street and south of TV Place. The

Proponent also owns a small parcel of land north of TV Place that can accommodate the expanded cross-section of Gould Street north of the intersection.

As noted previously, the proposed improvements at this intersection match what was proposed in the 2020 GPI Traffic Impact Study for the rezoning of the Project Site. While the rezoning study looked at the potential redevelopment of the Project Site as well as the Channel 5 site and the small office building north of TV Place, the current Project only includes redevelopment of the former car dealership and car wash sites. However, the Proponent is proposing to construct all improvements at this intersection at this time to prepare for any potential redevelopment of the Channel 5 and office building sites in the future.

Figure 2.16 provides an illustration of the proposed improvements along Gould Street and at this intersection. A summary of the traffic operations with the proposed mitigation in place is provided in the following section.

2.7.1.3 Traffic Operations Analysis with Roadway Mitigation

To understand how traffic will operate with the proposed mitigation at each intersection, additional intersection capacity analyses have been conducted for the 2029 Build Conditions with the proposed improvements in place. Tables 2-15 and 2-16 summarize the intersection capacity analyses for the signalized and unsignalized mitigated study area intersections, respectively, and the capacity analysis worksheets are included in Appendix C.

Table 2-15 Signalized Intersection Capacity Analysis Summary – with Proposed Mitigation

	2029 No-Build Conditions					2029 Build Without Mitigation					2029 Build With Mitigation				
Location / Movement	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Central Avenue at Gould Street															
Weekday Morning															
Central Ave EB T/R	*Intersection unsignalized under 2029 No Build Conditions*					*Intersection unsignalized under 2029 Build without Mitigation Conditions*					1.05	59.3	E	368	#960
Central Ave WB T											0.72	28.7	C	18	#151
Central Ave WB L											0.27	5.1	A	36	141
Gould St NB L/R											0.85	55.7	E	82	#199
Overall											**0.93**	**46.0**	**D**	-	-
Weekday Evening															
Central Ave EB T/R											0.81	30.0	C	228	#554
Central Ave WB T											0.67	20.0	C	41	#130
Central Ave WB L											0.86	24.4	C	287	#661
Gould St NB L/R											0.91	48.8	D	206	242
Overall											**0.89**	**31.1**	**C**	-	-
Gould Street at Wingate Driveway and the Project Site Driveway															
Weekday Morning															
Wingate Dwy EB L/T/R	*Intersection unsignalized under 2029 No Build Conditions*					*Intersection unsignalized under 2029 Build without Mitigation Conditions*					0.01	54.4	D	0	0
Site Dwy WB L											0.46	57.1	E	40	82
Site Dwy WB L/T/R											0.27	54.6	D	22	63
Gould St NB L/T											0.59	2.9	A	172	m202
Gould St NB R											0.29	1.4	A	19	m17
Gould St SB L											0.09	3.4	A	3	25
Gould St SB T/R											0.15	3.2	A	19	89
Overall											**0.55**	**5.8**	**A**	-	-
Weekday Evening															
Wingate Dwy EB L/T/R											0.03	43.4	D	0	12
Site Dwy WB L											0.75	44.2	D	174	187
Site Dwy WB L/T/R											0.70	41.6	D	163	176
Gould St NB L/T											0.31	10.2	B	48	m245
Gould St NB R											0.06	14.7	B	0	m25
Gould St SB L											0.03	8.8	A	4	21
Gould St SB T/R											0.37	11.4	B	124	270
Overall											**0.44**	**21.7**	**C**	-	-

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 2-15 Signalized Intersection Capacity Analysis Summary - with Proposed Mitigation (cont.)

	2029 No-Build Conditions					2029 Build Without Mitigation					2029 Build With Mitigation				
Location / Movement	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
Highland Avenue at Gould Street and Hunting Road															
Weekday Morning															
Highland Ave EB L	1.04	>120	F	~93	#234	>1.20	>120	F	~190	#353	0.97	110.4	F	~148	#277
Highland Ave EB T/R	0.86	40.2	D	364	#512	0.79	36.6	D	364	#512	0.68	28.4	C	336	433
Highland Ave WB L	0.58	58.6	E	36	83	0.61	65.3	E	38	83	0.38	53.8	D	37	76
Highland Ave WB T/R	0.94	52.1	D	362	#545	1.15	117.8	F	~616	#841	0.97	51.4	D	510	#718
Hunting Rd NB L/T	0.96	89.0	F	206	#434	1.13	>120	F	~263	#480	1.02	107.2	F	~241	#409
Hunting Rd NB R	0.48	39.8	D	48	102	0.51	44.0	D	52	102	0.55	41.8	D	81	130
Gould St SB L	0.82	64.8	E	145	#281	0.91	84.5	F	182	#347	0.72	62.3	E	105	180
Gould St SB L/T/R	0.78	59.4	E	137	#264	0.88	77.3	E	175	#335	-	-	-	-	-
Gould St SB T	-	-	-	-	-	-	-	-	-	-	0.41	56.1	E	64	136
Gould St SB R	-	-	-	-	-	-	-	-	-	-	0.03	46.2	D	0	10
Overall	**0.98**	**55.1**	**E**	**-**	**-**	**1.20**	**100.2**	**F**	**-**	**-**	**0.98**	**52.5**	**D**	**-**	**-**
Weekday Evening															
Highland Ave EB L	>1.20	>120	F	19	57	>1.20	>120	F	27	72	0.60	58.2	E	24	57
Highland Ave EB T/R	0.81	42.3	D	287	440	0.81	42.4	D	290	442	0.71	31.4	C	248	#360
Highland Ave WB L	0.86	83.3	F	100	194	0.87	84.5	F	101	196	0.78	61.6	E	89	#182
Highland Ave WB T/R	1.00	61.7	E	~535	#774	1.07	84.0	F	~599	#861	0.99	53.0	D	~515	#689
Hunting Rd NB L/T	0.56	51.4	D	66	127	0.58	52.2	D	70	134	0.93	108.6	F	66	#150
Hunting Rd NB R	0.10	35.7	D	4	24	0.10	35.7	D	4	24	0.07	35.5	D	0	6
Gould St SB L	0.91	61.1	E	295	#574	>1.20	>120	F	~681	#1051	0.95	56.5	E	307	#364
Gould St SB L/T/R	0.88	56.9	E	284	#554	>1.20	>120	F	~653	#1022	-	-	-	-	-
Gould St SB T	-	-	-	-	-	-	-	-	-	-	0.44	32.5	C	134	134
Gould St SB R	-	-	-	-	-	-	-	-	-	-	0.10	81.4	F	12	22
Overall	**1.03**	**59.5**	**E**	**-**	**-**	**>1.20**	**>120**	**F**	**-**	**-**	**1.05**	**50.6**	**D**	**-**	**-**

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal.

Table 2-16 Unsignalized Intersection Capacity Analysis Summary - with Proposed Mitigation

	2029 No-Build Conditions				2029 Build Without Mitigation				2029 Build With Mitigation			
Location / Movement	v/c [a]	Del [b]	LOS [c]	95 Q [d]	v/c	Del	LOS	95 Q	v/c	Del	LOS	95 Q
Gould Street at TV Place												
Weekday Morning												
TV Place WB L/R	0.15	20.5	C	13	0.36	32.0	D	39	-	-	-	-
TV Place WB L	-	-	-	-	-	-	-	-	0.28	26.7	D	27
TV Place WB R	-	-	-	-	-	-	-	-	0.39	0.0	A	0
Gould Street SB L	0.03	0.8	A	2	0.12	3.2	A	10	0.12	10.3	B	10
Weekday Evening												
TV Place WB L/R	0.19	21.7	C	17	0.88	72.7	F	183	-	-	-	-
TV Place WB L	-	-	-	-	-	-	-	-	0.78	50.2	F	148
TV Place WB R	-	-	-	-	-	-	-	-	0.24	0.0	A	0
Gould Street SB L	0.01	0.2	A	0	0.02	0.5	A	1	0.02	8.2	A	1

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 95th percentile queue, in feet.

As shown in Table 2-15, the intersection of Central Avenue at Gould Street with the proposed mitigation is expected to operate at overall LOS D during the weekday morning peak hour and LOS C during the weekday evening peak hour. While the eastbound and northbound approaches are expected to operate at LOS E during the weekday morning peak hour, this is because each approach is proposed to consist of a single lane in order to limit right-of-way impacts.

The intersection of Gould Street at the Project Site driveway / Wingate Driveway with the proposed mitigation is expected to operate at overall LOS A during the weekday morning peak hour and LOS C during the weekday evening peak hour. While the westbound site driveway approach is expected to operate at LOS E during the weekday morning peak hour, the volume to capacity ratio is less than 0.50. The intersection is proposed to be coordinated with the intersection of Highland Avenue at Gould Street / Hunting Road and the northbound queues at this intersection are not expected to extend back to the upstream intersection. The inclusion of two southbound through lanes will provide adequate queueing storage that is not expected to extend more than 300 feet.

The intersection of Highland Avenue at Gould Street / Hunting Road with the proposed mitigation is expected to operate at overall LOS D during the both the weekday morning and weekday evening peak hours, which is an improvement over the 2029 No Build Conditions. The intersection is proposed to be coordinated with the intersection of Gould Street at the Project Site driveway / Wingate driveway and the southbound queues at this intersection are not expected to extend back to the upstream intersection. In addition, in the 2020 GPI traffic study to support the rezoning of the Project Site, additional mitigation at this intersection included the construction of a dedicated westbound right-turn lane. Without the dedicated right-turn lane, the westbound approach is expected to operate at LOS E with v/c below 1.00. While adding a dedicated right-turn lane would improve right-turning operations, it would add a new weaving conflict between drivers coming off the I-95 Southbound off-ramp and drivers turning right onto Gould Street, which could cause a safety issue. To not add a new weaving conflict, no dedicated westbound right-turn lane is proposed as mitigation.

As shown in Table 2-16, while the unsignalized TV Place approach to Gould Street is still expected to operate at LOS F with the mitigation in place under the 2029 Build Conditions during the weekday evening peak hour, creating dedicated left-turn and right-turn lanes is expected to reduce the average delay by over 20 seconds for left-turning vehicles, from 73 seconds to 50 seconds. With a v/c ratio of 0.78, the intersection is expected to be able to handle the additional Site-generated traffic. The additional northbound and southbound turn lanes into TV Place will provide vehicles space to turn without blocking through traffic and will also be able to accommodate any potential future development along TV Place.

2.7.2 Transportation Demand Management

The Proponent is exploring a wide array of TDM measures to offer as a means to reduce single occupant driving and increase use of alternative forms of transportation to access the workplace.

- Providing an Employee Transportation Advisor who will coordinate with the 128 Business Council;
- Provide covered and secure bicycle parking spaces on-site;
- Exploring the feasibility of providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line);
- Requiring tenants to provide a 50 percent transit pass subsidy for their employees;
- Carpool assistance and incentives;
- Emergency ride home;
- Bicycling/walking incentives and amenities;
- Provide on-site locker rooms and showers for employees;
- Offer on-site amenities for employees to reduce midday trip making;
- Telecommuting and compressed workweeks, when feasible;
- Display in the Main Lobby transportation-related information for tenants' employees and visitors; and
- Promotional efforts.

2.7.2.1 Transportation Management Association

The Transportation Management Association serving businesses in Needham is the 128 Business Council. The Proponent will join and become an active member of the 128 Business Council.

2.7.3 Transportation Monitoring

The Proponent is committed to a robust transportation monitoring program to evaluate the effectiveness of its TDM program and to measure the Project's impacts on the transportation network. As detailed next, the monitoring program will include the annual collection of traffic counts and parking garage activity by tenants' employees and visitors to the Project Site. The transportation monitoring program will begin six months after full occupancy of the proposed development and continue for a period of five years. The results of each transportation monitoring program will be summarized in a report and provided to MassDOT and to the Town of Needham.

2.7.3.1 Traffic Monitoring: Vehicle Volumes and Parking Activity

Annual traffic counts will be conducted both on-Site and off-Site to evaluate the impact of the Project as compared to the estimated impact as outlined in this report.

On-Site Traffic Monitoring: Parking Activity

The actual number of weekday morning peak hour, weekday evening peak hour, and weekday daily vehicle trips generated by the Project will be measured using simultaneous automatic traffic recorder (ATR) counts or via a parking revenue control system at each parking entrance/exit for a continuous 24-hour period on a typical weekday.

These volumes entering and exiting each parking facility will be compared against the estimated Project-generated vehicle trips presented in this report to determine if the Project Site is generating trips at a rate higher or lower than what was projected.

Off-Site Traffic Monitoring

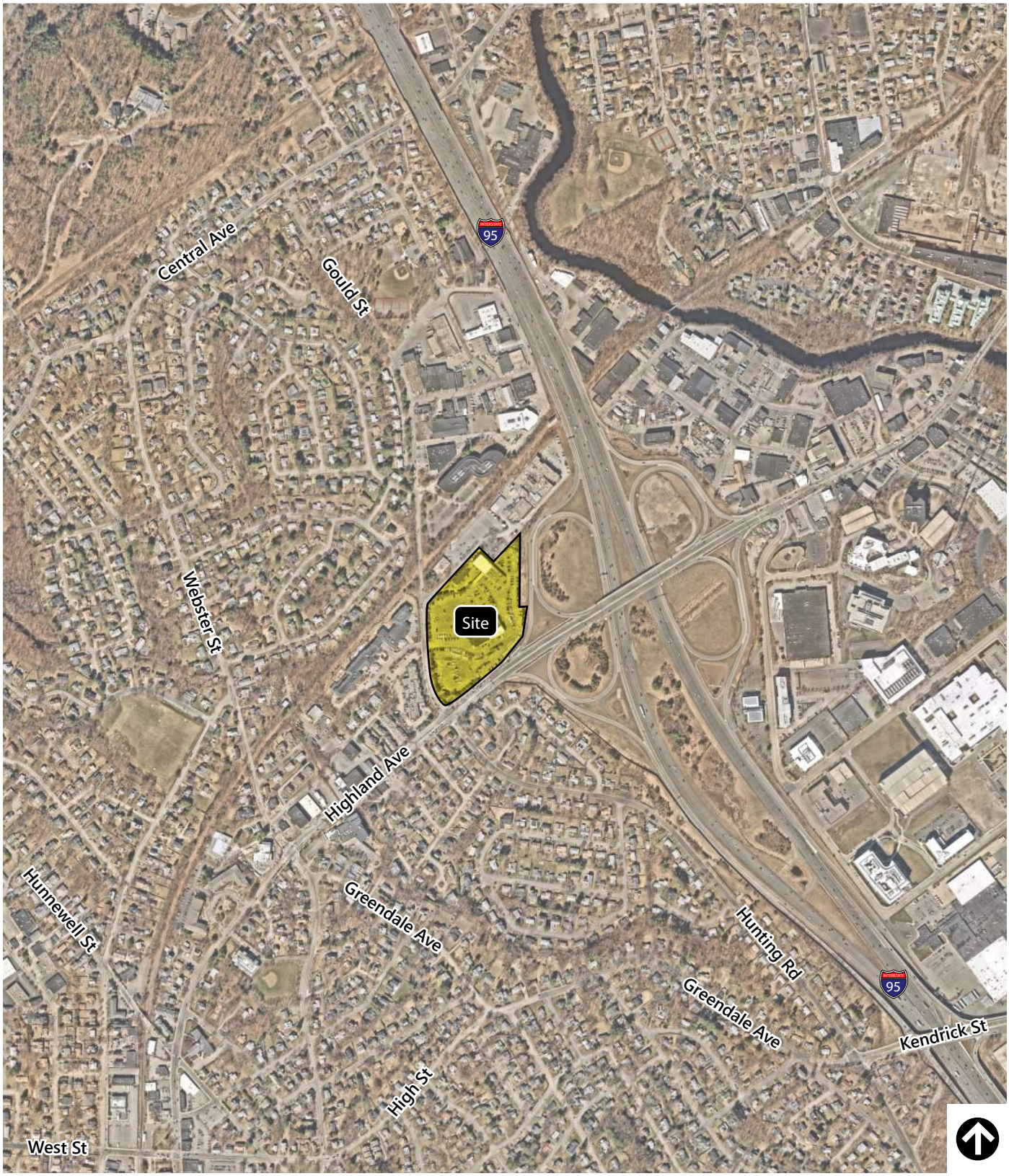
The traffic monitoring program will include collecting weekday morning and weekday evening peak period turning movement counts at the following study area intersections:

- Central Avenue at Gould Street
- Gould Street at TV Place
- Gould Street at the Project Site driveway
- Highland Avenue at Gould Street / Hunting Road

These area intersections represent the key vehicular gateways to the Project Site and are the focus of the proposed roadway mitigation.

In addition to peak period turning movement counts at the identified intersections above, the traffic monitoring program will include collecting continuous 48-hour ATR counts along Gould Street north of Highland Avenue.

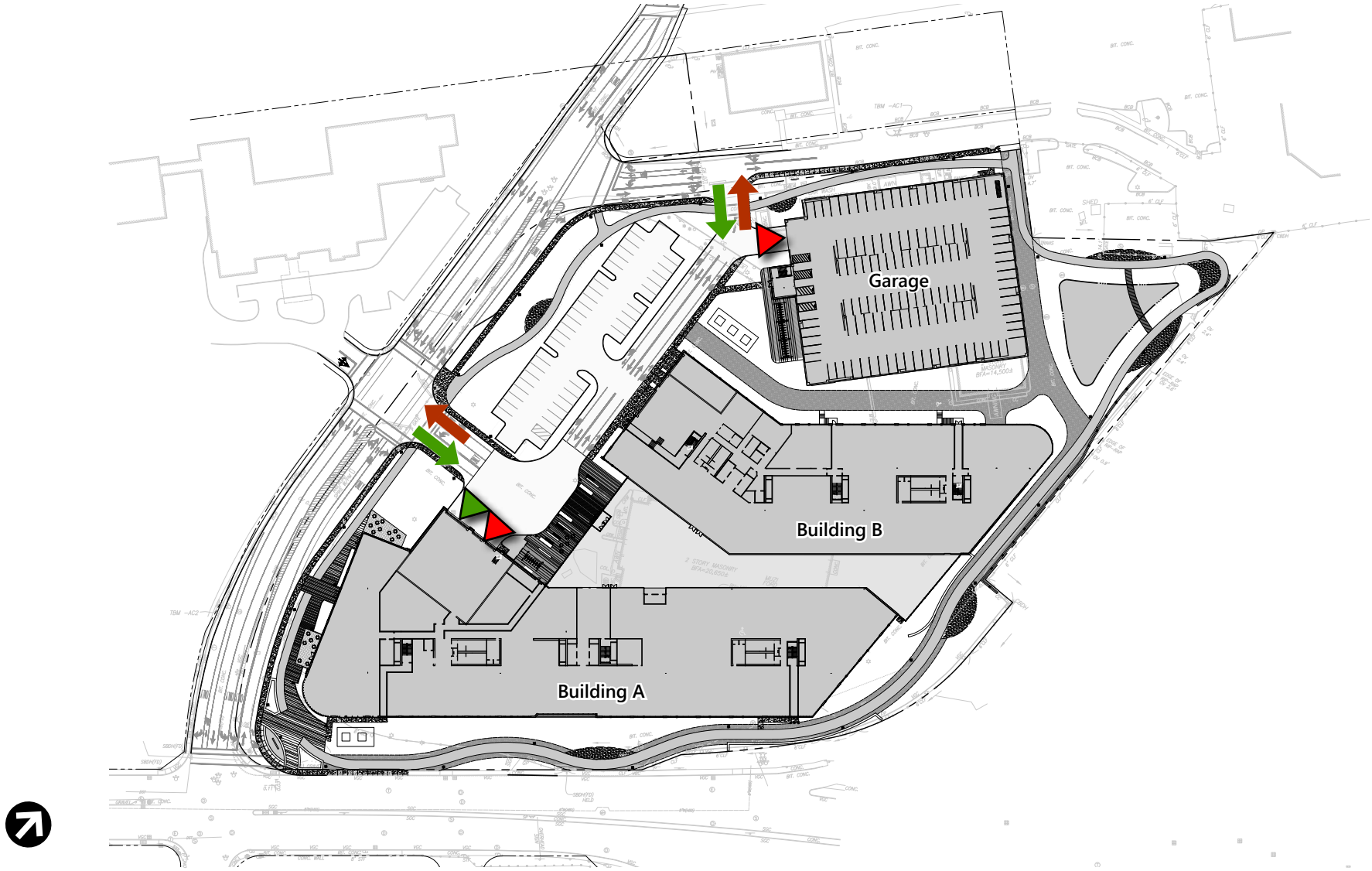
These counts will be collected on a non-holiday week, during midweek days.



Source: NearMap

Figure 2.1
Site Location Map

Highland Science Center
Needham, Massachusetts

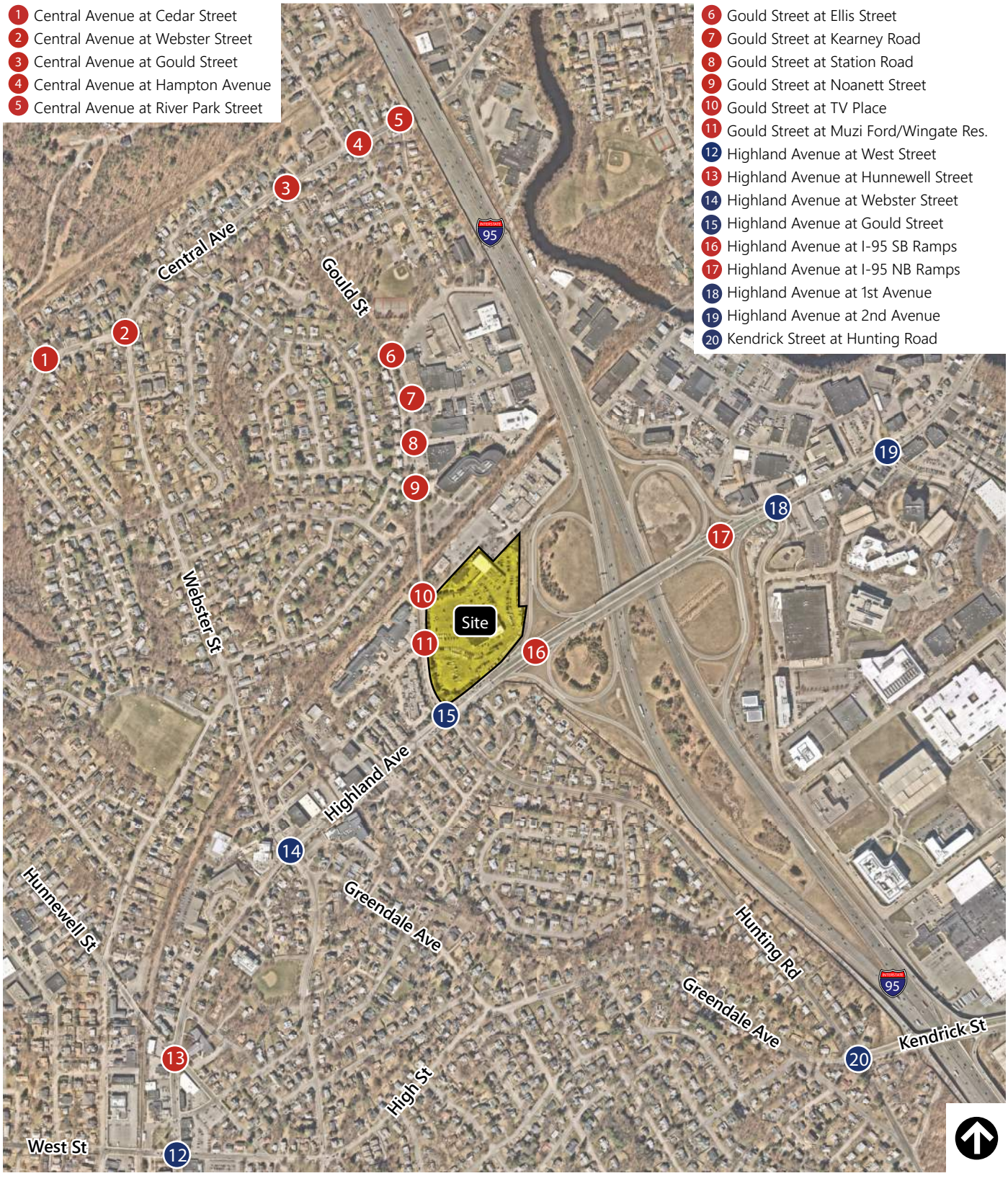


Source: Paul Finger Associates

- Vehicle Access
- Vehicle Egress
- Garage Access
- Loadings Access

Figure 2.2
Site Plan & Circulation

Highland Science Center
Needham, Massachusetts



Source: NearMap

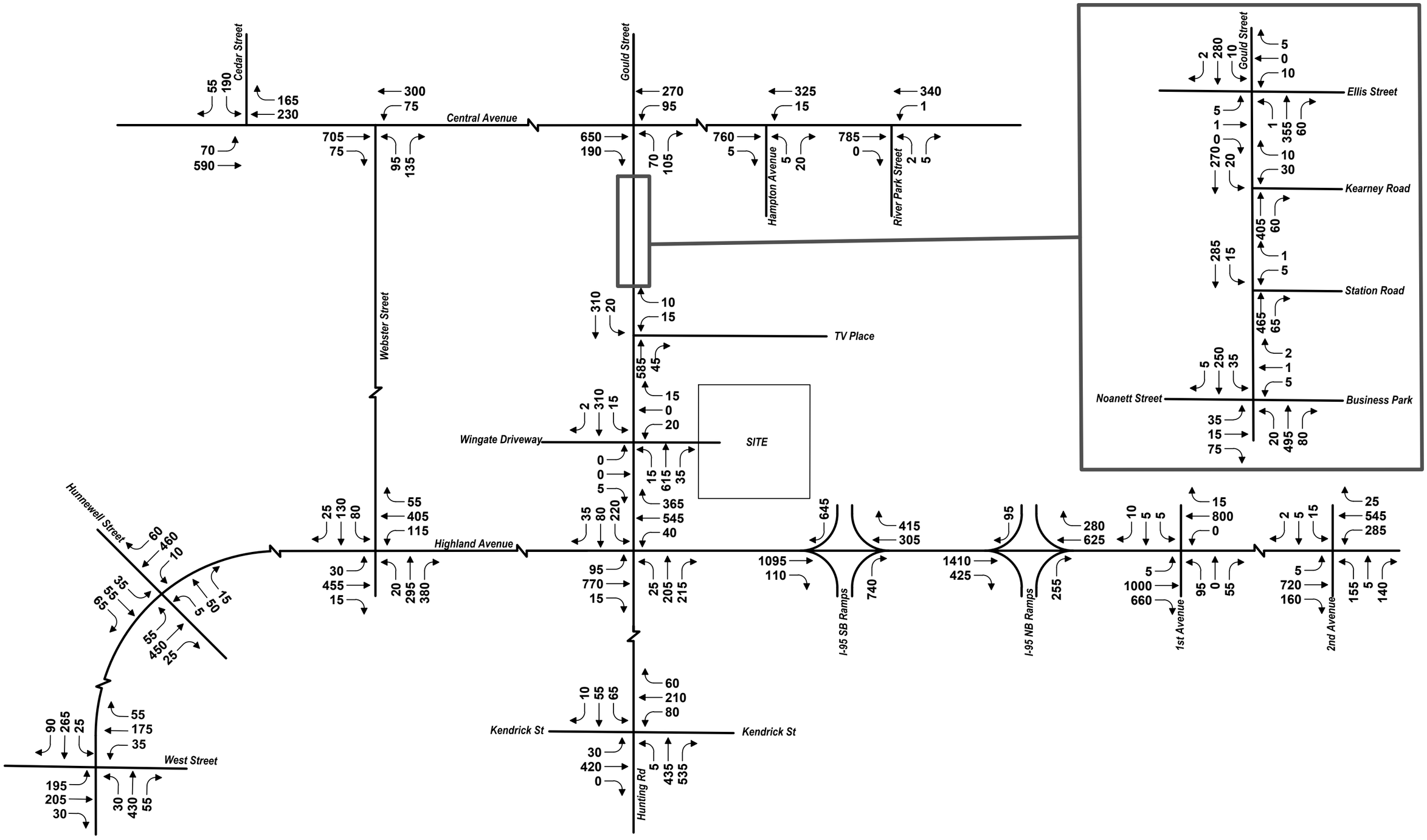
Unsignalized Intersection

Signalized Intersection

Figure 2.3

Study Area Intersections

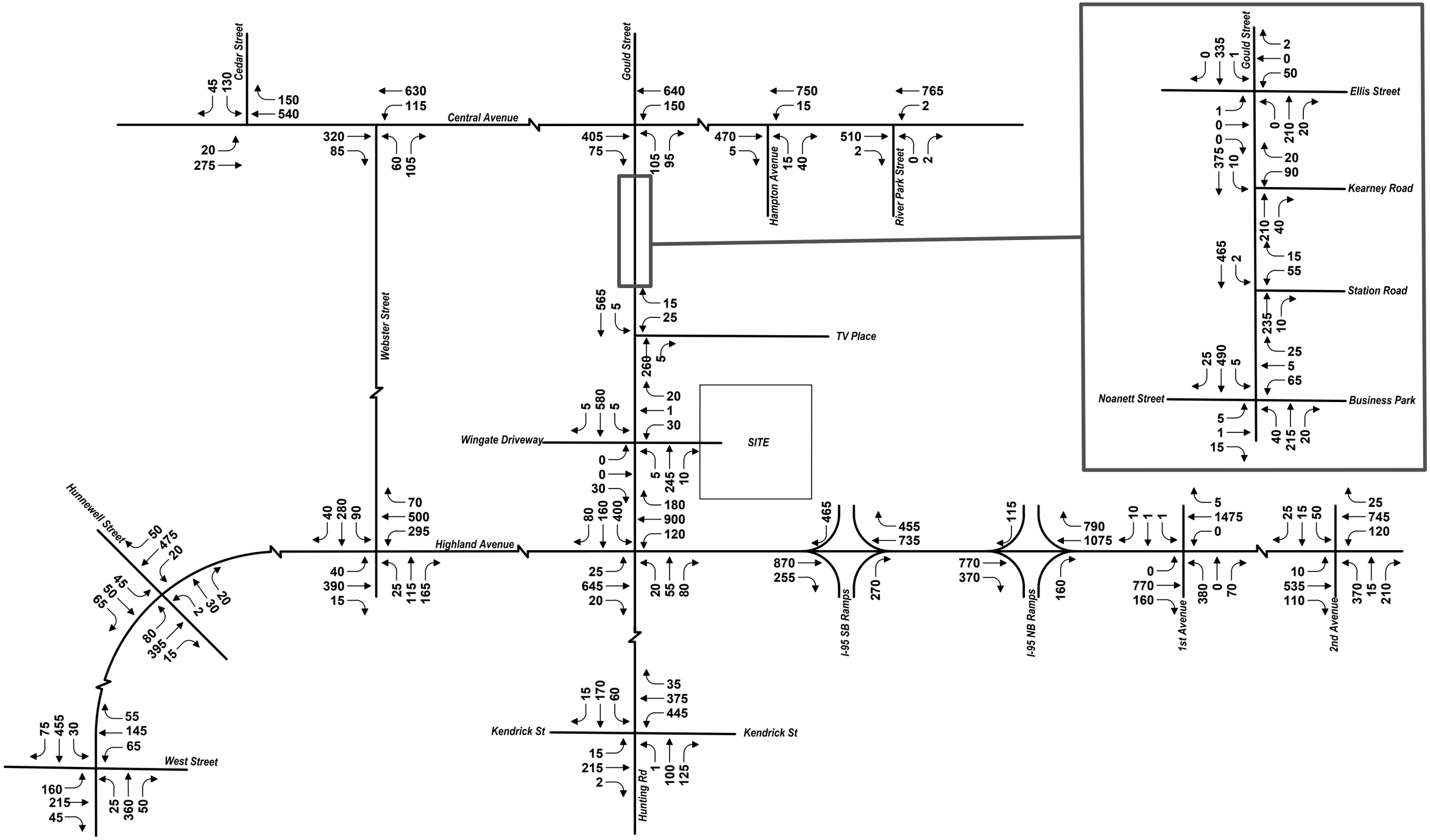
Highland Science Center
Needham, Massachusetts



Not to Scale

Existing Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

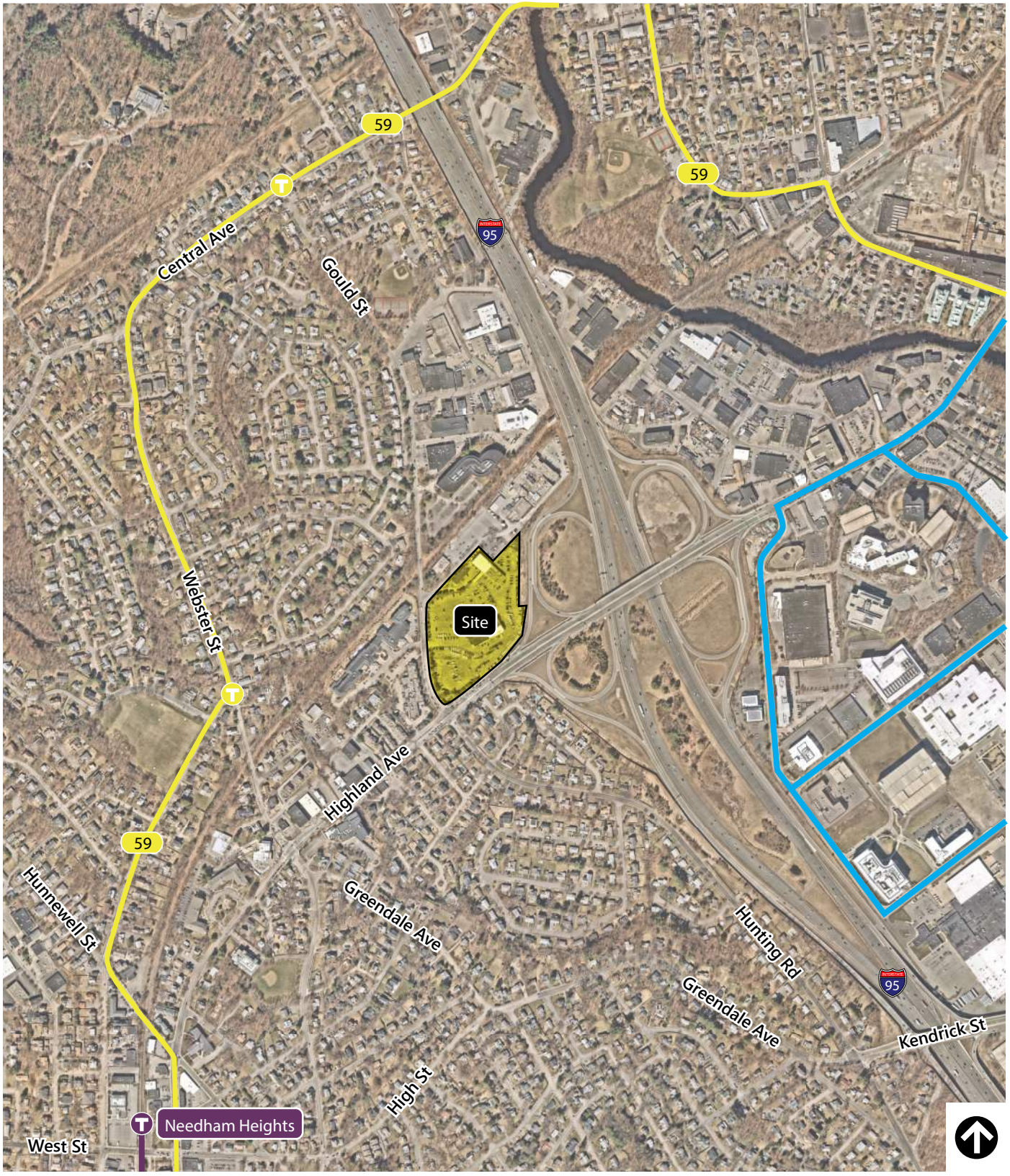
Figure 2.4



Not to Scale

Existing Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 2.5



Source: NearMap / MBTA 2021 Sytem Map

Local Bus Stop near Site

Local Bus Route

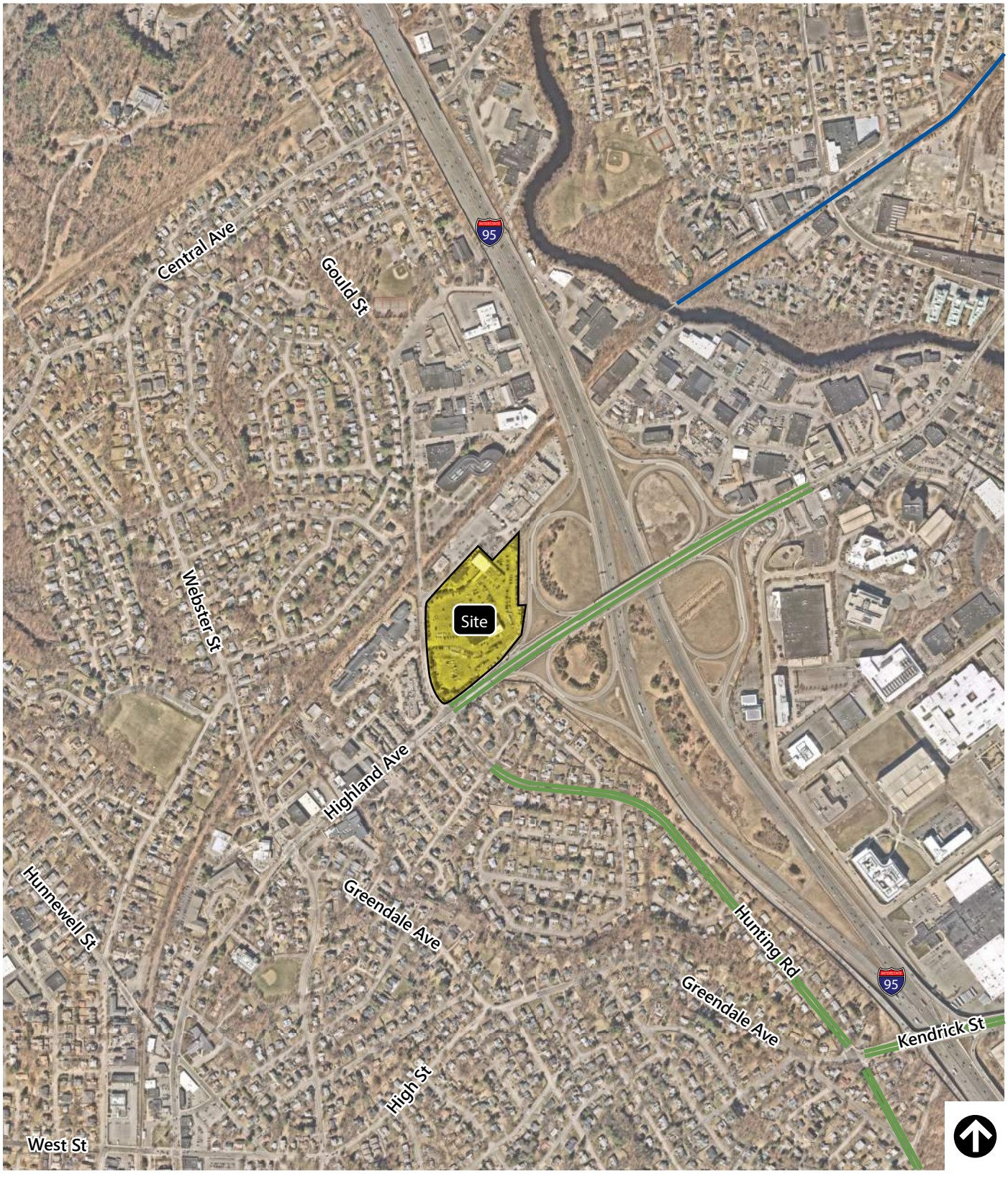
128 Business Council Needham Private Shuttle Bus Route

Commuter Rail

Figure 2.6

Public & Private Transportation

Highland Science Center
Needham, Massachusetts



Source: NearMap

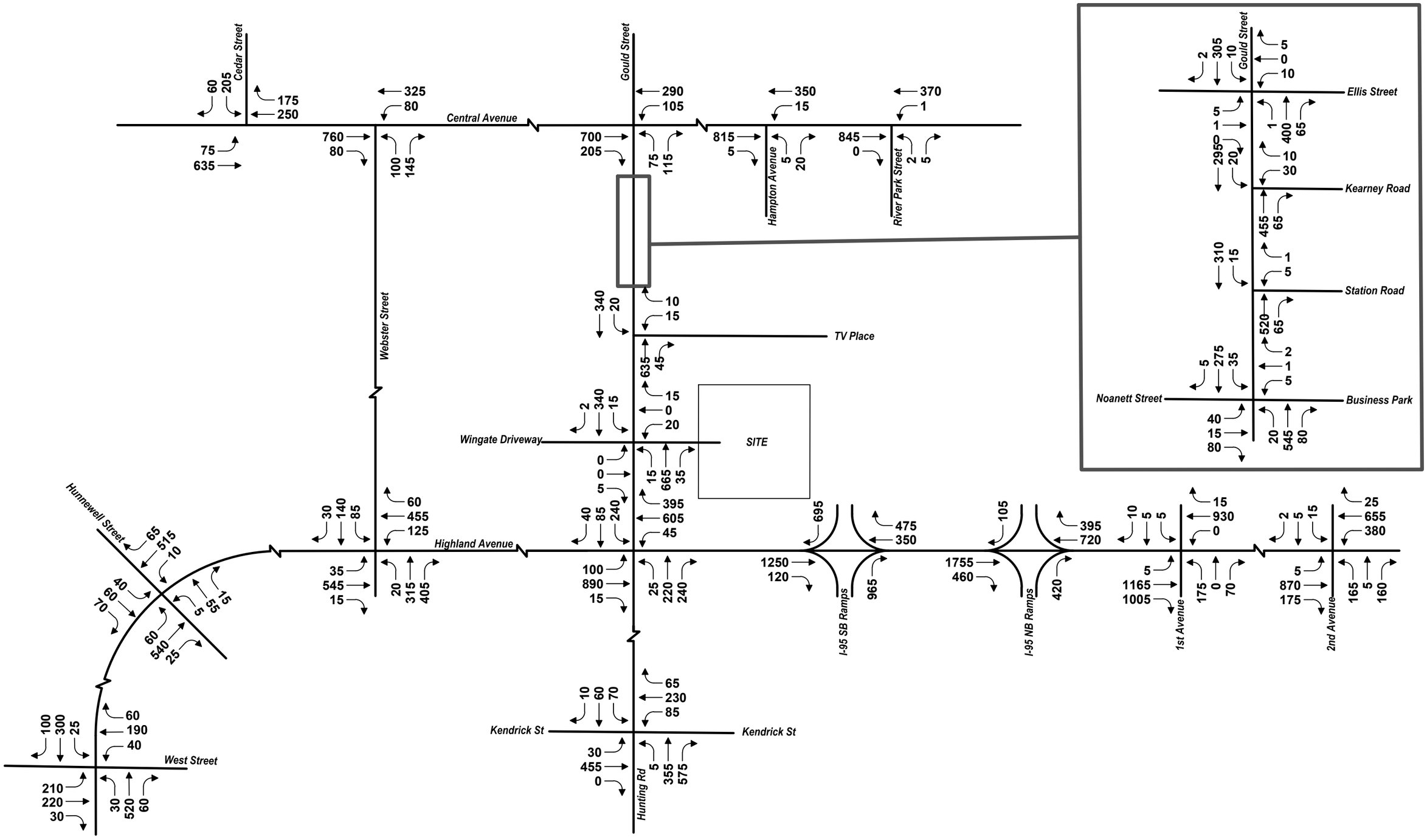
Bike Lane

Trail

Figure 2.7

Existing Bicycle Facilities

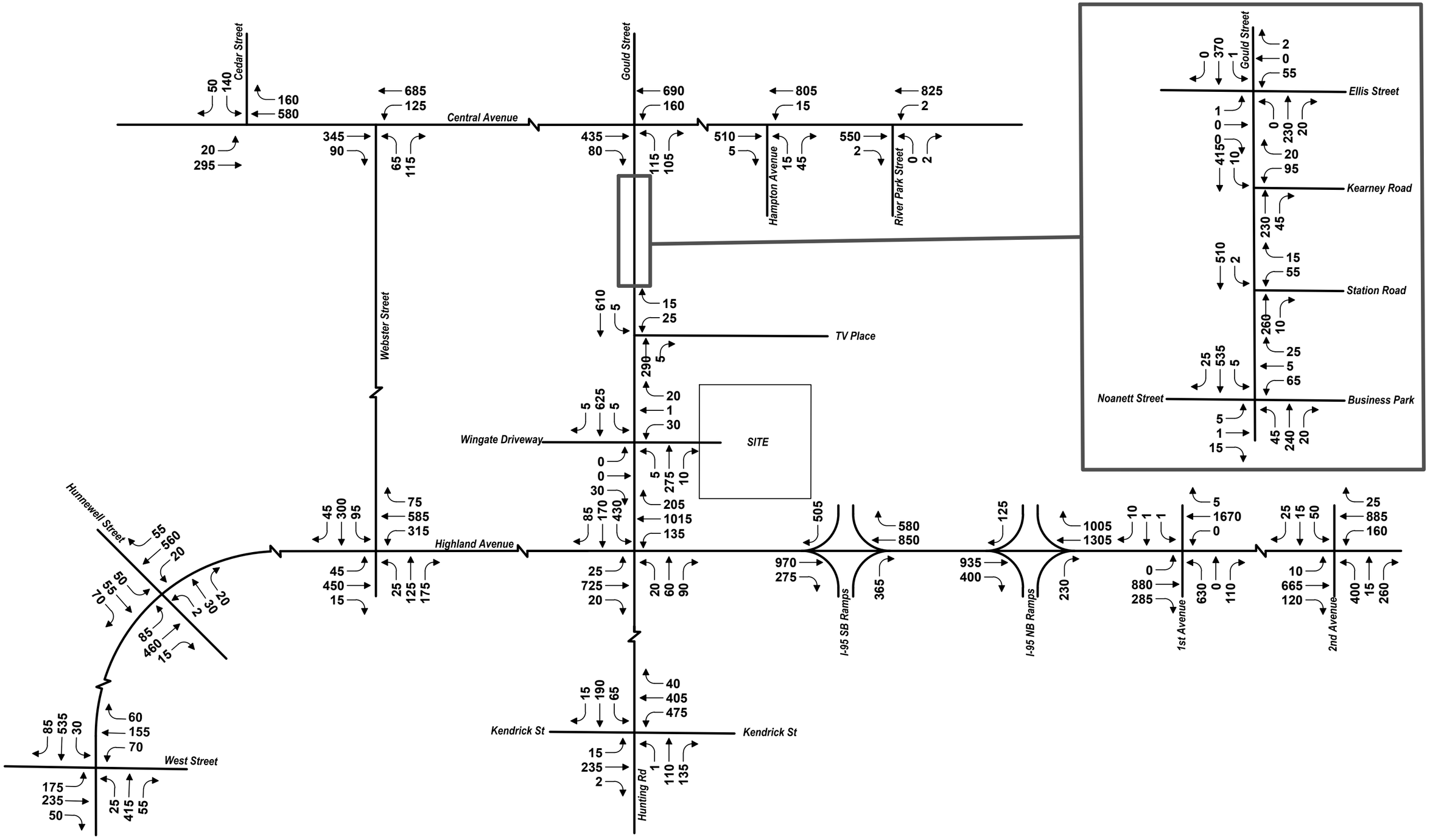
Highland Science Center
Needham, Massachusetts



Not to Scale

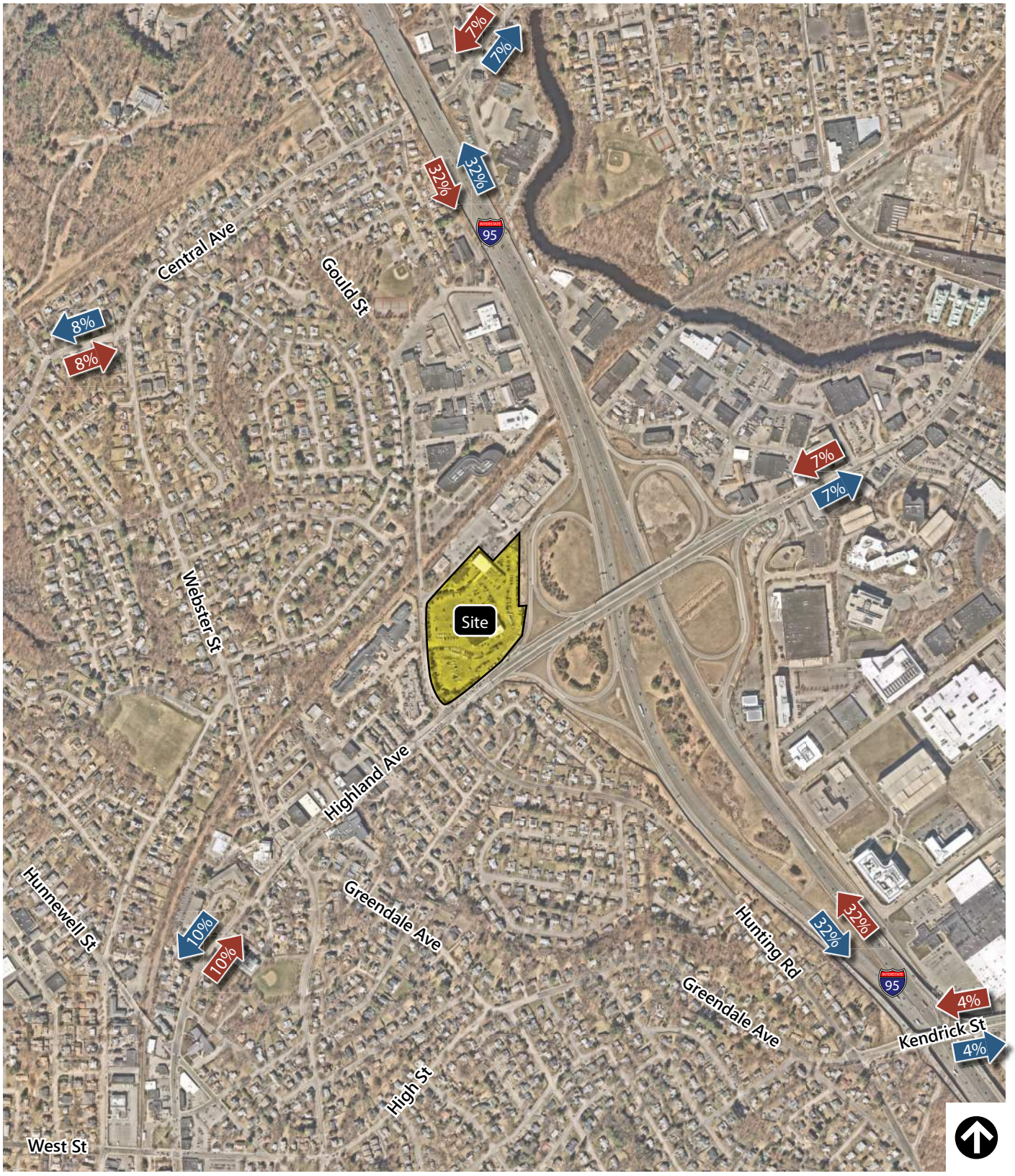
No-Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 2.8



No-Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 2.9



Source: NearMap

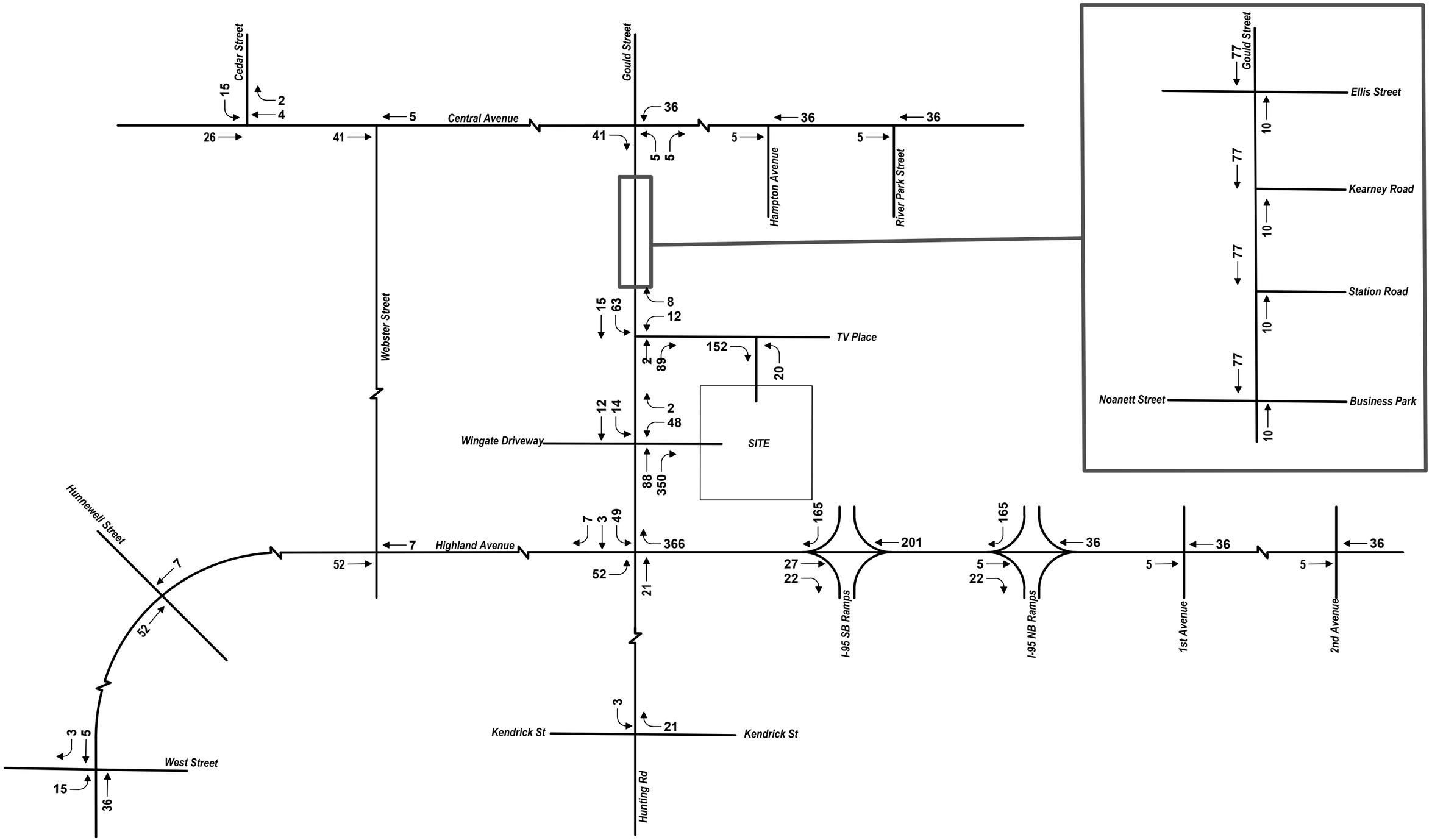
% Outbound

% Inbound

Figure 2.10

Trip Distribution

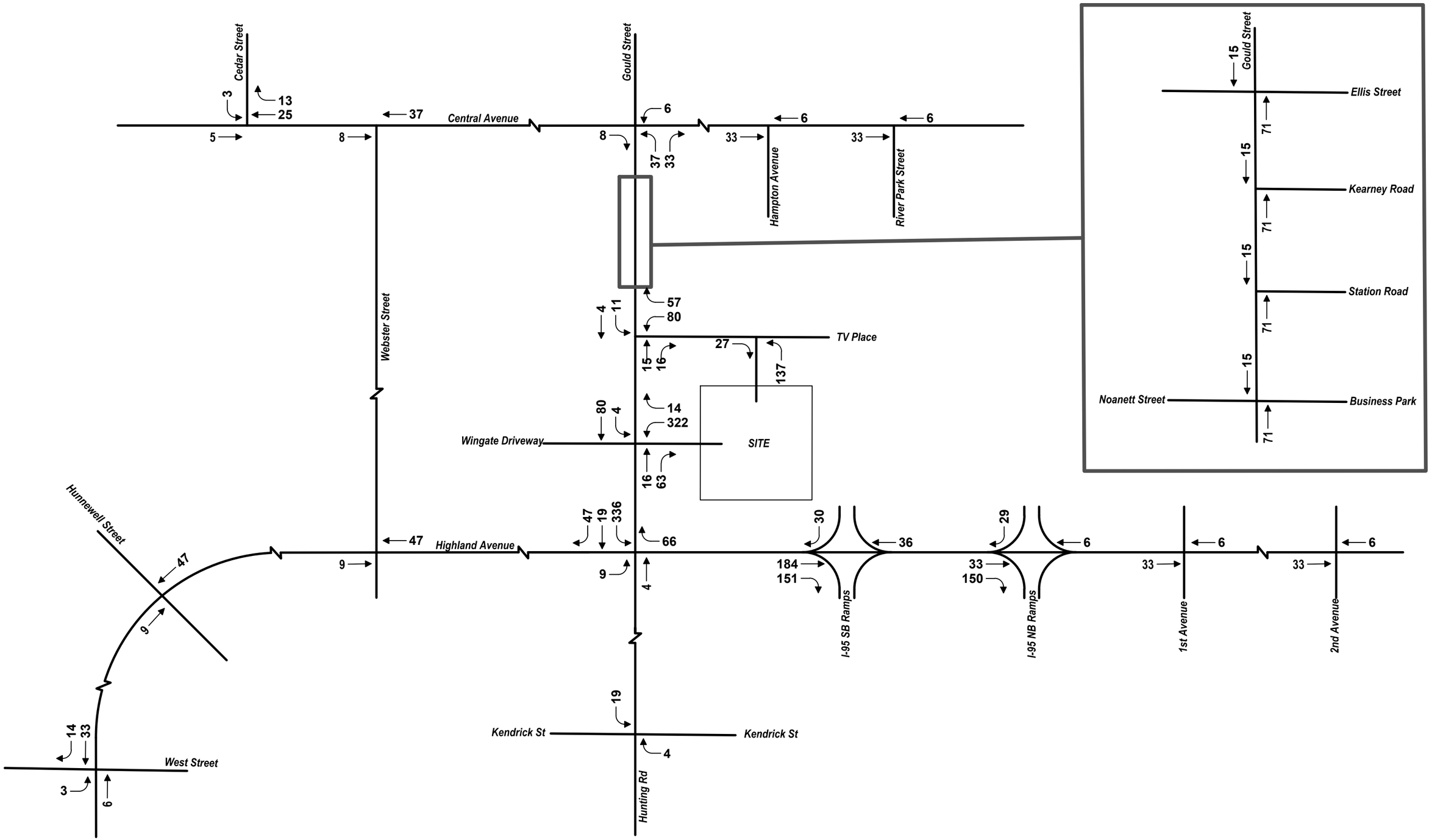
Highland Science Center
Needham, Massachusetts



Not to Scale

Project Generated Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

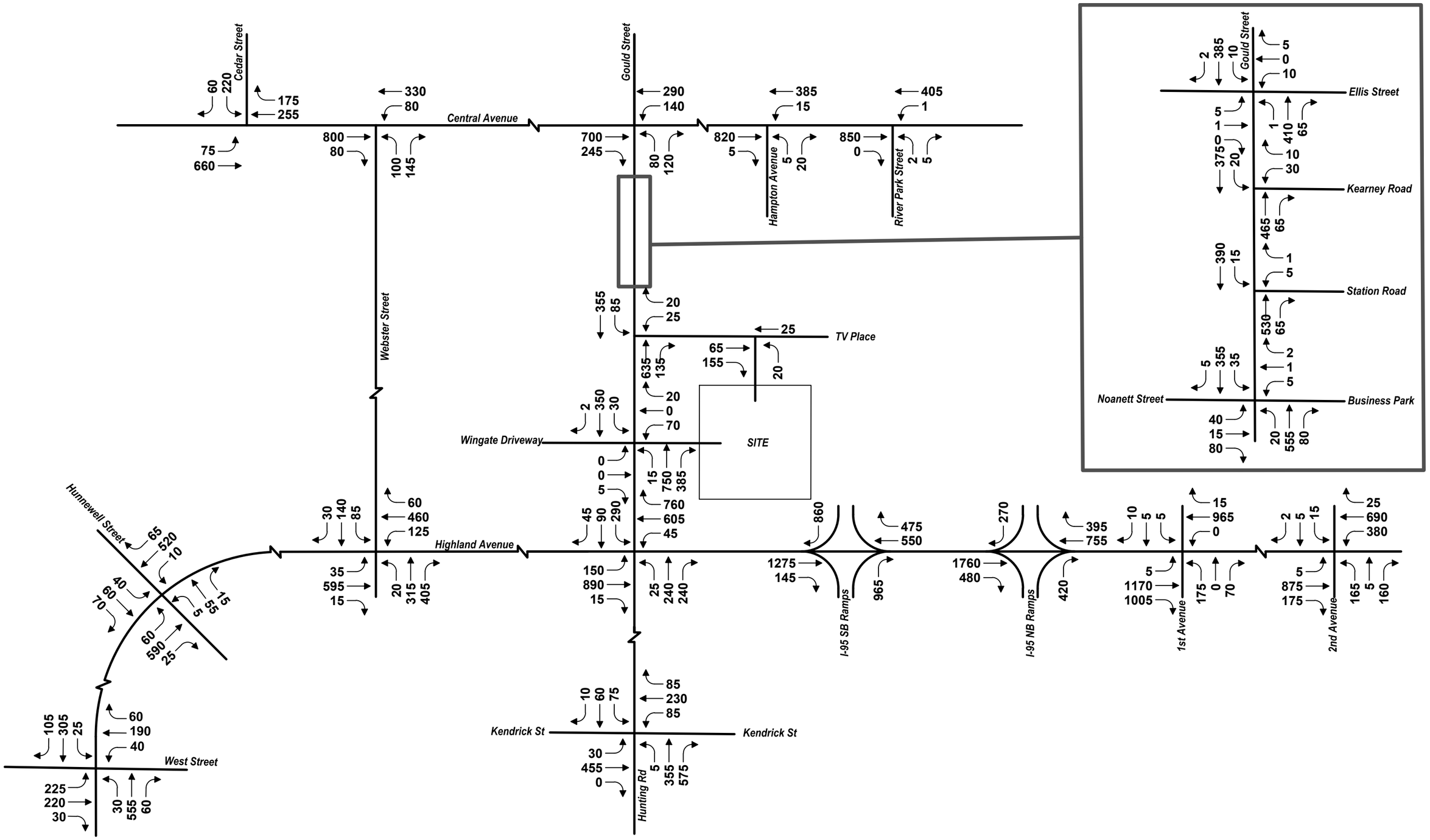
Figure 2.11



Not to Scale

Project Generated Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

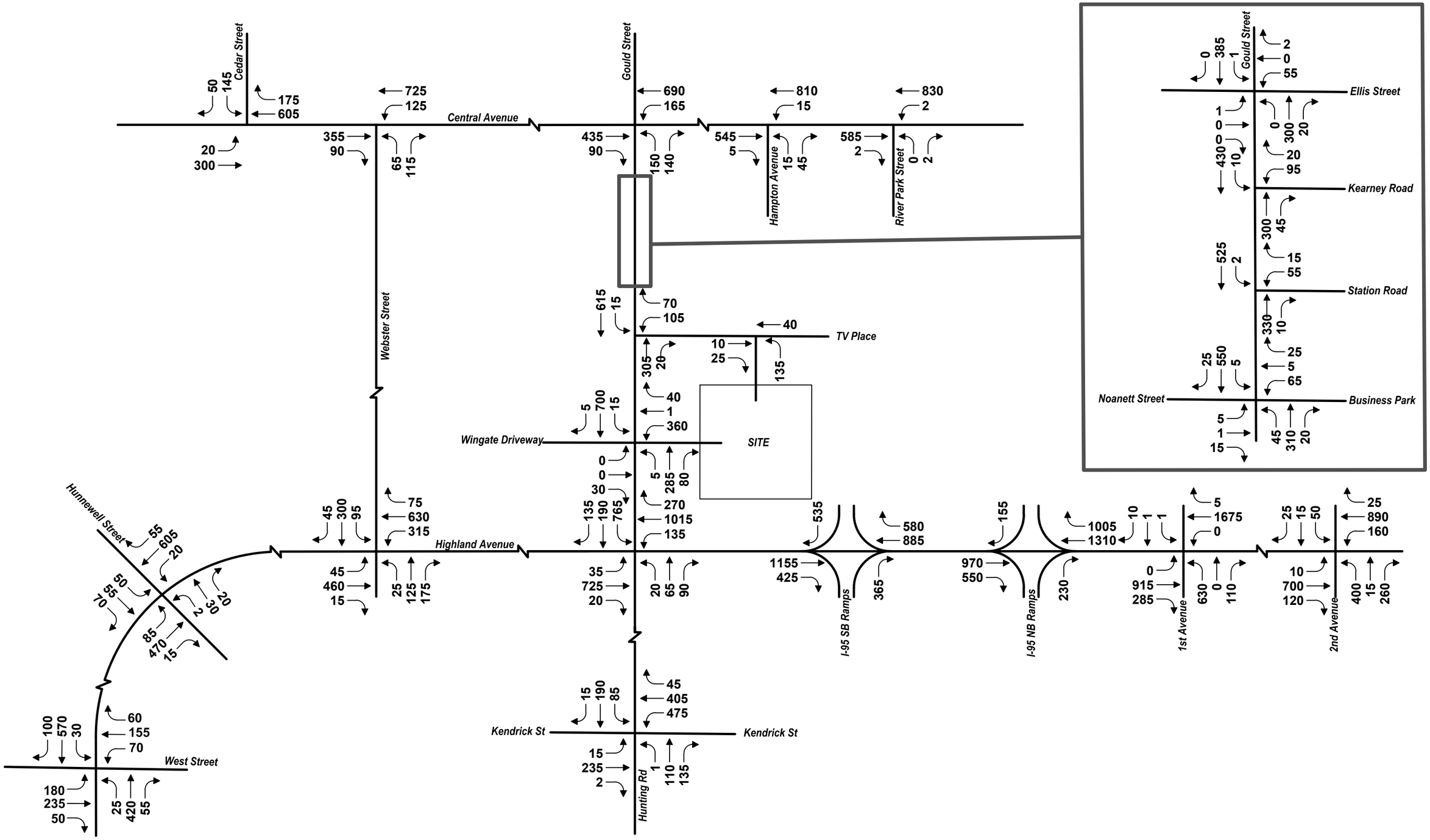
Figure 2.12



Not to Scale

Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

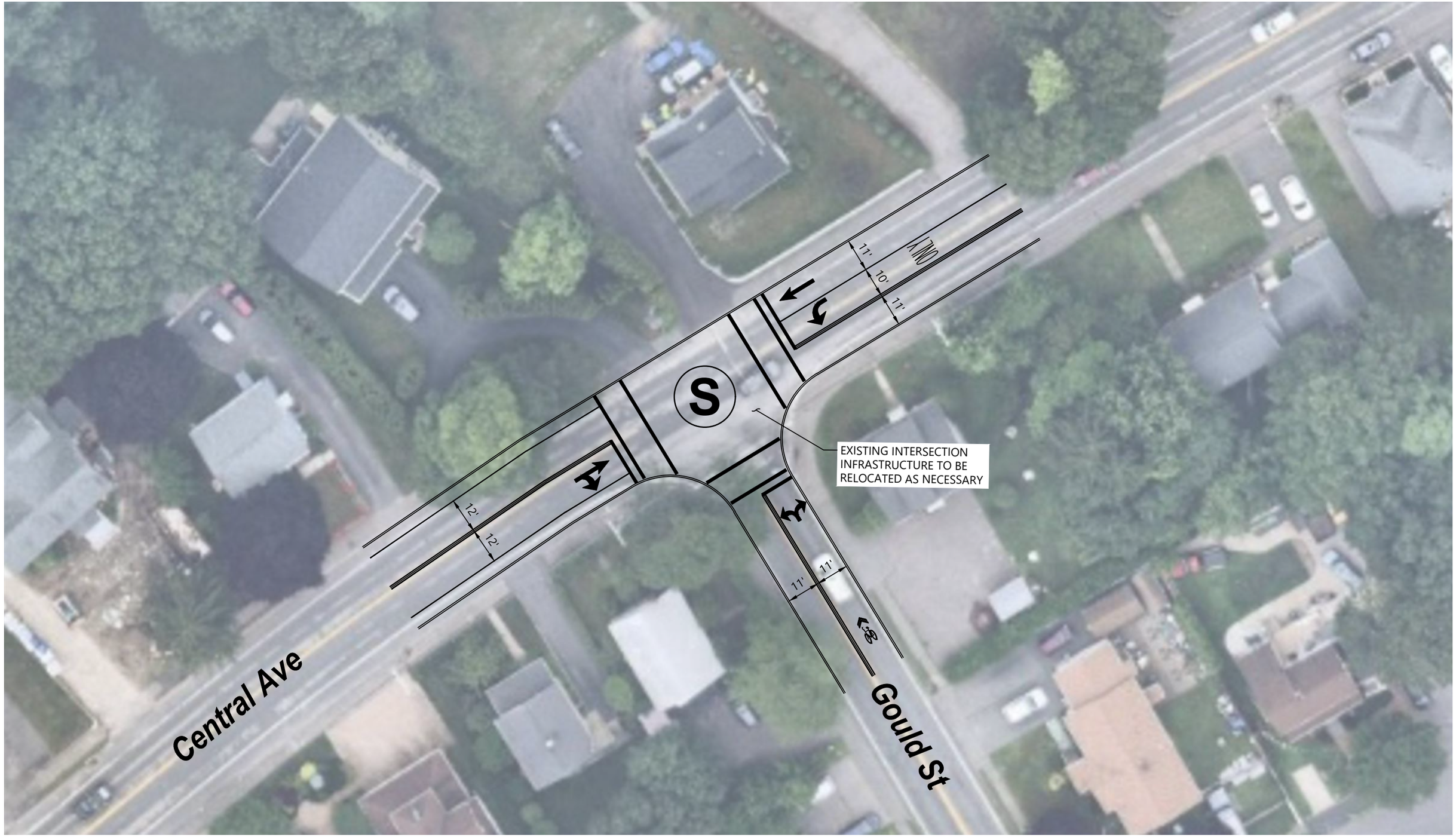
Figure 2.13



Not to Scale

Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 2.14



NOT FOR CONSTRUCTION

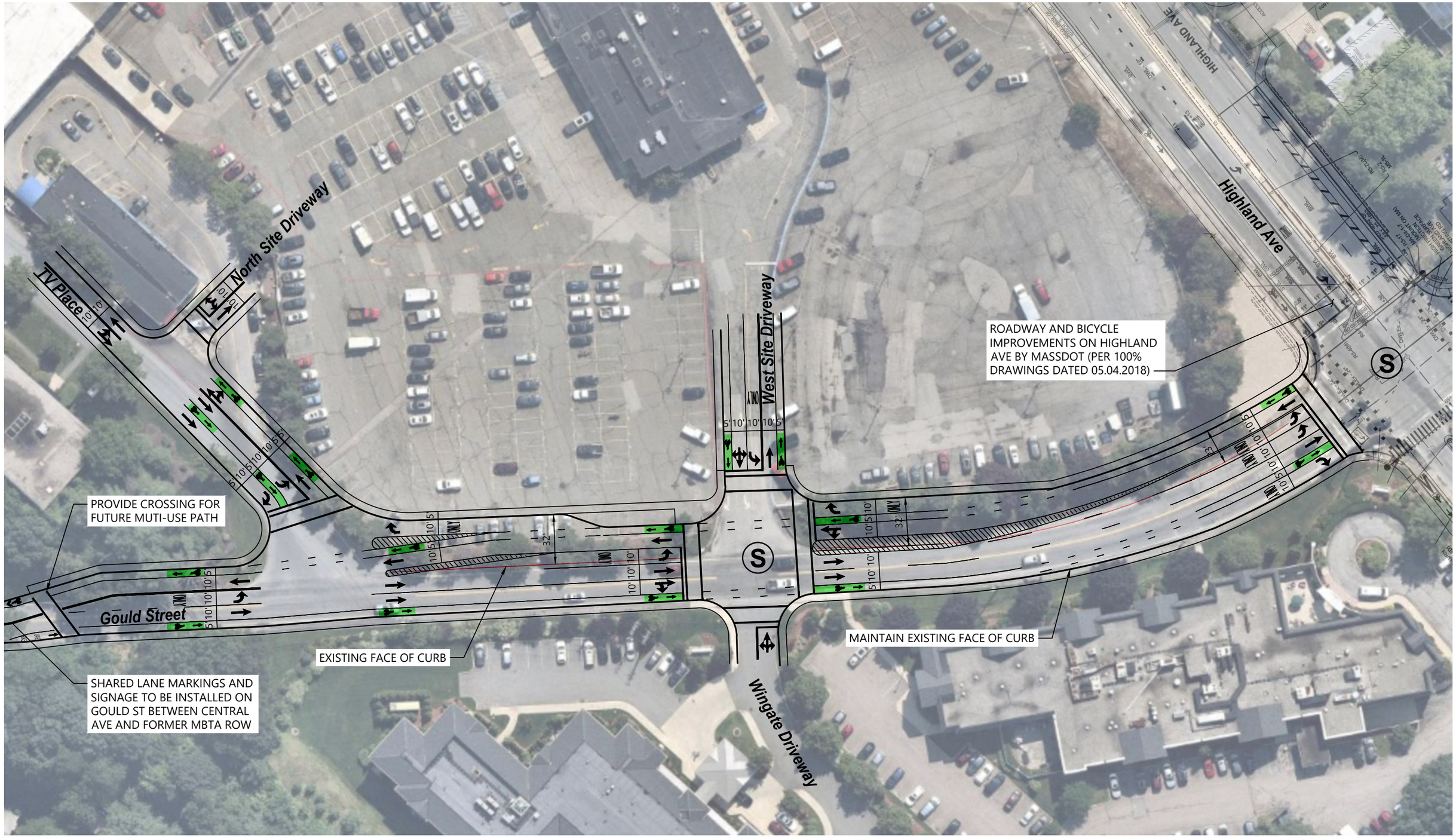
0 15 30 60 Feet

vhb

Proposed Intersection Improvements
Central Avenue at Gould Street
Highland Science Center
Needham, Massachusetts

Figure 2.15

03.30.22 - MEPA



NOT FOR CONSTRUCTION

0 30 60 120 Feet

Proposed Intersection Improvements **Figure 2.16**
Gould Street between TV Place and Highland Avenue
Highland Science Center
Needham, Massachusetts 03.30.22 - MEPA

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: Automated Car Wash
LANDUSE CODE: 948
SETTING/LOCATION:
JOB NAME: **557 Highland Avenue**
JOB NUMBER:

Independent Variable --- 1,000 Sq. Feet Gross Floor Area

FLOOR AREA (KSF): 4.60

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends: Average	Low	High	Independent Variable Range: Average	Low	High	Directional Distribution: Enter	Exit
DAILY	--	--	--	--	--	--	--	--	--	--
AM PEAK OF GENERATOR	--	--	--	--	--	--	--	--	--	--
PM PEAK OF GENERATOR	2	--	11.66	8.35	16.63	5.00	4.39	6.59	50%	50%

TRIPS:

	BY AVERAGE: Total	Enter	Exit	BY REGRESSION: Total	Enter	Exit
DAILY	--	--	--	--	--	--
AM PEAK OF GENERATOR	--	--	--	--	--	--
PM PEAK OF GENERATOR	54	27	27	--	--	--

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends: Average	Low	High	Independent Variable Range: Average	Low	High	Directional Distribution: Enter	Exit
DAILY	--	--	--	--	--	--	--	--	--	--
PEAK OF GENERATOR	3	--	30.40	14.20	37.75	3.00	1.69	5.00	50%	50%

TRIPS:

	BY AVERAGE: Total	Enter	Exit	BY REGRESSION: Total	Enter	Exit
DAILY	--	--	--	--	--	--
PEAK OF GENERATOR	140	70	70	--	--	--

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends: Average	Low	High	Independent Variable Range: Average	Low	High	Directional Distribution: Enter	Exit
DAILY	--	--	--	--	--	--	--	--	--	--
PEAK OF GENERATOR	--	--	--	--	--	--	--	--	--	--

TRIPS:

	BY AVERAGE: Total	Enter	Exit	BY REGRESSION: Total	Enter	Exit
DAILY	--	--	--	--	--	--
PEAK OF GENERATOR	--	--	--	--	--	--

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: Automobile Sales (New)
LANDUSE CODE: 840
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **557 Highland Avenue**
JOB NUMBER:

Independent Variable --- 1,000 Sq. Feet Gross Floor Area

FLOOR AREA (KSF): 35.15

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	18	0.80	27.84	14.98	41.78	36	15.00	77.00	50%	50%
AM PEAK OF GENERATOR	40	0.65	2.15	0.59	4.13	32	9.34	80.00	54%	46%
PM PEAK OF GENERATOR	39	0.61	2.65	0.89	5.64	33	9.34	80.00	46%	54%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	980	490	490	978	489	489
AM PEAK OF GENERATOR	76	41	35	75	40	34
PM PEAK OF GENERATOR	93	43	50	92	42	50

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	1	--	52.24	52.24	52.24	33	33	33	50%	50%
PEAK OF GENERATOR	4	0.92	4.02	1.41	5.64	21	16	33	50%	50%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	1,838	919	919	--	--	--
PEAK OF GENERATOR	141	71	71	206	103	103

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	1	--	21.73	21.73	21.73	33	33	33	50%	50%
PEAK OF GENERATOR	--	--	--	--	--	--	--	--	--	--

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	764	382	382	--	--	--
PEAK OF GENERATOR	--	--	--	--	--	--

\\vhb.com\gbl\proj\Boston\15306.00\tech\Crash Data\Crash Diagrams.dwg

SYMBOLS

- Moving Vehicle
- Backing Vehicle
- Non-Involved Vehicle

Involved	Non-Involved	
		Pedestrian
		Bicycle
		Animal
		Direction of Motion
		Parked Vehicle
		Fixed Object

TYPES OF CRASH

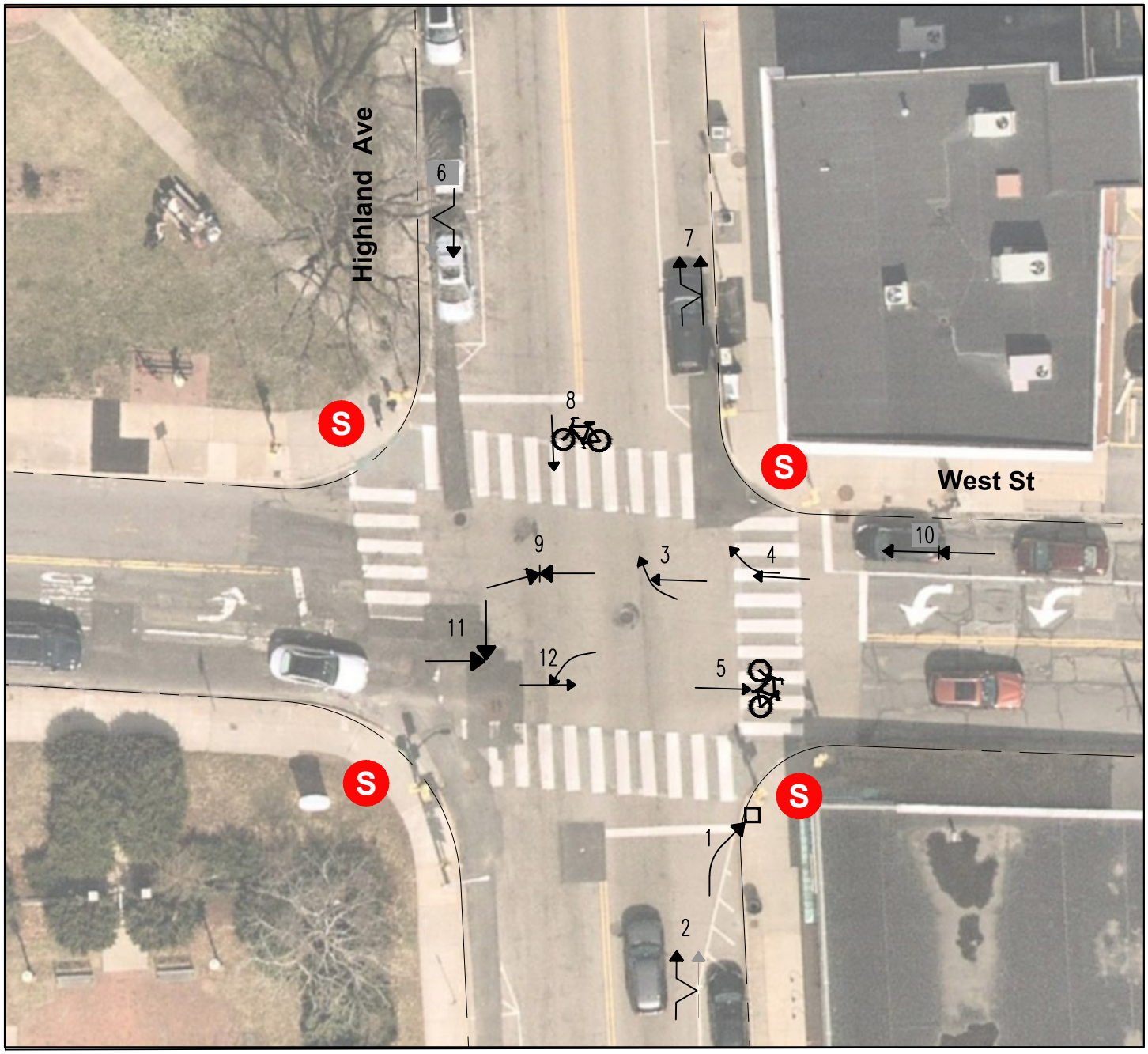
- Head on
- Rear End
- Angle
- Turning Movement
- Sideswipe
- Out of Control
- Night Time Crash

SEVERITY

- Injury
- Fatal

TRAFFIC CONTROL

- Traffic Signal Post
- Stop Sign
- Yield Sign
- One Way Sign



Not to Scale

TIME PERIOD ANALYZED: 2017-2019
SOURCE OF CRASH REPORTS: Needham Police Dept.

vhb

Collision Diagram
Highland Avenue at
West Street
Needham, MA

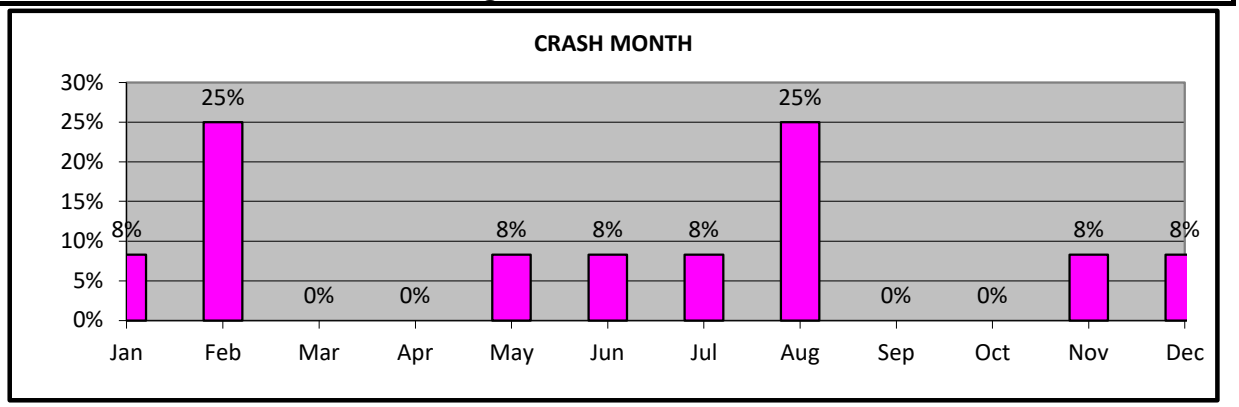
Crash Data Summary Table

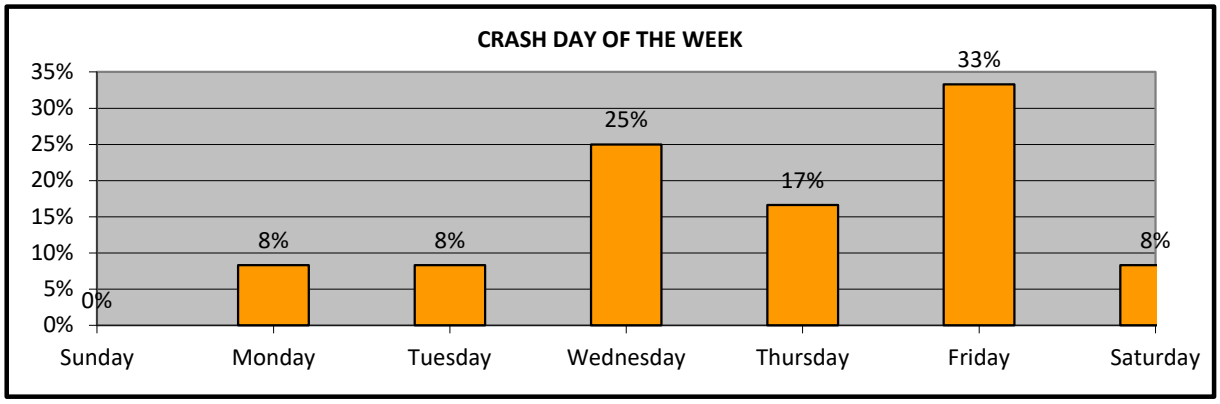
Highland Ave at West St
2017 - 2019

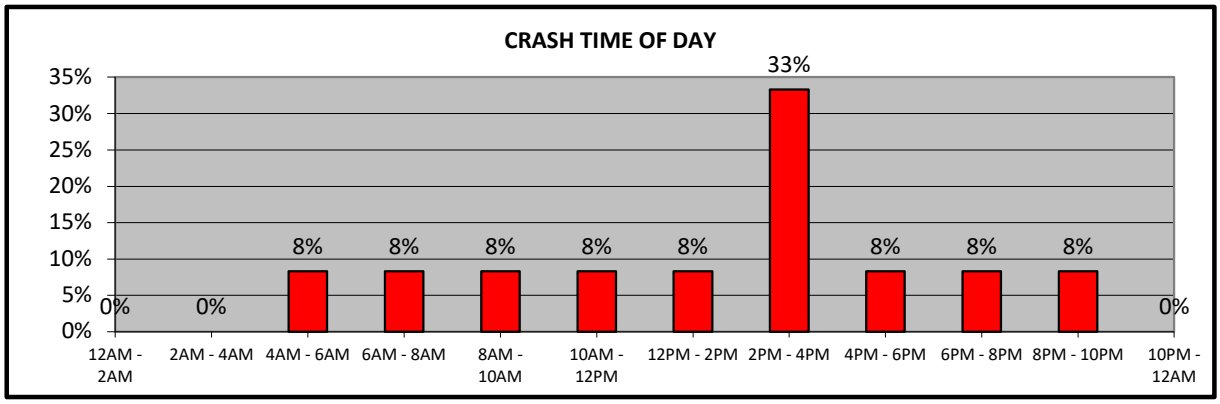
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	D1 Age	D2 Age	D3 Age	D4 Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	#	#	
1	02/03/17	Friday	4:11 PM	Single vehicle crash	Daylight	Clear	Dry	Inattention	Unknown	Unknown			Tractor trailer struck and knocked down a light post, then continued driving. Truck took a right from Highland Ave onto West St. Light portion of the traffic pole was knocked down and hanging on pole by 3 wires.
2	02/08/17	Wednesday	5:45 AM	Sideswipe, same direction	Daylight	Clear	Ice	No improper driving	Unknown	Unknown			Vehicle #2 was traveling north on Highland Ave. Flash freeze on the roads at the time. Vehicle #2 stopped for red light signal and its trailer slid sideways stricking Vehicle #1 which was parked.
3	05/19/17	Friday	2:09 PM	Angle	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	Unknown			Vehicle #2 was stopped at red light at the intersection of Highland Ave and West St. Vehilce #2 was in a marked left turn only lane. To the right of Vehicle #2 is a separate lane for right turns and for traffic going straight. When the ligh turned green, Vehicle #2 took a right turn, failing to follow the marked lane, and caused a collision with Vehicle #1. Vehicle #1 was to the right of Vehicle #2 at the red light. Property damage, no injury.
4	07/19/17	Wednesday	3:59 PM	Sideswipe, same direction	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Bus turning right from West St to Highland Ave. Rear of Bus struck the right side of Vehicle that was sitting to the left of it. No injuries.
5	08/28/17	Monday	10:45 AM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			Vehicle crash involving a cyclist. Vehicle #1 was moving eastbound on West St towards Highland Ave with a green light. Cyclist entered crosswalk to cross the intersection. Property damaged, no injury.
6	02/07/19	Thursday	8:41 PM	Angle	Dark - lighted roadway	Clear	Dry	Unknown	Unknown	Unknown			Hit and run crash to a parked vehicle. Vehicle parked on Corner of Highland Ave facing south, truck hit her vehicle while taking a left turn into Trader Joes.
7	08/15/19	Thursday	2:57 PM	Sideswipe, same direction	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Hit and run. No injuries were reported. Vehicle #1 was attempting to park on Highland Ave, tractor trailer truck was turning onto Highland Ave from West St and clipped the driver's side of Vehicle #1.
8	08/23/19	Friday	12:09 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			Vehicle #1 was stopped at the red light ton West St in the left turn only lane. The cyclist entered the crosswalk just before the walk signal ended and was proceding thru the crosswalk. The light turned to green and Vehicle #1 started the left turn and was about half way through the crosswalk when the cyclist ran into the passenger side of vehicle #1. The cyclist fell off the bicycle on the ground. No injuries or damages.
9	12/07/19	Saturday	8:00 AM	Head on	Daylight	Clear	Dry	Other improper action	Unknown	Unknown			Vehicle #1 was turning left to go northbound onto Highland Ave from West St. Vehicle #2 was travelling westbound on West St crossing over Highland Ave. Vehicle #2 was struck vehicle #1 as it was making the turn. Both vehicles sustained moderate damage, but did not have to be towed from the scene. No injuries were reported.
10	01/25/17	Wednesday	6:11 PM	Rear-end	Dark - lighted roadway	Clear	Dry	Unknown	Unknown	Unknown			No injuries. Vehicle #1 was unable to stop when Vehicle #2 in front of her stopped. Vehicle #1 had heavy front end damage, there was damage to the rear of vehicle #2.
11	06/01/18	Friday	6:38 AM	Angle	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	Unknown			Vehicle #2 was traveling north on Highland Ave and was struck by Vehicle #1 that was traveling WB on West St.
12	11/13/18	Tuesday	3:49 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			No injuries. Vehicle #1 was traveling down West St and turning left. Vehicle #2 was on West St going towards Webster St when the operator of Vehicle #1 turned left and hit vehicle #2. Vehicle #1 was removed by tow.

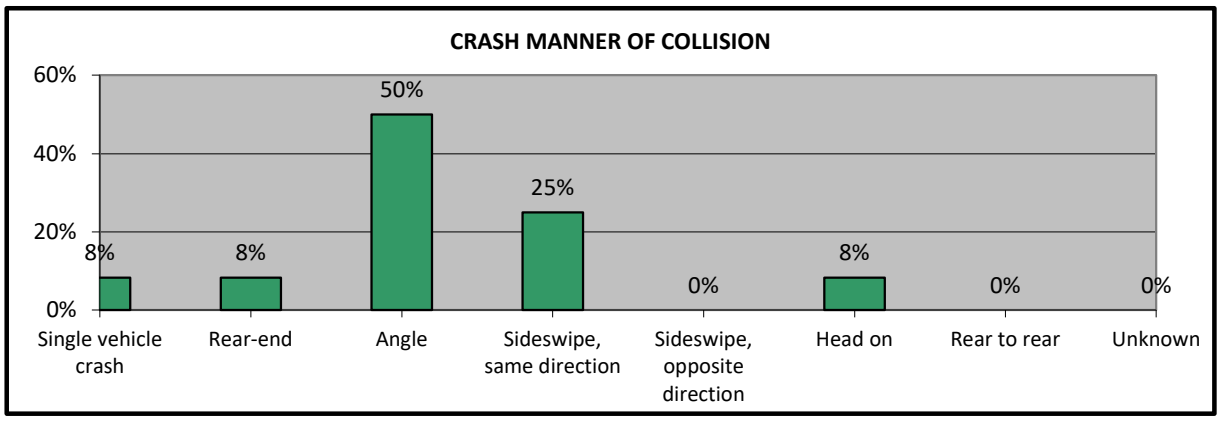
Crash Data Summary Charts

Highland Ave at West St



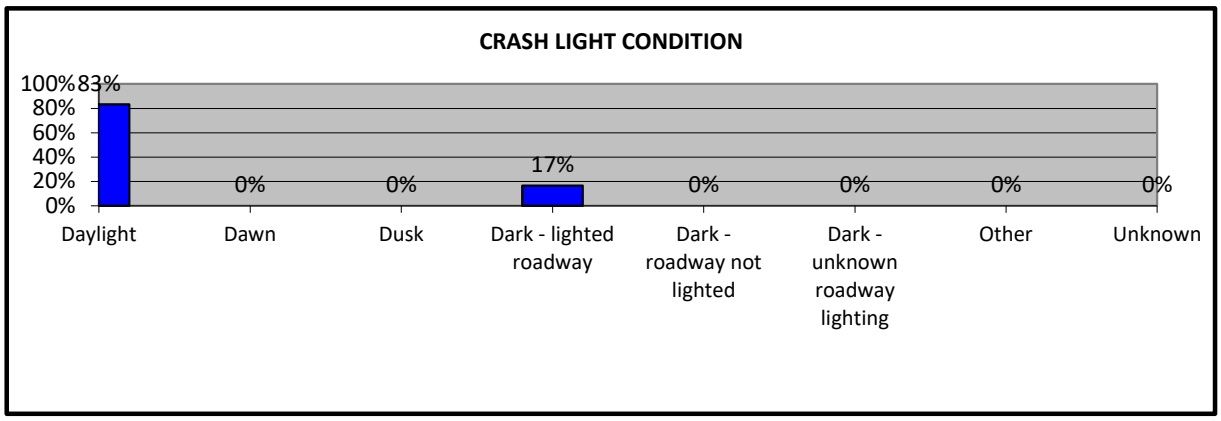


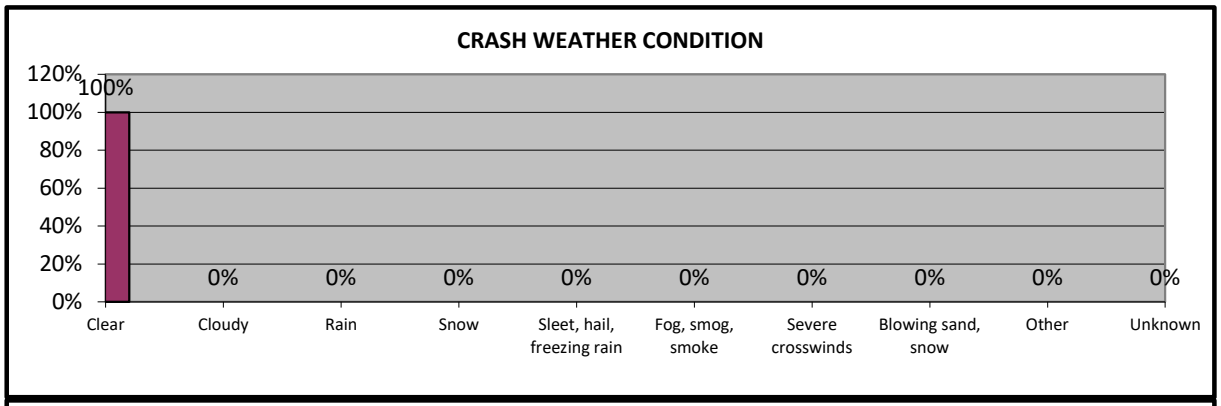


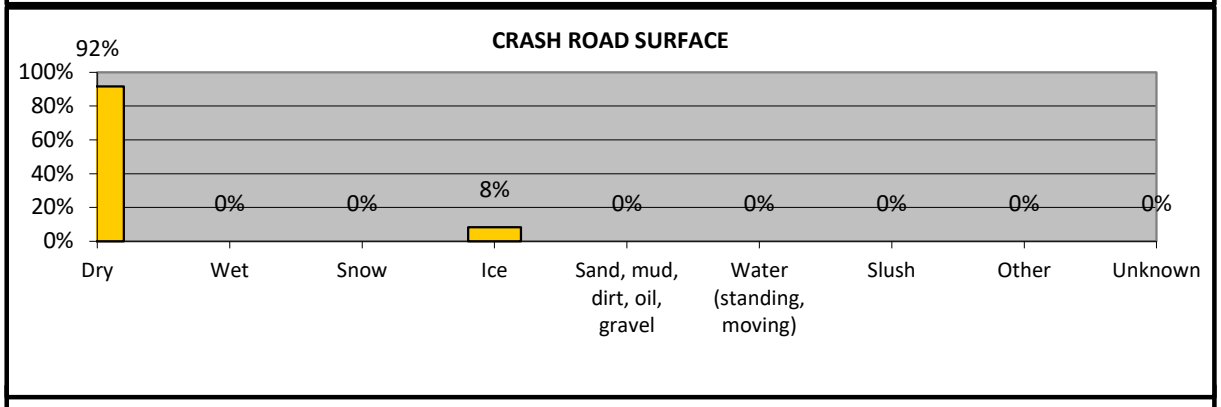


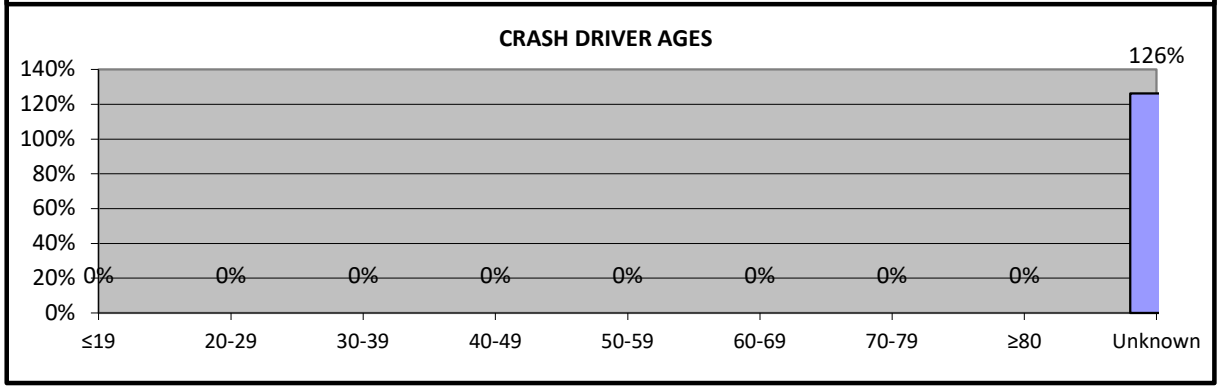
Crash Data Summary Charts

Highland Ave at West St









\\vhb\gbl\proj\Boston\15306.00\tech\Crash Data\Crash Diagrams.dwg

SYMBOLS

- Moving Vehicle
- Backing Vehicle
- Non-Involved Vehicle

Involved	Non-Involved	
		Pedestrian
		Bicycle
		Animal
		Direction of Motion
		Parked Vehicle
		Fixed Object

TYPES OF CRASH

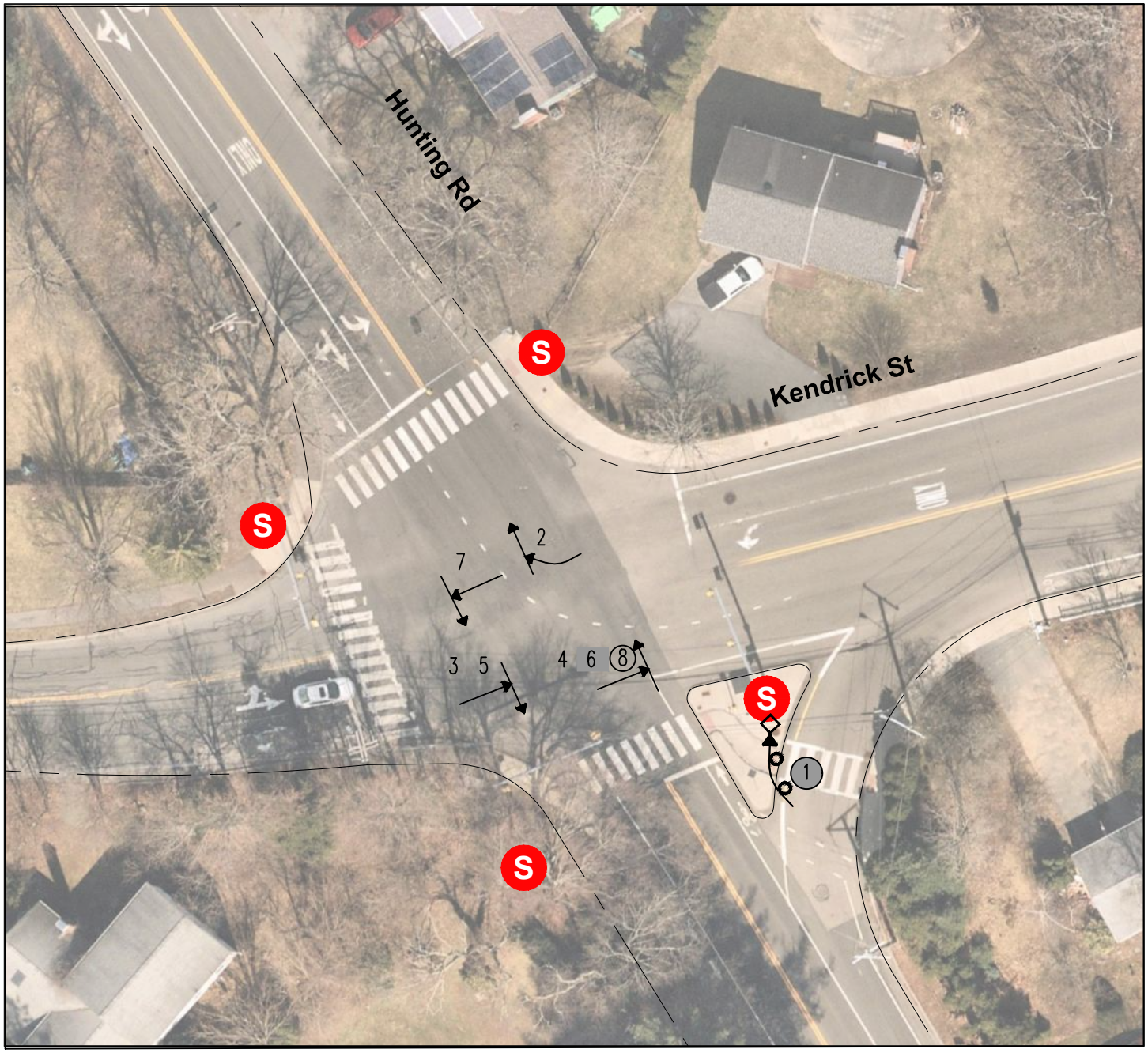
- Head on
- Rear End
- Angle
- Turning Movement
- Sideswipe
- Out of Control
- Night Time Crash

SEVERITY

- Injury
- Fatal

TRAFFIC CONTROL

- Traffic Signal Post
- Stop Sign
- Yield Sign
- One Way Sign



Not to Scale

TIME PERIOD ANALYZED: 2017-2019
SOURCE OF CRASH REPORTS: Needham Police Dept.

vhb

Collision Diagram
Hunting Road at
Kendrick Street
Needham, MA

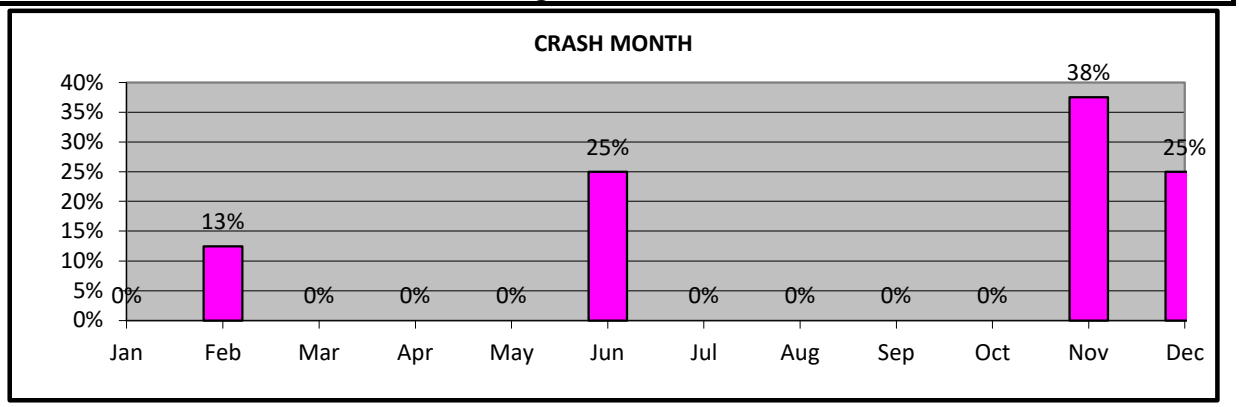
Crash Data Summary Table

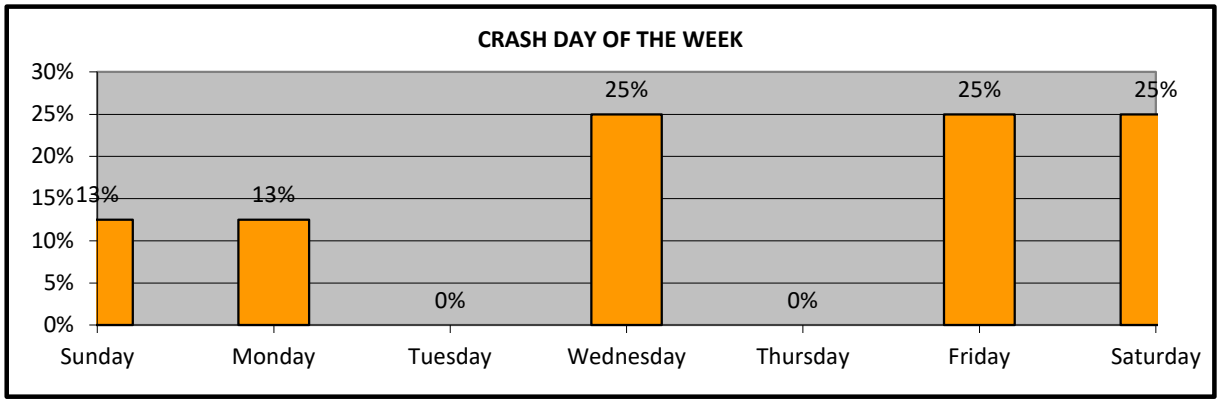
Hunting Rd at Kendrick St
2017 - 2019

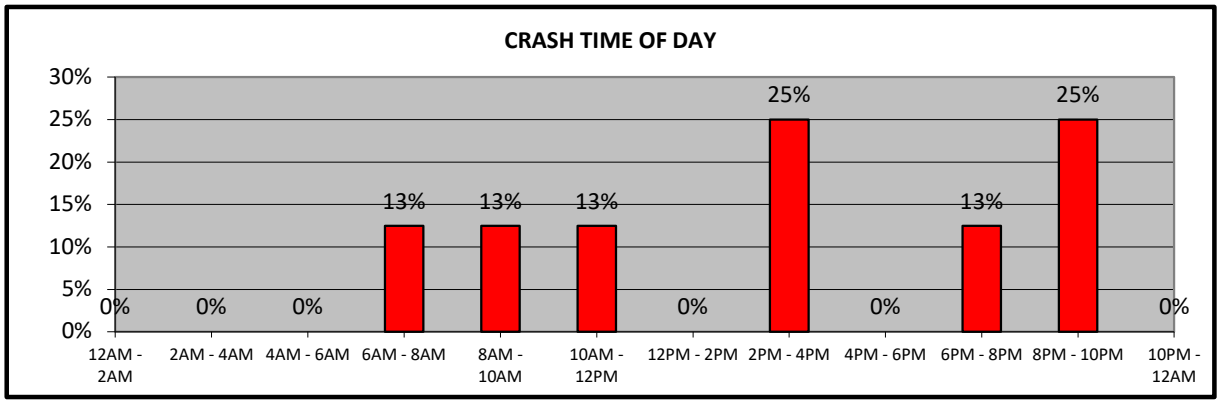
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	D1 Age	D2 Age	D3 Age	D4 Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	#	#	
1	02/08/17	Wednesday	6:30 AM	Single vehicle crash	Dark - lighted roadway	Clear	Ice	No improper driving	Unknown				Vehicle #1 was traveling northobund on Hunting Road when the extremely ice condition caused him to slide up onto a curb and struck the base of the a traffic light pole. Driver complained of dizziness and was evaluated. Flash freeze. Pole was not damaged.
2	11/10/17	Friday	10:57 AM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			Vehicle #1 was traveling on Hunting Rd and crossing through a green light over Kendrick St to continue on Hunting Rd. Vehicle #2 stated he was stopped at red light on Kendrick St when he tried to take a right turn on red onto Hunting Rd. Vehilce #2 struck Vehicle #1 as it attempted to turn onto Hunting Rd. Vehicle #1 suffered minor damage ot the passenger side of front door. Vehicle #2 suffered minor damage to the driver's side front wheel well and front driver's side panel. No injuries were reported.
3	06/18/18	Monday	9:37 PM	Angle	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	Unknown			Vehicle #1 was traveling on Hunting Rd SB heading towards Cheney St. Vehicle #2 was on Kendrick St heading EB towards Newton. No injuries reported, Vehicle #1 had minor to moderate passenger side damage. Vehicle #2 had moderate front end damage.
4	11/03/18	Saturday	8:41 PM	Angle	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	Unknown			Vehicle #1 east on Hunting, Vehicle #2 north of Kendrick. No injury, minor to moderate damage.
5	11/21/18	Wednesday	2:44 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			Vehicle #1 traveling EB on Kendrick St heading towards Newton. Vehicle #2 traveling WB on Kendrick St, making a left turn onto Hunting Rd. No inuries reported, moderate damages to vehicles
6	06/28/19	Friday	7:50 PM	Angle	Dark - lighted roadway	Clear	Dry	Inattention	Unknown	54			Vehicle #2 was traveling west on Kendrick Street with the right of way when vehicle #1 entered the intersection on a red light. No reported injuries and both vehicles had to be towed from the scene.
7	12/28/19	Saturday	3:48 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			Vehicle #1 traveling esouth on Hunting Rd when vehicle #2 crashed into the left side of his car. No injuries, both vehicles were towed.
8	12/01/19	Sunday	8:48 AM	Angle	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Vehicle #1 was travelling EB on Kendrick St. Vehicle #2 was travelling northbound on Hunting Road. Serious damage to both vehicles.

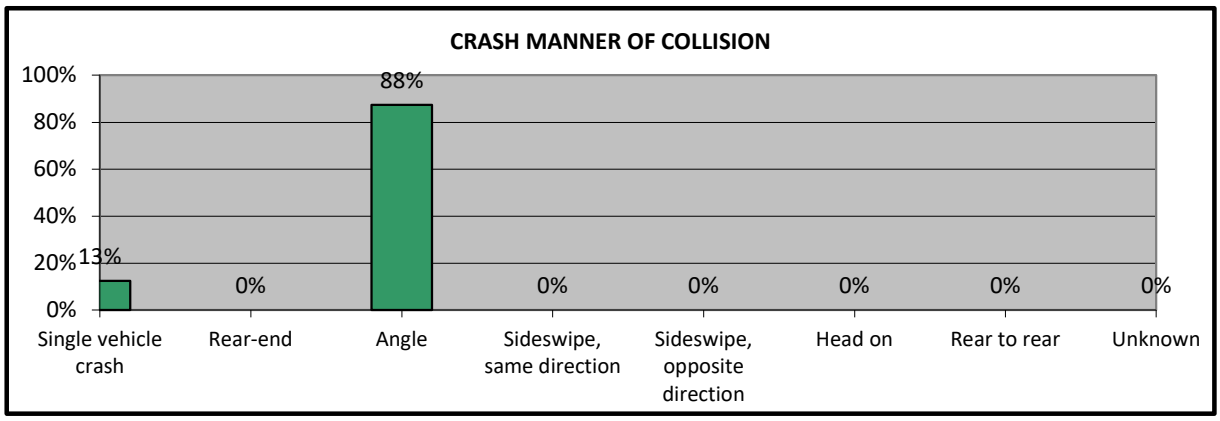
Crash Data Summary Charts

Hunting Rd at Kendrick St



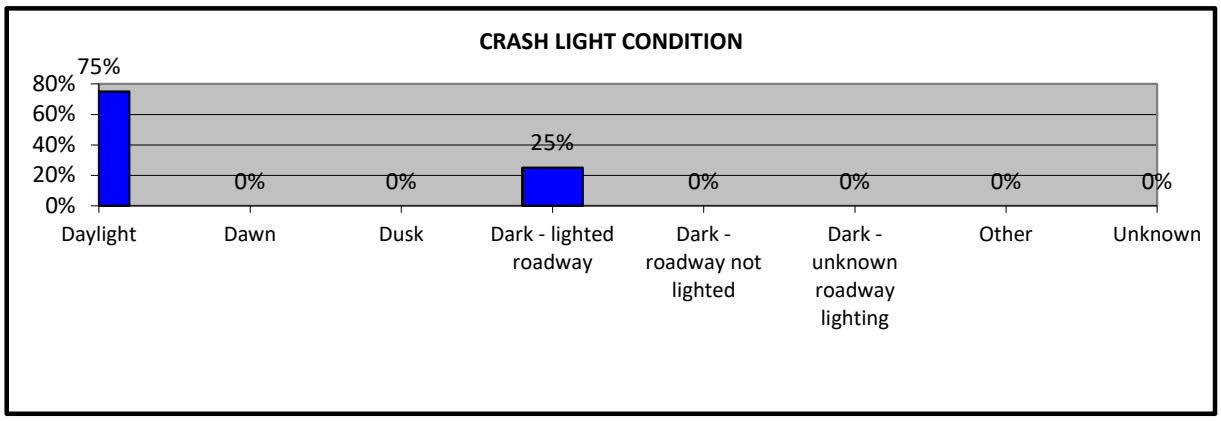


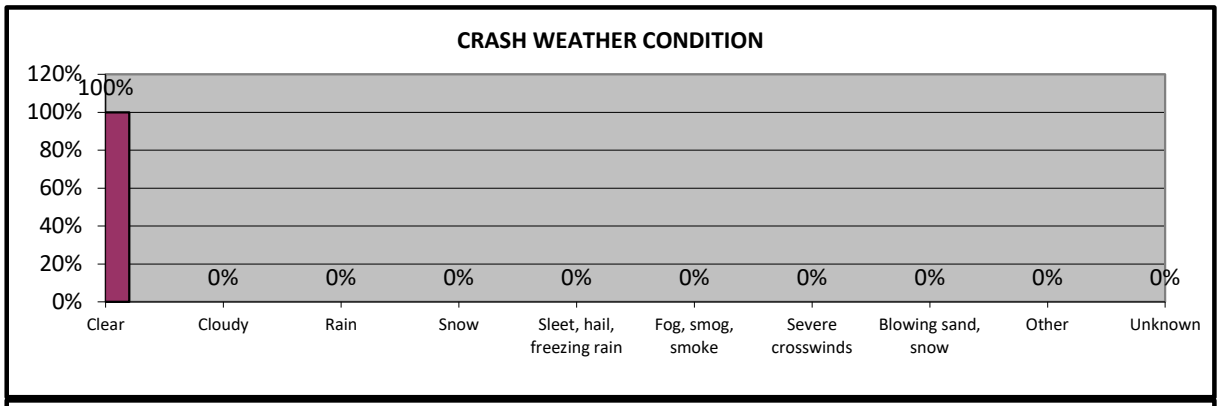


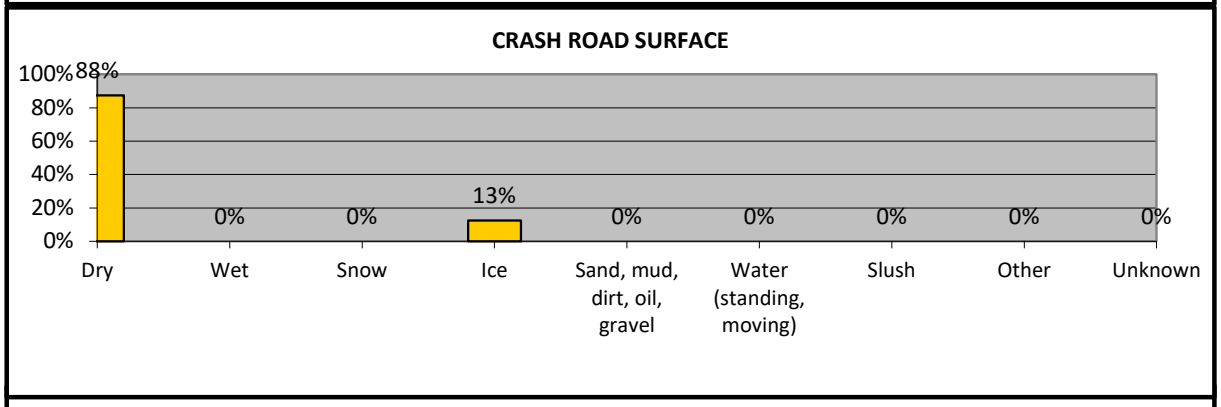


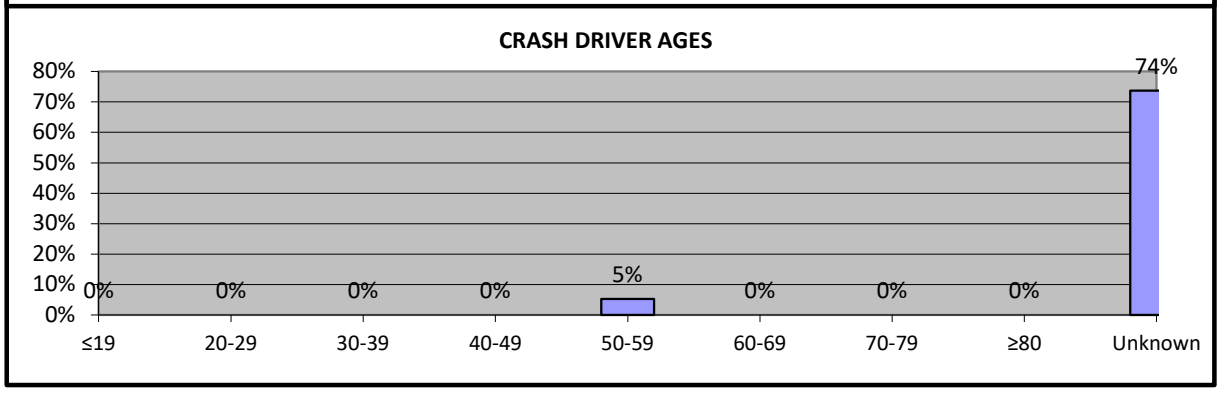
Crash Data Summary Charts

Hunting Rd at Kendrick St









\\vhb.com\gbl\proj\Boston\15306.00\tech\Crash Data\Crash Diagrams.dwg

SYMBOLS

- Moving Vehicle
- Backing Vehicle
- Non-Involved Vehicle

Involved	Non-Involved	
		Pedestrian
		Bicycle
		Animal
		Direction of Motion
		Parked Vehicle
		Fixed Object

TYPES OF CRASH

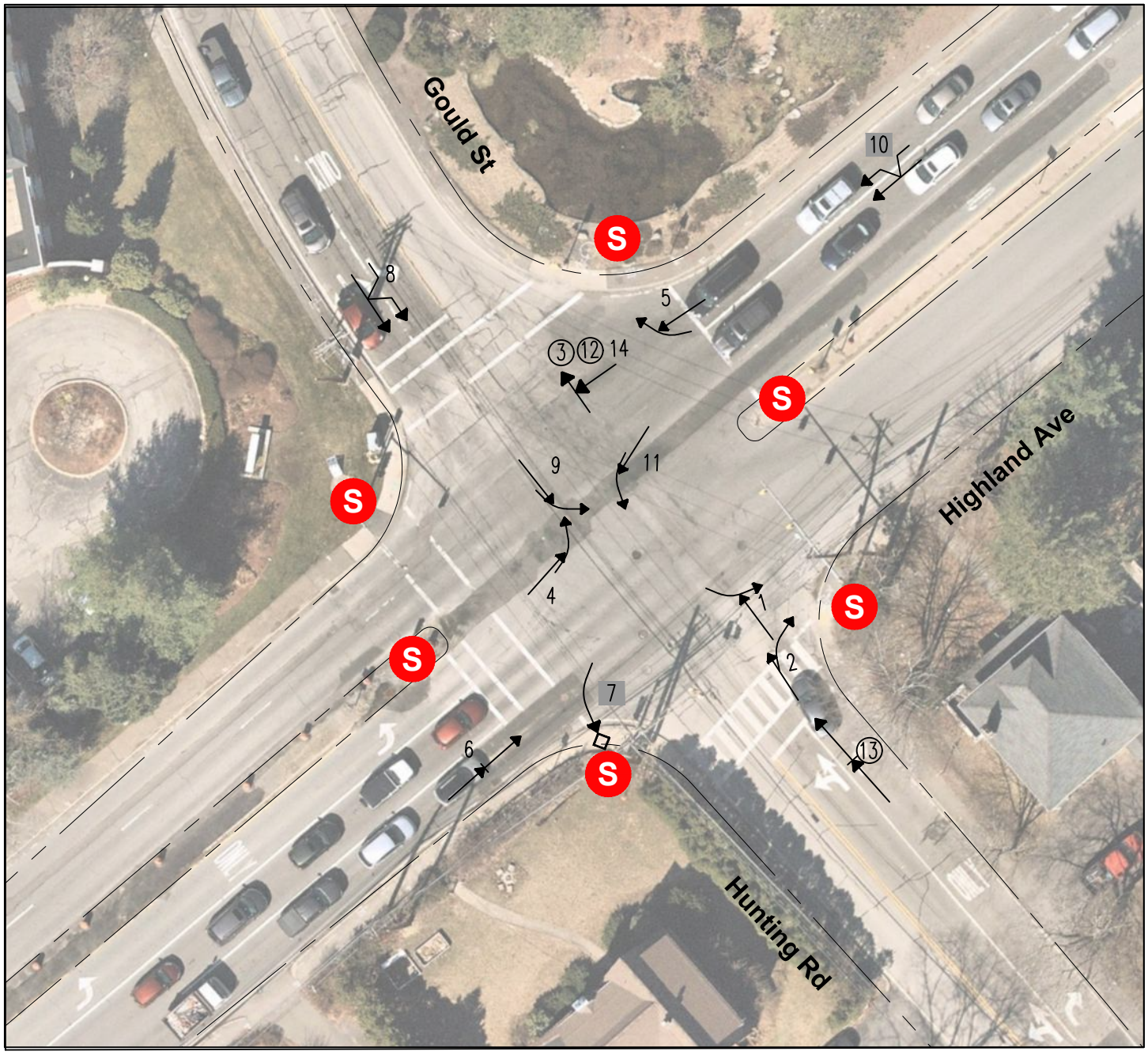
- Head on
- Rear End
- Angle
- Turning Movement
- Sideswipe
- Out of Control
- Night Time Crash

SEVERITY

- Injury
- Fatal

TRAFFIC CONTROL

- Traffic Signal Post
- Stop Sign
- Yield Sign
- One Way Sign



Not to Scale

TIME PERIOD ANALYZED: 2017-2019
SOURCE OF CRASH REPORTS: Needham Police Dept.

vhb

Collision Diagram
Highland Avenue at
Hunting Road/Gould Street
Needham, MA

Crash Data Summary Table

Highland Ave at Gould St / Hunting Rd
2017 - 2019

Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	D1 Age	D2 Age	D3 Age	D4 Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	#	#	
1	08/03/19	Saturday	2:55 PM	Angle	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Vehcile #1 was turning onto Highland Ave at green. Vehicle #2 took a right on red and crashed into the passenger side of Vehicle #1.
2	03/01/17	Wednesday	1:31 PM	Sideswipe, same direction	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	Unknown			Vehicle #2 was turning right onto Highland Ave from Hunting Road. Vehicle #1 was behind Vehicle #2 and attempted to pass it o nthe rigth and turn right onto Highland Ave as well. Vehicle #2 sustained moderate damage to the left rear and side Vehicle #1 sustained minor damage to the right front corner. There were no reported injuries and both vehicles were able to be driver from the scene.
3	06/27/18	Wednesday	7:23 AM	Angle	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	Unknown			Vehicle #2 stated he got a green arrow to turn right from his traffic signal, but accidentaly continued straight and vehicle #1 drove into him. Air bag deployment in both vehicles. Witness stated that Vehicle #1's lane of traffic had a green light, all of a sudden vehicle #2 came across the intersection at a high rate of speed and vehicle 1 drove into vehicle 2.
4	12/09/19	Monday	11:10 AM	Sideswipe, same direction	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	Unknown	Unknown			Vehicle #1 and Vehicle #2 were turning eastbound from Gould Street onto Highland Ave when Vehicle #1 did not stay in the proper lane, striking Vehicle #2 on the driver's side losest to the driver side door. Vehicle #1 had minor damage to the front right side bumper. Vehicle #2 had substantial damage to the left side mirror. No injuries were reported.
5	03/22/18	Thursday	4:40 PM	Rear-end	Daylight	Clear	Dry	Failed to yield right of way	Unknown	Unknown			Vehicle #2 was in the left lane on Gould St when she realized she needed to be on the right. Vehicle #2 was changing lanes and her vehicle struck Vehicle #1. Vehicle #2 sustained minor rear end damage, and Vehicle #1 sustained minor damage to the front fender and bumper.
6	05/04/18	Friday	6:00 PM	Rear-end	Daylight	Clear	Dry	Distracted	Unknown	Unknown			No injuries. Vehicle #1 was stopped at the lights on Highland Ave waiting to travel westbound on Highland Ave, when he was rear ended by vehicle #2.
7	07/17/18	Tuesday	2:03 AM	Single vehicle crash	Dark - lighted roadway	Clear	Dry	Inattention	Unknown	Unknown			Report of flashing lights possibly caused by a passing construction vehicle. Truck operator struck two signs along Highland Ave as well. The traffic signal was struck.
8	07/26/18	Thursday	8:20 AM	Sideswipe, same direction	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	Unknown	Unknown			Vehicle #2 was stopped in traffic on Highland Ave facing eastbound. According to Vehicle #2, vehicle #1 drove by his stopped vehicle and sideswiped it, knocking his mirror off and damaging it. Vehicle #1 then turned onto Gould St and never stopped. No injuries were reported. Vehicle #2 had very minor damage.
9	12/12/18	Wednesday	12:11 PM	Angle	Daylight	Clear	Dry	No improper driving	Unknown	Unknown			Vehicle #2 was in the left lane, which is a left turn only lane. Vehicle #1 was in the right lane which has no turning restrictions. The light was red and when it turned green vehicle #1 turned left and vehicle #2 went straight ahead. Vehicle #2 struck vehicle #1 in the left rear and then fled the area on Highland Ave towards Netwon.
10	02/05/19	Tuesday	7:21 PM	Sideswipe, same direction	Dark - lighted roadway	Clear	Dry	No improper driving	Unknown	Unknown			Hit and run accident. Vehicle #2 stated that she was traveling west on Highland Ave, approaching the Gould St intersection, when Vehicle #1 sideswiped the right side of her vehicle as unkown vehicle #1 passed her on the right side. No one reported injury. Vehicle #2 sustained right side damage. Unknown vehicle #1 did not pull over after the accident and there is no information available for the vehicle make or operator.
11	03/23/19	Saturday	11:04 AM	Angle	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Vehicle #1 was facing southbound on Gould St attempting to make a left turn onto Highland Ave eastbound. Vehicle #1 started from inside travel lane of Gould Street. Vehicle #2 was facing on Gould St in the outside lane attempting to make a left turn onto Highland Ave eastbound. At some point during the turn the vehicles collided. The paint line delineating the traffic lanes at thsi intersection are faded. No injuries are reported. Vehicle #1 had minor right front bumper damage and vehicle #2 had minor left rear quarter panel damage (dents and scrape marks).

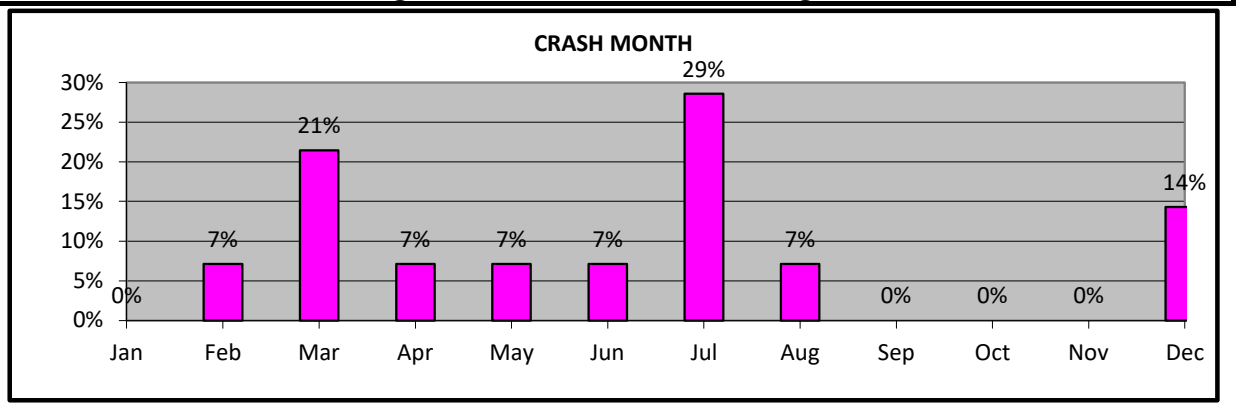
Crash Data Summary Table

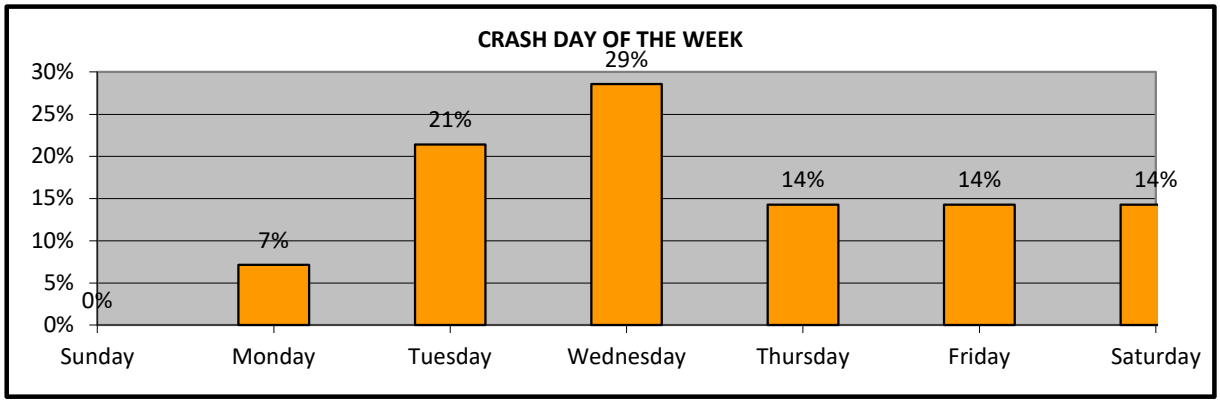
Highland Ave at Gould St / Hunting Rd
2017 - 2019

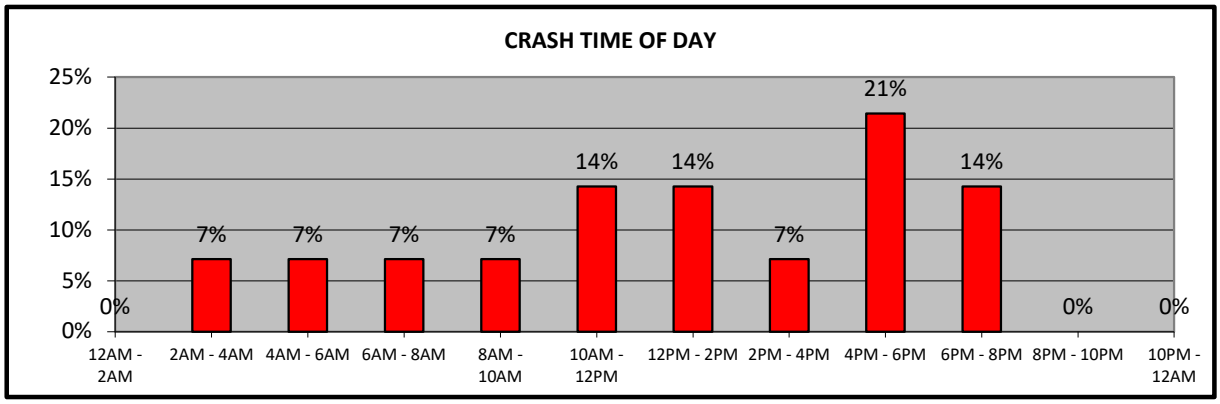
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	D1 Age	D2 Age	D3 Age	D4 Age	Comments
#	*mm/dd/yy*	*Day*	*hh:mm*	*Type*	*Type*	*Type*	*Type*	*Type*	*#*	*#*	*#*	*#*	
12	04/30/19	Tuesday	4:49 AM	Angle	Daylight	Clear	Dry	Unknown	Unknown	Unknown			At 4:49 am, 2 car crash at intersection of Highland Ave and Gould St with no reported injuries. Vehicle #1 stated she was driving on Highland Ave (west) and turning right (north) onto Gould St when she struck vehicle #2. Some left shoulder pain of vehicle #2. Vehicle #2 was towed from the scene.
13	07/13/18	Friday	5:59 PM	Rear-end	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Vehicle #2 at the intersection of Highland Ave at Hunting Rd. Vehicle #1 rear ends Vehicle #2 while it is stopped. No injuries reported at the scene. Vehicles had significant damage but neither had to be towed from the scene. No injuries.
14	07/31/19	Wednesday	4:35 PM	Angle	Daylight	Clear	Dry	Unknown	Unknown	Unknown			Vehicle #1 was going southwest on Highland Ave. Vehicle #2 was driving towards her. Minimal damage on Vehicle #1. No injury.

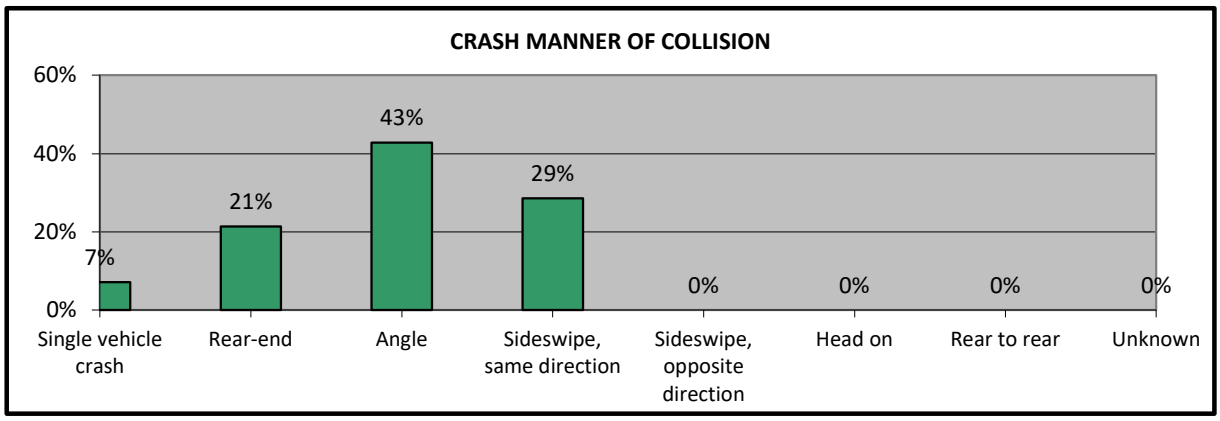
Crash Data Summary Charts

Highland Ave at Gould St / Hunting Rd



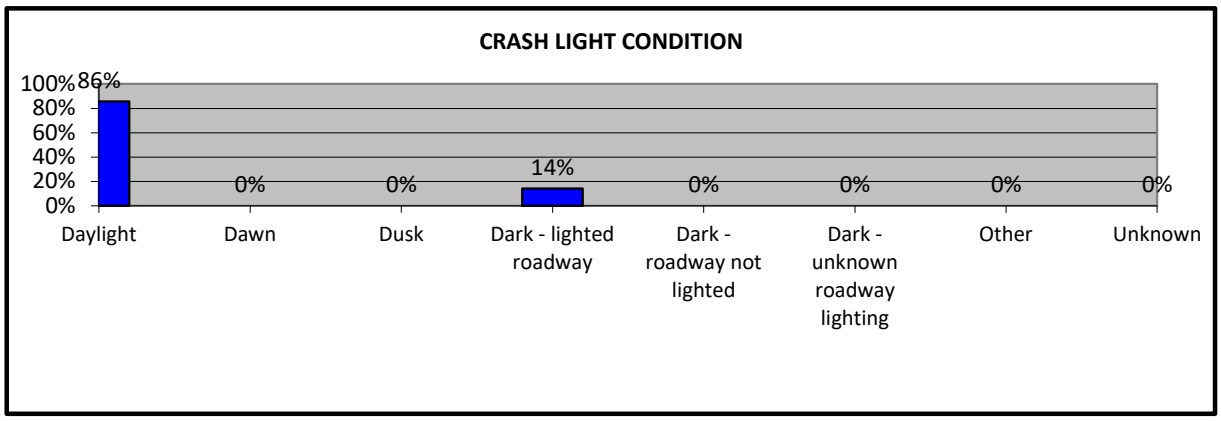


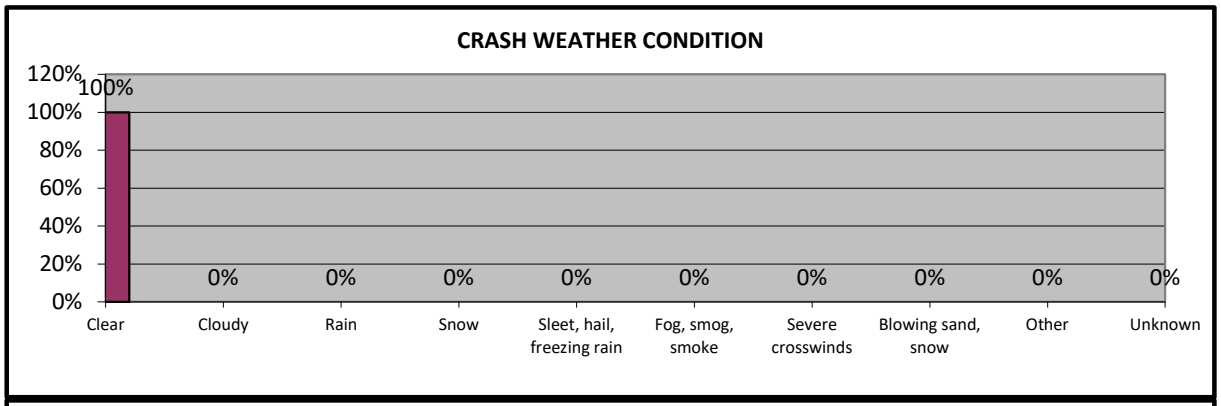


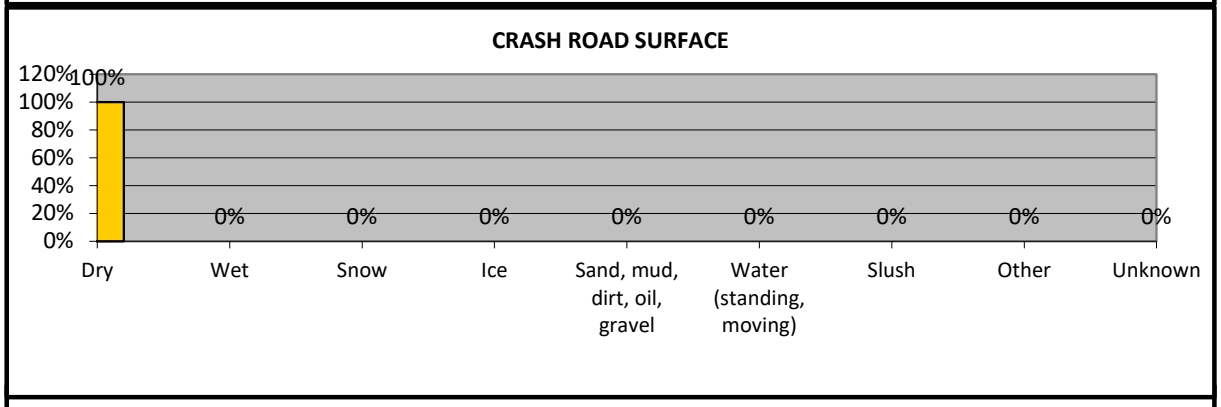


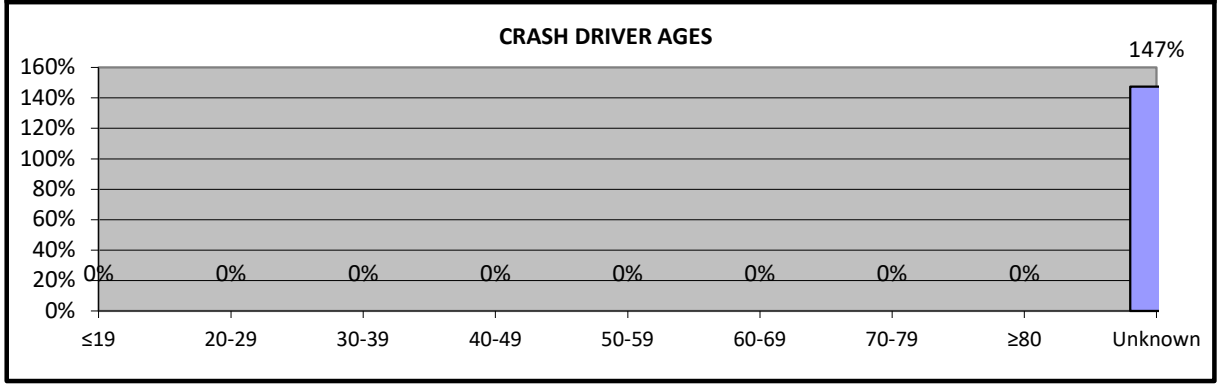
Crash Data Summary Charts

Highland Ave at Gould St / Hunting Rd









557 Highland Avenue TIS
Weaving Segment Analysis

1.

Scenario	Direction	Road	Start	End	Freeway or Highway/C-D Road	Number of lanes within the weaving segment, N	One-sided vs two-sided Weave	Short length of weaving segment, L_S	Number of lane changes, LC_{RF}	Number of lane changes, LC_{FR}	Number of lane changes, LC_{RR}	Number of weaving lanes	Interchanges within 3 miles up/downstream	Terrain type	Free-flow speed	Equivalent capacity of basic freeway segment	Hourly demand volume, V_{FF} (Freeway-to-Freeway)	PHF_{FF}	$HV\%_{FF}$	Hourly demand volume, V_{RF} (Ramp-to-Freeway)	PHF_{RF}	$HV\%_{RF}$	Hourly demand volume, V_{FR} (Freeway-to-Ramp)	PHF_{FR}	$HV\%_{FR}$	Hourly demand volume, V_{RR} (Ramp-to-Ramp)	PHF_{RR}	$HV\%_{RR}$
Step 1: Input Data																												
					Geometric Inputs												**Volume Characteristics for Each Movement**												
2022 EXISTING ANALYSIS																												
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	Highway	3	One-sided	750	1	1	0	2	12	Level	45	1900	685	0.98	0.01	725	0.91	0.02	410	0.98	0.01	15	0.91	0.02
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	Highway	3	One-sided	670	1	1	0	2	12	Level	45	1900	215	0.97	0.03	90	0.93	0.01	410	0.97	0.03	5	0.93	0.01
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	Highway	3	One-sided	750	1	1	0	2	12	Level	45	1900	505	0.98	0.01	265	0.96	0.02	365	0.98	0.01	5	0.96	0.02
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	Highway	3	One-sided	670	1	1	0	2	12	Level	45	1900	625	0.95	0.01	110	0.94	0.01	450	0.95	0.01	5	0.94	0.01
2029 NO BUILD ANALYSIS																												
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	Highway	3	One-sided	750	1	1	0	2	12	Level	45	1900	810	0.92	0.01	945	0.92	0.02	440	0.92	0.01	20	0.92	0.02
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	Highway	3	One-sided	670	1	1	0	2	12	Level	45	1900	250	0.92	0.03	100	0.92	0.01	470	0.92	0.03	5	0.92	0.01
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	Highway	3	One-sided	750	1	1	0	2	12	Level	45	1900	575	0.92	0.01	360	0.92	0.02	395	0.92	0.01	5	0.92	0.02
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	Highway	3	One-sided	670	1	1	0	2	12	Level	45	1900	730	0.92	0.01	120	0.92	0.01	575	0.92	0.01	5	0.92	0.01
2029 BUILD ANALYSIS																												
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	Highway	3	One-sided	750	1	1	0	2	12	Level	45	1900	815	0.92	0.01	945	0.92	0.02	460	0.92	0.01	20	0.92	0.02
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	Highway	3	One-sided	670	1	1	0	2	12	Level	45	1900	285	0.92	0.03	265	0.92	0.01	470	0.92	0.03	5	0.92	0.01
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	Highway	3	One-sided	750	1	1	0	2	12	Level	45	1900	610	0.92	0.01	360	0.92	0.02	545	0.92	0.01	5	0.92	0.02
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	Highway	3	One-sided	670	1	1	0	2	12	Level	45	1900	735	0.92	0.01	150	0.92	0.01	575	0.92	0.01	5	0.92	0.01

Source: Based on methodology presented in the Highway Capacity Manual: 6th Edition (HCM 6)

2.

Scenario	Direction	Road	Start	End	Passenger Car Equivalent of Heavy Vehicle for Freeway, E_T	Heavy Vehicle Adjustment Factor, $f_{HV,FF}$	Heavy Vehicle Adjustment Factor, $f_{HV,RF}$	Heavy Vehicle Adjustment Factor, $f_{HV,FR}$	Heavy Vehicle Adjustment Factor, $f_{HV,RR}$	Freeway-to-freeway demand flow rate, v_{FF}	Ramp-to-freeway demand flow rate, v_{RF}	Freeway-to-ramp demand flow rate, v_{FR}	Ramp-to-ramp demand flow rate, v_{RR}	Weaving demand flow rate, v_W	Nonweaving demand flow rate, v_{NW}	Total demand flow rate, v	Volume ratio, VR	Number of lanes within the weaving segment, N	Number of lanes from which a weaving maneuver may be made with one or no lane changes, N_{WL}	Minimum number of lane changes from on-ramp to freeway, LC_{RF}	Minimum number of lane changes from freeway to off-ramp, LC_{FR}	Equation 13-2 or 13-3 Minimum rate of lane changing, LC_{MIN}	Geometrics Length of weaving segment, L_S	Equation 13-4 Maximum weaving segment length, L_{MAX}	Check Check that Weave Analysis is Warranted
Step 2: Adjust Volume																	**Step 3: Determine Configuration Characteristics**					**Step 4: Determine Maximum Weaving Length**		
					Heavy Vehicle Volume Adjustment Factors					**Equation 13-1**				**Combined Volumes**				**Geometrics**				**Equation 13-2 or 13-3**	**Geometrics**	**Equation 13-4**	**Check**
2022 EXISTING ANALYSIS																									
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	2	0.99	0.98	0.99	0.98	706	813	423	17	1235	723	1958	0.63	3	2	1	1	1235	750	9396	OK
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	2	0.97	0.99	0.97	0.99	228	98	435	5	533	234	767	0.70	3	2	1	1	533	670	10196	OK
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	2	0.99	0.98	0.99	0.98	520	282	376	5	658	526	1184	0.56	3	2	1	1	658	750	8485	OK
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	2	0.99	0.99	0.99	0.99	664	118	478	5	597	670	1266	0.47	3	2	1	1	597	670	7490	OK
2029 NO BUILD ANALYSIS																									
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	2	0.99	0.98	0.99	0.98	889	1048	483	22	1531	911	2442	0.63	3	2	1	1	1531	750	9346	OK
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	2	0.97	0.99	0.97	0.99	280	110	526	5	636	285	921	0.69	3	2	1	1	636	670	10134	OK
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	2	0.99	0.98	0.99	0.98	631	399	434	6	833	637	1470	0.57	3	2	1	1	833	750	8616	OK
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	2	0.99	0.99	0.99	0.99	801	132	631	5	763	807	1570	0.49	3	2	1	1	763	670	7663	OK
2029 BUILD ANALYSIS																									
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	2	0.99	0.98	0.99	0.98	895	1048	505	22	1553	917	2470	0.63	3	2	1	1	1553	750	9369	OK
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	2	0.97	0.99	0.97	0.99	319	291	526	5	817	325	1142	0.72	3	2	1	1	817	670	10455	OK
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	2	0.99	0.98	0.99	0.98	670	399	598	6	997	675	1673	0.60	3	2	1	1	997	750	8974	OK
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	2	0.99	0.99	0.99	0.99	807	165	631	5	796	812	1608	0.49	3	2	1	1	796	670	7767	OK

Source: Based on methodology presented in the Highway Capacity Manual: 6th Edition (HCM 6)

3.

Scenario	Direction	Road	Start	End	Capacity per lane of the weaving segment under equivalent ideal conditions, c_{IWL}	Capacity per lane of a basic freeway segment with the same FFS under equivalent ideal conditions, c_{IFL}	Total capacity under prevailing conditions, c_W	Capacity of all lanes, c_{IW}	Capacity of all lanes under prevailing conditions, c_W	Final capacity, c_W	Volume-to-capacity ratio, v/c	LOS F Check	Geometrics Interchange density, ID	Equation 13-11 Total rate of lane changing by weaving vehicles, LC_W	Equation 13-12 Nonweaving vehicle index, I_{NW}	Equation 13-13 Total rate of lane changing by nonweaving vehicles, LC_{NW1}	Equation 13-14 Total rate of lane changing by nonweaving vehicles, LC_{NW2}	Equation 13-15 Total rate of lane changing by nonweaving vehicles, LC_{NW3}	Equation 13-16 Total rate of lane changing by nonweaving vehicles, LC_{NW}	Equation 13-17 Total rate of lane changing by all vehicles, LC_{ALL}	Equation 13-18/13-19 Average speed of weaving vehicles, S_W	Equation 13-20 Weaving intensity factor, W	Equation 13-21 Average speed of nonweaving vehicles, S_{NW}	Equation 13-22 Average speed of all vehicles, S	Equation 13-23 Average density of all vehicles, D	Exhibit 13-6 LOS
Step 5: Determine Weaving Segment Capacity													**Step 6: Determine Lane-Changing Rates**								**Step 7: Determine Average Speeds of Weaving and**				**Step 8: Determine LOS**	
					Weaving Segment Capacity Determined by Density Equations 13-5 & 13-6)			**Weaving Segment Capacity Determined by Weaving Demand Flows (Equations 13-7 & 13-8)**		**Final Capacity**	**Volume-to-Capacity Ratio (Equation 13-10)**	**LOS F**	**Geometrics**	**Equation 13-11**	**Equation 13-12**	**Equation 13-13**	**Equation 13-14**	**Equation 13-15**	**Equation 13-16**	**Equation 13-17**	**Equation 13-18/13-19**	**Equation 13-20**	**Equation 13-21**	**Equation 13-22**	**Equation 13-23**	**Exhibit 13-6**
2022 EXISTING ANALYSIS																									
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	1239	1900	3679	3804	3767	3679	0.53	NOT F	2.00	1415	108	0	1850	-3392	0	1415	36.9	0.37	33.0	35.3	**18.5**	**B**
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	1171	1900	3411	3452	3352	3352	0.22	NOT F	2.00	696	31	0	1741	-3398	0	696	39.3	0.23	39.9	39.5	**6.5**	**A**
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	1308	1900	3886	4318	4276	3886	0.30	NOT F	2.00	837	79	0	1806	-3393	0	837	39.1	0.25	38.4	38.8	**10.2**	**A**
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	1378	1900	4094	5095	5044	4094	0.31	NOT F	2.00	759	90	0	1838	-3423	0	759	39.0	0.25	38.7	38.8	**10.9**	**A**
2029 NO BUILD ANALYSIS																									
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	1242	1900	3690	3829	3791	3690	0.66	NOT F	2.00	1710	137	16	1892	-3341	16	1727	35.9	0.44	30.1	33.5	**24.3**	**C**
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	1176	1900	3425	3477	3376	3376	0.26	NOT F	2.00	799	38	0	1753	-3402	0	799	38.8	0.26	38.9	38.9	**7.9**	**A**
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	1298	1900	3856	4235	4193	3856	0.38	NOT F	2.00	1012	96	0	1831	-3393	0	1012	38.3	0.29	36.7	37.6	**13.0**	**B**
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	1365	1900	4054	4938	4889	4054	0.38	NOT F	2.00	926	108	0	1869	-3427	0	926	38.2	0.29	37.0	37.6	**13.9**	**B**
2029 BUILD ANALYSIS																									
Existing AM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	1241	1900	3685	3817	3779	3685	0.66	NOT F	2.00	1732	138	18	1893	-3337	18	1750	35.8	0.44	29.9	33.4	**24.7**	**C**
Existing AM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	1151	1900	3354	3353	3256	3256	0.34	NOT F	2.00	980	43	0	1761	-3405	0	980	38.0	0.31	37.3	37.8	**10.1**	**A**
Existing PM	EB	Highland Avenue EB	I-95 SB Off-Ramp	I-95 NB On-Ramp	1271	1900	3775	4025	3985	3775	0.44	NOT F	2.00	1177	101	0	1840	-3393	0	1177	37.7	0.32	35.1	36.6	**15.2**	**B**
Existing PM	WB	Highland Avenue WB	I-95 NB Off-Ramp	I-95 SB On-Ramp	1357	1900	4031	4850	4802	4031	0.40	NOT F	2.00	959	109	0	1870	-3427	0	959	38.1	0.30	36.7	37.4	**14.3**	**B**

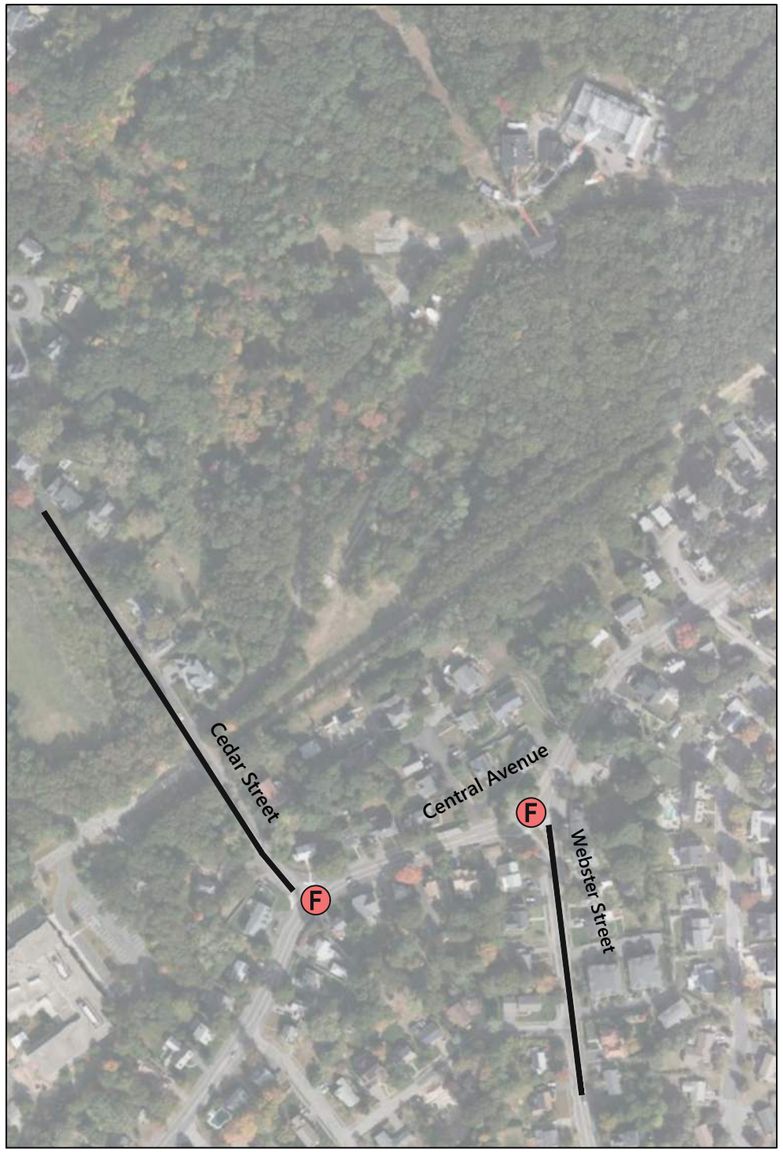
Source: Based on methodology presented in the Highway Capacity Manual: 6th Edition (HCM 6)

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

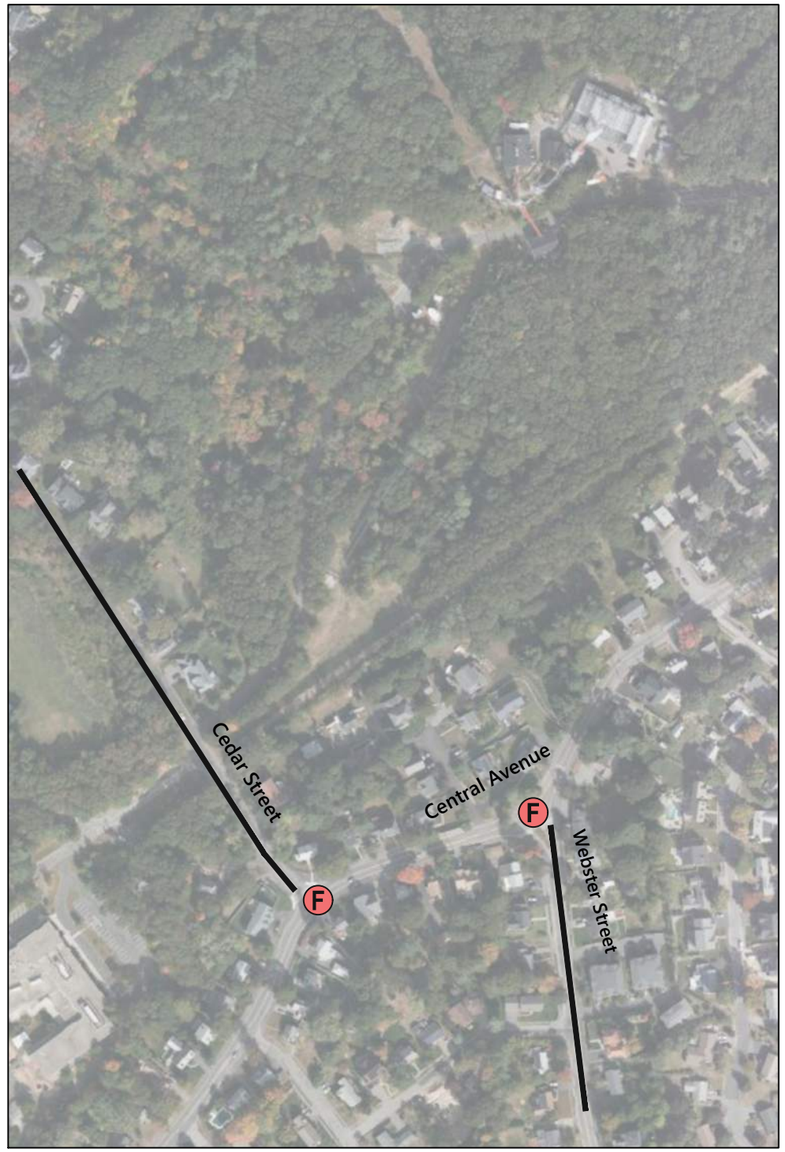
Central Avenue at Cedar Street and Webster Street (Unsignalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing



2029 No-Build



2029 Build

0 150 300 Feet

vhb

Queue Diagrams
Weekday Morning Peak Hour

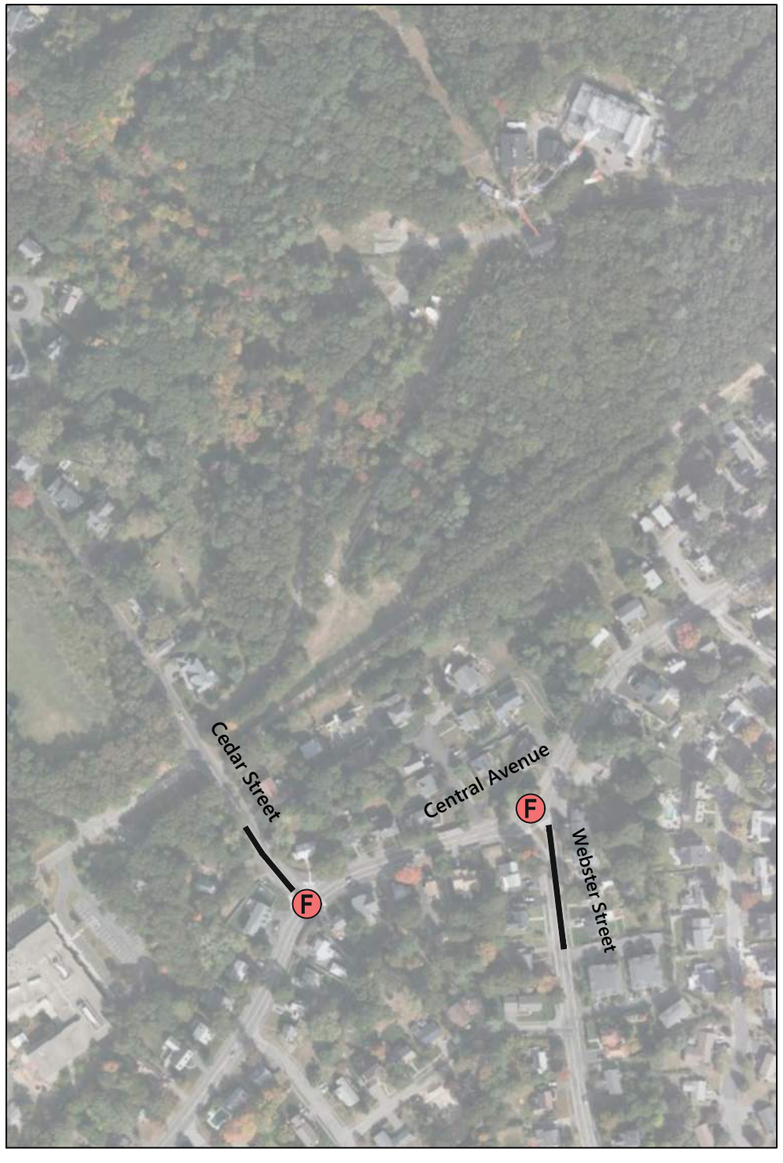
557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

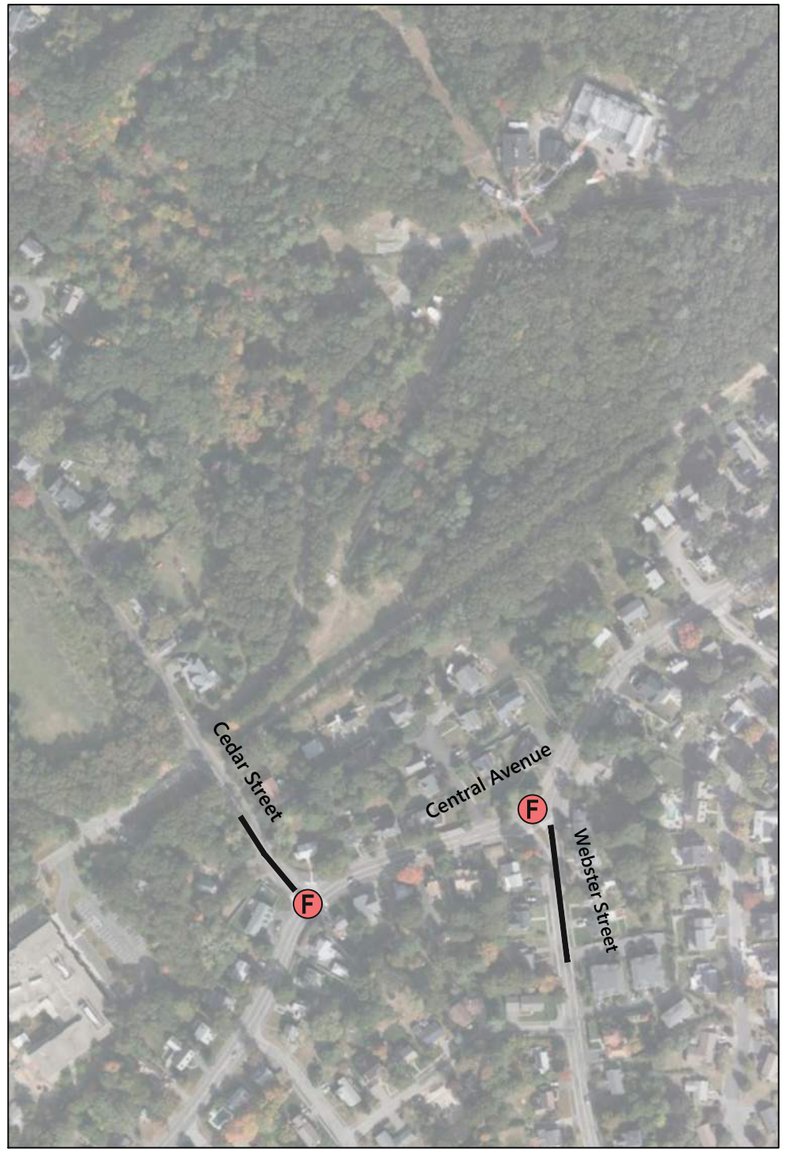
Central Avenue at Cedar Street and Webster Street (Unsignalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing



2029 No-Build



2029 Build

0 150 300 Feet

Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Central Avenue at Gould Street, Hampton Avenue, and River Park Street (Unsignalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing

2029 No-Build

2029 Build Without Mitigation

0 150 300 Feet

Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

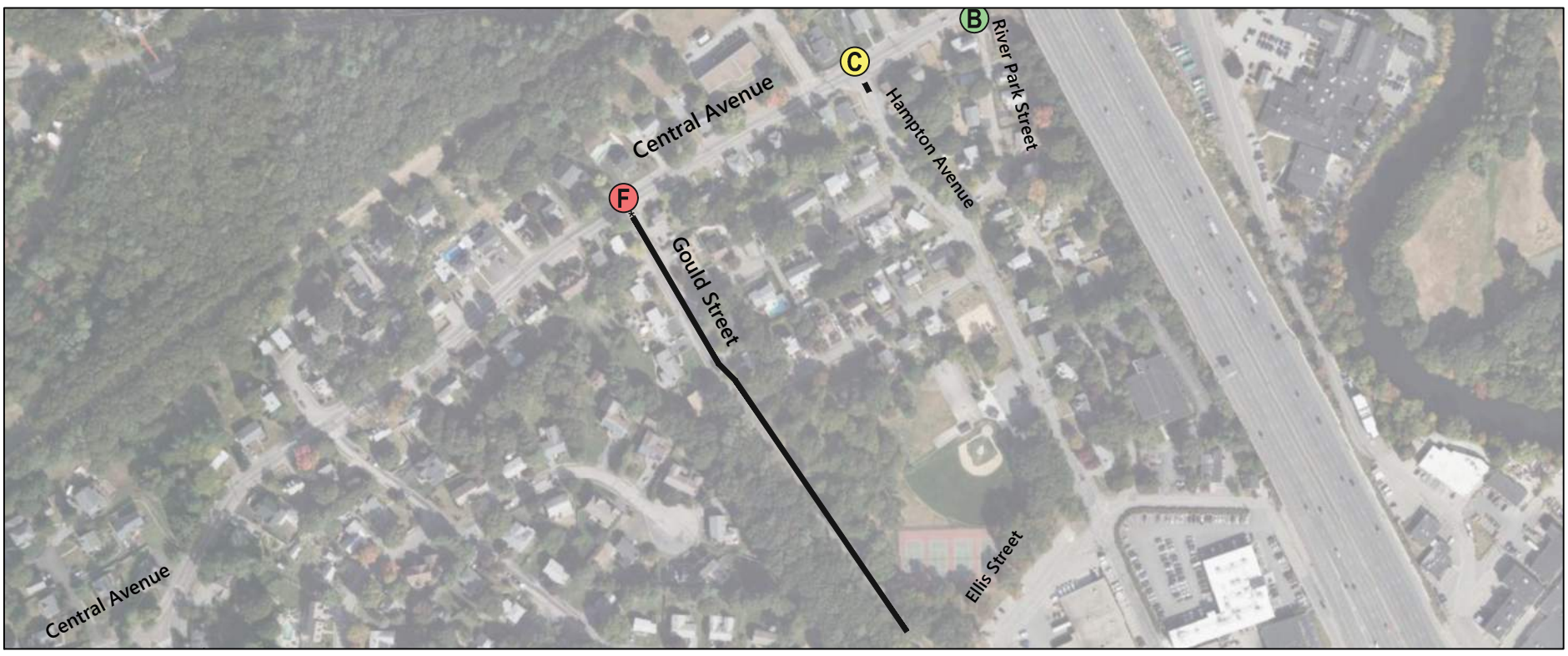
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Central Avenue at Gould Street, Hampton Avenue, and River Park Street (Unsignalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing

2029 No-Build



2029 Build Without Mitigation

* Movement beyond capacity, no results reported.

0 150 300 Feet

Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Central Avenue at Gould Street (Unsignalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2029 No-Build

2029 Build Without Mitigation

2029 Build With Mitigation

Central Avenue at Gould Street signalized under mitigation conditions.

0 150 300 Feet

Queue Diagrams
Weekday Morning Peak Hour

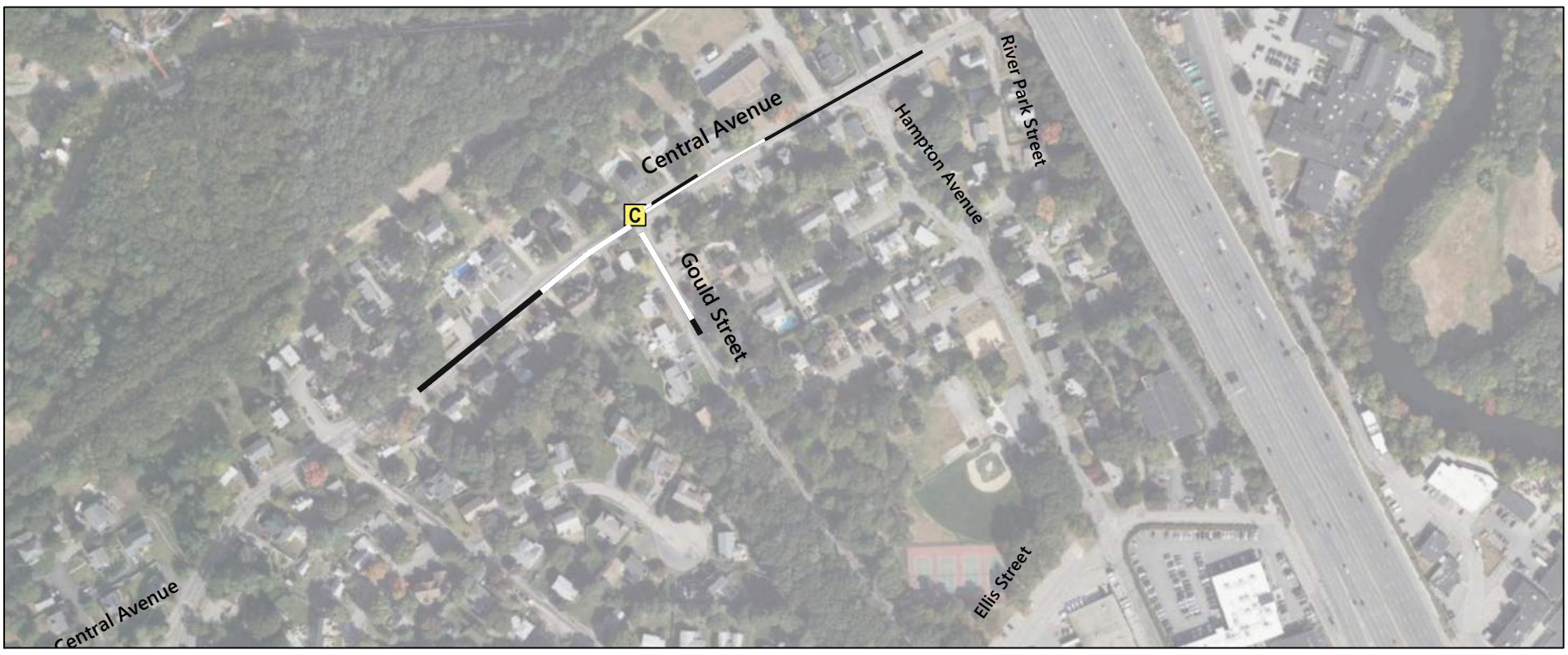
557 Highland Avenue
Needham, Massachusetts

Central Avenue at Gould Street (Unsignalized)

[X] Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2029 No-Build

2029 Build Without Mitigation



2029 Build With Mitigation

* Movement beyond capacity, no results reported.

Central Avenue at Gould Street signalized under mitigation conditions.

0 150 300 Feet

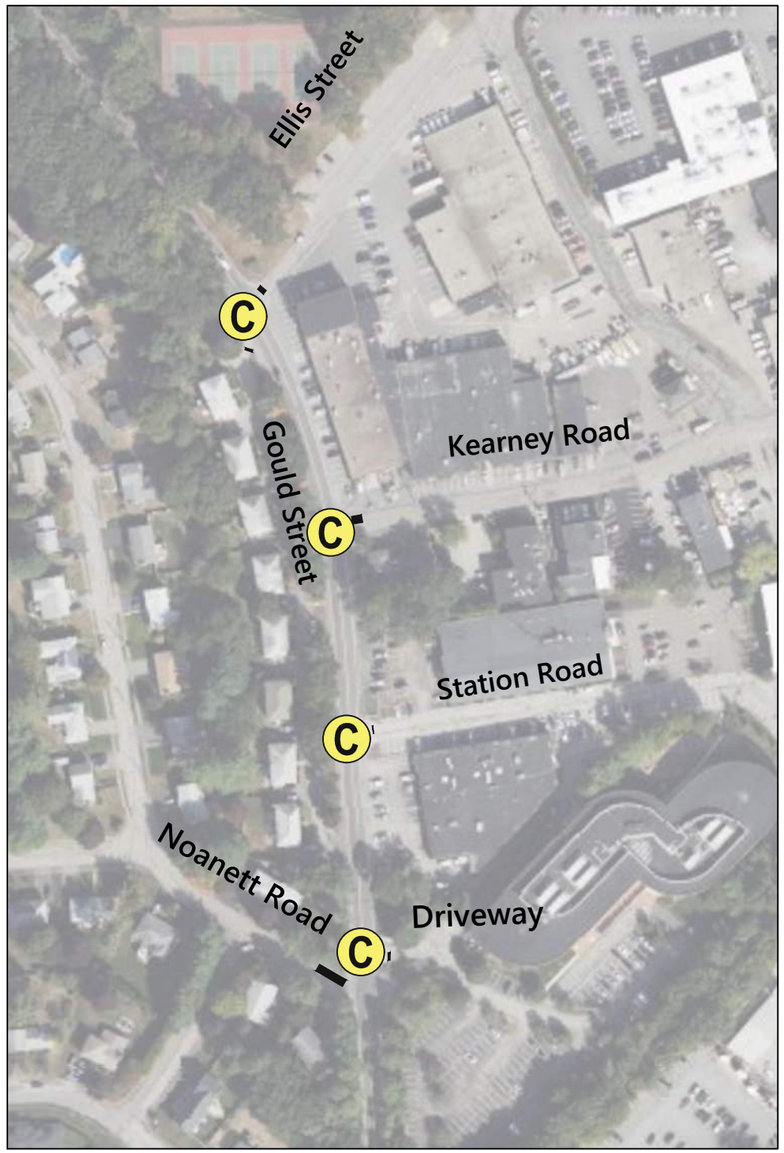
Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

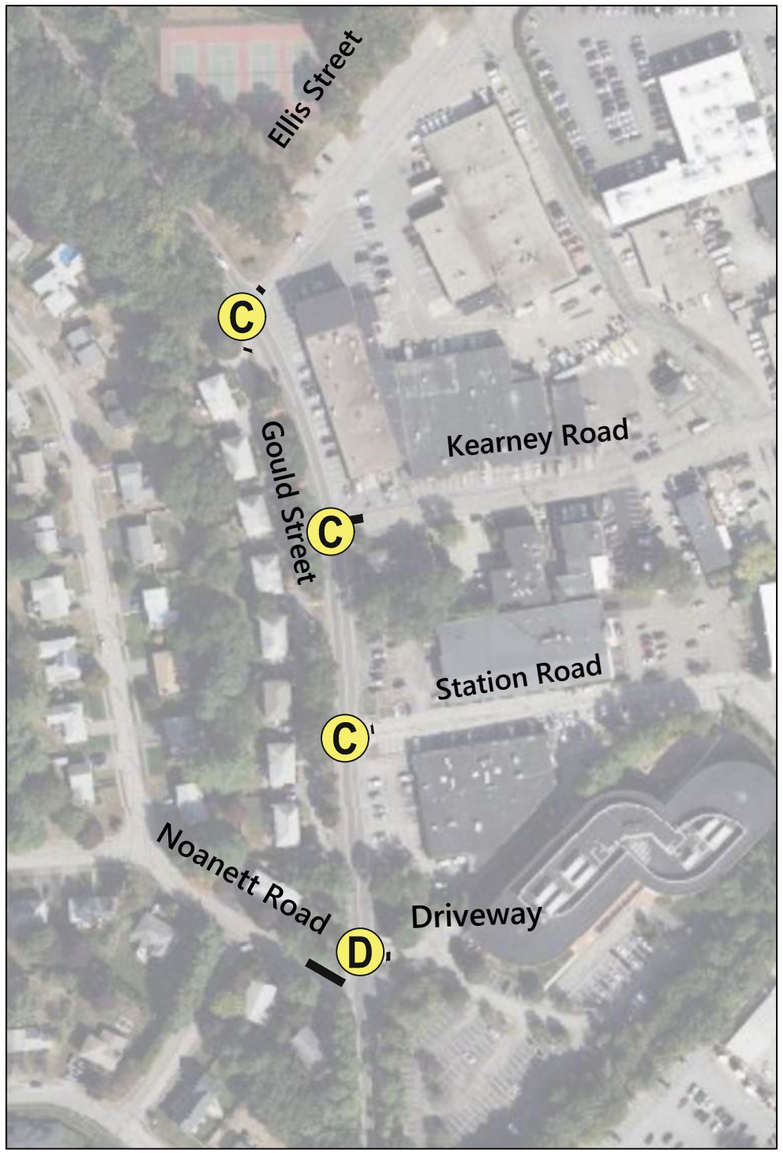
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Gould Street at Ellis Treet, Kearney Road, Station Road, and Noanett Road (Unsignalized)

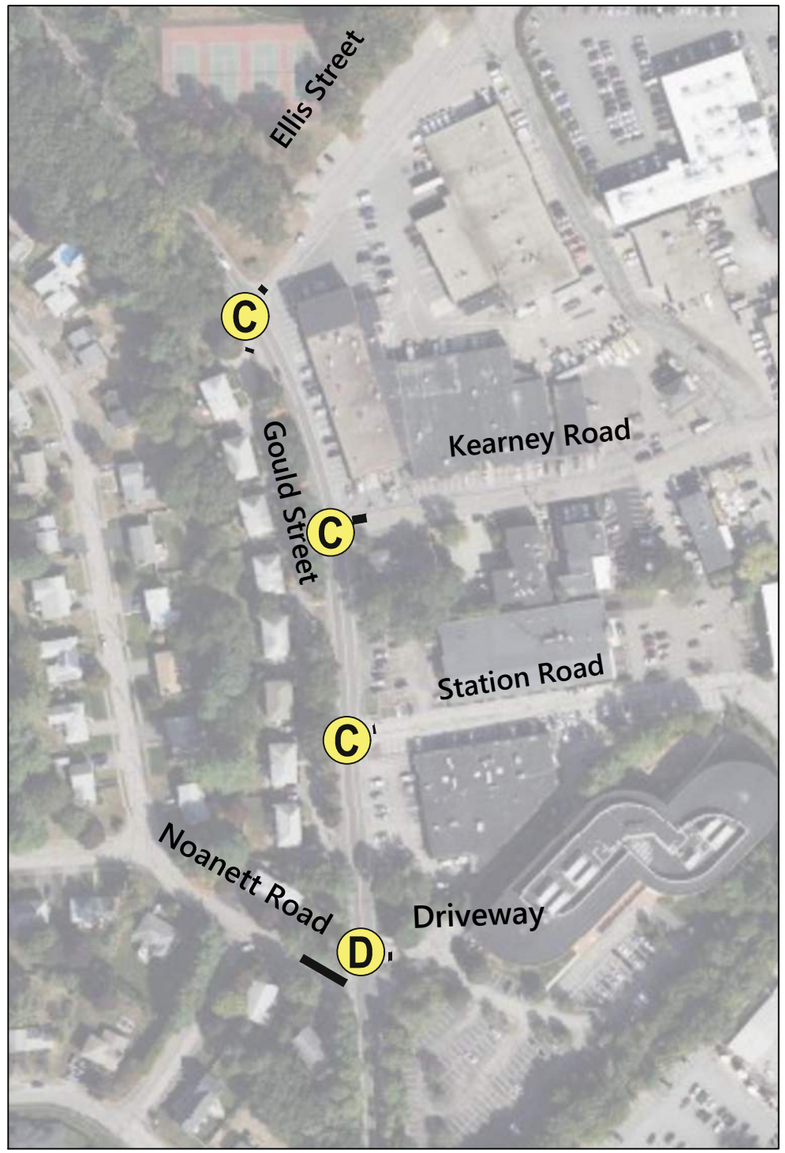
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build

vhb

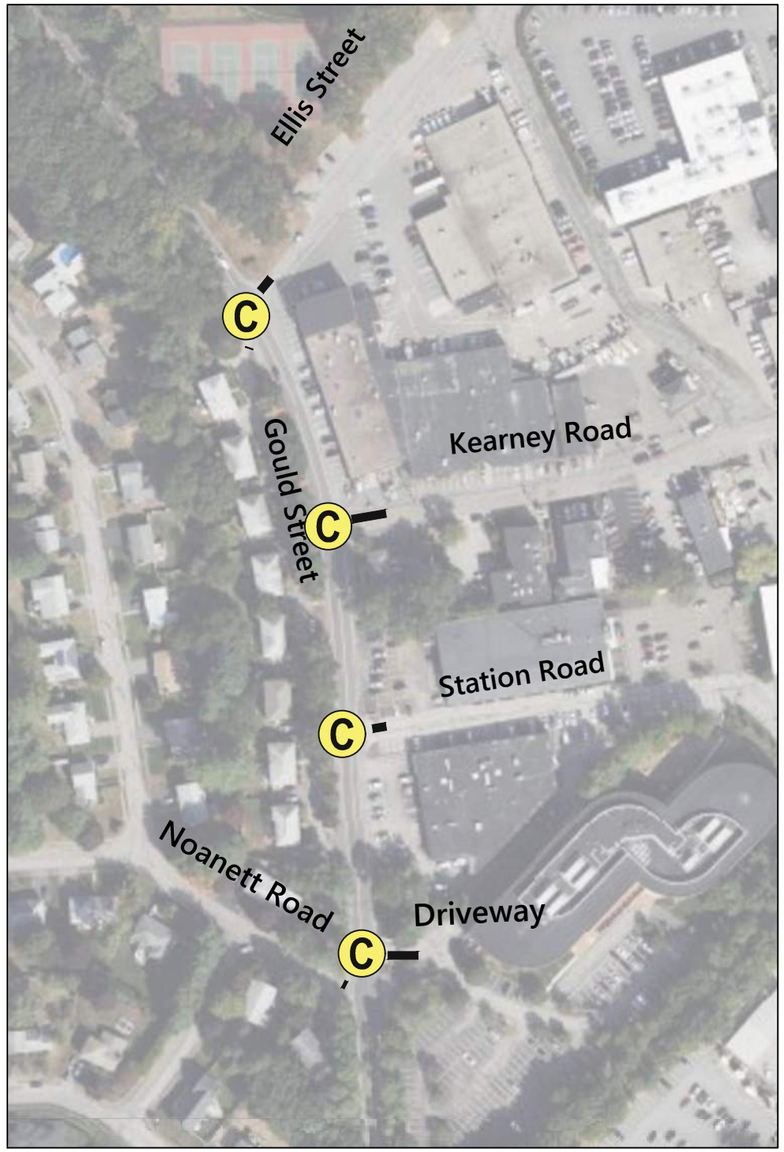
Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

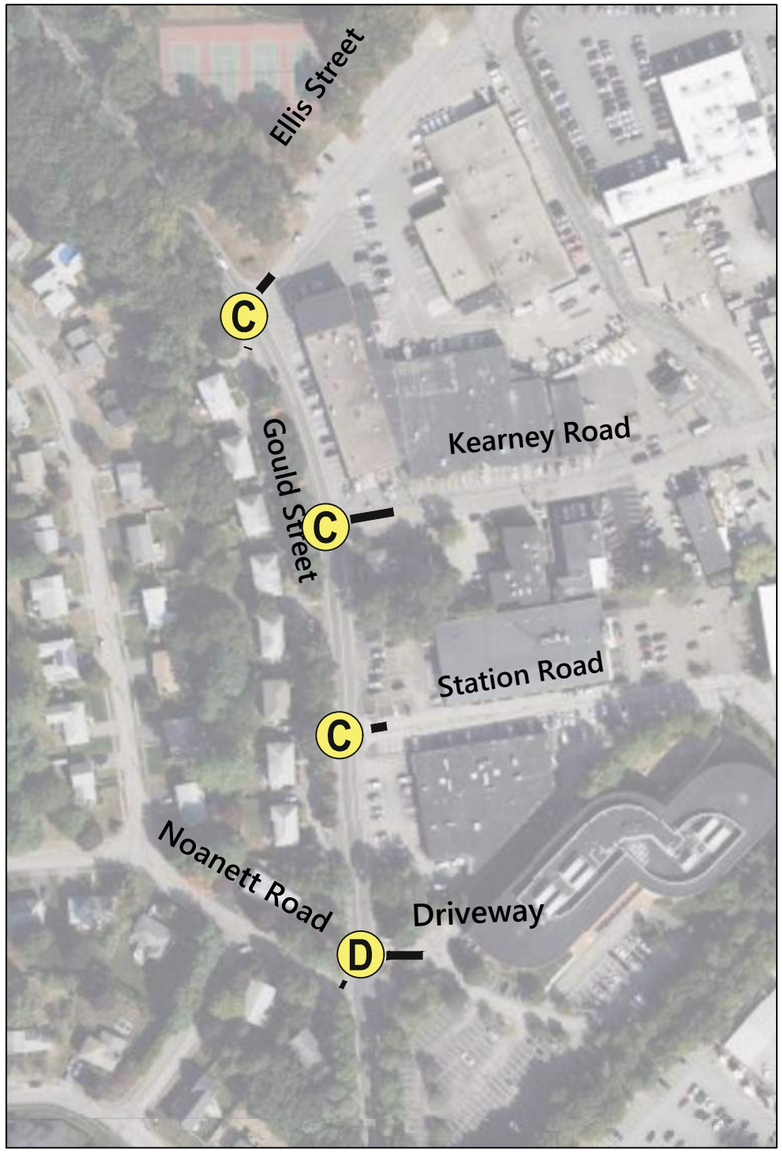
0 100 200 Feet

Gould Street at Ellis Treet, Kearney Road, Station Road, and Noanett Road (Unsignalized)

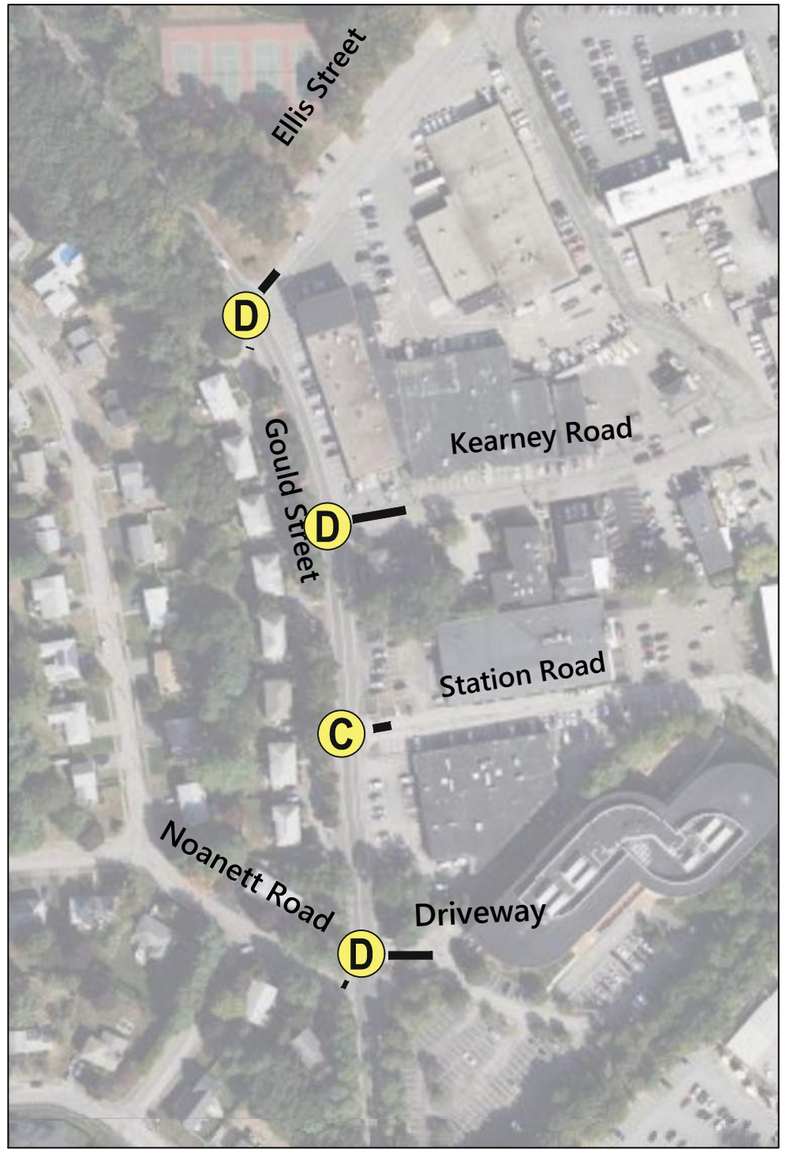
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build

0 100 200 Feet

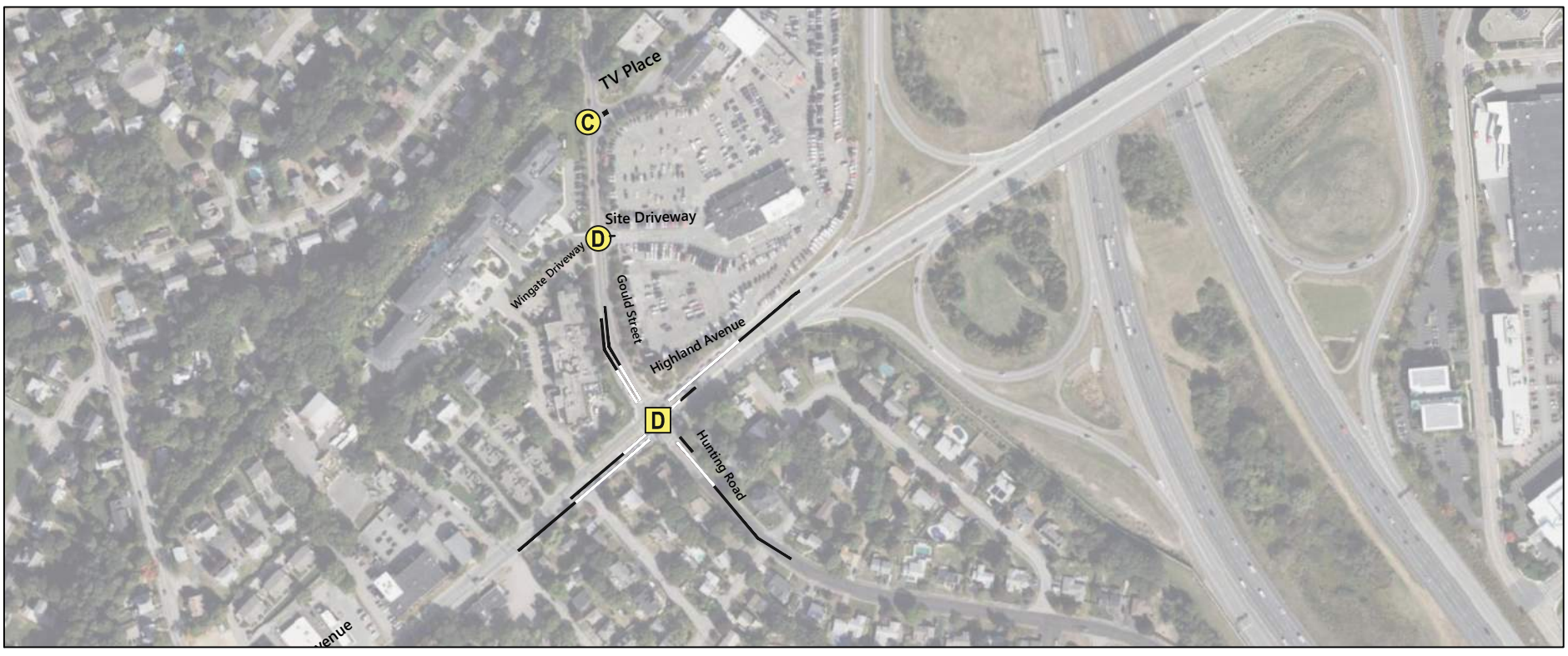
Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

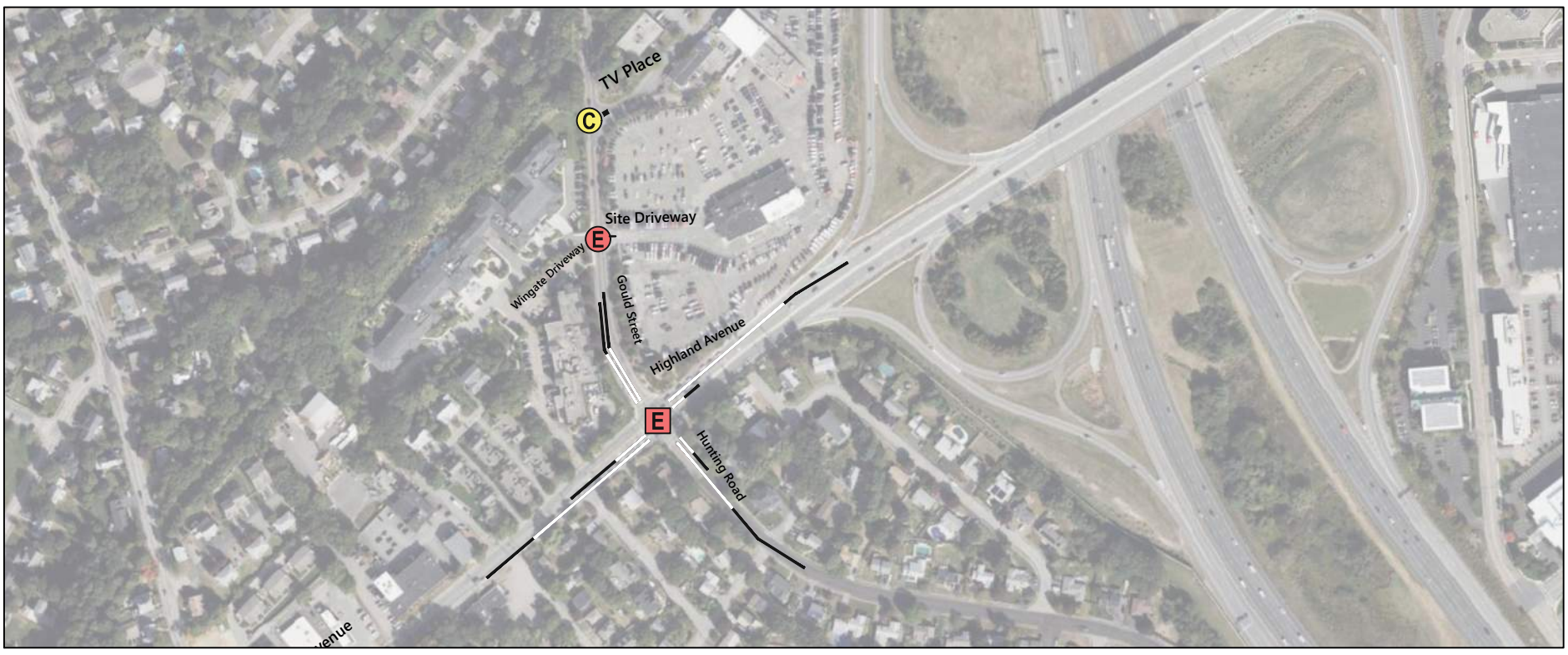
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Gould Street at Highland Avenue (Signalized), Site Driveway (Unsignalized), and TV Place (Unsignalized)

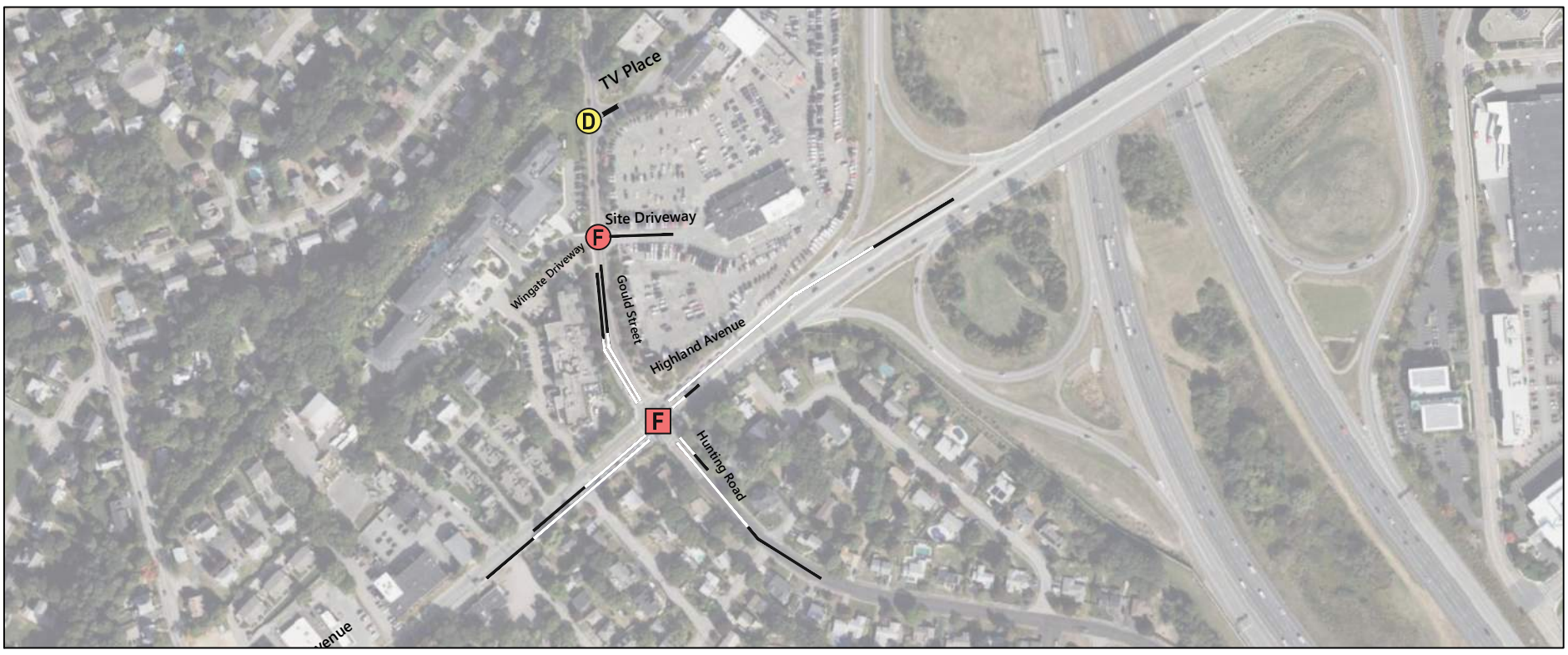
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build Without Mitigation

Queue Diagrams
Weekday Morning Peak Hour

0 200 400 Feet

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Gould Street at Highland Avenue (Signalized), Site Driveway (Unsignalized), and TV Place (Unsignalized)

[X] Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing

2029 No-Build

2029 Build Without Mitigation

* Movement beyond capacity, no results reported.

Queue Diagrams
Weekday Evening Peak Hour

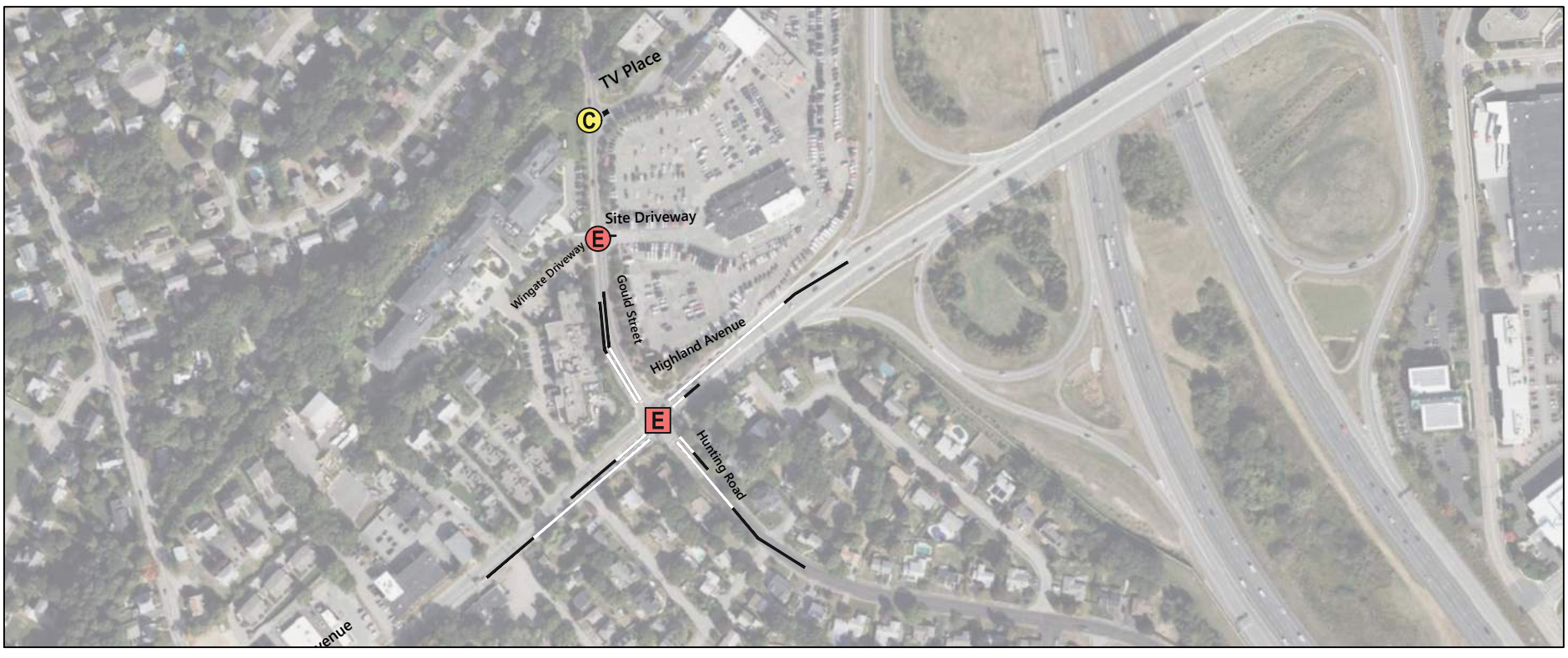
0 200 400 Feet

557 Highland Avenue
Needham, Massachusetts

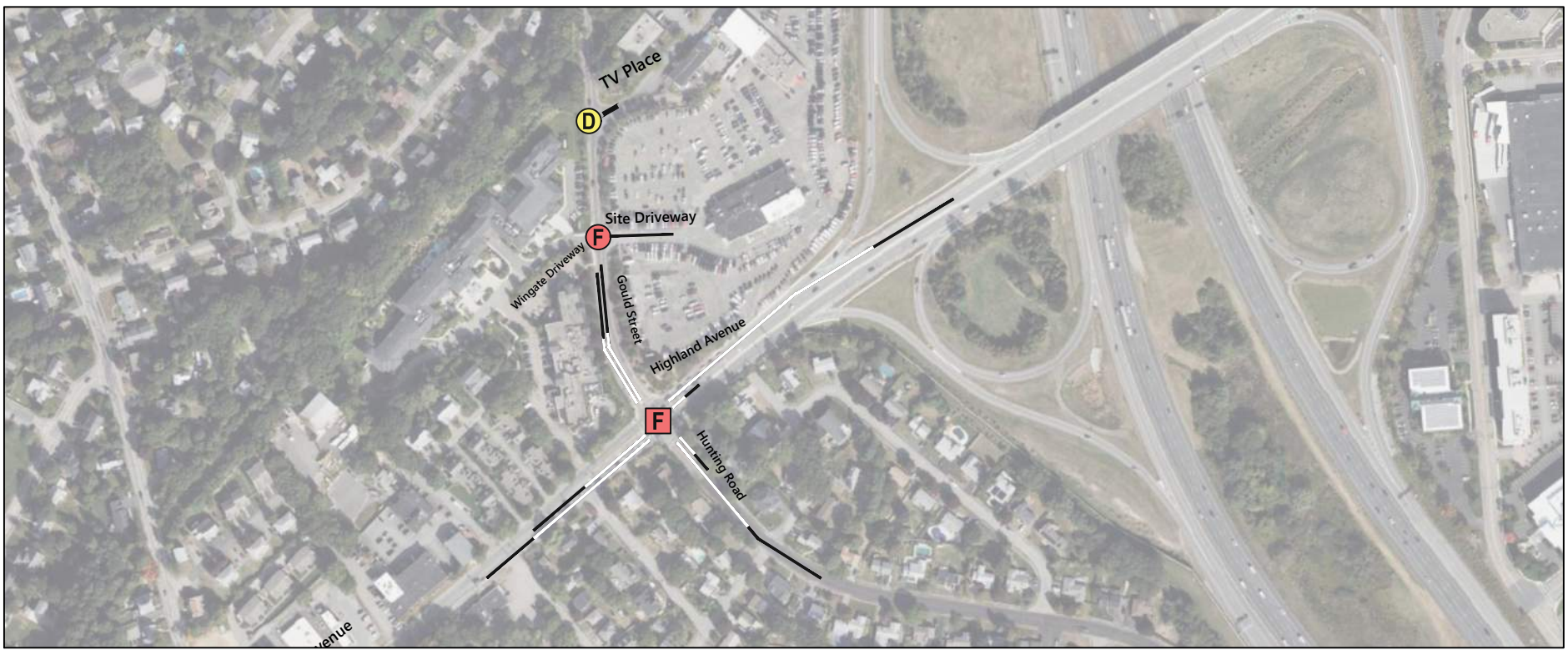
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues\Queues_AM.dwg

Gould Street at Highland Avenue (Signalized), Site Driveway (Unsignlaized), and TV Place (Unsignalized)

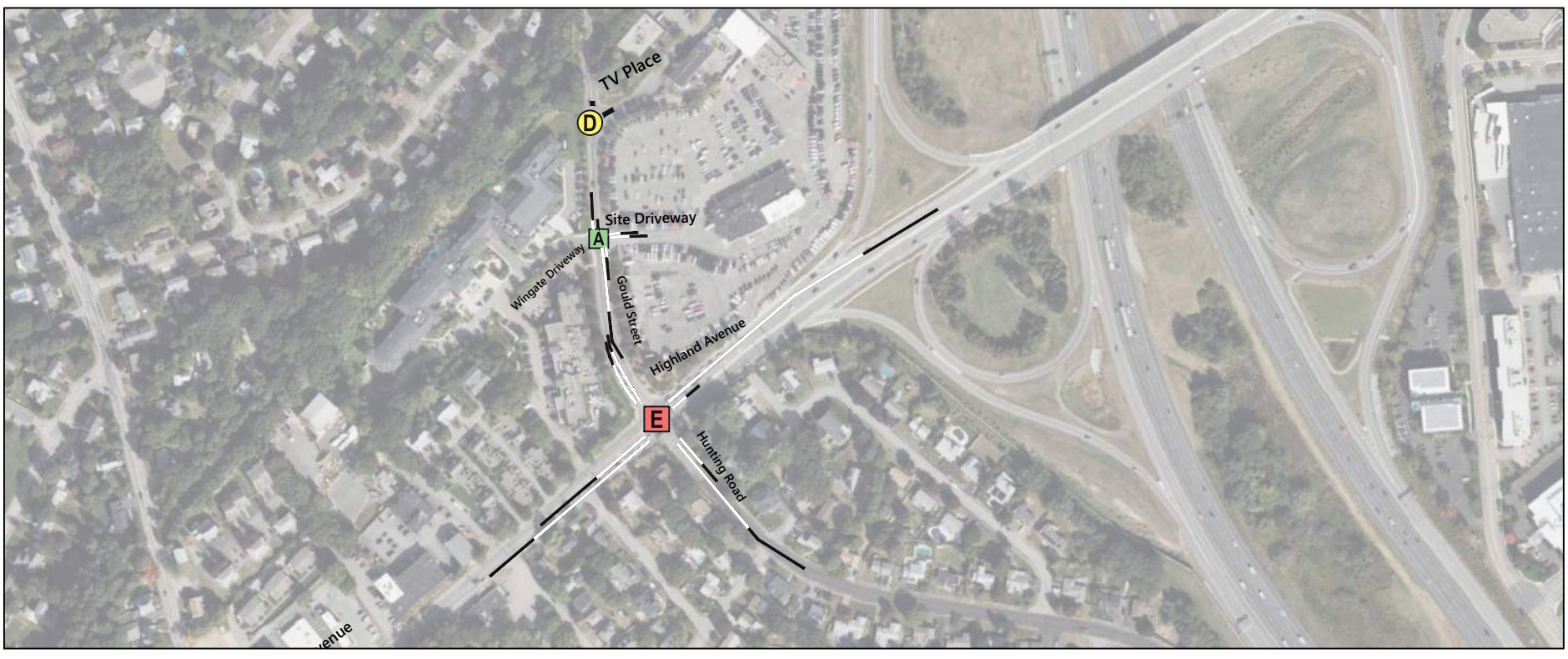
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2029 No-Build



2029 Build Without Mitigation



2029 Build With Mitigation

Gould Street at Site Driveway signalized under Mitigation Condition

Queue Diagrams
Weekday Morning Peak Hour

0 200 400 Feet

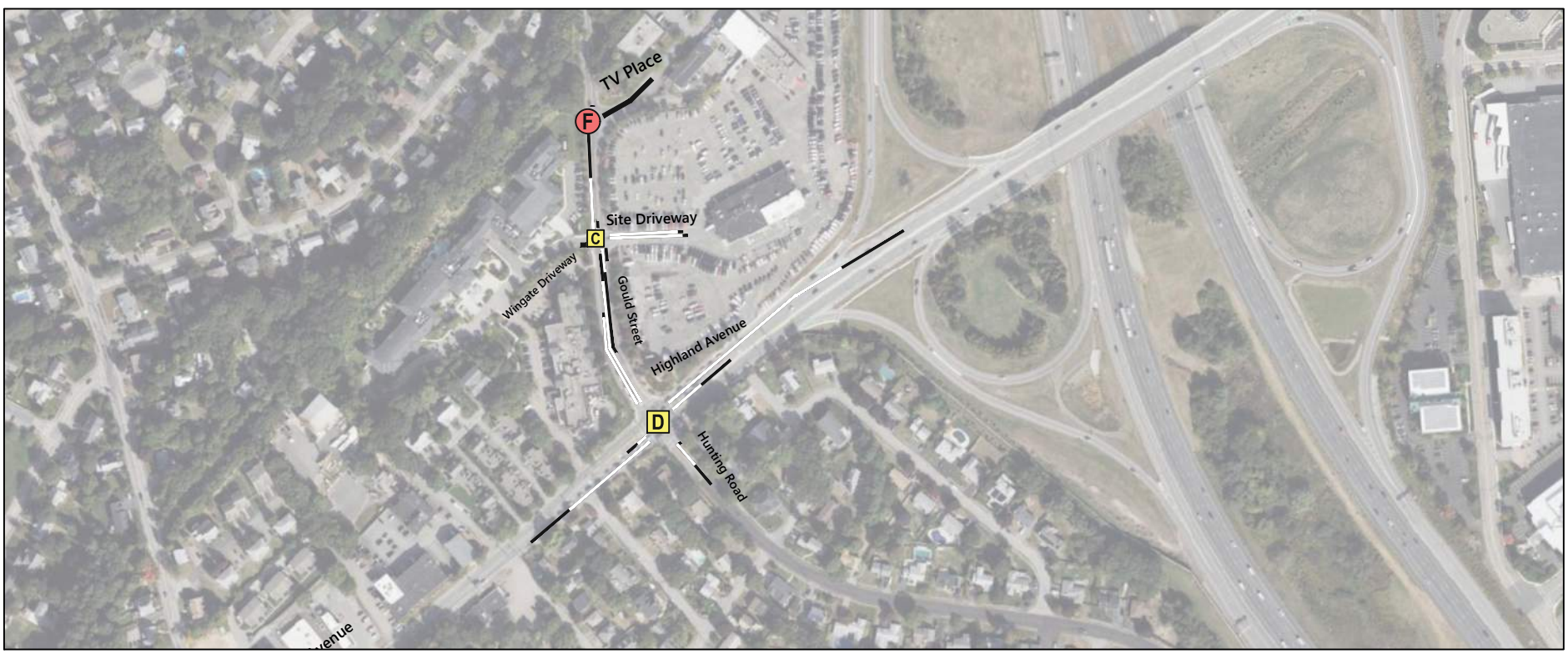
557 Highland Avenue
Needham, Massachusetts

Gould Street at Highland Avenue (Signalized), Site Driveway (Unsignlaized), and TV Place (Unsignalized)

X Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2029 No-Build

2029 Build Without Mitigation



2029 Build With Mitigation

* Movement beyond capacity, no results reported.

Gould Street at Site Driveway signalized under Mitigation Condition

Queue Diagrams
Weekday Evening Peak Hour

0 200 400 Feet

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Highland Avenue at West Street (Signalized) and Hunnewell Street (Unsignalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing

2029 No-Build

2029 Build Without Mitigation

* Movement beyond capacity, no results reported.

0 150 300 Feet

vhb

Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Highland Avenue at West Street (Signalized) and Hunnewell Street (Unsignalized)

X Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing

2029 No-Build

2029 Build Without Mitigation

0 150 300 Feet

Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Highland Avenue at West Street (Signalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2029 No-Build

2029 Build Without Mitigation

2029 Build With Mitigation

Signal timings modified under Mitigation Conditions

0 150 300 Feet

Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Highland Avenue at West Street (Signalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2029 No-Build

2029 Build Without Mitigation

2029 Build With Mitigation

Signal timings modified under Mitigation Conditions

0 150 300 Feet

vhb

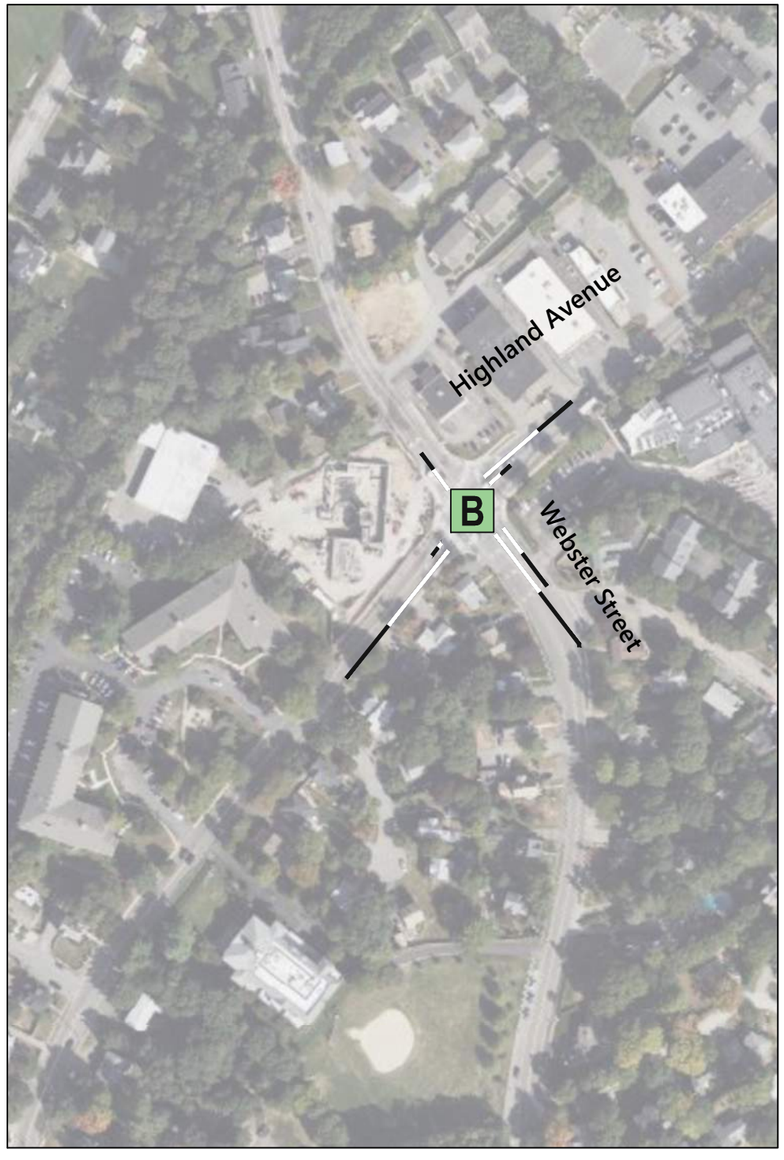
Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

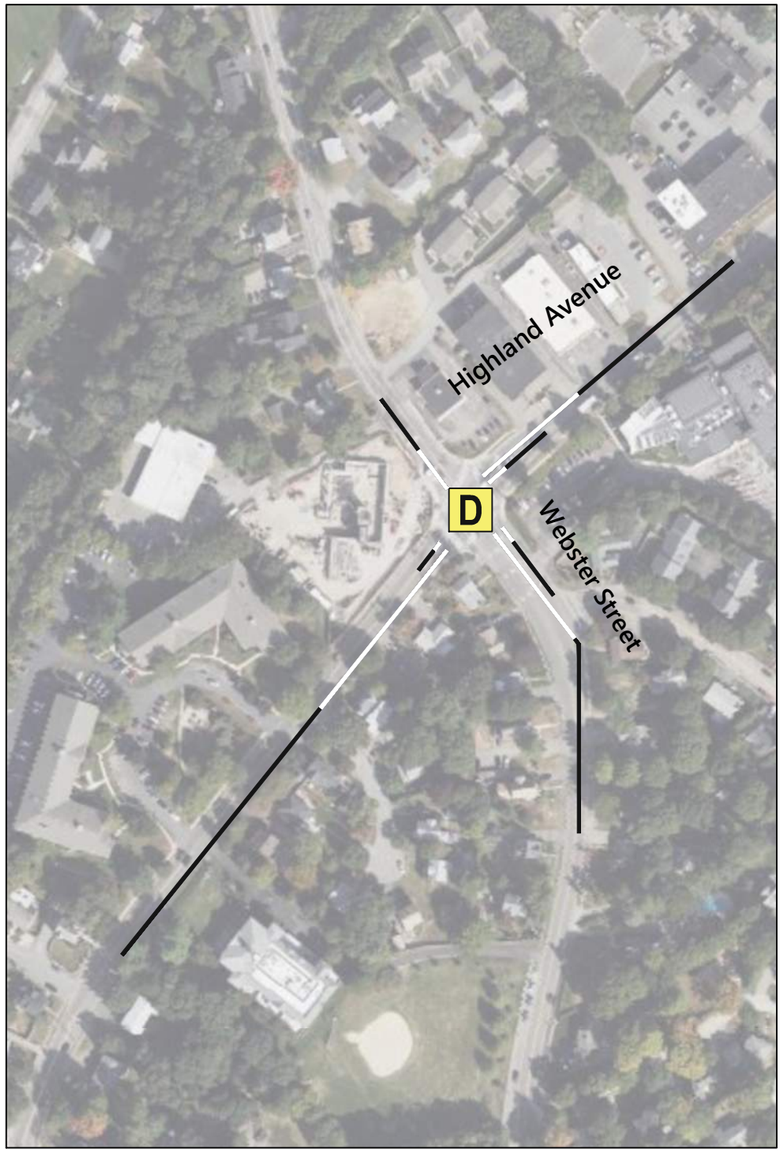
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Highland Avenue at Webster Street (Signalized)

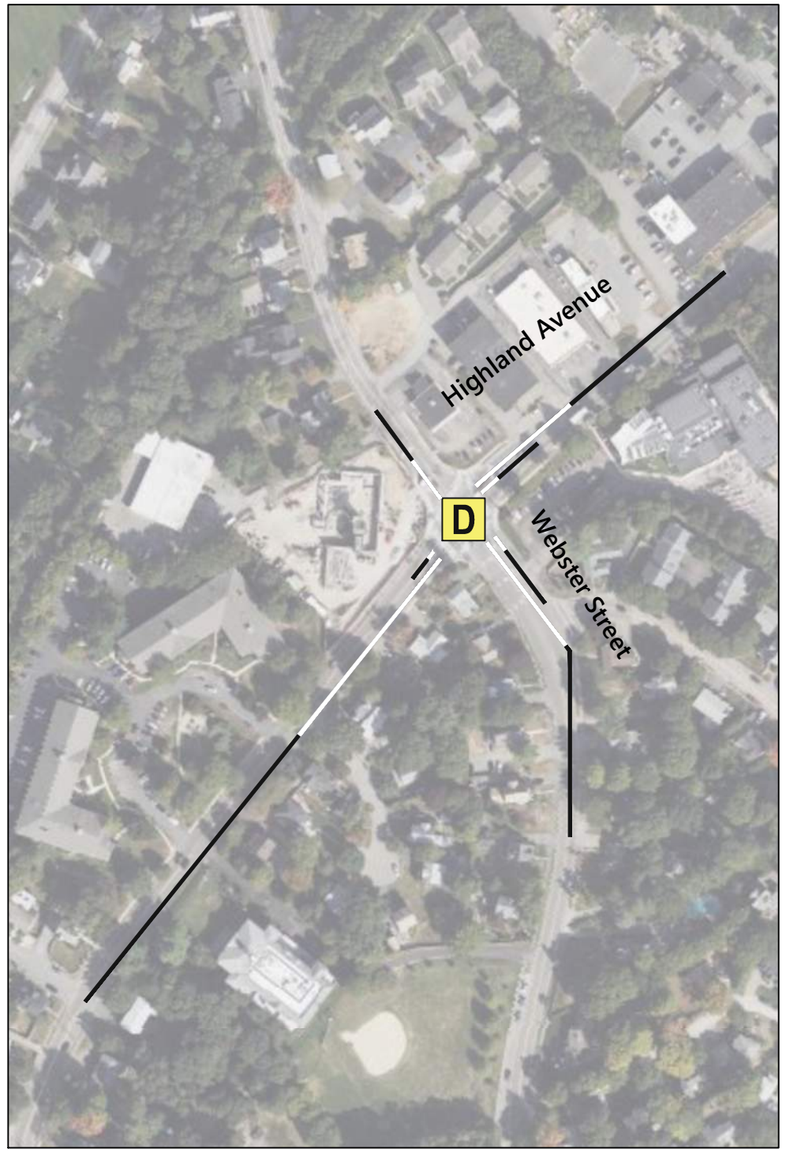
X Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build Without Mitigation

0 100 200 Feet

vhb

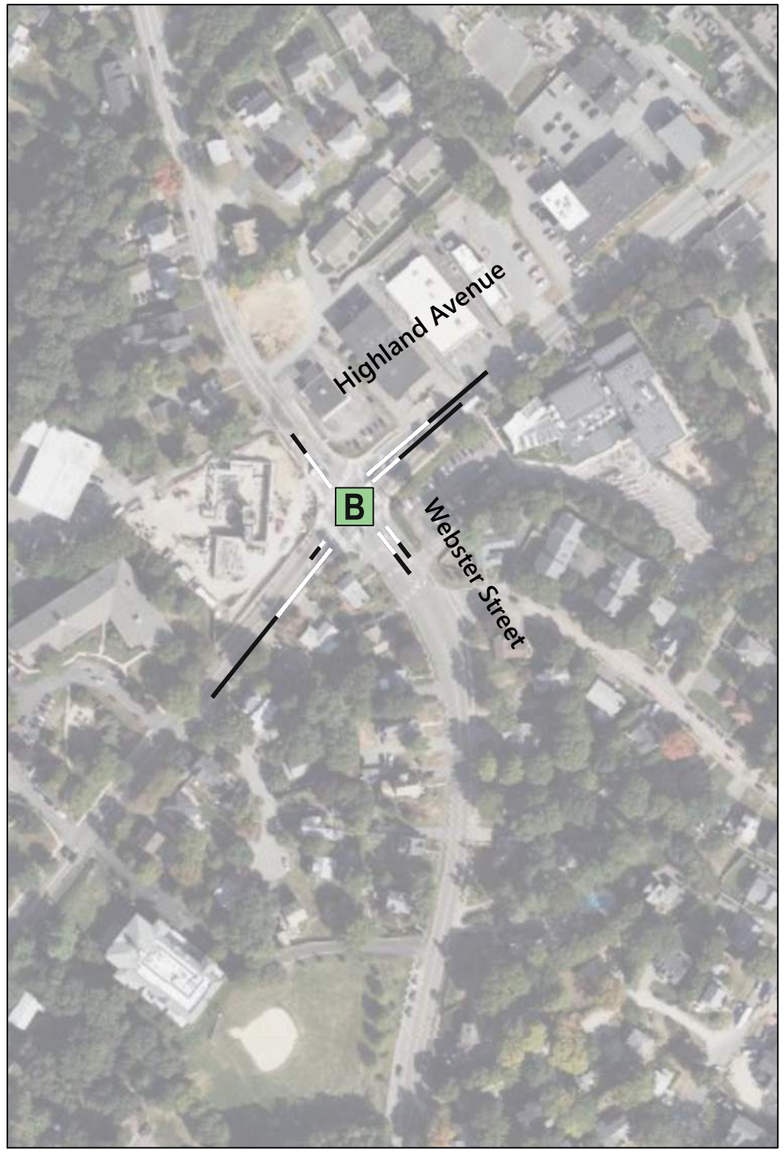
Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

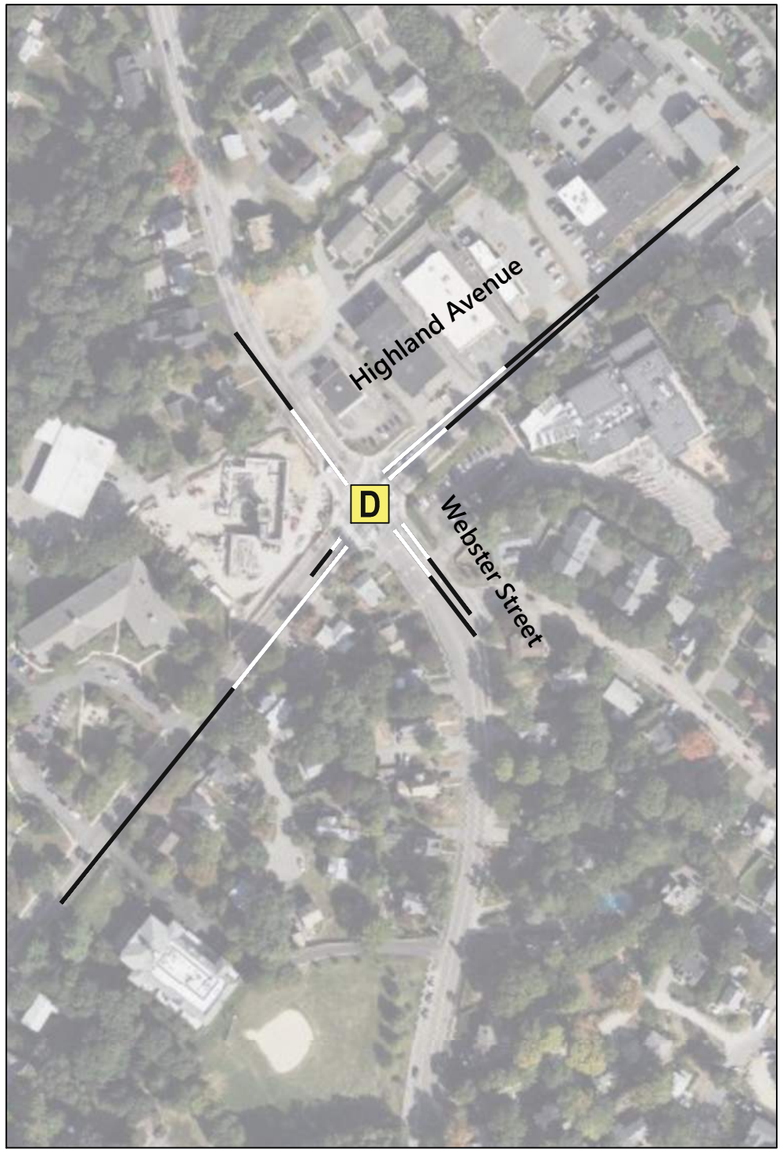
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Highland Avenue at Webster Street (Signalized)

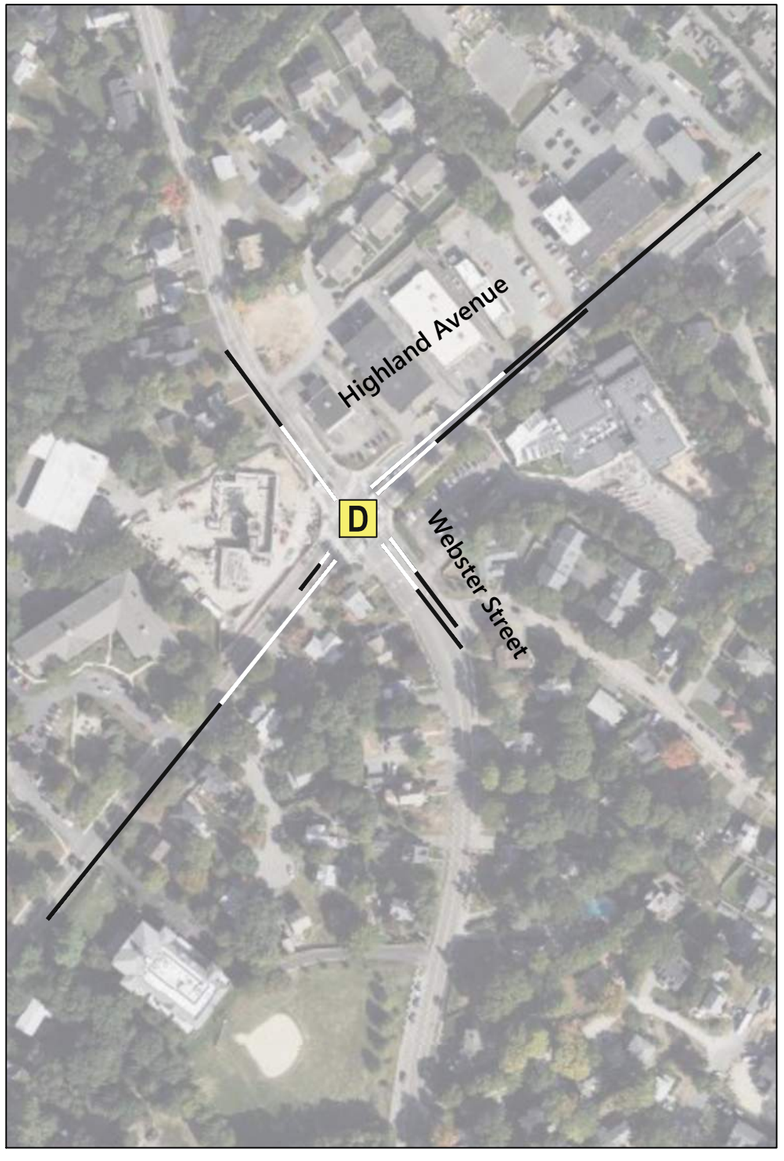
X Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build Without Mitigation

0 100 200 Feet

vhb

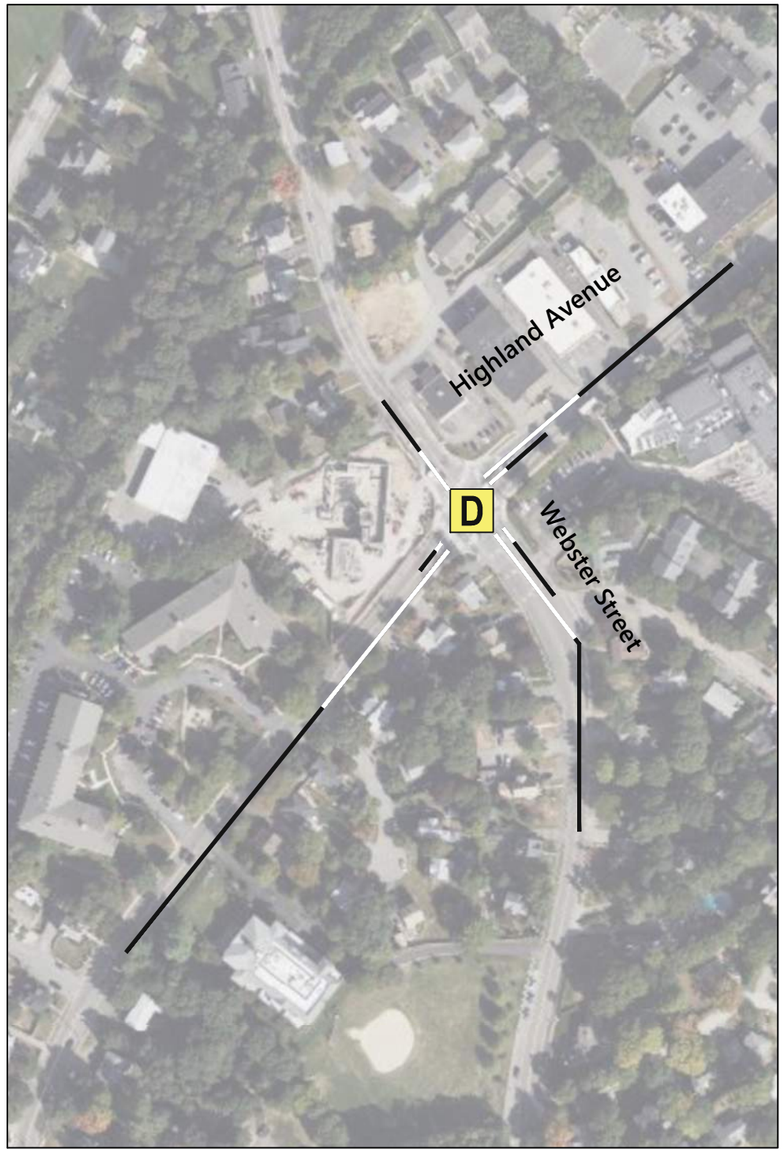
Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

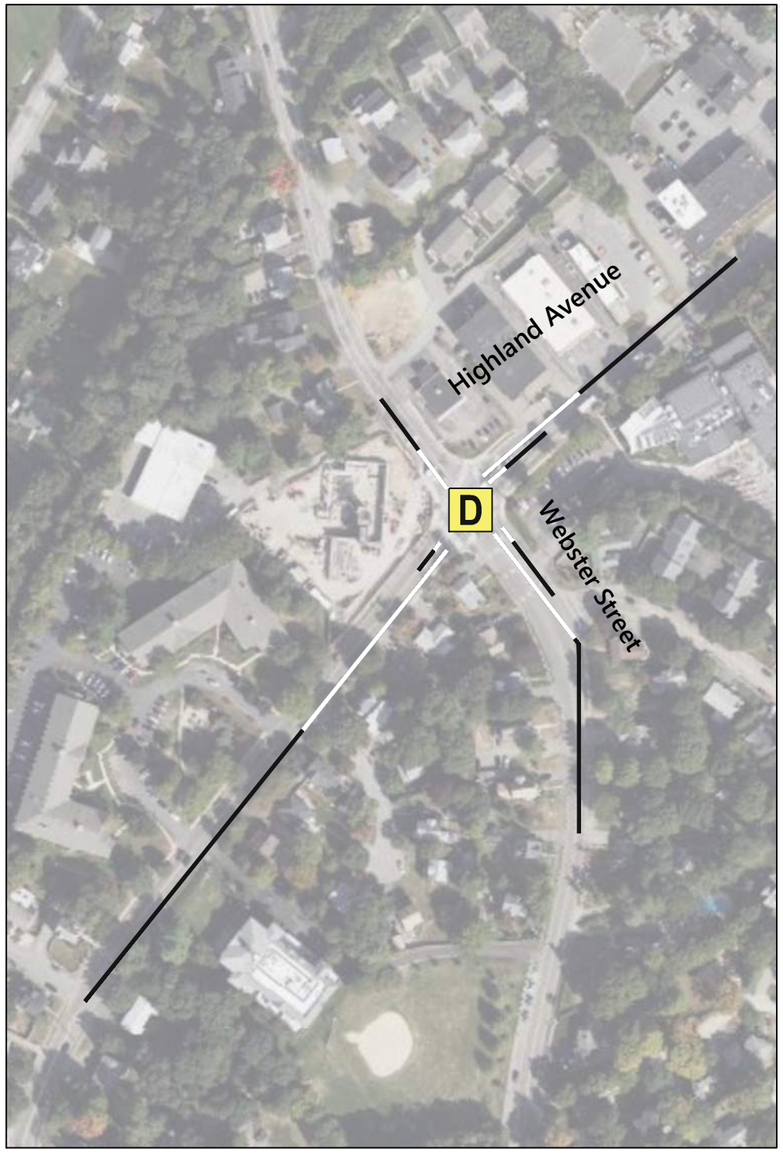
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Highland Avenue at Webster Street (Signalized)

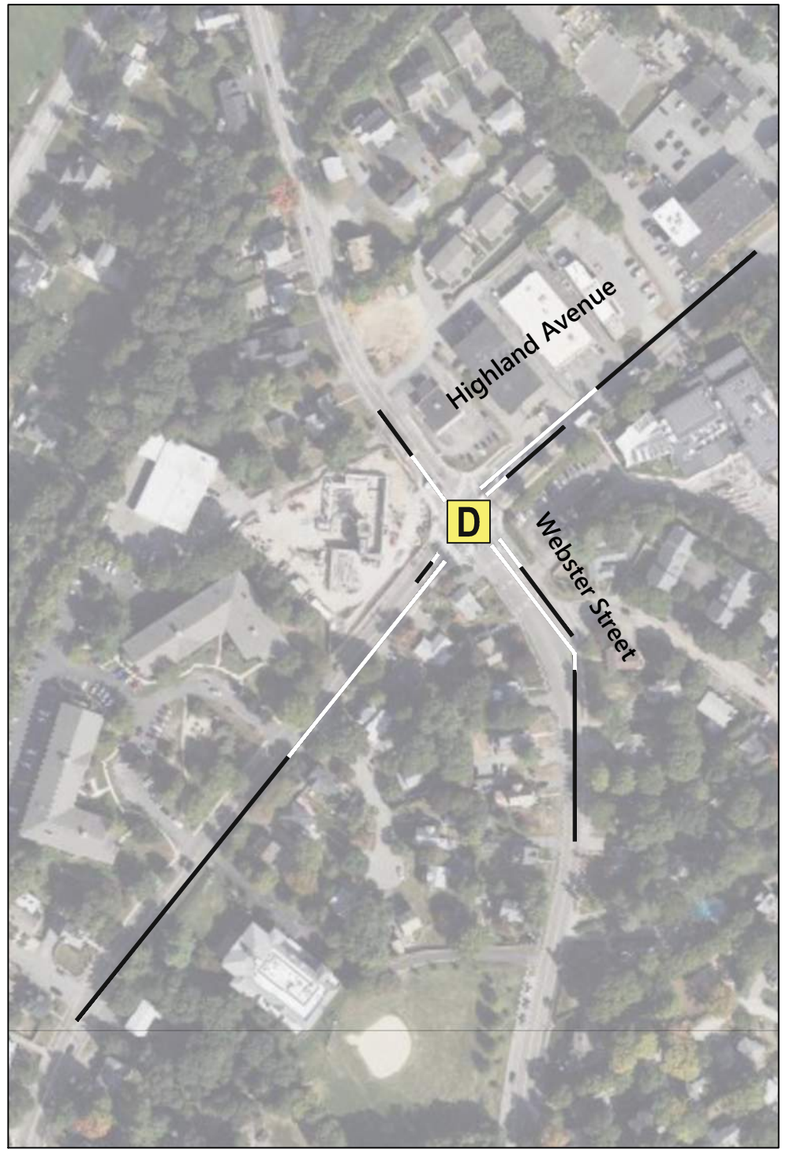
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2029 No-Build



2029 Build Without Mitigation



2029 Build With Mitigation

Signal Timings modified under Mitigation Conditions

0 100 200 Feet

vhb

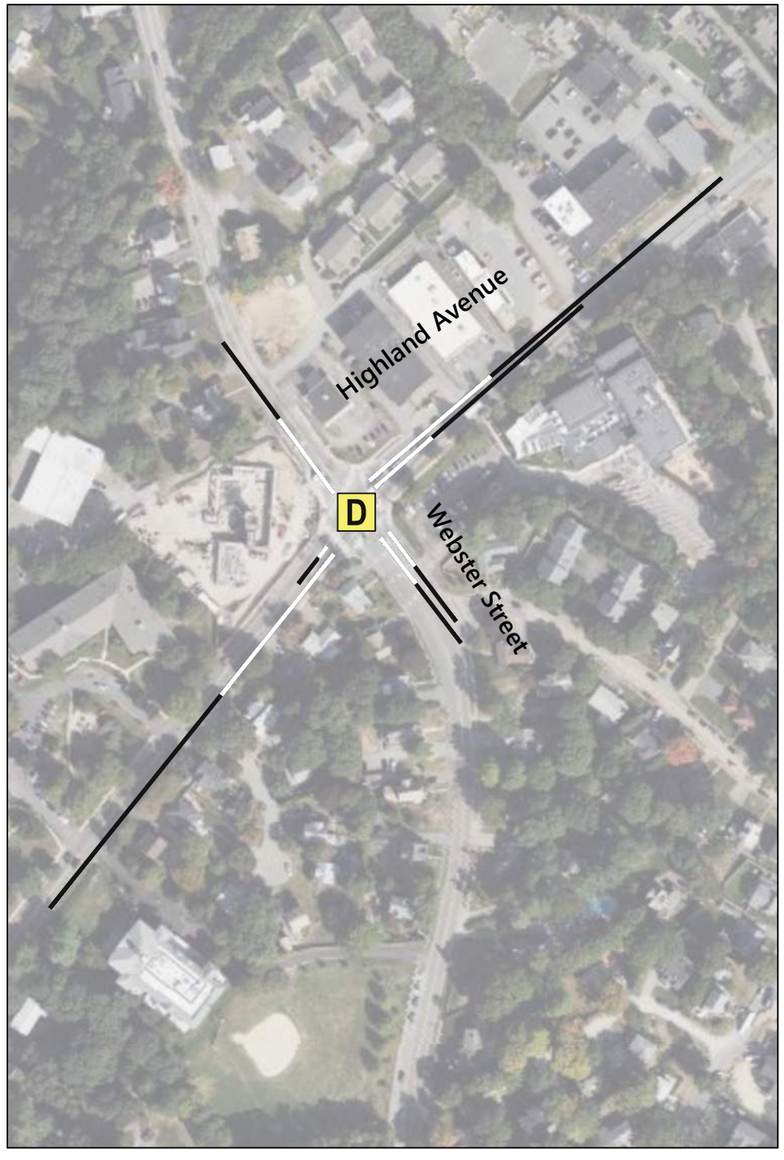
Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

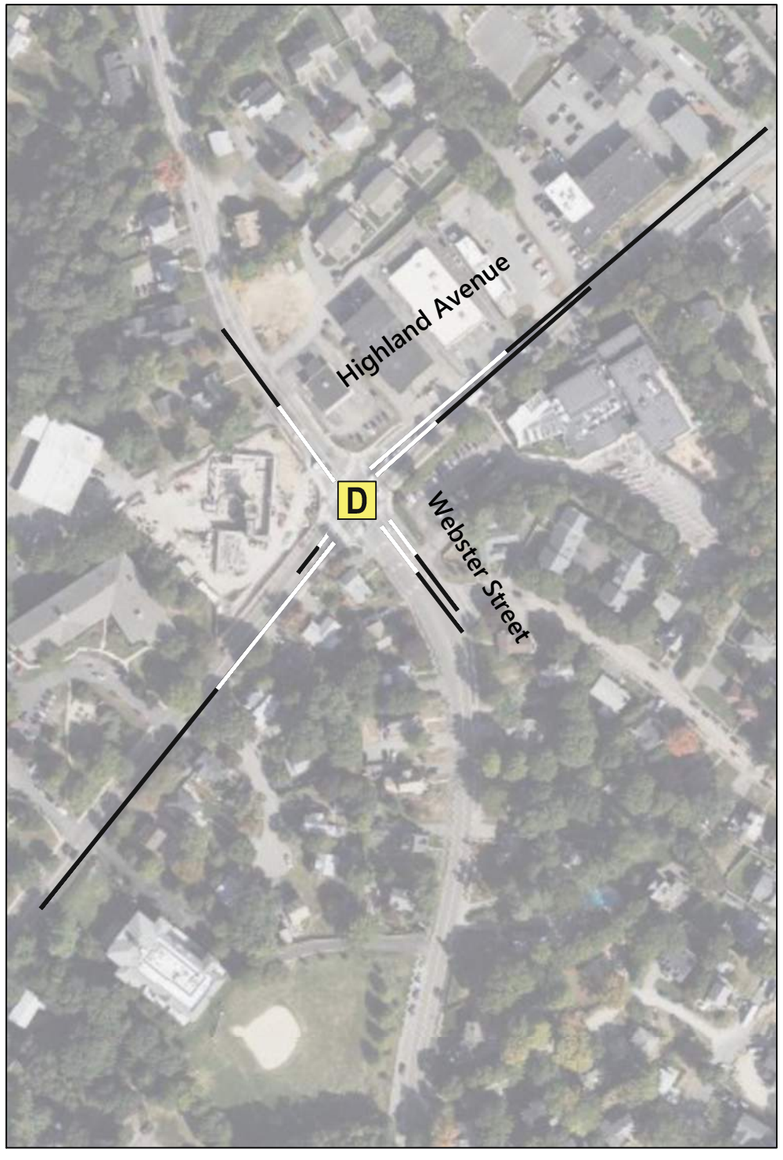
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Highland Avenue at Webster Street (Signalized)

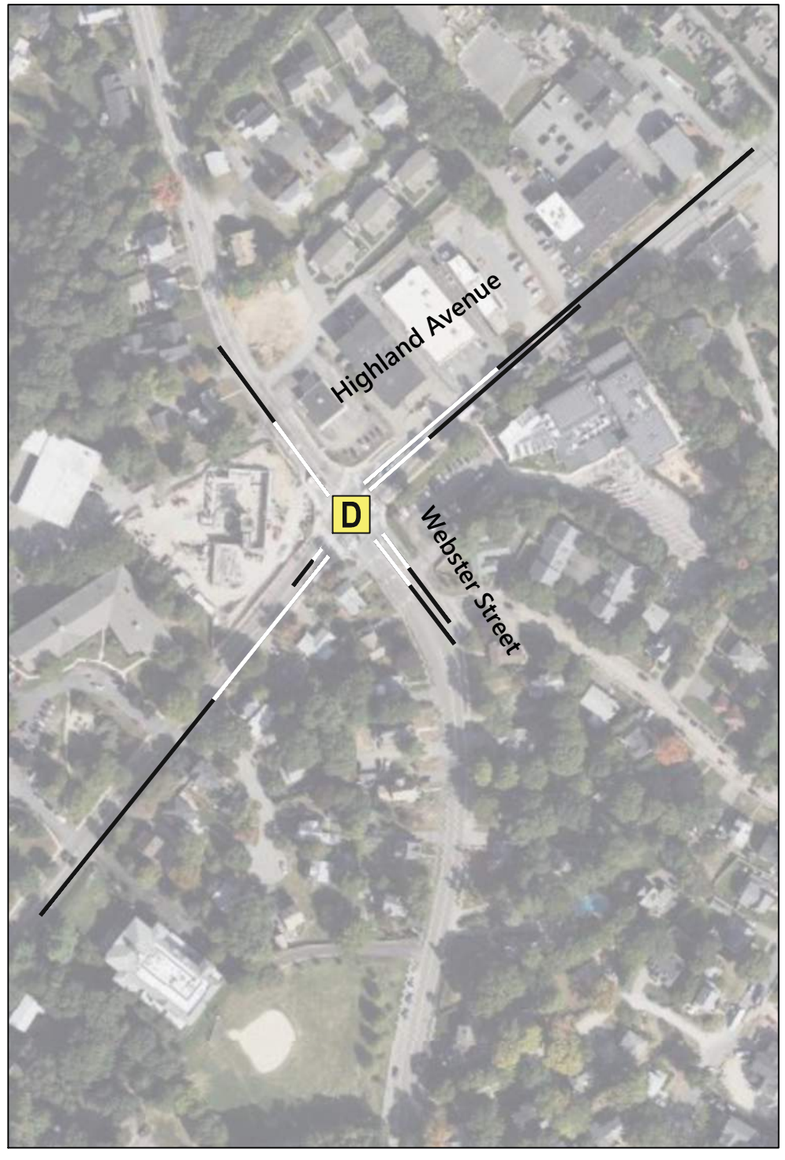
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2029 No-Build



2029 Build Without Mitigation



2029 Build With Mitigation

Signal Timings modified under Mitigation Conditions

0 100 200 Feet

vhb

Queue Diagrams
Weekday Evening Peak Hour

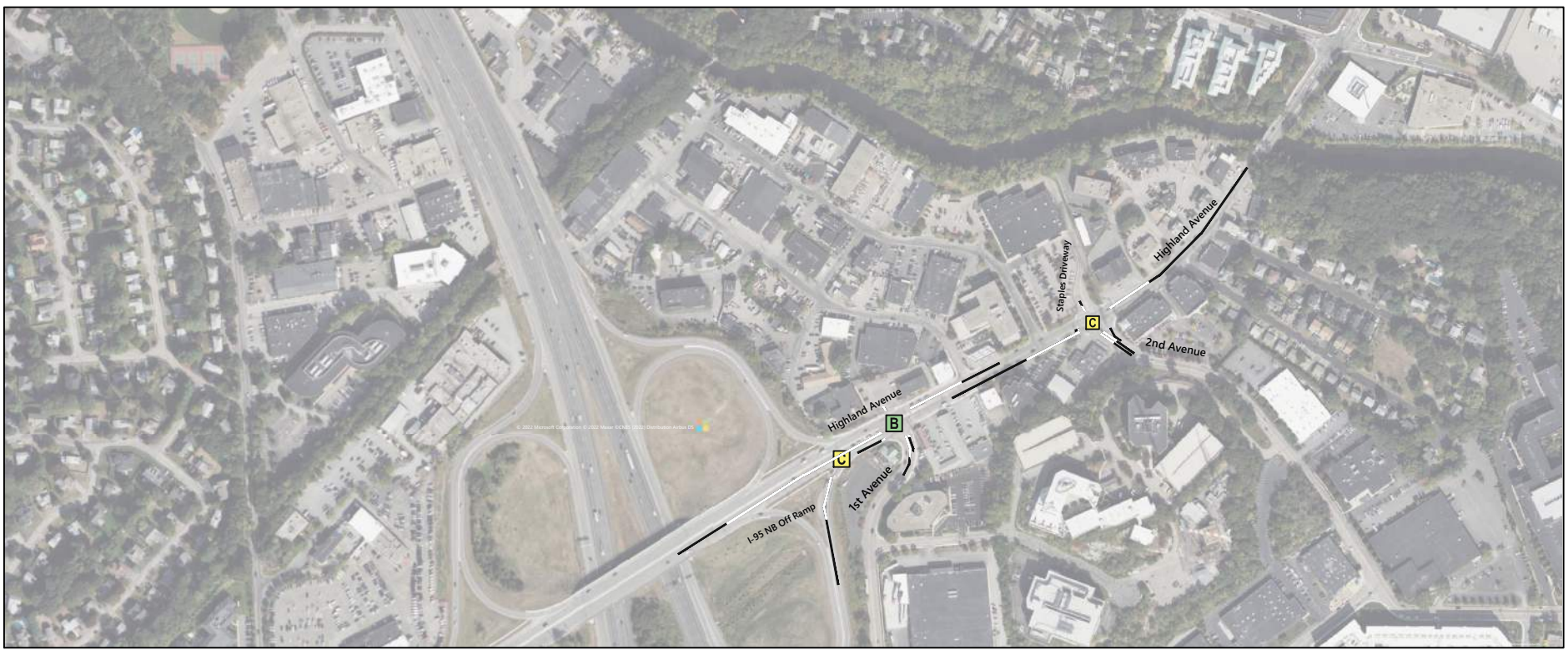
557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Highland Avenue at I-95 Ramps, 1st Avenue, and 2nd Avenue (Signalized)

X Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2022 Existing



2029 No-Build

2029 Build Without Mitigation

Queue Diagrams
Weekday Morning Peak Hour

0 275 550 Feet

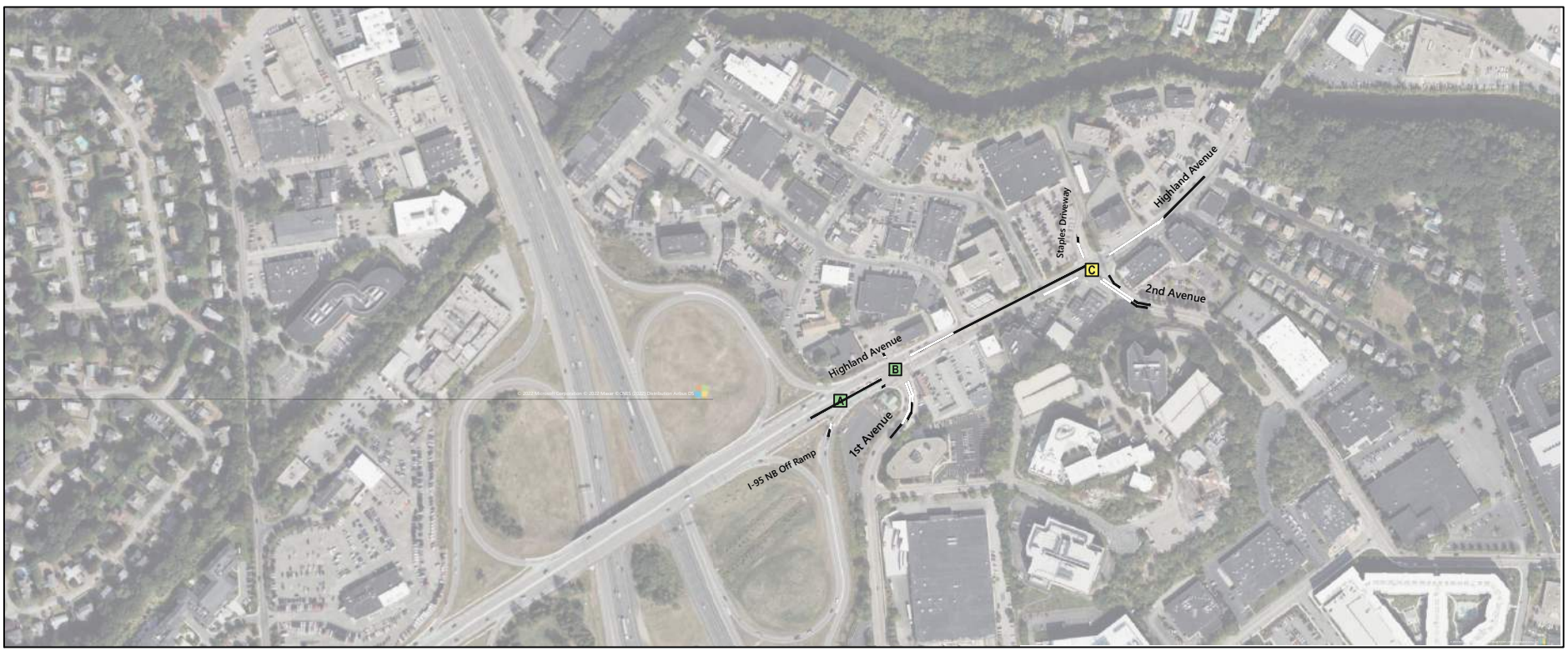
557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

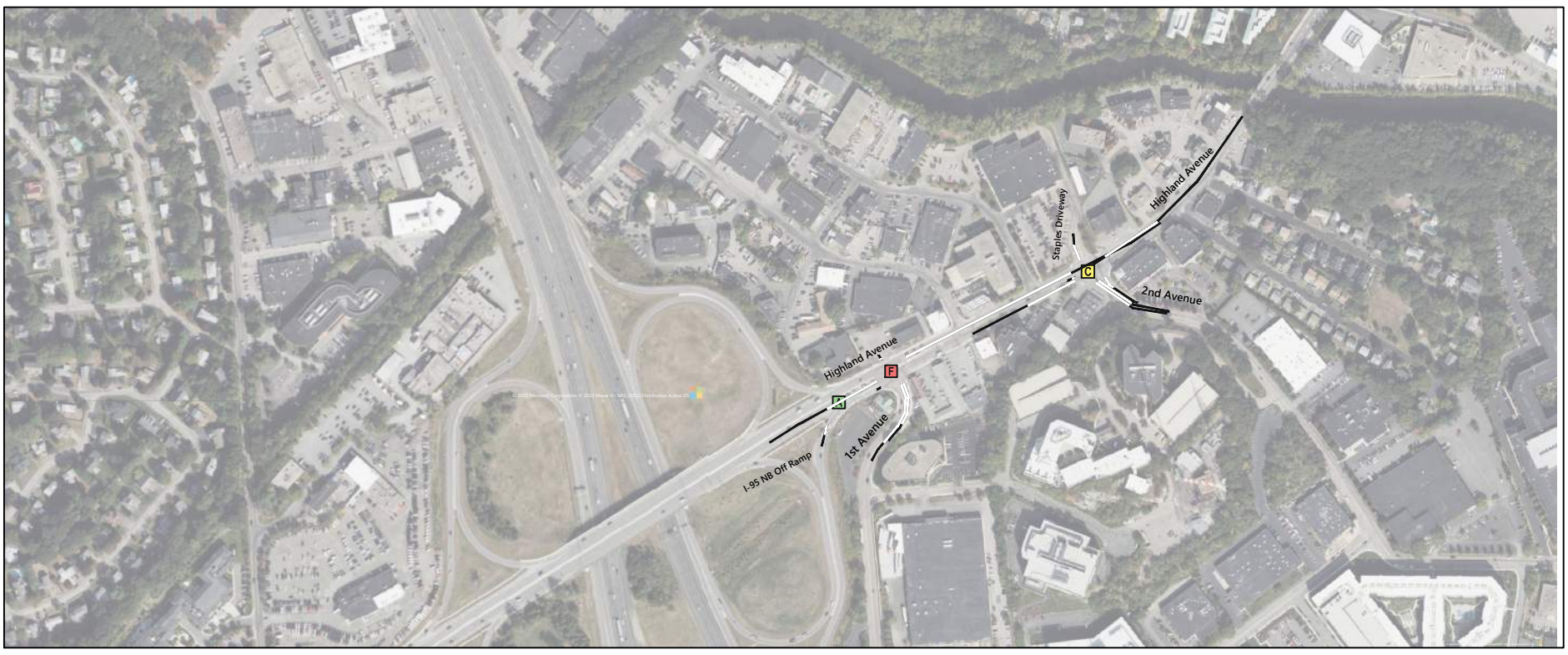
Highland Avenue at I-95 Ramps, 1st Avenue, and 2nd Avenue (Signalized)

[X] Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service

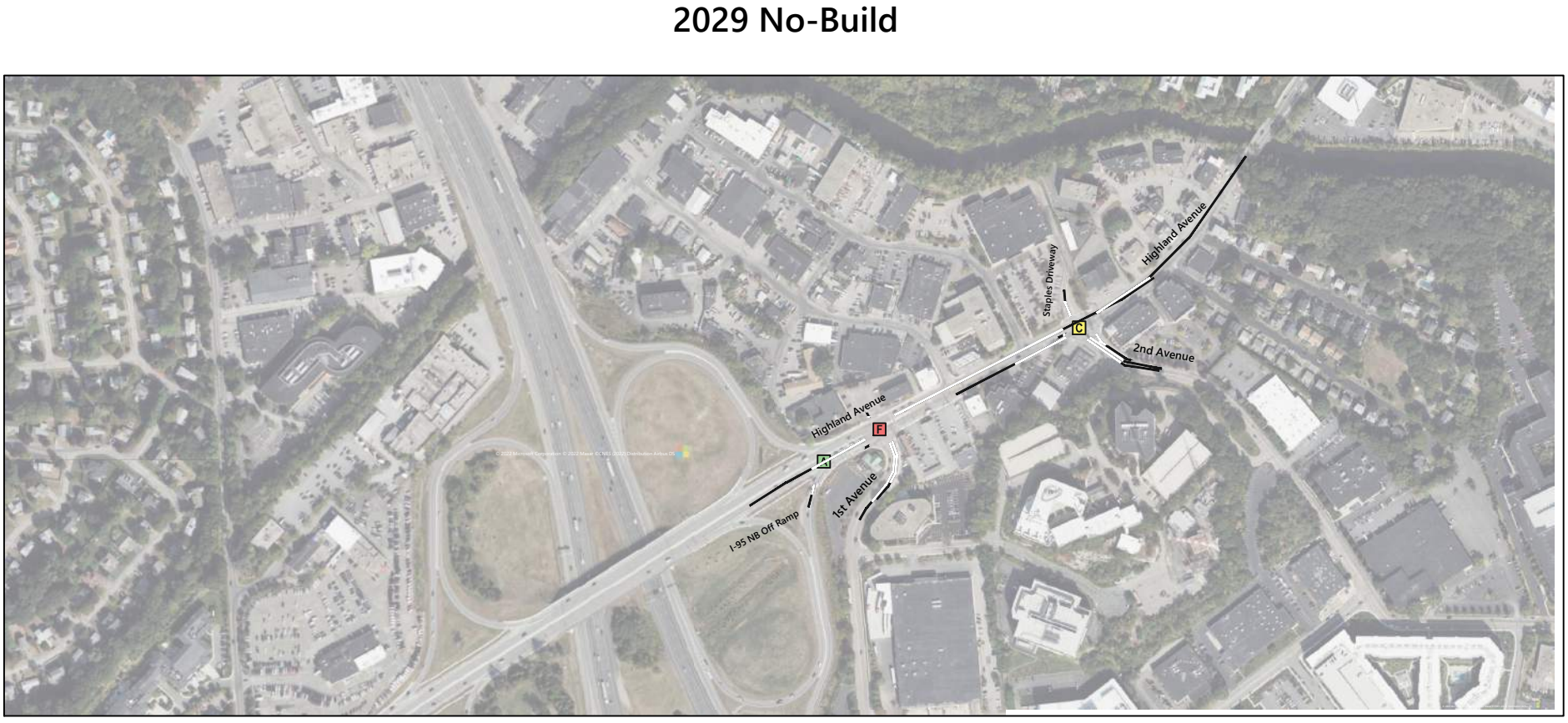
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build Without Mitigation

Queue Diagrams
Weekday Evening Peak Hour

0 275 550 Feet

557 Highland Avenue
Needham, Massachusetts

\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Highland Avenue at 1st Avenue (Signalized)

X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue

2029 No-Build

2029 Build Without Mitigation

2029 Build With Mitigation

Signal Timings modified under Mitigation Conditions

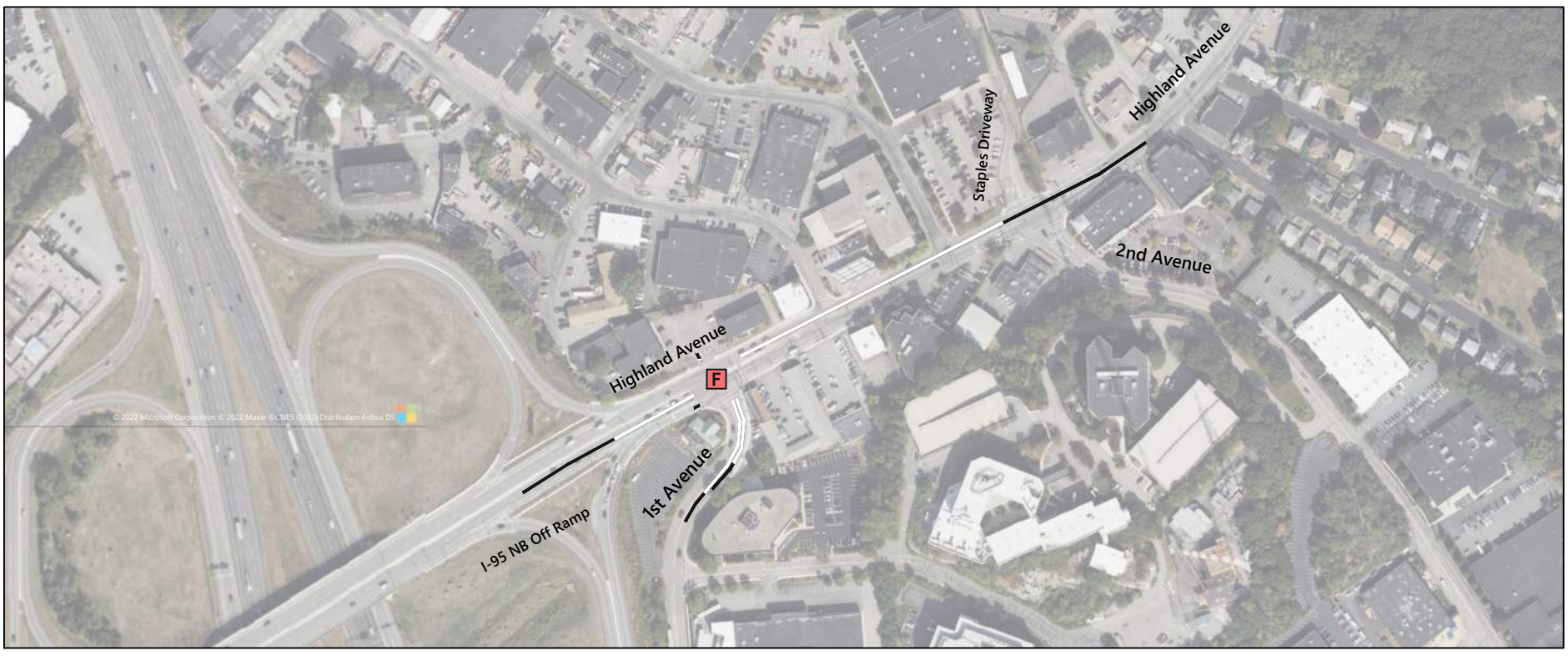
Queue Diagrams
Weekday Morning Peak Hour

0 175 350 Feet

557 Highland Avenue
Needham, Massachusetts

Highland Avenue at 1st Avenue (Signalized)

[X] Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2029 No-Build

2029 Build Without Mitigation

2029 Build With Mitigation

Signal Timings modified under Mitigation Conditions

Queue Diagrams
Weekday Evening Peak Hour

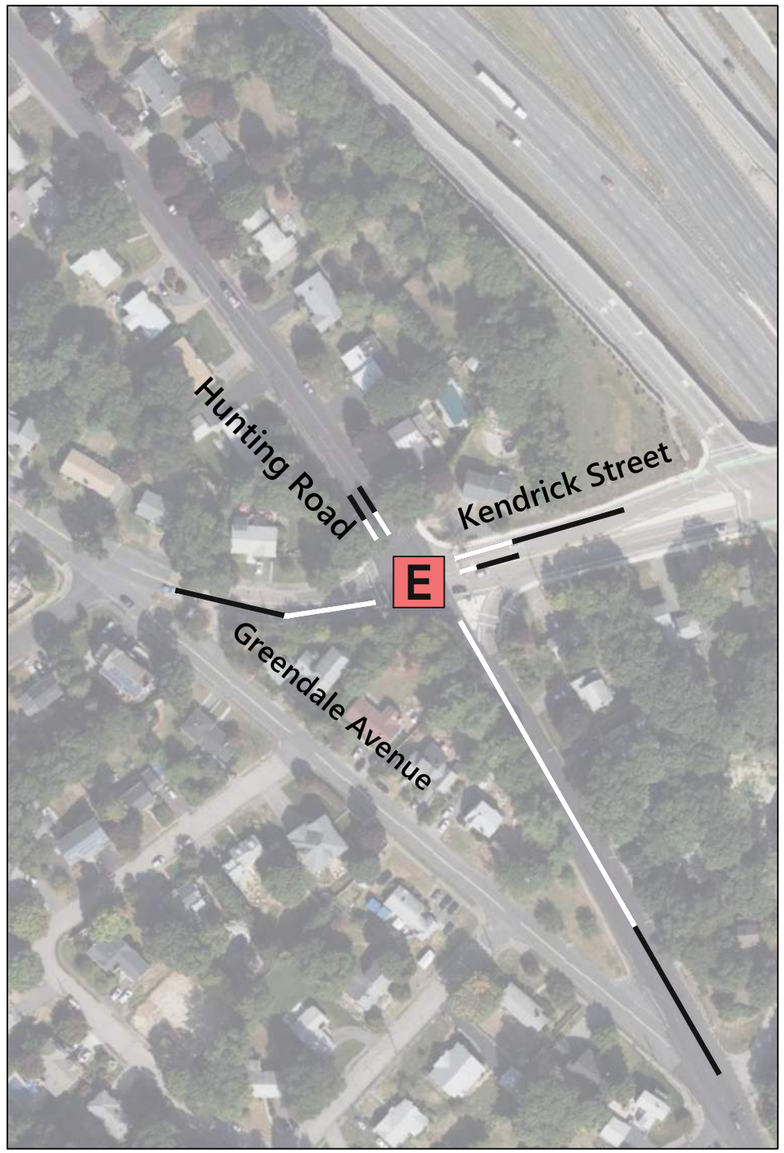
0 175 350 Feet

557 Highland Avenue
Needham, Massachusetts

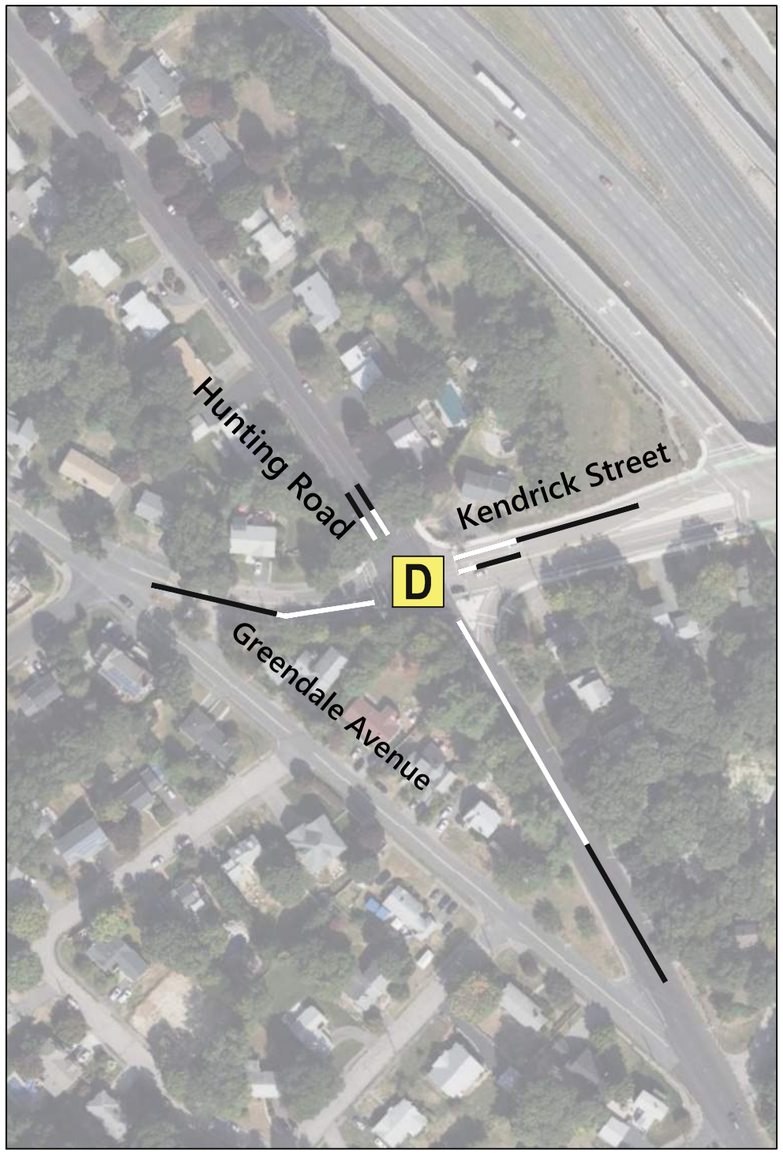
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Hunting Road at Kendrick Street (Signalized)

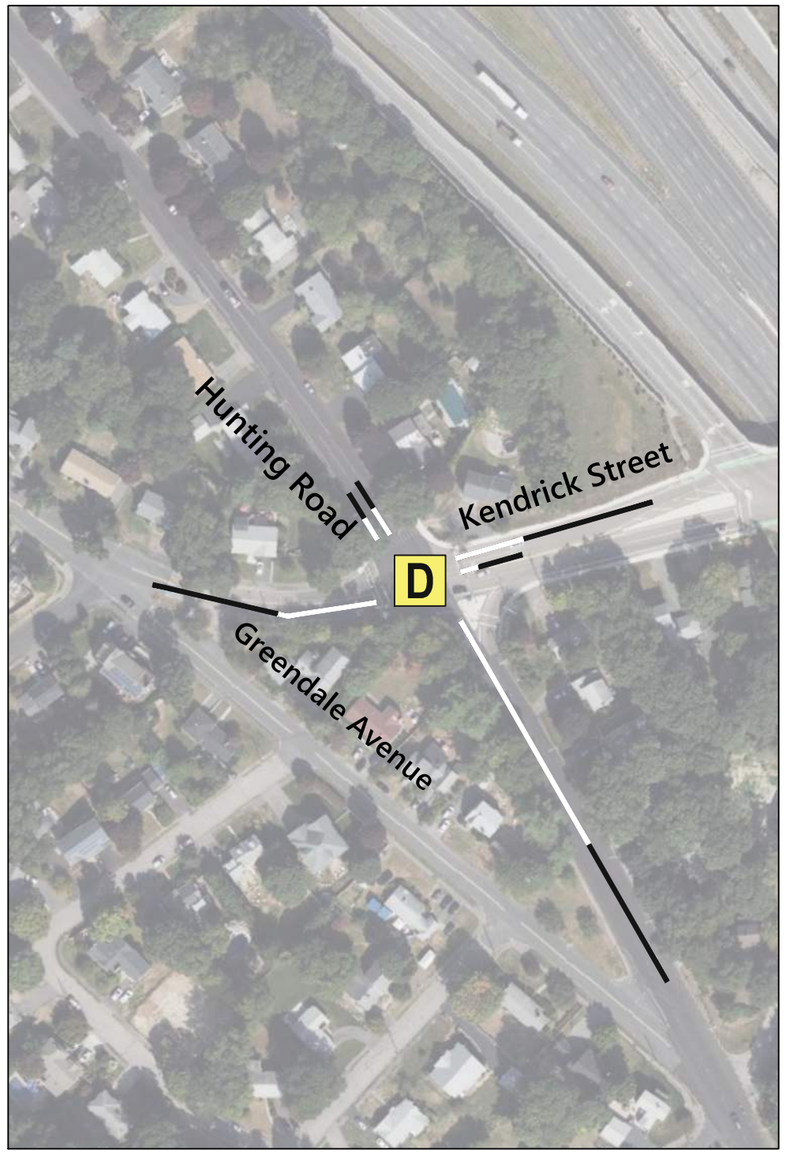
X Signalized Intersection Level of Service
(X) Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build Without Mitigation

vhb

Queue Diagrams
Weekday Morning Peak Hour

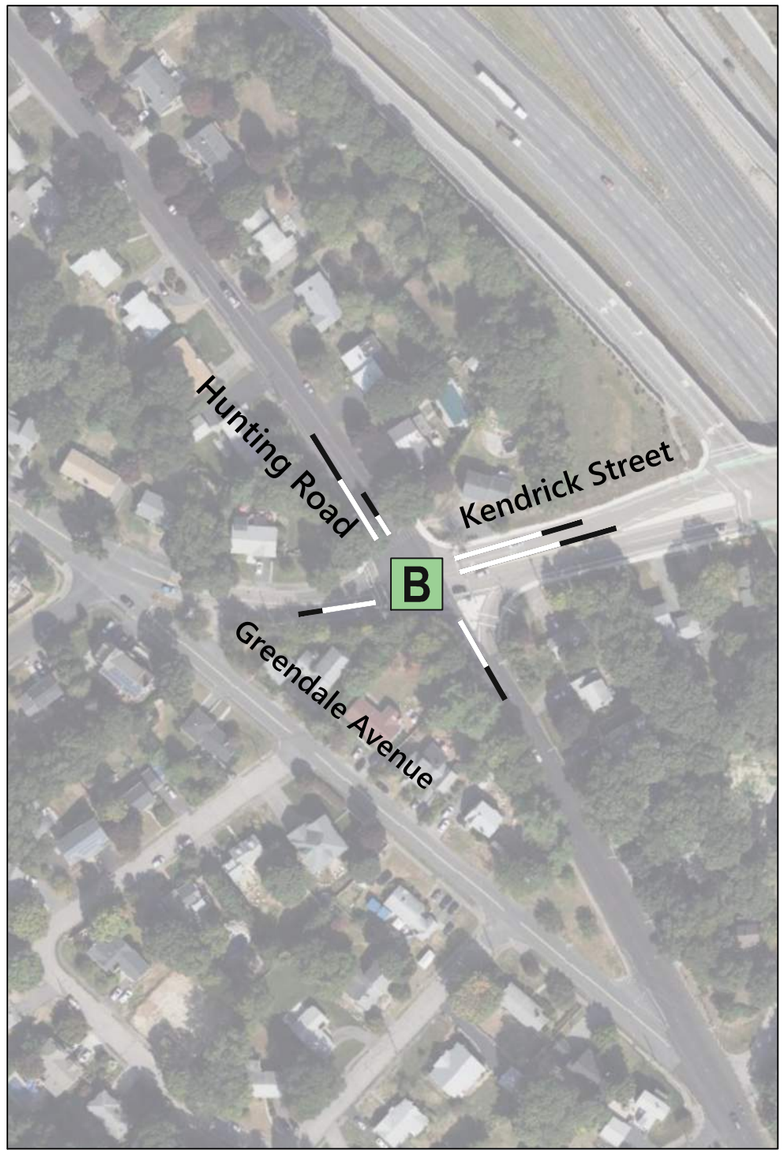
557 Highland Avenue
Needham, Massachusetts

0 100 200 Feet

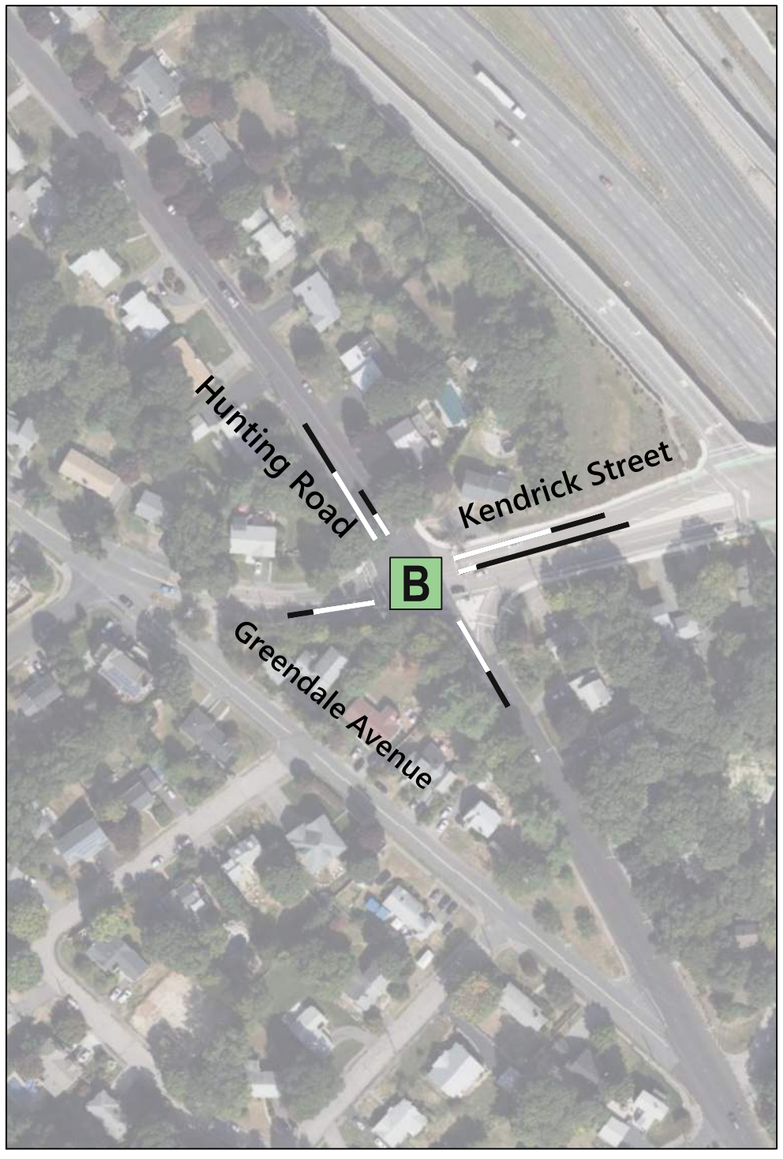
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Hunting Road at Kendrick Street (Signalized)

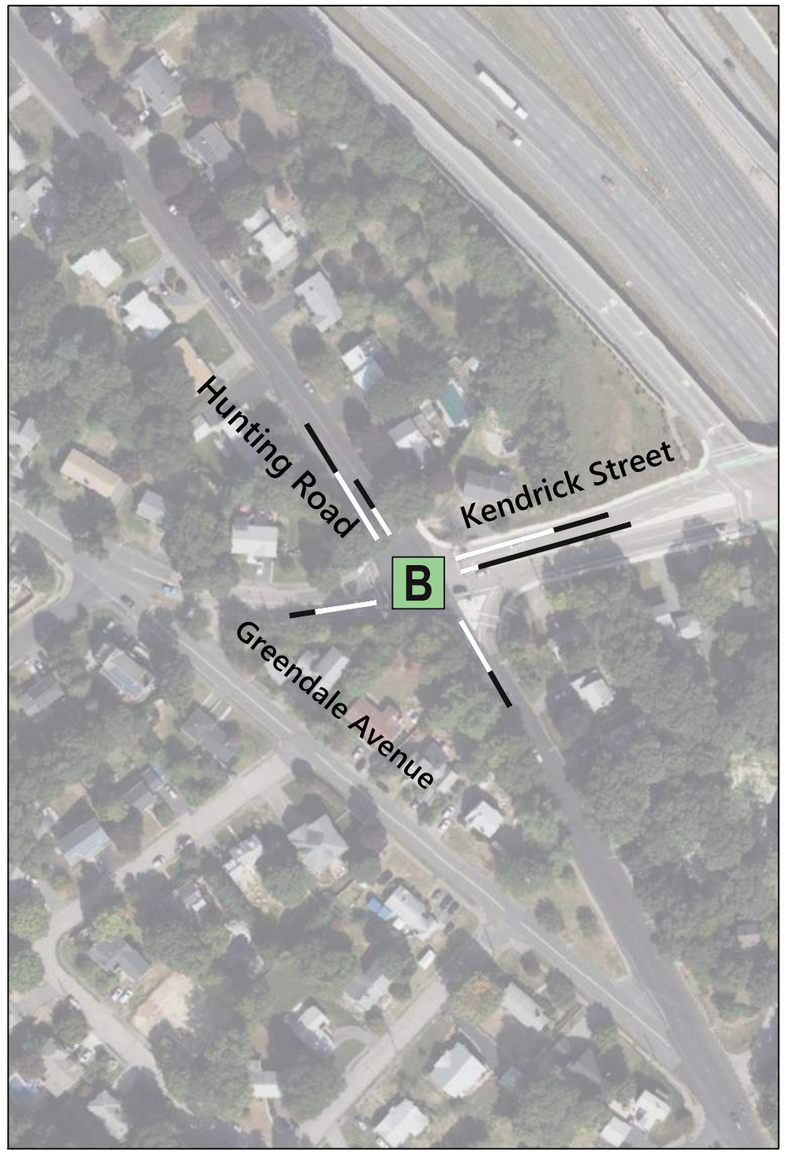
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2022 Existing



2029 No-Build



2029 Build Without Mitigation

0 100 200 Feet

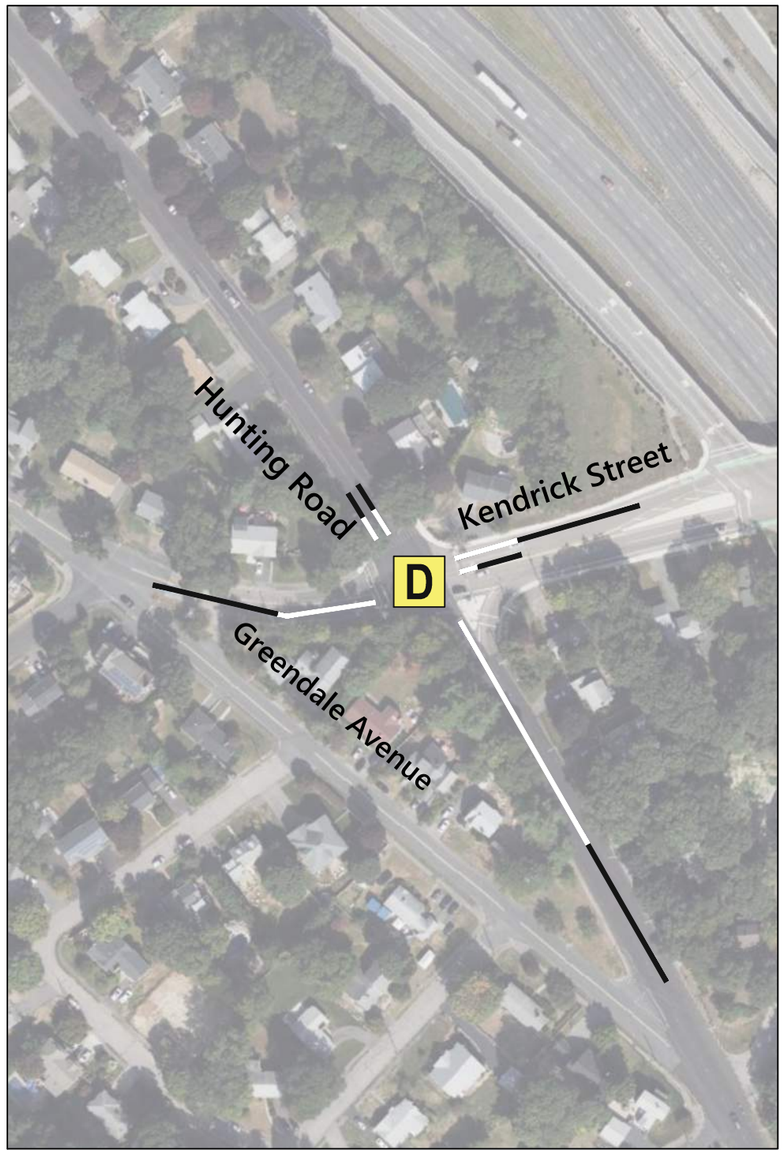
Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

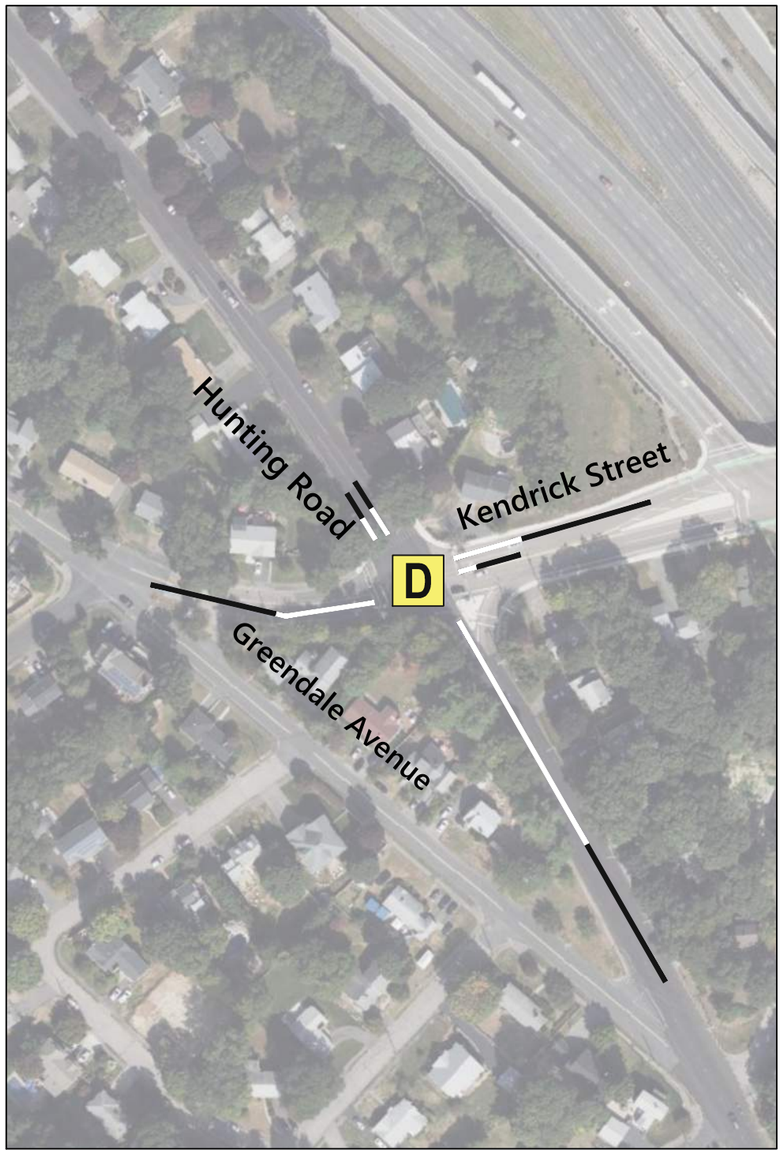
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_AM.dwg

Hunting Road at Kendrick Street (Signalized)

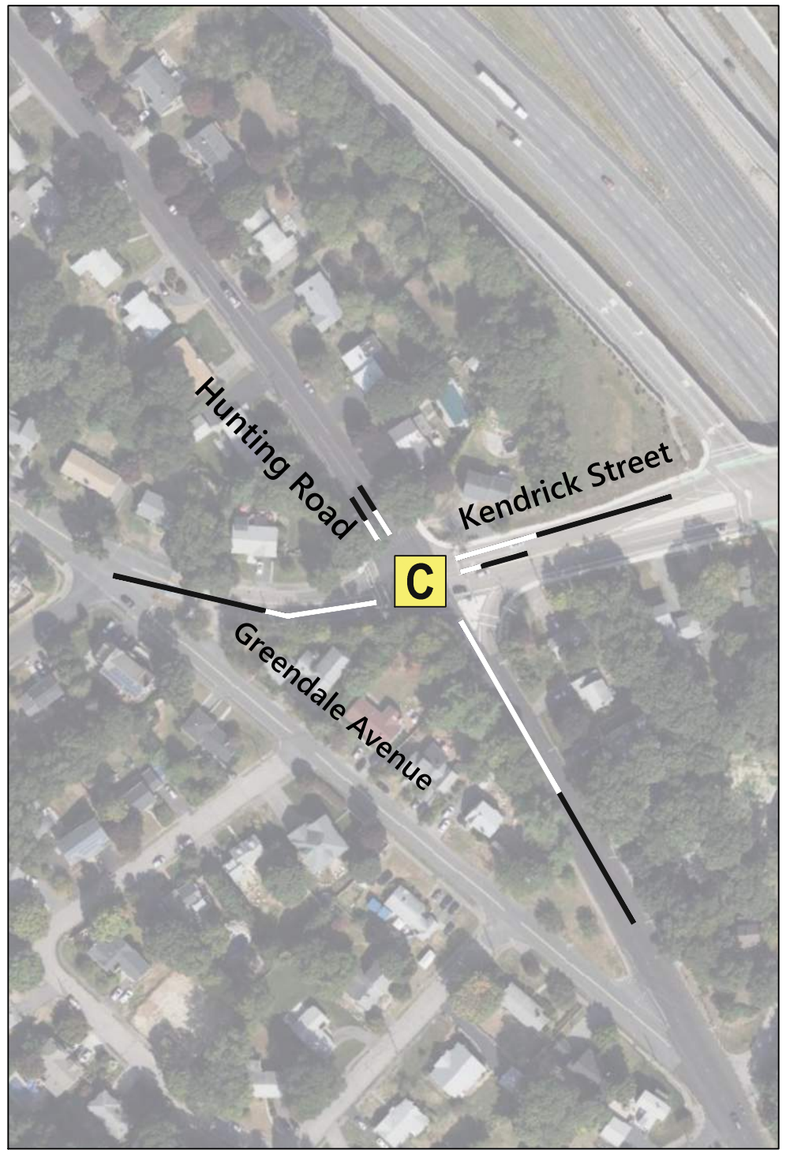
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2029 No-Build



2029 Build Without Mitigation



2029 Build With Mitigation

Signal timings modified under Mitigation Conditions

0 100 200 Feet

vhb

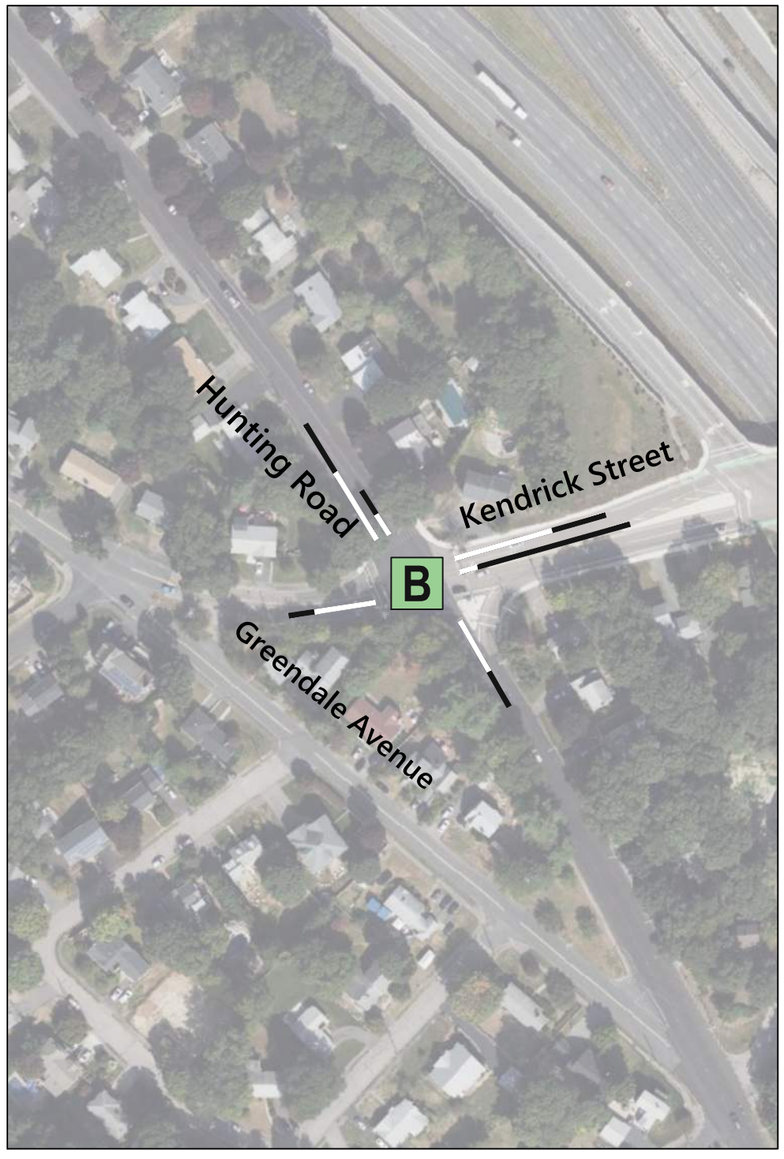
Queue Diagrams
Weekday Morning Peak Hour

557 Highland Avenue
Needham, Massachusetts

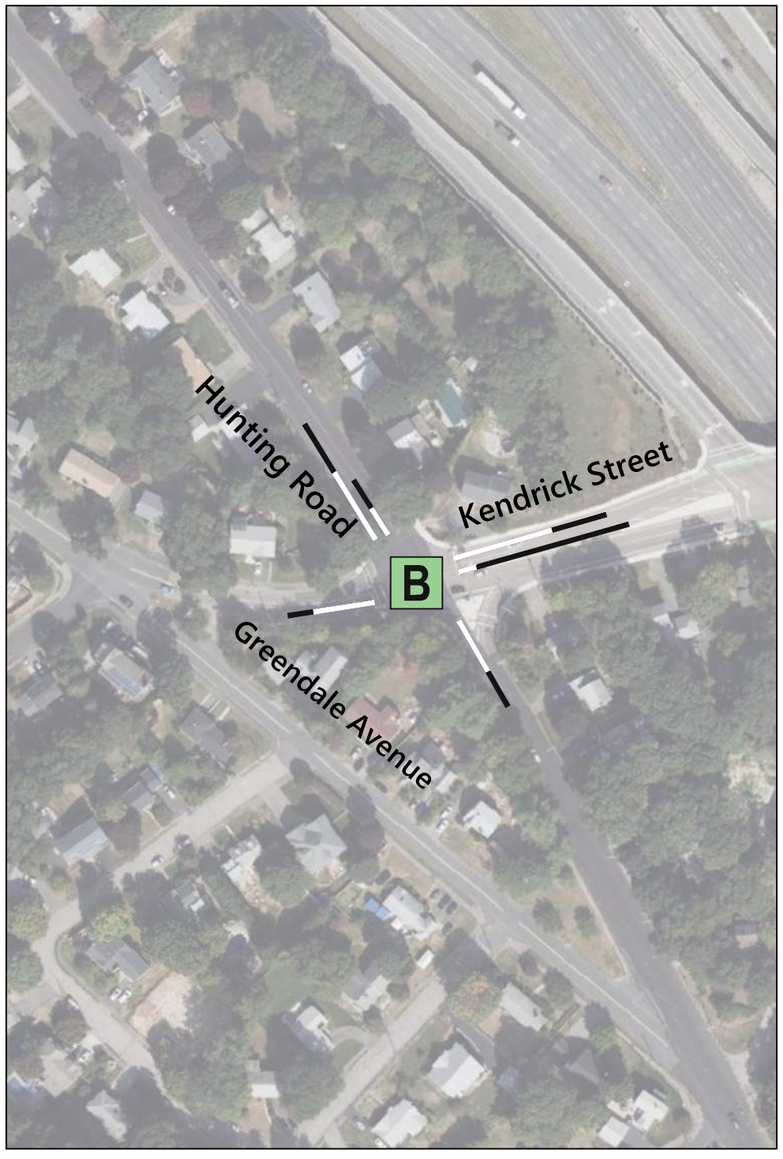
\\vhb.com\gbl\proj\Boston\15306.00\Graphics\FIGURES\Queues_PM.dwg

Hunting Road at Kendrick Street (Signalized)

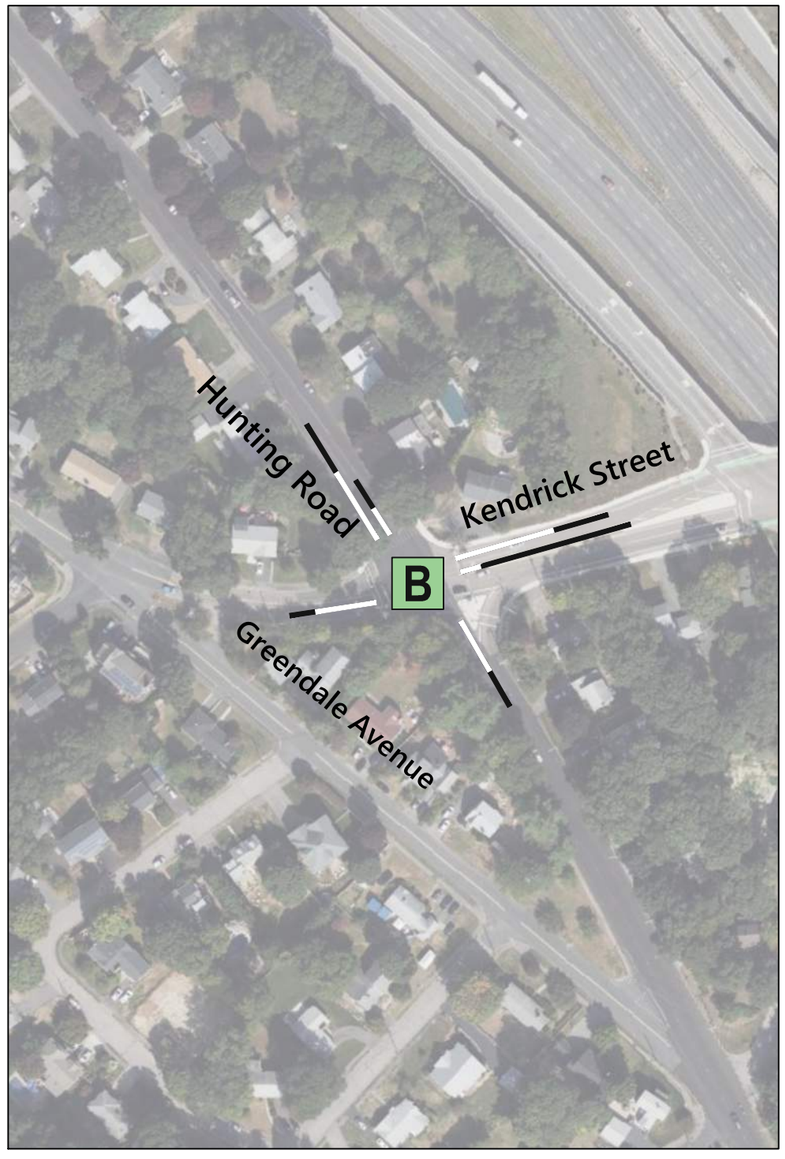
X Signalized Intersection Level of Service
X Unsignalized Intersection Level of Service
50th Percentile Queue
95th Percentile Queue



2029 No-Build



2029 Build Without Mitigation



2029 Build With Mitigation

Signal timings modified under Mitigation Conditions

0 100 200 Feet

vhb

Queue Diagrams
Weekday Evening Peak Hour

557 Highland Avenue
Needham, Massachusetts

2012-2016 American Community Survey - Work in Needham

Mode Share - Aggregate

Mode	Total	Percent
Car, Truck, or Van - Drove Alone	16,089	82.5%
Carpool - In 2-Person Carpool	1,072	5.5%
Carpooled - In 3-Person Carpool	181	0.9%
Carpooled - In 4-Person Carpool	65	0.3%
Carpooled - In a 5 or 6 Person Carpool	20	0.1%
Carpooled - In a 7 or More Person Carpool	140	0.7%
Public Transportation	302	1.5%
Walked	287	1.5%
Bicycle	99	0.5%
Taxicab / Motorcycle / Other	71	0.4%
Worked at Home	1,185	6.1%
Total	**19,511**	**100.0%**

Note: Based on Journey to Work data from the US Census Bureau (2012-2016 5-Year American Community Survey) for those who work in Needham.

Mode Share - Combined

Mode	Total	Percent
Vehicle	17,638	90.4%
Transit	302	1.5%
Bicycle	99	0.5%
Walked	287	1.5%
Worked at home	1,185	6.1%
Total	**19,511**	**100.0%**

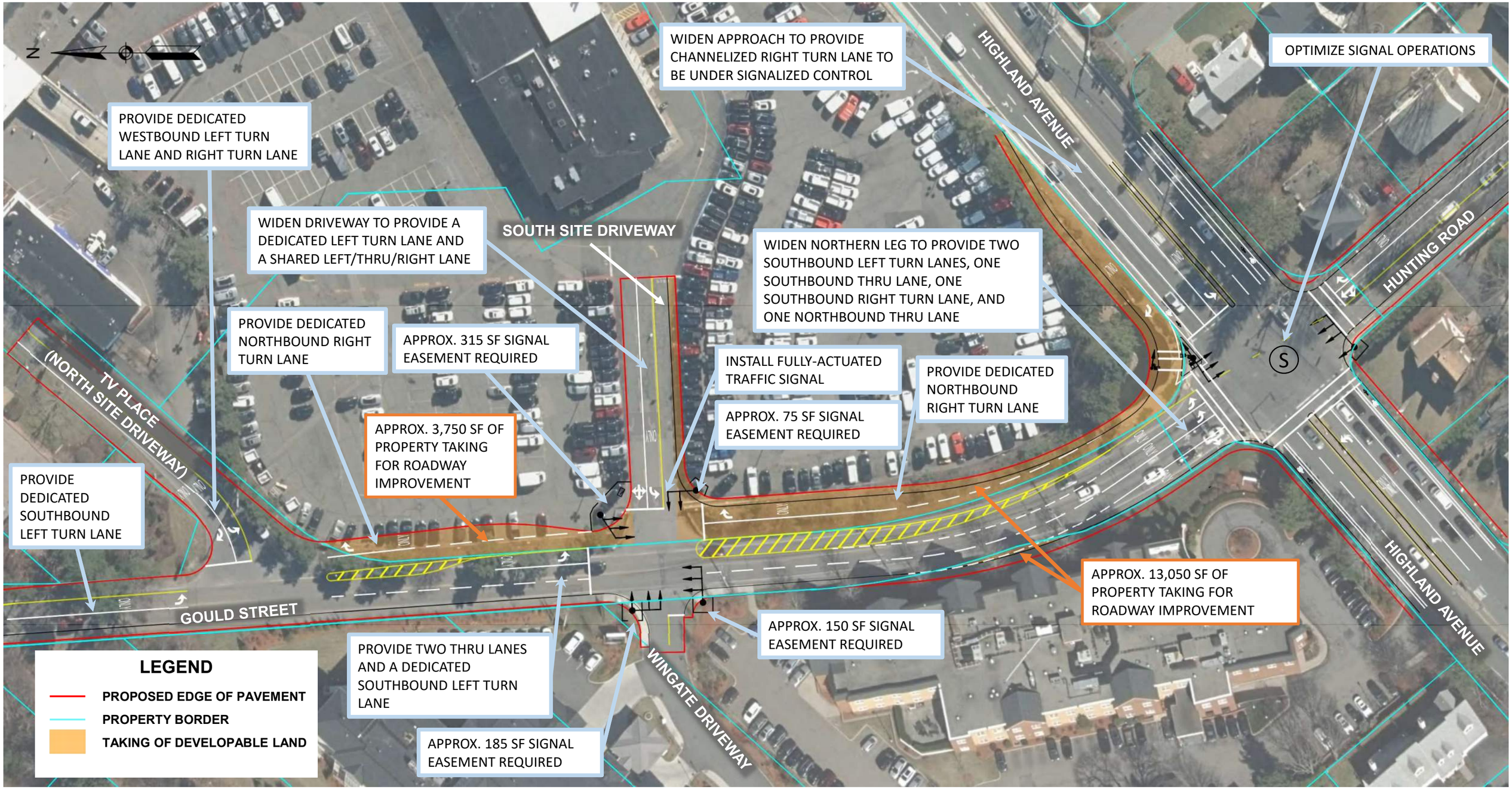
Mode Share - For Comparison

Mode	Total	Percent	% Rounded
Vehicle	17,638	96.2%	95%
Transit	302	1.6%	2%
Bike	99	0.5%	1%
Walk	287	1.6%	2%
Total	**18,326**	**100.0%**	**100.0%**

Note: Worked at home not incldued in dataset

Vehicle Occupancy Rate

Vehicule Occupancy	Total
1	16,160
2	1,072
3	181
4	65
5	10
6	10
7	140
VOR	**1.15**



GPI
Greenman-Pedersen, Inc. || 181 Ballardvale Street, Suite 202, Wilmington, MA 01887
MUZI FORD REDEVELOPMENT– NEEDHAM, MASSACHUSETTS

FIGURE 11

CONCEPT PLAN – ALTERNATIVE 1

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	25	20	635	135	85	355
Future Vol, veh/h	25	20	635	135	85	355
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	150	-	-	150	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	60	60	95	95	91	91
Heavy Vehicles, %	0	0	2	2	0	3
Mvmt Flow	42	33	668	142	93	390

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1315	739	0	0	810	0
Stage 1	739	-	-	-	-	-
Stage 2	576	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	176	421	-	-	825	-
Stage 1	476	-	-	-	-	-
Stage 2	566	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	156	421	-	-	825	-
Mov Cap-2 Maneuver	156	-	-	-	-	-
Stage 1	476	-	-	-	-	-
Stage 2	502	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	26.5	0	1.9
HCM LOS	D		

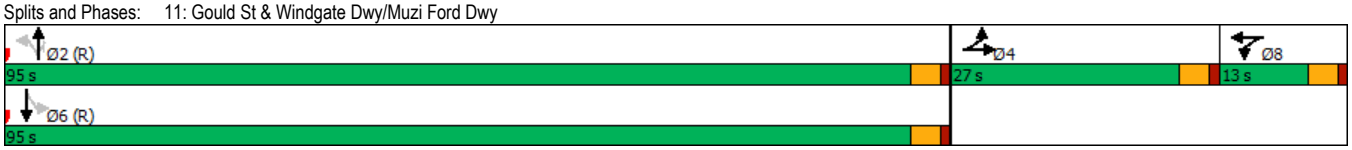
Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	156	421	825	-
HCM Lane V/C Ratio	-	-	0.267	0.079	0.113	-
HCM Control Delay (s)	-	-	36.3	14.3	9.9	-
HCM Lane LOS	-	-	E	B	A	-
HCM 95th %tile Q(veh)	-	-	1	0.3	0.4	-

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	0	5	70	1	20	15	750	385	30	350	2
Future Volume (vph)	1	0	5	70	1	20	15	750	385	30	350	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	13	13	12	12	12	12	12	12
Storage Length (ft)	0		0	0		0	0		100	150		0
Storage Lanes	0		0	1		0	0		1	1		0
Taper Length (ft)	25			25			25			25		
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		151			225			398			315	
Travel Time (s)		3.4			5.1			9.0			7.2	
Confl. Bikes (#/hr)									1			
Peak Hour Factor	0.63	0.63	0.63	0.90	0.90	0.90	0.90	0.90	0.90	0.83	0.83	0.83
Shared Lane Traffic (%)				34%								
Lane Group Flow (vph)	0	10	0	51	50	0	0	850	428	36	424	0
Turn Type	Split	NA		Split	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Detector Phase	4	4		8	8		2	2	2	6	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0		6.0	6.0		10.0	10.0	10.0	10.0	10.0	
Minimum Split (s)	27.0	27.0		11.0	11.0		15.0	15.0	15.0	23.0	23.0	
Total Split (s)	27.0	27.0		13.0	13.0		95.0	95.0	95.0	95.0	95.0	
Total Split (%)	20.0%	20.0%		9.6%	9.6%		70.4%	70.4%	70.4%	70.4%	70.4%	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)		0.0		0.0	0.0			0.0	0.0	0.0	0.0	
Total Lost Time (s)		4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None		C-Min	C-Min	C-Min	C-Min	C-Min	
v/c Ratio		0.07		0.43	0.36			0.55	0.32	0.08	0.14	
Control Delay		0.8		70.6	44.5			7.1	3.2	5.8	4.0	
Queue Delay		0.0		0.0	0.0			4.5	1.2	0.0	0.0	
Total Delay		0.8		70.6	44.5			11.6	4.5	5.8	4.0	
Queue Length 50th (ft)		0		46	25			153	22	3	20	
Queue Length 95th (ft)		0		90	68			m273	m78	24	88	
Internal Link Dist (ft)		71			145			318			235	
Turn Bay Length (ft)									100	150		
Base Capacity (vph)		313		128	147			1550	1339	447	2978	
Starvation Cap Reductn		0		0	0			611	669	0	0	
Spillback Cap Reductn		0		0	0			0	0	0	0	
Storage Cap Reductn		0		0	0			0	0	0	0	
Reduced v/c Ratio		0.03		0.40	0.34			0.91	0.64	0.08	0.14	

Intersection Summary	
Area Type:	Other
Cycle Length: 135	
Actuated Cycle Length: 135	
Offset: 15 (11%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 80	
Control Type: Actuated-Coordinated	

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 11: Gould St & Windgate Dwy/Muzi Ford Dwy



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	0	5	70	1	20	15	750	385	30	350	2
Future Volume (vph)	1	0	5	70	1	20	15	750	385	30	350	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	13	13	12	12	12	12	12	12
Total Lost time (s)		4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00		0.95	0.95			1.00	1.00	1.00	0.95	
Frpb, ped/bikes		1.00		1.00	1.00			1.00	0.98	1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Frt		0.89		1.00	0.93			1.00	0.85	1.00	1.00	
Flt Protected		0.99		0.95	0.97			1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1645		1681	1663			1861	1551	1770	3537	
Flt Permitted		0.99		0.95	0.97			0.99	1.00	0.29	1.00	
Satd. Flow (perm)		1645		1681	1663			1841	1551	531	3537	
Peak-hour factor, PHF	0.63	0.63	0.63	0.90	0.90	0.90	0.90	0.90	0.90	0.83	0.83	0.83
Adj. Flow (vph)	2	0	8	78	1	22	17	833	428	36	422	2
RTOR Reduction (vph)	0	10	0	0	21	0	0	0	40	0	0	0
Lane Group Flow (vph)	0	0	0	51	29	0	0	850	388	36	424	0
Confl. Bikes (#/hr)									1			
Turn Type	Split	NA		Split	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)		5.8		8.3	8.3			108.9	108.9	108.9	108.9	
Effective Green, g (s)		5.8		8.3	8.3			108.9	108.9	108.9	108.9	
Actuated g/C Ratio		0.04		0.06	0.06			0.81	0.81	0.81	0.81	
Clearance Time (s)		4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		70		103	102			1485	1251	428	2853	
v/s Ratio Prot		c0.00		c0.03	0.02						0.12	
v/s Ratio Perm								c0.46	0.25	0.07		
v/c Ratio		0.01		0.50	0.29			0.57	0.31	0.08	0.15	
Uniform Delay, d1		61.8		61.3	60.5			4.7	3.4	2.7	2.9	
Progression Factor		1.00		1.00	1.00			0.98	1.14	1.00	1.00	
Incremental Delay, d2		0.0		3.7	1.6			0.4	0.2	0.4	0.1	
Delay (s)		61.9		65.0	62.1			5.0	4.0	3.1	3.0	
Level of Service		E		E	E			A	A	A	A	
Approach Delay (s)		61.9			63.6			4.7			3.0	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM 2000 Control Delay	7.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	67.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	225	220	30	40	190	60	30	555	60	25	305	105	
Future Volume (vph)	225	220	30	40	190	60	30	555	60	25	305	105	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	120		0	100		0	0		0	0		0	
Storage Lanes	1		0	1		0	0		0	0		0	
Taper Length (ft)	25			25			25			25			
Right Turn on Red			No			No			No			No	
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		318			371			476			549		
Travel Time (s)		7.2			8.4			10.8			12.5		
Confl. Peds. (#/hr)	14		4	4		14	4		22	22		4	
Peak Hour Factor	0.94	0.94	0.94	0.87	0.87	0.87	0.87	0.87	0.87	0.96	0.96	0.96	
Heavy Vehicles (%)	4%	2%	4%	0%	2%	0%	4%	4%	0%	0%	7%	5%	
Bus Blockages (#/hr)	0	0	0	0	0	0	2	2	2	0	0	0	
Parking (#/hr)							0	0	0	0	0	0	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	239	266	0	46	287	0	0	741	0	0	453	0	
Turn Type	D.P+P	NA		Perm	NA		Perm	NA		Perm	NA		
Protected Phases	1	1 2			2			3			3		9
Permitted Phases	2	2		2			3			3			
Detector Phase	1	1 2		2	2		3	3		3	3		
Switch Phase													
Minimum Initial (s)	6.0			10.0	10.0		10.0	10.0		10.0	10.0		7.0
Minimum Split (s)	11.0			15.0	15.0		15.0	15.0		15.0	15.0		20.0
Total Split (s)	15.0			35.0	35.0		60.0	60.0		60.0	60.0		20.0
Total Split (%)	11.5%			26.9%	26.9%		46.2%	46.2%		46.2%	46.2%		15%
Yellow Time (s)	4.0			4.0	4.0		4.0	4.0		4.0	4.0		2.0
All-Red Time (s)	1.0			1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lost Time Adjust (s)	0.0			0.0	0.0			0.0			0.0		
Total Lost Time (s)	5.0			5.0	5.0			5.0			5.0		
Lead/Lag	Lead			Lag	Lag								
Lead-Lag Optimize?													
Recall Mode	None			None	None		Min	Min		Min	Min		None
v/c Ratio	0.88	0.42		0.20	0.77			0.91			0.60		
Control Delay	60.4	29.2		38.0	55.1			42.6			24.5		
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0		
Total Delay	60.4	29.2		38.0	55.1			42.6			24.5		
Queue Length 50th (ft)	114	128		25	176			407			189		
Queue Length 95th (ft)	#258	252		65	313			#913			453		
Internal Link Dist (ft)		238			291			396			469		
Turn Bay Length (ft)	120			100									
Base Capacity (vph)	273	778		320	508			811			761		
Starvation Cap Reductn	0	0		0	0			0			0		
Spillback Cap Reductn	0	0		0	0			0			0		
Storage Cap Reductn	0	0		0	0			0			0		
Reduced v/c Ratio	0.88	0.34		0.14	0.56			0.91			0.60		

Intersection Summary

Area Type: Other
Cycle Length: 130
Actuated Cycle Length: 106.5
Natural Cycle: 130
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 12: Highland Ave & West St

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	225	220	30	40	190	60	30	555	60	25	305	105
Future Volume (vph)	225	220	30	40	190	60	30	555	60	25	305	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	1.00	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.98		1.00	0.96			0.99			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1730	1819		1793	1781			1606			1545	
Flt Permitted	0.29	1.00		0.60	1.00			0.97			0.94	
Satd. Flow (perm)	524	1819		1123	1781			1554			1456	
Peak-hour factor, PHF	0.94	0.94	0.94	0.87	0.87	0.87	0.87	0.87	0.87	0.96	0.96	0.96
Adj. Flow (vph)	239	234	32	46	218	69	34	638	69	26	318	109
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	239	266	0	46	287	0	0	741	0	0	453	0
Confl. Peds. (#/hr)	14		4	4		14	4		22	22		4
Heavy Vehicles (%)	4%	2%	4%	0%	2%	0%	4%	4%	0%	0%	7%	5%
Bus Blockages (#/hr)	0	0	0	0	0	0	2	2	2	0	0	0
Parking (#/hr)							0	0	0	0	0	0
Turn Type	D.P+P	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases	1	1 2			2			3			3	
Permitted Phases	2	2		2			3			3		
Actuated Green, G (s)	32.3	37.3		22.2	22.2			55.7			55.7	
Effective Green, g (s)	32.3	37.3		22.2	22.2			55.7			55.7	
Actuated g/C Ratio	0.30	0.35		0.21	0.21			0.52			0.52	
Clearance Time (s)	5.0			5.0	5.0			5.0			5.0	
Vehicle Extension (s)	3.0			3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	269	628		231	366			802			751	
v/s Ratio Prot	c0.08	0.15			0.16							
v/s Ratio Perm	c0.18			0.04				c0.48			0.31	
v/c Ratio	0.89	0.42		0.20	0.78			0.92			0.60	
Uniform Delay, d1	33.3	27.1		35.5	40.6			24.1			18.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	27.7	0.5		0.4	10.5			16.2			1.4	
Delay (s)	61.0	27.5		35.9	51.1			40.3			19.7	
Level of Service	E	C		D	D			D			B	
Approach Delay (s)		43.4			49.0			40.3			19.7	
Approach LOS		D			D			D			B	

Intersection Summary			
HCM 2000 Control Delay	37.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	107.9	Sum of lost time (s)	17.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		

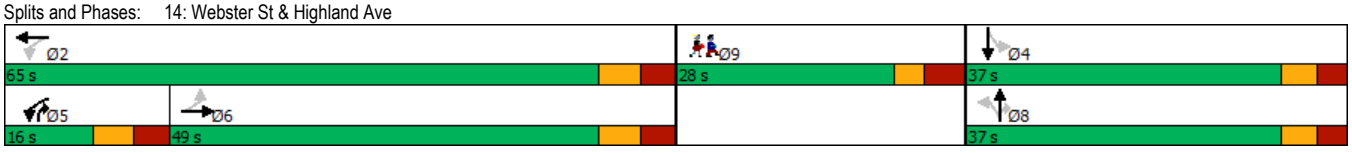
c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	35	595	15	125	460	60	20	315	405	85	140	30	
Future Volume (vph)	35	595	15	125	460	60	20	315	405	85	140	30	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	150		0	150		0	0		150	0		200	
Storage Lanes	1		0	1		0	0		1	0		1	
Taper Length (ft)	25			25			25			25			
Right Turn on Red			Yes			No			Yes			No	
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1325			691			391			2983		
Travel Time (s)		30.1			15.7			8.9			67.8		
Confl. Peds. (#/hr)	7					7	1		7	7		1	
Confl. Bikes (#/hr)			1										
Peak Hour Factor	0.94	0.94	0.94	0.88	0.88	0.88	0.87	0.87	0.87	0.88	0.88	0.88	
Heavy Vehicles (%)	4%	3%	0%	0%	2%	4%	1%	1%	0%	0%	1%	0%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	37	649	0	142	591	0	0	385	466	0	290	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pm+ov	Perm	NA		
Protected Phases		6		5	2			8	5		4		9
Permitted Phases	6			2			8		8	4			
Detector Phase	6	6		5	2		8	8	5	4	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0		7.0
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5		28.0
Total Split (s)	49.0	49.0		16.0	65.0		37.0	37.0	16.0	37.0	37.0		28.0
Total Split (%)	37.7%	37.7%		12.3%	50.0%		28.5%	28.5%	12.3%	28.5%	28.5%		22%
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5		3.0
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0		4.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0		
Total Lost Time (s)	7.5	7.5		7.5	7.5			6.5	7.5		6.5		
Lead/Lag	Lag	Lag		Lead					Lead				
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	Min		None	None	None	None	None		None
v/c Ratio	0.12	0.87		0.60	0.58			0.82	0.62		0.90dl		
Control Delay	25.4	44.6		26.6	20.6			52.2	11.5		40.4		
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay	25.4	44.6		26.6	20.6			52.2	11.5		40.4		
Queue Length 50th (ft)	14	366		39	223			223	51		82		
Queue Length 95th (ft)	52	#861		#152	531			#474	177		164		
Internal Link Dist (ft)		1245			611			311			2903		
Turn Bay Length (ft)	150			150					150				
Base Capacity (vph)	311	743		237	1019			537	747		566		
Starvation Cap Reductn	0	0		0	0			0	0		0		
Spillback Cap Reductn	0	0		0	0			0	0		0		
Storage Cap Reductn	0	0		0	0			0	0		0		
Reduced v/c Ratio	0.12	0.87		0.60	0.58			0.72	0.62		0.51		

Intersection Summary	
Area Type:	Other
Cycle Length: 130	
Actuated Cycle Length: 104.2	
Natural Cycle: 130	
Control Type: Actuated-Uncoordinated	

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 14: Webster St & Highland Ave



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	595	15	125	460	60	20	315	405	85	140	30
Future Volume (vph)	35	595	15	125	460	60	20	315	405	85	140	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.5	7.5		7.5	7.5			6.5	7.5		6.5	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.98		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frt	1.00	1.00		1.00	0.98			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00		0.98	
Satd. Flow (prot)	1729	1839		1805	1821			1875	1578		3453	
Flt Permitted	0.42	1.00		0.10	1.00			0.96	1.00		0.54	
Satd. Flow (perm)	772	1839		184	1821			1811	1578		1907	
Peak-hour factor, PHF	0.94	0.94	0.94	0.88	0.88	0.88	0.87	0.87	0.87	0.88	0.88	0.88
Adj. Flow (vph)	37	633	16	142	523	68	23	362	466	97	159	34
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	224	0	0	0
Lane Group Flow (vph)	37	648	0	142	591	0	0	385	242	0	290	0
Confl. Peds. (#/hr)	7					7	1		7	7		1
Confl. Bikes (#/hr)			1									
Heavy Vehicles (%)	4%	3%	0%	0%	2%	4%	1%	1%	0%	0%	1%	0%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pm+ov	Perm	NA	
Protected Phases		6		5	2			8	5		4	
Permitted Phases	6			2			8		8	4		
Actuated Green, G (s)	42.2	42.2		58.3	58.3			27.2	35.8		27.2	
Effective Green, g (s)	42.2	42.2		58.3	58.3			27.2	35.8		27.2	
Actuated g/C Ratio	0.38	0.38		0.53	0.53			0.25	0.33		0.25	
Clearance Time (s)	7.5	7.5		7.5	7.5			6.5	7.5		6.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	296	706		224	966			448	514		471	
v/s Ratio Prot		c0.35		0.05	c0.32				0.04			
v/s Ratio Perm	0.05			0.29				c0.21	0.12		0.15	
v/c Ratio	0.12	0.92		0.63	0.61			0.86	0.47		0.90dl	
Uniform Delay, d1	21.9	32.2		21.2	17.9			39.5	29.5		36.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.2	16.8		5.8	1.2			15.1	0.7		2.4	
Delay (s)	22.1	49.1		27.0	19.1			54.6	30.2		39.1	
Level of Service	C	D		C	B			D	C		D	
Approach Delay (s)		47.6			20.6			41.2			39.1	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	36.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	109.9	Sum of lost time (s)	28.5
Intersection Capacity Utilization	87.5%	ICU Level of Service	E
Analysis Period (min)	15		

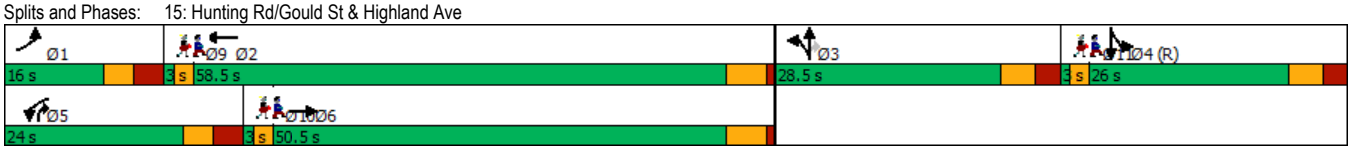
dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9	Ø10	Ø11
Lane Configurations															
Traffic Volume (vph)	150	890	15	45	605	760	25	240	240	290	90	45			
Future Volume (vph)	150	890	15	45	605	760	25	240	240	290	90	45			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900			
Storage Length (ft)	175		0	165		400	0		150	200		200			
Storage Lanes	1		0	1		0	0		1	1		0			
Taper Length (ft)	25			25			25			25					
Right Turn on Red			Yes			Yes			Yes			Yes			
Link Speed (mph)		30			30			30			30				
Link Distance (ft)		345			745			3028			398				
Travel Time (s)		7.8			16.9			68.8			9.0				
Confl. Peds. (#/hr)	1		1	1		1									
Confl. Bikes (#/hr)									1						
Peak Hour Factor	0.87	0.87	0.87	0.92	0.92	0.92	0.88	0.88	0.88	0.94	0.94	0.94			
Heavy Vehicles (%)	3%	2%	0%	0%	5%	1%	0%	1%	0%	3%	2%	0%			
Shared Lane Traffic (%)															
Lane Group Flow (vph)	172	1040	0	49	1484	0	0	301	273	309	144	0			
Turn Type	Prot	NA		Prot	NA		Split	NA	pm+ov	Split	NA				
Protected Phases	1	6		5	2		3	3	5	4	4		9	10	11
Permitted Phases									3						
Detector Phase	1	6		5	2		3	3	5	4	4				
Switch Phase															
Minimum Initial (s)	6.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0		1.0	1.0	1.0
Minimum Split (s)	12.0	20.0		12.0	25.0		12.0	12.0	12.0	29.5	29.5		3.0	3.0	3.0
Total Split (s)	16.0	50.5		24.0	58.5		28.5	28.5	24.0	26.0	26.0		3.0	3.0	3.0
Total Split (%)	11.9%	37.4%		17.8%	43.3%		21.1%	21.1%	17.8%	19.3%	19.3%		2%	2%	2%
Yellow Time (s)	3.0	4.0		3.0	4.0		3.5	3.5	3.0	3.5	3.5		2.0	2.0	2.0
All-Red Time (s)	3.0	1.0		3.0	1.0		2.5	2.5	3.0	2.5	2.5		0.0	0.0	0.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0	0.0	0.0				
Total Lost Time (s)	6.0	5.0		6.0	5.0			6.0	6.0	6.0	6.0				
Lead/Lag	Lead			Lead			Lead	Lead	Lead				Lag	Lag	Lag
Lead-Lag Optimize?															
Recall Mode	None	Min		None	Min		Min	Min	None	C-Min	C-Min		None	None	None
v/c Ratio	0.96	0.66		0.42	1.00			0.96	0.61	0.66	0.56				
Control Delay	117.3	33.3		70.2	56.2			98.4	22.8	68.6	63.4				
Queue Delay	15.8	0.0		0.0	2.4			0.0	0.0	0.0	0.0				
Total Delay	133.2	33.3		70.2	58.6			98.4	22.8	68.6	63.4				
Queue Length 50th (ft)	153	363		42	587			265	93	136	107				
Queue Length 95th (ft)	#330	503		83	#797			#433	136	180	166				
Internal Link Dist (ft)		265			665			2948			318				
Turn Bay Length (ft)	175			165					150	200					
Base Capacity (vph)	179	1574		240	1479			312	548	509	280				
Starvation Cap Reductn	0	0		0	0			0	0	0	0				
Spillback Cap Reductn	11	0		0	13			0	0	0	0				
Storage Cap Reductn	0	0		0	0			0	0	0	0				
Reduced v/c Ratio	1.02	0.66		0.20	1.01			0.96	0.50	0.61	0.51				

Intersection Summary

Area Type: Other
Cycle Length: 135
Actuated Cycle Length: 135
Offset: 0 (0%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 15: Hunting Rd/Gould St & Highland Ave



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	150	890	15	45	605	760	25	240	240	290	90	45
Future Volume (vph)	150	890	15	45	605	760	25	240	240	290	90	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	5.0		6.0	5.0			6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.97	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			1.00	0.99	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Frt	1.00	1.00		1.00	0.92			1.00	0.85	1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1752	3530		1805	3178			1874	1600	3400	1781	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1752	3530		1805	3178			1874	1600	3400	1781	
Peak-hour factor, PHF	0.87	0.87	0.87	0.92	0.92	0.92	0.88	0.88	0.88	0.94	0.94	0.94
Adj. Flow (vph)	172	1023	17	49	658	826	28	273	273	309	96	48
RTOR Reduction (vph)	0	1	0	0	159	0	0	0	74	0	14	0
Lane Group Flow (vph)	172	1039	0	49	1325	0	0	301	199	309	130	0
Confl. Peds. (#/hr)	1		1	1		1						
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	2%	0%	0%	5%	1%	0%	1%	0%	3%	2%	0%
Turn Type	Prot	NA		Prot	NA		Split	NA	pm+ov	Split	NA	
Protected Phases	1	6		5	2		3	3	5	4	4	
Permitted Phases									3			
Actuated Green, G (s)	13.8	60.2		8.9	58.2			22.5	31.4	17.5	17.5	
Effective Green, g (s)	13.8	60.2		8.9	58.2			22.5	31.4	17.5	17.5	
Actuated g/C Ratio	0.10	0.45		0.07	0.43			0.17	0.23	0.13	0.13	
Clearance Time (s)	6.0	5.0		6.0	5.0			6.0	6.0	6.0	6.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	179	1574		118	1370			312	372	440	230	
v/s Ratio Prot	c0.10	0.29		0.03	c0.42			c0.16	0.04	c0.09	0.07	
v/s Ratio Perm									0.09			
v/c Ratio	0.96	0.66		0.42	0.97			0.96	0.53	0.70	0.57	
Uniform Delay, d1	60.3	29.4		60.6	37.5			55.9	45.4	56.3	55.2	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.12	1.14	
Incremental Delay, d2	55.3	0.8		0.9	16.8			40.9	0.7	9.0	9.6	
Delay (s)	115.7	30.2		61.4	54.3			96.8	46.1	71.7	72.7	
Level of Service	F	C		E	D			F	D	E	E	
Approach Delay (s)		42.3			54.5			72.7			72.1	
Approach LOS		D			D			E			E	

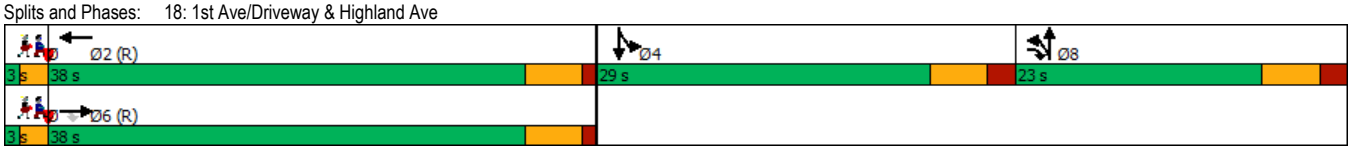
Intersection Summary			
HCM 2000 Control Delay	55.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	91.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø1	Ø5
Lane Configurations														
Traffic Volume (vph)	5	1170	1005	0	965	15	175	0	70	5	5	10		
Future Volume (vph)	5	1170	1005	0	965	15	175	0	70	5	5	10		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900		
Storage Length (ft)	0		0	0		0	75		0	0		0		
Storage Lanes	0		1	0		0	1		0	0		0		
Taper Length (ft)	25			25			25			25				
Right Turn on Red			Yes			Yes			Yes			Yes		
Link Speed (mph)		30			30			30			30			
Link Distance (ft)		176			681			500			267			
Travel Time (s)		4.0			15.5			11.4			6.1			
Confl. Peds. (#/hr)			1	1					8	8				
Confl. Bikes (#/hr)			2											
Peak Hour Factor	0.88	0.88	0.88	0.95	0.95	0.95	0.91	0.91	0.91	0.39	0.39	0.39		
Heavy Vehicles (%)	0%	4%	2%	0%	5%	0%	11%	0%	6%	33%	0%	0%		
Shared Lane Traffic (%)							28%							
Lane Group Flow (vph)	0	1336	1142	0	1032	0	138	131	0	0	52	0		
Turn Type		NA	pm+ov		NA		Split	NA		Split	NA			
Protected Phases		6	8		2		8	8		4	4		1	5
Permitted Phases			6											
Detector Phase		6	8		2		8	8		4	4			
Switch Phase														
Minimum Initial (s)		10.0	6.0		10.0		6.0	6.0		6.0	6.0		1.0	1.0
Minimum Split (s)		25.0	20.0		20.0		20.0	20.0		29.0	29.0		3.0	3.0
Total Split (s)		38.0	23.0		38.0		23.0	23.0		29.0	29.0		3.0	3.0
Total Split (%)		40.9%	24.7%		40.9%		24.7%	24.7%		31.2%	31.2%		3%	3%
Yellow Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0		2.0	2.0
All-Red Time (s)		1.0	2.0		1.0		2.0	2.0		2.0	2.0		0.0	0.0
Lost Time Adjust (s)		0.0	0.0		0.0		0.0	0.0			0.0			
Total Lost Time (s)		5.0	6.0		5.0		6.0	6.0			6.0			
Lead/Lag		Lag			Lag								Lead	Lead
Lead-Lag Optimize?														
Recall Mode		C-Min	None		C-Min		None	None		None	None		None	None
v/c Ratio		1.68	0.81		0.56		0.44	0.33			0.27			
Control Delay		334.2	7.4		19.2		36.1	9.9			24.3			
Queue Delay		0.0	0.0		0.0		0.0	0.0			0.0			
Total Delay		334.2	7.4		19.2		36.1	9.9			24.3			
Queue Length 50th (ft)		~611	11		203		73	7			15			
Queue Length 95th (ft)		#806	#103		354		140	58			10			
Internal Link Dist (ft)		96			601			420			187			
Turn Bay Length (ft)							75							
Base Capacity (vph)		794	1419		1840		347	421			419			
Starvation Cap Reductn		0	0		0		0	0			0			
Spillback Cap Reductn		0	0		0		0	0			0			
Storage Cap Reductn		0	0		0		0	0			0			
Reduced v/c Ratio		1.68	0.80		0.56		0.40	0.31			0.12			

Intersection Summary

Area Type: Other
Cycle Length: 93
Actuated Cycle Length: 93
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Green
Natural Cycle: 150
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 18: 1st Ave/Driveway & Highland Ave



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	1170	1005	0	965	15	175	0	70	5	5	10
Future Volume (vph)	5	1170	1005	0	965	15	175	0	70	5	5	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	6.0		5.0		6.0	6.0			6.0	
Lane Util. Factor		0.95	1.00		0.95		0.95	0.95			1.00	
Frpb, ped/bikes		1.00	0.98		1.00		1.00	0.99			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		1.00	0.85		1.00		1.00	0.91			0.93	
Flt Protected		1.00	1.00		1.00		0.95	0.98			0.99	
Satd. Flow (prot)		3471	1557		3433		1545	1472			1617	
Flt Permitted		0.95	1.00		1.00		0.95	0.98			0.99	
Satd. Flow (perm)		3300	1557		3433		1545	1472			1617	
Peak-hour factor, PHF	0.88	0.88	0.88	0.95	0.95	0.95	0.91	0.91	0.91	0.39	0.39	0.39
Adj. Flow (vph)	6	1330	1142	0	1016	16	192	0	77	13	13	26
RTOR Reduction (vph)	0	0	281	0	1	0	0	93	0	0	24	0
Lane Group Flow (vph)	0	1336	862	0	1031	0	138	38	0	0	28	0
Confl. Peds. (#/hr)			1	1					8	8		
Confl. Bikes (#/hr)			2									
Heavy Vehicles (%)	0%	4%	2%	0%	5%	0%	11%	0%	6%	33%	0%	0%
Turn Type		NA	pm+ov		NA		Split	NA		Split	NA	
Protected Phases		6	8		2		8	8		4	4	
Permitted Phases			6									
Actuated Green, G (s)		48.6	67.5		48.6		18.9	18.9			8.5	
Effective Green, g (s)		48.6	67.5		48.6		18.9	18.9			8.5	
Actuated g/C Ratio		0.52	0.73		0.52		0.20	0.20			0.09	
Clearance Time (s)		5.0	6.0		5.0		6.0	6.0			6.0	
Vehicle Extension (s)		2.0	2.0		2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)		1724	1230		1794		313	299			147	
v/s Ratio Prot			c0.14		0.30		0.09	0.03			c0.02	
v/s Ratio Perm		c0.40	0.41									
v/c Ratio		0.77	0.70		0.57		0.44	0.13			0.19	
Uniform Delay, d1		17.8	7.1		15.1		32.4	30.3			39.1	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		3.5	1.5		1.3		0.4	0.1			0.2	
Delay (s)		21.3	8.6		16.5		32.8	30.4			39.3	
Level of Service		C	A		B		C	C			D	
Approach Delay (s)		15.4			16.5			31.6			39.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	17.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	77.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	30	455	0	85	230	85	5	355	575	75	60	10	
Future Volume (vph)	30	455	0	85	230	85	5	355	575	75	60	10	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		100	190		0	0		400	125		0	
Storage Lanes	0		1	1		0	0		1	1		0	
Taper Length (ft)	25			25			25			25			
Right Turn on Red			Yes			Yes			Yes			Yes	
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		442			443			907			3028		
Travel Time (s)		10.0			10.1			20.6			68.8		
Confl. Peds. (#/hr)							2					2	
Confl. Bikes (#/hr)			1										
Peak Hour Factor	0.83	0.83	0.83	0.97	0.97	0.97	0.91	0.91	0.91	0.92	0.92	0.92	
Heavy Vehicles (%)	0%	1%	0%	4%	4%	3%	0%	1%	0%	2%	2%	8%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	584	0	88	325	0	0	395	632	82	76	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Free	pm+pt	NA		
Protected Phases		2		1	6			8		7	4		9
Permitted Phases	2			6			8		Free	4			
Detector Phase	2	2		1	6		8	8		7	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		7.0	10.0		10.0	10.0		2.0	10.0		1.0
Minimum Split (s)	16.0	16.0		12.0	28.0		15.0	15.0		7.0	27.0		24.0
Total Split (s)	17.0	17.0		12.0	29.0		26.0	26.0		11.0	37.0		24.0
Total Split (%)	18.9%	18.9%		13.3%	32.2%		28.9%	28.9%		12.2%	41.1%		27%
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0		2.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0		0.0	0.0		
Total Lost Time (s)		5.0		5.0	5.0			5.0		5.0	5.0		
Lead/Lag	Lag	Lag		Lead			Lead	Lead		Lag			
Lead-Lag Optimize?													
Recall Mode	C-Min	C-Min		None	C-Min		None	None		None	None		None
v/c Ratio		0.44		0.24	0.36			0.93	0.39	0.37	0.13		
Control Delay		26.4		17.7	17.3			65.0	0.7	30.5	17.8		
Queue Delay		0.0		0.0	0.0			0.0	0.0	0.0	0.0		
Total Delay		26.4		17.7	17.3			65.0	0.7	30.5	17.8		
Queue Length 50th (ft)		124		23	93			219	0	31	24		
Queue Length 95th (ft)		#298		77	249			#386	0	63	54		
Internal Link Dist (ft)		362			363			827			2948		
Turn Bay Length (ft)				190					400	125			
Base Capacity (vph)		1327		373	912			437	1615	231	647		
Starvation Cap Reductn		0		0	0			0	0	0	0		
Spillback Cap Reductn		0		0	0			0	0	0	0		
Storage Cap Reductn		0		0	0			0	0	0	0		
Reduced v/c Ratio		0.44		0.24	0.36			0.90	0.39	0.35	0.12		

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 11 (12%), Referenced to phase 2:EBTL and 6:WBTL, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 20: Hunting Rd & Kendrick St

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	455	0	85	230	85	5	355	575	75	60	10
Future Volume (vph)	30	455	0	85	230	85	5	355	575	75	60	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0			5.0	4.0	5.0	5.0	
Lane Util. Factor		0.95		1.00	1.00			1.00	1.00	1.00	1.00	
Frpb, ped/bikes		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Frt		1.00		1.00	0.96			1.00	0.85	1.00	0.98	
Flt Protected		1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)		3565		1736	1757			1880	1615	1770	1801	
Flt Permitted		0.91		0.30	1.00			1.00	1.00	0.23	1.00	
Satd. Flow (perm)		3269		544	1757			1876	1615	420	1801	
Peak-hour factor, PHF	0.83	0.83	0.83	0.97	0.97	0.97	0.91	0.91	0.91	0.92	0.92	0.92
Adj. Flow (vph)	36	548	0	88	237	88	5	390	632	82	65	11
RTOR Reduction (vph)	0	0	0	0	10	0	0	0	0	0	7	0
Lane Group Flow (vph)	0	584	0	88	315	0	0	395	632	82	69	0
Confl. Peds. (#/hr)							2					2
Confl. Bikes (#/hr)			1									
Heavy Vehicles (%)	0%	1%	0%	4%	4%	3%	0%	1%	0%	2%	2%	8%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Free	pm+pt	NA	
Protected Phases		2		1	6			8		7	4	
Permitted Phases	2			6			8		Free	4		
Actuated Green, G (s)		32.9		43.6	43.6			20.4	90.0	30.0	30.0	
Effective Green, g (s)		32.9		43.6	43.6			20.4	90.0	30.0	30.0	
Actuated g/C Ratio		0.37		0.48	0.48			0.23	1.00	0.33	0.33	
Clearance Time (s)		5.0		5.0	5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		1195		339	851			425	1615	209	600	
v/s Ratio Prot				0.02	0.18					0.02	0.04	
v/s Ratio Perm		c0.18		0.11				c0.21	c0.39	0.11		
v/c Ratio		0.49		0.26	0.37			0.93	0.39	0.39	0.11	
Uniform Delay, d1		22.1		13.5	14.6			34.1	0.0	33.7	20.8	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.4		0.1	1.2			26.2	0.7	0.4	0.0	
Delay (s)		23.5		13.6	15.8			60.3	0.7	34.1	20.8	
Level of Service		C		B	B			E	A	C	C	
Approach Delay (s)		23.5			15.3			23.6			27.7	
Approach LOS		C			B			C			C	

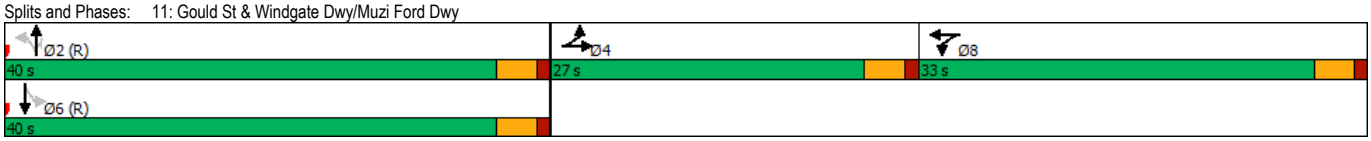
Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	74.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

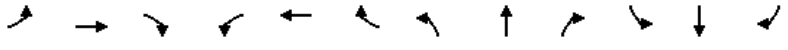
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	0	30	360	1	40	5	285	80	15	700	5
Future Volume (vph)	1	0	30	360	1	40	5	285	80	15	700	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	13	13	12	12	12	12	12	12
Storage Length (ft)	0		0	0		0	0		100	150		0
Storage Lanes	0		0	1		0	0		1	1		0
Taper Length (ft)	25			25			25			25		
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		151			225			398			315	
Travel Time (s)		3.4			5.1			9.0			7.2	
Peak Hour Factor	0.75	0.75	0.75	0.72	0.72	0.72	0.86	0.86	0.86	0.92	0.92	0.92
Shared Lane Traffic (%)				44%								
Lane Group Flow (vph)	0	41	0	280	277	0	0	337	93	16	766	0
Turn Type	Split	NA		Split	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Detector Phase	4	4		8	8		2	2	2	6	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0		6.0	6.0		10.0	10.0	10.0	10.0	10.0	
Minimum Split (s)	27.0	27.0		11.0	11.0		15.0	15.0	15.0	23.0	23.0	
Total Split (s)	27.0	27.0		33.0	33.0		40.0	40.0	40.0	40.0	40.0	
Total Split (%)	27.0%	27.0%		33.0%	33.0%		40.0%	40.0%	40.0%	40.0%	40.0%	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)		0.0		0.0	0.0			0.0	0.0	0.0	0.0	
Total Lost Time (s)		4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None		C-Min	C-Min	C-Min	C-Min	C-Min	
v/c Ratio		0.20		0.75	0.71			0.30	0.09	0.03	0.36	
Control Delay		8.5		48.3	43.8			14.0	8.2	15.4	13.9	
Queue Delay		0.0		0.0	0.0			0.6	0.0	0.0	0.1	
Total Delay		8.5		48.3	43.8			14.6	8.2	15.4	14.0	
Queue Length 50th (ft)		0		174	163			56	1	4	124	
Queue Length 95th (ft)		12		187	176			m252	m30	21	270	
Internal Link Dist (ft)		71			145			318			235	
Turn Bay Length (ft)									100	150		
Base Capacity (vph)		413		487	503			1112	986	568	2134	
Starvation Cap Reductn		0		0	0			437	0	0	0	
Spillback Cap Reductn		4		0	0			0	0	0	276	
Storage Cap Reductn		0		0	0			0	0	0	0	
Reduced v/c Ratio		0.10		0.57	0.55			0.50	0.09	0.03	0.41	

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 65
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 11: Gould St & Windgate Dwy/Muzi Ford Dwy





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	0	30	360	1	40	5	285	80	15	700	5
Future Volume (vph)	1	0	30	360	1	40	5	285	80	15	700	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	13	13	12	12	12	12	12	12
Total Lost time (s)		4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00		0.95	0.95			1.00	1.00	1.00	0.95	
Frt		0.87		1.00	0.97			1.00	0.85	1.00	1.00	
Flt Protected		1.00		0.95	0.96			1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1615		1681	1705			1861	1583	1770	3536	
Flt Permitted		1.00		0.95	0.96			0.99	1.00	0.51	1.00	
Satd. Flow (perm)		1615		1681	1705			1842	1583	941	3536	
Peak-hour factor, PHF	0.75	0.75	0.75	0.72	0.72	0.72	0.86	0.86	0.86	0.92	0.92	0.92
Adj. Flow (vph)	1	0	40	500	1	56	6	331	93	16	761	5
RTOR Reduction (vph)	0	38	0	0	10	0	0	0	32	0	0	0
Lane Group Flow (vph)	0	3	0	280	267	0	0	337	61	16	766	0
Turn Type	Split	NA		Split	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)		7.0		22.3	22.3			58.7	58.7	58.7	58.7	
Effective Green, g (s)		7.0		22.3	22.3			58.7	58.7	58.7	58.7	
Actuated g/C Ratio		0.07		0.22	0.22			0.59	0.59	0.59	0.59	
Clearance Time (s)		4.0		4.0	4.0			4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		113		374	380			1081	929	552	2075	
v/s Ratio Prot		c0.00		c0.17	0.16						c0.22	
v/s Ratio Perm								0.18	0.04	0.02		
v/c Ratio		0.03		0.75	0.70			0.31	0.07	0.03	0.37	
Uniform Delay, d1		43.3		36.2	35.8			10.4	8.9	8.7	10.9	
Progression Factor		1.00		1.00	1.00			0.99	1.48	1.00	1.00	
Incremental Delay, d2		0.1		8.0	5.8			0.4	0.1	0.1	0.5	
Delay (s)		43.4		44.2	41.6			10.7	13.2	8.8	11.4	
Level of Service		D		D	D			B	B	A	B	
Approach Delay (s)		43.4			42.9			11.2			11.3	
Approach LOS		D			D			B			B	

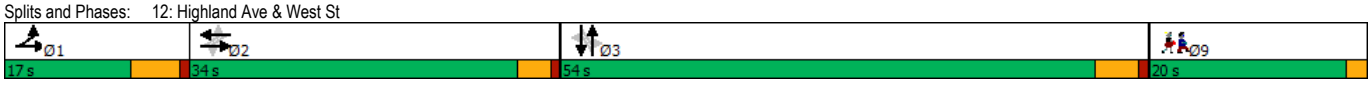
Intersection Summary			
HCM 2000 Control Delay	21.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	44.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	180	235	50	70	155	60	25	420	55	30	570	100	
Future Volume (vph)	180	235	50	70	155	60	25	420	55	30	570	100	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	120		0	100		0	0		0	0		0	
Storage Lanes	1		0	1		0	0		0	0		0	
Taper Length (ft)	25			25			25			25			
Right Turn on Red			No			No			No			No	
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		318			371			476			549		
Travel Time (s)		7.2			8.4			10.8			12.5		
Confl. Peds. (#/hr)	7		8	8		7	4		36	36		4	
Peak Hour Factor	0.87	0.87	0.87	0.86	0.86	0.86	0.89	0.89	0.89	0.93	0.93	0.93	
Heavy Vehicles (%)	3%	0%	0%	0%	2%	2%	1%	8%	0%	0%	3%	6%	
Bus Blockages (#/hr)	0	0	0	0	0	0	2	2	2	0	0	0	
Parking (#/hr)							0	0	0	0	0	0	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	207	327	0	81	250	0	0	562	0	0	753	0	
Turn Type	D.P+P	NA		Perm	NA		Perm	NA		Perm	NA		
Protected Phases	1	1 2			2			3			3		9
Permitted Phases	2	2		2			3			3			
Detector Phase	1	1 2		2	2		3	3		3	3		
Switch Phase													
Minimum Initial (s)	6.0			10.0	10.0		10.0	10.0		10.0	10.0		7.0
Minimum Split (s)	11.5			15.0	15.0		15.0	15.0		15.0	15.0		20.0
Total Split (s)	17.0			34.0	34.0		54.0	54.0		54.0	54.0		20.0
Total Split (%)	13.6%			27.2%	27.2%		43.2%	43.2%		43.2%	43.2%		16%
Yellow Time (s)	4.5			3.0	3.0		4.0	4.0		4.0	4.0		2.0
All-Red Time (s)	1.0			1.0	1.0		1.0	1.0		1.0	1.0		0.0
Lost Time Adjust (s)	0.0			0.0	0.0			0.0			0.0		
Total Lost Time (s)	5.5			4.0	4.0			5.0			5.0		
Lead/Lag	Lead			Lag	Lag								
Lead-Lag Optimize?													
Recall Mode	None			None	None		Min	Min		Min	Min		None
v/c Ratio	0.65	0.49		0.38	0.70			0.76			0.97		
Control Delay	35.2	28.2		40.5	48.3			31.4			52.7		
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0		
Total Delay	35.2	28.2		40.5	48.3			31.4			52.7		
Queue Length 50th (ft)	87	148		42	140			254			408		
Queue Length 95th (ft)	178	281		98	256			#669			#994		
Internal Link Dist (ft)		238			291			396			469		
Turn Bay Length (ft)	120			100									
Base Capacity (vph)	320	854		323	540			735			777		
Starvation Cap Reductn	0	0		0	0			0			0		
Spillback Cap Reductn	0	0		0	0			0			0		
Storage Cap Reductn	0	0		0	0			0			0		
Reduced v/c Ratio	0.65	0.38		0.25	0.46			0.76			0.97		

Intersection Summary

Area Type: Other
Cycle Length: 125
Actuated Cycle Length: 99.6
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 12: Highland Ave & West St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	180	235	50	70	155	60	25	420	55	30	570	100
Future Volume (vph)	180	235	50	70	155	60	25	420	55	30	570	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5		4.0	4.0			5.0			5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Frpb, ped/bikes	1.00	0.99		1.00	0.99			0.99			1.00	
Flpb, ped/bikes	1.00	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.96			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1749	1840		1782	1766			1552			1613	
Flt Permitted	0.33	1.00		0.56	1.00			0.95			0.96	
Satd. Flow (perm)	614	1840		1056	1766			1473			1556	
Peak-hour factor, PHF	0.87	0.87	0.87	0.86	0.86	0.86	0.89	0.89	0.89	0.93	0.93	0.93
Adj. Flow (vph)	207	270	57	81	180	70	28	472	62	32	613	108
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	207	327	0	81	250	0	0	562	0	0	753	0
Confl. Peds. (#/hr)	7		8	8		7	4		36	36		4
Heavy Vehicles (%)	3%	0%	0%	0%	2%	2%	1%	8%	0%	0%	3%	6%
Bus Blockages (#/hr)	0	0	0	0	0	0	2	2	2	0	0	0
Parking (#/hr)							0	0	0	0	0	0
Turn Type	D.P+P	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases	1	1 2			2			3			3	
Permitted Phases	2	2		2			3			3		
Actuated Green, G (s)	31.9	37.4		20.2	20.2			49.8			49.8	
Effective Green, g (s)	31.9	37.4		20.2	20.2			49.8			49.8	
Actuated g/C Ratio	0.32	0.37		0.20	0.20			0.49			0.49	
Clearance Time (s)	5.5			4.0	4.0			5.0			5.0	
Vehicle Extension (s)	3.0			3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	325	680		210	352			725			766	
v/s Ratio Prot	c0.07	0.18			c0.14							
v/s Ratio Perm	0.13			0.08				0.38			c0.48	
v/c Ratio	0.64	0.48		0.39	0.71			0.78			0.98	
Uniform Delay, d1	27.4	24.4		35.1	37.7			21.1			25.2	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	4.1	0.5		1.2	6.6			5.2			28.1	
Delay (s)	31.4	24.9		36.2	44.3			26.2			53.4	
Level of Service	C	C		D	D			C			D	
Approach Delay (s)		27.5			42.4			26.2			53.4	
Approach LOS		C			D			C			D	

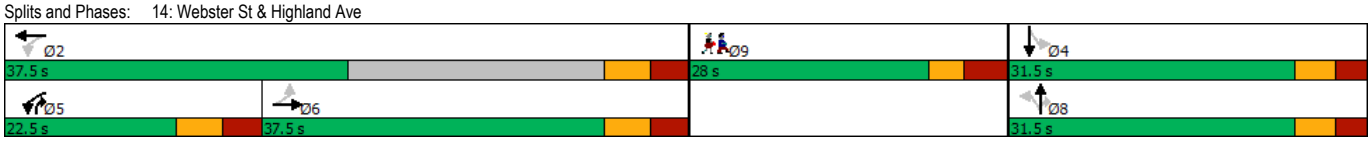
Intersection Summary			
HCM 2000 Control Delay	38.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	101.1	Sum of lost time (s)	16.5
Intersection Capacity Utilization	82.3%	ICU Level of Service	E
Analysis Period (min)	15		

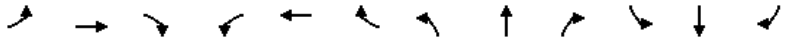
c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	45	460	15	315	630	75	25	125	175	95	300	45	
Future Volume (vph)	45	460	15	315	630	75	25	125	175	95	300	45	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	150		0	150		0	0		150	0		200	
Storage Lanes	1		0	1		0	0		1	0		1	
Taper Length (ft)	25			25			25			25			
Right Turn on Red			Yes			Yes			No			No	
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		1325			691			391			2983		
Travel Time (s)		30.1			15.7			8.9			67.8		
Confl. Peds. (#/hr)	2					2	2					2	
Peak Hour Factor	0.91	0.91	0.91	0.97	0.97	0.97	0.87	0.87	0.87	0.88	0.88	0.88	
Heavy Vehicles (%)	0%	0%	0%	1%	2%	1%	0%	0%	0%	0%	0%	0%	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	49	521	0	325	726	0	0	173	201	0	500	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pm+ov	Perm	NA		
Protected Phases		6		5	2			8	5		4		9
Permitted Phases	6			2			8		8	4			
Detector Phase	6	6		5	2		8	8	5	4	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0		7.0
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5		28.0
Total Split (s)	37.5	37.5		22.5	37.5		31.5	31.5	22.5	31.5	31.5		28.0
Total Split (%)	31.4%	31.4%		18.8%	31.4%		26.4%	26.4%	18.8%	26.4%	26.4%		23%
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5		3.0
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0		4.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0		
Total Lost Time (s)	7.5	7.5		7.5	7.5			6.5	7.5		6.5		
Lead/Lag	Lag	Lag		Lead					Lead				
Lead-Lag Optimize?													
Recall Mode	Min	Min		None	Min		None	None	None	None	None		None
v/c Ratio	0.21	0.85		0.85	0.70			0.53	0.27		0.75		
Control Delay	30.6	46.0		42.4	21.9			39.9	18.2		42.8		
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0		
Total Delay	30.6	46.0		42.4	21.9			39.9	18.2		42.8		
Queue Length 50th (ft)	20	268		115	257			83	62		134		
Queue Length 95th (ft)	68	#673		#409	#750			191	162		#271		
Internal Link Dist (ft)		1245			611			311			2903		
Turn Bay Length (ft)	150			150					150				
Base Capacity (vph)	233	614		384	1042			378	752		768		
Starvation Cap Reductn	0	0		0	0			0	0		0		
Spillback Cap Reductn	0	0		0	0			0	0		0		
Storage Cap Reductn	0	0		0	0			0	0		0		
Reduced v/c Ratio	0.21	0.85		0.85	0.70			0.46	0.27		0.65		

Intersection Summary	
Area Type:	Other
Cycle Length: 119.5	
Actuated Cycle Length: 94	
Natural Cycle: 130	
Control Type: Actuated-Uncoordinated	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 14: Webster St & Highland Ave





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	460	15	315	630	75	25	125	175	95	300	45
Future Volume (vph)	45	460	15	315	630	75	25	125	175	95	300	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.5	7.5		7.5	7.5			6.5	7.5		6.5	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frt	1.00	1.00		1.00	0.98			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00		0.99	
Satd. Flow (prot)	1803	1891		1787	1831			1884	1615		3508	
Flt Permitted	0.38	1.00		0.12	1.00			0.74	1.00		0.80	
Satd. Flow (perm)	716	1891		232	1831			1401	1615		2841	
Peak-hour factor, PHF	0.91	0.91	0.91	0.97	0.97	0.97	0.87	0.87	0.87	0.88	0.88	0.88
Adj. Flow (vph)	49	505	16	325	649	77	29	144	201	108	341	51
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	0	0	0	0
Lane Group Flow (vph)	49	520	0	325	723	0	0	173	201	0	500	0
Confl. Peds. (#/hr)	2					2	2					2
Heavy Vehicles (%)	0%	0%	0%	1%	2%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	pm+ov	Perm	NA	
Protected Phases		6		5	2			8	5		4	
Permitted Phases	6			2			8		8	4		
Actuated Green, G (s)	30.6	30.6		53.4	53.4			21.9	37.2		21.9	
Effective Green, g (s)	30.6	30.6		53.4	53.4			21.9	37.2		21.9	
Actuated g/C Ratio	0.31	0.31		0.54	0.54			0.22	0.37		0.22	
Clearance Time (s)	7.5	7.5		7.5	7.5			6.5	7.5		6.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	219	580		363	981			308	603		624	
v/s Ratio Prot		0.28		0.14	c0.40				0.05			
v/s Ratio Perm	0.07			c0.34				0.12	0.07		c0.18	
v/c Ratio	0.22	0.90		0.90	0.74			0.56	0.33		0.80	
Uniform Delay, d1	25.7	33.0		25.3	17.7			34.6	22.3		36.8	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.5	16.4		23.4	2.9			2.3	0.3		7.3	
Delay (s)	26.2	49.4		48.7	20.6			36.9	22.7		44.1	
Level of Service	C	D		D	C			D	C		D	
Approach Delay (s)		47.4			29.3			29.3			44.1	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	36.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	99.6	Sum of lost time (s)	28.5
Intersection Capacity Utilization	89.9%	ICU Level of Service	E
Analysis Period (min)	15		

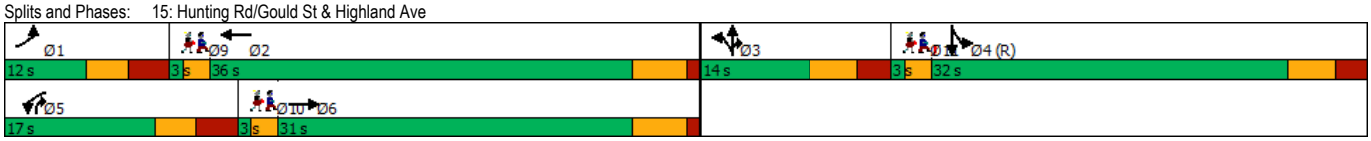
c Critical Lane Group

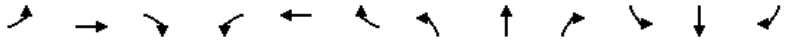
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9	Ø10	Ø11
Lane Configurations															
Traffic Volume (vph)	35	725	20	135	1015	270	20	65	90	765	190	135			
Future Volume (vph)	35	725	20	135	1015	270	20	65	90	765	190	135			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900			
Storage Length (ft)	175		0	165		400	0		150	200		200			
Storage Lanes	1		0	1		0	0		1	1		0			
Taper Length (ft)	25			25			25			25					
Right Turn on Red			Yes			Yes			Yes			Yes			
Link Speed (mph)		30			30			30			30				
Link Distance (ft)		345			745			3028			398				
Travel Time (s)		7.8			16.9			68.8			9.0				
Confl. Bikes (#/hr)						1									
Peak Hour Factor	0.91	0.91	0.91	0.95	0.95	0.95	0.83	0.83	0.83	0.83	0.83	0.83			
Shared Lane Traffic (%)															
Lane Group Flow (vph)	38	819	0	142	1352	0	0	102	108	922	392	0			
Turn Type	Prot	NA		Prot	NA		Split	NA	pt+ov	Split	NA				
Protected Phases	1	6		5	2		3	3	3 5	4	4		9	10	11
Permitted Phases															
Detector Phase	1	6		5	2		3	3	3 5	4	4				
Switch Phase															
Minimum Initial (s)	6.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0		1.0	1.0	1.0
Minimum Split (s)	12.0	20.0		12.0	25.0		12.0	12.0		21.0	21.0		3.0	3.0	3.0
Total Split (s)	12.0	31.0		17.0	36.0		14.0	14.0		32.0	32.0		3.0	3.0	3.0
Total Split (%)	12.0%	31.0%		17.0%	36.0%		14.0%	14.0%		32.0%	32.0%		3%	3%	3%
Yellow Time (s)	3.0	4.0		3.0	4.0		3.5	3.5		3.5	3.5		2.0	2.0	2.0
All-Red Time (s)	3.0	1.0		3.0	1.0		2.5	2.5		2.5	2.5		0.0	0.0	0.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0		0.0	0.0				
Total Lost Time (s)	6.0	5.0		6.0	5.0			6.0		6.0	6.0				
Lead/Lag	Lead			Lead			Lead	Lead					Lag	Lag	Lag
Lead-Lag Optimize?															
Recall Mode	None	Min		None	Min		Min	Min		C-Min	C-Min		None	None	None
v/c Ratio	0.36	0.80		0.78	1.02			0.73	0.26	0.93	0.74				
Control Delay	55.0	40.1		71.9	62.3			74.0	2.7	54.5	41.2				
Queue Delay	0.0	0.0		0.0	0.2			5.4	0.0	5.1	1.1				
Total Delay	55.0	40.1		71.9	62.5			79.4	2.7	59.6	42.3				
Queue Length 50th (ft)	24	252		89	~527			65	0	310	228				
Queue Length 95th (ft)	57	#373		#182	#702			#126	5	#376	#239				
Internal Link Dist (ft)		265			665			2948			318				
Turn Bay Length (ft)	175			165					150	200					
Base Capacity (vph)	106	1027		194	1324			147	424	987	527				
Starvation Cap Reductn	0	0		0	0			0	0	43	32				
Spillback Cap Reductn	0	0		0	1			17	0	0	0				
Storage Cap Reductn	0	0		0	0			0	0	0	0				
Reduced v/c Ratio	0.36	0.80		0.73	1.02			0.78	0.25	0.98	0.79				

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle: 110
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 15: Hunting Rd/Gould St & Highland Ave





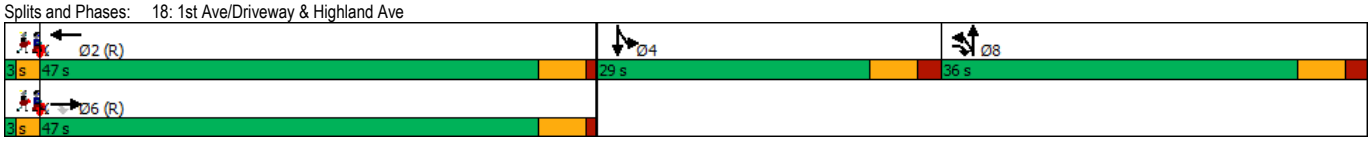
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	725	20	135	1015	270	20	65	90	765	190	135
Future Volume (vph)	35	725	20	135	1015	270	20	65	90	765	190	135
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	5.0		6.0	5.0			6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.97	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Frt	1.00	1.00		1.00	0.97			1.00	0.85	1.00	0.94	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3525		1770	3413			1841	1583	3433	1747	
Flt Permitted	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3525		1770	3413			1841	1583	3433	1747	
Peak-hour factor, PHF	0.91	0.91	0.91	0.95	0.95	0.95	0.83	0.83	0.83	0.83	0.83	0.83
Adj. Flow (vph)	38	797	22	142	1068	284	24	78	108	922	229	163
RTOR Reduction (vph)	0	2	0	0	22	0	0	0	89	0	25	0
Lane Group Flow (vph)	38	817	0	142	1330	0	0	102	19	922	367	0
Confl. Bikes (#/hr)						1						
Turn Type	Prot	NA		Prot	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	1	6		5	2		3	3	3 5	4	4	
Permitted Phases												
Actuated Green, G (s)	3.6	31.5		10.3	38.2			7.6	17.9	27.6	27.6	
Effective Green, g (s)	3.6	31.5		10.3	38.2			7.6	17.9	27.6	27.6	
Actuated g/C Ratio	0.04	0.32		0.10	0.38			0.08	0.18	0.28	0.28	
Clearance Time (s)	6.0	5.0		6.0	5.0			6.0		6.0	6.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)	63	1110		182	1303			139	283	947	482	
v/s Ratio Prot	0.02	0.23		c0.08	c0.39			c0.06	0.01	c0.27	0.21	
v/s Ratio Perm												
v/c Ratio	0.60	0.74		0.78	1.02			0.73	0.07	0.97	0.76	
Uniform Delay, d1	47.5	30.5		43.7	30.9			45.2	34.1	35.8	33.2	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.09	1.07	
Incremental Delay, d2	10.7	2.2		17.8	30.4			15.8	0.0	22.4	10.0	
Delay (s)	58.2	32.8		61.6	61.3			61.0	34.2	61.6	45.5	
Level of Service	E	C		E	E			E	C	E	D	
Approach Delay (s)		33.9			61.3			47.2			56.8	
Approach LOS		C			E			D			E	

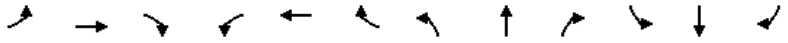
Intersection Summary			
HCM 2000 Control Delay	52.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	84.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø1	Ø5
Lane Configurations														
Traffic Volume (vph)	0	915	285	0	1675	5	630	0	110	1	1	10		
Future Volume (vph)	0	915	285	0	1675	5	630	0	110	1	1	10		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900		
Storage Length (ft)	0		0	0		0	75		0	0		0		
Storage Lanes	0		1	0		0	1		0	0		0		
Taper Length (ft)	25			25			25			25				
Right Turn on Red			Yes			Yes			Yes			Yes		
Link Speed (mph)		30			30			30			30			
Link Distance (ft)		176			681			500			267			
Travel Time (s)		4.0			15.5			11.4			6.1			
Confl. Peds. (#/hr)									1	1				
Confl. Bikes (#/hr)						1								
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.63	0.63	0.63		
Heavy Vehicles (%)	0%	0%	2%	0%	2%	0%	2%	0%	1%	0%	0%	0%		
Shared Lane Traffic (%)							40%							
Lane Group Flow (vph)	0	1028	320	0	1888	0	425	407	0	0	20	0		
Turn Type		NA	pm+ov		NA		Split	NA		Split	NA			
Protected Phases		6	8		2		8	8		4	4		1	5
Permitted Phases			6											
Detector Phase		6	8		2		8	8		4	4			
Switch Phase														
Minimum Initial (s)		10.0	6.0		10.0		6.0	6.0		6.0	6.0		1.0	1.0
Minimum Split (s)		25.0	12.0		16.0		12.0	12.0		29.0	29.0		3.0	3.0
Total Split (s)		47.0	36.0		47.0		36.0	36.0		29.0	29.0		3.0	3.0
Total Split (%)		40.9%	31.3%		40.9%		31.3%	31.3%		25.2%	25.2%		3%	3%
Yellow Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0		2.0	2.0
All-Red Time (s)		1.0	2.0		1.0		2.0	2.0		2.0	2.0		0.0	0.0
Lost Time Adjust (s)		0.0	0.0		0.0		0.0	0.0			0.0			
Total Lost Time (s)		5.0	6.0		5.0		6.0	6.0			6.0			
Lead/Lag		Lag			Lag								Lead	Lead
Lead-Lag Optimize?														
Recall Mode		C-Min	None		C-Min		None	None		None	None		None	None
v/c Ratio		0.55	0.22		1.02		0.82	0.72			0.13			
Control Delay		22.5	0.9		53.9		51.1	34.9			23.6			
Queue Delay		0.0	0.0		0.0		0.0	0.0			0.0			
Total Delay		22.5	0.9		53.9		51.1	34.9			23.6			
Queue Length 50th (ft)		231	0		651		291	207			3			
Queue Length 95th (ft)		427	24		#1090		#532	#396			13			
Internal Link Dist (ft)		96			601			420			187			
Turn Bay Length (ft)							75							
Base Capacity (vph)		1874	1447		1856		518	568			350			
Starvation Cap Reductn		0	0		0		0	0			0			
Spillback Cap Reductn		0	0		0		0	0			0			
Storage Cap Reductn		0	0		0		0	0			0			
Reduced v/c Ratio		0.55	0.22		1.02		0.82	0.72			0.06			

Intersection Summary	
Area Type:	Other
Cycle Length: 115	
Actuated Cycle Length: 115	
Offset: 0 (0%), Referenced to phase 2:WBT and 6:EBT, Start of Green	
Natural Cycle: 150	
Control Type: Actuated-Coordinated	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 18: 1st Ave/Driveway & Highland Ave





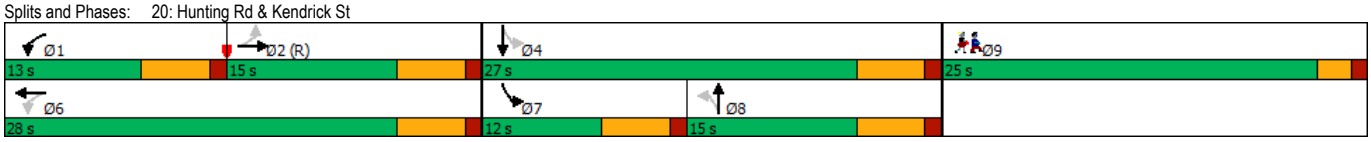
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	915	285	0	1675	5	630	0	110	1	1	10
Future Volume (vph)	0	915	285	0	1675	5	630	0	110	1	1	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	6.0		5.0		6.0	6.0			6.0	
Lane Util. Factor		0.95	1.00		0.95		0.95	0.95			1.00	
Frpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		1.00	0.85		1.00		1.00	0.95			0.89	
Flt Protected		1.00	1.00		1.00		0.95	0.97			1.00	
Satd. Flow (prot)		3610	1583		3538		1681	1630			1686	
Flt Permitted		1.00	1.00		1.00		0.95	0.97			1.00	
Satd. Flow (perm)		3610	1583		3538		1681	1630			1686	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.63	0.63	0.63
Adj. Flow (vph)	0	1028	320	0	1882	6	708	0	124	2	2	16
RTOR Reduction (vph)	0	0	63	0	0	0	0	66	0	0	15	0
Lane Group Flow (vph)	0	1028	257	0	1888	0	425	341	0	0	5	0
Confl. Peds. (#/hr)									1	1		
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	0%	2%	0%	2%	0%	2%	0%	1%	0%	0%	0%
Turn Type		NA	pm+ov		NA		Split	NA		Split	NA	
Protected Phases		6	8		2		8	8		4	4	
Permitted Phases			6									
Actuated Green, G (s)		56.7	92.2		56.7		35.5	35.5			5.8	
Effective Green, g (s)		56.7	92.2		56.7		35.5	35.5			5.8	
Actuated g/C Ratio		0.49	0.80		0.49		0.31	0.31			0.05	
Clearance Time (s)		5.0	6.0		5.0		6.0	6.0			6.0	
Vehicle Extension (s)		2.0	2.0		2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)		1779	1351		1744		518	503			85	
v/s Ratio Prot		0.28	0.06		c0.53		c0.25	0.21			c0.00	
v/s Ratio Perm			0.10									
v/c Ratio		0.58	0.19		1.08		0.82	0.68			0.06	
Uniform Delay, d1		20.7	2.7		29.1		36.8	34.8			52.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		1.4	0.0		47.7		9.6	2.9			0.1	
Delay (s)		22.0	2.7		76.8		46.4	37.6			52.1	
Level of Service		C	A		E		D	D			D	
Approach Delay (s)		17.4			76.8			42.1			52.1	
Approach LOS		B			E			D			D	

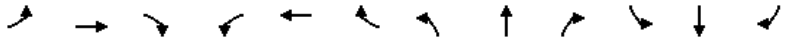
Intersection Summary			
HCM 2000 Control Delay	50.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	115.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	15	235	2	475	405	45	1	110	135	85	190	15	
Future Volume (vph)	15	235	2	475	405	45	1	110	135	85	190	15	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Storage Length (ft)	0		100	190		0	0		400	125		0	
Storage Lanes	0		1	1		0	0		1	1		0	
Taper Length (ft)	25			25			25			25			
Right Turn on Red			Yes			Yes			Yes			Yes	
Link Speed (mph)		30			30			30			30		
Link Distance (ft)		442			443			907			3028		
Travel Time (s)		10.0			10.1			20.6			68.8		
Peak Hour Factor	0.91	0.91	0.91	0.95	0.95	0.95	0.83	0.83	0.83	0.94	0.94	0.94	
Shared Lane Traffic (%)													
Lane Group Flow (vph)	0	276	0	500	473	0	0	134	163	90	218	0	
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Free	pm+pt	NA		
Protected Phases		2		1	6			8		7	4		9
Permitted Phases	2			6			8		Free	4			
Detector Phase	2	2		1	6		8	8		7	4		
Switch Phase													
Minimum Initial (s)	10.0	10.0		7.0	10.0		10.0	10.0		5.0	10.0		7.0
Minimum Split (s)	15.0	15.0		12.0	16.0		15.0	15.0		10.0	27.0		25.0
Total Split (s)	15.0	15.0		13.0	28.0		15.0	15.0		12.0	27.0		25.0
Total Split (%)	18.8%	18.8%		16.3%	35.0%		18.8%	18.8%		15.0%	33.8%		31%
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0		2.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)		0.0		0.0	0.0			0.0		0.0	0.0		
Total Lost Time (s)		5.0		5.0	5.0			5.0		5.0	5.0		
Lead/Lag	Lag	Lag		Lead			Lag	Lag		Lead			
Lead-Lag Optimize?													
Recall Mode	C-Min	C-Min		None	Min		None	None		None	None		None
v/c Ratio		0.53		0.57	0.41			0.58	0.10	0.33	0.48		
Control Delay		33.7		11.4	9.3			43.8	0.1	26.1	28.2		
Queue Delay		0.0		0.0	0.0			0.0	0.0	0.0	0.0		
Total Delay		33.7		11.4	9.3			43.8	0.1	26.1	28.2		
Queue Length 50th (ft)		68		126	113			64	0	34	87		
Queue Length 95th (ft)		97		196	176			109	0	71	150		
Internal Link Dist (ft)		362			363			827			2948		
Turn Bay Length (ft)				190					400	125			
Base Capacity (vph)		523		875	1159			232	1583	277	510		
Starvation Cap Reductn		0		0	0			0	0	0	0		
Spillback Cap Reductn		0		0	0			0	0	0	0		
Storage Cap Reductn		0		0	0			0	0	0	0		
Reduced v/c Ratio		0.53		0.57	0.41			0.58	0.10	0.32	0.43		

Intersection Summary	
Area Type:	Other
Cycle Length: 80	
Actuated Cycle Length: 80	
Offset: 5 (6%), Referenced to phase 2:EBTL, Start of Green	
Natural Cycle: 90	
Control Type: Actuated-Coordinated	

Splits and Phases: 20: Hunting Rd & Kendrick St





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	235	2	475	405	45	1	110	135	85	190	15
Future Volume (vph)	15	235	2	475	405	45	1	110	135	85	190	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0			5.0	4.0	5.0	5.0	
Lane Util. Factor		0.95		1.00	1.00			1.00	1.00	1.00	1.00	
Frt		1.00		1.00	0.99			1.00	0.85	1.00	0.99	
Flt Protected		1.00		0.95	1.00			1.00	1.00	0.95	1.00	
Satd. Flow (prot)		3525		1770	1835			1862	1583	1770	1842	
Flt Permitted		0.91		0.38	1.00			1.00	1.00	0.42	1.00	
Satd. Flow (perm)		3202		704	1835			1857	1583	781	1842	
Peak-hour factor, PHF	0.91	0.91	0.91	0.95	0.95	0.95	0.83	0.83	0.83	0.94	0.94	0.94
Adj. Flow (vph)	16	258	2	500	426	47	1	133	163	90	202	16
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	275	0	500	470	0	0	134	163	90	214	0
Turn Type	Perm	NA		pm+pt	NA		Perm	NA	Free	pm+pt	NA	
Protected Phases		2		1	6			8		7	4	
Permitted Phases	2			6			8		Free	4		
Actuated Green, G (s)		12.0		49.4	49.4			10.0	80.0	20.6	20.6	
Effective Green, g (s)		12.0		49.4	49.4			10.0	80.0	20.6	20.6	
Actuated g/C Ratio		0.15		0.62	0.62			0.12	1.00	0.26	0.26	
Clearance Time (s)		5.0		5.0	5.0			5.0		5.0	5.0	
Vehicle Extension (s)		2.0		2.0	2.0			2.0		2.0	2.0	
Lane Grp Cap (vph)		480		866	1133			232	1583	270	474	
v/s Ratio Prot				c0.23	0.26					0.02	c0.12	
v/s Ratio Perm		0.09		c0.12				c0.07	0.10	0.06		
v/c Ratio		0.57		0.58	0.42			0.58	0.10	0.33	0.45	
Uniform Delay, d1		31.6		8.6	7.9			33.0	0.0	23.4	25.0	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		4.9		0.6	0.1			2.2	0.1	0.3	0.3	
Delay (s)		36.5		9.2	8.0			35.2	0.1	23.7	25.2	
Level of Service		D		A	A			D	A	C	C	
Approach Delay (s)		36.5			8.6			15.9			24.8	
Approach LOS		D			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	16.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	58.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	6.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	105	70	305	20	15	615
Future Vol, veh/h	105	70	305	20	15	615
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	150	-	-	150	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	81	81	75	75	73	73
Heavy Vehicles, %	0	0	0	0	0	6
Mvmt Flow	130	86	407	27	21	842

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1305	421	0	0	434	0
Stage 1	421	-	-	-	-	-
Stage 2	884	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	178	637	-	-	1136	-
Stage 1	667	-	-	-	-	-
Stage 2	407	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	175	637	-	-	1136	-
Mov Cap-2 Maneuver	175	-	-	-	-	-
Stage 1	667	-	-	-	-	-
Stage 2	400	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	45.7	0	0.2
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	175	637	1136	-
HCM Lane V/C Ratio	-	-	0.741	0.136	0.018	-
HCM Control Delay (s)	-	-	68.5	11.5	8.2	-
HCM Lane LOS	-	-	F	B	A	-
HCM 95th %tile Q(veh)	-	-	4.7	0.5	0.1	-

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Cedar Street

Major Street Direction: Eastbound-Westbound

Year: 2022 **Condition:** Existing Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 3

		Required approach volumes Minimum*	Adjusted Minimum**
Warrant 1	**EIGHT-HOUR VEHICULAR VOLUME**		
Warrant 1A	MINIMUM VEHICULAR VOLUME (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	500	500
	Minor Street : 1 Lane(s) on each approach	150	150
Warrant 1B	INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	750	750
	Minor Street : 1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
	Major Street : 1 Lane(s) on each approach	400	600
	Minor Street : 1 Lane(s) on each approach	120	60

Warrant 2 **FOUR HOUR VEHICULAR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 **PEAK HOUR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road Eastbound	Entering Vol. on Major Road Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	100	324	121	445	No	No	No	No	No
7:00 - 8:00 AM	203	656	226	882	Yes	Yes	Yes	Yes	No
8:00 - 9:00 AM	204	660	230	890	Yes	Yes	Yes	Yes	No
9:00 - 10:00 AM	156	505	215	720	Yes	No	Yes	No	No
10:00 - 11:00 AM	132	428	223	651	No	No	Yes	No	No
11:00 - 12:00 AM	140	451	243	694	No	No	Yes	No	No
12:00 - 1:00 PM	140	450	247	697	No	No	Yes	No	No
1:00 - 2:00 PM	150	314	401	715	No	No	Yes	No	No
2:00 - 3:00 PM	159	330	395	725	Yes	No	Yes	No	No
3:00 - 4:00 PM	184	384	367	751	Yes	Yes	Yes	Yes	No
4:00 - 5:00 PM	175	366	422	788	Yes	Yes	Yes	Yes	No
5:00 - 6:00 PM	141	295	540	835	No	Yes	Yes	Yes	No
6:00 - 7:00 PM	136	283	471	754	No	Yes	Yes	No	No
					No	**No**	**Yes**	**Yes**	**No**
			Warrants Met?		**1**			**2**	**3**
					Yes			**Yes**	**No**

Note: Major road volumes include through and left-turning vehicles.

Note: Minor Road volumes include 100% of left-turning volumes and 25% of right-turning volumes

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

*107 pedestrians per hour is the minimum threshold

Peak Four Hour Pedestrian Volumes:

<100	7:00 AM
<100	8:00 AM
<100	4:00 PM
<100	5:00 PM

Warrant 5, School Crossing: No

See MUTCD for details.

Warrant 6, Coordinated Signal System: No

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months:

(threshold is 5 crashes in last year correctable by signalization)

Warrant 8, Roadway Network: No

See MUTCD for details.

Total Crashes 2015-2019: 4

based on MassDOT crash portal

Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Cedar Street

Major Street Direction: Eastbound-Westbound

Year: 2029 **Condition:** No Build Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 3

Warrant 1 EIGHT-HOUR VEHICULAR VOLUME		Required approach volumes: Minimum*	Adjusted Minimum**
Warrant 1A MINIMUM VEHICULAR VOLUME (8 hours of day)			
Major Street :	1 Lane(s) on each approach	500	500
Minor Street :	1 Lane(s) on each approach	150	150
Warrant 1B INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)			
Major Street :	1 Lane(s) on each approach	750	750
Minor Street :	1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
Major Street :	1 Lane(s) on each approach	400	600
Minor Street :	1 Lane(s) on each approach	120	60

Warrant 2 FOUR HOUR VEHICULAR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 PEAK HOUR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road: Eastbound	Entering Vol. on Major Road: Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	109	349	132	481	No	No	No	No	No
7:00 - 8:00 AM	219	705	245	950	Yes	Yes	Yes	Yes	No
8:00 - 9:00 AM	220	710	250	960	Yes	Yes	Yes	Yes	No
9:00 - 10:00 AM	169	543	234	777	Yes	Yes	Yes	Yes	No
10:00 - 11:00 AM	143	462	242	704	No	No	Yes	No	No
11:00 - 12:00 AM	150	485	264	749	Yes	No	Yes	No	No
12:00 - 1:00 PM	150	484	268	752	Yes	Yes	Yes	No	No
1:00 - 2:00 PM	162	335	431	766	Yes	Yes	Yes	Yes	No
2:00 - 3:00 PM	171	352	425	777	Yes	Yes	Yes	Yes	No
3:00 - 4:00 PM	198	410	394	804	Yes	Yes	Yes	Yes	No
4:00 - 5:00 PM	190	391	453	844	Yes	Yes	Yes	Yes	No
5:00 - 6:00 PM	153	315	580	895	Yes	Yes	Yes	Yes	No
6:00 - 7:00 PM	146	302	506	808	No	Yes	Yes	No	No
					Yes	Yes	Yes	Yes	No
			Warrants Met?			1		2	3
						Yes		Yes	No

Note: Major road volumes include through and left-turning vehicles.

Note: Minor Road volumes include 100% of left-turning volumes and 25% of right-turning volumes

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

*107 pedestrians per hour is the minimum threshold

Peak Four Hour Pedestrian Volumes:

<100	7:00 AM
<100	8:00 AM
<100	4:00 PM
<100	5:00 PM

Warrant 5, School Crossing: No

See MUTCD for details.

Warrant 6, Coordinated Signal System: No

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months:

(threshold is 5 crashes in last year correctable by signalization)

Warrant 8, Roadway Network: No

See MUTCD for details.

Total Crashes 2015-2019: 4

based on MassDOT crash portal

Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Cedar Street

Major Street Direction: Eastbound-Westbound

Year: 2029 **Condition:** Build Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 3

		Required approach volumes	
Warrant 1	**EIGHT-HOUR VEHICULAR VOLUME**	Minimum*	Adjusted Minimum**
Warrant 1A	MINIMUM VEHICULAR VOLUME (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	500	500
	Minor Street : 1 Lane(s) on each approach	150	150
Warrant 1B	INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	750	750
	Minor Street : 1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
	Major Street : 1 Lane(s) on each approach	400	600
	Minor Street : 1 Lane(s) on each approach	120	60

Warrant 2 **FOUR HOUR VEHICULAR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 **PEAK HOUR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road Eastbound	Entering Vol. on Major Road Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	112	355	133	488	No	No	No	No	No
7:00 - 8:00 AM	230	723	248	971	Yes	Yes	Yes	Yes	**Yes**
8:00 - 9:00 AM	235	736	253	989	Yes	Yes	Yes	Yes	**Yes**
9:00 - 10:00 AM	173	551	240	791	Yes	Yes	Yes	**Yes**	No
10:00 - 11:00 AM	147	469	249	718	No	No	Yes	No	No
11:00 - 12:00 AM	155	492	277	769	Yes	Yes	Yes	**No**	No
12:00 - 1:00 PM	158	497	281	778	Yes	Yes	Yes	**Yes**	No
1:00 - 2:00 PM	169	346	439	785	Yes	Yes	Yes	**Yes**	No
2:00 - 3:00 PM	177	363	433	795	Yes	Yes	Yes	**Yes**	No
3:00 - 4:00 PM	204	419	404	824	Yes	Yes	Yes	Yes	No
4:00 - 5:00 PM	193	398	473	870	Yes	Yes	Yes	Yes	No
5:00 - 6:00 PM	155	320	604	923	Yes	Yes	Yes	Yes	No
6:00 - 7:00 PM	147	304	509	812	No	Yes	Yes	**No**	No
					Yes	**Yes**	**Yes**	**Yes**	**Yes**
			Warrants Met?		**1**			**2**	**3**
					Yes			**Yes**	**Yes**

Note: Major road volumes include through and left-turning vehicles.

Note: Minor Road volumes include 100% of left-turning volumes and 25% of right-turning volumes

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

*107 pedestrians per hour is the minimum threshold

Peak Four Hour Pedestrian Volumes:

<100	7:00 AM
<100	8:00 AM
<100	4:00 PM
<100	5:00 PM

Warrant 5, School Crossing: No

See MUTCD for details.

Warrant 6, Coordinated Signal System: No

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months:

(threshold is 5 crashes in last year correctable by signalization)

Warrant 8, Roadway Network: No

See MUTCD for details.

Total Crashes 2015-2019: 4

based on MassDOT crash portal

Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Webster Street

Major Street Direction: Eastbound-Westbound

Year: 2022 **Condition:** Existing Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 3

		Required approach volumes	
Warrant 1	**EIGHT-HOUR VEHICULAR VOLUME**	Minimum*	Adjusted Minimum**
Warrant 1A	MINIMUM VEHICULAR VOLUME (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	500	500
	Minor Street : 1 Lane(s) on each approach	150	150
Warrant 1B	INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	750	750
	Minor Street : 1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
	Major Street : 1 Lane(s) on each approach	400	600
	Minor Street : 1 Lane(s) on each approach	120	60

Warrant 2 **FOUR HOUR VEHICULAR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 **PEAK HOUR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road Eastbound	Entering Vol. on Major Road Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	64	347	198	545	No	No	No	No	No
7:00 - 8:00 AM	128	700	369	1069	No	Yes	Yes	Yes	No
8:00 - 9:00 AM	129	705	375	1080	No	Yes	Yes	Yes	No
9:00 - 10:00 AM	99	539	351	890	No	Yes	No	No	No
10:00 - 11:00 AM	84	458	364	822	No	Yes	No	No	No
11:00 - 12:00 AM	88	482	395	877	No	Yes	No	No	No
12:00 - 1:00 PM	88	481	402	883	No	Yes	No	No	No
1:00 - 2:00 PM	92	341	553	894	No	Yes	No	No	No
2:00 - 3:00 PM	97	358	545	903	No	Yes	No	No	No
3:00 - 4:00 PM	112	417	506	923	No	Yes	No	**No**	No
4:00 - 5:00 PM	107	397	583	980	No	Yes	No	**Yes**	No
5:00 - 6:00 PM	86	320	745	1065	No	Yes	No	**No**	No
6:00 - 7:00 PM	83	307	649	956	No	Yes	No	No	No
					No	**Yes**	**No**	**No**	**No**
			Warrants Met?		**1**			**2**	**3**
					Yes			**No**	**No**

Note: Major road volumes include through and left-turning vehicles.

Note: Minor Road volumes include 100% of left-turning volumes and 25% of right-turning volumes

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

*107 pedestrians per hour is the minimum threshold

Peak Four Hour Pedestrian Volumes:

<100	7:00 AM
<100	8:00 AM
<100	4:00 PM
<100	5:00 PM

Warrant 5, School Crossing: No

See MUTCD for details.

Warrant 6, Coordinated Signal System: No

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months:

(threshold is 5 crashes in last year correctable by signalization)

Total Crashes 2015-2019: 1

based on MassDOT crash portal

Warrant 8, Roadway Network: No

See MUTCD for details.

Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Webster Street

Major Street Direction: Eastbound-Westbound

Year: 2029 **Condition:** No Build Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 3

Warrant 1 EIGHT-HOUR VEHICULAR VOLUME		Required approach volumes: Minimum*	Adjusted Minimum**
Warrant 1A MINIMUM VEHICULAR VOLUME (8 hours of day)			
Major Street :	1 Lane(s) on each approach	500	500
Minor Street :	1 Lane(s) on each approach	150	150
Warrant 1B INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)			
Major Street :	1 Lane(s) on each approach	750	750
Minor Street :	1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
Major Street :	1 Lane(s) on each approach	400	600
Minor Street :	1 Lane(s) on each approach	120	60

Warrant 2 FOUR HOUR VEHICULAR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 PEAK HOUR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road: Eastbound	Entering Vol. on Major Road: Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	67	374	213	587	No	No	No	No	No
7:00 - 8:00 AM	135	755	398	1153	No	Yes	Yes	Yes	No
8:00 - 9:00 AM	136	760	405	1165	No	Yes	Yes	Yes	No
9:00 - 10:00 AM	104	581	379	960	No	Yes	No	No	No
10:00 - 11:00 AM	89	494	392	886	No	Yes	No	No	No
11:00 - 12:00 AM	93	519	427	946	No	Yes	No	No	No
12:00 - 1:00 PM	93	518	435	953	No	Yes	No	No	No
1:00 - 2:00 PM	100	367	602	969	No	Yes	No	No	No
2:00 - 3:00 PM	105	386	593	979	No	Yes	No	No	No
3:00 - 4:00 PM	123	449	551	1000	No	Yes	Yes	Yes	No
4:00 - 5:00 PM	117	428	634	1062	No	Yes	No	Yes	No
5:00 - 6:00 PM	94	345	810	1155	No	Yes	No	Yes	No
6:00 - 7:00 PM	90	331	706	1037	No	Yes	No	No	No
					No	**Yes**	**No**	**Yes**	**No**
			Warrants Met?		**1**			**2**	**3**
					Yes			**Yes**	**No**

Note: Major road volumes include through and left-turning vehicles.

Note: Minor Road volumes include 100% of left-turning volumes and 25% of right-turning volumes

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

*107 pedestrians per hour is the minimum threshold

Peak Four Hour Pedestrian Volumes:

<100	7:00 AM
<100	8:00 AM
<100	4:00 PM
<100	5:00 PM

Warrant 5, School Crossing: No

See MUTCD for details.

Warrant 6, Coordinated Signal System: No

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months:

(threshold is 5 crashes in last year correctable by signalization)

Warrant 8, Roadway Network: No

See MUTCD for details.

Total Crashes 2015-2019: 1

based on MassDOT crash portal

Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Webster Street

Major Street Direction: Eastbound-Westbound

Year: 2029 **Condition:** Build Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 3

Warrant 1 EIGHT-HOUR VEHICULAR VOLUME		Required approach volumes: Minimum*	Adjusted Minimum**
Warrant 1A MINIMUM VEHICULAR VOLUME (8 hours of day)			
Major Street :	1 Lane(s) on each approach	500	500
Minor Street :	1 Lane(s) on each approach	150	150
Warrant 1B INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)			
Major Street :	1 Lane(s) on each approach	750	750
Minor Street :	1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
Major Street :	1 Lane(s) on each approach	400	600
Minor Street :	1 Lane(s) on each approach	120	60

Warrant 2 FOUR HOUR VEHICULAR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 PEAK HOUR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road: Eastbound	Entering Vol. on Major Road: Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	67	384	214	598	No	No	No	No	No
7:00 - 8:00 AM	135	784	402	1186	No	Yes	Yes	Yes	No
8:00 - 9:00 AM	136	801	411	1212	No	Yes	Yes	Yes	No
9:00 - 10:00 AM	104	594	388	982	No	Yes	No	No	No
10:00 - 11:00 AM	89	505	404	909	No	Yes	No	No	No
11:00 - 12:00 AM	93	531	448	979	No	Yes	No	No	No
12:00 - 1:00 PM	93	539	455	994	No	Yes	No	No	No
1:00 - 2:00 PM	100	385	615	1000	No	Yes	No	No	No
2:00 - 3:00 PM	105	403	605	1008	No	Yes	No	Yes	No
3:00 - 4:00 PM	123	464	568	1031	No	Yes	Yes	Yes	No
4:00 - 5:00 PM	117	438	665	1104	No	Yes	No	Yes	No
5:00 - 6:00 PM	94	352	848	1200	No	Yes	No	Yes	No
6:00 - 7:00 PM	90	334	710	1044	No	Yes	No	No	No
					No	**Yes**	**No**	**Yes**	**No**
			Warrants Met?		**1**			**2**	**3**
					Yes			**Yes**	**No**

Note: Major road volumes include through and left-turning vehicles.

Note: Minor Road volumes include 100% of left-turning volumes and 25% of right-turning volumes

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

*107 pedestrians per hour is the minimum threshold

Peak Four Hour Pedestrian Volumes:

<100	7:00 AM
<100	8:00 AM
<100	4:00 PM
<100	5:00 PM

Warrant 5, School Crossing: No

See MUTCD for details.

Warrant 6, Coordinated Signal System: No

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months:

(threshold is 5 crashes in last year correctable by signalization)

Total Crashes 2015-2019: 1

based on MassDOT crash portal

Warrant 8, Roadway Network: No

See MUTCD for details.

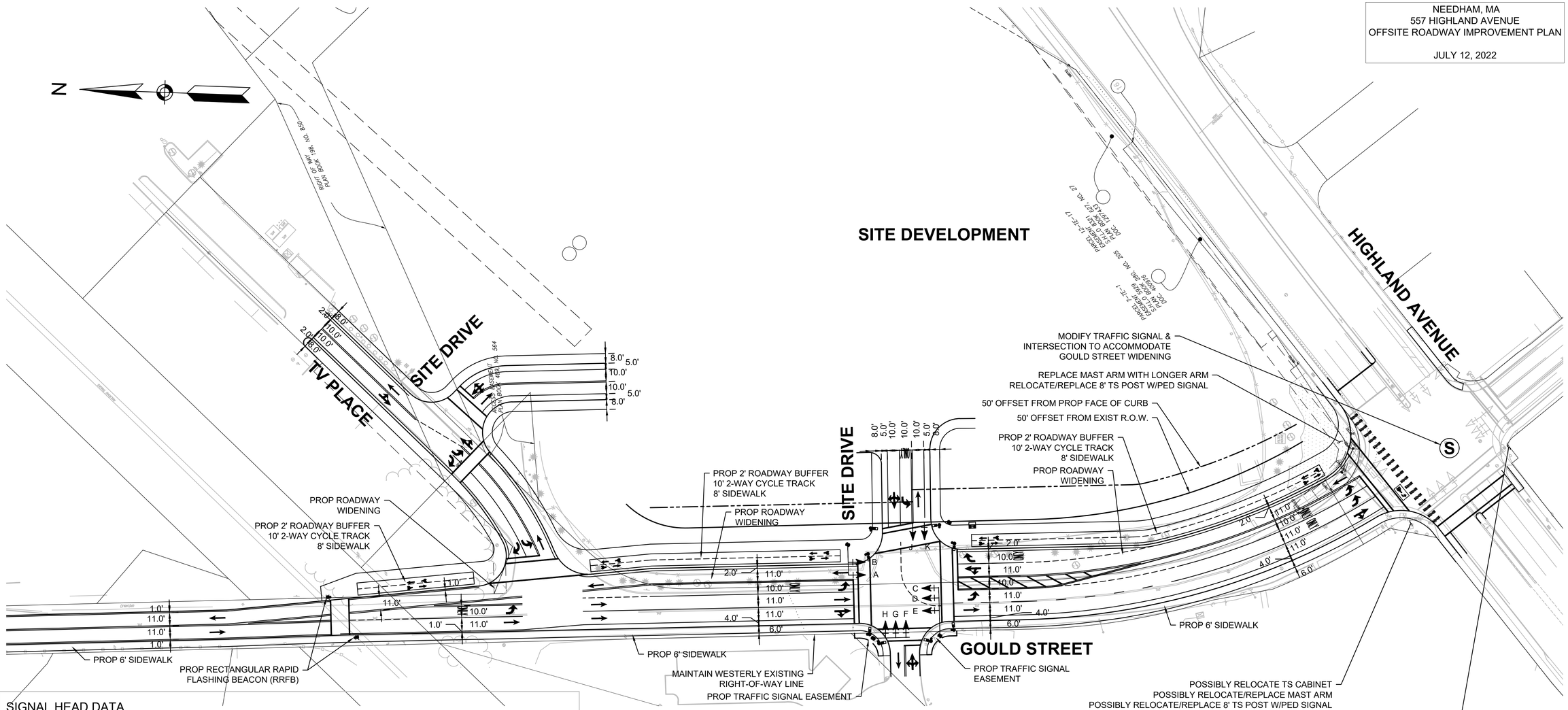
Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

NEEDHAM, MA
557 HIGHLAND AVENUE
OFFSITE ROADWAY IMPROVEMENT PLAN

JULY 12, 2022

15306.00 - CONCEPT - ALT5 - 2WAY CT & WALK EAST - V4.DWG Plotted on 13-Jul-2022 7:15 AM

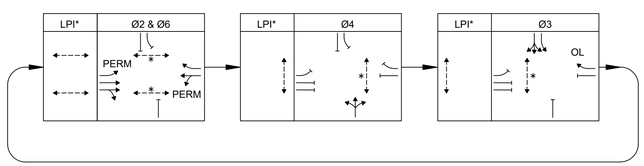


SIGNAL HEAD DATA

A,D,E,H,K	B	C	F	G,J	ALL
R Y G	R Y Y G G	R Y FY	R Y G	R Y G G	W/COUNTDOWN TIMER
ALL 12" LENS					

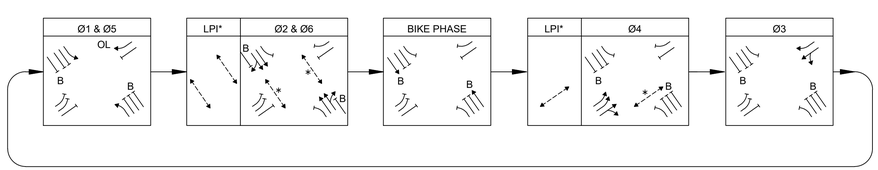
NOTES:
1. ALL SIGNAL HEADS SHALL BE RIGID MOUNTED.
2. ALL SIGNAL HEADS SHALL BE EQUIPPED WITH 5"± NON- LOUVERED BACKPLATES. ALL BACKPLATES SHALL CONTAIN A 3" WIDE YELLOW REFLECTIVE BORDER.
3. ALL SIGNAL HEADS SHALL BE EQUIPPED WITH TUNNEL VISORS.
4. ALL SIGNAL DISPLAYS SHALL BE EQUIPPED WITH L.E.D. MODULES.

SITE DRIVEWAY
PREFERENTIAL PHASE SEQUENCE



* NORMALLY DW, W/FDW UPON PEDESTRIAN PUSH BUTTON ACTUATION
PERM = PERMISSIVE
LPI = LEADING PEDESTRIAN INTERVAL

HIGHLAND AVENUE
PREFERENTIAL PHASE SEQUENCE



* NORMALLY DW, W/FDW UPON PEDESTRIAN PUSH BUTTON ACTUATION
OL = OVERLAP
LPI = LEADING PEDESTRIAN INTERVAL
B = HIGHLAND AVENUE SEPARATED BIKE LANE

0 40 100 160
SCALE: 1" = 40'

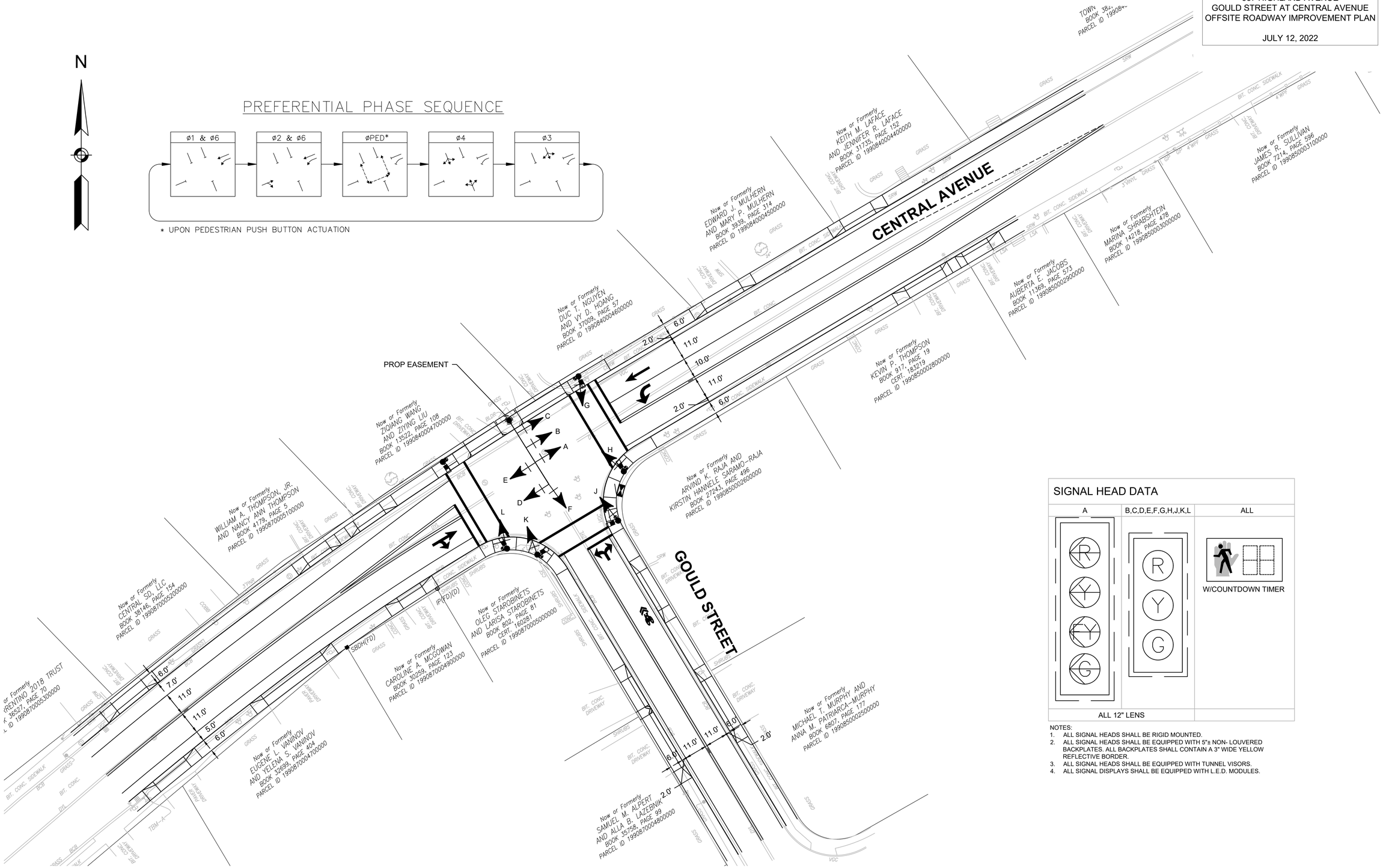
NEEDHAM, MA
557 HIGHLAND AVENUE
GOULD STREET AT CENTRAL AVENUE
OFFSITE ROADWAY IMPROVEMENT PLAN

JULY 12, 2022

N

PREFERENTIAL PHASE SEQUENCE

* UPON PEDESTRIAN PUSH BUTTON ACTUATION



SIGNAL HEAD DATA

A	B,C,D,E,F,G,H,J,K,L	ALL
		W/COUNTDOWN TIMER
ALL 12" LENS		

NOTES:
1. ALL SIGNAL HEADS SHALL BE RIGID MOUNTED.
2. ALL SIGNAL HEADS SHALL BE EQUIPPED WITH 5"± NON- LOUVERED BACKPLATES. ALL BACKPLATES SHALL CONTAIN A 3" WIDE YELLOW REFLECTIVE BORDER.
3. ALL SIGNAL HEADS SHALL BE EQUIPPED WITH TUNNEL VISORS.
4. ALL SIGNAL DISPLAYS SHALL BE EQUIPPED WITH L.E.D. MODULES.

0 20 50 100

SCALE: 1" = 20'

15006.00 - CONCEPT - GOULDCENTRAL-V1.DWG Plotted on 12-Jul-2022 8:50 PM

APPENDIX E: GHG Assessment

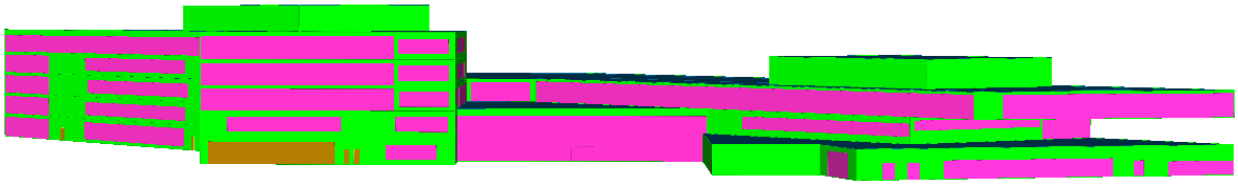
- Stationary Source Analysis
- Solar Photovoltaic (PV) Analysis
- Mobile Source Mesoscale Analysis

Stationary Source Analysis

ASHRAE 90.1-2013 with MA Amendments Energy Analysis

577 Highland Avenue

Needham, MA



Prepared by:

AHA

June 08, 2022

Table of Contents

- **Baseline and Proposed Models Summary Report**
- **Baseline Model & MA Amendments**
  - ECM#1, Reduced air-infiltration in accordance with Section C406.9.
  - ECM#2, Reduced lighting power density system in accordance with section C406.3.
  - ECM#3, More efficient HVAC performance in accordance with section C406.2.
  - Thermal Energy Demand Intensity Analysis (TEDI) – Baseline Model
- **Proposed Model**
  - Envelope
  - Lighting
  - Domestic Hot Water System
  - HVAC System
  - Thermal Energy Demand Intensity Analysis (TEDI) – Proposed Model
  - Annual Energy Savings, Energy Cost Savings & GHG Reduction
- **Benchmark to Existing Building Peer Group**
- **Hybrid Alternative Model**
  - Envelope, Lighting, Domestic Hot Water System
  - HVAC Hybrid System
  - Thermal Energy Demand Intensity Analysis (TEDI) – Hybrid Alternative Model
  - Annual Energy Savings, Energy Cost Savings & GHG Reduction
  - Air Source HP Chiller Payback Period
- **Appendix A**
  - Proposed Envelope Component Performance Alternative Calculation
  - Baseline Envelope Component Performance Alternative Calculation
  - Proposed Envelope Per Article 37 Component Performance Alternative Calculation
- **Appendix B**
  - Table 1: Energy Model Inputs
- **Appendix C**
  - Table 3: Proposed Energy Summery by End Use
  - Table 4: Performance Rating Energy Consumption and Cost by Fuel Type
- **Appendix D**
  - Table 5: Hybrid Alternative Energy Summery by End Use
  - Table 6: Performance Rating Energy Consumption and Cost by Fuel Type (Hybrid Alternative)

Baseline and Proposed Models Summary Report

Preliminary energy modeling analysis has been performed for the 557 Highland Ave project new laboratory (60%)/office (40%) using eQUEST 3.65 (DOE 2.3) based on the project's bases of design narratives provided by the architect and the engineering team. The gross area is approximately 520,000 SF per energy model output. The goal of this analysis is to evaluate the project's energy performance against the minimum code requirements and the Hybrid Alternative case with partially electric space heating option per DOER recommendation. Three models have been created for this analysis. The Baseline model which represents the code minimum requirement, the Proposed model per the bases of design and the Hybrid Alternative model with HP heating system.

Baseline Model & MA Amendments

The Baseline Model is based on ASHRAE 90-2013 appendix G and includes MA amendments with the three C406 additional efficiency measures. These three efficiency measures are as following:

- ECM#1: ECM#1, Reduced air-infiltration in accordance with Section C406.9.
- ECM#2: Reduced lighting power density system in accordance with section C406.3.
- ECM#3: More efficient HVAC performance in accordance with section C406.2.

ECM#1
The Baseline and Proposed models have been modeled per maximum leakage rate of 0.25 cfm/sf under a pressure differential 0f 0.3 inches water column, with the calculated surface area being the same of the above grade building envelope. The eQuest models' infiltration inputs are based on the Mass Save hourly simulation guidelines.

ECM#2
The interior lighting power density for the Baseline model has been reduced by 10% per C406.1-2, section C406.3. The lighting power density (LPD) for the office area has been modeled as 0.58 W/SF per table C405.3.2(1) and the Laboratory area and parking garage have been modeled as 1.2 W/SF and 0.162 per table C405.3.2(2). Please note that the Proposed case has been modeled with similar LPD. Please see Appendix B for Table 1: Energy Model Inputs.

ECM#3
The Baseline model HVAC equipment minimum efficiency have been increased by 10% according to C406.1-1, section C406.2. The minimum chiller efficiency per table C403.3.2(7) is 0.560 kw/ton (COP 6.28) for cooling range above 600 tons. The modeled chiller's efficiency with 10% increase is calculated as COP of 6.908.
The minimum boiler efficiency per table C403.3.2(5) is 82% Ec for heating range above 2,500 kBtu/h. The modeled boiler's efficiency with 10% increase calculated as 90.2% Ec.
Please see Appendix B for the Baseline model HVAC system efficiency inputs and its comparison to the Proposed model.
The modeled Baseline HVAC system per appendix G is system 7 with 100% outdoor air system for the laboratory area. One air handling unit is modeled per floor and the laboratory area has a separate AHU per floor. The water-side system includes two natural draft boilers per G3.1.3.2 and three water-cooled centrifugal chillers per table G3.1.3.7.

The average Baseline Model performance of the four building orientations has been calculated at 279 kBtu/sf/yr. Please see Appendix B for the Baseline model HVAC system selection inputs and its comparison to the Proposed model.

Table 2: Energy Model Outputs								Energy Use Intensity	Fossil Fuel Use Intensity
Category	Electricity (kWh)	Natural Gas (Therm)	**Total Site Energy** (MMBtu)	Cost	Electricity GHG (kg)	Natural Gas GHG (kg)	**Total GHG** (kg)	**EUI** (Kbtu/sf/yr)	**EUIff** (Kbtu/sf)
Baseline Model: ASHRAE 90.1-2013 + MA	19,977,361	773,507	145,513	$4,137,189	6,179,992	4,105,021	10,285,013	**279**	148.37

Thermal Energy Demand Intensity Analysis (TEDI) – Baseline Model

TEDI describes the annual heating required by the building for space conditioning and for conditioning of ventilation air, estimated by using an energy model, normalized per square feet of area of conditioned space and expressed in kBtu/sf/yr. TEDI considers thermal transmittance of the building envelope components (including assemblies, windows, doors and skylights), air leakage through the air barrier system, internal heat gains from occupants and equipment, and heat recovery from exhaust ventilation.

Project 81 DOE-2.3-50h 5/24/2022 16:30:00 BDL RUN 1

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- Boston MA TMY2

	COOLING					HEATING					ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	3.37393	12	1	57.F	55.F	503.935	-13258.718	31	8	12.F	8.F	-28932.291	1232874.	3150.607
FEB	2.41255	25	15	47.F	39.F	182.690	-11161.515	17	8	10.F	7.F	-28833.135	1138844.	3150.455
MAR	52.44351	27	18	64.F	46.F	5037.372	-9737.865	17	8	16.F	12.F	-27540.750	1314012.	3156.930
APR	357.04715	18	14	82.F	60.F	17523.787	-5709.025	1	8	27.F	22.F	-20927.492	1231674.	3166.594
MAY	2694.08423	29	16	85.F	71.F	19837.189	-1825.233	1	6	38.F	31.F	-12325.826	1256519.	3191.317
JUN	5694.22998	3	15	88.F	72.F	22890.902	-650.518	6	18	53.F	52.F	-5439.548	1269152.	3209.949
JUL	9122.52051	20	13	92.F	69.F	23268.982	-239.749	25	8	66.F	56.F	-3421.305	1235333.	3213.517
AUG	7981.73926	26	11	86.F	70.F	22033.996	-409.177	15	8	59.F	56.F	-4197.007	1320471.	3207.927
SEP	4721.94336	14	16	88.F	67.F	21271.680	-783.383	29	8	49.F	45.F	-7351.307	1237237.	3197.230
OCT	1165.62268	3	12	72.F	65.F	13148.229	-2782.522	27	8	39.F	37.F	-13555.971	1224856.	3174.897
NOV	205.38411	9	14	71.F	66.F	12452.195	-7145.041	14	8	22.F	17.F	-25852.578	1205441.	3158.265
DEC	72.44381	15	15	65.F	55.F	6453.524	-10925.526	20	8	10.F	6.F	-29107.244	1258716.	3154.312
TOTAL	32073.244						-64628.273						14925129.	
MAX						23268.982						-29107.244		3213.517

The estimated **Heating** TEDI for the Baseline case model per SS-D report

64,628,273 kBtu / 521,332 sf = **123.96 kBtu/sf-y**

Proposed Model

Envelope
The Proposed model vision glass WWR has been designed at 38% to maximize building energy performance while providing sufficient daylight and quality views for wellbeing of building occupants. The backstop calculator analysis indicates that the Proposed building envelope UA is performing 5.22% better that the code (IECC2018).

- **Roof:** R-40 c.i. vs code R-30 c.i.
- **Exterior Wall:** U-0.041 exterior wall (R-19 batt+R-15 c.i.) and U-0.125 spandrel insulated glass (R-8) vs code U-0.064
- **Floor:** U-0.033 vs code U-0.033
- **Vision Glazing System:** U-0.30 & SHGC: 0.40 vs code U-0.38 & SHGC: 0.40

To achieve higher level of thermal performance, the Proposed envelope exterior walls and window system have higher thermal performance compared to IECC 2018 (please note all U-value for various assemblies are conformed to Appendix A and the spandrel glass assembly with c.i. U-value is confirmed to NYC energy code table C402.1.4.2).
Please see Appendix A for the designed vertical surfaces UA and the whole building envelope UA.

Interior Lighting
No credit has been taken for interior lighting. The lighting power density (LPD) is the same as the Baseline case in the Proposed model. Please see Appendix B for Table 1: Energy Model Inputs.

DHW System
Our analysis indicates service water heating is approximately 0.1% of annual energy usage. An all-electric system will be designed. Heat pump service water heating using packaged air source heat pump equipment has been recommended.

HVAC System
The current design of the building systems is based on 40/60 office to laboratory ratio. The ACH rate has been estimated as 7 ACH for this project and has been modeled identically in all models. The Proposed mechanical system includes custom 100% outdoor air chilled water / hot water Laboratory air handling units conditioning the laboratory area and provide outdoor air to the office section. Future office cooling and heating will be provided by 4-pipe fan coil units with MERV 13 filters. The basis of design includes six water cooled chillers, water-side economizer, and ten condensing boilers. In climate zone 5A, the biggest energy consumption for laboratory projects is related to interior fans, process load and space heating. In this project, it is calculated that approximately 9% of annual energy consumption is space heating, over 45% is interior fan energy consumption and 30% is process load. A high-performance heat recovery system (Konvekta) with 79% effectiveness has been included in the proposed design to recover energy through the exhaust system. Critical operating parameters are monitored in both part- and full-load operation and all system malfunctions are detected and corrected. Energy analysis for this system indicates that the Konvekta heat recovery system reduces heating energy by 91%. The SmartStack active sensing laboratory exhaust technology indexes the exit velocity of the lab exhaust Fans based on the cleanliness of the lab exhaust air. The high-performance Konvekta heat recovery and the SmartStack active sensing laboratory exhaust technology are the main factors in reducing EUI and GHG of the Proposed model. Please see Appendix B for the Proposed model HVAC system selection inputs, efficiencies, and controls.

Thermal Energy Demand Intensity Analysis (TEDI) – Proposed Model

TEDI describes the annual heating required by the building for space conditioning and for conditioning of ventilation air, estimated by using an energy model, normalized per square feet of area of conditioned space and expressed in kBtu/sf/yr. TEDI considers thermal transmittance of the building envelope components (including assemblies, windows, doors and skylights), air leakage through the air barrier system, internal heat gains from occupants and equipment, and heat recovery from exhaust ventilation.

Project 81 DOE-2.3-50h 5/24/2022 17:09:19 BDL RUN 1

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- Boston MA TMY2

	- - - - - - - - C O O L I N G - - - - - - - -						- - - - - - - - H E A T I N G - - - - - - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	1.24398	11	14	54.F	47.F	176.944	-1846.887	31	8	12.F	8.F	-8061.891	1508794.	3939.766
FEB	0.88008	18	11	28.F	22.F	40.920	-1339.308	17	8	10.F	7.F	-6596.944	1393724.	3939.808
MAR	14.60516	27	18	64.F	46.F	2152.419	-854.354	21	8	22.F	17.F	-5143.876	1608434.	3943.654
APR	222.41942	18	15	80.F	60.F	14697.187	-215.571	4	8	33.F	28.F	-2737.897	1513992.	3948.420
MAY	1657.06580	20	17	78.F	67.F	15785.691	-60.909	2	8	43.F	35.F	-2107.954	1543026.	3957.503
JUN	4044.79150	3	14	86.F	72.F	26245.570	-24.444	27	8	59.F	58.F	-1385.366	1550595.	3964.018
JUL	7572.57373	7	17	78.F	73.F	29968.812	-14.014	5	8	70.F	63.F	-1078.391	1512096.	3966.727
AUG	6515.83447	3	12	80.F	71.F	25815.357	-21.803	1	8	64.F	62.F	-1347.111	1611763.	3963.644
SEP	3215.32617	15	14	79.F	68.F	19598.312	-26.598	26	8	56.F	53.F	-1322.498	1516428.	3962.588
OCT	550.42944	7	15	70.F	66.F	12939.507	-76.192	31	8	50.F	44.F	-2013.659	1509158.	3952.376
NOV	108.26227	9	13	71.F	66.F	12653.775	-631.526	20	7	19.F	17.F	-5704.833	1480781.	3948.055
DEC	28.19597	1	9	65.F	58.F	3944.516	-1349.351	25	6	6.F	4.F	-8624.011	1541809.	3943.644
TOTAL	23931.629						-6460.956						18290600.	
MAX						29968.812						-8624.011		3966.727

The energy analysis indicates that the proposed high-performance envelope with 38% WWR, thermally broken windows, low glazing system U-value, high performing opaque spandrels with insulation of R-8, and high-performance heat recovery system have resulted result in significant reduction in heating (and cooling) thermal energy demand intensity (TEDI, units of kBtu/sf-yr). As a result, occupant comfort has been increased, building resiliency has been improved and peak demands have been reduced significantly compared to the Baseline model.

The estimated **Heating** TEDI for the Proposed case model per SS-D report
6,460,956 kBtu / 521,332 sf = **12.39 kBtu/sf-yr**

The estimated **Heating** TEDI for the Baseline case model per SS-D report
64,628,273 kBtu / 521,332 sf = **123.96 kBtu/sf-y**

Results indicate that the Thermal Energy Demand Intensity (TEDI) has been reduced by **90%** in the Proposed case.

Annual Energy Savings, Energy Cost Savings & Greenhouse Gas Reduction

The Proposed model Energy Use Intensity (EUI) has been calculated as 147 kBtu/sf/yr. Modeling results indicates 47% saving annual energy savings and 91% reduction in natural gas usage.

The annual energy cost savings is estimated as $660,220 annually.

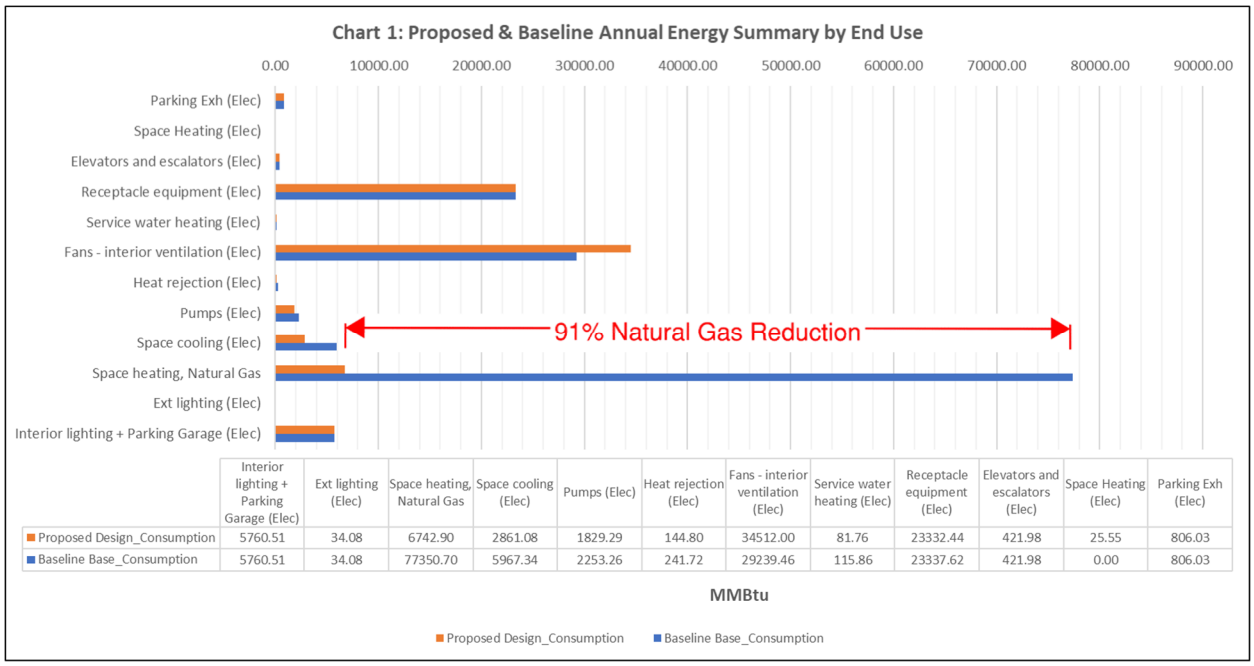
The Proposed building GHG has been calculated at 6,686,958 kg reduced by 34.98% from the Baseline model. The annual reduction of natural gas by 91% is the main factor in reducing GHG. The natural gas usage in the Proposed model is less than 9% of the building annual energy consumption. Please see Table 2 & Chart 1 below, Appendix C for Table 3: Proposed Energy Summery by End Use, and Table 4: Performance rating energy consumption and cost by fuel type.

Table 2: Energy Model Outputs								Energy Use Intensity	Fossil Fuel Use Intensity
Category	Electricity (kWh)	Natural Gas (Therm)	**Total Site Energy** (MMBtu)	Cost	Electricity GHG (kg)	Natural Gas GHG (kg)	**Total GHG** (kg)	**EUI** (Kbtu/sf/yr)	**EUIff** (Kbtu/sf)
Baseline Model: ASHRAE 90.1-2013 + MA	19,977,361	773,507	145,513	$4,137,189	6,179,992	4,105,021	10,285,013	**279**	148.37
Proposed Design	20,459,402	67,429	76,550	$3,475,312	6,329,111	357,847	6,686,958	**147**	12.93
% Improved beyond ASHRAE 2013	**-2.41%**	**91.28%**	**47.39%**	**$661,876**			**34.98%**		

GHG	LB/MWh		LB/MMBtu
Electricity	682	Natural Gas	117
Electricity projected ISO-NE emission factor	392		
CO_2 Emission Factors:			
Electricity [1]	*682*	*lb/MWh*	
Natural Gas [2]	*117*	*lb/MMBtu*	

[1] *2016 ISO New England Electric Generator Air Emissions Report*

[2] *EIA Fuel Emissions Factors, Weighted National Average (1029 Btu/scf)*



	Interior lighting + Parking Garage (Elec)	Ext lighting (Elec)	Space heating, Natural Gas	Space cooling (Elec)	Pumps (Elec)	Heat rejection (Elec)	Fans - interior ventilation (Elec)	Service water heating (Elec)	Receptacle equipment (Elec)	Elevators and escalators (Elec)	Space Heating (Elec)	Parking Exh (Elec)
Proposed Design_Consumption	5760.51	34.08	6742.90	2861.08	1829.29	144.80	34512.00	81.76	23332.44	421.98	25.55	806.03
Baseline Base_Consumption	5760.51	34.08	77350.70	5967.34	2253.26	241.72	29239.46	115.86	23337.62	421.98	0.00	806.03

Benchmark to Existing Building Peer Group

The proposed model EUI performance has been calculated at 147 kBtu/sf/yr. Based on the International Institute for Sustainable Laboratories the median EUI for new and existing laboratories in this climate zone (5A) has been estimated at 368 KBtu/sf/yr. This data indicates that the proposed project energy performance is approximately 60% below the average similar buildings in this climate zone.

Summary Statistics for Selected Peer Group Buildings

Site EUI: mean 370 kBtu/sf/yr | median 368 kBtu/sf/yr
Site EUI: mean 370 kBtu/sf/yr | median 368 kBtu/sf/yr
Number of Matching Buildings: 35/862

Hybrid Alternative Model

Envelope, Lighting, Domestic Hot Water System

The Hybrid system option has similar envelope, lighting design, and domestic hot water system as the Proposed model.

HVAC Hybrid System

To study GHG emissions reduction compared to the Proposed case, a cold climate air source heat pump chillers have been included in the design to reduce natural gas usage. A 180-ton Multistack ARA chiller can produce 120F water down to 0F ambient temperature. The heat pump is sized for 25% of the peak load and the boilers are sized for 100% of the peak load. The air source heat pumps are prioritized to operate first, and boilers are utilized when load exceed 25% or when ambient temperature is below 0F. All other systems are similar to the Proposed design. Please see Appendix B for the Hybrid Alternative model HVAC system selection inputs, efficiencies, and controls.

Thermal Energy Demand Intensity Analysis (TEDI) – Hybrid Alternative Model

The Hybrid Alternative case has a similar building envelope and heat recovery system. Therefore, it is expected that the thermal energy demand intensity analysis (TEDI) to be very similar to the Proposed case.

Project 81 DOE-2.3-50h 5/25/2022 17:00:57 BDL RUN 1

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- Boston MA TMY2

	COOLING						HEATING						ELEC-	MAXIMUM
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY- BULB TEMP	WET- BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY- BULB TEMP	WET- BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	TRICAL ENERGY (KWH)	ELEC LOAD (KW)
JAN	1.24331	11	14	54.F	47.F	176.944	-1846.877	31	8	12.F	8.F	-8077.028	1508793.	3939.766
FEB	0.87904	18	11	28.F	22.F	40.898	-1339.290	17	8	10.F	7.F	-6597.686	1393724.	3939.807
MAR	14.59910	27	18	64.F	46.F	2152.419	-854.170	21	8	22.F	17.F	-5144.995	1608434.	3943.654
APR	222.40198	18	15	80.F	60.F	14697.050	-214.924	4	8	33.F	28.F	-2738.102	1513992.	3948.420
MAY	1657.04590	20	17	78.F	67.F	15785.537	-60.263	2	8	43.F	35.F	-2107.960	1543027.	3957.504
JUN	4044.77271	3	14	86.F	72.F	26245.484	-23.894	27	8	59.F	58.F	-1325.034	1550595.	3964.018
JUL	7572.48145	7	17	78.F	73.F	29968.826	-13.568	5	8	70.F	63.F	-1029.745	1512096.	3966.725
AUG	6515.74219	3	12	80.F	71.F	25815.189	-21.146	1	8	64.F	62.F	-1288.280	1611763.	3963.640
SEP	3215.31470	15	14	79.F	68.F	19598.129	-25.883	26	8	56.F	53.F	-1264.693	1516428.	3962.592
OCT	550.41168	7	15	70.F	66.F	12939.378	-75.348	31	8	50.F	44.F	-1930.172	1509158.	3952.375
NOV	108.25346	9	13	71.F	66.F	12653.525	-630.880	20	7	19.F	17.F	-5704.875	1480781.	3948.052
DEC	28.19358	1	9	65.F	58.F	3944.516	-1349.142	25	6	6.F	4.F	-8623.994	1541809.	3943.644
TOTAL	23931.338						-6455.386						18290600.	
MAX						29968.826						-8623.994		3966.725

The estimated **Heating** TEDI for the Hybrid Alternative model per SS-D report
6,455,386 kBtu / 521,332 sf = **12.38 kBtu/sf-yr**

The estimated **Heating** TEDI for the Baseline case model per SS-D report
64,628,273 kBtu / 521,332 sf = **123.96 kBtu/sf-y**

Results indicate that the Thermal Energy Demand Intensity (TEDI) has been reduced by **90%** in the Hybrid case.

Annual Energy Savings, Energy Cost Savings & Greenhouse Gas Reduction

The Hybrid Alternative Case Energy Use Intensity (EUI) has been calculated as 144 kBtu/sf/yr. Modeling results indicate:

- 48.33% reduction of annual energy consumption vs the Baseline Case
- 93.67% reduction of natural gas usage vs the Baseline Case
- 27.36% reduction of natural gas usage vs the Proposed Case

The annual energy cost savings is estimated at $657,499 annually. There is a $4,376 annual energy cost increase for the hybrid system compared to the proposed case due to higher cost of electricity compared to natural gas.

The Hybrid Alternative case GHG has been calculated at 6,633,216 kg reduced by 35.51% from the Baseline model. The air source heat pump option decreases GHG with additional 0.53% compared to the Proposed Case. Please see Table 2, Chart 2, and Chart 3 below for details. Additionally, please see Appendix D for Table 5: Hybrid Alternative Energy Summery by End Use, and Table 6: Performance Rating Energy Consumption and Cost by Fuel Type.

Table 2: Energy Model Outputs								Energy Use Intensity	Fossil Fuel Use Intensity
Category	Electricity (kWh)	Natural Gas (Therm)	**Total Site Energy** (MMBtu)	Cost	Electricity GHG (kg)	Natural Gas GHG (kg)	**Total GHG** (kg)	**EUI** (Kbtu/sf/yr)	**EUIff** (Kbtu/sf)
Baseline Model: ASHRAE 90.1-2013 + MA	19,977,361	773,507	145,513	$4,137,189	6,179,992	4,105,021	10,285,013	**279**	148.37
Proposed Design	20,459,402	67,429	76,550	$3,475,312	6,329,111	357,847	6,686,958	**147**	12.93
% Improved beyond ASHRAE 2013	**-2.41%**	**91.28%**	**47.39%**	**$661,876**			**34.98%**		
Hybrid Alternative (HP with 25% of heating load)	20,602,262	48,975	75,192	$3,479,689	6,373,304	259,912	6,633,216	**144**	9.39
% Improved beyond ASHRAE 2013		**93.67%**	**48.33%**	**$657,499**			**35.51%**		

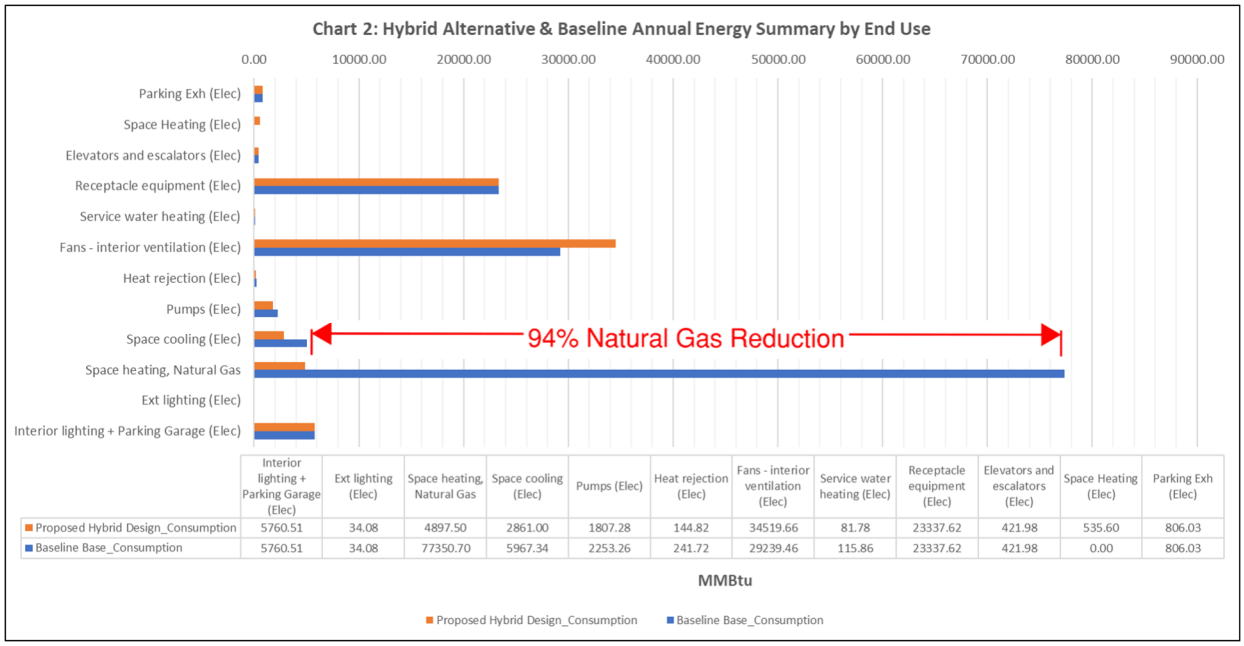
GHG	LB/MWh		LB/MMBtu
Electricity	682	Natural Gas	117
Electricity projected ISO-NE emission factor	392		
CO_2 Emission Factors:			
Electricity [1]	*682*	*lb/MWh*	
Natural Gas [2]	*117*	*lb/MMBtu*	

[1] *2016 ISO New England Electric Generator Air Emissions Report*

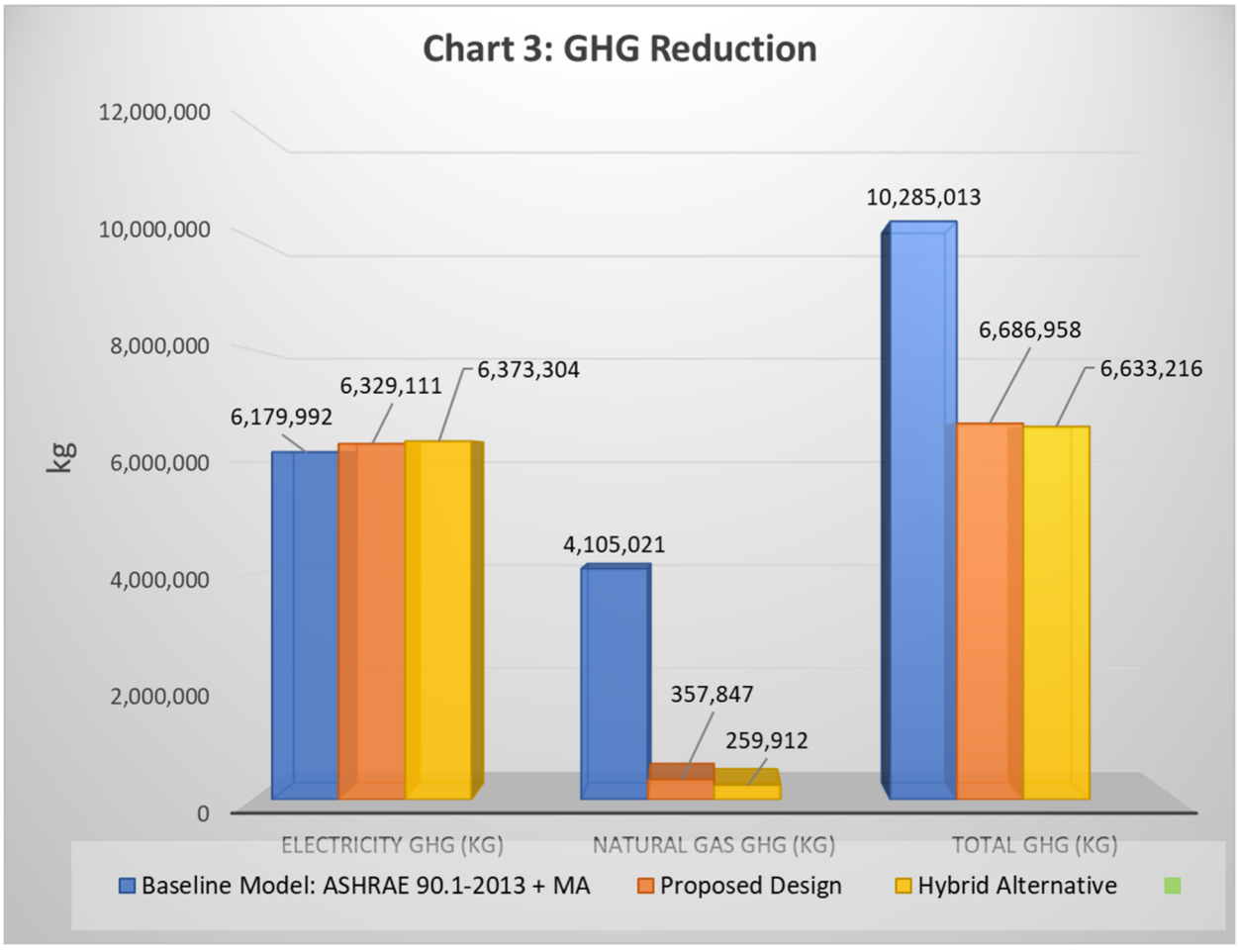
[2] *EIA Fuel Emissions Factors, Weighted National Average (1029 Btu/scf)*

Air Source HP Chiller Payback Period

Energy analysis results indicate that including HP chiller reduces natural gas usage by 27.36% compared to the Proposed model and reduces GHG by additional 53,742 kg. Due to the higher cost of electricity (State average: $0.1661/kWh) compared to natural gas ($1.051 therm), total annual energy cost for the Hybrid Alternative case is estimated $4,376 higher annually compared to the Proposed Case. Additionally, the initial cost of HP chillers is estimates to be approximately $2,000,000. **Even though, the Hybrid Alternative design will not pay back its initial investment during the lifetime of the system, the design team have decided to include air source HP chiller with 25% capacity of the heating peak load in the designed mechanical system.**



	Interior lighting + Parking Garage (Elec)	Ext lighting (Elec)	Space heating, Natural Gas	Space cooling (Elec)	Pumps (Elec)	Heat rejection (Elec)	Fans - interior ventilation (Elec)	Service water heating (Elec)	Receptacle equipment (Elec)	Elevators and escalators (Elec)	Space Heating (Elec)	Parking Exh (Elec)
Proposed Hybrid Design_Consumption	5760.51	34.08	4897.50	2861.00	1807.28	144.82	34519.66	81.78	23337.62	421.98	535.60	806.03
Baseline Base_Consumption	5760.51	34.08	77350.70	5967.34	2253.26	241.72	29239.46	115.86	23337.62	421.98	0.00	806.03



Appendix A

Proposed Envelope Component Performance Alternative Calculation

557 Highland
C402.1.5 Component Performance Alternative
May 16, 2022

AHA

Proposed Design			37.6% WWR	
	Area(SF)	R-Equivalent	U-Value	UxA
Window	47,477	3.33	0.300	14,243.10
Wall	54,036	24.39	0.041	2,215.48
Spandrel	24,858	8.00	0.125	3,107.25
Vertical Total	126,371	6.46	**0.155**	19,565.83
Roof	151,077	40.00	0.025	3,776.93
Exposed Floor	151,077	30.30	0.033	4,985.54
Slabs on grade	-	n/a	0.540	-
Below grade wall	-	n/a	0.119	-
Building Total	428,525	15.13	0.066	

IECC 2018			30.0% WWR	
	Area(SF)	R-Equivalent	U-Value	UxA
Window	37,911	2.63	0.38	14,406.29
Wall	88,460	15.63	0.064	5,661.42
Vertical Total	126,371	6.30	**0.159**	20,067.71
Roof	151,077	31.25	0.032	4,834.46
Exposed Floor	151,077	30.30	0.033	4,985.54
Slabs on grade	-	n/a	0.54	-
Below grade wall	-	n/a	0.119	-
Building Total	428,525	14.34	0.070	

A+B+C+D+E	-170.76
C402.1.5 Compliance	PASSED

Proposed UA Improvement	5.22%
C406.8 ECM Compliance	NOT ELIGIBLE

A- Calculation **THERMAL ENVELOPE**

A= Sum of the (UA Dif) values for ach distinct assembly type of the building thermal envelope, other than slabs on grade and below grade walls

	UA Proposed	UA Table
Window	14,243.10	14,406.29
Wall	5,322.73	5,661.42
Roof	3,776.93	4,834.46
Exposed Floor	4,985.54	4,985.54
UA Improvement	28,328.29	29,887.72
A	-1,559.43	

B- Calculation **SLAB ON GRADE**

B-= Sum of the (FL Dif) for each distinct slab-on grade perimeter condition of the building thermal envelope

B	0

C- Calculation **CONDITIONED BELOW GRADE WALLS**

C= Sum of the (CA Dif) values for each distinct below-grade wall assembly type of the building thermal envelope

C	0

D- Calculation **EXCESS VERTICAL GLAZING**

D= (DA*UV) -(DA*U Wall), but not less than zero

DA	9,566
UV	0.300
U Wall	0.155
D	1,388.7

E- Calculation **SKYLIGHTS**

E= (EA*US) - (EA*U Roof), but not less than zero

E	0.0

Appendix B
Table 1: Energy Model Inputs

Building Component	**Baseline Model:** ASHRAE 90.1-2013 + MA Amendments	Proposed Model	**Hybrid Alternative** Case assessment Model	**Notes & C406 (*three additional efficiency measures*).**
Total Area /# of Floors	520,000 SF / 5 Floors & 480,000 SF Parking Garage	520,000 SF / 5 Floors & 480,000 SF Parking Garage	520,000 SF / 5 Floors & 480,000 SF Parking Garage	
Wall Construction	Steel framed with R-11 cavity and R-14 c.i. with U-factor of **0.064**	Steel framed with R-19 cavity and R-15 c.i. (U-0.041)& insulated spandrel glass (U-0.125) with weighted average U-factor of **0.067**	Steel framed with R-19 cavity and R-15 c.i. (U-0.041)& insulated spandrel glass (U-0.125) with weighted average U-factor of **0.067**	
Roof Construction	R-30 Insulation entirely above deck with a U-factor of **0.032**	R-40 Insulation entirely above deck with a U-factor of **0.025**	R-40 Insulation entirely above deck with a U-factor of **0.025**	
Floor Construction	R-30 c.i. , U-factor of **0.033**	R-30 c.i. , U-factor of **0.033**	R-30 c.i. , U-factor of **0.033**	
Window Type	Metal Framing	Metal Framing	Metal Framing	
Window to Wall Ratio	38%	38%	38%	Building area type is not included in Table G3.1.1-1 therefore, the Baseline WWR is based on Table G3.1.5 and it is equal that in the Proposed design
Window U-Value / SHGC	**U-0.38 / 0.40**	**U-0.30 / SHGC: 0.40**	**U-0.30 / SHGC: 0.40**	
Infiltration Rate	0.25 CFM/SF	0.25 CFM/SF	0.25 CFM/SF	The Baseline and Proposed models infiltration rates are modeled per C406.1.8 as the **1st ECM**
Lighting Power Density (W/SF)	**0.58** Office / **1.2** Lab / **0.162** Garage per C406.1-2 as **ECM#1**	**0.58** Office / **1.2** Lab / **0.162** Garage	**0.58** Office / **1.2** Lab / **0.162** Garage	The Baseline lighting LPD reduced by 10% as the **2nd ECM** per C406.1-2 from Tables C405.3.2(1) & C405.3.2(2)
Lighting Controls	Daylighting per code	Daylighting per code	Daylighting per code	
Plug Load	Lab: 7 W/SF; Office: 0.75 W/SF	Lab: 7 W/SF; Office: 0.75 W/SF	Lab: 7 W/SF; Office: 0.75 W/SF	
DHW System	All Electric	Heat Pump, UEF: 3.45	Heat Pump, UEF: 3.45	
HVAC System (Air-Side)	System 7, VAV System with Reheat System 3, Retail Area	**Lab:** Chilled water/Hot water AHUs (100% OA system) **Office:** 4 Pipe Fan Coil System with a DOAS (from 100% OA units) **Retail:** All electric Heat Pump	**Lab:** Chilled water/Hot water AHUs (100% OA system) **Office:** 4 Pipe Fan Coil System with a DOAS (from 100% OA units) **Retail:** All electric Heat Pump	
HVAC System (Water-Side)	3 water-cooled centrifugal chillers & 2 natural draft boilers	Three, 900 tons Water cooled centrifugal chillers, Three, 750 tons centrifugal chillers & ten, 4000 MBH condensing boilers	Three, 900 tons Water cooled centrifugal chillers, Three, 750 tons centrifugal chillers & one HP Chiller (120F supply T) designed per 25% of the heating load & eight, 4000 MBH condensing boilers	One 2.15 Mbtu/h (approximately 25% of the peak heating load) Multistack HP chiller is added to hot water loop of the hybrid system. HP chiller supply 120F hot water.
Chiller & Rooftop DX Efficiency	6.9 COP per Table C403.3.2(7) & C406.1-1 as **ECM#3**	Chillers with COP of 6.9	Chiller with COP of 6.9, HP Chiller 2.45 COP @ 30F ambient T	The Baseline Chillers are > 600 tons with 10% improvement over 0.560 kw/ton FL efficiency (COP 6.908) as the **third ECM** per C406.1-1
Boiler Efficiency	**90.2%** per Table C403.3.2(5) & C406.1-1 as **ECM#3**	95%	95%	The Baseline boiler's capacity are greater than 2500 MBH with 10% improvement over 82% efficiency as the **third ECM** per C406.1-1
Water-side Economizer	Yes	Yes	Yes	
Pumps	Code Minimum Requirement	Variable Speed	Variable Speed	
Energy Recovery	Modeled per Section 6.5.7.2 (b)	**High efficiency Konvekta ERV with 79% Effectiveness**	**High efficiency Konvekta ERV with 79% Effectiveness**	

Appendix C

Table 3: Proposed Energy Summery by End Use

End Use	Unregulated?	Energy Type	Units of Annual Energy and Peak Demand	Baseline	Proposed	Energy / Demand Savings per End-Use	Percent of Total Proposed Site Energy Consumption
Interior lighting		Electricity	Consumption (kWh)	1,320,047	1,320,047	0.0%	5.9%
			Demand (kW)	432	432.2	0.0%	
Exterior lighting		Electricity	Consumption (kWh)	9,986	9,986	0.0%	0.0%
			Demand (kW)	2.7	2.7	0.0%	
Space heating		Natural Gas	Consumption (therm)	773,507	67,429	91.3%	8.8%
			Demand (Btuh x 10^6)	320.3	106.5	66.8%	
Space cooling		Electricity	Consumption (kWh)	1,748,540	838,348	52.1%	3.7%
			Demand (kW)	1,107.6	1,506.9	-36.1%	
Pumps		Electricity	Consumption (kWh)	660,247	536,133	18.8%	2.4%
			Demand (kW)	210.0	152.8	27.2%	
Heat rejection		Electricity	Consumption (kWh)	70,827	42,437	40.1%	0.2%
			Demand (kW)	65.3	115.2	-76.5%	
Fans - interior ventilation		Electricity	Consumption (kWh)	8,567,694	10,114,888	-18.1%	45.1%
			Demand (kW)	1,177.3	1,614.3	-37.1%	
Fans - parking garage	x	Electricity	Consumption (kWh)	236,180	236,180	0.0%	1.1%
			Demand (kW)	41.0	41.0	0.0%	
Service water heating		Electricity	Consumption (kWh)	33,957	23,962	29.4%	0.1%
			Demand (kW)	14.5	4.7	67.4%	
Receptacle equipment	x	Electricity	Consumption (kWh)	6,838,348.0	6,838,348.0	0.0%	30.5%
			Demand (kW)	1,893.3	1,893.3	0.0%	
Elevators and escalators	x	Electricity	Consumption (kWh)	123,648	123,648	0.0%	0.6%
			Demand (kW)	56.0	56.0	0.0%	
Heat Pump Supplementary		Electricity	Consumption (kWh)				0.0%
			Demand (kW)				
Space Heating (Electricity)		Electricity	Consumption (kWh)				0.0%
			Demand (kW)				
Parking Garage Lighting		Electricity	Consumption (kWh)	367,888	367,888	0.0%	1.6%
			Demand (kW)	78.3	78	0.0%	

Table 4: Performance Rating Energy Consumption and Cost by Fuel Type

Energy Type	Site Energy Units	Baseline			Proposed			Percent Savings	
		Site Energy Use (Units shown per energy type)	Source Energy Use (Btu x 10^6)	Cost	Site Energy Use (Units shown per energy type)	Source Energy Use (Btu x 10^6)	Cost	Site Energy Use	Cost
Electricity	kWh	19,977,361.3	214,031.5	$ 3,324,234	20,459,402.0	219,115.1	$ 3,404,444	-2.4%	-2.4%
Natural Gas	therm	773,506.8	81,218.2	$ 812,956	67,429.0	7,080.0	$ 70,868	91.3%	91.3%
District Cooling	MWh	0.0	0.0		0.0	0.0	0		
Energy model subtotal (Btu x 10^6)		145,513.4	295,249.7	$ 4,137,190	76,550.4	226,195.2	$ 3,475,312	47.4%	16.0%

Appendix D

Table 5: Hybrid Alternative Energy Summery by End Use

End Use	Unregulated?	Energy Type	Units of Annual Energy and Peak Demand	Baseline	Hybrid Alternative	Energy / Demand Savings per End-Use	Percent of Total Proposed Site Energy Consumption
Interior lighting		Electricity	Consumption (kWh)	1,320,047	1,320,047	0.0%	6.0%
			Demand (kW)	432	432.2	0.0%	
Exterior lighting		Electricity	Consumption (kWh)	9,986	9,986	0.0%	0.0%
			Demand (kW)	2.7	2.7	0.0%	
Space heating		Natural Gas	Consumption (therm)	773,507	48,975	93.7%	6.5%
			Demand (Btuh x 10^6)	320.3	87.8	72.6%	
Space cooling		Electricity	Consumption (kWh)	1,748,540	838,325	52.1%	3.8%
			Demand (kW)	1,107.6	1,506.9	-36.1%	
Pumps		Electricity	Consumption (kWh)	660,247	529,567	19.8%	2.4%
			Demand (kW)	210.0	152.8	27.2%	
Heat rejection		Electricity	Consumption (kWh)	70,827	42,436	40.1%	0.2%
			Demand (kW)	65.3	115.2	-76.5%	
Fans - interior ventilation		Electricity	Consumption (kWh)	8,567,694	10,114,888	-18.1%	45.9%
			Demand (kW)	1,177.3	1,614.3	-37.1%	
Fans - parking garage	x	Electricity	Consumption (kWh)	236,180	236,180	0.0%	1.1%
			Demand (kW)	41.0	41.0	0.0%	
Service water heating		Electricity	Consumption (kWh)	33,957	23,962	29.4%	0.1%
			Demand (kW)	14.5	4.7	67.4%	
Receptacle equipment	x	Electricity	Consumption (kWh)	6,838,348.0	6,838,348.0	0.0%	31.0%
			Demand (kW)	1,893.3	1,893.3	0.0%	
Elevators and escalators	x	Electricity	Consumption (kWh)	123,648	123,648	0.0%	0.6%
			Demand (kW)	56.0	56.0	0.0%	
Heat Pump Supplementary		Electricity	Consumption (kWh)				0.0%
			Demand (kW)				
Space Heating (Electricity)		Electricity	Consumption (kWh)		156,941		0.7%
			Demand (kW)		272.4		
Parking Garage Lighting		Electricity	Consumption (kWh)	367,888	367,888	0.0%	1.7%
			Demand (kW)	78.3	78	0.0%	

Table 6: Performance Rating Energy Consumption and Cost by Fuel Type (Hybrid Alternative)

Energy Type	Site Energy Units	Baseline			Proposed			Percent Savings	
		Site Energy Use (Units shown per energy type)	Source Energy Use (Btu x 10^6)	Cost	Site Energy Use (Units shown per energy type)	Source Energy Use (Btu x 10^6)	Cost	Site Energy Use	Cost
Electricity	kWh	19,977,361.3	214,031.5	$ 3,324,234	20,602,262.0	220,726.0	$ 3,428,216	-3.1%	-3.1%
Natural Gas	therm	773,506.8	81,218.2	$ 812,956	48,975.0	5,142.4	$ 51,473	93.7%	93.7%
District Cooling	MWh	0.0	0.0		0.0	0.0	0		
Energy model subtotal (Btu x 10^6)		145,513.4	295,249.7	$ 4,137,190	75,192.4	225,868.3	$ 3,479,689	48.3%	15.9%

Stationary Source Greenhouse Gas Emissions Estimate with MEPA Emission Factors

Job number: 15306.00
Project: 557 Highland Avenue
Design: Proposed Design

Lab/Office

ENERGY CONSUMPTION

Scenario	Interior Lights (kWh)	General Equipment (kWh)	Pumps and Aux (kWh)	Heat Rejection (kWh)	Escalators and Elevators (kWh)	Parking Garage Lighting (kWh)	Gas Heat (therm)	Electric Heat (kWh)	Cooling (kWh)	Fans (kWh)	Electric DHW (kWh)	Exterior Lights (kWh)	Total Electricity (MWh)	Total Gas (MMBtu)	Total Energy (MMBtu)
BASELINE (Nov 2020 Energy Code)	1,320,047	6,838,348	660,247	70,827	123,648	367,888	773,507	0	1,748,540	8,803,874	33,957	9,986	19,977	77,351	145,513
Proposed Design	1,320,047	6,838,348	529,567	42,436	123,648	367,888	48,975	156,941	838,325	10,351,068	23,962	9,986	20,602	4,898	75,192
END-USE SAVINGS	0	0	130,680	28,391	0	0	724,532	-156,941	910,215	-1,547,194	9,995	0	-625	72,453	70,321
PERCENT SAVINGS															48.3%

GREENHOUSE GAS EMISSIONS

Scenario	Interior Lights (tons/yr)	General Equipment (tons/yr)	Pumps and Aux (tons/yr)	Heat Rejection (tons/yr)	Escalators and Elevators (tons/yr)	Parking Garage Lighting (tons/yr)	Gas Heat (tons/yr)	Electric Heat (tons/yr)	Cooling (tons/yr)	Fans (tons/yr)	Electric DHW (tons/yr)	Exterior Lights (tons/yr)	Total Electricity (tons/yr)	Total Gas (tons/yr)	Total Energy (tons/yr)
BASELINE (Nov 2020 Energy Code)	432	2,236	216	23	40	120	4,525	0	572	2,879	11	3	6,533	4,525	11,058
Hybrid Alternative	432	2,236	173	14	40	120	287	51	274	3,385	8	3	6,737	287	7,023
END-USE SAVINGS	0	0	43	9	0	0	4,239	-51	298	-506	3	0	-204	4,239	4,034
PERCENT SAVINGS															36.5%

CONVERSION TABLE

CONVERT	MULTIPLY BY
KWH TO MWH	0.001
MWH TO LBS[2]	654
THERMS TO MMBTU	0.1
LBS TO SHORT TONS	0.0005
kBtu to KWH	0.2930711
MMBTU to LBS[3]	117

2 mwh to lbs of CO2 conversion factor from 2020 ISO New England Electric Generator Air Emissions Report
3 MMbtu to lbs of CO2 conversion factor from the EIA

MEMORANDUM

From: Adam Jennings – AHA

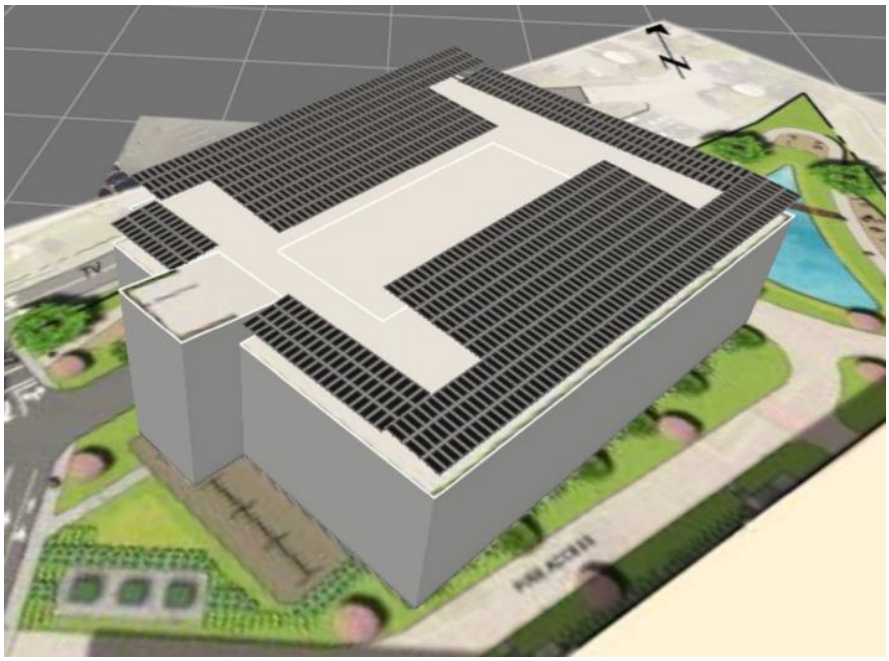
Date: June 13, 2022

Subject: 557 Highland Ave, Needham – Solar Photovoltaic (PV) Analysis

---

1- Preliminary garage canopy solar

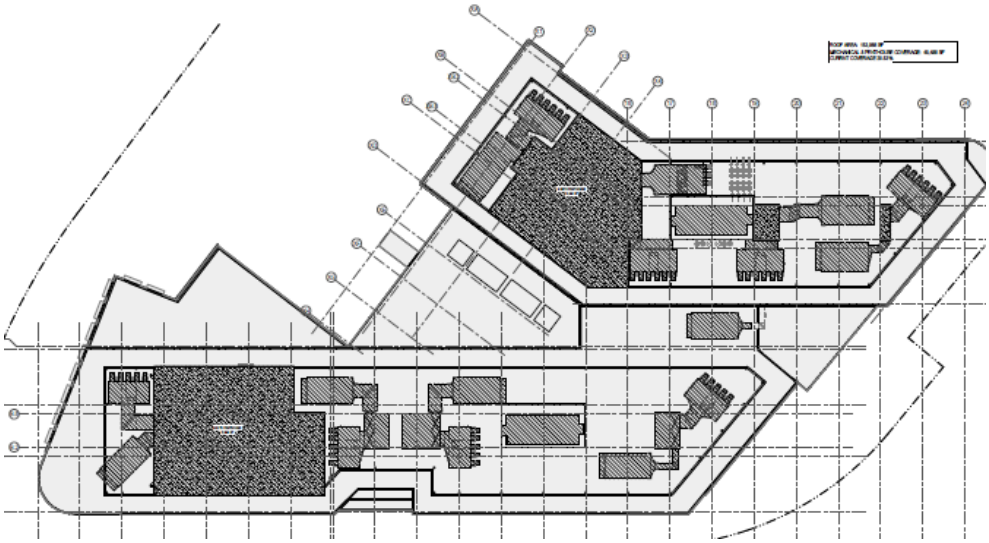
Solar PV is planned for the garage pending town approval of the total height of the garage with PV. An early concept design is shown below for a 507 kW system. This system would produce 600,000 kWh/year.



Estimated Installed Cost ($3/W)	$1,521,000
Estimated Year One FITC (26%)	-$395,366
Net Year One Cost	$1,125,274
Electricity Cost Savings Year One	$101,719
SMART Revenue Year One	$35,318
Total Annual Revenue	$137,037
Simple Payback	8.2 Years

Preliminary garage canopy solar

The roof of the North and South Buildings have height restrictions and limited space for rooftop equipment per town zoning. Flat Solar PV could potentially be put on top of the penthouses if allowed by the town of Needham. The penthouses provide approximately 22,000 square feet, which we'd estimate to fit a 200 kW system capable of producing 216,000 kW/year. Based on an estimated installed cost of $3/W, and accounting for 26% Federal Investment Tax Credit, and available SMART incentives, the project simple payback is less than 8 years.



Estimated Installed Cost ($3/W)	$600,000
Estimated Year One FITC (26%)	-$156,000
Net Year One Cost	$444,000
Electricity Cost Savings Year One	$36,720
SMART Revenue Year One	$12,707
Total Annual Revenue	$49,427
Simple Payback	8.2 Years

\\Aha-engineers.com\AHALexCam\Projects\2021-Lex-Bos-Rep\M0527-042.00\LEED\DEIR Energy Analysis\Report\557 Highland - DEIR PV analysis 2022-06-13.docx

Mobile Source Mesoscale Analysis

557 Highland

Mesoscale Analysis

	2022 Existing	2029 No-Build	2029 Build	2029 Mitigation- Roadway Improvements	2029 Mitigation- TDM Reduction	2029 Build Mitigation
OXIDES OF NITROGEN (NOx)						
Emissions (kg/d)	24.2	15.0	20.8	15.3		15.2
Project Contribution (kg/d)			5.8	-5.5	-0.1	0.2
VOLATILE ORGANIC COMPOUNDS (VOC)						
Emissions (kg/d)	45.3	34.9	41.0	36.9		36.8
Project Contribution (kg/d)			6.1	-4.1	-0.1	1.9
GREENHOUSE GAS (CO_2)						
Emissions (short tons per year)	16,656	18,658	25,352	19,073		18,939
Project Contribution/Mitigation Reduction (short tons per year)			6,694	-6,279	-134	281

557 Highland

Build With Mitigation

Link No.	Description	Roadway Link Length Speed	Roadway Link Length (miles)	Emission Factor (g/mi) NO_x	Emission Factor (g/mi) VOC	AADT (veh/day)	Seasonally Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Peak Period Factor	Peak Traffic Data Period Volume (vehicles)	Peak Traffic Data Average Delay (sec)	Peak Traffic Data Adjusted Delay (veh-sec)	Off-Peak Traffic Data Period Volume (vehicles)	Off-Peak Traffic Data Average Delay (sec)	Off-Peak Traffic Data Adjusted Delay (veh-sec)	Link Emissions NO_x (grams)	Link Emissions VOC (grams)
1	Central Ave (West of Cedar)	25	0.45	0.12	0.17	12,080	12,080	2,707	2,729	0.50	6,015	1	3,008	6,065	0	2,729	629	902
2	Cedar St	25	0.10	0.13	0.54	4,832	4,832	241	243	0.50	2,406	41	98,165	2,426	37	89,086	63	259
3	Central Ave (Cedar to Webster)	25	0.10	0.17	0.54	15,178	15,178	756	762	0.50	7,557	0	0	7,620	0	0	262	825
4	Central Ave (Webster to Gould)	25	0.26	0.13	0.24	17,036	17,036	2,206	2,224	0.50	8,483	2	19,086	8,554	2	17,321	566	1,085
5	Gould St (North of Central)	5	0.02	0.42	2.59	0	0	0	0	0.50	0	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.10	0.16	0.54	17,408	17,408	867	874	0.50	8,668	2	21,236	8,740	2	19,272	278	942
7	Hampton Ave	25	0.10	0.20	0.55	991	991	49	50	0.50	494	10	5,059	498	9	4,591	20	54
8	Central Ave (Hampton to River Park)	25	0.05	0.17	1.02	17,495	17,495	436	439	0.50	8,711	0	1,742	8,784	0	1,581	145	888
9	River Park St	25	0.06	0.18	0.86	74	74	2	2	0.50	37	6	233	37	6	212	1	4
10	Central Ave (East of River Park)	25	0.09	0.12	0.59	17,581	17,581	788	794	0.50	8,754	0	438	8,827	0	397	191	930
11	Highland Ave (South of West St)	25	0.10	0.12	0.54	14,744	14,744	734	740	0.50	7,341	13	96,173	7,403	12	87,278	182	789
12	West St (West of Highland)	25	0.08	0.22	0.67	9,231	9,231	368	371	0.50	4,596	14	63,196	4,634	12	57,351	162	497
13	West St (East of Highland)	25	0.10	0.17	0.54	7,496	7,496	373	376	0.50	3,732	21	79,127	3,764	19	71,809	125	407
14	Highland Ave (West to Hunnewell)	25	0.12	0.12	0.46	15,735	15,735	940	948	0.50	7,835	28	219,379	7,900	25	199,089	230	861
15	Hunnewell St (West of Highland)	25	0.13	0.12	0.43	4,275	4,275	277	279	0.50	2,128	246	523,905	2,146	222	475,450	66	236
16	Hunnewell St (East of Highland)	25	0.07	0.14	0.74	1,759	1,759	61	62	0.50	876	27	23,609	883	24	21,426	17	91
17	Highland Ave (Hunnewell to Webster)	35	0.28	0.10	0.22	14,868	14,868	2,073	2,090	0.50	7,403	24	177,305	7,465	22	160,906	434	906
18	Webster St (Highland to Central)	25	0.63	0.14	0.14	7,682	7,682	2,410	2,430	0.50	3,825	119	456,507	3,857	107	414,286	673	677
19	Webster St (South of Highland)	25	0.10	0.17	0.54	11,832	11,832	589	594	0.50	5,892	15	86,313	5,941	13	78,330	197	642
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	0.13	0.25	22,302	22,302	2,665	2,687	0.50	11,105	32	350,908	11,197	28	318,453	698	1,339
21	Hunting Rd (Highland to Kendrick)	25	0.64	0.12	0.14	5,761	5,761	1,836	1,851	0.50	2,869	36	103,274	2,893	32	93,722	437	499
22	Kendrick St (West of Hunting)	25	0.10	0.13	0.54	8,338	8,338	415	419	0.50	4,152	18	75,772	4,187	16	68,764	111	448
23	Kendrick St (East of Hunting)	25	0.10	0.29	0.58	17,098	17,098	851	858	0.50	8,514	4	36,608	8,585	4	33,223	503	990
24	Hunting Rd (South of Kendrick)	25	0.12	0.12	0.46	11,312	11,312	676	682	0.50	5,633	8	44,779	5,680	7	40,637	165	619
25	Gould St (Highland to Wingate)	25	0.09	0.13	0.59	18,089	18,089	811	817	0.50	9,007	36	320,203	9,082	32	290,588	209	959
26	Wingate Driveway	20	0.04	0.15	1.26	508	508	10	10	0.50	253	22	5,489	255	20	4,981	3	26
27	Site Driveway	20	0.04	0.25	1.28	6,145	6,145	122	123	0.50	3,060	21	65,636	3,085	19	59,565	60	314
28	Gould St (Wingate to TV Place)	25	0.06	0.13	0.85	12,948	12,948	387	390	0.50	6,447	6	36,425	6,501	5	33,056	101	662
29	TV Place	20	0.05	0.13	1.02	2,602	2,602	65	65	0.50	1,296	36	47,093	1,306	33	42,738	17	132
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	0.17	0.46	12,452	12,452	744	750	0.50	6,200	1	6,510	6,252	1	5,908	252	693
31	Noanett St	25	0.06	0.19	0.86	1,189	1,189	36	36	0.50	592	8	4,916	597	7	4,461	14	62
32	Business Park	15	0.04	0.17	1.27	1,499	1,499	30	30	0.50	746	17	12,653	753	15	11,483	10	76
33	Gould St (Noanett to Station Rd)	25	0.06	0.17	0.86	11,399	11,399	341	343	0.50	5,676	0	284	5,723	0	258	115	587
34	Station Rd	20	0.07	0.16	0.75	1,016	1,016	35	36	0.50	506	10	4,806	510	9	4,361	11	53
35	Gould St (Station Rd to Kearney Rd)	25	0.05	0.13	1.01	10,804	10,804	269	271	0.50	5,380	0	0	5,424	0	0	68	545
36	Kearney Rd	25	0.10	0.14	0.54	2,106	2,106	105	106	0.50	1,049	15	15,732	1,058	14	14,277	30	113
37	Gould St (Kearney to Ellis)	25	0.06	0.13	0.85	9,416	9,416	281	284	0.50	4,689	0	703	4,728	0	638	73	481
38	Ellis St (West of Gould)	25	0.02	0.38	2.51	12	12	0	0	0.50	6	10	63	6	9	57	0	1
39	Ellis St (East of Gould)	25	0.09	0.14	0.59	966	966	43	44	0.50	481	13	6,280	485	12	5,699	12	51
40	Gould St (Ellis to Central)	25	0.23	0.12	0.27	8,376	8,376	959	967	0.50	4,170	443	1,846,873	4,205	399	1,676,058	230	515
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	0.11	0.44	37,170	37,170	2,221	2,239	0.50	18,508	0	0	18,662	0	0	507	1,952
42	I95 SB Ramp to Highland WB	25	0.24	0.16	0.27	6,629	6,629	792	799	0.50	3,301	97	319,824	3,328	87	290,244	259	423
43	Highland St WB to I95 SB Ramp	25	0.20	0.08	0.29	7,186	7,186	716	722	0.50	3,578	0	0	3,608	0	0	119	420
44	Highland EB to I95 SB	25	0.23	0.09	0.26	5,266	5,266	603	608	0.50	2,622	0	0	2,644	0	0	109	318
45	I95 SB Ramp to Highland EB	25	0.17	0.15	0.34	4,522	4,522	383	386	0.50	2,252	27	61,474	2,271	25	55,788	116	265
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.20	0.10	0.28	36,984	36,984	3,683	3,714	0.50	18,415	3	61,691	18,569	3	55,985	761	2,057
47	I95 NB Ramp to Highland WB	25	0.20	0.14	0.30	1,920	1,920	191	193	0.50	956	138	131,483	964	124	119,322	54	116
48	Highland St WB to I95 NB Ramp	25	0.21	0.10	0.28	12,452	12,452	1,302	1,313	0.50	6,200	0	0	6,252	0	0	263	742
49	Highland EB to I95 NB	25	0.24	0.10	0.26	6,815	6,815	814	821	0.50	3,393	0	0	3,421	0	0	159	417
50	I95 NB Ramp to Highland EB	25	0.26	0.11	0.24	2,850	2,850	369	372	0.50	1,419	17	23,554	1,431	15	21,376	82	179
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	0.11	0.72	43,551	43,551	1,518	1,531	0.50	21,685	9	188,659	21,866	8	171,210	340	2,192
52	1st Ave (North of Highland)	25	0.03	0.12	1.64	211	211	3	3	0.50	105	26	2,732	106	23	2,479	1	10
53	1st Ave (South of Highland)	25	0.09	0.11	0.59	12,712	12,712	570	574	0.50	6,330	21	133,240	6,382	19	120,916	131	671
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	0.10	0.39	31,099	31,099	2,168	2,186	0.50	15,485	48	746,370	15,614	43	677,339	449	1,682
55	2nd Ave (North of Highland)	25	0.06	0.13	0.85	1,735	1,735	52	52	0.50	864	21	18,051	871	19	16,382	14	89
56	2nd Ave (South of Highland)	25	0.10	0.12	0.53	12,018	12,018	598	603	0.50	5,984	19	113,700	6,034	17	103,184	145	643
57	Highland Ave (East of 2nd Ave)	25	0.10	0.12	0.53	25,833	25,833	1,286	1,297	0.50	12,863	15	188,442	12,970	13	171,013	311	1,382
58	Site Driveway off TV Place	25	0.03	0.11	1.64	1,982	1,982	30	30	0.50	987	0	0	995	0	0	7	97
							VMT (per day)	43,856	44,222								11.2	33.8
							VMT (per year)	16,007,381	16,140,977.5			Arterial	6,848,707			6,215,279	Daily Total (kg) NO_X	Daily Total (kg) VOC

VMT Total (per year)	32,148,358.84

	EF (g/s)	NOx Idle (g/day)	Idle (kg/day)	EF (g/s)	VOC Idle (g/day)	Idle (kg/day)
Peak Period	0.0003	2,158	**2.16**	0.0002	1,617	**1.62**
Off-Peak Period	0.0003	1,959	**1.96**	0.0002	1,467	**1.47**
Total (Including Link)			**15.30**			**36.90**

557 Highland
Build

Link No.	Description	Roadway Link Length Speed	(miles)	Emission Factor (g/mi) NO_x	VOC	AADT (veh/day)	Seasonally Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Peak Period Factor	Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Off-Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Link Emissions NO_x (grams)	VOC (grams)
1	Central Ave (West of Cedar)	25	0.45	0.12	0.17	12,080	12,080	2,707	2,729	0.50	6,015	1	3,008	6,065	0	2,729	629	902
2	Cedar St	25	0.10	0.13	0.54	4,832	4,832	241	243	0.50	2,406	41	98,165	2,426	37	89,086	63	259
3	Central Ave (Cedar to Webster)	25	0.10	0.17	0.54	15,178	15,178	756	762	0.50	7,557	0	0	7,620	0	0	262	825
4	Central Ave (Webster to Gould)	25	0.26	0.13	0.24	17,036	17,036	2,206	2,224	0.50	8,483	2	19,086	8,554	2	17,321	566	1,085
5	Gould St (North of Central)	5	0.02	0.42	2.59	0	0	0	0	0.50	0	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.10	0.16	0.54	17,408	17,408	867	874	0.50	8,668	2	21,236	8,740	2	19,272	278	942
7	Hampton Ave	25	0.10	0.20	0.55	991	991	49	50	0.50	494	10	5,059	498	9	4,591	20	54
8	Central Ave (Hampton to River Park)	25	0.05	0.17	1.02	17,495	17,495	436	439	0.50	8,711	0	1,742	8,784	0	1,581	145	888
9	River Park St	25	0.06	0.18	0.86	74	74	2	2	0.50	37	6	233	37	6	212	1	4
10	Central Ave (East of River Park)	25	0.09	0.12	0.59	17,581	17,581	788	794	0.50	8,754	0	438	8,827	0	397	191	930
11	Highland Ave (South of West St)	25	0.10	0.12	0.54	14,744	14,744	734	740	0.50	7,341	15	106,451	7,403	13	96,605	182	789
12	West St (West of Highland)	25	0.08	0.22	0.67	9,231	9,231	368	371	0.50	4,596	12	53,315	4,634	10	48,384	162	497
13	West St (East of Highland)	25	0.10	0.17	0.54	7,496	7,496	373	376	0.50	3,732	17	65,130	3,764	16	59,107	125	407
14	Highland Ave (West to Hunnewell)	25	0.12	0.12	0.46	15,735	15,735	940	948	0.50	7,835	37	292,244	7,900	34	265,215	230	861
15	Hunnewell St (West of Highland)	25	0.13	0.12	0.43	4,275	4,275	277	279	0.50	2,128	246	523,905	2,146	222	475,450	66	236
16	Hunnewell St (East of Highland)	25	0.07	0.14	0.74	1,759	1,759	61	62	0.50	876	27	23,609	883	24	21,426	17	91
17	Highland Ave (Hunnewell to Webster)	35	0.28	0.10	0.22	14,868	14,868	2,073	2,090	0.50	7,403	24	177,305	7,465	22	160,906	434	906
18	Webster St (Highland to Central)	25	0.63	0.14	0.14	7,682	7,682	2,410	2,430	0.50	3,825	119	456,507	3,857	107	414,286	673	677
19	Webster St (South of Highland)	25	0.10	0.17	0.54	11,832	11,832	589	594	0.50	5,892	15	86,313	5,941	13	78,330	197	642
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	0.13	0.25	22,302	22,302	2,665	2,687	0.50	11,105	44	491,937	11,197	40	446,439	698	1,339
21	Hunting Rd (Highland to Kendrick)	25	0.64	0.12	0.14	5,761	5,761	1,836	1,851	0.50	2,869	34	98,253	2,893	31	89,166	437	499
22	Kendrick St (West of Hunting)	25	0.10	0.13	0.54	8,338	8,338	415	419	0.50	4,152	18	75,772	4,187	16	68,764	111	448
23	Kendrick St (East of Hunting)	25	0.10	0.29	0.58	17,098	17,098	851	858	0.50	8,514	4	36,608	8,585	4	33,223	503	990
24	Hunting Rd (South of Kendrick)	25	0.12	0.12	0.46	11,312	11,312	676	682	0.50	5,633	8	44,779	5,680	7	40,637	165	619
25	Gould St (Highland to Wingate)	25	0.09	0.13	0.59	18,089	18,089	811	817	0.50	9,007	127	1,146,608	9,082	115	1,040,559	209	959
26	Wingate Driveway	20	0.04	0.15	1.26	508	508	10	10	0.50	253	7	1,884	255	7	1,710	3	26
27	Site Driveway	20	0.04	0.25	1.28	6,145	6,145	122	123	0.50	3,060	2,500	7,649,891	3,085	2,250	6,942,363	60	314
28	Gould St (Wingate to TV Place)	25	0.06	0.13	0.85	12,948	12,948	387	390	0.50	6,447	0	1,289	6,501	0	1,170	101	662
29	TV Place	20	0.05	0.13	1.02	2,602	2,602	65	65	0.50	1,296	36	47,093	1,306	33	42,738	17	132
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	0.17	0.46	12,452	12,452	744	750	0.50	6,200	1	6,510	6,252	1	5,908	252	693
31	Noanett St	25	0.06	0.19	0.86	1,189	1,189	36	36	0.50	592	8	4,916	597	7	4,461	14	62
32	Business Park	15	0.04	0.17	1.27	1,499	1,499	30	30	0.50	746	17	12,653	753	15	11,483	10	76
33	Gould St (Noanett to Station Rd)	25	0.06	0.17	0.86	11,399	11,399	341	343	0.50	5,676	0	284	5,723	0	258	115	587
34	Station Rd	20	0.07	0.16	0.75	1,016	1,016	35	36	0.50	506	10	4,806	510	9	4,361	11	53
35	Gould St (Station Rd to Kearney Rd)	25	0.05	0.13	1.01	10,804	10,804	269	271	0.50	5,380	0	0	5,424	0	0	68	545
36	Kearney Rd	25	0.10	0.14	0.54	2,106	2,106	105	106	0.50	1,049	15	15,732	1,058	14	14,277	30	113
37	Gould St (Kearney to Ellis)	25	0.06	0.13	0.85	9,416	9,416	281	284	0.50	4,689	0	703	4,728	0	638	73	481
38	Ellis St (West of Gould)	25	0.02	0.38	2.51	12	12	0	0	0.50	6	10	63	6	9	57	0	1
39	Ellis St (East of Gould)	25	0.09	0.14	0.59	966	966	43	44	0.50	481	13	6,280	485	12	5,699	12	51
40	Gould St (Ellis to Central)	25	0.23	0.12	0.27	8,376	8,376	959	967	0.50	4,170	443	1,846,873	4,205	399	1,676,058	230	515
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	0.11	0.44	37,170	37,170	2,221	2,239	0.50	18,508	0	0	18,662	0	0	507	1,952
42	I95 SB Ramp to Highland WB	25	0.24	0.16	0.27	6,629	6,629	792	799	0.50	3,301	97	319,824	3,328	87	290,244	259	423
43	Highland St WB to I95 SB Ramp	25	0.20	0.08	0.29	7,186	7,186	716	722	0.50	3,578	0	0	3,608	0	0	119	420
44	Highland EB to I95 SB	25	0.23	0.09	0.26	5,266	5,266	603	608	0.50	2,622	0	0	2,644	0	0	109	318
45	I95 SB Ramp to Highland EB	25	0.17	0.15	0.34	4,522	4,522	383	386	0.50	2,252	27	61,474	2,271	25	55,788	116	265
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.20	0.10	0.28	36,984	36,984	3,683	3,714	0.50	18,415	3	61,691	18,569	3	55,985	761	2,057
47	I95 NB Ramp to Highland WB	25	0.20	0.14	0.30	1,920	1,920	191	193	0.50	956	138	131,483	964	124	119,322	54	116
48	Highland St WB to I95 NB Ramp	25	0.21	0.10	0.28	12,452	12,452	1,302	1,313	0.50	6,200	0	0	6,252	0	0	263	742
49	Highland EB to I95 NB	25	0.24	0.10	0.26	6,815	6,815	814	821	0.50	3,393	0	0	3,421	0	0	159	417
50	I95 NB Ramp to Highland EB	25	0.26	0.11	0.24	2,850	2,850	369	372	0.50	1,419	17	23,554	1,431	15	21,376	82	179
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	0.11	0.72	43,551	43,551	1,518	1,531	0.50	21,685	10	206,007	21,866	9	186,954	340	2,192
52	1st Ave (North of Highland)	25	0.03	0.12	1.64	211	211	3	3	0.50	105	22	2,334	106	20	2,118	1	10
53	1st Ave (South of Highland)	25	0.09	0.11	0.59	12,712	12,712	570	574	0.50	6,330	13	81,336	6,382	12	73,814	131	671
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	0.10	0.39	31,099	31,099	2,168	2,186	0.50	15,485	86	1,330,150	15,614	77	1,207,126	449	1,682
55	2nd Ave (North of Highland)	25	0.06	0.13	0.85	1,735	1,735	52	52	0.50	864	21	18,051	871	19	16,382	14	89
56	2nd Ave (South of Highland)	25	0.10	0.12	0.53	12,018	12,018	598	603	0.50	5,984	19	113,700	6,034	17	103,184	145	643
57	Highland Ave (East of 2nd Ave)	25	0.10	0.12	0.53	25,833	25,833	1,286	1,297	0.50	12,863	15	188,442	12,970	13	171,013	311	1,382
58	Site Driveway off TV Place	25	0.03	0.11	1.64	1,982	1,982	30	30	0.50	987	0	0	995	0	0	7	97
							VMT (per day)	43,856	44,222								11.2	33.8
							VMT (per year)	16,007,381	16,140,977.5			Arterial	15,964,726			14,488,169	Daily Total (kg)	
																	NO_X	VOC

VMT Total (per year)	**32,148,358.84**

	NOx EF (g/s)	NOx Idle (g/day)	NOx Idle (kg/day)	VOC EF (g/s)	VOC Idle (g/day)	VOC Idle (kg/day)
Peak Period	0.0003	5,031	**5.03**	0.0002	3,769	**3.77**
Off-Peak Period	0.0003	4,566	**4.57**	0.0002	3,421	**3.42**
Total (Including Link)			**20.78**			**41.01**

557 Highland

No Build

Link No.	Description	Roadway Link Length Speed	(miles)	Emission Factor (g/mi) NO_x	VOC	AADT (veh/day)	Seasonally Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Peak Period Factor	Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Off-Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Link Emissions NO_x (grams)	VOC (grams)
1	Central Ave (West of Cedar)	25	0.45	0.12	0.17	11,709	11,709	2,623	2,645	0.50	5,830	0	2,623	5,879	0	2,381	610	874
2	Cedar St	25	0.10	0.13	0.54	4,584	4,584	228	230	0.50	2,283	32	73,843	2,302	29	67,013	60	246
3	Central Ave (Cedar to Webster)	25	0.10	0.17	0.54	14,558	14,558	725	731	0.50	7,249	0	0	7,309	0	0	251	792
4	Central Ave (Webster to Gould)	25	0.26	0.13	0.24	16,417	16,417	2,125	2,143	0.50	8,174	2	17,575	8,243	2	15,949	545	1,045
5	Gould St (North of Central)	5	0.02	0.42	2.59	0	0	0	0	0.50	0	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.10	0.16	0.54	16,912	16,912	842	849	0.50	8,421	2	19,789	8,491	2	17,959	270	915
7	Hampton Ave	25	0.10	0.20	0.55	991	991	49	50	0.50	494	10	4,812	498	9	4,367	20	54
8	Central Ave (Hampton to River Park)	25	0.05	0.17	1.02	16,999	16,999	423	427	0.50	8,464	0	1,693	8,535	0	1,536	141	863
9	River Park St	25	0.06	0.18	0.86	74	74	2	2	0.50	37	6	226	37	5	205	1	4
10	Central Ave (East of River Park)	25	0.09	0.12	0.59	17,086	17,086	766	772	0.50	8,507	0	425	8,578	0	386	186	903
11	Highland Ave (South of West St)	25	0.10	0.12	0.54	14,249	14,249	709	715	0.50	7,095	14	99,680	7,154	13	90,461	176	763
12	West St (West of Highland)	25	0.08	0.22	0.67	8,983	8,983	358	361	0.50	4,473	11	51,213	4,510	10	46,476	158	484
13	West St (East of Highland)	25	0.10	0.17	0.54	7,496	7,496	373	376	0.50	3,732	17	65,130	3,764	16	59,107	125	407
14	Highland Ave (West to Hunnewell)	25	0.12	0.12	0.46	14,992	14,992	896	903	0.50	7,465	27	198,564	7,527	24	180,199	219	821
15	Hunnewell St (West of Highland)	25	0.13	0.12	0.43	4,275	4,275	277	279	0.50	2,128	178	379,174	2,146	160	344,105	66	236
16	Hunnewell St (East of Highland)	25	0.07	0.14	0.74	1,759	1,759	61	62	0.50	876	21	18,791	883	19	17,053	17	91
17	Highland Ave (Hunnewell to Webster)	35	0.28	0.10	0.22	14,187	14,187	1,978	1,994	0.50	7,064	23	161,408	7,123	21	146,480	414	864
18	Webster St (Highland to Central)	25	0.63	0.14	0.14	7,682	7,682	2,410	2,430	0.50	3,825	100	381,921	3,857	90	346,597	673	677
19	Webster St (South of Highland)	25	0.10	0.17	0.54	11,832	11,832	589	594	0.50	5,892	15	86,313	5,941	13	78,330	197	642
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	0.13	0.25	21,621	21,621	2,584	2,605	0.50	10,765	42	451,607	10,855	38	409,839	677	1,298
21	Hunting Rd (Highland to Kendrick)	25	0.64	0.12	0.14	5,452	5,452	1,737	1,752	0.50	2,714	34	92,292	2,737	31	83,756	414	472
22	Kendrick St (West of Hunting)	25	0.10	0.13	0.54	8,338	8,338	415	419	0.50	4,152	18	75,357	4,187	16	68,388	111	448
23	Kendrick St (East of Hunting)	25	0.10	0.29	0.58	16,788	16,788	836	843	0.50	8,359	4	35,527	8,429	4	32,241	494	972
24	Hunting Rd (South of Kendrick)	25	0.12	0.12	0.46	11,312	11,312	676	682	0.50	5,633	8	44,779	5,680	7	40,637	165	619
25	Gould St (Highland to Wingate)	25	0.09	0.13	0.59	12,080	12,080	541	546	0.50	6,015	30	178,045	6,065	27	161,578	139	640
26	Wingate Driveway	20	0.04	0.15	1.26	508	508	10	10	0.50	253	7	1,745	255	6	1,584	3	26
27	Site Driveway	20	0.04	0.25	1.28	818	818	16	16	0.50	407	11	4,642	411	10	4,212	8	42
28	Gould St (Wingate to TV Place)	25	0.06	0.13	0.85	11,523	11,523	344	347	0.50	5,737	0	287	5,785	0	260	90	589
29	TV Place	20	0.05	0.13	1.02	620	620	15	16	0.50	308	11	3,347	311	10	3,037	4	32
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	0.17	0.46	11,399	11,399	681	687	0.50	5,676	1	5,676	5,723	1	5,151	230	635
31	Noanett St	25	0.06	0.19	0.86	1,189	1,189	36	36	0.50	592	8	4,620	597	7	4,192	14	62
32	Business Park	15	0.04	0.17	1.27	1,499	1,499	30	30	0.50	746	14	10,376	753	13	9,416	10	76
33	Gould St (Noanett to Station Rd)	25	0.06	0.17	0.86	10,346	10,346	309	312	0.50	5,151	0	258	5,194	0	234	105	533
34	Station Rd	20	0.07	0.16	0.75	1,016	1,016	35	36	0.50	506	9	4,300	510	8	3,902	11	53
35	Gould St (Station Rd to Kearney Rd)	25	0.05	0.13	1.01	9,751	9,751	243	245	0.50	4,855	0	0	4,896	0	0	62	492
36	Kearney Rd	25	0.10	0.14	0.54	2,106	2,106	105	106	0.50	1,049	12	12,900	1,058	11	11,707	30	113
37	Gould St (Kearney to Ellis)	25	0.06	0.13	0.85	8,363	8,363	250	252	0.50	4,164	0	625	4,199	0	567	65	428
38	Ellis St (West of Gould)	25	0.02	0.38	2.51	12	12	0	0	0.50	6	9	56	6	8	51	0	1
39	Ellis St (East of Gould)	25	0.09	0.14	0.59	966	966	43	44	0.50	481	11	5,269	485	10	4,782	12	51
40	Gould St (Ellis to Central)	25	0.23	0.12	0.27	7,323	7,323	839	846	0.50	3,646	443	1,614,647	3,676	399	1,465,311	201	450
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	0.11	0.44	32,214	32,214	1,925	1,941	0.50	16,040	0	0	16,174	0	0	439	1,692
42	I95 SB Ramp to Highland WB	25	0.24	0.16	0.27	6,257	6,257	748	754	0.50	3,115	69	213,722	3,141	62	193,955	245	399
43	Highland St WB to I95 SB Ramp	25	0.20	0.08	0.29	7,186	7,186	716	722	0.50	3,578	0	0	3,608	0	0	119	420
44	Highland EB to I95 SB	25	0.23	0.09	0.26	3,407	3,407	390	393	0.50	1,697	0	0	1,711	0	0	71	206
45	I95 SB Ramp to Highland EB	25	0.17	0.15	0.34	4,522	4,522	383	386	0.50	2,252	15	32,651	2,271	13	29,631	116	265
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.20	0.10	0.28	34,258	34,258	3,412	3,440	0.50	17,058	3	58,850	17,200	3	53,407	705	1,906
47	I95 NB Ramp to Highland WB	25	0.20	0.14	0.30	1,549	1,549	154	156	0.50	771	88	68,170	778	80	61,865	43	93
48	Highland St WB to I95 NB Ramp	25	0.21	0.10	0.28	12,452	12,452	1,302	1,313	0.50	6,200	0	0	6,252	0	0	263	742
49	Highland EB to I95 NB	25	0.24	0.10	0.26	4,956	4,956	592	597	0.50	2,468	0	0	2,488	0	0	115	303
50	I95 NB Ramp to Highland EB	25	0.26	0.11	0.24	2,850	2,850	369	372	0.50	1,419	15	21,284	1,431	14	19,315	82	179
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	0.11	0.72	43,055	43,055	1,501	1,513	0.50	21,438	59	1,269,142	21,617	53	1,151,760	336	2,167
52	1st Ave (North of Highland)	25	0.03	0.12	1.64	211	211	3	3	0.50	105	22	2,334	106	20	2,118	1	10
53	1st Ave (South of Highland)	25	0.09	0.11	0.59	12,712	12,712	570	574	0.50	6,330	13	81,336	6,382	12	73,814	131	671
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	0.10	0.39	30,603	30,603	2,133	2,151	0.50	15,238	85	1,293,714	15,365	76	1,174,060	442	1,655
55	2nd Ave (North of Highland)	25	0.06	0.13	0.85	1,735	1,735	52	52	0.50	864	21	18,051	871	19	16,382	14	89
56	2nd Ave (South of Highland)	25	0.10	0.12	0.53	12,018	12,018	598	603	0.50	5,984	19	113,700	6,034	17	103,184	145	643
57	Highland Ave (East of 2nd Ave)	25	0.10	0.12	0.53	25,338	25,338	1,262	1,272	0.50	12,616	13	169,687	12,721	12	153,993	305	1,355
58	Site Driveway off TV Place	25	0.03	0.11	1.64	0	0	0	0	0.50	0	0	0	0	0	0	0	0
							VMT (per day)	41,290	41,635								10.5	31.5
							VMT (per year)	15,070,978	15,196,758.7			Arterial	7,452,175			6,762,934	Daily Total (kg)	
																	NO_X	VOC

VMT Total (per year)	30,267,736.20

	EF (g/s)	NOx Idle (g/day)	Idle (kg/day)	EF (g/s)	VOC Idle (g/day)	Idle (kg/day)
Peak Period	0.0003	2,348	**2.35**	0.0002	1,759	**1.76**
Off-Peak Period	0.0003	2,131	**2.13**	0.0002	1,597	**1.60**
Total (Including Link)			**15.03**			**34.86**

557 Highland

Existing

Link No.	Description	Roadway Link Length Speed	(miles)	Emission Factor (g/mi) NO_x	VOC	AADT (veh/day)	Seasonally Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Peak Period Factor	Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Off-Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Link Emissions NO_x (grams)	VOC (grams)
1	Central Ave (West of Cedar)	25	0.45	0.25	0.26	10,903	10,903	2,443	2,463	0.50	5,429	0	2,443	5,474	0	2,217	1,222	1,297
2	Cedar St	25	0.10	0.28	0.83	4,275	4,275	213	215	0.50	2,128	22	46,718	2,146	20	42,397	119	356
3	Central Ave (Cedar to Webster)	25	0.10	0.37	0.85	13,567	13,567	676	681	0.50	6,755	0	0	6,812	0	0	503	1,149
4	Central Ave (Webster to Gould)	25	0.26	0.27	0.39	15,178	15,178	1,965	1,981	0.50	7,557	2	13,603	7,620	2	12,345	1,082	1,524
5	Gould St (North of Central)	5	0.02	0.79	3.97	0	0	0	0	0.50	0	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.10	0.34	0.84	15,673	15,673	780	787	0.50	7,804	2	16,389	7,869	2	14,873	537	1,320
7	Hampton Ave	25	0.10	0.43	0.86	929	929	46	47	0.50	463	9	4,164	467	8	3,779	40	80
8	Central Ave (Hampton to River Park)	25	0.05	0.36	1.57	15,822	15,822	394	397	0.50	7,878	0	1,576	7,944	0	1,430	282	1,241
9	River Park St	25	0.06	0.39	1.33	74	74	2	2	0.50	37	6	218	37	5	198	2	6
10	Central Ave (East of River Park)	25	0.09	0.26	0.91	15,847	15,847	710	716	0.50	7,890	0	395	7,956	0	358	371	1,297
11	Highland Ave (South of West St)	25	0.10	0.27	0.83	12,390	12,390	617	622	0.50	6,169	11	67,553	6,221	10	61,306	329	1,029
12	West St (West of Highland)	25	0.08	0.48	1.05	8,239	8,239	328	331	0.50	4,103	11	45,949	4,137	10	41,699	315	692
13	West St (East of Highland)	25	0.10	0.36	0.84	6,938	6,938	345	348	0.50	3,455	17	60,113	3,484	16	54,554	248	586
14	Highland Ave (West to Hunnewell)	25	0.12	0.26	0.71	13,010	13,010	777	784	0.50	6,478	15	99,109	6,532	14	89,943	409	1,107
15	Hunnewell St (West of Highland)	25	0.13	0.26	0.66	3,965	3,965	257	259	0.50	1,974	59	116,673	1,991	53	105,882	132	341
16	Hunnewell St (East of Highland)	25	0.07	0.30	1.15	1,697	1,697	59	60	0.50	845	16	13,354	852	14	12,119	36	136
17	Highland Ave (Hunnewell to Webster)	35	0.28	0.23	0.34	12,266	12,266	1,710	1,724	0.50	6,108	12	72,680	6,159	11	65,958	793	1,171
18	Webster St (Highland to Central)	25	0.63	0.30	0.23	7,124	7,124	2,235	2,253	0.50	3,547	46	162,822	3,577	41	147,763	1,340	1,017
19	Webster St (South of Highland)	25	0.10	0.36	0.84	11,089	11,089	552	557	0.50	5,521	6	33,405	5,568	5	30,315	396	937
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	0.29	0.39	19,266	19,266	2,302	2,322	0.50	9,593	21	203,376	9,673	19	184,566	1,332	1,815
21	Hunting Rd (Highland to Kendrick)	25	0.64	0.26	0.22	4,956	4,956	1,579	1,593	0.50	2,468	47	117,093	2,488	43	106,263	809	691
22	Kendrick St (West of Hunting)	25	0.10	0.29	0.83	7,719	7,719	384	388	0.50	3,843	16	59,958	3,876	14	54,412	221	643
23	Kendrick St (East of Hunting)	25	0.10	0.67	0.92	15,549	15,549	774	781	0.50	7,742	4	28,647	7,807	3	25,997	1,045	1,426
24	Hunting Rd (South of Kendrick)	25	0.12	0.26	0.71	10,445	10,445	624	629	0.50	5,201	9	44,206	5,244	8	40,117	328	889
25	Gould St (Highland to Wingate)	25	0.09	0.28	0.91	11,151	11,151	500	504	0.50	5,552	52	286,223	5,599	46	259,751	276	915
26	Wingate Driveway	20	0.04	0.31	1.94	508	508	10	10	0.50	253	7	1,669	255	6	1,515	6	39
27	Site Driveway	20	0.04	0.52	1.97	818	818	16	16	0.50	407	10	4,092	411	9	3,714	17	65
28	Gould St (Wingate to TV Place)	25	0.06	0.28	1.31	10,593	10,593	316	319	0.50	5,275	0	264	5,319	0	239	177	836
29	TV Place	20	0.05	0.27	1.57	620	620	15	16	0.50	308	10	2,977	311	9	2,701	8	49
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	0.36	0.72	10,470	10,470	626	631	0.50	5,213	1	4,692	5,257	1	4,258	454	911
31	Noanett St	25	0.06	0.41	1.34	1,127	1,127	34	34	0.50	561	7	4,070	566	7	3,694	28	91
32	Business Park	15	0.04	0.34	1.96	1,499	1,499	30	30	0.50	746	12	8,771	753	11	7,960	21	117
33	Gould St (Noanett to Station Rd)	25	0.06	0.36	1.33	9,478	9,478	283	286	0.50	4,719	0	236	4,759	0	214	206	755
34	Station Rd	20	0.07	0.33	1.16	1,016	1,016	35	36	0.50	506	8	3,946	510	7	3,581	24	83
35	Gould St (Station Rd to Kearney Rd)	25	0.05	0.27	1.55	8,884	8,884	221	223	0.50	4,423	0	0	4,460	0	0	121	691
36	Kearney Rd	25	0.10	0.31	0.84	1,982	1,982	99	100	0.50	987	10	10,216	995	9	9,271	61	166
37	Gould St (Kearney to Ellis)	25	0.06	0.28	1.31	7,620	7,620	228	230	0.50	3,794	0	569	3,826	0	516	128	601
38	Ellis St (West of Gould)	25	0.02	0.90	3.88	12	12	0	0	0.50	6	8	51	6	7	46	0	1
39	Ellis St (East of Gould)	25	0.09	0.31	0.92	904	904	41	41	0.50	450	10	4,301	454	9	3,903	25	75
40	Gould St (Ellis to Central)	25	0.23	0.26	0.42	6,641	6,641	761	767	0.50	3,307	291	961,266	3,334	262	872,359	393	641
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	0.26	0.68	28,807	28,807	1,721	1,736	0.50	14,344	0	0	14,463	0	0	892	2,335
42	I95 SB Ramp to Highland WB	25	0.24	0.35	0.42	5,761	5,761	688	694	0.50	2,869	36	101,839	2,893	32	92,420	484	582
43	Highland St WB to I95 SB Ramp	25	0.20	0.18	0.45	5,637	5,637	561	566	0.50	2,807	0	0	2,830	0	0	202	513
44	Highland EB to I95 SB	25	0.23	0.20	0.41	3,159	3,159	362	365	0.50	1,573	0	0	1,586	0	0	142	298
45	I95 SB Ramp to Highland EB	25	0.17	0.32	0.54	3,345	3,345	283	286	0.50	1,666	14	23,320	1,680	13	21,163	183	308
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.20	0.23	0.43	28,869	28,869	2,875	2,899	0.50	14,374	3	38,811	14,494	2	35,221	1,352	2,488
47	I95 NB Ramp to Highland WB	25	0.20	0.30	0.47	1,425	1,425	142	143	0.50	709	36	25,612	715	32	23,243	86	135
48	Highland St WB to I95 NB Ramp	25	0.21	0.22	0.44	9,788	9,788	1,023	1,032	0.50	4,874	0	0	4,914	0	0	449	912
49	Highland EB to I95 NB	25	0.24	0.21	0.40	4,584	4,584	548	552	0.50	2,283	0	0	2,302	0	0	231	439
50	I95 NB Ramp to Highland EB	25	0.26	0.24	0.38	1,982	1,982	257	259	0.50	987	14	13,523	995	12	12,272	123	196
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	0.25	1.11	34,630	34,630	1,207	1,217	0.50	17,243	6	97,424	17,387	5	88,413	615	2,680
52	1st Ave (North of Highland)	25	0.03	0.27	2.52	211	211	3	3	0.50	105	22	2,334	106	20	2,118	2	16
53	1st Ave (South of Highland)	25	0.09	0.25	0.91	7,570	7,570	339	342	0.50	3,769	19	69,734	3,801	17	63,285	168	618
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	0.23	0.60	26,453	26,453	1,844	1,859	0.50	13,171	11	145,544	13,281	10	132,083	847	2,219
55	2nd Ave (North of Highland)	25	0.06	0.28	1.31	1,735	1,735	52	52	0.50	864	21	18,526	871	19	16,813	29	137
56	2nd Ave (South of Highland)	25	0.10	0.26	0.83	10,408	10,408	518	523	0.50	5,182	19	96,648	5,225	17	87,709	269	863
57	Highland Ave (East of 2nd Ave)	25	0.10	0.26	0.83	21,249	21,249	1,058	1,067	0.50	10,580	10	102,629	10,669	9	93,137	549	1,761
58	Site Driveway off TV Place	25	0.03	0.25	2.52	0	0	0	0	0.50	0	0	0	0	0	0	0	0
							VMT (per day)	36,471	36,776								20.5	43.3
							VMT (per year)	13,311,998	13,423,098.5			Arterial	3,239,731			2,940,092	Daily Total (kg)	
																	NO_X	VOC

VMT Total (per year)	26,735,096.11

	NOx (g/s)	NOx (g/day)	NOx (kg/day)	VOC (g/s)	VOC (g/day)	VOC (kg/day)
Peak Period	0.0006	1,939	**1.94**	0.0003	1,049	**1.05**
Off-Peak Period	0.0006	1,760	**1.76**	0.0003	952	**0.95**
Total (Including Link)			**24.16**			**45.28**

557 Highland

Build With Mitgation

Link No.	Description	Roadway Link Length Speed	Roadway Link Length (miles)	Emission Factor (g/mi) CO_2	AADT (veh/day)	Weekday Seasonally Adjusted ADT (veh/day)	Weekday VMT Peak (veh-miles)	Weekday VMT Off-Peak (veh-miles)	Weekday Annual Weekday Trips (veh/yr)	Weekday Peak Period Factor	Weekday Peak Traffic Data Period Volume (vehicles)	Weekday Peak Traffic Data Average Delay (sec)	Weekday Peak Traffic Data Adjusted Delay (veh-sec)	Weekday Off-Peak Traffic Data Period Volume (vehicles)	Weekday Off-Peak Traffic Data Average Delay (sec)	Weekday Off-Peak Traffic Data Adjusted Delay (veh-sec)	Link Emissions CO_2 (grams)
1	Central Ave (West of Cedar)	25	0.45	383.7	12,080	12,080	987,970	996,215	4,409,299	0.50	2,195,488	1	1,097,744	2,213,811	0	996,215	761,265,502
2	Cedar St	25	0.1	412.6	4,832	4,832	87,820	88,552	1,763,720	0.50	878,195	41	35,830,363	885,525	37	32,516,460	72,767,545
3	Central Ave (Cedar to Webster)	25	0.1	500.2	15,178	15,178	275,843	278,146	5,539,889	0.50	2,758,434	0	0	2,781,455	0	0	277,105,783
4	Central Ave (Webster to Gould)	25	0.26	408.1	17,036	17,036	805,012	811,731	6,218,242	0.50	3,096,201	2	6,966,452	3,122,042	2	6,322,134	659,767,971
5	Gould St (North of Central)	5	0.02	1237.4	0	0	0	0	0	0.50	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.1	473.4	17,408	17,408	316,375	319,016	6,353,913	0.50	3,163,754	2	7,751,198	3,190,159	2	7,034,300	300,786,613
7	Hampton Ave	25	0.1	558.9	991	991	18,014	18,165	361,789	0.50	180,143	10	1,846,462	181,646	9	1,675,685	20,219,970
8	Central Ave (Hampton to River Park)	25	0.05	486.5	17,495	17,495	158,976	160,303	6,385,570	0.50	3,179,517	0	635,903	3,206,053	0	577,090	155,318,122
9	River Park St	25	0.06	514.5	74	74	811	817	27,134	0.50	13,511	6	85,117	13,623	6	77,245	837,656
10	Central Ave (East of River Park)	25	0.09	394.2	17,581	17,581	287,575	289,975	6,417,226	0.50	3,195,279	0	159,764	3,221,947	0	144,988	227,695,366
11	Highland Ave (South of West St)	25	0.1	399.6	14,744	14,744	267,962	270,199	5,381,606	0.50	2,679,621	13	35,103,037	2,701,985	12	31,856,404	215,048,976
12	West St (West of Highland)	25	0.08	612.8	9,231	9,231	134,206	135,326	3,369,157	0.50	1,677,578	14	23,066,697	1,691,579	12	20,933,289	165,160,456
13	West St (East of Highland)	25	0.1	486.5	7,496	7,496	136,233	137,370	2,736,027	0.50	1,362,328	21	28,881,362	1,373,698	19	26,210,163	133,098,673
14	Highland Ave (West to Hunnewell)	25	0.12	396.4	15,735	15,735	343,172	346,036	5,743,395	0.50	2,859,764	28	80,073,385	2,883,631	25	72,667,504	273,205,258
15	Hunnewell St (West of Highland)	25	0.13	390.8	4,275	4,275	100,992	101,835	1,560,214	0.50	776,865	246	191,225,310	783,349	222	173,539,134	79,255,577
16	Hunnewell St (East of Highland)	25	0.07	437.3	1,759	1,759	22,383	22,570	642,175	0.50	319,753	27	8,617,346	322,422	24	7,820,339	19,657,743
17	Highland Ave (Hunnewell to Webster)	35	0.28	347.5	14,868	14,868	756,599	762,913	5,426,830	0.50	2,702,139	24	64,716,229	2,724,691	22	58,730,710	527,980,621
18	Webster St (Highland to Central)	25	0.63	431.3	7,682	7,682	879,546	886,887	2,803,862	0.50	1,396,105	119	166,625,149	1,407,757	107	151,214,210	761,899,037
19	Webster St (South of Highland)	25	0.1	486.5	11,832	11,832	215,045	216,840	4,318,852	0.50	2,150,452	15	31,504,126	2,168,400	13	28,590,351	210,097,905
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	404.6	22,302	22,302	972,770	980,889	8,140,245	0.50	4,053,208	32	128,081,388	4,087,036	28	116,235,310	790,438,136
21	Hunting Rd (Highland to Kendrick)	25	0.64	389.8	5,761	5,761	670,130	675,723	2,102,897	0.50	1,047,079	36	37,694,839	1,055,818	32	34,208,493	524,565,463
22	Kendrick St (West of Hunting)	25	0.1	419.3	8,338	8,338	151,545	152,810	3,043,547	0.50	1,515,450	18	27,656,955	1,528,097	16	25,099,000	127,618,667
23	Kendrick St (East of Hunting)	25	0.1	824.3	17,098	17,098	310,746	313,339	6,240,854	0.50	3,107,460	4	13,362,077	3,133,394	4	12,126,236	514,457,323
24	Hunting Rd (South of Kendrick)	25	0.12	396.4	11,312	11,312	246,705	248,764	4,128,913	0.50	2,055,877	8	16,344,225	2,073,036	7	14,832,570	196,406,614
25	Gould St (Highland to Wingate)	25	0.09	409.1	18,089	18,089	295,884	298,354	6,602,643	0.50	3,287,602	36	116,874,267	3,315,040	32	106,064,720	243,100,712
26	Wingate Driveway	20	0.04	458.2	508	508	3,693	3,724	185,417	0.50	92,323	22	2,003,411	93,094	20	1,818,118	3,398,484
27	Site Driveway	20	0.04	672.1	6,145	6,145	44,675	45,048	2,243,090	0.50	1,116,884	21	23,957,164	1,126,206	19	21,741,398	60,298,737
28	Gould St (Wingate to TV Place)	25	0.06	412.6	12,948	12,948	141,187	142,365	4,725,864	0.50	2,353,113	6	13,295,087	2,372,752	5	12,065,442	116,987,832
29	TV Place	20	0.05	427.6	2,602	2,602	23,644	23,841	949,695	0.50	472,874	36	17,188,982	476,821	33	15,599,195	20,302,204
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	490.9	12,452	12,452	271,565	273,831	4,544,970	0.50	2,263,041	1	2,376,193	2,281,929	1	2,156,422	267,751,450
31	Noanett St	25	0.06	544.6	1,189	1,189	12,970	13,079	434,146	0.50	216,171	8	1,794,220	217,975	7	1,628,275	14,186,689
32	Business Park	15	0.04	527.9	1,499	1,499	10,899	10,990	547,205	0.50	272,466	17	4,618,293	274,740	15	4,191,153	11,555,828
33	Gould St (Noanett to Station Rd)	25	0.06	490.9	11,399	11,399	124,298	125,336	4,160,570	0.50	2,071,640	0	103,582	2,088,930	0	94,002	122,552,902
34	Station Rd	20	0.07	481.2	1,016	1,016	12,925	13,033	370,833	0.50	184,646	10	1,754,139	186,187	9	1,591,901	12,491,523
35	Gould St (Station Rd to Kearney Rd)	25	0.05	405.9	10,804	10,804	98,178	98,997	3,943,496	0.50	1,963,554	0	0	1,979,942	0	0	80,038,387
36	Kearney Rd	25	0.1	439.9	2,106	2,106	38,280	38,600	768,801	0.50	382,803	15	5,742,045	385,998	14	5,210,971	33,821,781
37	Gould St (Kearney to Ellis)	25	0.06	412.6	9,416	9,416	102,681	103,538	3,436,992	0.50	1,711,355	0	256,703	1,725,638	0	232,961	85,082,059
38	Ellis St (West of Gould)	25	0.02	1067.7	12	12	45	45	4,522	0.50	2,252	10	23,081	2,271	9	20,946	96,574
39	Ellis St (East of Gould)	25	0.09	439.4	966	966	15,808	15,939	352,744	0.50	175,639	13	2,292,089	177,105	12	2,080,097	13,948,835
40	Gould St (Ellis to Central)	25	0.23	391.8	8,376	8,376	350,107	353,029	3,057,114	0.50	1,522,205	443	674,108,468	1,534,909	399	611,761,068	275,471,349
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	370.3	37,170	37,170	810,642	817,407	13,567,074	0.50	6,755,347	0	0	6,811,727	0	0	602,824,471
42	I95 SB Ramp to Highland WB	25	0.24	480.3	6,629	6,629	289,129	291,542	2,419,462	0.50	1,204,704	97	116,735,782	1,214,758	87	105,939,044	278,893,776
43	Highland St WB to I95 SB Ramp	25	0.2	318.7	7,186	7,186	261,207	263,387	2,622,968	0.50	1,306,034	0	0	1,316,934	0	0	167,205,796
44	Highland EB to I95 SB	25	0.23	334.2	5,266	5,266	220,112	221,949	1,922,002	0.50	957,008	0	0	964,995	0	0	147,746,616
45	I95 SB Ramp to Highland EB	25	0.17	454.3	4,522	4,522	139,723	140,889	1,650,661	0.50	821,901	27	22,437,887	828,760	25	20,362,636	127,474,916
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.2	345.9	36,984	36,984	1,344,314	1,355,534	13,499,239	0.50	6,721,571	3	22,517,262	6,777,668	3	20,434,670	934,011,035
47	I95 NB Ramp to Highland WB	25	0.2	433.0	1,920	1,920	69,805	70,388	700,966	0.50	349,026	138	47,991,114	351,939	124	43,552,480	60,701,579
48	Highland St WB to I95 NB Ramp	25	0.21	354.4	12,452	12,452	475,239	479,205	4,544,970	0.50	2,263,041	0	0	2,281,929	0	0	338,221,687
49	Highland EB to I95 NB	25	0.24	347.6	6,815	6,815	297,235	299,716	2,487,297	0.50	1,238,480	0	0	1,248,817	0	0	207,509,975
50	I95 NB Ramp to Highland EB	25	0.26	373.2	2,850	2,850	134,657	135,780	1,040,142	0.50	517,910	17	8,597,306	522,232	15	7,802,152	100,925,438
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	365.7	43,551	43,551	554,051	558,675	15,896,089	0.50	7,915,015	9	68,860,634	7,981,074	8	62,491,806	406,889,006
52	1st Ave (North of Highland)	25	0.03	401.4	211	211	1,148	1,158	76,880	0.50	38,280	26	997,202	38,600	23	904,972	925,782
53	1st Ave (South of Highland)	25	0.09	380.8	12,712	12,712	207,930	209,665	4,639,939	0.50	2,310,329	21	48,632,422	2,329,611	19	44,134,474	159,005,624
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	345.1	31,099	31,099	791,276	797,880	11,351,119	0.50	5,651,974	48	272,425,149	5,699,145	43	247,228,908	548,414,574
55	2nd Ave (North of Highland)	25	0.06	412.6	1,735	1,735	18,915	19,073	633,130	0.50	315,250	21	6,588,716	317,881	19	5,979,334	15,673,011
56	2nd Ave (South of Highland)	25	0.1	393.0	12,018	12,018	218,423	220,246	4,386,687	0.50	2,184,229	19	41,500,351	2,202,458	17	37,662,039	172,376,194
57	Highland Ave (East of 2nd Ave)	25	0.1	393.0	25,833	25,833	469,497	473,415	9,429,117	0.50	4,694,966	15	68,781,259	4,734,150	13	62,419,772	370,519,963
58	Site Driveway off TV Place	25	0.03	380.8	1,982	1,982	10,809	10,899	723,577	0.50	360,285	0	0	363,292	0	0	8,265,424
						VMT (per year)	16,007,381	16,140,978									14,355.52
											Arterial		2,499,777,938			2,268,576,787	**Total (tons/year)**

	Weekday	Total
VMT per year	**32,148,358.84**	**32,148,358.84**

	Weekday Idle EF (g/s)	Weekday Idle Idle (g/year)	Weekday Idle Idle (tons/year)	Total Idle EF (g/s)	Total Idle Idle (g/year)	Total Idle Idle (tons/year)
Peak Period	0.8975	2,243,640,888	**2,473.15**			**2,473.15**
Off-Peak Period	0.8975	2,036,129,513	**2,244.41**			**2,244.41**
Total			**4,717.56**		Total (Including Link)	**19,073.08**

557 Highland

Build		Weekday									Weekday						Link Emissions
												Peak Traffic Data			Off-Peak Traffic Data		
Link No.	Description	Roadway Link Length Speed	(miles)	Emission Factor (g/mi) CO_2	AADT (veh/day)	Seasonally Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Annual Weekday Trips (veh/yr)	Peak Period Factor	Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	CO_2 (grams)
1	Central Ave (West of Cedar)	25	0.45	383.7	12,080	12,080	987,970	996,215	4,409,299	0.50	2,195,488	1	1,097,744	2,213,811	0	996,215	761,265,502
2	Cedar St	25	0.1	412.6	4,832	4,832	87,820	88,552	1,763,720	0.50	878,195	41	35,830,363	885,525	37	32,516,460	72,767,545
3	Central Ave (Cedar to Webster)	25	0.1	500.2	15,178	15,178	275,843	278,146	5,539,889	0.50	2,758,434	0	0	2,781,455	0	0	277,105,783
4	Central Ave (Webster to Gould)	25	0.26	408.1	17,036	17,036	805,012	811,731	6,218,242	0.50	3,096,201	2	6,966,452	3,122,042	2	6,322,134	659,767,971
5	Gould St (North of Central)	5	0.02	1237.4	0	0	0	0	0	0.50	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.1	473.4	17,408	17,408	316,375	319,016	6,353,913	0.50	3,163,754	2	7,751,198	3,190,159	2	7,034,300	300,786,613
7	Hampton Ave	25	0.1	558.9	991	991	18,014	18,165	361,789	0.50	180,143	10	1,846,462	181,646	9	1,675,685	20,219,970
8	Central Ave (Hampton to River Park)	25	0.05	486.5	17,495	17,495	158,976	160,303	6,385,570	0.50	3,179,517	0	635,903	3,206,053	0	577,090	155,318,122
9	River Park St	25	0.06	514.5	74	74	811	817	27,134	0.50	13,511	6	85,117	13,623	6	77,245	837,656
10	Central Ave (East of River Park)	25	0.09	394.2	17,581	17,581	287,575	289,975	6,417,226	0.50	3,195,279	0	159,764	3,221,947	0	144,988	227,695,366
11	Highland Ave (South of West St)	25	0.1	399.6	14,744	14,744	267,962	270,199	5,381,606	0.50	2,679,621	15	38,854,507	2,701,985	13	35,260,905	215,048,976
12	West St (West of Highland)	25	0.08	612.8	9,231	9,231	134,206	135,326	3,369,157	0.50	1,677,578	12	19,459,904	1,691,579	10	17,660,083	165,160,456
13	West St (East of Highland)	25	0.1	486.5	7,496	7,496	136,233	137,370	2,736,027	0.50	1,362,328	17	23,772,631	1,373,698	16	21,573,932	133,098,673
14	Highland Ave (West to Hunnewell)	25	0.12	396.4	15,735	15,735	343,172	346,036	5,743,395	0.50	2,859,764	37	106,669,188	2,883,631	34	96,803,496	273,205,258
15	Hunnewell St (West of Highland)	25	0.13	390.8	4,275	4,275	100,992	101,835	1,560,214	0.50	776,865	246	191,225,310	783,349	222	173,539,134	79,255,577
16	Hunnewell St (East of Highland)	25	0.07	437.3	1,759	1,759	22,383	22,570	642,175	0.50	319,753	27	8,617,346	322,422	24	7,820,339	19,657,743
17	Highland Ave (Hunnewell to Webster)	35	0.28	347.5	14,868	14,868	756,599	762,913	5,426,830	0.50	2,702,139	24	64,716,229	2,724,691	22	58,730,710	527,980,621
18	Webster St (Highland to Central)	25	0.63	431.3	7,682	7,682	879,546	886,887	2,803,862	0.50	1,396,105	119	166,625,149	1,407,757	107	151,214,210	761,899,037
19	Webster St (South of Highland)	25	0.1	486.5	11,832	11,832	215,045	216,840	4,318,852	0.50	2,150,452	15	31,504,126	2,168,400	13	28,590,351	210,097,905
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	404.6	22,302	22,302	972,770	980,889	8,140,245	0.50	4,053,208	44	179,557,136	4,087,036	40	162,950,134	790,438,136
21	Hunting Rd (Highland to Kendrick)	25	0.64	389.8	5,761	5,761	670,130	675,723	2,102,897	0.50	1,047,079	34	35,862,451	1,055,818	31	32,545,580	524,565,463
22	Kendrick St (West of Hunting)	25	0.1	419.3	8,338	8,338	151,545	152,810	3,043,547	0.50	1,515,450	18	27,656,955	1,528,097	16	25,099,000	127,618,667
23	Kendrick St (East of Hunting)	25	0.1	824.3	17,098	17,098	310,746	313,339	6,240,854	0.50	3,107,460	4	13,362,077	3,133,394	4	12,126,236	514,457,323
24	Hunting Rd (South of Kendrick)	25	0.12	396.4	11,312	11,312	246,705	248,764	4,128,913	0.50	2,055,877	8	16,344,225	2,073,036	7	14,832,570	196,406,614
25	Gould St (Highland to Wingate)	25	0.09	409.1	18,089	18,089	295,884	298,354	6,602,643	0.50	3,287,602	127	418,511,790	3,315,040	115	379,804,189	243,100,712
26	Wingate Driveway	20	0.04	458.2	508	508	3,693	3,724	185,417	0.50	92,323	7	687,807	93,094	7	624,193	3,398,484
27	Site Driveway	20	0.04	672.1	6,145	6,145	44,675	45,048	2,243,090	0.50	1,116,884	2,500	2,792,210,287	1,126,206	2,250	2,533,962,455	60,298,737
28	Gould St (Wingate to TV Place)	25	0.06	412.6	12,948	12,948	141,187	142,365	4,725,864	0.50	2,353,113	0	470,623	2,372,752	0	427,095	116,987,832
29	TV Place	20	0.05	427.6	2,602	2,602	23,644	23,841	949,695	0.50	472,874	36	17,188,982	476,821	33	15,599,195	20,302,204
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	490.9	12,452	12,452	271,565	273,831	4,544,970	0.50	2,263,041	1	2,376,193	2,281,929	1	2,156,422	267,751,450
31	Noanett St	25	0.06	544.6	1,189	1,189	12,970	13,079	434,146	0.50	216,171	8	1,794,220	217,975	7	1,628,275	14,186,689
32	Business Park	15	0.04	527.9	1,499	1,499	10,899	10,990	547,205	0.50	272,466	17	4,618,293	274,740	15	4,191,153	11,555,828
33	Gould St (Noanett to Station Rd)	25	0.06	490.9	11,399	11,399	124,298	125,336	4,160,570	0.50	2,071,640	0	103,582	2,088,930	0	94,002	122,552,902
34	Station Rd	20	0.07	481.2	1,016	1,016	12,925	13,033	370,833	0.50	184,646	10	1,754,139	186,187	9	1,591,901	12,491,523
35	Gould St (Station Rd to Kearney Rd)	25	0.05	405.9	10,804	10,804	98,178	98,997	3,943,496	0.50	1,963,554	0	0	1,979,942	0	0	80,038,387
36	Kearney Rd	25	0.1	439.9	2,106	2,106	38,280	38,600	768,801	0.50	382,803	15	5,742,045	385,998	14	5,210,971	33,821,781
37	Gould St (Kearney to Ellis)	25	0.06	412.6	9,416	9,416	102,681	103,538	3,436,992	0.50	1,711,355	0	256,703	1,725,638	0	232,961	85,082,059
38	Ellis St (West of Gould)	25	0.02	1067.7	12	12	45	45	4,522	0.50	2,252	10	23,081	2,271	9	20,946	96,574
39	Ellis St (East of Gould)	25	0.09	439.4	966	966	15,808	15,939	352,744	0.50	175,639	13	2,292,089	177,105	12	2,080,097	13,948,835
40	Gould St (Ellis to Central)	25	0.23	391.8	8,376	8,376	350,107	353,029	3,057,114	0.50	1,522,205	443	674,108,468	1,534,909	399	611,761,068	275,471,349
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	370.3	37,170	37,170	810,642	817,407	13,567,074	0.50	6,755,347	0	0	6,811,727	0	0	602,824,471
42	I95 SB Ramp to Highland WB	25	0.24	480.3	6,629	6,629	289,129	291,542	2,419,462	0.50	1,204,704	97	116,735,782	1,214,758	87	105,939,044	278,893,776
43	Highland St WB to I95 SB Ramp	25	0.2	318.7	7,186	7,186	261,207	263,387	2,622,968	0.50	1,306,034	0	0	1,316,934	0	0	167,205,796
44	Highland EB to I95 SB	25	0.23	334.2	5,266	5,266	220,112	221,949	1,922,002	0.50	957,008	0	0	964,995	0	0	147,746,616
45	I95 SB Ramp to Highland EB	25	0.17	454.3	4,522	4,522	139,723	140,889	1,650,661	0.50	821,901	27	22,437,887	828,760	25	20,362,636	127,474,916
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.2	345.9	36,984	36,984	1,344,314	1,355,534	13,499,239	0.50	6,721,571	3	22,517,262	6,777,668	3	20,434,670	934,011,035
47	I95 NB Ramp to Highland WB	25	0.2	433.0	1,920	1,920	69,805	70,388	700,966	0.50	349,026	138	47,991,114	351,939	124	43,552,480	60,701,579
48	Highland St WB to I95 NB Ramp	25	0.21	354.4	12,452	12,452	475,239	479,205	4,544,970	0.50	2,263,041	0	0	2,281,929	0	0	338,221,687
49	Highland EB to I95 NB	25	0.24	347.6	6,815	6,815	297,235	299,716	2,487,297	0.50	1,238,480	0	0	1,248,817	0	0	207,509,975
50	I95 NB Ramp to Highland EB	25	0.26	373.2	2,850	2,850	134,657	135,780	1,040,142	0.50	517,910	17	8,597,306	522,232	15	7,802,152	100,925,438
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	365.7	43,551	43,551	554,051	558,675	15,896,089	0.50	7,915,015	10	75,192,647	7,981,074	9	68,238,178	406,889,006
52	1st Ave (North of Highland)	25	0.03	401.4	211	211	1,148	1,158	76,880	0.50	38,280	22	851,737	38,600	20	772,961	925,782
53	1st Ave (South of Highland)	25	0.09	380.8	12,712	12,712	207,930	209,665	4,639,939	0.50	2,310,329	13	29,687,726	2,329,611	12	26,941,947	159,005,624
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	345.1	31,099	31,099	791,276	797,880	11,351,119	0.50	5,651,974	86	485,504,571	5,699,145	77	440,600,896	548,414,574
55	2nd Ave (North of Highland)	25	0.06	412.6	1,735	1,735	18,915	19,073	633,130	0.50	315,250	21	6,588,716	317,881	19	5,979,334	15,673,011
56	2nd Ave (South of Highland)	25	0.1	393.0	12,018	12,018	218,423	220,246	4,386,687	0.50	2,184,229	19	41,500,351	2,202,458	17	37,662,039	172,376,194
57	Highland Ave (East of 2nd Ave)	25	0.1	393.0	25,833	25,833	469,497	473,415	9,429,117	0.50	4,694,966	15	68,781,259	4,734,150	13	62,419,772	370,519,963
58	Site Driveway off TV Place	25	0.03	380.8	1,982	1,982	10,809	10,899	723,577	0.50	360,285	0	0	363,292	0	0	8,265,424
						VMT (per year)	16,007,381	16,140,978									14,355.52
												Arterial	5,827,124,897			5,288,181,831	**Total (tons/year)**

	Weekday	Total
VMT per year	**32,148,358.84**	**32,148,358.84**

	Weekday Idle			Total Idle		
	(g/s)	(g/year)	(tons/year)	(g/s)	(g/year)	(tons/year)
Peak Period	0.8975	5,230,054,829	**5,765.05**			**5,765.05**
Off-Peak Period	0.8975	4,746,333,984	**5,231.85**			**5,231.85**
Total			**10,996.90**	Total (Including Link)		**25,352.42**

557 Highland

No Build

Link No.	Description	Weekday: Roadway Link Length Speed	Link Length (miles)	Emission Factor (g/mi) CO_2	AADT (veh/day)	Seasonally Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Annual Weekday Trips (veh/yr)	Peak Period Factor	Weekday: Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Off-Peak Traffic Data Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Link Emissions CO_2 (grams)
1	Central Ave (West of Cedar)	25	0.45	383.7	11,709	11,709	957,571	965,562	4,273,628	0.50	2,127,934	0	957,571	2,145,694	0	869,006	737,841,948
2	Cedar St	25	0.1	412.6	4,584	4,584	83,316	84,011	1,673,273	0.50	833,160	32	26,952,711	840,113	29	24,459,890	69,035,876
3	Central Ave (Cedar to Webster)	25	0.1	500.2	14,558	14,558	264,584	266,793	5,313,771	0.50	2,645,844	0	0	2,667,926	0	0	265,795,343
4	Central Ave (Webster to Gould)	25	0.26	408.1	16,417	16,417	775,739	782,213	5,992,125	0.50	2,983,612	2	6,414,765	3,008,513	2	5,821,472	635,776,409
5	Gould St (North of Central)	5	0.02	1237.4	0	0	0	0	0	0.50	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.1	473.4	16,912	16,912	307,368	309,934	6,173,019	0.50	3,073,683	2	7,223,155	3,099,336	2	6,555,095	292,223,293
7	Hampton Ave	25	0.1	558.9	991	991	18,014	18,165	361,789	0.50	180,143	10	1,756,390	181,646	9	1,593,944	20,219,970
8	Central Ave (Hampton to River Park)	25	0.05	486.5	16,999	16,999	154,472	155,761	6,204,675	0.50	3,089,446	0	617,889	3,115,230	0	560,741	150,918,175
9	River Park St	25	0.06	514.5	74	74	811	817	27,134	0.50	13,511	6	82,415	13,623	5	74,793	837,656
10	Central Ave (East of River Park)	25	0.09	394.2	17,086	17,086	279,469	281,801	6,236,332	0.50	3,105,208	0	155,260	3,131,124	0	140,901	221,276,892
11	Highland Ave (South of West St)	25	0.1	399.6	14,249	14,249	258,955	261,116	5,200,712	0.50	2,589,550	14	36,383,176	2,611,162	13	33,018,144	207,820,439
12	West St (West of Highland)	25	0.08	612.8	8,983	8,983	130,603	131,693	3,278,710	0.50	1,632,542	11	18,692,609	1,646,167	10	16,963,755	160,726,618
13	West St (East of Highland)	25	0.1	486.5	7,496	7,496	136,233	137,370	2,736,027	0.50	1,362,328	17	23,772,631	1,373,698	16	21,573,932	133,098,673
14	Highland Ave (West to Hunnewell)	25	0.12	396.4	14,992	14,992	326,959	329,688	5,472,053	0.50	2,724,657	27	72,475,871	2,747,397	24	65,772,674	260,297,923
15	Hunnewell St (West of Highland)	25	0.13	390.8	4,275	4,275	100,992	101,835	1,560,214	0.50	776,865	178	138,398,492	783,349	160	125,598,199	79,255,577
16	Hunnewell St (East of Highland)	25	0.07	437.3	1,759	1,759	22,383	22,570	642,175	0.50	319,753	21	6,858,704	322,422	19	6,224,352	19,657,743
17	Highland Ave (Hunnewell to Webster)	35	0.28	347.5	14,187	14,187	721,921	727,947	5,178,100	0.50	2,578,291	23	58,913,948	2,599,809	21	53,465,075	503,781,509
18	Webster St (Highland to Central)	25	0.63	431.3	7,682	7,682	879,546	886,887	2,803,862	0.50	1,396,105	100	139,401,099	1,407,757	90	126,508,076	761,899,037
19	Webster St (South of Highland)	25	0.1	486.5	11,832	11,832	215,045	216,840	4,318,852	0.50	2,150,452	15	31,504,126	2,168,400	13	28,590,351	210,097,905
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	404.6	21,621	21,621	943,047	950,917	7,891,515	0.50	3,929,360	42	164,836,671	3,962,155	38	149,591,145	766,285,860
21	Hunting Rd (Highland to Kendrick)	25	0.64	389.8	5,452	5,452	634,102	639,394	1,989,838	0.50	990,784	34	33,686,666	999,053	31	30,571,031	496,363,019
22	Kendrick St (West of Hunting)	25	0.1	419.3	8,338	8,338	151,545	152,810	3,043,547	0.50	1,515,450	18	27,505,411	1,528,097	16	24,961,472	127,618,667
23	Kendrick St (East of Hunting)	25	0.1	824.3	16,788	16,788	305,117	307,663	6,127,795	0.50	3,051,165	4	12,967,452	3,076,630	4	11,768,110	505,137,444
24	Hunting Rd (South of Kendrick)	25	0.12	396.4	11,312	11,312	246,705	248,764	4,128,913	0.50	2,055,877	8	16,344,225	2,073,036	7	14,832,570	196,406,614
25	Gould St (Highland to Wingate)	25	0.09	409.1	12,080	12,080	197,594	199,243	4,409,299	0.50	2,195,488	30	64,986,443	2,213,811	27	58,975,933	162,344,654
26	Wingate Driveway	20	0.04	458.2	508	508	3,693	3,724	185,417	0.50	92,323	7	637,029	93,094	6	578,111	3,398,484
27	Site Driveway	20	0.04	672.1	818	818	5,945	5,994	298,476	0.50	148,618	11	1,694,241	149,858	10	1,537,543	8,023,622
28	Gould St (Wingate to TV Place)	25	0.06	412.6	11,523	11,523	125,649	126,698	4,205,793	0.50	2,094,158	0	104,708	2,111,635	0	95,024	104,113,573
29	TV Place	20	0.05	427.6	620	620	5,629	5,676	226,118	0.50	112,589	11	1,221,592	113,529	10	1,108,609	4,833,858
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	490.9	11,399	11,399	248,597	250,672	4,160,570	0.50	2,071,640	1	2,071,640	2,088,930	1	1,880,037	245,105,805
31	Noanett St	25	0.06	544.6	1,189	1,189	12,970	13,079	434,146	0.50	216,171	8	1,686,135	217,975	7	1,530,186	14,186,689
32	Business Park	15	0.04	527.9	1,499	1,499	10,899	10,990	547,205	0.50	272,466	14	3,787,273	274,740	13	3,436,993	11,555,828
33	Gould St (Noanett to Station Rd)	25	0.06	490.9	10,346	10,346	112,814	113,756	3,776,169	0.50	1,880,238	0	94,012	1,895,931	0	85,317	111,230,080
34	Station Rd	20	0.07	481.2	1,016	1,016	12,925	13,033	370,833	0.50	184,646	9	1,569,492	186,187	8	1,424,332	12,491,523
35	Gould St (Station Rd to Kearney Rd)	25	0.05	405.9	9,751	9,751	88,608	89,347	3,559,096	0.50	1,772,153	0	0	1,786,943	0	0	72,236,480
36	Kearney Rd	25	0.1	439.9	2,106	2,106	38,280	38,600	768,801	0.50	382,803	12	4,708,477	385,998	11	4,272,996	33,821,781
37	Gould St (Kearney to Ellis)	25	0.06	412.6	8,363	8,363	91,197	91,958	3,052,592	0.50	1,519,953	0	227,993	1,532,639	0	206,906	75,566,303
38	Ellis St (West of Gould)	25	0.02	1067.7	12	12	45	45	4,522	0.50	2,252	9	20,379	2,271	8	18,494	96,574
39	Ellis St (East of Gould)	25	0.09	439.4	966	966	15,808	15,939	352,744	0.50	175,639	11	1,923,247	177,105	10	1,745,369	13,948,835
40	Gould St (Ellis to Central)	25	0.23	391.8	7,323	7,323	306,085	308,639	2,672,714	0.50	1,330,803	443	589,346,308	1,341,910	399	534,838,449	240,833,679
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	370.3	32,214	32,214	702,556	708,420	11,758,131	0.50	5,854,634	0	0	5,903,497	0	0	522,447,875
42	I95 SB Ramp to Highland WB	25	0.24	480.3	6,257	6,257	272,916	275,194	2,283,791	0.50	1,137,150	69	78,008,501	1,146,641	62	70,793,598	263,254,872
43	Highland St WB to I95 SB Ramp	25	0.2	318.7	7,186	7,186	261,207	263,387	2,622,968	0.50	1,306,034	0	0	1,316,934	0	0	167,205,796
44	Highland EB to I95 SB	25	0.23	334.2	3,407	3,407	142,425	143,614	1,243,648	0.50	619,240	0	0	624,408	0	0	95,600,751
45	I95 SB Ramp to Highland EB	25	0.17	454.3	4,522	4,522	139,723	140,889	1,650,661	0.50	821,901	15	11,917,559	828,760	13	10,815,320	127,474,916
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.2	345.9	34,258	34,258	1,245,236	1,255,628	12,504,320	0.50	6,226,179	3	21,480,316	6,278,142	3	19,493,630	865,172,701
47	I95 NB Ramp to Highland WB	25	0.2	433.0	1,549	1,549	56,295	56,764	565,295	0.50	281,473	88	24,882,197	283,822	80	22,580,875	48,952,887
48	Highland St WB to I95 NB Ramp	25	0.21	354.4	12,452	12,452	475,239	479,205	4,544,970	0.50	2,263,041	0	0	2,281,929	0	0	338,221,687
49	Highland EB to I95 NB	25	0.24	347.6	4,956	4,956	216,171	217,975	1,808,943	0.50	900,713	0	0	908,230	0	0	150,916,345
50	I95 NB Ramp to Highland EB	25	0.26	373.2	2,850	2,850	134,657	135,780	1,040,142	0.50	517,910	15	7,768,650	522,232	14	7,050,137	100,925,438
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	365.7	43,055	43,055	547,746	552,318	15,715,195	0.50	7,824,944	59	463,236,694	7,890,250	53	420,392,545	402,258,690
52	1st Ave (North of Highland)	25	0.03	401.4	211	211	1,148	1,158	76,880	0.50	38,280	22	851,737	38,600	20	772,961	925,782
53	1st Ave (South of Highland)	25	0.09	380.8	12,712	12,712	207,930	209,665	4,639,939	0.50	2,310,329	13	29,687,726	2,329,611	12	26,941,947	159,005,624
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	345.1	30,603	30,603	778,666	785,165	11,170,225	0.50	5,561,903	85	472,205,543	5,608,322	76	428,531,878	539,674,900
55	2nd Ave (North of Highland)	25	0.06	412.6	1,735	1,735	18,915	19,073	633,130	0.50	315,250	21	6,588,716	317,881	19	5,979,334	15,673,011
56	2nd Ave (South of Highland)	25	0.1	393.0	12,018	12,018	218,423	220,246	4,386,687	0.50	2,184,229	19	41,500,351	2,202,458	17	37,662,039	172,376,194
57	Highland Ave (East of 2nd Ave)	25	0.1	393.0	25,338	25,338	460,490	464,333	9,248,222	0.50	4,604,895	13	61,935,840	4,643,327	12	56,207,476	363,411,666
58	Site Driveway off TV Place	25	0.03	380.8	0	0	0	0	0	0.50	0	0	0	0	0	0	0
						VMT (per year)	15,070,978	15,196,759									13,524.76
											Arterial		2,720,044,036			2,468,470,765	**Total (tons/year)**

	Weekday	Total
VMT per year	**30,267,736.20**	**30,267,736.20**

	Weekday Idle (g/s)	Weekday Idle (g/year)	Weekday Idle (tons/year)	Total Idle (g/s)	Total Idle (g/year)	Total Idle (tons/year)
Peak Period	0.8975	2,441,337,658	**2,691.07**			**2,691.07**
Off-Peak Period	0.8975	2,215,541,571	**2,442.18**			**2,442.18**
Total			**5,133.24**	Total (Including Link)		**18,658.00**

557 Highland

Existing		Weekday									Weekday						Link Emissions
		Roadway Link Length		Emission		Seasonally					Peak Traffic Data			Off-Peak Traffic Data			
Link No.	Description	Type	(miles)	Factor (g/mi) CO_2	AADT (veh/day)	Adjusted ADT (veh/day)	VMT Peak (veh-miles)	VMT Off-Peak (veh-miles)	Annual Weekday Trips (veh/yr)	Peak Period Factor	Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	Period Volume (vehicles)	Average Delay (sec)	Adjusted Delay (veh-sec)	CO_2 (grams)
1	Central Ave (West of Cedar)	25	0.45	449.4	10,903	10,903	891,706	899,148	3,979,675	0.50	1,981,569	0	891,706	1,998,107	0	809,233	804,757,980
2	Cedar St	25	0.1	483.0	4,275	4,275	77,686	78,335	1,560,214	0.50	776,865	22	17,052,186	783,349	20	15,475,052	75,364,866
3	Central Ave (Cedar to Webster)	25	0.1	584.9	13,567	13,567	246,570	248,628	4,951,982	0.50	2,465,702	0	0	2,486,280	0	0	289,653,324
4	Central Ave (Webster to Gould)	25	0.26	477.8	15,178	15,178	717,193	723,178	5,539,889	0.50	2,758,434	2	4,965,180	2,781,455	2	4,505,957	688,270,255
5	Gould St (North of Central)	5	0.02	1445.7	0	0	0	0	0	0.50	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	25	0.1	553.9	15,673	15,673	284,850	287,228	5,720,783	0.50	2,848,505	2	5,981,860	2,872,278	2	5,428,606	316,847,848
7	Hampton Ave	25	0.1	653.5	929	929	16,888	17,029	339,177	0.50	168,884	9	1,519,953	170,293	8	1,379,375	22,166,529
8	Central Ave (Hampton to River Park)	25	0.05	569.1	15,822	15,822	143,776	144,976	5,775,051	0.50	2,875,526	0	575,105	2,899,525	0	521,915	164,323,885
9	River Park St	25	0.06	601.7	74	74	811	817	27,134	0.50	13,511	6	79,713	13,623	5	72,341	979,546
10	Central Ave (East of River Park)	25	0.09	461.7	15,847	15,847	259,203	261,366	5,784,096	0.50	2,880,030	0	144,001	2,904,066	0	130,683	240,345,948
11	Highland Ave (South of West St)	25	0.1	467.9	12,390	12,390	225,178	227,058	4,522,358	0.50	2,251,782	11	24,657,018	2,270,576	10	22,376,523	211,618,322
12	West St (West of Highland)	25	0.08	716.4	8,239	8,239	119,795	120,795	3,007,368	0.50	1,497,435	11	16,771,276	1,509,933	10	15,220,123	172,364,003
13	West St (East of Highland)	25	0.1	569.1	6,938	6,938	126,100	127,152	2,532,521	0.50	1,260,998	17	21,941,369	1,271,522	16	19,912,040	144,121,435
14	Highland Ave (West to Hunnewell)	25	0.12	464.2	13,010	13,010	283,725	286,093	4,748,476	0.50	2,364,372	15	36,174,886	2,384,104	14	32,829,118	264,518,620
15	Hunnewell St (West of Highland)	25	0.13	457.6	3,965	3,965	93,674	94,456	1,447,155	0.50	720,570	59	42,585,710	726,584	53	38,647,014	86,094,706
16	Hunnewell St (East of Highland)	25	0.07	512.0	1,697	1,697	21,595	21,775	619,563	0.50	308,494	16	4,874,208	311,069	14	4,423,399	22,205,511
17	Highland Ave (Hunnewell to Webster)	35	0.28	406.4	12,266	12,266	624,194	629,404	4,477,135	0.50	2,229,265	12	26,528,250	2,247,870	11	24,074,687	509,444,197
18	Webster St (Highland to Central)	25	0.63	505.0	7,124	7,124	815,708	822,516	2,600,356	0.50	1,294,775	46	59,430,169	1,305,581	41	53,933,552	827,274,666
19	Webster St (South of Highland)	25	0.1	569.1	11,089	11,089	201,535	203,217	4,047,511	0.50	2,015,345	6	12,192,839	2,032,165	5	11,065,140	230,336,936
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	473.1	19,266	19,266	840,365	847,379	7,032,267	0.50	3,501,522	21	74,232,262	3,530,745	19	67,366,618	798,422,528
21	Hunting Rd (Highland to Kendrick)	25	0.64	456.5	4,956	4,956	576,456	581,267	1,808,943	0.50	900,713	47	42,738,832	908,230	43	38,785,974	528,493,651
22	Kendrick St (West of Hunting)	25	0.1	490.9	7,719	7,719	140,286	141,457	2,817,429	0.50	1,402,860	16	21,884,624	1,414,569	14	19,860,544	138,306,187
23	Kendrick St (East of Hunting)	25	0.1	963.6	15,549	15,549	282,599	284,957	5,675,559	0.50	2,825,987	4	10,456,152	2,849,572	3	9,489,076	546,890,673
24	Hunting Rd (South of Kendrick)	25	0.12	464.2	10,445	10,445	227,790	229,691	3,812,348	0.50	1,898,253	9	16,135,147	1,914,095	8	14,642,829	212,370,664
25	Gould St (Highland to Wingate)	25	0.09	479.0	11,151	11,151	182,394	183,917	4,070,122	0.50	2,026,604	52	104,471,449	2,043,518	46	94,809,023	175,464,600
26	Wingate Driveway	20	0.04	536.2	508	508	3,693	3,724	185,417	0.50	92,323	7	609,332	93,094	6	552,976	3,977,002
27	Site Driveway	20	0.04	785.1	818	818	5,945	5,994	298,476	0.50	148,618	10	1,493,607	149,858	9	1,355,466	9,373,419
28	Gould St (Wingate to TV Place)	25	0.06	483.0	10,593	10,593	115,516	116,481	3,866,616	0.50	1,925,274	0	96,264	1,941,342	0	87,360	112,064,208
29	TV Place	20	0.05	500.5	620	620	5,629	5,676	226,118	0.50	112,589	10	1,086,485	113,529	9	985,997	5,658,646
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	574.3	10,470	10,470	228,331	230,236	3,821,393	0.50	1,902,756	1	1,712,481	1,918,636	1	1,554,096	263,352,042
31	Noanett St	25	0.06	636.8	1,127	1,127	12,295	12,397	411,535	0.50	204,912	7	1,485,613	206,622	7	1,348,211	15,723,462
32	Business Park	15	0.04	617.5	1,499	1,499	10,899	10,990	547,205	0.50	272,466	12	3,201,472	274,740	11	2,905,372	13,516,739
33	Gould St (Noanett to Station Rd)	25	0.06	574.3	9,478	9,478	103,357	104,219	3,459,604	0.50	1,722,614	0	86,131	1,736,990	0	78,165	119,209,652
34	Station Rd	20	0.07	562.9	1,016	1,016	12,925	13,033	370,833	0.50	184,646	8	1,440,240	186,187	7	1,307,034	14,612,096
35	Gould St (Station Rd to Kearney Rd)	25	0.05	475.3	8,884	8,884	80,726	81,400	3,242,531	0.50	1,614,528	0	0	1,628,003	0	0	77,057,121
36	Kearney Rd	25	0.1	515.1	1,982	1,982	36,029	36,329	723,577	0.50	360,285	10	3,728,952	363,292	9	3,384,066	37,268,065
37	Gould St (Kearney to Ellis)	25	0.06	483.0	7,620	7,620	83,091	83,784	2,781,250	0.50	1,384,846	0	207,727	1,396,404	0	188,515	80,607,588
38	Ellis St (West of Gould)	25	0.02	1245.0	12	12	45	45	4,522	0.50	2,252	8	18,690	2,271	7	16,961	112,608
39	Ellis St (East of Gould)	25	0.09	514.4	904	904	14,794	14,918	330,132	0.50	164,380	10	1,569,830	165,752	9	1,424,639	15,284,425
40	Gould St (Ellis to Central)	25	0.23	458.9	6,641	6,641	277,600	279,917	2,423,984	0.50	1,206,955	291	350,861,939	1,217,029	262	318,411,183	255,817,576
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	432.4	28,807	28,807	628,247	633,491	10,514,483	0.50	5,235,394	0	0	5,279,088	0	0	545,601,769
42	I95 SB Ramp to Highland WB	25	0.24	561.9	5,761	5,761	251,299	253,396	2,102,897	0.50	1,047,079	36	37,171,299	1,055,818	32	33,733,375	283,596,636
43	Highland St WB to I95 SB Ramp	25	0.2	373.7	5,637	5,637	204,912	206,622	2,057,673	0.50	1,024,561	0	0	1,033,112	0	0	153,799,529
44	Highland EB to I95 SB	25	0.23	391.8	3,159	3,159	132,067	133,169	1,153,201	0.50	574,205	0	0	578,997	0	0	103,919,352
45	I95 SB Ramp to Highland EB	25	0.17	531.6	3,345	3,345	103,357	104,219	1,221,037	0.50	607,981	14	8,511,738	613,055	13	7,724,498	110,349,477
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.2	404.0	28,869	28,869	1,049,331	1,058,088	10,537,095	0.50	5,246,653	3	14,165,964	5,290,441	2	12,855,772	851,453,049
47	I95 NB Ramp to Highland WB	25	0.2	506.9	1,425	1,425	51,791	52,223	520,071	0.50	258,955	36	9,348,275	261,116	32	8,483,665	52,728,457
48	Highland St WB to I95 NB Ramp	25	0.21	415.4	9,788	9,788	373,571	376,689	3,572,663	0.50	1,778,908	0	0	1,793,755	0	0	311,647,690
49	Highland EB to I95 NB	25	0.24	407.5	4,584	4,584	199,958	201,627	1,673,273	0.50	833,160	0	0	840,113	0	0	163,635,849
50	I95 NB Ramp to Highland EB	25	0.26	437.3	1,982	1,982	93,674	94,456	723,577	0.50	360,285	14	4,935,907	363,292	12	4,479,392	82,262,062
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	427.1	34,630	34,630	440,561	444,238	12,639,991	0.50	6,293,732	6	35,559,586	6,346,259	5	32,270,727	377,881,385
52	1st Ave (North of Highland)	25	0.03	470.0	211	211	1,148	1,158	76,880	0.50	38,280	22	851,737	38,600	20	772,961	1,084,109
53	1st Ave (South of Highland)	25	0.09	446.0	7,570	7,570	123,826	124,859	2,763,161	0.50	1,375,839	19	25,453,023	1,387,322	17	23,098,907	110,921,007
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	403.6	26,453	26,453	673,058	678,675	9,655,235	0.50	4,807,556	11	53,123,490	4,847,679	10	48,210,168	545,562,267
55	2nd Ave (North of Highland)	25	0.06	483.0	1,735	1,735	18,915	19,073	633,130	0.50	315,250	21	6,762,103	317,881	19	6,136,685	18,349,695
56	2nd Ave (South of Highland)	25	0.1	460.2	10,408	10,408	189,150	190,728	3,798,781	0.50	1,891,497	19	35,276,424	1,907,284	17	32,013,755	174,828,632
57	Highland Ave (East of 2nd Ave)	25	0.1	460.2	21,249	21,249	386,181	389,404	7,755,844	0.50	3,861,807	10	37,459,528	3,894,037	9	33,994,946	356,941,791
58	Site Driveway off TV Place	25	0.03	446.0	0	0	0	0	0	0.50	0	0	0	0	0	0	0
						VMT (per year)	13,311,998	13,423,098									14,041.92
												Arterial	1,182,501,732			1,073,133,713	**Total (tons/year)**

	Weekday	Total
VMT per year	**26,735,096.11**	**26,735,096.11**

	Weekday			Total		
	(g/s)	(g/year)	(tons/year)	(g/s)	(g/year)	(tons/year)
Peak Period	1.0513	1,243,216,656	**1,370.41**			**1,370.41**
Off-Peak Period	1.0513	1,128,233,193	**1,243.66**			**1,243.66**
Total			**2,614.08**	Total (Including Link)		**16,656.00**

557 Highland

Weekday Traffic

Link No.	Roadway Description	Existing			No Build			Build				Build with Mitigation			
		Roadway S.A.F.	Roadway ADT (veh/day)	Seasonal ADT (veh/day)	Roadway ADT (veh/day)	Seasonal ADT (veh/day)	Traffic Increase (existing)	Roadway ADT (veh/day)	Seasonal ADT (veh/day)	Traffic Increase (existing)	Traffic Increase (no-build)	Roadway ADT (veh/day)	Seasonal ADT (veh/day)	Traffic Increase (existing)	Traffic Increase (no-build)
1	Central Ave (West of Cedar)	100%	10,903	10,903	11,709	11,709	7%	12,080	12,080	11%	3%	12,080	12,080	11%	3%
2	Cedar St	100%	4,275	4,275	4,584	4,584	7%	4,832	4,832	13%	5%	4,832	4,832	13%	5%
3	Central Ave (Cedar to Webster)	100%	13,567	13,567	14,558	14,558	7%	15,178	15,178	12%	4%	15,178	15,178	12%	4%
4	Central Ave (Webster to Gould)	100%	15,178	15,178	16,417	16,417	8%	17,036	17,036	12%	4%	17,036	17,036	12%	4%
5	Gould St (North of Central)	100%	0	0	0	0	#DIV/0!	0	0	#DIV/0!	#DIV/0!	0	0	#DIV/0!	#DIV/0!
6	Central Ave (Gould to Hampton)	100%	15,673	15,673	16,912	16,912	8%	17,408	17,408	11%	3%	17,408	17,408	11%	3%
7	Hampton Ave	100%	929	929	991	991	7%	991	991	7%	0%	991	991	7%	0%
8	Central Ave (Hampton to River Park)	100%	15,822	15,822	16,999	16,999	7%	17,495	17,495	11%	3%	17,495	17,495	11%	3%
9	River Park St	100%	74	74	74	74	0%	74	74	0%	0%	74	74	0%	0%
10	Central Ave (East of River Park)	100%	15,847	15,847	17,086	17,086	8%	17,581	17,581	11%	3%	17,581	17,581	11%	3%
11	Highland Ave (South of West St)	100%	12,390	12,390	14,249	14,249	15%	14,744	14,744	19%	3%	14,744	14,744	19%	3%
12	West St (West of Highland)	100%	8,239	8,239	8,983	8,983	9%	9,231	9,231	12%	3%	9,231	9,231	12%	3%
13	West St (East of Highland)	100%	6,938	6,938	7,496	7,496	8%	7,496	7,496	8%	0%	7,496	7,496	8%	0%
14	Highland Ave (West to Hunnewell)	100%	13,010	13,010	14,992	14,992	15%	15,735	15,735	21%	5%	15,735	15,735	21%	5%
15	Hunnewell St (West of Highland)	100%	3,965	3,965	4,275	4,275	8%	4,275	4,275	8%	0%	4,275	4,275	8%	0%
16	Hunnewell St (East of Highland)	100%	1,697	1,697	1,759	1,759	4%	1,759	1,759	4%	0%	1,759	1,759	4%	0%
17	Highland Ave (Hunnewell to Webster)	100%	12,266	12,266	14,187	14,187	16%	14,868	14,868	21%	5%	14,868	14,868	21%	5%
18	Webster St (Highland to Central)	100%	7,124	7,124	7,682	7,682	8%	7,682	7,682	8%	0%	7,682	7,682	8%	0%
19	Webster St (South of Highland)	100%	11,089	11,089	11,832	11,832	7%	11,832	11,832	7%	0%	11,832	11,832	7%	0%
20	Highland Ave (Webster to Hunting/Gould)	100%	19,266	19,266	21,621	21,621	12%	22,302	22,302	16%	3%	22,302	22,302	16%	3%
21	Hunting Rd (Highland to Kendrick)	100%	4,956	4,956	5,452	5,452	10%	5,761	5,761	16%	6%	5,761	5,761	16%	6%
22	Kendrick St (West of Hunting)	100%	7,719	7,719	8,338	8,338	8%	8,338	8,338	8%	0%	8,338	8,338	8%	0%
23	Kendrick St (East of Hunting)	100%	15,549	15,549	16,788	16,788	8%	17,098	17,098	10%	2%	17,098	17,098	10%	2%
24	Hunting Rd (South of Kendrick)	100%	10,445	10,445	11,312	11,312	8%	11,312	11,312	8%	0%	11,312	11,312	8%	0%
25	Gould St (Highland to Wingate)	100%	11,151	11,151	12,080	12,080	8%	18,089	18,089	62%	50%	18,089	18,089	62%	50%
26	Wingate Driveway	100%	508	508	508	508	0%	508	508	0%	0%	508	508	0%	0%
27	Site Driveway	100%	818	818	818	818	0%	6,145	6,145	652%	652%	6,145	6,145	652%	652%
28	Gould St (Wingate to TV Place)	100%	10,593	10,593	11,523	11,523	9%	12,948	12,948	22%	12%	12,948	12,948	22%	12%
29	TV Place	100%	620	620	620	620	0%	2,602	2,602	320%	320%	2,602	2,602	320%	320%
30	Gould St (TV Place to Noanett/Business Park)	100%	10,470	10,470	11,399	11,399	9%	12,452	12,452	19%	9%	12,452	12,452	19%	9%
31	Noanett St	100%	1,127	1,127	1,189	1,189	5%	1,189	1,189	5%	0%	1,189	1,189	5%	0%
32	Business Park	100%	1,499	1,499	1,499	1,499	0%	1,499	1,499	0%	0%	1,499	1,499	0%	0%
33	Gould St (Noanett to Station Rd)	100%	9,478	9,478	10,346	10,346	9%	11,399	11,399	20%	10%	11,399	11,399	20%	10%
34	Station Rd	100%	1,016	1,016	1,016	1,016	0%	1,016	1,016	0%	0%	1,016	1,016	0%	0%
35	Gould St (Station Rd to Kearney Rd)	100%	8,884	8,884	9,751	9,751	10%	10,804	10,804	22%	11%	10,804	10,804	22%	11%
36	Kearney Rd	100%	1,982	1,982	2,106	2,106	6%	2,106	2,106	6%	0%	2,106	2,106	6%	0%
37	Gould St (Kearney to Ellis)	100%	7,620	7,620	8,363	8,363	10%	9,416	9,416	24%	13%	9,416	9,416	24%	13%
38	Ellis St (West of Gould)	100%	12	12	12	12	0%	12	12	0%	0%	12	12	0%	0%
39	Ellis St (East of Gould)	100%	904	904	966	966	7%	966	966	7%	0%	966	966	7%	0%
40	Gould St (Ellis to Central)	100%	6,641	6,641	7,323	7,323	10%	8,376	8,376	26%	14%	8,376	8,376	26%	14%
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	100%	28,807	28,807	32,214	32,214	12%	37,170	37,170	29%	15%	37,170	37,170	29%	15%
42	I95 SB Ramp to Highland WB	100%	5,761	5,761	6,257	6,257	9%	6,629	6,629	15%	6%	6,629	6,629	15%	6%
43	Highland St WB to I95 SB Ramp	100%	5,637	5,637	7,186	7,186	27%	7,186	7,186	27%	0%	7,186	7,186	27%	0%
44	Highland EB to I95 SB	100%	3,159	3,159	3,407	3,407	8%	5,266	5,266	67%	55%	5,266	5,266	67%	55%
45	I95 SB Ramp to Highland EB	100%	3,345	3,345	4,522	4,522	35%	4,522	4,522	35%	0%	4,522	4,522	35%	0%
46	Highland Ave (I95 SB ramp to NB ramp)	100%	28,869	28,869	34,258	34,258	19%	36,984	36,984	28%	8%	36,984	36,984	28%	8%
47	I95 NB Ramp to Highland WB	100%	1,425	1,425	1,549	1,549	9%	1,920	1,920	35%	24%	1,920	1,920	35%	24%
48	Highland St WB to I95 NB Ramp	100%	9,788	9,788	12,452	12,452	27%	12,452	12,452	27%	0%	12,452	12,452	27%	0%
49	Highland EB to I95 NB	100%	4,584	4,584	4,956	4,956	8%	6,815	6,815	49%	38%	6,815	6,815	49%	38%
50	I95 NB Ramp to Highland EB	100%	1,982	1,982	2,850	2,850	44%	2,850	2,850	44%	0%	2,850	2,850	44%	0%
51	Highland Ave (I95 NB Ramps to 1st Ave)	100%	34,630	34,630	43,055	43,055	24%	43,551	43,551	26%	1%	43,551	43,551	26%	1%
52	1st Ave (North of Highland)	100%	211	211	211	211	0%	211	211	0%	0%	211	211	0%	0%
53	1st Ave (South of Highland)	100%	7,570	7,570	12,712	12,712	68%	12,712	12,712	68%	0%	12,712	12,712	68%	0%
54	Highland Ave (1st Ave to 2nd Ave)	100%	26,453	26,453	30,603	30,603	16%	31,099	31,099	18%	2%	31,099	31,099	18%	2%
55	2nd Ave (North of Highland)	100%	1,735	1,735	1,735	1,735	0%	1,735	1,735	0%	0%	1,735	1,735	0%	0%
56	2nd Ave (South of Highland)	100%	10,408	10,408	12,018	12,018	15%	12,018	12,018	15%	0%	12,018	12,018	15%	0%
57	Highland Ave (East of 2nd Ave)	100%	21,249	21,249	25,338	25,338	19%	25,833	25,833	22%	2%	25,833	25,833	22%	2%
58	Site Driveway off TV Place	100%	0	0	0	0	#DIV/0!	1,982	1,982	#DIV/0!	#DIV/0!	1,982	1,982	#DIV/0!	#DIV/0!

557 Highland
Weekday Vehicle Delay

Link No.	Description	Directions	Existing					No Build					Build					Build-Mit				
			Delay By Approach		Adjusted Delay *		Combined	Delay By Approach		Adjusted Delay *		Combined	Delay By Approach		Adjusted Delay *		Combined	Delay By Approach		Adjusted Delay *		Combined
			NB or EB (sec)	SB or WB (sec)	NB or EB (sec)	SB or WB (sec)	Delay (sec)	NB or EB (sec)	SB or WB (sec)	NB or EB (sec)	SB or WB (sec)	Delay (sec)	NB or EB (sec)	SB or WB (sec)	NB or EB (sec)	SB or WB (sec)	Delay (sec)	NB or EB (sec)	SB or WB (sec)	NB or EB (sec)	SB or WB (sec)	Delay (sec)
1	Central Ave (West of Cedar)	2	0.9	0.0	0.9	0	0.45	0.9	0	0.9	0	0.45	1.0	0.0	1	0	0.5	1.0	0	1	0	0.5
2	Cedar St	2	0.0	43.9	0	43.9	21.95	0.0	64.7	0	64.7	32.35	0.0	81.6	0	81.6	40.8	0	81.6	0	81.6	40.8
3	Central Ave (Cedar to Webster)	2	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0.0	0	0	0	0	0	0	0	0	0
4	Central Ave (Webster to Gould)	2	0.0	3.6	0	3.6	1.8	0	4.3	0	4.3	2.15	0.0	4.5	0	4.5	2.25	0	4.5	0	4.5	2.25
5	Gould St (North of Central)	2	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0
6	Central Ave (Gould to Hampton)	2	0.0	4.2	0	4.2	2.1	0.0	4.7	0	4.7	2.35	0.0	4.9	0	4.9	2.45	0	4.9	0	4.9	2.45
7	Hampton Ave	2	18.0	0.0	18	0	9	19.5	0.0	19.5	0	9.75	20.5	0.0	20.5	0	10.25	20.5	0.0	20.5	0	10.25
8	Central Ave (Hampton to River Park)	2	0.0	0.4	0	0.4	0.2	0.0	0.4	0	0.4	0.2	0.0	0.4	0	0.4	0.2	0	0.4	0	0.4	0.2
9	River Park St	2	11.8	0.0	11.8	0	5.9	12.2	0.0	12.2	0	6.1	12.6	0.0	12.6	0	6.3	12.6	0	12.6	0	6.3
10	Central Ave (East of River Park)	2	0.0	0.1	0	0.1	0.05	0.0	0.1	0	0.1	0.05	0.0	0.1	0	0.1	0.05	0	0.1	0	0.1	0.05
11	Highland Ave (South of West St)	2	21.9	0.0	21.9	0	10.95	28.1	0.0	28.1	0	14.05	29.0	0.0	29	0	14.5	26.2	0	26.2	0	13.1
12	West St (West of Highland)	2	22.4	0.0	22.4	0	11.2	22.9	0.0	22.9	0	11.45	23.2	0.0	23.2	0	11.6	27.5	0	27.5	0	13.75
13	West St (East of Highland)	2	0.0	34.8	0	34.8	17.4	0.0	34.9	0	34.9	17.45	0.0	34.9	0	34.9	17.45	0	42.4	0	42.4	21.2
14	Highland Ave (West to Hunnewell)	2	2.3	28.3	2.3	28.3	15.3	2.5	50.7	2.5	50.7	26.6	2.6	72.0	2.6	72	37.3	2.6	53.4	2.6	53.4	28
15	Hunnewell St (West of Highland)	2	118.2	0.0	118.2	0	59.1	356.3	0.0	356.3	0	178.15	492.3	0.0	492.3	0	246.15	492.3	0	492.3	0	246.15
16	Hunnewell St (East of Highland)	2	0.0	31.6	0	31.6	15.8	0.0	42.9	0	42.9	21.45	0.0	53.9	0	53.9	26.95	0	53.9	0	53.9	26.95
17	Highland Ave (Hunnewell to Webster)	2	23.3	0.5	23.3	0.5	11.9	45.2	0.5	45.2	0.5	22.85	47.4	0.5	47.4	0.5	23.95	47.4	0.5	47.4	0.5	23.95
18	Webster St (Highland to Central)	2	76.2	15.6	76.2	15.6	45.9	155.6	44.1	155.6	44.1	99.85	194.6	44.1	194.6	44.1	119.35	194.6	44.1	194.6	44.1	119.35
19	Webster St (South of Highland)	2	12.1	0.0	12.1	0	6.05	29.3	0.0	29.3	0	14.65	29.3	0.0	29.3	0	14.65	29.3	0	29.3	0	14.65
20	Highland Ave (Webster to Hunting/Gould)	2	25.5	16.9	25.5	16.9	21.2	56.7	27.2	56.7	27.2	41.95	59.3	29.3	59.3	29.3	44.3	33.9	29.3	33.9	29.3	31.6
21	Hunting Rd (Highland to Kendrick)	2	69.2	25.7	69.2	25.7	47.45	43.1	24.9	43.1	24.9	34	43.7	24.8	43.7	24.8	34.25	47.2	24.8	47.2	24.8	36
22	Kendrick St (West of Hunting)	2	31.2	0.0	31.2	0	15.6	36.3	0.0	36.3	0	18.15	36.5	0.0	36.5	0	18.25	36.5	0	36.5	0	18.25
23	Kendrick St (East of Hunting)	2	0.0	7.4	0	7.4	3.7	0.0	8.5	0	8.5	4.25	0.0	8.6	0	8.6	4.3	0	8.6	0	8.6	4.3
24	Hunting Rd (South of Kendrick)	2	17.0	0.0	17	0	8.5	15.9	0.0	15.9	0	7.95	15.9	0.0	15.9	0	7.95	15.9	0	15.9	0	7.95
25	Gould St (Highland to Wingate)	2	0.2	102.9	0.2	102.9	51.55	0.2	59.0	0.2	59	29.6	0.2	254.4	0.2	254.4	127.3	11.8	59.3	11.8	59.3	35.55
26	Wingate Driveway	2	13.2	0.0	13.2	0	6.6	13.8	0.0	13.8	0	6.9	14.9	0.0	14.9	0	7.45	43.4	0	43.4	0	21.7
27	Site Driveway	2	0.0	20.1	0	20.1	10.05	0.0	22.8	0	22.8	11.4	0.0	8976.9	0	5000	2500	0	42.9	0	42.9	21.45
28	Gould St (Wingate to TV Place)	2	0.0	0.1	0	0.1	0.05	0.0	0.1	0	0.1	0.05	0.0	0.4	0	0.4	0.2	0	11.3	0	11.3	5.65
29	TV Place	2	0.0	19.3	0	19.3	9.65	0.0	21.7	0	21.7	10.85	0.0	72.7	0	72.7	36.35	0	72.7	0	72.7	36.35
30	Gould St (TV Place to Noanett/Business Park)	2	1.6	0.2	1.6	0.2	0.9	1.8	0.2	1.8	0.2	1	1.6	0.5	1.6	0.5	1.05	1.6	0.5	1.6	0.5	1.05
31	Noanett St	2	14.5	0.0	14.5	0	7.25	15.6	0.0	15.6	0	7.8	16.6	0.0	16.6	0	8.3	16.6	0	16.6	0	8.3
32	Business Park	2	0.0	23.5	0	23.5	11.75	0.0	27.8	0	27.8	13.9	0.0	33.9	0	33.9	16.95	0	33.9	0	33.9	16.95
33	Gould St (Noanett to Station Rd)	2	0.0	0.1	0	0.1	0.05	0.0	0.1	0	0.1	0.05	0.0	0.1	0	0.1	0.05	0	0.1	0	0.1	0.05
34	Station Rd	2	0.0	15.6	0	15.6	7.8	0.0	17.0	0	17	8.5	0.0	19.0	0	19	9.5	0	19	0	19	9.5
35	Gould St (Station Rd to Kearney Rd)	2	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0
36	Kearney Rd	2	0.0	20.7	0	20.7	10.35	0.0	24.6	0	24.6	12.3	0.0	30.0	0	30	15	0	30	0	30	15
37	Gould St (Kearney to Ellis)	2	0.0	0.3	0	0.3	0.15	0.0	0.3	0	0.3	0.15	0.0	0.3	0	0.3	0.15	0	0.3	0	0.3	0.15
38	Ellis St (West of Gould)	2	16.6	0.0	16.6	0	8.3	18.1	0.0	18.1	0	9.05	20.5	0	20.5	0	10.25	20.5	0	20.5	0	10.25
39	Ellis St (East of Gould)	2	0.0	19.1	0	19.1	9.55	0.0	21.9	0	21.9	10.95	0.0	26.1	0	26.1	13.05	0	26.1	0	26.1	13.05
40	Gould St (Ellis to Central)	2	581.4	0.0	581.4	0	290.7	885.7	0.0	885.7	0	442.85	885.7	0	885.7	0	442.85	885.7	0	885.7	0	442.85
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	2	0.0	23.1	0	23.1	0	0.0	63.8	0	63.8	0	0	84	0	84	0	0	60.7	0	60.7	0
42	I95 SB Ramp to Highland WB	1	0.0	35.5	0	35.5	35.5	0.0	68.6	0	68.6	68.6	0	96.9	0	96.9	96.9	0	96.9	0	96.9	96.9
43	Highland St WB to I95 SB Ramp	1	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Highland EB to I95 SB	1	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	I95 SB Ramp to Highland EB	1	14.0	0.0	14	0	14	14.5	0.0	14.5	0	14.5	27.3	0	27.3	0	27.3	27.3	0	27.3	0	27.3
46	Highland Ave (I95 SB ramp to NB ramp)	2	5.4	0.0	5.4	0	2.7	6.9	0	6.9	0	3.45	6.7	0	6.7	0	3.35	6.7	0	6.7	0	3.35
47	I95 NB Ramp to Highland WB	1	0.0	36.1	0	36.1	36.1	0	88.4	0	88.4	88.4	0	137.5	0	137.5	137.5	0	137.5	0	137.5	137.5
48	Highland St WB to I95 NB Ramp	1	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	Highland EB to I95 NB	1	0.0	0.0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	I95 NB Ramp to Highland EB	1	13.7	0.0	13.7	0	13.7	15.0	0	15	0	15	16.6	0	16.6	0	16.6	16.6	0	16.6	0	16.6
51	Highland Ave (I95 NB Ramps to 1st Ave)	2	11.3	0.0	11.3	0	5.65	118.4	0	118.4	0	59.2	19	0	19	0	9.5	17.4	0	17.4	0	8.7
52	1st Ave (North of Highland)	2	0.0	44.5	0	44.5	22.25	0.0	44.5	0	44.5	22.25	0	44.5	0	44.5	22.25	0	52.1	0	52.1	26.05
53	1st Ave (South of Highland)	2	37.0	0.0	37	0	18.5	25.7	0.0	25.7	0	12.85	25.7	0	25.7	0	12.85	42.1	0	42.1	0	21.05
54	Highland Ave (1st Ave to 2nd Ave)	2	4.9	17.2	4.9	17.2	11.05	19.3	150.5	19.3	150.5	84.9	19.6	152.2	19.6	152.2	85.9	19.6	76.8	19.6	76.8	48.2
55	2nd Ave (North of Highland)	2	0.0	42.9	0	42.9	21.45	0	41.8	0	41.8	20.9	0	41.8	0	41.8	20.9	0	41.8	0	41.8	20.9
56	2nd Ave (South of Highland)	2	37.3	0.0	37.3	0	18.65	38.0	0	38	0	19	38	0	38	0	19	38	0	38	0	19
57	Highland Ave (East of 2nd Ave)	2	0.0	19.4	0	19.4	9.7	0	26.9	0	26.9	13.45	0	29.3	0	29.3	14.65	0	29.3	0	29.3	14.65

PM PEAK CONDITION
DELAY BY APPROACH (seconds)

		Existing				No Build				Build				Build-Mit			
		EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
1	1: Central Ave & Cedar St	0.9	0.0		43.9	0.9	0.0		64.7	1.0	0.0		81.6	1.0	0.0		81.6
2	2: Webster St & Central Ave	0.0	3.6	76.2		0.0	4.3	155.6		0.0	4.5	194.6		0.0	4.5	194.6	
3	3: Gould St & Central Ave	0.0	4.2	581.4		0.0	4.7	885.7		0.0	4.9	885.7		0.0	4.9	885.7	
4	4: Hampton Ave & Central Ave	0.0	0.4	18.0		0.0	0.4	19.5		0.0	0.4	20.5		0.0	0.4	20.5	
5	5: River Park St & Central Ave	0.0	0.1	11.8		0.0	0.1	12.2		0.0	0.1	12.6		0.0	0.1	12.6	
6	6: Gould St & Driveway/Ellis St	16.6	19.1	0.0	0.0	18.1	21.9	0.0	0.0	20.5	26.1	0.0	0.0	20.5	26.1	0.0	0.0
7	7: Gould St & Kearney Rd		20.7	0.0	0.3		24.6	0.0	0.3		30.0	0.0	0.3		30.0	0.0	0.3
8	8: Gould St & Station Rd		15.6	0.0	0.0		17.0	0.0	0.0		19.0	0.0	0.0		19.0	0.0	0.0
9	9: Gould St & Noanett Rd/Driveway	14.5	23.5	1.6	0.1	15.6	27.8	1.8	0.1	16.6	33.9	1.6	0.1	16.6	33.9	1.6	0.1
10	10: Gould St & TV Place		19.3	0.0	0.2		21.7	0.0	0.2		72.7	0.0	0.5		72.7	0.0	0.5
11	11: Gould St & Windgate Dwy/Muzi Ford Dwy	13.2	20.1	0.2	0.1	13.8	22.8	0.2	0.1	14.9	8976.9	0.2	0.4	***43.4***	***42.9***	***11.8***	***11.3***
12	12: Highland Ave & West St	22.4	34.8	21.9	28.3	22.9	34.9	28.1	50.7	23.2	34.9	29.0	72.0	***27.5***	***42.4***	***26.2***	***53.4***
13	13: Highland Ave & Hunnewell St	118.2	31.6	2.3	0.5	356.3	42.9	2.5	0.5	492.3	53.9	2.6	0.5	492.3	53.9	2.6	0.5
14	14: Webster St & Highland Ave	23.3	16.9	12.1	15.6	45.2	27.2	29.3	44.1	47.4	29.3	29.3	44.1	***47.4***	***29.3***	***29.3***	***44.1***
15	15: Hunting Rd/Gould St & Highland Ave	25.5	23.1	69.2	102.9	56.7	63.8	43.1	59.0	59.3	84.0	43.7	254.4	***33.9***	***60.7***	***47.2***	***59.3***
16	16: I-95 SB Ramps & Highland Ave	0.0	0.0	14.0	35.5	0.0	0.0	14.5	68.6	0.0	0.0	27.3	96.9	0.0	0.0	27.3	96.9
17	18: 1st Ave/Driveway & Highland Ave	11.3	17.2	37.0	44.5	118.4	150.5	25.7	44.5	19.0	152.2	25.7	44.5	***17.4***	***76.8***	***42.1***	***52.1***
18	19: 2nd Ave/Staples Dwy & Highland Ave	4.9	19.4	37.3	42.9	19.3	26.9	38.0	41.8	19.6	29.3	38.0	41.8	19.6	29.3	38.0	41.8
19	20: Hunting Rd & Kendrick St	31.2	7.4	17.0	25.7	36.3	8.5	15.9	24.9	36.5	8.6	15.9	24.8	***36.5***	***8.6***	***15.9***	***24.8***
20	171: Highland Ave WB & I-95 NB Ramps		0.0		36.1		0.0		88.4		0.0		137.5	0.0	0.0	0.0	137.5
21	172: I-95 NB Ramps & Highland Ave EB	5.4	0.0	13.7		6.9	0.0	15.0		6.7	0.0	16.6		6.7	0.0	16.6	0.0

557 Highland

Weekday Average Daily Traffic (ADT) for Mesoscale Roadway Network

	Roadway Segments	Speed (mph)	Existing Volume (ADT)	2029 No-Build Volume (ADT)	2029 Build Volume (ADT)	2029 Build-Mit Volume (ADT)	K Factor	S.A.F.	Unadjusted PM Peak Hour			
									Existing	No-Build	Build	Build-Mit
							8.1%	1.00				
1	Central Ave (West of Cedar)	25	10,903	11,709	12,080	12,080			880	945	975	975
2	Cedar St	25	4,275	4,584	4,832	4,832			345	370	390	390
3	Central Ave (Cedar to Webster)	25	13,567	14,558	15,178	15,178			1095	1175	1225	1225
4	Central Ave (Webster to Gould)	25	15,178	16,417	17,036	17,036			1225	1325	1375	1375
5	Gould St (North of Central)	5	0	0	0	0			0	0	0	0
6	Central Ave (Gould to Hampton)	25	15,673	16,912	17,408	17,408			1265	1365	1405	1405
7	Hampton Ave	25	929	991	991	991			75	80	80	80
8	Central Ave (Hampton to River Park)	25	15,822	16,999	17,495	17,495			1277	1372	1412	1412
9	River Park St	25	74	74	74	74			6	6	6	6
10	Central Ave (East of River Park)	25	15,847	17,086	17,581	17,581			1279	1379	1419	1419
11	Highland Ave (South of West St)	25	12,390	14,249	14,744	14,744			1000	1150	1190	1190
12	West St (West of Highland)	25	8,239	8,983	9,231	9,231			665	725	745	745
13	West St (East of Highland)	25	6,938	7,496	7,496	7,496			560	605	605	605
14	Highland Ave (West to Hunnewell)	25	13,010	14,992	15,735	15,735			1050	1210	1270	1270
15	Hunnewell St (West of Highland)	25	3,965	4,275	4,275	4,275			320	345	345	345
16	Hunnewell St (East of Highland)	25	1,697	1,759	1,759	1,759			137	142	142	142
17	Highland Ave (Hunnewell to Webster)	35	12,266	14,187	14,868	14,868			990	1145	1200	1200
18	Webster St (Highland to Central)	25	7,124	7,682	7,682	7,682			575	620	620	620
19	Webster St (South of Highland)	25	11,089	11,832	11,832	11,832			895	955	955	955
20	Highland Ave (Webster to Hunting/Gould)	35	19,266	21,621	22,302	22,302			1555	1745	1800	1800
21	Hunting Rd (Highland to Kendrick)	25	4,956	5,452	5,761	5,761			400	440	465	465
22	Kendrick St (West of Hunting)	25	7,719	8,338	8,338	8,338			623	673	673	673
23	Kendrick St (East of Hunting)	25	15,549	16,788	17,098	17,098			1255	1355	1380	1380
24	Hunting Rd (South of Kendrick)	25	10,445	11,312	11,312	11,312			843	913	913	913
25	Gould St (Highland to Wingate)	25	11,151	12,080	18,089	18,089			900	975	1460	1460
26	Wingate Driveway	20	508	508	508	508			41	41	41	41
27	Site Driveway	20	818	818	6,145	6,145			66	66	496	496
28	Gould St (Wingate to TV Place)	25	10,593	11,523	12,948	12,948			855	930	1045	1045
29	TV Place	20	620	620	2,602	2,602			50	50	210	210
30	Gould St (TV Place to Noanett/Business Park)	25	10,470	11,399	12,452	12,452			845	920	1005	1005
31	Noanett St	25	1,127	1,189	1,189	1,189			91	96	96	96
32	Business Park	15	1,499	1,499	1,499	1,499			121	121	121	121
33	Gould St (Noanett to Station Rd)	25	9,478	10,346	11,399	11,399			765	835	920	920
34	Station Rd	20	1,016	1,016	1,016	1,016			82	82	82	82
35	Gould St (Station Rd to Kearney Rd)	25	8,884	9,751	10,804	10,804			717	787	872	872
36	Kearney Rd	25	1,982	2,106	2,106	2,106			160	170	170	170
37	Gould St (Kearney to Ellis)	25	7,620	8,363	9,416	9,416			615	675	760	760
38	Ellis St (West of Gould)	25	12	12	12	12			1	1	1	1
39	Ellis St (East of Gould)	25	904	966	966	966			73	78	78	78
40	Gould St (Ellis to Central)	25	6,641	7,323	8,376	8,376			536	591	676	676
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	28,807	32,214	37,170	37,170			2325	2600	3000	3000
42	I95 SB Ramp to Highland WB	25	5,761	6,257	6,629	6,629			465	505	535	535
43	Highland St WB to I95 SB Ramp	25	5,637	7,186	7,186	7,186			455	580	580	580
44	Highland EB to I95 SB	25	3,159	3,407	5,266	5,266			255	275	425	425
45	I95 SB Ramp to Highland EB	25	3,345	4,522	4,522	4,522			270	365	365	365
46	Highland Ave (I95 SB ramp to NB ramp)	45	28,869	34,258	36,984	36,984			2330	2765	2985	2985
47	I95 NB Ramp to Highland WB	25	1,425	1,549	1,920	1,920			115	125	155	155
48	Highland St WB to I95 NB Ramp	25	9,788	12,452	12,452	12,452			790	1005	1005	1005
49	Highland EB to I95 NB	25	4,584	4,956	6,815	6,815			370	400	550	550
50	I95 NB Ramp to Highland EB	25	1,982	2,850	2,850	2,850			160	230	230	230
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	34,630	43,055	43,551	43,551			2795	3475	3515	3515
52	1st Ave (North of Highland)	25	211	211	211	211			17	17	17	17
53	1st Ave (South of Highland)	25	7,570	12,712	12,712	12,712			611	1026	1026	1026
54	Highland Ave (1st Ave to 2nd Ave)	35	26,453	30,603	31,099	31,099			2135	2470	2510	2510
55	2nd Ave (North of Highland)	25	1,735	1,735	1,735	1,735			140	140	140	140
56	2nd Ave (South of Highland)	25	10,408	12,018	12,018	12,018			840	970	970	970
57	Highland Ave (East of 2nd Ave)	25	21,249	25,338	25,833	25,833			1715	2045	2085	2085
58	Site Driveway off TV Place	25	0	0	1,982	1,982			0	0	160	160

557 Highland

Weekday ATR Volumes

Monday, September 14, 2020					Tuesday, September 15, 2020				
			Peak Period Data					Peak Period Data	
Begin Time	Volume	V/C Ratio	Hours	Volume	Begin Time	Volume	V/C Ratio	Hours	Volume
12:00 AM	38	0.01	0	0	12:00 AM	42	0.01	0	0
1:00 AM	30	0.01	0	0	1:00 AM	31	0.01	0	0
2:00 AM	8	0.00	0	0	2:00 AM	15	0.00	0	0
3:00 AM	23	0.01	0	0	3:00 AM	33	0.01	0	0
4:00 AM	68	0.02	0	0	4:00 AM	47	0.01	0	0
5:00 AM	205	0.05	0	0	5:00 AM	183	0.04	0	0
6:00 AM	656	0.15	0	0	6:00 AM	621	0.15	0	0
7:00 AM	1276	0.30	1	1,276	7:00 AM	1169	0.28	0	0
8:00 AM	1369	0.32	1	1,369	8:00 AM	1250	0.29	0	0
9:00 AM	1131	0.27	0	0	9:00 AM	1051	0.25	0	0
10:00 AM	1090	0.26	0	0	10:00 AM	1159	0.27	0	0
11:00 AM	1254	0.30	0	0	11:00 AM	1236	0.29	0	0
12:00 PM	1277	0.30	1	1,277	12:00 PM	1341	0.32	1	1,341
1:00 PM	1284	0.30	1	1,284	1:00 PM	1298	0.31	1	1,298
2:00 PM	1289	0.30	1	1,289	2:00 PM	1439	0.34	1	1,439
3:00 PM	1350	0.32	1	1,350	3:00 PM	1453	0.34	1	1,453
4:00 PM	1278	0.30	1	1,278	4:00 PM	1412	0.33	1	1,412
5:00 PM	1233	0.29	0	0	5:00 PM	1331	0.31	1	1,331
6:00 PM	986	0.23	0	0	6:00 PM	1036	0.24	0	0
7:00 PM	657	0.15	0	0	7:00 PM	635	0.15	0	0
8:00 PM	351	0.08	0	0	8:00 PM	415	0.10	0	0
9:00 PM	214	0.05	0	0	9:00 PM	229	0.05	0	0
10:00 PM	160	0.04	0	0	10:00 PM	127	0.03	0	0
11:00 PM	90	0.02	0	0	11:00 PM	88	0.02	0	0
Total	**17,317**		**7**	**9,123**	**Total**	**17,641**		**6**	**8,274**

Roadway Capacity	Crit. V/C	Critical Capacity
4,250	30%	1,275

Peak Hour (K) Factor	0.079
Peak Period Volume Factor	0.527

Roadway Capacity	Crit. V/C	Critical Capacity
4,250	30%	1,275

Peak Hour (K) Factor	0.082
Peak Period Volume Factor	0.469

Average Data

Peak Hour (K) Factor	0.081
Peak Period Volume Factor	0.498

557 Highland

Emissions Factors By Link (g/mi)

Emission Factors From MOVES3

	Roadway Segments	2022 Existing			2029 No Build			2029 Build			2029 Build-Mit		
		NO_x	VOC	CO_2	NO_x	VOC	CO_2	NO_x	VOC	CO_2	NO_x	VOC	CO_2
1	Central Ave (West of Cedar)	0.25	0.26	449.37	0.12	0.17	383.67	0.12	0.17	383.67	0.12	0.17	383.67
2	Cedar St	0.28	0.83	483.04	0.13	0.54	412.58	0.13	0.54	412.58	0.13	0.54	412.58
3	Central Ave (Cedar to Webster)	0.37	0.85	584.92	0.17	0.54	500.20	0.17	0.54	500.20	0.17	0.54	500.20
4	Central Ave (Webster to Gould)	0.27	0.39	477.84	0.13	0.24	408.08	0.13	0.24	408.08	0.13	0.24	408.08
5	Gould St (North of Central)	0.79	3.97	1445.67	0.42	2.59	1237.36	0.42	2.59	1237.36	0.42	2.59	1237.36
6	Central Ave (Gould to Hampton)	0.34	0.84	553.85	0.16	0.54	473.39	0.16	0.54	473.39	0.16	0.54	473.39
7	Hampton Ave	0.43	0.86	653.54	0.20	0.55	558.89	0.20	0.55	558.89	0.20	0.55	558.89
8	Central Ave (Hampton to River Park)	0.36	1.57	569.08	0.17	1.02	486.47	0.17	1.02	486.47	0.17	1.02	486.47
9	River Park St	0.39	1.33	601.67	0.18	0.86	514.51	0.18	0.86	514.51	0.18	0.86	514.51
10	Central Ave (East of River Park)	0.26	0.91	461.70	0.12	0.59	394.24	0.12	0.59	394.24	0.12	0.59	394.24
11	Highland Ave (South of West St)	0.27	0.83	467.94	0.12	0.54	399.60	0.12	0.54	399.60	0.12	0.54	399.60
12	West St (West of Highland)	0.48	1.05	716.42	0.22	0.67	612.77	0.22	0.67	612.77	0.22	0.67	612.77
13	West St (East of Highland)	0.36	0.84	569.08	0.17	0.54	486.47	0.17	0.54	486.47	0.17	0.54	486.47
14	Highland Ave (West to Hunnewell)	0.26	0.71	464.22	0.12	0.46	396.41	0.12	0.46	396.41	0.12	0.46	396.41
15	Hunnewell St (West of Highland)	0.26	0.66	457.63	0.12	0.43	390.75	0.12	0.43	390.75	0.12	0.43	390.75
16	Hunnewell St (East of Highland)	0.30	1.15	512.01	0.14	0.74	437.30	0.14	0.74	437.30	0.14	0.74	437.30
17	Highland Ave (Hunnewell to Webster)	0.23	0.34	406.39	0.10	0.22	347.47	0.10	0.22	347.47	0.10	0.22	347.47
18	Webster St (Highland to Central)	0.30	0.23	504.98	0.14	0.14	431.32	0.14	0.14	431.32	0.14	0.14	431.32
19	Webster St (South of Highland)	0.36	0.84	569.08	0.17	0.54	486.47	0.17	0.54	486.47	0.17	0.54	486.47
20	Highland Ave (Webster to Hunting/Gould)	0.29	0.39	473.07	0.13	0.25	404.59	0.13	0.25	404.59	0.13	0.25	404.59
21	Hunting Rd (Highland to Kendrick)	0.26	0.22	456.49	0.12	0.14	389.76	0.12	0.14	389.76	0.12	0.14	389.76
22	Kendrick St (West of Hunting)	0.29	0.83	490.89	0.13	0.54	419.31	0.13	0.54	419.31	0.13	0.54	419.31
23	Kendrick St (East of Hunting)	0.67	0.92	963.59	0.29	0.58	824.34	0.29	0.58	824.34	0.29	0.58	824.34
24	Hunting Rd (South of Kendrick)	0.26	0.71	464.22	0.12	0.46	396.41	0.12	0.46	396.41	0.12	0.46	396.41
25	Gould St (Highland to Wingate)	0.28	0.91	479.00	0.13	0.59	409.10	0.13	0.59	409.10	0.13	0.59	409.10
26	Wingate Driveway	0.31	1.94	536.22	0.15	1.26	458.22	0.15	1.26	458.22	0.15	1.26	458.22
27	Site Driveway	0.52	1.97	785.11	0.25	1.28	672.05	0.25	1.28	672.05	0.25	1.28	672.05
28	Gould St (Wingate to TV Place)	0.28	1.31	483.04	0.13	0.85	412.58	0.13	0.85	412.58	0.13	0.85	412.58
29	TV Place	0.27	1.57	500.50	0.13	1.02	427.55	0.13	1.02	427.55	0.13	1.02	427.55
30	Gould St (TV Place to Noanett/Business Park)	0.36	0.72	574.29	0.17	0.46	490.93	0.17	0.46	490.93	0.17	0.46	490.93
31	Noanett St	0.41	1.34	636.78	0.19	0.86	544.62	0.19	0.86	544.62	0.19	0.86	544.62
32	Business Park	0.34	1.96	617.54	0.17	1.27	527.95	0.17	1.27	527.95	0.17	1.27	527.95
33	Gould St (Noanett to Station Rd)	0.36	1.33	574.29	0.17	0.86	490.93	0.17	0.86	490.93	0.17	0.86	490.93
34	Station Rd	0.33	1.16	562.91	0.16	0.75	481.21	0.16	0.75	481.21	0.16	0.75	481.21
35	Gould St (Station Rd to Kearney Rd)	0.27	1.55	475.29	0.13	1.01	405.93	0.13	1.01	405.93	0.13	1.01	405.93
36	Kearney Rd	0.31	0.84	515.05	0.14	0.54	439.93	0.14	0.54	439.93	0.14	0.54	439.93
37	Gould St (Kearney to Ellis)	0.28	1.31	483.04	0.13	0.85	412.58	0.13	0.85	412.58	0.13	0.85	412.58
38	Ellis St (West of Gould)	0.90	3.88	1245.01	0.38	2.51	1067.74	0.38	2.51	1067.74	0.38	2.51	1067.74
39	Ellis St (East of Gould)	0.31	0.92	514.42	0.14	0.59	439.38	0.14	0.59	439.38	0.14	0.59	439.38
40	Gould St (Ellis to Central)	0.26	0.42	458.85	0.12	0.27	391.78	0.12	0.27	391.78	0.12	0.27	391.78
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	0.26	0.68	432.42	0.11	0.44	370.27	0.11	0.44	370.27	0.11	0.44	370.27
42	I95 SB Ramp to Highland WB	0.35	0.42	561.92	0.16	0.27	480.30	0.16	0.27	480.30	0.16	0.27	480.30
43	Highland St WB to I95 SB Ramp	0.18	0.45	373.72	0.08	0.29	318.73	0.08	0.29	318.73	0.08	0.29	318.73
44	Highland EB to I95 SB	0.20	0.41	391.80	0.09	0.26	334.22	0.09	0.26	334.22	0.09	0.26	334.22
45	I95 SB Ramp to Highland EB	0.32	0.54	531.61	0.15	0.34	454.27	0.15	0.34	454.27	0.15	0.34	454.27
46	Highland Ave (I95 SB ramp to NB ramp)	0.23	0.43	404.03	0.10	0.28	345.95	0.10	0.28	345.95	0.10	0.28	345.95
47	I95 NB Ramp to Highland WB	0.30	0.47	506.93	0.14	0.30	432.99	0.14	0.30	432.99	0.14	0.30	432.99
48	Highland St WB to I95 NB Ramp	0.22	0.44	415.39	0.10	0.28	354.37	0.10	0.28	354.37	0.10	0.28	354.37
49	Highland EB to I95 NB	0.21	0.40	407.47	0.10	0.26	347.62	0.10	0.26	347.62	0.10	0.26	347.62
50	I95 NB Ramp to Highland EB	0.24	0.38	437.26	0.11	0.24	373.19	0.11	0.24	373.19	0.11	0.24	373.19
51	Highland Ave (I95 NB Ramps to 1st Ave)	0.25	1.11	427.08	0.11	0.72	365.67	0.11	0.72	365.67	0.11	0.72	365.67
52	1st Ave (North of Highland)	0.27	2.52	470.04	0.12	1.64	401.40	0.12	1.64	401.40	0.12	1.64	401.40
53	1st Ave (South of Highland)	0.25	0.91	446.03	0.11	0.59	380.77	0.11	0.59	380.77	0.11	0.59	380.77
54	Highland Ave (1st Ave to 2nd Ave)	0.23	0.60	403.60	0.10	0.39	345.10	0.10	0.39	345.10	0.10	0.39	345.10
55	2nd Ave (North of Highland)	0.28	1.31	483.04	0.13	0.85	412.58	0.13	0.85	412.58	0.13	0.85	412.58
56	2nd Ave (South of Highland)	0.26	0.83	460.22	0.12	0.53	392.95	0.12	0.53	392.95	0.12	0.53	392.95
57	Highland Ave (East of 2nd Ave)	0.26	0.83	460.22	0.12	0.53	392.95	0.12	0.53	392.95	0.12	0.53	392.95
58	Site Driveway off TV Place	0.25	2.52	446.03	0.11	1.64	380.77	0.11	1.64	380.77	0.11	1.64	380.77

557 Highland

Mesoscale Roadway Data

Link No.	Description	Speed (mph)	Link Length (miles)	Start Elev (ft)	Finish Elev (ft)	Grade (%)	Directions
1	Central Ave (West of Cedar)	25	0.45	133	135	0.1	2
2	Cedar St	25	0.10	133	138	0.9	2
3	Central Ave (Cedar to Webster)	25	0.10	133	115	3.4	2
4	Central Ave (Webster to Gould)	25	0.26	115	104	0.8	2
5	Gould St (North of Central)	5	0.02	104	110	5.7	2
6	Central Ave (Gould to Hampton)	25	0.10	105	119	2.7	2
7	Hampton Ave	25	0.10	119	94	4.7	2
8	Central Ave (Hampton to River Park)	25	0.05	119	111	3.0	2
9	River Park St	25	0.06	111	99	3.8	2
10	Central Ave (East of River Park)	25	0.09	111	113	0.4	2
11	Highland Ave (South of West St)	25	0.10	173	170	0.6	2
12	West St (West of Highland)	25	0.08	173	147	6.2	2
13	West St (East of Highland)	25	0.10	173	189	3.0	2
14	Highland Ave (West to Hunnewell)	25	0.12	173	176	0.5	2
15	Hunnewell St (West of Highland)	25	0.13	176	178	0.3	2
16	Hunnewell St (East of Highland)	25	0.07	176	182	1.6	2
17	Highland Ave (Hunnewell to Webster)	35	0.28	176	165	0.7	2
18	Webster St (Highland to Central)	25	0.63	165	116	1.5	2
19	Webster St (South of Highland)	25	0.10	165	181	3.0	2
20	Highland Ave (Webster to Hunting/Gould)	35	0.24	165	137	2.2	2
21	Hunting Rd (Highland to Kendrick)	25	0.64	137	146	0.3	2
22	Kendrick St (West of Hunting)	25	0.10	147	153	1.1	2
23	Kendrick St (East of Hunting)	25	0.10	147	88	11.2	2
24	Hunting Rd (South of Kendrick)	25	0.12	147	150	0.5	2
25	Gould St (Highland to Wingate)	25	0.09	137	133	0.8	2
26	Wingate Driveway	20	0.04	133	131	0.9	2
27	Site Driveway	20	0.04	133	147	6.6	2
28	Gould St (Wingate to TV Place)	25	0.06	133	130	0.9	2
29	TV Place	20	0.05	133	133	0.0	2
30	Gould St (TV Place to Noanett/Business Park)	25	0.12	133	113	3.2	2
31	Noanett St	25	0.06	115	101	4.4	2
32	Business Park	15	0.04	115	113	0.9	2
33	Gould St (Noanett to Station Rd)	25	0.06	115	105	3.2	2
34	Station Rd	20	0.07	105	99	1.6	2
35	Gould St (Station Rd to Kearney Rd)	25	0.05	105	103	0.8	2
36	Kearney Rd	25	0.10	103	94	1.7	2
37	Gould St (Kearney to Ellis)	25	0.06	103	100	0.9	2
38	Ellis St (West of Gould)	25	0.02	100	120	18.9	2
39	Ellis St (East of Gould)	25	0.09	100	92	1.7	2
40	Gould St (Ellis to Central)	25	0.23	100	104	0.3	2
41	Highland Ave (Hunting/Gould to I95 SB Ramps)	45	0.12	136	125	1.7	2
42	I95 SB Ramp to Highland WB	25	0.24	91	127	2.8	1
43	Highland St WB to I95 SB Ramp	25	0.20	117	93	-2.3	1
44	Highland EB to I95 SB	25	0.23	128	108	-1.6	1
45	I95 SB Ramp to Highland EB	25	0.17	101	120	2.1	1
46	Highland Ave (I95 SB ramp to NB ramp)	45	0.20	117	105	1.1	2
47	I95 NB Ramp to Highland WB	25	0.20	94	110	1.5	1
48	Highland St WB to I95 NB Ramp	25	0.21	101	91	-0.9	1
49	Highland EB to I95 NB	25	0.24	111	96	-1.2	1
50	I95 NB Ramp to Highland EB	25	0.26	103	100	-0.2	1
51	Highland Ave (I95 NB Ramps to 1st Ave)	45	0.07	104	98	1.6	2
52	1st Ave (North of Highland)	25	0.03	98	97	0.6	2
53	1st Ave (South of Highland)	25	0.09	98	98	0.0	2
54	Highland Ave (1st Ave to 2nd Ave)	35	0.14	98	93	0.7	2
55	2nd Ave (North of Highland)	25	0.06	93	96	0.9	2
56	2nd Ave (South of Highland)	25	0.10	93	95	0.4	2
57	Highland Ave (East of 2nd Ave)	25	0.10	93	91	0.4	2
58	Site Driveway off TV Place	25	0.03	125	125	0.0	2

Project Data

TRAFFIC DATA

Project Name	557 Highland
Project County	Norfolk, MA
Existing Year	2022
No-Build Year	2029
Build Year	2029
Build with Mitigation Year	2029
Seasonal Adjustment Factor	1.00
K-Factor	8.1%

Idle Emission Factors

Year	NOx (g/hr)	VOC (g/hr)	CO2 (g/hr)
2022	2.15	1.17	3,784.84
2029	1.13	0.85	3,231.13

APPENDIX F: ENF Certificate and Comment Letters

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

Bethany A. Card
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1081
http://www.mass.gov/eea

May 9, 2022

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: 557 Highland Avenue
PROJECT MUNICIPALITY	: Needham
PROJECT WATERSHED	: Charles River
EEA NUMBER	: 16546
PROJECT PROPONENT	: 557 Highland, LLC
DATE NOTICED IN MONITOR	: April 8, 2022

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G.L. c. 30, ss. 61-62L) and Section 11.06 of the MEPA Regulations (301 CMR 11.00), I hereby determine that this project **requires** the preparation of a mandatory Draft Environmental Impact Report (DEIR).

Project Description

As described in the Environmental Notification Form (ENF), the project consists of redevelopment of a former car dealership (Muzi Motors) and carwash site to construct an office/laboratory research facility with below-grade parking and a standalone parking structure. The new building is intended for life science tenants and will contain ancillary retail, café, daycare, and fitness amenities based on market demand.

According to the ENF, the proposed development program will include 260,500 square feet (sf) of office space, 260,500 sf of lab/research development space, and 10,000 sf of retail space. The project will include 310,000 sf of below grade parking on two levels, and a 297,000 sf free-standing parking garage with two stories below grade and five stories above. A surface parking lot with approximately 44 spaces is proposed for retail space visitors. As described in the ENF, the office/lab buildings are designed as one structure articulated into three distinct parts: a three-story South Building, a five-story North Building, and a two-story Atrium that connects the two buildings.

The project includes open space improvements including an 8-foot wide walking path around the perimeter of the site, onsite bicycle lanes, bicycle parking, and a hardscape/softscape plaza space for the retail tenants to offer outdoor seating. Site redevelopment will include stormwater management, landscape improvements and utility connections. The ENF states the primary access will be signalized and other onsite and offsite transportation improvements including on-road bike lanes and intersection improvements are proposed.

Project Site

The 9.27-acre project site is located at 557 Highland Avenue in Needham. The site is bordered by Highland Avenue to the south, Interstate 95/Route 128 to the east, Gould Street to the west, and a private way (TV Place) and commercial buildings (WCVB/Channel 5) and parking lots to the north. The site previously served as a car dealership and carwash and was entirely paved. The site buildings (39,750 sf) have been demolished and soil remediation activities have occurred. The entire site is currently paved or contains gravel (in remediation locations). The Needham Heights Massachusetts Bay Transportation Authority (MBTA) commuter rail station is within 0.8 miles southwest of the project site and local MBTA bus route #59 currently stops at two locations within one-half mile of the project site. A portion of the project site is currently regulated under the Massachusetts Contingency Plan (MCP; 310 CMR 40.0000) and was assigned Release Tracking Number (RTN) 3-37285. The site does not contain any structures listed in the State Register of Historic Places or the Massachusetts Historical Commission's (MHC) Inventory of Historic and Archaeological Assets of the Commonwealth.

The project site is not located within or within one mile of an Environmental Justice (EJ) population. However, it is within one mile of a census tract in which five percent or more of the population have limited English proficiency (LEP) and are identified as speaking a primary language other than English (Chinese). The site is located within five miles of EJ populations characterized by Income; Minority; Minority and Income; Minority and English Isolation; and Minority, Income, and English Isolation criteria. As described below, the ENF identified the "Designated Geographic Area" (DGA), as defined in 301 CMR 11.02, for the project as 1 mile, included a review of potential impacts and benefits to the EJ/LEP populations within this DGA, and described public involvement efforts undertaken to date.

Environmental Impacts and Mitigation

Potential environmental impacts of the project include generation of 5,005 new unadjusted average daily trips (adt) (total of 5,892 unadjusted adt); construction of up to 1,238 new parking spaces (1,770 total); increase in water demand by 72,313 gallons per day (gpd) (total of 74,618 gpd); and new generation of 31,501 gpd of wastewater (total of 54,554 gpd).[1] Greenhouse Gas (GHG) emissions and other air pollutants are associated with the burning of fossil fuels for on-site energy use and for vehicle trips generated by the project.

Measures to avoid, minimize and mitigate Damage to the Environment include removal of 1.83 acres of impervious area; creation of a recreational path and other onsite amenities accessible to the

[1] "New" impacts deduct impacts associated with prior site uses (car dealership and car wash). "Total" impacts reflect those that will be created by the proposed project, in addition to those that were previously created at the site by virtue of the prior site uses.

public; stormwater management improvements; sustainable design features such as rainwater reuse and green roofs; transportation demand management (TDM) measures; and pedestrian and bicycle accommodations. The Proponent also commits to fund a feasibility study of converting the former MBTA railroad ROW north of the site into a shared use path that would connect other converted sections to the south and north. The ENF identified potential measures to incorporate climate resiliency that should be further analyzed in the DEIR. The DEIR should provide further analysis to demonstrate that the project includes measures to minimize stationary- and mobile-source GHG emissions generated by the project to the maximum extent practicable.

Jurisdiction and Permitting

The project is subject to the preparation of a mandatory EIR pursuant to 301 CMR 11.03(6)(a)(6) and 301 CMR 11.03(6)(a)(7) because it requires Agency Action and will generate 3,000 or more new adt on roadways providing access to a single location and will construct 1,000 or more new parking spaces at a single location, respectively. The project requires a Vehicular Access Permit from the Massachusetts Department of Transportation (MassDOT). Although not identified by the Proponent, the project may require a Sewer Use Discharge Permit from the Massachusetts Water Resources Authority (MWRA), as stated in MWRA's comment letter, for disposal of industrial process or laboratory wastewater. The project is subject to MEPA's Greenhouse Gas (GHG) Policy and Protocol (GHG Policy).

The project requires a determination of no hazard to air navigation from the Federal Aviation Administration (FAA), and a National Pollutant Discharge Elimination System (NPDES) Construction General Permit from the U.S. Environmental Protection Agency (EPA). The project requires a Special Permit and Site Plan Approval from the Needham Planning Board.

Because the project is not seeking Financial Assistance from an Agency, MEPA jurisdiction extends to those aspects of the project that are within the subject matter of required or potentially required Permits, and that are likely, directly or indirectly, to cause Damage to the Environment.

Review of the ENF

The ENF provided a description of existing and proposed conditions, preliminary project plans, and an identification of measures to avoid, minimize and mitigate environmental impacts. Consistent with the MEPA Interim Protocol on Climate Change Adaptation and Resiliency, the ENF contained an output report from the MA Climate Resilience Design Standards Tool prepared by the Resilient Massachusetts Action Team (RMAT) (the "MA Resilience Design Tool"),[2] together with information on climate resilience strategies to be undertaken by the project.

[2] https://resilientma.org/rmat_home/designstandards/

SCOPE

General

The DEIR should follow Section 11.07 of the MEPA regulations for outline and content and provide the information and analyses required in this Scope. It should clearly demonstrate that the Proponent has sought to avoid, minimize, and mitigate Damage to the Environment to the maximum extent practicable.

Project Description and Permitting

The DEIR should describe the project and identify any changes since the filing of the ENF. It should identify and describe state, federal, and local permitting and review requirements associated with the project and provide an update on the status of each of these pending actions. The DEIR should include a description and analysis of applicable statutory and regulatory standards and requirements, and a discussion of the project's consistency with those standards. It should confirm that the height of any proposed buildings will comply with the Massachusetts Port Authority's (Massport) Logan Airspace Map and any related FAA requirements. C.1 C.2 C.3 C.4

The DEIR should include detailed site plans for existing and post-development conditions at a legible scale. Plans should clearly identify buildings, interior and exterior public areas, impervious areas, transportation improvements, pedestrian and bicycle accommodations, and stormwater and utility infrastructure. The DEIR should provide detailed plans, sections, and elevations to accurately depict existing and proposed conditions, including proposed above- and below-ground structures and on- and-offsite open space and resiliency and other mitigation measures. C.5 C.6

The information and analyses identified in this Scope should be addressed within the main body of the DEIR and not in appendices. In general, appendices should be used only to provide raw data, such as drainage calculations, traffic counts, capacity analyses and energy modelling, that is otherwise adequately summarized with text, tables, and figures within the main body of the DEIR. Information provided in appendices should be indexed with page numbers and separated by tabs, or, if provided in electronic format, include links to individual sections. Any references in the DEIR to materials provided in an appendix should include specific page numbers to facilitate review. C.7

Alternatives Analysis

The ENF considers the following four alternatives: No Build, Preferred Alternative (as described herein); As-of-Right Build; and Residential Build. The No Build Alternative would maintain the existing condition at the project site, leaving extensive paving in place. The ENF states that the remnants of two former car dealership buildings and a car wash would also remain; however, these structures have already been demolished and removed from the site. Although this alternative would not result in any additional environmental impacts (i.e., increased traffic impacts, wastewater generation, water demand, GHG emissions, etc.), the benefits associated with the Preferred Alternative, including economic development, improved infrastructure and vehicular and pedestrian circulation would not be realized. The Town of Needham recently rezoned the former car dealership/carwash and adjacent WCVB/Chanel

5 properties from Industrial to Highway Commercial to allow for redevelopment of the site.[3] The new Highway Commercial zoning created "as of right" and "special permit" zoning requirements. Both require the approval of the Needham Planning Board with the "special permit" development proposals requiring a more robust vetting process as described in outreach materials provided on the Needham Planning Department website.[4]

An As-of-Right Build Alternative would construct up to approximately 403,933 SF of office/laboratory/research and development uses in one building, and approximately 1,346 structured above-grade parking spaces. This building alternative would meet the Town's height restrictions for the new zoning district "as of right" requirements. The ENF indicates that this alternative was rejected because it would not meet the Proponent's desired development program which includes a building of greater height (as allowed by special permit). In addition, the massing and placement of the parking garage were considered less desirable from a design perspective as compared with the Preferred Alternative. The ENF does not include the impacts (i.e., traffic, water/wastewater, etc.) of this alternative as compared to the Preferred Alternative. The DEIR should include an analysis of the impacts of each alternative as compared with the Preferred Alternative, preferably in table format. C.8

The Proponent also considered a Residential Build Alternative consisting of up to 555 dwelling units with 833 parking spaces. The ENF states this alternative was not economically viable given the cost for land acquisition and abatement/removal of hazardous materials associated with the former automobile service/repair facilities and other prior commercial operations. The ENF also states this alternative would not generate the tax revenue Needham anticipated when it created the Highway Commercial 1 Zoning district in which this project site is located. As stated above, the alternatives analysis does not detail the proposed impacts of this alternative as compared with the Preferred Alternative. The DEIR should include this comparison as described above. In addition, it is not clear that the Residential Build Alternative would meet the zoning requirements of the Highway Commercial 1 district. Materials on the Planning Department website indicate that housing as capped at 240 units in the new Highway Commercial 1 district. The DEIR should clarify if an all residential development is an allowed use and therefore a viable alternative. C.9

During the MEPA remote consultation session, the Proponent acknowledged community concerns regarding the proposed public amenity spaces. The DEIR should outline alternatives considered for auxiliary programing within the public spaces on the project and how these alternatives are expected to impact traffic and impervious area creation at the site (i.e., parking demand). C.10

Environmental Justice Populations

As noted above, the project site is within one mile of a census tract in which five percent or more of the population have limited English proficiency (LEP) and are identified as speaking Chinese as their primary language. However, no mapped "Environmental Justice Populations" as defined in 301 CMR 11.02 are present within the 1-mile DGA for the project. Accordingly, the project should undertake efforts to provide meaningful opportunities for LEP populations to participate in review of the project, C.11

[3] The Highway Commercial 1 Zoning district and a corresponding zoning map amendment were adopted by Needham Town Meeting on May 3, 2021. The new zoning district will allow for the development of up to 880,000 sf of office, research and development, and ancillary retail and service space.
[4] Spring Town Meeting 2021 - Highway Commercial 1 | Needham, MA (needhamma.gov)

but the project is not required to analyze impacts on EJ populations in accordance with new regulations and protocols that took effect on January 1, 2022.[5]

According to the ENF, the Proponent has commenced a community outreach program and will continue to engage with the local community throughout both the upcoming MEPA process and the Town review process. The Proponent submitted supplemental information containing the components of their public outreach campaign including copies of letters hand delivered to all residents within a half-mile radius, including the neighboring nursing home/independent living community (Wingate). The Proponent has held one neighborhood outreach meeting (approximately 50 participants) and has scheduled four additional meetings. An additional publicly-advertised meeting was held with the Charles River Regional Chamber of Commerce. The Proponent has created a website for the project, www.557Highland.com, with posted images of the project, links enabling visitors to download the slides from the April 20, 2022 MEPA remote consultation session, FAQs answering frequently asked questions, and the slides from the first neighborhood Zoom meeting. During the MEPA review period, the Proponent translated notice of the MEPA remote consultation session into Chinese and offered to provide oral translation at the consultation session upon request (no requests were received). The translated meeting notices were distributed to a list of community-based organizations (CBOs) and tribes/indigenous organizations (the "EJ Reference List") provided by the MEPA Office in consultation with the EEA EJ Director.

The DEIR should address how the public involvement plan will facilitate meaningful participation in review of the project by LEP populations located within the identified DGA. A translated project fact sheet on the project website should be a minimum outreach measure. C.12

Public Health

In accordance with St. 2021, c. 8, s. 57, the DEIR should include a separate section on "Public Health," and discuss any known or reasonably foreseeable public health consequences that may result from the environmental impacts of the project. Particular focus should be given to any impacts that may materially exacerbate "vulnerable health EJ criteria," in accordance with the MEPA Interim Protocol for Analysis of EJ Impacts. In addition, other publicly available data, including through the DPH EJ Tool, should be surveyed to assess the public health conditions in the immediate vicinity of the project site, in accordance with 301 CMR 11.07(6)(g)10. Any project impacts that could materially exacerbate such conditions, including industrial/laboratory wastewater discharge and 21E cleanup, should be analyzed. C.13

To the extent any required Permits for the project contain performance standards intended to protect public health, the DEIR should contain a specific discussion of such standards and how the project intends to meet or exceed them. C.14

Stormwater

The project is proposed as redevelopment and includes removal of impervious area and improvements to stormwater management. The DEIR should list stormwater related permits required by the project and detail compliance with associated permit regulations. C.15 The project is likely subject to the Town's Stormwater Bylaw and Regulations required by the General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer systems (MS4s) (MS4Permit).

[5] More information on new EJ requirements are available here: https://www.mass.gov/service-details/information-about-upcoming-regulatory-updates

The ENF describes a stormwater management plan that will utilize a wet pond and structural water quality devices to treat the required water quality volume and states that the overall project will result in a decrease in the peak runoff rate as well as runoff volume for the site as compared to existing conditions. However, conceptual utility plans included with the ENF show catch basins, a potential subsurface infiltration system, and a trench drain all connecting to the system located on property owned by MassDOT (State Highway/Route 128). The Proponent has stated that the capacity for onsite infiltration is limited based on prior soil contamination; however, the Proponent should continue to consider Low Impact Development (LID) and green infrastructure (GI) measures where feasible. Conceptual plans depict a green roof and outreach materials submitted with the ENF describe installation of a cistern to capture stormwater from the standalone garage that would be used for irrigation. C.16

The DEIR should provide more detail on the components of the stormwater management system and analyze how the system will be designed to meet the Town's Stormwater Bylaw and Regulations and/or the MassDEP Stormwater Management Standards to improve water quality and reduce pre-development peak discharge rates and volumes. C.17 It should include a plan showing the location of BMPs, LID and GI measures. C.18 The DEIR should provide analysis of the capacity of the stormwater management system under future climate conditions, as described below. It should provide a detailed description of how specific stormwater management measures, such as infiltration, will be designed in conformance with the phosphorous and pathogen Total Maximum Daily Loads (TMDL) established for the Charles River. C.19 The DEIR should discuss any permit requirements that would be imposed by MassDOT for use of its drainage systems, and how pollutant loading and runoff would be managed if connecting to MassDOT infrastructure. C.20

The Proponent should also address comments from the MWRA comment letter which describes the prohibition on discharge of groundwater and stormwater into the sanitary sewer system given the site's access to separate sewer and stormwater drain systems. C.21 The DEIR should address comments from the Charles River Watershed Association (CRWA) regarding impervious area and stormwater management, water quality, trees and vegetation, and climate resilience. C.22

Traffic and Transportation

The project exceeds EIR level thresholds as it surpasses 3,000 adt and includes more than 1,000 parking spaces on site. The project requires a Vehicular Access Permit from MassDOT as it is anticipated to generate substantially increased vehicle trips on Highland Avenue and I-95, both MassDOT jurisdictional roadways. According to the MassDOT comment letter, the Proponent submitted a Transportation Scoping Letter (TSL) outlining the methodology for the Transportation Impact Assessment (TIA). MassDOT approved the TSL in a memo dated February 2, 2022, a copy of which is included in the ENF. Comments from MassDOT further state that the TIA included in the ENF was developed in accordance with MassDOT/EOEEA's Transportation Impact Assessment (TIA) Guidelines. The ENF also describes the project's consistency with a 2020 traffic study commissioned by the Town to support the rezoning effort proposed for the car dealership and adjacent WCVB/Channel 5 properties.[6] Although the Proponent does not own the Channel 5 properties, and no additional development is currently proposed there, it proposes to implement all of the recommended traffic mitigation measures in the study associated with redevelopment of both sites.

[6] Traffic Impact Study, Muzi Motors Redevelopment, Greenman-Pederson, Inc. (GPI) November 20, 2020.

The ENF notes the current MassDOT reconstruction of the Highland Avenue corridor (MassDOT Project#606635), which includes the area adjacent to the project site. The MassDOT reconstruction project will enhance bicycle and pedestrian accommodations along the corridor and improve traffic flow. In addition, the MassDOT project will change the lane geometry at several intersections. Construction on the project is under way; however, information in the ENF is based on conditions as of early 2022 and does not take into consideration this ongoing corridor reconstruction project. The Proponent should continue consultation with the Town, the MBTA, and appropriate MassDOT units, including PPDU, Traffic Operations, and the District 6 Office during the preparation of the DEIR for the project. The DEIR should address transportation related items as outlined in the scope below. C.23

Study Area

The ENF states the study area for the proposal includes input from the Town and MassDOT and includes the following intersections and their approach roadways:

1. Central Avenue at Cedar Street
2. Central Avenue at Webster Street
3. Central Avenue at Gould Street
4. Central Avenue at Hampton Avenue
5. Central Avenue at River Park Street
6. Gould Street at Ellis Street
7. Gould Street at Kearney Road
8. Gould Street at Station Road
9. Gould Street at Noanett Road
10. Gould Street at TV Place
11. Gould Street at Muzi Ford/Wingate Residences driveways
12. Highland Avenue at West Street
13. Highland Avenue at Hunnewell Street
14. Highland Avenue at Webster Street
15. Highland Avenue at Gould Street / Hunting Road
16. Highland Avenue at I-95 SB Ramps
17. Highland Avenue at I-95 NB Ramps
18. Highland Avenue at 1st Avenue
19. Highland Avenue at 2nd Avenue
20. Kendrick Street at Hunting Road

As noted, MassDOT comments note that it has approved the Proponent's TSL for the project. MassDOT does not recommend the addition of any other intersections into the TIA.

Trip Generation

According to the ENF, the combination of uses proposed for the project site will generate an additional 5,005 vehicle trips over existing conditions in accordance with the Institute of Traffic Engineers (ITE) Trip Generation Manual, using Land Use Code (LUC) 710: Office for the 260,500 sf of office space, LUC 760: Research and Development Center for the 260,500 sf of research and development space, and LUC 122: Community Shopping Center for the 10,000 sf retail component. In

order to provide a conservative analysis of traffic impacts generated by the project, the Proponent provided traffic analysis assuming no mode share for pedestrian, bicycle, or transit trips to the project site. As noted below, the Proponent does intend to implement a Transportation Demand Management (TDM) program to encourage other modes of travel and reduce single occupancy vehicle (SOV) trips to and from the site.

Comments received on behalf of the Town from the peer review consultant, GPI, note that the existing site-generated trips were estimated based on empirical traffic counts collected at the site driveways, which show that only 887 daily trips are currently generated by the site. It is important to note that these empirical counts were collected in the fall of 2021, during COVID conditions, and as a result, may underestimate the trips generated under pre-COVID conditions when the site was fully operational. While the use of the lower existing site-generated trips will result in a more conservative (higher) estimate of the net increase in trips generated by the project, the Proponent should consult with MassDOT and the Town to ensure that more accurate data are incorporated to the extent warranted. The DEIR should describe changes made to the TIA, if any, including any changes in assumption about the project's trip generation and associated mitigation. C.24 C.25

Traffic Operations

The TIA includes analysis of traffic operations at study area intersections under 2022 Existing Conditions, the 2029 No-Build Scenario, and the 2029 Build Scenario, as well as a network map of trip distribution within the study area. The Proponent estimates that overall Level of Service (LOS) for vehicular traffic will degrade at certain study area intersections under the 2029 Build Scenario as compared to the 2029 No-Build Scenario. Per ENF Table 2-9: Signalized Intersection Capacity Analysis Summary, Highland Avenue at West Street will see a drop in performance from LOS C to LOS D and Highland Avenue at Gould Street and Hunting Road will decline from LOS E to LOS F. As requested in comments from GPI, the DEIR should consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of this intersection. C.26

The Proponent estimates that the majority of vehicle traffic generated by the project will access and depart the site via Interstate 95 (I-95) northbound and southbound, with substantially smaller proportions travelling via Highland Avenue to and from points south or via Webster Street to and from points west. As stated previously, Highland Avenue is currently under reconstruction (MassDOT Project #606635) to improve pedestrian and bicycle infrastructure as well as traffic operations along this corridor. As recommended by MassDOT, the DEIR should include analysis of queuing at study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area. C.27

Safety

The TIA includes a summary of crash rates derived from the MassDOT crash data portal for the five-year period between 2015 and 2019. Of the study area intersections included for analysis, Highland Avenue at West Street represents a higher-than-average rate Needham – Highland Science Center Page 3 4/28/2022 of accidents, with 0.86 accidents per million vehicles as compared to the District 6 average of 0.71. There are no 2017-2019 HSIP crash clusters identified within the study area. As requested by MassDOT, the DEIR should include analysis of existing and proposed weave conditions on Highland Avenue to ensure that increased traffic volumes do not lead to degraded safety conditions in the area of the Highland Avenue/I-95 interchange. C.28

In the comment letter prepared on behalf of the Town, GPI requests additional information related to collision history including collision diagrams for any locations that experience an average of more than 3 crashes per year or a crash rate higher than the state or district-wide average per MassDOT guidelines. GPI comments also state that the Proponent should investigate measures to improve safety and mitigate collision occurrence in any location where five or more crashes of a similar type occurred over the analysis period. The DEIR should document any additional analysis and mitigation measures. C.29

Transit Operations

As stated previously, the ENF included information regarding existing transit options in the area of the project. The closest subway service available to site visitors is the MBTA Green Line D Branch via the Newton Highlands station, approximately two miles from the project site via Centre Street. The Needham Heights commuter rail station is also located approximately 0.75 miles south of the project site along Highland Avenue. MBTA Bus Route 59 provides service to the Needham area, including stops on Highland Avenue approximately 0.6 miles south of the project site. The Proponent should consider coordination with MBTA in order to determine the feasibility of additional MBTA Bus Route 59 service closer to the project site and include feasible options in the DEIR. C.30

Pedestrian and Bicycle Access

The TIA includes a summary of existing pedestrian infrastructure within the study area. The primary roadways serving the project site, Highland Avenue and Gould Street, each possess existing sidewalks and crosswalks at major intersections, while the Gould Street/Ellis Street and Gould Street/Noanett Road intersections each lack crosswalks. The project site design includes several features to support pedestrian access to and from the site, including sidewalks connecting to site driveways, proposed mitigation to improve pedestrian infrastructure in the study area (see Mitigation below), and the construction of a 0.5-mile public walking path circling the project site.

The TIA includes a summary of bicycle infrastructure within the study area. The project site is served by very limited bicycle infrastructure, except for on-street bicycle lanes on Highland Avenue between Wexford and Gould Streets and on Kendrick Street between Hunting Road and 3rd Avenue. The project site will include bicycle racks and 89 total bicycle parking spaces outside as well as secured bicycle storage within the project buildings. Both the MassDOT Project and the Proponent's proposed mitigation (see Mitigation below) include improvements to bicycle infrastructure in the study area. As stated in the Town's comments, the DEIR should include an assessment of the potential bicycle parking demand that could be generated by the project and the adequacy of the number of bicycle parking spaces provided to accommodate this demand including the number of spaces to be accommodated inside (secured) versus outside. C.31

Parking

The project includes two below-grade parking garages with a total area of 310,000 sf and one 297,000 sf standalone parking garage, which along with new proposed surface parking represents up to 1,770 total parking spaces. This parking provision conforms to the Town's off street parking minimums, which call for one parking space per 300 sf of floor area. MassDOT believes that this parking capacity is sufficient to support site operations when taken together with proposed mitigation including

Transportation Demand Management (TDM) measures outlined below. The Proponent has indicated they intend to seek a reduction in parking as part of the Special Permit process with the Town. The DEIR should provide an update on the potential reduction and how that may contribute to an associated reduction in impervious area. C.32

Mitigation

The Proponent proposes mitigation measures in the TIA intended to address both project-generated traffic impacts as well as noted deficiencies in area pedestrian and bicycle infrastructure. The Proponent proposes the following measures as mitigation requiring limited design or construction prior to implementation:

- Installation of on-road bicycle lanes on Gould Street between Highland Avenue and TV Place (adjacent to the project site);
- Installation of a shared bicycle lane on Gould Street between TV Place and Central Avenue;
- Design and installation of traffic signals at Gould Street/Hunting Road (aligned with Wingate driveway) and Gould Street/Central Avenue intersections;
- Geometric improvements at the Highland Avenue/Gould Street/Hunting Road and Gould Street/TV Place intersections.

In addition to the above, the Proponent includes the following conceptual proposals which may result in future mitigation activities within the study area:

- Coordination with the Town of Needham to study the feasibility of converting the MBTA rail right-of-way north of the project site into a mixed-use walkway;
- Coordination with the Route 128 Business Council to provide shuttle service to existing transit options.

Further, the Proponent commits to Transportation Demand Management (TDM) measures and a five-year monitoring program as outlined in the respective sections below. As noted in the Bicycle and Pedestrian Access section above, the project area includes sub-standard infrastructure for bicycle and pedestrian employees of the proposed science center. MassDOT requests that the Proponent consider coordinating with District 6 to install adequate bicycle and pedestrian infrastructure on Highland Avenue at the I-95 interchange to connect with proposed Complete Streets improvements to be installed under the MassDOT Project. With this suggestion, MassDOT otherwise finds that the proposed mitigation is appropriate to the scale of the project and will serve to offset traffic impacts generated by the project and improve access to the project site. C.33

The DEIR should include sufficiently detailed conceptual plans (minimum of 80-scale) for any proposed roadway improvements including the proposed signalization, geometric improvements, and bicycle lanes to verify the feasibility of constructing such improvements. These plans should clearly show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed. C.34

Transportation Demand Management

The ENF identifies potential TDM measures that will be implemented to minimize the number of single-occupancy vehicle (SOV) trips to the site by employees and visitors. The TDM program includes the following measures:

- Assignment of an on-site Employee Transportation Advisor to coordinate with the Route 128 Business Council;
- Coordination with the Route 128 Business Council to provide shuttle service to existing transit options;
- Provision of a 50 percent transit pass subsidy to be offered by tenants to employees; • Carpool assistance and emergency ride home services;
- Bicycle/walk incentives to travel to work;
- Telecommuting and shortened workweek opportunities for staff;
- Posting of transit information in the public Main Lobby, and;
- Promotional efforts.

The DEIR should provide additional information on how carpool assistance and emergency ride home services will be provided, as well as what incentive program may be implemented. C.35 In addition to providing shuttle service to nearby commuter rail and Green Line services, the Proponent should explore the possibility of extending bus service to the site as requested by the Town. C.36 Given the high number of new vehicular trips anticipated from the project, the DEIR should demonstrate a strong commitment to implementing TDM measures to the greatest extent feasible to reduce SOV travel to and from the site. C.37 The DEIR should quantify the anticipated mode share that is expected for the project (both with and without TDM measures) and demonstrate that the project will take all feasible measures to encourage non-vehicular travel to and from the site. C.38 The DEIR should describe the methodology used to estimate the effectiveness of TDM measures and should discuss what measures the Proponent intends to take if the TDM program proves to be less effective than anticipated as shown through monitoring efforts. C.39

The ENF indicates that parking facilities will provide electric vehicle (EV) charging stations, with consideration as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions. Outreach materials further identify a commitment to EV charging on parking levels beneath the North and South Buildings and Atrium. The materials further state that parking areas will include the infrastructure required to install additional charging stations if and when there is demand for them. C.40 The DEIR should maximize opportunities to make the site EV-ready and install EV charging wherever feasible. C.41 The DEIR should clarify the Proponent's commitment to EV charging (number of spaces) and describe how it will be implemented on the site.

Transportation Monitoring Program

The DEIR should include a draft transportation monitoring program (TMP) commitment. C.42 The goals of the monitoring program will be to evaluate the assumptions made in the DEIR and the adequacy of the mitigation measures, as well as to determine the effectiveness of the TDM program. As described in MassDOT's comment letter, C.43 the Proponent will be required to conduct the TMP for a period of five years, beginning six months after occupancy of the full-build project. It should include:

- Simultaneous automatic traffic recorder (ATR) counts at each parking entrance for a continuous 24-hour period on a typical weekday;
- Travel survey of employees and patrons at the site;
- Weekday AM and PM peak hour turning movement counts (TMCs) and operations analysis at study area intersections, and;
- Updates on efficacy of the TDM program.

The DEIR should discuss in detail how the Proponent intends to implement the monitoring program, and what measures it plans to take if traffic counts for the project are shown to be higher than anticipated, and if TDM and other mitigation measures prove less effective than expected. C.44

Water and Wastewater

The ENF states the project will increase wastewater flow by 31,501 gallons per day (gpd), from an existing wastewater flow of 23,053 gpd to 54,554 gpd. The site is served by a sanitary sewer system owned and operated by the Town that conveys flows to MWRA's Wellesley Extension Relief Sewer in the Town of Dedham, which delivers flows to the MWRA High Level Sewer, the Nut Island Headworks, and ultimately MWRA's Deer Island Wastewater Treatment Plant. Sections of the MWRA system can surcharge and overflow in large storms to the Charles River, due to high levels of infiltration and inflow ("I/I") entering tributary community sewer systems. To ensure that the project's new wastewater flow does not increase surcharging and overflows in large storms, the Proponent should fully offset the project's wastewater flows with I/I removal in accordance with Town's policies and regulations. C.45 The DEIR should describe how the Proponent will assist the Town's efforts of removing infiltration and inflow (I/I) from the municipal collection system. C.46

As discussed above, the discharge of groundwater or stormwater to the sanitary sewer system associated with this project is prohibited by MWRA pursuant to 360 C.M.R. 10.023(1). A Sewer Use Discharge Permit is required prior to discharging laboratory wastewater and/or industrial process wastewater from any laboratory and commercial space associated with the project into the MWRA sanitary sewer system. Any gas/oil separators in parking garages associated with the project must comply with 360 C.M.R. 10.016 and State Plumbing Code and their installation may not be back filled until inspected and approved by MWRA and the Local Plumbing Inspector. The DEIR should describe measures that the Proponent will take to comply with the above permits. C.47

Water use is expected to increase by 103,814 gpd to 129,172 gpd. According to the ENF, the project is being designed to minimize demands on the Town's water supply and to minimize sanitary sewer discharges. As described above, a cistern integrated into the standalone garage will store captured stormwater, for use in irrigation, as makeup water for the HVAC cooling towers, and elsewhere in the buildings. Within the buildings, water will be recycled to the extent feasible, with graywater used for flushing toilets and urinals. The building's water faucets, toilets, urinals, and other water fixtures use high-efficiency, low-flow designs. The DEIR should further describe all measures that will be implemented as the project design progresses. C.48

Solid and Hazardous Waste

The ENF states that due to the former uses as an automobile dealership and service center, coupled with historical filling of a former gravel quarry, releases of oil and hazardous materials have affected localized areas of soils at the project site. The reported releases have been assigned RTNs 3-36733 and 3-37285. These releases are currently being managed in accordance with 310 CMR 40.0000, the Massachusetts Contingency Plan (MCP). Specifically, a Permanent Solution Statement (PSS) with No Conditions was filed with MassDEP for RTN 3-36733 on August 9, 2021. RTN 3-37285 is currently being managed under the IRA provisions of the MCP. As part of redevelopment of the site, affected soils will be managed in accordance with the MCP as well as applicable MassDEP policies. Upon completion of redevelopment, a PSS is anticipated to be filed for the RTN 3-37285 site. A Licensed Site Professional (LSP) is overseeing MCP compliance and remediation.

The ENF describes subsurface assessment activities that have been recently completed at the project site have identified localized areas of soil exhibiting Reportable Concentrations of metals, PCBs, petroleum hydrocarbons and polycyclic aromatic hydrocarbons which require notification to MassDEP as a 120-day reporting condition in accordance with 310 CMR 40.0333(2). In accordance with 310 CMR 40.0333(2), MassDEP will be notified of the release condition which will be subsequently managed in accordance with the provisions of the MCP. As part of the site redevelopment, affected soils will be managed in accordance with the MCP, as well as applicable MassDEP policies. Upon completion of redevelopment, a PSS is anticipated to be filed for the 120-day reporting condition.

Comments from MassDEP state that excavating, removing and/or disposing of contaminated soil, pumping of contaminated groundwater, or working in contaminated media must be done under the provisions of M.G.L. c. 21E and all other applicable federal, state, and local laws, regulations, and bylaws. If contamination at the site is known or suspected, the appropriate tests should be conducted well in advance of the start of construction and professional environmental consulting services should be readily available to provide technical guidance. If dewatering activities are to occur at a site with contaminated groundwater, or in proximity to contaminated groundwater where dewatering can draw in the contamination, a plan must be in place to properly manage the groundwater. As is already the case, an LSP must be employed or engaged to manage, supervise or actually perform the necessary response actions at the site. MassDEP comments state further investigation of subsurface conditions is expected to continue, and the results provided to MassDEP in the next scheduled submittal due in May of 2022. The DEIR should contain the results of ongoing analysis and describe measures to protect public health.

C.49

C.50

C.51

C.52

Climate Change

Governor Baker's Executive Order 569: Establishing an Integrated Climate Change Strategy for the Commonwealth was issued on September 16, 2016. The Order recognizes the serious threat presented by climate change and direct Executive Branch agencies to develop and implement an integrated strategy that leverages state resources to combat climate change and prepare for its impacts. The urgent need to address climate change was again recognized by Governor Baker and the Massachusetts Legislature with the recent passage of St. 2021, c. 8, *An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy*, which sets a goal of Net Zero emissions by 2050. I note that the MEPA statute directs all Agencies to consider reasonably foreseeable climate change impacts, including additional greenhouse gas emissions, and effects, such as predicted sea level rise, when issuing permits, licenses and other administrative approvals and decisions. M.G.L. c. 30, § 61.

Additionally, the Town is a participant in the Commonwealth's Municipal Vulnerability Preparedness (MVP) program. The MVP program is a community-driven process to define natural and climate-related hazards, identify existing and future vulnerabilities and strengths of infrastructure, environmental resources, and vulnerable populations, and develop, prioritize, and implement specific actions the Town can take to reduce risk and build resilience. Through the MVP program, the Town received funding to conduct a planning process for climate change resiliency and implementing priority projects. The results of the initial community-driven process were presented in the "Community Resilience Building Workshop - Summary of Findings" (the Report), dated May 2020. The Report identified flooding, heat waves, severe storms (wind, ice, snow), and drought as top climate hazards in Needham.

Adaptation and Resiliency

Effective October 1, 2021, all MEPA projects are required to submit an output report from the MA Resilience Design Tool to assess the climate risks of the project. Based on the output report attached to the ENF, the project has a high exposure rating based on the project's location for the following climate parameters: extreme precipitation (urban flooding) and extreme heat. Based on the 50-year useful life identified for the project and the self-assessed criticality of the lab/office building, the MA Resilience Design Tool recommends a planning horizon of 2070 and a return period associated with a 10-year (10% chance) storm event when designing the lab/office building of the project. This recommendation appears to be correlated with a "low" criticality assessment of the project, based on user inputs. For assets with medium or high criticality, the MA Resilience Design Tool recommends planning for a 25-year or 50-year storm as of the 2070 planning horizon.[7]

To adapt to extreme heat events, the ENF states the Proponent is developing appropriate strategies for a changing climate in the near term as well as planning for a longer-term adaptation strategy over the course of the project's lifespan. Strategies include decreasing the total impervious surface of the project site and adding natural barriers to extreme heat, including trees and landscaping throughout the project. These strategies are expected to make improvements to existing conditions because the current site is almost entirely an impervious surface parking lot. As detailed above, the ENF describes water conservation measures to address drought conditions including a cistern integrated into the standalone garage that will store captured stormwater for use in irrigation. The project is also exploring reuse of graywater for flushing toilets and urinals. The building's water faucets, toilets, urinals, and other water fixtures use high-efficiency, low-flow designs.

The DEIR should continue to identify opportunities to increase resilience through enhancement of the site, including increased open space and permeable surfaces. C.53

Effective April 25, 2022, the MA Resilience Design Tool now provides rainfall volumes associated with a 24-hour storm for multiple storm scenarios and planning horizons for projects subject to extreme precipitation risks. The DEIR should consult these volumes for the 10-year, 25-year and 50-year storm in 2070 in assessing the efficacy of the stormwater design in attenuating peak runoff and pollutant loading. C.54 Estimates can be provided in lieu of exact calculations, to the extent stormwater design is not advanced enough by the time of the DEIR. To the extent the project is unable to accommodate future year storm scenarios, the DEIR should discuss whether the project has engaged in flexible adaptative strategies, and whether current designs allow for future upgrades to be made to adapt to climate change. C.55 General guidance on

[7] See https://eea-nescaum-dataservices-assets-prd.s3.amazonaws.com/cms/GUIDELINES/20210401Section3ClimateResilienceDesignStandardsOverview.pdf, at p. 19.

flexible adaptive strategies is available on the MA Resilience Design Tool website.[8]

I encourage the Proponent to consult the data available from the Town, including the findings of its Community Resilience Building Workshop (May 2020) and additional reports it may have prepared, and the resilientMA.org website to develop climate change scenarios for the site and identify potential adaptation measures C.56

Greenhouse Gas (GHG) Emissions

This project is subject to review under the May 5, 2010 MEPA GHG Policy. The Policy requires Proponents to quantify carbon dioxide (CO_2) emissions and identify measures to avoid, minimize or mitigate such emissions. The analysis should quantify the direct and indirect CO_2 emissions of the project's energy use (stationary sources) and transportation-related emissions (mobile sources). Direct emissions include on-site stationary sources, which typically emit GHGs by burning fossil fuel for heat, hot water, steam and other processes. Indirect emissions result from the consumption of energy, such as electricity, that is generated off-site by burning of fossil fuels, and from emissions from vehicles used by employees, vendors, customers and others. C.57

Stationary Sources

The ENF states the Proponent is committed to taking all feasible steps to reduce carbon emissions and minimize energy usage. Energy modeling will evaluate several emissions mitigation measures including:

- Hybrid electric/gas heating with electric heating being the first to operate whenever capacity allows;
- High efficiency glycol heat recovery loop;
- High efficiency chilled water plant; - Reduced laboratory exhaust through exhaust monitoring;
- Electric water heating;
- Improved envelope insulation and infiltration without thermal bridging; and,
- High performance lighting and controls.

In addition to these emission reduction strategies, the ENF states the project will utilize the LEED v4 BD+C rating system for the Core and Shell building components to incorporate other sustainability strategies. These additional strategies may include green vehicle parking; open space; rainwater management; heat island reduction; construction and demolition waste management; and building product disclosure and optimization. The current goal is to achieve LEED Silver Certified with higher targets being evaluated.

The DEIR should include a GHG analysis that calculates and compares GHG emissions associated with a 1) Base Case that conforms to the 9th Edition of the Massachusetts Building Code, which references the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2013 and the International Energy Conservation Code (IECC) 2015, and 2) a Preferred Alternative that achieves greater reductions in GHG emissions. The Town has adopted the C.58 C.59

[8] https://eea-nescaum-dataservices-assets-prd.s3.amazonaws.com/cms/GUIDELINES/20210330FlexibleAdaptationPathwaysFormFinal.pdf

Massachusetts Stretch Energy Code (SC). Therefore, the project will be required to meet the applicable version of the SC in effect at the time of construction. The SC increases the energy efficiency code requirements for new construction (both residential and commercial) and for major residential renovations or additions in municipalities that adopt it. The Stretch Code requires a 10% energy performance improvement over ASHRAE 90.1-2013-Appendix G plus Massachusetts amendments including C402.1.5 (envelope), C405.3 and C405.4 (lighting), C405.10 (EV charging), and C406 (three additional efficiency measures). The analysis should include the three C406 additional efficiency measures in their Baseline. C.59 (cont.) C.60

The DEIR should present an evaluation of mitigation measures identified in DOER's comment letter. In particular, the feasibility of each of the mitigation measures outlined below should be assessed for each of the major project elements, and if feasible, GHG emissions reduction potential associated with major mitigation elements should be evaluated to assess the relative benefits of each measure. The DEIR should explain, in reasonable detail, why certain measures that could provide significant GHG reductions were not selected – either because it is not applicable to the project or is deemed technically or financially infeasible. If financially infeasible, the DEIR should describe the cost effectiveness metrics that were used to evaluate feasibility, whether energy savings that would accrue to future tenants were considered, and what "payback period" the Proponent would deem to be reasonable given the financial constraints identified. It should include a review of available financial incentives potentially available for the project, as described in DOER's comment letter. At a minimum, the DEIR should consider the following GHG mitigation measures: C.61 C.62 C.63

- Building design and construction practices that result in low heating and cooling TEDI by:
  - Maintaining envelope integrity with framed, insulated walls with continuous insulation
  - Thermally broken windows and other components to eliminate thermal bridges
  - Minimizing glass curtain wall assemblies and excessive windows
  - Low air-infiltration, confirmed with in-building air-infiltration testing
  - Energy recovery
  - Management of solar heat gains
- Efficient electrification of space heating including:
  - For highly ventilated lab/office: low temperature, hydronic space heating with heat-input provided by hybrid, in-building, central plant consisting of air-to-water heat pump (primary) and gas boilers (secondary)
  - For not highly ventilated space: low temperature, hydronic space heating with heat-input provided by in-building central plant consisting of air-to-water heat pump, or, air source heat pump (ASHP)/variable refrigerant flow (VRF)
- Efficient electrification of water heating where feasible
- Extensive rooftop solar-readiness
- EV ready parking spaces

C.64

Mobile Sources/Air Quality

The GHG analysis should include an evaluation of potential GHG emissions associated with mobile emissions sources. The DEIR should follow the guidance provided in the GHG Policy for *Indirect Emissions from Transportation* to determine mobile emissions for Existing Conditions, Build Conditions, and Build Conditions with Mitigation. The Proponent should thoroughly explore means to reduce overall SOV trips. The DEIR should also review measures to promote the use of low-emissions C.65 C.66 C.67 C.68

vehicles, including installing EV charging stations and providing designated parking spaces for these vehicles. The ENF includes discussion of incorporating EV charging stations into parking facilities, with consideration as to how increased EV capacity can be implemented in the future as warranted by demand and market conditions. The DEIR should present Existing Conditions, a future No Build scenario, Build scenario with project impacts included, and Build with Mitigation showing the effect of TDM measures and any roadway improvements implemented by the project. The analysis should document the reductions in GHG emissions associated with the mitigation. The DEIR should explain how TDM measures will be monitored and adjusted over time and provide a methodology for quantifying emission reductions impacts rather than an assumed percentage reduction.

C.68 (cont.)
C.69
C.70
C.71

The Proponent should conduct an indirect source review analysis in accordance with MassDEP *Guidelines for Performing Mesoscale Analysis of Indirect Sources*. The purpose of the analysis is to determine whether and to what extent the project will increase the amount of volatile organic compounds (VOC) and nitrogen oxides (NOx) emitted in the project area as compared to existing and future no-build conditions, and to discuss mitigation measures as appropriate. The analysis should model emissions under No Build and Build conditions. If the analysis demonstrates that emissions under future Build conditions are greater than under the No Build scenario, mitigation measures must be provided, including a TDM Program.

C.72

GHG Self-Certification

The DEIR should include a commitment to provide a GHG self-certification to the MEPA Office upon construction of the project. It should be signed by an appropriate professional (e.g., engineer, architect, transportation planner, general contractor) indicating that all of the GHG mitigation measures, or equivalent measures that are designed to collectively achieve identified reductions in stationary source GHG emission and transportation-related measures, have been incorporated into the project. If equivalent measures are adopted, the project is encouraged to commit to achieving the same level of GHG emissions (i.e., "carbon footprint") identified in the Preferred Alternative expressed as a volumetric measure (tpy) in addition to a percentage GHG reduction from Base Case.

C.73
C.74

Construction Period

The DEIR should describe all construction-period impacts and mitigation relative to noise, air quality, water quality, and traffic. It should confirm that the project will require its construction contractors to use Ultra Low Sulfur Diesel fuel, and discuss the use of after-engine emissions controls, such as oxidation catalysts or diesel particulate filters. The DEIR should provide more information regarding the project's generation, handling, recycling, and disposal of construction and demolition debris (C&D) and identify measures to reduce solid waste generated by the project. I encourage the Proponent to commit to C&D recycling activities as a sustainable measure for the project. The DEIR should describe how any contaminated material encountered during construction will be managed in accordance with M.G.L. c. 21E and the MCP.

C.75
C.76
C.77
C.78
C.79

The project will be required to develop a Stormwater Pollution Prevention Plan (SWPP) in accordance with its NPDES CGP to manage stormwater during the construction period. The DEIR should describe stormwater management measures that will be implemented during construction. It should describe potential construction period dewatering activities and identify mitigation measures in compliance with those required for contaminated sites. All construction-period mitigation measures should be listed in the draft Section 61 Findings.

C.80
C.81
C.82
C.83

Mitigation/Draft Section 61 Findings

The DEIR should include a separate chapter summarizing all proposed mitigation measures including construction-period measures. This chapter should also include a comprehensive list of all commitments made by the Proponent to avoid, minimize and mitigate the environmental and related public health impacts of the project. The filing 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. The list of commitments should be provided in a tabular format organized by subject matter (traffic, water/wastewater, GHG, etc.) and identify the Agency Action or Permit associated with each category of impact. Draft Section 61 Findings should be separately included for each Agency Action to be taken on the project. The filing should clearly indicate which mitigation measures will be constructed or implemented based upon project phasing to ensure that adequate measures are in place to mitigate impacts associated with each development phase. C.84 C.85 C.86 C.87 C.88

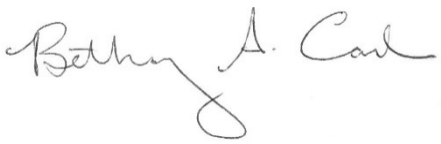
To ensure that all GHG emissions reduction measures adopted by the Proponent as the Preferred Alternative are constructed or performed by the Proponent, the Secretary requires proponents to provide a self-certification to the MEPA Office indicating that all of the required mitigation measures, or their equivalent, have been completed. The commitment to provide this self-certification in the manner outlined above should be incorporated into the draft Section 61 Findings included in the DEIR. C.89

Responses to Comments

The DEIR should contain a copy of this Certificate and a copy of each comment letter received. To ensure that the issues raised by commenters are addressed, the DEIR 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 DEIR beyond what has been expressly identified in this certificate. C.90

Circulation

The Proponent should circulate the DEIR to those parties who commented on the ENF, to any State Agencies from which the Proponent will seek permits or approvals, and to any parties specified in section 11.16 of the MEPA regulations. Per 301 CMR 11.16(5), the Proponent may circulate copies electronically. However, the Proponent must make a reasonable number of hard copies available to accommodate those without convenient access to a computer and distribute these upon request on a first-come, first-served basis. A copy of the DEIR should be made available for review in the Needham Public Library. C.91 C.92 C.93



May 9, 2022
Date

Bethany A. Card

Comments received:

04/25/2022 GPI (for the Town of Needham)
04/26/2022 Town of Needham
04/28/2022 Massachusetts Water Resources Authority (MWRA)
04/28/2022 Massachusetts Department of Energy Resources (DOER)
04/28/2022 Charles River Watershed Association (CRWA)
04/28/2022 Massachusetts Department of Transportation (MassDOT)
04/28/2022 Massachusetts Department of Environmental Protection (MassDEP)

BAC/JH/jh

REF.: NEX-2200133.00

April 25, 2022

Ms. Lee Newman
Director of Planning and Community Development
Needham Department of Public Works
500 Dedham Avenue
Needham, MA 02492

SUBJECT: Highland Science Center, Gould Street, Needham, MA
MEPA ENF – Traffic Peer Review

Dear Ms. Newman:

On behalf of the Town of Needham, ***Greenman-Pedersen Inc.*** (GPI) performed a review of the *Environmental Notification Form*[1] (ENF) prepared by Vanasse Hangen Brustlin, Inc. (VHB) for review by the Massachusetts Environmental Policy Act (MEPA) office for the proposed Highland Science Center in Needham, Massachusetts. The site is located on the northeast corner of the intersection of Highland Avenue and Gould Street, and currently contains a Muzi Ford car dealership, Charles River Media Group and WCVB Channel 5. The site was recently part of a rezoning effort by the Town to allow for the development of up to ±880,000 square feet (SF) of office, research and development, and ancillary retail and service space. GPI has reviewed the ENF and supporting traffic analysis for consistency with the goals and studies prepared as part of the Town's rezoning, as well as for compliance with the Massachusetts Department of Transportation (MassDOT) guidelines for traffic impact analysis and general engineering practice. The following summarizes GPI's comments related to the ENF.

Transportation Section (Traffic Generation)

1. In Section 1.B on page 18 of the ENF, the Applicant notes that a MassDOT Vehicular Access Permit will be required for the potential need to modify roadway geometry within the state highway layout (SHLO). It should be noted that MassDOT will require a minimum of two permits for this development. One permit will be for the change-in-use of the property as the property directly abuts land owned by the Commonwealth of Massachusetts (Interstate 95 / Route 128) and the project will generate more than 2,000 daily vehicle trips. A separate MassDOT access permit will be required for the construction of any off-site roadway improvements within the SHLO.

2. The table in Section 11.A on page 19 of the ENF Form notes that the existing site-generated trips were estimated based on empirical traffic counts collected at the site driveways, which show only 887 daily trips are currently generated by the site. It is important to note that these empirical counts were collected in the fall of 2021, during COVID, and as a result, may under estimate the trips generated by the site pre-COVID when it was fully operational. The use of the lower existing site-generated trips will result in a more conservative (higher) estimate of the net increase in trips generated by the proposed redevelopment.

3. In Section III on page 19 of the ENF Form, the Applicant is requested to describe any transportation demand management measures (TDM) to be implemented to reduce single-occupant vehicle trips to the site, including any transit-related measures. The Applicant has not described any TDM measures related to transit services in this section. However, these measures are described in Section 2.7.2 if the *Transportation* chapter, which notes that the Applicant will:

[1] *Environmental Notification Form, Highland Science Center, Needham Heights, Massachusetts;* prepared by Vanasse Hangen Brustlin, Inc. (VHB); March 2022.

- Explore the feasibility of providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line);
- Require tenants to provide a 50 percent transit pass subsidy for their employees;
- Carpool assistance and incentives;
- Emergency ride home;
- Display in the Main Lobby transportation-related information for tenants' employees and visitors; and
- Promotional efforts.

The Applicant should provide additional information on how carpool assistance and emergency ride home services will be provided, as well as what incentive program may be implemented. In addition to providing shuttle service to nearby commuter rail and Green Line services, the Applicant should explore the possibility of extending bus service to the site.

Transportation Section (Roadways and Other Transportation Facilities)

4. In Section 1.B on page 21 of the ENF Form, the Applicant has stated that no permits will be required related to roadways or other transportation facilities. However, a MassDOT access permit will be required for the construction of off-site roadway improvements within the SHLO. Therefore, the Applicant should complete the *Transportation Facility Impacts* section of the ENF Form.

Air Quality Section

5. In Section 1.A on page 23 of the ENF Form, the Applicant notes that the project does not exceed any of the thresholds related to air quality. However, MEPA requires that an *Air Quality and Greenhouse Gas Emissions* study be conducted for all projects that require a mandatory Environmental Impact Report (EIR). As the project is anticipated to generate more than 3,000 daily vehicle trips and provide more than 300 parking spaces, a mandatory EIR will be required. Therefore, the project will exceed the thresholds for an Air Quality analysis, which will include an evaluation of impacts from both stationary and mobile sources of emissions.

Project Description

6. Section 1.3 of the ENF notes that geometric improvements are proposed at the intersection of Highland Avenue / Gould Street / Hunting Road. The widening of the roadway that will be required to accommodate the additional lanes at this location will also likely require reconstruction of the traffic signal at this intersection to accommodate new signal indications and mast arms, as well as vehicle detection and pedestrian signal equipment. No mention of the signal upgrades were provided in this section.

7. Figure 1.4 provides a graphic depiction of the roadway geometry proposed at the intersection of Highland Avenue / Gould Street / Hunting Road and along Gould Street fronting the site. While the geometry on the majority of the approaches appears consistent with the conceptual improvement sketches prepared as part of the former rezoning effort, the Hunting Road northbound approach to Highland Avenue and the receiving approach on Gould Street are inconsistent with the rezoning plans. The analysis and plans prepared as part of the rezone indicated that two through lanes would be required on Hunting Road with two receiving lanes on Gould Street to accommodate the traffic generated by the project. The capacity and queue analysis summarized in Table 2-15 of the ENF indicates that even with the mitigation measures proposed by the Applicant, the Hunting Road northbound movement will operate over capacity at level-of-service (LOS) F during the weekday AM and PM peak hours under 2029 Build with Mitigation conditions. The Highland Avenue eastbound left-turn movement will also operate at LOS F during the weekday AM peak hour. Therefore, the Applicant should consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of this intersection.

Bicycle Accommodations

8. Section 2.3.4.1 of the ENF notes that a total of 89 bicycle parking spaces will be provided indoors and outdoors, but no description is given on how many spaces will be indoors and how many will be outdoors. The study also does not contain any assessment of the potential bicycle parking demand that could be generated and the adequacy of the number of bicycle parking spaces provided to accommodate this demand.

Collision History

9. Table 2-2 of the ENF does not provide a calculation of the crash rates (in crashes per million entering vehicles) experienced at any of the study area intersections. The crash rate is utilized to assess the significance of the crash occurrence at a study intersection by comparing the crash rate experienced to the statewide and district-wide averages for similar intersections and/or roadway segments. In addition, per MassDOT guidelines, collision diagrams should be prepared for any locations that experience an average of more than 3 crashes per year or a crash rate higher than the state or district-wide average. The Applicant should calculate the crash rates for all study area intersections and prepare collision diagrams, as necessary, to identify collision patterns at the study area intersections. For any location where 5 or more crashes of a similar type occurred over the analysis period, the Applicant should investigate measures to improve safety and mitigate collision occurrence.

Transportation Operations Analysis

10. According to Table 2-9, the Highland Avenue southbound approach to West Street will operate over capacity with long delays during the weekday PM peak hour under 2029 Build conditions, with an increase in delay of 22 seconds per vehicle generated by the project. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

11. The Highland Avenue eastbound through/right-turn movement at the intersection with Webster Street will operate over capacity during the weekday AM peak hour under 2029 Build conditions, with an increase in delay of 26 seconds per vehicle generated by the project. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

12. Although not heavily impacted by project-generated traffic, the Highland Avenue westbound left/through movement at the intersection with 1st Avenue will be well over capacity during the weekday PM peak hour under both 2029 No-Build and Build conditions. GPI recommends the Applicant consider measures to reduce delay and improve operations at this location.

13. Similarly, the Hunting Road northbound approach to Kendrick Street will be well over capacity during the weekday AM peak hour under 2029 No-Build and Build conditions. GPI recommends the Applicant consider options for reducing delay and improving operations at this location.

14. The Webster Street and Cedar Street approaches to Central Avenue are expected to operate well over capacity with long delays and queues under 2029 No-Build and Build conditions, particularly during the weekday AM peak hour. The Applicant should investigate options for improving the operations of these intersections, including conducting a signal warrant analysis to assess whether a warrant for installation of traffic signal will be met at either of these locations.

15. As noted in Comment 7, even with the proposed mitigation at the Highland Avenue / Gould Street / Hunting Road intersection, some movements will continue operating at LOS F under 2029 Build with Mitigation conditions. Therefore, the Applicant should investigate the feasibility of providing additional capacity at this location to accommodate 2029 Build traffic volumes.

Traffic Monitoring Program

16. Section 2.7.3 of the ENF describes a transportation monitoring program that will be conducted post-occupancy to monitor parking occupancy and traffic operations at four of the study area intersections, including the site driveway. The Applicant should also provide monitoring of the effectiveness of the proposed TDM program in encouraging walking/biking, carpooling, and public transportation travel to/from the site.

17. The proposed traffic monitoring program will include the collection of vehicle turning movement counts during the weekday AM and PM peak periods at the following study area intersections:
    - Central Avenue / Gould Street
    - Gould Street / TV Place
    - Gould Street / Project Site Driveway
    - Highland Avenue / Gould Street / Hunting Road

    GPI agrees that these represent the critical locations that would experience the greatest increase in traffic due to the project. However, should the result of the monitoring study indicate that the actual traffic increase generated by the project exceeds the traffic projections contained within the ENF by ten percent or more, the study area for the monitoring program should be expanded to include additional locations to verify that the project's impacts does not create any operation deficiencies at nearby locations. In addition, the monitoring programs should include a capacity and queue analysis to verify the operations of each of the study area intersections under post-occupancy conditions. The monitoring program should also include the collection of daily traffic volumes on TV Place and the Project Site driveway to verify the daily traffic generated by the project.

Should you have any questions regarding these comments, please contact me directly at 603-766-5223.

Sincerely,

GREENMAN–PEDERSEN, INC.

Rebecca L. Brown, P.E.
Senior Project Manager

TOWN OF NEEDHAM
TOWN HALL
Needham, MA 02492-2669

Office of the
TOWN MANAGER

TEL: (781) 455-7500
FAX: (781) 449-4569

April 26, 2022

Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

RE: MEPA ENF #16546
Highland Science Center, 557 Highland Avenue, Needham, MA

Dear Secretary Theoharides:

We have reviewed the *Environmental Notification Form*[1] (ENF) prepared by Vanasse Hangen Brustlin, Inc. (VHB) for review by the Massachusetts Environmental Policy Act (MEPA) office for the proposed Highland Science Center in Needham, Massachusetts. The site is located at 557 Highland Avenue on the northeast corner of the intersection of Highland Avenue and Gould Street, and currently contains a Muzi Ford car dealership, Charles River Media Group and WCVB Channel 5. The site was recently part of a rezoning effort by the Town to allow for the development of up to ±880,000 square feet (SF) of office, research and development, and ancillary retail and service space.

As part of our review the Town has retained the services of Greenman-Pedersen Inc. (GPI) to evaluate the ENF and supporting traffic analysis for consistency with the goals and studies prepared as part of the Town's rezoning, as well as for compliance with the Massachusetts Department of Transportation (MassDOT) guidelines for traffic impact analysis and general engineering practice. The comments related to the ENF as prepared by GPI are detailed in the attached letter from Rebecca L. Brown, Senior Project Manager, GPI, to Lee Newman, Director of Planning and Community Development, dated April 25, 2022 (copy attached). Said comments comprise the Town's formal response to the traffic component of the ENF. Furthermore, we offer the following additional comments for your consideration.

Traffic at the Intersection of Highland and Gould

The proposed development revises the currently under construction traffic pattern from the MassDOT's Highland Avenue Corridor project. The newly proposed layout for this project shows sidewalks on both sides of the road and consists of one bike lane with 4-vehicle traffic lanes exiting Gould Street onto Highland Avenue, and one bike lane with one vehicle lane entering Gould Street from Highland Avenue.

This new road design increases the traveled width by 32-feet from the intersection of Highland Avenue at Gould to just beyond TV Place. A portion of the design shows the travel lanes located on private property owned by the development. We expect the developer to work with the Town in

[1] *Environmental Notification Form, Highland Science Center, Needham Heights, Massachusetts;* prepared by Vanasse Hangen Brustlin, Inc. (VHB); March 2022.

providing an alteration/taking plan and recordings for a new Road Right of Way layout on Gould Street and for optimizing the traffic signals at Highland Avenue and Gould Street.

Water Supply:
We are seeking clarification for the facility's proposed water use of 129,172 gallons per day (GPD) while the wastewater design flow generation is 54,554 GPD.
We expect to work with the developer on determining the optimum water loop design. The current proposal shows a 10-inch water connection to the site off a 12-inch main on Gould Street and a connection to an existing 8-inch water main on TV place. The additional loop connection may be more optimum if connected from Highland Avenue in front of the development instead of, or an addition to the 8-inch on TV Place connection.

Wastewater:
According to the ENF filed by the applicant, the proposed project will generate a total design wastewater flow of 54,554 GPD; this is an increase of 31,501 GPD from the existing facility to the Town's sewer system. The applicant has been in contact with Town of Needham representatives and understands the requirements to have a rate of four gallons for every one gallon of sewage added to the system removed through an actual inflow and infiltration removal (I/I) program. (See attached Town of Needham Sewer System Impact Program Regulations approved October 18, 2016.)

For the new facility, four times the increased flow equates to a total of 126,004 GPD I/I removal anticipated from the development. This may be satisfied by either undertaking a construction project or paying a fee to the Town's I&I program at a rate of $8.00 per gallon required to be removed. We are in the process of analyzing the target areas for the inflow/infiltration to be removed and expect to work with the developer through the site plan approval process.

Thank you for the opportunity to provide the Town's thoughts on the above-noted ENF. We note that the project will require a mandatory Environmental Impact Report (EIR) having met or exceeded two of MEPA's review thresholds namely 301 CMR 11.03 (6)(a)(6), generation of 3,000 or more new daily trips per day at a single location and 301 CMR 11.03 (6)(a)(7), construction of 1,000 or more new parking spaces at a single location and having triggered the requirement for a MassDOT vehicle access permit. Accordingly, we ask that the Secretary include the above identified items in the Scope of Work developed for this EIR. Should you have any questions or need additional information, please contact me at 781-455-7500.

Very truly yours,

Kate Fitzpatrick,
Town Manager

cc: Board of Selectmen
Planning Board
Carys Lustig, Director of Public Works
Thomas Ryder, Town Engineer
Lee Newman, Director of Planning & Community Development

Charles River Watershed Association

April 28, 2022

Via Email

Jennifer Hughes
Environmental Analyst, MEPA Office
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114
Jennifer.Hughes@mass.gov

Re: Environmental Notification Form for Highland Science Center, Needham
EEA No. 16546

Dear Jennifer:

Charles River Watershed Association ("CRWA") submits the following comments on the Environmental Notification Form ("ENF") for the proposed Highland Science Center project in Needham filed with the MEPA Office on March 31, 2022. The proponent is proposing to redevelop a 9+ acre former car dealership site into a 531,000 square foot office/laboratory/research and development building, with associated landscape and hardscape improvements, including a fitness trail, up to an approximately 310,000-SF below-grade parking garage, and a 6-story, approximately 297,000-SF stand-alone parking garage.

Impervious Surface and Stormwater Management

This project will decrease impervious cover on the project site by 1.83 acres for a total impervious area of 6.7 acres. This will result in an improvement over existing conditions, as impervious surfaces exacerbate stormwater pollution and runoff quantity and contribute to heat island effects. Existing impervious area should be reduced wherever possible and where impossible due to necessary uses, impervious cover impacts should be mitigated through modern stormwater management.

As noted during the virtual MEPA consultation session, the ENF contains general statements about improved stormwater management, but more detail is necessary to fully evaluate the stormwater management measures proposed for this project. During the consultation session, the proponent indicated that there will be a green roof area on the building, that permeable pavers will be used in some locations, and that they are looking at stormwater reuse in the building. Green infrastructure should be extensively incorporated into the building, parking lots, and other paved areas to treat stormwater generated by impervious surfaces and provide cooling benefits for the community.

Water Quality

Any stormwater runoff discharged from the project site will ultimately reach the Charles River, which is an impaired waterbody according to the Massachusetts Year 2016 Integrated List of Waters. Two Total Maximum Daily Loads (TMDLs) apply to this segment of the river: the TMDL for nutrients in the Upper/Middle Charles River (2011) and the final pathogen TMDL for the Charles River (2007). There is no discussion in the ENF about how the project will comply with these TMDLs.

Under the nutrient TMDL, significant reductions in phosphorus loading are required in order to meet water quality standards—there is no "room" for any additional phosphorus loading to the Charles River. The pre- and post-development annual phosphorus load from the site should be provided, along with calculations showing that the project complies with the phosphorus TMDL.

As a reminder, the Town of Needham is regulated by the General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) (MS4 Permit). The MS4 Permit requires Needham to reduce its phosphorus load and achieve a total allowable load of 797 kg/yr to comply with the TMDL for nutrients in the Upper/Middle Charles River, which is a 55% reduction over its current phosphorus load. Rather than being a target or a goal, achieving the total allowable load is a legally-binding requirement under the MS4 Permit, with which failure to comply would be a violation of the permit and the Clean Water Act. Reduction requirements contained within Appendix F of the MS4 Permit are based on the TMDL; the baseline phosphorus load, load reduction requirement, and allowable phosphorus load follow the assumption, as relevant here, that commercial, industrial, high density residential, and medium density residential land uses will achieve or exceed an average annual phosphorus load reduction of 65%. We are encouraged that the project proponent indicated during the consultation session that it would meet the 65% phosphorus load reduction requirement. We look forward to seeing more detail in the EIR about how this will be accomplished, including the calculations noted above.

The project must also address the discharge of bacteria to the Charles River. Inflow and Infiltration (I&I) mitigation work to address aging sewer infrastructure is one important way to limit the migration of bacteria into our local water bodies; illicit discharge detection and elimination (IDDE) is another. Under Stormwater Handbook Standard 10 – Prohibition of Illicit Discharges, for any sewer and storm drain infrastructure remaining on site, we would expect the proponent to confirm the condition and separation of stormwater utilities, and that there are no illicit connections. Bacteria can also come from soils and decomposition of natural materials. Catch basins and water quality units collect much of this material, and some of it may enter the infiltration systems. Frequent cleaning as part of a long-term operation and maintenance program is a critical way to keep these materials from entering the piped network and subsurface systems.

Trees & Vegetation

Trees and other vegetation improve air and water quality, help control stormwater runoff and flooding, and provide natural cooling. We recommend that native trees and shrubs be planted within proposed landscaped areas and along proposed roadways wherever possible.

Thank you for considering these comments.

Sincerely,

Heather Miller, Esq.
General Counsel and Policy Director

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Jamey Tesler, Secretary & CEO

massDOT
Massachusetts Department of Transportation

April 28, 2022

Kathleen Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114-2150

RE: Needham - Highland Science Center – ENF
(EEA #16546)

ATTN: MEPA Unit
Jennifer Hughes

Dear Secretary Theoharides:

On behalf of the Massachusetts Department of Transportation, I am submitting comments regarding the Environmental Notification Form filed for the proposed Highland Science Center at 557 Highland Avenue in Needham as prepared by the Office of Transportation Planning. If you have any questions regarding these comments, please contact J. Lionel Lucien, P.E., Manager of the Public/Private Development Unit, at (857) 368-8862.

Sincerely,

David J. Mohler
Executive Director
Office of Transportation Planning

DJM/jll

Ten Park Plaza, Suite 4160, Boston, MA 02116
Tel: 857-368-4636, TTY: 857-368-0655
www.mass.gov/massdot

cc: Jonathan Gulliver, Administrator, Highway Division
Carrie Lavallee, P.E., Chief Engineer, Highway Division
John McInerney, P.E., District 6 Highway Director
Neil Boudreau, Assistant Administrator of Traffic and Highway Safety
Planning Board, Town of Needham
Metropolitan Area Planning Council
Boston Regional Metropolitan Planning Organization

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Jamey Tesler, Secretary & CEO

massDOT
Massachusetts Department of Transportation

Memorandum

TO: David J. Mohler, Executive Director
Office of Transportation Planning

FROM: J. Lionel Lucien, P.E., Manager
Public/Private Development Unit

DATE: April 28, 2022

RE: Needham: Highland Science Center – ENF
(EEA #16546)

The Public/Private Development Unit (PPDU) has reviewed the Environmental Notification Form ("ENF") for the proposed Highland Science Center located at 557 Highland Avenue (the "Project") submitted by VHB, Inc. on behalf of 557 Highland, LLC (collectively, the "Proponent"). The Project exceeds MEPA thresholds for the preparation of a Draft Environmental Impact Report ("DEIR") due to impacts on Transportation established in 301 CMR 11.03 as it surpasses 3,000 average daily vehicle trips and includes more than 1,000 parking spaces on site. The project additionally requires a Vehicular Access Permit from MassDOT as it is anticipated to generate substantially increased vehicle trips on Highland Avenue and I-95, both jurisdictional roadways.

The Project is located on a parcel at 557 Highland Avenue with a total area of 9.281 acres. The site is currently fully developed with existing structures, impervious surface, and utilities, and operated as a Ford automotive service and sales center until late 2021. The Proponent proposes the demolition of the existing 39,750 square foot (sf) commercial building to construct a science and manufacturing campus, including a five-story commercial building, a three-story commercial building, shared atrium area, and a seven-level parking garage (with two levels below-grade). Site access will be provided via two driveways: a two-lane full access driveway connecting to TV Place (a private road) north of the Project, and a three-lane full access driveway connecting to Gould Street. Provisional site plans include demarcated bike lanes at the Gould Street driveway as well as pedestrian infrastructure at both points of access.

According to the ENF, the Project in total comprises 531,000 sf of new structures, including 260,500 sf of office space, 260,500 sf of research and development space, and 10,000 sf of retail space.

Based on the Project's anticipated impacts, the DEIR will require a Transportation Impact Assessment (TIA). In February 2022, the Proponent submitted a Transportation Scoping Letter (TSL) outlining the methodology for the TIA. Based on the MassDOT memo dated February 2, 2022 approving the TSL, the ENF includes a TIA developed in accordance with MassDOT/EOEEA's *Transportation Impact Assessment (TIA) Guidelines.*

Trip Generation

In Section 2 of the ENF submittal, titled "Transportation," the Proponent estimates that the combination of uses proposed for the Project site will generate an additional 5,005 vehicle trips over existing conditions in accordance with the Institute of Traffic Engineers (ITE) *Trip Generation Manual*, using Land Use Code (LUC) 710: Office for the 260,500 sf of office space, LUC 760: Research and Development Center for the 260,500 sf of research and development space, and LUC 122: Community Shopping Center for the 10,000 sf retail component. In order to provide a conservative analysis of traffic impacts generated by the Project, the Proponent provides traffic analysis assuming no mode share for pedestrian, bicycle, or transit trips to the Project site.

Traffic Operations

The TIA includes analysis of traffic operations at study area intersections under 2022 Existing Conditions, the 2029 No-Build Scenario, and the 2029 Build Scenario, as well as a network map of trip distribution within the study area. The Proponent estimates that overall Level of Service (LOS) for vehicular traffic will degrade at certain study area intersections under the 2029 Build Scenario as compared to the 2029 No-Build Scenario. Per Table 2-9: Signalized Intersection Capacity Analysis Summary, Highland Avenue at West Street will see a drop in performance from LOS C to LOS D and Highland Avenue at Gould Street and Hunting Road will decline from LOS E to LOS F.

The Proponent estimates that the majority of vehicle traffic generated by the Project will access and depart the site via Interstate 95 (I-95) northbound and southbound, with substantially smaller proportions travelling via Highland Avenue to and from points south or via Webster Street to and from points west.

The Proponent notes that Highland Avenue is currently under reconstruction by MassDOT Project #606635 to improve pedestrian and bicycle infrastructure as well as traffic operations along this corridor. The roadway conditions and multi-modal access assumptions included in the 2029 No-Build and Build scenarios do not consider any operational or accessibility improvements resulting from these as-yet incomplete roadway improvements.

In the DEIR, the Proponent should include analysis of queuing at study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area.

Safety

The TIA includes a summary of crash rates derived from the MassDOT crash data portal for the five-year period between 2015 and 2019. Of the study area intersections included for analysis, Highland Avenue at West Street represents a higher-than-average rate

of accidents, with 0.86 accidents per million vehicles as compared to the District 6 average of 0.71. There are no 2017-2019 HSIP crash clusters identified within the study area.

In the DEIR, the Proponent should include analysis of existing and proposed weave conditions on Highland Avenue to ensure that increased traffic volumes do not lead to degraded safety conditions in the area of the Highland Avenue/I-95 interchange.

Transit Operations

The Proponent includes information regarding existing transit options in the area of the Project. The closest subway service available to site visitors is the Massachusetts Bay Transportation Authority (MBTA) Green Line D Branch via the Newton Highlands station, approximately two miles from the Project site via Centre Street. The Needham Heights commuter rail station is also located approximately 0.75 miles south of the Project site along Highland Avenue. MBTA Bus Route 59 provides service to the Needham area, including stops on Highland Avenue approximately 0.6 miles south of the Project site.

Pedestrian Access

The TIA includes a summary of existing pedestrian infrastructure within the study area. The primary roadways serving the Project site, Highland Avenue and Gould Street, each possess existing sidewalks and crosswalks at major intersections, while the Gould Street/Ellis Street and Gould Street/Noanett Road intersections each lack crosswalks. The Project site design includes several features to support pedestrian access to and from the site, including sidewalks connecting to site driveways, proposed mitigation to improve pedestrian infrastructure in the study area (see Mitigation below), and the construction of a 0.5-mile public walking path circling the Project site.

Bicycle Access

The TIA includes a summary of bicycle infrastructure within the study area. The Project site is served by very limited bicycle infrastructure, except for on-street bicycle lanes on Highland Avenue between Wexford and Gould Streets and on Kendrick Street between Hunting Road and 3rd Avenue. The Project site will include bicycle racks and 89 total bicycle parking spaces outside as well as secured bicycle storage within the Project buildings. Both MassDOT Project #606635 and the Proponent's proposed mitigation (see Mitigation below) include improvements to bicycle infrastructure in the study area.

Parking

The Project will include two below-grade parking garages with a total area of 310,000 sf and one 297,000 sf standing garage, which along with new proposed surface parking represents up to 1,770 total parking spaces. This parking provision conforms to Needham off-street parking minimums, which call for one parking space per 300 sf of floor area. MassDOT

believes that this parking capacity is sufficient to support site operations when taken together with proposed mitigation including Transportation Demand Management (TDM) measures outlined below.

Mitigation

The Proponent proposes mitigation measures in the TIA intended to address both Project-generated traffic impacts as well as noted deficiencies in area pedestrian and bicycle infrastructure. The Proponent proposes the following measures as mitigation requiring limited design or construction prior to implementation:

- Installation of on-road bicycle lanes on Gould Street between Highland Avenue and TV Place (adjacent to the Project site).
- Installation of a shared bicycle lane on Gould Street between TV Place and Central Avenue.
- Design and installation of traffic signals at Gould Street/Hunting Road (aligned with Wingate driveway) and Gould Street/Central Avenue intersections.
- Geometric improvements at the Highland Avenue/Gould Street/Hunting Road and Gould Street/TV Place intersections.

In addition to the above, the Proponent includes the following conceptual proposals which may result in future mitigation activities within the study area:

- Coordination with the Town of Needham to study the feasibility of converting the MBTA rail right-of-way north of the Project site into a mixed-use walkway.
- Coordination with the Route 128 Business Council to provide shuttle service to existing transit options.

Further, the Proponent commits to Transportation Demand Management (TDM) measures and a five-year monitoring program as outlined in the respective sections below.

As noted in the Bicycle and Pedestrian Access sections above, the Project area includes sub-standard infrastructure for bicycle and pedestrian employees of the proposed science center. MassDOT requests that the Proponent consider coordinating with District 6 to install adequate bicycle and pedestrian infrastructure on Highland Avenue at the I-95 interchange to connect with proposed Complete Streets improvements to be installed under MassDOT Project #606635. With this suggestion, MassDOT otherwise finds that the proposed mitigation is appropriate to the scale of the Project and will serve to offset traffic impacts generated by the Project and improve access to the Project site.

The DEIR should include sufficiently detailed conceptual plans (minimum of 80-scale) for any proposed roadway improvements including the proposed signalization, geometric improvements, and bicycle lanes to verify the feasibility of constructing such

improvements. These plans should clearly show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed. The Proponent should also consider coordination with MBTA in order to determine the feasibility of additional MBTA Bus Route 59 service closer to the Project site.

Transportation Demand Management (TDM)

The Proponent proposes to instate TDM measures with the goal of reducing vehicle trips to the Project site. To this end, the TDM program includes the following measures:

- Assignment of an on-site Employee Transportation Advisor to coordinate with the Route 128 Business Council;
- Coordination with the Route 128 Business Council to provide shuttle service to existing transit options;
- Provision of a 50 percent transit pass subsidy to be offered by tenants to employees;
- Carpool assistance and emergency ride home services;
- Bicycle/walk incentives to travel to work;
- Telecommuting and shortened workweek opportunities for staff;
- Posting of transit information in the public Main Lobby, and;
- Promotional efforts.

Transportation Monitoring Program

The Proponent commits to the implementation of a Transportation Monitoring Program (TMP) to run for five years with annual reporting to MassDOT and the Town of Needham. In accordance with MassDOT/EEA standards, the TMP will include:

- Simultaneous automatic traffic recorder (ATR) counts at each site driveway for a continuous 24-hour period on a typical weekday;
- Travel survey of employees and patrons at the site;
- Weekday AM and PM peak hour turning movement counts (TMCs) and operations analysis at study area intersections, and;
- Updates on efficacy of TDM program.

Conclusion

The Proponent should continue consultation with the Town of Needham, the MBTA, and appropriate MassDOT units, including PPDU, Traffic Operations, and the District 6 Office during the preparation of the DEIR for the Project. Additionally, the Proponent should include a Draft Section 61 Finding in the DEIR that summarizes the proposed mitigation plan and the monitoring program. If you have any questions regarding these comments, please contact *Curtis.B.Wiemann@dot.state.ma.us*.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection
Northeast Regional Office • 205B Lowell Street, Wilmington MA 01887 • 978-694-3200

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Kathleen A. Theoharides
Secretary

Martin Suuberg
Commissioner

April 28, 2022

Kathleen A. Theoharides, Secretary
Executive Office of
Energy & Environmental Affairs
100 Cambridge Street
Boston MA, 02114

RE: Needham
Highland Science Center
EEA # 16546

Attn: MEPA Unit

Dear Secretary Theoharides:

The Massachusetts Department of Environmental Protection Northeast Regional Office (MassDEP-NERO) has reviewed the Environmental Notification Form (ENF) for the proposed Highland Science Center in Needham. MassDEP provides the following comments.

MCP/ M.G.L. Chapter 21E

The site is the former location of an automobile dealership, which operated from 1955 to 2021. The former automotive dealership complex had consisted of two 2-story masonry car dealership and service buildings that covered the southern and northeastern portions of the site. A smaller building also occupied the northern portion of the site that was formerly operated as a car wash. The remainder of the site was generally covered by asphalt paved parking areas and landscaped margins. In February 2022, the former buildings were demolished, and the site was leveled.

The proposed Highland Science Center development includes an approximately 531,000 square foot office/laboratory/research and development building. The new building will vary in height from 3-5 stories and include associated landscape and hardscape improvements and is intended to attract office and life science tenants, with ancillary retail, café, daycare, and fitness amenities subject to market demand. The Project will include up to an approximately 310,000

square foot below-grade parking garage and a six-story, approximately 297,000 square foot stand-alone parking garage.

Current MGL Chapter 21E Status

There are two Massachusetts Contingency Plan (310 CMR 40.0000, the "MCP") Release Tracking Numbers (RTNs) associated with oil and hazardous materials releases at or in close proximity to the Highland Science Center development project site.

The earlier RTN, 3-36733, pertains to the discovery of reportable concentrations of naphthalene, 1,4-dichlorobenzene and 2-methylnaphthalene in soil during the performance of an environmental site assessment in 2021. The contamination was attributed to historic fill operations at the property. Further subsurface characterization of the site was conducted, and a risk assessment determined that exposure point concentrations were below applicable cleanup standards under the MCP. A Permanent Solution with No Conditions was submitted to MassDEP in August, 2021. No further response actions are anticipated under this RTN.

The later RTN, 3-37285, was issued in January, 2022, and pertains to the discovery of gasoline contamination in soil during the removal of a 6,000 gallon underground storage tank at the property. Release response actions involving the excavation and disposal of impacted soils are currently being conducted as an Immediate Response Action pursuant to the provisions of the MCP. To date, approximately 1,000 cubic yards of impacted soils have been excavated and shipped off-site for recycling into asphalt. It is anticipated that an additional 100 yards of soils will be excavated and recycled. Groundwater at the site is not believed to be impacted by the gasoline release. Further investigation of subsurface conditions is expected to continue, and the results provided to MassDEP in the next scheduled submittal due in May, 2022.

In addition, subsurface assessment activities that have been recently completed at the site have identified localized areas of soil exhibiting Reportable Concentrations of metals, PCBs, petroleum hydrocarbons and polycyclic aromatic hydrocarbons which require notification to MassDEP as a 120-day reporting condition in accordance with 310 CMR 40.0333(2). The Reportable Concentrations of these constituents are attributable to the former site usage as automobile dealerships and service center, coupled with historical filling of the former gravel quarry. In accordance with 310 CMR 40.0333(2), MassDEP will be notified of the release condition which will be subsequently managed in accordance with the provisions of the MCP. As part of the Project Site redevelopment, affected soils will be managed in accordance with the MCP, as well as applicable MassDEP policies. Upon completion of redevelopment, a Permanent Solution Statement is anticipated to be filed for the 120-day reporting condition.

Future Compliance Required by the MCP for the Highland Science Center Redevelopment Project

Response actions pursuant to RTN 3-37285 are expected to continue at the site of the proposed project. Pursuant to section 40.0560(2)(b) of the MCP, a Phase I Site Assessment report for RTN 3-37285 must be submitted to MassDEP by January 21, 2023. Additionally, Immediate

Response Action Status Reports must continue to be submitted to MassDEP in accordance with the requirements of section 310 CMR 40.0425 of the MCP, until an Immediate Response Action Completion Statement is submitted to MassDEP.

The project proponent is advised that excavating, removing and/or disposing of contaminated soil, pumping of contaminated groundwater, or working in contaminated media must be done under the provisions of M.G.L. c. 21E and all other applicable federal, state, and local laws, regulations, and bylaws. If contamination at the site is known or suspected, the appropriate tests should be conducted well in advance of the start of construction and professional environmental consulting services should be readily available to provide technical guidance. If dewatering activities are to occur at a site with contaminated groundwater, or in proximity to contaminated groundwater where dewatering can draw in the contamination, a plan must be in place to properly manage the groundwater. A Licensed Site Professional (LSP) must be employed or engaged to manage, supervise or actually perform the necessary response actions at the site.

Dust and/or vapor monitoring and controls are often necessary for large-scale projects in contaminated areas. The need to conduct real-time air monitoring for contaminated dust and to implement dust suppression must be determined prior to excavation of soils, especially those contaminated with compounds such as metals and PCBs. An evaluation of contaminant concentrations in soil should be completed to determine the concentration of contaminated dust that could pose a risk to health of on-site workers and nearby human receptors. If this dust concentration, or action level, is reached during excavation, dust suppression should be implemented as needed, or earthwork should be halted.

If capping of contaminated soil is needed to achieve a level of No Significant Risk, MassDEP recommends the following capping design criteria. In unpaved areas, a minimum of three feet of clean soil should be placed over the contaminated soil. This protective layer of clean soil should be separated from the underlying contaminated soil by a geotextile or combination of materials, which will provide both a brightly colored visual marker and a permeable fabric to separate the clean soil from the contaminated soil. In paved areas, a minimum one-foot cap consisting of clean soil, road base and the pavement layer should be placed over the contaminated soil. Similar to unpaved areas, the contaminated soil should be separated from the clean soil or road base using a visual marker and geotextile. In such cases, an Activity and Use Limitation (AUL), prepared in accordance with 310 CMR 40.1012 would be necessary to identify the maintenance requirements of the cap. It should also be noted that a cap constructed as an Immediate Response Action or as a Release Abatement Measure will not be considered a Permanent Solution until a Phase III completed in accordance with 310 CMR 40.0850 demonstrates the lack of a feasible alternative, as required by 310 CMR 40.0414(7) and 40.0442(4).

Parties constructing and/or renovating buildings in contaminated areas should consider whether chemical or petroleum vapors in subsurface soils and/or groundwater could impact the indoor air quality of the buildings. All relevant site data, such as contaminant concentrations in soil and groundwater, depth to groundwater, and soil gas concentrations should be evaluated to determine the potential for indoor air impacts to existing or proposed building structures. Particular attention should be paid to the vapor intrusion pathway for sites with elevated levels of chlorinated volatile organic compounds such as tetrachloroethylene (PCE) and trichloroethylene (TCE).

MassDEP has additional information about the vapor intrusion pathway on its website at https://www.mass.gov/lists/policies-guidance-technical-support-for-site-cleanup?_ga=2.165003519.1902262297.1534291448-758575996.1534291448#vapor-intrusion-.

Construction activities conducted at a disposal site shall not prevent or impede the implementation of likely assessment or remedial response actions at the site. Construction of structures at a contaminated site may be conducted as a Release Abatement Measure if assessment and remedial activities prescribed at 310 CMR 40.0442(3) are completed within and adjacent to the footprint of the proposed structure prior to or concurrent with the construction activities. Excavation of contaminated soils to construct clean utility corridors should be conducted for all new utility installations.

An Activity and Use Limitation (AUL) is a legal document that is recorded or registered at the appropriate Registry of Deeds and identifies site conditions that are the basis for maintaining a condition of No Significant Risk at a property where contamination remains after a cleanup. The AUL identifies permitted and allowable site uses and activities that may occur at a property while maintaining No Significant Risk. The AUL also identifies restricted uses and activities, which could result in the exposure of people at or near the disposal site to remaining contamination if such activities were to occur. The project proponent is advised that in cases where proposed activities would not be consistent with a level of No Significant Risk and/or an existing AUL, additional cleanup and the amendment or termination of the initial AUL and implementation of a revised AUL would be necessary before the proposed activities could occur

Solid Waste

MassDEP's current *Massachusetts 2030 Solid Waste Master Plan–Working Together Toward Zero Waste*, issued in October 2021 identifies a key goal to reduce solid waste disposal by 30% by 2030 and 90% by 2050. MassDEP encourages the Proponent to review the plan to identify project management and operational practices that will assist the Commonwealth in meeting its material management goals. More information on the *Solid Waste Master Plan* and yearly update reports can be found at: https://www.mass.gov/guides/solid-waste-master-plan.

Waste Ban

Section 310 CMR 19.017 *Waste Bans* of the Massachusetts Solid Waste regulations prohibit the disposal of certain construction-related wastes in Massachusetts, including, but not limited to, metal, wood, asphalt pavement, brick, concrete, clean gypsum wallboard. Further guidance can be found at: https://www.mass.gov/guides/massdep-waste-disposal-bans.

MassDEP regulations also ban disposal of food and other organic wastes from businesses and institutions that dispose of more than one ton[1] of these materials per week. The ban is one of MassDEP's initiatives to help achieve our goal of further reducing food waste by 500,000 tons

[1] Beginning in November 2022, the ban will be lowered to include businesses and institutions that dispose of more than ½ ton of food and other organic wastes per week.

annually by 2030. Diverted food waste may be composted, converted to energy (through anaerobic digestion), recycled, or reused. Additional information, including a full list of banned materials, can be found at: https://www.mass.gov/guides/massdep-waste-disposal-bans.

C&D Recycling

Many construction and demolition materials are currently banned from disposal or transfer for disposal in Massachusetts (https://www.mass.gov/guides/massdep-waste-disposal-bans). Therefore, MassDEP encourages the Proponent to make a significant commitment to construction and demolition (C&D) waste recycling activities as a sustainable measure for the project and to assist in complying with waste ban requirements. MassDEP considers an asphalt, brick, and concrete (ABC) rubble processing or recycling facility (pursuant to the provisions of Section (2)(b) under 310 CMR 16.03), the Site Assignment regulations for solid waste management facilities), to be exempt from the site assignment requirements, if the ABC rubble at such facilities is separated from other solid waste materials at the point of generation. In accordance with 310 CMR 16.03(2)(b), ABC can be crushed on-site with a 30-day notification to MassDEP. However, the asphalt is limited to weathered bituminous concrete (no roofing asphalt), and the brick and concrete must be uncoated or not impregnated with materials such as roofing epoxy. If the brick and concrete are not clean, the material is defined as C&D waste and requires either a Beneficial Use Determination (BUD) or a Site Assignment and permit before it can be crushed.

Pursuant to the requirements of 310 CMR 7.02 of the Air Pollution Control regulations, if the ABC crushing activities are projected to result in the emission of one ton or more of particulate matter or other pollutant to the ambient air per year, and/or if the crushing equipment employs a diesel oil fired engine with an energy input capacity of three million or more British thermal units per hour for either mechanical or electrical power which will remain on-site for twelve or more months, then a plan application must be submitted to MassDEP for written approval prior to installation and operation of the crushing equipment.

Asbestos

Pursuant to 310 CMR 7.15 the removal of asbestos from the buildings must adhere to the special safeguards defined in the Air Pollution Control regulations. An asbestos survey to identify all asbestos containing materials (ACM) shall be conducted by a Massachusetts Department of Labor Standards certified Asbestos Inspector. All identified ACM shall be abated prior to demolition activities. The Proponent is required to submit to MassDEP an Asbestos Removal Notification (Form AQ04 (ANF-001)) at least 10 working days prior to initiating work for any project involving asbestos abatement, removal, or disposal. If any ACM will need to be abated through non-traditional abatement methods, the Proponent must apply for and obtain approval from MassDEP, through Application BWP AQ36 - Application for Non-Traditional Asbestos Abatement Work Practice Approval.

Pursuant to 310 CMR 7.09, for any Construction and Demolition, except in a residential building with fewer than 20 units, the Proponent is required to submit to MassDEP a Construction/Demolition Notification (Form BWP AQ06) at least 10 working days prior to

initiating work. MassDEP Asbestos, Construction and Demolition Notifications can be found at: https://www.mass.gov/guides/massdep-asbestos-construction-demolition-notifications.

Pursuant to 310 CMR 19.061, disposal of ACWM within the Commonwealth must be at a facility specifically approved by MassDEP. The Proponent is advised that asbestos containing waste materials (ACWM) are a special waste as defined in the Solid Waste Management regulations. There are specific ACWM disposal exceptions for intact vinyl asbestos tile (VAT) and asphaltic-asbestos felt and shingles. The disposal of the ACWM outside the jurisdictional boundaries of the Commonwealth must comply with all the applicable laws and regulations of the state receiving the material. Pursuant to 310 CMR 16.05, ACM including VAT, and/or asphaltic-asbestos felts or shingles may not be disposed of at a facility operating as a recycling facility.

Recycling Infrastructure

MassDEP supports voluntary initiatives to institutionalize source reduction, materials reuse, and recycling into operations. Adapting the design, infrastructure, and contractual requirements necessary to incorporate reduction, recycling and recycled products into existing large-scale developments has presented significant challenges to recycling proponents. Integrating those components into developments during the planning and design stage enables the project's management and occupants to establish and maintain effective waste diversion programs. For more guidance on how to reuse building materials, see https://www.mass.gov/lists/managing-construction-demolition-cd-wastes. Free assistance is available from RecyclingWorks in Massachusetts, a recycling assistance program funded by MassDEP – see www.recyclingworksma.com for more information.

The MassDEP appreciates the opportunity to comment on this proposed project. Please contact Stephen.Johnson@mass.gov at (978) 694-3350 for further information on MCP/Chapter 21E issues. Please contact John.MacAuley@mass.gov at (978) 694-3262 for further information on solid waste, construction and debris, and asbestos issues. If you have any general questions regarding these comments, please contact me at John.D.Viola@mass.gov or at (978) 694-3304.

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John D. Viola
Deputy Regional Director

cc: Brona Simon, Massachusetts Historical Commission
Eric Worrall, Steve Johnson, John MacAuley, MassDEP-NERO

MASSACHUSETTS WATER RESOURCES AUTHORITY
Charlestown Navy Yard
100 First Avenue, Building 39
Boston, MA 02129

Frederick A. Laskey
Executive Director

Telephone: (617) 242-6000
Fax: (617) 788-4899
TTY: (617) 788-4971

April 28, 2022

Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge St, Suite 900
Attn: MEPA Office, Jennifer Hughes
Boston, MA 02114

Subject: EOEEA #16546 – Environmental Notification Form
Highland Science Center, Needham, MA

Dear Secretary Theoharides,

The Massachusetts Water Resources Authority (MWRA) appreciates the opportunity to comment on the Environmental Notification Form (ENF) submitted by 557 Highland, LLC (the "Proponent") for Highland Science Center (the "Project") located in Needham. The 9.27 acre Project site is located adjacent to I-95 and the Exit 35C off ramp and currently consists of a car dealership and car wash with approximately 532 parking spaces. The Project involves redevelopment of the site to include a new office and laboratory building complex containing three buildings as well as below grade parking and a parking garage.

MWRA's comments on this NPC relate to wastewater issues and the need for Infiltration/Inflow (I/I) Removal as well as Toxic Reduction and Control (TRAC) discharge permitting.

Wastewater

The ENF reports that the Project will increase wastewater flow by 731,501 gallons per day (gpd), from an existing wastewater flow of 23,053 gpd to 54,554 gpd. The site is served by a sanitary sewer system owned and operated by the Town of Needham that conveys flows to MWRA's Wellesley Extension Relief Sewer in the Town of Dedham, which delivers flows to the MWRA High Level Sewer, the Nut Island Headworks, and ultimately MWRA's Deer Island Wastewater Treatment Plant. Sections of the MWRA system can surcharge and overflow in large storms to the Charles River, due to high levels of infiltration and inflow entering tributary community sewer systems. To ensure that the Project's new wastewater flow does not increase surcharging and overflows in large storms, the Proponent should fully offset the Project's

wastewater flows with infiltration and inflow ("I/I") removal in accordance with Town of Needham's policies and regulations.

Additionally, the Charles River is surrounded by Environmental Justice Populations. The proponent should carefully analyze ways to offset the additional wastewater generated by this development to limit/eliminate potential impacts that additional flow to the sewer may have on CSOs to the Charles River and associated downstream communities.

TRAC Discharge Permitting

MWRA prohibits the discharge of groundwater and stormwater into the sanitary sewer system, pursuant to 360 C.M.R. 10.023(1) except in a combined sewer area when permitted by the Authority and the local community. The Project site has access to separate sewer and storm drain systems. Therefore, the discharge of groundwater or stormwater to the sanitary sewer system associated with this Project is prohibited.

A Sewer Use Discharge Permit is required prior to discharging industrial process or laboratory wastewater from office, laboratory, or commercial space associated with the Project into the MWRA sanitary sewer system. For assistance in obtaining this permit, a representative of the proposed office and laboratory space should contact Stephen Buczko, Industrial Coordinator, in the TRAC Department at (617) 305-5619 or Stephen.Buczko@mwra.com. Completed Sewer Use Discharge Application forms and attachments should be submitted via standard mail to Stephen Buczko, MWRA, Industrial Coordinator, MWRA, TRAC, 2 Griffin Way, Chelsea, MA 02150 and via email to TRACPermits@mwra.com.

Any gas/oil separators in parking garages associated with the Project must comply with 360 C.M.R. 10.016 and State Plumbing Code. Installation of gas/oil separator(s) may not be back filled until inspected and approved by the MWRA and the Local Plumbing Inspector. For assistance in obtaining an inspection, the Proponent should contact Michael J. Quercio, Source Coordinator, in the TRAC Department at (617) 305-5645 or Michael.Quercio@mwra.com.

Additionally, due to the proximity of planned MWRA infrastructure to the Project site, MWRA requests coordination with the Proponent during design and construction. On behalf of the MWRA, thank you for the opportunity to provide comments on this Project. Please do not hesitate to contact Katie Ronan of my staff at (857) 289-1742 with any questions or concerns.

Sincerely,

Rebecca Weidman
Director
Environmental and Regulatory Affairs

cc: John Viola, MassDEP

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 Woodcock
Commissioner

6 May 2022

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

RE: Highland Science Center, MA, EEA #16546

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

Dear Secretary Theoharides:

We've reviewed the Environmental Notification Form (ENF) for the proposed project. The project includes the construction of 531,000-sf of office and lab/office buildings with some retail, daycare, fitness, and other ground floor use. For this project we expect key mitigation measures to include:

- Building design and construction practices that result in low heating and cooling thermal energy demand intensity (heating and cooling "TEDI") by:
    - Maintaining envelope integrity with framed, insulated walls with continuous insulation;
    - Thermal-bridge free envelope;
    - Minimizing glass curtain wall assemblies and excessive windows;
    - Low air-infiltration, confirmed with in-building air-infiltration testing;
    - Energy recovery;

  - Management of solar heat gains;

- Efficient electrification of space heating, including:

  - For buildings and portions of buildings that are highly ventilated such as lab/office space: low temperature, hydronic space heating with heat-input provided by hybrid, in-building, central plant consisting of air-to-water heat pump (primary) and gas boilers (secondary). Target a fossil fuel-based use intensity (EUI_{ff}) of 10 kBtu/sf-yr or less;

  - For buildings and portion of buildings that are not highly ventilated (such as ground floor retail, daycare, office, etc): low temperature, hydronic space heating with heat-input provided by in-building central plant consisting of air-to-water heat pump; or, air source heat pumps/VRF.

- Efficient electrification of water heating, where feasible;

- Extensive rooftop solar-readiness;

- Electric vehicle ready parking spaces.

Note that significant incentives may be available, including MassSave® incentives, Alternative Energy Credits (AECs), and Solar Massachusetts Renewable Target (SMART) credits.

The ENF describes examining some of the above-mentioned strategies. We commend the project for their early consideration of energy efficiency.

Envelope, Heat Recovery, and Solar Gains

The combination of quality envelope, heat recovery, and management of solar gains can result in significant reduction in heating (and cooling) thermal energy demand intensity (TEDI, units of kBtu/sf-yr)[1]. In addition to reduced utility costs and emissions, the value of a targeted focus on heating and cooling TEDI results in:

- Simplified space heating electrification;
- Reduction, and possible elimination, of perimeter heating systems;
- Improved resiliency;
- Reduced peak demands;
- Improved occupant comfort;
- Reduced maintenance.

[1] Although they have the same units, heating and cooling TEDI is not the same as heating and cooling EUI. TEDI represents energy requirement, or demand, not energy consumption. For guidance on how to extract TEDI information from building models see "Energy Modeling Guidelines", City of Vancouver, Planning, Urban Design and Sustainability Department, Land Use Development and Policy Guidelines, Version 2.0, amended 18 July 2018 and "Designing to TEDI, TEUI, and GHGI Performance Metrics", International Building Performance Simulation Association (IBPSA), by Chan *et al*

Specific TEDI reduction strategies are:

- High-performance window and walls;
- Thermally-broken windows and other components to eliminate thermal bridges;
- Low air-infiltration;
- Ventilation energy recovery;
- Solar gain management via external shading and/or low solar heat gain coefficient (SHGC)

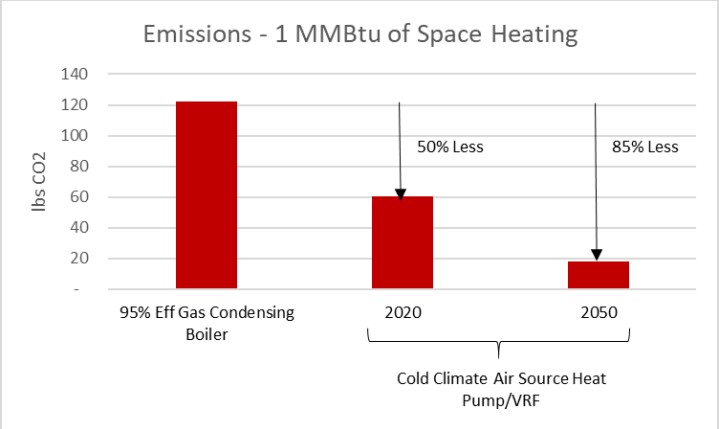
Buildings with curtain wall envelope require high performing windows and high performing opaque spandrels to achieve heating TEDI reductions. High performing windows and high performing opaque spandrels should be carefully evaluated if curtain-wall construction is considered.

Efficient Electrification – Space Heating

Efficient electrification of space heating entails the swapping of fossil fuels (natural gas, oil, and propane), or electric resistance systems, with cold-climate rated air source heat pumps or ground source heat pumps.

Electrification of space heating is a key mitigation strategy with significant short- and long-term implications on GHG emissions. Massachusetts grid emissions rates continue to decline with the implementation of clean energy policies that increase renewable electricity sources. The implication is that efficient electric space heating with cold climate air source heat pump (or ground source heat pump) has lower emissions than other fossil-fuel based heating options, including best-in-class (95% efficient) condensing natural gas equipment.

Currently, efficient electric heating has approximately **50% lower emissions** in Massachusetts than condensing natural gas heating. By 2050, and possibly sooner, efficient electric heating is expected to have approximately **85% lower emissions** in Massachusetts than condensing natural gas heating. See illustration below.



Electrifying Space Heating: High ventilation spaces

The proposed lab/office spaces may have high ventilation loads. High ventilation loads have made electrification of space heating a challenge in the past. However, since about beginning of 2020, more than 90% of all highly-ventilated buildings that the DOER has reviewed have committed to partial electrification of space heating.

This approach uses a hybrid of air to water (or ground to water) heat pumps with fossil fuel-based input as backup in which the heat pump can provide 90% total annual heating end use. In most cases, fossil fuel-based use intensity (EUI_{ff})[2] is 5 to 10 kBtu/sf-yr, or less.

Key strategies for this hybrid approach are as follows:

a) Include hydronic space heating and space cooling, including a hot water distribution loop of 120°F;

b) Include heat recovery chillers or similar approach to recover heat energy from chilled water for use in the hot water loop;

c) Include an in-building, centralized heating plant consisting of an air-to-water (or ground-to-water) heat pump and a gas-fired condensing boiler;

d) Size the boiler for 100% of the peak load; size the air source heat pump for 25% to 50% of the peak load;

e) After heat recovery with equipment in (b) above, prioritize the air or ground source heat pump operation first and utilize boiler only when loads exceed 25-50% of peak. The objective is to provide 90% of the total annual heating with air source and reduce fossil fuel-based use intensity (EUI_{ff}) to 5-10 kBtu/sf-yr, or less.

Electrifying Space Heating: Normally ventilated spaces

If the building does not have high ventilation loads and is more in line with standard ventilation loads, full efficient electrification of space heating is readily possible using one of the strategies below:

- Central air to water heat pump serving a hot water loop.

- Air to water heat pump or VRF systems.

Ground floor retail spaces, office spaces, and day care spaces, for example, can readily be fully electrified.

[2] Fossil fuel use intensity (EUI_{ff}) is the total annual energy use from fossil fuels or fossil fuel-based sources, divided by the conditioned building area. The units are 1,000-Btu per square foot per year, or kBtu/sf-yr

Efficient Electrification – Service Water Heating

Similar to above, due to Massachusetts low electric grid emissions, swapping from even "best in class" condensing gas equipment to electric air source heat pump service water heating results in significant emissions reduction. However, air source heat pump service water heating can be challenging in some building settings.

Service water heating

Lab/office buildings usually have low service water loads. Retail and office buildings are expected to have low service water loads. In these cases, packaged electric air source heat pump equipment is usually readily feasible. Such units can be distributed throughout the buildings at or near the service water points of use. If service water demands are low, DOER recommends this approach.

Sometimes, lab/office buildings have larger service water loads and/or limited interior space to locate packaged heat pump water heating equipment near point of use. Alternative approaches in these applications include:

- *Centrally located air source water heating:* These systems consist of centrally located air source heat pumps, usually with the compressors outdoors, which provide hot water to water distribution piping to the end use locations. These are usually engineered solutions with less packaged equipment options.

- *Condensing gas hot water heaters*: These systems consist of either centrally located, or distributed, natural gas fired heating equipment. Centrally located equipment is preferable as it allows an opportunity to swap to heat pump water heating in the future.

- *Electric resistance hot water heaters:* These systems usually consist of distributed packaged electric resistance heaters and are suitable for applications with small service water demands.

- Some combination of above.

Opportunities for efficient electrification should be considered throughout the design process.

Solar PV

Rooftop PV can provide significant GHG benefits as well as significant financial benefits. Even if PV is not installed during building construction, it is important to plan the project to ensure that roof space is set aside for PV and that roof space doesn't become unnecessarily encroached with HVAC appurtenances, diminishing the opportunities for future PV. Electrification of heating and low TEDI can both contribute to enabling more PV as these approaches can reduce rooftop equipment.

Note that code section C402.3 mandates PV readiness for buildings of less than 4 stories above grade.

Electric Vehicle (EV) Parking Spaces

EV charging stations are critical for the continual transition towards electric mobility. Even if EV charging stations are not installed during construction, it is critical to maximize EV-ready spaces as it is significantly cheaper and easier to size electrical service and install wiring or wiring conduit during construction, rather than retrofitting a project later.

Opportunities to maximize EV-ready parking spaces should be considered through the design of this project.

Incentives

Buildings which incorporate the above strategies can qualify for significant incentives:

- MassSave® performance-based incentives[3] offer incentives for every kWh or therm saved compared to a program-provided energy model. The above energy efficiency strategies offer opportunities for large kWh and therm savings.

- Alternative Energy Credits (AECs)[4] offer incentives to electrify building space heating using heat pumps and/or VRF. This program also includes multipliers which increase value if the building meets Passivehouse standards or buildings built to HERs 50 or less. These credits may be distributed on a quarterly basis over time; or, may be distributed in a lump sum to the developer if certain conditions are met.

- Massachusetts SMART program[5] provides significant incentives for solar development on top of federal and state tax incentives. SMART includes pathways which allow solar production to be sold without off-takers. This may be of potential interest to building developers as this allows them to develop rooftop solar without necessarily engaging with building tenants. For this reason, setting aside rooftop solar PV areas helps ensure that building owners' ability to monetize the roof is not impacted.

Codes and Baseline

Massachusetts Stretch Code applies to this project. Stretch Code requires a 10% energy performance improvement over ASHRAE 90.1-2013-Appendix G plus Massachusetts amendments including C402.1.5 (envelope), C405.3 and C405.4 (lighting), C405.10 (EV charging), and C406 (three additional efficiency measures). Three C406 additional efficiency measures should be included in the Baseline.

[3] https://www.masssave.com/en/saving/business-rebates/new-buildings-and-major-renovations/
[4] https://www.mass.gov/guides/aps-renewable-thermal-statement-of-qualification-application
[5] https://www.mass.gov/solar-massachusetts-renewable-target-smart

Recommendations for the Next Submission

Recommendations are as follows:

1. Separately, develop two UA analysis tables, as follows:

    a. One table that shows how the baseline complies with Table 5.5-5 of ASHRAE 90.1 2013 Appendix G plus Massachusetts Amendment C401.2.4. Fenestration limits will vary depending upon building type.

    b. A second table that shows how the proposed complies with 2018 IECC Tables C-402.1.3, C402.1.4, and C-402.4. Fenestration limit should be 30% when calculating minimum performance requirements for all building types.

2. A combination of high-performing, thermally broken envelope, heat recovery, and solar gain management should be used throughout with an aim toward reducing heating TEDI. Strategies to achieve this include:

    a. Above code-threshold envelope (vertical walls, windows, roofs and exposed lower level floors). Priority should be given to increasing continuous insulation and framed insulated wall sections. Distinguish between R value of batt and R value of continuous insulation. Continuous insulation necessarily means insulation that is uninterrupted by hangers, studs, etc. Indicate planned wall assembly U value and wall construction type (mass, wood, metal stud, etc). Confirm that the relationship between R-value and assembly U-factor conform to Appendix A of the Code.

    b. Account for thermal bridges in assemblies and components with calculating U values. Use thermal bridge free assemblies and components to thermally break:

        i. Hangers, girts, ties, and brick shelfs
        ii. Intersections between balconies and vertical walls
        iii. Intersections between the floor and vertical walls
        iv. Transitions from wall to window
        v. Parapets
        vi. Vertical wall to vertical wall transitions (where the wall “turns”)

        Consult https://thermalenvelope.ca/catalogue/ for pre-solved clear wall thermal bridge and linear thermal bridge values.

    c. Minimize glass curtain wall/spandrel systems as much as possible. Avoid these systems where possible, as these are the lowest performing wall systems.

    d. If curtain wall systems are used, evaluate systems having opaque “spandrel” portion between R-4 through R-10. Opaque spandrel systems with performance better than R-10 are not recommended as there are significant difficulties to achieve performance higher than this in practice. Consult

https://thermalenvelope.ca/catalogue/ for pre-solved opaque curtain wall performance values.

e. If curtain wall systems are used, evaluate using at least R-4 vision glass.

f. For all wall sections, use the thermal comfort tool to help evaluate reduction/elimination of perimeter heating systems. https://www.payette.com/glazing-and-winter-comfort-tool/

g. Reduce air infiltration to at least 0.4 cfm at 75 Pa. In-building field tests are recommended to confirm air-infiltration.

h. Incorporate ventilation energy recovery. High performing energy recovery is essential to achieving low TEDI.

i. Manage solar gains with external shading and/or low solar heat gain coefficient (SHGC).

3. At a minimum, develop the following scenario for the highly ventilated lab/office portions of the project:

   a. Improved envelope described above and inclusion of energy recovery to achieve heating TEDI reduction;

   b. Air infiltration of 0.4 cfm/sf at 75 Pa;

   c. Downsize the HVAC as much as possible, including evaluating perimeter heating downsizing and/or elimination;

   d. Near elimination of use of gas or other fossil fuels with EUI_{ff} goal of 5 to 10 kBtu/sf-yr or less using following strategy:

      i. Ventilation incorporating dedicated outside air systems and energy recovery;

      ii. Energy recovery of concurrent heating and cooling with heat recovery chillers or similar approach;

      iii. In-building, centrally-located hybrid efficient electric space heating (air to water heat pump sized at 25 to 50% peak heating capacity as priority backed-up with 95% efficient gas boiler sized at 100% peak, connected to 120°F thermal distribution hot water loop);

   e. External shading and improved solar heat gain coefficient windows to control space cooling loads;

   f. Conduct sub-scenarios with and without air source heat pump water heating.

4. At a minimum, develop the following scenario for office, retail, and other normally ventilated portions of the project:

    a. Improved envelope described above and inclusion of energy recovery to achieve heating TEDI reduction;

    b. Air infiltration of 0.4 cfm/sf at 75 Pa;

    c. Downsize the HVAC as much as possible, including evaluating perimeter heating downsizing and/or elimination;

    d. Elimination of use of gas or other fossil fuels with EUI_{ff} goal of 0 kBtu/sf-yr or less using following strategy:

        i. Ventilation incorporating dedicated outside air systems and energy recovery;

        ii. Energy recovery of concurrent heating and cooling with heat recovery chillers or similar approach;

        iii. Electric air source heat pump/VRF heating/cooling systems.

    e. External shading and improved solar heat gain coefficient windows to control space cooling loads;

    f. Conduct sub-scenarios with and without air source heat pump water heating.

5. Evaluate incentives, including:

    g. Estimate of Alternative Energy Credits;

    h. Estimates of MassSave® incentives, based on meeting with utility.

6. Evaluate rooftop solar PV readiness. This should include building roof plans showing location of PV readiness areas and location of roof HVAC equipment and other appurtenances. Provide table showing areas needed for code required PV readiness and proposed, above-code PV readiness.

7. Maximize EV-ready parking spaces, target 100% EV Readiness. Clarify commitments to installed EV charging station and EV ready spaces.

8. Compare model results total and individual end uses with representative, prototype buildings developed by Pacific Northwest National Labs/Department of Energy found at the link below. Provide a summary explaining potential differences.

    - https://www.energycodes.gov/sites/default/files/documents/BECP_901_2013_Progress_Indicator_0_0.pdf
    - http://www.energycodes.gov/sites/default/files/documents/2013EndUseTables.zip

- https://www.energycodes.gov/commercial-energy-cost-savings-analysis

9. Include a table similar to the example below. For "code value" ensure that the value incorporates any improved efficiency per requirements of Section C406.1 of the Massachusetts' amendments.

Measure/Area	**Base Code**	**Proposed**	**% Change**	**Comment**
AC Efficiency (EER)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
ERV Effectiveness (%)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
Boiler (% efficiency)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
LPD (Watts/sq ft)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
(continue to include service water, equipment, etc)				

Sincerely,

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

REF.: NEX-2200133.00

April 25, 2022

Ms. Lee Newman
Director of Planning and Community Development
Needham Department of Public Works
500 Dedham Avenue
Needham, MA 02492

SUBJECT: Highland Science Center, Gould Street, Needham, MA
MEPA ENF – Traffic Peer Review

Dear Ms. Newman:

On behalf of the Town of Needham, ***Greenman-Pedersen Inc.*** (GPI) performed a review of the *Environmental Notification Form*[1] (ENF) prepared by Vanasse Hangen Brustlin, Inc. (VHB) for review by the Massachusetts Environmental Policy Act (MEPA) office for the proposed Highland Science Center in Needham, Massachusetts. The site is located on the northeast corner of the intersection of Highland Avenue and Gould Street, and currently contains a Muzi Ford car dealership, Charles River Media Group and WCVB Channel 5. The site was recently part of a rezoning effort by the Town to allow for the development of up to ±880,000 square feet (SF) of office, research and development, and ancillary retail and service space. GPI has reviewed the ENF and supporting traffic analysis for consistency with the goals and studies prepared as part of the Town's rezoning, as well as for compliance with the Massachusetts Department of Transportation (MassDOT) guidelines for traffic impact analysis and general engineering practice. The following summarizes GPI's comments related to the ENF.

Transportation Section (Traffic Generation)

1. In Section 1.B on page 18 of the ENF, the Applicant notes that a MassDOT Vehicular Access Permit will be required for the potential need to modify roadway geometry within the state highway layout (SHLO). It should be noted that MassDOT will require a minimum of two permits for this development. One permit will be for the change-in-use of the property as the property directly abuts land owned by the Commonwealth of Massachusetts (Interstate 95 / Route 128) and the project will generate more than 2,000 daily vehicle trips. A separate MassDOT access permit will be required for the construction of any off-site roadway improvements within the SHLO.

2. The table in Section 11.A on page 19 of the ENF Form notes that the existing site-generated trips were estimated based on empirical traffic counts collected at the site driveways, which show only 887 daily trips are currently generated by the site. It is important to note that these empirical counts were collected in the fall of 2021, during COVID, and as a result, may under estimate the trips generated by the site pre-COVID when it was fully operational. The use of the lower existing site-generated trips will result in a more conservative (higher) estimate of the net increase in trips generated by the proposed redevelopment.

3. In Section III on page 19 of the ENF Form, the Applicant is requested to describe any transportation demand management measures (TDM) to be implemented to reduce single-occupant vehicle trips to the site, including any transit-related measures. The Applicant has not described any TDM measures related to transit services in this section. However, these measures are described in Section 2.7.2 if the *Transportation* chapter, which notes that the Applicant will:

[1] *Environmental Notification Form, Highland Science Center, Needham Heights, Massachusetts;* prepared by Vanasse Hangen Brustlin, Inc. (VHB); March 2022.

- Explore the feasibility of providing shuttle service connectivity to nearby public transportation nodes (commuter rail and Green Line);
- Require tenants to provide a 50 percent transit pass subsidy for their employees;
- Carpool assistance and incentives;
- Emergency ride home;
- Display in the Main Lobby transportation-related information for tenants' employees and visitors; and
- Promotional efforts.

The Applicant should provide additional information on how carpool assistance and emergency ride home services will be provided, as well as what incentive program may be implemented. In addition to providing shuttle service to nearby commuter rail and Green Line services, the Applicant should explore the possibility of extending bus service to the site.

Transportation Section (Roadways and Other Transportation Facilities)

4. In Section 1.B on page 21 of the ENF Form, the Applicant has stated that no permits will be required related to roadways or other transportation facilities. However, a MassDOT access permit will be required for the construction of off-site roadway improvements within the SHLO. Therefore, the Applicant should complete the *Transportation Facility Impacts* section of the ENF Form.

Air Quality Section

5. In Section 1.A on page 23 of the ENF Form, the Applicant notes that the project does not exceed any of the thresholds related to air quality. However, MEPA requires that an *Air Quality and Greenhouse Gas Emissions* study be conducted for all projects that require a mandatory Environmental Impact Report (EIR). As the project is anticipated to generate more than 3,000 daily vehicle trips and provide more than 300 parking spaces, a mandatory EIR will be required. Therefore, the project will exceed the thresholds for an Air Quality analysis, which will include an evaluation of impacts from both stationary and mobile sources of emissions.

Project Description

6. Section 1.3 of the ENF notes that geometric improvements are proposed at the intersection of Highland Avenue / Gould Street / Hunting Road. The widening of the roadway that will be required to accommodate the additional lanes at this location will also likely require reconstruction of the traffic signal at this intersection to accommodate new signal indications and mast arms, as well as vehicle detection and pedestrian signal equipment. No mention of the signal upgrades were provided in this section.

7. Figure 1.4 provides a graphic depiction of the roadway geometry proposed at the intersection of Highland Avenue / Gould Street / Hunting Road and along Gould Street fronting the site. While the geometry on the majority of the approaches appears consistent with the conceptual improvement sketches prepared as part of the former rezoning effort, the Hunting Road northbound approach to Highland Avenue and the receiving approach on Gould Street are inconsistent with the rezoning plans. The analysis and plans prepared as part of the rezone indicated that two through lanes would be required on Hunting Road with two receiving lanes on Gould Street to accommodate the traffic generated by the project. The capacity and queue analysis summarized in Table 2-15 of the ENF indicates that even with the mitigation measures proposed by the Applicant, the Hunting Road northbound movement will operate over capacity at level-of-service (LOS) F during the weekday AM and PM peak hours under 2029 Build with Mitigation conditions. The Highland Avenue eastbound left-turn movement will also operate at LOS F during the weekday AM peak hour. Therefore, the Applicant should consider the feasibility of providing an additional northbound lane on Hunting Road to improve the capacity and operations of this intersection.

Bicycle Accommodations

8. Section 2.3.4.1 of the ENF notes that a total of 89 bicycle parking spaces will be provided indoors and outdoors, but no description is given on how many spaces will be indoors and how many will be outdoors. The study also does not contain any assessment of the potential bicycle parking demand that could be generated and the adequacy of the number of bicycle parking spaces provided to accommodate this demand.

Collision History

9. Table 2-2 of the ENF does not provide a calculation of the crash rates (in crashes per million entering vehicles) experienced at any of the study area intersections. The crash rate is utilized to assess the significance of the crash occurrence at a study intersection by comparing the crash rate experienced to the statewide and district-wide averages for similar intersections and/or roadway segments. In addition, per MassDOT guidelines, collision diagrams should be prepared for any locations that experience an average of more than 3 crashes per year or a crash rate higher than the state or district-wide average. The Applicant should calculate the crash rates for all study area intersections and prepare collision diagrams, as necessary, to identify collision patterns at the study area intersections. For any location where 5 or more crashes of a similar type occurred over the analysis period, the Applicant should investigate measures to improve safety and mitigate collision occurrence.

Transportation Operations Analysis

10. According to Table 2-9, the Highland Avenue southbound approach to West Street will operate over capacity with long delays during the weekday PM peak hour under 2029 Build conditions, with an increase in delay of 22 seconds per vehicle generated by the project. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

11. The Highland Avenue eastbound through/right-turn movement at the intersection with Webster Street will operate over capacity during the weekday AM peak hour under 2029 Build conditions, with an increase in delay of 26 seconds per vehicle generated by the project. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

12. Although not heavily impacted by project-generated traffic, the Highland Avenue westbound left/through movement at the intersection with 1st Avenue will be well over capacity during the weekday PM peak hour under both 2029 No-Build and Build conditions. GPI recommends the Applicant consider measures to reduce delay and improve operations at this location.

13. Similarly, the Hunting Road northbound approach to Kendrick Street will be well over capacity during the weekday AM peak hour under 2029 No-Build and Build conditions. GPI recommends the Applicant consider options for reducing delay and improving operations at this location.

14. The Webster Street and Cedar Street approaches to Central Avenue are expected to operate well over capacity with long delays and queues under 2029 No-Build and Build conditions, particularly during the weekday AM peak hour. The Applicant should investigate options for improving the operations of these intersections, including conducting a signal warrant analysis to assess whether a warrant for installation of traffic signal will be met at either of these locations.

15. As noted in Comment 7, even with the proposed mitigation at the Highland Avenue / Gould Street / Hunting Road intersection, some movements will continue operating at LOS F under 2029 Build with Mitigation conditions. Therefore, the Applicant should investigate the feasibility of providing additional capacity at this location to accommodate 2029 Build traffic volumes.

Traffic Monitoring Program

16. Section 2.7.3 of the ENF describes a transportation monitoring program that will be conducted post-occupancy to monitor parking occupancy and traffic operations at four of the study area intersections, including the site driveway. The Applicant should also provide monitoring of the effectiveness of the proposed TDM program in encouraging walking/biking, carpooling, and public transportation travel to/from the site.

17. The proposed traffic monitoring program will include the collection of vehicle turning movement counts during the weekday AM and PM peak periods at the following study area intersections:
    - Central Avenue / Gould Street
    - Gould Street / TV Place
    - Gould Street / Project Site Driveway
    - Highland Avenue / Gould Street / Hunting Road

    GPI agrees that these represent the critical locations that would experience the greatest increase in traffic due to the project. However, should the result of the monitoring study indicate that the actual traffic increase generated by the project exceeds the traffic projections contained within the ENF by ten percent or more, the study area for the monitoring program should be expanded to include additional locations to verify that the project's impacts does not create any operation deficiencies at nearby locations. In addition, the monitoring programs should include a capacity and queue analysis to verify the operations of each of the study area intersections under post-occupancy conditions. The monitoring program should also include the collection of daily traffic volumes on TV Place and the Project Site driveway to verify the daily traffic generated by the project.

Should you have any questions regarding these comments, please contact me directly at 603-766-5223.

Sincerely,

GREENMAN–PEDERSEN, INC.

Rebecca L. Brown, P.E.
Senior Project Manager

TOWN OF NEEDHAM
TOWN HALL
Needham, MA 02492-2669

Office of the
TOWN MANAGER

TEL: (781) 455-7500
FAX: (781) 449-4569

April 26, 2022

Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

RE: MEPA ENF #16546
Highland Science Center, 557 Highland Avenue, Needham, MA

Dear Secretary Theoharides:

We have reviewed the *Environmental Notification Form*[1] (ENF) prepared by Vanasse Hangen Brustlin, Inc. (VHB) for review by the Massachusetts Environmental Policy Act (MEPA) office for the proposed Highland Science Center in Needham, Massachusetts. The site is located at 557 Highland Avenue on the northeast corner of the intersection of Highland Avenue and Gould Street, and currently contains a Muzi Ford car dealership, Charles River Media Group and WCVB Channel 5. The site was recently part of a rezoning effort by the Town to allow for the development of up to ±880,000 square feet (SF) of office, research and development, and ancillary retail and service space.

As part of our review the Town has retained the services of Greenman-Pedersen Inc. (GPI) to evaluate the ENF and supporting traffic analysis for consistency with the goals and studies prepared as part of the Town's rezoning, as well as for compliance with the Massachusetts Department of Transportation (MassDOT) guidelines for traffic impact analysis and general engineering practice. The comments related to the ENF as prepared by GPI are detailed in the attached letter from Rebecca L. Brown, Senior Project Manager, GPI, to Lee Newman, Director of Planning and Community Development, dated April 25, 2022 (copy attached). Said comments comprise the Town's formal response to the traffic component of the ENF. Furthermore, we offer the following additional comments for your consideration.

Traffic at the Intersection of Highland and Gould

The proposed development revises the currently under construction traffic pattern from the MassDOT's Highland Avenue Corridor project. The newly proposed layout for this project shows sidewalks on both sides of the road and consists of one bike lane with 4-vehicle traffic lanes exiting Gould Street onto Highland Avenue, and one bike lane with one vehicle lane entering Gould Street from Highland Avenue.

This new road design increases the traveled width by 32-feet from the intersection of Highland Avenue at Gould to just beyond TV Place. A portion of the design shows the travel lanes located on private property owned by the development. We expect the developer to work with the Town in

[1] *Environmental Notification Form, Highland Science Center, Needham Heights, Massachusetts;* prepared by Vanasse Hangen Brustlin, Inc. (VHB); March 2022.

providing an alteration/taking plan and recordings for a new Road Right of Way layout on Gould Street and for optimizing the traffic signals at Highland Avenue and Gould Street.

Water Supply:
We are seeking clarification for the facility's proposed water use of 129,172 gallons per day (GPD) while the wastewater design flow generation is 54,554 GPD.
We expect to work with the developer on determining the optimum water loop design. The current proposal shows a 10-inch water connection to the site off a 12-inch main on Gould Street and a connection to an existing 8-inch water main on TV place. The additional loop connection may be more optimum if connected from Highland Avenue in front of the development instead of, or an addition to the 8-inch on TV Place connection.

Wastewater:
According to the ENF filed by the applicant, the proposed project will generate a total design wastewater flow of 54,554 GPD; this is an increase of 31,501 GPD from the existing facility to the Town's sewer system. The applicant has been in contact with Town of Needham representatives and understands the requirements to have a rate of four gallons for every one gallon of sewage added to the system removed through an actual inflow and infiltration removal (I/I) program. (See attached Town of Needham Sewer System Impact Program Regulations approved October 18, 2016.)

For the new facility, four times the increased flow equates to a total of 126,004 GPD I/I removal anticipated from the development. This may be satisfied by either undertaking a construction project or paying a fee to the Town's I&I program at a rate of $8.00 per gallon required to be removed. We are in the process of analyzing the target areas for the inflow/infiltration to be removed and expect to work with the developer through the site plan approval process.

Thank you for the opportunity to provide the Town's thoughts on the above-noted ENF. We note that the project will require a mandatory Environmental Impact Report (EIR) having met or exceeded two of MEPA's review thresholds namely 301 CMR 11.03 (6)(a)(6), generation of 3,000 or more new daily trips per day at a single location and 301 CMR 11.03 (6)(a)(7), construction of 1,000 or more new parking spaces at a single location and having triggered the requirement for a MassDOT vehicle access permit. Accordingly, we ask that the Secretary include the above identified items in the Scope of Work developed for this EIR. Should you have any questions or need additional information, please contact me at 781-455-7500.

Very truly yours,

Kate Fitzpatrick,
Town Manager

cc: Board of Selectmen
Planning Board
Carys Lustig, Director of Public Works
Thomas Ryder, Town Engineer
Lee Newman, Director of Planning & Community Development

MASSACHUSETTS WATER RESOURCES AUTHORITY
Charlestown Navy Yard
100 First Avenue, Building 39
Boston, MA 02129

Frederick A. Laskey
Executive Director

Telephone: (617) 242-6000
Fax: (617) 788-4899
TTY: (617) 788-4971

April 28, 2022

Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge St, Suite 900
Attn: MEPA Office, Jennifer Hughes
Boston, MA 02114

Subject: EOEEA #16546 – Environmental Notification Form
Highland Science Center, Needham, MA

Dear Secretary Theoharides,

The Massachusetts Water Resources Authority (MWRA) appreciates the opportunity to comment on the Environmental Notification Form (ENF) submitted by 557 Highland, LLC (the "Proponent") for Highland Science Center (the "Project") located in Needham. The 9.27 acre Project site is located adjacent to I-95 and the Exit 35C off ramp and currently consists of a car dealership and car wash with approximately 532 parking spaces. The Project involves redevelopment of the site to include a new office and laboratory building complex containing three buildings as well as below grade parking and a parking garage.

MWRA's comments on this NPC relate to wastewater issues and the need for Infiltration/Inflow (I/I) Removal as well as Toxic Reduction and Control (TRAC) discharge permitting.

Wastewater

The ENF reports that the Project will increase wastewater flow by 731,501 gallons per day (gpd), from an existing wastewater flow of 23,053 gpd to 54,554 gpd. The site is served by a sanitary sewer system owned and operated by the Town of Needham that conveys flows to MWRA's Wellesley Extension Relief Sewer in the Town of Dedham, which delivers flows to the MWRA High Level Sewer, the Nut Island Headworks, and ultimately MWRA's Deer Island Wastewater Treatment Plant. Sections of the MWRA system can surcharge and overflow in large storms to the Charles River, due to high levels of infiltration and inflow entering tributary community sewer systems. To ensure that the Project's new wastewater flow does not increase surcharging and overflows in large storms, the Proponent should fully offset the Project's

wastewater flows with infiltration and inflow ("I/I") removal in accordance with Town of Needham's policies and regulations.

Additionally, the Charles River is surrounded by Environmental Justice Populations. The proponent should carefully analyze ways to offset the additional wastewater generated by this development to limit/eliminate potential impacts that additional flow to the sewer may have on CSOs to the Charles River and associated downstream communities.

TRAC Discharge Permitting

MWRA prohibits the discharge of groundwater and stormwater into the sanitary sewer system, pursuant to 360 C.M.R. 10.023(1) except in a combined sewer area when permitted by the Authority and the local community. The Project site has access to separate sewer and storm drain systems. Therefore, the discharge of groundwater or stormwater to the sanitary sewer system associated with this Project is prohibited.

A Sewer Use Discharge Permit is required prior to discharging industrial process or laboratory wastewater from office, laboratory, or commercial space associated with the Project into the MWRA sanitary sewer system. For assistance in obtaining this permit, a representative of the proposed office and laboratory space should contact Stephen Buczko, Industrial Coordinator, in the TRAC Department at (617) 305-5619 or Stephen.Buczko@mwra.com. Completed Sewer Use Discharge Application forms and attachments should be submitted via standard mail to Stephen Buczko, MWRA, Industrial Coordinator, MWRA, TRAC, 2 Griffin Way, Chelsea, MA 02150 and via email to TRACPermits@mwra.com.

Any gas/oil separators in parking garages associated with the Project must comply with 360 C.M.R. 10.016 and State Plumbing Code. Installation of gas/oil separator(s) may not be back filled until inspected and approved by the MWRA and the Local Plumbing Inspector. For assistance in obtaining an inspection, the Proponent should contact Michael J. Quercio, Source Coordinator, in the TRAC Department at (617) 305-5645 or Michael.Quercio@mwra.com.

Additionally, due to the proximity of planned MWRA infrastructure to the Project site, MWRA requests coordination with the Proponent during design and construction. On behalf of the MWRA, thank you for the opportunity to provide comments on this Project. Please do not hesitate to contact Katie Ronan of my staff at (857) 289-1742 with any questions or concerns.

Sincerely,

Rebecca Weidman
Director
Environmental and Regulatory Affairs

cc: John Viola, MassDEP

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 Woodcock
Commissioner

6 May 2022

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

RE: Highland Science Center, MA, EEA #16546

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

Dear Secretary Theoharides:

We've reviewed the Environmental Notification Form (ENF) for the proposed project. The project includes the construction of 531,000-sf of office and lab/office buildings with some retail, daycare, fitness, and other ground floor use. For this project we expect key mitigation measures to include:

- Building design and construction practices that result in low heating and cooling thermal energy demand intensity (heating and cooling "TEDI") by:
    - Maintaining envelope integrity with framed, insulated walls with continuous insulation;
    - Thermal-bridge free envelope;
    - Minimizing glass curtain wall assemblies and excessive windows;
    - Low air-infiltration, confirmed with in-building air-infiltration testing;
    - Energy recovery;

  - Management of solar heat gains;

- Efficient electrification of space heating, including:

  - For buildings and portions of buildings that are highly ventilated such as lab/office space: low temperature, hydronic space heating with heat-input provided by hybrid, in-building, central plant consisting of air-to-water heat pump (primary) and gas boilers (secondary). Target a fossil fuel-based use intensity (EUI_{ff}) of 10 kBtu/sf-yr or less;

  - For buildings and portion of buildings that are not highly ventilated (such as ground floor retail, daycare, office, etc): low temperature, hydronic space heating with heat-input provided by in-building central plant consisting of air-to-water heat pump; or, air source heat pumps/VRF.

- Efficient electrification of water heating, where feasible;

- Extensive rooftop solar-readiness;

- Electric vehicle ready parking spaces.

Note that significant incentives may be available, including MassSave® incentives, Alternative Energy Credits (AECs), and Solar Massachusetts Renewable Target (SMART) credits.

The ENF describes examining some of the above-mentioned strategies. We commend the project for their early consideration of energy efficiency.

Envelope, Heat Recovery, and Solar Gains

The combination of quality envelope, heat recovery, and management of solar gains can result in significant reduction in heating (and cooling) thermal energy demand intensity (TEDI, units of kBtu/sf-yr)[1]. In addition to reduced utility costs and emissions, the value of a targeted focus on heating and cooling TEDI results in:

- Simplified space heating electrification;
- Reduction, and possible elimination, of perimeter heating systems;
- Improved resiliency;
- Reduced peak demands;
- Improved occupant comfort;
- Reduced maintenance.

[1] Although they have the same units, heating and cooling TEDI is not the same as heating and cooling EUI. TEDI represents energy requirement, or demand, not energy consumption. For guidance on how to extract TEDI information from building models see "Energy Modeling Guidelines", City of Vancouver, Planning, Urban Design and Sustainability Department, Land Use Development and Policy Guidelines, Version 2.0, amended 18 July 2018 and "Designing to TEDI, TEUI, and GHGI Performance Metrics", International Building Performance Simulation Association (IBPSA), by Chan *et al*

Specific TEDI reduction strategies are:

- High-performance window and walls;
- Thermally-broken windows and other components to eliminate thermal bridges;
- Low air-infiltration;
- Ventilation energy recovery;
- Solar gain management via external shading and/or low solar heat gain coefficient (SHGC)

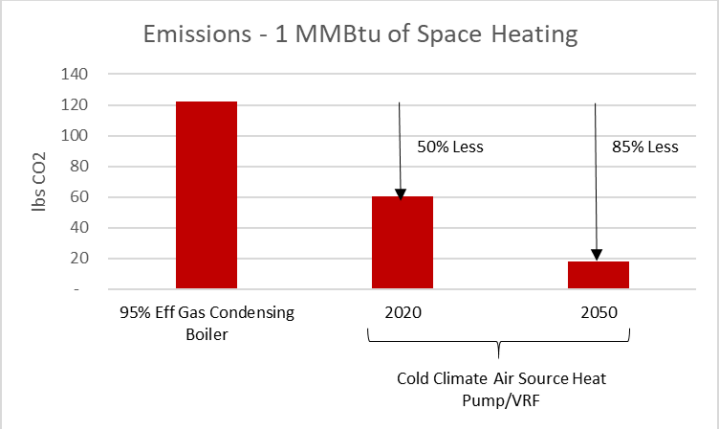
Buildings with curtain wall envelope require high performing windows and high performing opaque spandrels to achieve heating TEDI reductions. High performing windows and high performing opaque spandrels should be carefully evaluated if curtain-wall construction is considered.

Efficient Electrification – Space Heating

Efficient electrification of space heating entails the swapping of fossil fuels (natural gas, oil, and propane), or electric resistance systems, with cold-climate rated air source heat pumps or ground source heat pumps.

Electrification of space heating is a key mitigation strategy with significant short- and long-term implications on GHG emissions. Massachusetts grid emissions rates continue to decline with the implementation of clean energy policies that increase renewable electricity sources. The implication is that efficient electric space heating with cold climate air source heat pump (or ground source heat pump) has lower emissions than other fossil-fuel based heating options, including best-in-class (95% efficient) condensing natural gas equipment.

Currently, efficient electric heating has approximately **50% lower emissions** in Massachusetts than condensing natural gas heating. By 2050, and possibly sooner, efficient electric heating is expected to have approximately **85% lower emissions** in Massachusetts than condensing natural gas heating. See illustration below.



Electrifying Space Heating: High ventilation spaces

The proposed lab/office spaces may have high ventilation loads. High ventilation loads have made electrification of space heating a challenge in the past. However, since about beginning of 2020, more than 90% of all highly-ventilated buildings that the DOER has reviewed have committed to partial electrification of space heating.

This approach uses a hybrid of air to water (or ground to water) heat pumps with fossil fuel-based input as backup in which the heat pump can provide 90% total annual heating end use. In most cases, fossil fuel-based use intensity (EUI_{ff})[2] is 5 to 10 kBtu/sf-yr, or less.

Key strategies for this hybrid approach are as follows:

a) Include hydronic space heating and space cooling, including a hot water distribution loop of 120°F;

b) Include heat recovery chillers or similar approach to recover heat energy from chilled water for use in the hot water loop;

c) Include an in-building, centralized heating plant consisting of an air-to-water (or ground-to-water) heat pump and a gas-fired condensing boiler;

d) Size the boiler for 100% of the peak load; size the air source heat pump for 25% to 50% of the peak load;

e) After heat recovery with equipment in (b) above, prioritize the air or ground source heat pump operation first and utilize boiler only when loads exceed 25-50% of peak. The objective is to provide 90% of the total annual heating with air source and reduce fossil fuel-based use intensity (EUI_{ff}) to 5-10 kBtu/sf-yr, or less.

Electrifying Space Heating: Normally ventilated spaces

If the building does not have high ventilation loads and is more in line with standard ventilation loads, full efficient electrification of space heating is readily possible using one of the strategies below:

- Central air to water heat pump serving a hot water loop.

- Air to water heat pump or VRF systems.

Ground floor retail spaces, office spaces, and day care spaces, for example, can readily be fully electrified.

[2] Fossil fuel use intensity (EUI_{ff}) is the total annual energy use from fossil fuels or fossil fuel-based sources, divided by the conditioned building area. The units are 1,000-Btu per square foot per year, or kBtu/sf-yr

Efficient Electrification – Service Water Heating

Similar to above, due to Massachusetts low electric grid emissions, swapping from even "best in class" condensing gas equipment to electric air source heat pump service water heating results in significant emissions reduction. However, air source heat pump service water heating can be challenging in some building settings.

Service water heating

Lab/office buildings usually have low service water loads. Retail and office buildings are expected to have low service water loads. In these cases, packaged electric air source heat pump equipment is usually readily feasible. Such units can be distributed throughout the buildings at or near the service water points of use. If service water demands are low, DOER recommends this approach.

Sometimes, lab/office buildings have larger service water loads and/or limited interior space to locate packaged heat pump water heating equipment near point of use. Alternative approaches in these applications include:

- *Centrally located air source water heating:* These systems consist of centrally located air source heat pumps, usually with the compressors outdoors, which provide hot water to water distribution piping to the end use locations. These are usually engineered solutions with less packaged equipment options.

- *Condensing gas hot water heaters*: These systems consist of either centrally located, or distributed, natural gas fired heating equipment. Centrally located equipment is preferable as it allows an opportunity to swap to heat pump water heating in the future.

- *Electric resistance hot water heaters:* These systems usually consist of distributed packaged electric resistance heaters and are suitable for applications with small service water demands.

- Some combination of above.

Opportunities for efficient electrification should be considered throughout the design process.

Solar PV

Rooftop PV can provide significant GHG benefits as well as significant financial benefits. Even if PV is not installed during building construction, it is important to plan the project to ensure that roof space is set aside for PV and that roof space doesn't become unnecessarily encroached with HVAC appurtenances, diminishing the opportunities for future PV. Electrification of heating and low TEDI can both contribute to enabling more PV as these approaches can reduce rooftop equipment.

Note that code section C402.3 mandates PV readiness for buildings of less than 4 stories above grade.

Electric Vehicle (EV) Parking Spaces

EV charging stations are critical for the continual transition towards electric mobility. Even if EV charging stations are not installed during construction, it is critical to maximize EV-ready spaces as it is significantly cheaper and easier to size electrical service and install wiring or wiring conduit during construction, rather than retrofitting a project later.

Opportunities to maximize EV-ready parking spaces should be considered through the design of this project.

Incentives

Buildings which incorporate the above strategies can qualify for significant incentives:

- MassSave® performance-based incentives[3] offer incentives for every kWh or therm saved compared to a program-provided energy model. The above energy efficiency strategies offer opportunities for large kWh and therm savings.

- Alternative Energy Credits (AECs)[4] offer incentives to electrify building space heating using heat pumps and/or VRF. This program also includes multipliers which increase value if the building meets Passivehouse standards or buildings built to HERs 50 or less. These credits may be distributed on a quarterly basis over time; or, may be distributed in a lump sum to the developer if certain conditions are met.

- Massachusetts SMART program[5] provides significant incentives for solar development on top of federal and state tax incentives. SMART includes pathways which allow solar production to be sold without off-takers. This may be of potential interest to building developers as this allows them to develop rooftop solar without necessarily engaging with building tenants. For this reason, setting aside rooftop solar PV areas helps ensure that building owners' ability to monetize the roof is not impacted.

Codes and Baseline

Massachusetts Stretch Code applies to this project. Stretch Code requires a 10% energy performance improvement over ASHRAE 90.1-2013-Appendix G plus Massachusetts amendments including C402.1.5 (envelope), C405.3 and C405.4 (lighting), C405.10 (EV charging), and C406 (three additional efficiency measures). Three C406 additional efficiency measures should be included in the Baseline.

[3] https://www.masssave.com/en/saving/business-rebates/new-buildings-and-major-renovations/
[4] https://www.mass.gov/guides/aps-renewable-thermal-statement-of-qualification-application
[5] https://www.mass.gov/solar-massachusetts-renewable-target-smart

Recommendations for the Next Submission

Recommendations are as follows:

1. Separately, develop two UA analysis tables, as follows:

    a. One table that shows how the baseline complies with Table 5.5-5 of ASHRAE 90.1 2013 Appendix G plus Massachusetts Amendment C401.2.4. Fenestration limits will vary depending upon building type.

    b. A second table that shows how the proposed complies with 2018 IECC Tables C-402.1.3, C402.1.4, and C-402.4. Fenestration limit should be 30% when calculating minimum performance requirements for all building types.

2. A combination of high-performing, thermally broken envelope, heat recovery, and solar gain management should be used throughout with an aim toward reducing heating TEDI. Strategies to achieve this include:

    a. Above code-threshold envelope (vertical walls, windows, roofs and exposed lower level floors). Priority should be given to increasing continuous insulation and framed insulated wall sections. Distinguish between R value of batt and R value of continuous insulation. Continuous insulation necessarily means insulation that is uninterrupted by hangers, studs, etc. Indicate planned wall assembly U value and wall construction type (mass, wood, metal stud, etc). Confirm that the relationship between R-value and assembly U-factor conform to Appendix A of the Code.

    b. Account for thermal bridges in assemblies and components with calculating U values. Use thermal bridge free assemblies and components to thermally break:

        i. Hangers, girts, ties, and brick shelfs
        ii. Intersections between balconies and vertical walls
        iii. Intersections between the floor and vertical walls
        iv. Transitions from wall to window
        v. Parapets
        vi. Vertical wall to vertical wall transitions (where the wall “turns”)

        Consult https://thermalenvelope.ca/catalogue/ for pre-solved clear wall thermal bridge and linear thermal bridge values.

    c. Minimize glass curtain wall/spandrel systems as much as possible. Avoid these systems where possible, as these are the lowest performing wall systems.

    d. If curtain wall systems are used, evaluate systems having opaque “spandrel” portion between R-4 through R-10. Opaque spandrel systems with performance better than R-10 are not recommended as there are significant difficulties to achieve performance higher than this in practice. Consult

https://thermalenvelope.ca/catalogue/ for pre-solved opaque curtain wall performance values.

e. If curtain wall systems are used, evaluate using at least R-4 vision glass.

f. For all wall sections, use the thermal comfort tool to help evaluate reduction/elimination of perimeter heating systems. https://www.payette.com/glazing-and-winter-comfort-tool/

g. Reduce air infiltration to at least 0.4 cfm at 75 Pa. In-building field tests are recommended to confirm air-infiltration.

h. Incorporate ventilation energy recovery. High performing energy recovery is essential to achieving low TEDI.

i. Manage solar gains with external shading and/or low solar heat gain coefficient (SHGC).

3. At a minimum, develop the following scenario for the highly ventilated lab/office portions of the project:

   a. Improved envelope described above and inclusion of energy recovery to achieve heating TEDI reduction;

   b. Air infiltration of 0.4 cfm/sf at 75 Pa;

   c. Downsize the HVAC as much as possible, including evaluating perimeter heating downsizing and/or elimination;

   d. Near elimination of use of gas or other fossil fuels with EUI_{ff} goal of 5 to 10 kBtu/sf-yr or less using following strategy:

      i. Ventilation incorporating dedicated outside air systems and energy recovery;

      ii. Energy recovery of concurrent heating and cooling with heat recovery chillers or similar approach;

      iii. In-building, centrally-located hybrid efficient electric space heating (air to water heat pump sized at 25 to 50% peak heating capacity as priority backed-up with 95% efficient gas boiler sized at 100% peak, connected to 120°F thermal distribution hot water loop);

   e. External shading and improved solar heat gain coefficient windows to control space cooling loads;

   f. Conduct sub-scenarios with and without air source heat pump water heating.

4. At a minimum, develop the following scenario for office, retail, and other normally ventilated portions of the project:

    a. Improved envelope described above and inclusion of energy recovery to achieve heating TEDI reduction;

    b. Air infiltration of 0.4 cfm/sf at 75 Pa;

    c. Downsize the HVAC as much as possible, including evaluating perimeter heating downsizing and/or elimination;

    d. Elimination of use of gas or other fossil fuels with EUI_{ff} goal of 0 kBtu/sf-yr or less using following strategy:

        i. Ventilation incorporating dedicated outside air systems and energy recovery;

        ii. Energy recovery of concurrent heating and cooling with heat recovery chillers or similar approach;

        iii. Electric air source heat pump/VRF heating/cooling systems.

    e. External shading and improved solar heat gain coefficient windows to control space cooling loads;

    f. Conduct sub-scenarios with and without air source heat pump water heating.

5. Evaluate incentives, including:

    g. Estimate of Alternative Energy Credits;

    h. Estimates of MassSave® incentives, based on meeting with utility.

6. Evaluate rooftop solar PV readiness. This should include building roof plans showing location of PV readiness areas and location of roof HVAC equipment and other appurtenances. Provide table showing areas needed for code required PV readiness and proposed, above-code PV readiness.

7. Maximize EV-ready parking spaces, target 100% EV Readiness. Clarify commitments to installed EV charging station and EV ready spaces.

8. Compare model results total and individual end uses with representative, prototype buildings developed by Pacific Northwest National Labs/Department of Energy found at the link below. Provide a summary explaining potential differences.

    - https://www.energycodes.gov/sites/default/files/documents/BECP_901_2013_Progress_Indicator_0_0.pdf
    - http://www.energycodes.gov/sites/default/files/documents/2013EndUseTables.zip

- https://www.energycodes.gov/commercial-energy-cost-savings-analysis

9. Include a table similar to the example below. For "code value" ensure that the value incorporates any improved efficiency per requirements of Section C406.1 of the Massachusetts' amendments.

Measure/Area	**Base Code**	**Proposed**	**% Change**	**Comment**
AC Efficiency (EER)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
ERV Effectiveness (%)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
Boiler (% efficiency)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
LPD (Watts/sq ft)				
Bldg 1	*code value*	*design value*	%	
Bldg 2	*code value*	*design value*	%	
(continue to include service water, equipment, etc)				

Sincerely,

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

Charles River Watershed Association

April 28, 2022

Via Email

Jennifer Hughes
Environmental Analyst, MEPA Office
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114
Jennifer.Hughes@mass.gov

Re: Environmental Notification Form for Highland Science Center, Needham
EEA No. 16546

Dear Jennifer:

Charles River Watershed Association ("CRWA") submits the following comments on the Environmental Notification Form ("ENF") for the proposed Highland Science Center project in Needham filed with the MEPA Office on March 31, 2022. The proponent is proposing to redevelop a 9+ acre former car dealership site into a 531,000 square foot office/laboratory/research and development building, with associated landscape and hardscape improvements, including a fitness trail, up to an approximately 310,000-SF below-grade parking garage, and a 6-story, approximately 297,000-SF stand-alone parking garage.

Impervious Surface and Stormwater Management

This project will decrease impervious cover on the project site by 1.83 acres for a total impervious area of 6.7 acres. This will result in an improvement over existing conditions, as impervious surfaces exacerbate stormwater pollution and runoff quantity and contribute to heat island effects. Existing impervious area should be reduced wherever possible and where impossible due to necessary uses, impervious cover impacts should be mitigated through modern stormwater management.

As noted during the virtual MEPA consultation session, the ENF contains general statements about improved stormwater management, but more detail is necessary to fully evaluate the stormwater management measures proposed for this project. During the consultation session, the proponent indicated that there will be a green roof area on the building, that permeable pavers will be used in some locations, and that they are looking at stormwater reuse in the building. Green infrastructure should be extensively incorporated into the building, parking lots, and other paved areas to treat stormwater generated by impervious surfaces and provide cooling benefits for the community.

Water Quality

Any stormwater runoff discharged from the project site will ultimately reach the Charles River, which is an impaired waterbody according to the Massachusetts Year 2016 Integrated List of Waters. Two Total Maximum Daily Loads (TMDLs) apply to this segment of the river: the TMDL for nutrients in the Upper/Middle Charles River (2011) and the final pathogen TMDL for the Charles River (2007). There is no discussion in the ENF about how the project will comply with these TMDLs.

Under the nutrient TMDL, significant reductions in phosphorus loading are required in order to meet water quality standards—there is no "room" for any additional phosphorus loading to the Charles River. The pre- and post-development annual phosphorus load from the site should be provided, along with calculations showing that the project complies with the phosphorus TMDL.

As a reminder, the Town of Needham is regulated by the General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) (MS4 Permit). The MS4 Permit requires Needham to reduce its phosphorus load and achieve a total allowable load of 797 kg/yr to comply with the TMDL for nutrients in the Upper/Middle Charles River, which is a 55% reduction over its current phosphorus load. Rather than being a target or a goal, achieving the total allowable load is a legally-binding requirement under the MS4 Permit, with which failure to comply would be a violation of the permit and the Clean Water Act. Reduction requirements contained within Appendix F of the MS4 Permit are based on the TMDL; the baseline phosphorus load, load reduction requirement, and allowable phosphorus load follow the assumption, as relevant here, that commercial, industrial, high density residential, and medium density residential land uses will achieve or exceed an average annual phosphorus load reduction of 65%. We are encouraged that the project proponent indicated during the consultation session that it would meet the 65% phosphorus load reduction requirement. We look forward to seeing more detail in the EIR about how this will be accomplished, including the calculations noted above.

The project must also address the discharge of bacteria to the Charles River. Inflow and Infiltration (I&I) mitigation work to address aging sewer infrastructure is one important way to limit the migration of bacteria into our local water bodies; illicit discharge detection and elimination (IDDE) is another. Under Stormwater Handbook Standard 10 – Prohibition of Illicit Discharges, for any sewer and storm drain infrastructure remaining on site, we would expect the proponent to confirm the condition and separation of stormwater utilities, and that there are no illicit connections. Bacteria can also come from soils and decomposition of natural materials. Catch basins and water quality units collect much of this material, and some of it may enter the infiltration systems. Frequent cleaning as part of a long-term operation and maintenance program is a critical way to keep these materials from entering the piped network and subsurface systems.

Trees & Vegetation

Trees and other vegetation improve air and water quality, help control stormwater runoff and flooding, and provide natural cooling. We recommend that native trees and shrubs be planted within proposed landscaped areas and along proposed roadways wherever possible.

Thank you for considering these comments.

Sincerely,

Heather Miller, Esq.
General Counsel and Policy Director

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Jamey Tesler, Secretary & CEO

massDOT
Massachusetts Department of Transportation

April 28, 2022

Kathleen Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114-2150

RE: Needham - Highland Science Center – ENF
(EEA #16546)

ATTN: MEPA Unit
Jennifer Hughes

Dear Secretary Theoharides:

On behalf of the Massachusetts Department of Transportation, I am submitting comments regarding the Environmental Notification Form filed for the proposed Highland Science Center at 557 Highland Avenue in Needham as prepared by the Office of Transportation Planning. If you have any questions regarding these comments, please contact J. Lionel Lucien, P.E., Manager of the Public/Private Development Unit, at (857) 368-8862.

Sincerely,

David J. Mohler
Executive Director
Office of Transportation Planning

DJM/jll

Ten Park Plaza, Suite 4160, Boston, MA 02116
Tel: 857-368-4636, TTY: 857-368-0655
www.mass.gov/massdot

cc: Jonathan Gulliver, Administrator, Highway Division
Carrie Lavallee, P.E., Chief Engineer, Highway Division
John McInerney, P.E., District 6 Highway Director
Neil Boudreau, Assistant Administrator of Traffic and Highway Safety
Planning Board, Town of Needham
Metropolitan Area Planning Council
Boston Regional Metropolitan Planning Organization

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Jamey Tesler, Secretary & CEO

massDOT
Massachusetts Department of Transportation

Memorandum

TO: David J. Mohler, Executive Director
Office of Transportation Planning

FROM: J. Lionel Lucien, P.E., Manager
Public/Private Development Unit

DATE: April 28, 2022

RE: Needham: Highland Science Center – ENF
(EEA #16546)

The Public/Private Development Unit (PPDU) has reviewed the Environmental Notification Form ("ENF") for the proposed Highland Science Center located at 557 Highland Avenue (the "Project") submitted by VHB, Inc. on behalf of 557 Highland, LLC (collectively, the "Proponent"). The Project exceeds MEPA thresholds for the preparation of a Draft Environmental Impact Report ("DEIR") due to impacts on Transportation established in 301 CMR 11.03 as it surpasses 3,000 average daily vehicle trips and includes more than 1,000 parking spaces on site. The project additionally requires a Vehicular Access Permit from MassDOT as it is anticipated to generate substantially increased vehicle trips on Highland Avenue and I-95, both jurisdictional roadways.

The Project is located on a parcel at 557 Highland Avenue with a total area of 9.281 acres. The site is currently fully developed with existing structures, impervious surface, and utilities, and operated as a Ford automotive service and sales center until late 2021. The Proponent proposes the demolition of the existing 39,750 square foot (sf) commercial building to construct a science and manufacturing campus, including a five-story commercial building, a three-story commercial building, shared atrium area, and a seven-level parking garage (with two levels below-grade). Site access will be provided via two driveways: a two-lane full access driveway connecting to TV Place (a private road) north of the Project, and a three-lane full access driveway connecting to Gould Street. Provisional site plans include demarcated bike lanes at the Gould Street driveway as well as pedestrian infrastructure at both points of access.

According to the ENF, the Project in total comprises 531,000 sf of new structures, including 260,500 sf of office space, 260,500 sf of research and development space, and 10,000 sf of retail space.

Based on the Project's anticipated impacts, the DEIR will require a Transportation Impact Assessment (TIA). In February 2022, the Proponent submitted a Transportation Scoping Letter (TSL) outlining the methodology for the TIA. Based on the MassDOT memo dated February 2, 2022 approving the TSL, the ENF includes a TIA developed in accordance with MassDOT/EOEEA's *Transportation Impact Assessment (TIA) Guidelines.*

Trip Generation

In Section 2 of the ENF submittal, titled "Transportation," the Proponent estimates that the combination of uses proposed for the Project site will generate an additional 5,005 vehicle trips over existing conditions in accordance with the Institute of Traffic Engineers (ITE) *Trip Generation Manual*, using Land Use Code (LUC) 710: Office for the 260,500 sf of office space, LUC 760: Research and Development Center for the 260,500 sf of research and development space, and LUC 122: Community Shopping Center for the 10,000 sf retail component. In order to provide a conservative analysis of traffic impacts generated by the Project, the Proponent provides traffic analysis assuming no mode share for pedestrian, bicycle, or transit trips to the Project site.

Traffic Operations

The TIA includes analysis of traffic operations at study area intersections under 2022 Existing Conditions, the 2029 No-Build Scenario, and the 2029 Build Scenario, as well as a network map of trip distribution within the study area. The Proponent estimates that overall Level of Service (LOS) for vehicular traffic will degrade at certain study area intersections under the 2029 Build Scenario as compared to the 2029 No-Build Scenario. Per Table 2-9: Signalized Intersection Capacity Analysis Summary, Highland Avenue at West Street will see a drop in performance from LOS C to LOS D and Highland Avenue at Gould Street and Hunting Road will decline from LOS E to LOS F.

The Proponent estimates that the majority of vehicle traffic generated by the Project will access and depart the site via Interstate 95 (I-95) northbound and southbound, with substantially smaller proportions travelling via Highland Avenue to and from points south or via Webster Street to and from points west.

The Proponent notes that Highland Avenue is currently under reconstruction by MassDOT Project #606635 to improve pedestrian and bicycle infrastructure as well as traffic operations along this corridor. The roadway conditions and multi-modal access assumptions included in the 2029 No-Build and Build scenarios do not consider any operational or accessibility improvements resulting from these as-yet incomplete roadway improvements.

In the DEIR, the Proponent should include analysis of queuing at study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area.

Safety

The TIA includes a summary of crash rates derived from the MassDOT crash data portal for the five-year period between 2015 and 2019. Of the study area intersections included for analysis, Highland Avenue at West Street represents a higher-than-average rate

of accidents, with 0.86 accidents per million vehicles as compared to the District 6 average of 0.71. There are no 2017-2019 HSIP crash clusters identified within the study area.

In the DEIR, the Proponent should include analysis of existing and proposed weave conditions on Highland Avenue to ensure that increased traffic volumes do not lead to degraded safety conditions in the area of the Highland Avenue/I-95 interchange.

Transit Operations

The Proponent includes information regarding existing transit options in the area of the Project. The closest subway service available to site visitors is the Massachusetts Bay Transportation Authority (MBTA) Green Line D Branch via the Newton Highlands station, approximately two miles from the Project site via Centre Street. The Needham Heights commuter rail station is also located approximately 0.75 miles south of the Project site along Highland Avenue. MBTA Bus Route 59 provides service to the Needham area, including stops on Highland Avenue approximately 0.6 miles south of the Project site.

Pedestrian Access

The TIA includes a summary of existing pedestrian infrastructure within the study area. The primary roadways serving the Project site, Highland Avenue and Gould Street, each possess existing sidewalks and crosswalks at major intersections, while the Gould Street/Ellis Street and Gould Street/Noanett Road intersections each lack crosswalks. The Project site design includes several features to support pedestrian access to and from the site, including sidewalks connecting to site driveways, proposed mitigation to improve pedestrian infrastructure in the study area (see Mitigation below), and the construction of a 0.5-mile public walking path circling the Project site.

Bicycle Access

The TIA includes a summary of bicycle infrastructure within the study area. The Project site is served by very limited bicycle infrastructure, except for on-street bicycle lanes on Highland Avenue between Wexford and Gould Streets and on Kendrick Street between Hunting Road and 3rd Avenue. The Project site will include bicycle racks and 89 total bicycle parking spaces outside as well as secured bicycle storage within the Project buildings. Both MassDOT Project #606635 and the Proponent's proposed mitigation (see Mitigation below) include improvements to bicycle infrastructure in the study area.

Parking

The Project will include two below-grade parking garages with a total area of 310,000 sf and one 297,000 sf standing garage, which along with new proposed surface parking represents up to 1,770 total parking spaces. This parking provision conforms to Needham off-street parking minimums, which call for one parking space per 300 sf of floor area. MassDOT

believes that this parking capacity is sufficient to support site operations when taken together with proposed mitigation including Transportation Demand Management (TDM) measures outlined below.

Mitigation

The Proponent proposes mitigation measures in the TIA intended to address both Project-generated traffic impacts as well as noted deficiencies in area pedestrian and bicycle infrastructure. The Proponent proposes the following measures as mitigation requiring limited design or construction prior to implementation:

- Installation of on-road bicycle lanes on Gould Street between Highland Avenue and TV Place (adjacent to the Project site).
- Installation of a shared bicycle lane on Gould Street between TV Place and Central Avenue.
- Design and installation of traffic signals at Gould Street/Hunting Road (aligned with Wingate driveway) and Gould Street/Central Avenue intersections.
- Geometric improvements at the Highland Avenue/Gould Street/Hunting Road and Gould Street/TV Place intersections.

In addition to the above, the Proponent includes the following conceptual proposals which may result in future mitigation activities within the study area:

- Coordination with the Town of Needham to study the feasibility of converting the MBTA rail right-of-way north of the Project site into a mixed-use walkway.
- Coordination with the Route 128 Business Council to provide shuttle service to existing transit options.

Further, the Proponent commits to Transportation Demand Management (TDM) measures and a five-year monitoring program as outlined in the respective sections below.

As noted in the Bicycle and Pedestrian Access sections above, the Project area includes sub-standard infrastructure for bicycle and pedestrian employees of the proposed science center. MassDOT requests that the Proponent consider coordinating with District 6 to install adequate bicycle and pedestrian infrastructure on Highland Avenue at the I-95 interchange to connect with proposed Complete Streets improvements to be installed under MassDOT Project #606635. With this suggestion, MassDOT otherwise finds that the proposed mitigation is appropriate to the scale of the Project and will serve to offset traffic impacts generated by the Project and improve access to the Project site.

The DEIR should include sufficiently detailed conceptual plans (minimum of 80-scale) for any proposed roadway improvements including the proposed signalization, geometric improvements, and bicycle lanes to verify the feasibility of constructing such

improvements. These plans should clearly show proposed lane widths and offsets, layout lines and jurisdictions, and land uses adjacent to areas where improvements are proposed. The Proponent should also consider coordination with MBTA in order to determine the feasibility of additional MBTA Bus Route 59 service closer to the Project site.

Transportation Demand Management (TDM)

The Proponent proposes to instate TDM measures with the goal of reducing vehicle trips to the Project site. To this end, the TDM program includes the following measures:

- Assignment of an on-site Employee Transportation Advisor to coordinate with the Route 128 Business Council;
- Coordination with the Route 128 Business Council to provide shuttle service to existing transit options;
- Provision of a 50 percent transit pass subsidy to be offered by tenants to employees;
- Carpool assistance and emergency ride home services;
- Bicycle/walk incentives to travel to work;
- Telecommuting and shortened workweek opportunities for staff;
- Posting of transit information in the public Main Lobby, and;
- Promotional efforts.

Transportation Monitoring Program

The Proponent commits to the implementation of a Transportation Monitoring Program (TMP) to run for five years with annual reporting to MassDOT and the Town of Needham. In accordance with MassDOT/EEA standards, the TMP will include:

- Simultaneous automatic traffic recorder (ATR) counts at each site driveway for a continuous 24-hour period on a typical weekday;
- Travel survey of employees and patrons at the site;
- Weekday AM and PM peak hour turning movement counts (TMCs) and operations analysis at study area intersections, and;
- Updates on efficacy of TDM program.

Conclusion

The Proponent should continue consultation with the Town of Needham, the MBTA, and appropriate MassDOT units, including PPDU, Traffic Operations, and the District 6 Office during the preparation of the DEIR for the Project. Additionally, the Proponent should include a Draft Section 61 Finding in the DEIR that summarizes the proposed mitigation plan and the monitoring program. If you have any questions regarding these comments, please contact *Curtis.B.Wiemann@dot.state.ma.us*.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection
Northeast Regional Office • 205B Lowell Street, Wilmington MA 01887 • 978-694-3200

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Kathleen A. Theoharides
Secretary

Martin Suuberg
Commissioner

April 28, 2022

Kathleen A. Theoharides, Secretary
Executive Office of
Energy & Environmental Affairs
100 Cambridge Street
Boston MA, 02114

RE: Needham
Highland Science Center
EEA # 16546

Attn: MEPA Unit

Dear Secretary Theoharides:

The Massachusetts Department of Environmental Protection Northeast Regional Office (MassDEP-NERO) has reviewed the Environmental Notification Form (ENF) for the proposed Highland Science Center in Needham. MassDEP provides the following comments.

MCP/ M.G.L. Chapter 21E

The site is the former location of an automobile dealership, which operated from 1955 to 2021. The former automotive dealership complex had consisted of two 2-story masonry car dealership and service buildings that covered the southern and northeastern portions of the site. A smaller building also occupied the northern portion of the site that was formerly operated as a car wash. The remainder of the site was generally covered by asphalt paved parking areas and landscaped margins. In February 2022, the former buildings were demolished, and the site was leveled.

The proposed Highland Science Center development includes an approximately 531,000 square foot office/laboratory/research and development building. The new building will vary in height from 3-5 stories and include associated landscape and hardscape improvements and is intended to attract office and life science tenants, with ancillary retail, café, daycare, and fitness amenities subject to market demand. The Project will include up to an approximately 310,000

square foot below-grade parking garage and a six-story, approximately 297,000 square foot stand-alone parking garage.

Current MGL Chapter 21E Status

There are two Massachusetts Contingency Plan (310 CMR 40.0000, the "MCP") Release Tracking Numbers (RTNs) associated with oil and hazardous materials releases at or in close proximity to the Highland Science Center development project site.

The earlier RTN, 3-36733, pertains to the discovery of reportable concentrations of naphthalene, 1,4-dichlorobenzene and 2-methylnaphthalene in soil during the performance of an environmental site assessment in 2021. The contamination was attributed to historic fill operations at the property. Further subsurface characterization of the site was conducted, and a risk assessment determined that exposure point concentrations were below applicable cleanup standards under the MCP. A Permanent Solution with No Conditions was submitted to MassDEP in August, 2021. No further response actions are anticipated under this RTN.

The later RTN, 3-37285, was issued in January, 2022, and pertains to the discovery of gasoline contamination in soil during the removal of a 6,000 gallon underground storage tank at the property. Release response actions involving the excavation and disposal of impacted soils are currently being conducted as an Immediate Response Action pursuant to the provisions of the MCP. To date, approximately 1,000 cubic yards of impacted soils have been excavated and shipped off-site for recycling into asphalt. It is anticipated that an additional 100 yards of soils will be excavated and recycled. Groundwater at the site is not believed to be impacted by the gasoline release. Further investigation of subsurface conditions is expected to continue, and the results provided to MassDEP in the next scheduled submittal due in May, 2022.

In addition, subsurface assessment activities that have been recently completed at the site have identified localized areas of soil exhibiting Reportable Concentrations of metals, PCBs, petroleum hydrocarbons and polycyclic aromatic hydrocarbons which require notification to MassDEP as a 120-day reporting condition in accordance with 310 CMR 40.0333(2). The Reportable Concentrations of these constituents are attributable to the former site usage as automobile dealerships and service center, coupled with historical filling of the former gravel quarry. In accordance with 310 CMR 40.0333(2), MassDEP will be notified of the release condition which will be subsequently managed in accordance with the provisions of the MCP. As part of the Project Site redevelopment, affected soils will be managed in accordance with the MCP, as well as applicable MassDEP policies. Upon completion of redevelopment, a Permanent Solution Statement is anticipated to be filed for the 120-day reporting condition.

Future Compliance Required by the MCP for the Highland Science Center Redevelopment Project

Response actions pursuant to RTN 3-37285 are expected to continue at the site of the proposed project. Pursuant to section 40.0560(2)(b) of the MCP, a Phase I Site Assessment report for RTN 3-37285 must be submitted to MassDEP by January 21, 2023. Additionally, Immediate

Response Action Status Reports must continue to be submitted to MassDEP in accordance with the requirements of section 310 CMR 40.0425 of the MCP, until an Immediate Response Action Completion Statement is submitted to MassDEP.

The project proponent is advised that excavating, removing and/or disposing of contaminated soil, pumping of contaminated groundwater, or working in contaminated media must be done under the provisions of M.G.L. c. 21E and all other applicable federal, state, and local laws, regulations, and bylaws. If contamination at the site is known or suspected, the appropriate tests should be conducted well in advance of the start of construction and professional environmental consulting services should be readily available to provide technical guidance. If dewatering activities are to occur at a site with contaminated groundwater, or in proximity to contaminated groundwater where dewatering can draw in the contamination, a plan must be in place to properly manage the groundwater. A Licensed Site Professional (LSP) must be employed or engaged to manage, supervise or actually perform the necessary response actions at the site.

Dust and/or vapor monitoring and controls are often necessary for large-scale projects in contaminated areas. The need to conduct real-time air monitoring for contaminated dust and to implement dust suppression must be determined prior to excavation of soils, especially those contaminated with compounds such as metals and PCBs. An evaluation of contaminant concentrations in soil should be completed to determine the concentration of contaminated dust that could pose a risk to health of on-site workers and nearby human receptors. If this dust concentration, or action level, is reached during excavation, dust suppression should be implemented as needed, or earthwork should be halted.

If capping of contaminated soil is needed to achieve a level of No Significant Risk, MassDEP recommends the following capping design criteria. In unpaved areas, a minimum of three feet of clean soil should be placed over the contaminated soil. This protective layer of clean soil should be separated from the underlying contaminated soil by a geotextile or combination of materials, which will provide both a brightly colored visual marker and a permeable fabric to separate the clean soil from the contaminated soil. In paved areas, a minimum one-foot cap consisting of clean soil, road base and the pavement layer should be placed over the contaminated soil. Similar to unpaved areas, the contaminated soil should be separated from the clean soil or road base using a visual marker and geotextile. In such cases, an Activity and Use Limitation (AUL), prepared in accordance with 310 CMR 40.1012 would be necessary to identify the maintenance requirements of the cap. It should also be noted that a cap constructed as an Immediate Response Action or as a Release Abatement Measure will not be considered a Permanent Solution until a Phase III completed in accordance with 310 CMR 40.0850 demonstrates the lack of a feasible alternative, as required by 310 CMR 40.0414(7) and 40.0442(4).

Parties constructing and/or renovating buildings in contaminated areas should consider whether chemical or petroleum vapors in subsurface soils and/or groundwater could impact the indoor air quality of the buildings. All relevant site data, such as contaminant concentrations in soil and groundwater, depth to groundwater, and soil gas concentrations should be evaluated to determine the potential for indoor air impacts to existing or proposed building structures. Particular attention should be paid to the vapor intrusion pathway for sites with elevated levels of chlorinated volatile organic compounds such as tetrachloroethylene (PCE) and trichloroethylene (TCE).

MassDEP has additional information about the vapor intrusion pathway on its website at https://www.mass.gov/lists/policies-guidance-technical-support-for-site-cleanup?_ga=2.165003519.1902262297.1534291448-758575996.1534291448#vapor-intrusion-.

Construction activities conducted at a disposal site shall not prevent or impede the implementation of likely assessment or remedial response actions at the site. Construction of structures at a contaminated site may be conducted as a Release Abatement Measure if assessment and remedial activities prescribed at 310 CMR 40.0442(3) are completed within and adjacent to the footprint of the proposed structure prior to or concurrent with the construction activities. Excavation of contaminated soils to construct clean utility corridors should be conducted for all new utility installations.

An Activity and Use Limitation (AUL) is a legal document that is recorded or registered at the appropriate Registry of Deeds and identifies site conditions that are the basis for maintaining a condition of No Significant Risk at a property where contamination remains after a cleanup. The AUL identifies permitted and allowable site uses and activities that may occur at a property while maintaining No Significant Risk. The AUL also identifies restricted uses and activities, which could result in the exposure of people at or near the disposal site to remaining contamination if such activities were to occur. The project proponent is advised that in cases where proposed activities would not be consistent with a level of No Significant Risk and/or an existing AUL, additional cleanup and the amendment or termination of the initial AUL and implementation of a revised AUL would be necessary before the proposed activities could occur

Solid Waste

MassDEP's current *Massachusetts 2030 Solid Waste Master Plan–Working Together Toward Zero Waste*, issued in October 2021 identifies a key goal to reduce solid waste disposal by 30% by 2030 and 90% by 2050. MassDEP encourages the Proponent to review the plan to identify project management and operational practices that will assist the Commonwealth in meeting its material management goals. More information on the *Solid Waste Master Plan* and yearly update reports can be found at: https://www.mass.gov/guides/solid-waste-master-plan.

Waste Ban

Section 310 CMR 19.017 *Waste Bans* of the Massachusetts Solid Waste regulations prohibit the disposal of certain construction-related wastes in Massachusetts, including, but not limited to, metal, wood, asphalt pavement, brick, concrete, clean gypsum wallboard. Further guidance can be found at: https://www.mass.gov/guides/massdep-waste-disposal-bans.

MassDEP regulations also ban disposal of food and other organic wastes from businesses and institutions that dispose of more than one ton[1] of these materials per week. The ban is one of MassDEP's initiatives to help achieve our goal of further reducing food waste by 500,000 tons

[1] Beginning in November 2022, the ban will be lowered to include businesses and institutions that dispose of more than ½ ton of food and other organic wastes per week.

annually by 2030. Diverted food waste may be composted, converted to energy (through anaerobic digestion), recycled, or reused. Additional information, including a full list of banned materials, can be found at: https://www.mass.gov/guides/massdep-waste-disposal-bans.

C&D Recycling

Many construction and demolition materials are currently banned from disposal or transfer for disposal in Massachusetts (https://www.mass.gov/guides/massdep-waste-disposal-bans). Therefore, MassDEP encourages the Proponent to make a significant commitment to construction and demolition (C&D) waste recycling activities as a sustainable measure for the project and to assist in complying with waste ban requirements. MassDEP considers an asphalt, brick, and concrete (ABC) rubble processing or recycling facility (pursuant to the provisions of Section (2)(b) under 310 CMR 16.03), the Site Assignment regulations for solid waste management facilities), to be exempt from the site assignment requirements, if the ABC rubble at such facilities is separated from other solid waste materials at the point of generation. In accordance with 310 CMR 16.03(2)(b), ABC can be crushed on-site with a 30-day notification to MassDEP. However, the asphalt is limited to weathered bituminous concrete (no roofing asphalt), and the brick and concrete must be uncoated or not impregnated with materials such as roofing epoxy. If the brick and concrete are not clean, the material is defined as C&D waste and requires either a Beneficial Use Determination (BUD) or a Site Assignment and permit before it can be crushed.

Pursuant to the requirements of 310 CMR 7.02 of the Air Pollution Control regulations, if the ABC crushing activities are projected to result in the emission of one ton or more of particulate matter or other pollutant to the ambient air per year, and/or if the crushing equipment employs a diesel oil fired engine with an energy input capacity of three million or more British thermal units per hour for either mechanical or electrical power which will remain on-site for twelve or more months, then a plan application must be submitted to MassDEP for written approval prior to installation and operation of the crushing equipment.

Asbestos

Pursuant to 310 CMR 7.15 the removal of asbestos from the buildings must adhere to the special safeguards defined in the Air Pollution Control regulations. An asbestos survey to identify all asbestos containing materials (ACM) shall be conducted by a Massachusetts Department of Labor Standards certified Asbestos Inspector. All identified ACM shall be abated prior to demolition activities. The Proponent is required to submit to MassDEP an Asbestos Removal Notification (Form AQ04 (ANF-001)) at least 10 working days prior to initiating work for any project involving asbestos abatement, removal, or disposal. If any ACM will need to be abated through non-traditional abatement methods, the Proponent must apply for and obtain approval from MassDEP, through Application BWP AQ36 - Application for Non-Traditional Asbestos Abatement Work Practice Approval.

Pursuant to 310 CMR 7.09, for any Construction and Demolition, except in a residential building with fewer than 20 units, the Proponent is required to submit to MassDEP a Construction/Demolition Notification (Form BWP AQ06) at least 10 working days prior to

initiating work. MassDEP Asbestos, Construction and Demolition Notifications can be found at: https://www.mass.gov/guides/massdep-asbestos-construction-demolition-notifications.

Pursuant to 310 CMR 19.061, disposal of ACWM within the Commonwealth must be at a facility specifically approved by MassDEP. The Proponent is advised that asbestos containing waste materials (ACWM) are a special waste as defined in the Solid Waste Management regulations. There are specific ACWM disposal exceptions for intact vinyl asbestos tile (VAT) and asphaltic-asbestos felt and shingles. The disposal of the ACWM outside the jurisdictional boundaries of the Commonwealth must comply with all the applicable laws and regulations of the state receiving the material. Pursuant to 310 CMR 16.05, ACM including VAT, and/or asphaltic-asbestos felts or shingles may not be disposed of at a facility operating as a recycling facility.

Recycling Infrastructure

MassDEP supports voluntary initiatives to institutionalize source reduction, materials reuse, and recycling into operations. Adapting the design, infrastructure, and contractual requirements necessary to incorporate reduction, recycling and recycled products into existing large-scale developments has presented significant challenges to recycling proponents. Integrating those components into developments during the planning and design stage enables the project's management and occupants to establish and maintain effective waste diversion programs. For more guidance on how to reuse building materials, see https://www.mass.gov/lists/managing-construction-demolition-cd-wastes. Free assistance is available from RecyclingWorks in Massachusetts, a recycling assistance program funded by MassDEP – see www.recyclingworksma.com for more information.

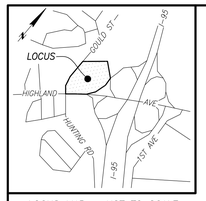
The MassDEP appreciates the opportunity to comment on this proposed project. Please contact Stephen.Johnson@mass.gov at (978) 694-3350 for further information on MCP/Chapter 21E issues. Please contact John.MacAuley@mass.gov at (978) 694-3262 for further information on solid waste, construction and debris, and asbestos issues. If you have any general questions regarding these comments, please contact me at John.D.Viola@mass.gov or at (978) 694-3304.

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John D. Viola
Deputy Regional Director

cc: Brona Simon, Massachusetts Historical Commission
Eric Worrall, Steve Johnson, John MacAuley, MassDEP-NERO



LOCUS MAP – NOT TO SCALE

NOTES:

1. BENCH MARK INFORMATION:

   ELEVATIONS WERE OBTAINED BY GPS OBSERVATIONS ON MARCH 28, 2021.

   TEMPORARY BENCH MARKS SET:

   TBM–AC1: X–CUT ON RIGHT BOLT OVER MAIN OUTLET OF A HYDRANT ON TV PLACE 325'± FROM THE INTERSECTION OF GOULD STREET, AS SHOWN HEREON.
   ELEVATION = 128.44

   TBM–AC2: X–CUT ON RIGHT BOLT OVER MAIN OUTLET OF A HYDRANT ON GOULD STREET 175'± FROM THE INTERSECTION OF HIGHLAND STREET, AS SHOWN HEREON.
   ELEVATION = 145.59

   TBM–BB1: SPIKE IN UPVZ28 ON THE WEST SIDE OF GOULD STREET, AS SHOWN HEREON.
   ELEVATION = 141.95

   TBM–BB2: THE RIGHT BONNET BOLT OVER MAIN OUTLET OF A HYDRANT ON GOULD STREET 100'± FROM THE INTERSECTION OF TV PLACE, AS SHOWN HEREON.
   ELEVATION = 141.03

   TBM–BB3: SOUTHWEST CORNER OF A CONCRETE BOUND WITH DRILL HOLE ON TV PLACE 300'± FROM THE INTERSECTION OF GOULD STREET, AS SHOWN HEREON.
   ELEVATION = 125.28

2. ELEVATIONS REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

3. CONTOUR INTERVAL EQUALS ONE (1) FOOT.

4. BY GRAPHIC PLOTTING ONLY, THE PARCEL SHOWN HEREON LIES WITHIN A ZONE "X" (UNSHADED), AN AREA OUTSIDE OF THE 0.2% ANNUAL CHANCE FLOOD, AS SHOWN ON THE FEDERAL EMERGENCY MANAGEMENT AGENCY (F.E.M.A) FLOOD INSURANCE RATE MAP (F.I.R.M.) FOR NORFOLK COUNTY, MASSACHUSETTS, MAP NUMBER 25021C0036E, TOWN OF NEEDHAM COMMUNITY NUMBER 255215, PANEL NUMBER 0036, HAVING AN EFFECTIVE DATE OF JULY 17, 2012.

5. UTILITY INFORMATION SHOWN IS BASED ON BOTH A FIELD SURVEY AND PLANS OF RECORD. THE LOCATIONS OF UNDERGROUND PIPES AND CONDUITS HAVE BEEN DETERMINED FROM THE AFOREMENTIONED RECORD PLANS AND ARE APPROXIMATE ONLY. WE CANNOT ASSUME RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES THAT ARE OMITTED OR INACCURATELY SHOWN ON SAID RECORD PLANS, SINCE SUBSURFACE UTILITIES CANNOT BE VISIBLY VERIFIED. BEFORE PLANNING FUTURE CONNECTIONS, THE PROPER UTILITY ENGINEERING DEPARTMENT SHOULD BE CONSULTED AND THE ACTUAL LOCATION OF SUBSURFACE STRUCTURES SHOULD BE DETERMINED IN THE FIELD. CALL, TOLL FREE, THE DIG SAFE CALL CENTER AT 1–888–344–7233 SEVENTY–TWO HOURS PRIOR TO EXCAVATION.

6. THIS DOCUMENT IS AN INSTRUMENT OF SERVICE OF FELDMAN LAND SURVEYORS ISSUED TO OUR CLIENT FOR PURPOSES RELATED DIRECTLY AND SOLELY TO FELDMAN LAND SURVEYORS' SCOPE OF SERVICES UNDER CONTRACT TO OUR CLIENT FOR THIS PROJECT. ANY USE OR REUSE OF THIS DOCUMENT FOR ANY REASON BY ANY PARTY FOR PURPOSES UNRELATED DIRECTLY AND SOLELY TO SAID CONTRACT SHALL BE AT THE USER'S SOLE AND EXCLUSIVE RISK AND LIABILITY, INCLUDING LIABILITY FOR VIOLATION OF COPYRIGHT LAWS, UNLESS WRITTEN CONSENT IS PROVIDED BY FELDMAN LAND SURVEYORS.

7. BORING LOCATIONS ARE FROM A REPORT BY ARDENT GROUP "PHASE I & II ENVIRONMENTAL PROPERTY ASSESSMENT & SUPPLEMENTAL PROPERTY ASSESSMENT 557 HIGHLAND AVENUE, 56 & 70 TV PLACE & 0 GOULD STREET NEEDHAM, MASSACHUSETTS", DATED JANUARY 28, 2021.

REFERENCES

COUNTY REGISTRY OF DEEDS

PLAN NO. 850 OF 1955
PLAN NO. 760 OF 1980
PLAN NO. 564 OF 2001
PLAN NO. 50 OF 2011
PLAN BOOK 627, PLAN 27

MASSACHUSETTS LAND COURT

LCC PLAN
18403N
37005A
CERTIFICATE OF TITLE
110971
167967
206689

MASSACHUSETTS HIGHWAY DEPARTMENT

LAYOUT NO. 8729
LAYOUT NO. 8321
LAYOUT NO. 6460
LAYOUT NO. 5929
LAYOUT NO. 4062

LIST OF POTENTIAL ENCROACHMENTS

HEARST–ARGYLE STATIONS, INC.

1 OVERHEAD WIRES CROSS PROPERTY LINE
2 CHAIN LINK FENCE OVER 0.0'–16.1'

COMMONWEALTH OF MASSACHUSETTS

4 RIP RAP OVER 0.0'–2.6'
5 BIT CONCRETE OVER 0.0'–2.6'
6 HANDHOLE OVER 0.6'

GOULD STREET

7 BITUMINOUS CONCRETE CURB OVER 0.0'–0.6'

LOT 5

MASS BAY TRANSPORTATION AUTHORITY

8 CHAIN LINK FENCE OVER 5.6'

COMMONWEALTH OF MASSACHUSETTS

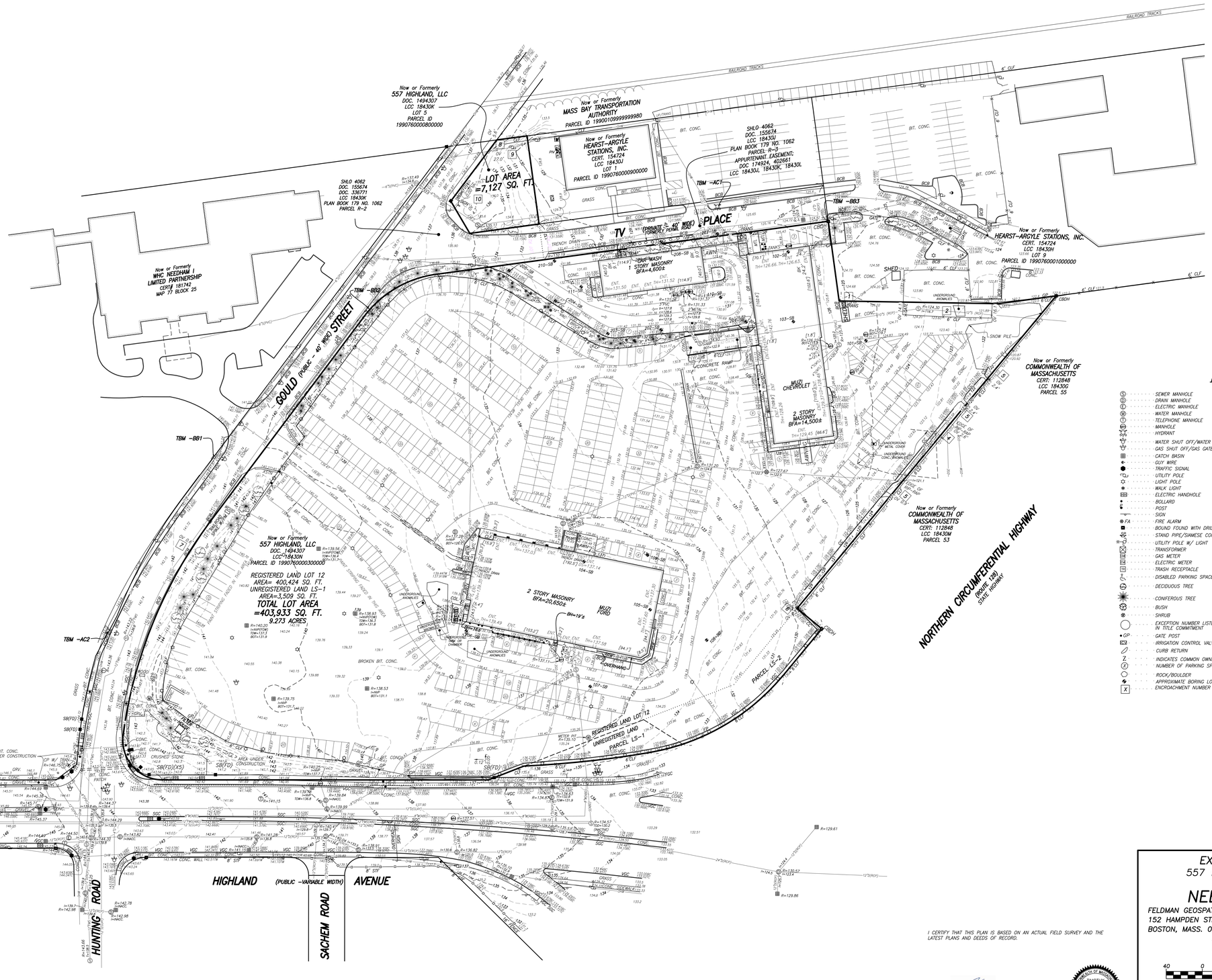
9 UTILITY POLE AND OVERHEAD WIRES OVER 27.0'

HEARST–ARGYLE STATIONS, INC.

10 SIGN OVER 4.7'

PARKING SUMMARY

530 STANDARD SPACES
2 HANDICAP SPACES
532 TOTAL SPACES



LEGEND

(S)	SEWER MANHOLE
(D)	DRAIN MANHOLE
(E)	ELECTRIC MANHOLE
(W)	WATER MANHOLE
(T)	TELEPHONE MANHOLE
(M)	MANHOLE
	HYDRANT
	WATER SHUT OFF/WATER GATE
	GAS SHUT OFF/GAS GATE
	CATCH BASIN
	GUY WIRE
	TRAFFIC SIGNAL
	UTILITY POLE
	LIGHT POLE
	WALK LIGHT
	ELECTRIC HANDHOLE
	BOLLARD
	POST
	SIGN
FA	FIRE ALARM
	BOUND FOUND WITH DRILL HOLE
	STAND PIPE/SIAMESE CONNECTION
	UTILITY POLE W/ LIGHT
	TRANSFORMER
GM	GAS METER
EM	ELECTRIC METER
	TRASH RECEPTACLE
	DISABLED PARKING SPACE
	DECIDUOUS TREE
	CONIFEROUS TREE
	BUSH
	SHRUB
	EXCEPTION NUMBER LISTED IN TITLE COMMITMENT
GP	GATE POST
	IRRIGATION CONTROL VALVE
	CURB RETURN
Z	INDICATES COMMON OWNERSHIP
(X)	NUMBER OF PARKING SPACES
	ROCK/BOULDER
	APPROXIMATE BORING LOCATION
X	ENCROACHMENT NUMBER

AWN	AWNING
B	BOTTOM
BC	BOTTOM OF CURB
BCB	BIT. CONC. BERM
[X.X']	BUILDING DIMENSION
BFA	BUILDING FOOTPRINT AREA
BH	BUILDING HEIGHT
BIT	BITUMINOUS
BK	BACK
BOT=	BOTTOM ELEVATION
BW	BOTTOM OF WALL
(C)	CALCULATED
CC	CONCRETE CURB
CHB	CHORD BEARING
CHD	CHORD DISTANCE
CLF	CHAIN LINK FENCE
COL	COLUMN
CONC	CONCRETE
CRW	CONCRETE RETAINING WALL
Δ=	DELTA ANGLE
DH	DRILL HOLE
DI	DUCTILE IRON PIPE
ENT	ENTRANCE
FFE	FINISH FLOOR ELEVATION
GD	GARAGE DOOR
GRAN	GRANITE
INACC.	INACCESSIBLE
L=	ARC LENGTH
LCC	LAND COURT CASE
LD	LOADING DOCK
LSA	LANDSCAPED AREA
MHB	MASSACHUSETTS HIGHWAY BOUND
M&S	MULCH & SHRUBS
NVP	NO VISIBLE PIPES
OHD	OVERHEAD DOOR
OV	OVER
POB	POINT OF BEGINNING
R=	RADIUS
(R)	RECORD
(REC)	RECORD
RET	RETAINING
SGC	SLOPED GRANITE CURB
SQ. FT.	SQUARE FEET
T	TOP
TBM	TEMPORARY BENCH MARK
TC	TOP OF CURB
TH	THRESHOLD
TYP	TYPICAL
VGC	VERTICAL GRANITE CURB

D	DRAIN
E	ELECTRIC
FMS	FORCE MAIN SEWER
G	GAS
OHW	OVERHEAD WIRES
S	SEWER
W	WATER
S(ABD)	ABANDONED
12"D(C)	PIPE SIZE AND MATERIAL
PVC	POLYVINYL CHLORIDE
RCP	REINFORCED CONCRETE PIPE
X	METAL FENCE
DSE	DIGSAFE ELECTRIC
DSET	DIGSAFE ELECTRIC & TELEPHONE
DSG	DIGSAFE GAS
DSST	DIGSAFE STEAM
DST	DIGSAFE TELEPHONE

I CERTIFY THAT THIS PLAN IS BASED ON AN ACTUAL FIELD SURVEY AND THE LATEST PLANS AND DEEDS OF RECORD.

TIMOTHY R. ADURKIS, PLS (MA# 52782)
TRA@FELDMANSURVEYORS.COM

1/31/2022
DATE

COMMONWEALTH OF MASSACHUSETTS TIMOTHY R. ADURKIS No.52782 REGISTERED PROFESSIONAL LAND SURVEYOR

EXISTING CONDTIONS
557 HIGHLAND AVENUE AND
0 GOULD STREET
NEEDHAM, MASS.

FELDMAN GEOSPATIAL
152 HAMPDEN STREET
BOSTON, MASS. 02119
PHONE: (617)357–9740
www.feldmangeospatial.com

DECEMBER 19, 2021

FELDMAN GEOSPATIAL

40 0 20 40 80 160

SCALE: 1"=40'

RESEARCH	FIELD CHIEF	PROJ MGR TRA	APPROVED	SHEET NO. 1 OF 1
CALC MAM	CADD MAM, MDH	FIELD CHECKED	ORD FILE 18000	JOB NO. 18000

FILENAME: S:\PROJECTS\18000\18000\DWG\18000–EC–12–20–2021.dwg

\\vhb\gbl\proj\Boston\15306.00\cadd\dt\Planset\15306.00 - LG.dwg

Legend

Exist.	Prop.	
		PROPERTY LINE
		PROJECT LIMIT LINE
		RIGHT-OF-WAY/PROPERTY LINE
		EASEMENT
		BUILDING SETBACK
		PARKING SETBACK
10+00	10+00	BASELINE
		CONSTRUCTION LAYOUT
		ZONING LINE
		TOWN LINE
		LIMIT OF DISTURBANCE
		WETLAND LINE WITH FLAG
		FLOODPLAIN
BLSF		BORDERING LAND SUBJECT TO FLOODING
BZ		WETLAND BUFFER ZONE
NDZ		NO DISTURB ZONE
200'RA		200' RIVERFRONT AREA
		GRAVEL ROAD
EOP	EOP	EDGE OF PAVEMENT
BB	BB	BITUMINOUS BERM
BC	BC	BITUMINOUS CURB
CC	CC	CONCRETE CURB
	CG	CURB AND GUTTER
CC	ECC	EXTRUDED CONCRETE CURB
CC	MCC	MONOLITHIC CONCRETE CURB
CC	PCC	PRECAST CONC. CURB
SGE	SGE	SLOPED GRAN. EDGING
VGC	VGC	VERT. GRAN. CURB
		LIMIT OF CURB TYPE
		SAWCUT
		BUILDING
	EN	BUILDING ENTRANCE
	LD	LOADING DOCK
		BOLLARD
D	D	DUMPSTER PAD
		SIGN
		DOUBLE SIGN
		STEEL GUARDRAIL
		WOOD GUARDRAIL
		PATH
		TREE LINE
		WIRE FENCE
		FENCE
		STOCKADE FENCE
		STONE WALL
		RETAINING WALL
		STREAM / POND / WATER COURSE
		DETENTION BASIN
		HAY BALES
		SILT FENCE
		SILT SOCK / STRAW WATTLE
4	4	MINOR CONTOUR
20	20	MAJOR CONTOUR
10	10	PARKING COUNT
	C10	COMPACT PARKING STALLS
DYL	DYL	DOUBLE YELLOW LINE
SL	SL	STOP LINE
		CROSSWALK
		ACCESSIBLE CURB RAMP
		ACCESSIBLE PARKING
VAN	VAN	VAN-ACCESSIBLE PARKING

Exist.	Prop.	
		CONCRETE
		HEAVY DUTY PAVEMENT
		BUILDINGS
		RIPRAP
		CONSTRUCTION EXIT
27.35 TC×	27.35 TC×	TOP OF CURB ELEVATION
26.85 BC×	26.85 BC×	BOTTOM OF CURB ELEVATION
132.75×	132.75×	SPOT ELEVATION
45.0 TW× 38.5 BW	45.0 TW× 38.5 BW	TOP & BOTTOM OF WALL ELEVATION
		BORING LOCATION
		TEST PIT LOCATION
MW	MW	MONITORING WELL
UD	UD	UNDERDRAIN
12"D	12"D	DRAIN
6"RD	6"RD	ROOF DRAIN
12"S	12"S	SEWER
FM	FM	FORCE MAIN
OHW	OHW	OVERHEAD WIRE
6"W	6"W	WATER
4"FP	4"FP	FIRE PROTECTION
	2"DW	DOMESTIC WATER
3"G	G	GAS
E	E	ELECTRIC
STM	STM	STEAM
T	T	TELEPHONE
FA	FA	FIRE ALARM
CATV	CATV	CABLE TV
		CATCH BASIN CONCENTRIC
		CATCH BASIN ECCENTRIC
		DOUBLE CATCH BASIN CONCENTRIC
		DOUBLE CATCH BASIN ECCENTRIC
		GUTTER INLET
		DRAIN MANHOLE CONCENTRIC
		DRAIN MANHOLE ECCENTRIC
TD		TRENCH DRAIN
		PLUG OR CAP
CO	CO	CLEANOUT
		FLARED END SECTION
		HEADWALL
		SEWER MANHOLE CONCENTRIC
		SEWER MANHOLE ECCENTRIC
CS	CS	CURB STOP & BOX
WV	WV	WATER VALVE & BOX
TSV	TSV	TAPPING SLEEVE, VALVE & BOX
		FIRE DEPARTMENT CONNECTION
HYD	HYD	FIRE HYDRANT
WM	WM	WATER METER
PIV	PIV	POST INDICATOR VALVE
W	W	WATER WELL
GG	GG	GAS GATE
GM	GM	GAS METER
E	EMH	ELECTRIC MANHOLE
EM	EM	ELECTRIC METER
		LIGHT POLE
T	TMH	TELEPHONE MANHOLE
T	T	TRANSFORMER PAD
		UTILITY POLE
		GUY POLE
		GUY WIRE & ANCHOR
HH	HH	HAND HOLE
PB	PB	PULL BOX
		MATCHLINE

Abbreviations

General

ABAN	ABANDON
ACR	ACCESSIBLE CURB RAMP
ADJ	ADJUST
APPROX	APPROXIMATE
BIT	BITUMINOUS
BS	BOTTOM OF SLOPE
BWLL	BROKEN WHITE LANE LINE
CONC	CONCRETE
DYCL	DOUBLE YELLOW CENTER LINE
EL	ELEVATION
ELEV	ELEVATION
EX	EXISTING
FDN	FOUNDATION
FFE	FIRST FLOOR ELEVATION
GRAN	GRANITE
GTD	GRADE TO DRAIN
LA	LANDSCAPE AREA
LOD	LIMIT OF DISTURBANCE
MAX	MAXIMUM
MIN	MINIMUM
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
PERF	PERFORATED
PROP	PROPOSED
REM	REMOVE
RET	RETAIN
R&D	REMOVE AND DISPOSE
R&R	REMOVE AND RESET
SWEL	SOLID WHITE EDGE LINE
SWLL	SOLID WHITE LANE LINE
TS	TOP OF SLOPE
TYP	TYPICAL

Utility

CB	CATCH BASIN
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT
DCB	DOUBLE CATCH BASIN
DMH	DRAIN MANHOLE
CIP	CAST IRON PIPE
COND	CONDUIT
DIP	DUCTILE IRON PIPE
FES	FLARED END SECTION
FM	FORCE MAIN
F&G	FRAME AND GRATE
F&C	FRAME AND COVER
GI	GUTTER INLET
GT	GREASE TRAP
HDPE	HIGH DENSITY POLYETHYLENE PIPE
HH	HANDHOLE
HW	HEADWALL
HYD	HYDRANT
INV	INVERT ELEVATION
I=	INVERT ELEVATION
LP	LIGHT POLE
MES	METAL END SECTION
PIV	POST INDICATOR VALVE
PWW	PAVED WATER WAY
PVC	POLYVINYLCHLORIDE PIPE
RCP	REINFORCED CONCRETE PIPE
R=	RIM ELEVATION
RIM=	RIM ELEVATION
SMH	SEWER MANHOLE
TSV	TAPPING SLEEVE, VALVE AND BOX
UG	UNDERGROUND
UP	UTILITY POLE

Notes

General

1. CONTRACTOR SHALL NOTIFY "DIG-SAFE" (1-888-344-7233) AT LEAST 72 HOURS BEFORE EXCAVATING.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR SITE SECURITY AND JOB SAFETY. CONSTRUCTION ACTIVITIES SHALL BE IN ACCORDANCE WITH OSHA STANDARDS AND LOCAL REQUIREMENTS.
3. ACCESSIBLE ROUTES, PARKING SPACES, RAMPS, SIDEWALKS AND WALKWAYS SHALL BE CONSTRUCTED IN CONFORMANCE WITH THE FEDERAL AMERICANS WITH DISABILITIES ACT AND WITH STATE AND LOCAL LAWS AND REGULATIONS (WHICHEVER ARE MORE STRINGENT).
4. AREAS DISTURBED DURING CONSTRUCTION AND NOT RESTORED WITH IMPERVIOUS SURFACES (BUILDINGS, PAVEMENTS, WALKS, ETC.) SHALL RECEIVE 6 INCHES LOAM AND SEED.
5. WITHIN THE LIMITS OF THE BUILDING FOOTPRINT, THE SITE CONTRACTOR SHALL PERFORM EARTHWORK OPERATIONS REQUIRED UP TO SUBGRADE ELEVATIONS.
6. WORK WITHIN THE LOCAL RIGHTS-OF-WAY SHALL CONFORM TO LOCAL MUNICIPAL STANDARDS. WORK WITHIN STATE RIGHTS-OF-WAY SHALL CONFORM TO THE LATEST EDITION OF THE STATE HIGHWAY DEPARTMENTS STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES.
7. UPON AWARD OF CONTRACT, CONTRACTOR SHALL MAKE NECESSARY CONSTRUCTION NOTIFICATIONS AND APPLY FOR AND OBTAIN NECESSARY PERMITS, PAY FEES, AND POST BONDS ASSOCIATED WITH THE WORK INDICATED ON THE DRAWINGS, IN THE SPECIFICATIONS, AND IN THE CONTRACT DOCUMENTS. DO NOT CLOSE OR OBSTRUCT ROADWAYS, SIDEWALKS, AND FIRE HYDRANTS, WITHOUT APPROPRIATE PERMITS.
8. TRAFFIC SIGNAGE AND PAVEMENT MARKINGS SHALL CONFORM TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.
9. AREAS OUTSIDE THE LIMITS OF PROPOSED WORK DISTURBED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED BY THE CONTRACTOR TO THEIR ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE.
10. IN THE EVENT THAT SUSPECTED CONTAMINATED SOIL, GROUNDWATER, AND OTHER MEDIA ARE ENCOUNTERED DURING EXCAVATION AND CONSTRUCTION ACTIVITIES BASED ON VISUAL, OLFACTORY, OR OTHER EVIDENCE, THE CONTRACTOR SHALL STOP WORK IN THE VICINITY OF THE SUSPECT MATERIAL TO AVOID FURTHER SPREADING OF THE MATERIAL, AND SHALL NOTIFY THE OWNER IMMEDIATELY SO THAT THE APPROPRIATE TESTING AND SUBSEQUENT ACTION CAN BE TAKEN.
11. CONTRACTOR SHALL PREVENT DUST, SEDIMENT, AND DEBRIS FROM EXITING THE SITE AND SHALL BE RESPONSIBLE FOR CLEANUP, REPAIRS AND CORRECTIVE ACTION IF SUCH OCCURS.
12. DAMAGE RESULTING FROM CONSTRUCTION LOADS SHALL BE REPAIRED BY THE CONTRACTOR AT NO ADDITIONAL COST TO OWNER.
13. CONTRACTOR SHALL CONTROL STORMWATER RUNOFF DURING CONSTRUCTION TO PREVENT ADVERSE IMPACTS TO OFF SITE AREAS, AND SHALL BE RESPONSIBLE TO REPAIR RESULTING DAMAGES, IF ANY, AT NO COST TO OWNER.
14. THIS PROJECT DISTURBS MORE THAN ONE ACRE OF LAND AND FALLS WITHIN THE NPDES CONSTRUCTION GENERAL PERMIT (CGP) PROGRAM AND EPA JURISDICTION. PRIOR TO THE START OF CONSTRUCTION CONTRACTOR IS TO FILE A CGP NOTICE OF INTENT WITH THE EPA AND PREPARE A STORMWATER POLLUTION PREVENTION PLAN IN ACCORDANCE WITH THE NPDES REGULATIONS. CONTRACTOR SHALL CONFIRM THE OWNER HAS ALSO FILED A NOTICE OF INTENT WITH THE EPA.

Utilities

1. THE LOCATIONS, SIZES, AND TYPES OF EXISTING UTILITIES ARE SHOWN AS AN APPROXIMATE REPRESENTATION ONLY. THE OWNER OR ITS REPRESENTATIVE(S) HAVE NOT INDEPENDENTLY VERIFIED THIS INFORMATION AS SHOWN ON THE PLANS. THE UTILITY INFORMATION SHOWN DOES NOT GUARANTEE THE ACTUAL EXISTENCE, SERVICEABILITY, OR OTHER DATA CONCERNING THE UTILITIES, NOR DOES IT GUARANTEE AGAINST THE POSSIBILITY THAT ADDITIONAL UTILITIES MAY BE PRESENT THAT ARE NOT SHOWN ON THE PLANS. PRIOR TO ORDERING MATERIALS AND BEGINNING CONSTRUCTION, THE CONTRACTOR SHALL VERIFY AND DETERMINE THE EXACT LOCATIONS, SIZES, AND ELEVATIONS OF THE POINTS OF CONNECTIONS TO EXISTING UTILITIES AND, SHALL CONFIRM THAT THERE ARE NO INTERFERENCES WITH EXISTING UTILITIES AND THE PROPOSED UTILITY ROUTES, INCLUDING ROUTES WITHIN THE PUBLIC RIGHTS OF WAY.
2. WHERE AN EXISTING UTILITY IS FOUND TO CONFLICT WITH THE PROPOSED WORK, OR EXISTING CONDITIONS DIFFER FROM THOSE SHOWN SUCH THAT THE WORK CANNOT BE COMPLETED AS INTENDED, THE LOCATION, ELEVATION, AND SIZE OF THE UTILITY SHALL BE ACCURATELY DETERMINED WITHOUT DELAY BY THE CONTRACTOR, AND THE INFORMATION FURNISHED IN WRITING TO THE OWNER'S REPRESENTATIVE FOR THE RESOLUTION OF THE CONFLICT AND CONTRACTOR'S FAILURE TO NOTIFY PRIOR TO PERFORMING ADDITIONAL WORK RELEASES OWNER FROM OBLIGATIONS FOR ADDITIONAL PAYMENTS WHICH OTHERWISE MAY BE WARRANTED TO RESOLVE THE CONFLICT.
3. SET CATCH BASIN RIMS, AND INVERTS OF SEWERS, DRAINS, AND DITCHES IN ACCORDANCE WITH ELEVATIONS ON THE GRADING AND UTILITY PLANS.
4. RIM ELEVATIONS FOR DRAIN AND SEWER MANHOLES, WATER VALVE COVERS, GAS GATES, ELECTRIC AND TELEPHONE PULL BOXES, AND MANHOLES, AND OTHER SUCH ITEMS, ARE APPROXIMATE AND SHALL BE SET/RESET AS FOLLOWS:
   A. PAVEMENTS AND CONCRETE SURFACES: FLUSH
   B. ALL SURFACES ALONG ACCESSIBLE ROUTES: FLUSH
   C. LANDSCAPE, LOAM AND SEED, AND OTHER EARTH SURFACE AREAS: ONE INCH ABOVE SURROUNDING AREA AND TAPER EARTH TO THE RIM ELEVATION.
5. THE LOCATION, SIZE, DEPTH, AND SPECIFICATIONS FOR CONSTRUCTION OF PROPOSED PRIVATE UTILITY SERVICES SHALL BE INSTALLED ACCORDING TO THE REQUIREMENTS PROVIDED BY, AND APPROVED BY, THE RESPECTIVE UTILITY COMPANY (GAS, TELEPHONE, ELECTRIC, FIRE ALARM, ETC.). FINAL DESIGN LOADS AND LOCATIONS TO BE COORDINATED WITH OWNER AND ARCHITECT.
6. CONTRACTOR SHALL MAKE ARRANGEMENTS FOR AND SHALL BE RESPONSIBLE FOR PAYING FEES FOR POLE RELOCATION AND FOR THE ALTERATION AND ADJUSTMENT OF GAS, ELECTRIC, TELEPHONE, FIRE ALARM, AND ANY OTHER PRIVATE UTILITIES, WHETHER WORK IS PERFORMED BY CONTRACTOR OR BY THE UTILITIES COMPANY.
7. UTILITY PIPE MATERIALS SHALL BE AS FOLLOWS, UNLESS OTHERWISE NOTED ON THE PLAN:
   A. WATER PIPES SHALL BE CLASS 52 CEMENT LINED DUCTILE IRON (CLDI).
   B. SANITARY SEWER PIPES SHALL BE SDR 35 POLYVINYL CHLORIDE (PVC).
   C. STORM DRAINAGE PIPES SHALL BE HIGH DENSITY POLYETHYLENE (HDPE).
   D. PIPE INSTALLATION AND MATERIALS SHALL COMPLY WITH THE STATE PLUMBING CODE WHERE APPLICABLE. CONTRACTOR SHALL COORDINATE WITH LOCAL PLUMBING INSPECTOR PRIOR TO BEGINNING WORK.
8. CONTRACTOR SHALL COORDINATE WITH ELECTRICAL CONTRACTOR AND SHALL FURNISH EXCAVATION, INSTALLATION, AND BACKFILL OF ELECTRICAL FURNISHED SITEWORK RELATED ITEMS SUCH AS PULL BOXES, CONDUITS, DUCT BANKS, LIGHT POLE BASES, AND CONCRETE PADS. SITE CONTRACTOR SHALL FURNISH CONCRETE ENCASEMENT OF DUCT BANKS IF REQUIRED BY THE UTILITY COMPANY AND AS INDICATED ON THE DRAWINGS.
9. CONTRACTOR SHALL EXCAVATE AND BACKFILL TRENCHES FOR GAS IN ACCORDANCE WITH GAS COMPANY'S REQUIREMENTS.
10. ALL DRAINAGE AND SANITARY STRUCTURE INTERIOR DIAMETERS (4' MIN.) SHALL BE DETERMINED BY THE MANUFACTURER BASED ON THE PIPE CONFIGURATIONS SHOWN ON THESE PLANS AND LOCAL MUNICIPAL STANDARDS. FOR MANHOLES THAT ARE 20 FEET IN DEPTH AND GREATER, THE MINIMUM DIAMETER SHALL BE 5 FEET.

Layout and Materials

1. DIMENSIONS ARE FROM THE FACE OF CURB, FACE OF BUILDING, FACE OF WALL, AND CENTER LINE OF PAVEMENT MARKINGS, UNLESS OTHERWISE NOTED.
2. CURB RADII ARE 3 FEET UNLESS OTHERWISE NOTED.
3. CURBING SHALL BE VERTICAL GRANITE WITHIN THE SITE UNLESS OTHERWISE INDICATED ON THE PLANS.
4. SEE ARCHITECTURAL DRAWINGS FOR EXACT BUILDING DIMENSIONS AND DETAILS CONTIGUOUS TO THE BUILDING, INCLUDING SIDEWALKS, RAMPS, BUILDING ENTRANCES, STAIRWAYS, UTILITY PENETRATIONS, CONCRETE DOOR PADS, COMPACTOR PAD, LOADING DOCKS, BOLLARDS, ETC.
5. PROPOSED BOUNDS AND ANY EXISTING PROPERTY LINE MONUMENTATION DISTURBED DURING CONSTRUCTION SHALL BE SET OR RESET BY A PROFESSIONAL LAND SURVEYOR.
6. PRIOR TO START OF CONSTRUCTION, CONTRACTOR SHALL VERIFY EXISTING PAVEMENT ELEVATIONS AT INTERFACE WITH PROPOSED PAVEMENTS, AND EXISTING GROUND ELEVATIONS ADJACENT TO DRAINAGE OUTLETS TO ASSURE PROPER TRANSITIONS BETWEEN EXISTING AND PROPOSED FACILITIES.

Demolition

1. PROJECT PRESENTED HEREIN IS THE ADAPTIVE REUSE OF AN EXISTING SITE. TO THE EXTENT REQUIRED TO BUILD THE PROJECT, CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING MANMADE SURFACE FEATURES WITHIN THE LIMIT OF WORK INCLUDING BUILDINGS, STRUCTURES, PAVEMENTS, SLABS, CURBING, FENCES, UTILITY POLES, SIGNS, ETC. UNLESS INDICATED OTHERWISE ON THE DRAWINGS. REMOVE AND DISPOSE OF EXISTING UTILITIES, FOUNDATIONS, AND UNSUITABLE MATERIAL BENEATH AND FOR A DISTANCE OF TEN (10) FEET BEYOND THE PROPOSED BUILDING FOOTPRINT INCLUDING EXTERIOR COLUMNS.
2. EXISTING UTILITIES SHALL BE TERMINATED, UNLESS OTHERWISE NOTED, IN CONFORMANCE WITH LOCAL, STATE AND INDIVIDUAL UTILITY COMPANY STANDARD SPECIFICATIONS AND DETAILS. THE CONTRACTOR SHALL COORDINATE UTILITY SERVICE DISCONNECTS WITH THE UTILITY REPRESENTATIVES.
3. CONTRACTOR SHALL DISPOSE OF DEMOLITION DEBRIS IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS, ORDINANCES AND STATUTES.
4 THE DEMOLITION LIMITS DEPICTED IN THE PLANS IS INTENDED TO AID THE CONTRACTOR DURING THE BIDDING AND CONSTRUCTION PROCESS AND IS NOT INTENDED TO DEPICT EACH AND EVERY ELEMENT OF DEMOLITION. THE CONTRACTOR IS RESPONSIBLE FOR IDENTIFYING THE DETAILED SCOPE OF DEMOLITION BEFORE SUBMITTING ITS BID/PROPOSAL TO PERFORM THE WORK AND SHALL MAKE NO CLAIMS AND SEEK NO ADDITIONAL COMPENSATION FOR CHANGED CONDITIONS OR UNFORESEEN OR LATENT SITE CONDITIONS RELATED TO ANY CONDITIONS DISCOVERED DURING EXECUTION OF THE WORK.
5. UNLESS OTHERWISE SPECIFICALLY PROVIDED ON THE PLANS OR IN THE SPECIFICATIONS, THE ENGINEER HAS NOT PREPARED DESIGNS FOR AND SHALL HAVE NO RESPONSIBILITY FOR THE PRESENCE, DISCOVERY, REMOVAL, ABATEMENT OR DISPOSAL OF HAZARDOUS MATERIALS, TOXIC WASTES OR POLLUTANTS AT THE PROJECT SITE. THE ENGINEER SHALL NOT BE RESPONSIBLE FOR ANY CLAIMS OF LOSS, DAMAGE, EXPENSE, DELAY, INJURY OR DEATH ARISING FROM THE PRESENCE OF HAZARDOUS MATERIAL AND CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS THE ENGINEER FROM ANY CLAIMS MADE IN CONNECTION THEREWITH. MOREOVER, THE ENGINEER SHALL HAVE NO ADMINISTRATIVE OBLIGATIONS OF ANY TYPE WITH REGARD TO ANY CONTRACTOR AMENDMENT INVOLVING THE ISSUES OF PRESENCE, DISCOVERY, REMOVAL, ABATEMENT OR DISPOSAL OF ASBESTOS OR OTHER HAZARDOUS MATERIALS.

Erosion Control

1. PRIOR TO STARTING ANY OTHER WORK ON THE SITE, THE CONTRACTOR SHALL NOTIFY APPROPRIATE AGENCIES AND SHALL INSTALL EROSION CONTROL MEASURES AS SHOWN ON THE PLANS AND AS IDENTIFIED IN FEDERAL, STATE, AND LOCAL APPROVAL DOCUMENTS PERTAINING TO THIS PROJECT.
2. CONTRACTOR SHALL INSPECT AND MAINTAIN EROSION CONTROL MEASURES ON A WEEKLY BASIS (MINIMUM) OR AS REQUIRED PER THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP). THE CONTRACTOR SHALL ADDRESS DEFICIENCIES AND MAINTENANCE ITEMS WITHIN TWENTY-FOUR HOURS OF INSPECTION. CONTRACTOR SHALL PROPERLY DISPOSE OF SEDIMENT SUCH THAT IT DOES NOT ENCUMBER OTHER DRAINAGE STRUCTURES AND PROTECTED AREAS.
3. CONTRACTOR SHALL BE FULLY RESPONSIBLE TO CONTROL CONSTRUCTION SUCH THAT SEDIMENTATION SHALL NOT AFFECT REGULATORY PROTECTED AREAS, WHETHER SUCH SEDIMENTATION IS CAUSED BY WATER, WIND, OR DIRECT DEPOSIT.
4. CONTRACTOR SHALL PERFORM CONSTRUCTION SEQUENCING SUCH THAT EARTH MATERIALS ARE EXPOSED FOR A MINIMUM OF TIME BEFORE THEY ARE COVERED, SEEDED, OR OTHERWISE STABILIZED TO PREVENT EROSION.
5. UPON COMPLETION OF CONSTRUCTION AND ESTABLISHMENT OF PERMANENT GROUND COVER, CONTRACTOR SHALL REMOVE AND DISPOSE OF EROSION CONTROL MEASURES AND CLEAN SEDIMENT AND DEBRIS FROM ENTIRE DRAINAGE AND SEWER SYSTEMS.

Existing Conditions Information

1. BASE PLAN: THE PROPERTY LINES AND EXISTING CONDITIONS ARE SHOWN BASED ON "ALTA/NSPS LAND TITLE SURVEY 557 HIGHLAND AVENUE", PREPARED BY FELDMAN LAND SURVEYORS, DATED 12/09/2021.
2. TOPOGRAPHY: ELEVATIONS ARE BASED ON NAVD88.
3. GEOTECHNICAL DATA INCLUDING TEST PIT AND BORING LOCATIONS AND ELEVATIONS WERE OBTAINED FROM A MEMO ENTITLED "PRELIMINARY EVALUATION OF SOIL HYDRAULIC CONDUCTIVITY", PREPARED BY MCPHAIL ASSOCIATES, DATED MARCH 18, 2022.

Document Use

1. THESE PLANS AND CORRESPONDING CADD DOCUMENTS ARE INSTRUMENTS OF PROFESSIONAL SERVICE, AND SHALL NOT BE USED, IN WHOLE OR IN PART, FOR ANY PURPOSE OTHER THAN FOR WHICH IT WAS CREATED WITHOUT THE EXPRESSED, WRITTEN CONSENT OF VHB. ANY UNAUTHORIZED USE, REUSE, MODIFICATION OR ALTERATION, INCLUDING AUTOMATED CONVERSION OF THIS DOCUMENT SHALL BE AT THE USER'S SOLE RISK WITHOUT LIABILITY OR LEGAL EXPOSURE TO VHB.
2. CONTRACTOR SHALL NOT RELY SOLELY ON ELECTRONIC VERSIONS OF PLANS, SPECIFICATIONS, AND DATA FILES THAT ARE OBTAINED FROM THE DESIGNERS, BUT SHALL VERIFY LOCATION OF PROJECT FEATURES IN ACCORDANCE WITH THE PAPER COPIES OF THE PLANS AND SPECIFICATIONS THAT ARE SUPPLIED AS PART OF THE CONTRACT DOCUMENTS.
3. SYMBOLS AND LEGENDS OF PROJECT FEATURES ARE GRAPHIC REPRESENTATIONS AND ARE NOT NECESSARILY SCALED TO THEIR ACTUAL DIMENSIONS OR LOCATIONS ON THE DRAWINGS. THE CONTRACTOR SHALL REFER TO THE DETAIL SHEET DIMENSIONS, MANUFACTURERS' LITERATURE, SHOP DRAWINGS AND FIELD MEASUREMENTS OF SUPPLIED PRODUCTS FOR LAYOUT OF THE PROJECT FEATURES.

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. All rights reserved. No part of this drawing may be reproduced by any means. Any use which may be made of these designs or drawings without the prior written consent of Stantec is prohibited.

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

By	Appd	YYYY.MM.DD	Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
NEEDHAM, MA 02494

Project No.: 15306.00
File Name: N/A
Scale:

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEGEND AND GENERAL NOTES

Revision:
Drawing No.
C-01

Saved Tuesday, March 29, 2022 12:51:53 PM DWENAO Plotted Thursday, May 26, 2022 3:27:33 PM Sean Diamond
ORIGINAL SHEET - ARCH E

Parking Summary Chart

Description	Size Required	Size Provided	Spaces Required	Spaces Provided
STANDARD SPACES	9 x 18.5	9 x 18.5		809[1]
COMPACT SPACES (50% ALLOWED)	8 x 16	8 x 16	-	568[2]
STANDARD ACCESSIBLE SPACES	8 x 18.5	8 x 18.5	20[3]	24[4]
VAN ACCESSIBLE SPACES	8 x 18.5	8 x 18.5	5[3]	7[5]
TOTAL SPACES			1,689	1,408[6]
LOADING BAYS			**	5

1. REQUIRED ACCESSIBLE SPACES BASED ON TOTAL PROVIDED SPACES PER ADA/MAAB REQUIREMENTS.
2. INCLUDES 767 GARAGE/BUILDING SPACES.
3. INCLUDES 568 GARAGE/BUILDING SPACES.
4. INCLUDES 24 GARAGE/BUILDING SPACES.
5. INCLUDES 5 GARAGE/BUILDING SPACES.
6. APPLICANT IS REQUESTING A SPECIAL PERMIT FOR DEVIATION FROM THE REQUIRED NUMBER OF PARKING SPACES.

** ADEQUATE OFF-STREET LOADING FACILITIES SHALL BE PROVIDED.

Parking Requirements:

OFFICE	248,347 SF	x	1 SPACES	/ 300	=	828 SPACES
R&D	248,347 SF	x	1 SPACES	/ 300	=	828 SPACES
RETAIL	6,000 SF	x	1 SPACES	/ 300	=	20 SPACES
RESTAURANT	9 SEATS	x	1 SPACES	/ 3 SEAT	=	3 SPACES
	1 TAKEOUT STATION	x	10 SPACES	/ 1 TAKEOUT STATION	=	10 SPACES
				TOTAL PARKING REQUIRED	=	1,689 SPACES

Zoning Summary Chart

Zoning District(s): Highway Commercial 1

Overlay District(s):

Zoning Regulation Requirements	Required*	Provided
MINIMUM LOT AREA	0.5 Acres	9.3 Acres
FRONTAGE	100 Feet	> 100 Feet
FRONT YARD SETBACK	See Plan	See Plan
SIDE YARD SETBACK	See Plan	See Plan
REAR YARD SETBACK	See Plan	See Plan
MINIMUM LOT WIDTH	100 Feet	> 100 Feet
MAXIMUM FLOOR AREA RATIO	0.70 [1]	1.26
MAXIMUM BUILDING HEIGHT	56 Feet [2,3,4]	42 / 70 Feet
MAXIMUM LOT COVERAGE	65.0 %	48.0 %
MINIMUM OPEN SPACE	25.0 %	27.1 %
INTERIOR PARKING LANDSCAPING PERCENTAGE	10.0 %	> 10%

* Zoning regulation requirements as specified in Zoning By-Law of the Town of Needham dated June, 2020, and amended through August 21, 2021.

1. Floor area ratio of up to 1.35 may be allowed by a Special Permit from the Planning Board per §4.11.1(5).
2. Buildings within 200 feet of Highland Avenue or the extension of the right-of-way line or within 200 feet of Gould Street shall be limited to a height of 35 feet and 2.5 stories as-of-right. The maximum height may be increased to 42 feet and 3 stories by Special Permit from the Planning Board per §4.11.1(1)(a,b).
3. The maximum building height may be increased to 70 feet and 5 stories by Special Permit from the Planning Board, provided the building is not located within 200 feet of Highland Avenue or the extension of the right-of-way line or within 200 feet of Gould Street per §4.11.1(1)(b).
4. The height of a parking garage may not exceed 44 feet. The maximum height may be increased to 55 feet by Special Permit from the Planning Board per §4.11.2(1).

Notes

1. REFER TO LANDSCAPE PLANS FOR DETAILED SITE LAYOUT AND MATERIALS INFORMATION.
2. REFER TO ARCHITECTURAL PLANS FOR PROPOSED GARAGE PARKING SPACES.

0 15 30 60 Feet

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. Reproduction of this drawing without the permission of Stantec is prohibited by law. © Stantec

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	ADJUSTED PLAN CHANGES PER TEC			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

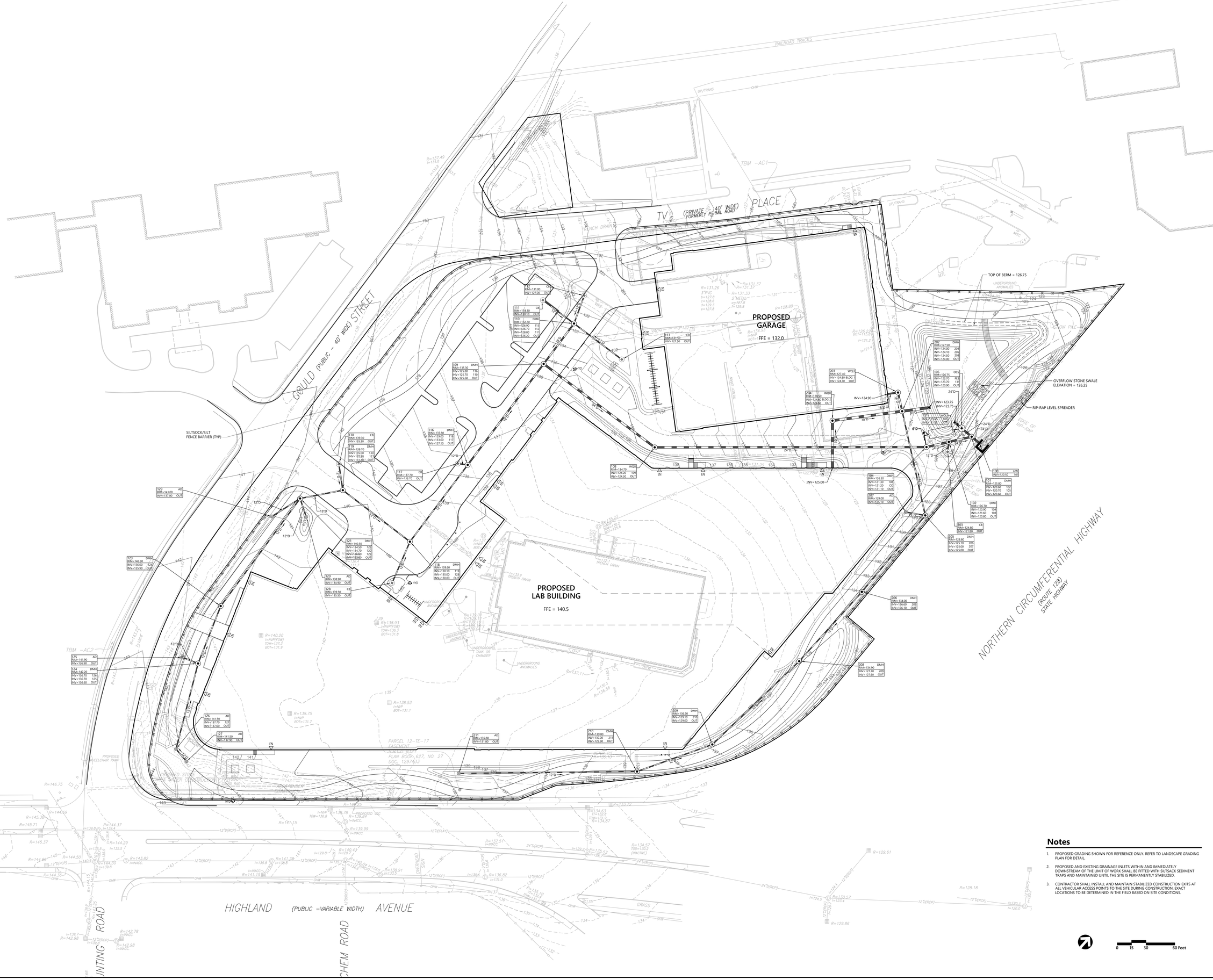
Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
NEEDHAM, MA 02494

Project No.: 15306.00
File Name: N/A
Scale: 1" = 30'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
OVERALL SITE PLAN

Revision:
Drawing No.
C-02



Notes

1. PROPOSED GRADING SHOWN FOR REFERENCE ONLY. REFER TO LANDSCAPE GRADING PLAN FOR DETAIL.
2. PROPOSED AND EXISTING DRAINAGE INLETS WITHIN AND IMMEDIATELY DOWNSTREAM OF THE LIMIT OF WORK SHALL BE FITTED WITH SILTSACK SEDIMENT TRAPS AND MAINTAINED UNTIL THE SITE IS PERMANENTLY STABILIZED.
3. CONTRACTOR SHALL INSTALL AND MAINTAIN STABILIZED CONSTRUCTION EXITS AT ALL VEHICULAR ACCESS POINTS TO THE SITE DURING CONSTRUCTION. EXACT LOCATIONS TO BE DETERMINED IN THE FIELD BASED ON SITE CONDITIONS.

0 15 30 60 Feet

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. Reproduction of this drawing, in whole or in part, is forbidden without the consent of Stantec. Copyright Reserved. The Architectural Work may be constructed only in accordance with the Drawings and Specifications prepared by Stantec.

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	ADDENDUM #1			2022.03.25

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

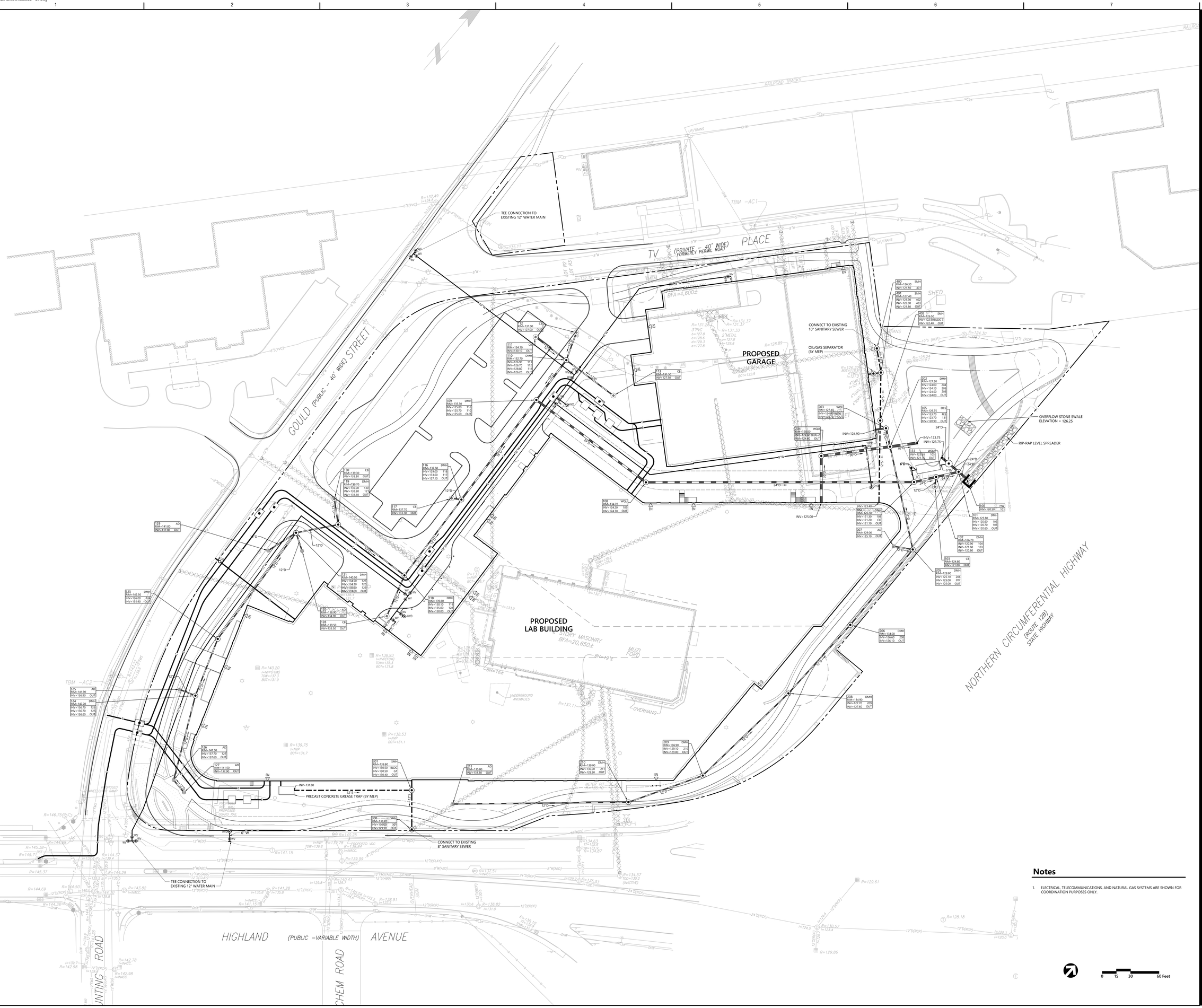
Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave.
NEEDHAM, MA 02494

Project No.: 15306.00
File Name: N/A
Scale: 1" = 30'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
DRAINAGE AND EROSION CONTROL PLAN

Revision:
Drawing No.
C-03



Notes

1. ELECTRICAL, TELECOMMUNICATIONS, AND NATURAL GAS SYSTEMS ARE SHOWN FOR COORDINATION PURPOSES ONLY.

0 15 30 60 Feet

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. Reproduction, publication or use of this drawing in any manner without prior written permission of Stantec is prohibited.

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	ADDENDUM #1 - CONCEPT SET			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

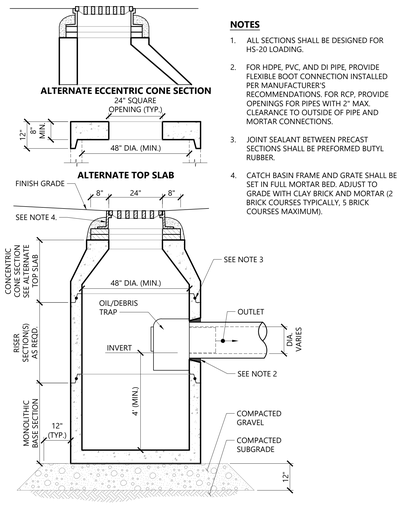
Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
NEEDHAM, MA 02494

Project No.: 15306.00
File Name: N/A
Scale: 1" = 30'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
UTILITY PLAN

Revision:
Drawing No.
C-04



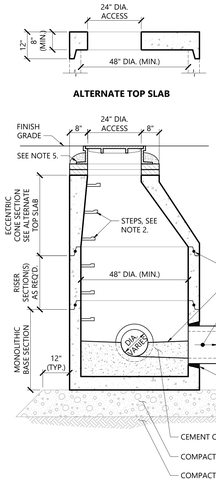
NOTES

1. ALL SECTIONS SHALL BE DESIGNED FOR HS-20 LOADING.
2. FOR HDPE, PVC, AND DI PIPE, PROVIDE FLEXIBLE BOOT CONNECTION INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. FOR RCP, PROVIDE OPENINGS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE AND MORTAR CONNECTIONS.
3. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
4. CATCH BASIN FRAME AND GRATE SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH CLAY BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM).

Catch Basin (CB) With Oil/Debris Trap

3/21

N.T.S. Source: VHB LD_101



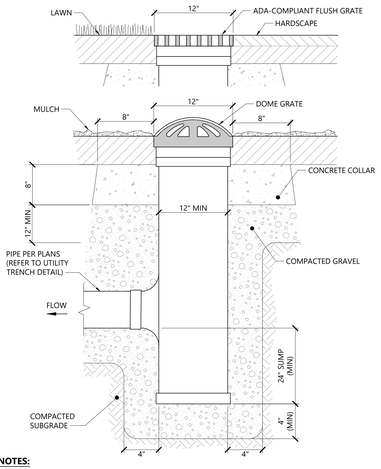
NOTES

1. ALL SECTIONS SHALL BE DESIGNED FOR HS-20 LOADING. DIAMETER OF STRUCTURES SHALL BE COORDINATED WITH PIPE CONFIGURATIONS.
2. COPOLYMER MANHOLE STEPS SHALL BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. FOR HDPE, PVC, AND DI PIPE, PROVIDE FLEXIBLE BOOT CONNECTION INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. FOR RCP, PROVIDE OPENINGS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE AND MORTAR CONNECTIONS.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
5. DRAIN MANHOLE FRAME AND COVER SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH CLAY BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)

Drain Manhole (DMH)

11/19

N.T.S. Source: VHB LD_115



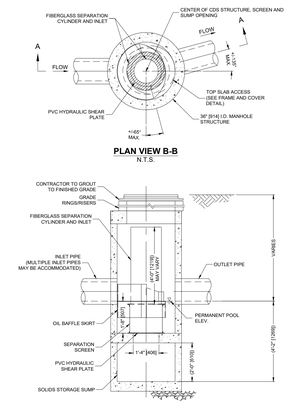
NOTES:

1. AREA DRAINS SHALL BE NYLOPLAST 12" DIAMETER DRAIN BASIN, OR APPROVED EQUAL.
2. GRATES SHALL BE NYLOPLAST 12" PEDESTRIAN MODEL 1299CGP OR 12" DOME GRATE MODEL 1299CGD (OR APPROVED EQUAL).

Area Drain (AD) Type 1

12/19

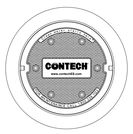
N.T.S. Source: VHB LD_193



WQU-203 (CDS1515-3)

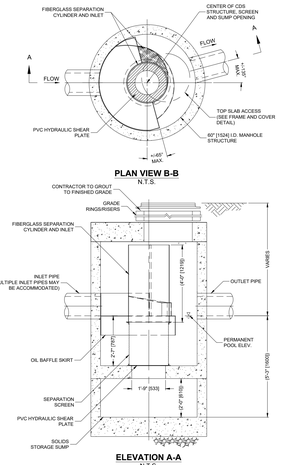
N.T.S. Source: Contech

CDS1515-3-C DESIGN NOTES
CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.
THE STANDARD CDS1515-3-C CONFIGURATION IS SHOWN.



GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE or www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.



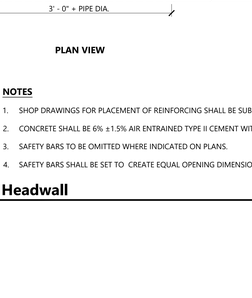
CDS2020-5-C DESIGN NOTES
CDS2020-5-C RATED TREATMENT CAPACITY IS 2.2 CFS, OR PER LOCAL REGULATIONS.
THE STANDARD CDS2020-5-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.
CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE www.ContechES.com
3. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO H520 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

WQU-204 (CD2020-5)

N.T.S. Source: Contech



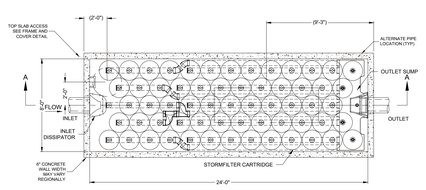
JELLYFISH DESIGN NOTES				
JELLYFISH TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE LENGTH AND THE NUMBER OF CARTRIDGES. THE STANDARD PEAK DIVERSION STYLE WITH PRECAST TOP SLAB IS SHOWN. ALTERNATE OFFLINE VAULT AND/OR SHALLOW ORIENTATIONS ARE AVAILABLE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD				
CARTRIDGE SELECTION				
CARTRIDGE LENGTH	54"	40"	27"	15"
OUTLET INVERT TO STRUCTURE INVERT (A)	5'-8"	5'-4"	4'-3"	3'-3"
FLOW RATE HI-FLO / DRAINDOWN (CFS) (PER CART)	0.178 / 0.089	0.133 / 0.067	0.089 / 0.045	0.049 / 0.025
MAX. TREATMENT (GPS)	1.98	1.47	0.98	0.54
DECK TO INSIDE TOP (MIN) (B)	5.00	4.00	4.00	4.00

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE.
3. JELLYFISH WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS-20 OR PER APPROVING JURISDICTION REQUIREMENTS, WHICHEVER IS MORE STRINGENT, ASSUMING EARTH COVER OF 0' - 10', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 LOAD RATING AND BE CAST WITH THE CONTECH LOGO.
5. STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-857, ASTM C-858, AND AASHTO LOAD FACTOR DESIGN METHOD.
6. OUTLET PIPE INVERT IS EQUAL TO THE CARTRIDGE DECK ELEVATION.
7. THE OUTLET PIPE DIAMETER FOR NEW INSTALLATIONS IS RECOMMENDED TO BE ONE PIPE SIZE LARGER THAN THE INLET PIPE AT EQUAL OR GREATER SLOPE.
8. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

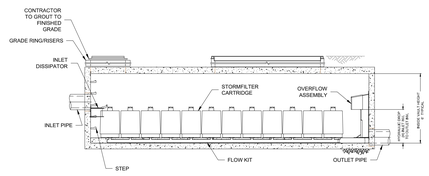
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE.
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT).
D. CARTRIDGE INSTALLATION, BY CONTECH, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE JELLYFISH UNIT IS CLEAN AND FREE OF DEBRIS. CONTACT CONTECH TO COORDINATE CARTRIDGE INSTALLATION WITH SITE STABILIZATION.

WQU-108 (Jellyfish JFPD0806-8-2)

N.T.S. Source: Contech



STORMFILTER DESIGN NOTES									
STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD VAULT STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (81). VAULT STYLE OPTIONS INCLUDE INLET BAY (56), INLET BAY/OUTLET BAY (51), OUTLET BAY (59), INLET BAY/FULL HEIGHT BAFFLE WALL (45), FULL HEIGHT BAFFLE WALL (54). STORMFILTER 8X24 PEAK HYDRAULIC CAPACITY IS 1.8 CFS. IF THE SITE CONDITIONS EXCEED 1.8 CFS AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.									
CARTRIDGE SELECTION									
CARTRIDGE HEIGHT	27"			18"			LOW DROP		
RECOMMENDED HYDRAULIC DROP (H)	3.05'			2.3'			1.8'		
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf
CARTRIDGE FLOW RATE (gpm)	22.5	18.79	11.25	15	12.53	7.5	10	8.35	5
* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY									

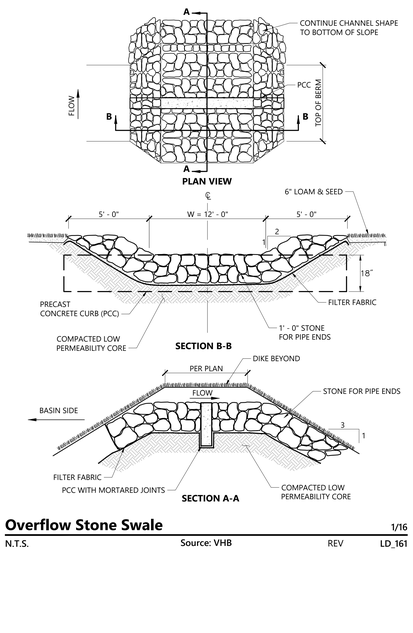


GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO H520 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).
8. STORMFILTER STRUCTURE SHALL BE PRECAST CONFORMING TO ASTM C-857 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER VAULT (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL VAULT SECTIONS AND ASSEMBLE VAULT.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

WQU-131 (StormFilter SF0824 with 57-18" Cartridges)

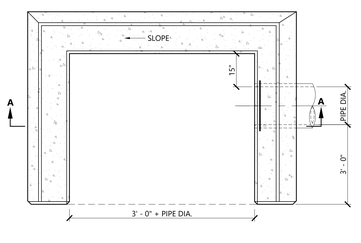
N.T.S. Source: Contech



Overflow Stone Swale

1/16

N.T.S. Source: VHB REV LD_161



NOTES

1. SHOP DRAWINGS FOR PLACEMENT OF REINFORCING SHALL BE SUBMITTED TO THE ENGINEER BY THE CONTRACTOR.
2. CONCRETE SHALL BE 6% ±1.5% AIR ENTRAINED TYPE II CEMENT WITH MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI.
3. SAFETY BARS TO BE OMITTED WHERE INDICATED ON PLANS.
4. SAFETY BARS SHALL BE SET TO CREATE EQUAL OPENING DIMENSIONS.

Directional Headwall

10/20

N.T.S. Source: VHB LD_135

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston, MA 02210
Tel: (617) 234-3100 • www.vhbtec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. Reproduction or use of this drawing without permission of Stantec is prohibited. Copyright reserved. The Architectural Work and the drawings prepared by Stantec are instruments of service for this project, and Stantec retains all common law, statutory and other reserved rights, including copyright.

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Issued/Revision	By	Appd	YYYY.MM.DD
100% DESIGN DEVELOPMENT			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
MEDFIHAM, MA 02494

Project No.: 15306.00
File Name: N/A
Scale:

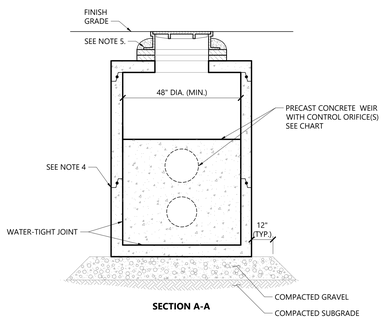
Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
Site Details

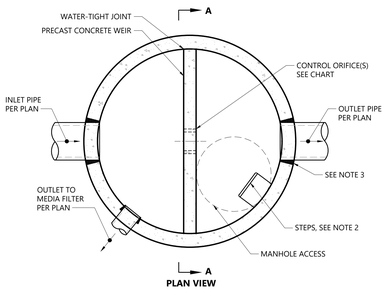
Revision:
Drawing No.
C-05

OUTLET STRUCTURE CHART

DETENTION BASIN	STRUCTURE NUMBER	TOP OF WEIR ELEVATION	DIMENSIONS ORIFICE A	INVERT ORIFICE A	DIMENSIONS ORIFICE B	INVERT ORIFICE B
P1	105	125.0	N/A	N/A	N/A	N/A



SECTION A-A



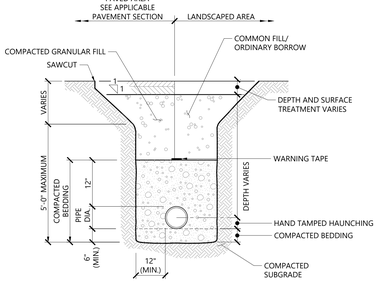
PLAN VIEW

NOTES

1. ALL SECTIONS SHALL BE DESIGNED FOR HS-20 LOADING. DIAMETER OF STRUCTURES SHALL BE COORDINATED WITH PIPE CONFIGURATIONS.
2. COPOLYMER MANHOLE STEPS SHALL BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. FOR HDPE, PVC, AND DI PIPE, PROVIDE FLEXIBLE BOOT CONNECTION INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. FOR RCP, PROVIDE OPENINGS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE AND MORTAR CONNECTIONS.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
5. DRAIN MANHOLE FRAME AND COVER SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH CLAY BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)

Outlet Control Structure with Weir (OCS)

N.T.S. Source: VHB REV LD_162A 3/20

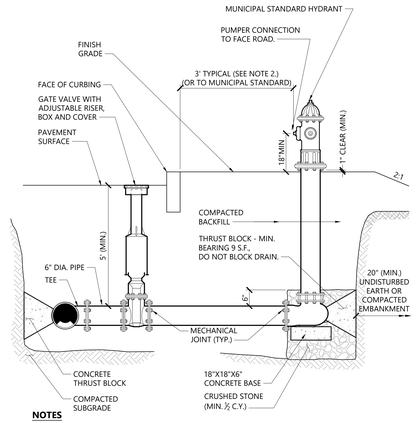


NOTES

1. WHERE UTILITY TRENCHES ARE CONSTRUCTED THROUGH DETENTION BASIN BERMS OR OTHER SUCH SPECIAL SECTIONS, PLACE TRENCH BACKFILL WITH MATERIALS SIMILAR TO THE SPECIAL SECTION REQUIREMENTS.
2. USE METALLIC TRACING/WARNING TAPE OVER ALL PIPES.
3. COMPACTED GRANULAR FILL MAY CONSIST OF GRAVEL, CRUSHED STONE, SAND, OR OTHER MATERIAL AS APPROVED BY ENGINEER.

Utility Trench

N.T.S. Source: VHB LD_300 11/19



NOTES

1. CONCRETE THRUST BLOCKS TO BE USED ONLY WHERE THEY CAN BEAR ON UNDISTURBED EARTH AS SHOWN. USE CLAMPS AND TIE RODS OR OTHER ACCEPTABLE METHOD OF JOINT RESTRAINT WHERE SOIL CONDITIONS PROHIBIT THE USE OF THRUST BLOCKS.
2. HYDRANT IN SIDEWALK AREAS TO BE LOCATED TO PROVIDE MINIMUM CLEAR SIDEWALK PASSAGE WIDTH OF 3 FEET AT HYDRANT.
3. A 36-INCH CLEAR SPACE SHALL BE MAINTAINED AROUND THE CIRCUMFERENCE OF THE HYDRANT UNLESS OTHERWISE APPROVED BY AUTHORITY HAVING JURISDICTION.

Hydrant Construction

N.T.S. Source: VHB LD_250 12/19

RESTRAINED JOINTS

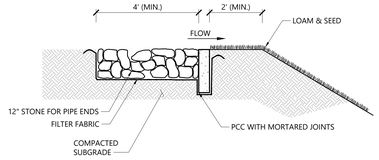
FITTINGS	NUMBER OF JOINTS TO RESTRAIN ON EITHER SIDE OF FITTING (BASED ON 18-FOOT PIPE LENGTH)
90 DEGREE BEND	3
45 DEGREE BEND	2
22-1/2 DEGREE BEND	2
TEE:	
BRANCH	3
RUN	2

NOTES

1. PIPE WITH RESTRAINED JOINTS SHALL BE INSTALLED IN ALL AREAS WHERE THE PIPE IS WITHIN FILL MATERIALS AND ALSO AT LOCATIONS SHOWN ON THE DRAWINGS. RESTRAINED JOINTS SHALL BE INSTALLED AT BENDS, REDUCERS, TEES, VALVES, DEAD ENDS, AND HYDRANTS. THE MINIMUM LENGTH OF PIPE TO BE RESTRAINED ON EITHER SIDE OF THE JOINT SHALL BE AS SHOWN ON THE TABLE ABOVE THE FITTINGS OF THE NEW PIPING SHALL BE FOR RESTRAINED JOINTS, AS MARKED ON THE DRAWINGS.
2. NO RESTRAINING IS REQUIRED IN THE DIRECTION OF THE EXISTING PIPE IF ONLY A SHORT LENGTH OF IT IS EXPOSED IN THE TRENCH FOR MAKING A CONNECTION.
3. RESTRAINED JOINT ASSEMBLIES FOR PUSH-ON PIPE AND FITTINGS SHALL BE MADE IN STRICT ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDED INSTALLATION PROCEDURES.

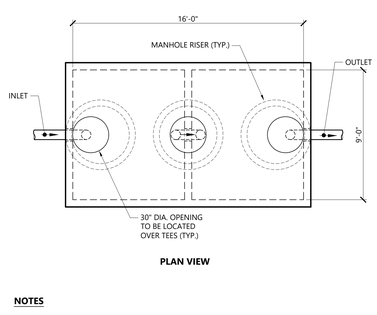
Restrained Joints for Water Pipe

N.T.S. Source: VHB LD_261 3/20

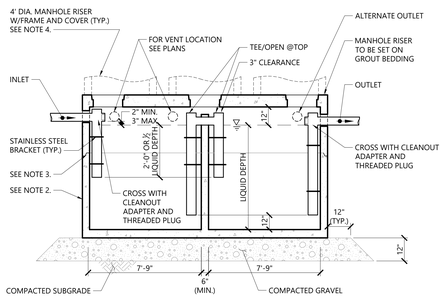


Level Spreader Section

N.T.S. Source: VHB



PLAN VIEW



SECTION

GREASE TRAP

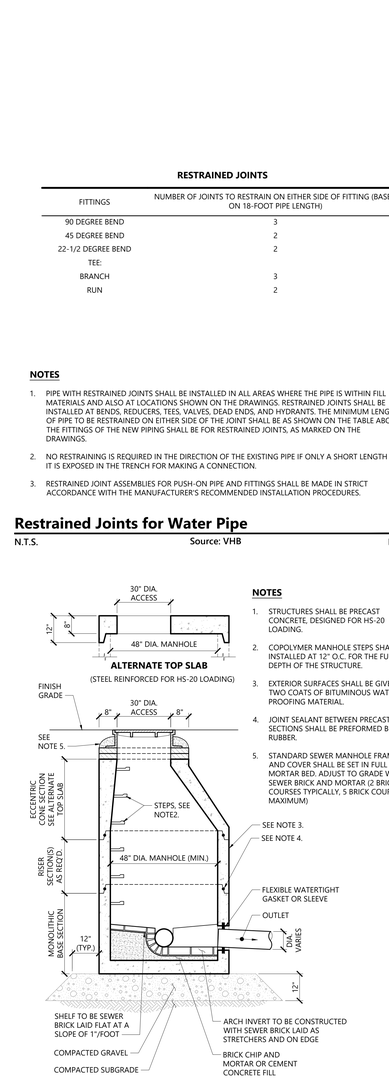
SIZE (GAL.)	LIQUID DEPTH
4,000	4'-0"
5,000	5'-0"
6,000	6'-0"
7,000	7'-0"
8,000	8'-0"
9,000	9'-0"
10,000	10'-0"

NOTES

1. STRUCTURE SHALL BE DESIGNED FOR HS-20 LOADING.
2. EXTERIOR SURFACES SHALL BE GIVEN TWO COATS OF BITUMINOUS WATER-PROOFING MATERIAL.
3. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
4. STANDARD 30-INCH SEWER MANHOLE FRAME AND COVER SHALL BE LOCATED OVER CROSSES AND SET IN FULL MORTAR BED. ADJUST TO GRADE WITH SEWER BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)
5. PIPING SHALL BE SCH 40 PVC WITH SOLVENT WELDED JOINTS. INTERNAL PIPE DIAMETER SHALL BE SAME SIZE AS OUTLET PIPE.
6. FINAL DESIGN OF GREASE TRAP TO BE BY PLUMBING ENGINEER.
7. THE INSTALLATION OF GREASE TRAP, THE PIPING TO AND 10 FEET BEYOND IS BY PLUMBER.

Precast Concrete Grease Trap (GT)

N.T.S. Source: VHB LD_211 12/19



ALTERNATE TOP SLAB

(STEEL REINFORCED FOR HS-20 LOADING)

NOTES

1. STRUCTURES SHALL BE PRECAST CONCRETE, DESIGNED FOR HS-20 LOADING.
2. COPOLYMER MANHOLE STEPS SHALL BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. EXTERIOR SURFACES SHALL BE GIVEN TWO COATS OF BITUMINOUS WATER-PROOFING MATERIAL.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
5. STANDARD SEWER MANHOLE FRAME AND COVER SHALL BE SET IN FULL MORTAR BED. ADJUST TO GRADE WITH SEWER BRICK AND MORTAR (2 BRICK COURSES TYPICALLY, 5 BRICK COURSES MAXIMUM)

Sanitary Sewer Manhole (SMH)

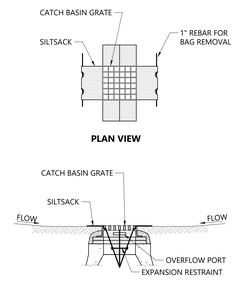
N.T.S. Source: VHB LD_200 1/16

NOTES

1. SILTSOCK SHALL BE FILTREXX SILTSOXX, OR APPROVED EQUAL.
2. SILTSOCKS SHALL OVERLAP A MINIMUM OF 12 INCHES.
3. SILTSOCK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS, AND REPAIR OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED.
4. UPON SITE STABILIZATION, COMPOST MATERIAL SHALL BE DISPERSED ON SITE, AS DETERMINED BY THE ENGINEER.
5. IF NON BIODEGRADABLE NETTING IS USED THE NETTING SHALL BE COLLECTED AND DISPOSED OF OFFSITE.

Siltsock / Silt Fence Barrier

N.T.S. Source: VHB LD_658-A 10/20



PLAN VIEW

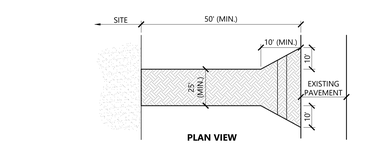
SECTION VIEW

NOTES

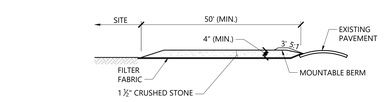
1. INSTALL SILTSACK IN ALL CATCH BASINS WHERE INDICATED ON THE PLAN BEFORE COMMENCING WORK OR IN PAVED AREAS AFTER BINDER COURSE IS PLACED AND HAY BALES HAVE BEEN REMOVED.
2. GRATE TO BE PLACED OVER SILTSACK.
3. SILTSACK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS AND CLEANING OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED. MAINTAIN UNTIL UPSTREAM AREAS HAVE BEEN PERMANENTLY STABILIZED

Siltsack Sediment Trap

N.T.S. Source: VHB LD_674 1/20



PLAN VIEW



CROSS-SECTION

NOTES

1. EXIT WIDTH SHALL BE A TWENTY-FIVE (25) FOOT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
2. THE EXIT SHALL BE MAINTAINED IN A CONDITION WHICH SHALL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS-OF-WAY MUST BE REMOVED IMMEDIATELY. BERM SHALL BE PERMITTED. PERIODIC INSPECTION AND MAINTENANCE SHALL BE PROVIDED AS NEEDED.
3. STABILIZED CONSTRUCTION EXIT SHALL BE REMOVED PRIOR TO FINAL FINISH MATERIALS BEING INSTALLED.

Stabilized Construction Exit

N.T.S. Source: VHB LD_682 1/16

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston, MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any discrepancies shall be reported to the Engineer without delay. All rights reserved. No part of this drawing may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without the permission in writing from the Engineer. © Stantec.

Consultant
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

By	Appd	YYYY.MM.DD	Issued/Revision
		2020.07.27	90% SUBMISSION

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
537 Highland Ave.
NEEDHAM, MA 02494

Project No.: 15306.00
File Name: N/A

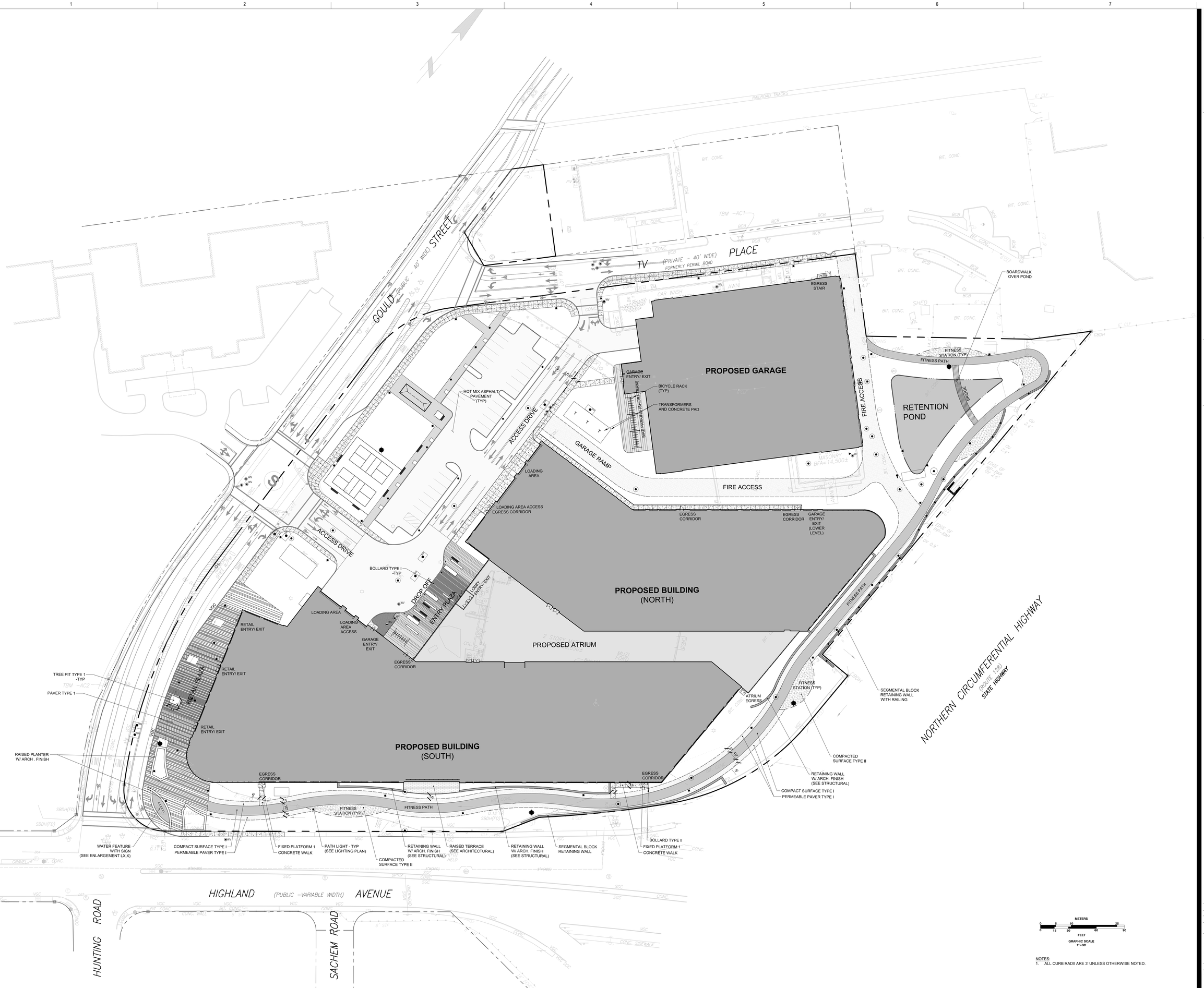
Scale:

Author	Designer	Checker	2020.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
Site Details

Revision:

Drawing No.
C-06



NOTES:
1. ALL CURB RADII ARE 3' UNLESS OTHERWISE NOTED.

METERS 0 5 10 25 / FEET 0 15 30 60 90
GRAPHIC SCALE 1"=30'

ORIGINAL SHEET - ARCH E

Stantec

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. Reproduction of this drawing without the permission of Stantec is prohibited. Stantec 2020

Consultant

pfa Landscape Architects + Planners
Civil Engineers + Wetland Scientists
PAUL FINGER ASSOCIATES
14 Bobrow Street
Second floor
Watertown, Massachusetts 02451-4429
(781) 252-6307 /
info@pfa-net

Permit/Seal

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	35% DESIGN DEVELOPMENT SET			2022.03.31
2	SPECIAL PERMIT PACKAGE			2022.05.27

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.: 218421343
File Name:
Scale: 1" = 30'-0"

Dwn.	Dsgn.	Chkd.	2022.05.27

Title
SITE LAYOUT & MATERIALS PLAN

Revision:
Drawing No.
L-1.0

Client/Project

Bulfinch

HIGHLAND INNOVATION CENTER

557 Highland Ave
Needham, MA 02494

Project No.: 2184/21343
Re Notes:
Scale: 1" = 30'-0"

Dsn.	Dgn.	Chkd.	2022.03.07

Title
SITE GRADING PLAN

Revision:
Drawing No.
L-2.0

Permit/Seal

Issued/Revision	By	#dd	YYYY.MM.DD
SDS DESIGN DEVELOPMENT SET			2022.03.07
SPECIAL PERMIT PACKAGE			2022.03.30

Consultant

PAUL FINGER ASSOCIATES
Landscape Architects • Planners
Civil Engineers • Wetland Scientists
16 Spring Street
Second Floor
Waltham, Massachusetts 02451-4429
(781) 252-0307 f
(781) 647-8900 t
mail@pfa.net

Stantec

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

PLANT MATERIAL LEGEND:

- STREET TREE / SHADE TREE (DECIDUOUS)
- ORNAMENTAL TREE (DECIDUOUS)
- SCREENING TREE (EVERGREEN)
- EVERGREEN SHRUB
- DECIDUOUS SHRUB
- RAIN GARDEN AREAS
- GROUNDCOVER

PLANTING SCHEDULE

KEY	BOTANICAL NAME	COMMON NAME	QTY	SIZE	ROOT	COMMENTS
SHADE TREES						
QP	Quercus palustris	Pin Oak	8	3.5" - 4" CAL	B&B	
AR1	Acer Rubrum ' Armstrong' (wet)	Armstrong Red Maple	ALT	3.5" - 4" CAL	B&B	
TA	Tilia americana	American Linden	2	3.5" - 4" CAL	B&B	
AR2	Quercus rubra	Red Maple	3	3.5" - 4" CAL	B&B	
QA	Quercus alba / bicolor (wet)	Swamp White Oak	ALT	3.5" - 4" CAL	B&B	
GT	Gleditsia Triacanthos Inermis	Thornless Honeylocust	7	3.5" - 4" CAL	B&B	
LS	Liquidambar styraciflua	Sweetgum	3	3.5" - 4" CAL	B&B	
NS	Nyssa sylvatica (wet)	Black Tupelo	ALT	3.5" - 4" CAL	B&B	
AF	Acer Freemanii 'Armstrong'	Columnar Armstrong Red Maple	2	3.5" - 4" CAL	B&B	
	SUB-TOTAL		**25**			
ORNAMENTAL TREE						
AC	Amelanchier canadensis	Canadian Serviceberry	7	7' - 8' HT	B&B	
MS	Malus Spring Snow	Spring Snow Flowering Crabapple	5	3.5" - 4" CAL	B&B	
BP	Betula Populifolia 'Whitespire'	Whitespire Birch	12	7' - 8' HT	B&B	
FS	Fagus sylvatica 'Tortuosa Purpurea'	Dwarf Beech	ALT	10' HT	B&B	
CV	Chionanthus Virginicus	White Fringetree	ALT	10 GAL	CONT.	
CK	Cornus Kousa	Kousa Dogwood	17	10 GAL	CONT.	
HV	Hamamelis Virginiana	American witch-hazel	ALT	10 GAL	CONT.	
MV	Magnolia Virginiana	Sweetbay Magnolia	ALT	10' HT	B&B	
	SUB-TOTAL		**41**			
EVERGREEN/SCREENING TREES						
TO	Thuja Occidentalis 'Smaragd'	Emerald Green Arborvitae	19	8-10' HT	B&B	
TC	Tsuga canadensis	Canadian Hemlock	5	14'-16' HT	B&B	
PG	Picea glauca	White spruce	11	14'-16' HT	B&B	
	SUB-TOTAL		**35**			
EVERGREEN SHRUBS						
PP	Picea pungens 'Glauca Globosa'	Dwarf Colorado Blue Spruce	47	5 GAL	CONT.	
JC	Juniperus conferta	Blue Pacific Shore Juniper	ALT	5 GAL	CONT.	
KL	Kalmia latifolia	Mountain Laurel	41	5 GAL	CONT.	
RC	Rhodendron Cunningham White	White Rhodondenron	72	5 GAL	CONT.	
RO	Rhododendron 'Olga Mezitt'	Olga Mezitt Rhododendron	45	3-5' HT	B&B	
IG	Ilex glabra	Inkberry	232	5 GAL	CONT.	
	SUB-TOTAL		**437**			
DECIDIOUS SHRUBS						
EC	Enkianthus campanulatus	Redvein Enkianthus	22	4'-6' HT	B&B	
CS	Cornus sericea variegata	Variegated dogwood	72	4-6' HT	B&B	
HP	Hydrangea paniculata 'Limelight'	Limelight Hardy Hydrangea	109	6'-8' HT	B&B	
SP	Syringa pubscens patula 'Miss Kim'	Lilac	38	4-6' HT	B&B	
IV1	Ilex verticillata ' Jim Dandy'	Jim Dandy Winterberry	20	3-5' HT	B&B	
IV2	Ilex verticillata 'Red Sprite'	Red Sprite Winterberry	50	3-5' HT	B&B	
RS	Rosa x'Knock out'	Shrub Rose	38	3-5' HT	B&B	
LB	Lindera Benzoin	Spicebush	34	3 GAL	CONT.	
	SUB-TOTAL		**383**			
GROUNDCOVER						
RA	Rhus Aromatica 'Gro-Low'	Gro-Low Fragrant Sumac	20	3 GAL	CONT.	
HM	Hemerocallis X 'Happy Returns'	Happy Returns Daylily	330	1 GAL	CONT.	
CE	Calamagrostis x acutiflora 'Eldorado'	Eldorado Feather Reed Grass	371	2 GAL	CONT.	
JS	Juniperus Chinensis 'Sargentii'	Sargent Juniper	ALT	1 GAL	CONT.	
WF	Waldsteinia Fragaroides	Barren Strawberry	ALT	4" POT		
GA	Gaultheria procumbens	Creeping Wintergreen	1000	2 GAL	CONT.	
VA	Vaccinium angustifolium	Lowbush Blueberry	ALT	1 GAL	CONT.	
SR	Spiraea 'Magic Carpet'Dwarf	Spirea	390	1 GAL	CONT.	
	SUB-TOTAL		**2111**			
RAINGARDEN						
RU	Rudbeckia hirta	Blackeyed Susan	500	2 GAL	CONT.	
AS	Asclepias incarnata	Swamp Milkweed	450	2 GAL	CONT.	
IR	Iris versicolor	Blue Flag Iris	650	1 GAL	PK	
LO	Lobelia siphilitica	Blue Lobelia	250	4.5" POT	PK	
AN	Andropogon virginicus	Broomsedge	150	1 QT	CONT.	
OS	Osmunda cinnamomea	Cinnamon Fern	255	1 GAL	PK	
AT	Aster novae-angliae	New England Aster	200	2 QAL	CONT.	
AA	Asarum canadense	Wild Ginger	350	3.5" POT	PK	
PA	Panicum virgatum	Switchgrass	100	3 GAL	CONT.	
VE	Vernonia noveboracensis	Ironweed	100	1 GAL	PK	
HY	Hypericum fasciculatum	St. John's Wort	50	3 GAL	CONT.	
AQ	Aquilegia canadensis	Red Columbine	50	1 GAL	PK	
EU	Eupatorium fistulosum	Joe-Pye Weed	450	1 GAL	PK	
LI	Listris pycnostachya	Liatris	100	1 GAL	PK	
	SUB-TOTAL		**3655**			
SEED MIX						
	NEW ENGLAND CONSERVATION / WILDLIFE MIX Virginia Wild Rye (Elymus virginicus), Little Bluestem (Schizachyrium scoparium), Big Bluestem (Andropogon gerardii), Red Fescue (Festuca rubra), Switch Grass (Panicum virgatum), Partridge Pea (Chamaecrista fasciculata), Panicledleaf Tick Trefoil (Desmodium paniculatum), Indian Grass (Sorghastrum nutans), Blue Vervain (Verbena hastata), Butterfly Milkweed (Asclepias tuberosa), Black Eyed Susan (Rudbeckia hirta), Common Sneezeweed (Helenium autunale), Heath Aster (Asterpilosus/Symphyotrichum pilosum), Early Goldenrod (Solidago juncea), Upland Bentgrass (Agrostis perennans).		19,000	SF		
	NEW ENGLAND WETLAND MIX Fox Sedge (Carex vulpinoidea), Lurid Sedge (Carex lurida), Blunt Broom Sedge (Carex scoparia), Blue Vervain (Verbena hastata), Fowl Bluegrass (Poa palustris), Hop Sedge (Carex lupulina), Green Bulrush (Scirpus atrovirens), Creeping Spike Rush (Eleocharis palustris), Fringed Sedge (Carex crinita), Soft Rush (Juncus effusus), Spotted Joe Pye Weed (Eupatorium maculatum), Rattlesnake Grass (Glyceria canadensis), Swamp aster (Aster puniceus), Blueflag (Iris versicolor), Swamp Milkweed (Asclepias incarnata), Square stemmed Monkey Flower (Mimulus ringens).		2,000	SF		
	LAWN MICROCLOVER SOD: GOLCONDA TALL FESCUE (29.72%), DORADO TALL FESCUE (19.74%), MONTANA TALL FESCUE (19.88%), DEEPBLUE KENTUCKY BLUEGRASS (7.72%), SPF HYBRID BLUEGRASS (5%), PROSPERITY KENTUCKY BLUEGRASS (4.91%), SINGULAR PERENNIAL RYEGRASS (4.97%), FRONTIER PERENNIAL RYEGRASS (4.92%), MICRO-CLOVER WHITE CLOVER (1.97%), INERT MATTER (1.17%)		20,000	SF		

Stantec

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any discrepancies shall be reported to the Owner without delay. All drawings, plans and specifications are the property of Stantec and shall not be reproduced or used for any purpose other than that authorized by Stantec in writing.

Consultant

pfa
Landscape Architects • Planners
Civil Engineers • Wetland Scientists
PAUL FINGER ASSOCIATES
14 Mount Auburn Street
Second floor
Watertown, Massachusetts 02841-4429
(781) 314-0031
(781) 252-8307 f
info@pfa-net

By	Appd	YYYY.MM.DD	Issued/Revision
		2022.05.18	90% SUBMISSION/PACKAGE
		2022.05.31	SPECIAL PERMIT PACKAGE

Permit/Seal

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
537 Highland Ave
Needham, MA 02494

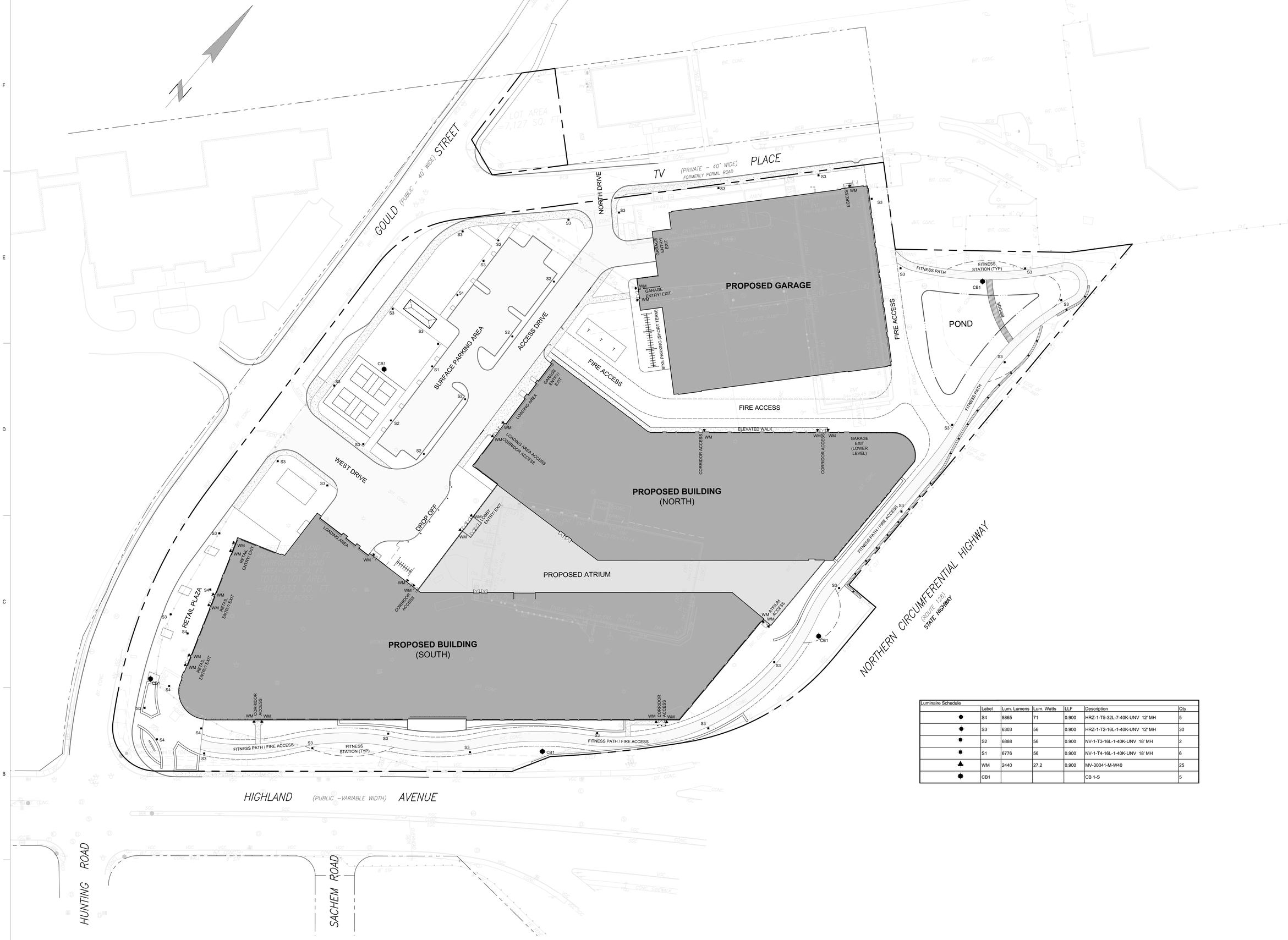
Project No.: 218421343
File Name: SHS-PLANTING PLAN.DWG
Scale: 1" = 30'-0"

Dwn.	Dsgn.	Chkd.	2022.05.27

Title
SITE PLANTING PLAN

Revision:
Drawing No.
L-3.0

ORIGINAL SHEET - ARCH E



Luminaire Schedule						
	Label	Lum. Lumens	Lum. Watts	LLF	Description	Qty
⬢	S4	8865	71	0.900	HRZ-1-T5-32L-7-40K-UNV 12' MH	5
⬢	S3	6303	56	0.900	HRZ-1-T2-16L-1-40K-UNV 12' MH	30
■	S2	6888	56	0.900	NV-1-T3-16L-1-40K-UNV 18' MH	2
■	S1	6776	56	0.900	NV-1-T4-16L-1-40K-UNV 18' MH	6
▲	WM	2440	27.2	0.900	MV-30041-M-W40	25
⬢	CB1				CB 1-S	5

METERS 0 5 10 20
FEET 0 15 30 60 90
GRAPHIC SCALE 1"=30'

ORIGINAL SHEET - ARCH E

Stantec

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any discrepancies shall be reported to the Consultant immediately before proceeding with the work. The Consultant shall not be responsible for any deviations in dimensions or omissions in the drawings that are not reported to the Consultant by the Contractor prior to construction.

Consultant

pfa
Landscape Architects + Planners
Civil Engineers + Wetland Scientists
PAUL FINGER ASSOCIATES
14 Bobrow Drive
Second Floor
Waltham, Massachusetts 02451-4429
(781) 252-4500 / (781) 314-4500
mail@pfa.net

No.	Description	By	Appd	YYYY.MM.DD
1	90% DESIGN DEVELOPMENT			2022.03.30
2	SPECIAL PERMIT PACKAGE			2022.05.27

Issued/Revision

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS PAUL J. FINGER REGISTERED LANDSCAPE ARCHITECT

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
537 Highland Ave
Needham, MA 02494

Project No.: 218421343
File Name: S-LIGHTING PLAN.DWG
Scale: 1" = 30'-0"

Dwn.	Dsgn.	Chkd.	
EFJ	LH	EFJ	2022.03.30
			2022.05.27

Title
SITE LIGHTING PLAN

Revision:
Drawing No.
L-4.0

CB 1-S SIGNATURE HELP POINT®

Code Blue

Product Description

The CB 1-s is our most popular pedestal Help Point. Highlighted by a high intensity area light that provides added visibility, this blue light emergency tower provides direct contact with first responders and is an excellent choice for walkways, parking lots, open campus areas and more.

Standard Features

- Durable quarter-inch steel construction
- Trademarked cylindrical design
- 9 feet tall
- 12.75" diameter
- LED faceplate light

Popular Applications

Open Spaces, Entry Points, Infrastructure

Popular Upgrades

Public Address, Overhead Camera Mount, Dual Faceplates, Mounting Rings, AED Housing

Get It Customized

We know your installation is unique. From paint and graphics to height and mountings, if you dream it, we can make it. Contact Customer Service at customerservice@codeblue.com or 800-205-7186 to learn more.

© 2020 Code Blue Corporation

Technical Features

Specifications
- Height: 9' (274.32 cm)
- Weight: 330 lbs. (149.69 kg)
- Diameter: 12.75" (32.38 cm)
- Material & thickness: 0.25" steel
- Access doors: 15.88" x 9.64" (40.34 x 24.49 cm)

Power
- Standard: 12-24V AC/DC
- Optional: 120, 240, 277V AC
  - Hardwire
  - NightCharger
  - PoE

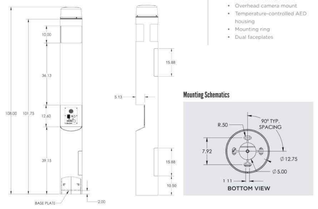
Communication
- Speakerphone Options
  - IP5000: Full duplex, SIP compatible VoIP phone.
  - IA4100: Analog full duplex phone.
- Hardwire
- Cellular
- IP wireless

Lighting
- LED faceplate light
- Beacon/strobe
- Area light

Style
- Standard wet coat colors: Dark Bronze, Gloss White, Gloss Black, Safety Blue, Safety Red, Safety Yellow, Bright Silver
- Graphics text: Assistance, Emergency
- Graphics colors: Black, Blue, White

Compliance
- NS, 2017
- UL 60950-1
- NEMA 3S
- ADA

Options
- Public address speakers
- Overhead camera mount
- Temperature-controlled AED housing
- Mounting ring
- Dual faceplates



Mounting Schematics

Note: Specifications subject to change without notice or obligation on the part of Code Blue Corporation.

© 2020 Code Blue Corporation

CODE BLUE LIGHTS (CB1)

NOT TO SCALE

NV-1

NLS LIGHTING

AREA LIGHTING

FORM AND FUNCTION
- Sleek, low profile housing
- Spec grade performance
- Engineered for optimum thermal management
- Low depreciation rate
- Reduces energy consumption and costs up to 65%
- Exceeds IES foot candle levels utilizing the least number of poles and fixtures per project
- Optical system designed for
  - Parking Lots
  - Auto Dealerships
  - General Area Lighting

CONSTRUCTION
- Die Cast Aluminum
- External cooling fins
- Corrosion resistant external hardware
- One-piece silicone gasket ensures IP-65 seal for electronics compartment
- One-piece Optics Plate™ mounting silicone Micro Optics
- Two-piece silicone Micro Optic system ensures IP-67 level seal around each PCB
- Grade 2 Clear Anodized Optics Plate™ standard

FINISH
- 3-5 mils electrostatic powder coat
- NLS standard high-quality finishes prevent corrosion, protects against and extreme environmental conditions

WARRANTY
Five-year limited warranty for drivers and LEDs.

LISTINGS
- Certified to UL 1598
- UL 8750
- CSA C22.2 No. 250.0
- DesignLights Consortium® (DLC)
- DesignLights Consortium Premium® (DLCP)
- IP65/ IP67 Rated
- 3G Vibration Rated per ANSI C136.31-2010

LED WATTAGE CHART

	16L	32L	48L	64L
350 milliamps	16w	32w	48w	64w
530 milliamps	29w	58w		
700 milliamps	36w	71w	104w	136w
1050 milliamps	58w	108w	156w	205w

Project Name: Type:

Cat#	Light Dist.	# of LEDs	Milliamps	Kelvin	Volts	Mounting	Color	Options
(NV-1)	Type I (T1)	16 (16L)	350 (35)	2700K (27K)●	120V (120)	Direct Pole 3" Arm Single (DPS3)●	Bronze (BRZ)	B-2 Slots (B2) Mandatory for (DPS3)● (MGF) Optic Plate Painted to Match (OPP) Nema 7 Pin Receptacle (PE7) Photocell + Receptacle (PCR) Receptacle + Shorting Cap (PER) (FSP-211)● (FSP-27)● (FSP-40)● (FSP-48)● 27' 40' Heights
	Type II (T2)	32 (32L)	530 (53)	3000K (30K)●	208-240V (HV)	Direct Pole 3" Arm DI80, DM2, DM3, DM4 Quad (DPS3)●	White (WHT)	
	Type III (T3)	48 (48L)	700 (7)	3500K (35K)●		Knuckle Mount (KM)	Smooth White (SWT)	
	Type IV (T4)	64 (64L)	1050 (1)	4000K (40K)●		Wallmount (WM)	Sandstone (SST)	
	Type V (T5)			5000K (50K)●		Trunnion Mount (TM)●	Black (BLK)	
	Narrow 30° Traverse Beam (N3)					Mast Arm (MA)	Graphite Metallic (GPM)	
							Gray (GRY)	
							Custom (C5)	

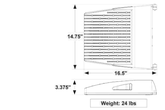
Notes:
- Consult Factory for Lead Time. Consult Factory for 90 CRI Requests.
- Not available with Type V (T5)
- Standard finish is stainless steel. Can be painted to match fixture
- Not available with Narrow 120-277
- H30 not applicable with Nema 2 and Nema 3 Optics

ELECTRICAL
- 120-277 Volts (UNV) or 347-480 Volts (HV)
- 0-10V dimming driver by Philips Advance
- Driver power factor at maximum load is ≥ 95, THD maximum load is 15%
- All internal wiring UL certified for 600 VAC and 105°C
- All drivers, controls, and sensors housed in enclosed IP-65 compartment
- Lumileds Luxeon MX LED's
- CRI 70, 80 or 90
- Color temperatures: 2700K, 3000K, 3500K, 4000K, 5000K
- Surge Protection: 20KVA supplies as standard.

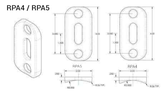
OPTIONS
- **BIRD SPIKES (BS)** - Offers effective and humane deterrent for larger bird species and provides cost-effective long-term solution to nuisance bird infestations and protect your property.
- **MARINE GRADE FINISH (MGF)** - A multi-step process creating protective finishing coat against harsh environments:
  - Chemically washed in a 5 stage cleaning system
  - Pre-baked
  - Powder coated 3-5 mils of Zinc Rich Super Durable Polyester Primer.
  - 1-2 feet inside pole coverage top and bottom.
  - Oven Baked.
  - Finished Powder Coating of Super Durable Polyester Powder Coat 3-5 mil thickness.
- **SHIELDS (HSS, AHS)** - House Side Shield (HSS) is designed for full property line cut off. Automotive House Side Shield (AHS) is a single-sided shield allowing partial cut off on either side or front of luminaire.
- **ROUND POLE ADAPTER (RPA)**- When using round poles, specify Round Pole Adapter (RPA). Specify RPA4 when installing on 3"-4" round poles, and RPA5 when installing on 5"-6" round poles.

CONTROLS
- **FSP-211 (FSP-X)**—Passive infrared (PIR) sensor providing multi-level control based on motion/daylight contribution.
  - All control parameters adjustable via wireless configuration remote storing and transmitting sensor profiles
  - FSP-20 mounting height's 9-20 feet
  - FSP-40 mounting heights 21-40 feet
  - Includes 5 dimming event cycles, 0-10V dimming with motion sensing, reprogrammable in the field.
- **NEMA 7-PIN RECEPTACLE (PE7)**– An ANSI C136.41-2013 receptacle provides electrical and mechanical interconnection between photo control cell and luminaire. Dimming receptacle available two or four dimming contacts supports 0-10 VDC dimming methods or Digital Addressable Lighting Interface (DALI), providing reliable power interconnect.

OPTICS
Silicone optics high photothermal stability and light output provides higher powered LEDs with minimized lumen depreciation LED life. UV and thermal stability with scratch resistance increases exterior application durability.
- IES Types



RPA4 / RPA5



HOUSE SIDE SHIELD

AUTOMOTIVE HOUSE SIDE SHIELD

FSP-211

LUMENS

PART NUMBER	N3	LM/W	T2	LM/W	DLC	T3	LM/W	DLC	T3 HSS	LM/W	T4	LM/W	DLC	T4 AHS	LM/W	T4 HSS	LM/W	T5	LM/W	DLC	W
NV1-16L-35-30K	2013	115	2098	116	P	2126	117	P	1936	107	2126	117	P	1936	107	1936	107	2126	117	P	18
NV1-16L-35-40K	2306	128	2397	132	P	2426	134	P	2210	122	2426	134	P	2210	122	2210	122	2426	134	P	18
NV1-16L-35-50K	2366	131	2297	128	P	1188	66	P	2277	127	1170	65	P	2376	132	18					
NV1-16L-53-30K	3076	117	3192	114	P	1824	58	P	3186	119	1856	57	P	3264	118	28					
NV1-16L-53-40K	3524	106	3436	123	P	1736	62	P	3456	122	1708	61	P	3556	127	28					
NV1-16L-53-50K	3603	129	3511	125	P	1840	66	P	3482	124	1820	65	P	3640	130	28					
NV1-16L-70-30K	4100	114	4115	111	P	2088	58	P	4003	111	2052	57	P	4176	116	36					
NV1-16L-70-40K	4695	116	4652	122	P	2368	59	P	4556	126	2336	57	P	4692	130	36					
NV1-16L-70-50K	4720	130	7168	128	P	7224	129	P	3976	71	7112	127	P	4480	80	3920	70	7280	130	P	56
NV1-32L-70-30K	7952	113	7819	112	S	7810	112	S	4473	63	7739	109	S	8173	72	4452	63	7861	113	S	71
NV1-32L-70-40K	8236	118	8017	127	P	8449	119	P	4767	67	8307	117	P	8296	76	4686	66	8520	120	P	71
NV1-32L-70-50K	9184	131	8971	126	P	8971	126	P	5096	72	8897	125	P	8960	80	5040	70	9100	128	P	71
NV1-32L-2-70K	11453	113	11460	115	S	12084	114	S	6676	66	11630	112	S	7422	73	6972	62	13190	126	S	106
NV1-32L-1-40K	12296	116	12552	122	P	13038	123	P	7102	67	12825	121	P	8056	76	6995	66	13144	124	P	106
NV1-32L-1-50K	12720	120	13068	126	P	13674	129	P	7526	71	13462	127	P	8480	80	7429	70	13780	130	P	106
NV1-48L-7-30K	11648	113	11440	113	S	11440	113	S	6553	63	11336	109	S	7468	72	6448	62	11544	111	S	104
NV1-48L-7-40K	12064	116	12289	121	P	12376	119	P	6998	67	12198	117	P	7904	76	6864	66	13480	130	P	104
NV1-48L-7-50K	12481	120	13520	130	P	13000	125	P	7394	71	12792	123	P	8320	80	7280	70	13104	126	P	104
NV1-48L-1-30K	17413	112	17160	110	S	17784	114	S	9838	63	17472	112	S	11222	72	9672	62	17940	115	S	156
NV1-48L-1-40K	18096	116	19032	122	P	19188	123	P	10452	67	18876	121	P	11856	76	10296	66	19344	124	P	156
NV1-48L-1-50K	18720	120	19968	128	P	20124	129	P	11076	71	19812	127	P	12480	80	10920	70	20280	130	P	156
NV1-64L-7-30K	15232	112	14950	110	S	14960	110	S	8568	63	14824	109	S	9792	72	8432	62	15096	111	S	136
NV1-64L-7-40K	15776	116	15272	127	P	16184	119	P	9116	67	15912	117	P	10336	76	8976	66	16320	120	P	136
NV1-64L-7-50K	16320	120	17680	130	P	17000	125	P	9656	71	16728	123	P	10880	80	9520	70	17136	126	P	136
NV1-64L-1-30K	22780	112	22880	112	S	23712	116	S	12876	63	22880	112	S	14560	72	12720	62	23920	117	S	205
NV1-64L-1-40K	23680	116	25432	124	P	25536	125	P	14728	72	24336	119	P	15392	76	13552	66	25432	124	P	205
NV1-64L-1-50K	24560	120	26520	130	P	26440	129	P	14600	71	26003	127	P	16400	80	14560	70	26650	130	P	205

*DLC S= Standard P= Premium

BUG RATINGS

PART NUMBER	T2	T3	T3 HSS	T4	T4 HSS	T5
NV1-16L-35-30K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G2
NV1-16L-35-40K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G2
NV1-16L-35-50K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G2
NV1-16L-53-30K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G1
NV1-16L-53-40K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G1
NV1-16L-53-50K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G1
NV1-16L-7-30K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G1
NV1-16L-7-40K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G1
NV1-16L-7-50K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B2-U0-G1
NV1-32L-7-30K	B1-U0-G1	B1-U0-G1	B0-U0-G1	B1-U0-G1	B0-U0-G1	B3-U0-G2
NV1-32L-7-40K	B1-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B3-U0-G2
NV1-32L-7-50K	B1-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B3-U0-G2
NV1-32L-1-30K	B1-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B3-U0-G2
NV1-32L-1-40K	B1-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B4-U0-G2
NV1-32L-1-50K	B1-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B4-U0-G2
NV1-48L-7-30K	B2-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B4-U0-G2
NV1-48L-7-40K	B2-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B4-U0-G2
NV1-48L-7-50K	B2-U0-G2	B2-U0-G2	B0-U0-G2	B1-U0-G2	B0-U0-G2	B4-U0-G2
NV1-48L-1-30K	B3-U0-G3	B3-U0-G3	B1-U0-G2	B1-U0-G2	B1-U0-G2	B5-U0-G3
NV1-48L-1-40K	B3-U0-G3	B3-U0-G3	B1-U0-G2	B1-U0-G2	B1-U0-G2	B5-U0-G3
NV1-48L-1-50K	B3-U0-G3	B3-U0-G3	B1-U0-G2	B1-U0-G2	B1-U0-G2	B5-U0-G3
NV1-64L-7-30K	B2-U0-G3	B3-U0-G3	B1-U0-G3	B1-U0-G3	B1-U0-G2	B4-U0-G2
NV1-64L-7-40K	B3-U0-G3	B3-U0-G3	B1-U0-G3	B1-U0-G3	B1-U0-G2	B5-U0-G3
NV1-64L-7-50K	B3-U0-G3	B3-U0-G3	B1-U0-G3	B1-U0-G3	B1-U0-G2	B5-U0-G3
NV1-64L-1-30K	B3-U0-G3	B3-U0-G3	B1-U0-G3	B1-U0-G3	B1-U0-G3	B5-U0-G3
NV1-64L-1-40K	B3-U0-G3	B3-U0-G3	B1-U0-G3	B1-U0-G3	B1-U0-G3	B5-U0-G3
NV1-64L-1-50K	B3-U0-G3	B3-U0-G3	B1-U0-G3	B1-U0-G3	B1-U0-G3	B5-U0-G3

NLS LIGHTING
701 Kingshill Place, Carson, CA 90746
Call Us Today (310) 341-2037
nlslighting.com

PARKING AREA LIGHTS (S1- [redacted] & S2- [redacted] : MOUNTING HEIGHT 18' - POLE MOUNTED)

NOT TO SCALE

UMV-30011

Marvik 2 Surface Downlight

LIGMAN LIGHTING USA

Construction

Aluminum
Less than 0.1% copper content - Marine Grade 6061 extruded & LM6 Aluminum High Pressure die casting provides excellent thermal performance, clean detailed product lines and excellent heat dissipation.

Pre-paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive- Silicon Gasket
Custom designed, compression molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
Engineered management for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman Lighting USA engineers, keeps the LED junction and other critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 70% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

RUS Rating
RU -UV- HD

Finishing
All our products go through an extensive finishing process that includes finishing to improve paint adherence.

Paint
UV Stabilized 4 Mill thick powder coat paint and baked at 200 Deg. C. This process ensure that Ligman products can withstand harsh environments. Better for use in natural areas.

Inspired by Nature Finishes
Ligman Lighting USA's Woodgrain finishing is a unique system of decorative powder coating. Our metal decorative system can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, stone and granite grains finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coating film, so the finish cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder, this powder coating is then cured in an oven at 200°C for 10 minutes to form a corrosion and acts as the relief base coat for the finalized wood decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a period of 10 minutes at 200°C, during which the film softens and melts over. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a wood timber look as aluminum remains.

Wood grain coating can create beautiful wood looking products that are UV stable, will not crack, peel, corrode, rust or oxidize currently in use. Wood grains can be made with different colors, designs etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty, which ensures that the finish maintains excellent standard of performance excellence and design innovation.

Added Benefits:
• Resistance to salt-acid room, accelerated aging
• Boiling water, lime and condensed water resistant
• Resistant to UV, Xenon, Chemical, Anti Scratch
• Super durable (UV resistant)
• TIGE free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound that prevents the screws from corroding and seizing due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and maximum output of light.
LED CRI > 80

Lumen - Maintenance Life
L80/ B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Cylindrical, single or double-sided wall family. Compact and decorative appearance belies powerful outputs and technical optics for perfect task illumination

A stunning new waterproof & dust proof wall cylinder range, designed with no visible fasteners, a one-piece body and integrated driver housing.
This smart mechanical modern designed luminaire with cylindrical body provides a stylish solution to wall mounted cylinders.

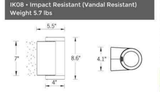
This innovative design houses a variety of COB wattages to suit designer's specific requirements as well as a selcion of field interchangeable reflector optics, that include narrow, medium, wide and very wide distributions. This series is available in 3 different diameters, namely 3", 4" & 6" to suit lighting design requirements.

These luminaires are suitable for various facade lighting requirements along with accent lighting, building columns and architectural highlighting etc. The Marvik 1 protrudes 4" from the wall, making this product suitable for ADA applications.

This luminaire range can be provided with a bayonet lock baffle to reduce glare, as well as a frosted lens option. The SCE surface conduit entry box option can be provided as an option for an attractive solution to surface conduit entry.

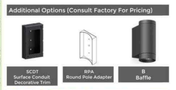
Ligman can also provide custom made boxes to fit on a round surface like a column, pillar or pole.

20w COB 1802 Lumens
IP65 - Suitable For Wet Locations
IK08 - Impact Resistant (Vandal Resistant)
Weight 5.7 lbs



Mounting Detail

Additional Options (Consult Factory For Pricing)



Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements of LED technology data and components may change without notice.

WALL MOUNTED LIGHTS (WM-Downlight Only)

NOT TO SCALE

HORIZON PT

NLS LIGHTING

ARCHITECTURAL LIGHTING

Horizon Post Top luminaire is a blend of beautiful luminaire design which is a compliment to commerical or recreational pathways. It is named the Horizon because the luminaire is intended to be a vehicle of which the horizon can be viewed through the inside and around the luminaire without obstruction.

This Dark Sky Friendly Full Cutoff luminaire utilizes silicone Micro Optics to distribute light uniformly as its LEDs are recessed and hidden. Its performance exceeds IES minimum foot candle levels at lower wattage and extends maintenance cycles throughout its lifetime. Horizon MA is available in (warm) 3000, (neutral) 4000 and (cool) 5000 Kelvin temperatures and a range of 18 to 205 watts.

Built to conform to the strictest Made in America standards. Designed, tooled, fabricated and assembled in the USA.

MICRO OPTIC SYSTEM

Our new cell-inclosed, micro optic silicone modules produce high clarity and outstanding performance.

LED WATTAGE CHART

	16L	32L	48L	64L
350 millamps	16w	32w	48w	64w
530 millamps	29w	58w		
700 millamps	36w	71w	104w	136w
1050 millamps	58w	108w	156w	205w

Project Name: Type:

Cat #	Light Dist.	No. of LEDs	Milliamps	Kelvin	Volts	Mounting	Color	Options
Horizon 1 (HRZ-1)	Type 2 (T2)	16 (16L)	350 (35) *Fifty-three	3000 (30K)	120-277 (UNIV)	Post Top Over 27.00 (PT2)	Bronze (BRZ)	Dome Top (DT)
	Type 3 (T3)	32 (32L)	530 (53)	4000 (40K)	347-480 (HV)	Post Top Over 27.00 (PT3) Round	White (WHT)	Marine Grade Finish (MGF)
	Type 4 (T4)	48 (48L)	700 (7)	5000 (50K)		Post Top Over 3 1/2" OD (PT312)	Silver (SVR)	House Side Shield (HSS)
	Type 5 (T5)	64 (64L)	1050 (1)				Haynes Green (HGN)	Nema 7-Pin Receptacle (PE7)
							Black (BLK)	Receptacle + Short Cap (PER)
							Graphite (GPM)	Photocell (PC) *Universal Voltage 120-277
							Gray (GRY)	Surge Protector (10K)
							Custom (C5)	FSP-211 with Motion Sensor (Universal Voltage) (FSP-9) *For 9' + below (FSP-20) *For 9' to 20' (FSP-40) *For 21' to 40'

NLS LIGHTING
701 Kingshill Place, Carson, CA 90746
Call Us Today (310) 341-2037
nlslighting.com

PATHWAY LIGHTS (S3 - [redacted] & S4 - [redacted] : MOUNTING HEIGHT 12'-POST TOP MOUNTED)

NOT TO SCALE

PRODUCT SPECIFICATIONS

Housing: Low Profile Cast, Spun Aluminum Housing + Frame
LED: Lumileds Luxeon MX CRI 70
Optics: Micro Optics; T2, T3, T4 and T5
Watts: 18-205
L70 Depreciation: 483,000 Hours (@77°F/ 25°C)
L90: 70,000
Listings: Conforms to UL 1598 Standards

Driver: 0-10V Dimming driver as standard by Philips Advance THD @ Max Load < 15%
Power Factor @ Max Load < 0.95
Kelvin: 3000, 4000, or 5000
Finish: 3-5 mils Powder Coat
Warranty: Standard Warranty is 5 years for Driver and LEDs

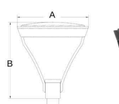
PRODUCT DIMENSIONS

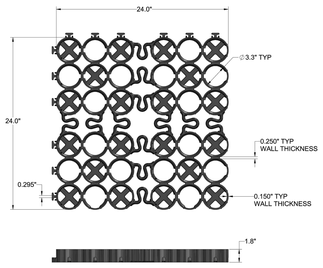
LUMEN DATA CHART

PART NUMBER	T2 LUMENS	T2 LM/W	T3 LUMENS	T3 LM/W	T3-HSS LUMENS	T3-HSS LM/W	T4 LUMENS	T4 LM/W	T4-HSS LUMENS	T4-HSS LM/W	T5 LUMENS	T5 LM/W	Watts
HRZ-1-16L-35-30K	2142	119	2088	116	1044	58	2070	115	1026	57	2160	120	18
HRZ-1-16L-35-40K	2306	128	2241	125	1116	62	2221	124	1098	61	2322	129	18
HRZ-1-16L-35-50K	2356	131	2297	128	1188	66	2277	127	1170	65	2376	132	18
HRZ-1-16L-53-30K	3076	117	3192	114	1824	58	3186	119	1856	57	3264	118	28
HRZ-1-16L-53-40K	3524	106	3436	123	1736	62	3456	122	1708	61	3556	127	28
HRZ-1-16L-53-50K	3603	129	3511	125	1840	66	3482	124	1820	65	3640	130	28
HRZ-1-16L-7-30K	4100	114	4115	111	2088	58	4003	111	2052	57	4176	116	36
HRZ-1-16L-7-40K	4695	116	4652	122	2368	59	4556	126	2336	57	4692	130	36
HRZ-1-16L-7-50K	4720	130	7168	128	7224	129	3976	71	7112	127	4480	80	3920	70	7280	130	P	56
HRZ-1-32L-7-30K	7952	113	7819	112	7810	112	4473	63	7739	109	8173	72	4452	63	7861	113	S	71
HRZ-1-32L-7-40K	8236	118	8017	127	8449	119	4767	67	8307	117	8296	76	4686	66	8520	120	P	71
HRZ-1-32L-7-50K	9184	131	8971	126	8971	126	5096	72	8897	125	8960	80	5040	70	9100	128	P	71
HRZ-1-32L-2-70K	11453	113	11460	115	12084	114	6676	66	11630	112	7422	73	6972	62	13190	126	S	106
HRZ-1-32L-1-40K	12296	116	12552	122	13038	123	7102	67	12825	121	8056	76	6995	66	13144	124	P	106
HRZ-1-32L-1-50K	12720	120	13068	126	13674	129	7526	71	13462	127	8480	80	7429	70	13780	130	P	106
HRZ-1-48L-7-30K	11648	113	11440	113	11440	113	6553	63	11336	109	7468	72	6448	62	11544	111	S	104
HRZ-1-48L-7-40K	12064	116	12289	121	12376	119	6998	67	12198	117	7904	76	6864	66	13480	130	P	104
HRZ-1-48L-7-50K	12481	120	13520	130	13000	125	7394	71	12792	123	8320	80	7280	70	13104	126	P	104
HRZ-1-48L-1-30K	17413	112	17160	110	17784	114	9838	63	17472	112	11222	72	9672	62	17940	115	S	156
HRZ-1-48L-1-40K	18096	116	19032	122	19188	123	10452	67	18876	121	11856	76	10296	66	19344	124	P	156
HRZ-1-48L-1-50K	18720	120	19968	128	20124	129	11076	71	19812	127	12480	80	10920	70	20280	130	P	156
HRZ-1-64L-7-30K	15232	112	14950	110	14960	110	8568	63	14824	109	9792	72	8432	62	15096	111	S	136
HRZ-1-64L-7-40K	15776	116	15272	127	16184	119	9116	67	15912	117	10336	76	8976	66	16320	120	P	136
HRZ-1-64L-7-50K	16320	120	17680	130	17000	125	9656	71	16728	123	10880	80	9520	70	17136	126	P	136
HRZ-1-64L-1-30K	22780	112	22880	112	23712	116	12876	63	22880	112	14560	72	12720	62	23920	117	S	205
HRZ-1-64L-1-40K	23680	116	25432	124	25536	125	14728	72	24336	119	15392	76	13552	66	25432	124	P	205
HRZ-1-64L-1-50K	24560	120	26520	130	26440	129	14600	71	26003	127	16400	80	14560	70	26650	130	P	205

DIMENSION	HRZ-1
A	24.00 in
B	25.75 in

EPA	STD TOP	DOME TOP
HRZ-1	1.15	1.40

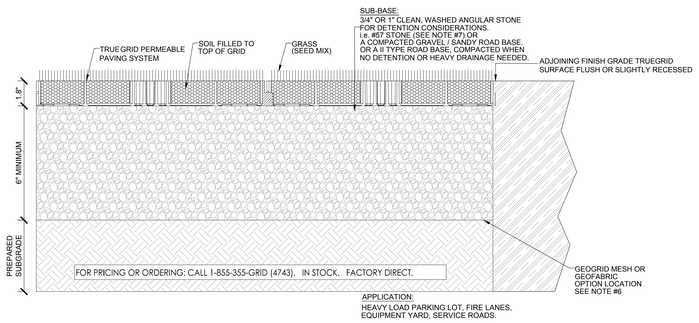

A
B



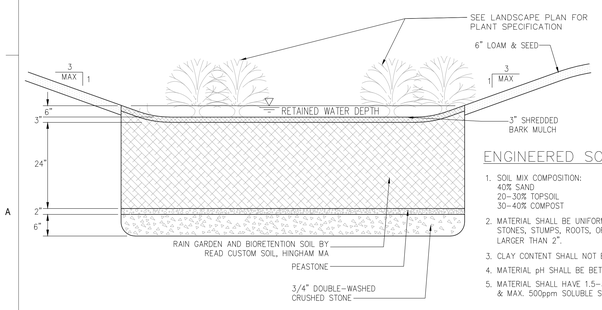
NOTES:

1. SUB-BASE DEPTH AND PREPARATION IS DEPENDENT ON SITE CONDITIONS PLUS LOADING REQUIREMENTS.
2. TRUEGRID PRO PLUS PRODUCTS ARE SUFFICIENTLY RATED FOR H-20 /HS-20 LOADING AND GREATER.
3. TYPICAL SEEDING OR HYDROSEEDING METHODS FOR GRASS GROWTH ARE ACCEPTABLE WITH TRUEGRID.
4. SOD CAN BE LAID ON SOIL FILLED GRID FOR IMMEDIATE GRASS (TYPICAL FOR FIRE LANES)
5. FOR HIGHER TRAFFIC SOD INSTALLATIONS, RECESS SOIL LEVEL WITHIN TRUEGRID AND PRESS IN SOD SO THAT TOP OF GRID IS AT SOIL LEVEL.
6. GEOGRID MESH OR GEOFABRIC MAY BE REQUIRED BETWEEN SUBGRADE & SUBBASE FOR CERTAIN SOILS AND SITE SPECIFIC REQUIREMENTS.
7. FILTER FABRIC MAY BE REQUIRED BETWEEN TRUEGRID AND SUB-BASE MATERIAL IF HIGH VOID RATIO IN SUB-BASE MATERIAL.
8. NO STAKING NECESSARY WITH TRUEGRID PRO PLUS WHEN SLOPE IS BELOW 10 DEGREES. ASSESS PROJECT, AS NEEDED.
9. FINAL ENGINEERED CROSS SECTION AGGREGATES AND DEPTH SHOULD ALLOW FOR EXPECTED INFILTRATION RATES,STORAGE CAPACITIES, OUTLET FLOW RATES, AND OTHER SITE SPECIFIC CONDITIONS AND LOAD REQUIREMENTS.
10. THIS CROSS SECTION IS FOR INFORMATION ONLY.

REINFORCED LAWN - PLAN VIEW



REINFORCED LAWN
NOT TO SCALE



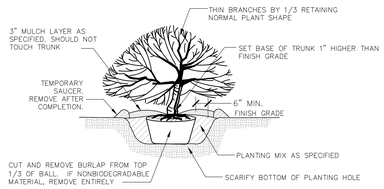
ENGINEERED SOIL MIX SPECIFICATIONS

1. SOIL MIX COMPOSITION:
   40% SAND
   20-30% TOPSOIL
   30-40% COMPOST
2. MATERIAL SHALL BE UNIFORM, FREE FROM STONES, STUMPS, ROOTS, OR OBJECTS LARGER THAN 2".
3. CLAY CONTENT SHALL NOT EXCEED 5%
4. MATERIAL pH SHALL BE BETWEEN 5.5-6.5.
5. MATERIAL SHALL HAVE 1.5-3% ORGANIC CONTENT & MAX. 500ppm SOLUBLE SALT.
6. SAND COMPONENT SHALL MEET ASTM D 422 AND THE FOLLOWING GRADATION:

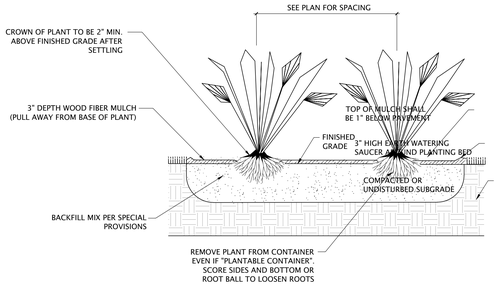
SIEVE SIZE	% PASSING
2-INCH	100
3/4 INCH	70-100
1/4 INCH	50-80
No. 4	15-40
No. 200	0-3

7. TOPSOIL SHALL BE A SANDY LOAM, LOAMY SAND, OR LOAM.
8. COMPOST SHALL BE PROCESSED FROM YARD WASTE IN ACCORDANCE WITH DEP GUIDELINES AND SHALL NOT CONTAIN BIO-SOLIDS.

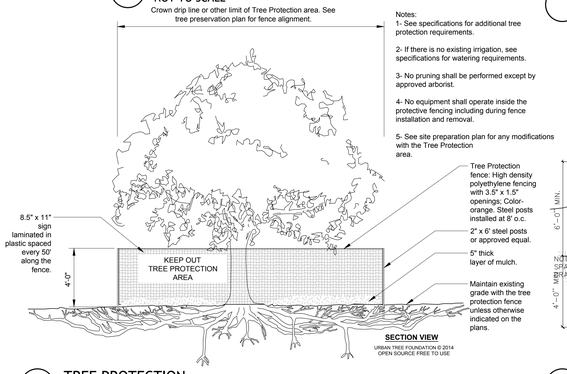
RAIN GARDEN
NOT TO SCALE



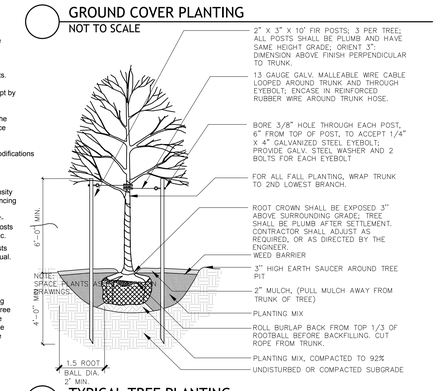
SHRUB PLANTING
NOT TO SCALE



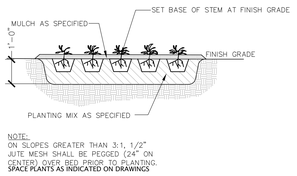
PERENNIAL PLANTING
NOT TO SCALE



TREE PROTECTION
NOT TO SCALE



GROUND COVER PLANTING
NOT TO SCALE



TYPICAL SEEDED NO-MOW LAWN
NOT TO SCALE

TYPICAL TREE PLANTING
NOT TO SCALE

Stantec

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any discrepancies shall be reported to the Engineer without delay. The Engineer's written permission shall be obtained before using any drawing or design for construction purposes. All rights reserved. Unauthorized use or reproduction is prohibited. © Stantec

Consultant

pfa
Landscape Architects • Planners
Civil Engineers • Wetland Scientists
PAUL FINGER ASSOCIATES
14 Mount Auburn Street
Second Floor
Watertown, Massachusetts 02841-4429
(781) 314-0031
(781) 252-8307 f
info@pfa-net

Issued/Revision	By	Appd	YYYY.MM.DD
90% DESIGN DEVELOPMENT SET			2022.03.31
SPECIAL PERMIT PACKAGE			2022.05.57

Permit/Seal

Client/Project

Bulfinch
HIGHLAND INNOVATION CENTER
537 Highland Ave
Needham, MA 02494

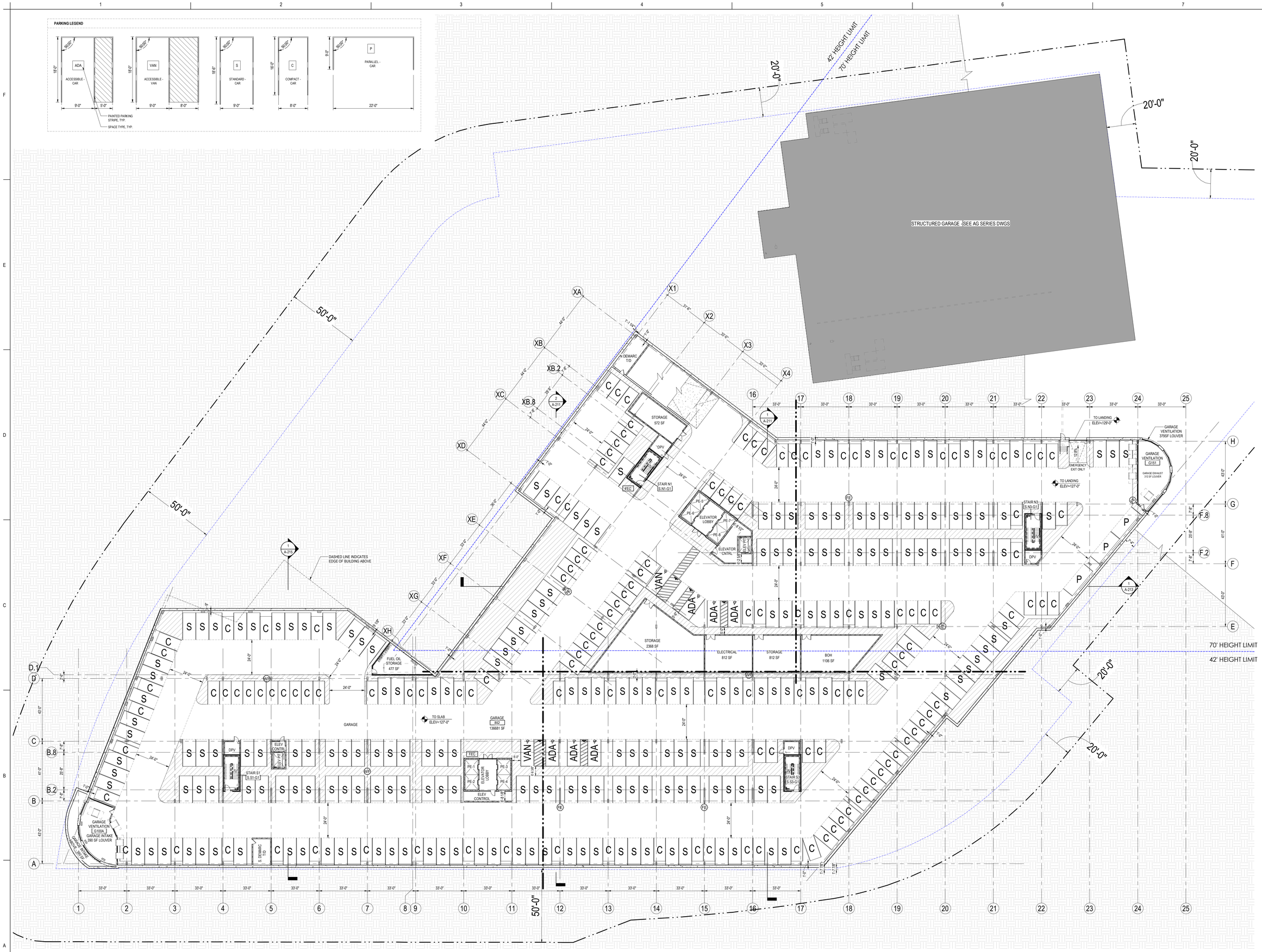
Project No.: 218421343
File Name: SP+5.0-SITE DETAILS.dwg
Scale: As Specified

Dsn.	Dsgn.	Chkd.	2022.05.57

Title
SITE
DETAILS #2

Revision:
Drawing No.
L-5.1

ORIGINAL SHEET - ARCH E



1 GARAGE LEVEL G1 PLAN
A-100G1 — 1" = 20'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

Consultant

No.	Description/Submission	By	Appd	YYYY.MM.DD
1	SPECIAL PERMIT PACKAGE			2022.05.31

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

KEY PLAN

PARKING COUNT	
Type Comments	Count

LEVEL G1	
ACCESSIBLE	6
ACCESSIBLE VAN	2
COMPACT	137
PARALLEL	3
STANDARD	207
LEVEL G1 355	355
GRAND TOTAL 355	355

PARKING SYMBOLS

ADA =	ACCESSIBLE
ADA-EV =	ACCESSIBLE ELECTRIC VEHICLE
VAN =	ACCESSIBLE VAN
B =	BOLLARD - EMBEDDED IN SLAB
EV =	ELECTRIC VEHICLE
P=	PARALLEL
S =	STANDARD
WF =	WHEELED FIRE EXTINGUISHER

STALL STRIPING

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name:N/A
Scale: As indicated

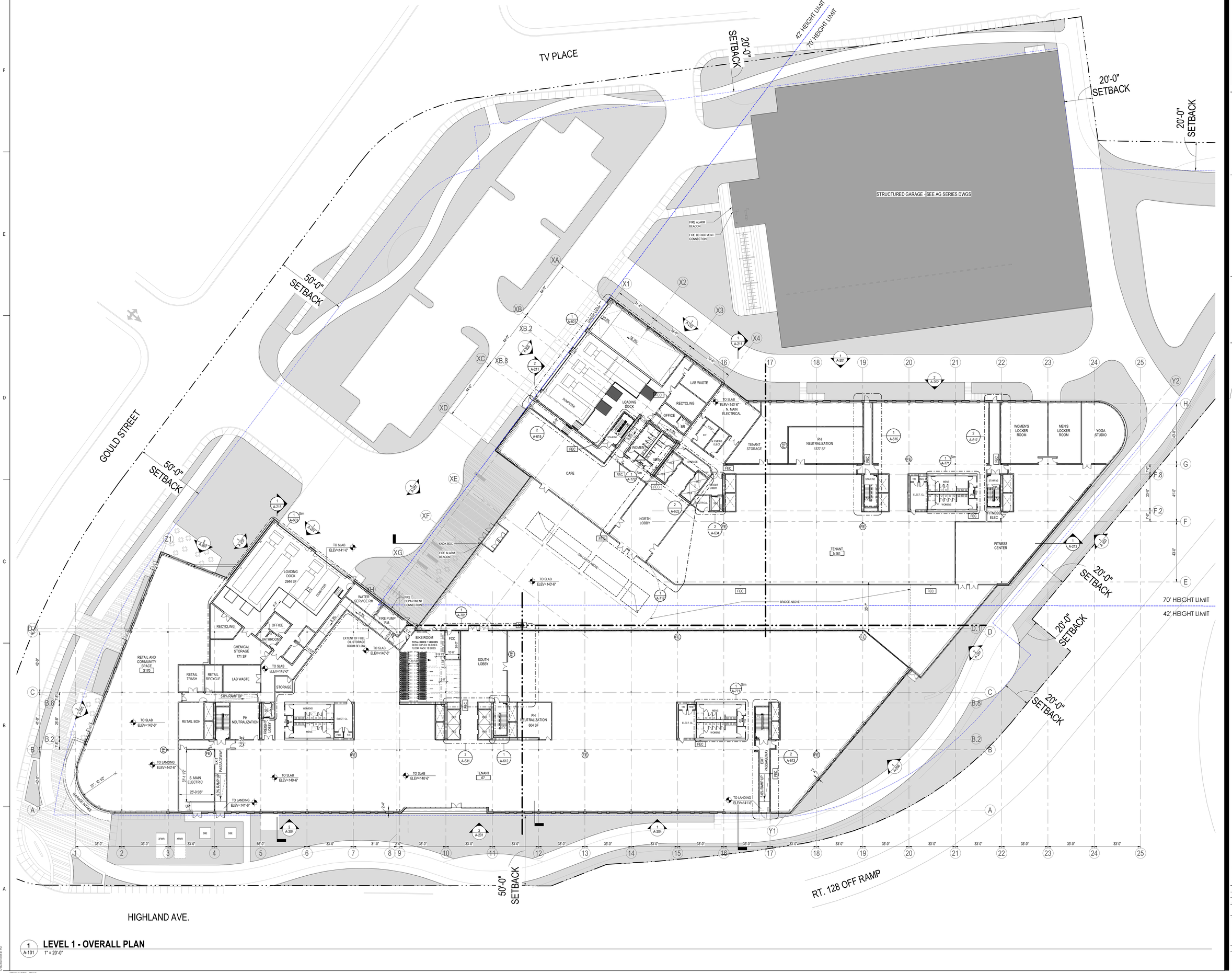
Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL G1 - OVERALL PLAN & PARKING LEGEND

Revision:
Drawing No.
A-100G1

C:\Revit Local\Project Information\
2/5/2022 8:03:33 PM

ORIGINAL SHEET - ARCH E



LEVEL 1 - OVERALL PLAN

1 A-101 — 1" = 20'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston, MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright in all drawings, specifications and models prepared by Stantec is the property of Stantec and must not be reproduced or used for any purpose other than that authorized by Stantec in writing.

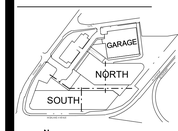
Consultant

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	100% DESIGN DEVELOPMENT & SPECIAL PERMIT PACKAGE			2022.03.30
2				2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

LEGEND

WF	WHEELED FIRE EXTINGUISHER
FE	FIRE EXTINGUISHER BRACKET WALL MTD
FEC	FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

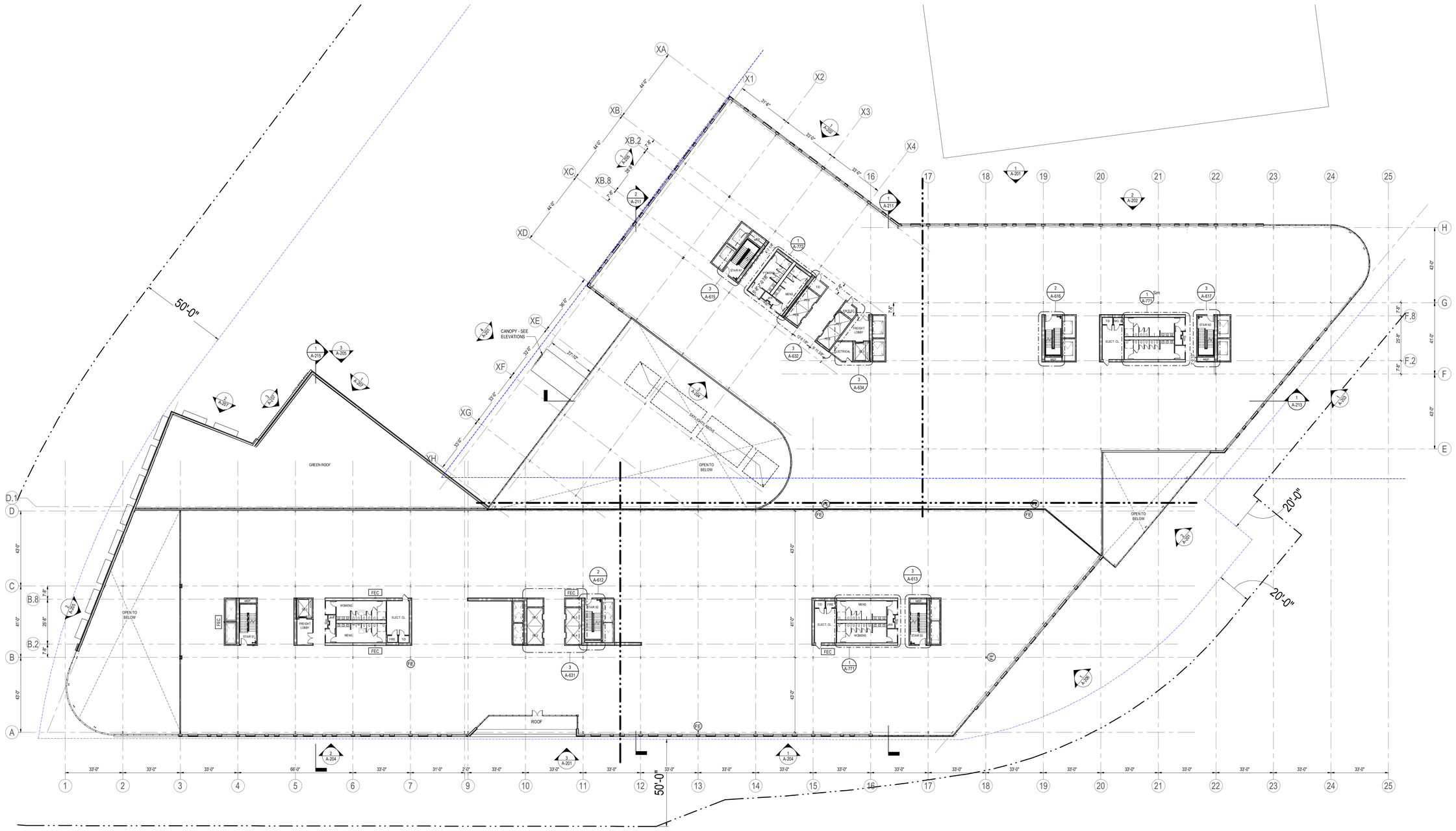
Project No.:218421343
File Name:N/A
Scale: As indicated

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEVEL 1 - OVERALL PLAN

Revision:
Drawing No.
A-101

*DO NOT SCALE DRAWING - Refer to Project Information
12 Oct 2022 8:53:41 PM
ORIGINAL SHEET - ARCH E



1 LEVEL 2 PLAN - OVERALL PLAN

A-102 — 1" = 20'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1573
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright in all drawings, reports, specifications, bills of quantities, calculations and other documents prepared by Stantec is the property of Stantec whether the project for which they are made is executed or not. The reproduction, alteration or use of any such documents for any purpose without the written permission of Stantec is prohibited.

Consultant

No.	Description/Submission	By	Appd	YYYY.MM.DD
1	SPECIAL PERMIT PACKAGE			2022.05.27
2	SPECIAL PERMIT PACKAGE			2022.09.30

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

KEY PLAN

LEGEND

- WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project

Bulfinch

HIGHLAND INNOVATION CENTER

557 Highland Ave
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: As indicated

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

LEVEL 2 - OVERALL PLAN

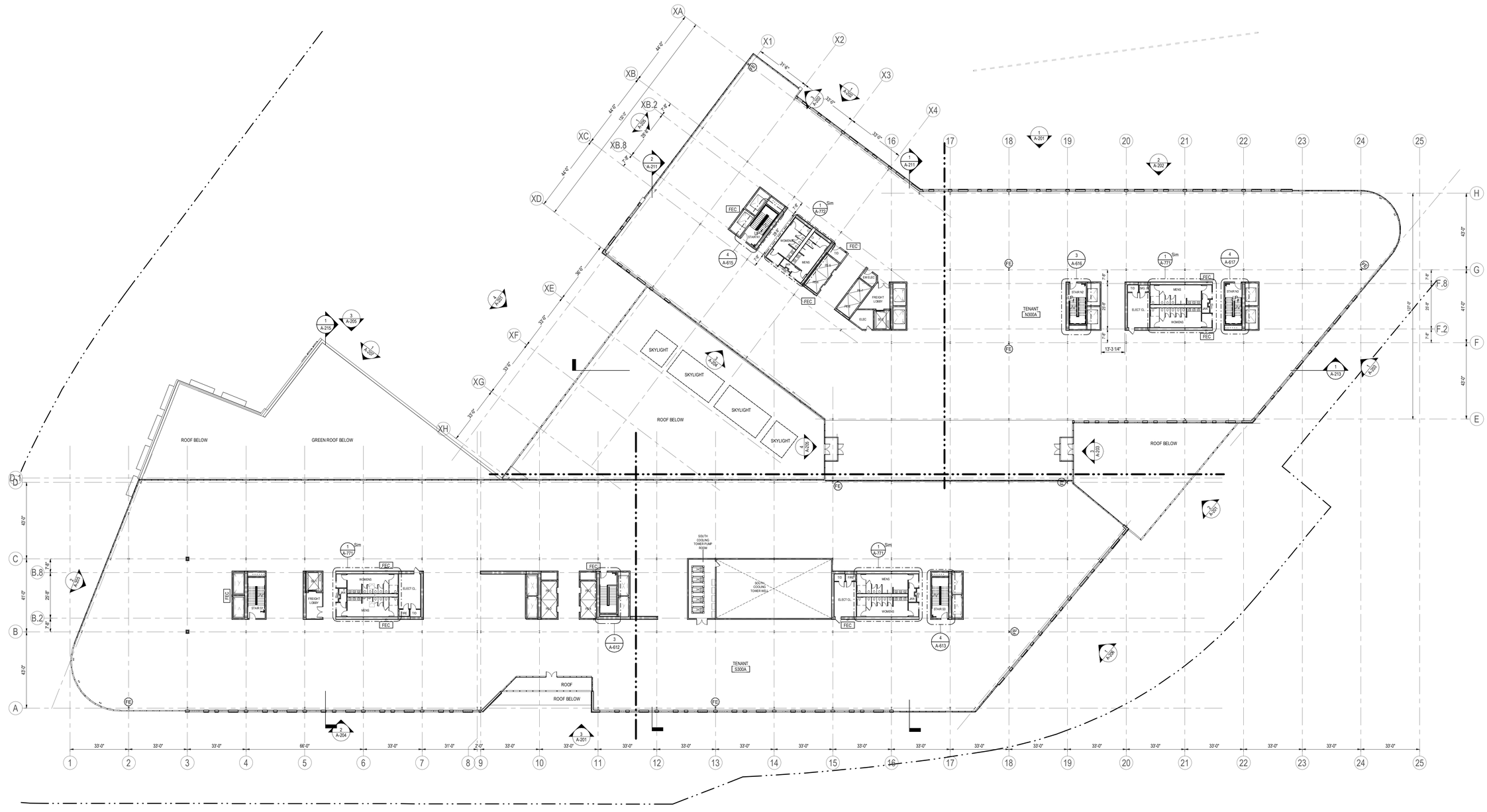
Revision:

Drawing No.

A-102

\\Rvt Auditor\A Project Information
1/31/2022 8:43:23 PM

ORIGINAL SHEET - ARCH E



1 A-103 **LEVEL 3 - OVERALL PLAN**
1" = 20'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

Consultant

No.	Description	By	Appd	YYYY.MM.DD
1	SPECIFICATION SUBMISSION			2022.03.30
2	SPECIAL PERMIT PACKAGE			2022.05.27

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave.
Needham, MA 02494

Project No.:218421343
File Name:N/A
Scale: As indicated

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

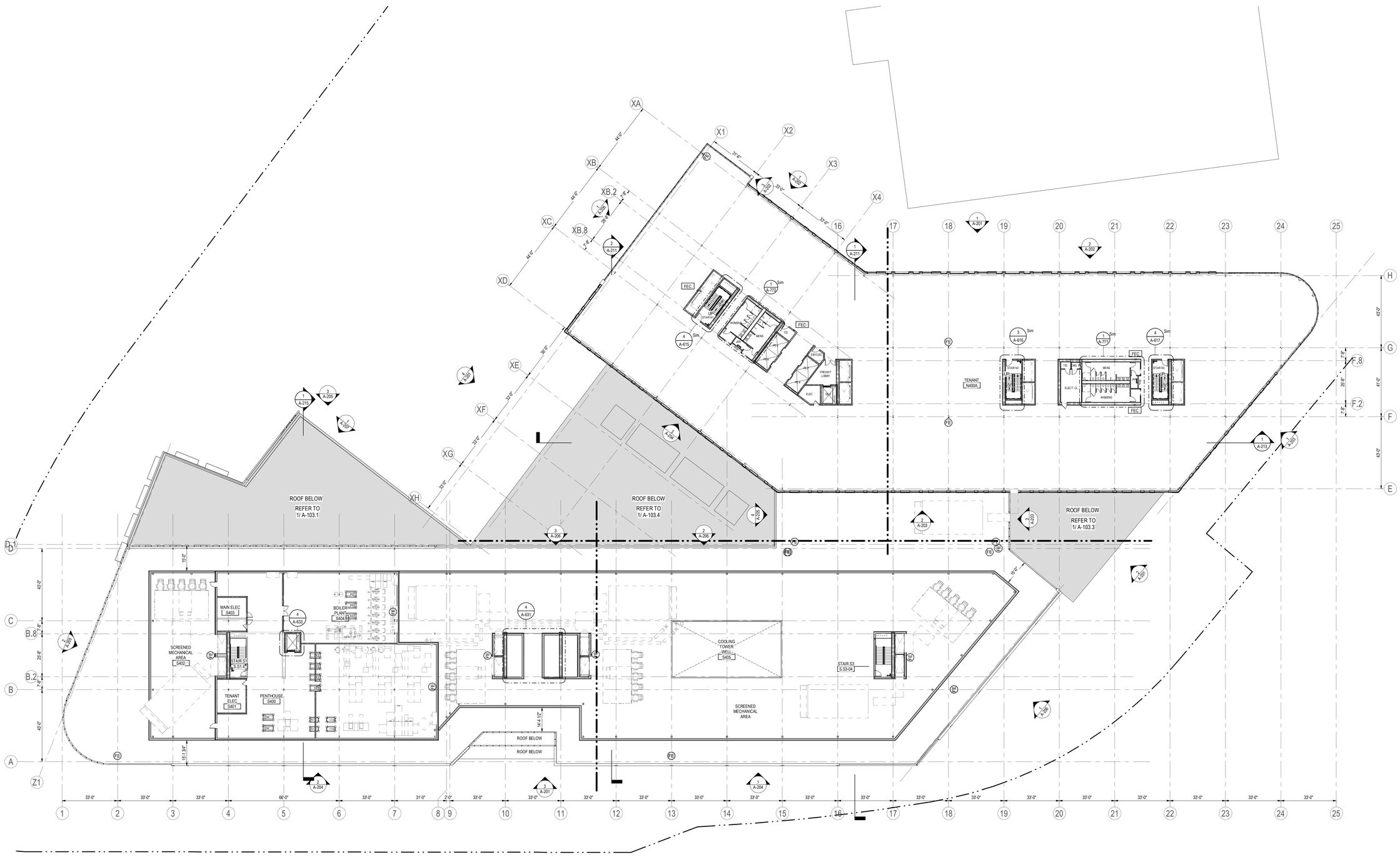
Title
LEVEL 3 - OVERALL PLAN

Revision:

Drawing No.
A-103

*\\ha.fluidnet.ca Project Information\218421343\Revit\18.rvt
12/5/2022 8:47:18 PM

ORIGINAL SHEET - ARCH E



1 LEVEL 4 / SOUTH BUILDING PENTHOUSE - OVERALL PLAN

1" = 20'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright in all drawings, reports, specifications, electronic files and other documents prepared by Stantec is the property of Stantec and must not be copied, reused or altered in any way without the written permission of Stantec.

Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
100% DESIGN DEVELOPMENT			2022.05.27
SPECIAL BOARD PACKAGE			2022.03.30

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A

Scale: As indicated

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

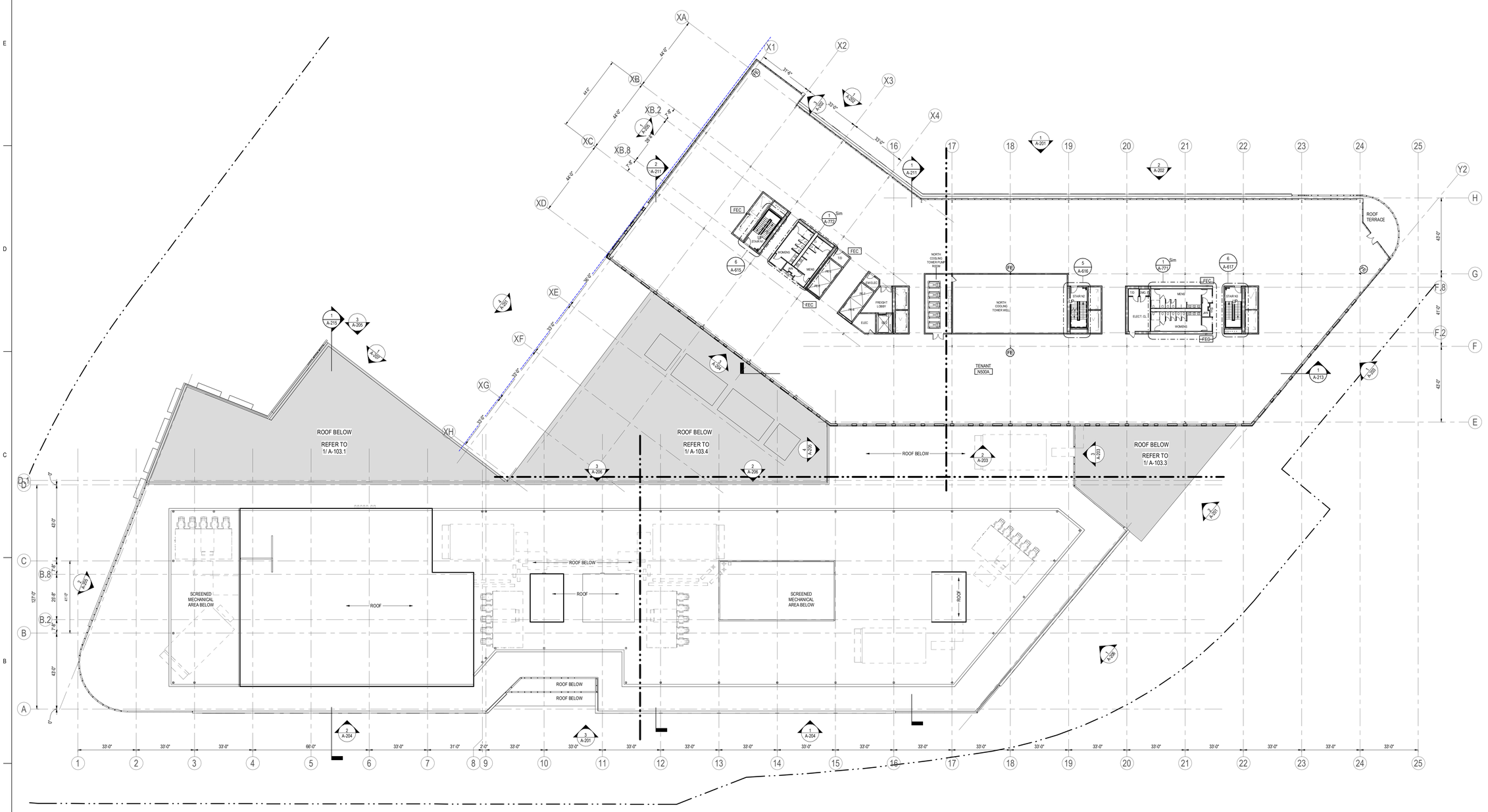
Title
LEVEL 4 / SOUTH BUILDING PENTHOUSE - OVERALL PLAN

Revision:

Drawing No.
A-104

\\Bu-bulfinch-fs Project Information
1/31/2022 8:04:43 PM

ORIGINAL SHEET - ARCH E



1 LEVEL 5 / SOUTH BUILDING UPPER ROOF - OVERALL PLAN

A-105 1" = 20'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1573
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright in all drawings, specifications and models contains the property of Stantec and must not be reproduced or used for any purpose other than that authorized by Stantec. © Stantec

Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
90% DESIGN DEVELOPMENT SUBMISSION			2022.03.30
SPECIAL PERMIT PACKAGE			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

KEY PLAN

LEGEND

- WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project

Bulfinch

HIGHLAND INNOVATION CENTER

557 Highland Ave
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: As indicated

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

LEVEL 5 / SOUTH BUILDING UPPER ROOF - OVERALL PLAN

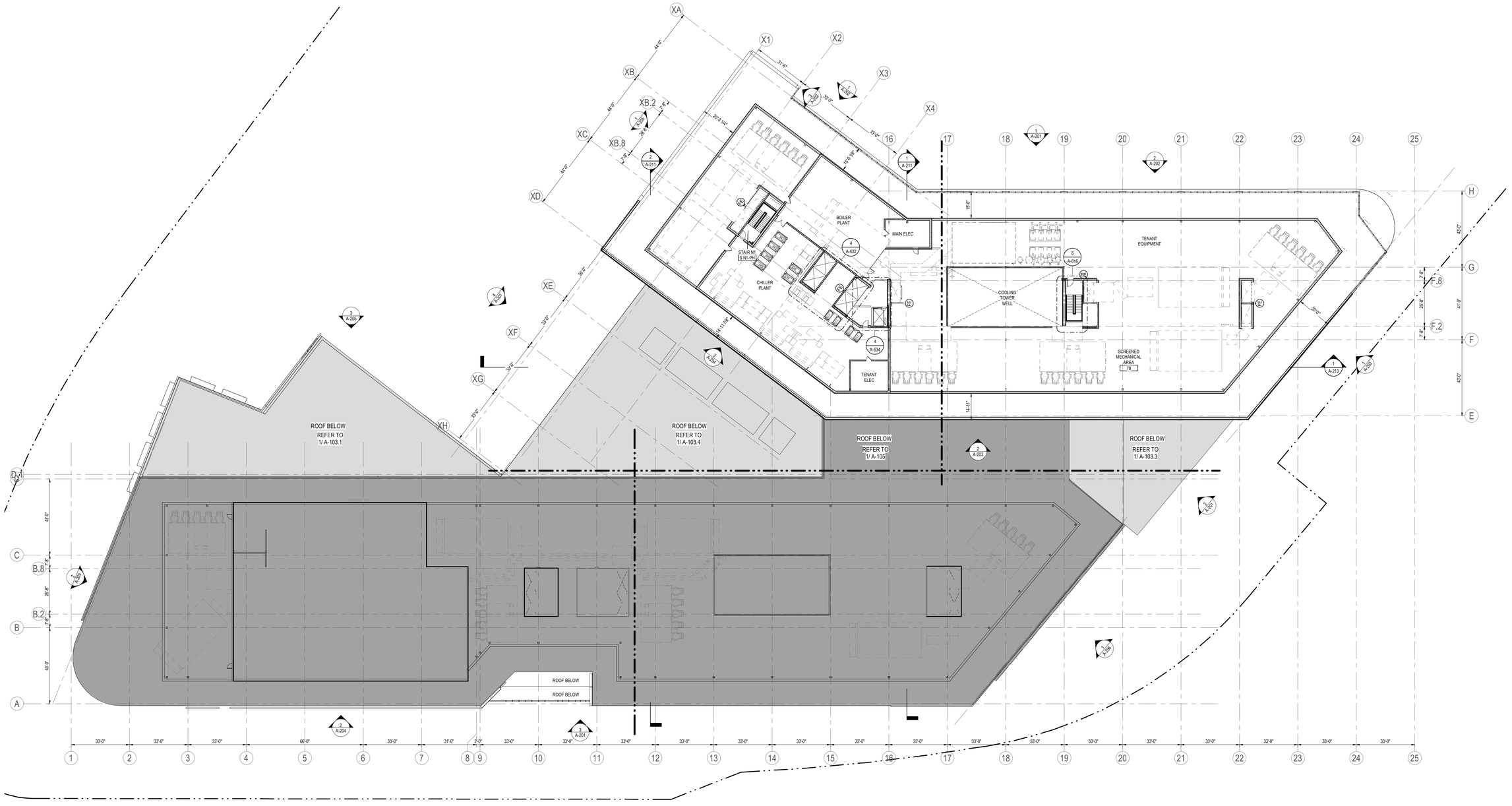
Revision:

Drawing No.

A-105

<Plot Scale>
<Plot Information>
12/14/2022 8:05:13 PM

ORIGINAL SHEET - ARCH E



1 NORTH BUILDING PENTHOUSE - OVERALL PLAN

A-106 — 1" = 20'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright in all drawings, reports, specifications, bills of quantities, calculations and other documents prepared by Stantec is the property of Stantec whether the project for which they are made is executed or not. The reproduction or use for any purpose other than that authorized by Stantec is forbidden.

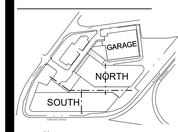
Consultant

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	100% CONSTRUCTION DOCUMENTS			2022.05.27
2	SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

LEGEND

- WE — WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

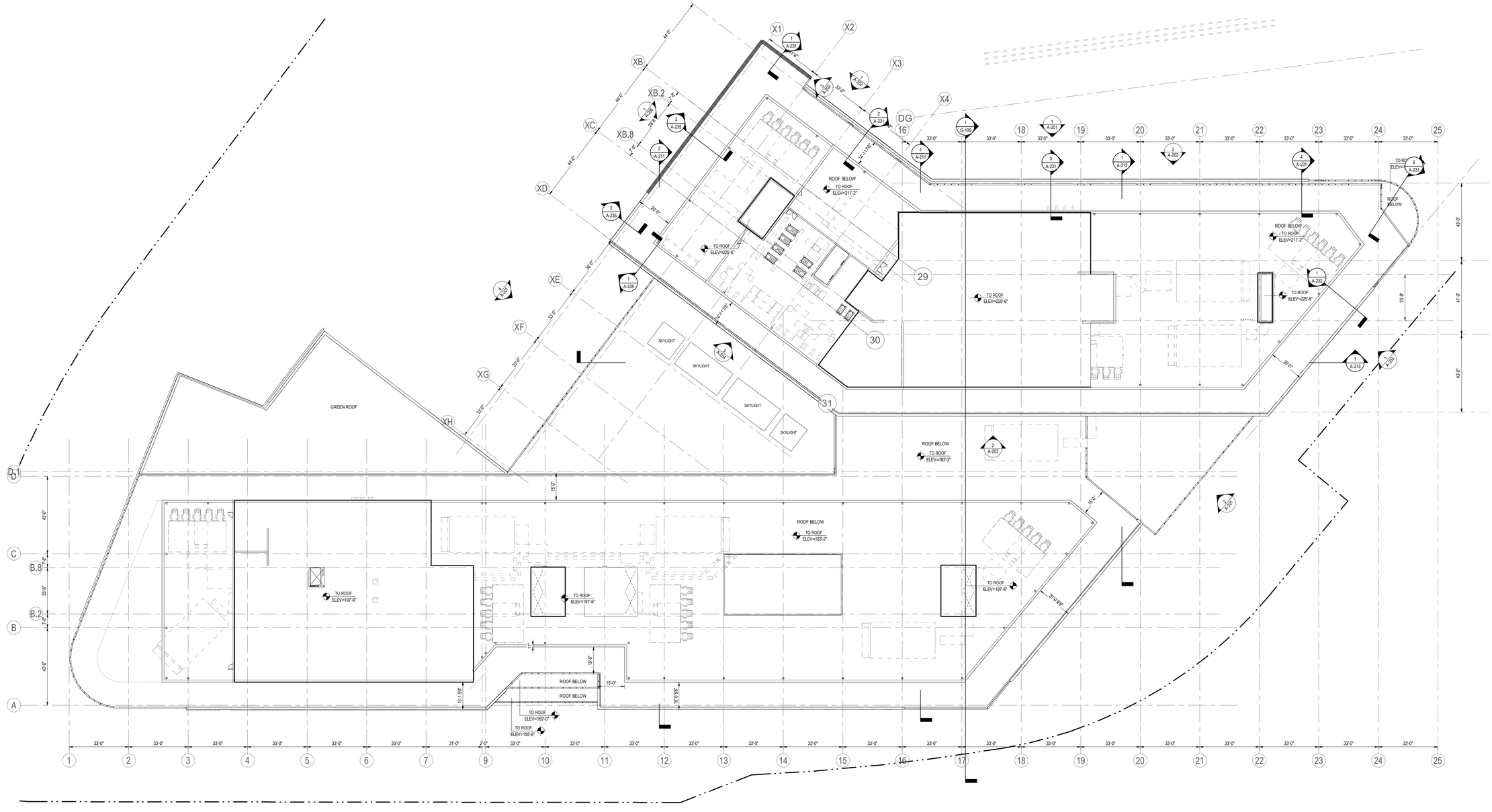
Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

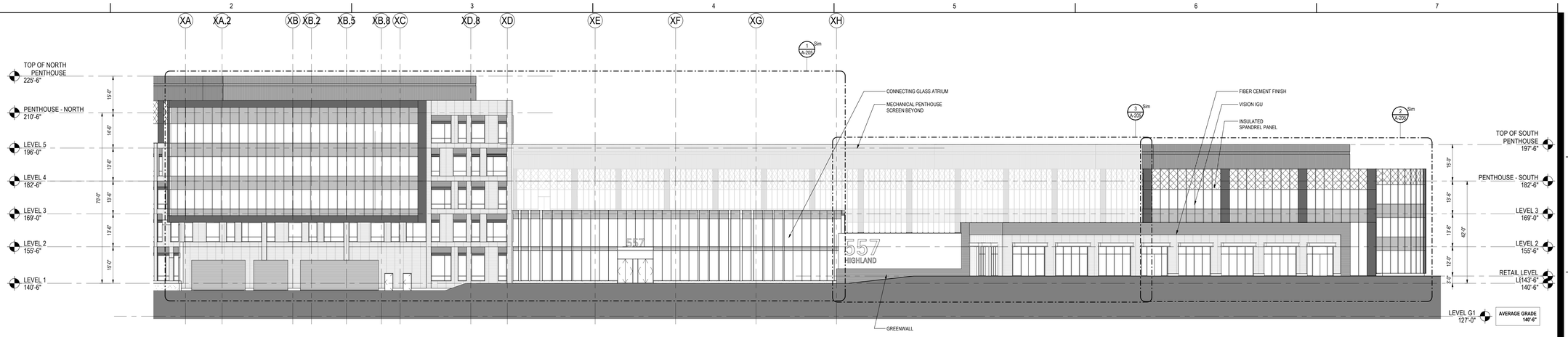
Title
NORTH BUILDING PENTHOUSE - OVERALL PLAN

Revision:

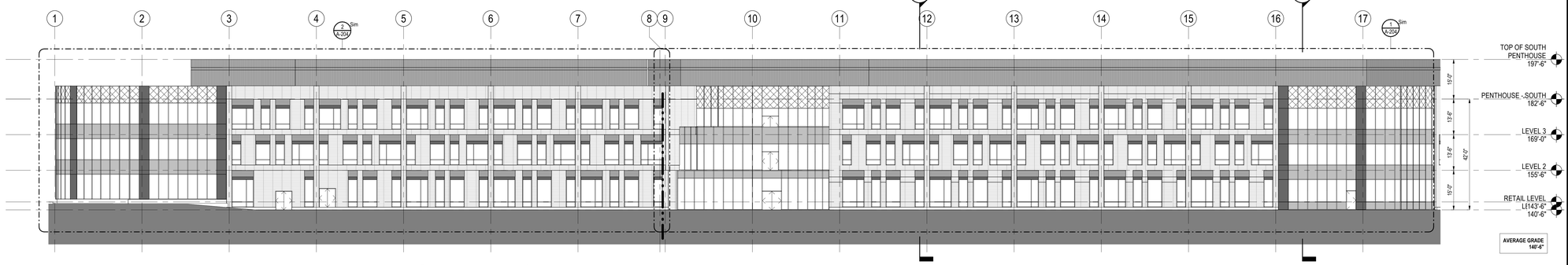
Drawing No.
A-106

ORIGINAL SHEET - ARCH E

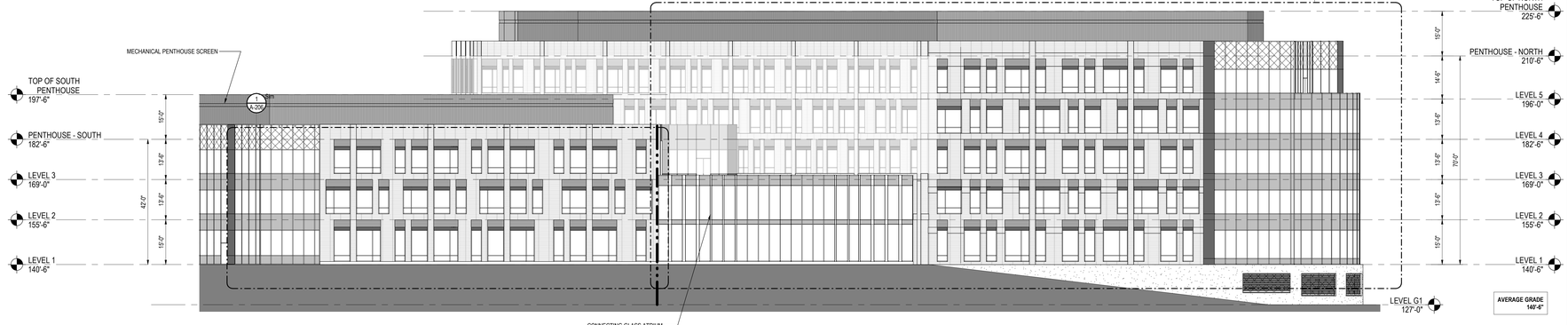

GREEN ROOF
SKYLIGHT
SKYLIGHT
SKYLIGHT
SKYLIGHT
ROOF BELOW
TO ROOF
ELEV=211'-2"
TO ROOF
ELEV=225'-6"
ROOF BELOW
TO ROOF
ELEV=211'-2"
TO ROOF
ELEV=225'-6"
ROOF BELOW
TO ROOF
ELEV=183'-2"
ROOF BELOW
TO ROOF
ELEV=183'-2"
TO ROOF
ELEV=197'-6"
TO ROOF
ELEV=197'-6"
TO ROOF
ELEV=197'-6"
ROOF BELOW
ROOF BELOW
TO ROOF
ELEV=169'-0"
TO ROOF
ELEV=155'-6"
ROOF BELOW
TO ROOF
ELEV=225'-6"
44'-0"
44'-0"
44'-0"
38'-0"
33'-0"
30'-0"
30'-0"
43'-0"
25'-8"
7'-8"
43'-0"
43'-0"
25'-8"
41'-0"
43'-0"
15'-0"
15'-0"
20'-0"
20'-0"
20'-0"
20'-0"
15'-0"
15'-0"
15



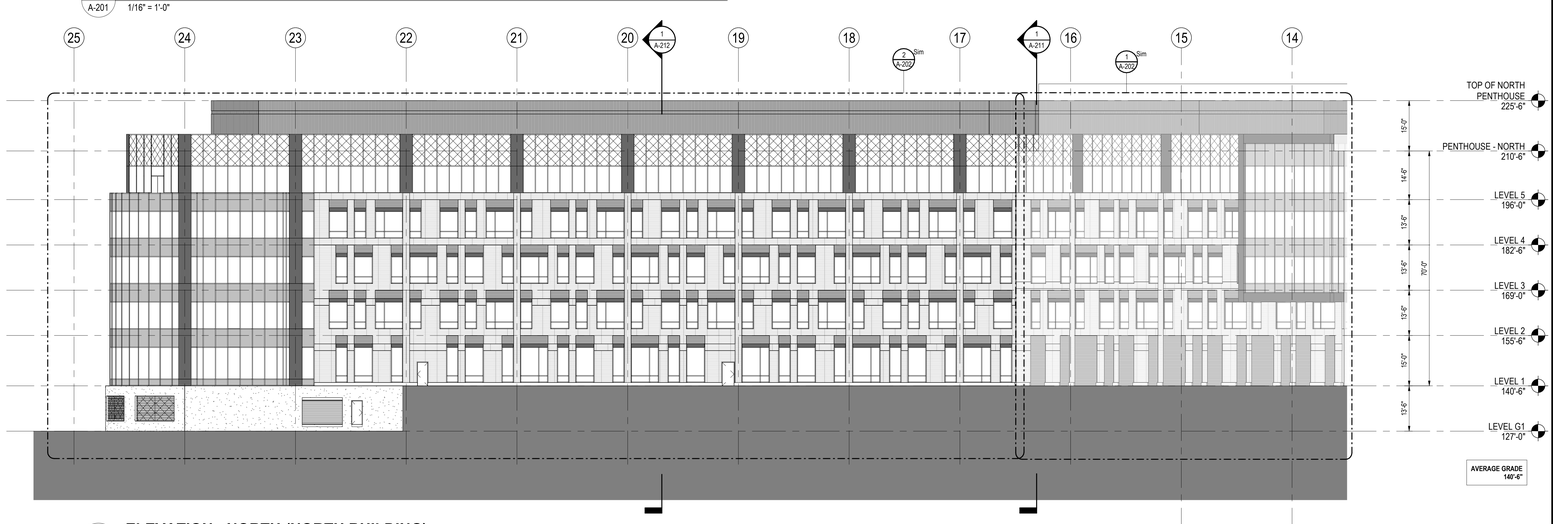
4 A-201 ELEVATION - WEST
1/16" = 1'-0"



3 A-201 ELEVATION - SOUTH (SOUTH BUILDING)
1/16" = 1'-0"



2 A-201 ELEVATION - EAST
1/16" = 1'-0"



1 A-201 ELEVATION - NORTH (NORTH BUILDING)
1/16" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

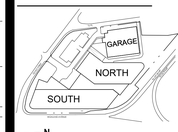
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. Copyright reserved. The information contained in this drawing is the property of Stantec and shall not be reproduced in whole or in part without the prior written permission of Stantec. © 2020 Stantec.

Consultant

No.	Issued/Revision	By	Appvd	YYYY.MM.DD
1	90% DESIGN DEVELOPMENT SET			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/16" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - LOCATOR ELEVATIONS

Revision:
Drawing No.
A-201

"Pro Builder in Project Information" 5/27/2022 10:33:52 AM

ORIGINAL SHEET - ARCH E

2 A-202 **ENLARGED ELEVATION - NORTH BUILDING - NORTH**
1/8" = 1'-0"

3 A-202 **ENLARGED ELEVATION - NORTH BUILDING - NORTH (HIDDEN) AT GRID X2**
1/8" = 1'-0"

1 A-202 **ENLARGED ELEVATION - NORTH BUILDING - NORTH (ANGLED WALL)**
1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction of any of these drawings in whole or in part is prohibited.

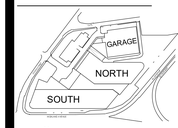
Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
90% DESIGN DEVELOPMENT SUBMISSION			2022.05.27
SPECIAL PERMIT PACKAGE			2022.08.30

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

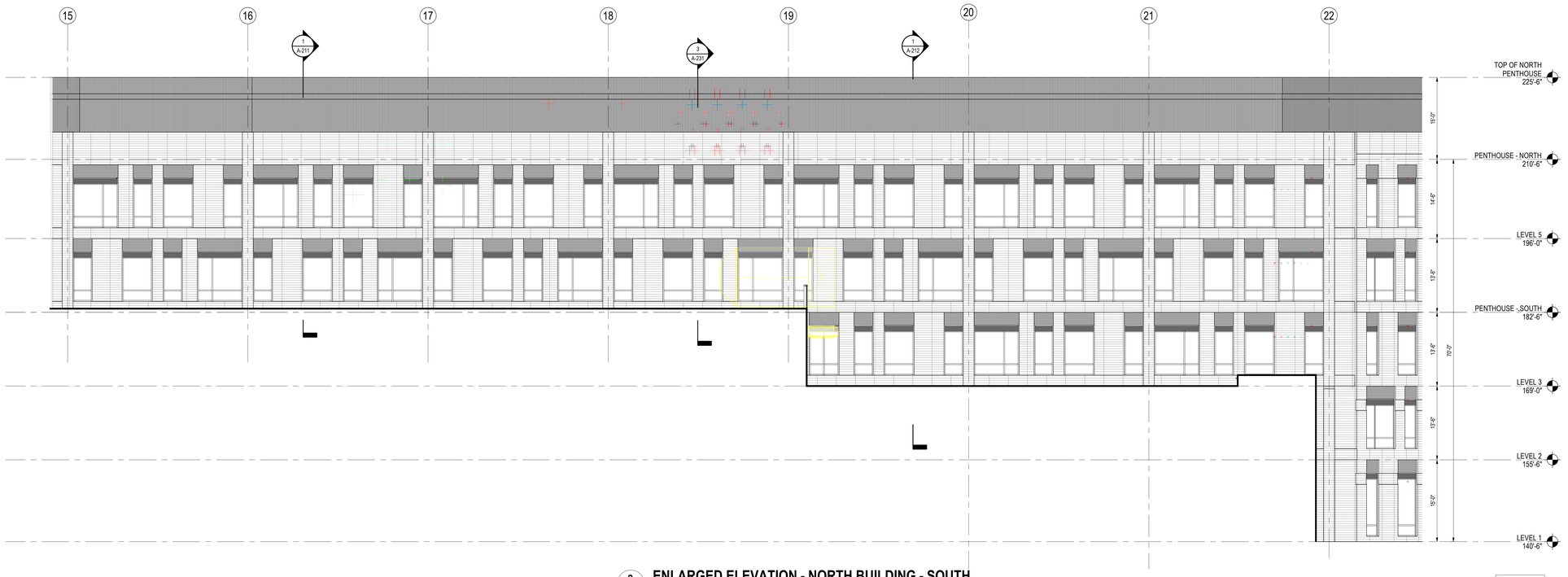
Title
BUILDING ELEV - NORTH BLDG - NORTH

Revision:

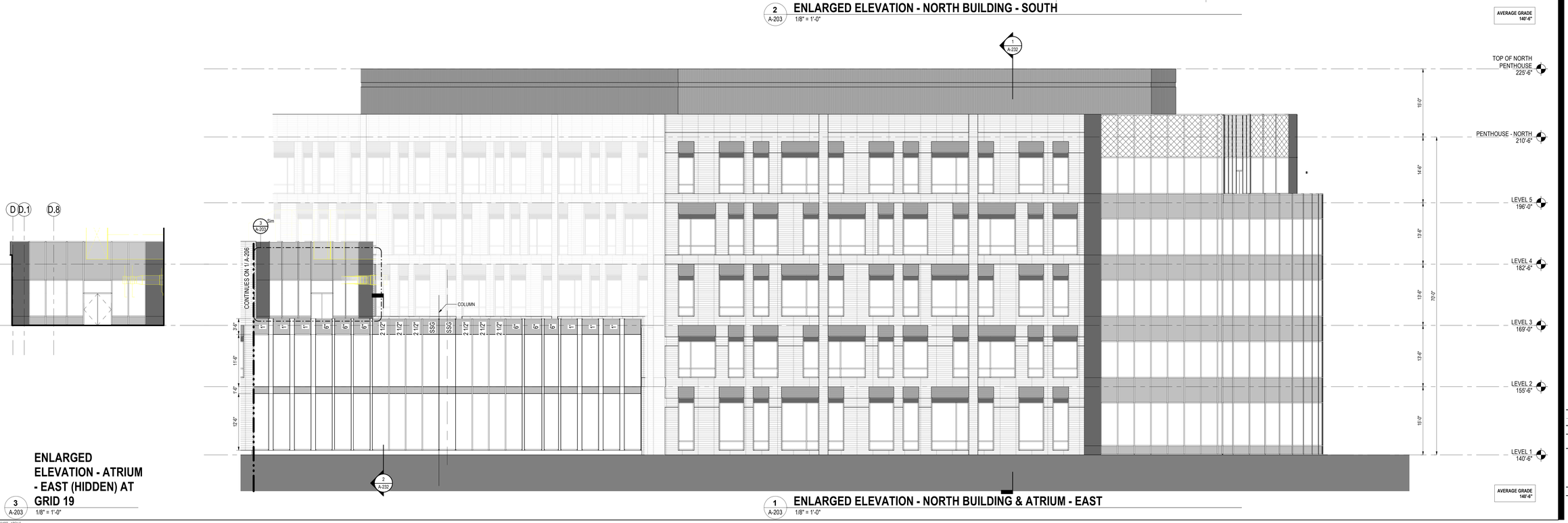
Drawing No.
A-202

<Do Not Delete or Move> Project Information
12 Oct 2022 8:56:23 PM

ORIGINAL SHEET - ARCH E



2 A-203 **ENLARGED ELEVATION - NORTH BUILDING - SOUTH**
1/8" = 1'-0"



3 A-203 **ENLARGED ELEVATION - ATRIUM - EAST (HIDDEN) AT GRID 19**
1/8" = 1'-0"

1 A-203 **ENLARGED ELEVATION - NORTH BUILDING & ATRIUM - EAST**
1/8" = 1'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1775
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright on the contents and layout of this drawing shall remain the property of Stantec and may not be reproduced in whole or part for any purpose other than that authorized by Stantec. © 2020 Stantec.

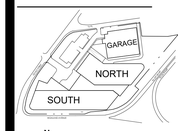
Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
30% DESIGN DEVELOPMENT SET			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A

Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

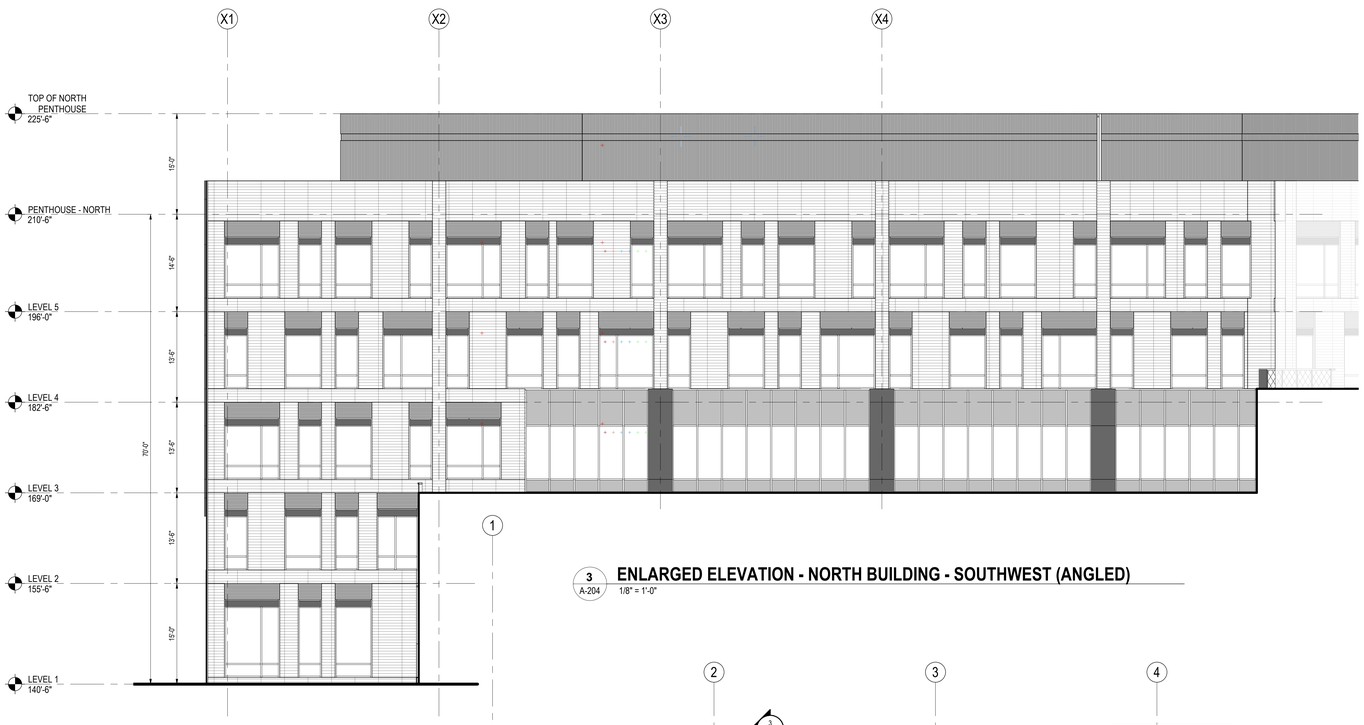
Title
BUILDING ELEV - NORTH BLDG - SOUTH & EAST

Revision:

Drawing No.
A-203

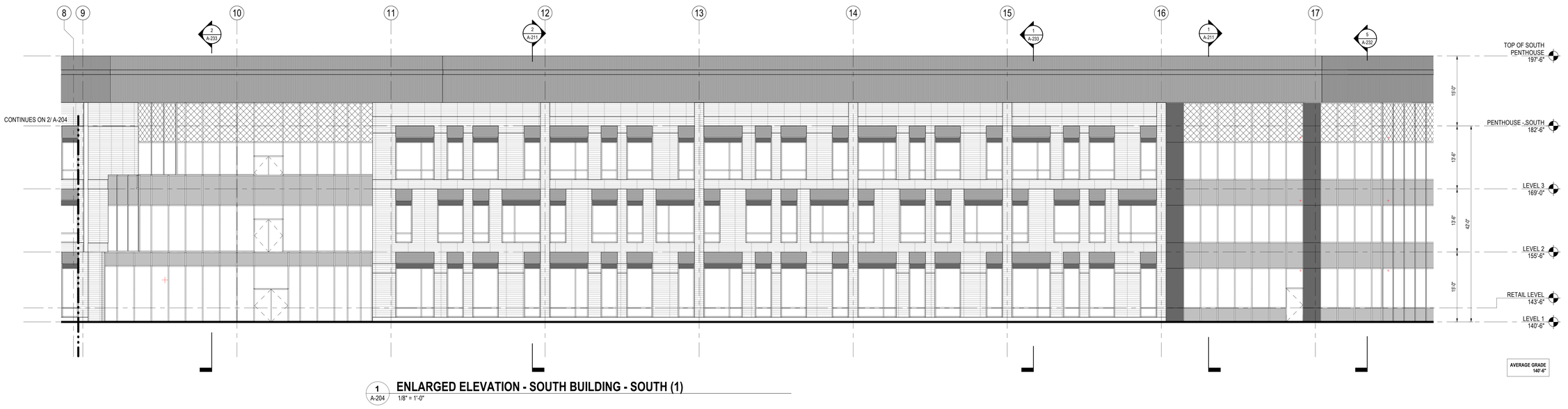
<File location in Project Information>
12/7/2022 10:54:33 AM

ORIGINAL SHEET - ARCH E



3 A-204 **ENLARGED ELEVATION - NORTH BUILDING - SOUTHWEST (ANGLED)**
1/8" = 1'-0"

2 A-204 **ENLARGED ELEVATION - SOUTH BUILDING - SOUTH (2)**
1/8" = 1'-0"



1 A-204 **ENLARGED ELEVATION - SOUTH BUILDING - SOUTH (1)**
1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

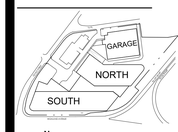
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing, any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
30% DESIGN DEVELOPMENT SET			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A

Scale: 1/8" = 1'-0"

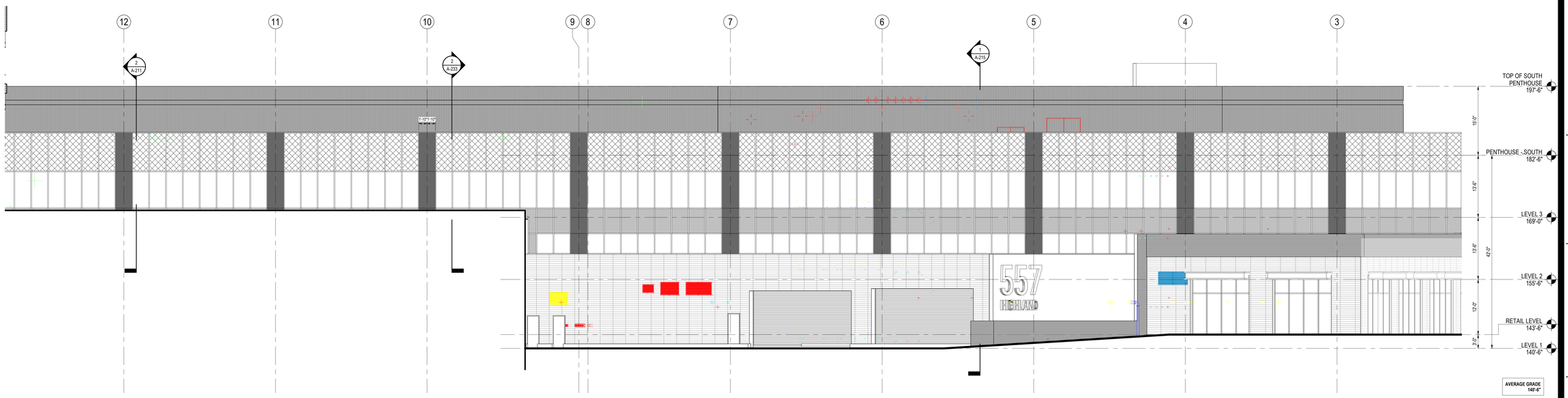
Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG (SOUTHWEST) & SOUTH BLDG (SOUTH)

Revision:

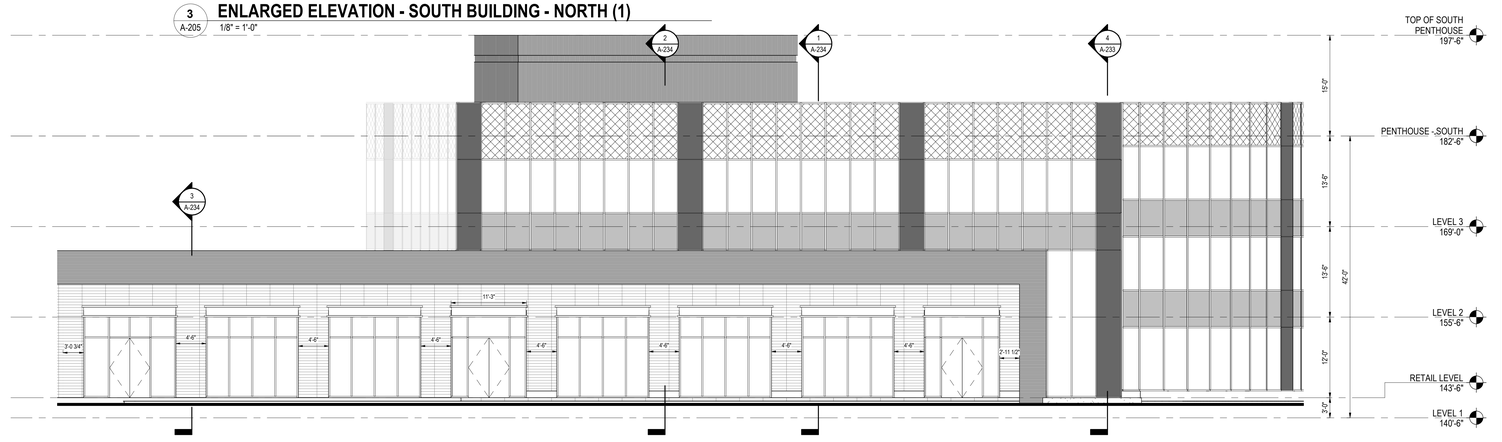
Drawing No.
A-204

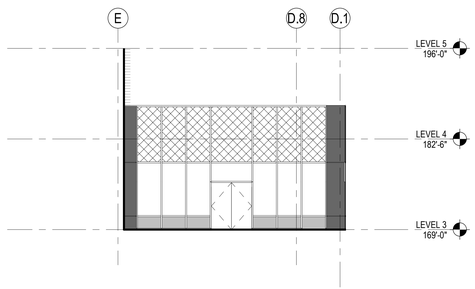
Plot Scale/Print Information
5/27/2022 9:39:52 AM
ORIGINAL SHEET - ARCH E



3 A-205 ENLARGED ELEVATION - SOUTH BUILDING - NORTH (1)

1/8" = 1'-0"



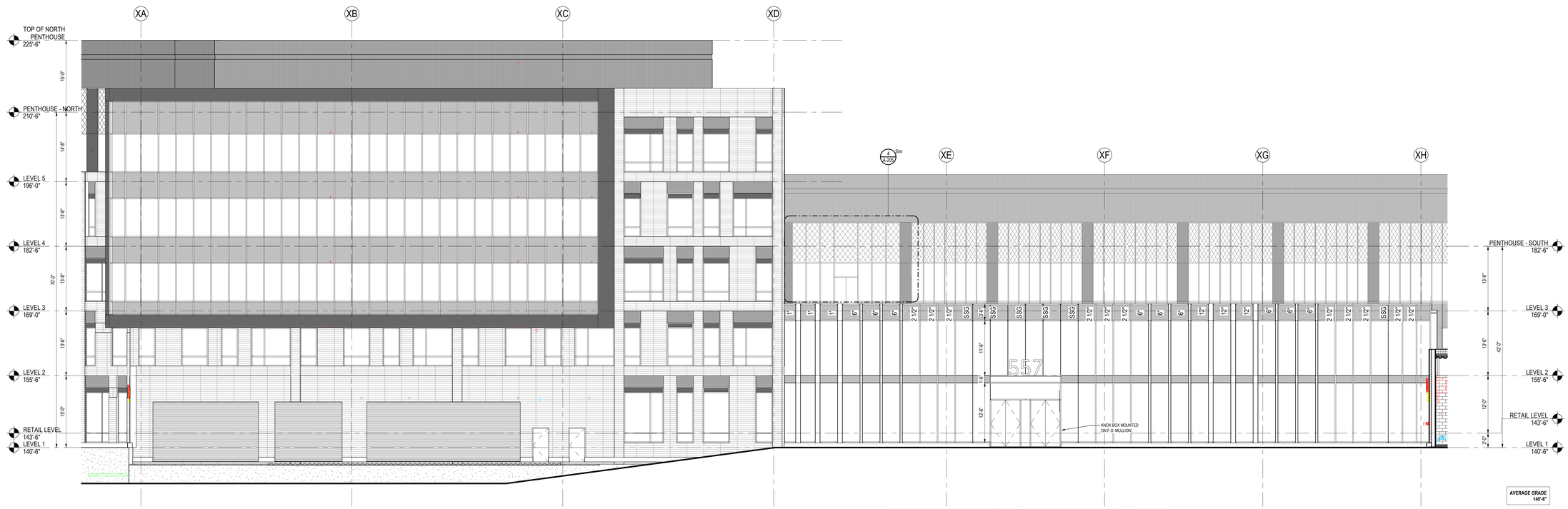


ENLARGED ELEVATION - ATRIUM - EAST (HIDDEN) AT GRID 15

4 A-205 1/8" = 1'-0"

2 A-205 ENLARGED ELEVATION - SOUTH BUILDING - WEST

1/8" = 1'-0"



1 A-205 ENLARGED ELEVATION - NORTH BUILDING - WEST

1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1705
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Use only the dimensions and levels shown or indicated. Report discrepancies, errors or omissions in the drawings or other information to the Architect before proceeding with the work. Drawings are not to be used for construction purposes unless issued for construction.

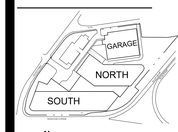
Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
90% DESIGN DEVELOPMENT SET			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

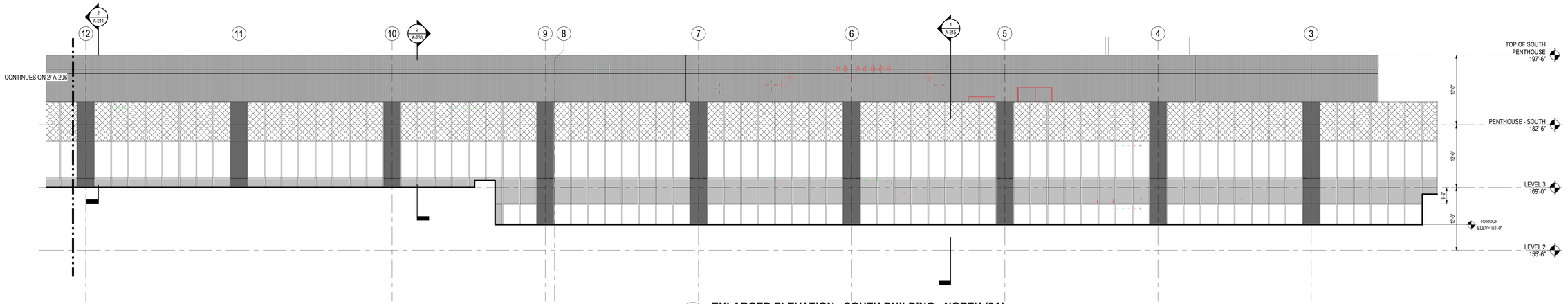
Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG (WEST) & SOUTH BLDG (NORTH & WEST)

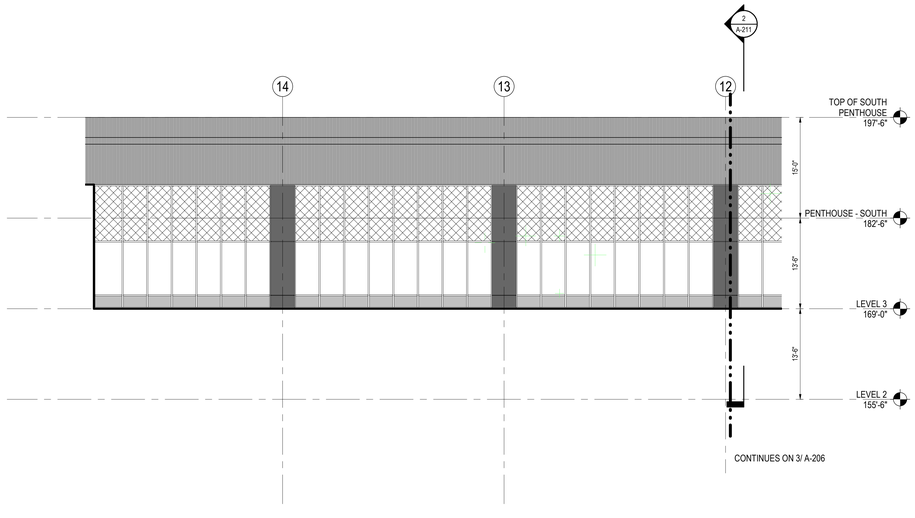
Revision:

Drawing No.
A-205

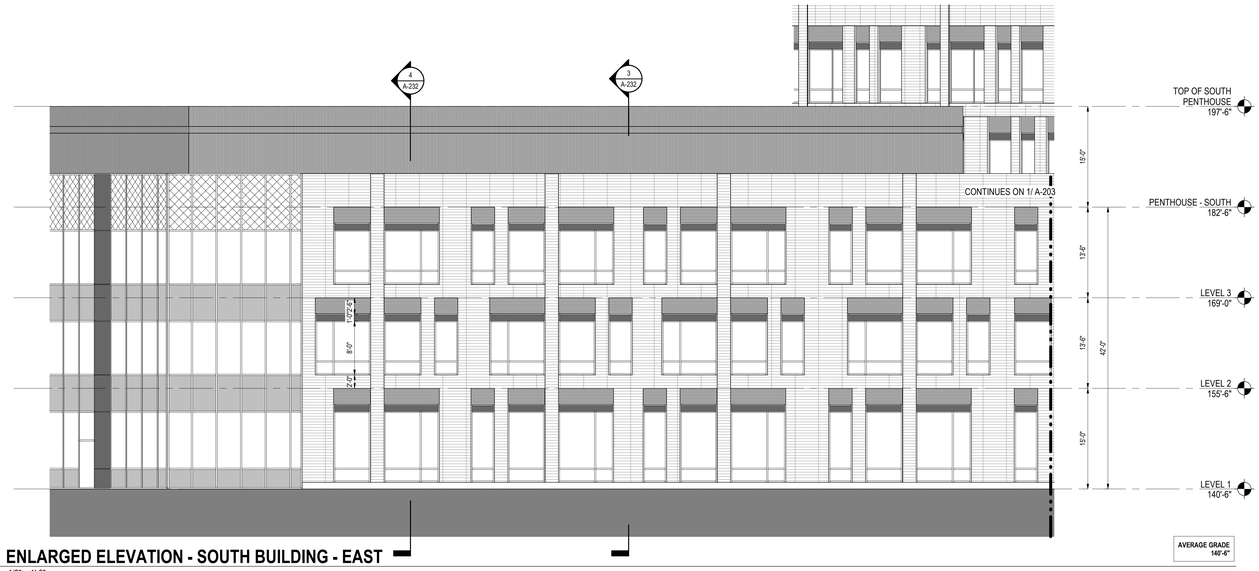
ORIGINAL SHEET - ARCH E



3 A-206 ENLARGED ELEVATION - SOUTH BUILDING - NORTH (2A)
1/8" = 1'-0"



2 A-206 ENLARGED ELEVATION - SOUTH BUILDING - NORTH (2B)
1/8" = 1'-0"



1 A-206 ENLARGED ELEVATION - SOUTH BUILDING - EAST
1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

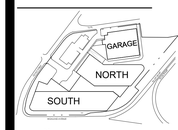
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

Consultant

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	30% DESIGN DEVELOPMENT SET			2022.03.31

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

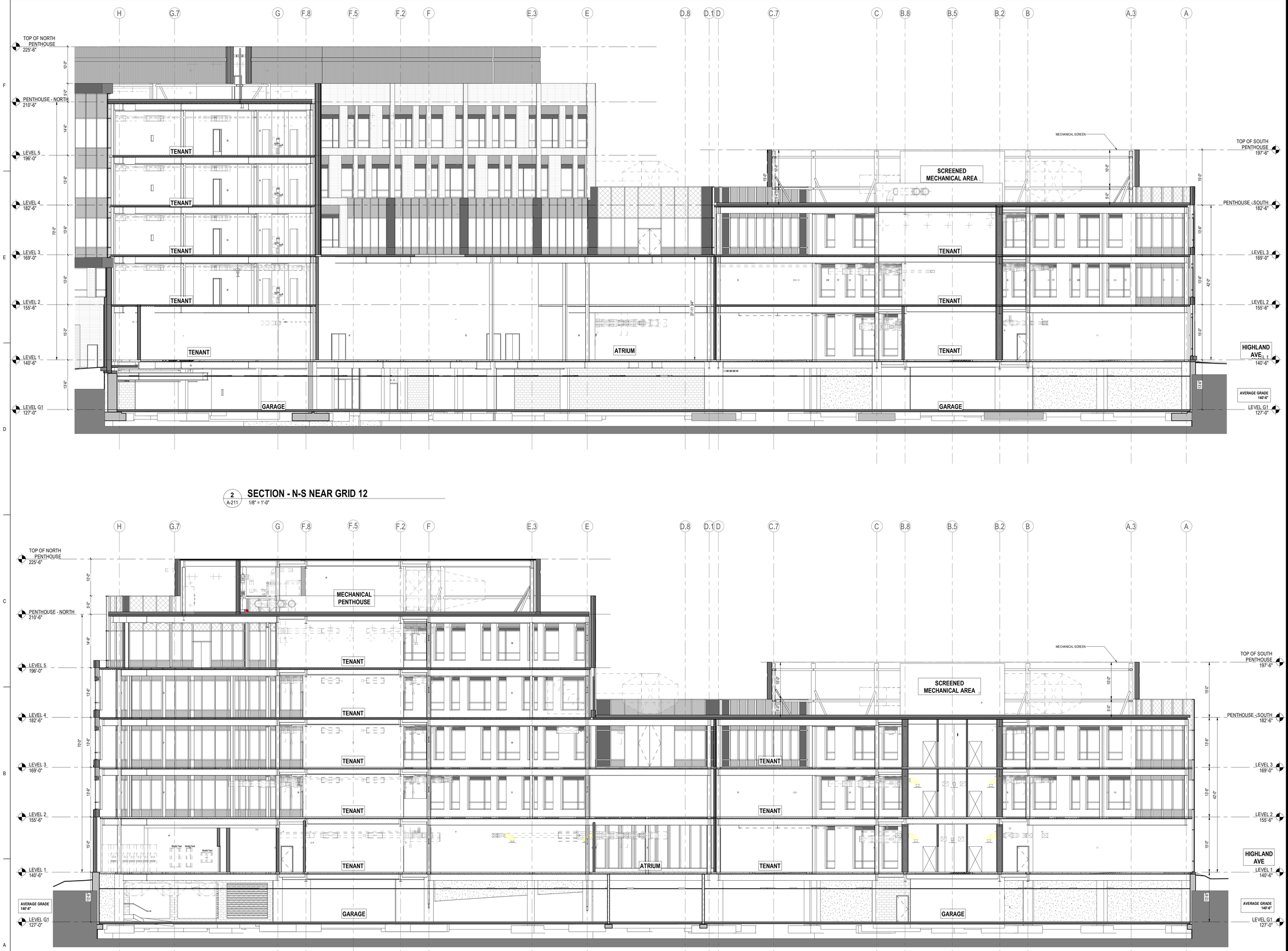
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - SOUTH BLDG - NORTH & EAST

Revision:
Drawing No.
A-206

Plot by Autodesk Design Automation
5/27/2022 10:44:44 AM
ORIGINAL SHEET - ARCH E



2 A-211 **SECTION - N-S NEAR GRID 12**
1/8" = 1'-0"

1 A-211 **SECTION - N-S NEAR GRID 16**
1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1573
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright and Intellectual Property rights in this drawing and in any part of it are and shall remain the property of Stantec and may not be used except with the written permission of Stantec. © Stantec

Consultant

No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	DESIGN DEVELOPMENT & SPECIAL PERMIT PACKAGE			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

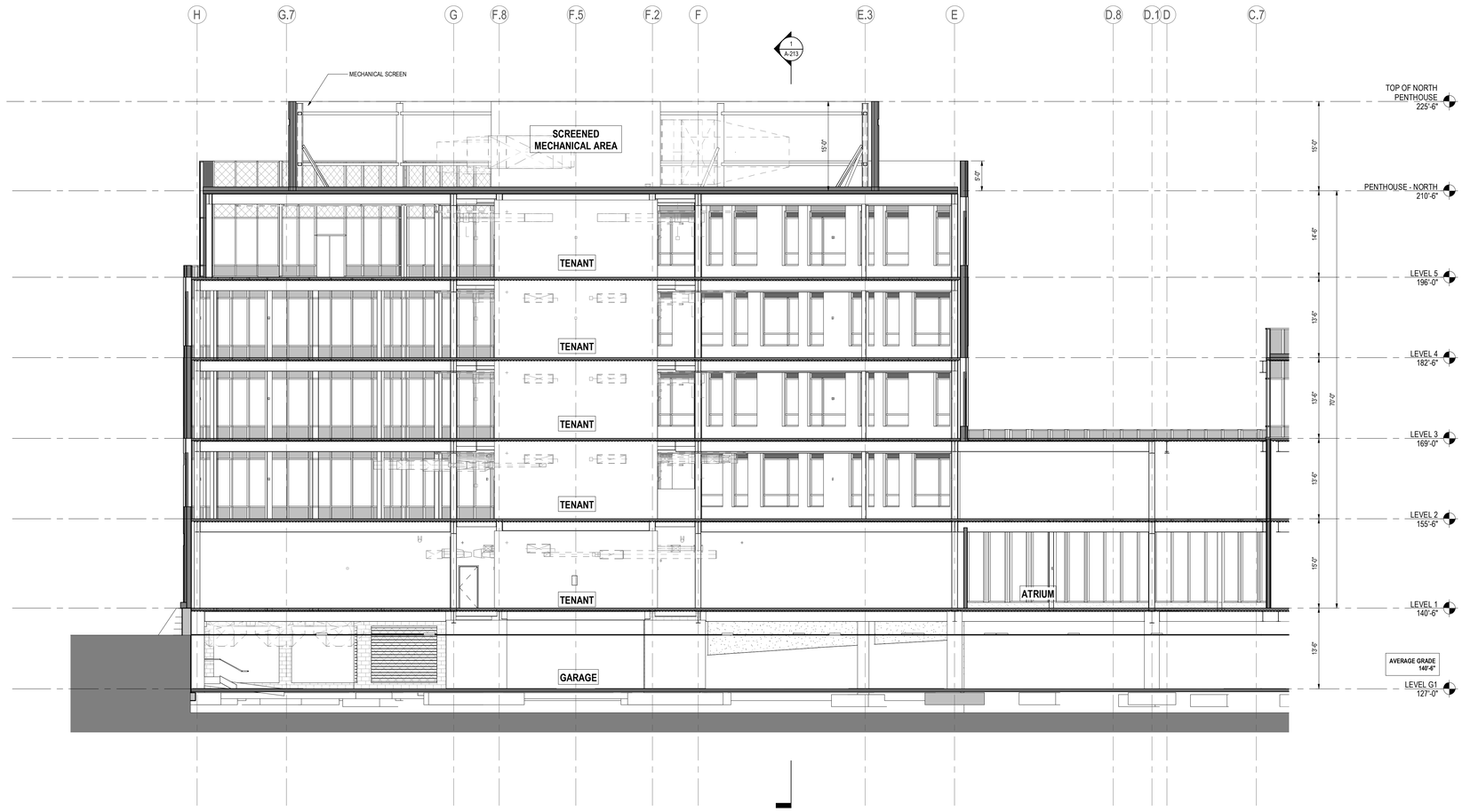
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING SECTIONS - OVERALL

Revision:
Drawing No.
A-211

<Plot Scale> in Project Information
12 Oct 2022 8:07:38 PM
ORIGINAL SHEET - ARCH E



1 / A-212 SECTION - NORTH BUILDING - SECTION N-S NEAR GRID 20
1/8" = 1'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1775
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing - use only the dimensions shown. This drawing is the property of the Consultant and is not to be used for any purpose not expressly permitted by agreement with the Consultant. Unauthorized use of this drawing without the express permission of the Consultant is prohibited. © Copyright reserved. All rights reserved.

Consultant

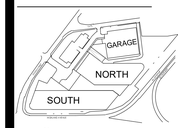
No.	Description	By	Appd	YYYY.MM.DD
1	SPECIAL PERMIT PACKAGE			2022.05.27

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name:N/A

Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

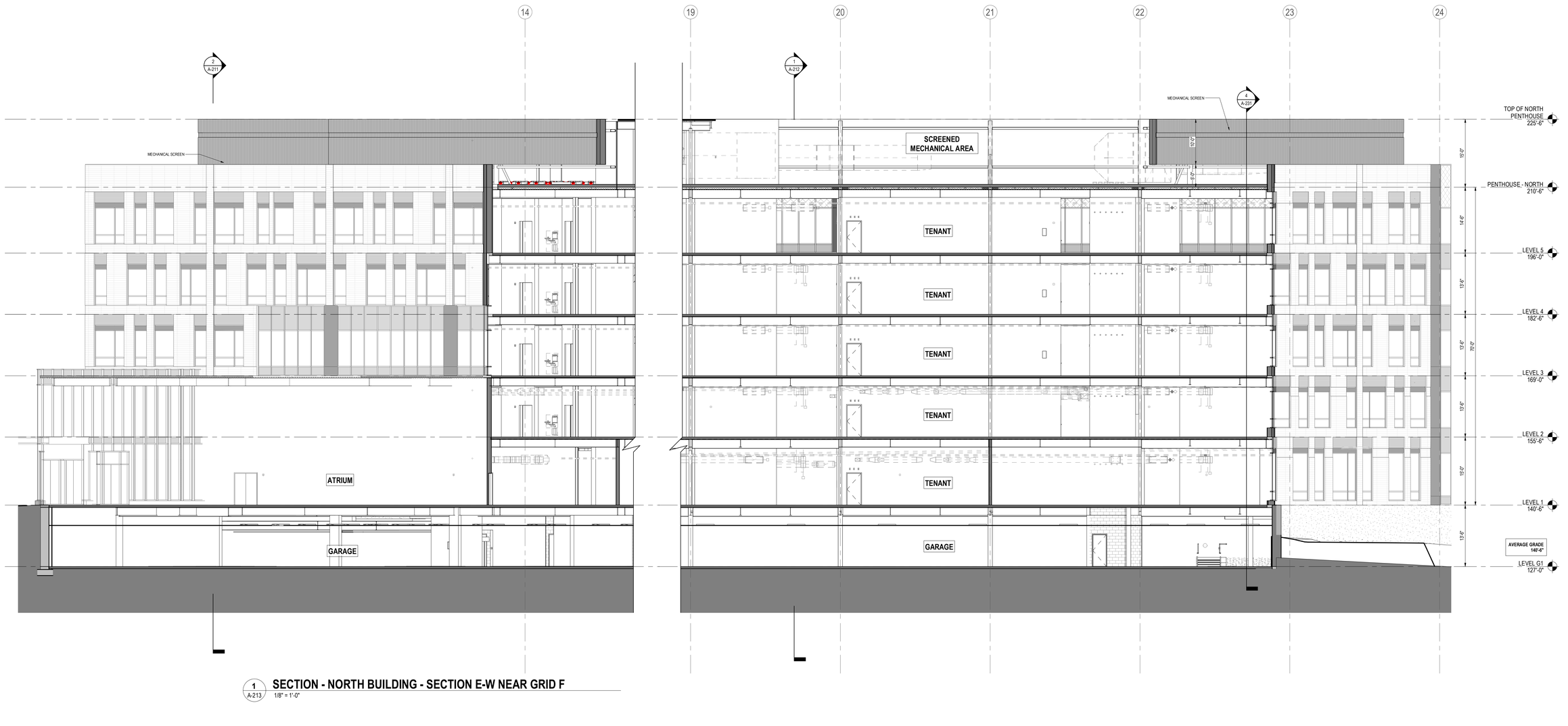
Title
BUILDING SECTIONS - NORTH BLDG

Revision:

Drawing No.
A-212

<Plot Scale for Proper Information>
12/5/2022 8:58:28 PM

ORIGINAL SHEET - ARCH E



1 A-213 **SECTION - NORTH BUILDING - SECTION E-W NEAR GRID F**

1/8" = 1'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

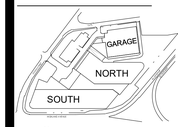
Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
30% DESIGN DEVELOPMENT			2022.03.30
SPECIAL PERMIT PACKAGE			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project

Bulfinch

HIGHLAND INNOVATION CENTER

557 Highland Ave.
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

BUILDING SECTIONS - NORTH BLDG

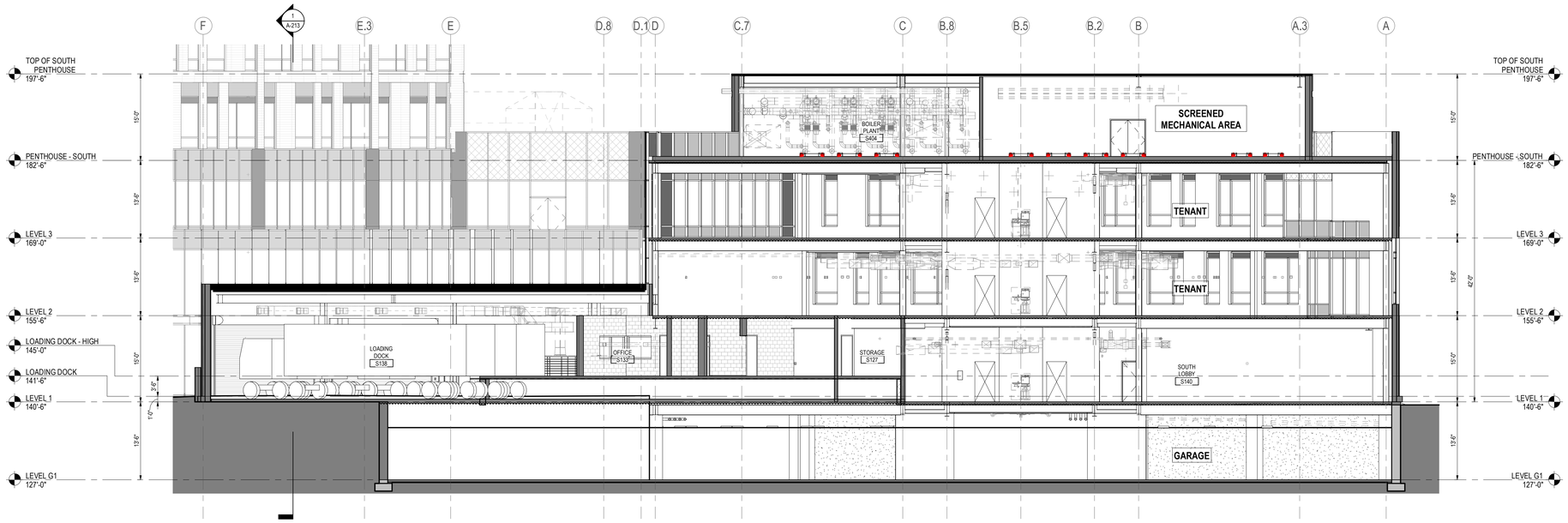
Revision:

Drawing No.

A-213

<File Location & Project Information>
5/25/2022 8:08:34 AM

ORIGINAL SHEET - ARCH E



1 / A-215 **SECTION - SOUTH BUILDING - SECTION N-S NEAR GRID 5**
1/8" = 1'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and is responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
30% DESIGN DEVELOPMENT SET			2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

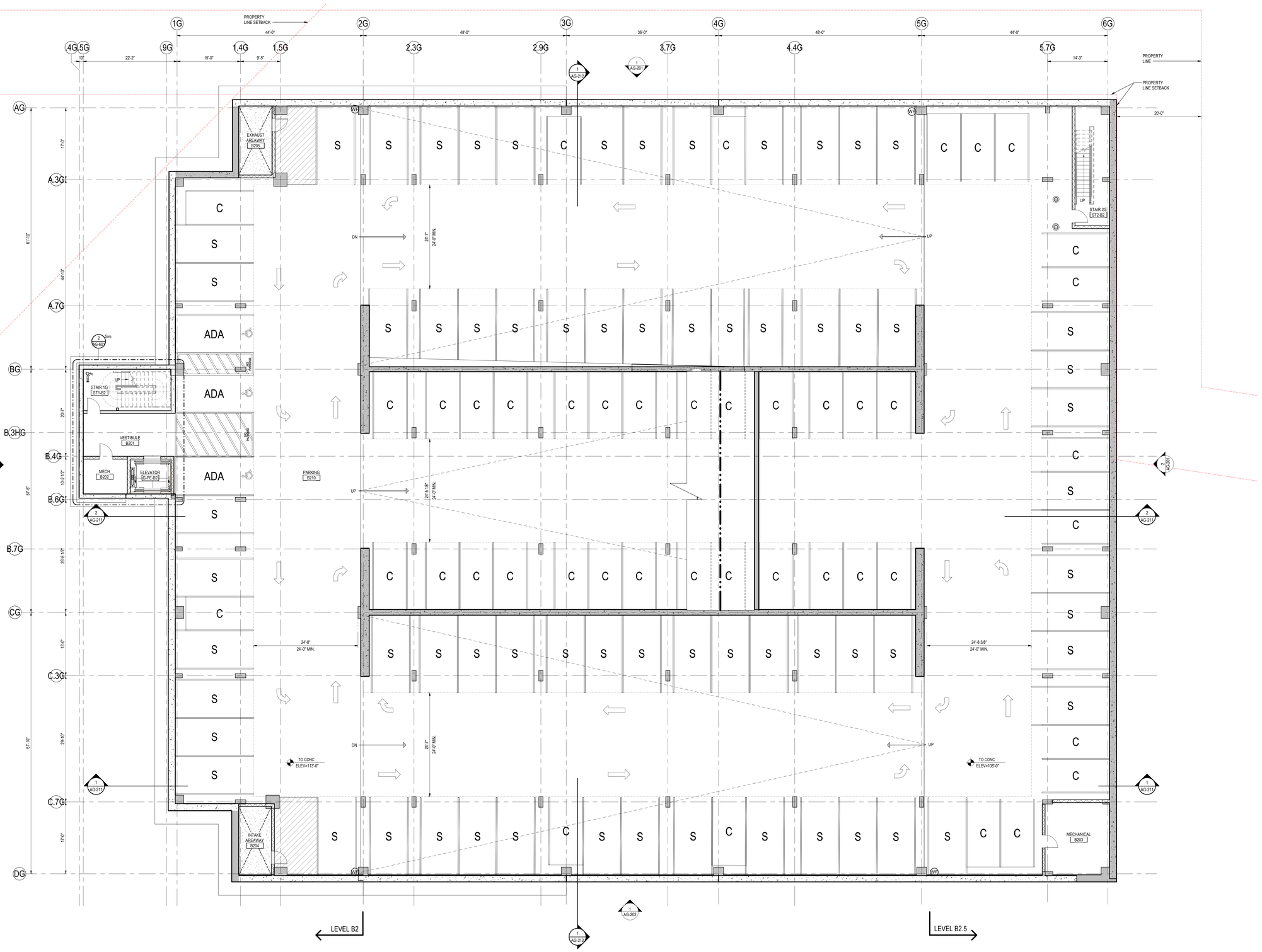
Title
BUILDING SECTIONS - SOUTH BLDG

Revision:

Drawing No.
A-215

<Pro Ex Library or Project Information>
12 Oct 2022 8:08:38 PM

ORIGINAL SHEET - ARCH E



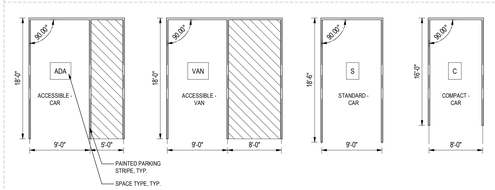
1 GARAGE - LEVEL B2
AG-100B2 1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1775
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

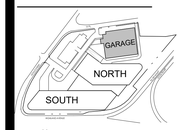
Consultant

No.	By	Issued/Revision
1	ADPC	2022.05.27 YYYY.MM.DD
2		2022.07.27 YYYY.MM.DD

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	41
STANDARD	67
	111
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	43
STANDARD	68
	114
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	50
STANDARD	68
	122
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	69
	130
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	43
STANDARD	66
	111
TOTAL: 981	981

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: 1/8" = 1'-0"

RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

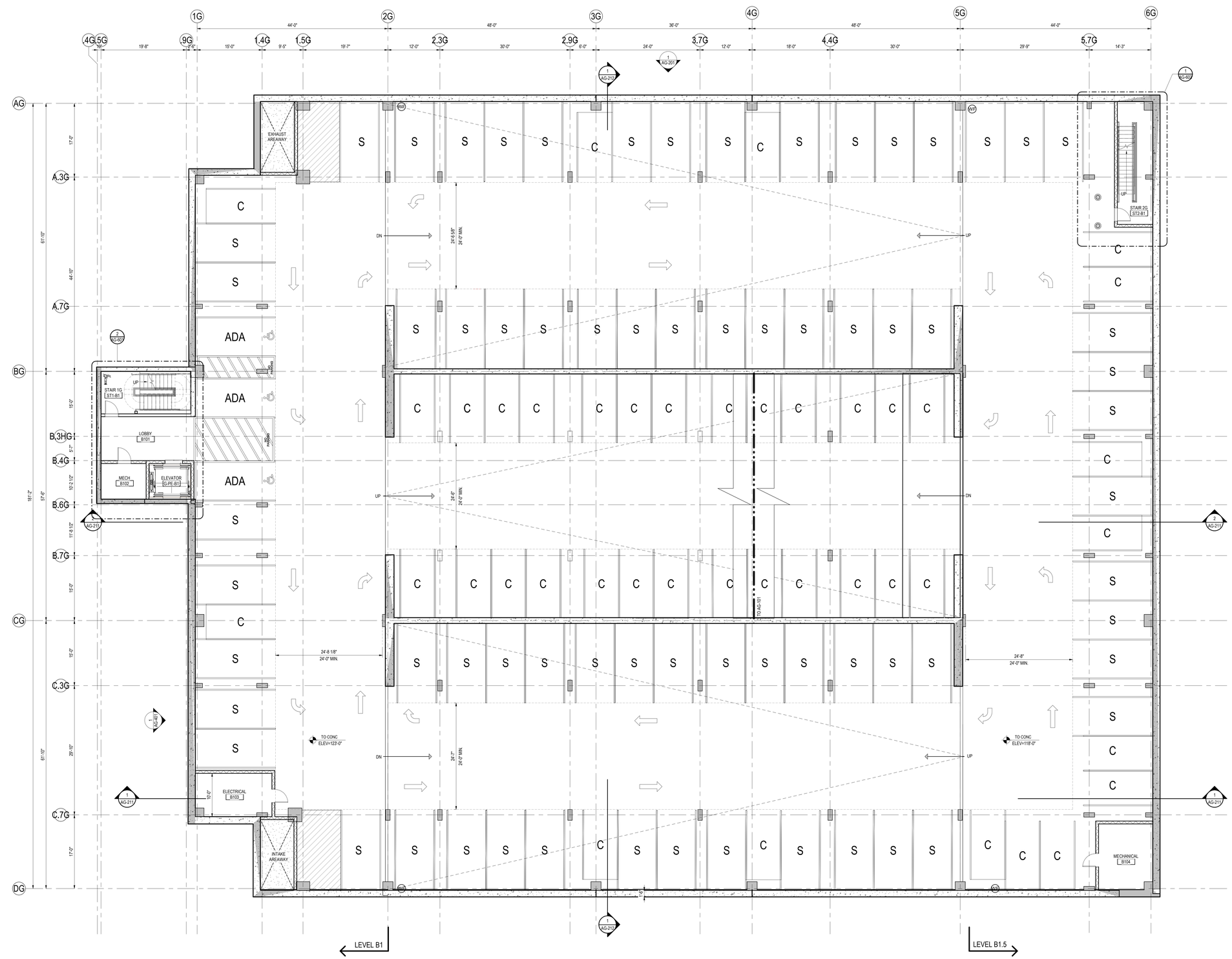
Title
GARAGE LEVEL B2

Revision:

Drawing No.
AG-100B2
GARAGE

\\Rc-boston-fs-1\Project Information\218421343.rvt 5/5/2022 3:41:19 PM

ORIGINAL SHEET - ARCH E



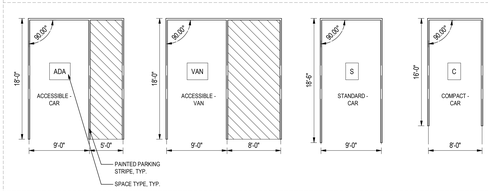
1 AG-100B1 **GARAGE - LEVEL B1**
1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

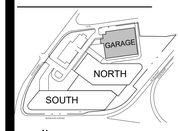
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

Consultant

No.	By	Appd.	YYYY.MM.DD	Issued/Revision
1			2022.05.27	30% DESIGN DEVELOPMENT SET

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	41
STANDARD	67
	111
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	43
STANDARD	68
	114
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	50
STANDARD	68
	122
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	69
	130
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	43
STANDARD	66
	111
TOTAL: 981	981

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A

Scale: 1/8" = 1'-0"

KS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

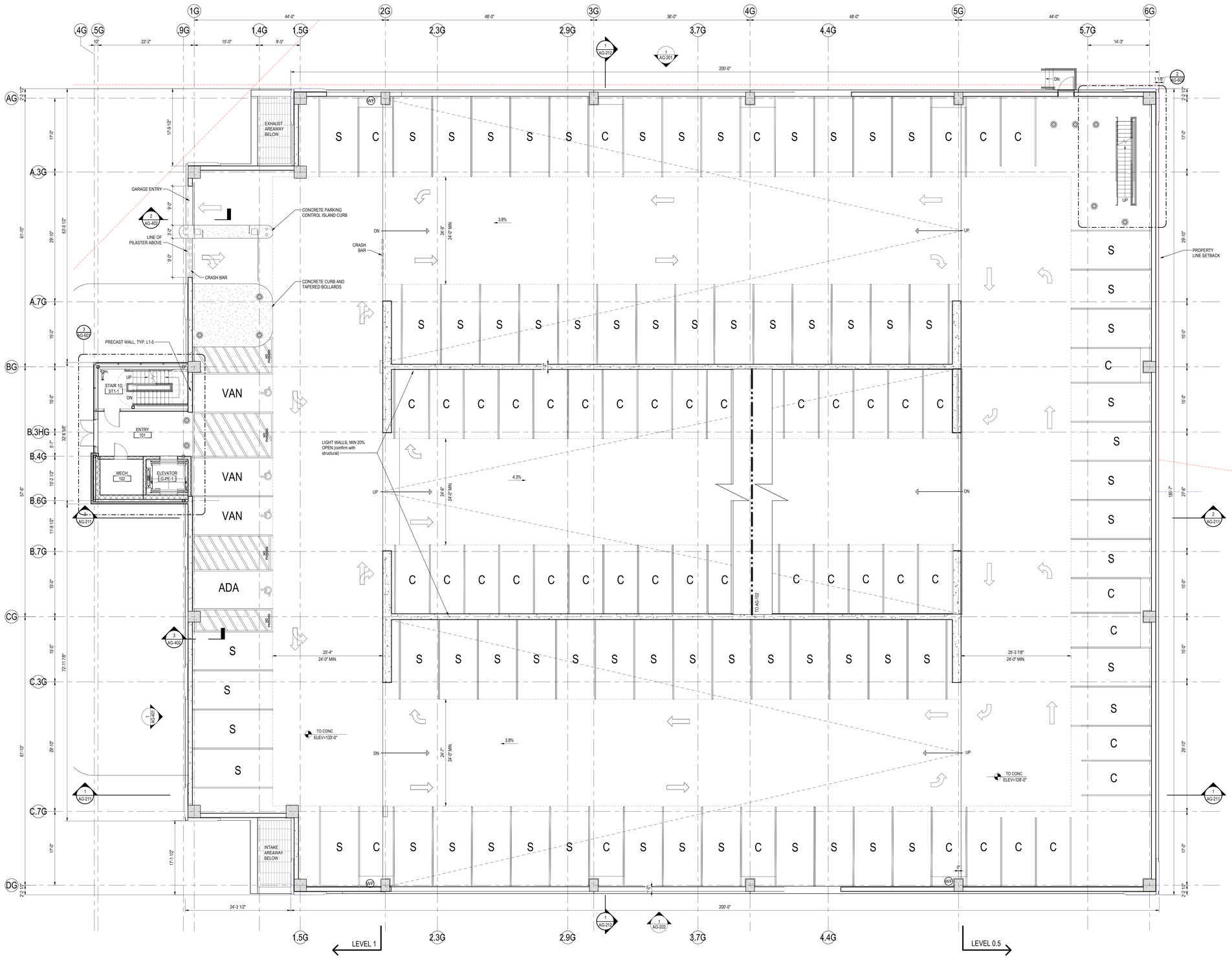
Title
GARAGE LEVEL B1

Revision:

Drawing No.
AG-100B1
GARAGE

*Plot Scaled to Project Information
05/26/2022 3:41:57 PM

ORIGINAL SHEET - ARCH E



1 AG-101 GARAGE - LEVEL 1-

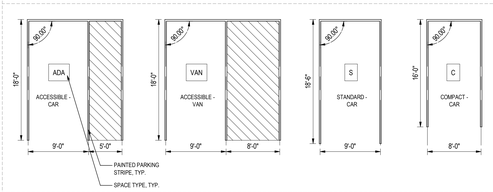
1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

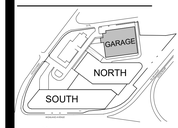
Consultant

No.	By	Appvd	YYYY.MM.DD	Issued/Revision
1	RS	TMU	2022.05.27	30% DESIGN DEVELOPMENT SET

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

GARAGE PARKING COUNT

PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	41
STANDARD	67
	111
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	43
STANDARD	68
	114
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	50
STANDARD	68
	122
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	69
	130
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	43
STANDARD	66
	111
TOTAL: 981	981

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave.
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: 1/8" = 1'-0"

RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

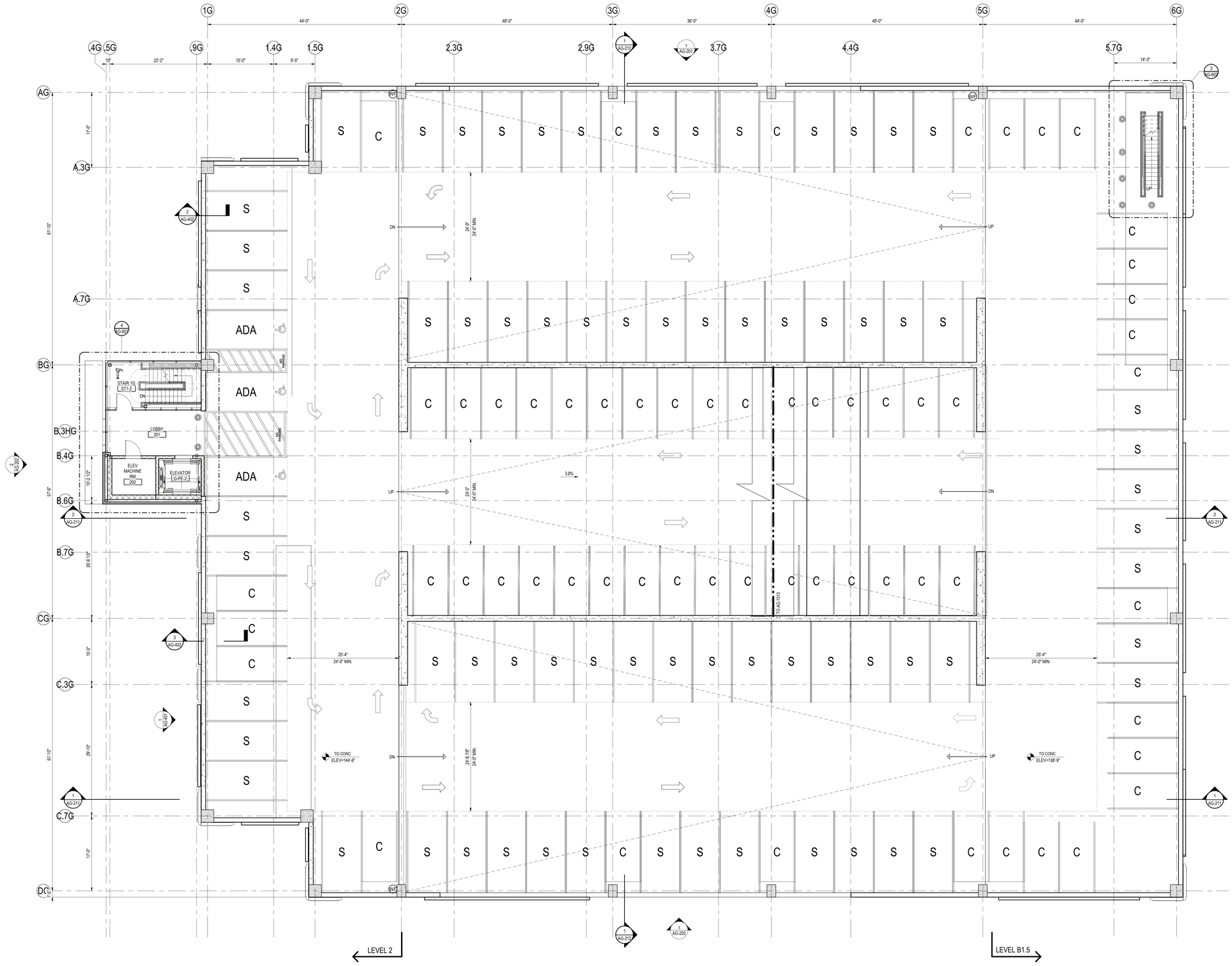
Title
GARAGE LEVEL 1

Revision:

Drawing No.
AG-101
GARAGE

This Drawing is Progress Information Only
2022.5.4 4:21 PM

ORIGINAL SHEET - ARCH E



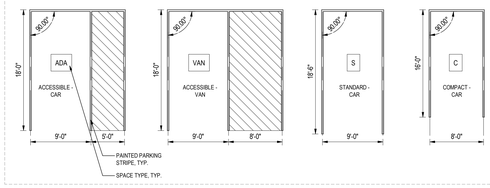
1 GARAGE - LEVEL 2
1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

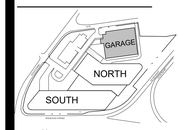
Consultant

No.	By	Appd.	YYYY.MM.DD	Issued/Revision
			2022.03.30	30% DESIGN DEVELOPMENT SET

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	41
STANDARD	67
	111
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	43
STANDARD	68
	114
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	50
STANDARD	68
	122
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	69
	130
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	43
STANDARD	66
	111
TOTAL: 981	981

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave.
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

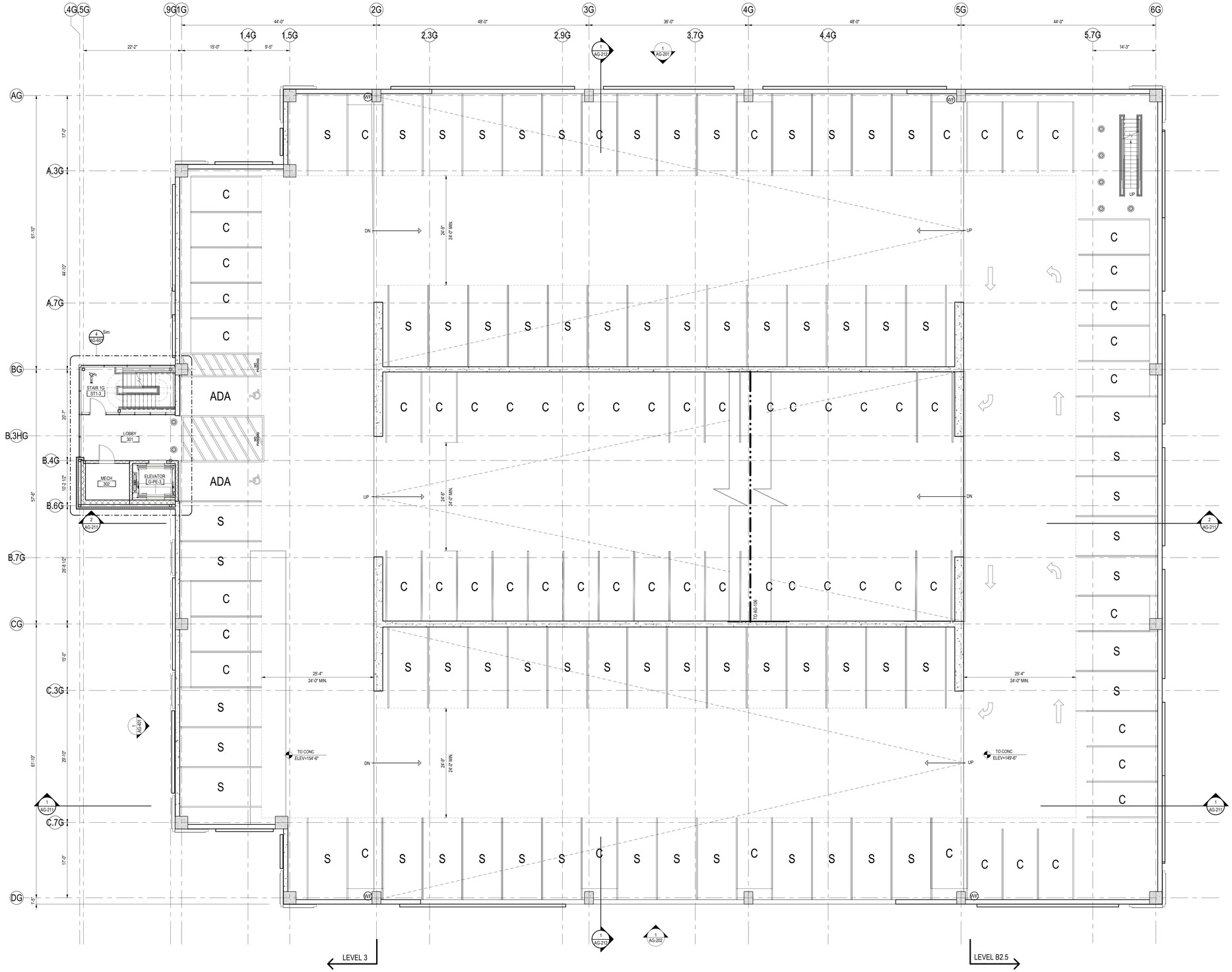
Title
GARAGE LEVEL 2

Revision:

Drawing No.
AG-102
GARAGE

\\Rs-bos-fs1\Projects\Bulfinch\Highland Ave, Needham\Highland Ave, Needham_Garage_Central_22.rvt
5/26/2022 9:43:21 PM

ORIGINAL SHEET - ARCH E



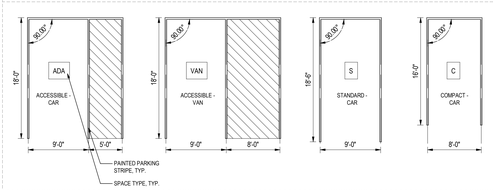
1 AG-103 **GARAGE - LEVEL 3 (LEVEL 4-5 SIM.)**
1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

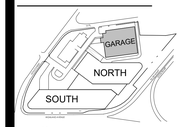
Consultant

No.	By	Issued/Revision
1	Arpan	2022.05.27 - 1ST SUBMISSION

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	41
STANDARD	67
	111
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	43
STANDARD	68
	114
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	50
STANDARD	68
	122
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	69
	130
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	43
STANDARD	66
	111
TOTAL: 981	981

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

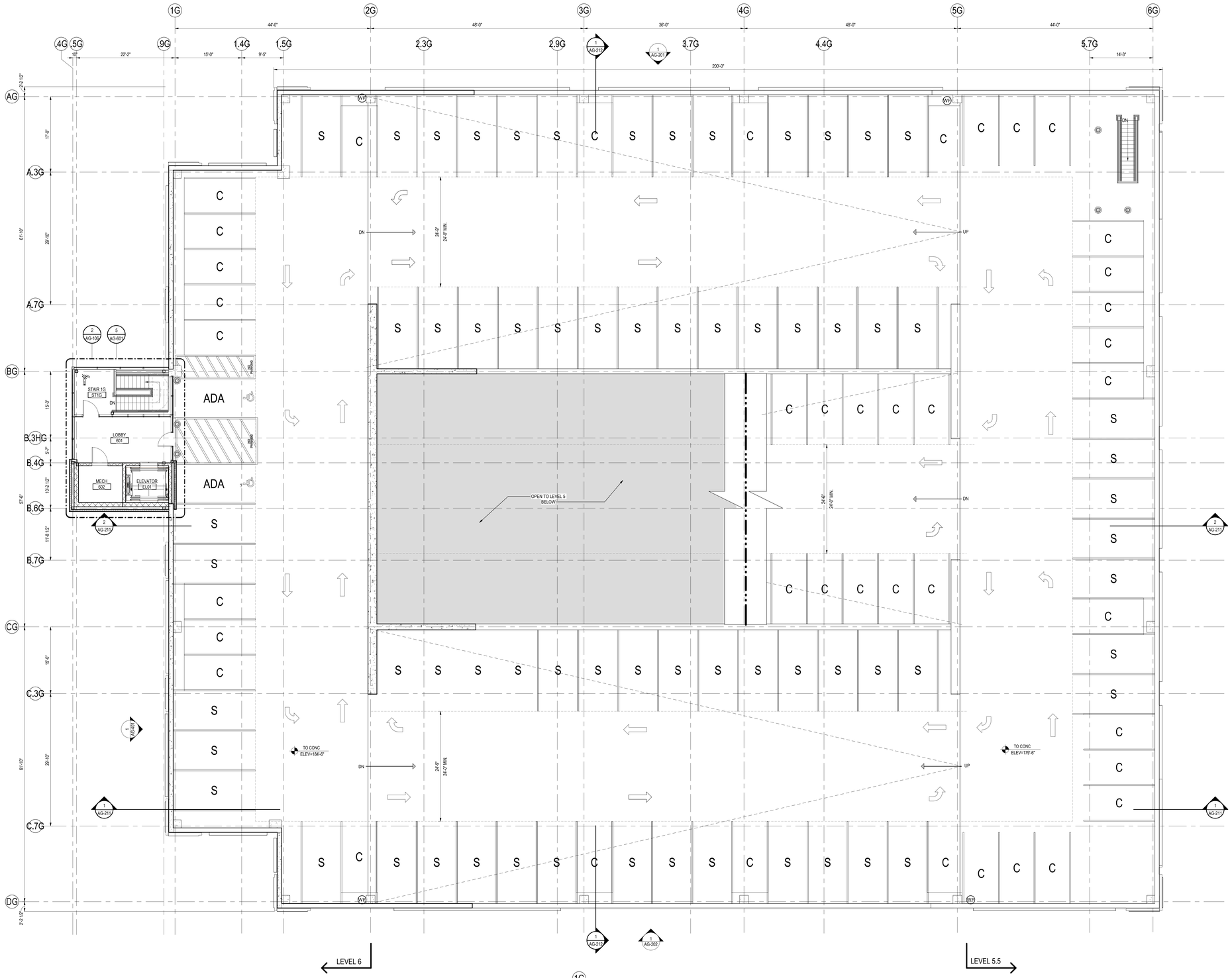
Title
GARAGE LEVEL 3 (LEVEL 4-5 SIM.)

Revision:

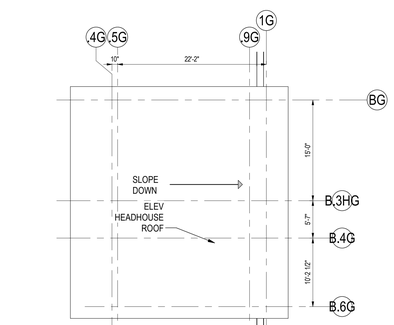
Drawing No.
AG-103
GARAGE

<Bulfinch Project Information>
2/6/2022 9:42 PM

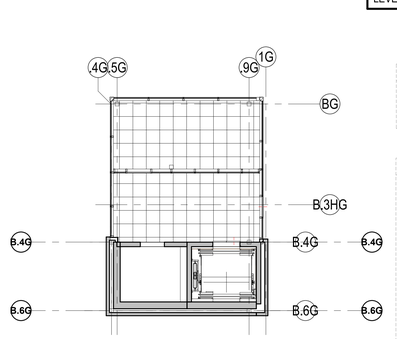
ORIGINAL SHEET - ARCH E



1 AG-106 **GARAGE - LEVEL 6**
1/8" = 1'-0"



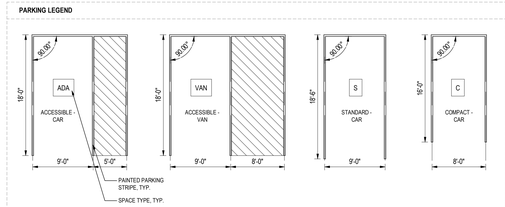
2 AG-106 **GARAGE - MAIN ENTRY ROOF**
1/8" = 1'-0"



3 AG-106 **GARAGE - LEVEL 6 - RCP**
1/8" = 1'-0"

LEGEND
WF WHEELED FIRE EXTINGUISHER
75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions should be reported to Stantec without delay. Copyright reserved. The information contained in this drawing is the property of Stantec and may not be reproduced in any form without permission from Stantec. CADD#: 1-CADD#

Consultant

No.	By	Appvd	YYYY.MM.DD
1	RS	TMU	2022.05.27

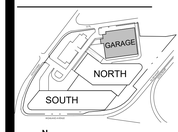
1ST SUBMISSION/PACKAGE #1

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	41
STANDARD	67
	111
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	43
STANDARD	68
	114
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	50
STANDARD	68
	122
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	69
	130
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	63
STANDARD	66
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	43
STANDARD	66
	111
TOTAL: 981	981

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave.
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

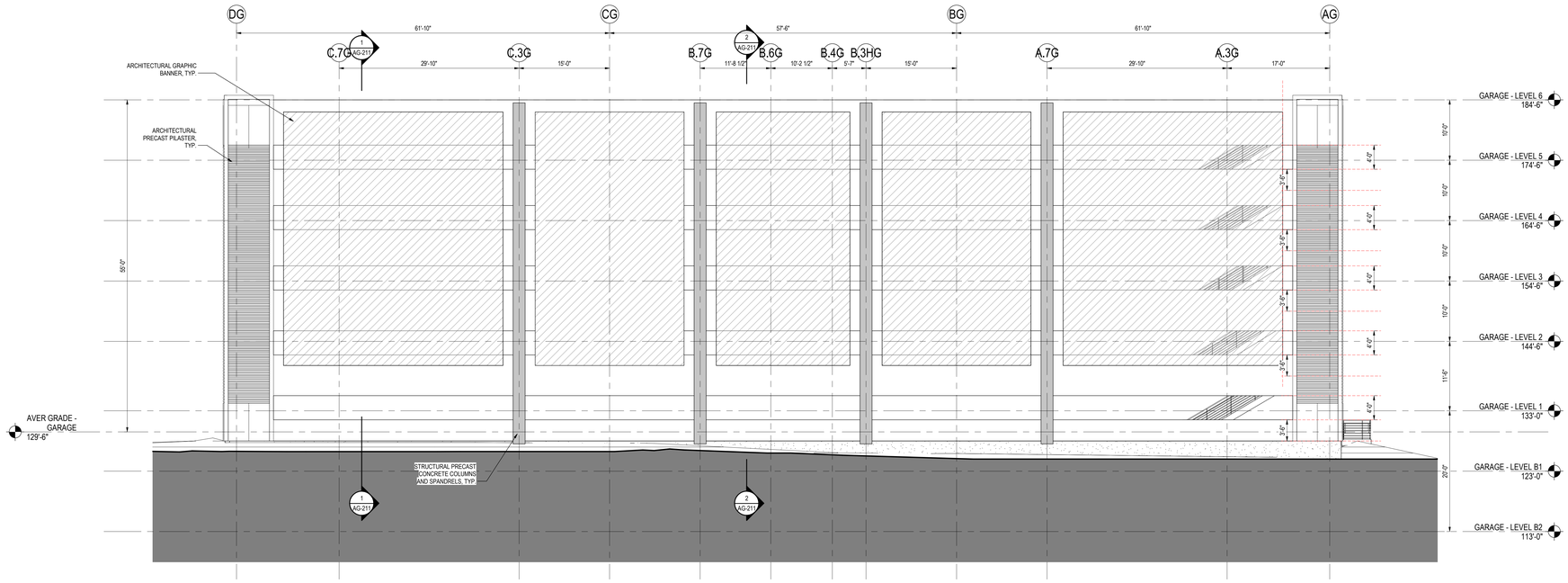
RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 6

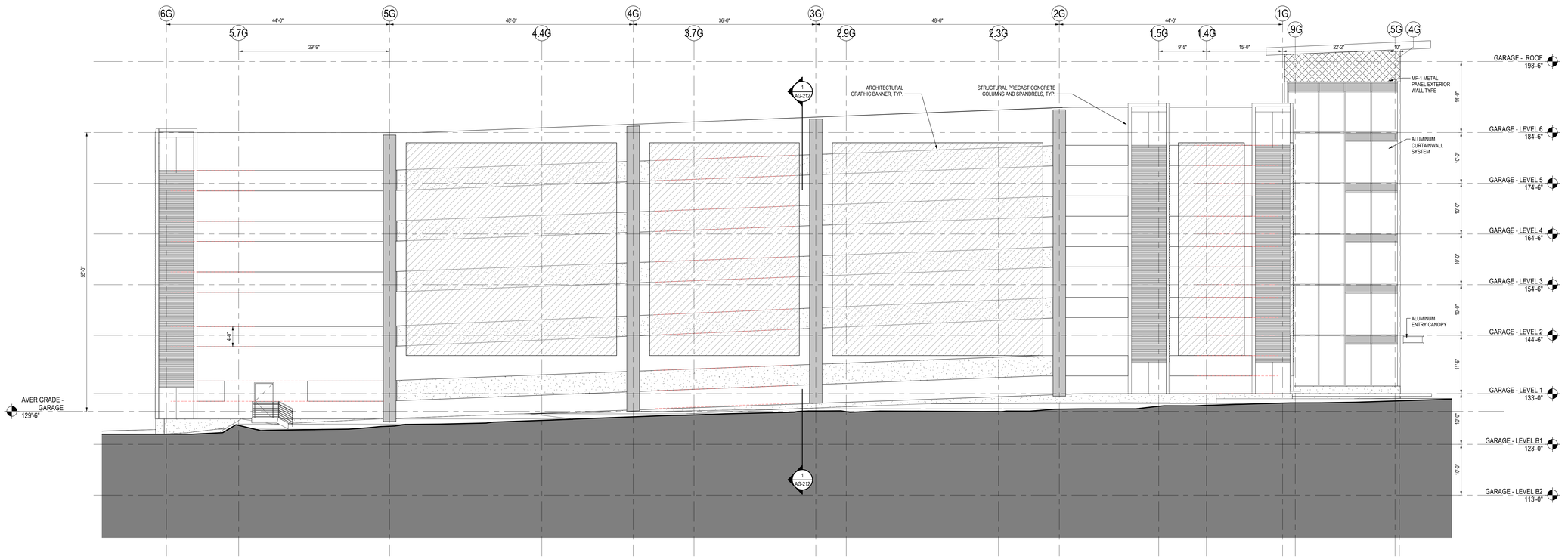
Revision:
Drawing No.
AG-106
GARAGE

<File location>\Project Information>
2/24/2023 9:43 PM

ORIGINAL SHEET - ARCH E



2 AG-201 EAST ELEVATION
1/8" = 1'-0"



1 AG-201 NORTH ELEVATION
1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1573
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

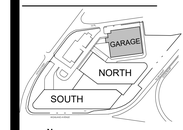
Consultant

No.	By	Appd.	YYYY.MM.DD
1			2022.05.27
			YYYY.MM.DD

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave
Needham, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

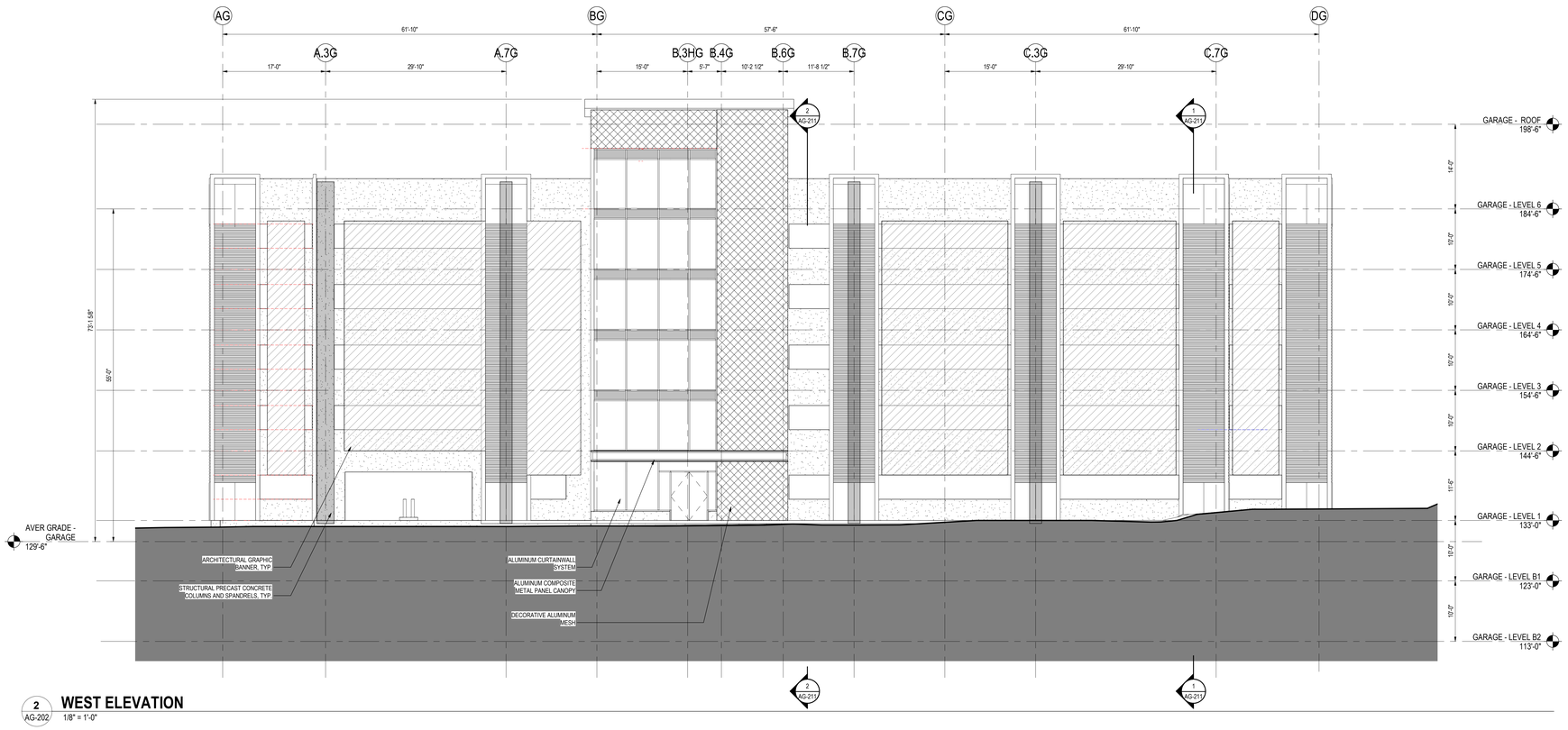
RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ELEVATIONS - NORTH & EAST

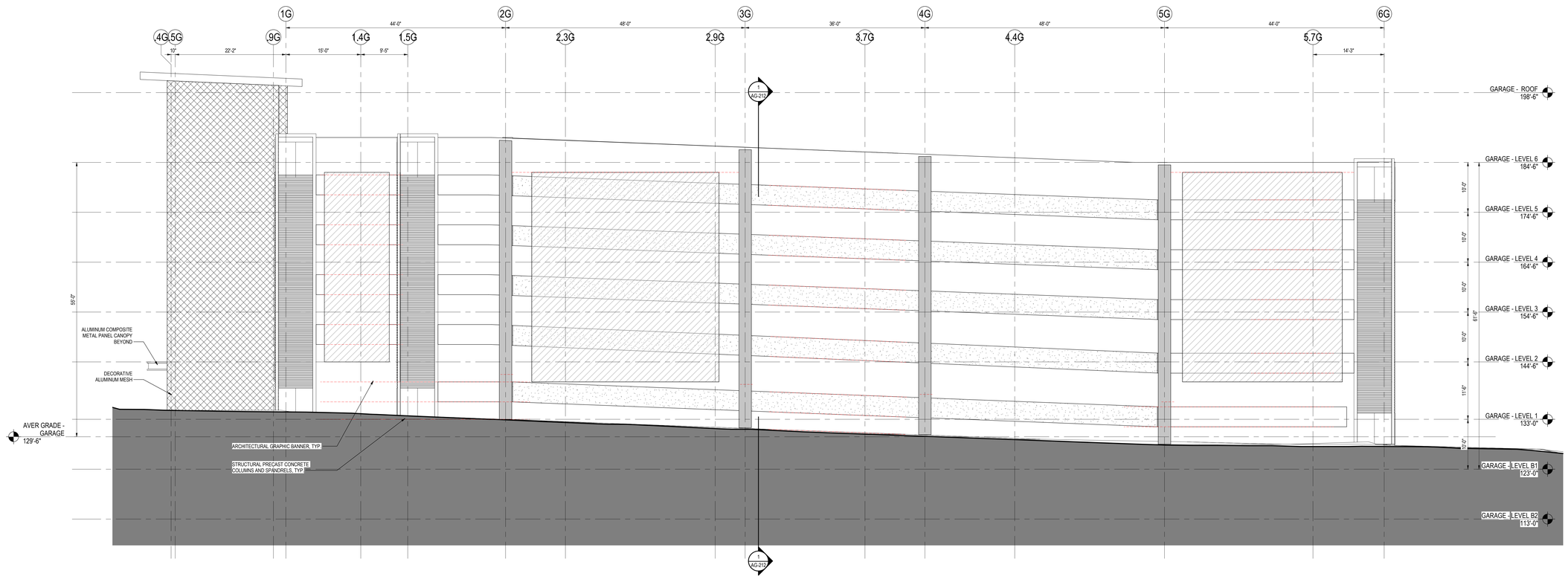
Revision:
Drawing No.
AG-201
GARAGE

<PX Location or Project Information>
1/26/2022 3:14:24 PM

ORIGINAL SHEET - ARCH E



2 AG-202 **WEST ELEVATION**
1/8" = 1'-0"



1 AG-202 **SOUTH ELEVATION**
1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

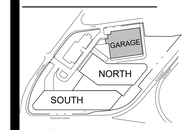
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

Consultant

No.	Issued/Revision	By	YYYY.MM.DD
1	100% DESIGN DEVELOPMENT SET	TMU	2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION
Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave
Needham, MA 02494

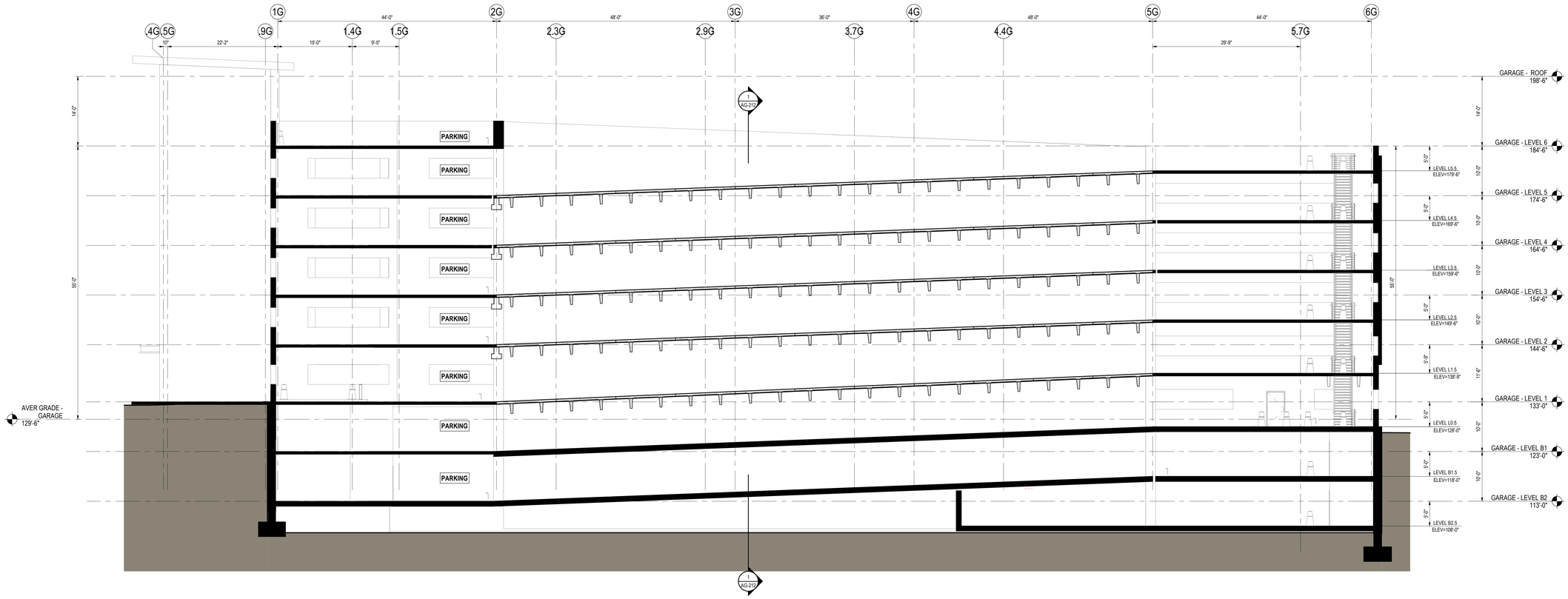
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

BS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ELEVATIONS - SOUTH & WEST

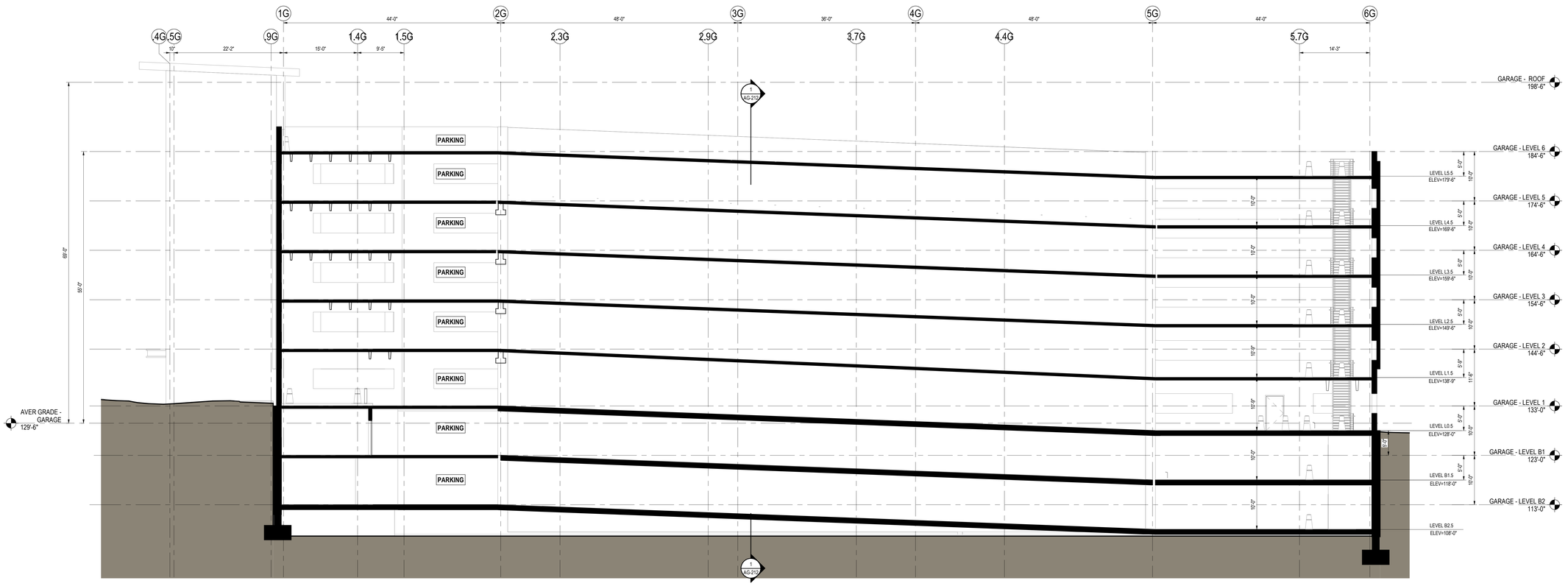
Revision:
Drawing No.
AG-202
GARAGE

<Pro Levitate v.x Project Information>
5/26/2022 9:14:43 PM
ORIGINAL SHEET - ARCH E



2 AG-211 **GARAGE SECTION BB - CENTRAL RAMP**

1/8" = 1'-0"



1 AG-211 **GARAGE SECTION AA - OUTER RAMP**

1/8" = 1'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright and Intellectual Property rights in these plans are and shall remain the property of Stantec whether the project for which they are made is executed or not. The reproduction or use for any purpose other than that authorized by Stantec is forbidden.

Consultant

No.	By	Appd.	YYYY.MM.DD
1	RS	Appd	2022.05.27

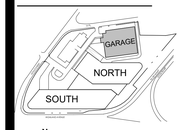
Issued/Revision

SITE DEVELOPMENT PLAN SET

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.



KEY PLAN

Client/Project

Bulfinch

HIGHLAND INNOVATION CENTER - GARAGE

557 Highland Ave
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: 1/8" = 1'-0"

RS	Designer	TMU	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

GARAGE SECTIONS

Revision:

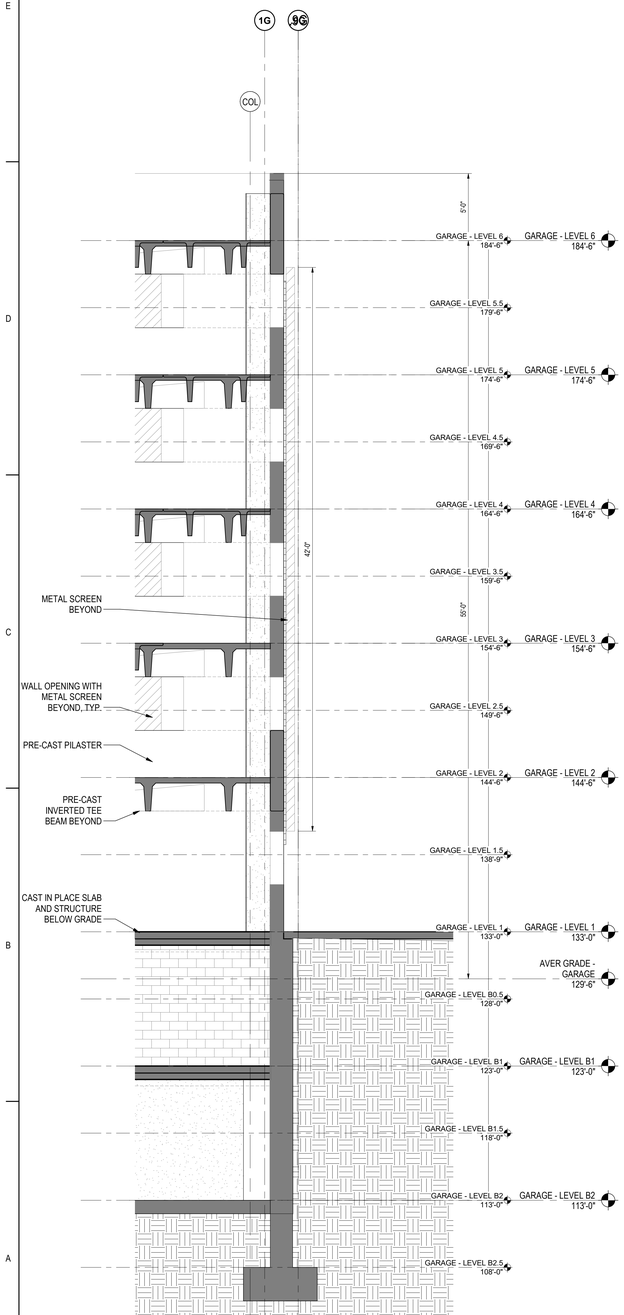
Drawing No.

AG-211

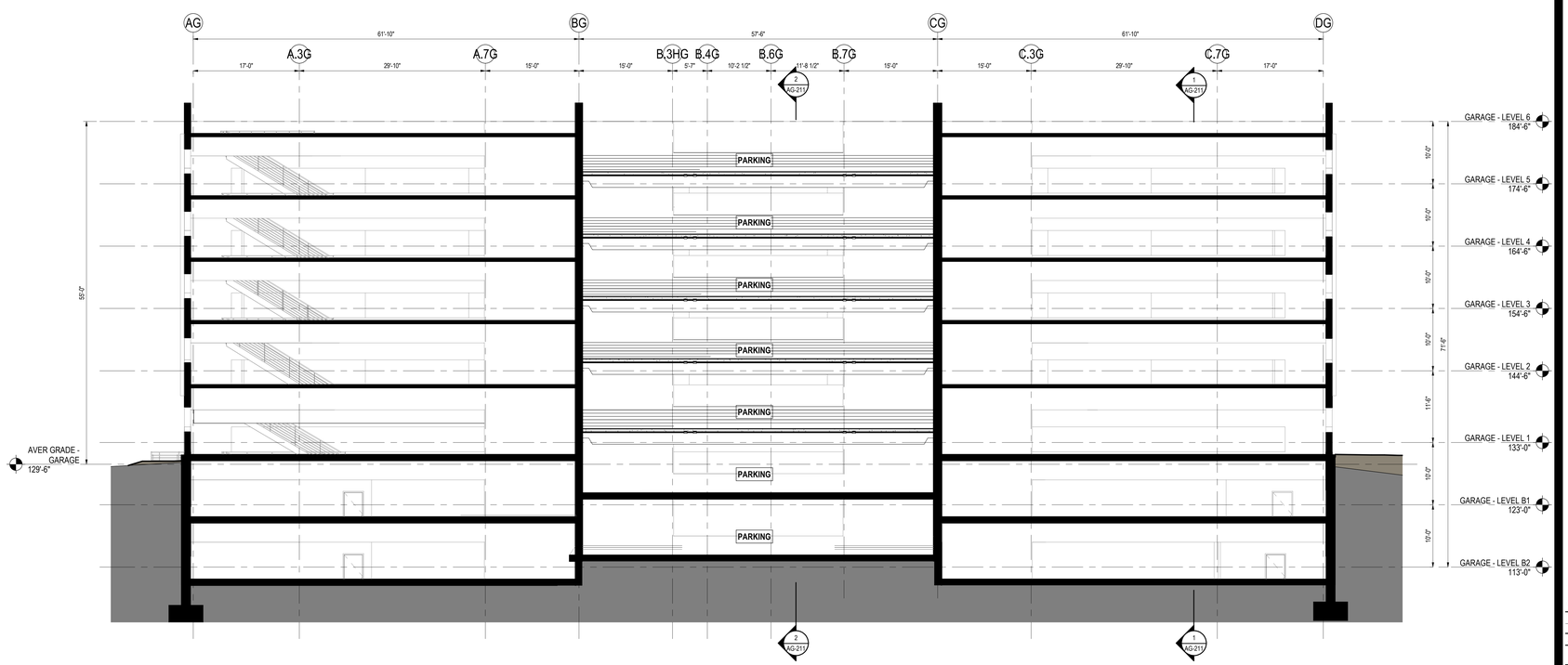
GARAGE

<Pit Number> <Project Information>
1/24/2023 3:41:06 PM

ORIGINAL SHEET - ARCH E



2 TYP. BAY SECTION - FOUNDATION OUTBOARD
2 / AG-212 — 1/4" = 1'-0"



1 GARAGE SECTION CC - Transverse
1 / AG-212 — 1/8" = 1'-0"

Stantec
Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1573
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than those authorized by Stantec is forbidden.

Consultant

No.	By	Issued/Revision	YYYY.MM.DD
1		SPC SUBMISSION PACKAGE #1	2022.05.27

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

KEY PLAN

Client/Project
Bulfinch
HIGHLAND INNOVATION CENTER - GARAGE
557 Highland Ave
Needham, MA 02494

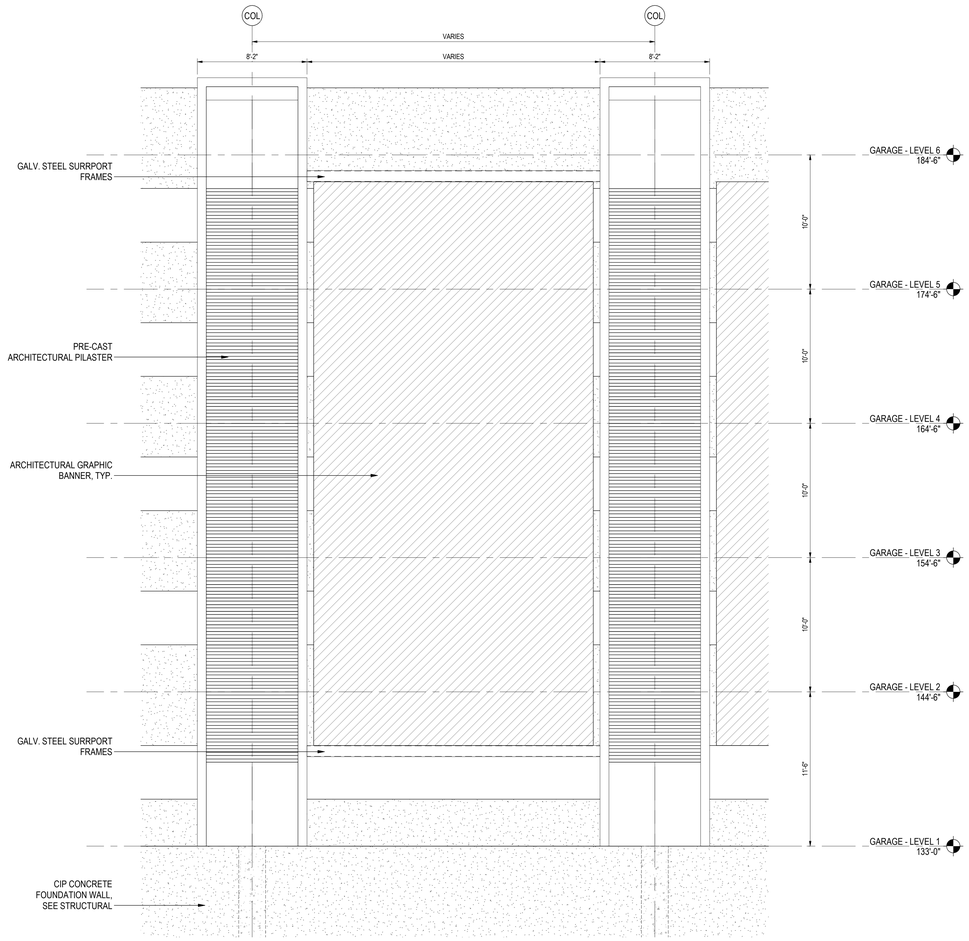
Project No.:218421343
File Name: N/A
Scale: As indicated

By	Designer	Date	2022.05.27
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE SECTIONS

Revision:
Drawing No.
AG-212
GARAGE

<Dy Ex Ref> in Project Information
5/26/2022 3:14:48 PM
ORIGINAL SHEET - ARCH E



1 AG-401 **TYP. BAY ELEVATION**

1/4" = 1'-0"

Stantec

Stantec Architecture and Engineering P.C.
311 Summer Street
Boston MA 02210-1573
Tel: (617) 234-3100 • www.stantec.com

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing. Any errors or omissions shall be reported to Stantec without delay. The Copyright on these documents is retained by Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

Consultant

No.	By	Appd.	YYYY.MM.DD
1			2022.03.07

Issued/Revision

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

Client/Project

Bulfinch

HIGHLAND INNOVATION CENTER - GARAGE

557 Highland Ave
Needham, MA 02494

Project No.:218421343

File Name: N/A

Scale: 1/4" = 1'-0"

Author	Designer	Checker	12/13/21
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title

ENLARGED BAY PLANS, SECTIONS, ELEVATIONS AND DETAILS

Revision:

Drawing No.

AG-401

GARAGE

<Fix Location in Project Information>
12/6/2021 3:4 pM Phil

ORIGINAL SHEET - ARCH E