NEEDHAM PLANNING BOARD
Tuesday June 7, 2022
7:00 p.m.

Powers Hall
Needham Town Hall, 1471 Highland Avenue
AND
Virtual Meeting using Zoom
Meeting ID: **826-5899-3198**
(Instructions for accessing below)

To view and participate in this virtual meeting on your phone, download the "Zoom Cloud Meetings" app in any app store or at www.zoom.us. At the above date and time, click on "Join a Meeting" and enter the following Meeting ID: 826-5899-3198

To view and participate in this virtual meeting on your computer, at the above date and time, go to www.zoom.us click "Join a Meeting" and enter the following ID: 826-5899-3198

Or to Listen by Telephone: Dial (for higher quality, dial a number based on your current location): US: +1 312 626 6799 or +1 646 558 8656 or +1 301 715 8592 or +1 346 248 7799 or +1 669 900 9128 or +1 253 215 8782 Then enter ID: 826-5899-3198

Direct Link to meeting: https://us02web.zoom.us/s/82658993198

1. Minutes.

2. Heather Lane Definitive Subdivision and Heather Lane Extension Definitive Subdivision/Residential Compound Special Permit Bond Reduction.

3. Board of Appeals – June 16, 2022.

4. Public Hearing:

   7:20 p.m. Major Project Site Plan Special Permit No. 2022-02: 557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc., 116 Huntington Avenue, Suite 600, Boston, MA, Petitioner. (Property located at 557 Highland Avenue, Needham, Massachusetts). Regarding proposal to redevelop the Property with approximately 496,694 square feet of office, laboratory and research and development uses (see legal notice and application for more details).

5. Report from Planning Director and Board members.

6. Correspondence.

(Items for which a specific time has not been assigned may be taken out of order.)

NEEDHAM PLANNING BOARD MINUTES

April 12, 2022

The Special Needham Planning Board Virtual Meeting using Zoom was remotely called to order by Paul Alpert, Chairman, on Tuesday, April 12, 2022, at 10:30 a.m. with Messrs. Jacobs and Block and Mmes. McKnight and Espada, as well as Planning Director, Ms. Newman and Assistant Planner, Ms. Clee.

Mr. Alpert took a roll call attendance of the Board members and staff. He noted this is an open meeting that is being held remotely because of Governor Baker's executive order on March 12, 2020 due to the COVID Virus. All attendees are present by video conference. He reviewed the rules of conduct for ~~z~~Zoom meetings. He noted this meeting does not include any public hearings and there will not be any public comment allowed. If any votes are taken at the meeting the vote will be conducted by roll call. All supporting materials, including the agenda, are posted on the town's website.

Decision: Amendment to Major Project Site Plan Special Permit No. 2005-07: Carbon Health Medical Group of Florida, PA, 300 California St (Suite 799), San Francisco, CA and Needham Gateway LLC, 66 Cranberry Lane, Needham, MA, Petitioners (Property located at 100 and 120 Highland Avenue, Needham, MA). Regarding request for a new principal use in the subject property, described as a medical professional office providing primary and walk-in medical care.

Mr. Alpert noted there was a draft decision prepared, then the Board received an extensively red-lined copy from Attorney Rick Mann. He has reviewed the red-lined version. Most of his changes and comments go to the changes requested by Mr. Mann. All members have reviewed both versions. Mr. Mann was brought into the Zoom meeting. Mr. Alpert went through the red-lined version in order. On page 1, Mr. Mann put in a finding that Carbon Health is allowed as a matter of right. This is covered in the 3rd paragraph, and~~.~~ Mr. Alpert~~He~~ does not feel it needs to be added in the 1st paragraph. Mr. Mann stated he has no strong feelings about it. Ms. McKnight agreed with Mr. Alpert that additional wording is not necessary. Mr. Mann is happy to take it out.

Ms. McKnight stated in the 1st paragraph "shopping center" is used but is not defined. This is the place to define that phrase. Mr. Jacobs agreed. Mr. Alpert noted on page 2, Mr. Mann stated Exhibit 5 and 9 refer to the same thing. Ms. Newman noted that was correct and she will fix it. Mr. Alpert noted on page 3, he had no problem with Mr. Mann's one change to Section 1.1. In Section 1.2, the word "Board" should be inserted after "Planning." Ms. McKnight stated that "Shopping Center" is defined in Section 1.2, ~~"Shopping Center" is defined here~~ so it does not need to be defined in the 1st paragraph. Mr. Jacobs would prefer it be inserted on page 1. Mr. Alpert suggested taking it out on page 3 and inserting it on page 1. Mr. Block noted Section 1.5 has 8 staff. He would like added a note that not more than 2 would be a physician, physician assistant or nurse practitioner. Ms. Newman can move the Section 3.9 language over to findings.

Mr. Block noted the hours are 9:00 a.m. to 7:00 p.m. but the hours are modified elsewhere. Mr. Mann stated the hours were changed from the 8:00 a.m. to 8:00 p.m. that was in the application. Mr. Jacobs has no problem with longer hours. Ms. Espada and Ms. McKnight agree. Mr. Block asked what other businesses have been open prior to 9:00 a.m. and after 8:00 p.m. Mr. Mann did not know about the others, but Panera Bread has been. Mr. Block commented they are reducing the traffic factor to have longer hours, so he has no issue with it. All agreed to the hours of 8:00 a.m. to 8:00 p.m. Ms. McKnight noted in Section 1.4, 4th line, after "floor area" "premises" is not defined and not capitalized. It should be defined here as "The Premises." Mr. Mann suggested adding "Premises" here after "in the building." All agreed.

Mr. Alpert noted on page 4, Section 1.7, Mr. Mann added "from any previously approved changes." Why is that there? Mr. Mann stated it is not necessary. It will be removed. Mr. Alpert noted Section 1.9, 7th line, it says 43.33 seats. He thinks it should be spaces. Ms. Newman stated that would be correct. There are 130 seats but 43 spaces plus 20 spaces for 2 take-out stations. Mr. Alpert noted 2 lines below has 3,275 and 4,747. There should be "square feet" after those numbers. At the bottom of the paragraph, take out the last sentence that begins "In the event that the proposed future use of the building…." He stated the applicant is going to have to come back when there is a tenant for FW Webb. Mr. Mann is creating an out under certain circumstances not to come back.

Ms. Newman stated any use going into the Webb building would need a parking waiver. The Board will need to get rid of the parking waiver that was previously granted for that building. Mr. Mann disagreed. He does not see the logic with getting rid of the waiver. The applicant would absolutely have to come back. If the applicant subdivides the Webb building, and have tenants come in a progression of time, they may have an issue with the last one to come in. He does not want to get rid of the waiver. Mr. Alpert stated the parking waiver goes to the entire shopping center. Ms. Newman noted that, the way she drafted the decision, ~~it this~~ the parking waiver now to be granted ~~was~~ only sufficient to allow the use in the Carbon Health building and not the Webb building. Mr. Alpert stated that would bifurcate the parking requirement between the 2 buildings. The special permit allows 96 spaces for the entire shopping center. The Board has waived a total number of spaces so there are 96 spaces. Mr. Mann noted the Board granted the waiver based on a number of uses. The basic waiver of 30 should remain in effect. This is going down a path that is just not right. He suggested the differential between Carbon Health and what was there before. Why not say if a new use exceeds 25 spaces the applicant needs to come back? Mr. Block stated there is a potential some parking engineer did not get it right. Under any new lease it would require a presentation and further amendment to the special permit. Mr. Alpert stated the parking study showed, at the peak hour, there were possibly 87 spaces filled, which would leave only 9 spaces empty. At peak hours they do not have 24 spaces. Mr. Mann stated any retailer would be looking at the parking situation and would not want to be where there is no parking.

Mr. Jacobs noted he has to leave soon. He stated the Board should vote the relief and wordsmith it later.

Upon a motion made by Mr. Block, and seconded by Mr. Jacobs, it was by a roll call vote of the five members present unanimously:

VOTED: to grant: (1) an amendment to Major Project Site Plan Review Special Permit No. 2005-07 issued by the Needham Planning Board under Section 7.4 of the Needham Zoning By-Law and Further Site Plan Review under Section 4.2 of Major Project Site Plan Special Permit No. 2005-07 dated January 24, 2006, amended August 15, 2006, December 19, 2006, April 1, 2008, November 15, 2011, March 6, 2012, July 10, 2012, August 13, 2012, July 20, 2021 and March 28, 2022 and (2) a Special Permit Amendment under Section 5.1.1.5 of the By-Law, to waive strict adherence with the requirements of Sections 5.1.2 and 5.1.3 of the By-Law (required parking and parking plan and design requirements, respectively): subject to the following plan modifications, conditions and limitations.

Mr. Alpert stated the Board will finish the discussion on wording at the next meeting. Ms. Newman noted there will need to be a special meeting. Mr. Jacobs left the meeting at 11:30 a.m.

Peer review pursuant to M.G.L. c.44, §53G – Traffic impacts associated with the Highland Innovation Center, 557 Highland Avenue, Needham, MA.

Ms. Newman stated there was a filing on the Muzi property. There was a finding that a peer review was necessary. Greenman-Pedersen, Inc. (GPI) has submitted a proposal for a peer review. She stated the total amount would be $30,598.84. Mr. Block noted it was $34,650.89 on the spreadsheet.

Upon a motion made by Mr. Block, and seconded by Ms. McKnight, it was by a roll call vote of the four members present unanimously:

VOTED: the Planning Board recommends the need for a peer review for traffic impacts associated with the proposed redevelopment of 557 Highland Avenue and further requires the developer to finance the peer review which shall not exceed $34,651.

Executive session pursuant to M.G.L. c.30A, §21(a)(3) to pending litigation – Appeal of Planning Board decision on 1688 Central Avenue.

A motion was made to convene in Executive session. Mr. Block noted Ms. Espada was recused during the matter but has been named in the applicant's appeal. Both the applicant's attorney and the town's attorney have agreed to remove Ms. Espada from the legal proceeding. Mr. Block, Mr. Alpert and Ms. McKnight will be the only members of the Board participating in the executive session~~there~~.

Upon a motion made by Mr. Block, and seconded by Ms. McKnight, it was by a roll call vote of the five members present unanimously:

VOTED: to convene an executive session for the purposes of discussing strategy with respect to litigation being Needham Enterprises LLC vs the Town of Needham Planning Board because the Chair has determined that having the discussion in open session would have a detrimental effect on the Board's litigation position and to allow the Town Planner and the Assistant Town Planner to participate as non-members in the discussion and to adjourn at the conclusion of the session without returning to the open session at 11:30 a.m.

Respectfully submitted,
Donna J. Kalinowski, Notetaker

_____
Adam Block, Vice-Chairman and Clerk

From: Bill Piersiak
To: Alexandra Clee; Robert Smart Office
Subject: Heather Lane & Heather Lane Extension Bond Reduction
Date: Tuesday, May 17, 2022 7:13:09 AM

Alex,

I would like to formally request a reduction in the bond amount for both Heather Lane and Heather Lane Extension. Although the road is not 100% complete, it is substantially more advanced than when the bond was posted.

I am happy to meet with you or the DPW to discuss the progress, review the process and get you any information you may need in order to process the request.

I await your direction.

Thank you.

Bill Piersiak
617 759 9820

Sent from my iPhone

PLANNING & COMMUNITY DEVELOPMENT
PLANNING DIVISION

MEMORANDUM

TO: Thomas Ryder –Engineering Department

CC: Carys Lustig – Public Works Department

FROM: Planning Department

DATE: May 23, 2022

SUBJECT: **Reduction of Surety -** DEFINITIVE SUBDIVISION PLANS
Heather Lane Definitive Subdivision
764, 766, 768-768A & 768B Chestnut Street, Needham, MA

Enclosed please find a copy of an email from Bill Piersiak, directed to Lee Newman, Director of Planning and Community Development, dated May 17, 2022. Mr. Piersiak is requesting the reduction of the surety being held for roadway improvements on the Heather Lane Definitive Subdivision.

The Town is presently holding $136,500.000. This amount includes $122,500.00 to be held for roadway improvements in accordance with the recommendations of the Needham Public Works Department and $14,000.00 to be held for off-street drainage in accordance with the recommendations of the Board of Health. The off-street drainage surety is being held for Lots 1, Lot 3, Lot 5 and Lot 6.

Please review this request and provide the Planning Board with a recommendation relative to the reduction of the above-described performance surety. The Planning Board will be considering this request at its meeting of Tuesday, June 7, 2022, and would appreciate receiving your recommendation by noon on Thursday June 2, 2022.

For your review I have enclosed your original bond estimate and Mr. Piersiak's request.

Thank you for your attention to this matter.

TOWN OF NEEDHAM, MASSACHUSETTS
PUBLIC WORKS DEPARTMENT
500 Dedham Avenue, Needham, MA 02492
Telephone (781) 455-7550 FAX (781) 449-9023

June 24, 2021

Needham Planning Board
Public Service Administration Building
Needham, MA 02492

RE: Definitive Subdivision- Heather Lane
Off Chestnut Street-Request for Bond to release Lots

Dear Members of the Board:

The Department of Public Works has conducted several inspections of the subdivision. Per your request the following is the estimate of the remaining work required for the above referenced project.

Our estimate to complete this work is calculated as follows:

Item	Unit	Unit Price	Amount
Final ROW berm/seed	LS	$13,500	$13,500
Asphalt top course	LS	$42,500	$42,500
Bounds	LS	$5,500	$5,500
Curbs	LS	$35,000	$35,000
Asbuilt Plans/NPDES	LS	$6,000	$6,000
		Subtotal	$102,500
~ 15% Engineering and Contingency			$15,375
		Subtotal	$117,875
~ 2.0% inflation per year for 2-years		TOTAL:	**$122,500**

If you have any questions regarding the above, please contact our office at 781-455-7538.

Truly yours,

Sincerely,

Thomas A Ryder
Assistant Town Engineer

TOWN OF NEEDHAM, MASSACHUSETTS
PUBLIC WORKS DEPARTMENT
500 Dedham Avenue, Needham, MA 02492
Telephone (781) 455-7550 FAX (781) 449-9023

June 7, 2022

Needham Planning Board
Public Service Administration Building
Needham, MA 02492

RE: Definitive Subdivision- Heather Lane
Off Chestnut Street-Request for Bond to release Lots

Dear Members of the Board:

The Department of Public Works has conducted several inspections of the subdivision. Per your request the following is an updated estimate of the remaining work required for the above referenced project.

Our estimate to complete this work is calculated as follows:

Item	Unit	Unit Price		Amount
Asphalt top course	LS	$42,500		$42,500
Bounds	LS	$5,500		$5,500
Curbs	LS	$25,000		$25,000
Asbuilt Plans/NPDES	LS	$6,000		$6,000
		Subtotal	$79,000	
~ 15% Engineering and Contingency				$11,850
		Subtotal	$90,850	
~ 2.0% inflation per year for 2-years		TOTAL:		**$95,000**

If you have any questions regarding the above, please contact our office at 781-455-7538.

Truly yours,

Sincerely,

Thomas A Ryder
Town Engineer

PLANNING & COMMUNITY DEVELOPMENT
PLANNING DIVISION

MEMORANDUM

TO: Thomas Ryder –Engineering Department

CC: Carys Lustig – Public Works Department

FROM: Planning Department

DATE: May 23, 2022

SUBJECT: **Reduction of Surety -** DEFINITIVE SUBDIVISION PLANS
Heather Lane EXTENSION Definitive Subdivision
768 and 768A Chestnut Street, Needham, MA

Enclosed please find a copy of an email from Bill Piersiak, directed to Lee Newman, Director of Planning and Community Development, dated May 17, 2022. Mr. Piersiak is requesting the reduction of the surety being held for roadway improvements on the Heather Lane Extension Definitive Subdivision.

The Town is presently holding $52,000.000. This amount includes $34,500.00 to be held for roadway improvements in accordance with the recommendations of the Needham Public Works Department and $17,500.00 to be held for off-street drainage in accordance with the recommendations of the Board of Health. The off-street drainage surety is being held for RC-Lot 1, RC-Lot 2, RC-Lot 3, RC-Lot 4, and RC-Lot 5.

Please review this request and provide the Planning Board with a recommendation relative to the reduction of the above-described performance surety. The Planning Board will be considering this request at its meeting of Tuesday, June 7, 2022, and would appreciate receiving your recommendation by noon on Thursday June 2, 2022.

For your review I have enclosed your original bond estimate and Mr. Piersiak's request.

Thank you for your attention to this matter.

TOWN OF NEEDHAM, MASSACHUSETTS
PUBLIC WORKS DEPARTMENT
500 Dedham Avenue, Needham, MA 02492
Telephone (781) 455-7550 FAX (781) 449-9023

June 24, 2021

Needham Planning Board
Public Service Administration Building
Needham, MA 02492

RE: Definitive Subdivision- Heather Lane Extension
768 and 768A Chestnut Street-Request for Bond to release Lots

Dear Members of the Board:

The Department of Public Works has conducted several inspections of the subdivision. Per your request the following is the estimate of the remaining work required for the above referenced project.

Our estimate to complete this work is calculated as follows:

Item	Unit	Unit Price		Amount
Final drive berm/seed	LS	$5,500		$5,500
Asphalt top course	LS	$17,500		$17,500
Asbuilt Plans/NPDES	LS	$6,000		$6,000
		Subtotal	$29,000	
~ 15% Engineering and Contingency				$3,350
		Subtotal	$33,350	
~ 2.0% inflation per year for 2-years		TOTAL:		**$34,500**

If you have any questions regarding the above, please contact our office at 781-455-7538.

Truly yours,

Sincerely,

Thomas A Ryder
Assistant Town Engineer

TOWN OF NEEDHAM, MASSACHUSETTS
PUBLIC WORKS DEPARTMENT
500 Dedham Avenue, Needham, MA 02492
Telephone (781) 455-7550 FAX (781) 449-9023

June 6, 2021

Needham Planning Board
Public Service Administration Building
Needham, MA 02492

RE: Definitive Subdivision- Heather Lane Extension
768 and 768A Chestnut Street-Request for Bond to release Lots

Dear Members of the Board:

The Department of Public Works has conducted several inspections of the subdivision. Per your request the following is an updated estimate of the remaining work required for the above referenced project.

Our estimate to complete this work is calculated as follows:

Item	Unit	Unit Price		Amount
Asphalt top course	LS	$17,500		$17,500
Asbuilt Plans/NPDES	LS	$6,000		$6,000
		Subtotal	$23,500	
~ 15% Engineering and Contingency				$3,500
		Subtotal	$27,000	
~ 2.0% inflation per year for 2-years		TOTAL:		**$28,000**

If you have any questions regarding the above, please contact our office at 781-455-7538.

Truly yours,

Sincerely,

Thomas A Ryder
Town Engineer

NEEDHAM
ZONING BOARD OF APPEALS
AGENDA

THURSDAY, June 16, 2022 - 7:30PM

Zoom Meeting ID Number: 869-6475-7241

To view and participate in this virtual meeting on your computer, at the above date and time, go to www.zoom.us, click "Join a Meeting" and enter the Meeting ID: 869-6475-7241

Or join the meeting at link: https://us02web.zoom.us/j/86964757241

AGENDA

Minutes	Review and approve Minutes from May 19, 2022 meeting.
Case #1 – 7:30PM	**68 Wilshire Park -** Public notice is hereby given that Adam Pase, applicant, has made application to the Board of Appeals to amend the Special Permit dated June 17, 2021 by substituting new plans for the Revised Building Plans approved in the Special Permit. The property is located at 68 Wilshire Park, Needham, MA in the Single Residence B (SRB) District.
Case #2 – 7:30 PM	**35 Highland Circle –** Public notice is hereby given that Zdorovie ADH Needham has made application to the Board of Appeals for a Special Permit under Sections 3.2.5.2 (b), 5.1.2, 5.13 and any other applicable Sections of the By-Law to the allow the use of an adult day care facility and to waive strict adherence to parking and parking design requirements associated with the conversion of the ground level garage of a three floor office building to house an adult day health program with capacity of 80 clients and 13 staff members. The property is located at 35 Highland Circle, Needham, MA in the Mixed-Use 128 (MU-128) District.
Case #3- 7:45PM	**670 Highland Avenue, 284 Webster Street and 28 Greendale Avenue –** Temple Beth Shalom and Davenport Holding Properties, Inc., applicants, applied to the Board of Appeals for an Special Permit Amendment under Sections 1.4.2, 5.1.1.5, 5.1.2, 5.1.3 and any other applicable Sections of the By-Law to provide relief for the following: a) an extension of the 2015 Special Permit to expand the parking lot due to the acquisition of the properties at 284 Webster Street and 28 Greendale Avenue; b) a waiver of strict adherence to the parking space and parking design requirements; and c) the continuance of pre-existing nonconforming buildings and structures, and uses thereon. This request is associated with the demolition of the existing house and garage at 284 Webster Street and the construction of a parking lot connected to the existing Temple driveway and main parking lot; and the renovations of the house and garage at 28 Greendale Avenue for use as additional classroom space. The property is located at 670

Highland Avenue, 284 Webster Street, and 28 Greendale Avenue, Needham, MA in the Single Residence B (SRB) District. (Continued from May 19, 2022)

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ZBA Application For Hearing

Applicants must consult with the Building Inspector prior to filing this Application. *Failure to do so will delay the scheduling of the hearing.*

Applicant Information

Applicant Name	Adam Pase		Date: 5/23/22
Applicant Address	68 Wilshire Park, Needham		
Phone	(202) 420-8076	email	adam.pase@gmail.com

Applicant is ☒Owner; ☐Tenant; ☐Purchaser; ☐Other_____

If not the owner, a letter from the owner certifying authorization to apply must be included

Representative Name	George Giunta, Jr.		
Address	281 Chestnut Street, Needham, MA 02492		
Phone	(781) 449-4520	email	george.giuntajr@needhamlaw.net

Representative is ☒Attorney; ☐Contractor; ☐Architect; ☐Other_____

Contact ☒Me ☐Representative in connection with this application.

Subject Property Information

Property Address	68 Wilshire Park, Needham		
Map/Parcel Number	Map No. 31 Parcel 47	Zone of Property	SR-B

Is property within 100 feet of wetlands, 200 feet of stream or in flood Plain?
☒Yes ☐No

Is property ☒Residential or ☐Commercial

If residential renovation, will renovation constitute "new construction"?
☒Yes ☐No

If commercial, does the number of parking spaces meet the By-Law requirement? ☐Yes ☐No
Do the spaces meet design requirements? ☐Yes ☐ No

Application Type (*select one*): ☐Special Permit ☐Variance ☐Comprehensive Permit ☒Amendment ☐Appeal Building Inspector Decision

ZBA Application For Hearing

Existing Conditions:
Existing single family residence currently permitted under permit No. BR-22-10289 for interior and exterior
renovations. Existing Second Flr ceilings are under 8ft. High.

Statement of Relief Sought:
Owner/Resident seaking relief for the following;
1. Add (2) additional dormers at existing front facade 2nd flr. windows
2. Raise existing ridge line 1'-6" to accommodate raising 2nd flr. ceiling height 1'-0"

Applicable Section(s) of the Zoning By-Law:

If application under Zoning Section 1.4 above, list non-conformities:

	Existing Conditions	**Proposed Conditions**
Use	Residence	Residence
# Dwelling Units	1	1
Lot Area *(square feet)*	7,622sf	7,622sf
Front Setback *(feet)*	20'	20'
Rear Setback *(feet)*	56.9'	56.9'
Left Setback *(feet)*	5.6'	5.6'
Right Setback *(feet)*	10.8	10.8'
Frontage *(feet)*	67'	67'
Lot Coverage *(%)*	20.8	20.8
FAR *(Floor area divided by the lot area)*		

Numbers must match those on the certified plot plan and supporting materials

ZBA Application For Hearing

Date Structure Constructed including additions:	Date Lot was created:

Submission Materials	Provided
Certified Signed Plot Plan of Existing and Proposed Conditions *(Required)*	
Application Fee, check made payable to the Town of Needham Check holders name, address, and phone number to appear on check and in the Memo line state: "ZBA Fee – Address of Subject Property" *(Required)*	
If applicant is tenant, letter of authorization from owner *(Required)*	
Electronic submission of the complete application with attachments *(Required)*	
Elevations of Proposed Conditions *(when necessary)*	
Floor Plans of Proposed Conditions *(when necessary)*	

Feel free to attach any additional information relative to the application. Additional information may be requested by the Board at any time during the application or hearing process.

❖❖❖❖

I hereby request a hearing before the Needham Zoning Board of Appeals. I have reviewed the Board Rules and instructions.

I certify that I have consulted with the Building Inspector May 17, 2022
date of consult

Date: 05/23/2022 Applicant Signature Adam Pase

An application must be submitted to the Town Clerk's Office at townclerk@needhamma.gov and the ZBA Office at dcollins@needhamma.gov

Construction Documents for
the Renovation and Addition to the:

PASE RESIDENCE

68 Wilshire Park
Needham, Massachusetts

1 October 2021
Revised: 8 February 2022

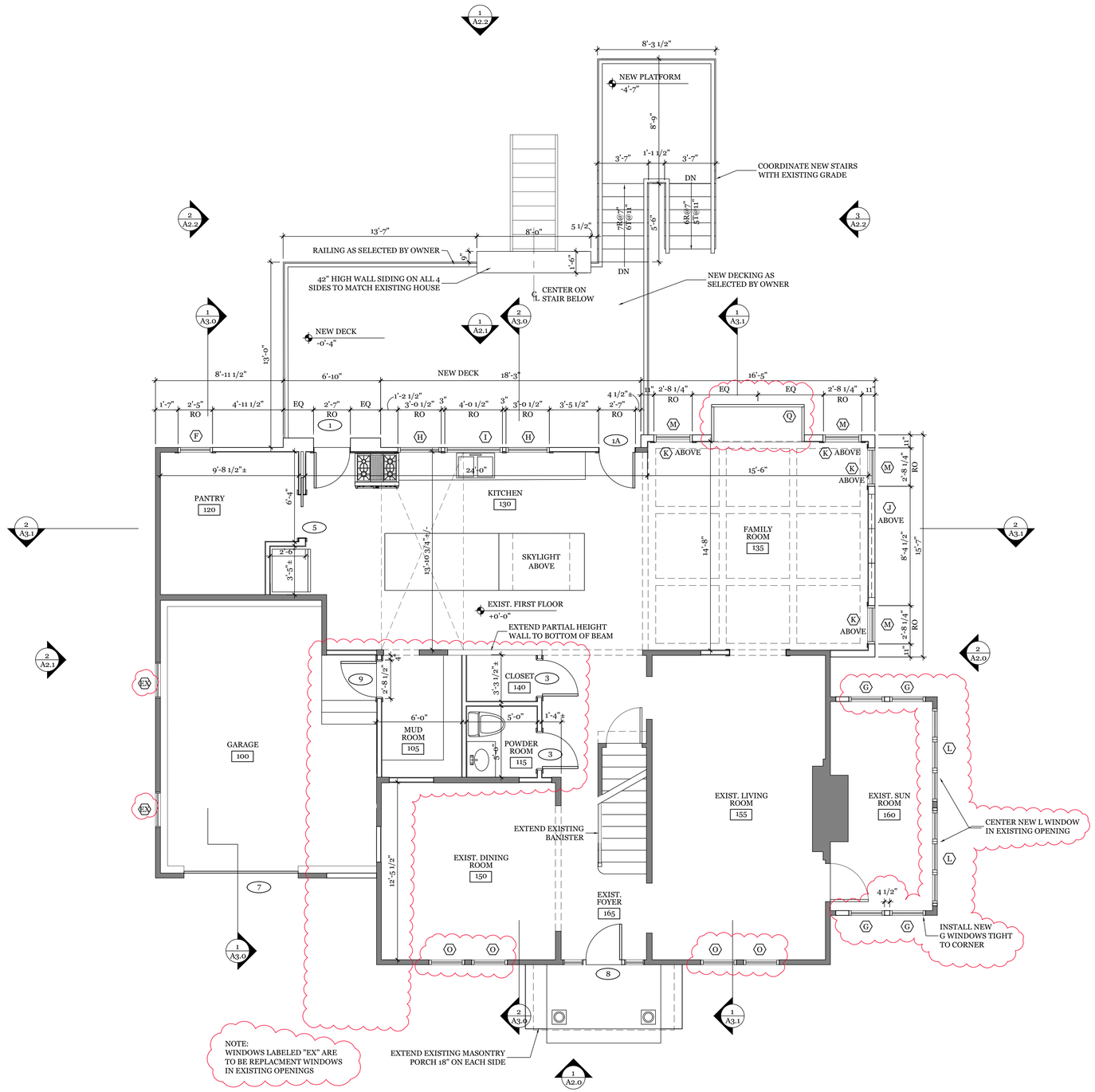
ARCHITECT

SMOOK Architecture & Urban Design, Inc.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
P: 617 423 3040

www.smookarchitecture.com

Patrice Fotino
E: fotino@smookarchitecture.com

Clay Benjamin Smook
E: clay@smookarchitecture.com



1 FIRST FLOOR NEW WORK PLAN
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

Additions and Renovations to:

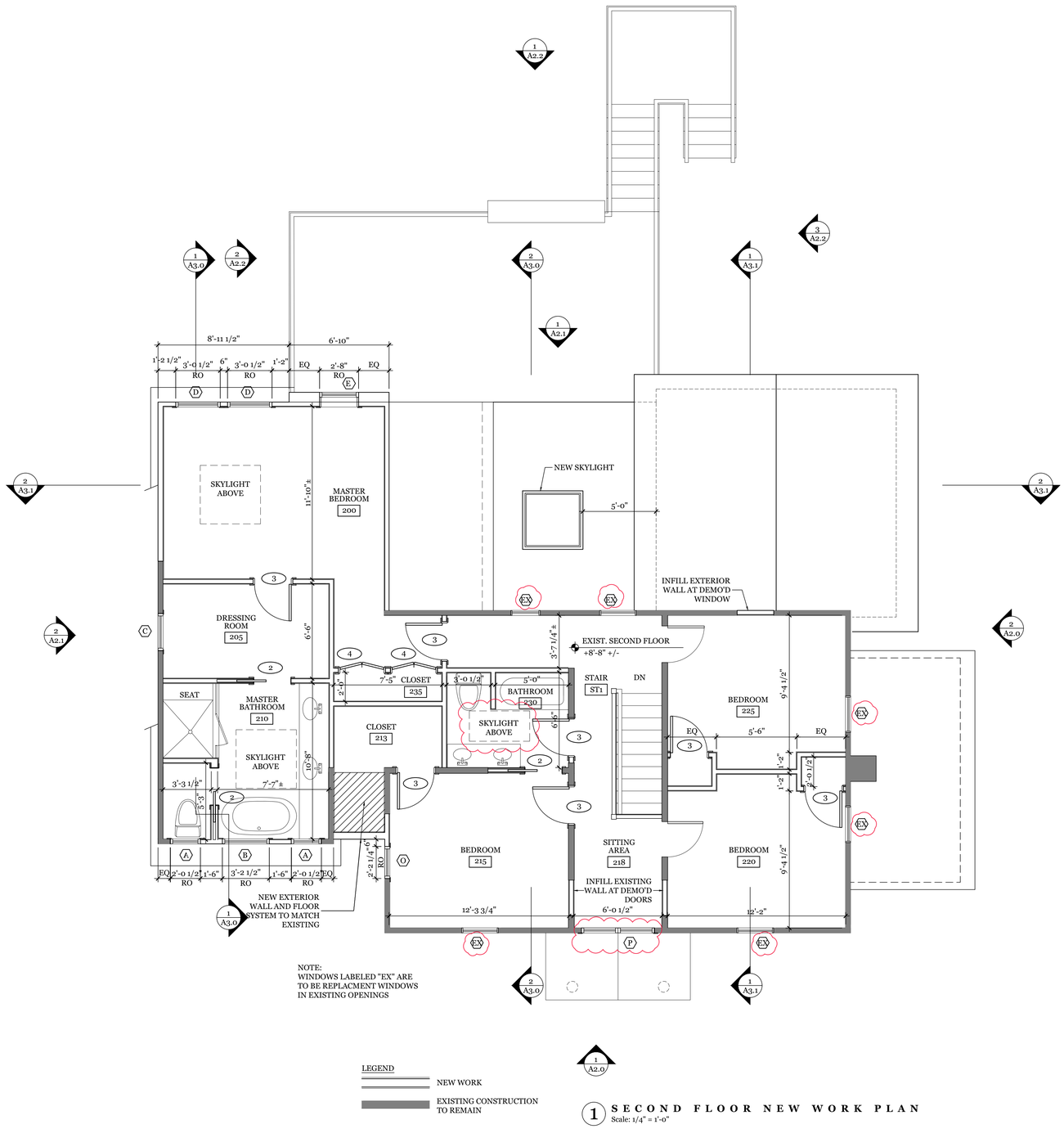
68 Wilshire Park
Needham, Massachusetts

REGISTERED ARCHITECT
GARY B. SMOOK
No. 7978
BOSTON
COMMONWEALTH OF MASSACHUSETTS

Revised: 8 February 2022
Issued: 1 October 2021

First Floor New Work Plan

A1.1



NOTE:
WINDOWS LABELED "EX" ARE TO BE REPLACMENT WINDOWS IN EXISTING OPENINGS

LEGEND

NEW WORK

EXISTING CONSTRUCTION TO REMAIN

1 SECOND FLOOR NEW WORK PLAN
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

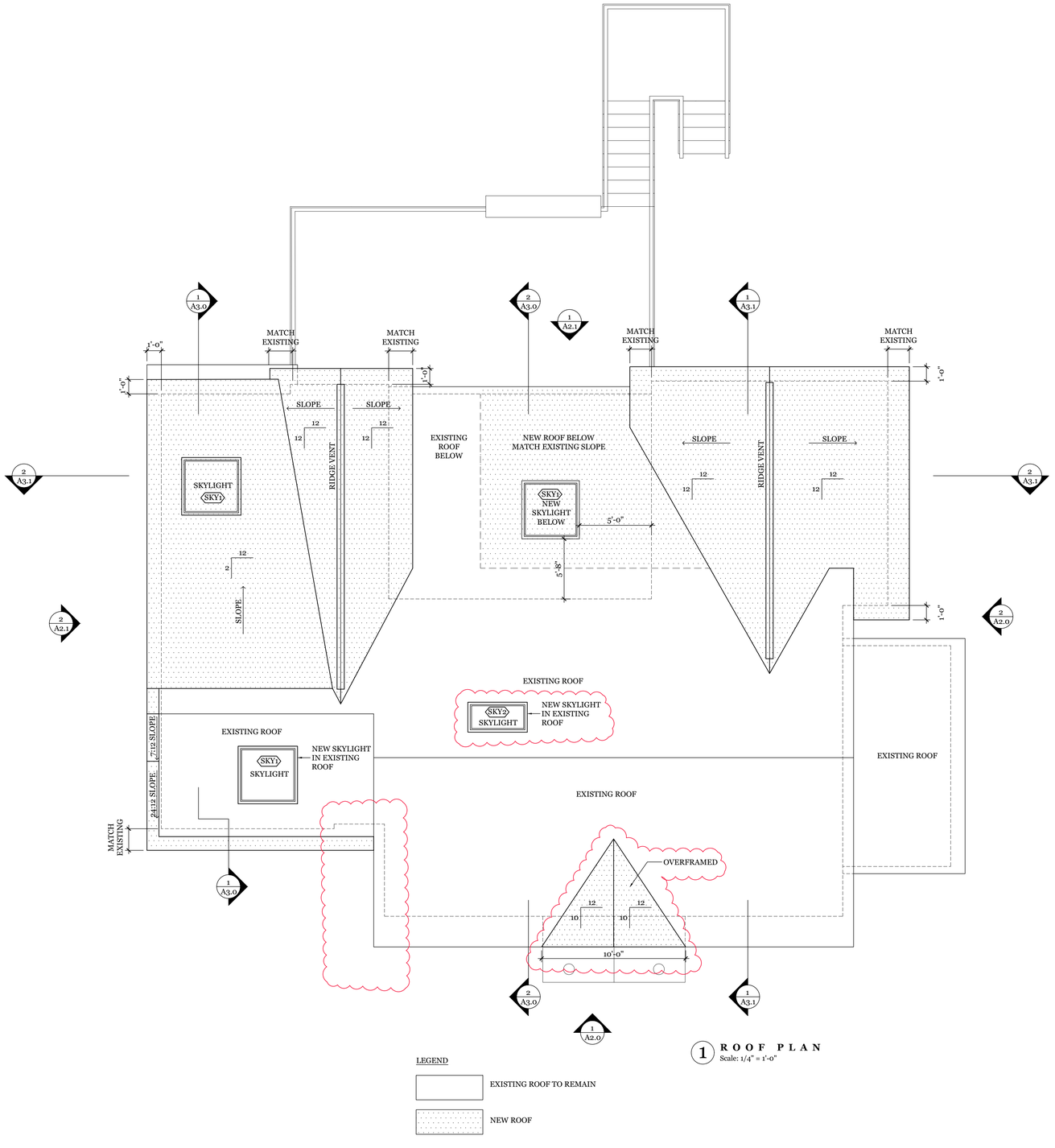
Additions and Renovations to:
68 Wilshire Park
Needham, Massachusetts

COMMONWEALTH OF MASSACHUSETTS
REGISTERED ARCHITECT
DAVID B. SMOOK
NO. 7172
BOSTON, MA

Revised: 8 February 2022
Issued: 1 October 2021

Second Floor New Work Plan

A1.2



LEGEND

EXISTING ROOF TO REMAIN

NEW ROOF

1 ROOF PLAN
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

Additions and Renovations to:

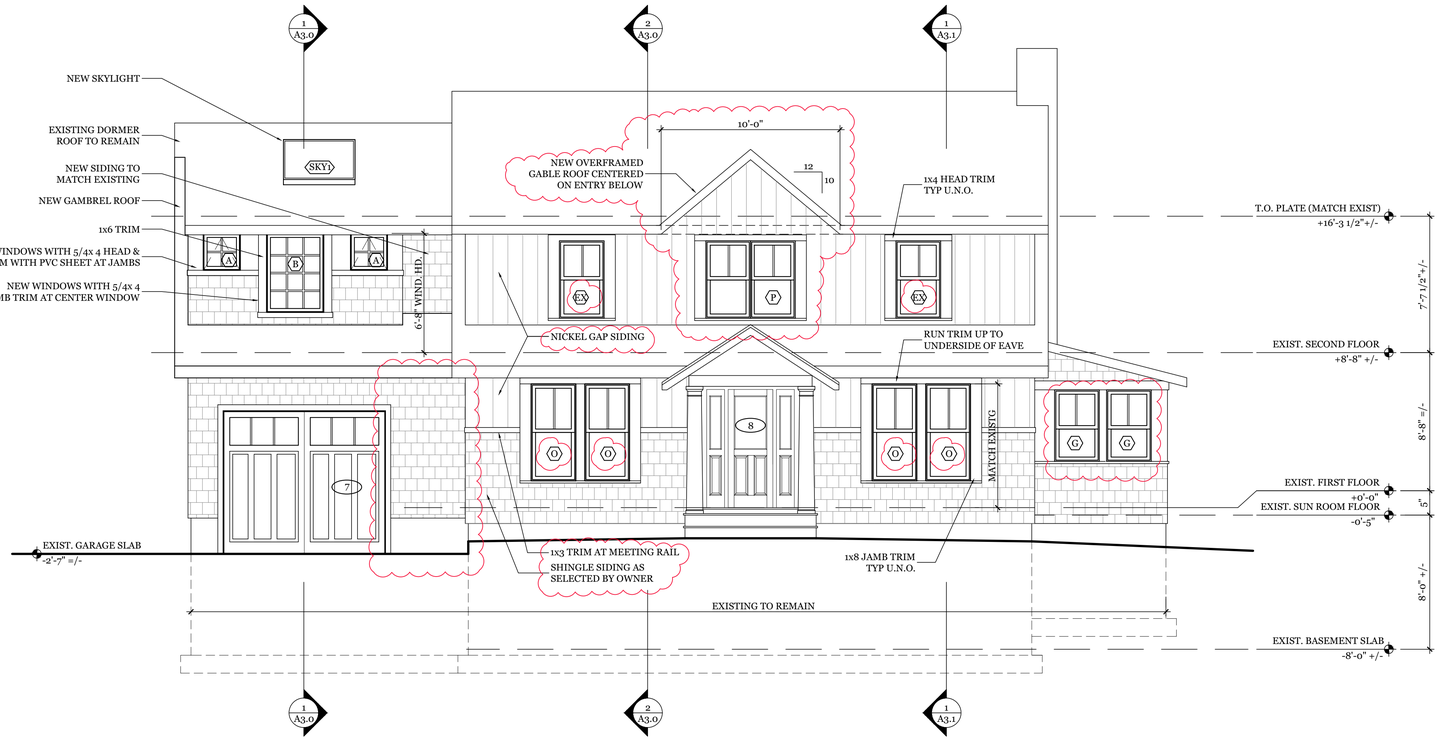
68 Wilshire Park
Needham, Massachusetts

REGISTERED ARCHITECT
CARL B. SMOOK
7972
BOSTON, MA
COMMONWEALTH OF MASSACHUSETTS

Revised: 8 February 2022
Issued: 1 October 2021

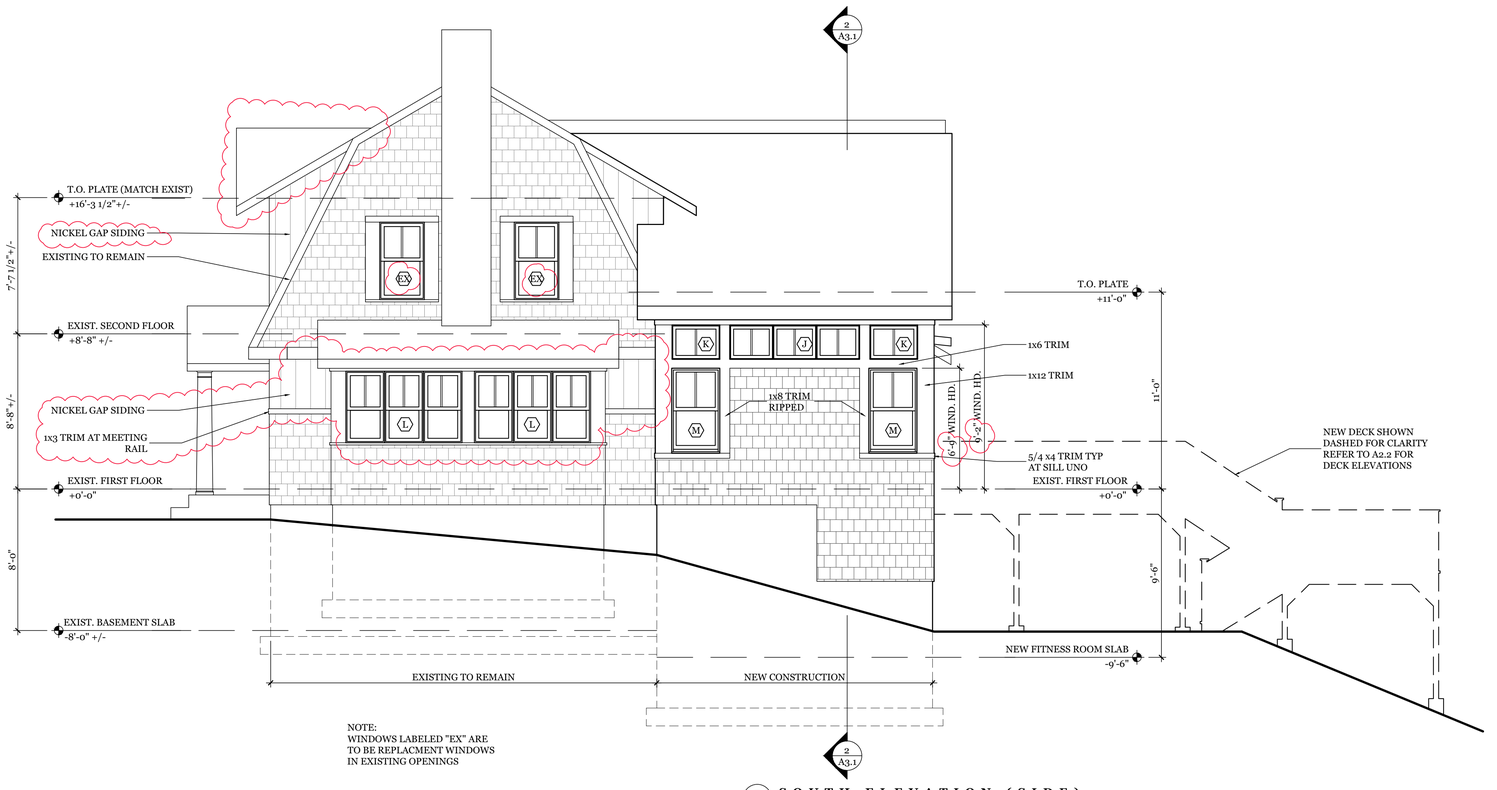
Roof Plan

A1.3



NOTE:
WINDOWS LABELED "EX" ARE TO BE REPLACMENT WINDOWS IN EXISTING OPENINGS

1 WEST ELEVATION (FRONT)
Scale: 1/4" = 1'-0"



NOTE:
WINDOWS LABELED "EX" ARE TO BE REPLACMENT WINDOWS IN EXISTING OPENINGS

2 SOUTH ELEVATION (SIDE)
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

Additions and Renovations to:
68 Wilshire Park
Needham, Massachusetts

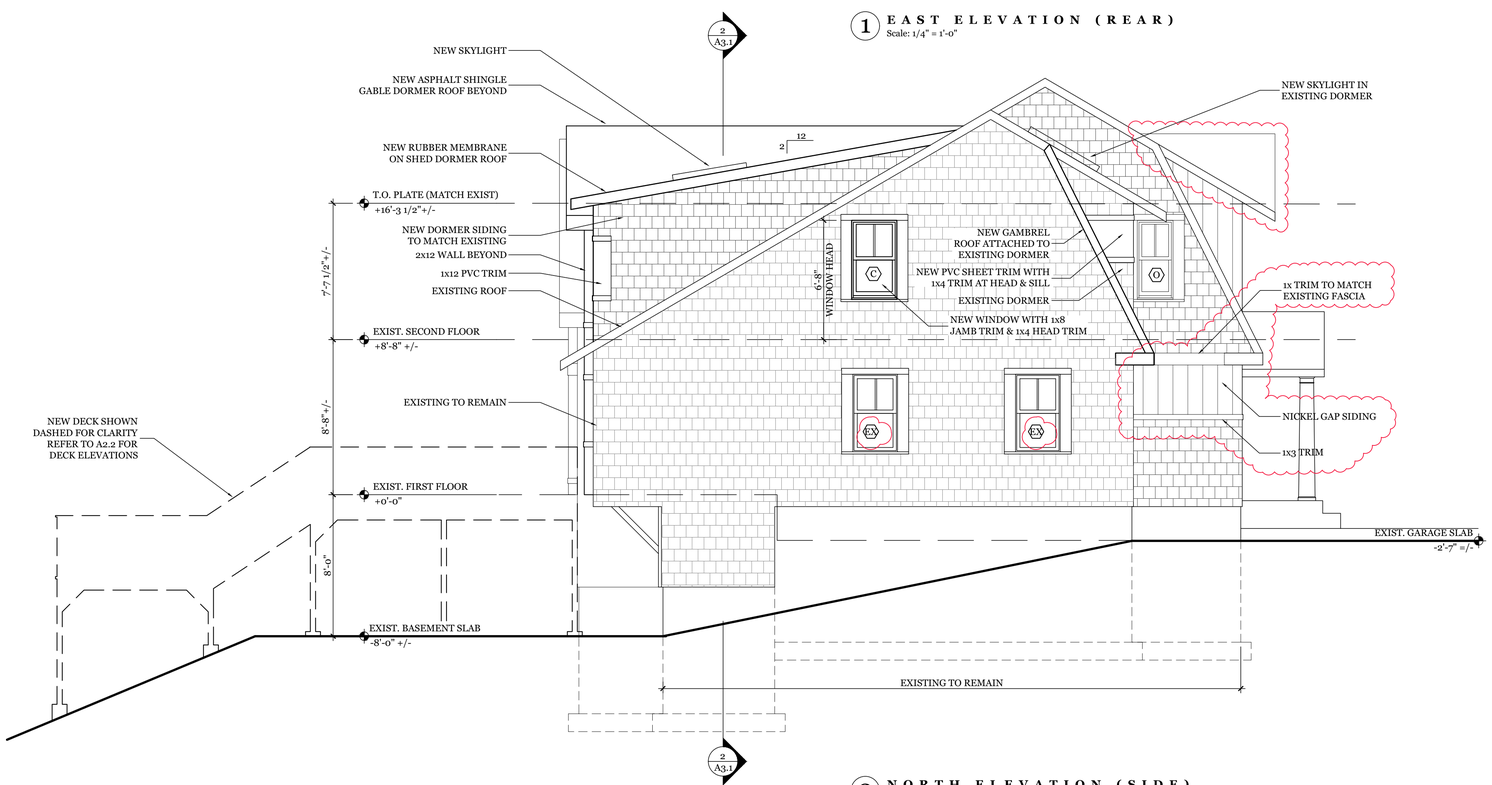
REGISTERED ARCHITECT
CLIFF B. SMOOK
7928
BOSTON, MA
COMMONWEALTH OF MASSACHUSETTS

Revised: 8 February 2022
Issued: 1 October 2021

West & South Elevations

A2.0

1 EAST ELEVATION (REAR)
Scale: 1/4" = 1'-0"



2 NORTH ELEVATION (SIDE)
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

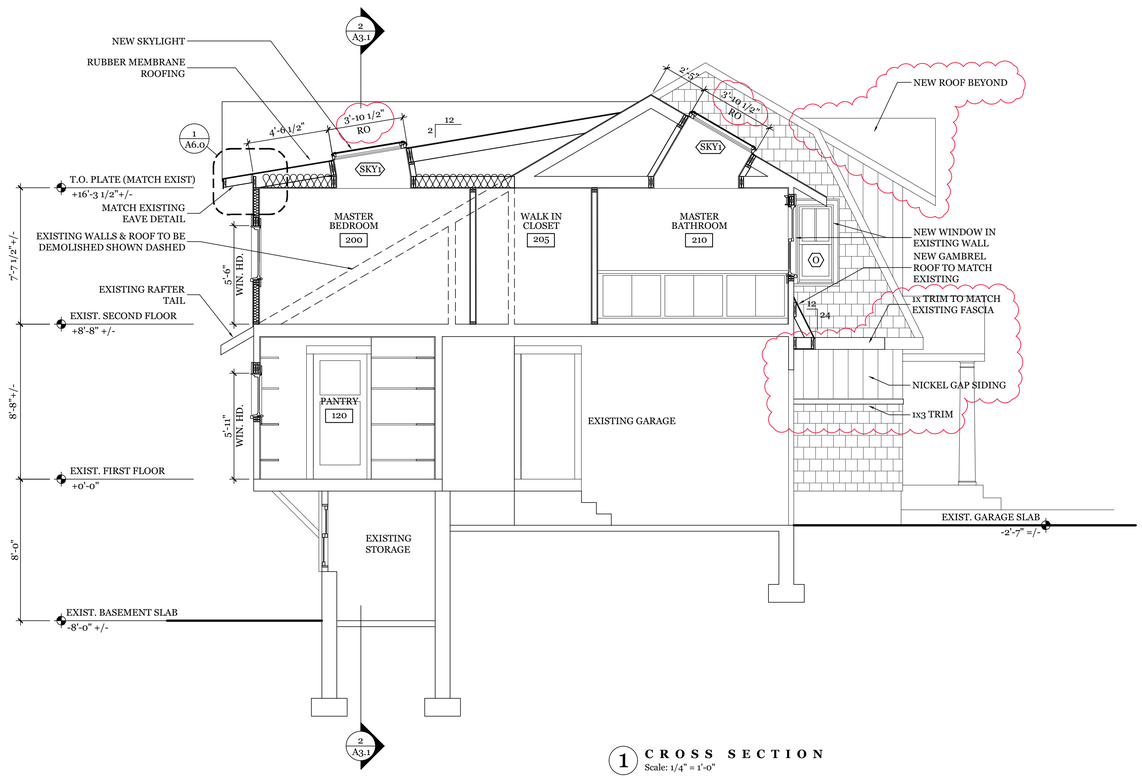
Additions and Renovations to:
68 Wilshire Park
Needham, Massachusetts

REGISTERED ARCHITECT
COMMONWEALTH OF MASSACHUSETTS
DAVID B. SMOOK
No. 21726
BOSTON, MA

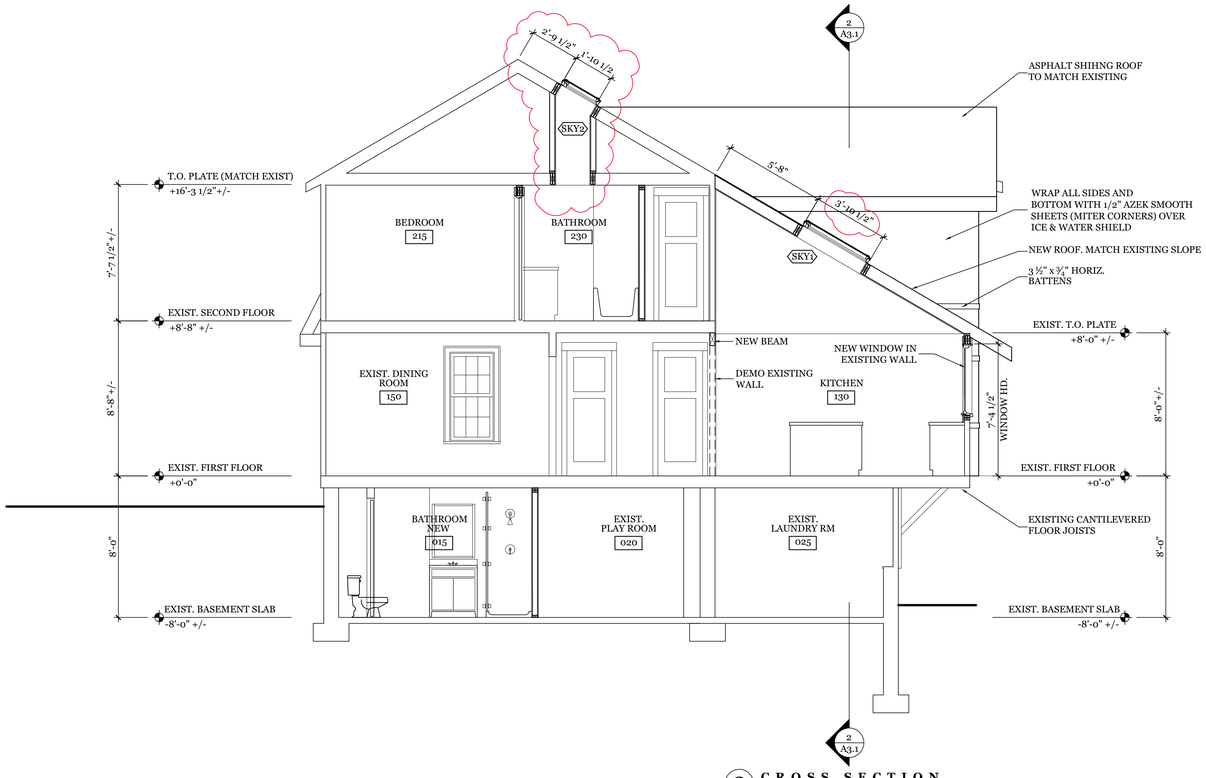
Revised: 8 February 2022
Issued: 1 October 2021

East & North Elevations

A2.1



1 **CROSS SECTION**
Scale: 1/4" = 1'-0"



2 **CROSS SECTION**
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

Additions and Renovations to:

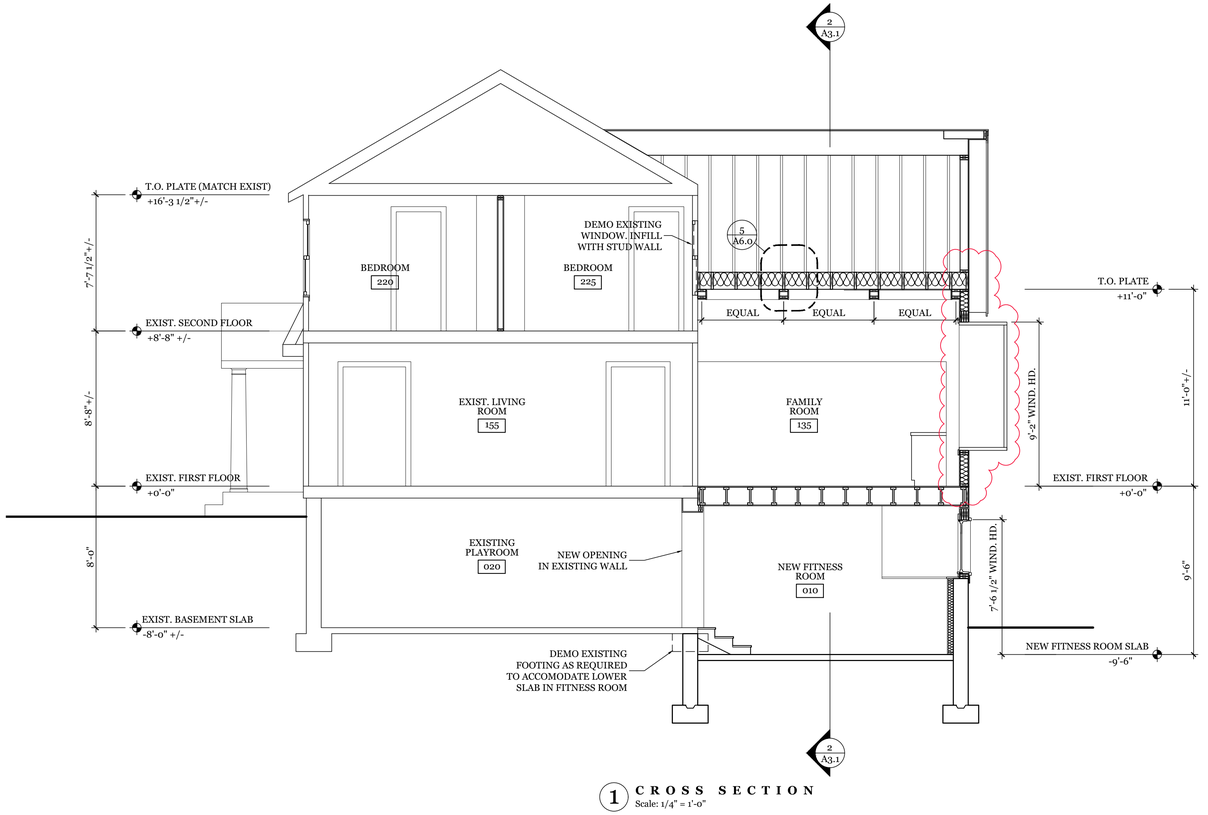
68 Wilshire Park
Needham, Massachusetts

COMMONWEALTH OF MASSACHUSETTS · REGISTERED ARCHITECT · CLIFF B. SMOOK · 7926 · BOSTON, MA

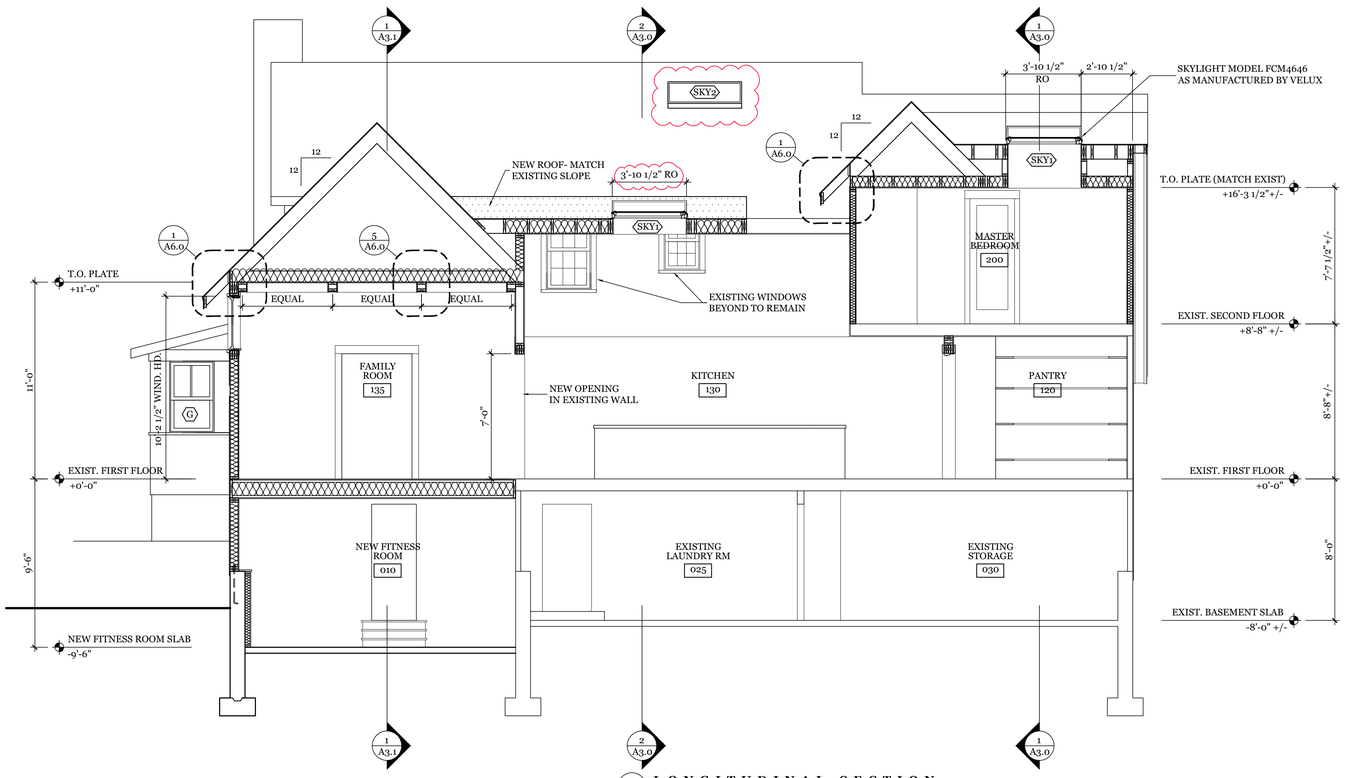
Revised: 8 February 2022
Issued: 1 October 2021

Sections

A3.0



1 **CROSS SECTION**
Scale: 1/4" = 1'-0"



2 **LONGITUDINAL SECTION**
Scale: 1/4" = 1'-0"

SMOOK
ARCHITECTURE & URBAN DESIGN, INC.
8 Lyman Street, Suite 206
Westborough, Massachusetts 01581
617.423.3040

Additions and Renovations to:

68 Wilshire Park
Needham, Massachusetts

CURT B. SMOOK
REGISTERED ARCHITECT
No. 7972
BOSTON
COMMONWEALTH OF MASSACHUSETTS

Revised: 8 February 2022
Issued: 1 October 2021

Sections

A3.1

TOWN OF NEEDHAM
PERMIT TO BUILD

Permit #:
BR-22-10289

Issued: March 29, 2022

Expires: September 25, 2022

This permit is granted to:
Robert DiPierro
36 Sturgis Street #3
Winthrop , MA 02152

Phone: 6172834867

Property Location: **68 WILSHIRE PARK**

Type of Structure:

Description of permitted work:
Add rear 16x17 2 story addition, Renovate kitchen and baths, all new windows, siding and trim. New primary bedroom dormer and bathroom. New bathroom in basement.

This permit is subject to all existing Building and Zoning Laws of Needham now in force, or that may hereafter be enacted, and in conformance with the details of application.

David Roche, Building Commissioner

Date: March 29, 2022

This card shall be left on the premises for the inspectors to sign throughout completion of the project. No work shall be covered until the required inspections are complete. If inspections are missed the Inspector having jurisdiction may require areas to be exposed or what they deem necessary for code compliance. No Rough inspections will be conducted until the building is watertight with an approved material by the Building Inspector.

Please Note: All inspections listed below are <u>not</u> applicable to all projects. Please refer to the guided process on the Building Department's website for applicable inspections.

ROUGH INSPECTIONS	
EXCAVATION	**FOUNDATION/FOOTING**
GAS	**ELECTRICAL**
FIRE DEPT	**PLUMBING**
FRAMING/FIRE STOPPING	**INSULATION**

FINAL INSPECTIONS	
GAS	**ELECTRICAL**
FIRE DEPT	**PLUMBING**
BUILDING	

TOWN OF NEEDHAM, MASSACHUSETTS

Building Inspection Department

Assessor's Map & Parcel No. ***MAP NO. 31, PARCEL 47***

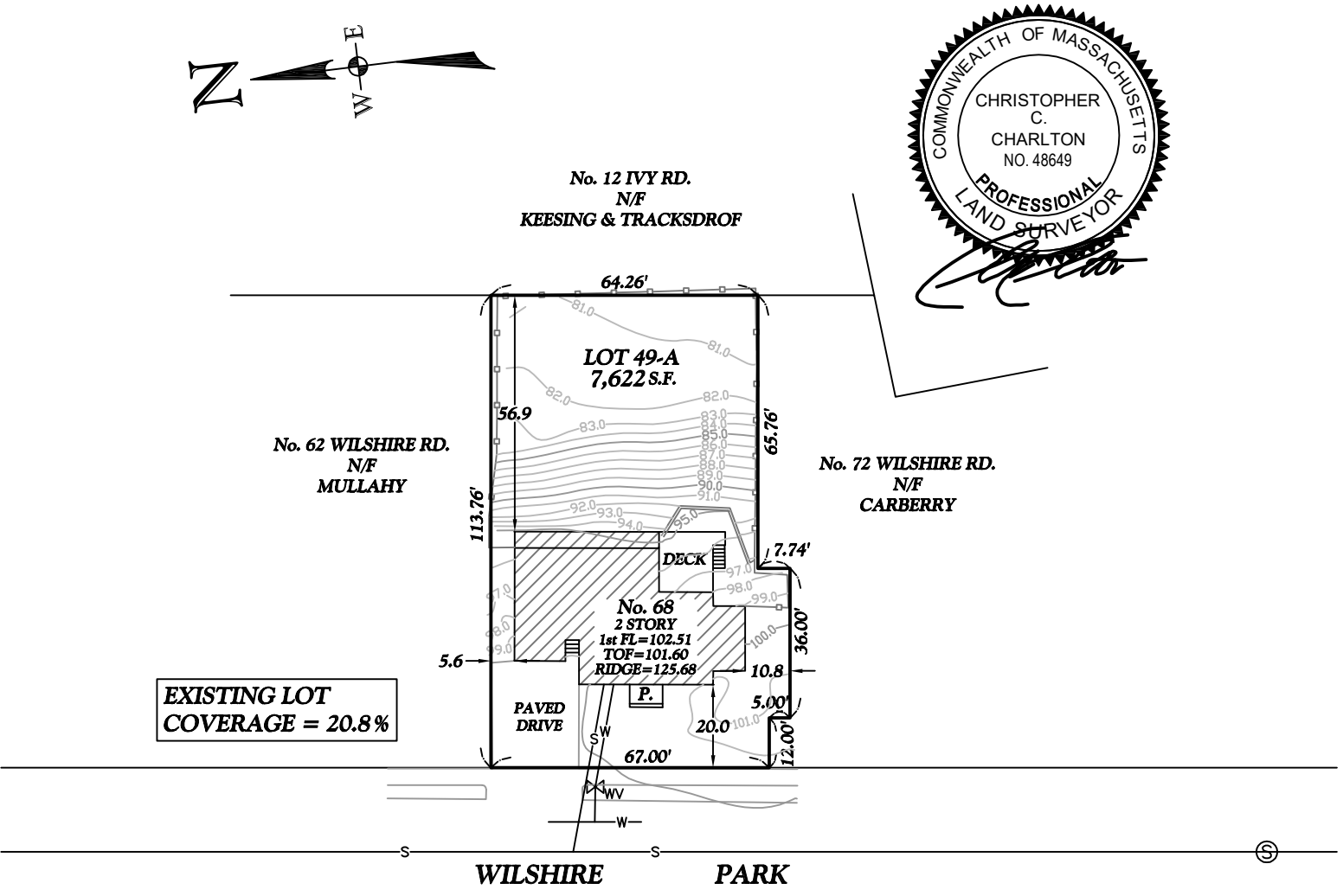
Building Permit No. _____ Zoning District ***SR-B***

Lot Area ***7,622 S.F.*** Address ***No. 68 WILSHIRE PARK***

Owner ***PASE & ROSEN*** Builder ***BALLAST CONSTR.***

EXISTING CONDITIONS PLOT PLAN

40' Scale



Note: Plot Plans shall be drawn in accordance with Sections 7.2.1 and 7.2.2 of the Zoning By-Laws for the town of Needham. All plot plans shall show existing structures and public & private utilities, including water mains, sewers, drains, gaslines, etc.; driveways, septic systems, wells, Flood Plain and Wetland Areas, lot dimensions, lot size, dimensions of proposed structures, sideline, front and rear offsets and setback distances, (measured to the face of structure) and elevation of top of foundations and garage floor. For new construction, lot coverage, building height calculations proposed grading and drainage of recharge structures. For pool permits, plot plans shall also show fence surrounding pool with a gate, proposed pool and any accessory structures*, offsets from all structures and property lines, existing elevations at nearest house corners and pool corners, nearest storm drain catch basin (if any) and, sewage disposal system location in areas with no public sewer.
(*Accessory structures may require a separate building permit — See Building Code)

I hereby certify that the information provided on this plan is accurately shown and correct as indicated.
The above is subscribed to and executed by me this ***12 th*** day of ***APRIL*** 20 ***21***.
Name ***CHRISTOPHER C. CHARLTON*** Registered Land Surveyor No. ***48649***
Address ***105 BEAVER STREET*** City ***FRANKLIN*** State ***MA*** Zip ***02038*** Tel. No. ***(508) 528-2528***
Approved _____ Director of Public Works Date _____
Approved _____ Building Inspector Date _____

David Gorski - DiPierro & Brown

From: Daphne Collins <dcollins@needhamma.gov>
Sent: Wednesday, May 18, 2022 3:35 PM
To: David Gorski - DiPierro & Brown; Adam Pase
Cc: David Roche
Subject: RE: 68 Wilshire Park - Request for review of Ridge Hgt. Change
Attachments: 2022 ZBA Meeting Schedule.pdf; Application - ZBA - Process.pdf; Application -ZBA.pdf; ZBA - Application Fees.pdf

Good Afternoon David and Adam-

The Building Department requires ZBA approval for changes in plans approved in a Board Decision.
The ZBA approval can be handled either by a *Plan Substitution* for minor changes or an *Amendment* to a Decision for major changes at a ZBA meeting.

The Building Commissioner has deemed the changes you're are proposing as major and an Amendment would be required.

The next ZBA Meeting is scheduled for June 16, 2022. The application deadline is May 23. See attached Application, Process, Fees and Meeting Schedule.
FYI - If the Building Commissioner had deemed the proposed changes as minor, the soonest a Plan Substitution option could be heard is June 16th, the same timeline as an Amendment.

If you have any questions, feel free to contact me.

Daphne

Daphne
Daphne M. Collins
Zoning Specialist

Phone 781-455-7550, x 261
Web https://www.needhamma.gov/
https://needhamma.gov/1101/Board-of-Appeals
www.needhamma.gov/NeedhamYouTube
Zoning Board of Appeals Office
Town of Needham
Planning and Community Development Dept.
500 Dedham Avenue
Needham, MA 02492

Regular Office Hours: Mon-Wed 8:30am – 5:00pm

From: David Gorski - DiPierro & Brown <d.gorski@dbbostongc.com>
Sent: Tuesday, May 17, 2022 4:48 PM
To: Daphne Collins <dcollins@needhamma.gov>
Cc: David Gorski - DiPierro & Brown <d.gorski@dbbostongc.com>
Subject: FW: 68 Wilshire Park - Request for review of Ridge Hgt. Change

Daphne,

Thank you for taking my call. See following my earlier email.

I look forward to speaking with you on this.

Have a nice evening.
Dave

From: David Gorski - DiPierro & Brown
Sent: Tuesday, May 17, 2022 4:33 PM
To: d.collins@needhamma.gov
Cc: David Gorski - DiPierro & Brown <d.gorski@dbbostongc.com>; Robert Ellis - DiPierro & Brown <r.ellis@dbbostongc.com>
Subject: 68 Wilshire Park - Request for review of Ridge Hgt. Change

Hi Daphne,

My name is David Gorski and I'm the contractor working on the Pase Residence renovations at 68 Wilshire Park, Needham.
Our client had previously been granted a Special Permit for the renovations based on the attached drawings. The client has recently ask for two changes;
1.) Adding (2) additional dormers (see attached sketch)
2.) Raise 2nd flr ceiling hgt 1'-0", thus raising the ridge 1'-4" (See Plot Plan for existing ridge height)

I've spoken to both Erik Tardif and David Roche of the Bldg Dept. and discussed the Special Permit and 1984 Variance that is in place and what would be possible under the current approved permits without having to resubmit for another review. Work has already commenced with demolition and framing per the original plans. David Roche asked that I reach out to you for a clearer interpretation of what would be possible given respect to timing.

The clients request centers around improving the existing low ceiling height at the 2nd flr and bringing in more natural light. The goal of the dormers is to open up the window sizes. These would remain in the same plain of the existing façade. Raising the ridge line 1'-4" would allow the ceiling height to increase to approx. 8'-6" and allow for new structural member framing of the current undersized roof rafters.

In reviewing the language of the special permit, particularly the "Findings" section our thought is that since the dormers and raising of the ridge remain in the allowable footprint of the existing structure and that the height change is diminutive in nature that the requested changes of our client may be permissible under the current permit.

With respect to the proposed dormer sketch drawings attached, please disregard the size of the front porch. The existing conforming porch will remain. Revised architectural drawings can be produced to reflect the request change and submitted for record, if this work is possible.

I thank you for your time and consideration and look forward to hearing from you soon.

Thank you.
Dave

DiPIERRO & BROWN CONSTRUCTION

David Gorski
Senior Project Manager
Mobile: 978-815-3425
Office: 781-281-0232
d.gorski@dbbostongc.com
https://www.dbbostongc.com

FRONT ELEVATION

Scale: 1/8"=1'-0"

Additions & Alterations

68 Wilshire Park, Needham

23 May 2022

SMOOK ARCHITECTURE

Additions & Alterations

68 Wilshire Park, Needham

SMOOK ARCHITECTURE

2022 MAY 24 AM 9:27

Memo

Please see attached amended application to include updated zoning bylaws as well as a special permit description as well as a program narrative for 35 Highland Circle in Needham. Thank you

Special Permit Application Description

35 Highland Circle is a 3-floor office building with 65 outside parking spaces and a ground level garage. Not including this ground level garage, there are 21.6 parking spaces per floor at 35 Highland Circle.

We are looking to convert the ground level to an adult day health center with a capacity of 80 clients and 13 staff members. The adult day health center will be using one of the above floors as administrative office and storage space and will not have additional staff or clients on that floor, therefore will not require parking spaces.

According to the capacity requested the parking calculation, 8 spaces plus 1 space per 40 clients and 1 per employee, requires 23 parking spaces (8 + (80/40) + 13). Existing parking is 21.6 parking spaces (since we are taking one floor of office space as storage and the ground level will be the ADH center). As a result, we will need a parking waiver of 1.4 stalls (23 required minus 21.6 existing), rounded up to 2 stalls parking waiver.

Zdorovie Operations Narrative

Zdorovie ADH Needham operates an adult day care center at 185 2nd Ave. There is currently a capacity of 132 clients and 22 staff with 16 parking spaces. The facility serves a local population of elders who desire to continue to live in a residential setting, often with extended family, and need support during the day. Many of these clients are Jewish immigrants of eastern European descent, and the program offers health and educational services in their languages, food as well cultural enrichment experiences which are familiar and comforting. The facility provides an important service for families in the Needham and surrounding areas who wish to keep their elders living at home but need coverage during the day.

Now Zdorovie is looking to move its adult day care center to 35 Highland Circle. The proposed capacity at 35 Highland Circle is 80 clients and 13 staff which would require 23 parking spaces based on Needham parking calculations (10 spaces for clients and 13 for employees). Currently there are 21.6 existing spaces on site for the ADH center which will take the ground level and one level of office space above. This requires a parking waiver of 2 stall although for our operations we would only actually need 5 for vans and 5 for staff. Historically one third of staff do not drive themselves to work. Some of these staffers live in the immediate local area and walk to work. Others carpool. In some instances, members of the same family work together at the facility.

Hours of operation are 8:00 am – 4:00 pm, Monday through Sunday. The facility currently offers home pick-up and drop-off of its clients in five dedicated vans, and all clients take advantage of this service. The vans operate on staggered schedules over a period of an hour and a half window in the morning and afternoon to minimize traffic in the parking lot.

Zdorovie staff arrive around 7:30am and leave when the facility closes at 4:00 pm. (Staff work one shift per day.) Staff have a dedicated break room which is utilized as needed throughout the business day and they typically do not leave the site during their break. Weekend and weekdays generally have the same daily capacity.

During the arrival and departure process, most of Zdorovie staff is involved in assisting in ambulation to and from the vans, assisting in loading in and out of the vans, assisting clients with their belongings, and making sure clients are safe. Nurses, program aids and supervisors all work together in the mornings and afternoons to ensure smooth and safe operations.

Sample Class Schedule

8:00 am – 9:00 am	Client arrival time
9:15 am	Therapeutic morning exercise
9:30 am	Breakfast time

10:00 am – 11:00 am	English Class
11:30 am – 12:15 pm	Computer class
12:30 pm – 1:00 pm	Memory enhancement games and quizzes
1:30 pm	Lunch time
2:00 – 3:00 pm	Departure time

During breaks in the schedule, clients may choose to rest, meet with nurses or other staff, go for walks, or participate in additional activities under the supervision of staff members.

Therapeutic Activity plan is developed monthly past topics have included the following:

- Health education and nursing procedure
- English language teaching
- Computer/technology proficiency teaching
- Education on signs of elder abuse
- Education of fraud and scams
- Education of assistive devices usage
- Education of proper body mechanics
- Education, supervision and assistance of physical exercise
- Cognitive stimulation games
- Historical and cultural educational field trips
- Lectures

Van Drop off and Pick up Schedule

Vehicle Schedule per each of 3 centers:

- Arrival
  - 8:00AM Van 1
  - 8:15AM Van 2
  - 8:30AM Van 3
  - 8:45AM Van 4
  - 9:00AM Van 5
  - 9:30AM Any additional route as needed
- Departure
  - 2:00PM Van 1
  - 2:15PM Van 2
  - 2:30PM Van 3
  - 2:45PM Van 4
  - 3:00PM Van 5
  - 3:30PM Any additional route as needed

ZBA Application For Hearing

2022 MAY 24 AM 9:27

Applicants must consult with the Building Inspector prior to filing this Application. *Failure to do so will delay the scheduling of the hearing.*

Applicant Information

Applicant Name	Zdorovie ADH Needham		Date: 5/23/22
Applicant Address	185 2nd Ave Needham MA 02494		
Phone	857-488-2399	email	baudymazaev2010@gmail.com
Applicant is ☐Owner; ☐Tenant; ☒Purchaser; ☐Other_____ If not the owner, a letter from the owner certifying authorization to apply must be included			
Representative Name	Robert Orsi, Esq.		
Address	160 GOULD STREET, SUITE 320		
Phone	781-239-8900	email	rorsi@oarlawyers.com
Representative is ☒Attorney; ☐Contractor; ☐Architect; ☐Other_____			
Contact ☐Me ☒Representative in connection with this application.			

Subject Property Information

Property Address	35 Highland Circle		
Map/Parcel Number	1990740001400000	Zone of Property	MU-128
Is property within 100 feet of wetlands, 200 feet of stream or in flood Plain? ☐Yes ☒No			
Is property ☐Residential or ☒Commercial			
If residential renovation, will renovation constitute "new construction"? ☐Yes ☐No			
If commercial, does the number of parking spaces meet the By-Law requirement? ☒Yes ☐No Do the spaces meet design requirements? ☒Yes ☐ No			
Application Type (*select one*): ☒Special Permit ☐Variance ☐Comprehensive Permit ☐Amendment ☐Appeal Building Inspector Decision			

ZBA Application For Hearing

Existing Conditions:

3 floors of office space with a ground level garage. Outside of the building there are 65 parking spaces for the property.

Statement of Relief Sought:

Special permit use for an adult day health center. Transfer existing Adult day health center from 185 2nd Ave in Needham to 35 Highland Circle. Also we are looking for a parking waiver of 2 stalls, and a waiver of a parking plan and design requirements

Applicable Section(s) of the Zoning By-Law:

Section 3.2.5.2 (b), 2) waiver of parking numbers Section 5.1.2 and 3) waiver of parking plan and design Section 5.1.3 to waive parking plan and design requirements; and any other applicable section of the By-Law

If application under Zoning Section 1.4 above, list non-conformities:

	Existing Conditions	Proposed Conditions
Use		
# Dwelling Units		
Lot Area *(square feet)*		
Front Setback *(feet)*		
Rear Setback *(feet)*		
Left Setback *(feet)*		
Right Setback *(feet)*		
Frontage *(feet)*		
Lot Coverage *(%)*		
FAR *(Floor area divided by the lot area)*		

Numbers must match those on the certified plot plan and supporting materials

ZBA Application For Hearing

Date Structure Constructed including additions:	Date Lot was created:
1980	1980

Submission Materials	Provided
Certified Signed Plot Plan of Existing and Proposed Conditions *(Required)*	Yes
Application Fee, check made payable to the Town of Needham Check holders name, address, and phone number to appear on check and in the Memo line state: "ZBA Fee – Address of Subject Property" *(Required)*	Yes
If applicant is tenant, letter of authorization from owner *(Required)*	Yes
Electronic submission of the complete application with attachments *(Required)*	Yes
Elevations of Proposed Conditions *(when necessary)*	NA
Floor Plans of Proposed Conditions *(when necessary)*	Yes

Feel free to attach any additional information relative to the application. Additional information may be requested by the Board at any time during the application or hearing process.

❖❖❖❖

I hereby request a hearing before the Needham Zoning Board of Appeals. I have reviewed the Board Rules and instructions.

I certify that I have consulted with the Building Inspector 5/20/2022
date of consult

Date: 5/23/2022 Applicant Signature B Mazzeo

An application must be submitted to the Town Clerk's Office at townclerk@needhamma.gov and the ZBA Office at dcollins@needhamma.gov

Riti Realty Trust II
21 Highland Circle
Needham, MA 02494
ritireatly@gmail.com

May 23, 2022

To Whom It May Concern:

I, Maria Serpentino Iriti, Trustee of Riti Realty Trust II, the owner of 35 Highland Circle, Needham, MA, authorize Baudy Mazaev to apply for a special permit on behalf of the property.

Sincerely,

Maria Iriti

Maria Serpentino Iriti, Trustee
Riti Realty Trust II

#21
EXISTING
BUILDING

104'-4"±

55'-8"±

18

19

20

ø 30'-0"±

21

22

23

24

25

118'-10"±

17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

10'-8"

27'-8"

ø 76'-0"±

58'-2"±

120'-0"

41'±

26

27

28

29

30

31

32

33

34

35

36

#35
EXISTING BUILDING
29,185 SQ.FT.

LOT SIZE:
0.67 ACRES
(DEED)

PARKING LOT ENTRANCE

60'-0"

25'-0"

10'-0"

51'-10"±

25'-0"

176'-0"±

23'-8"±

120'-0"

17'-7"±

24'-0"±

37 38 39 40 41 42 43 44 45 46 47 48 49 50

39'-3"

44'-8"

22'-3"±

51 52 53 54 55 56 57 58 59 60 61 62 63 64 65

9'-0"±

123'-6"±

DATE	REVISION

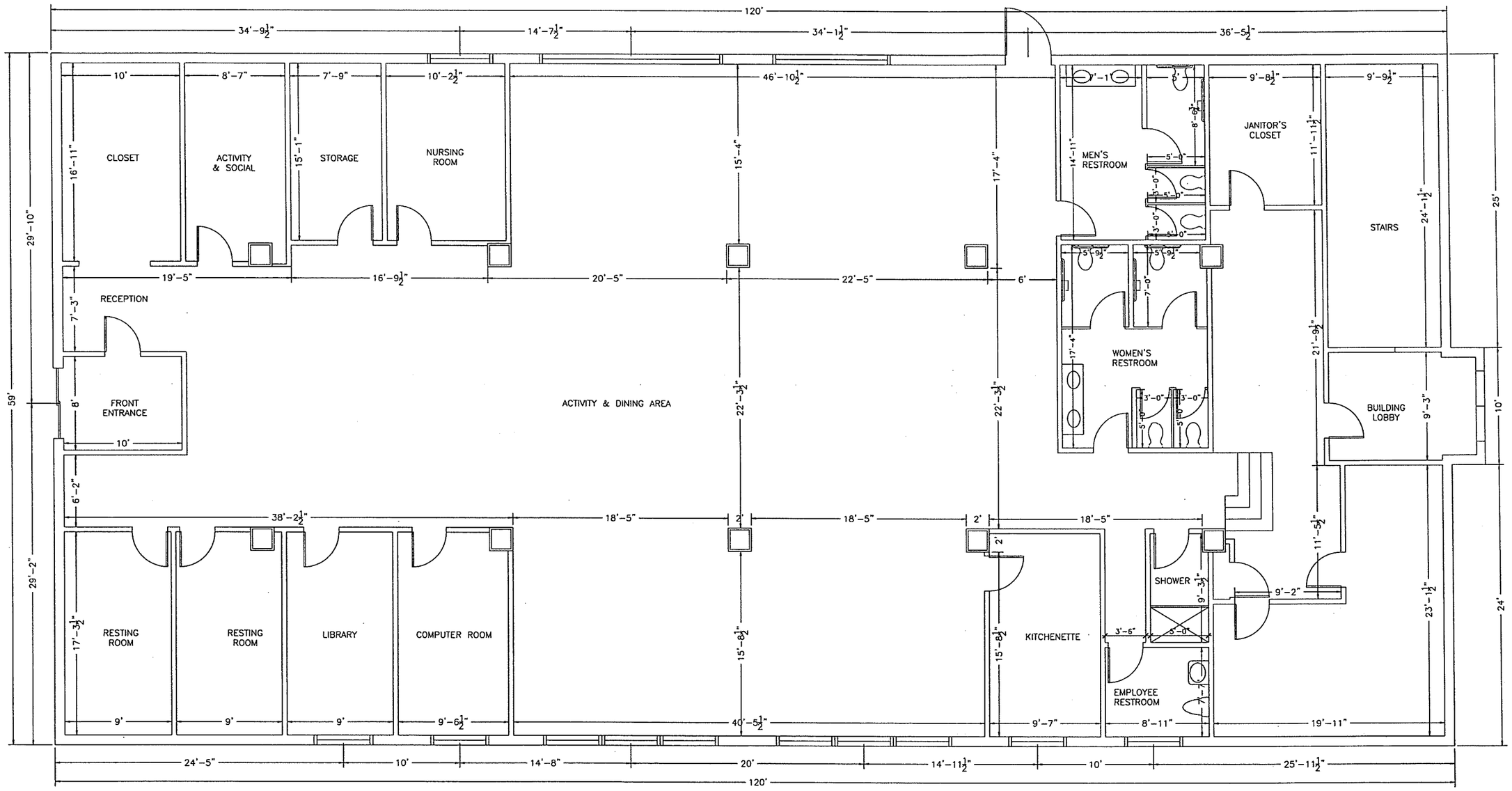
SITE PLAN – PARKING LOT

35 HIGHLAND CIRCLE, NEEDHAM, MASSACHUSETTS

RAV & Assoc., Inc.
21 HIGHLAND AVENUE
NEEDHAM, MASSACHUSETTS 02494
TELEPHONE: (781) 449-8200

RICHARD A. VOLKIN NO. 22243 REGISTERED PROFESSIONAL ENGINEER COMMONWEALTH OF MASSACHUSETTS

SCALE: 1"=10'		
APPROVED: R.A.V.	DESIGNED BY: I.K.	DRAWING No.
	DRAWN BY: N.J.	S–1
DATE: 04/01/2022	CHECKED BY: R.A.V	



PROPOSED FLOOR PLAN

GENERAL NOTES

1. All work shall conform to Massachusetts Building Code and all Federal, State and Town of Needham laws, codes and regulations as each may apply.

2. All existing conditions must be verified in field. If discrepancies are found, they have to be reported to the Engineer prior to start of work. Omissions or conflicts between the various elements of the working drawings and/or the specifications shall be brought to the attention of the Engineer prior to the start of such work.

3. The contractor shall be responsible for coordinating the scheduling and work of all trades and shall check all dimensions. All discrepancies shall be called to the attention of the Engineer and shall be resolved prior to proceeding with the work.

4. The Contractor shall supervise and direct the work and shall be solely responsible for the construction means, methods, techniques, sequences and procedures, including but not limited to bracing and shoring.

5. The Contractor agrees that in accordance with generally accepted construction practices, the Contractor shall assume sole and complete responsibility for the job site conditions during the course of construction, including the safety of all persons and property, and that this requirement shall apply continuously and not be limited to normal working hours.

6. All work shall be performed in a first class and workmanlike manner in conformity with the plans and specifications, and shall be in good usable condition at the completion of the Project.

7. The Contractor shall field verify all existing conditions, utility locations and structure placement, prior to start of the work. The Contractor will observe all possible precautions to avoid damage to same. Any damage to existing structures and utilities, whether shown or not on the drawings, shall be repaired or replaced at the Contractor's expense.

8. Prior to bidding the work the Contractor shall visit the site and thoroughly satisfy himself as to the actual conditions and quantities, if any. No claim agains the Owner or Engineer will be allowed for any excess or deficiency therein, actual or relative.

10. Contractor is responsible for all demolition and relocation works, if any.

DATE	REVISION

PROPOSED FLOOR PLAN

35 HIGHLAND CIRCLE, NEEDHAM, MASSACHUSETTS

RAV & Assoc., Inc.
21 HIGHLAND AVENUE
NEEDHAM, MASSACHUSETTS 02494
TELEPHONE: (781) 449-8200

SCALE: 1/4"=1'-0"

APPROVED: R.A.V.	DESIGNED BY: R.A.V	DRAWING No.
DATE: 05/10/2022	DRAWN BY: N.J.	A-2
	CHECKED BY: R.A.V	

TOWN OF NEEDHAM

Office of the Town Clerk

BY-LAWS

Approved By The Attorney General

Annual Town Meeting
May 3, 2021

August 21, 2021

MAURA HEALEY
ATTORNEY GENERAL

THE COMMONWEALTH OF MASSACHUSETTS
OFFICE OF THE ATTORNEY GENERAL

CENTRAL MASSACHUSETTS DIVISION
10 MECHANIC STREET, SUITE 301
WORCESTER, MA 01608

(508) 792-7600
(508) 795-1991 fax
www.mass.gov/ago

August 21, 2021

Theodora K. Eaton, Town Clerk
Town of Needham
1471 Highland Avenue
Needham, MA 02492

Re: Needham Annual Town Meeting of May 3, 2021 -- Case # 10146
Warrant Articles # 5 and 6 (Zoning)

Dear Ms. Eaton:

Articles 5 and 6 - We approve Articles 5 and 6, and the map amendments adopted under Article 6, from the May 3, 2021 Needham Annual Town Meeting. We will send the approved map to you by regular mail.

Note: Pursuant to G.L. c. 40, § 32, neither general nor zoning by-laws take effect unless the Town has first satisfied the posting/publishing requirements of that statute. Once this statutory duty is fulfilled, (1) general by-laws and amendments take effect on the date these posting and publishing requirements are satisfied unless a later effective date is prescribed in the by-law, and (2) zoning by-laws and amendments are deemed to have taken effect from the date they were approved by the Town Meeting, unless a later effective date is prescribed in the by-law.

Very truly yours,
MAURA HEALEY
ATTORNEY GENERAL
Kelli E. Gunagan
By: Kelli E. Gunagan
Assistant Attorney General
Municipal Law Unit
10 Mechanic Street, Suite 301
Worcester, MA 01608
(508) 792-7600

cc: Town Counsel Christopher H. Heep

Theodora K. Eaton, MMC
Town Clerk

TOWN OF NEEDHAM
Office of the Town Clerk
1471 Highland Avenue, Needham, MA 02492-0909
Telephone (781) 455-7500 x216
Fax (781) 449-1246
Email: Teaton@needhamma.gov

AT THE ANNUAL TOWN MEETING

HELD ON MONDAY, MAY 3, 2021

UNDER ARTICLE 5
It was

VOTED: That the Town will vote to amend the Needham Zoning By-Law as follows:

1. Amend Section 2.1, Classes of Districts, by adding the following term and abbreviation under the subsection Industrial:

"HC-1 -- Highway Commercial 1"

2. Amend Section 3.2, Schedule of Use Regulations, by adding a new Section 3.2.7 as follows:

"3.2.7 Uses in the Highway Commercial 1 District

3.2.7.1 Permitted Uses

The following uses are permitted within the Highway Commercial 1 District as a matter of right:

(a) Uses exempt from local zoning control pursuant to M.G.L. Chapter 40A, Section 3.

(b) Public parks and playgrounds, municipal buildings or uses.

(c) Retail establishment (not including grocery stores) or combination of retail establishments serving the general public where each establishment contains 5,750 square feet or less of floor area and where all items for sale or rent are kept inside a building.

(d) Manufacturing clearly incidental and accessory to a retail use on the same premises and the product is customarily sold on the premises.

(e) Craft, consumer or commercial service establishment dealing directly with the general public.

(f) Laundry or dry-cleaning pick-up station with processing done elsewhere.

(g) Professional, business or administrative office, but not including any of the following: a medical clinic or Medical Services Building or medical, surgical, psychiatric, dental, orthodontic, or psychologist group practices comprised of three or more such professionals (hereinafter "Group Practices") or physical therapy, alternative medicine practices, wellness treatments, including but not limited to, acupuncture, yoga, chiropractic and/or nutrition services. "Professional" shall include professional

medical, surgical, psychiatric, dental, orthodontic or psychologist practice by a group of two or fewer such professionals ("Non-group Practice").

(h) Bank or Credit Union.

(i) Medical Laboratory or laboratory engaged in scientific research and development and/or experimental and testing activities including, but not limited to, the fields of biology, genetics, chemistry, electronics, engineering, geology, medicine and physics, which may include the development of mock-ups and prototypes.

(j) Radio or television studio.

(k) Light non-nuisance manufacturing, including, but not limited to, the manufacture of electronics, pharmaceutical, bio-pharmaceutical, medical, robotic, and micro-biotic products, provided that all resulting cinders, dust, flashing, fuses, gases, odors, smoke, noise, vibration, refuse matter, vapor, and heat are effectively confined in a building or are disposed of in a manner so as not to create a nuisance or hazard to safety or health.

(l) Telecommunications facility housed within a building.

(m) Other customary and proper accessory uses incidental to lawful principal uses. Further provided, accessory uses for seasonal temporary outdoor seating for restaurants serving meals for consumption on the premises and at tables with service provided by waitress or waiter shall be allowed upon minor project site plan review with waiver of all requirements of Section 7.4.4 and 7.4.6 except as are necessary to demonstrate compliance with Section 6.9 by the Planning Board or Select Board in accordance with Section 6.9.

(n) More than one building on a lot.

(o) More than one use on a lot.

3.2.7.2 Uses Permitted by Special Permit

The following uses are permitted within the Highway Commercial 1 District upon the issuance of a Special Permit by the Special Permit Granting Authority under such conditions as it may require:

(a) Light-rail train station.

(b) Adult day care facility.

(c) Private school, nursery, or kindergarten not otherwise classified under Section 3.2.7.1 (a).

(d) Retail establishment (not including grocery stores) or combination of retail establishments serving the general public where any establishment contains more than 5,750 but less than 10,000 square feet of floor area and where all items for sale or rent are kept inside a building.

(e) Equipment rental service but not including any business that uses outside storage.

(f) Grocery store provided it does not exceed 10,000 square feet of floor area.

(g) Eat-in or take-out restaurant or other eating establishment except that a lunch counter incidental to a primary use shall be permissible by right.

(h) Veterinary office and/or treatment facility and/or animal care facility, including but not limited to, the care, training, sitting and/or boarding of animals.

(i) Indoor athletic or exercise facility or personal fitness service establishment, which may include outdoor pool(s) associated with such facilities.

(j) External automatic teller machine, drive-up window or auto-oriented branch bank accessory to a bank or credit union permitted under Section 3.2.7.1(h) hereof.

(k) Group Practices as defined in Section 3.2.7.1(g) and alternative medicine practices, physical therapy, and wellness treatments facilities including, but not limited to, acupuncture, yoga, chiropractic and/or nutrition services. Such uses may have customary and proper accessory uses incidental to the lawful principal uses, including but not limited to, pharmacies.

(l) Live performance theater, bowling alley, skating rink, billiard room, and similar commercial amusement or entertainment places.

(m) Apartment or multi-family dwelling provided that (1) the proposed apartment or multi-family dwelling complies with the lot area per unit requirements for apartments in the A-1 district as detailed in Section 4.3, (2) no more than 240 dwelling units shall be permitted in the Highway Commercial 1 District, (3) at least 40% but not more than 70% of all dwelling units within any project shall be one-bedroom units, and (4) at least 12.5% of all dwelling units shall be Affordable Units as regulated in Section 6.12."

3. Amend Section 4.7.1, Specific Front Setbacks, by deleting the following provisions:

"(b) On the easterly side of Gould Street from Highland Avenue northerly to land of the New York, New Haven and Hartford Railroad Company, there shall be a fifty (50) foot building setback line;

(c) On the northerly side of Highland Avenue from Gould Street northeasterly to the property of the Commonwealth of Massachusetts, there shall be a fifty (50) foot building setback line."

4. Amend Section 4.10, Dimensional Regulations for Industrial-1 District, by deleting Section 4.10.4, which refers to Section 4.7.1 (b) and (c).
5. Amend Section 4, Dimensional Regulations, by adding a new Section 4.11 Dimensional Regulations for Highway Commercial Districts as follows:

"4.11 Dimensional Regulations for Highway Commercial Districts

4.11.1 Highway Commercial 1

Minimum Lot Area (Sq. Ft.)	Minimum Lot Frontage (Ft.)	Front Setback (Ft.) (1)	Side Setback (Ft.) (1) (3)	Rear Setback (Ft.) (1) (3)	Maximum Height (Ft.) (1)	Maximum Stories (1)	Maximum Lot Coverage (2) (4)	Floor Area Ratio (5) (6)
20,000	100	5	10	10	56	4	65%	0.70

(1) a. All buildings shall be limited to a height of 56 feet and four stories, except that buildings within 200 feet of Highland Avenue or the extension of the right-of-way line as described below in paragraph c. and buildings within 200 feet of Gould Street shall be limited to a height of 35 feet and 2 ½ stories as-of-right. If the height of a building is increased above the height of 35 feet, the front setback shall be increased to 15 feet and the side and rear setbacks to 20 feet except that, along the MBTA right-of-way the side and rear yard setbacks shall be 10 feet.

b. By Special Permit from the Planning Board, the maximum height of a building may be increased to 3 stories and 42 feet within 200 feet of Highland Avenue or the extension of the right-of-way line as described below in paragraph c. and within 200 feet of Gould Street. By Special Permit from the Board, the maximum height of a building may be further increased to the following limits: 5 stories and 70 feet provided the building is not located within 200 feet of Highland Avenue or the extension of the right-of-way line as described below in paragraph c. or within 200 feet of Gould Street.

c. (i) The line from which the 200-foot setback from Highland Avenue referred to in paragraphs a. and b. above shall be measured is that line which starts at the point of curvature on Highland Avenue at Gould Street marked by a stone bound/drill hole (SB/DH) and runs northeasterly N63°56'51"E by the Highland Avenue 1980 State Highway Alteration 361.46 feet to a stone bond/drill hole, then continues on the same northeasterly course an additional 330.54 feet for a total distance from the first mentioned bound of 700 feet. Reference is made to a plan entitled "Plan of Land Gould Street, Needham, MA", prepared by Andover Engineering, Inc., dated July 27, 2000, last revised September 20, 2001, recorded in the Norfolk County Registry of Deeds as Plan No. 564 of 2001, Plan Book 489. (ii) The line from which the 50-foot landscaped setback from Highland Avenue referred to in paragraph d. below shall be measured is that line which starts at the point of curvature on Highland Avenue at Gould Street marked by a stone bound/drill hole (SB/DH) and runs northeasterly N63°56'51"E by the Highland Avenue 1980 State Highway Alteration 361.46 feet to a stone bound/drill hole. If the 1980 State Highway Alteration along Highland Avenue is superseded by a subsequent State Highway Alteration, the 50-foot landscaped setback from Highland Avenue shall be measured from the newly-established street line.

d. Buildings and structures abutting Highland Avenue for the distance described in subsection (1) c. (ii) above and/or abutting Highland Avenue as it continues southwesterly to the intersection with Gould Street and/or abutting Gould Street shall be set back at least 50 feet from said streets. Buildings and structures abutting the layout of Route 128/95 beyond said Highland Avenue distance from stone bound to stone bound shall be set back at least 20 feet from said Route 128/95 layout. Notwithstanding the location or height of any building and structures, the required 50-foot or 20-foot setback shall be a landscaped, vegetative buffer area, which shall be required along the aforementioned street frontages and said

layout in order to screen the development. Driveway openings, sidewalks, walkways and screened mechanical equipment shall be permitted in the buffer area.

e. Structures erected on a building and not used for human occupancy, such as chimneys, heating-ventilating or air conditioning equipment, solar or photovoltaic panels, elevator housings, skylights, cupolas, spires and the like may exceed the maximum building height provided that no part of such structure shall project more than 15 feet above the maximum allowable building height, the total horizontal coverage of all of such structures on the building does not exceed 25 percent, and all of such structures are set back from the roof edge by a distance no less than their height. The Planning Board may require screening for such structures as it deems necessary. Notwithstanding the above height limitations, cornices and parapets may exceed the maximum building height provided they do not extend more than 5 feet above the highest point of the roof.

f. For purposes of clarity, the required building setbacks and allowed envelopes (including setbacks) for allowance of additional height above 35 feet for the as-of right circumstance and 42 feet for the special permit circumstance are shown on figures 1 and 2 below.

Figure 1:

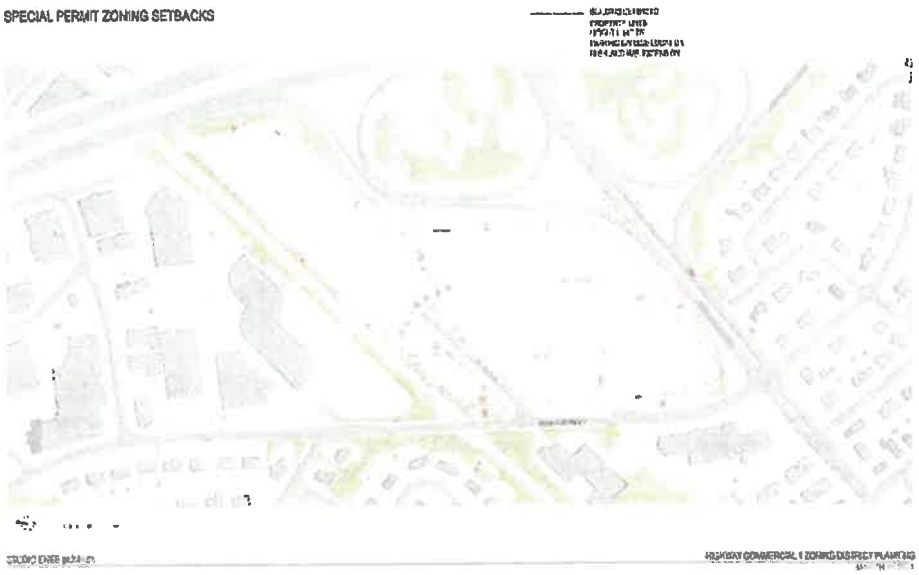
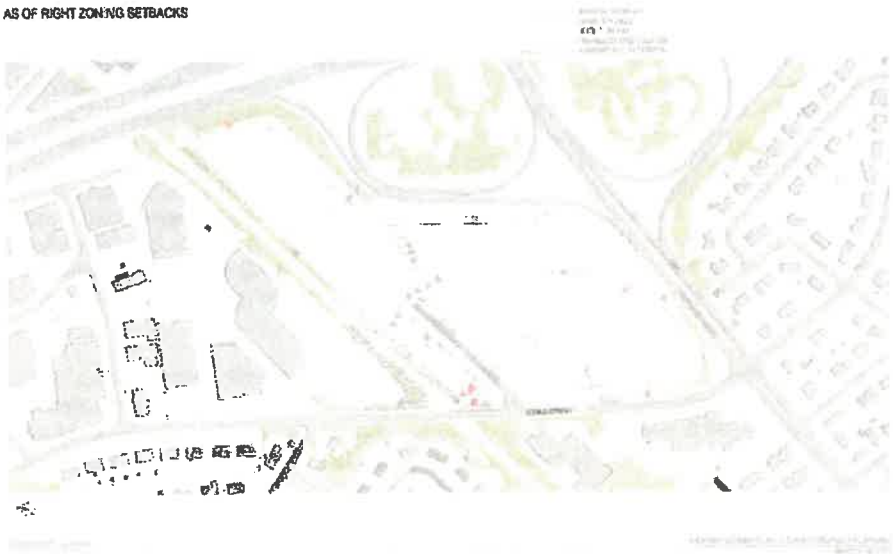


Figure 2:



(2) Maximum lot coverage shall be 65% for all projects. However, if a project is designed such that at least 65% of the required landscaped area immediately abuts at least 65% of the required landscaped area of an adjoining project for a distance of at least 50 feet, the maximum lot coverage may be increased to 75%.

(3) No side or rear yard setback is required for shared parking structures between adjoining properties, but only on one side of each lot, leaving the other side or rear yards open to provide access to the interior of the lot.

(4) A minimum of 25% of total lot area must be open space. The open space area shall be landscaped and may not be covered with buildings or structures of any kind, access streets, ways, parking areas, driveways, aisles, walkways, or other constructed approaches or service areas. Notwithstanding the preceding sentence, open space may include pervious surfaces used for walkways and patios. (Pervious surfaces shall not preclude porous pavement, porous concrete, and/or other permeable pavers.)

(5) A floor area ratio of up to 1.35 may be allowed by a special permit from the Planning Board. In granting such special permit, the Planning Board shall consider the following factors: the ability of the existing or proposed infrastructure to adequately service the proposed facility without negatively impacting existing uses or infrastructure, including but not limited to, water supply, drainage, sewage, natural gas, and electric services; impact on traffic conditions at the site, on adjacent streets, and in nearby neighborhoods, including, but not limited to, the adequacy of the roads and intersections to safely and effectively provide access and egress; the environmental impacts of the proposal; and the fiscal implications of the proposal to the Town. In granting a special permit, the Planning Board shall also consider any proposed mitigation measures and whether the proposed project's benefits to the Town outweigh the costs and adverse impacts, if any, to the Town.

(6) The calculation of floor area in determining floor area ratio shall not include parking areas or structures but shall include such active ground floor uses, such as retail, office, institutional, or display as are allowed by Section 4.11.2 (2).

4.11.2 Supplemental Dimensional Regulations

(1) Notwithstanding Section 3.2.7.1(m) and any other provision of this Section 4.11 to the contrary, a parking garage, even if it is for an as-of-right development, may not exceed 44 feet in height, may not have a building footprint in excess of 42,000 square feet and may not be located within 250 feet of Highland Avenue or the extension of the right-of-way line described in Section 4.11.1 (1) c. (i) or within 200 feet of Gould Street. Notwithstanding the above, the maximum height of a parking garage may be increased to 55 feet by Special Permit from the Planning Board. For purposes of clarity the height, coverage and location requirements for the as-of-right and special permit parking garage circumstance are shown on figure 3 below.

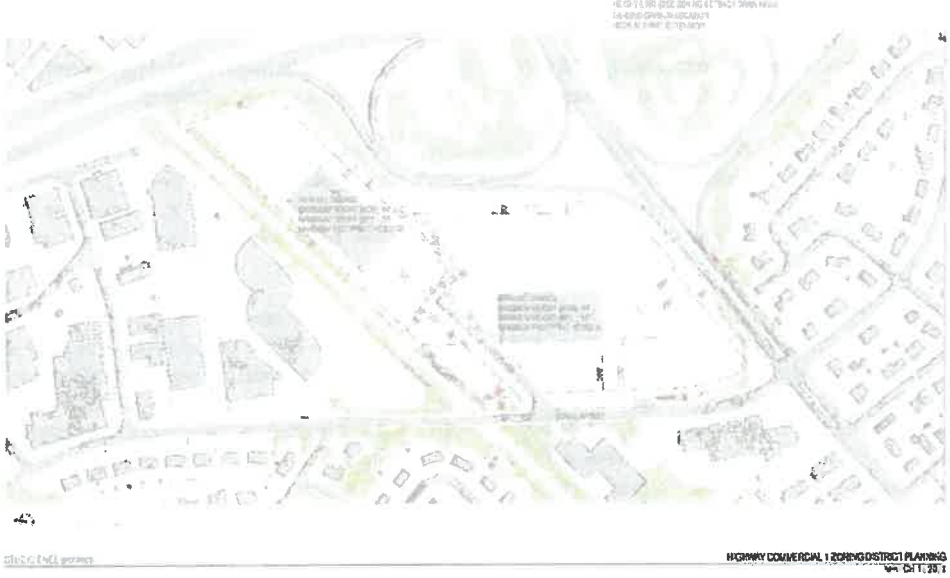
(2) Parking structures may have an active ground floor use, such as retail, office, institutional, or display. Structured parking must be located at least 20 feet from adjacent buildings but may be attached to the building it is servicing if all fire and safety requirements are met.

(3) Maximum uninterrupted facade length shall be 200 feet.

(4) All setback, height, and bulk requirements applicable to this Section 4.11 are contained in this Section and no additional requirements occasioned by this district abutting Route 128/95's SRB district shall apply.

PARKING GARAGE LOCATION

Figure 3:



HIGHWAY COMMERCIAL 1 ZONING DISTRICT PLANNING

4.11.3 Special Permit Requirements

In approving any special permit under Section 3.2.7.2 and/or Section 4.11, or for any project proceeding under the Highway Commercial 1 district provisions which constitute a Major Project under Section 7.4.2, the Planning Board shall consider the following design guidelines for development: (a) The proposed development should provide or contribute to providing pedestrian and neighborhood connections to surrounding properties, e.g., by creating inviting buildings or street edge, by creating shared publicly accessible green spaces, and/or by any other methods deemed appropriate by the Planning Board; (b) Any parking structure should have a scale, finish and architectural design that is compatible with the new buildings and which blunts the impact of such structures on the site and on the neighborhood; (c) The proposed development should encourage creative design and mix of uses which create an appropriate aesthetic for this gateway to Needham, including but not limited to, possible use of multiple buildings to enhance the corner of Highland Avenue and Gould Street, possible development of a landscape feature or park on Gould Street or Highland Avenue, varied façade treatments, streetscape design, integrated physical design, and/or other elements deemed appropriate by the Planning Board; (d) The proposed development should promote site features and a layout which is conducive to the uses proposed; (e) The proposed development should incorporate as many green building standards as practical, given the type of building and proposed uses; (f) The proposed development should be designed and conditioned to reduce or mitigate adverse impacts on adjacent properties or the surrounding area such as those resulting from excessive traffic congestion or excessive demand for parking; and (g) The proposed development shall include participation in a transportation demand management program to be approved by the Planning Board as a traffic mitigation measure, including but not limited to, membership and participation in an integrated or coordinated shuttle program."

6. Amend Section 5.1.3, Parking Plan and Design Requirements, by adding at the end of the second sentence of subsection (j) which reads "Such parking setback shall also be twenty (20) feet in an Industrial-1 District" the words "and Highway Commercial 1 District unless a deeper parking setback is required by Section 4.11."

7. Amend Section 6.5.1 of Section 6.5 Limited Heliports, by adding after the words "Industrial Districts," in the first sentence, the words "and in the Highway Commercial 1 District,".

8. Amend Section 6.12, Affordable Housing, by revising the first paragraph to read as follows:
"Any mixed-use building in the Neighborhood Business District (NB) with six or more dwelling units shall include affordable housing units as defined in Section 1.3 of this By-law. Any building in the Highway Commercial 1 District with six or more dwelling units shall include affordable housing units as defined in Section 1.3 of this By-law. The requirements detailed in paragraphs (a) thru (i) below shall apply to a development that includes affordable units in the Neighborhood Business District. The requirements detailed in paragraphs (a), (c), (d), (e), (f), (g), and (h) below shall apply to a development that includes affordable units in the Highway Commercial 1 District."

9. Amend Section 7.2.5 of Section 7.2 Building or Use Permit, by adding after the words "Industrial-1 District," in the first sentence, the words "Highway Commercial 1 District,".

10. Amend Section 7.4.2 of Section 7.4 Site Plan Review, by adding in the first sentence of the last paragraph, the words "Highway Commercial 1 District," after the words "Highland Commercial-128,".

11. Amend Section 7.7.2.2, Authority and Specific Powers (of Design Review Board) by adding after the words "Industrial-1 District," in the first sentence of the second paragraph, the words "Highway Commercial 1 District,".

PASSED BY A STANDING COUNT OF HANDS
YES 168 - NO 37

A true copy
ATTEST: Theodora K. Eaton
Theodora K. Eaton, MMC, Town Clerk

TOWN OF NEEDHAM
Office of the Town Clerk
1471 Highland Avenue, Needham, MA 02492-0909
Telephone (781) 455-7500 x216
Fax (781) 449-1246
Email: Teaton@needhamma.gov

Theodora K. Eaton, MMC
Town Clerk

AT THE ANNUAL TOWN MEETING

HELD ON MONDAY, MAY 3, 2021

UNDER ARTICLE 6
It was

VOTED: That the Town will vote to amend the Needham Zoning By-Law by amending the Zoning Map as follows: Place in the Highway Commercial 1 District all that land now zoned Industrial-1 and lying between the Circumferential Highway, known as Route 128/95 and Gould Street and between the Massachusetts Bay Transit Authority (M.B.T.A.) right-of-way and Highland Avenue. Said land is bounded and described as follows:

Beginning at a stone bound on the northerly layout line of Highland Avenue at the intersection of Gould Street as shown on a plan recorded at the Norfolk County Registry of Deeds, Plan No. 564 of 2001, Plan Book 489; thence turning and running southwesterly, westerly and northwesterly along a radius of 44.00 feet a distance of 80.06 feet to a stone bound on the easterly sideline of Gould Street; thence running northwesterly, northerly, and northeasterly along a curve of radius of 505.00 feet of said sideline of Gould Street a distance of 254.17 feet to a point on the said easterly sideline of Gould Street; thence running N10°49'50"E a distance of 284.29 feet to a point on the said easterly sideline of Gould Street at the intersection of TV Place, a privately owned Right of Way; thence continuing N10°49'50"E a distance of 160.00 feet more or less to a stone bound as shown on a plan recorded at the Norfolk County Registry of Deeds Land Court Case No. 18430I; thence continuing N10°49'50"E a distance of 84.82 feet to a stone bound located at the intersection of the easterly sideline of Gould Street and the southerly sideline of the M.B.T.A. Right of Way as shown on a plan recorded at the Norfolk County Registry of Deeds Land Court Case No. 18430I; thence turning and running along said southerly M.B.T.A. Right of Way line northeasterly a distance of 1,219.55 feet as shown on a plan recorded at the Norfolk County Registry of Deeds Land Court Case No. 18430I, 18430J and 18430H to a point at the intersection of the westerly sideline of the Route 128 Right of Way and said southerly sideline of the M.B.T.A. Right of Way; thence turning and running S4°25'46"E a distance of 292.00 feet to a stone bound as shown on a plan recorded at the Norfolk County Registry of Deeds Land Court Case No. 18430H; then turning and running southwesterly along the Route 128 Right of Way a distance of 484.61 feet to a point; thence turning and running S13°34'58"W a distance of 451.02 feet as shown on a plan recorded at the Norfolk County Registry of Deeds, Plan No. 564 of 2001, Plan Book 489 to a point; thence turning and running S76°26'41"E a distance of 35.56 feet to a point; thence turning and running S13°34'58"W a distance of 67.34 feet to a point; thence running southwesterly along a curve of radius 245.45 feet a distance of 136.59 feet to a point; thence running southwesterly along a curve of radius 248.02 feet a distance of 38.04 feet to a point; thence running southwesterly along a curve of radius 1180.00 feet a distance of 140.09 feet to a point; thence turning and running S42°43'47"W a distance of 42.52 feet to a stone bound located in the westerly sideline of the Route 128 Right of Way; thence turning and running S63°56'51"W a distance of 361.46 feet to the point of beginning.

PASSED BY A STANDING COUNT OF HANDS
YES 168 NO 37

A true copy
ATTEST: Theodora K. Eaton
Theodora K. Eaton, MMC, Town Clerk

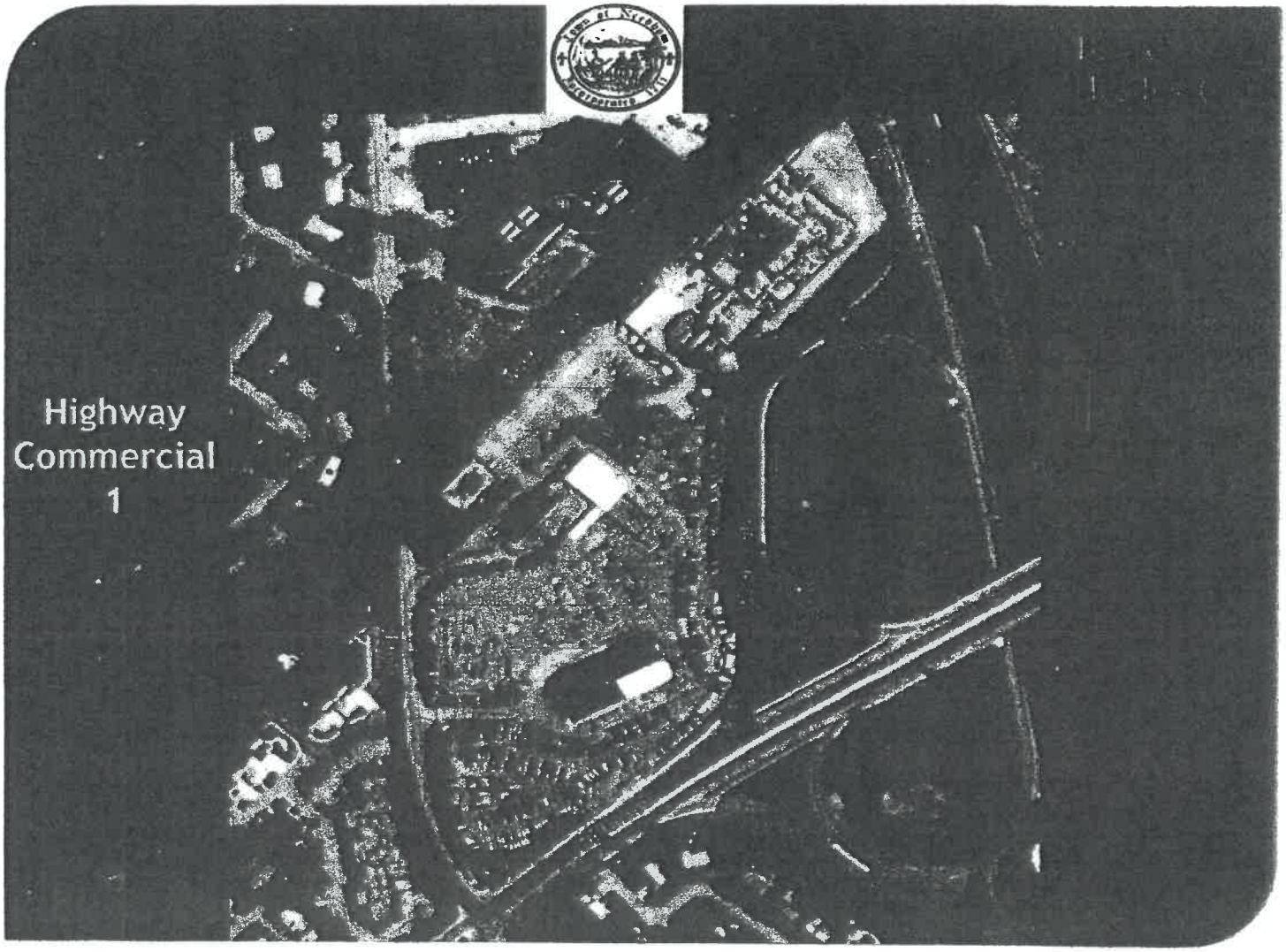
Annual Town Meeting
May 2021

Planning Board
Warrant Articles 5 + 6

Highway
Commercial
1

A True Copy
Attest:
Theodora K. Eaton
Town Clerk of Needham, MA

APPROVED
Attorney General's Office
By
Date 05/21/21
Art 5 Town Meeting Date 5/03/21



A True Copy
Attest:
Town Clerk of Needham, MA

PLANNING & COMMUNITY DEVELOPMENT
PLANNING DIVISION

LEGAL NOTICE
Planning Board
TOWN OF NEEDHAM
NOTICE OF HEARING

In accordance with the provisions of M.G.L., Chapter 40A, S.11; the Needham Zoning By-Laws, Sections 3.2.7.2, 4.11, 5.1.1.5, 6.11.5, 7.2, 7.4, 7.5 and 7.6, the Needham Planning Board will hold a public hearing on Tuesday, June 7, 2022 at 7:20 p.m. in the Needham Town Hall, Powers Hall, 1471 Highland Avenue, Needham, MA, as well as by Zoom Web ID Number 826-5899-3198 (further instructions for accessing by zoom are below), regarding the application of 557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc., 116 Huntington Avenue, Suite 600, Boston, MA, for a Major Project Special Permit under Site Plan Review, Section 7.4 of the Needham Zoning By-Law.

The subject property is located at 557 Highland Avenue, Needham, MA, located in the Highway Commercial 1 Zoning District. The property is shown on Assessors Plan No. 76 as Parcels 3 and 8 containing a total of 9.27 acres. The requested Major Project Site Plan Special Permit Amendment, would, if granted, permit the Petitioner to redevelop the Property with approximately 496,694 square feet of office, laboratory and research and development uses. The proposal also includes construction of one-level of below grade parking under each building and a separate stand-alone parking garage, as well as approximately 10,000 square feet of retail and restaurant uses. The proposal also includes two buildings, one on the northerly portion of the Property (the "North Building") and one on the southerly portion of the Property (the "South Building"), together with a shared connector atrium (the "Atrium").

The following items of zoning relief are requested: (1) Special Permit in accordance with By-Law Section 4.11.1(5) for an FAR of 1.25 for the Project; (2) Special Permit, in accordance with By-Law Section 4.11.1(1) for a building height of 70 feet for the North Building; (3) Special Permit, in accordance with By-Law Section 4.11.1(1) for 5 stories for the North Building; (4) Special Permit, in accordance with By-Law Section 4.11.1(1) for a building height of 42 feet for the South Building; (5) Special Permit, in accordance with By-Law Section 4.11.1(1) for 3 stories for the South Building; (6) Special Permit, in accordance with By-Law Section 3.2.7.2 (g), for restaurant use; (7) Special Permit, in accordance with By-Law Section 3.2.7.2 (d), for retail use by a single tenant of between 5,750 – 10,000 square feet; (8) Special Permit, in accordance with By-Law Section 4.11.2(1) for a parking garage structure height of 55 feet; (9) Site Plan Review and Approval of the Project as a Major Project in accordance with Section 7.4; (10) Special Permit, in accordance with By-Law Section 5.1.1.5, for deviation from the required parking space number under By-Law Section 5.1.2 to be provided as part of the Project; (11) Special Permit, in accordance with By-Law Section 6.11.5, for deviation from the design requirements for retaining walls; and (12) Any additional Special Permits required for the permitting of the Project.

To view and participate in this virtual meeting on your phone, download the "Zoom Cloud Meetings" app in any app store or at www.zoom.us. At the above date and time, click on "Join a Meeting" and enter the following Meeting ID: 826-5899-3198

To view and participate in this virtual meeting on your computer, at the above date and time, go to www.zoom.us click "Join a Meeting" and enter the following ID: 826-5899-3198

Or to Listen by Telephone: Dial (for higher quality, dial a number based on your current location):
US: +1 312 626 6799 or +1 646 558 8656 or +1 301 715 8592 or +1 346 248 7799 or +1 669 900 9128 or +1 253 215 8782 Then enter ID: 826-5899-3198

Direct Link to meeting: https://us02web.zoom.us/s/82658993198

The application may be viewed at this link: https://www.needhamma.gov/Archive.aspx?AMID=146&Type=&ADID= . Interested persons are encouraged to attend the public hearing and make their views known to the Planning Board. This legal notice is also posted on the Massachusetts Newspaper Publishers Association's (MNPA) website at (http://masspublicnotices.org/).

NEEDHAM PLANNING BOARD

Needham Hometown Weekly, May 12, 2022 and May 19, 2022.

2022 APR -7 PM 3:41

RECEIVED
APR - 7 2022
PLANNING DEPARTMENT
NEEDHAM, MA

TOWN OF NEEDHAM
MASSACHUSETTS

500 Dedham Avenue
Needham, MA 02492
781-455-7550

PLANNING BOARD

APPLICATION FOR SITE PLAN REVIEW

Project Determination: (circle one) [Major Project] Minor Project

This application must be completed, signed, and submitted with the filing fee by the applicant or his representative in accordance with the Planning Board's Rules as adopted under its jurisdiction as a Special Permit Granting Authority. Section 7.4 of the By-Laws.

Location of Property 557 Highland Avenue
Name of Applicant 557 Highland, LLC
Applicant's Address c/o The Bulfinch Companies, 116 Huntington Avenue,
Phone Number Suite 600, Boston, MA 02116

Applicant is: Owner x Tenant ____
Agent/Attorney ____ Purchaser ____

Property Owner's Name 557 Highland, LLC
Property Owner's Address c/o The Bulfinch Companies, 116 Huntington Avenue,
Telephone Number Suite 600, Boston, MA 02116

Characteristics of Property: Lot Area ____ Present Use Vacant, former car dealership
LOT AREA: 9.273 ACRES Map # __ Parcel # __ Zoning District Highway Commercial 1
PARCEL ID 1990760000300000

Description of Project for Site Plan Review under Section 7.4 of the Zoning By-Law:

Please see ~~attached~~ the filing and zoning letter filed herewith

557 Highland, LLC, by: Robert Schlager

Signature of Applicant (or representative) _____
Address if not applicant _____
Telephone # 781.707.4122
Owner's permission if other than applicant N/A

SUMMARY OF PLANNING BOARD ACTION
Received by Planning Board _____ Date April 7, 2022
Hearing Date _____ Parties of Interest Notified of Public Hearing _____
Decision Required by _____ Decision/Notices of Decision sent _____
Granted _____
Denied _____ Fee Paid _____ Fee Waived _____
Withdrawn _____
NOTE: Reports on Minor Projects must be issues within 35 days of filing date.

goulston&storrs
counsellors at law

April 5, 2022

BY HAND DELIVERY, OVERNIGHT DELIVERY & ELECTRONIC MAIL

Town of Needham Planning Board Members
Public Service Administration Building
500 Dedham Avenue
Needham, MA 02492
Attn: Lee Newman, Planning Director

Re: 557 Highland Avenue, Needham Heights, Massachusetts (the "Property")

Dear Planning Board Members:

We are counsel to 557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc. (the "Applicant") in connection with the redevelopment of approximately 9.27 acres of land, bordered by Highland Avenue to the south, Interstate 95/Route 128 to the east, Gould Street to the west, and TV Place (formerly known as Permil Road), a private way, to the north. The Property is the former site of the Muzi Ford and Chevrolet automotive dealership and service centers and the Muzi car wash.

The Applicant is proposing to redevelop the Property with approximately 496,694 square feet (sq. ft.) of office, laboratory and research and development uses (the "Project"). The Project will also include construction of one-level of below grade parking under each building and a separate stand-alone parking garage as well as approximately 10,000 sq. ft. of retail and restaurant uses. The Project will include two buildings, one on the northerly portion of the Property (the "North Building") and one on the southerly portion of the Property (the "South Building"), together with a shared connector atrium (the "Atrium").

As described below, zoning allows a maximum Floor Area Ratio ("FAR") of 1.35 for the Property generating a maximum build out of 542,000 sq. ft. The Application (defined below) proposes an FAR of 1.25, based on a buildout of 506,694 sq. ft., 35,306 sq. ft. less than the maximum buildout.

The materials and studies submitted with this Application (defined below) and in the Project's MEPA Environmental Notification Form have conservatively studied and presented an analysis based on a significantly higher build out for the Property of the approximately 531,000 sq. ft. Accordingly, the traffic generation numbers in these materials and studies can be reduced by approximately 5%, yielding lesser impacts than what was studied.

Pursuant to the Massachusetts Zoning Act, G.L. c. 40A, the Needham Zoning By-Law, and the Board Rules, enclosed is an Application for Site Plan Review and issuance of Special

Permits for the Project (the "Application"). In support of the Application, the Applicant is submitting the following materials and information (*5 copies of each unless otherwise indicated*):

1. Application for Site Plan Review;

2. Plan Set titled "557 Highland Avenue Needham, MA 02494 – Needham Special Permit Package" (the "Plan Set"), prepared by Stantec Architecture and Engineering P.C. ("Stantec"), which includes the following, all dated March 30, 2022 unless noted otherwise (*1 additional 11x17 copy mailed directly and sent via electronic mail to each Planning Board member*):

    a. Proposed Site Plan

    b. Site Aerial – Proposed

    c. Street View – Proposed

    d. G-000 – Cover Sheet

    e. Civil Plan Set containing the following:

        i. Sheet C-01 – Legend and General Notes

        ii. Sheet C-02 – Overall Site Plan

        iii. Sheet C-03 – Drainage and Erosion Control Plan

        iv. Sheet C-04 – Utility Plan

        v. Sheet C-05 – Site Details

        vi. Sheet C-06 – Site Details

    f. Landscape Plan Set containing the following:

        i. Sheet L-1.0 – Site Plan

        ii. Sheet L-2.0 – Site Grading Plan

        iii. Sheet L-3.0 – Site Planting Plan

        iv. Sheet L-4.0 – Site Lighting Plan

        v. Sheet L-5.0 – Site Details #1

        vi. Sheet L-5.1 – Site Details #2

g. Architectural Plan Set containing the following:

i. Sheet G-010 – Zoning Gross Area Plans

ii. Sheet A-100G1 – Garage Level G1 – Overall Plan

iii. Sheet A-101 - Level 1 – Overall Plan

iv. Sheet A-102 Level 2 – Overall Plan

v. Sheet A-103 Level 3 – Overall Plan

vi. Sheet A-104 Level 4 – Overall Plan

vii. Sheet A-105 Level 5 – Overall Plan

viii. Sheet A-106 Level 6 – Overall Plan

ix. Sheet A-107 – Roof Plan

x. Sheet A-201 – Building Elevations – Locator Elevations

xi. Sheet A-202 – Building Elevations – North Bldg. – North

xii. Sheet A-203 – Building Elevations –North Bldg. – South & East

xiii. Sheet A-204 – Building Elevations – North Bldg. (Southwest) & South Bldg. (South)

xiv. Sheet A-205 – Building Elevations – North Bldg. (West) & South Bldg. (North & West)

xv. Sheet A-206 – Building Elevations – South Bldg. – North & East

xvi. Sheet A-211 – Building Sections – Overall

xvii. Sheet A-212 – Building Sections – North Bldg.

xviii. Sheet A-213 – Building Sections – North Bldg.

h. Architectural – Garage Plan Set containing the following:

i. Sheet AG-100.B2 – Garage Level B2

ii. Sheet AG-100.B1 – Garage Level B1

iii. Sheet AG-101 – Garage Level 1

iv. Sheet AG-102 – Garage Level 2

v. Sheet AG-103 – Garage Level 3 (Level 4-5 Sim.)

vi. Sheet AG-106 – Garage Level 6

vii. Sheet AG-211 – Garage Sections

viii. Sheet AG-212 – Garage Sections

ix. Sheet AG-301 – Elevations – North & East

x. Sheet AG-302 – Elevations – South & West

3. Transportation Impact and Access Study prepared by Vanasse Hangen Brustlin, Inc. ("VHB"), dated March 2022 (the "TIAS");

4. Stormwater Report prepared by VHB, dated March 2022 (the "Stormwater Report");

5. Fiscal Impact Analysis, prepared for the Town by the Barrett Planning Group, LLC of Plymouth, MA dated March 20, 2021, summarizing the anticipated revenues from various redevelopment scenarios of the Property and the adjacent parcels (the "Fiscal Analysis");

6. Check payable to the Town of Needham in the amount of $98,992.90, representing the filing fee for Site Plan Review and Special Permit Application, calculated at $1000 plus $0.10 per square foot in excess of 10,000 sq. ft for 506,694 sq. ft. of office/lab/research and development/retail/restaurant uses and 483,235 sq. ft. of accessory parking uses.

The Applicant hereby requests pursuant to Zoning By-Law Section 7.4.4 that the Board waive the submission by Applicant of any required information not submitted herewith.

* * *

ZONING ANALYSIS DISCUSSION:

Background and Overview:

Pursuant to the Town of Needham Zoning Map, as amended by Article 6 of the Annual Town Meeting held on May 3, 2021 (as amended, the "Zoning Map"), the Property is located within the Highway Commercial 1 District (the "HC-1 District"). The HC-1 District was established by an amendment to the Town of Needham Zoning By-Law (as amended, the "By-Law") adopted by a 168-37 vote of Town Meeting pursuant to Article 5 of the Annual Town

Meeting held on May 3, 2021. According to the Zoning Map, the Property is not located within any overlay districts.

The creation of the HC-1 District was the result of an extensive planning effort by the Town of Needham (the "Town"). The Town's Council of Economic Advisors ("CEA") began an evaluation of the Town's Industrial Zoning Districts in 2013. The CEA held public meetings with residents, neighbors, public officials, businesses, and landowners (collectively, the stakeholders) in 2014 and obtained a build-out analysis and a traffic impact report. The CEA made preliminary recommendations to the public and Select Board to upgrade the zoning adjacent to I-95/Route 128 to make these areas more economically competitive.

The Planning Board and Select Board decided to move forward with rezoning of the former Industrial-1 Zoning District circumscribed by I-95/Route 128, Highland Avenue, Gould Street, and the MBTA right of way, and occupied by the Muzi Ford and Chevrolet dealership, a car wash, and WCVB Channel 5. An Article proposing to rezone this Industrial-1 Zoning District was developed and presented to the October 2019 Special Town Meeting, where it received a majority vote but less than the required two-thirds.

In response to public concerns about density, traffic impacts, permitted and special permit uses, and environmental issues, a Town-wide community meeting was held with stakeholders in January 2020 to discuss overall land use goals for the HC-1 District. A working group, including representatives from the Planning Board, Select Board, Finance Committee, and CEA was formed. The working group then commissioned an updated traffic study of the area, to analyze the ability of the Town's traffic infrastructure to accommodate development at various densities and use profiles, as well as an updated fiscal impact analysis. From these efforts, the Planning Board drafted a revised Zoning Article to establish the HC-1 District. The revised Zoning Article reduced maximum floor area ratios and building height, increased building setback distances, required additional landscape buffering along Gould Street and Highland Avenue, increased open space requirements and established green building standards for issuance of a special permit.

In connection with the above process, the Town commissioned the Fiscal Analysis to study the potential financial benefit of such rezoning. Based on the Fiscal Analysis, a full-build out of the Property and the adjacent parcels at 1.35 FAR would yield an annual net financial benefit to the Town of approximately $8,342,400. As described above, the Project proposes a build-out of approximately 60% of the full-build out, which results in a prorated annual net financial benefit of approximately $5,000,000 to the Town from development of the Project.

The Applicant now proposes the Project to realize the goals of this re-zoning.

Proposed Project:

Use

The Property contains approximately 9.27 acres of land. It was most recently used as an automotive dealership and car wash making up a nearly entirely impervious surface which included parking for approximately 532 vehicles. As described above, the Project will remove environmentally-hazardous materials and redevelop the existing underutilized site to include approximately 496,694 square feet of office, laboratory and research and development uses. The Project will also feature approximately 10,000 square feet of retail and/or restaurant uses and accessory parking use in the form of underground parking garages and separate stand-alone parking structure. A breakdown of proposed uses and the approximate square footage of such uses is as follows:

USES	PROPOSED[1]
Office	248,347 sq. ft.
Lab/Research and Development	248,347 sq. ft.
Retail/Restaurant	10,000 sq. ft.
Accessory Parking	1,408 total parking spaces of which 343 will be located beneath the buildings, 1,021 will be located in a stand-alone parking garage, and 44 will be surface parking.

Pursuant to By-Law Section 3.2.7, professional, business, or administrative offices and laboratory uses are allowed by-right in the HC-1 District. Retail uses are also allowed by-right so long as no single retail establishment contains more than 5,750 square feet of gross floor area. Light-manufacturing uses— including manufacture of pharmaceutical, bio-pharmaceutical, medical, robotic, and micro-biotic products, which may be part of the Project tenants' laboratory uses—are allowed by right and also as an accessory use to any lab/research development use. The Applicant anticipates that light-manufacturing uses accessory to research and development uses, including the production of prototypes, may be part of the Project depending upon the ultimate tenanting of the Project.

By-Law Section 3.2.7.1(m) allows all customary and proper uses accessory to lawful principal uses. Given that the accessory parking on the Property is intended to provide parking incidental to operation of the main uses described above, such accessory use is allowed by-right.

[1] The specific square footage breakdown is subject to final tenant demands and the Applicant requests that the Board allow the allocation among the uses (and floor plans) to change from time to time without further Board review or approval as long as the Project maintains the number of parking spaces required by the approvals. The Applicant requests the ability to construct the Project in phases, including the right to obtain a final certificate of occupancy for the parking garage and/or either building prior to completion of construction of both buildings.

Formerly, the Property showed 532 lined spaces, a portion of which were used for parking for customers and employees, and the balance of which were used for parking of new and used car inventory and auto repair activities in connection with the dealership on the Property. These spaces do not include any employees or visitors for the car wash.

The Applicant anticipates that the retail space may contain a tenant in excess of approximately 6,000 sq. ft., and a restaurant of approximately 4,000 sq. ft. Accordingly, the Project will require a Special Permit for the potential occupancy of a single retail tenant in excess of 5,750 sq. ft. and a Special Permit for restaurant use.

Parking

The Applicant plans to construct a total of 1,408 parking spaces to be provided between a one-level underground parking structure beneath the buildings and a separate above-ground parking garage.[2] The following chart describes the number of parking spaces required pursuant to By-Law Section 5.1.2.

Use	**Space Required by Zoning**	**Proposed Parking Spaces**
Research facilities/laboratories	828 spaces *(1 space per 300 sq. ft.)**	
Office	828 spaces *(1 space per 300 sq. ft.)*	
Retail	20 spaces *(1 space per 300 sq. ft.)*	
Restaurant	13 spaces *(1 space per 3 seats plus 10 spaces per take-out service station)*	
Total	1,689	1,408 total parking spaces of which 343 will be located beneath the buildings, 1,021 will be located in a stand-alone parking garage, and 44 will be surface parking.
**Provided that occupancy by a single tenant of more than 50,000 sq. ft. shall require one space per 300 sq. ft. for the first 50,000 sq. ft. and 1 space per 400 sq. ft. in excess of 50,000 sq. ft. Thus, the number of required parking spaces will be reduced if a single tenant occupies all of the North Building or the South Building, or both.*		

As shown above, the Applicant proposes 1,408 parking spaces. However, the By-Law's parking requirements assume a higher employee density than is typical for lab/research &

[2] The stand-alone garage will contain two levels of underground parking as shown in the Plan Set.

development uses. The By-Law also assumes that each employee will commute alone and does not take into account the Applicant's proposed use of carpool, walking, biking, and public transit alternatives that will reduce the number of vehicles required to be parked on-site. Furthermore, the By-Law does not consider the potentially permanent changes in commuting patterns resulting from the COVID-19 pandemic, including hybrid/remote work programs. For these reasons, the Applicant's proposed number of parking spaces is more reflective of expected demand than the parking requirement under the By-Law. Therefore, the Project will require a Special Permit from the Planning Board for the difference in its proposed 1,408 spaces from the required spaces under zoning owing to these special circumstances, or for less than 1,408 total spaces, as the Planning Board may deem sufficient based on a review of the Application.[3]

The parking spaces provided will comply with all design guidelines prescribed by By-Law Section 5.1.3 as shown on the Plan Set included with the Application.

Dimensional Requirements

The following chart sets forth dimensional requirements applicable to the Project:

Item	Required	Project	Compliance with Zoning?
Minimum Lot Area	20,000 sq. ft.	403,933 sq. ft.(1)	YES
Minimum Lot Frontage	100 ft.	At least 100 ft.	YES
Maximum Floor Area Ratio	0.70 as-of-right Up to 1.35 by special permit	1.25	**YES – Special Permit Required**
Front Setback from Highland Avenue and Gould Street	15 ft.	North Building: 200 ft. South Building: 50 ft.	YES
Landscape Buffer	50 ft. along Highland Ave. and Gould Street	50 ft.	YES
Increased Height Setback	200 ft. from Highland Ave. and Gould Street	North Building: 200ft.	YES
Side/Front Setback on Rt. 95	20 ft.	20 ft.	YES
Rear Setback	20 ft. (along TV	20 ft.	YES

[3] As described below, the Planning Board is the special permit granting authority for all special permit relief for Major Projects under Section 7.4.3 of the By-Law, and accordingly may grant relief under Section 5.1.1.5 from both parking space requirements under Section 5.1.2 and parking plan.

Item	Required	Project	Compliance with Zoning?
	Place)		
Maximum Lot Coverage	65%	48%	YES
Maximum South Building Height* (within 200 ft. height limitation zone)	35 ft. as-of-right 42 ft. by special permit	42 ft.	**YES – Special Permit Required**
Maximum Building North Height* (outside 200 ft. height limitation zone)	56 ft. as-of-right 70 ft. by special permit	70 ft.	**YES – Special Permit Required**
Maximum Garage Height*	44 ft. as-of-right 55 ft. by special permit	55 ft.	**YES – Special Permit Required**
Maximum Stories* (within 200 ft. height limitation zone)	2.5 stories as-of-right Up to 3 stories by special permit	3 stories (South Building)	**YES – Special Permit Required**
Maximum Stories* (outside 200 ft. height limitation zone)	4 stories as-of-right Up to 5 stories by special permit	5 stories (North Building)	**YES – Special Permit Required**
Maximum Garage Footprint	42,000 sq. ft.	42,000 sq. ft.	YES
Minimum Open Space	25%	27.1%	YES
Maximum Uninterrupted Façade Length	200 ft.	200 ft.[(2)]	YES
Building Parapet Height	5 ft.	5 ft.	YES

**Pursuant to Section 4.11.1(e), structures erected on a building and not used for human occupancy, including mechanical equipment, may exceed the maximum building height provided that no part of such structures extends more than 15 ft. above the maximum allowable building height (e.g., 57 ft and 85 ft., respectively for each building) and such structures do not cover more than 25% of the building roof.*

Item	Required	Project	Compliance with Zoning?
(1) The Applicant's property at 0 Gould Street containing approximately 7,127 sq. ft. is not included in calculation of lot area and other measurements. (2) As shown in the Plan Set, the façade length of the stand-alone garage will be broken up through the use of banners which will result in interruptions of the façade so as to make it less than 200 ft.			

Based on the foregoing, the Project will require Site Plan Review (described below) and Special Permits from the Planning Board as follows: (i) to allow a maximum Floor Area Ratio of 1.25; (ii) to allow a maximum height of 70 feet for the North Building; (iii) to allow a maximum of 5 stories in height for the North Building; (iv) to allow a maximum height of 42 feet for the South Building; (v) to allow a maximum of 3 stories in height for the South Building; and (vi) to allow a maximum building height of 55 feet for the above-ground parking structure.

With respect to clause (i) above, pursuant to By-Law Section 4.11.1(5) the Planning Board may allow an FAR of up to 1.35 by issuance of a Special Permit. The grant of a Special Permit pursuant to this section must consider the factors detailed further below.

With respect to clauses (ii) through (vi) above, pursuant to By-Law Section 4.11.1(1), buildings within 200 ft. of Highland Avenue and Gould Street are limited to a height of 35 ft. and 2.5 stories. The Planning Board may grant a Special Permit to increase the height of buildings within the 200 ft. height limitation zone to 42 ft. and 3 stories and may further increase the height of buildings beyond the 200 ft. height limitation zone to up to 70 ft. and 5 stories. The 200 ft. height limitation envelopes allowing for such height increases are depicted in Figure 1 and Figure 2 of By-Law Section 4.11.1(f), which provides for such figures to clarify the limits of the required setbacks and allowed envelopes. Additionally, pursuant to Section 4.11.2, the Planning Board may grant a Special Permit to increase the height of a parking structure up to 55 ft.[4]

The Project will also require a Special Permit to allow for retaining wall height greater than 4 ft. and other applicable design requirements for retaining walls pursuant to By-Law Section 6.11.5.

Major Project Site Plan Review and Special Permit:

Site Plan Review and Approval, in the form of a Planning Board Special Permit, is required for any "Major Project". Pursuant to Section 7.4.2 a "Major Project" is any project in the HC-1 District that involves the construction of 10,000 or more square feet, an increase in gross floor area of 5,000 or more square feet, or the creation of 25 or more new off-street parking

[4] In lieu of applying the height/story limitation in Section 4.11.1, the By-Law sets parking garage height at 44 ft. and allows an increase up to 55 ft. by Special Permit pursuant to Section 4.11.2(1).

spaces. The Project will exceed each of the foregoing thresholds and therefore qualifies as a Major Project subject to Site Plan Review.

Pursuant to By-Law Section 7.4.3, "the special permit granting authority for all permits the issuance of which is necessary for the construction or use of a Major Project shall be the Planning Board."

Based on the above, the Project will require Site Plan Review and Approval pursuant to By-Law Section 7.4 from the Planning Board and subject to review by the Design Review Board. Additionally, as a Major Project, the Project will require a Special Permit from the Planning Board in connection with Site Plan Review. As provided by By-Law Section 7.4.3, the Planning Board may also issue any other Special Permits required for the Project given its status as a Major Project.

Relief Requested:

Based on the foregoing analysis and in accordance with By-Law Sections 3.2.7.2, 4.11, 5.1.1.5, 6.11.5, 7.2, 7.4, 7.5 and 7.6, and such other By-Law Sections as may apply, the following items of zoning relief are requested:

1. Special Permit in accordance with By-Law Section 4.11.1(5) for an FAR of 1.25 for the Project.

2. Special Permit, in accordance with By-Law Section 4.11.1(1) for a building height of 70 feet for the North Building.

3. Special Permit, in accordance with By-Law Section 4.11.1(1) for 5 stories for the North Building.

4. Special Permit, in accordance with By-Law Section 4.11.1(1) for a building height of 42 feet for the South Building.

5. Special Permit, in accordance with By-Law Section 4.11.1(1) for 3 stories for the South Building.

6. Special Permit, in accordance with By-Law Section 3.2.7.2 (g), for restaurant use.

7. Special Permit, in accordance with By-Law Section 3.2.7.2 (d), for retail use by a single tenant of between 5,750 – 10,000 sq. ft.

8. Special Permit, in accordance with By-Law Section 4.11.2(1) for a parking garage structure height of 55 feet.

9. Site Plan Review and Approval of the Project as a Major Project in accordance with Section 7.4.

10. Special Permit, in accordance with By-Law Section 5.1.1.5, for deviation from the required parking space number under By-Law Section 5.1.2 to be provided as part of the Project.

11. Special Permit, in accordance with By-Law Section 6.11.5, for deviation from the design requirements for retaining walls.

12. Any additional Special Permits required for the permitting of the Project.

Satisfaction of Criteria for Granting Relief Requested:

In connection with granting the above-requested relief, the Planning Board must make certain findings related to the Project as set forth in the applicable Sections of the By-Law. The applicable criteria are set forth in bold below and are followed by the Applicant's description of how the Project complies or will comply with such criteria. Explanatory notes from the By-Law are provided in italics.

I. Pursuant to By-Law Section 7.6.1, the Planning Board must make the following findings and determinations when issuing a Special Permit, as delineated in By-Law Section 7.5.2.1:

Prior to granting a special permit, the Planning Board, shall make a finding and determination that the proposed use, building structure, off-street parking or loading, modification of dimensional standards, screening or landscaping, or other activity, which is the subject of the application for the special permit:

(a) Complies with such criteria or standards as may be set forth in the section of this By-Law which refers to the granting of the requested special permit;

As set forth below, the Project complies with the specific criteria and standards for the special permit relief requested herein.

(b) is consistent with: 1) the general purposes of this By-Law as set forth in subparagraph 1.1, and 2) the more specific objectives and purposes applicable to the requested special permit which may be set forth elsewhere in this By-Law, such as, but not limited to, those at the beginning of the various sections;

The Project is consistent with the general purposes of the By-Law, including the promotion of health, safety, convenience, morals, and welfare for Needham residents

because it redevelops an underutilized and environmentally compromised site into an economically viable and eco-friendly development with public amenities.

The Project will promote the welfare of the inhabitants of Needham through a significant increase in property tax revenues, providing approximately $5,000,000[5] in annual additional real estate and personal property taxes which will support the Town's educational and recreational programs, housing initiatives, community and open spaces, and other Town priorities. The Project includes traffic mitigation measures and bicycle lane improvements to lessen congestion on area streets. This is an appropriate use of the land, specifically contemplated by the recent rezoning of the area. With the requested special permits, the Project will comply with the applicable use, height, area, and building location requirements of the By-Law.

By-Law Section 1.2 requires that any building or structure erected and any use of premises established must be in conformity with the By-Law. With the requested special permits, the Project will be in conformity with the By-Law.

(c) is designed in a manner that is compatible with the existing natural features of the site and is compatible with the characteristics of the surrounding area.

The site has few natural features, as it is almost entirely covered with the foundations of the former car dealership and car wash buildings and associated impervious areas used for parking and for the display of motor vehicles for sale. The Project is compatible with the characteristics of the surrounding area. The orientation of the buildout with the parking garage located near the "rear" of the Property will result in limited visibility of the parking structures from the major surrounding roads, including Highland Avenue and Gould Street. Extensive landscaping will be provided around the entire Project site, including a circumferential walking path with exercise stations for use by tenants' employees, neighbors, and the general public.

Where the Planning Board determines that one or more of the following objectives are applicable to the particular application for a special permit, the Planning Board shall make a finding and determination that the objective will be met:

(d) the circulation patterns for motor vehicles and pedestrians which would result from the use or structure which is the subject of the special permit will not result in conditions that unnecessarily add to traffic congestion or the potential for traffic accidents on site or in the surrounding area; and

[5] As described above, this is an approximate proration based on the development scenarios for a full-buildout of the Property and the adjacent parcels described in the Fiscal Analysis and as applied to the Project, which is for approximately 60% of the full-buildout scenario.

The Transportation Impact and Access Study prepared by VHB analyzes existing traffic conditions on area roadways and at area intersections, under current conditions and as projected to exist in seven years with and without construction of the Project. The study recommends, and the Applicant has committed to implement, several measures to prevent the Project from increasing traffic congestion or the potential for traffic accidents. These measures include the grant of an easement to the Town to widen and reconfigure Gould Street at the intersection with Highland Avenue and at the intersection with the site entrance (opposite the Wingate Residences entrance), and adding sidewalks along Gould Street. The internal circulation pattern has been designed to control vehicle speeds and to reduce vehicle-pedestrian interactions by providing wide sidewalks.

(e) the proposed use, structure or activity will not constitute a demonstrable adverse impact on the surrounding area resulting from:

1) **excessive noise, level of illumination, glare, dust, smoke, or vibration which are higher than levels now experienced from uses permitted in the surrounding area,**
2) **emission or discharge of noxious or hazardous materials or substances, or**
3) **pollution of water ways or ground water.**

The proposed use, structures and activity at the Property will not have a demonstrable adverse impact on the surrounding area. Any minimal noise, illumination or glare associated with the Project will be mitigated with the design features such as landscaping and cut-off lighting, as more particularly demonstrated in the Plan Set. No noxious or hazardous substances are anticipated to be emitted as a result of the Project, and no waterways or groundwater will be polluted.

As referenced in the foregoing criteria, certain Sections of the By-Law prescribe additional criteria to be considered for particular Special Permit relief. Such criteria, and how the Project complies or will comply with such criteria, are provided below:

1. **Special Permit criteria for relief for FAR of 1.25, pursuant to By-Law Section 4.11.1(5):**

In granting such special permit, the Planning Board shall consider the following factors:

(i) the ability of the existing or proposed infrastructure to adequately service the proposed facility without negatively impacting existing uses or infrastructure, including but not limited to, water supply, drainage, sewage, natural gas, and electric services;

As set forth in the Stormwater Report, the TIAS and based on our engineer's independent review of the infrastructure, the existing or proposed infrastructure

can adequately service the Project without negatively impacting existing uses or infrastructure, including but not limited to, water supply, drainage, sewage, natural gas, and electric services.

(ii) impact on traffic conditions at the site, on adjacent streets, and in nearby neighborhoods, including, but not limited to, the adequacy of the roads and intersections to safely and effectively provide access and egress;

As set forth in the TIAS, the Project will include off-site mitigation that will counterbalance the intersection capacity impacts of the additional Project-generated trips added to the roadway network. The applicant will grant an easement to the Town which will expand the cross-section of Gould Street, as recommended by the Town's traffic consultant during the rezoning of the Site in 2020. The Project will also include a robust Traffic Demand Management (TDM) program to incentivize reduced single occupant driving and increase use of alternative forms of transportation.

(iii) the Environmental impacts of the proposal; and

Regarding direct Environmental Impacts, the Applicant 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, reduced laboratory exhaust through exhaust monitoring, electric water heating, and more. The Project will also be studying options to include photovoltaic solar panels at the roof of the parking garage and roof of the North & South Buildings. In addition to these emission reduction strategies, the Project will utilize the LEED v4 BD+C rating system for the Core and Shell building components to incorporate other sustainability strategies. The current goal is to achieve LEED Silver Certified with higher targets being evaluated.

In addition, the Project has utilized the MEPA Environmental Justice tool, which demonstrates that this Project is not within 1-mile of any Environmental Justice community. The Project will not exceed any air quality thresholds or cause impacts outside of the 1-mile radius and therefore will not negatively impact such communities.

Regarding future impacts due to Sea Level Rise/Storm Surge and other climate change considerations, the Project is not exposed to Sea Level Rise/Storm Surge or Extreme Precipitation-Riverine Flooding. Although the Property has a high risk of Extreme Precipitation-Urban Flooding and a high risk of Extreme Heat, the Project will combat these risks by including measures to reduce the threat of

urban flooding from extreme precipitation and 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.

No part of the Property has a historic structure, or a structure within a historic district listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth.

(iv) the fiscal implications of the proposal to the Town

Based on the Fiscal Analysis, a full-build out of the Property and the adjacent parcels at 1.35 FAR would yield a net annual financial benefit to the Town of approximately $8,342,400. As described above, the Project proposes a build-out of approximately 60% of the full-build out, which results in a prorated net annual financial benefit of approximately $5,000,000 to the Town from development of the Project, plus personal property taxes which would also generate significant additional revenue.

(v) In granting a special permit, the Planning Board shall also consider any proposed mitigation measures and whether the proposed project's benefits to the Town outweigh the costs and adverse impacts, if any, to the Town.

The Project will include significant mitigation as described above and below. In addition, based on the Fiscal Analysis, the Project is anticipated to provide a net annual financial benefit to the Town of approximately $5,000,000, plus personal property taxes which would also generate significant additional revenue.

2. Pursuant to By-Law Section 4.11.3, in addition to the foregoing criteria, the Planning Board must consider the below design guidelines when issuing a Special Permit for relief under By-Law Section 3.2.7.2 and/or Section 4.11:

(a) The proposed development should provide or contribute to providing pedestrian and neighborhood connections to surrounding properties, e.g., by creating inviting buildings or street edge, by creating shared publicly accessible green spaces, and/or by any other methods deemed appropriate by the Planning Board;

The Proposed Development will contain various pedestrian and neighborhood connections and amenities. The south end of the South Building, near the main intersection of Gould and Highland will contain the "retail zone" which will have approximately 10,000 sq. ft. of retail or restaurant use. This area is being developed with retail plaza and landscapes visible from the public streets, making it a vibrant and cohesive part of the neighborhood. A landscaped ½ mile public walking loop is

planned around the site, with various exercise areas planned at intervals on the loop, and including a pond and water feature.

(b) Any parking structure should have a scale, finish and architectural design that is compatible with the new buildings and which blunts the impact of such structures on the site and on the neighborhood;

The parking structure will be primarily constructed of structural precast concrete columns and spandrel beams with color and finish intended to coordinate with the color and finish of the lab buildings. In addition, the overall scale of the stand-alone parking structure will be broken up through the use of fabric banners hung from the upper levels, which will result in visual interruptions and a softening of the façades onto the sides most visible to the neighborhood. The parking structure will be in the northeast corner of the site, downgradient and well way from Gould Street. Its presence will be masked to the south and southwest by the North Building. The structure will also comply with the specific dimensional criteria developed for this district to integrate with the surrounding area.

(c) The proposed development should encourage creative design and mix of uses which create an appropriate aesthetic for this gateway to Needham, including but not limited to, possible use of multiple buildings to enhance the corner of Highland Avenue and Gould Street, possible development of a landscape feature or park on Gould Street or Highland Avenue, varied façade treatments, streetscape design, integrated physical design, and/or other elements deemed appropriate by the Planning Board;

The Project will include two buildings, the North Building on the northerly portion of the Property, and the South Building on the southerly portion of the Property and the shared Atrium to connect them and will help break down the scale of the overall project into smaller pieces. As noted above, the south end of the South Building, near the main intersection Gould Street and Highland Avenue is planned to contain the "retail zone" which will have approximately 10,000 sq. ft. of public retail or restaurant use. This area is being developed with retail plaza featuring soft and hardscape landscaping, outdoor seating, and a water feature at the former location of Muzi pond at the Gould Street and Highland Avenue intersection. Together the proposed R&D, Office, Lab use mixed with Retail use at the corner will create an active gateway condition visible from the public streets. A landscaped ½ mile public walking loop is planned around the site, with various exercise areas planned at intervals around the buildings, and including a pond and water feature.

(d) The proposed development should promote site features and a layout which is conducive to the uses proposed;

The building massing was designed to take advantage of unique view corridors, interesting topography, solar orientation, and comply with the zoning requirements outlined above. The building will provide flexible floorplates that are desirable for today's tenants looking for access to light and views and opportunities for shared indoor and outdoor amenities. In addition, a ½ mile fitness/walking loop rings the entire site culminating at the retail plaza at Gould & Highland providing an opportunity for internal and external users to enjoy the site.

(e) The proposed development should incorporate as many green building standards as practical, given the type of building and proposed uses;

The Project 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 emission reduction strategies, the Project will utilize the LEED v4 BD+C rating system for the core and shell building components to incorporate other sustainability strategies such as: 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. In addition, the Project will be Energy Star rated and certified as a WELL Building.

The WELL Building Standard takes a holistic approach to health in the built environment addressing behavior, operations and design. WELL is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being, through air, water, nourishment, light, fitness, comfort and mind. WELL is grounded in a body of medical research that explores the connection between the buildings where we spend more than 90 percent of our time, and the health and wellness impacts on us as occupants. WELL Certified™ spaces can help create a built environment that improves the nutrition, fitness, mood, sleep patterns and performance of its occupants.

(f) The proposed development should be designed and conditioned to reduce or mitigate adverse impacts on adjacent properties or the surrounding area such as those resulting from excessive traffic congestion or excessive demand for parking; and

The Project will include off-site mitigation that will counterbalance the intersection capacity impacts of the additional Project-generated trips added to the roadway network. The car wash previously reported 1,360 peak vehicle trips to the car wash during the winter months, or roughly 600 vehicles daily during peak periods. The car wash coupled with Muzi employees, visitors, new and used car sales, parts distribution, etc., yielded an additional 600 single occupancy vehicles such that there will be little, if any, increase in traffic from the Project. Nevertheless, as recommended by GPI, the Applicant will grant an easement to the Town to expand the cross-section of Gould Street, as recommended by the Town's traffic consultant during the rezoning of the Site in 2020. The Project will also look to augment the Town's rezoning concept with dedicated bicycle lanes on Gould Street that connect the Project and its future pedestrian and open space amenities to the bicycle lane network along Highland Avenue. As set forth above, the Project will also include a robust TDM program to incentivize reduced single occupant driving and increase use of alternative forms of transportation. Based on the TIAS, the roadway network as improved through the Project's proposed transportation mitigation, can safely and adequately handle the trips associated with the Project.

(g) The proposed development shall include participation in a transportation demand management program to be approved by the Planning Board as a traffic mitigation measure, including but not limited to, membership and participation in an integrated or coordinated shuttle program.

As set forth above, the Project will also include a robust TDM program to incentivize reduced single occupant driving and increase use of alternative forms of transportation. The Applicant 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 Property.

3. <u>Pursuant to By-Law Section 6.11.5, the Planning board must consider the specific criteria given below when issuing a Special Permit for relief from retaining wall requirements in By-Law 6.11:</u>

(a) That the retaining wall will not cause an increase of water flow off the property;

The 4-6 foot high retaining wall proposed along the eastern property boundary will be located along the side of the proposed fire lane/fitness path and adjacent to the I-95/Route 128 off ramp. The retaining wall will direct stormwater discharge toward the site's proposed drainage system and not to the MassDOT's ROW. This is a significant improvement over existing conditions, under which sheet drainage discharges untreated runoff off to adjacent properties and roadways.

(b) That the requested retaining wall will not adversely impact adjacent property or the public;

The requested retaining walls will face the Exit 35C ramp from I-95/Route 128 to Highland Avenue. As such, it will have little, if any, impact on adjacent property or the public. Additionally, the retaining wall has a low profile and there is a wide vegetated shoulder from the roadway before the wall.

(c) That the report of the Design Review Board has been received and considered.

We anticipate that any comments from the Design Review Board will continue to be considered and incorporated into the Project.

II. Special Permit in accordance with By-Law Section 5.1.1.5 waiving adherence to the required number of parking spaces and/or parking design requirements:

Such a special permit waiving strict adherence to the minimum number of required parking spaces may be granted only after it is demonstrated by an applicant that either:

(i) special circumstances in a particular use of structure does not warrant the minimum number of spaces required under Section 5.1.2; or

The By-Law's required parking ratios assume a higher employee density than is typical for lab/research & development uses. The By-Law also assumes that each office employee will commute alone, by motor vehicle. By contrast, the Applicant is committed to a transportation demand management program to encourage the use of carpool, walking, biking, and public transit alternatives to single occupancy vehicle trips. Also, the By-Law's parking ratio does not consider the potentially permanent changes in commuting patterns resulting from the COVID-19 pandemic, including hybrid/remote work programs. For these reasons, the minimum number of spaces that would be required under the By-Law is not warranted for the Project

(ii) the extent of existing building coverage on a particular lot is such that in laying out parking spaces in accordance with the design requirements of Subsection 5.1.3, the requirement for minimum number of spaces under Section 5.1.2 cannot be met.

As noted above, the proposed quantity of parking spaces is sufficient to satisfy the anticipated parking demand for the Project.

In reviewing a request for a special permit under this Section 5.1.1.5, the Planning Board shall consider the following:

(a) The issuance of a special permit will not be detrimental to the Town or to the general character and visual appearance of the surrounding neighborhood and abutting uses, and is consistent with the intent of this Zoning By-Law;

The Project redevelops an underutilized site into an economically viable development with public amenities. The addition of the Project will be a source of employment for Needham residents, will generate significant additional tax revenues for the Town, introduces uses, including retail/restaurant uses which will contribute to making the Project a vibrant and cohesive part of the neighborhood and will be designed to enhance the aesthetic of a prominent entry to Needham.

(b) In the case of waiving strict adherence to the requirements of Section 5.1.2 under subparagraph (i) above, the special permit shall define the conditions of the use of structure so as to preclude changes that would alter the special circumstances contributing to the reduced parking need or demand;

The Applicant anticipates working with the Board to incorporate appropriate conditions regarding such changes.

(c) [Not Applicable]

(d) Provisions to demonstrate the ability to provide for additional parking consistent with Section 5.1.2 and/or parking designed in accordance with the particular requirements of Section 5.1.3; and

As noted above, the proposed quantity of parking spaces is sufficient to satisfy the anticipated parking demand for the Project.

(e) The granting of a special permit under this Section shall not exempt a structure, use or lot from future compliance with the provisions of Section 5.1.2 and/or 5.1.3.

The special permit decision will not so exempt the structure, use, or lot.

III. Site Plan Review and Special Permit for Major Project

In conducting the Site Plan Review, the Planning Board shall consider the following matters:

(a) Protection of adjoining premises against seriously detrimental uses by provision for surface water drainage, sound and sight buffers and preservation of views, light, and air;

The Project maintains a significant landscape buffer between the proposed structures and Highland Avenue and Gould Street, which themselves provide a buffer for residential and other properties nearby. The buffer includes landscaped berms planted with shade trees and conifers. The buildings are far enough from the property lines so there will no shade cast towards any residential properties beyond the property boundary. Except for a small surface parking lot next to Gould Street, all parking will be contained below the buildings or within the parking garage. Service and loading areas are located within the buildings. A tree-lined fitness path is proposed around the site perimeter.

As detailed in the Stormwater Report, stormwater will be contained within the project boundary and catch basins with sumps and hoods, oil/water separators, rain gardens, and vegetated swales to improve storm water quality discharges, are provided. Stormwater will be infiltrated to mitigate storm water volumes. The retention pond is incorporated into the pedestrian and fitness path loop around the development.

(b) Convenience and safety of vehicular and pedestrian movement within the site and on adjacent streets, the location of driveway openings in relation to traffic or to adjacent streets and, when necessary, compliance with other regulations for the handicapped, minors and the elderly;

The parking garages and other parking areas proposed to be created will contain enough parking to accommodate all vehicles on the Property and the parking spaces provided will comply with the design criteria set forth in By-Law Section 5.1.3. The Project will provide a primary entrance on Gould Street, across from the existing curb cut for the Wingate senior housing community via a signalized intersection. An internal drive loop will mitigate traffic queuing in and out of the property. There will be a secondary entrance/exit from the parking garage to TV Place. The Applicant will grant an easement to the Town to allow for the proposed transportation mitigation, including the widening of Gould Street to better handle traffic movements and volume. Internal sidewalks and a bike lane connected to Gould Street will encourage multimodal transportation opportunities. Bicycle storage for short-term and long-term use is incorporated into the project design. Handicapped parking will be provided in compliance with applicable requirements. All access walks and paths are designed with slopes of less than 5%, so no ramps will be needed. Crosswalks are proposed at the Gould Street signalized intersection.

(c) Adequacy of the arrangement of parking and loading spaces in relation to the proposed uses of the premises;

Parking and loading spaces have been adequately arranged in relation to the proposed uses on the Property, and in compliance with parking plan and design requirements under By-Law Section 5.1.3. Structured parking is provided under the buildings, and

in a parking garage. A small surface parking area will provide handicapped parking near the primary building entrances, and parking for adjacent retail and/or restaurant space. Loading areas are included in each section of the buildings.

(d) Adequacy of the methods of disposal of refuse and other wastes resulting from the uses permitted on the site;

Adequate methods for disposal of refuse and waste will be provided by the Project. Solid waste and refuse will be disposed of in compliance with all applicable rules and regulations. The wastewater system will be connected to the municipal sewer system. Tenants will be required to comply with all regulations applicable to the handling and disposal of wastes.

(e) Relationship of structures and open spaces to the natural landscape, existing buildings and other community assets in the area and compliance with other requirements of this By-Law; and

The Project will comply with the setback and landscape buffer requirements of the By-Law that were specifically developed to create an appropriate relationship between the Project and the surrounding area. A curvilinear walking/jogging and bike path is proposed along the perimeter of the Property, to be available for use by the general public. Fitness stations will be provided along the path.

(f) Mitigation of adverse impacts on the Town's resources including the effect on the Town's water supply and distribution system, sewer collection and treatment, fire protection, and streets; and may require when acting as the Special Permit Granting Authority or recommend in the case of minor projects, when the Board of Appeals is acting as the Special Permit Granting Authority, such appropriate conditions, limitations, and safeguards necessary to assure the project meets the criteria of a through f.

The Project will not have any adverse impact on the Town's water supply and distribution system, sewer collection and treatment, fire protection, or streets. The Project will not have any adverse impact on the Town's water or wastewater infrastructure. Sufficient pump stations provide support for the area. The proposed buildings will be fully accessible for the Town's firefighting apparatus.

As detailed above and in the materials submitted herewith, the Project satisfies each of the applicable criteria for the requested relief.

As required by G.L. 40A and the By-Law, the Applicant has submitted a copy of these applications to the Town Clerk.

We appreciate your attention to this matter. The Applicant and the entire Project team look forward to meeting with you and discussing the Project on June 7, 2022 or any earlier date that is convenient for the Board.

Very truly yours,

Timothy W. Sullivan
Attorney for Applicant

Enclosures

557 Highland Ave
Needham, MA 02494

Needham Special Permit Package

03/30/2022

Bulfinch

Stantec

Proposed

Site Plan

Aerial – Looking North

Aerial – Looking West

Aerial – Looking South

Aerial – West Entry Drive

Site Aerial - Proposed

Gould Street – Looking North-East

Fitness Loop – Looking South

Street View - Proposed

Bulfinch

Stantec

557 HIGHLAND AVE

NEEDHAM, MA 02494

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DRAWING INDEX-SUBMISSION MATRIX

DRAWING NUMBER	DRAWING NAME
GENERAL	
G-000	COVER SHEET
G-010	ZONING GROSS AREA PLANS
CIVIL	
C-01	LEGEND AND GENERAL NOTES
C-02	OVERALL SITE PLAN
C-03	DRAINAGE AND EROSION CONTROL PLAN
C-04	UTILITY PLAN
C-05	SITE DETAILS
C-06	SITE DETAILS
LANDSCAPE	
L-1.0	SITE LAYOUT & MATERIALS PLAN
L-2.0	SITE GRADING PLAN
L-3.0	SITE PLANTING PLAN
L-4.0	SITE LIGHTING PLAN
L-5.0	SITE DETAILS 1
L-5.1	SITE DETAILS II
ARCHITECTURAL	
A-100G1	GARAGE LEVEL G1 - OVERALL PLAN
A-101	LEVEL 1 - OVERALL PLAN
A-102	LEVEL 2 - OVERALL PLAN
A-103	LEVEL 3 - OVERALL PLAN
A-104	LEVEL 4 - OVERALL PLAN
A-105	LEVEL 5 - OVERALL PLAN
A-106	LEVEL 6 - OVERALL PLAN

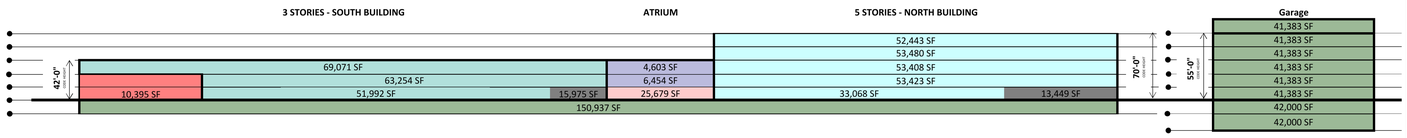
DRAWING INDEX-SUBMISSION MATRIX

DRAWING NUMBER	DRAWING NAME
A-107	ROOF PLAN
A-201	BUILDING ELEVATIONS - LOCATOR ELEVATIONS
A-202	BUILDING ELEVATIONS - NORTH BLDG - NORTH
A-203	BUILDING ELEVATIONS - NORTH BLDG - SOUTH & EAST
A-204	BUILDING ELEVATIONS - NORTH BLDG (SOUTHWEST) & SOUTH BLDG (SOUTH)
A-205	BUILDING ELEVATIONS - NORTH BLDG (WEST) & SOUTH BLDG (NORTH & WEST)
A-206	BUILDING ELEVATIONS - SOUTH BLDG - NORTH & EAST
A-211	BUILDING SECTIONS - OVERALL
A-212	BUILDING SECTIONS - NORTH BLDG
A-213	BUILDING SECTIONS - NORTH BLDG
ARCHITECTURAL - GARAGE	
AG-100.B2	GARAGE LEVEL B2
AG-100.B1	GARAGE LEVEL B1
AG-101	GARAGE LEVEL 1
AG-102	GARAGE LEVEL 2
AG-103	GARAGE LEVEL 3 (LEVEL 4-5 SIM.)
AG-106	GARAGE LEVEL 6
AG-211	GARAGE SECTIONS
AG-212	GARAGE SECTIONS
AG-301	ELEVATIONS
AG-302	ELEVATIONS

218421343
SPECIAL PERMIT SET - 03/30/2022

<Pick location in Project Information>
3/28/2022 4:58:47 PM
ORIGINAL SHEET - ARCH E1

Project Stats: Highland Ave
Date: 3/30/2022
Stantec DRAFT



Garage
41,383 SF
41,383 SF
41,383 SF
41,383 SF
41,383 SF
41,383 SF
42,000 SF
42,000 SF

GROUND FLOOR		
	Program	SF
A1	Retail	10,395 SF
A2	Amenity	25,679 SF
A3	Office/Lab	430,139 SF
A4	Tenant Bridge	11,057 SF
A5	BOH	29,424 SF
A6	PARKING & GARAGE (TOTAL)	483,235 SF
A7	**Total FAR SF (A1 + A2 + A3 + A4 + A5)**	**506,694 SF**

Garage	
Program	SF
Garage	**332,298 SF**

Parking Space Totals

Building Parking Count (Below Grade)					
Level	**Standard**	**Parallel**	**Compact**	**ADA - VAN**	**ADA**
Level G1	200	8	127	2	6
Total by Type	**200**	**8**	**127**	**2**	**6**
Total Parking			**343**		
% Compact			**37%**		

Garage Parking Count				
Level	**Standard**	**Compact**	**ADA - VAN**	**ADA**
Level B2	71	55	0	3
Level B1	70	58	0	3
Level 1	64	58	3	1
Level 2	70	58	0	3
Level 3	71	58	0	2
Level 4	71	58	0	2
Level 5	71	58	0	2
Roof	71	38	0	2
Total by Type	**559**	**441**	**3**	**18**
Total Parking		**1021**		
% Compact		**43%**		

Site Totals

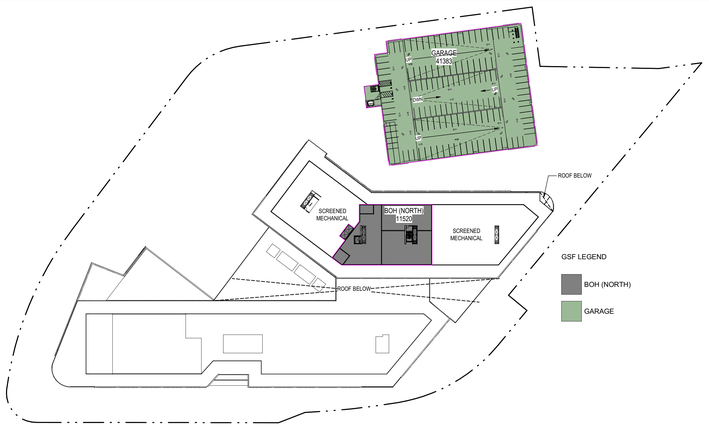
Program		
		Proposed
P1	**Total FAR SF** (Office + Garage)	**506,694 SF**
P2	**Total Office/Lab SF** (A3 + A4)	**441,196 SF**
P3	Site Parking and Drive Aisles	51,598 SF
P4	Total Lot Coverage (P7 - P4)	252,681 SF
P5	Total Open Space	151,252 SF
P6	Parking Spaces Required at 1/300sf	1689.0
P7	**TOTAL SITE SF**	**403,933 SF**
	SITE FAR	**1.25**

Site Parking Totals	
	Proposed
SP1 Surface Parking	44
SP2 Office/Lab Building	343
SP3 Garage	1021
SP4 **Total Parking** (SP1 + SP2 + SP3)	**1408**

BUILDINGS A&B (GROSS - OFFICE ONLY)			
BUILDING	GSF (SF)	Comments	
LEVEL G1			
PARKING	150937	EXCLUDED	
	150937		
LEVEL 1			
ATRIUM	25679		
BOH (NORTH)	13449		
BOH (SOUTH)	15975		
RETAIL	10395		
TENANT - NORTH	33068		
TENANT - SOUTH	51992		
	150558		
LEVEL 2			
TENANT - BRIDGE	6454		
TENANT - NORTH	53423		
TENANT - SOUTH	63254		
	123131		
LEVEL 3			
TENANT - BRIDGE	4603		
TENANT - NORTH	53408		
TENANT - SOUTH	69071		
	127082		
LEVEL 4			
BOH (SOUTH)	11045	EXCLUDED	
TENANT - NORTH	53480		
	64525		
LEVEL 5			
TENANT - NORTH	52443		
	52443		
PENTHOUSE - NORTH			
BOH (NORTH)	11520	EXCLUDED	
	11520		

BUILDINGS A&B (GROSS - GARAGE ONLY)		
BUILDING	GSF (SF)	Comments
LEVEL G2		
GARAGE	42000	EXCLUDED
	42000	
LEVEL G1		
GARAGE	42000	EXCLUDED
	42000	
LEVEL 1		
GARAGE	41383	
	41383	
LEVEL 2		
GARAGE	41383	
	41383	
LEVEL 3		
GARAGE	41383	
	41383	
LEVEL 4		
GARAGE	41383	
	41383	
LEVEL 5		
GARAGE	41383	
	41383	
PENTHOUSE - NORTH		
GARAGE	41383	
	41383	
TOTAL	332296	

GENERAL NOTE: ALL AREAS ARE IN PROGRESS AND SHOULD NOT BE CONSIDERED FINAL.



6 G-010 **GSF - ROOF** 1" = 80'-0"

5 G-010 **LEVEL 5 - BLDG B** 1" = 80'-0"

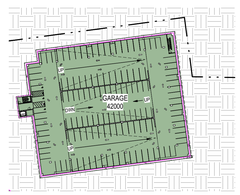
4 G-010 **GSF - LEVEL 4** 1" = 80'-0"

2 G-010 **GSF - LEVEL 2** 1" = 80'-0"

G1 G-010 **GSF - LEVEL G1** 1" = 80'-0"

3 G-010 **GSF - LEVEL 3** 1" = 80'-0"

1 G-010 **GSF - LEVEL 1** 1" = 80'-0"



G2 G-010 **GSF - LEVEL G2** 1" = 80'-0"

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Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1" = 80'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ZONING GROSS AREA PLANS

Revision:
Drawing No.
G-010

Legend

Exist. / Prop.	Exist. / Prop.
PROPERTY LINE	CONCRETE
PROJECT LIMIT LINE	HEAVY DUTY PAVEMENT
RIGHT-OF-WAY/PROPERTY LINE	BUILDINGS
EASEMENT	RIPRAP
BUILDING SETBACK	CONSTRUCTION EXIT
PARKING SETBACK	TOP OF CURB ELEVATION
BASELINE	BOTTOM OF CURB ELEVATION
CONSTRUCTION LAYOUT	SPOT ELEVATION
ZONING LINE	TOP & BOTTOM OF WALL ELEVATION
TOWN LINE	BORING LOCATION
LIMIT OF DISTURBANCE	TEST PIT LOCATION
WETLAND LINE WITH FLAG	MONITORING WELL
FLOODPLAIN	UNDERDRAIN
BORDERING LAND SUBJECT TO FLOODING	DRAIN
WETLAND BUFFER ZONE	ROOF DRAIN
NO DISTURB ZONE	SEWER
200' RIVERFRONT AREA	FORCE MAIN
GRAVEL ROAD	OVERHEAD WIRE
EDGE OF PAVEMENT	WATER
BITUMINOUS BERM	FIRE PROTECTION
BITUMINOUS CURB	DOMESTIC WATER
CONCRETE CURB	GAS
CURB AND GUTTER	ELECTRIC
EXTRUDED CONCRETE CURB	STEAM
MONOLITHIC CONCRETE CURB	TELEPHONE
PRECAST CONC. CURB	FIRE ALARM
SLOPED GRAN. EDGING	CABLE TV
VERT. GRAN. CURB	CATCH BASIN CONCENTRIC
LIMIT OF CURB TYPE	CATCH BASIN ECCENTRIC
SAWCUT	DOUBLE CATCH BASIN CONCENTRIC
BUILDING	DOUBLE CATCH BASIN ECCENTRIC
BUILDING ENTRANCE	GUTTER INLET
LOADING DOCK	DRAIN MANHOLE CONCENTRIC
BOLLARD	DRAIN MANHOLE ECCENTRIC
DUMPSTER PAD	TRENCH DRAIN
SIGN	PLUG OR CAP
DOUBLE SIGN	CLEANOUT
STEEL GUARDRAIL	FLARED END SECTION
WOOD GUARDRAIL	HEADWALL
PATH	SEWER MANHOLE CONCENTRIC
TREE LINE	SEWER MANHOLE ECCENTRIC
WIRE FENCE	CURB STOP & BOX
FENCE	WATER VALVE & BOX
STOCKADE FENCE	TAPPING SLEEVE, VALVE & BOX
STONE WALL	FIRE DEPARTMENT CONNECTION
RETAINING WALL	FIRE HYDRANT
STREAM / POND / WATER COURSE	WATER METER
DETENTION BASIN	POST INDICATOR VALVE
HAY BALES	WATER WELL
SILT FENCE	GAS GATE
SILT SOCK / STRAW WATTLE	GAS METER
MINOR CONTOUR	ELECTRIC MANHOLE
MAJOR CONTOUR	ELECTRIC METER
PARKING COUNT	LIGHT POLE
COMPACT PARKING STALLS	TELEPHONE MANHOLE
DOUBLE YELLOW LINE	TRANSFORMER PAD
STOP LINE	UTILITY POLE
CROSSWALK	GUY POLE
ACCESSIBLE CURB RAMP	GUY WIRE & ANCHOR
ACCESSIBLE PARKING	HAND HOLE
VAN-ACCESSIBLE PARKING	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.

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Permit/Seal

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00

Title
LEGEND AND GENERAL NOTES

Drawing No.
C-01

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

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By	Appd	YYYY.MM.DD	Issued/Revision
		2022.03.30	SPECIAL PERMIT SUBMISSION

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale: 1" = 30'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
OVERALL SITE PLAN

Revision:
Drawing No.
C-02

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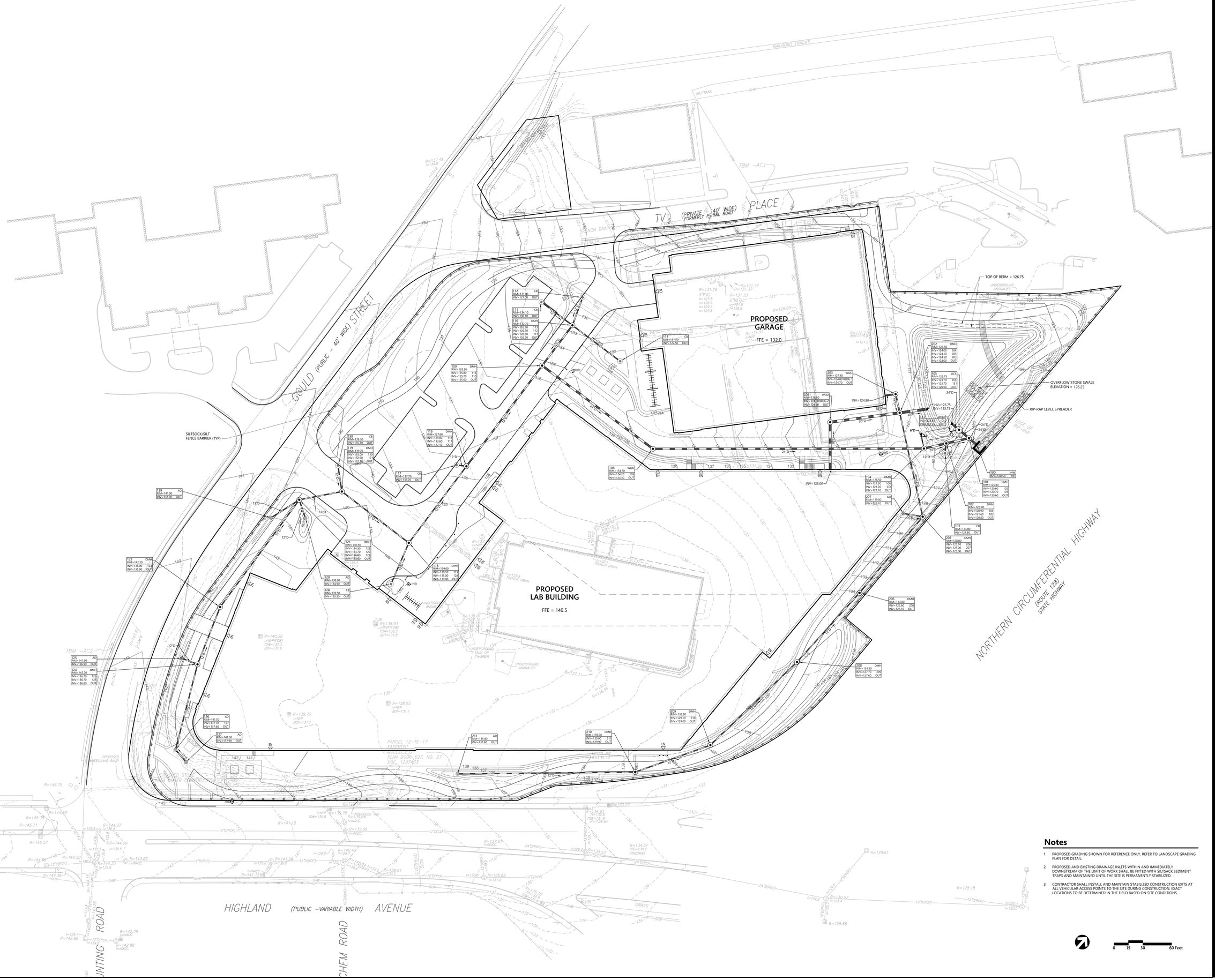

Notes

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

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DESIGN REVIEW PACKAGE

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
REGISTERED PROFESSIONAL ENGINEER

Client/Project

Bulfinch

557 Highland Ave

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Dwn.	Dsgn.	Chkr.	YYYY.MM.DD

Title

DRAINAGE AND EROSION CONTROL PLAN

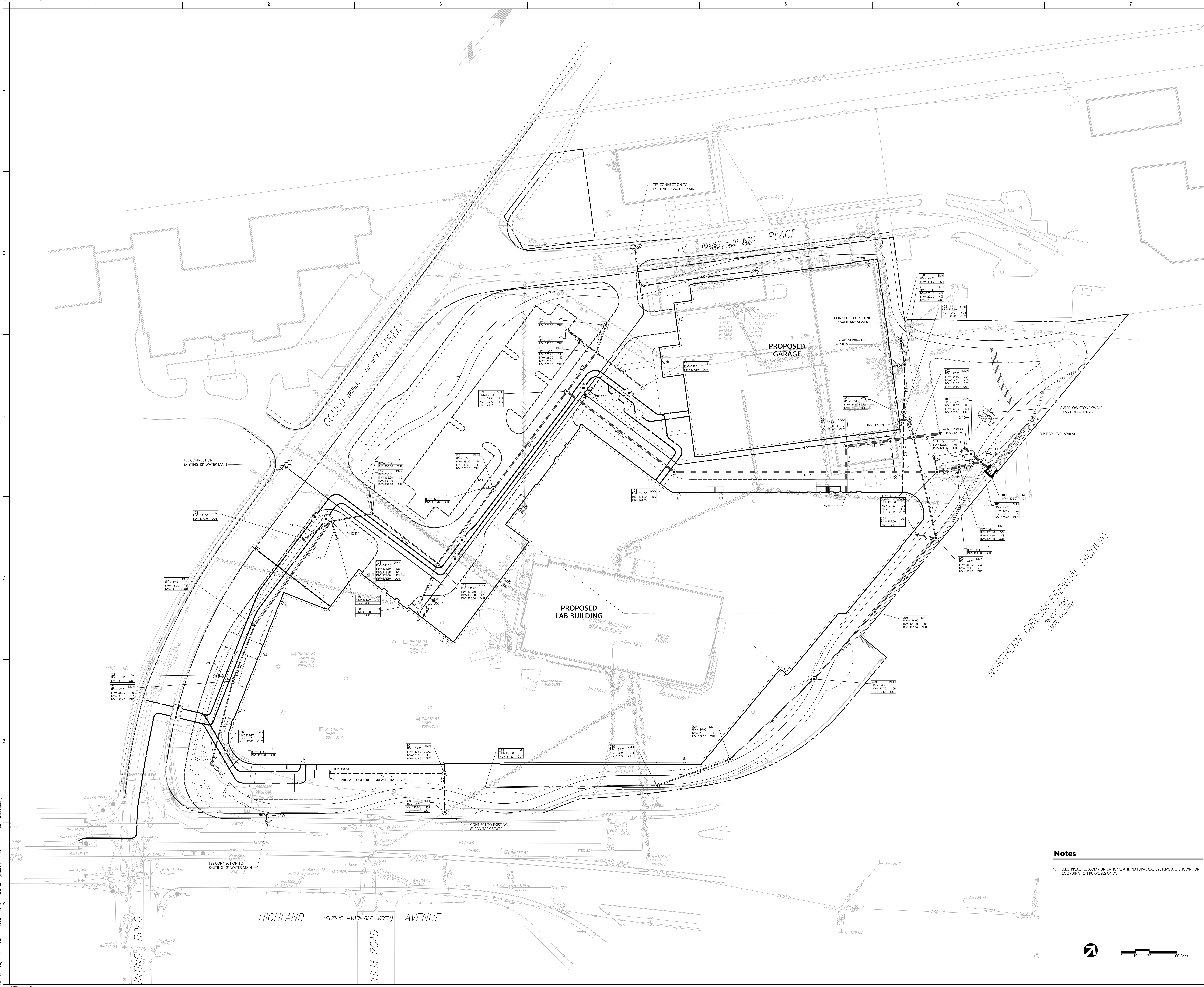
Revision:

Drawing No.

C-03

Saved Tuesday, March 29, 2022 1:33:06 PM DHEHAD Plotted Tuesday, March 29, 2022 1:55:51 PM David Henao Rodriguez

ORIGINAL SHEET - ARCH E



Notes

1. ELECTRICAL, TELECOMMUNICATIONS, AND NATURAL GAS SYSTEMS ARE SHOWN FOR COORDINATION PURPOSES ONLY.

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SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS — NICHOLAS J. SKOLY — CIVIL — No. 52677 — REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
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Scale: 1" = 30'-0"

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UTILITY PLAN

Revision:
Drawing No.
C-04

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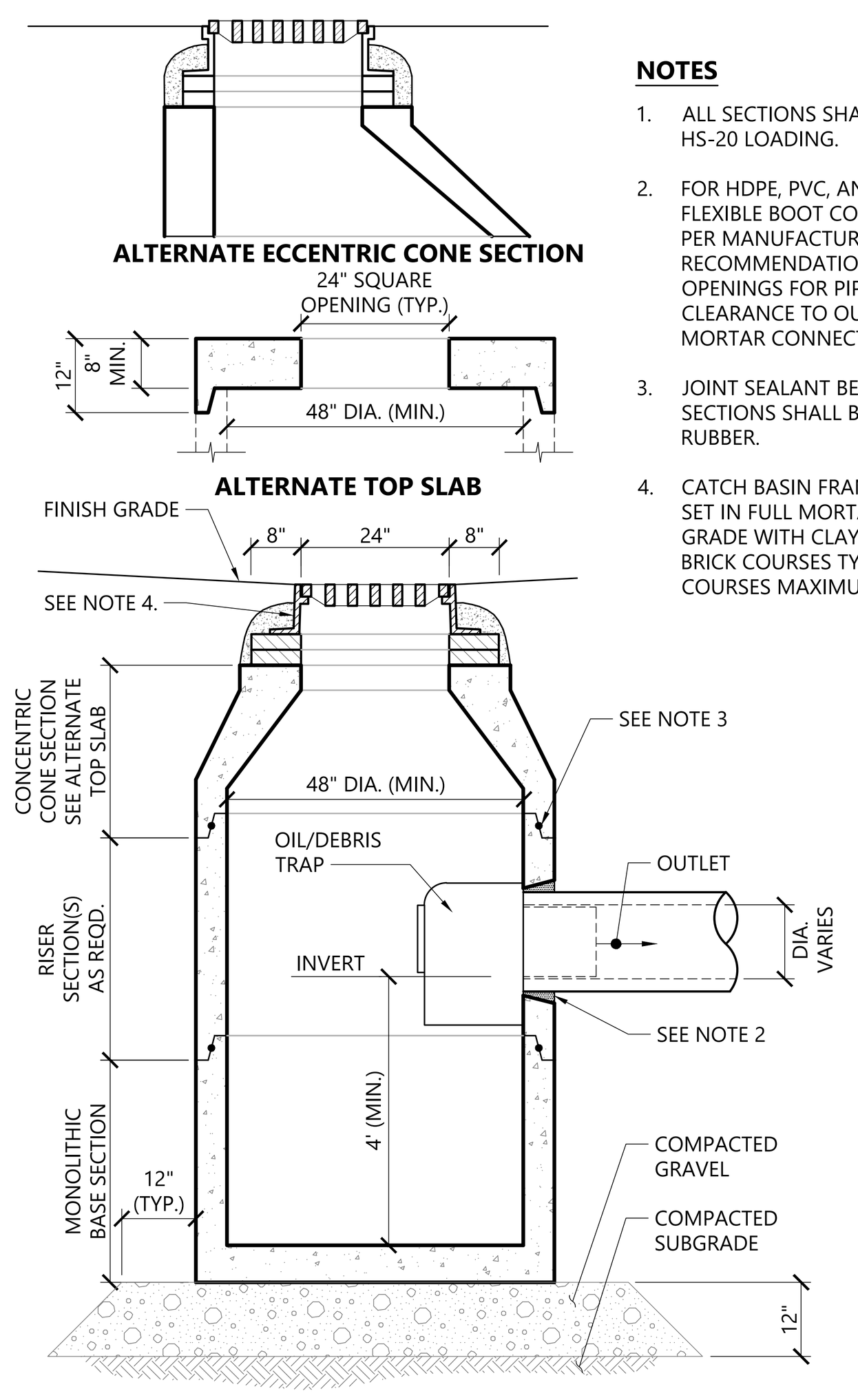


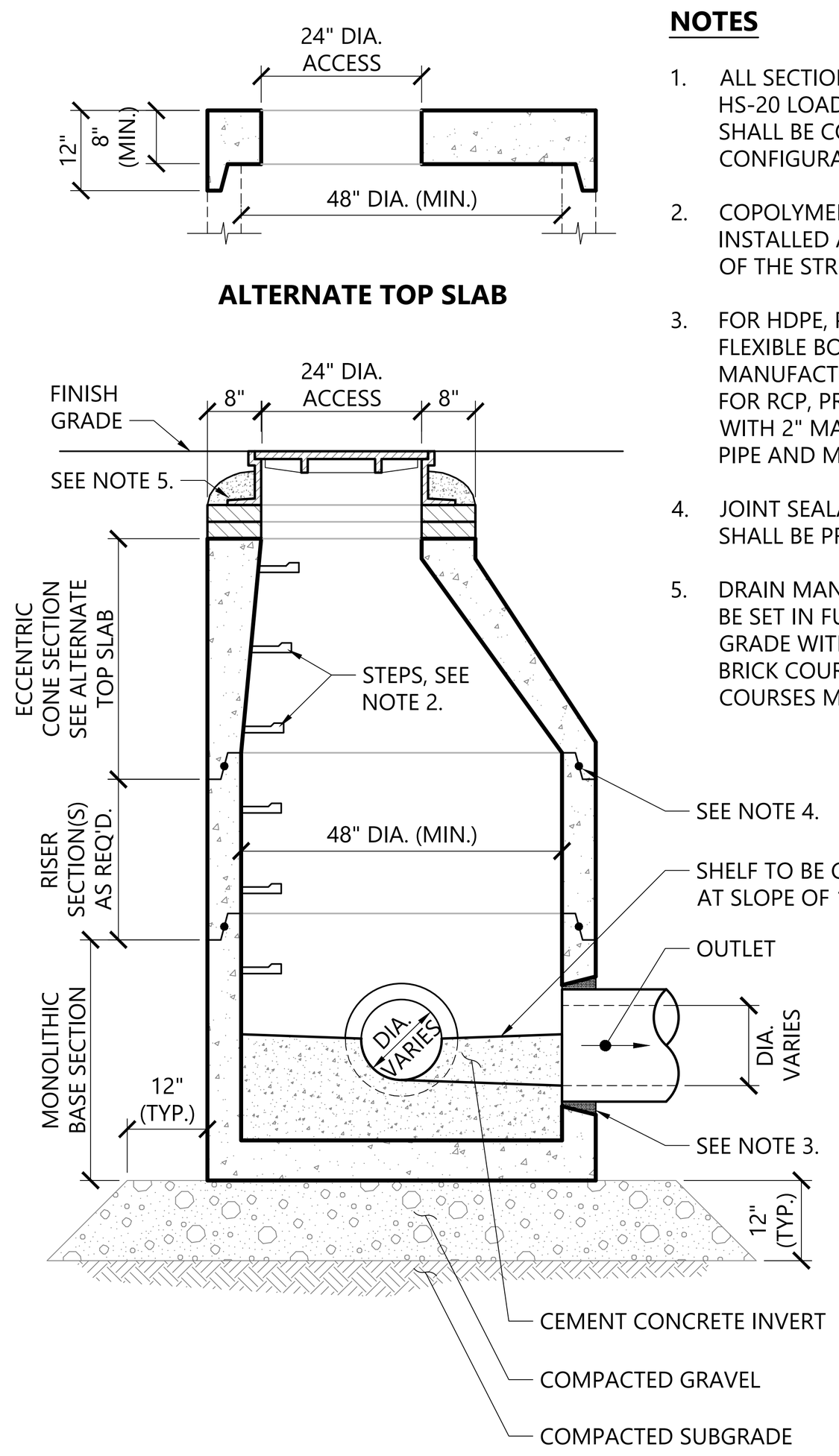
NOTES

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



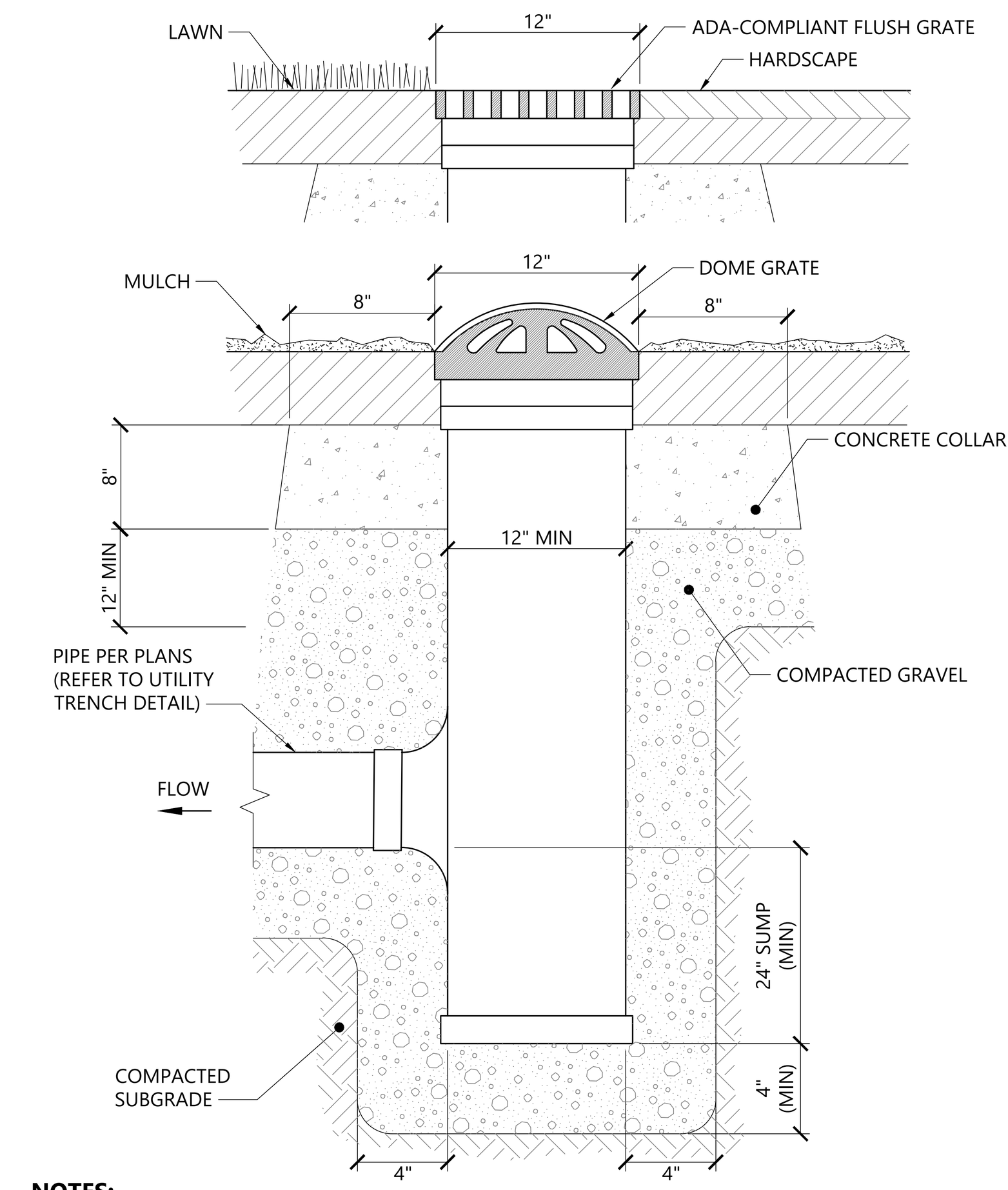
NOTES

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



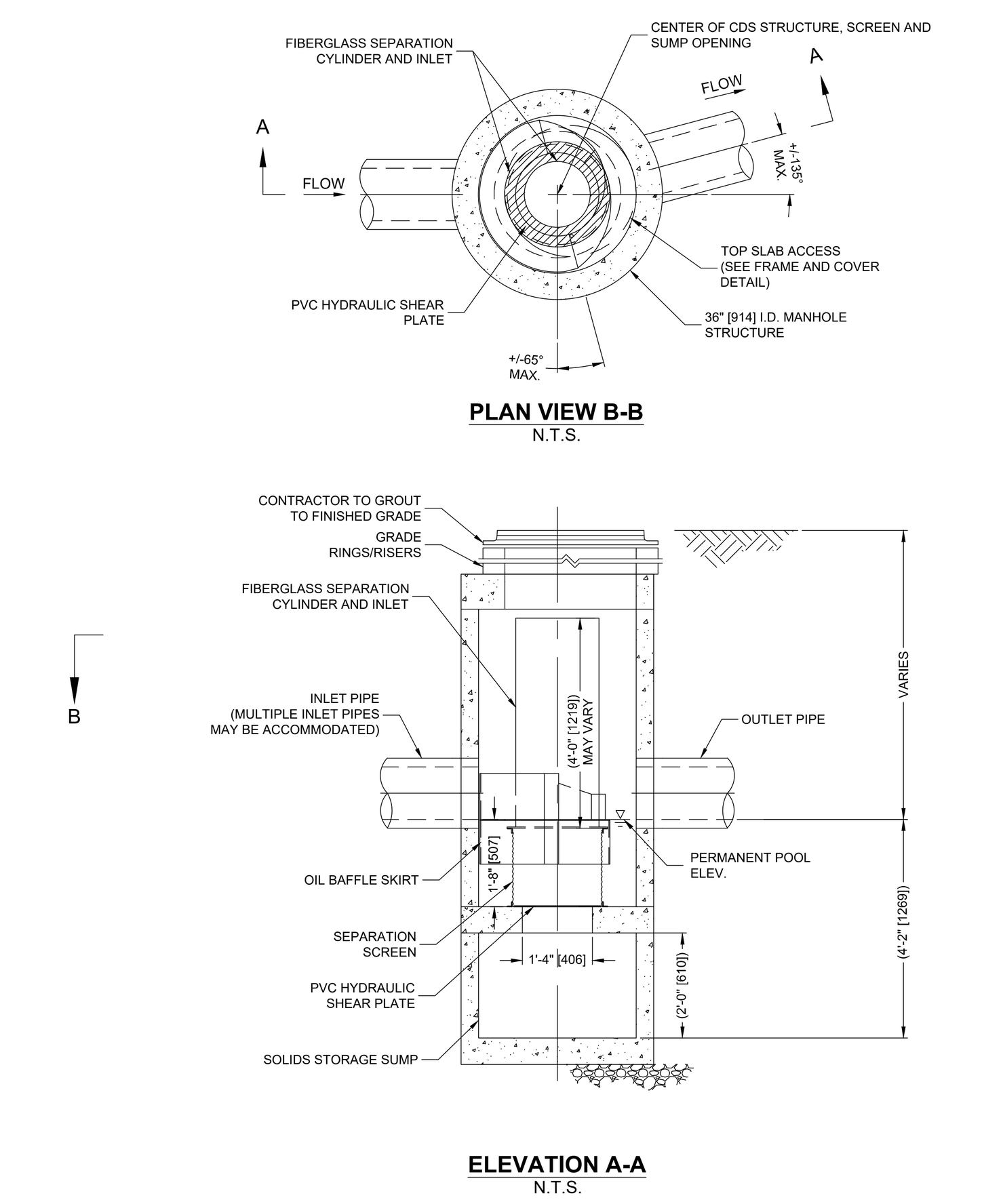
NOTES:

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).

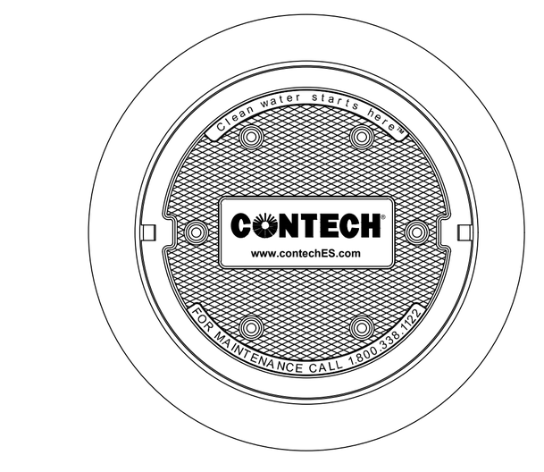
Area Drain (AD) Type 1

12/19

N.T.S. Source: VHB LD_193



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.



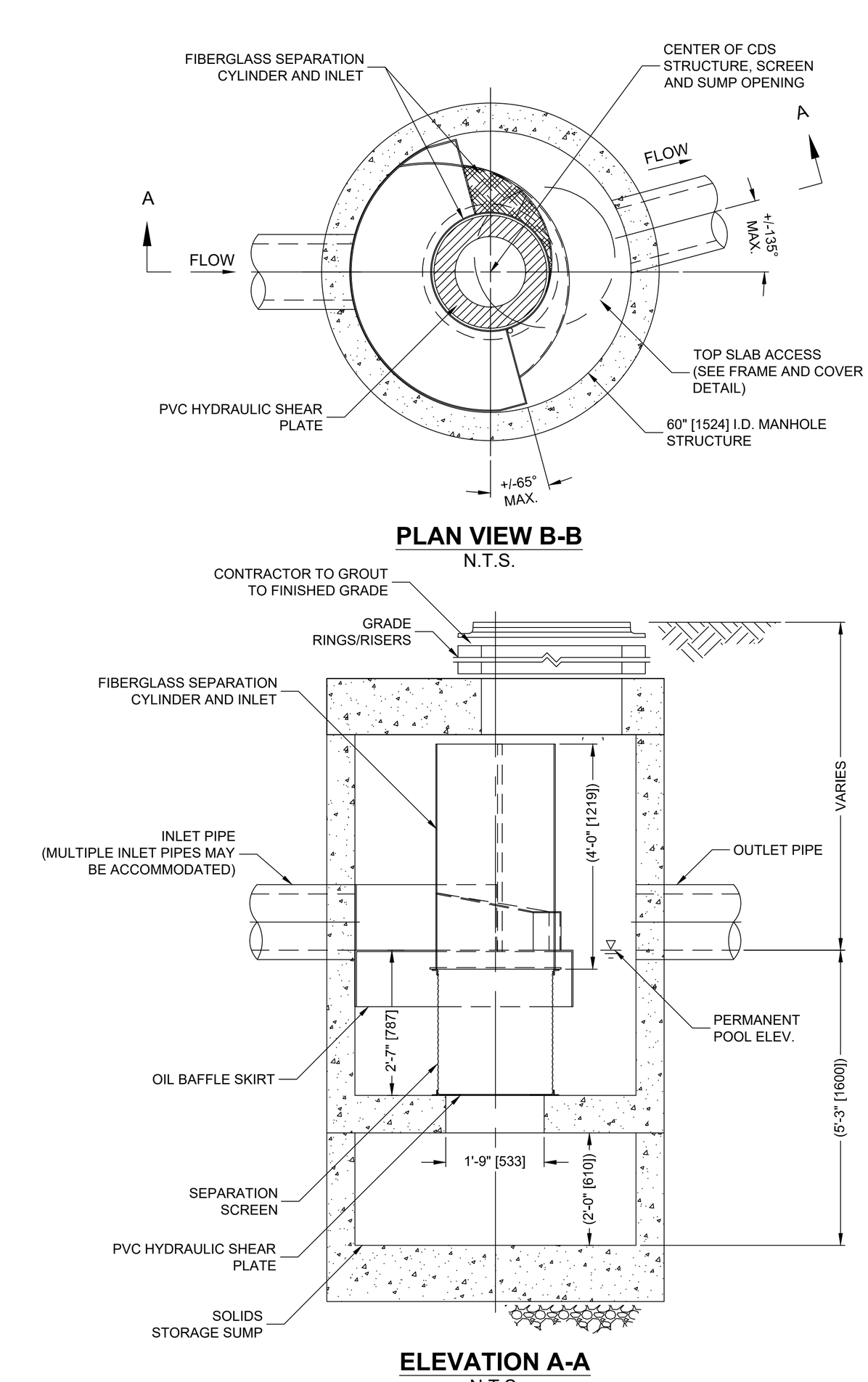
FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

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. CDS 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 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.

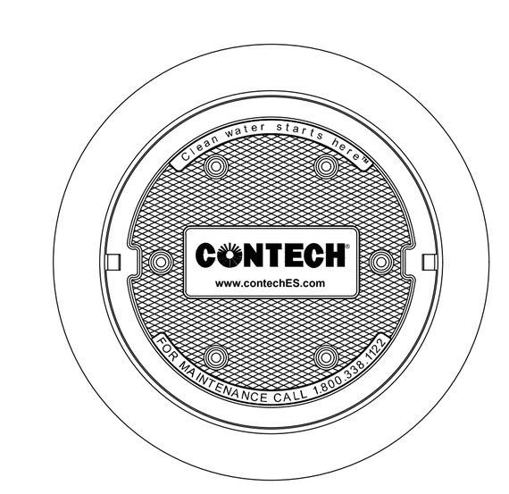
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR 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.

WQU-203 (CDS1515-3)

N.T.S. Source: Contech



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



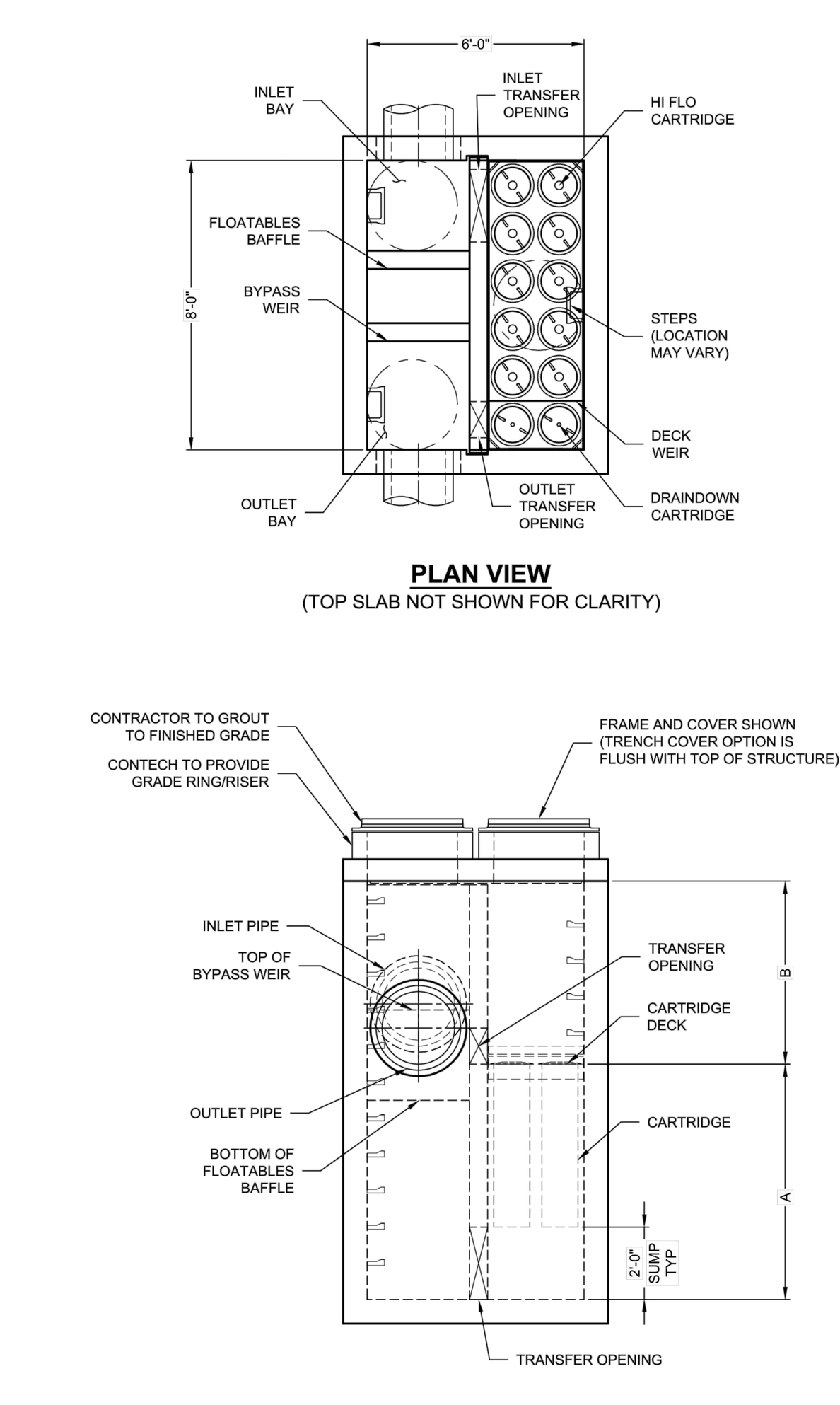
FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

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. CDS 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 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.

WQU-204 (CD2020-5)

N.T.S. Source: Contech

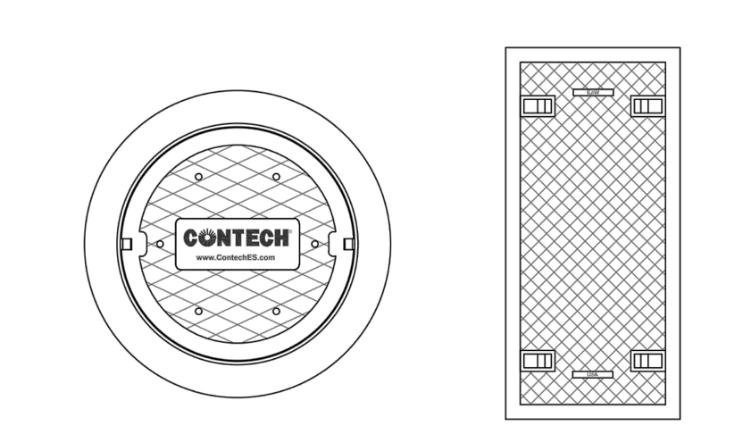


JELLYFISH DESIGN NOTES

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)	6'-6"	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 (CFS)	1.96	1.47	0.98	0.54
DECK TO INSIDE TOP (MIN) (B)	5.00	4.00	4.00	4.00



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

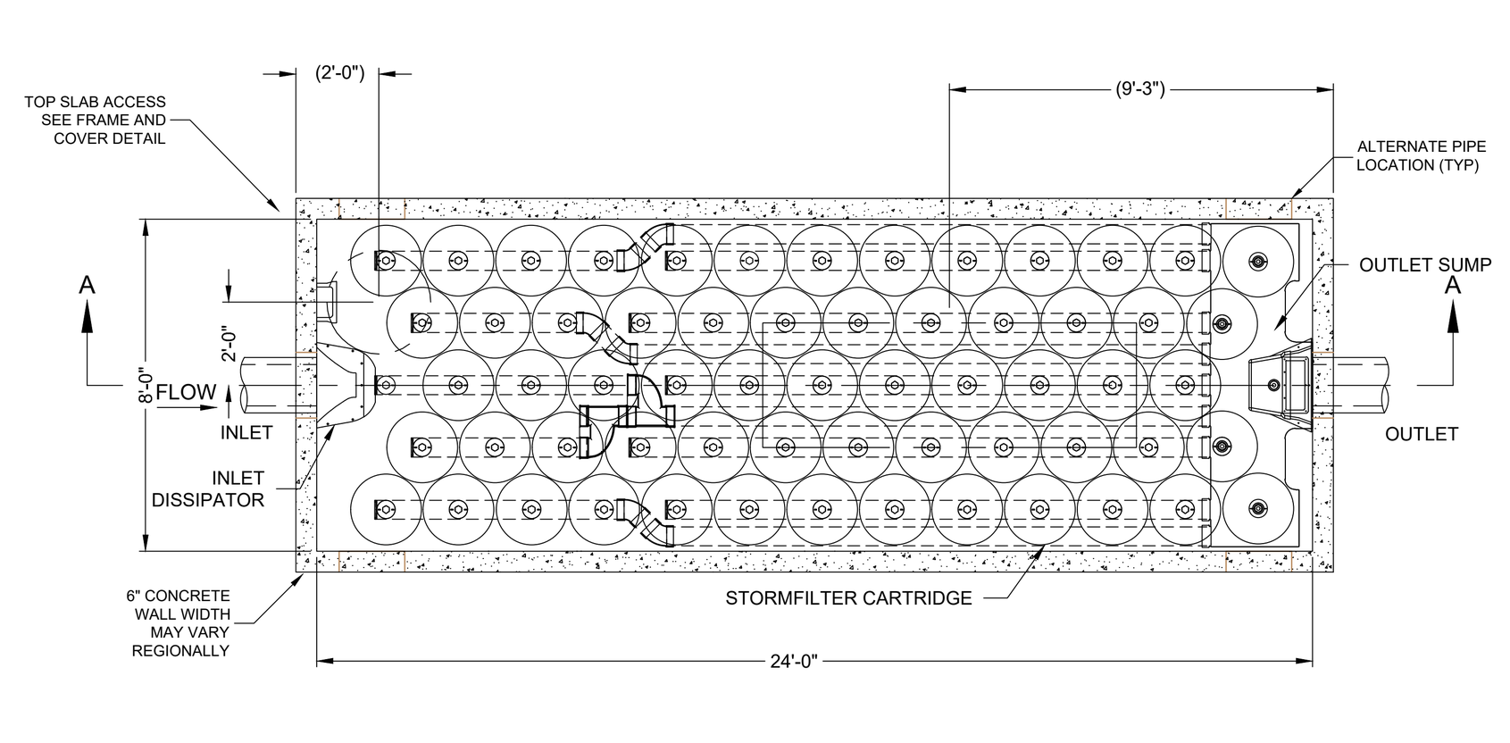
24" TRENCH COVER
(LENGTH VARIES)
N.T.S.

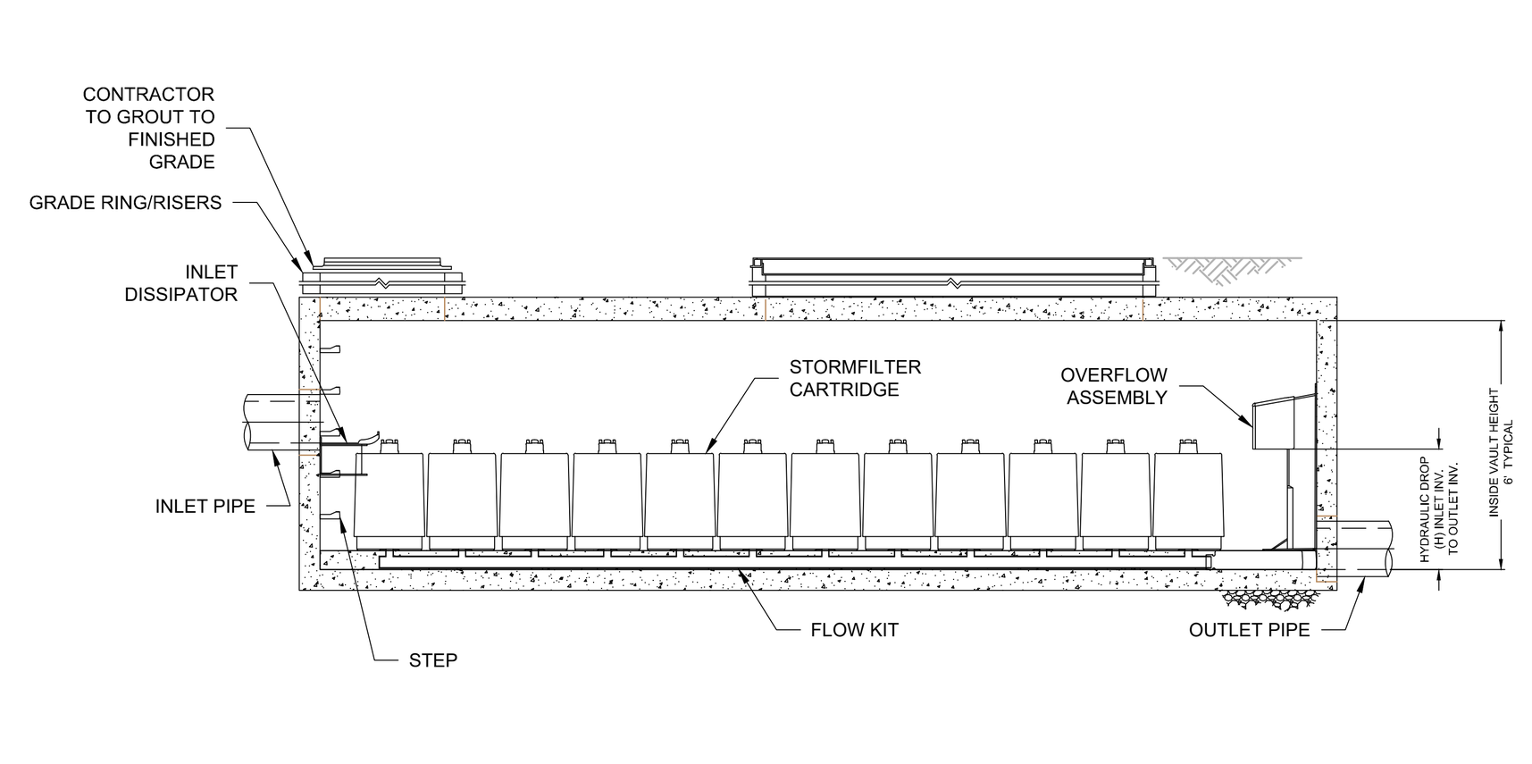
GENERAL NOTES:
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS REPRESENTATIVE. www.ContechES.com
3. JELLYFISH WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL 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-918, 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





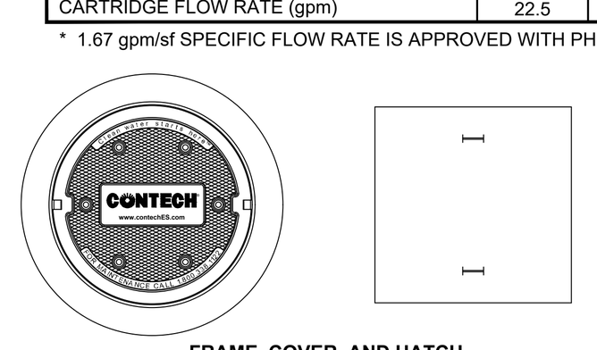
STORMFILTER DESIGN NOTES

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 (61). 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



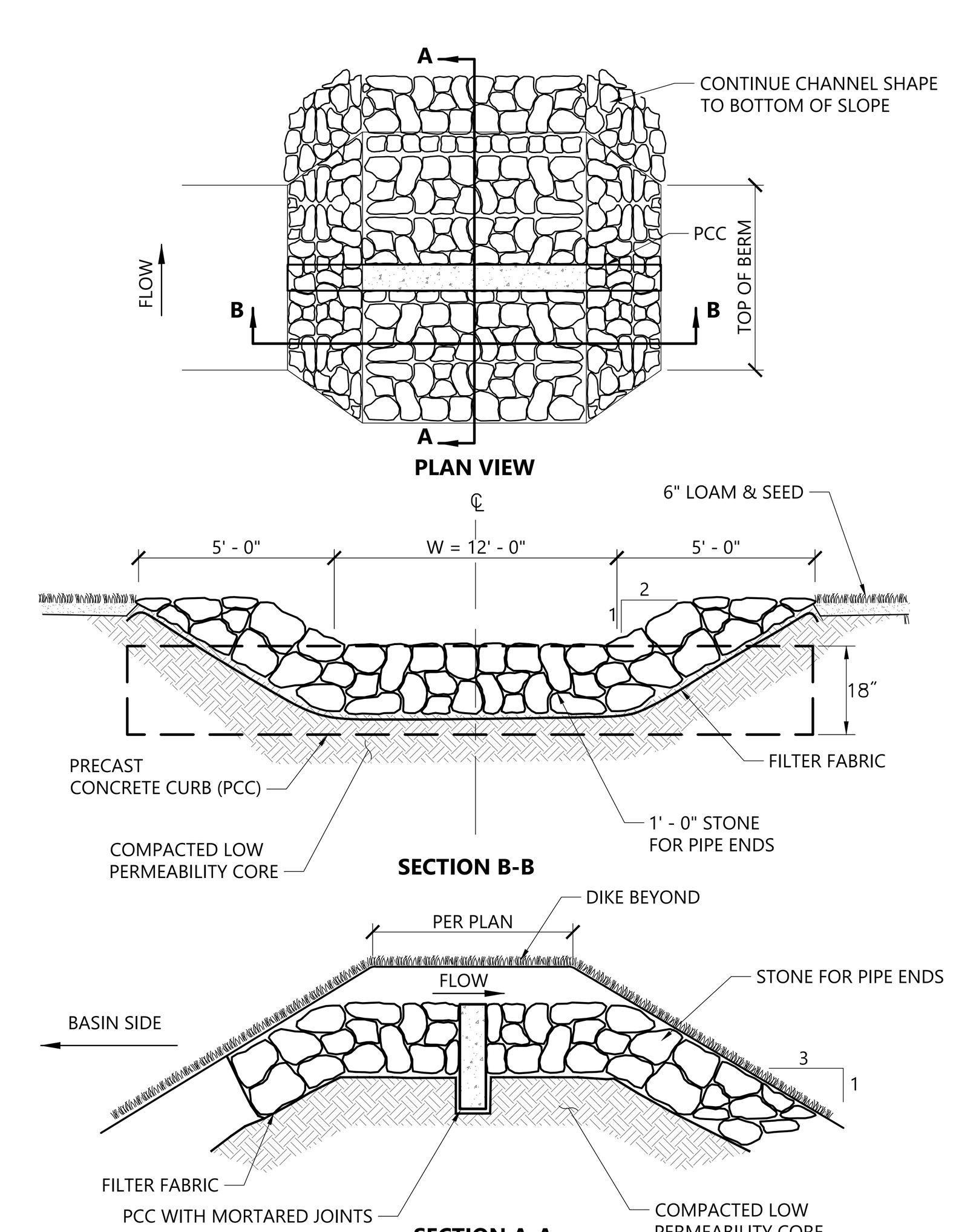
FRAME, COVER, AND HATCH
(SIZE AND CONFIGURATION VARY)
N.T.S.

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 HS20 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)

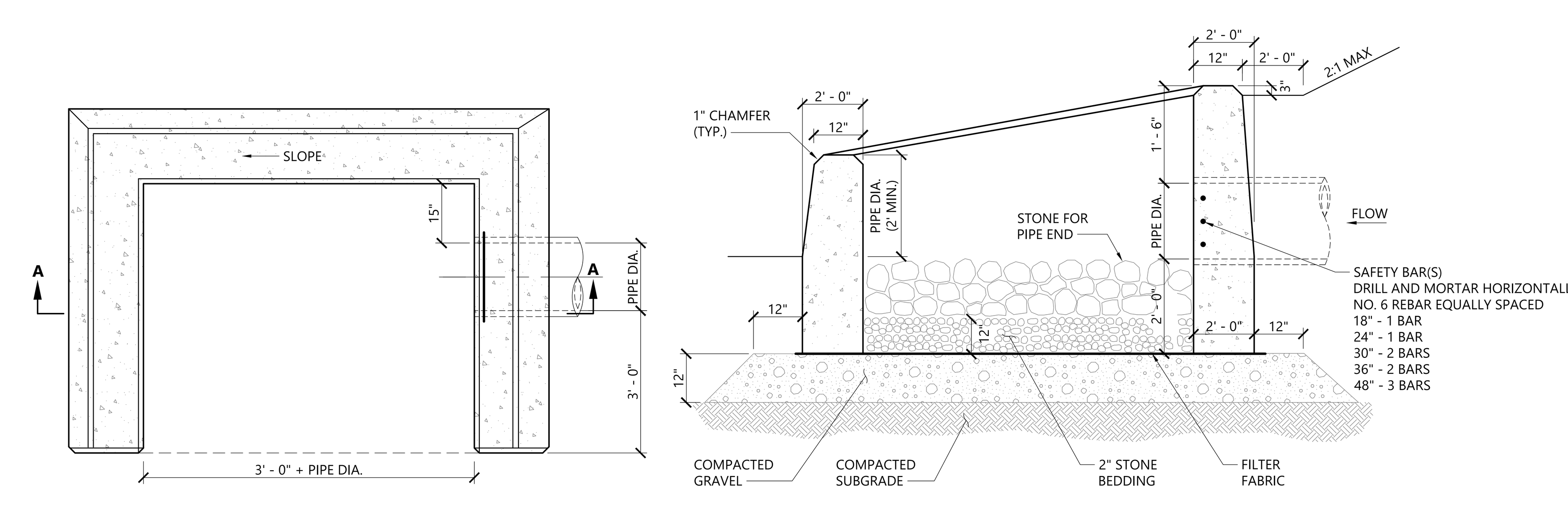
N.T.S. Source: Contech



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

Saved Tuesday, March 29, 2022 1:40:25 PM DKECHES Plotted Tuesday, March 29, 2022 1:56:15 PM David Heredia Rodriguez

ORIGINAL SHEET - ARCH D

Stantec

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

COMMONWEALTH OF MASSACHUSETTS
NICHOLAS J. SKOLY
CIVIL
No. 52677
REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale:

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

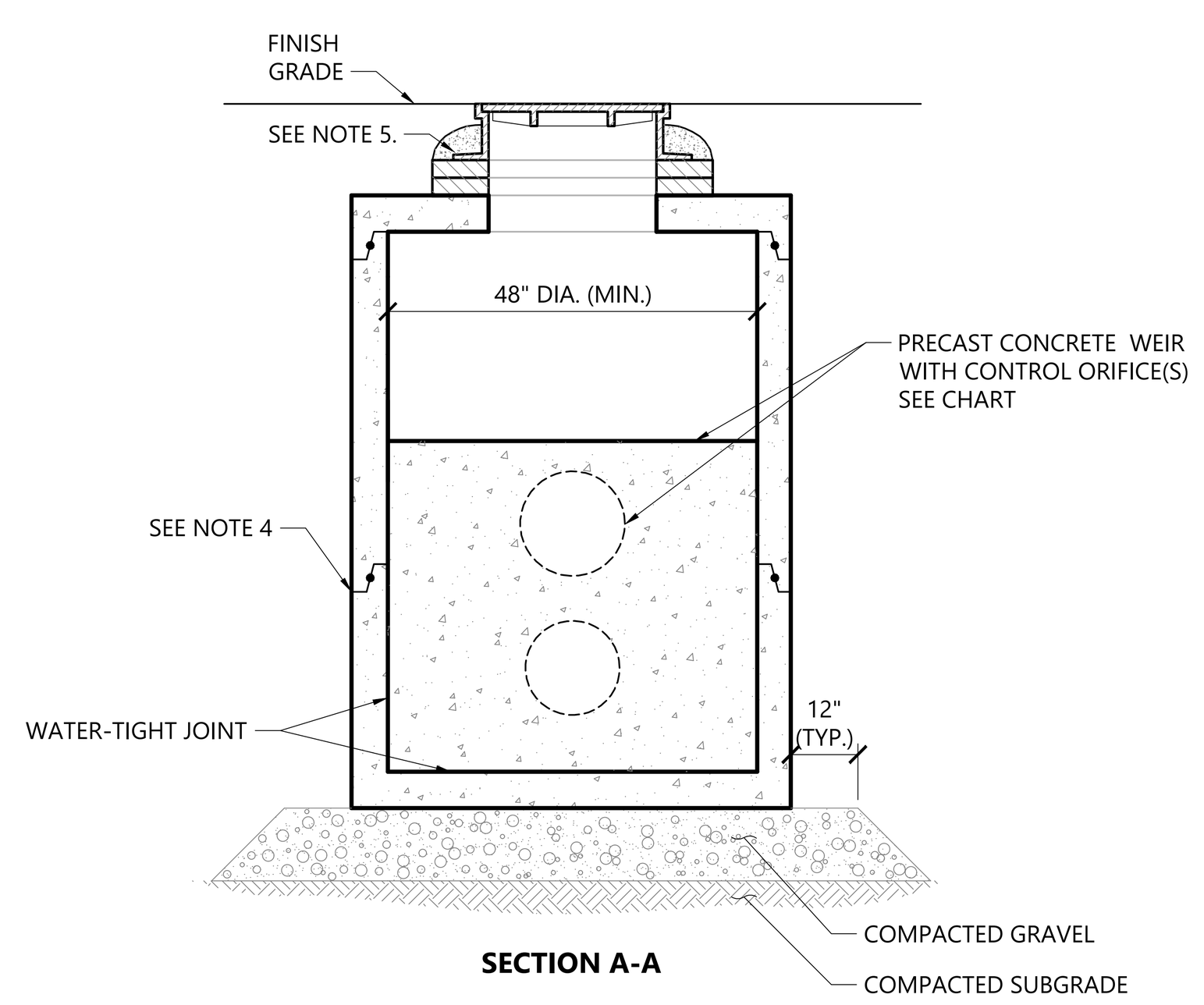
Title
Site Details

Revision:

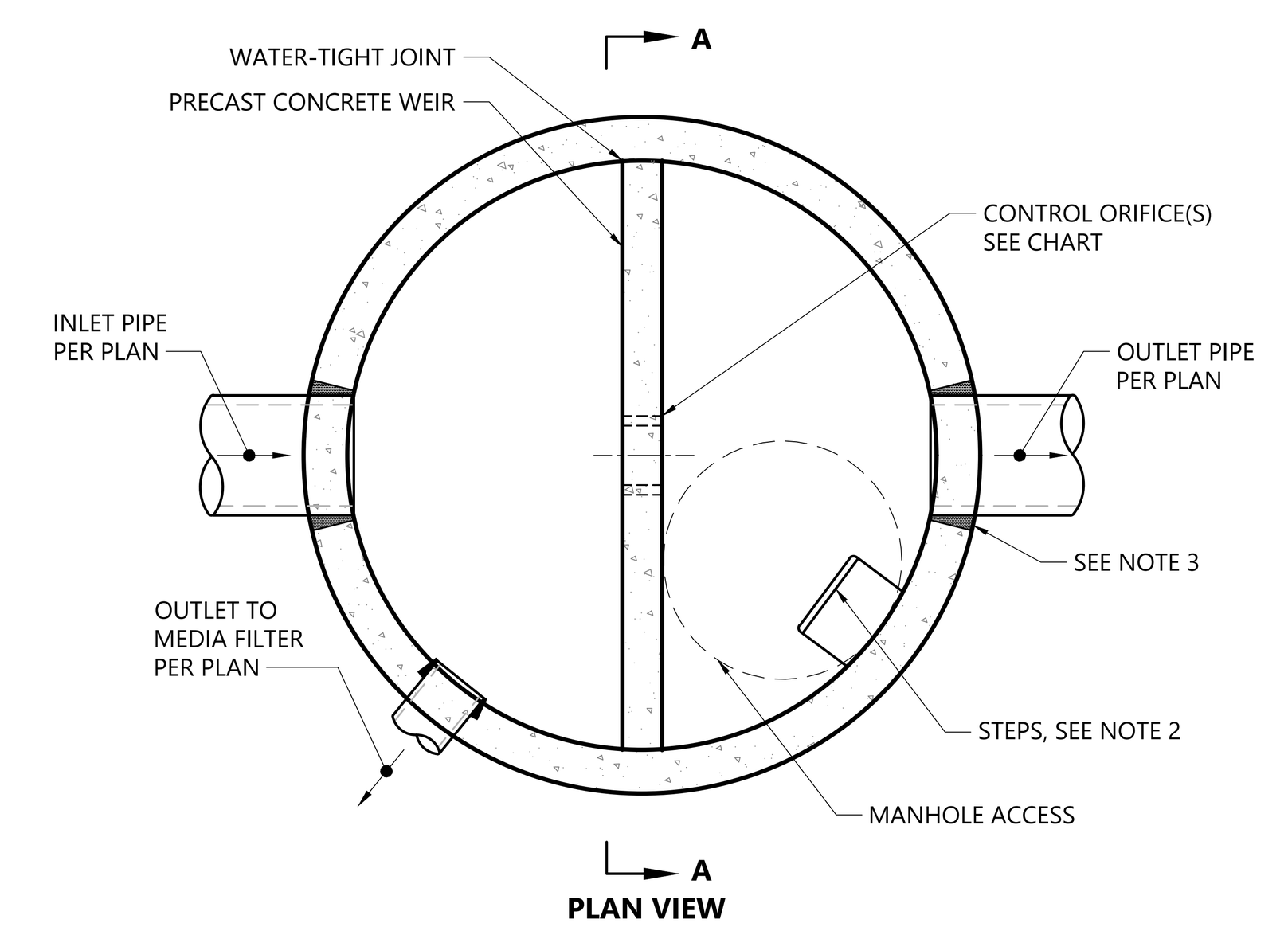
Drawing No.
C-05

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



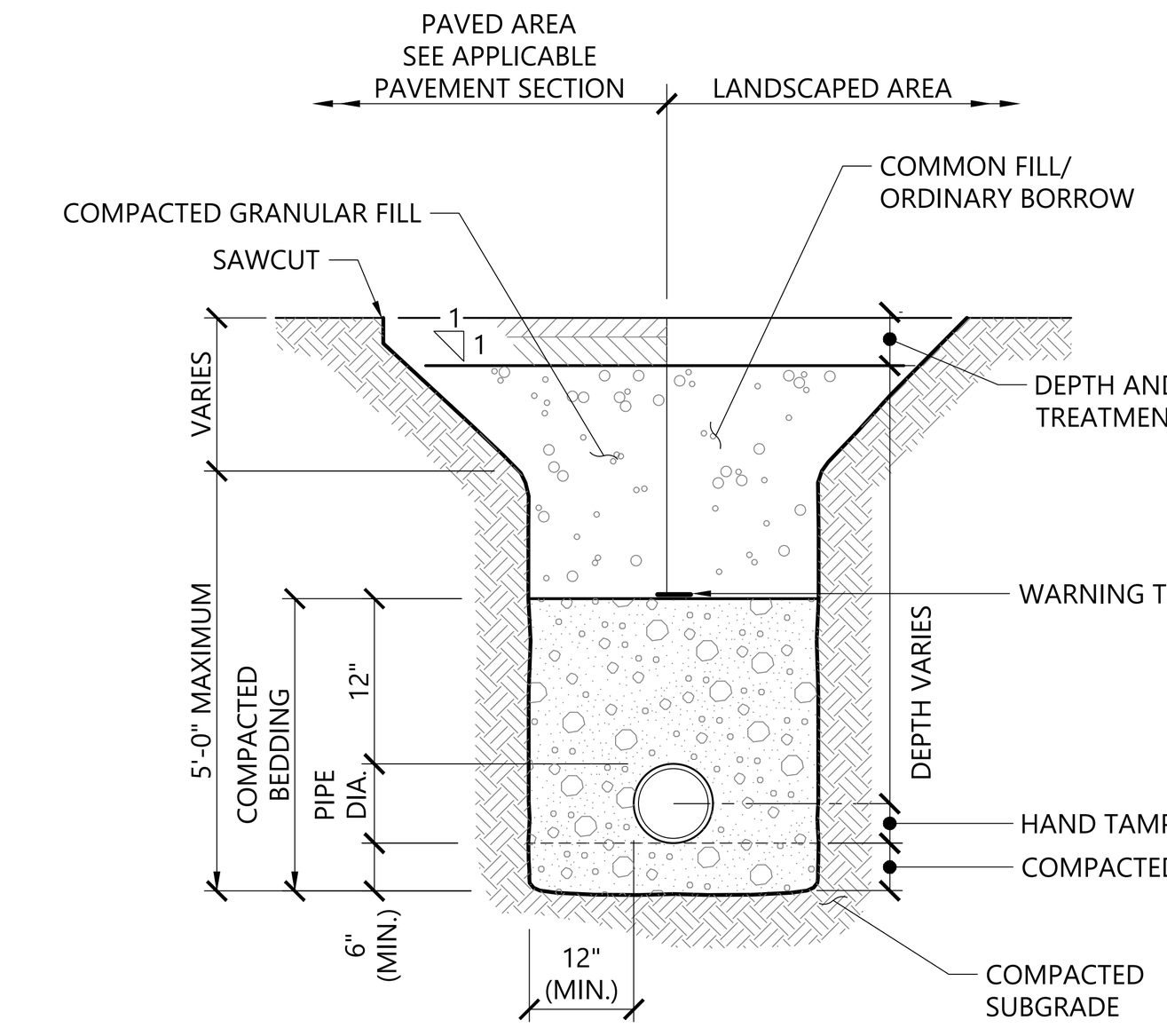
PLAN VIEW

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)

3/20
N.T.S. Source: VHB REV LD_162A

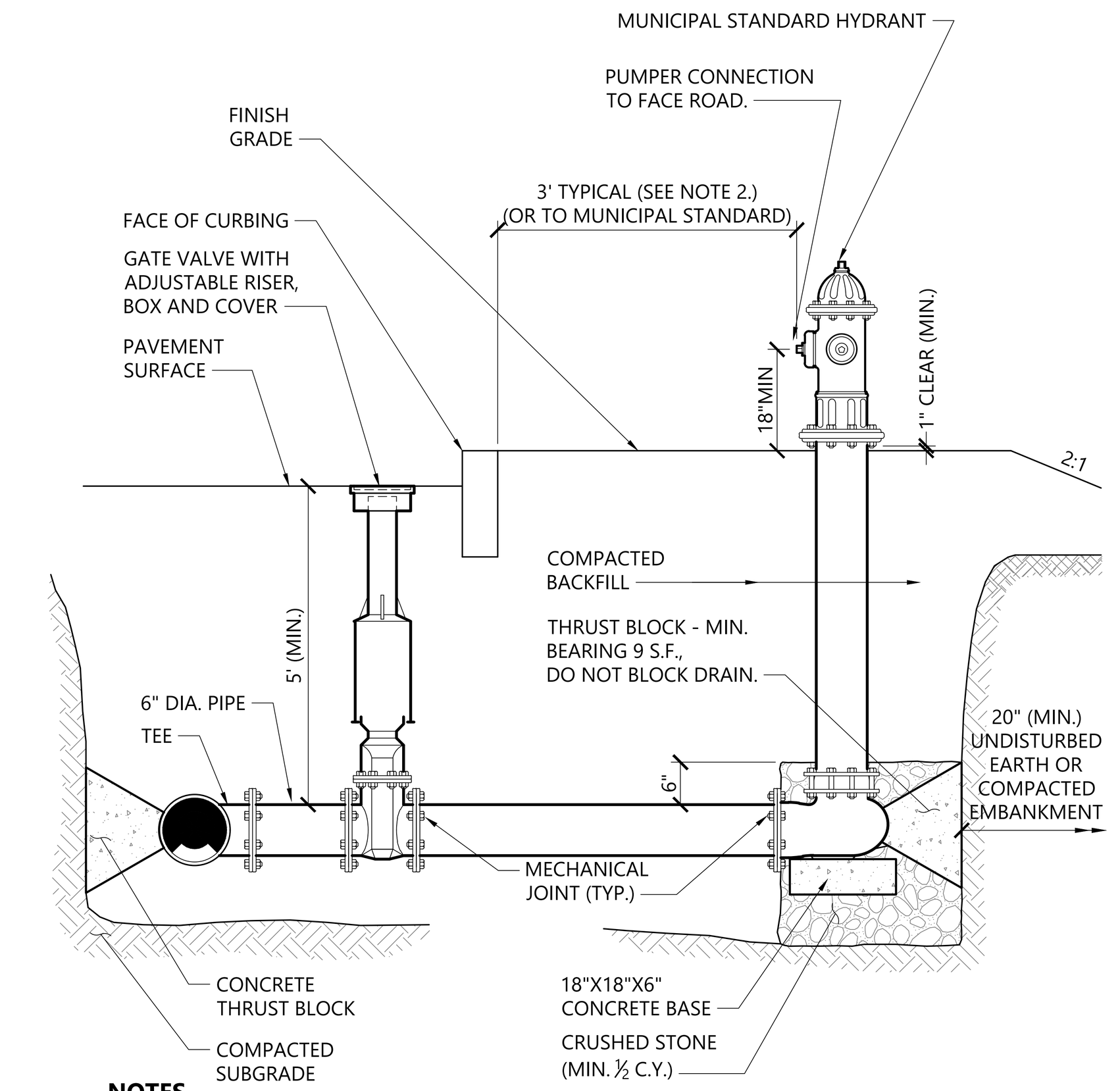


NOTES

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

11/19
N.T.S. Source: VHB LD_300



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

12/19
N.T.S. Source: VHB LD_250

RESTRAINED JOINTS

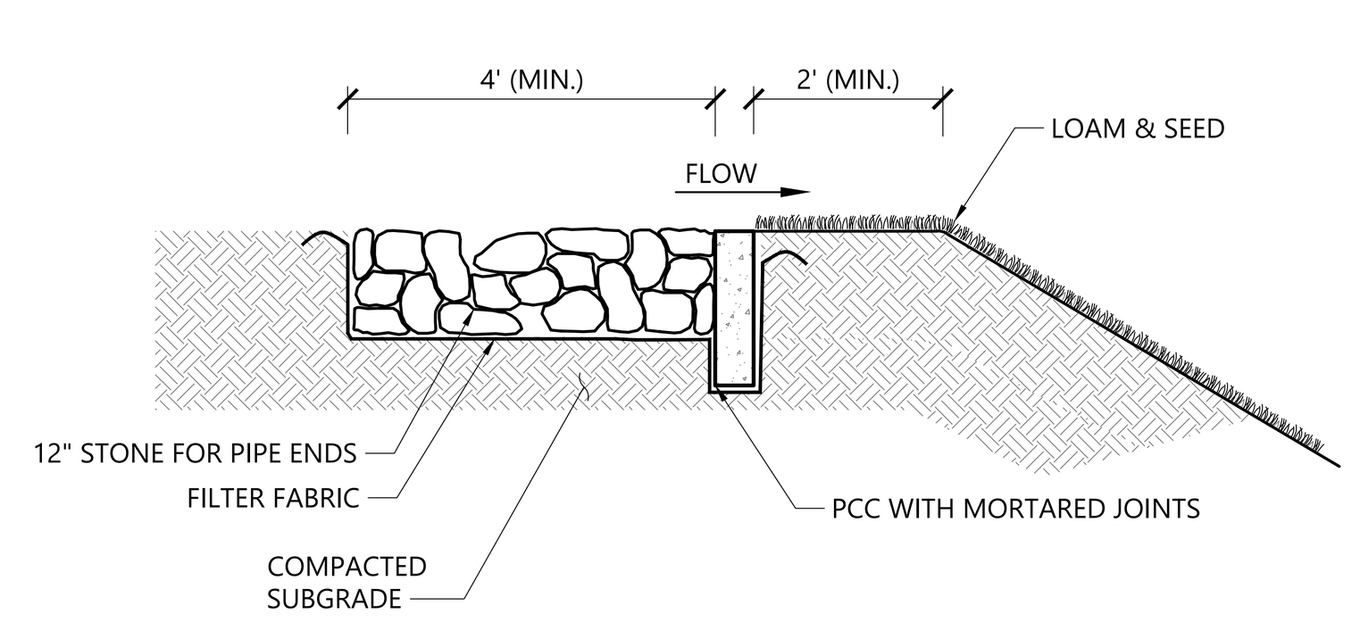
FITTINGS	NUMBER OF JOINTS TO RESTRAIN ON EITHER SIDE OF FITTING (BASED ON 18-FOOT PIPE LENGTH)
90 DEGREE BEND	3
45 DEGREE BEND	2
22-1/2 DEGREE BEND	2
TEE:	
BRANCH	3
RUN	2

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.

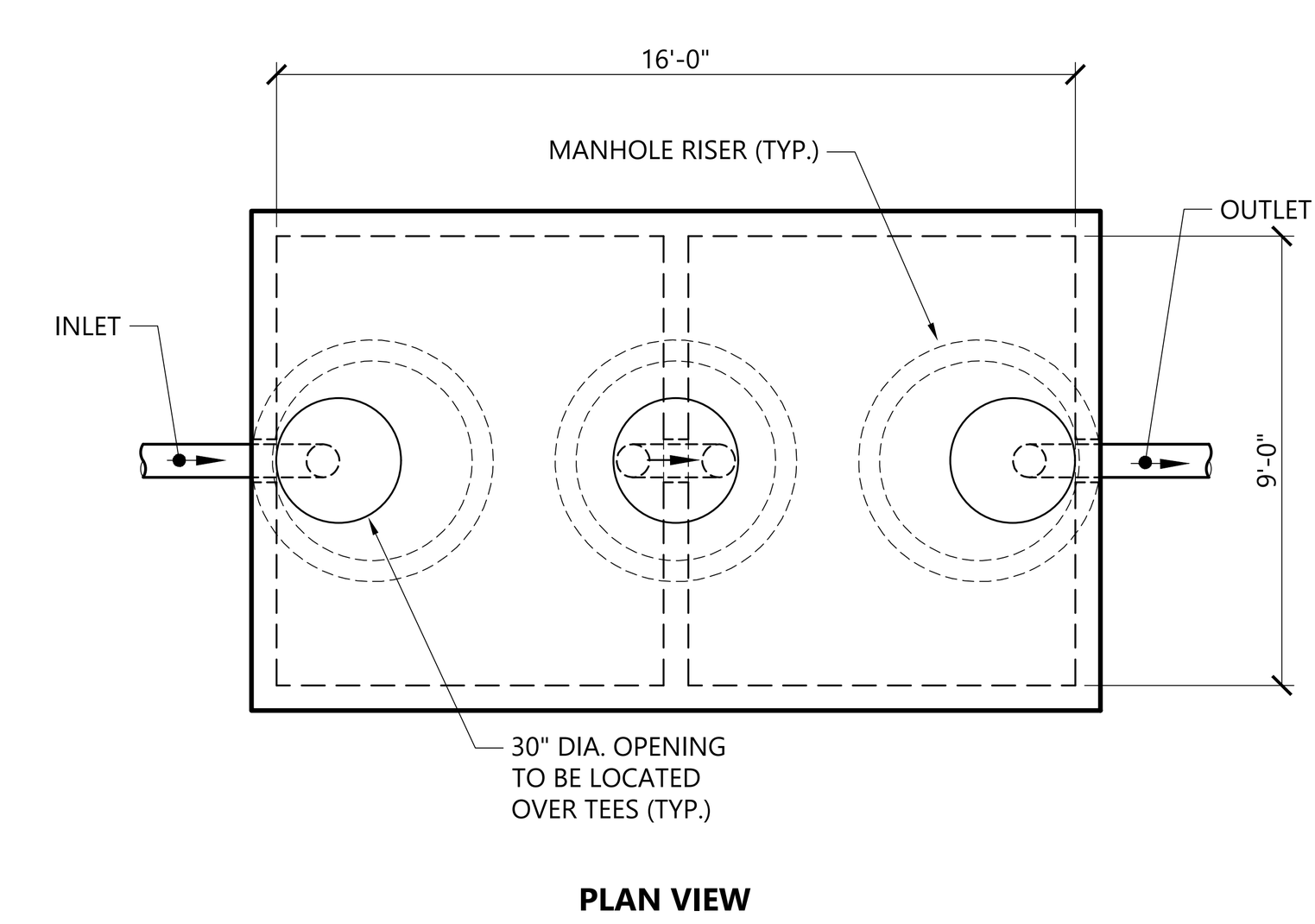
Restrained Joints for Water Pipe

3/20
N.T.S. Source: VHB LD_261

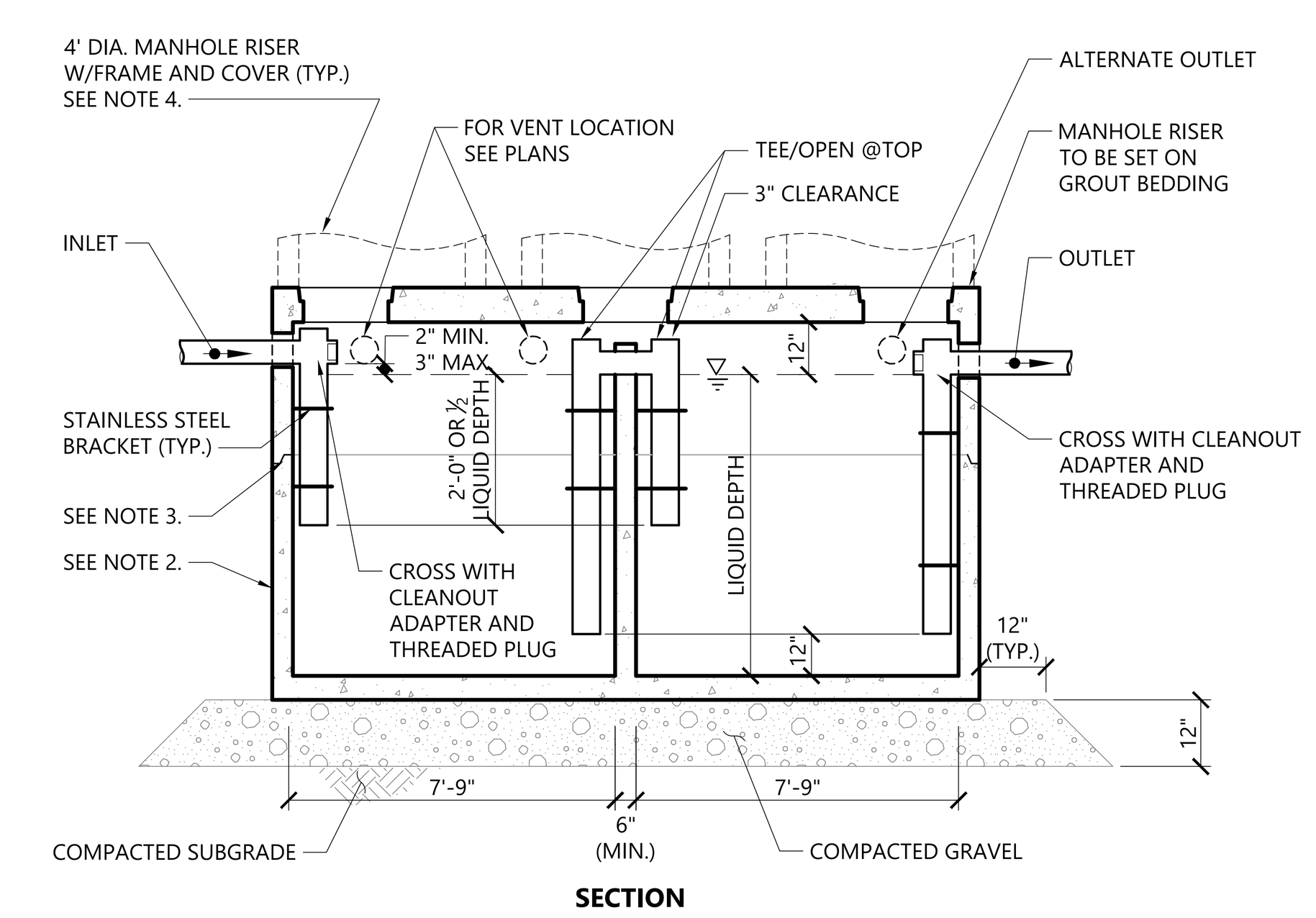


Level Spreader Section

N.T.S. Source: VHB



PLAN VIEW



SECTION

NOTES

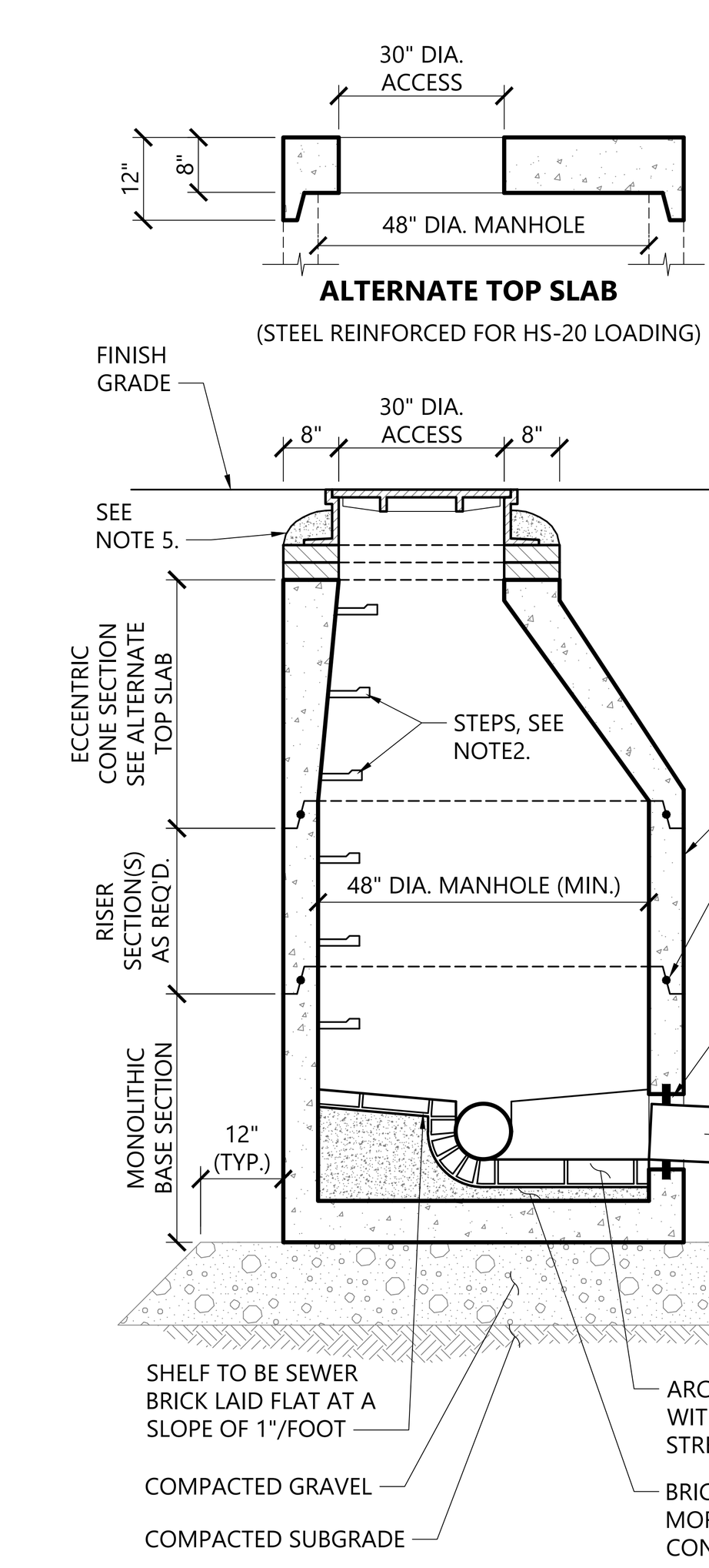
1. STRUCTURE SHALL BE DESIGNED FOR HS-20 LOADING.
2. EXTERIOR SURFACES SHALL BE GIVEN TWO COATS OF BITUMINOUS WATER-PROOFING MATERIAL.
3. JOINT SEALANT BETWEEN PRECAST SECTIONS SHALL BE PREFORMED BUTYL RUBBER.
4. STANDARD 30-INCH SEWER MANHOLE FRAME AND COVER SHALL BE LOCATED OVER CROSSES AND SET IN 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.

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"

Precast Concrete Grease Trap (GT)

12/19
N.T.S. Source: VHB LD_211

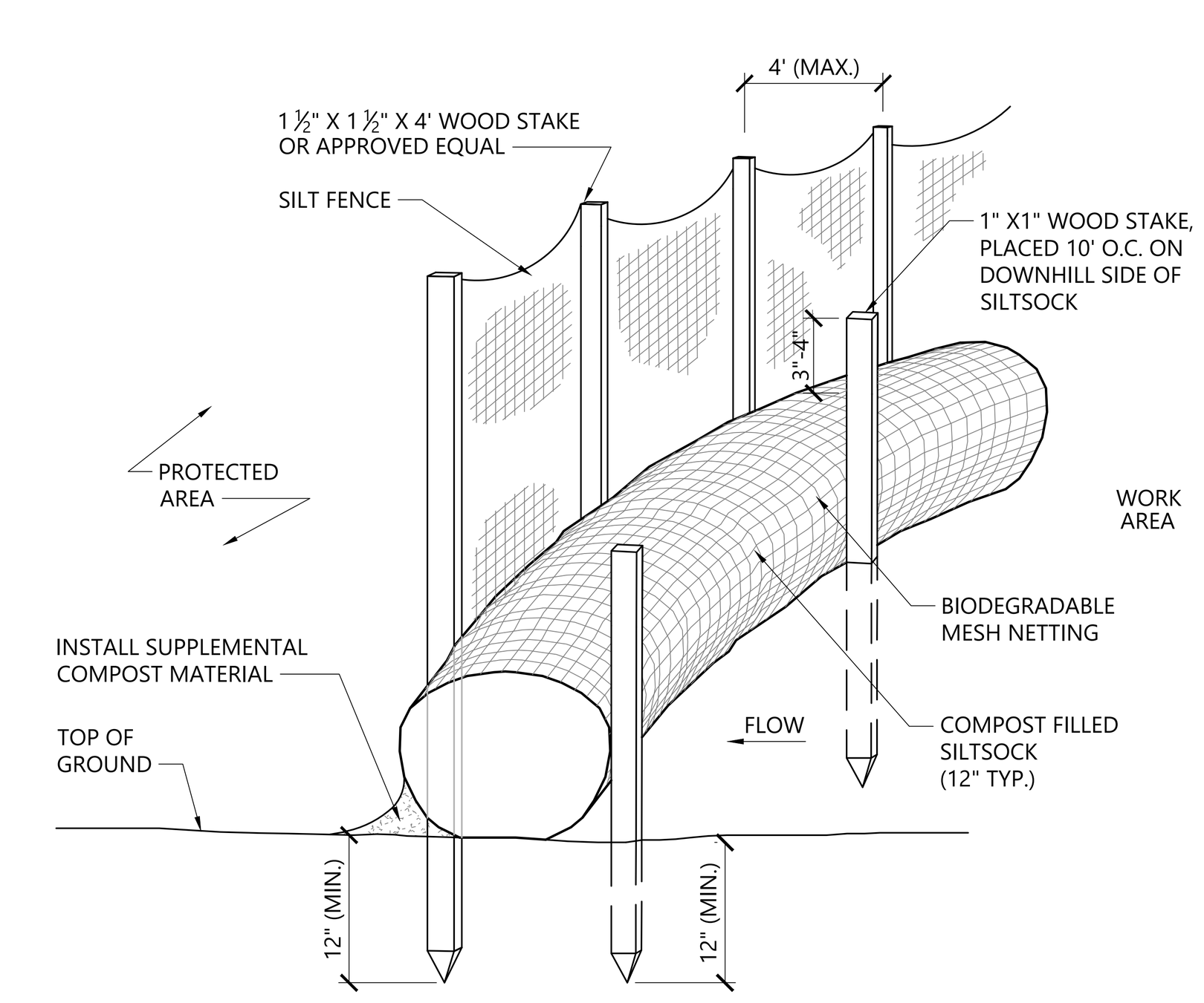


NOTES

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)

1/16
N.T.S. Source: VHB LD_200

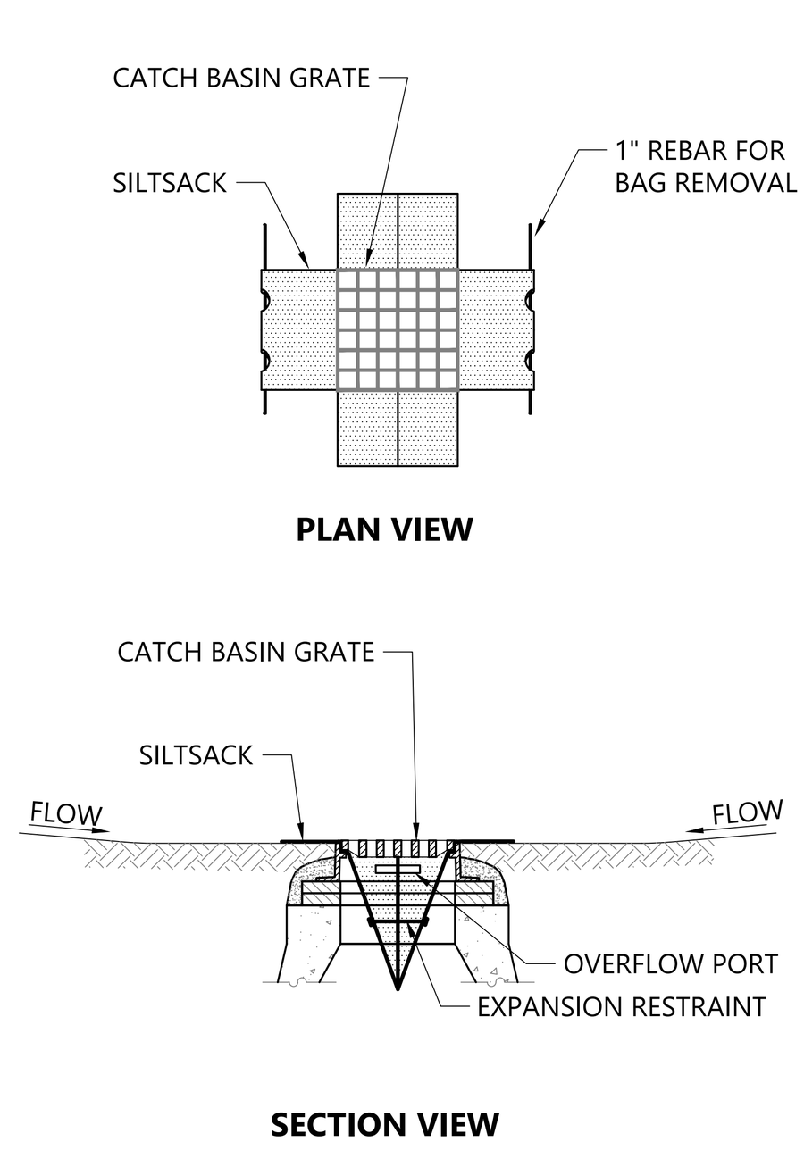


NOTES

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

10/20
N.T.S. Source: VHB LD_658-A



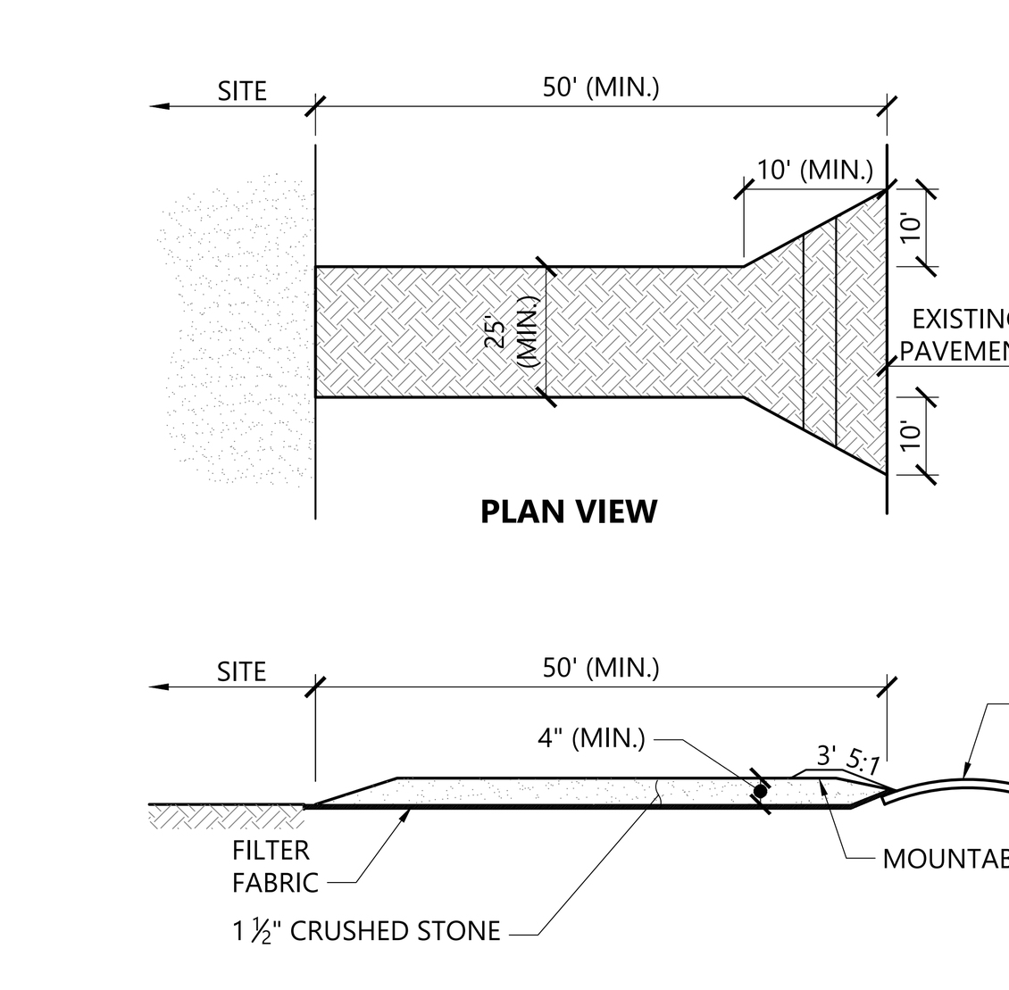
SECTION VIEW

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

1/20
N.T.S. Source: VHB LD_674



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

1/16
N.T.S. Source: VHB LD_682

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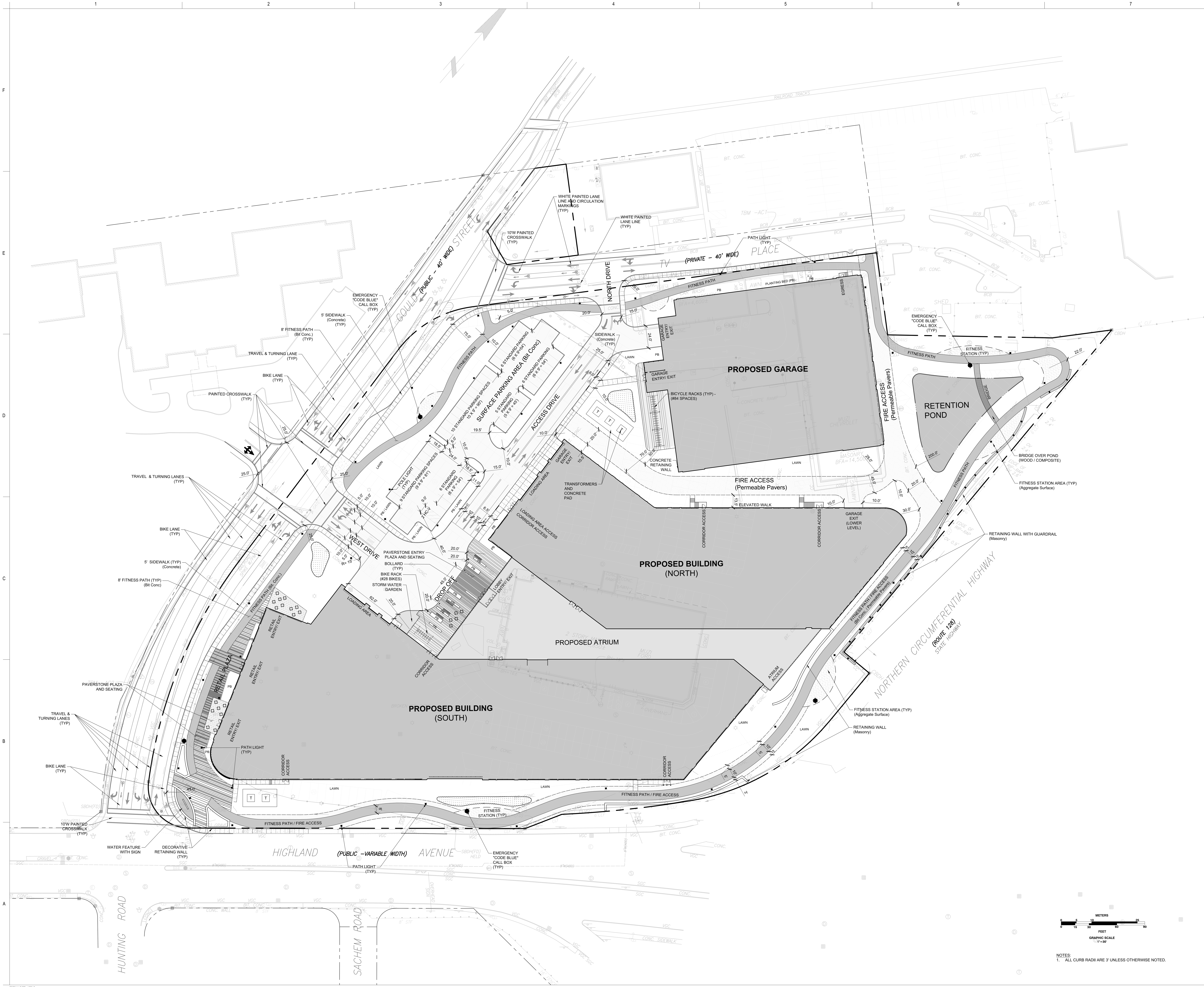
Permit/Seal
COMMONWEALTH OF MASSACHUSETTS NICHOLAS J. SKOLY CIVIL No. 52677 REGISTERED PROFESSIONAL ENGINEER

Client/Project
Bulfinch
557 Highland Ave

Project No.: 15216.00
File Name: N/A
Scale:
Author Designer Checker 2022.03.30
Dwn. Dsgn. Chkd. YYYY.MM.DD

Title
Site Details

Revision:
Drawing No.
C-06



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NEEDHAM, MA 02494

Project No.: 218421343
File Name:
Scale: 1" = 30'-0"

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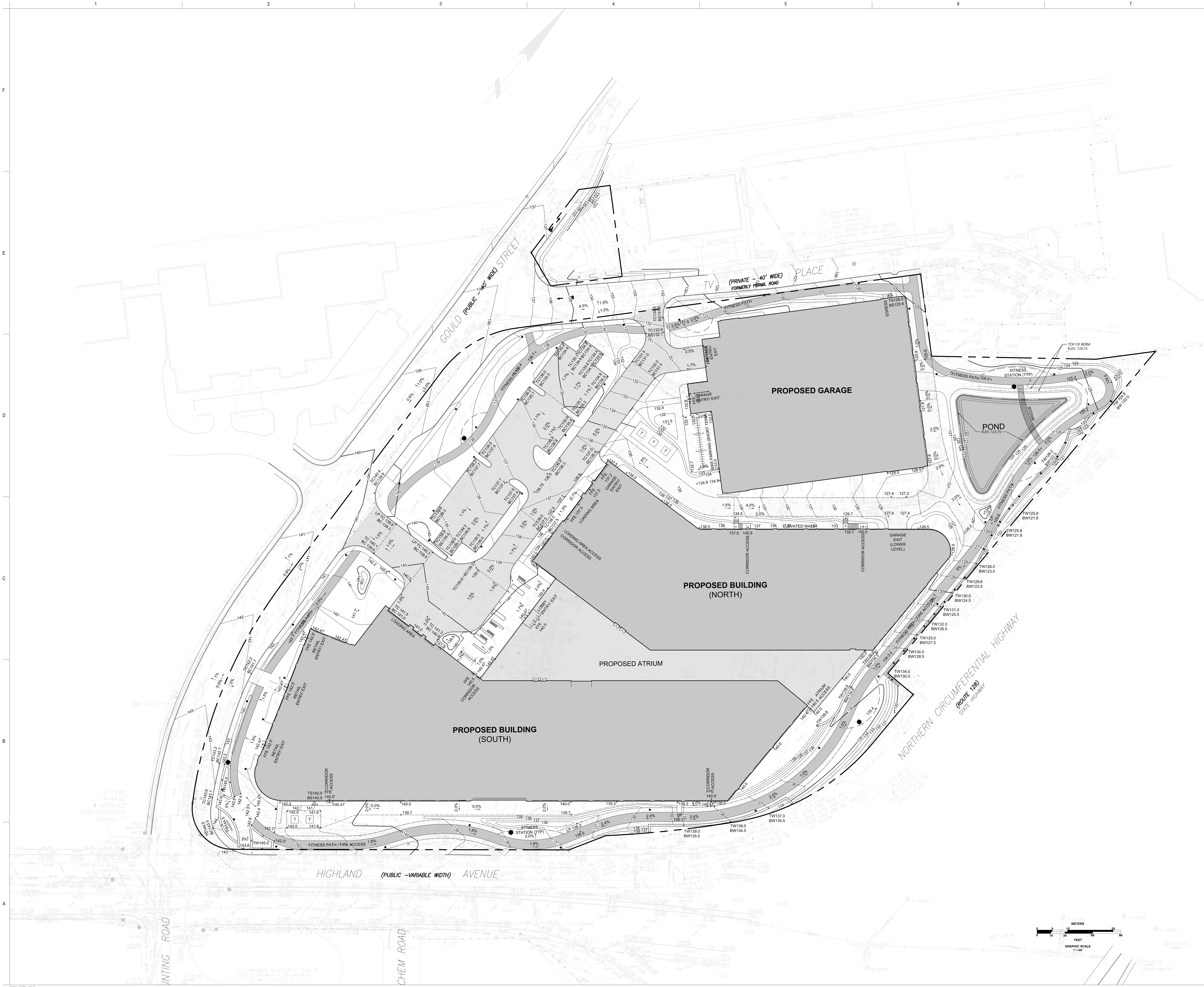
Title
SITE PLAN

Revision:
Drawing No.
L-1.0



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NEEDHAM, MA 02494

Project No.: 218421343

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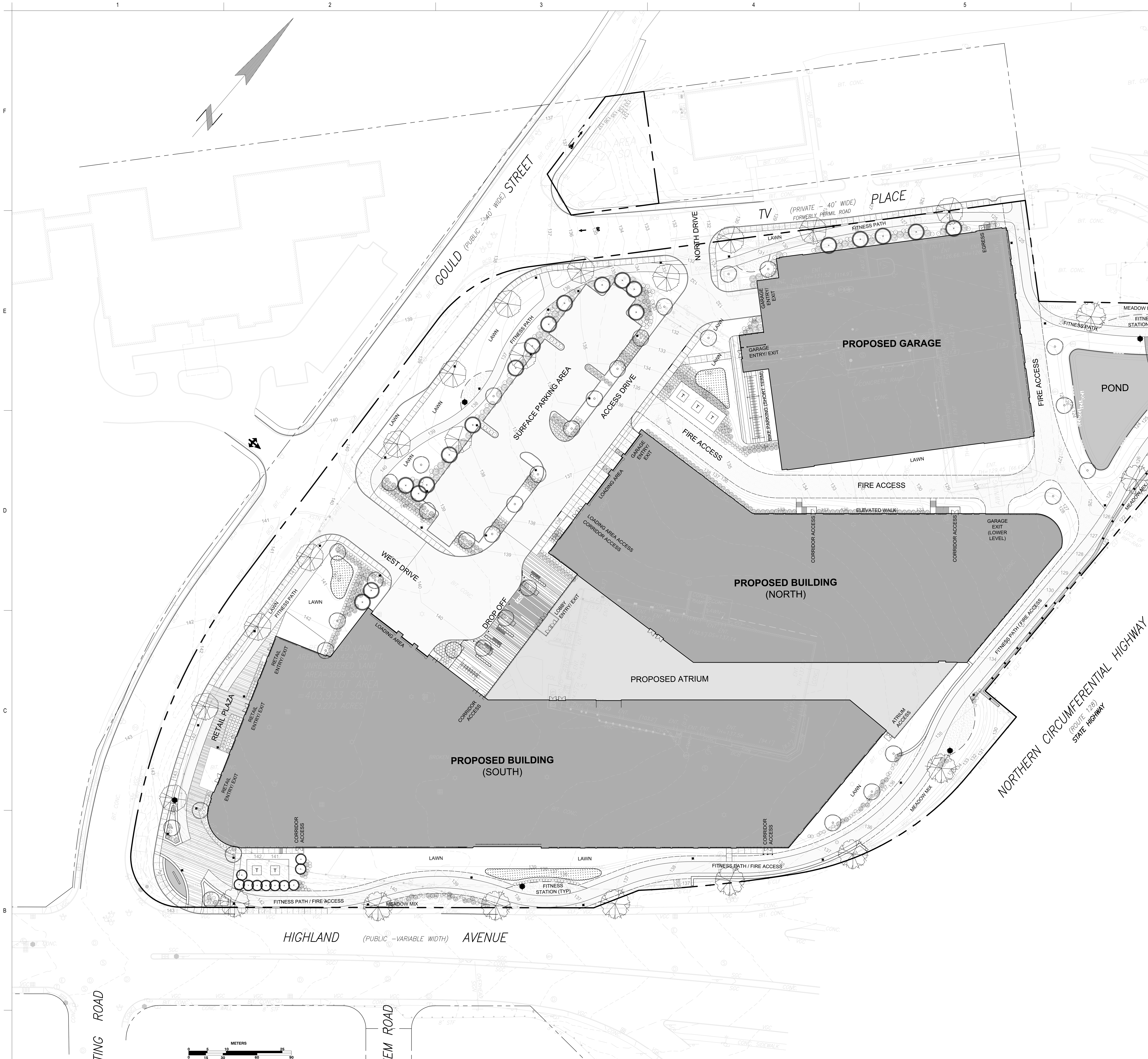
Title

SITE GRADING PLAN

Revision:

Drawing No.

L-2.0



PLANT MATERIAL LEGEND:

- STREET TREE / SHADE TREE (DECIDUOUS)
- ORNAMENTAL TREE (DECIDUOUS)
- SCREENING TREE (EVERGREEN)
- EVERGREEN SHRUB
- DECIDUOUS SHRUB
- RAIN GARDEN AREAS

PLANTING SCHEDULE

KEY	BOTANICAL NAME	COMMON NAME	QTY	SIZE	ROOT	COMMENTS
SHADE TREES						
	Quercus palustris	Pin Oak			3.5" CAL	
	Acer Rubrum ' Armstrong' (wet)	Armstrong Red Maple			3.5" CAL	
	Tilia americana	American Linden			3.5" CAL	
	Quercus rubra	Red Maple			3.5" CAL	
	Quercus alba / bicolor (wet)	Swamp White Oak			3.5" CAL	
	Gleditsia Triacanthos Inermis	Thornless Honeylocust			3.5" CAL	
	Liquidambar styraciflua	Sweetgum			3.5" CAL	
	Nyssa sylvatica (wet)	Black Tupelo			3.5" CAL	
	Acer Freemanii 'Armstrong'	Columnar Armstrong Red Maple			3.5" CAL	
ORNAMENTAL TREE						
	Amelanchier canadensis	Canadian Serviceberry		7-8' HT		
	Malus Spring Snow	Spring Snow Flowering Crabapple			3" CAL	
	Betula Populifolia "Whitespire"	Whitespire Birch		7-8' HT		
	Fagus sylvatica 'Tortuosa Purpurea'	Dwarf Beech		10' HT		
	Chionanthus Virginicus	White Fringetree		10 GAL		
	Cornus Kousa	Kousa Dogwood		10 GAL		
	Hamamelis Virginiana	American witch-hazel		10 GAL		
	Magnolia Virginiana	Sweetbay Magnolia		10' HT		
EVERGREEN/SCREENING TREES						
	Thuja Occidentalis `Smaragd`	Emerald Green Arborvitae		6-10' HT		
	Thuja occidentalis "Nigra"	Arborvitae 'Nigra'		6'-10' HT		
	Picea glauca	White spruce		14'-16' HT		
EVERGREEN SHRUBS						
	Picea pungens 'Glauca Globosa'	Dwarf Colorado Blue Spruce		5 GAL		
	Juniperus conferta	Blue Pacific Shore Juniper		5 GAL		
	Kalmia latifolia	Mountain Laurel		5 GAL		
	Rhodendron Cunningham White	White Rhodondenron		5 GAL		
	Rhododendron 'Olga mezitt'	Olga Mezitt Rhododendron		3-5' HT		
	Ilex glabra	Inkberry		5 GAL		
DECIDIOUS SHRUBS						
	Clethra alnifolia 'Ruby spice'	Sweetsummer		4'-6' HT		
	Enkianthus campanulatus	Redvein Enkianthus		4'-6' HT		
	Cornus sericea variegata	Variegated dogwood				
	Hydrangea paniculata 'Limelight'	Limelight Hardy Hydrangea		6'-8' HT		
	Syringa pubscens patula 'Miss Kim'	Lilac		4-6' HT		
	Ilex verticillata "Red Sprite"	Red Sprite Winterberry		3-5' HT		
	Rosa x'Knock out'	Shrub Rose		3-5' HT		
	Lindera Benzoin	Spicebush		3 GAL		
GROUNDCOVER						
	Rhus Aromatica `Gro-Low`	Gro-Low Fragrant Sumac		3 GAL		
	Hemerocallis X `Happy Returns`	Happy Returns Daylily		1 GAL		
	Anemone X Hybrida `Honorine Jobert`	Honorine Jobert Japanese Anemone		1 GAL		
	Juniperus Chinensis `Sargentii`	Sargent Juniper		1 GAL		
	Waldsteinia Fragarioides	Barren Strawberry		4" POT		
	Juniperus communis var. depressa	Common Juniper		3 GAL		
	Vaccinium angustifolium	Lowbush Blueberry		1 GAL		
	Spiraea 'Magic Carpet'Dwarf	Spirea		1 GAL		
RAINGARDEN						
	Rudbeckia hirta	Blackeyed Susan				
	Asclepias incarnata	Swamp Milkweed				
	Iris versicolor	Blue Flag Iris				
	Lobelia siphilitica	Blue Lobelia				
	Andropogon virginicus	Broomsedge				
	Osmunda cinnamomea	Cinnamon Fern				
	Aster novae-angliae	New England Aster				
	Asarum canadense	Wild Ginger				
	Panicum virgatum	Switchgrass				
	Vernonia noveboracensis	Ironweed				
	Hypericum fasciculatum	St. John's Wort				
	Aquilegia canadensis	Red Columbine				
	Eupatorium fistulosum	Joe-Pye Weed				
	Liatris pycnostachya	Liatris				
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).

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).

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Project No.: 218421343

File Name: S-PL-PLANTING PLAN.DWG

Scale: 1" = 30'-0"

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Title

SITE PLANTING PLAN

Revision:

Drawing No.

L-3.0

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	6
	S1	6776	56	0.900	NV-1-T4-16L-1-40K-UNV 18' MH	2
	WM	2440	27.2	0.900	MV-30041-M-W40	25
	CB1				CB 1-S	5

Calculation Summary						
Label	Units	Avg	Max	Min	Avg/Min	Max/Min
SITE_Planar	Fc	0.71	39.4	0.0	N.A.	N.A.
Retail Plaza	FC	2.89	39.4	0.1	28.90	394.00
Surface Parking	FC	1.38	10.2	0.1	13.80	102.00

METERS 0 5 10 20
FEET 0 15 30 60 90
GRAPHIC SCALE 1"=30'

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COMMONWEALTH OF MASSACHUSETTS PAUL J. FINGER REGISTERED LANDSCAPE ARCHITECT

Client/Project
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NEEDHAM, MA 02494

Project No.: 21842343
File Name: S-LIGHTING PLAN.DWG
Scale: 1" = 30'-0"

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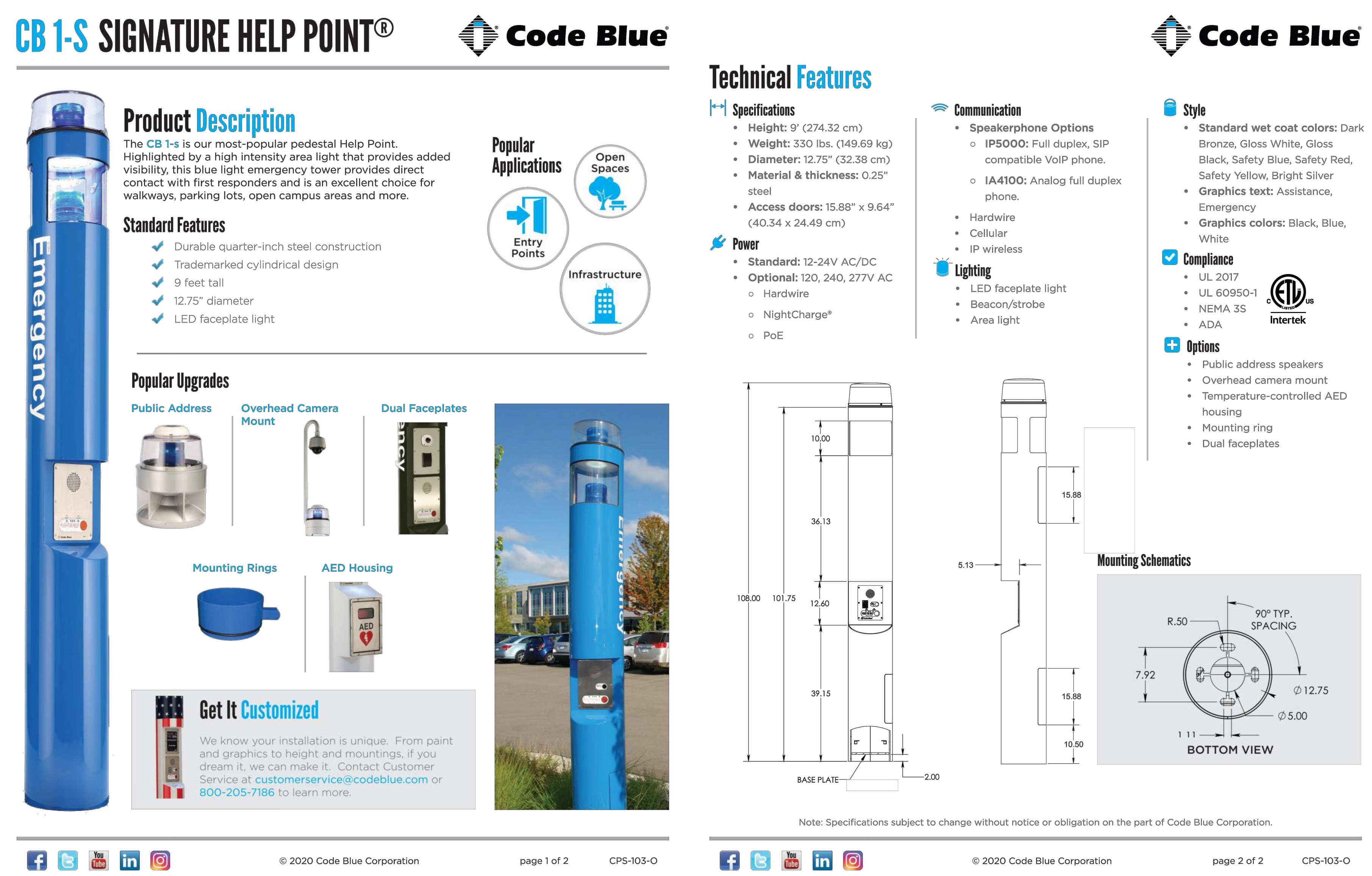
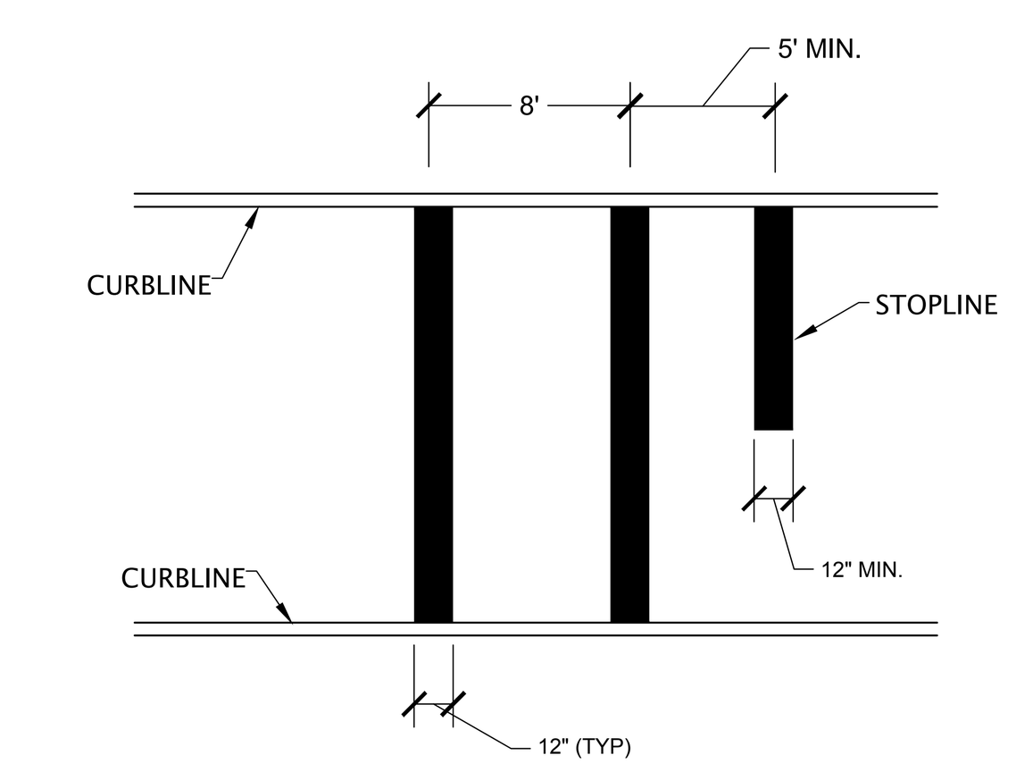
Title
SITE LIGHTING PLAN

Revision:
Drawing No.
L-4.0

ORIGINAL SHEET - ARCH E



BLUE LIGHT EMERGENCY TOWER
NOT TO SCALE

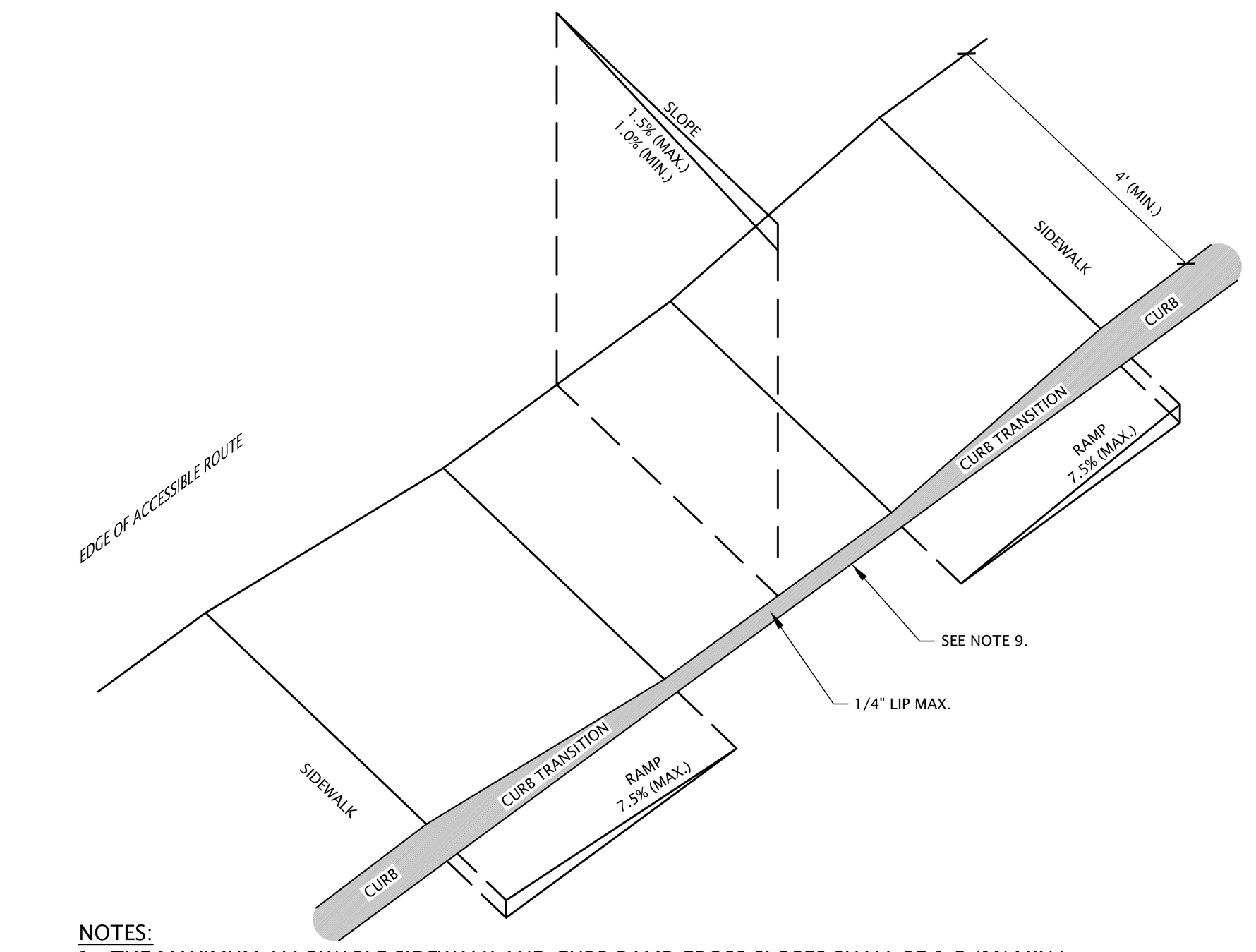


ALL TWELVE INCH (12") THERMO-PLASTIC LINES SHALL BE APPLIED IN ONE (1) APPLICATION, NO COMBINATION OF LINES (I.E. TWO 6" LINES) WILL BE ACCEPTED.

LAYOUT OF CROSSWALKS SHALL BE APPROVED BY A BOSTON TRANSPORTATION DEPARTMENT (BTD) ENGINEER PRIOR TO THERMO-PLASTIC BEING APPLIED.

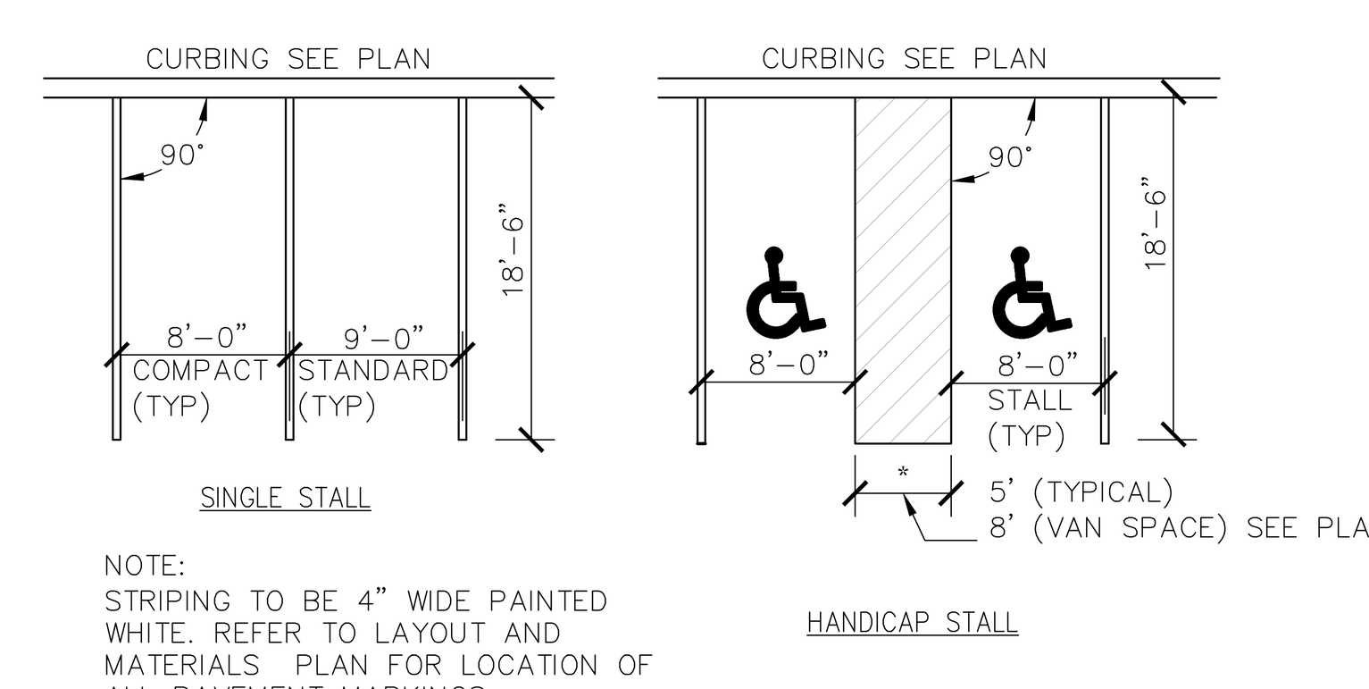
ALL CROSSWALKS INSTALLED SHALL CONFORM TO THE RELEVANT PROVISIONS OF THE MASSACHUSETTS HIGHWAY DEPARTMENT "STANDARD SPECIFICATION FOR HIGHWAY AND BRIDGES" DATED 1988, SECTION 860 FOR REFLECTORIZED LINE (THERMO-PLASTIC) AND MATERIAL M7.01.20, LATEST REVISIONS.

9 PEDESTRIAN CROSS WALK
NOT TO SCALE



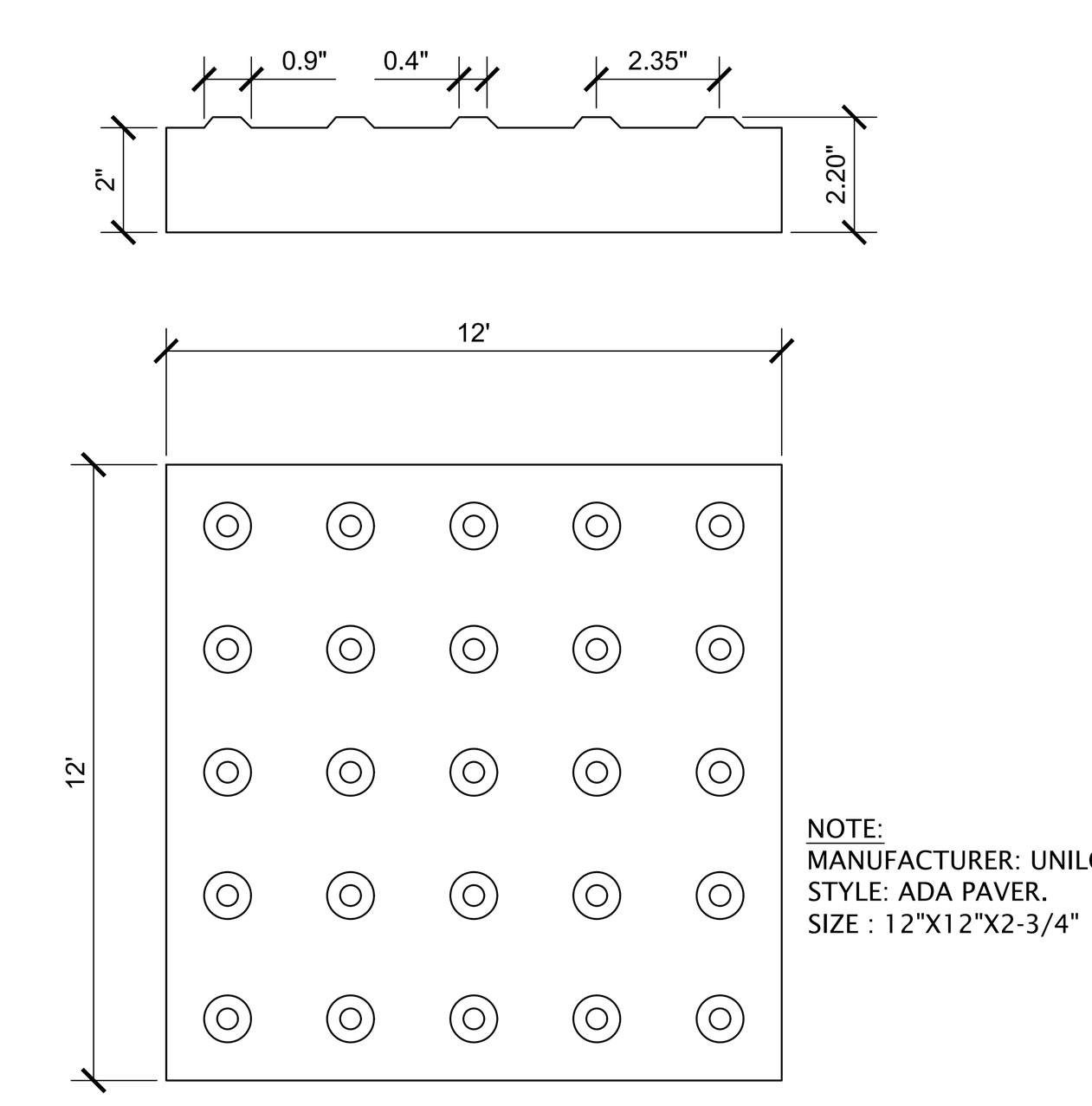
NOTES:
1. THE MAXIMUM ALLOWABLE SIDEWALK AND CURB RAMP CROSS SLOPES SHALL BE 1.5 (1% MIN.).
2. THE MAXIMUM ALLOWABLE SLOPE OF ACCESSIBLE ROUTE EXCLUDING CURB RAMPS SHALL BE 5%.
3. THE MAXIMUM ALLOWABLE SLOPE OF ACCESSIBLE ROUTE CURB RAMPS SHALL BE 7.5%
4. A MINIMUM OF 3 FEET CLEAR SHALL BE MAINTAINED AT ANY PERMANENT OBSTACLE IN ACCESSIBLE ROUTE (I.E., HYDRANTS, UTILITY POLES, TREE WELLS, SIGNS, ETC.).
5. CURB TREATMENT VARIES, SEE PLANS FOR CURB TYPE.
6. RAMP, CURB AND ADJACENT PAVEMENTS SHALL BE GRADED TO PREVENT PONDING.
7. SEE TYPICAL SIDEWALK SECTION FOR RAMP CONSTRUCTION.
8. WHERE ACCESSIBLE ROUTES ARE LESS THATN 5" IN WIDTH (EXCLUDING CURBING) A 5' X 5' PASSING AREA SHALL BE PROVIDED AT INTERVALS NOT TO EXCEED 200 FEET.
9. ELIMINATE CURBING AT RAMP (OTHER THAN VERTICAL CURBING, WHICH SHALL BE SET FLUSH) WHERE IT ABUTS ROADWAY.

ACCESSIBLE CURB RAMP
NOT TO SCALE



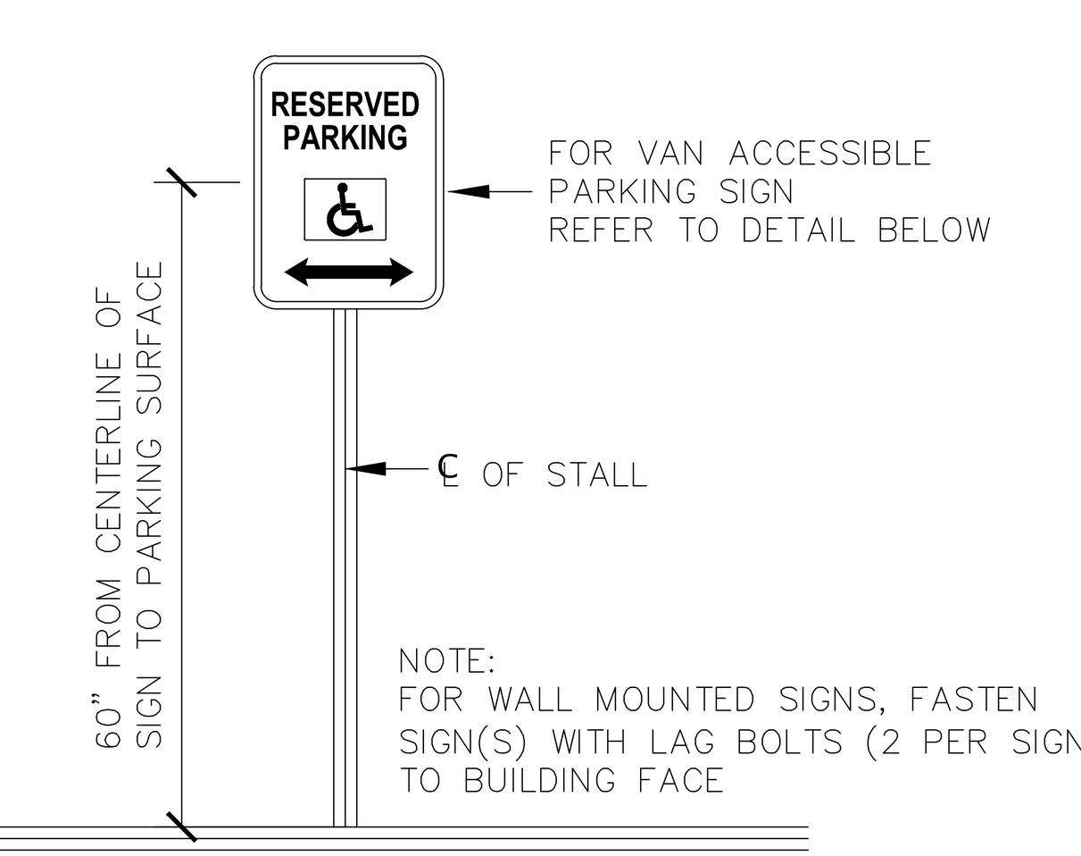
NOTE:
STRIPING TO BE 4" WIDE PAINTED WHITE. REFER TO LAYOUT AND MATERIALS PLAN FOR LOCATION OF ALL PAVEMENT MARKINGS.

PAVEMENT MARKING
NOT TO SCALE



NOTE:
MANUFACTURER: UNILOCK
STYLE: ADA PAVER.
SIZE : 12"X12"X2-3/4"

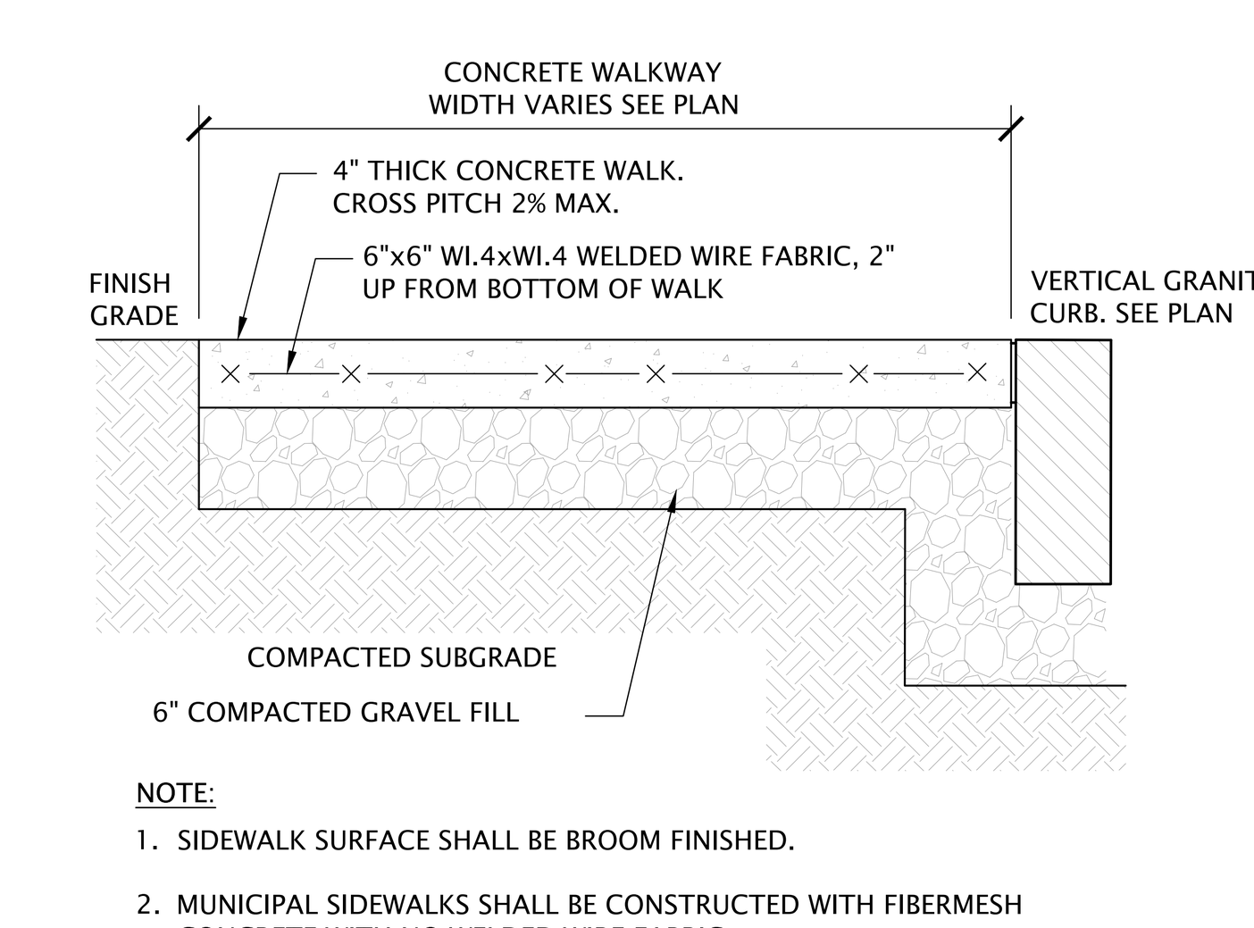
DETECTABLE WARNING PAVER TYPE
NOT TO SCALE



NOTE:
FOR WALL MOUNTED SIGNS, FASTEN SIGN(S) WITH LAG BOLTS (2 PER SIGN) TO BUILDING FACE

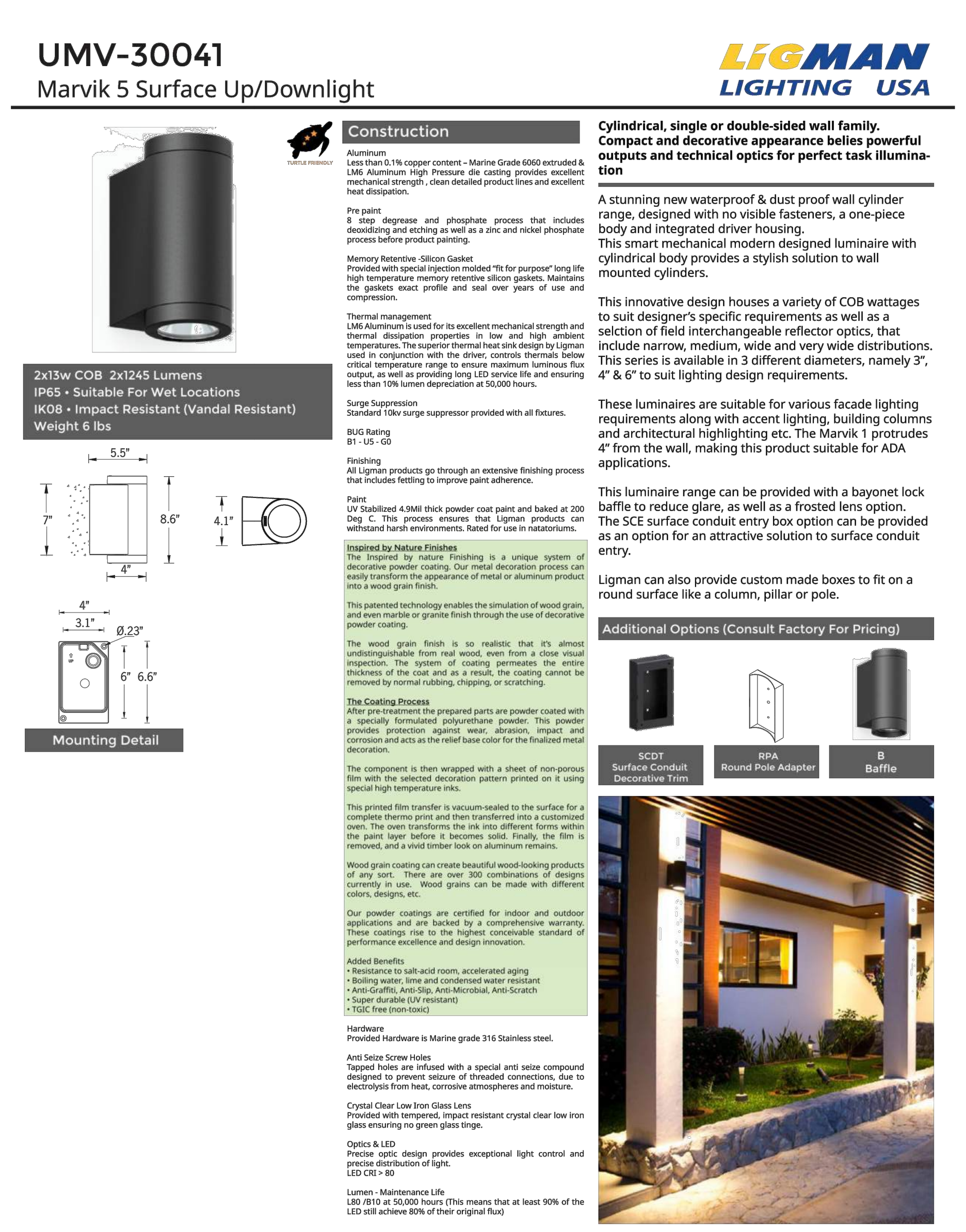
MHD REF. NO. R7-8

ADA HANDICAP PARKING SIGN
NOT TO SCALE

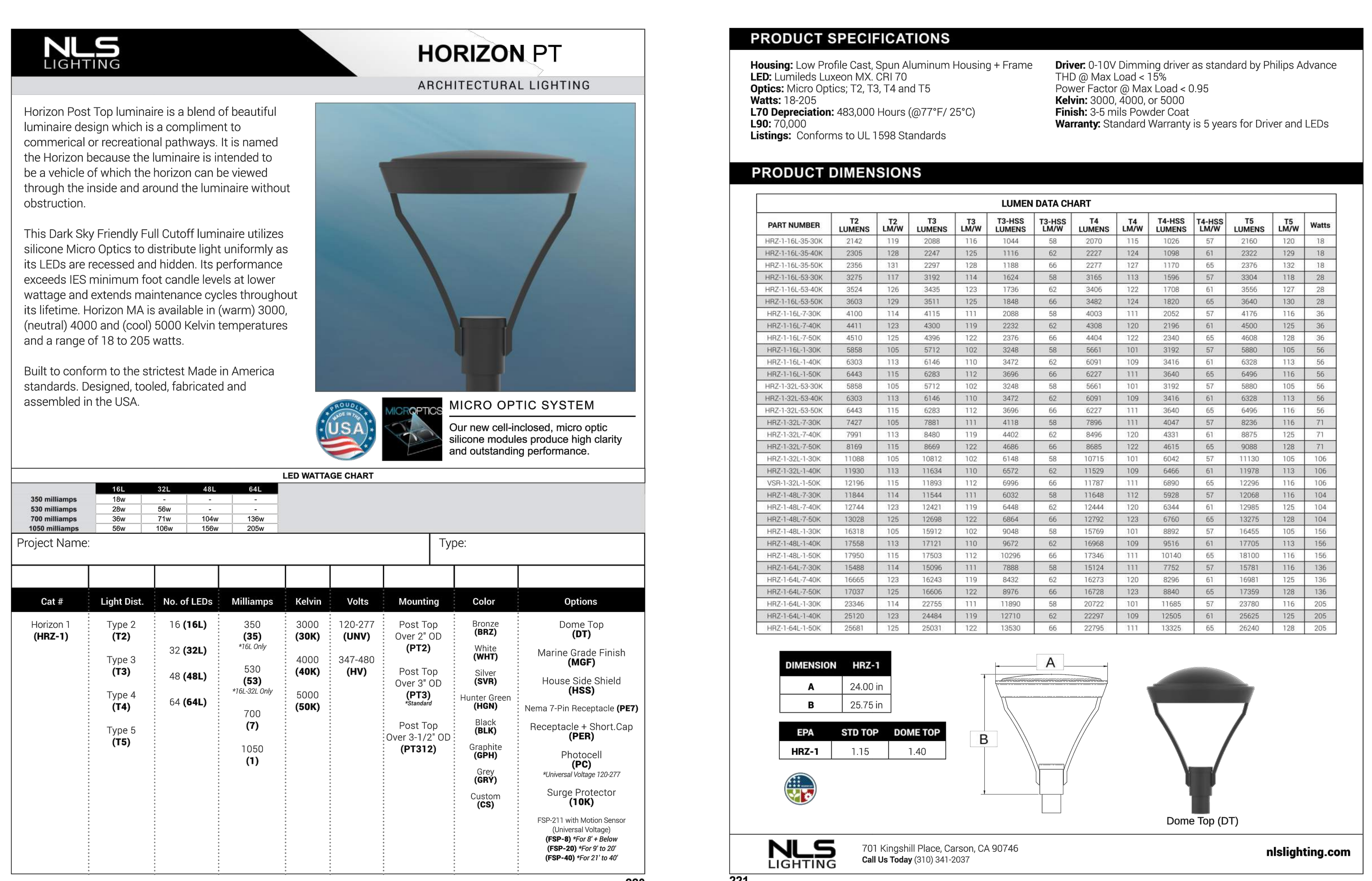


NOTE:
1. SIDEWALK SURFACE SHALL BE BROOM FINISHED.
2. MUNICIPAL SIDEWALKS SHALL BE CONSTRUCTED WITH FIBERMESH CONCRETE WITH NO WELDED WIRE FABRIC.

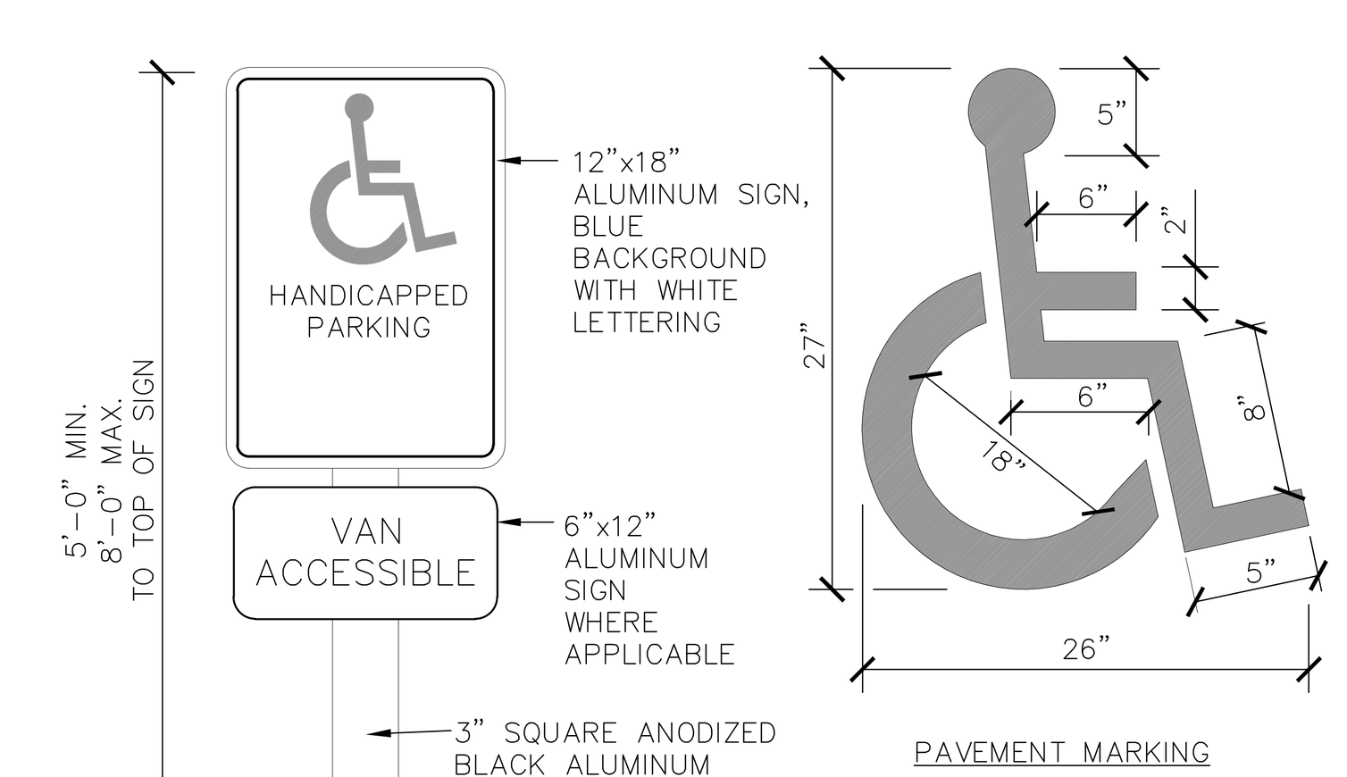
CONCRETE WALK WITH VERTICAL GRANITE CURB
NOT TO SCALE



LIGHTING TYPE I
NOT TO SCALE

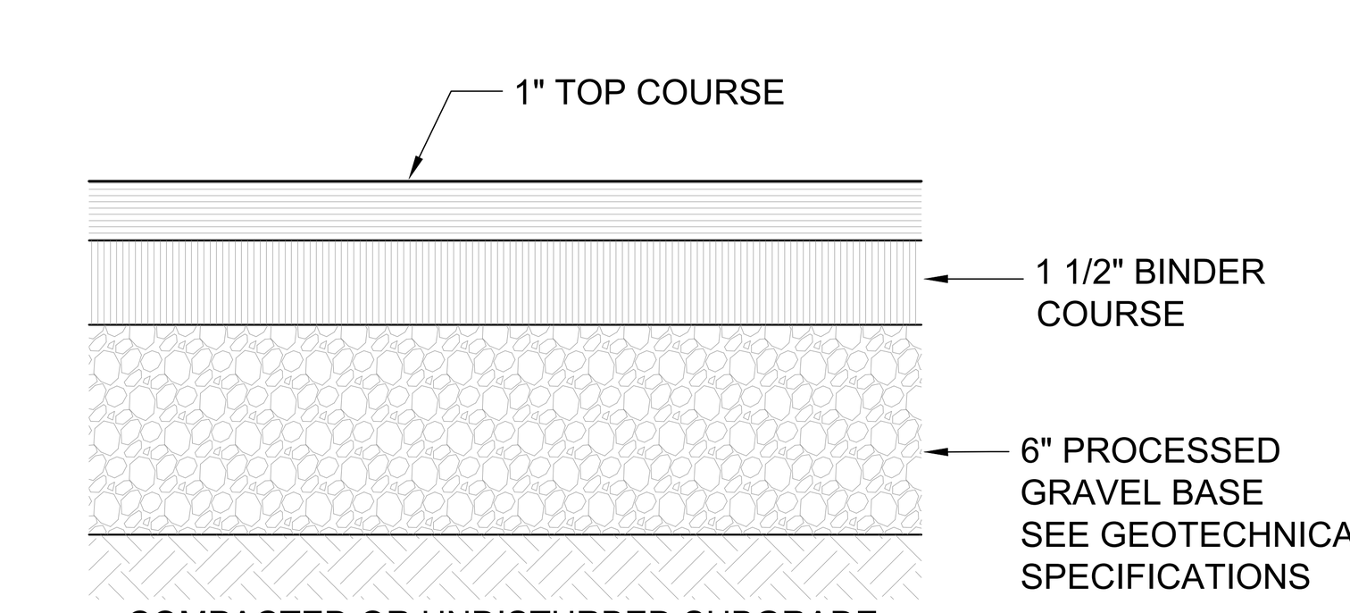


LIGHTING TYPE II
NOT TO SCALE



NOTE:
ALL HANDICAP PARKING AND SIGNAGE SHALL BE IN CONFORMANCE WITH THE RULES AND REGULATIONS OF THE AMERICANS WITH DISABILITIES ACT (ADA) AND THE MA ARCHITECTURAL ACCESS BOARD (AAB). SIGN(S) SHALL BE LOCATED SO THEY CANNOT BE OBSCURED BY A VEHICLE PARKED IN THE SPACE, AND LOCATED NOT MORE THAN 10 FEET FROM THE SPACE.

HANDICAP VAN SIGN AND PAVEMENT MARKING
NOT TO SCALE



BITUMINOUS CONCRETE PAVEMENT
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1 SPECIAL PERMIT PACKAGE			2022.03.30

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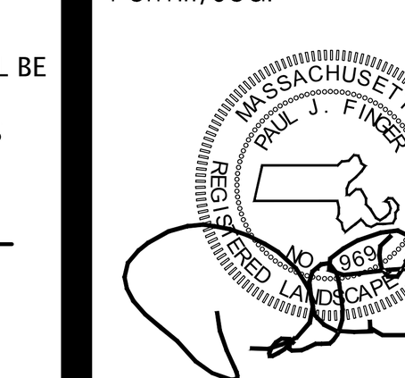


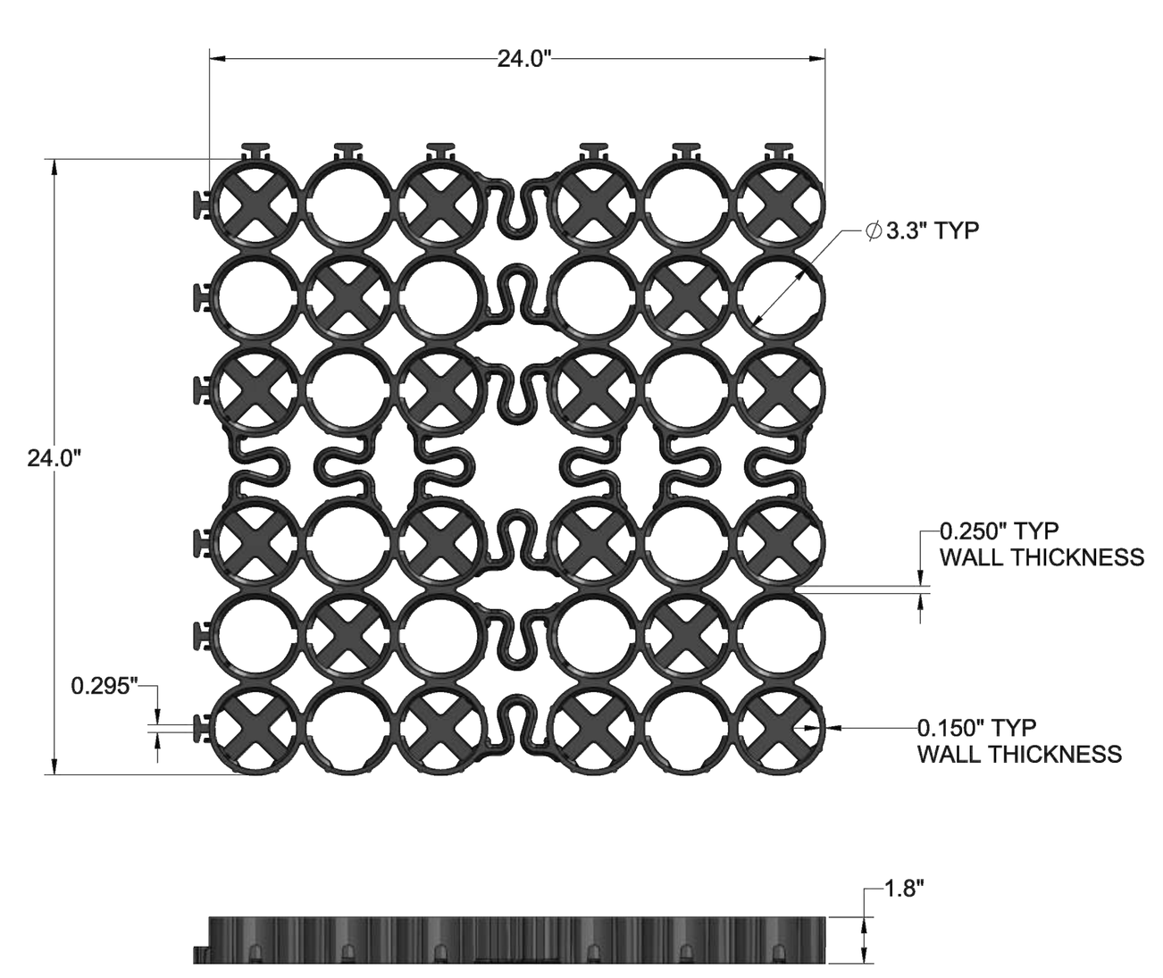
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343
File Name: SP-L-5.0-SITE DETAILS.dwg
Scale: As Specified

Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
SITE DETAILS #1

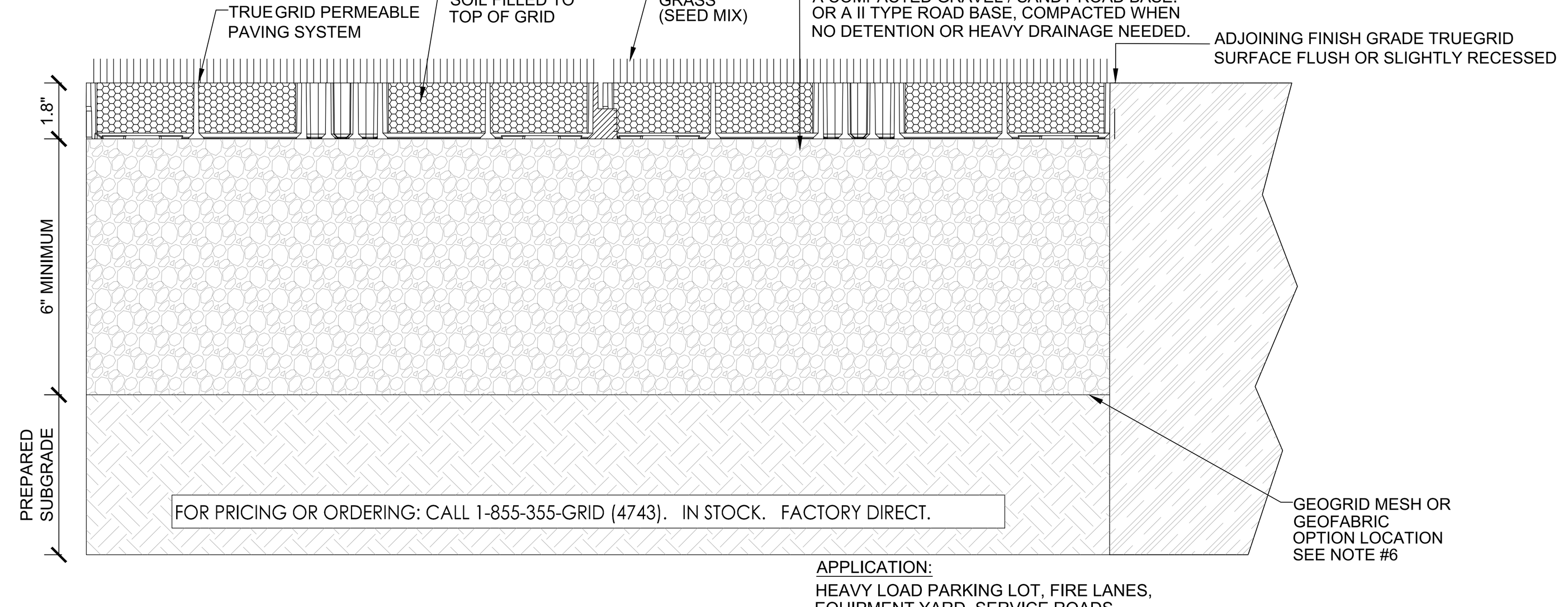
Revision:
Drawing No.
L-5.0



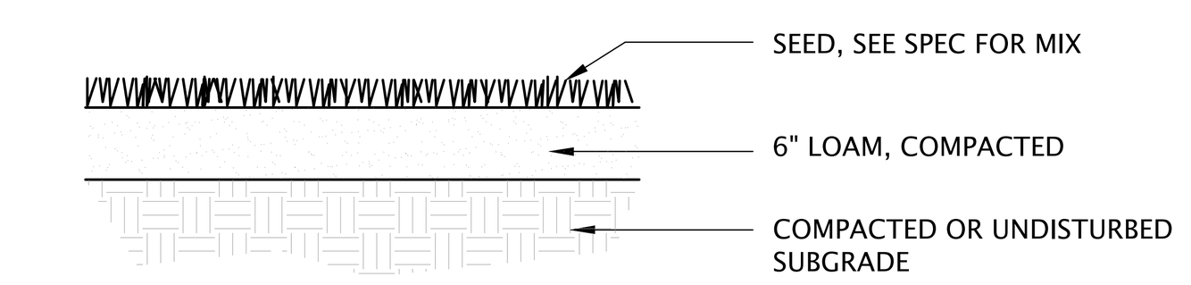
NOTES:

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.

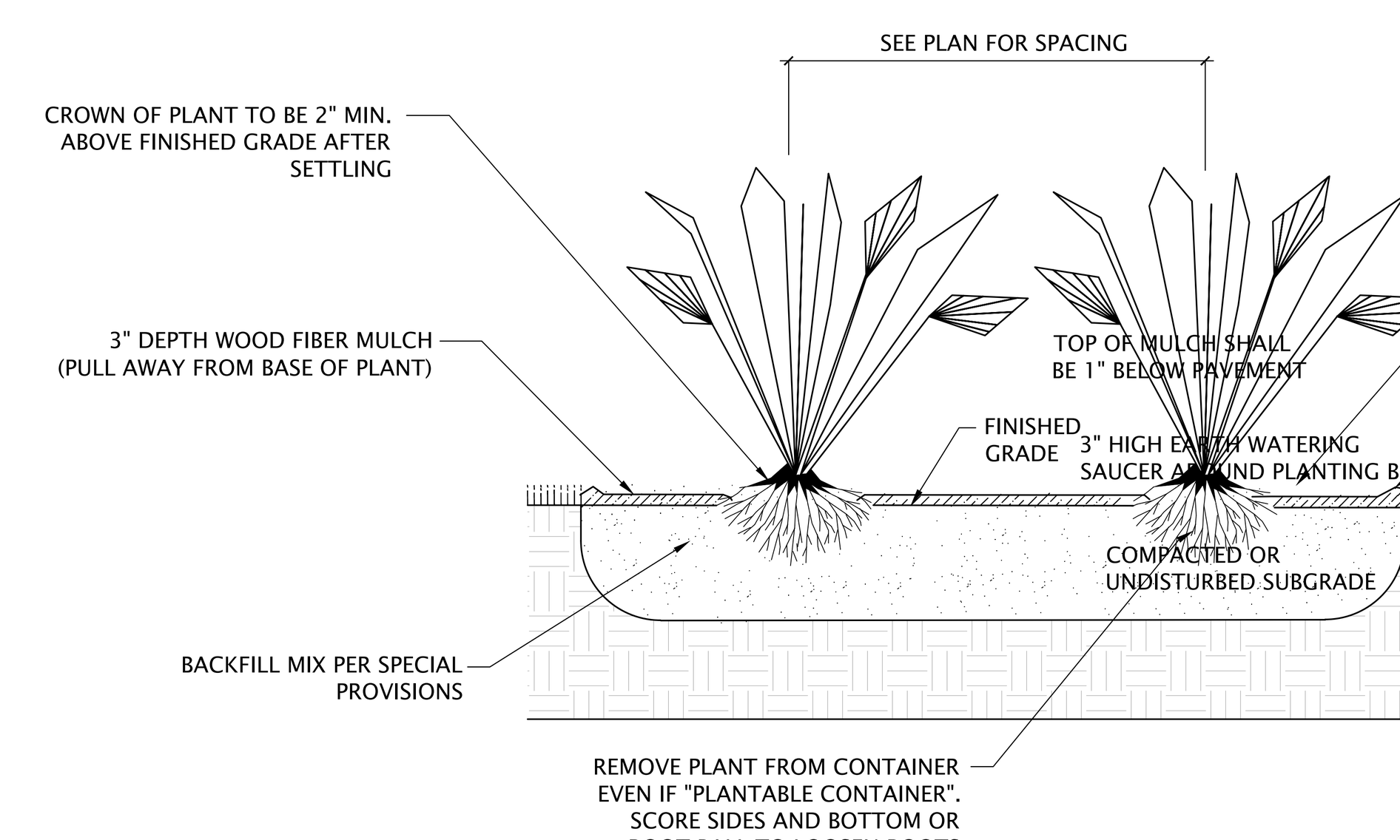
REINFORCED LAWN - PLAN VIEW



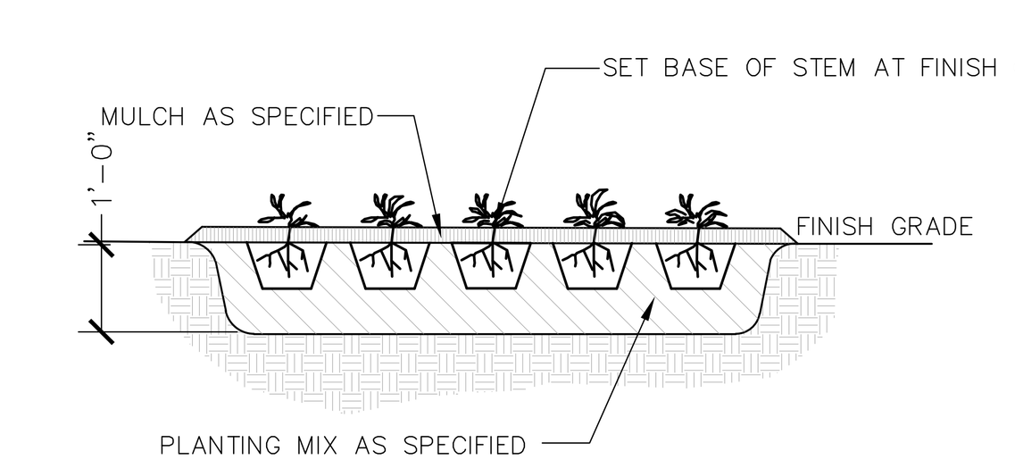
REINFORCED LAWN
NOT TO SCALE



TYPICAL SEEDED NO-MOW LAWN
NOT TO SCALE

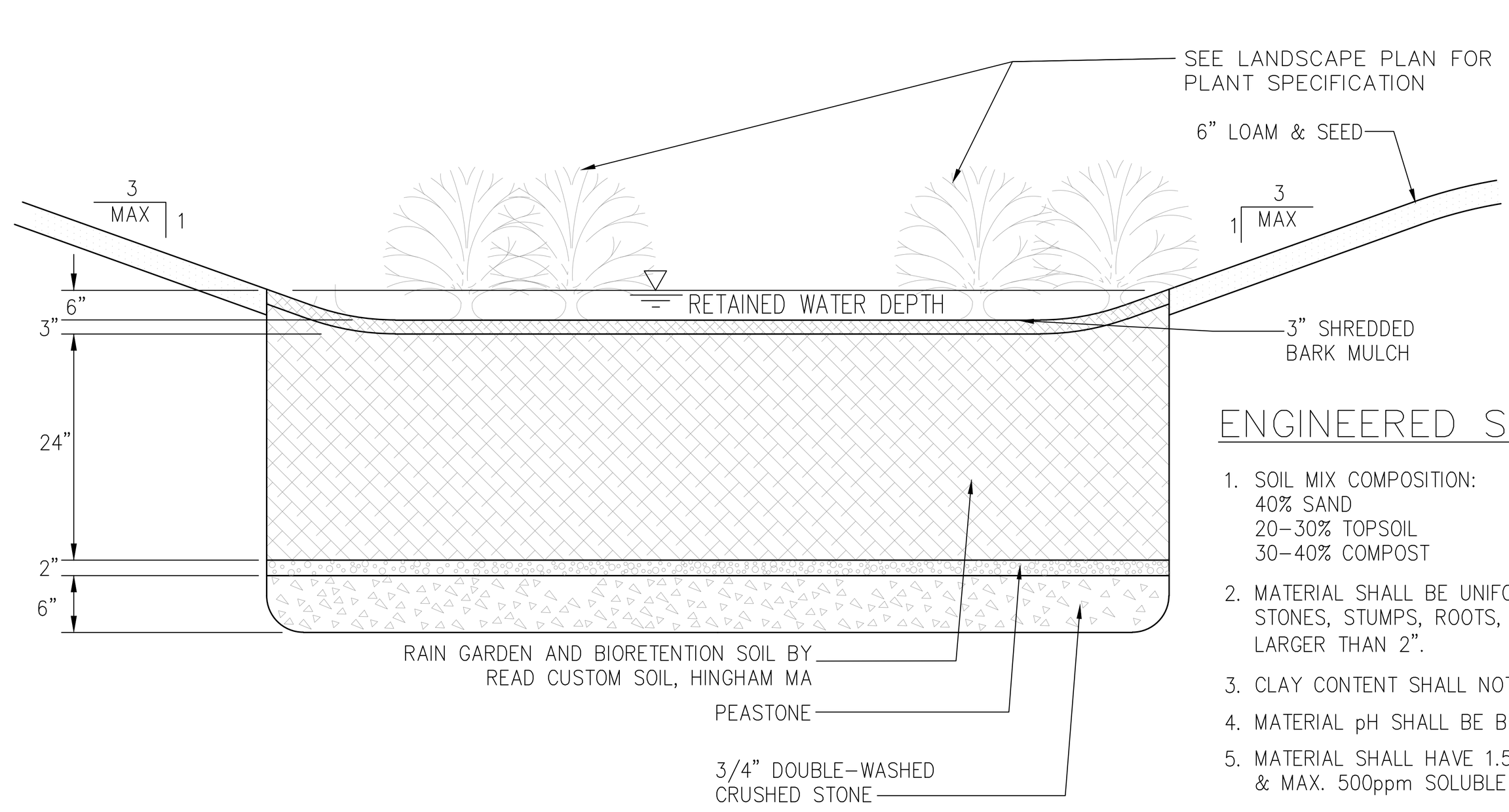


PERENNIAL PLANTING
NOT TO SCALE



NOTE:
ON SLOPES GREATER THAN 3:1, 1/2" JUTE MESH SHALL BE PEGGED (24" ON CENTER) OVER BED PRIOR TO PLANTING.
SPACE PLANTS AS INDICATED ON DRAWINGS

GROUND COVER PLANTING
NOT TO SCALE



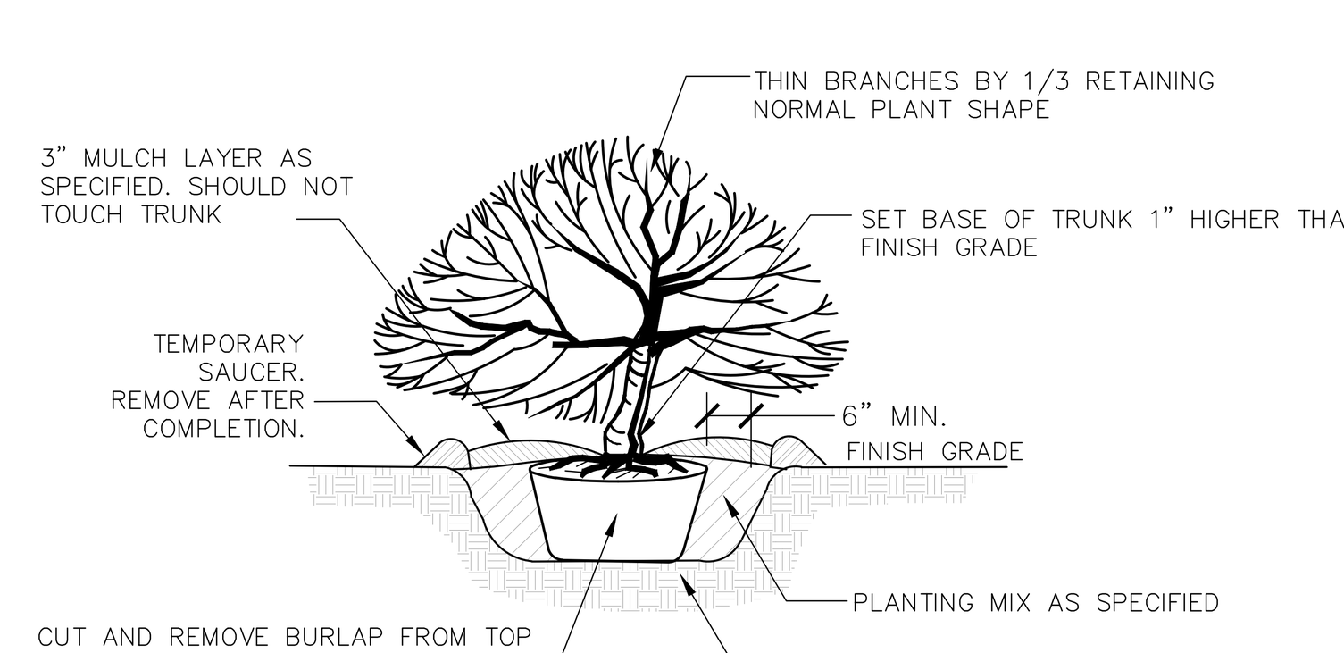
ENGINEERED SOIL MIX SPECIFICATIONS

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

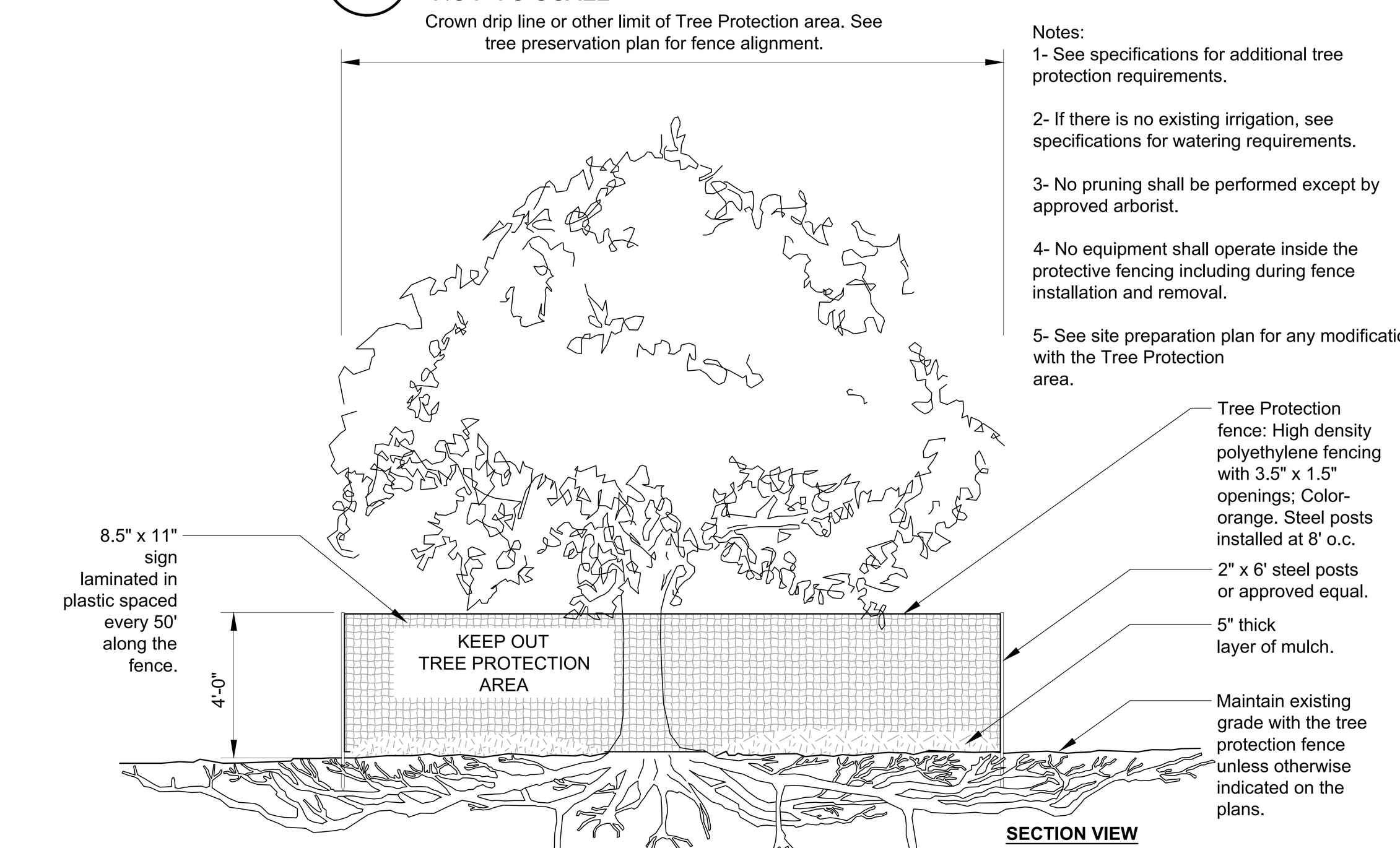
7. TOPSOIL SHALL BE A SANDY LOAM, LOAMY SAND, OR LOAM.
8. COMPOST SHALL BE PROCESSED FROM YARD WASTE IN ACCORDANCE WITH DEP GUIDELINES AND SHALL NOT CONTAIN BIO–SOLIDS.

RAIN GARDEN
NOT TO SCALE



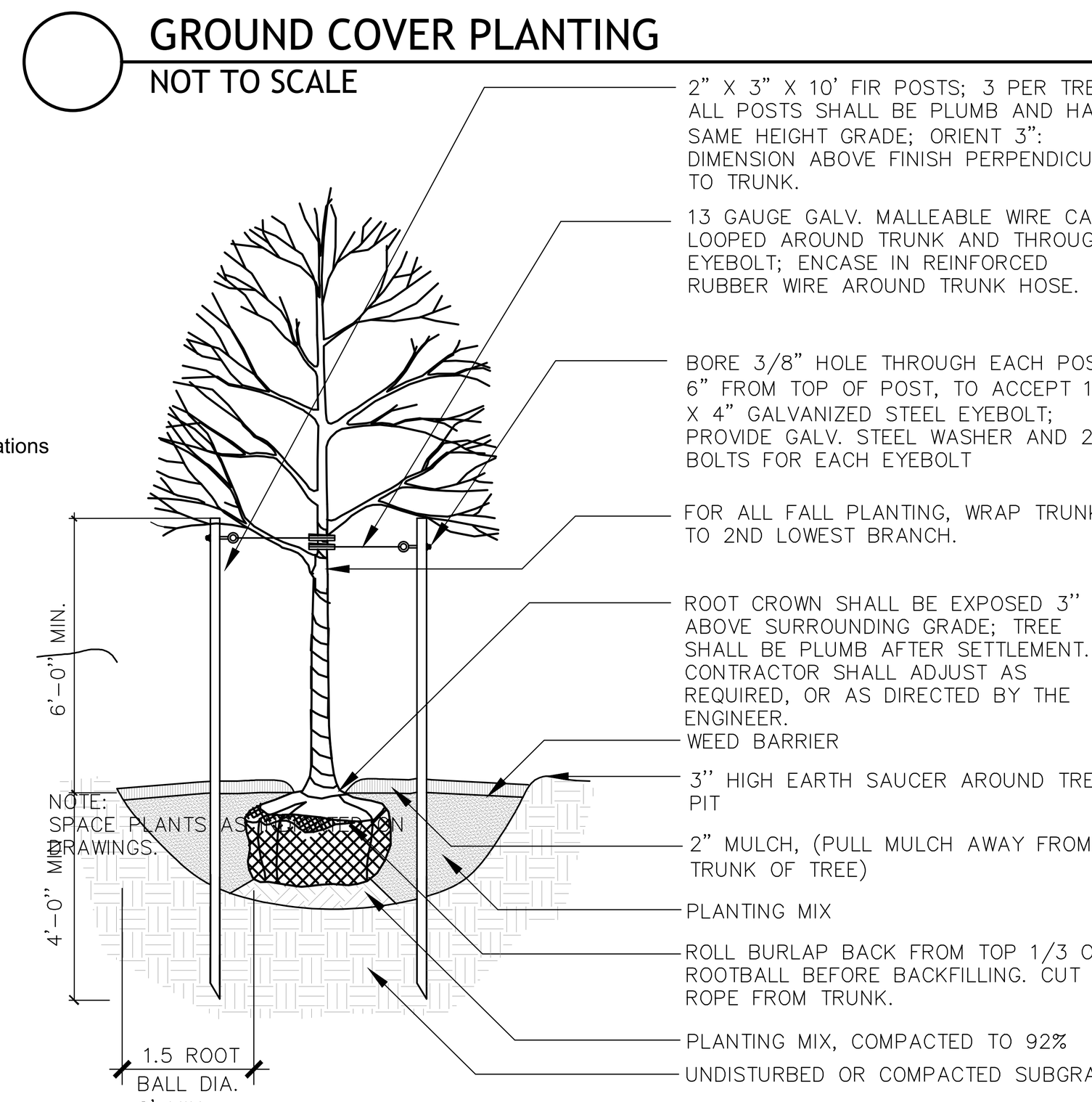
SHRUB PLANTING
NOT TO SCALE

Crown drip line or other limit of Tree Protection area. See tree preservation plan for fence alignment.



Notes:
1- See specifications for additional tree protection requirements.
2- If there is no existing irrigation, see specifications for watering requirements.
3- No pruning shall be performed except by approved arborist.
4- No equipment shall operate inside the protective fencing including during fence installation and removal.
5- See site preparation plan for any modifications with the Tree Protection area.

TREE PROTECTION
NOT TO SCALE



TYPICAL TREE PLANTING
NOT TO SCALE

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PAUL FINGER ASSOCIATES

Permit/Seal

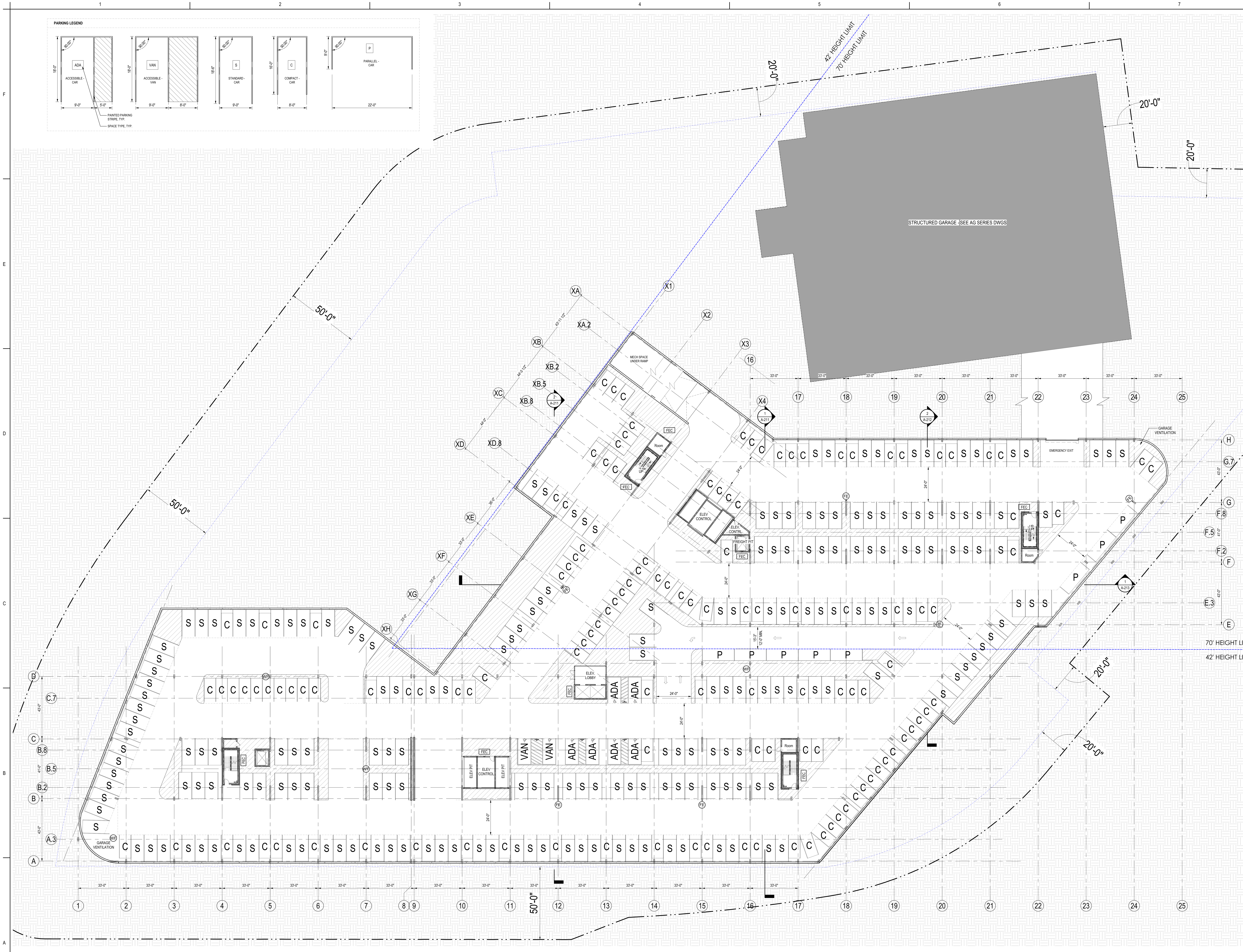
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343
File Name: SP-L-5.0-SITE DETAILS.dwg
Scale: As Specified

Dwn. Dsgn. Chkd. YYYY.MM.DD

Title
SITE
DETAILS #2

Revision:
Drawing No.
L-5.1



1 GARAGE LEVEL G1 PLAN
A-100G1
1" = 20'-0"

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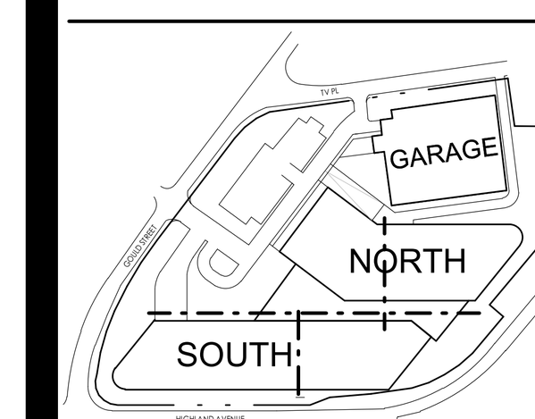


KEY PLAN

BUILDING BELOW GRADE PARKING

Type Comments	Count
LEVEL G1	
ACCESSIBLE	6
ACCESSIBLE VAN	2
COMPACT	127
PARALLEL	8
STANDARD	200
LEVEL G1: 343	343
GRAND TOTAL: 343	343

LEGEND

- WF — WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

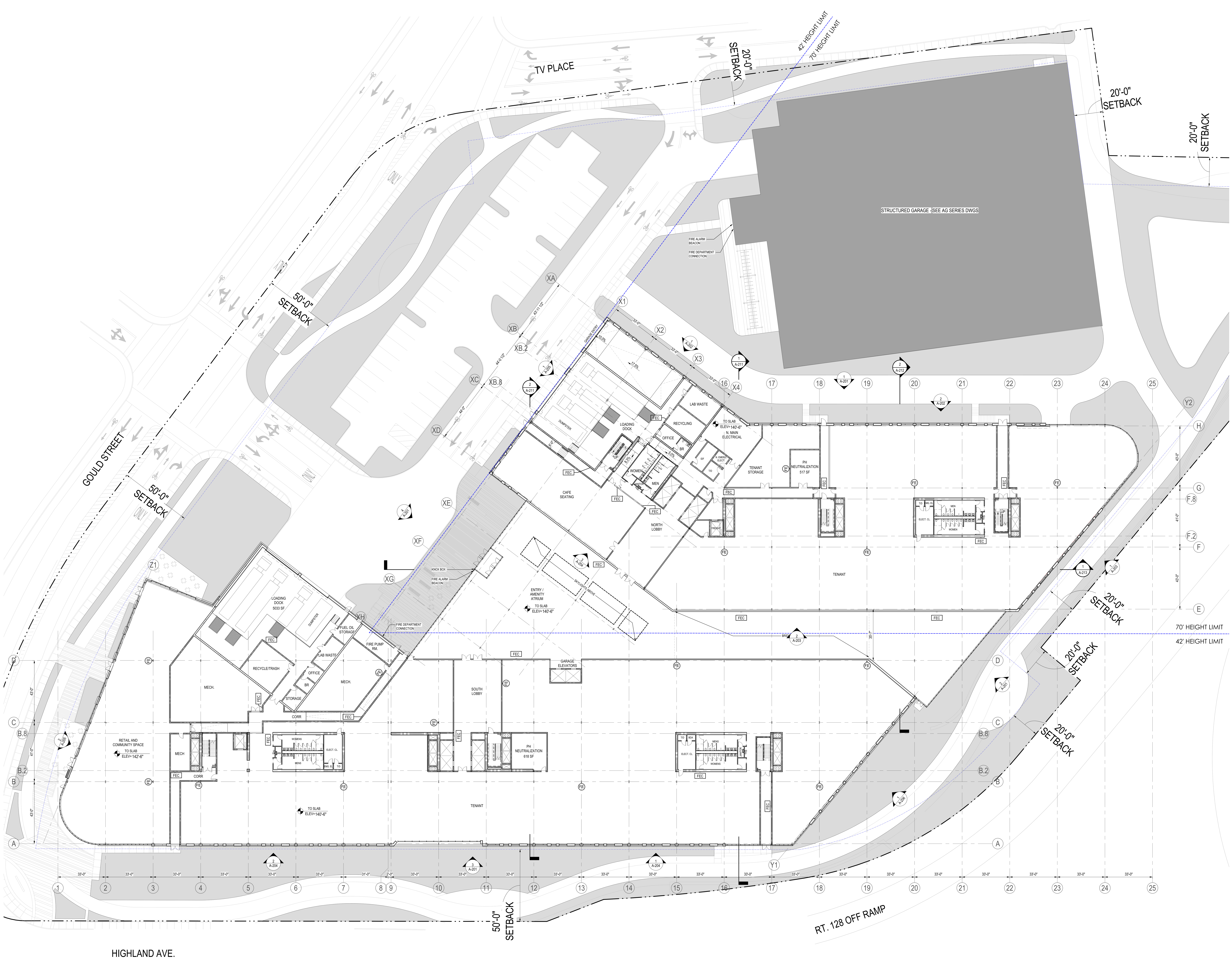
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL G1 - OVERALL PLAN

Revision:
Drawing No.
A-100G1



1
A-101

LEVEL 1 PLAN - ENTRY LEVEL

1" = 20'-0"

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Client/Project

Bulfinch

557 HIGHLAND AVE

NEEDHAM, MA 02494

Project No.: 218421343

Scale: As indicated

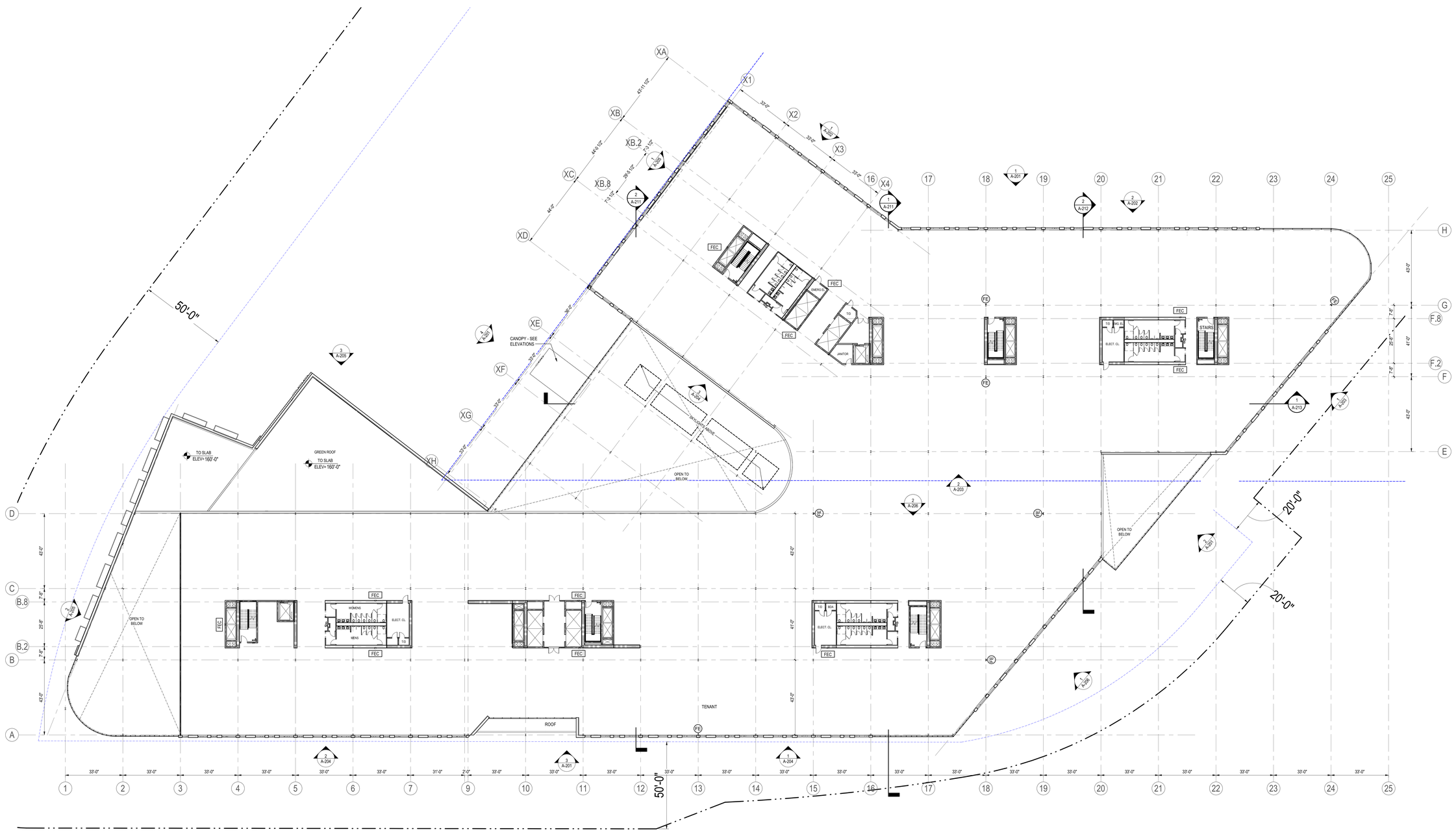
Title

LEVEL 1 - OVERALL PLAN

Revision:

Drawing No.

A-101



1 A-102 **LEVEL 2 PLAN - FULL PLAN**

1" = 20'-0"

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SPECIAL PERMIT PACKAGE			2022.03.30

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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
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343

File Name: N/A

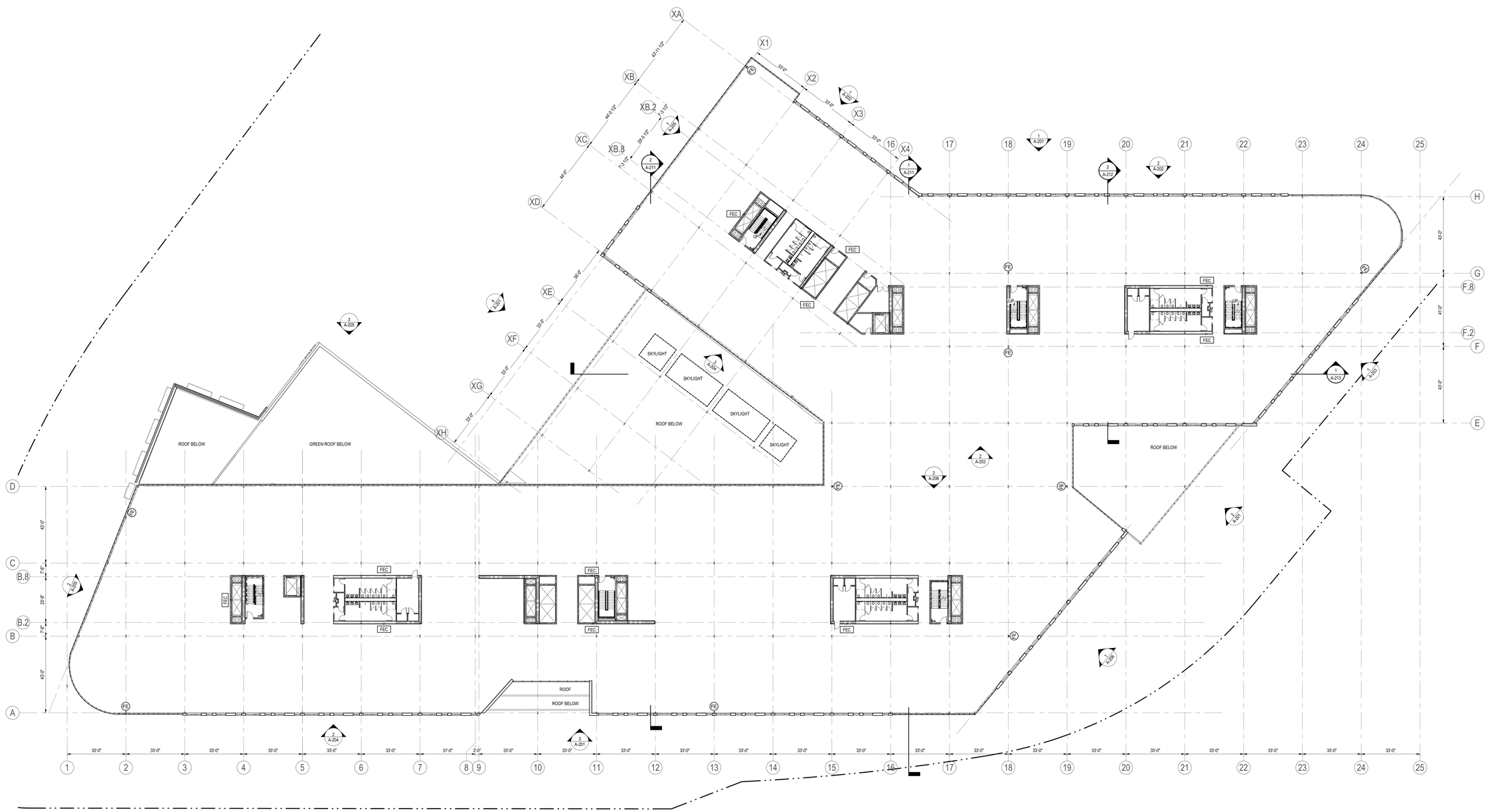
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEVEL 2 - OVERALL PLAN

Revision:

Drawing No.
A-102



1 A-103 **LEVEL 3 - FULL PLAN**
1" = 20'-0"

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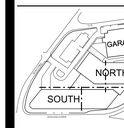


KEY PLAN

LEGEND

WF	WHEELED FIRE EXTINGUISHER
FE	FIRE EXTINGUISHER BRACKET WALL MTD
FEC	FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

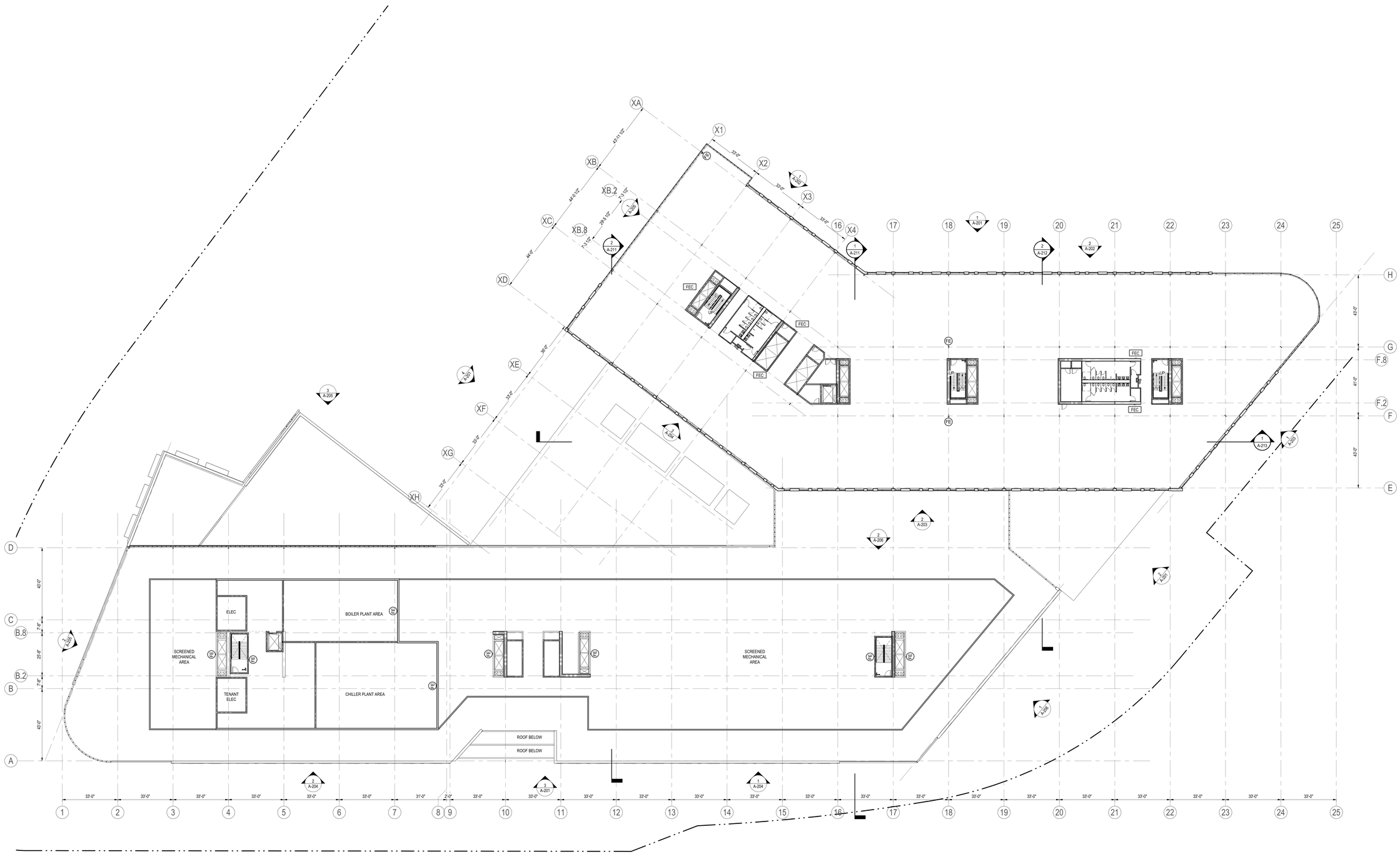
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEVEL 3 - OVERALL PLAN

Revision:
Drawing No.
A-103



1 LEVEL 4 - FULL PLAN
A-104 · 1" = 20'-0"

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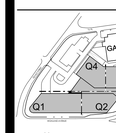
	By	Appd	YYYY.MM.DD
SPECIAL PERMIT/FACADE			2022.03.30

Permit/Seal



KEY PLAN

LEGEND
- WFE — 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
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEVEL 4 - OVERALL PLAN

Revision:

Drawing No.
A-104

*Plot Number in Project Information
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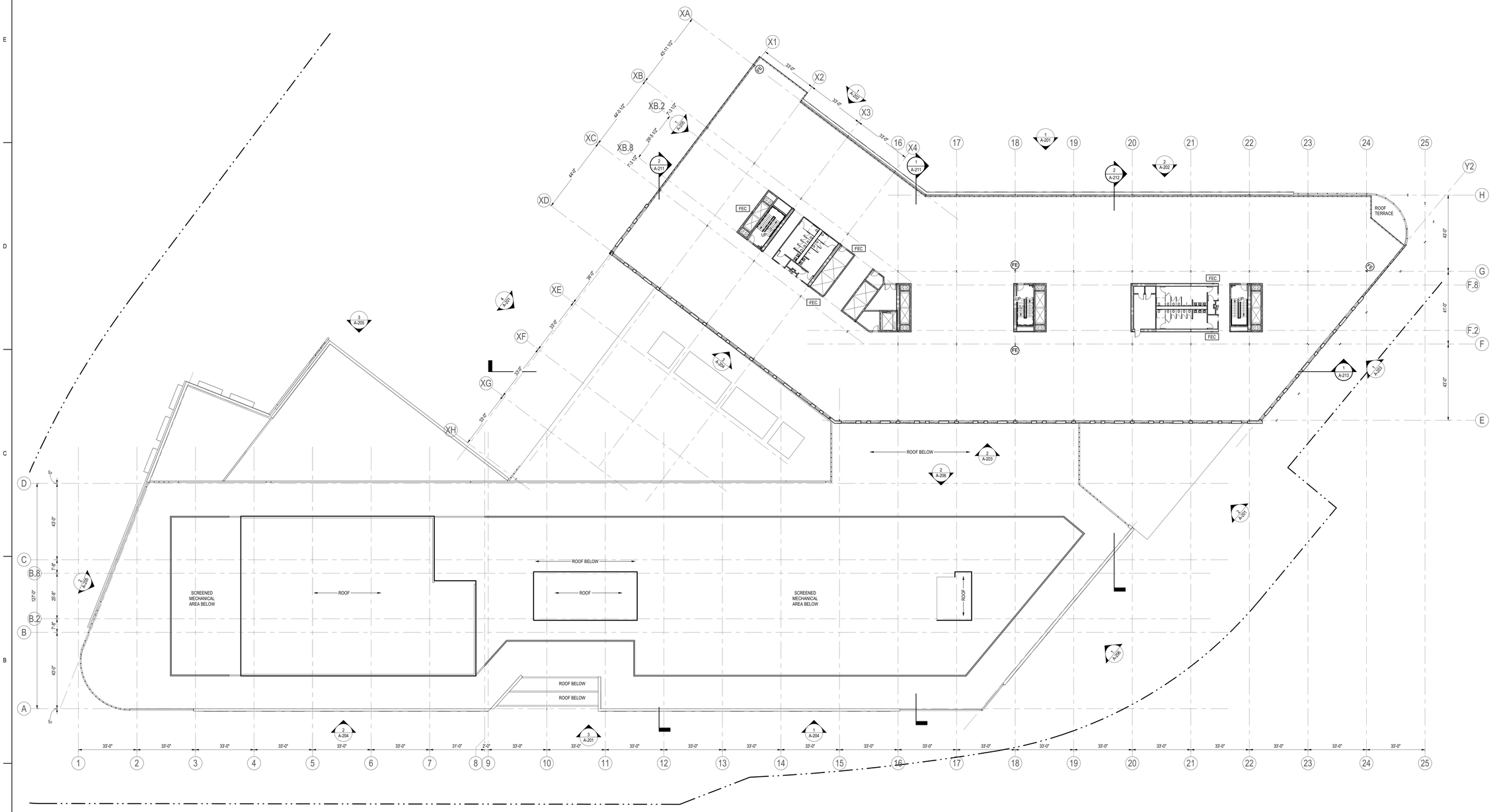
ORIGINAL SHEET - ARCH E



1 LEVEL 5 - FULL PLAN

A-105 1" = 20'-0"

ORIGINAL SHEET - ARCH E

<Plot Location or Project Information>
2/7/2022 4:54:03 PM

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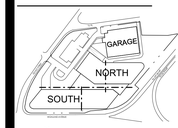


KEY PLAN

LEGEND

- WHEELED FIRE EXTINGUISHER
- FE — FIRE EXTINGUISHER BRACKET WALL MTD
- FEC — FIRE EXTINGUISHER CABINET WALL MTD

75'-0" MAX. DISTANCE PER CODE, TYP.

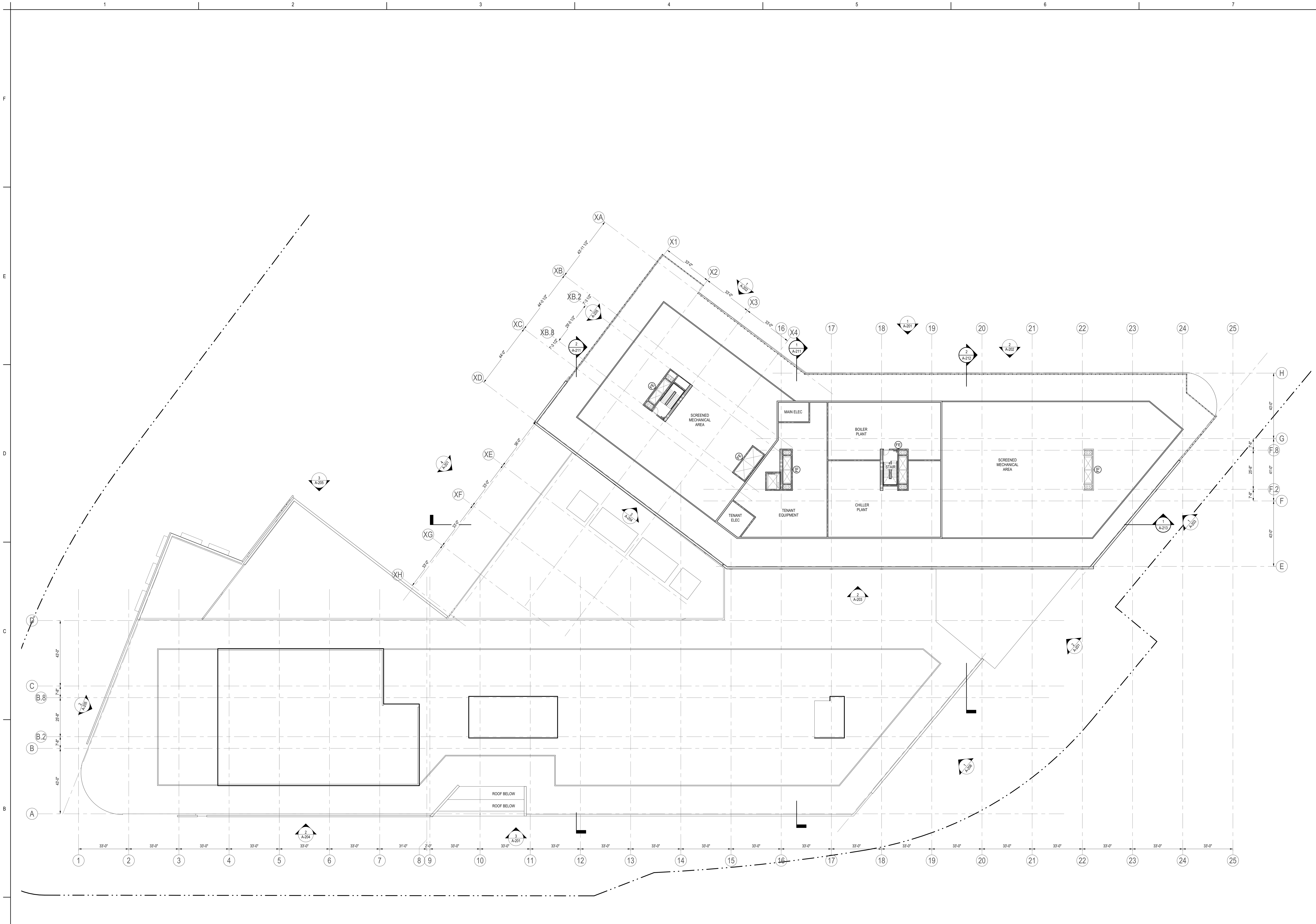
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEVEL 5 - OVERALL PLAN

Revision:
Drawing No.
A-105



1 A-106 **PENTHOUSE - NORTH**
1" = 20'-0"

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REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

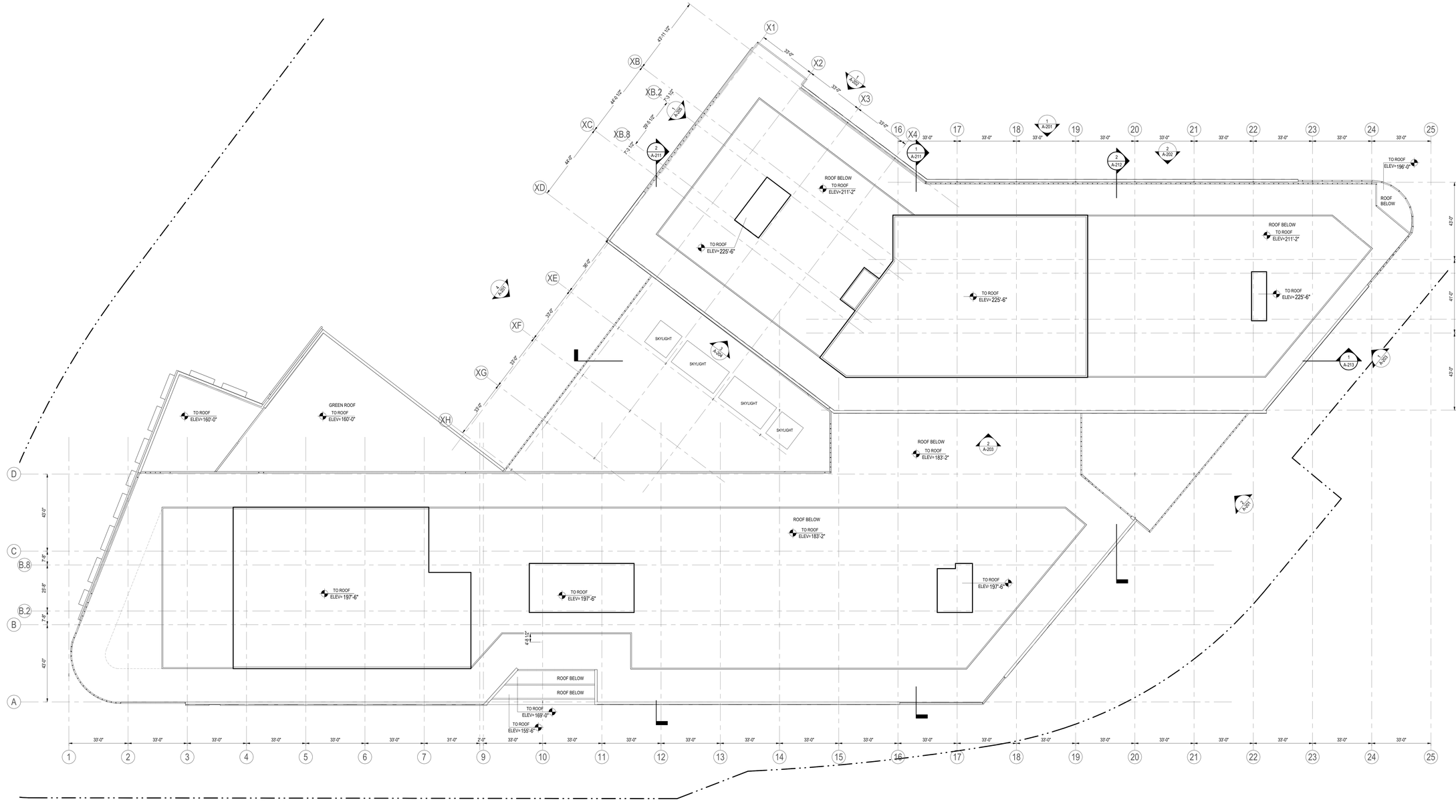
Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
LEVEL 6 - OVERALL PLAN

Revision:

Drawing No.
A-106



1 ROOF PLAN
A-107 — 1" = 20'-0"

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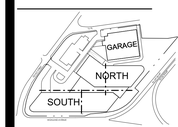
Permit/Seal



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
557 HIGHLAND AVE
NEEDHAM, MA 02494

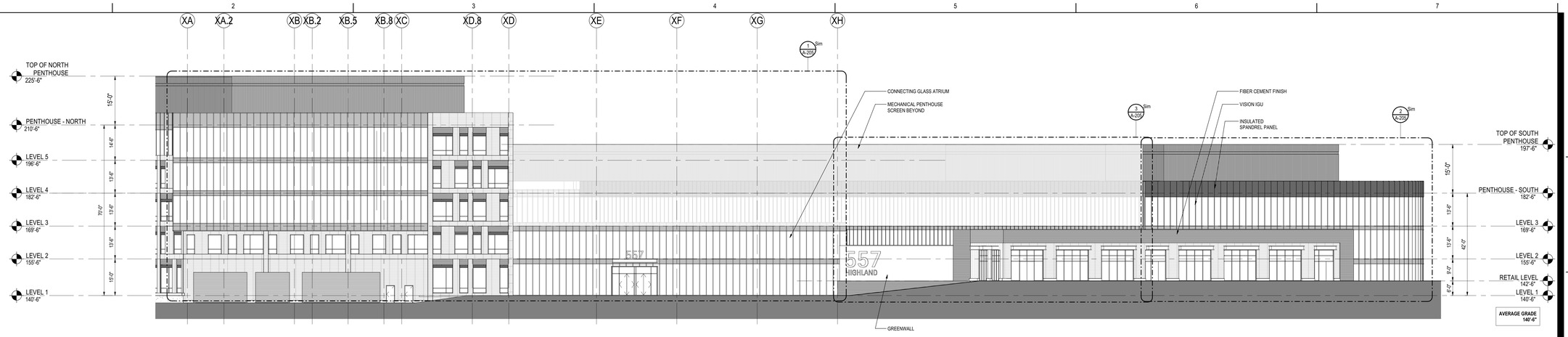
Project No.:218421343
File Name: N/A
Scale: As indicated

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

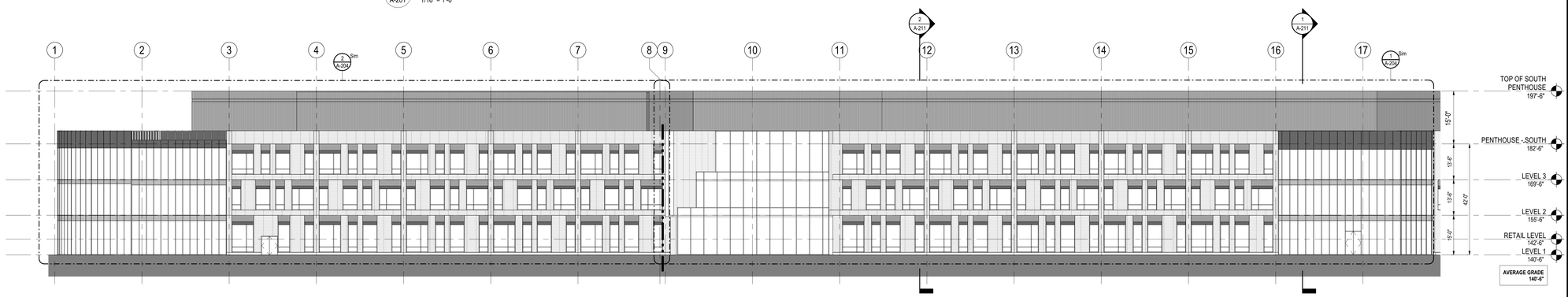
Title
ROOF PLAN

Revision:
Drawing No.
A-107

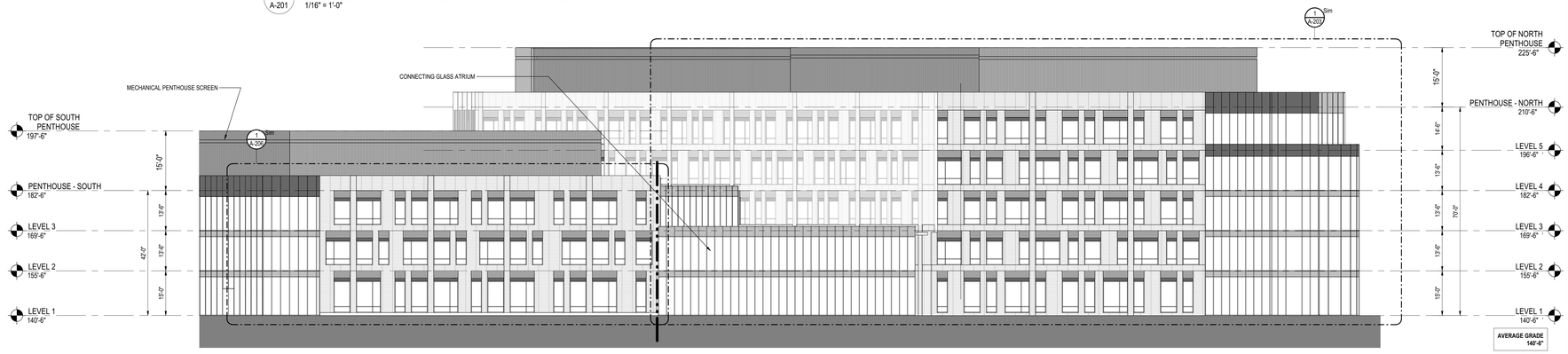
ORIGINAL SHEET - ARCH E



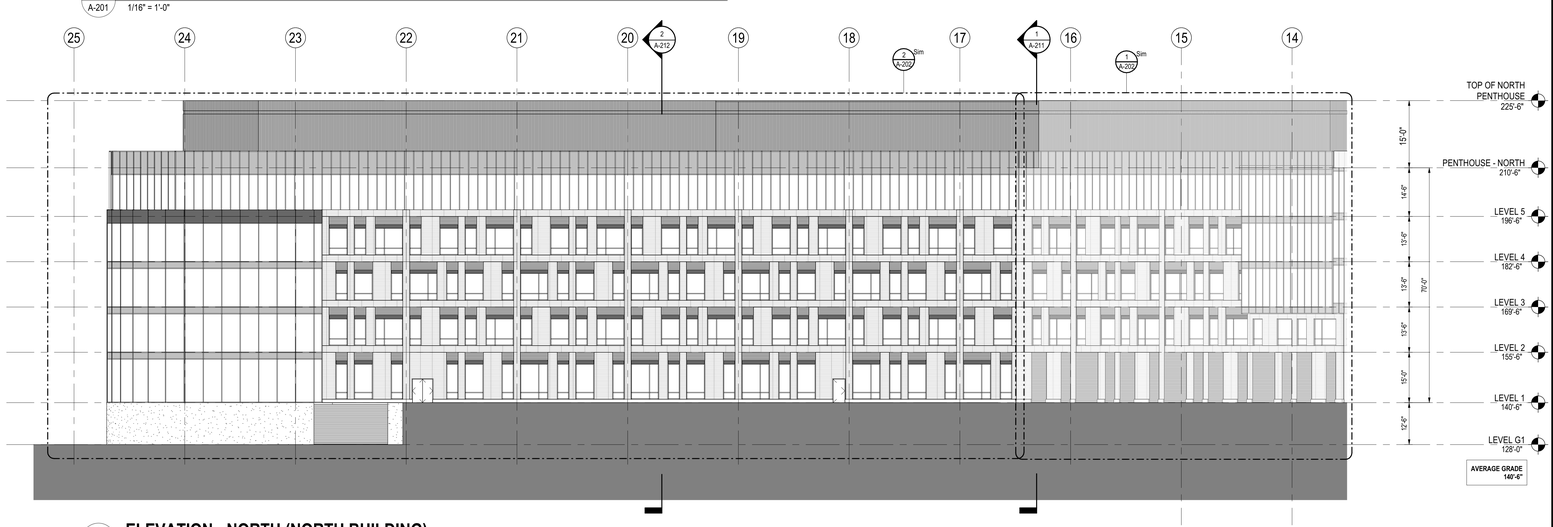
4 A-201 ELEVATION - WEST
1/16" = 1'-0"



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"

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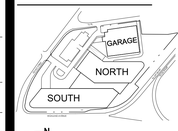


KEY PLAN

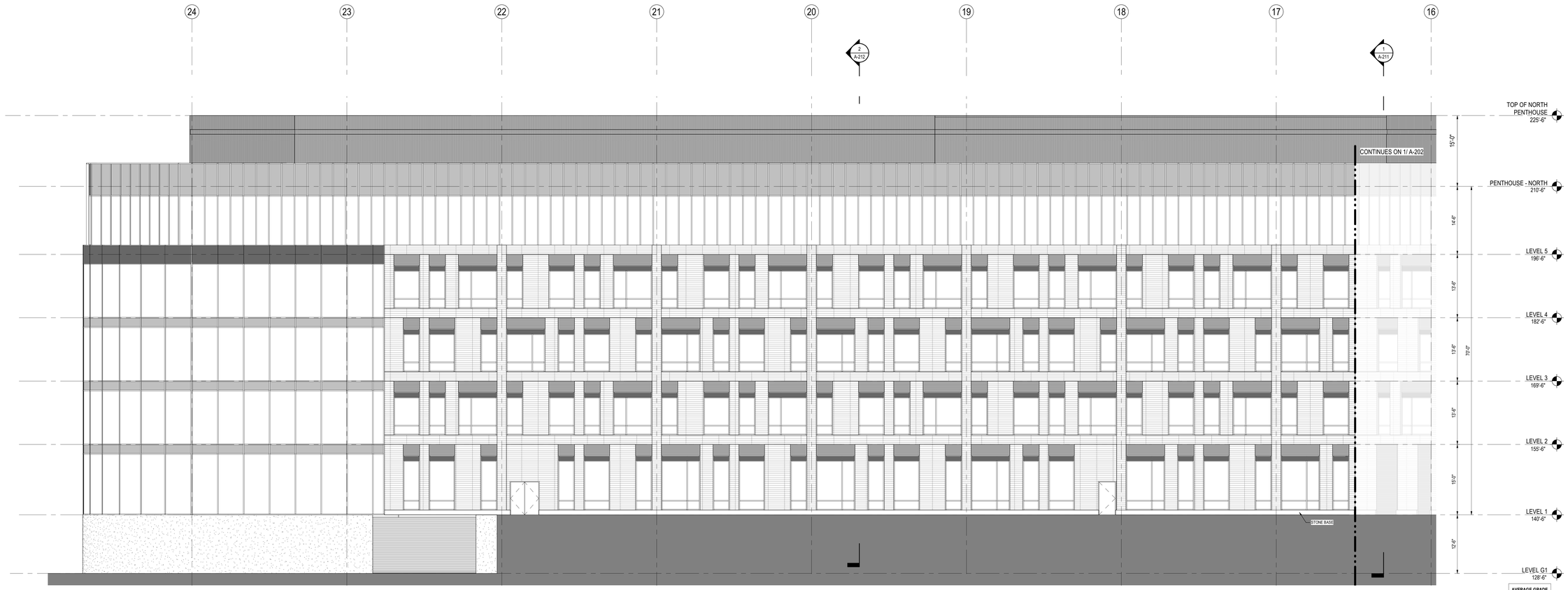
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/16" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - LOCATOR ELEVATIONS

Revision:
Drawing No.
A-201



2 A-202 ENLARGED ELEVATION - NORTH BUILDING - NORTH
1/8" = 1'-0"

1 A-202 ENLARGED ELEVATION - NORTH BUILDING - NORTH (ANGLED WALL)
1/8" = 1'-0"

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	Appvd	YYYY.MM.DD

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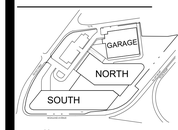


KEY PLAN

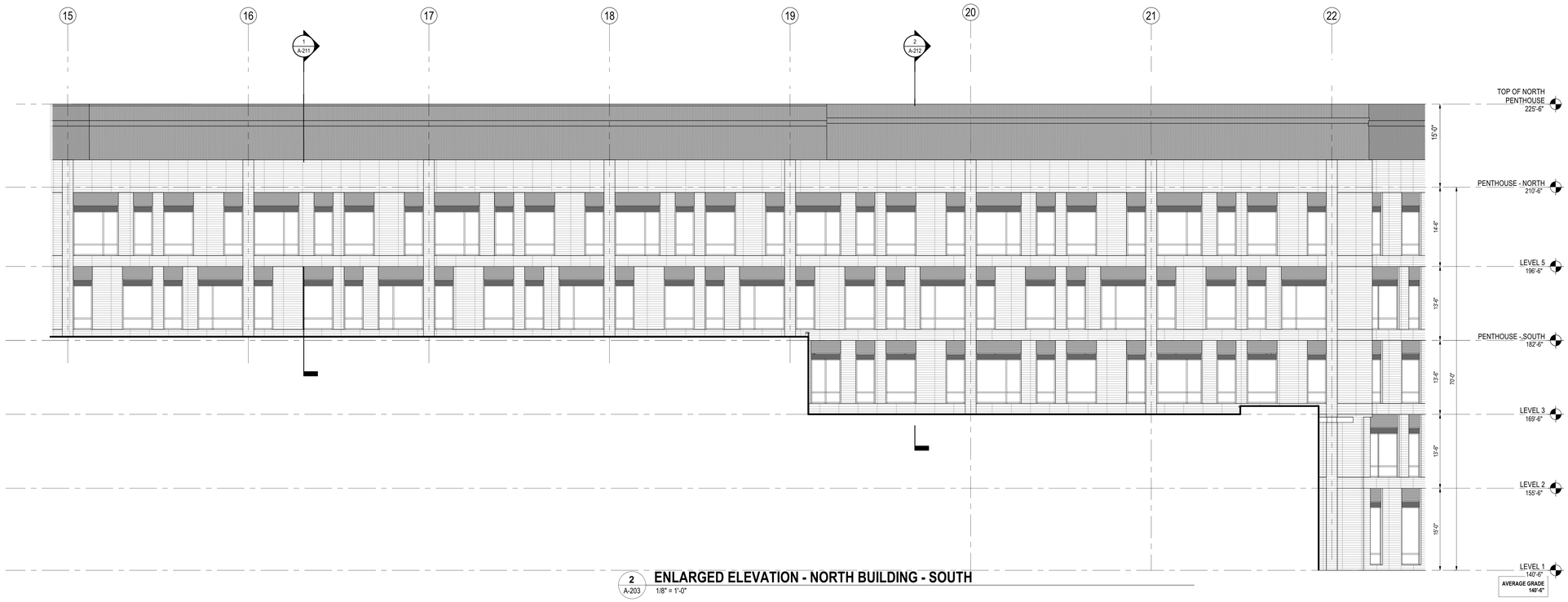
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG - NORTH

Revision:
Drawing No.
A-202



2 A-203 **ENLARGED ELEVATION - NORTH BUILDING - SOUTH**
1/8" = 1'-0"

1 A-203 **ENLARGED ELEVATION - NORTH BUILDING & ATRIUM - EAST**
1/8" = 1'-0"

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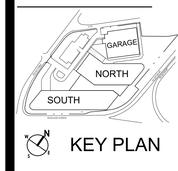
Consultant

Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT/FACADE			2022.03.30

Permit/Seal



KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

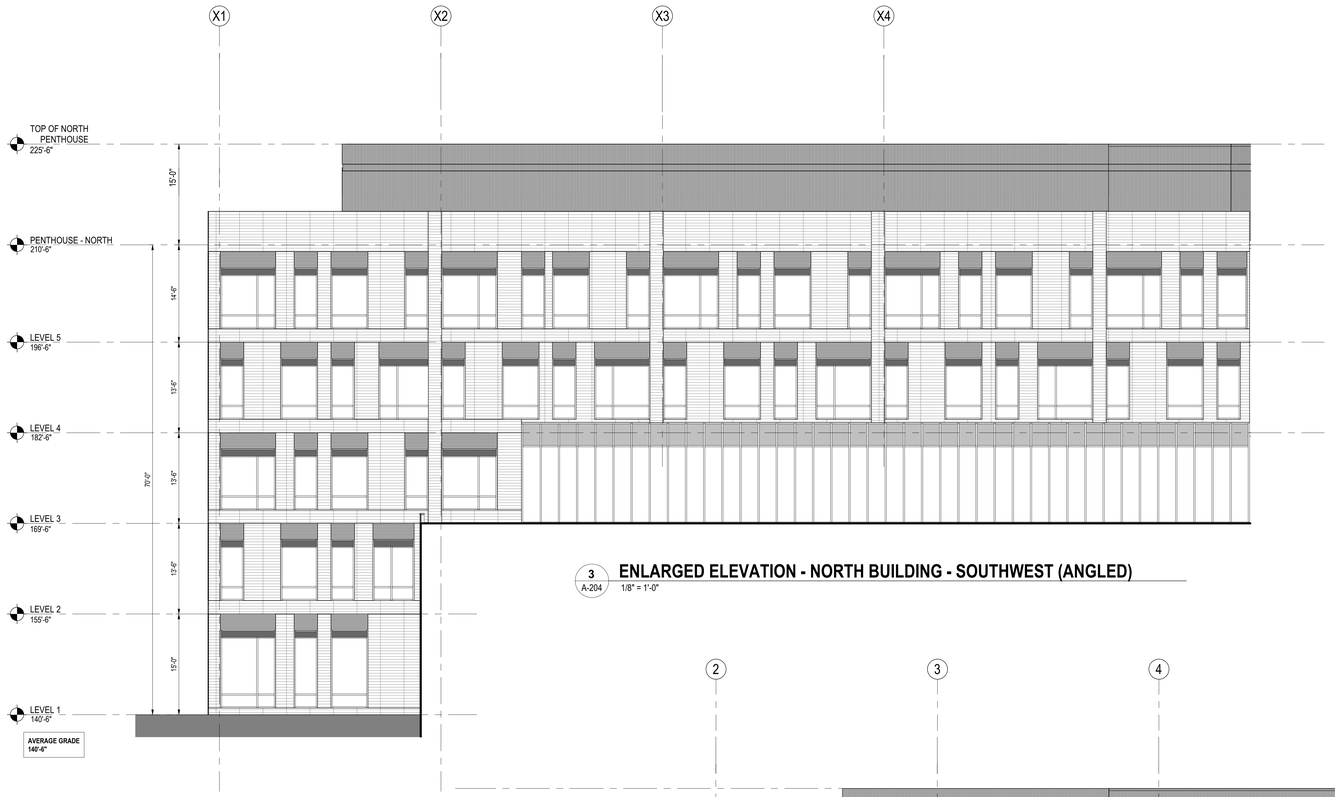
Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG - SOUTH & EAST

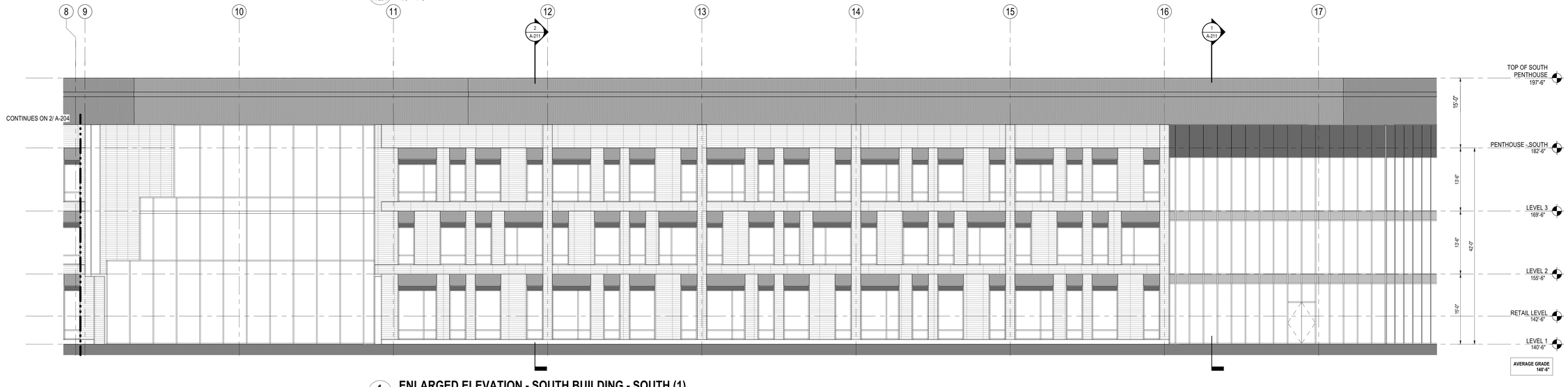
Revision:

Drawing No.
A-203



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"

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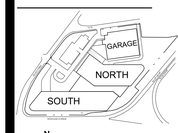
Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT/FACADE			2022.03.30

Permit/Seal

REGISTERED ARCHITECT BRYAN D. NEEDS No. 951652 BOSTON MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

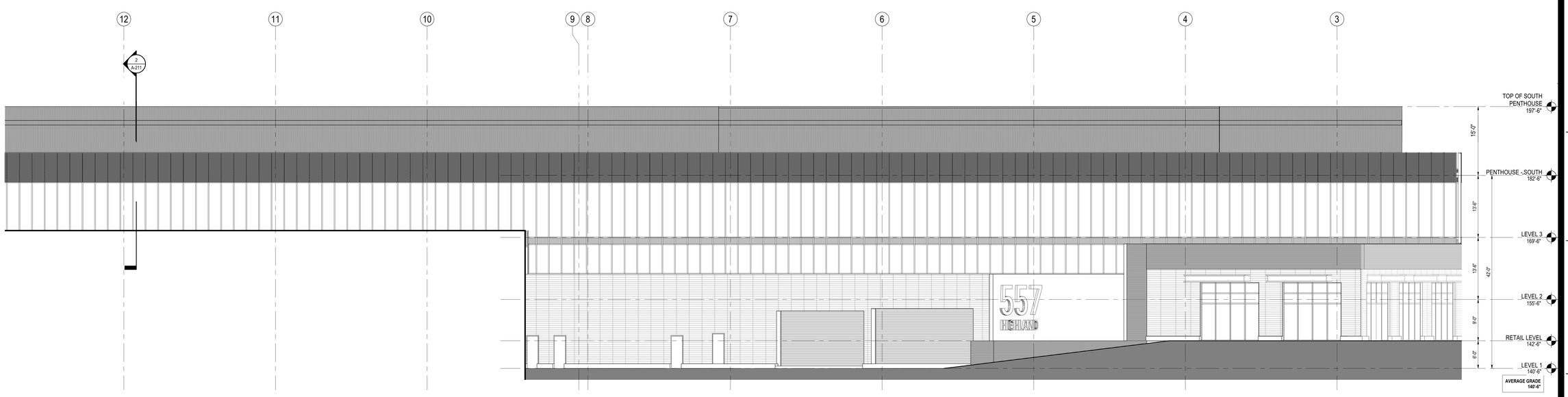
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

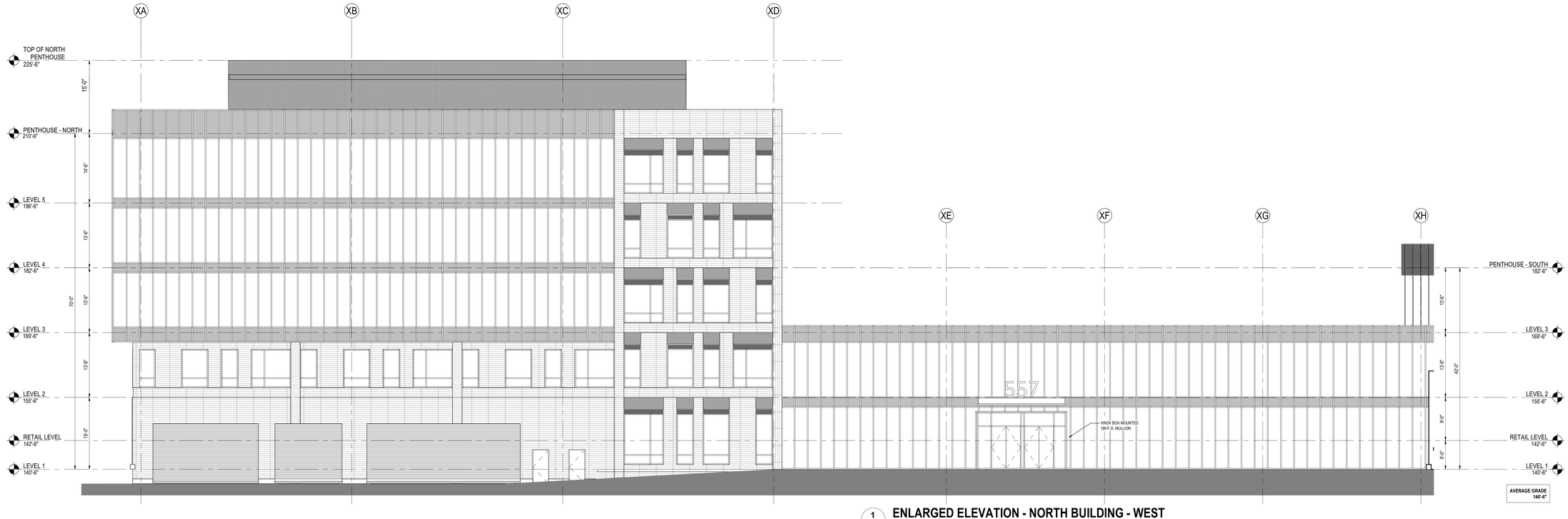
Title
BUILDING ELEV - NORTH BLDG (SOUTHWEST) & SOUTH BLDG (SOUTH)

Revision:
Drawing No.
A-204



3 A-205 **ENLARGED ELEVATION - SOUTH BUILDING - NORTH (1)**
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"

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No.	Issued/Revision	By	Appvd	YYYY.MM.DD
1	SPECIAL PERMIT PACKAGE			2022.03.30

Permit/Seal

KEY PLAN

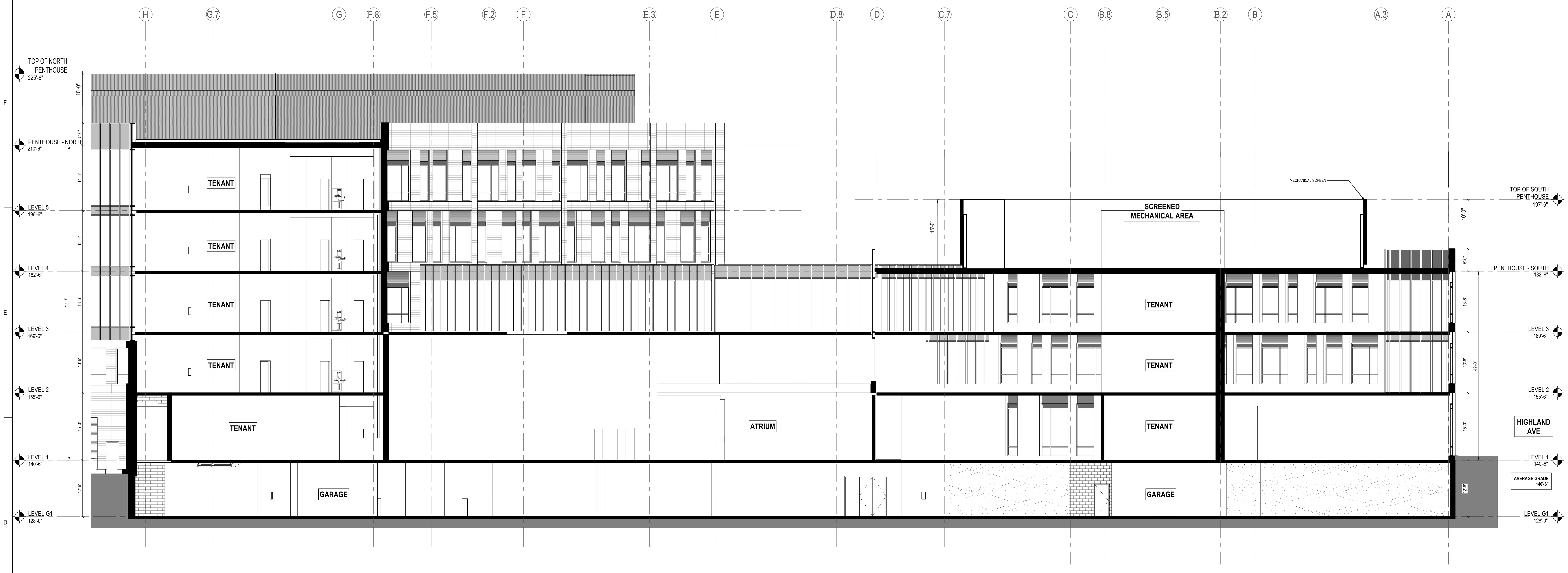
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

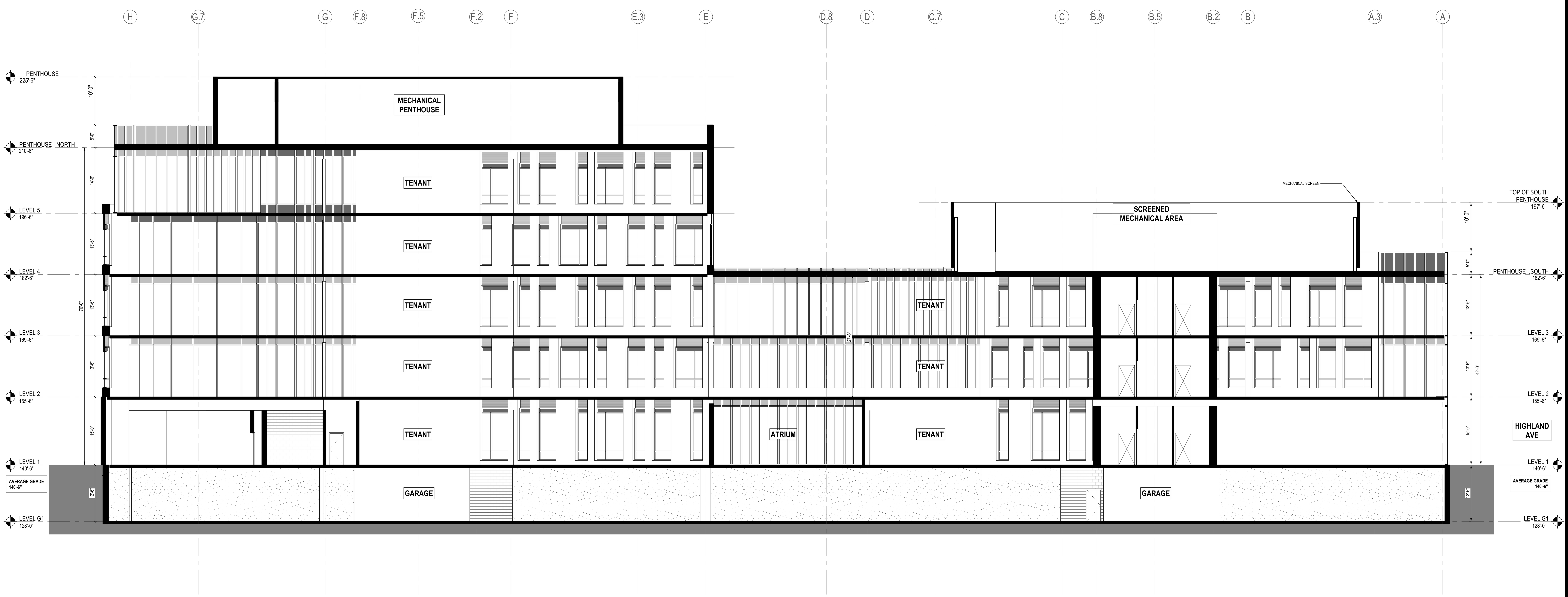
Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING ELEV - NORTH BLDG (WEST) & SOUTH BLDG (NORTH & WEST)

Revision:
Drawing No.
A-205



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"

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Issued/Revision

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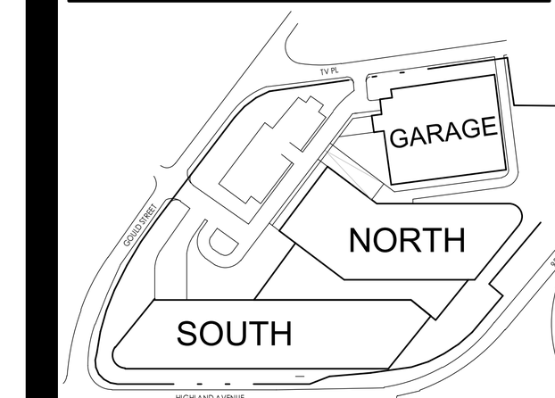

KEY PLAN

Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.: 218421343

Scale: 1/8" = 1'-0"

Title
BUILDING SECTIONS - OVERALL

Revision:

Drawing No.
A-211

2 A-212 **SECTION - NORTH BUILDING - SECTION N-S**
1/8" = 1'-0"

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Issued/Revision	By	Appd	YYYY.MM.DD
SPECIAL PERMIT FACADE			2022.03.30

Permit/Seal

KEY PLAN

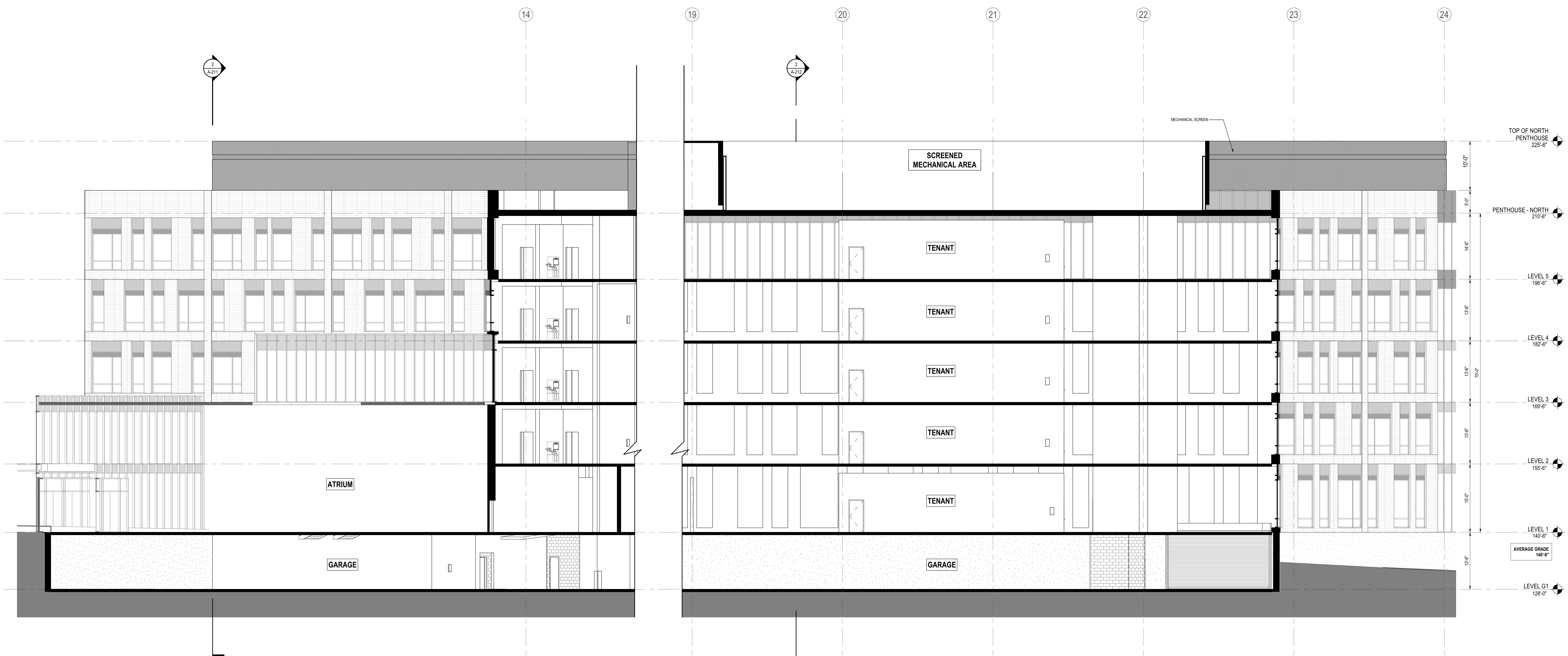
Client/Project
Bulfinch
557 HIGHLAND AVE
NEEDHAM, MA 02494

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
BUILDING SECTIONS - NORTH BLDG

Revision:
Drawing No.
A-212



1 A-213 **SECTION - NORTH BUILDING - SECTION E-W**

1/8" = 1'-0"

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KEY PLAN

GARAGE

NORTH

SOUTH

Client/Project

Bulfinch

557 HIGHLAND AVE

NEEDHAM, MA 02494

Project No.: 218421343

Scale: 1/8" = 1'-0"

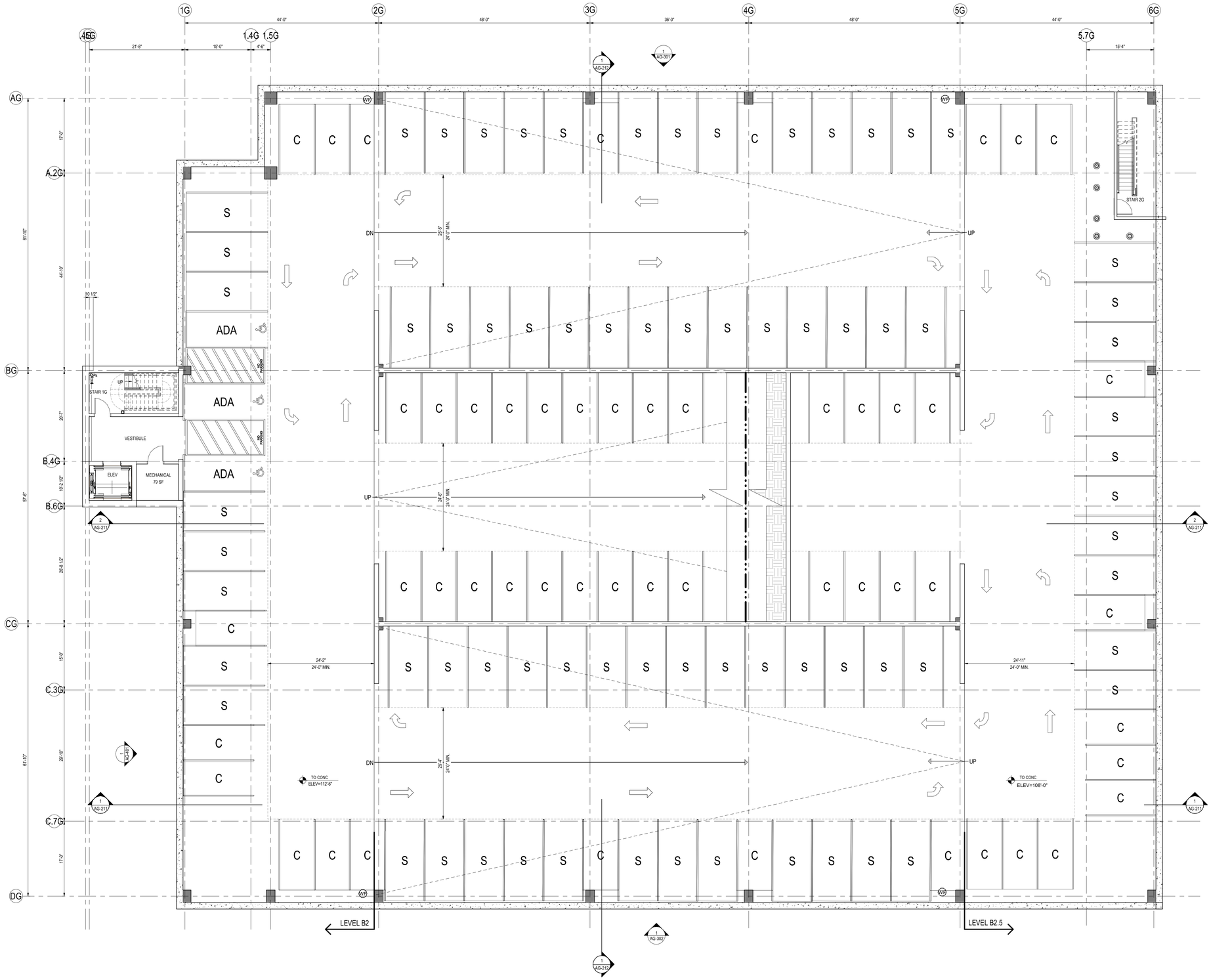
Title

BUILDING SECTIONS - NORTH BLDG

Revision:

Drawing No.

A-213



1 AG-100.B2 **GARAGE - LEVEL B2**

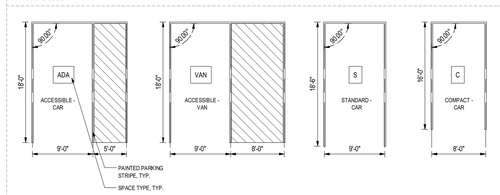
1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

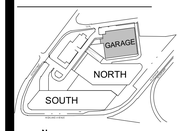
75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



GARAGE

KEY PLAN



GARAGE PARKING COUNT

PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

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No.	Issued/Revision	By	YYYY.MM.DD
1	PERMIT RESUBMISSION	Arpad	2022.03.30
0	CONCEPT DESIGN DRAFT	Arpad	2021.11.19

Permit/Seal

Client/Project
Bulfinch 557 Highland Ave HIGHLAND GARAGE

Project No.:218421343

File Name: N/A

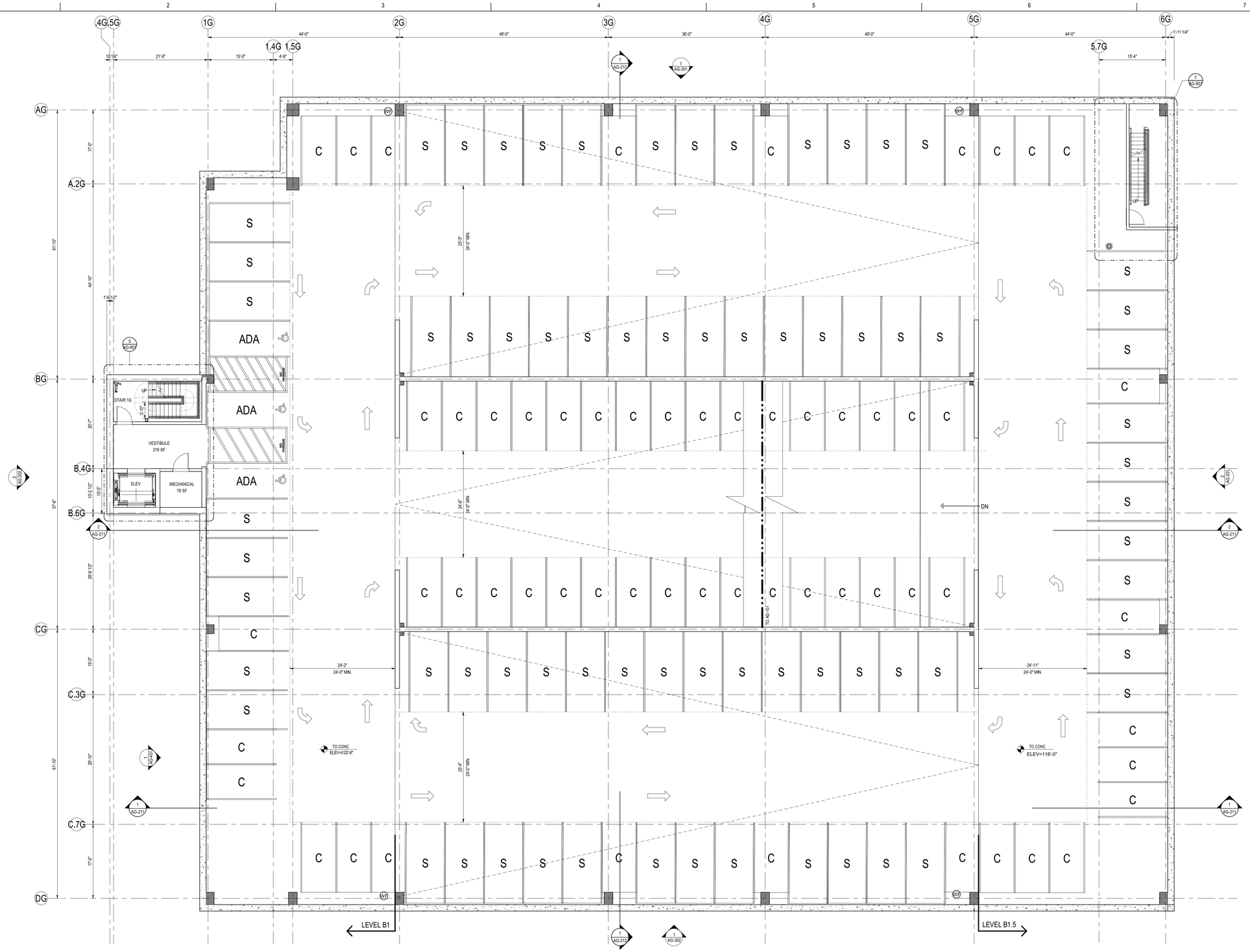
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL B2

Revision:2

Drawing No.
AG-100.B2



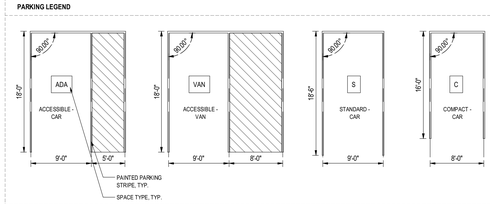
1 GARAGE - LEVEL B1
AG-100.B1 1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



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Issued/Revision	By	Appd	YYYY.MM.DD
1 CONCEPT DESIGN SUBMISSION			2022.03.30
2 PRICING SET PACKAGE			2022.05.27

Permit/Seal

KEY PLAN

GARAGE PARKING COUNT

PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A

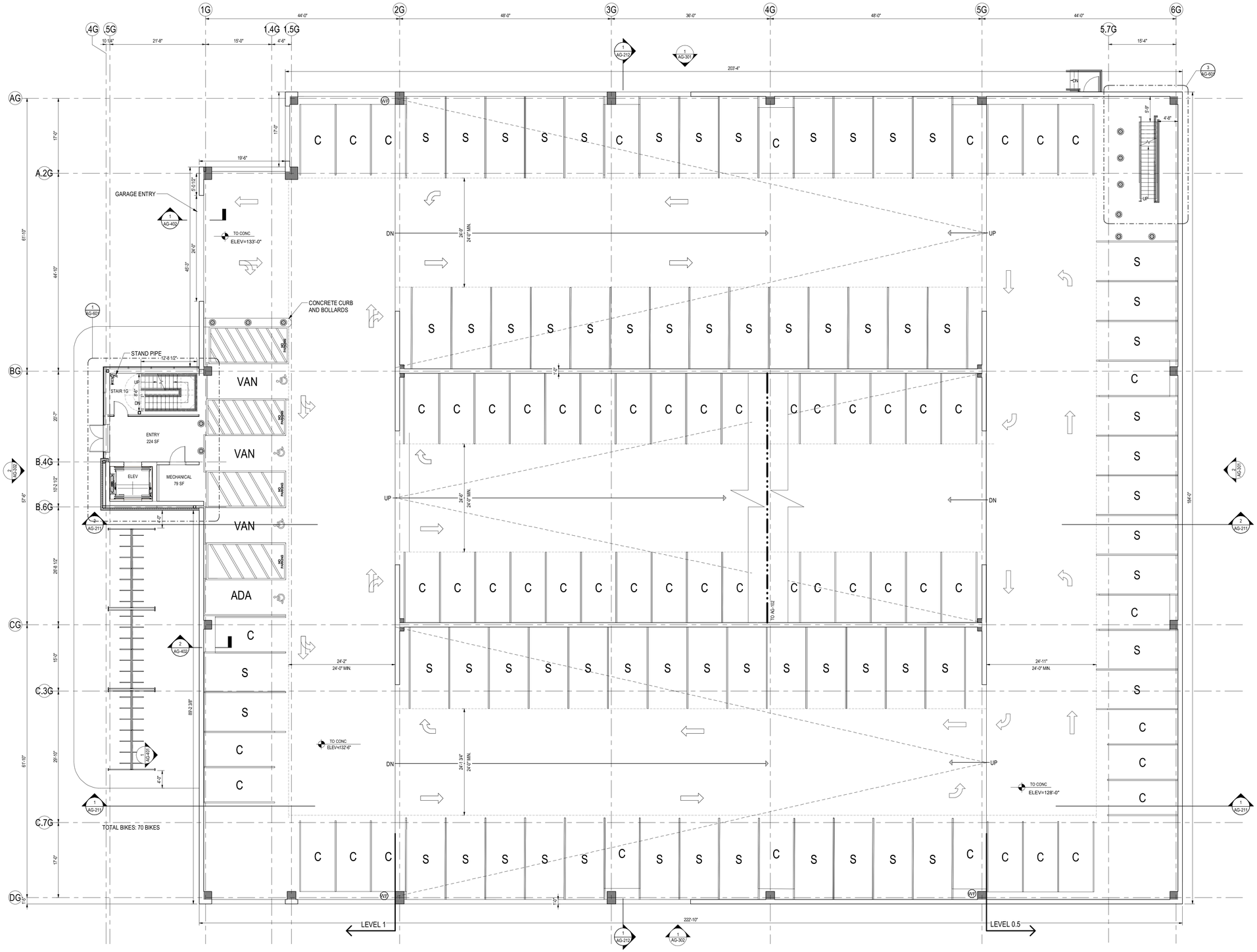
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL B1

Revision:2

Drawing No.
AG-100.B1
GARAGE



1 AG-101 GARAGE - LEVEL 1-

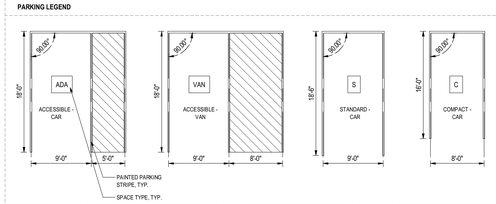
1/8" = 1'-0"

LEGEND

WP WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



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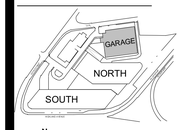
No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	PERMIT RESUBMISSION			2022.03.30
0	CONCEPT DESIGN/DRB			2021.11.19

Permit/Seal

REGISTERED ARCHITECT BRIAN D. NELSON No. 951652 BOSTON MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

Client/Project
Bulfinch 557 Highland Ave HIGHLAND GARAGE

Project No.:218421343
File Name: N/A

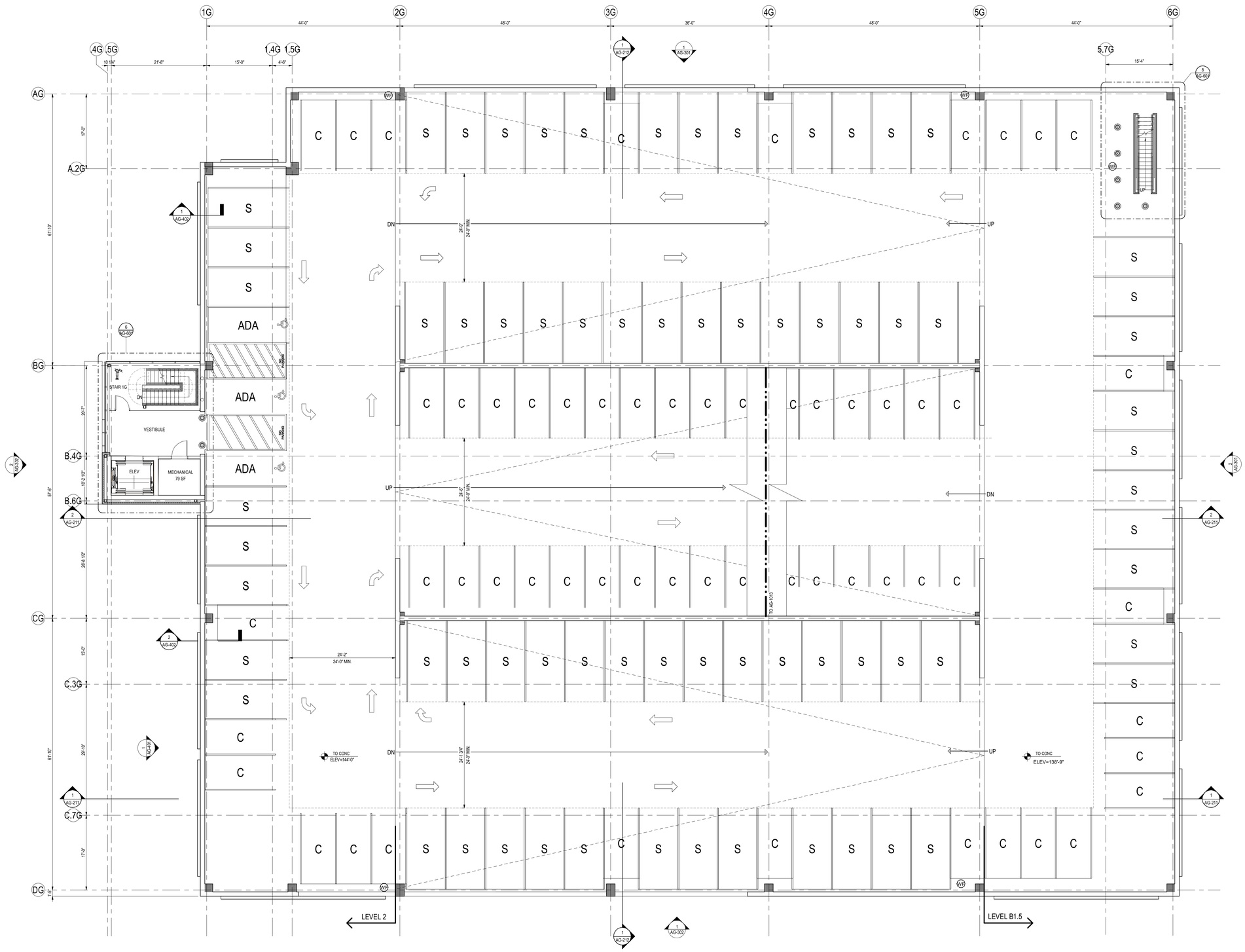
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 1

Revision:2

Drawing No.
AG-101
GARAGE



1 AG-102 GARAGE - LEVEL 2

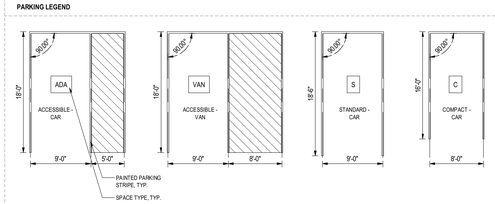
1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



GARAGE PARKING COUNT

PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

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Consultant

No.	Issued/Revision	By	Appvd	YYYY.MM.DD
1	CONCEPT DESIGN			2022.03.30
2	PRICING PACKAGE			2022.11.18

Permit/Seal

KEY PLAN

Client/Project
Bulfinch 557 Highland Ave HIGHLAND GARAGE

Project No.:218421343
File Name: N/A

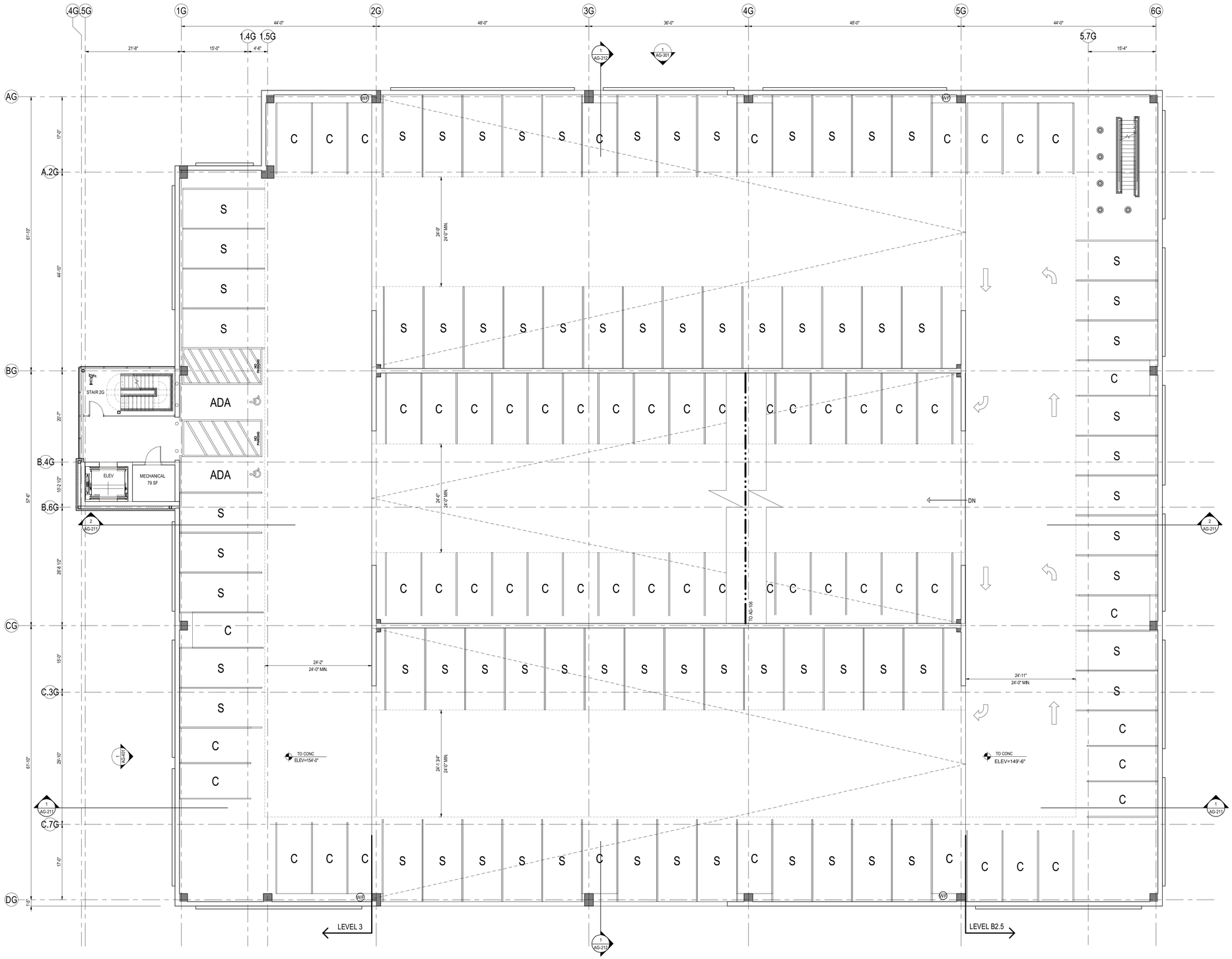
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 2

Revision:2

Drawing No.
AG-102
GARAGE



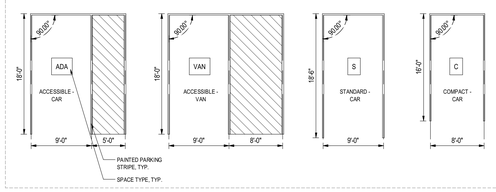
1 GARAGE - LEVEL 3
AG-103 1/8" = 1'-0"

LEGEND

WF WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



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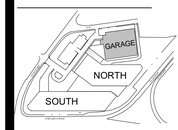
No.	Issued/Revision	By	Appvd	YYYY.MM.DD
1	SPECIAL REMEDY PACKAGE			2022.03.30

Permit/Seal



KEY PLAN

GARAGE PARKING COUNT	
PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

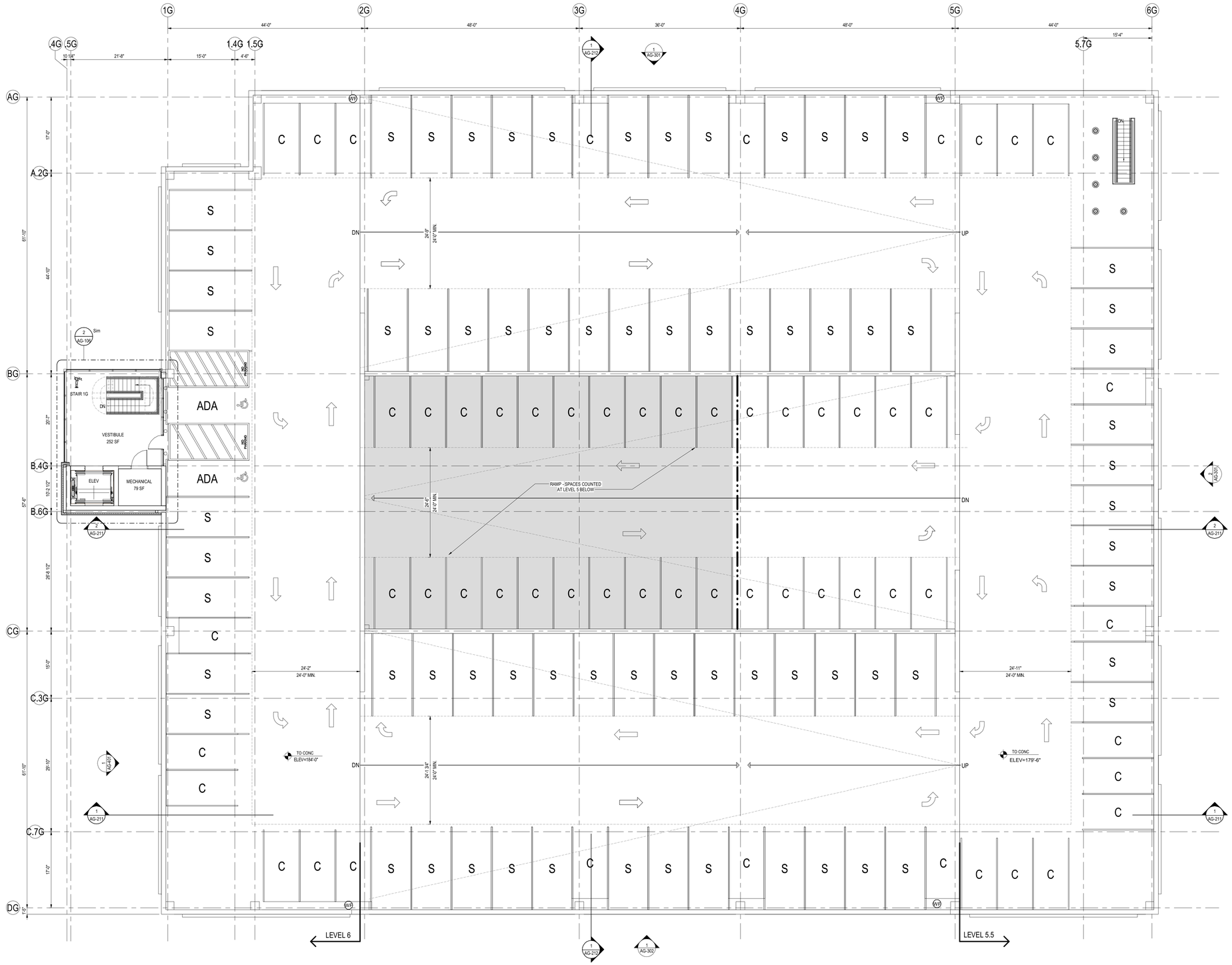
Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 3
(LEVEL 4-5 SIM.)

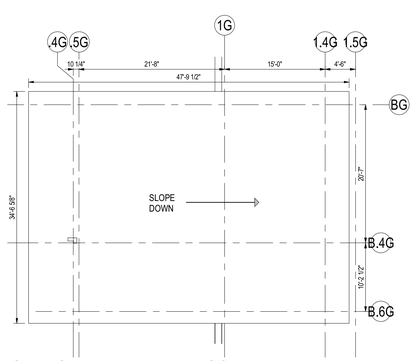
Revision: 1

Drawing No.
AG-103
GARAGE

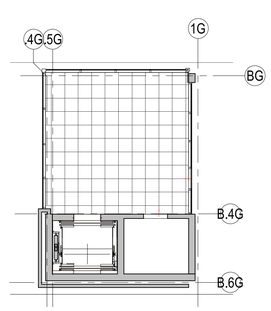
ORIGINAL SHEET - ARCH E



1 AG-106 GARAGE - LEVEL 6
1/8" = 1'-0"



2 AG-106 GARAGE - MAIN ENTRY ROOF
1/8" = 1'-0"



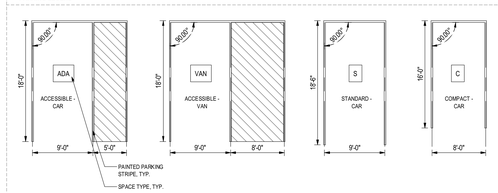
3 AG-106 GARAGE - LEVEL 6 - RCP
1/8" = 1'-0"

LEGEND

WP WHEELED FIRE EXTINGUISHER

75'-0" MAX. DISTANCE PER CODE, TYP.

PARKING LEGEND



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No.	Issued/Revision	By	Appd	YYYY.MM.DD
1	CONCEPT DESIGN			2022.03.30
2	PROJECT REFERENCE			2022.11.18

Permit/Seal

KEY PLAN

GARAGE PARKING COUNT

PARKING TYPE	COUNT
GARAGE - LEVEL B2	
ACCESSIBLE	3
COMPACT	55
STANDARD	71
	129
GARAGE - LEVEL B1	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 1	
ACCESSIBLE	1
ACCESSIBLE VAN	3
COMPACT	58
STANDARD	64
	126
GARAGE - LEVEL 2	
ACCESSIBLE	3
COMPACT	58
STANDARD	70
	131
GARAGE - LEVEL 3	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 4	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 5	
ACCESSIBLE	2
COMPACT	58
STANDARD	71
	131
GARAGE - LEVEL 6	
ACCESSIBLE	2
COMPACT	38
STANDARD	71
	111
TOTAL: 1021	1021

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A

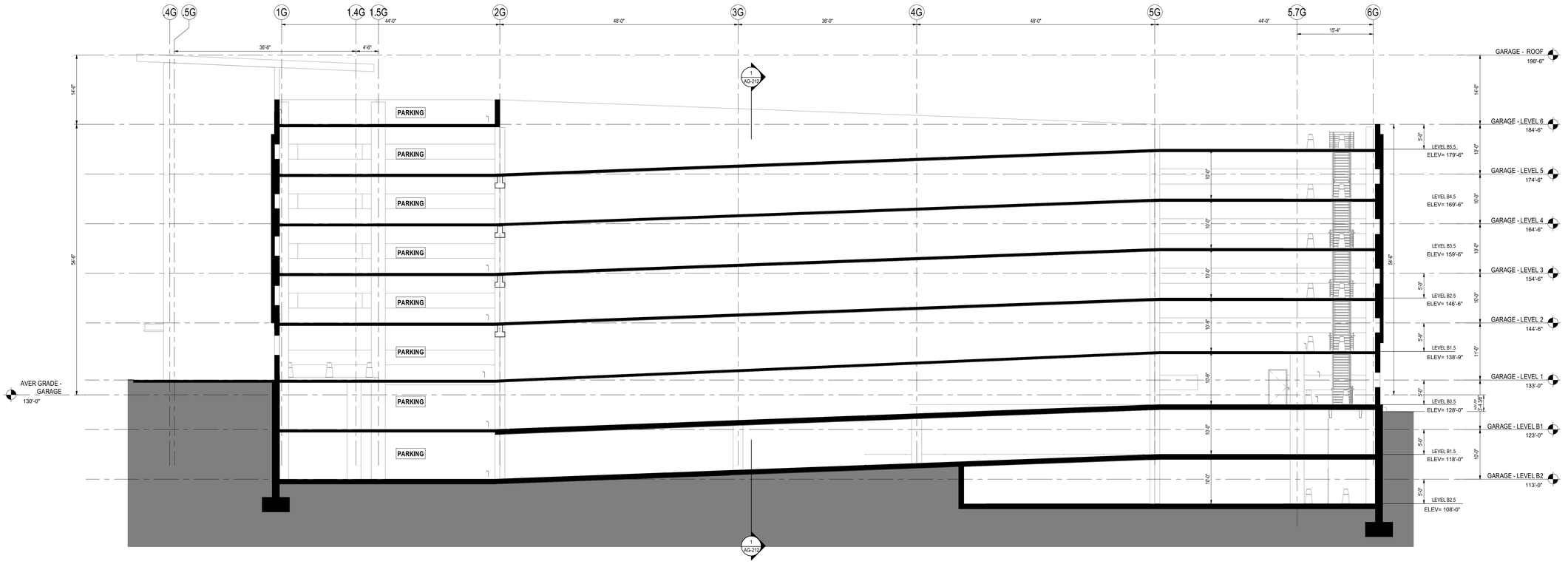
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE LEVEL 6

Revision:2

Drawing No.
AG-106
GARAGE



2 AG-211 **GARAGE SECTION BB - CENTRAL RAMP**
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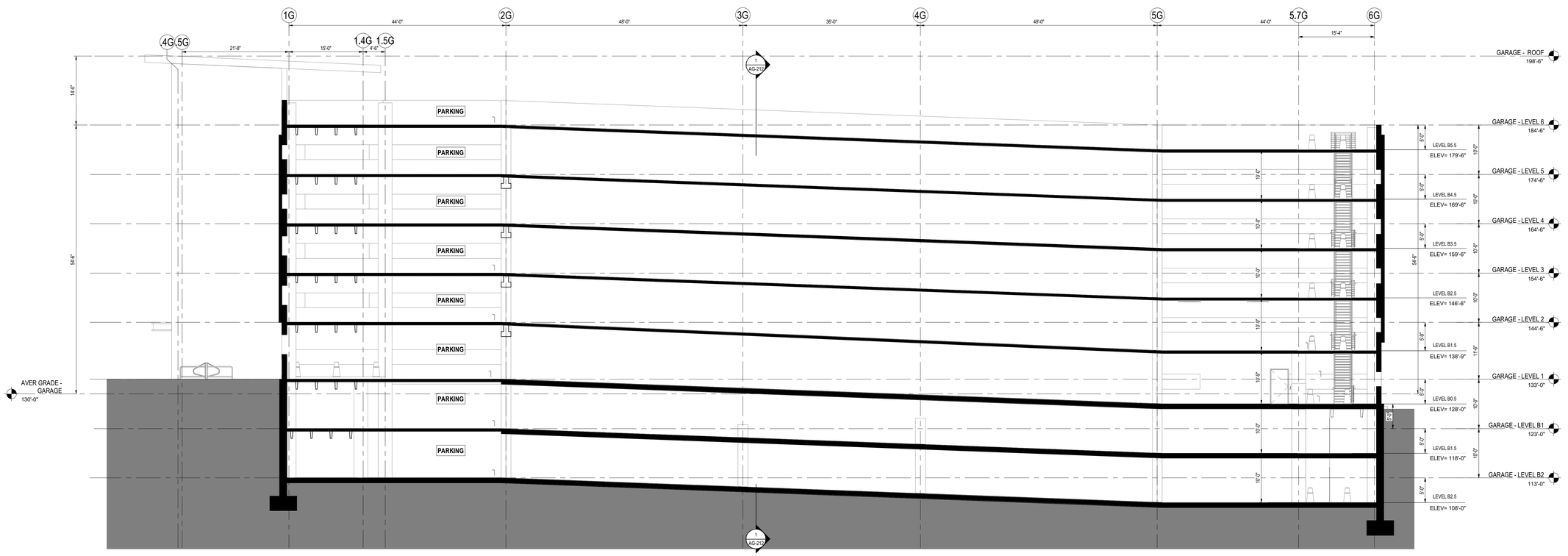

1 AG-211 **GARAGE SECTION AA - OUTER RAMP**
1/8" = 1'-0"

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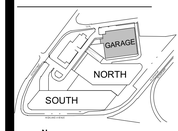
1	CONCEPT DESIGN			2022.03.30

Permit/Seal

REGISTERED ARCHITECT
BRYON D. NEUMAN
No. 951652
BOSTON
MA
COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

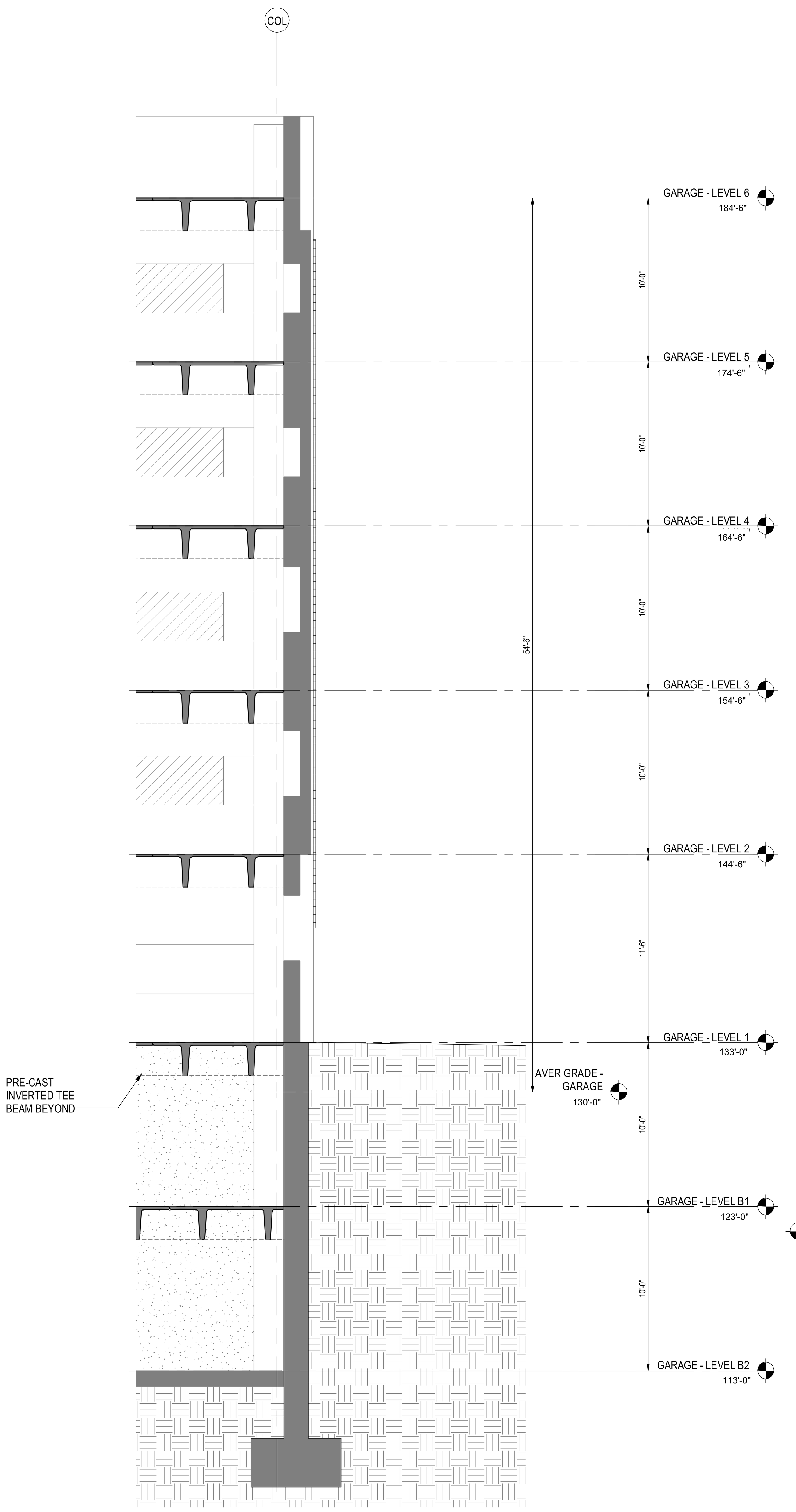
Project No.:218421343
File Name: N/A

Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
GARAGE SECTIONS

Revision:2
Drawing No.
AG-211
GARAGE



2 AG-212 **TYP. BAY SECTION - FOUNDATION OUTBOARD**
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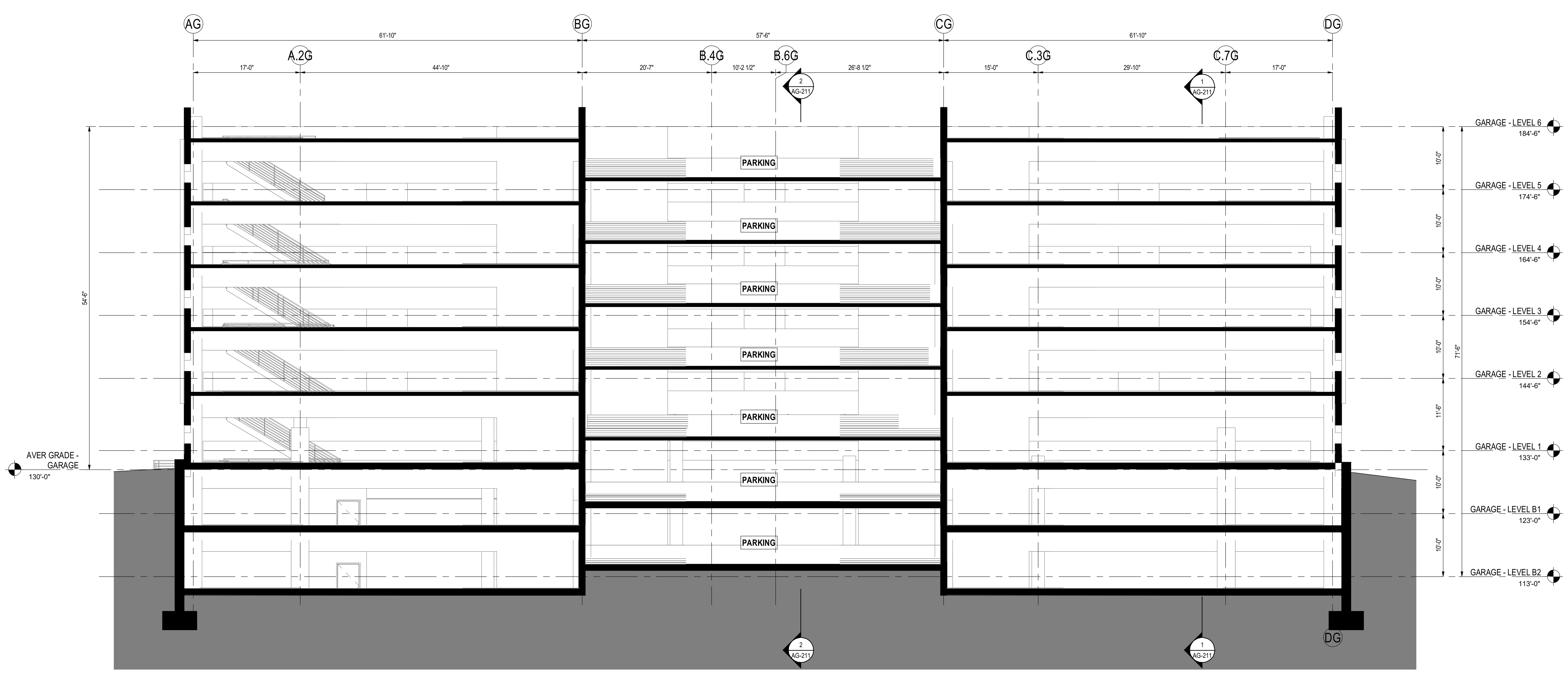

1 AG-212 **GARAGE SECTION CC - Transverse**
1/8" = 1'-0"

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Consultant

Issued/Revision

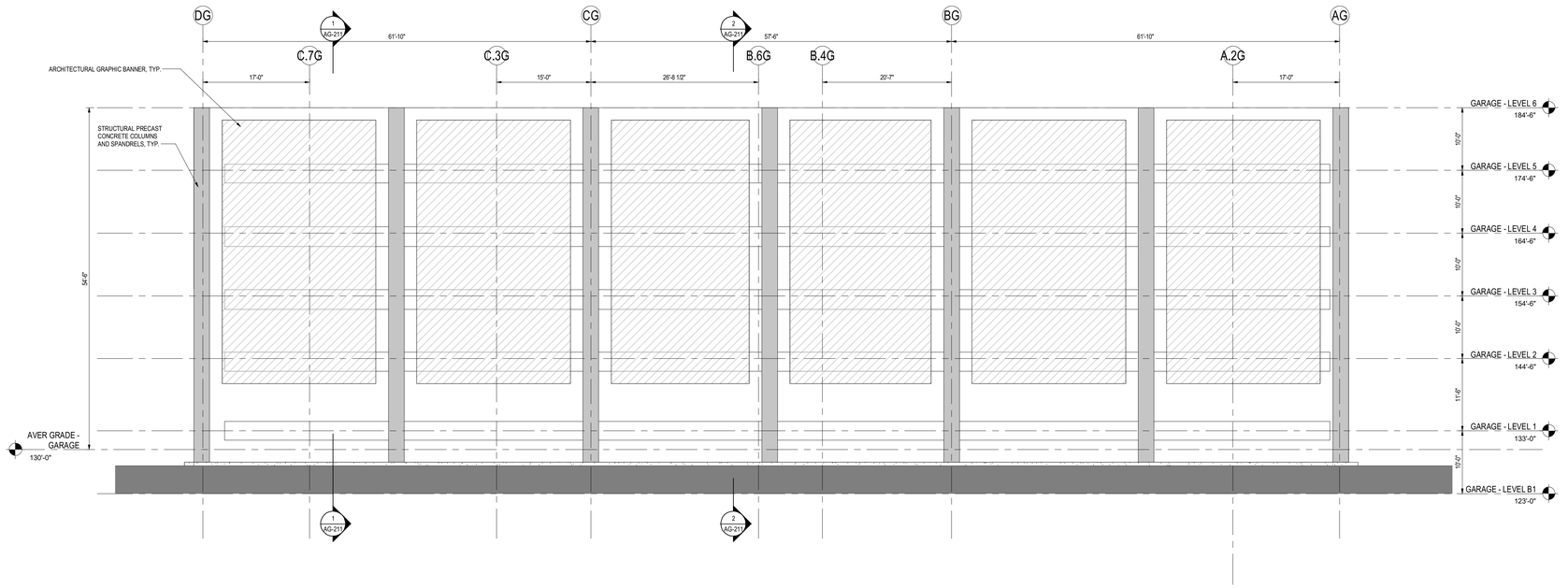
Permit/Seal

KEY PLAN

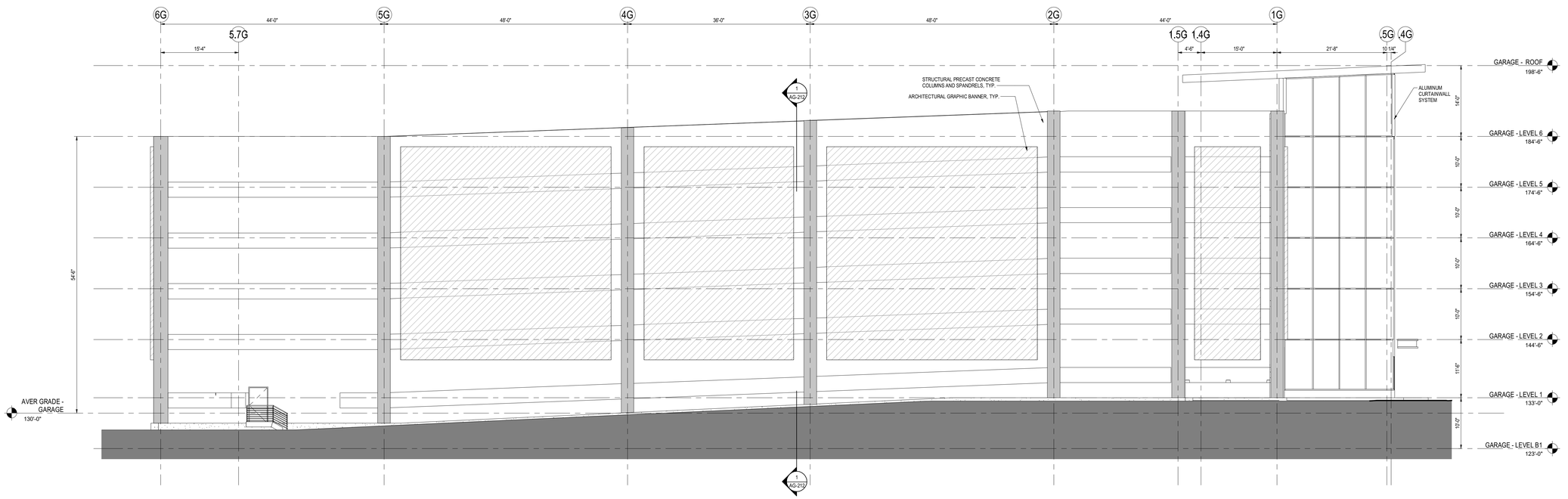
GARAGE
NORTH
SOUTH

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.: 218421343
Scale: As indicated
Title
GARAGE SECTIONS
Revision: 2
Drawing No.
AG-212
GARAGE



2 AG-301 EAST ELEVATION
1/8" = 1'-0"



1 AG-301 NORTH ELEVATION
1/8" = 1'-0"

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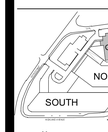
No.	Issued/Revision	By	Appvd	YYYY.MM.DD
1	CONCEPT DESIGN			2022.03.30
2	PRICING PACKAGE			2022.11.18

Permit/Seal



KEY PLAN

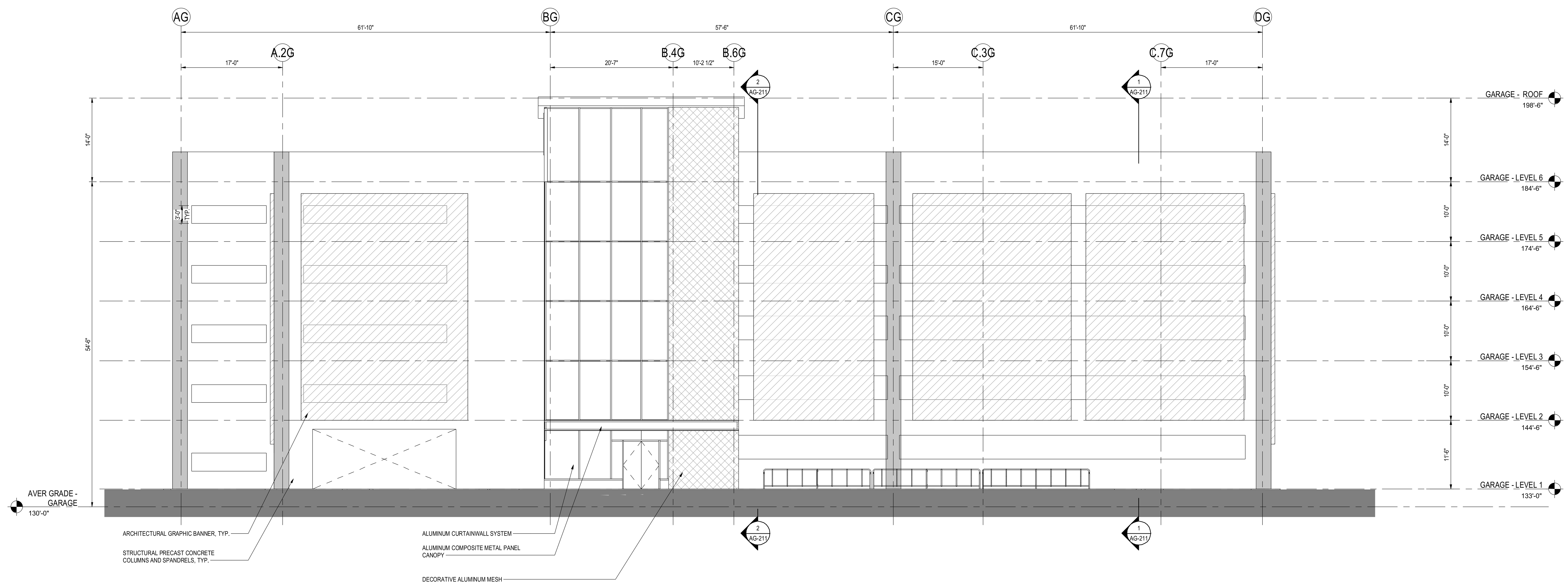
Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

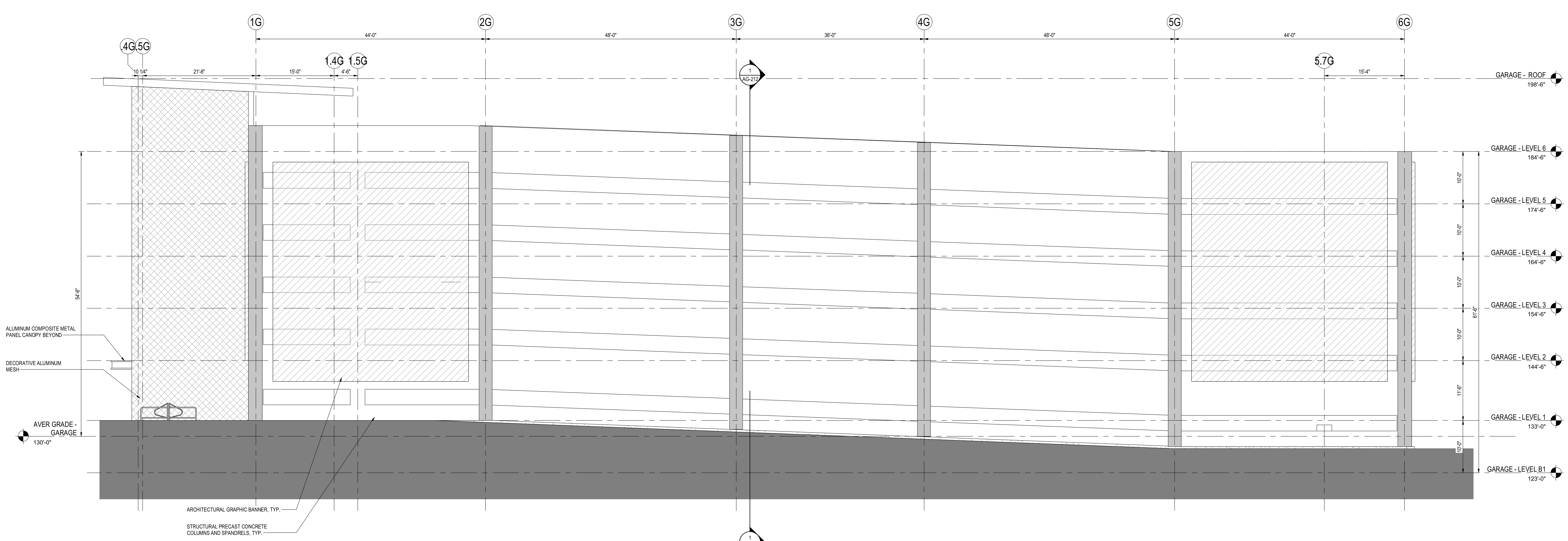
Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ELEVATIONS - NORTH & EAST

Revision:2
Drawing No.
AG-301
GARAGE



2 AG-302 **WEST ELEVATION**
1/8" = 1'-0"



1 AG-302 **SOUTH ELEVATION**
1/8" = 1'-0"

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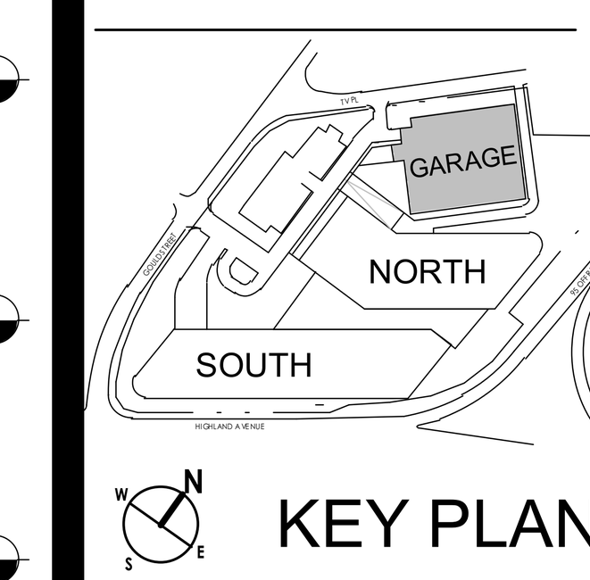
	Issued/Revision	By	Appd	YYYY.MM.DD
2	SPECIAL PERMIT PACKAGE			2022.03.30
1	CONCEPT DEVELOPMENT			2021.11.19

Permit/Seal

REGISTERED ARCHITECT BARTON D NELSON No. 951652 BOSTON, MA COMMONWEALTH OF MASSACHUSETTS



KEY PLAN

Client/Project
Bulfinch
557 Highland Ave
HIGHLAND GARAGE

Project No.:218421343
File Name: N/A
Scale: 1/8" = 1'-0"

Author	Designer	Checker	2022.03.30
Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Title
ELEVATIONS - SOUTH & WEST

Revision:2
Drawing No.
AG-302
GARAGE

Highland Innovation Center

557 Highland Avenue
Needham, Massachusetts

PREPARED FOR

557 Highland, LLC

c/o

The Bulfinch Companies, Inc.
116 Huntington Avenue
Boston, MA 02116

PREPARED BY

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

MARCH 2022

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Introduction

Vanasse Hangen Brustlin, Inc. (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 506,694 SF of rentable space, with approximately 248,347 SF of office space, approximately 248,347 SF of research and development space, and approximately 10,000 SF of retail space. The Project will also accommodate up to 1,408 off-street parking spaces. 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 the

[1] Traffic Impact Study, Muzi Motors Redevelopment, Greenman-Pederson, Inc. November 20, 2020

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.

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 70 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 adequate to accommodate the expected employee and visitor demands of the Project. The Project will include up to 1,408 spaces (an increase of 876 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 Transportation Demand Management (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.

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 the Appendix to this report 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.

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.

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.

Building Program

The development proposal for the Project Site includes up to 506,694 SF of rentable space, consisting of the following uses:

- Approximately 248,347 SF of office space;
- Approximately 248,347 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.

Site Access

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, provides 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 1.

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.

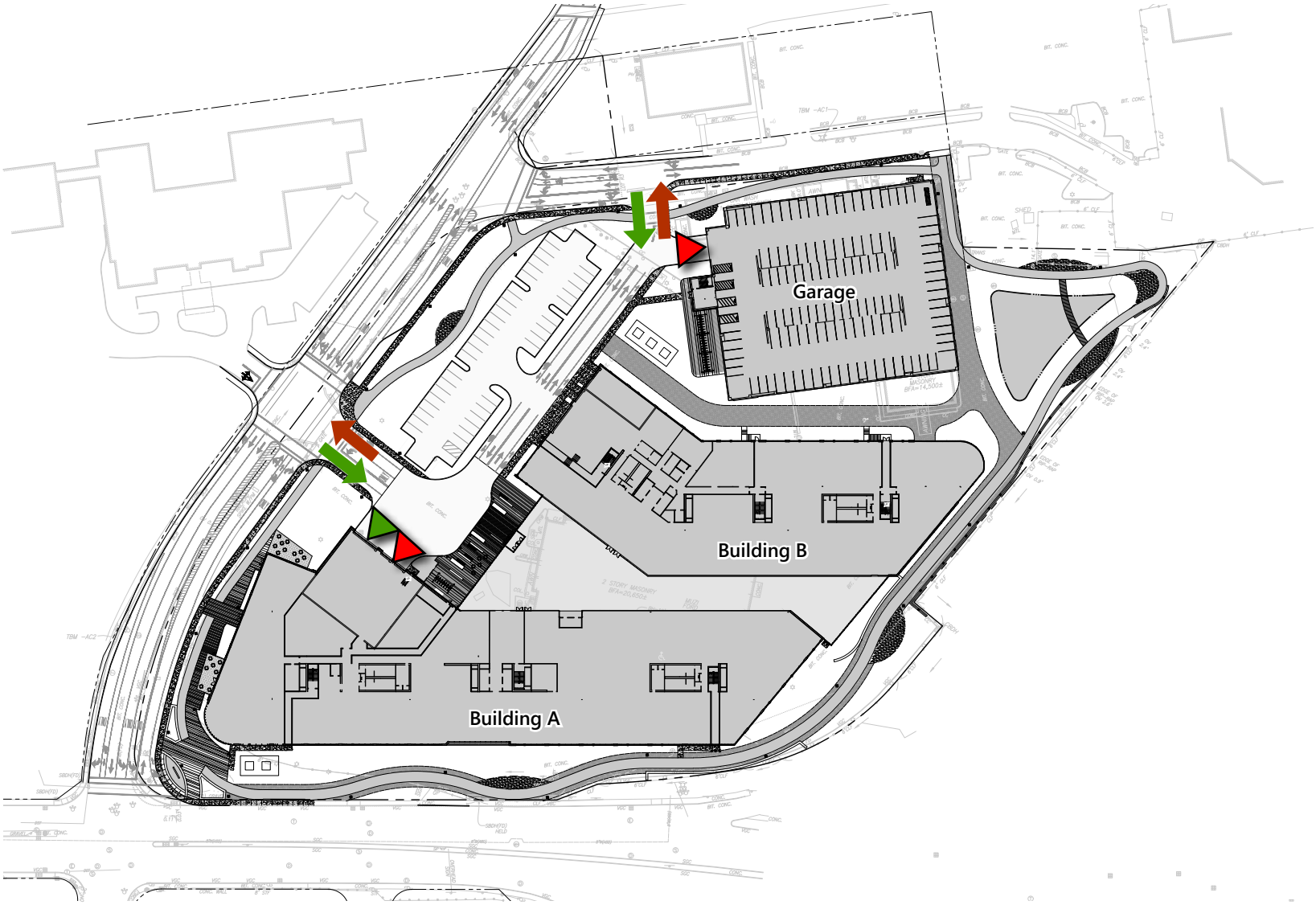
Figure 2 illustrates the site plan and external access points for the Project and includes the garage and loading access points.

Source: NearMap

Figure 1

Site Location Map

Highland Science Center
Needham, Massachusetts



Source: Paul Finger Associates

- Vehicle Access
- Vehicle Egress
- Garage Access
- Loadings Access

Figure 2

Site Plan & Circulation

Highland Science Center
Needham, Massachusetts

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.

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.

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. Up to 70 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.

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.

Vehicle Parking

The Project will include up to 1,408 off-street parking spaces. 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 876 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 the Appendix to this report.

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 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 1 Parking Generation Calculations

Use	SF	Employee/Patron Density [a]	Reduction for non-SOV [b]	Parking Demand
Office	248,347	3.33/ksf	0.92	762 spaces
R&D	248,347	2.46/ksf	0.92	562 spaces
Retail	10,000	3.33/ksf	0.92	31 spaces
Total				**1,355 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 1, the actual vehicle parking demand for the Project Site may be around 1,355 parking spaces. With approximately 1,408 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 1.

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.

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:

- 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

A map of the study area intersections is provided in Figure 3.

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 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.

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.

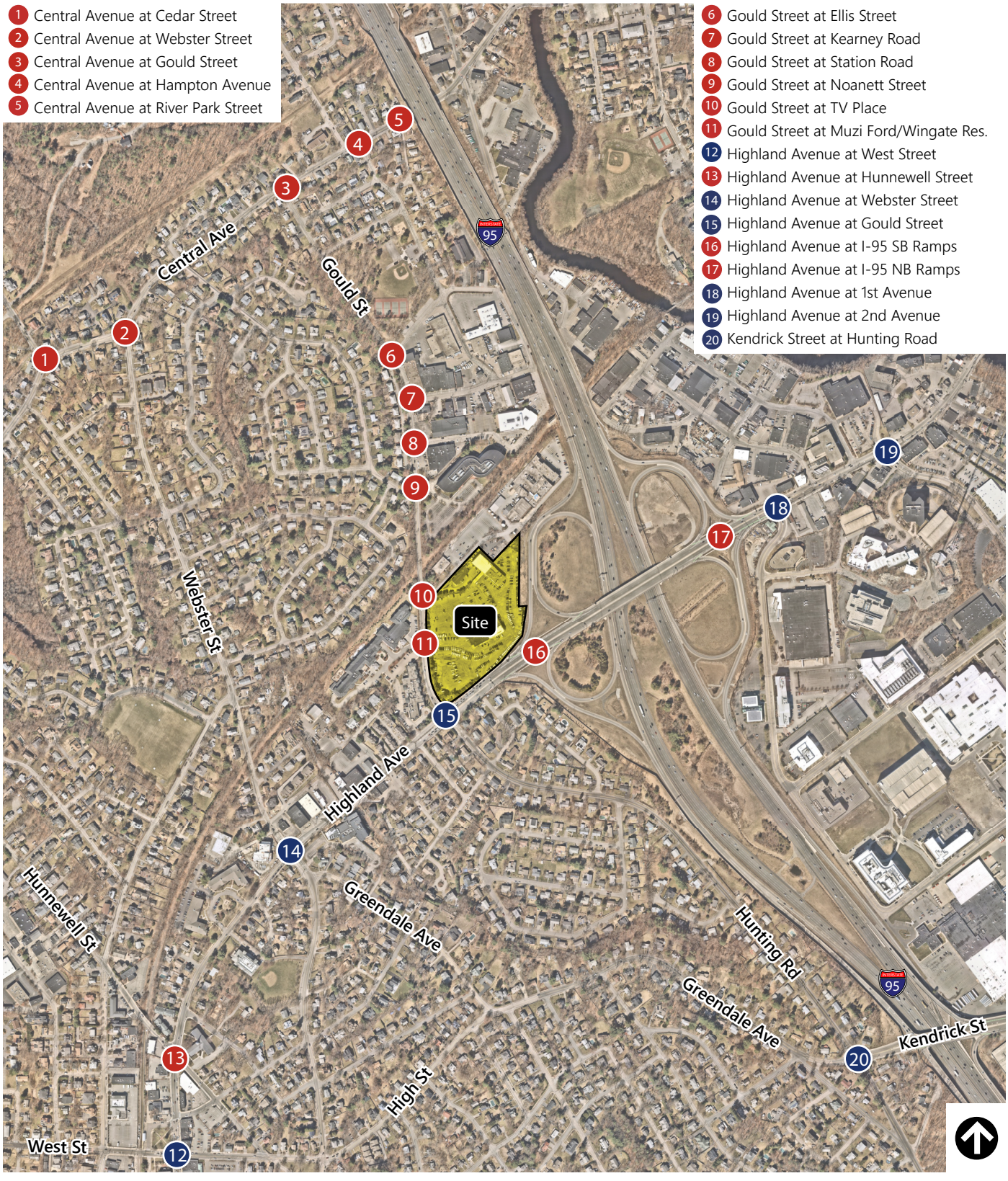
MassDOT is currently reconstructing portions of Highland Avenue.[4] The reconstruction project will enhance bicycle and pedestrian accommodations along the corridor and improve traffic flow. In addition, the MassDOT project will change the lane geometry at several intersections. A functional design report 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.

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 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.

[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.



Source: NearMap

- Unsignalized Intersection
- Signalized Intersection

Figure 3

Study Area Intersections

Highland Science Center
Needham, Massachusetts

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.

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 Driveway/Wingate Driveway

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 approach of Hunting Road consists 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.

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.

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 the Appendix to this report.

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 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 the Appendix to this report.

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

[5] MassDOT Guidance on Traffic Count Data. Apr 2020.

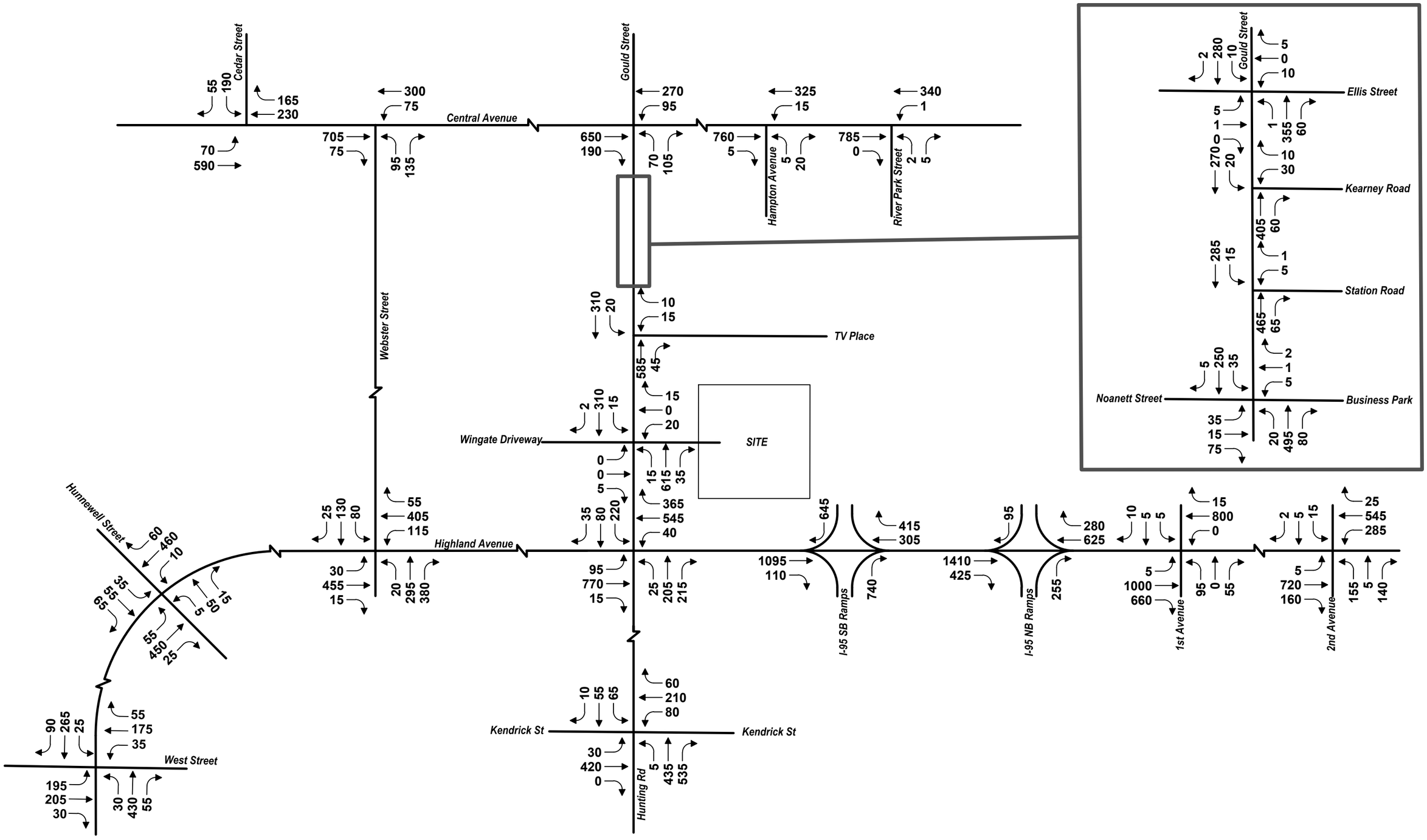
2018 were adjusted accordingly to represent 2019 conditions. The MassDOT yearly growth rate factors are included in the Appendix to this report.

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.

2022 Existing Conditions Traffic Volumes

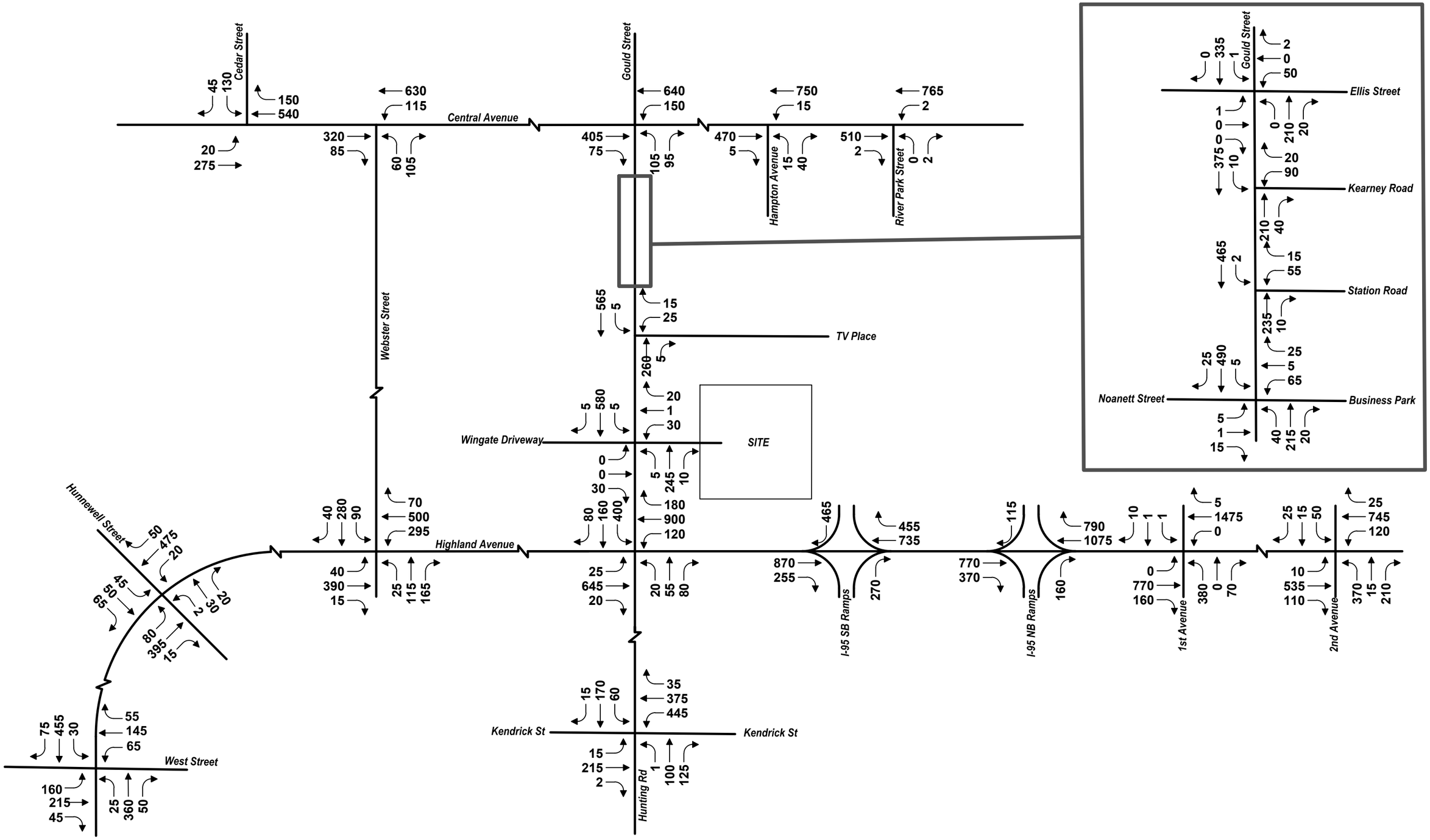
The 2022 Existing Conditions were developed by applying the adjustment factors described above to the counts conducted between 2015 and 2021. Based on MassDOT guidance, the 2022 Existing Conditions represent a pre-pandemic condition and do not take into account any shift in travel patterns caused by the pandemic. The resulting 2022 Existing Conditions weekday morning and weekday evening peak hour traffic volumes are shown in Figures 4, and 5, respectively.



Not to Scale

Existing Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 4



Not to Scale

Existing Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 5

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 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 the Appendix to this report. 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.

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.

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 6

Public & Private Transportation

Highland Science Center
Needham, Massachusetts

Active Transportation Infrastructure

Pedestrian Environment

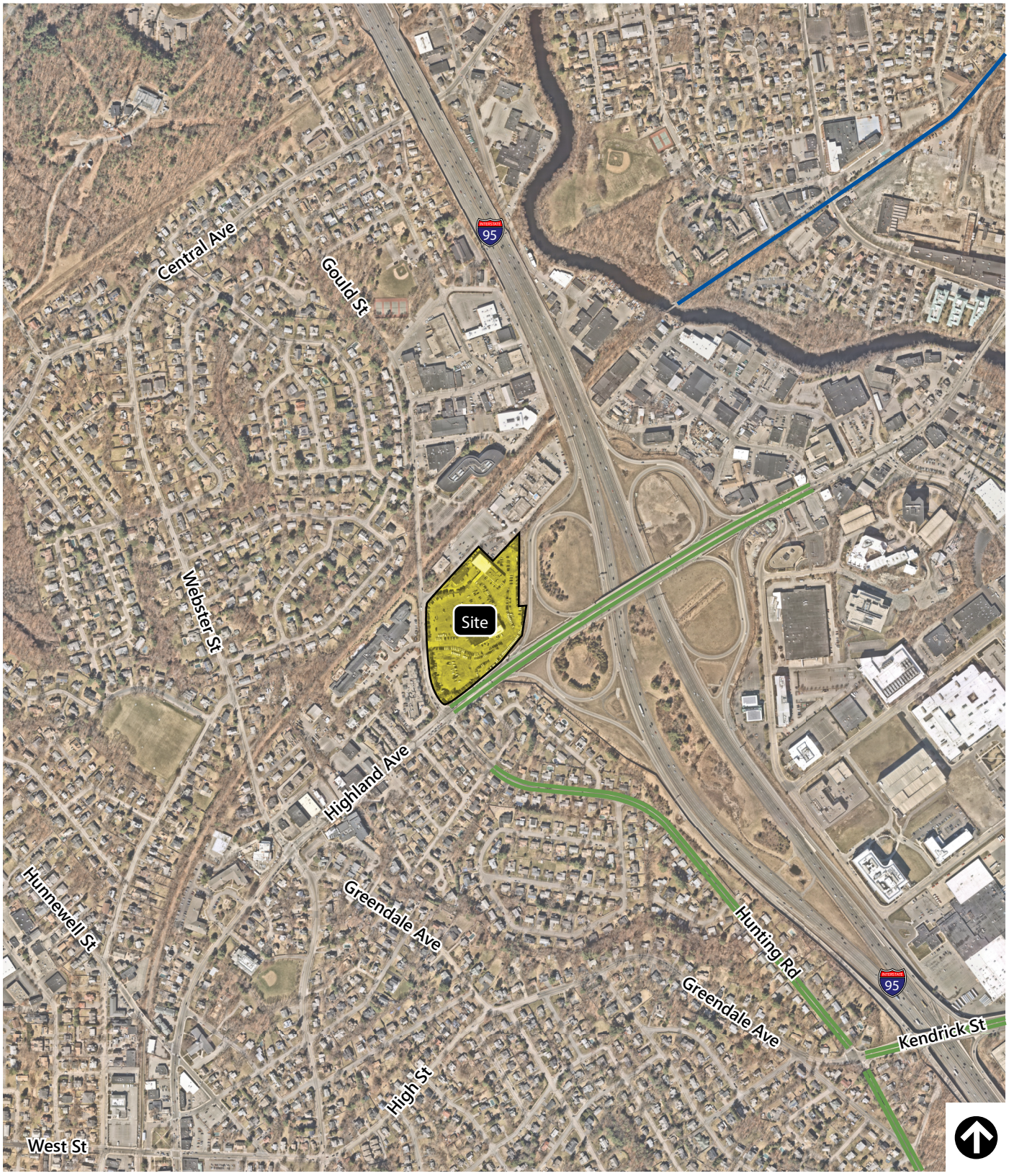
Varying levels of pedestrian accommodations are provided throughout the study area and are representative of the level of pedestrian accommodations throughout Needham. Sidewalks are provided on both sides of all major roadways in the study area, except along the east side of Gould Street between Highland 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.

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 7.



Source: NearMap

Bike Lane

Trail

Figure 7

Existing Bicycle Facilities

Highland Science Center
Needham, Massachusetts

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 and the detailed crash data is provided in the Appendix to this report 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 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 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 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, 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 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.

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.

[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.

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.

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 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.

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 the Appendix to this report.

- **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.

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:

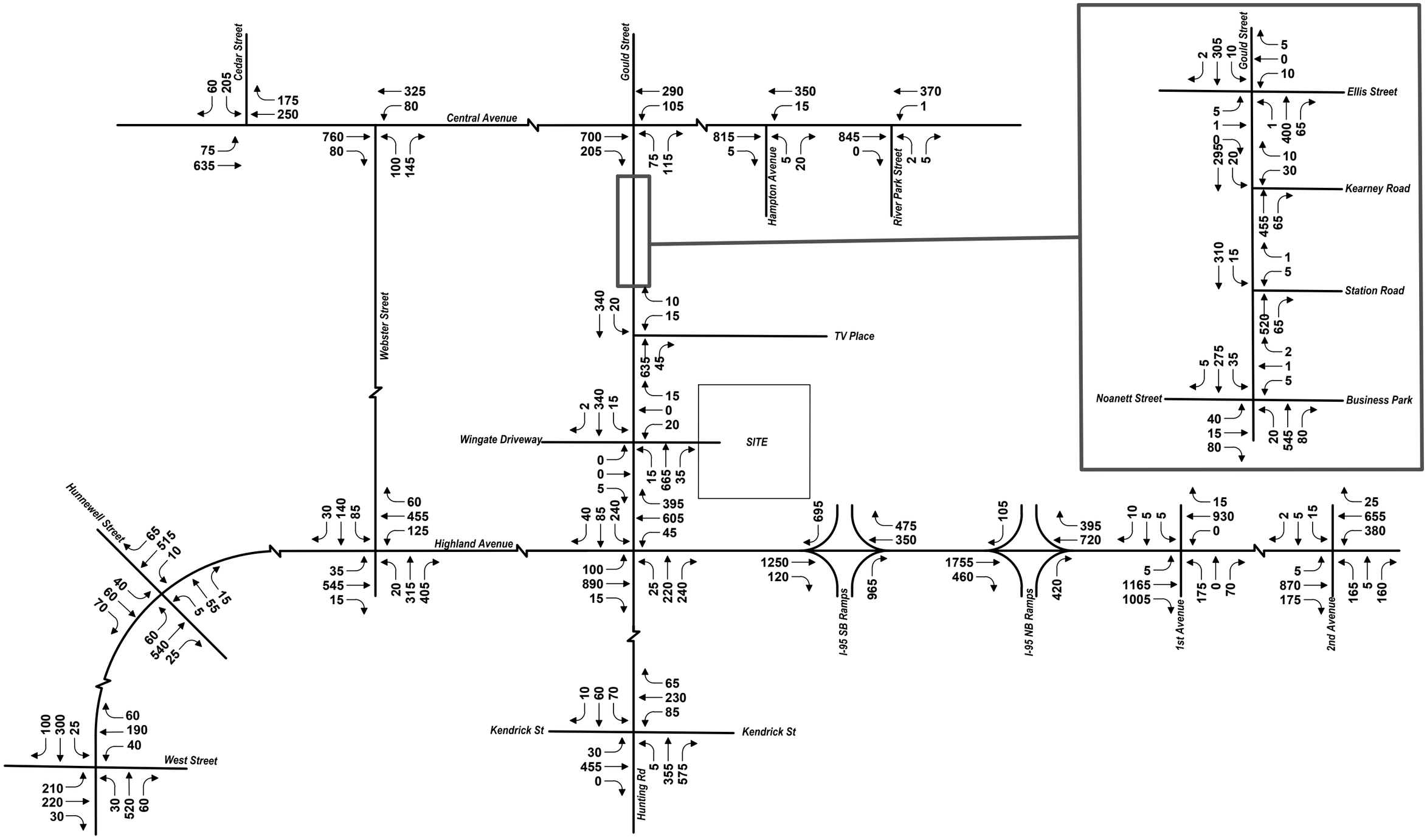
- **Needham-Newton Corridor Project** – This project involves the redesign of Highland Avenue, Needham Street, and Winchester Street in Needham and Newton (MassDOT Project No. 606635). The project involves reconstruction of portions of these three roadways to improve traffic operations, safety, and multimodal 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/Route 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.

No-Build Traffic Volumes

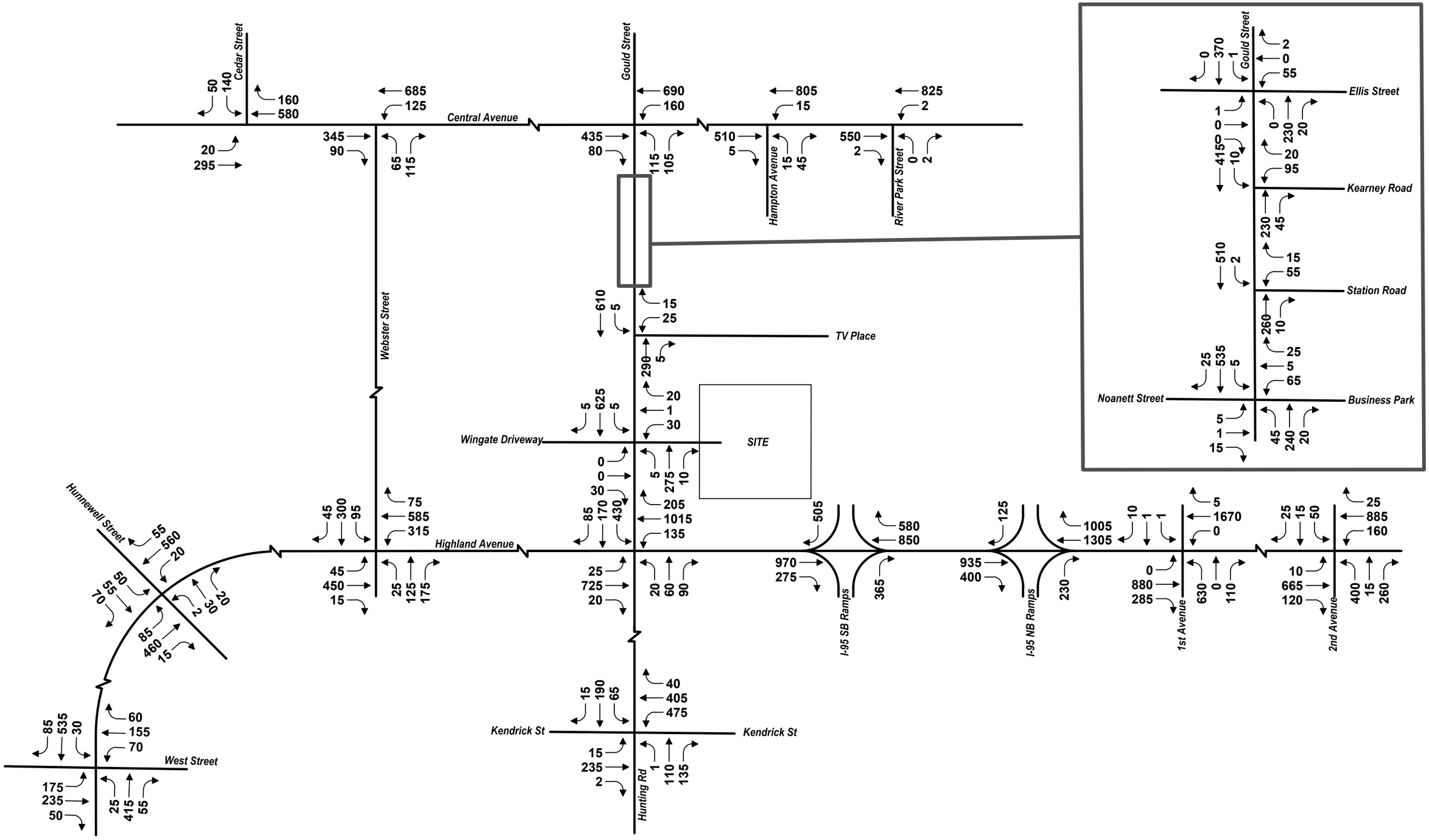
The 2029 No-Build traffic volumes were developed using a growth rate of 1.0 percent per year and adding in the background projects and roadway improvement projects described above. The resulting 2029 No-Build weekday morning and weekday evening peak hour traffic volume networks are illustrated in Figures 8 and 9, respectively.



Not to Scale

No-Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 8



Not to Scale

No-Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 9

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)

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 3 summarizes the traffic counts for the existing uses on-Site. The count sheets are included in the Appendix to this report.

Table 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 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 248,347 SF of office space, approximately 248,347 SF of lab space, and approximately 10,000 SF of supporting retail uses.

In March 2022, an Environmental Notification Form (ENF) was submitted for the Project based on a building program of up to 260,500 SF of office space, 260,500 SF of lab space, and 10,000 SF of supporting retail uses. The ENF included a transportation impact and access study based on those proposed square footages. To be consistent with the trip generation and the intersection capacity analyses presented in the ENF, the Project-generated trips presented in this report are also based on the larger building program. This provides a conservative analysis of the trip generation impact of the Project and presents a "worst-case" scenario of the Project's impacts on the roadway network.

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 4, and trip generation worksheets are included in the Appendix to this report.

Table 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, providing a conservative estimate for the currently proposed 248,347 SF of office space.

b Based on ITE LUC 760 (Research and Development Center) for 260,500 SF, providing a conservative estimate for the currently proposed 248,347 SF of lab space.

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 the Appendix to this report.

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 4 to develop the net trips expected to be generated by the Project Site. Table 5 presents the Project-generated net new trips.

Table 5 Project-Generated Trips

	Adjusted Vehicle Trips [a]						
	Office	R&D	Retail	Total	Pass-By [b]	Existing Site Trips [c]	Total Net New Vehicle Trips
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 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 6.

Table 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 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 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 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 7 provides a summary of the trip distribution. Detailed trip distribution calculations are provided in the Appendix to this report.

[8] It should be noted that 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 proposed 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

Table 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

Figure 10 provides an illustration of the Project Site trip distribution.

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.

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 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 11 and 12.

The 2029 Build Condition traffic volumes are shown in Figures 13 and 14 for the weekday morning and weekday evening, respectively.

Source: NearMap

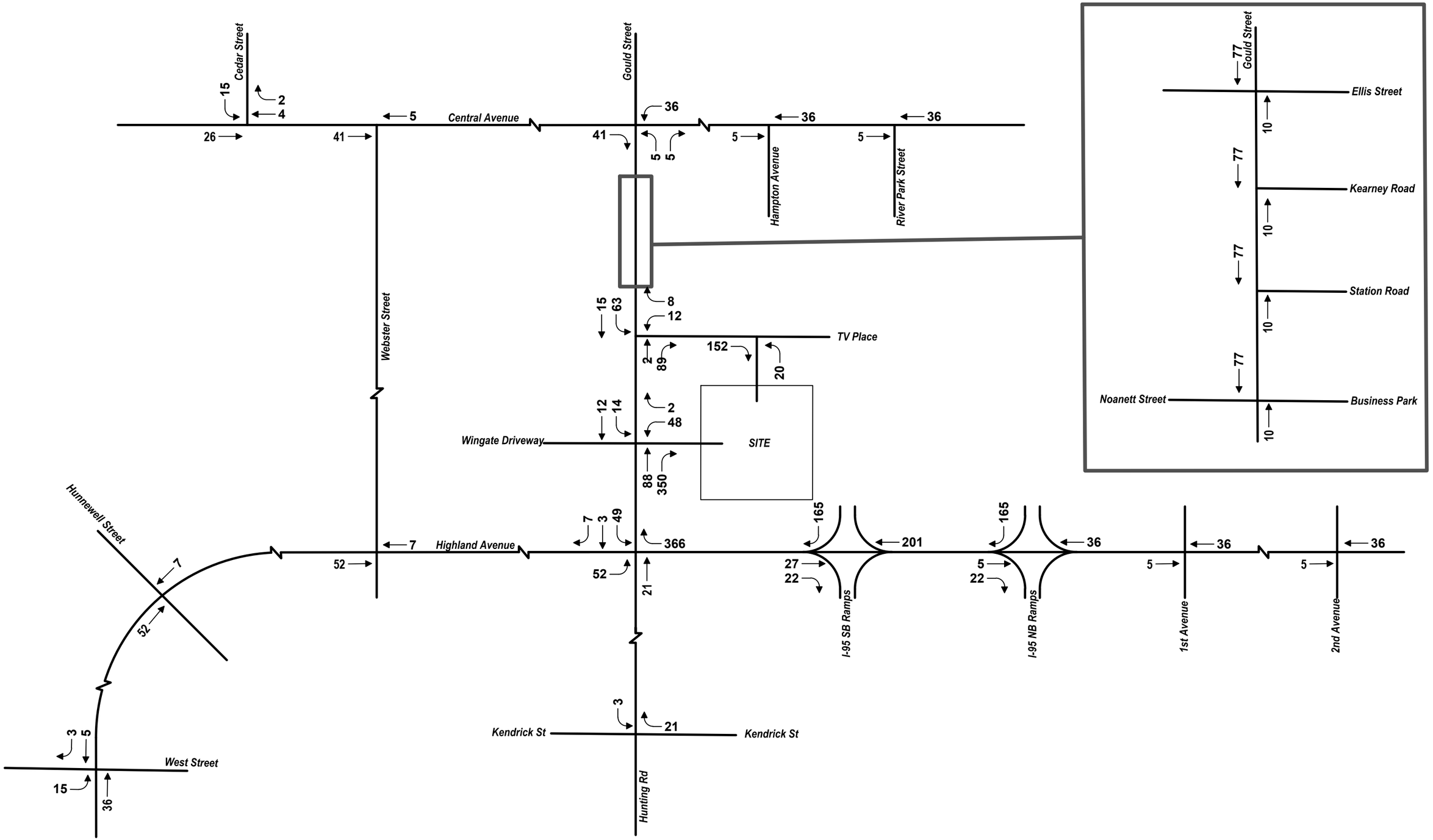
% Outbound

% Inbound

Figure 10

Trip Distribution

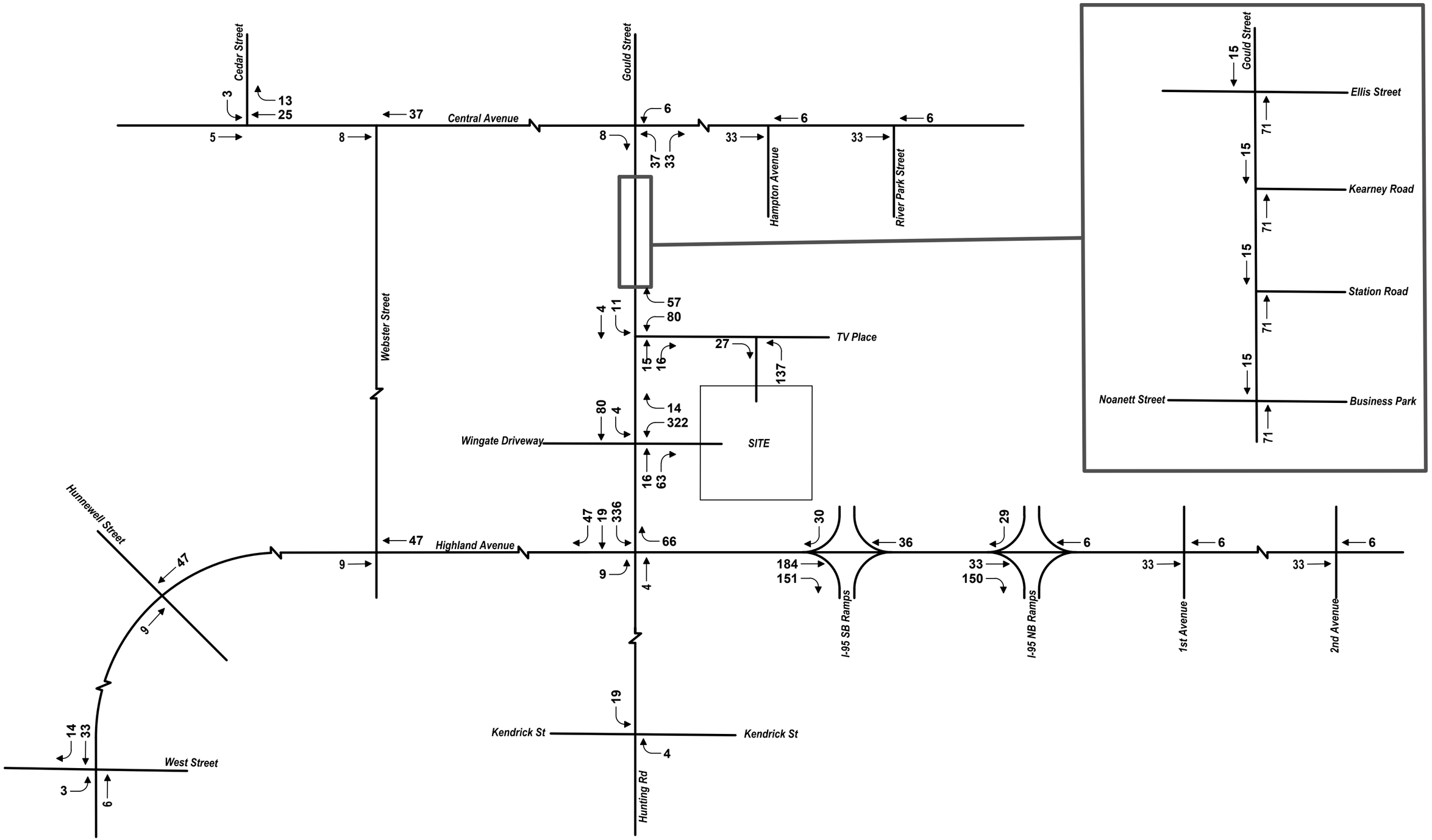
Highland Science Center
Needham, Massachusetts



Not to Scale

Project Generated Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

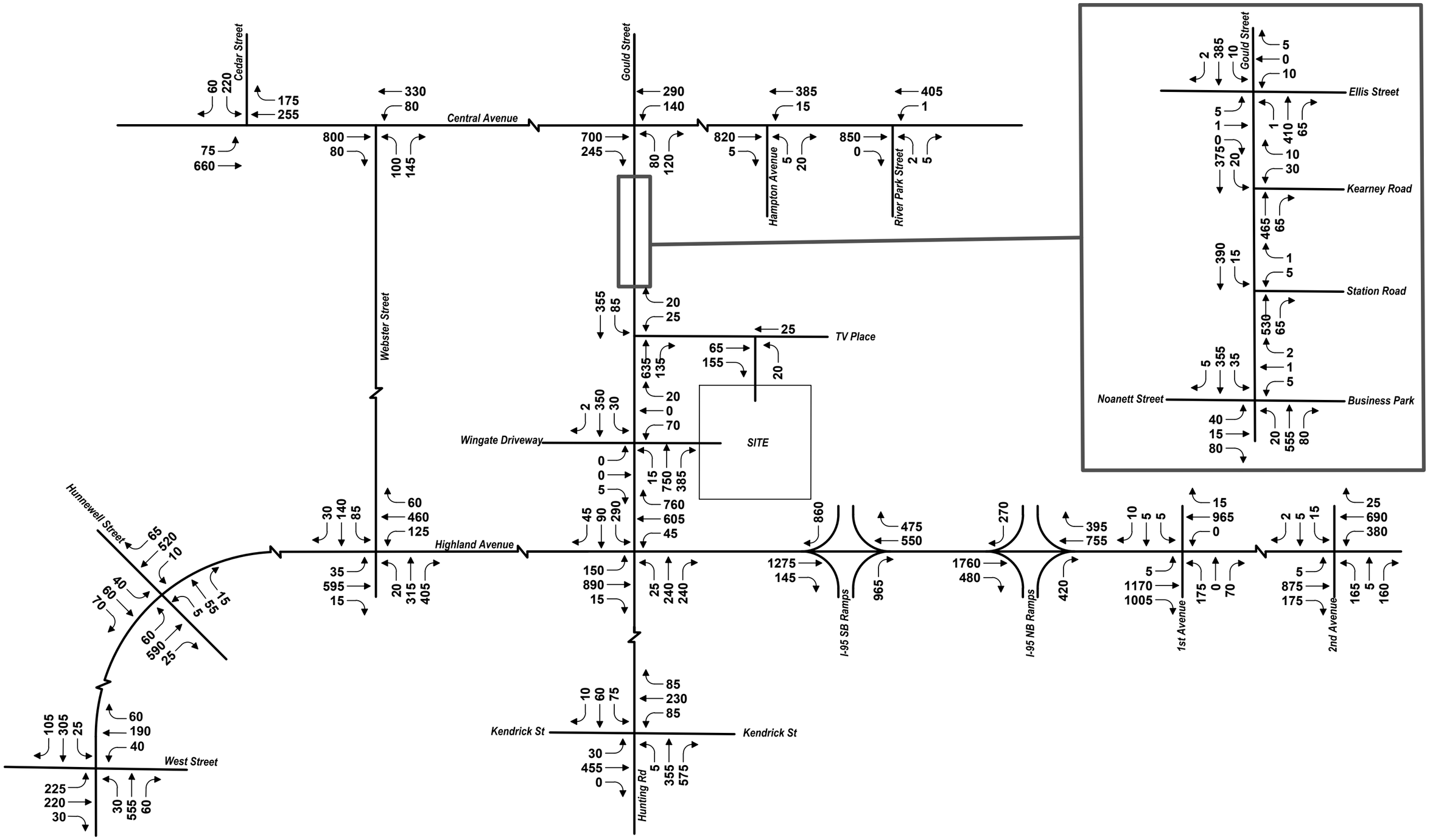
Figure 11



Not to Scale

Project Generated Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

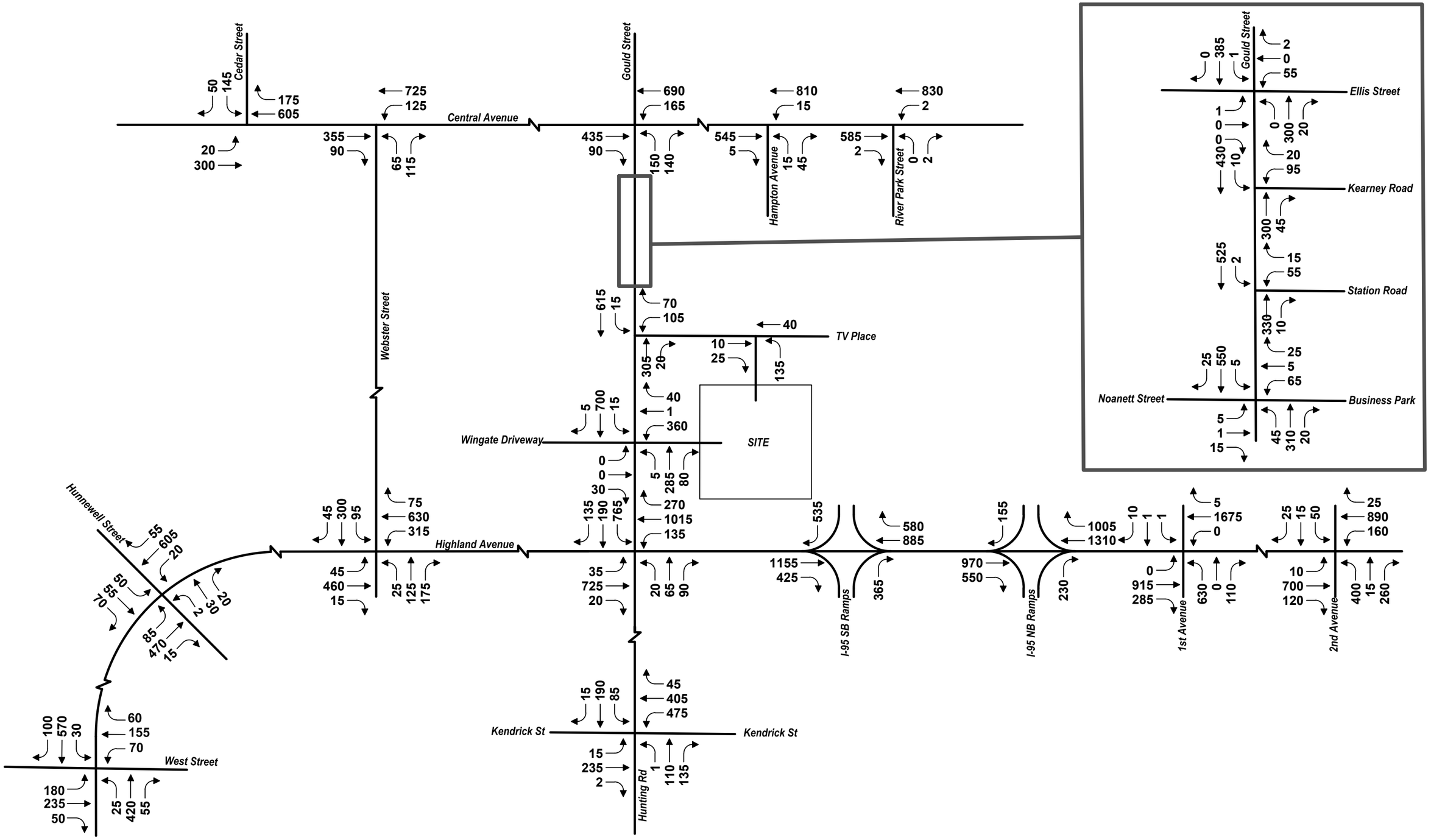
Figure 12



Not to Scale

Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 13



Not to Scale

Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 14

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.

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.

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

[9] Transportation Research Board, *Highway Capacity Manual*, 6th Edition, Washington, D.C., 2016.

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 8 shows the LOS criteria for both signalized intersections and unsignalized intersections.

Table 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.

Signalized Intersection Capacity Analyses

Table 9 summarizes the intersection capacity analyses for the signalized study area intersections and the capacity analysis worksheets are included in the Appendix to this report.

Table 9 Signalized Intersection Capacity Analysis Summary

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
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 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
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 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
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 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 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.

Unsignalized Intersection Capacity Analyses

Table 10 summarizes the intersection capacity analyses for the unsignalized study area intersections and the capacity analysis worksheets are included in the Appendix to this report.

Table 10 Unsignalized Intersection Capacity Analysis Summary

Location / Movement	2022 Existing Condition v/c [a]	Del [b]	LOS [c]	95 Q [d]	2029 No-Build Condition v/c	Del	LOS	95 Q	2029 Build Condition 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 10 Unsignalized Intersection Capacity Analysis Summary (cont.)

Location / Movement	2022 Existing Condition v/c [a]	Del [b]	LOS [c]	95 Q [d]	2029 No-Build Condition v/c	Del	LOS	95 Q	2029 Build Condition 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 Road 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 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.

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.

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 11 shows the level-of-service criteria for basic merge/diverge and weaving segments.

Table 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).

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 12 and the detailed analysis worksheets are provided in the Appendix to this report.

Table 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 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.

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 13 and the detailed analysis worksheets are provided in the Appendix to this report.

Table 13 Weave Segment Capacity Analysis Summary

Location/Period	2022 Existing Conditions			2029 No Build Conditions			2029 Build Conditions		
	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 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.

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.

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.

Traffic volumes were evaluated for the following three volume-based warrants:

[10] Manual on Uniform Traffic Control Devices, 2009 Edition; U.S. Department of Transportation Federal Highway Administration, Washington DC, December 2009.

- **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 the Appendix to this report.

Table 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 the Appendix to this report.

Table 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 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 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 crossing 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.

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 chapter 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.

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.

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.

Proposed Intersection Improvements

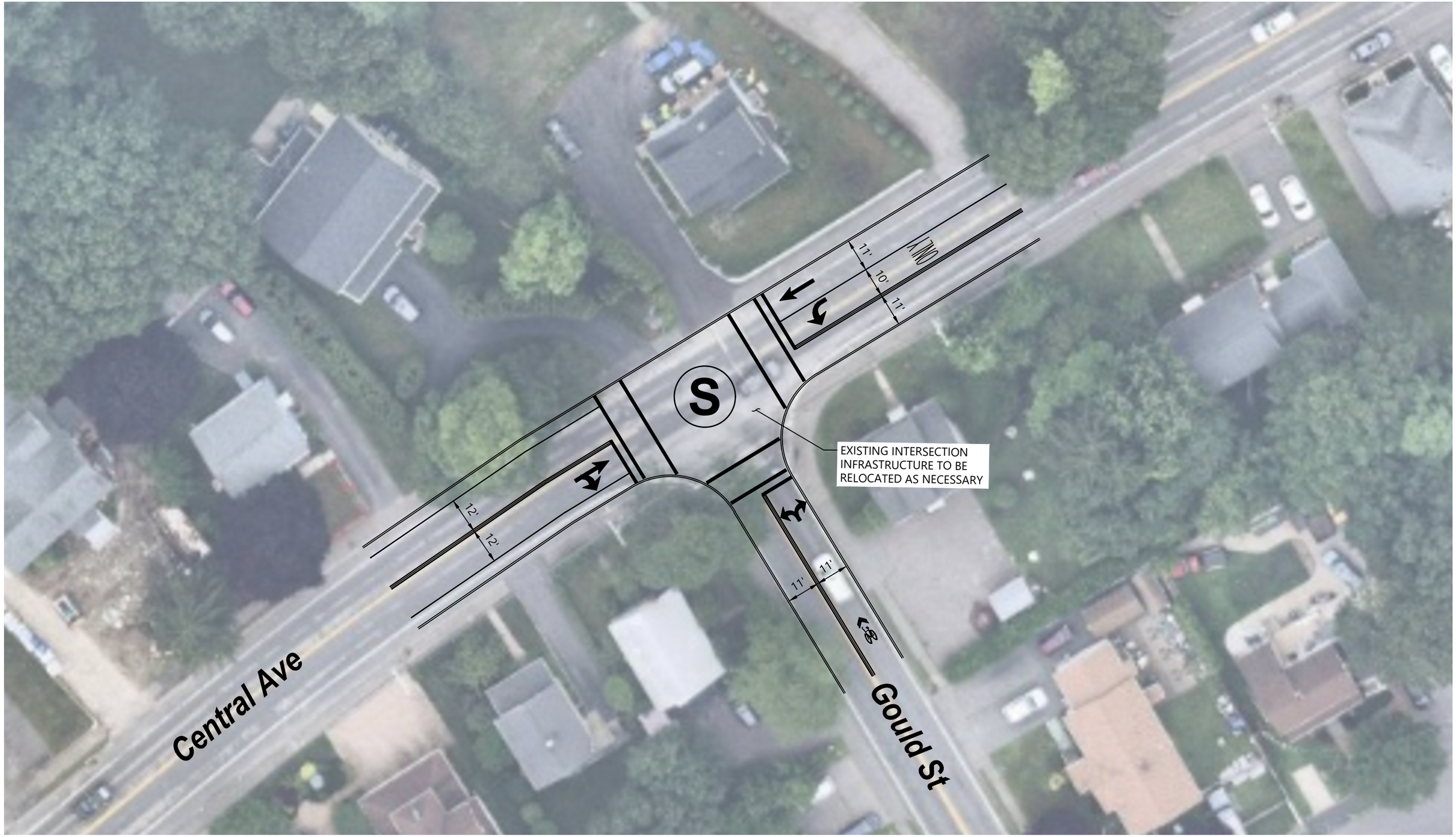
Central Avenue at Gould Street

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 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.



NOT FOR CONSTRUCTION

0 15 30 60 Feet

vhb

Proposed Intersection Improvements
Central Avenue at Gould Street
Highland Science Center
Needham, Massachusetts

Figure 15

03.30.22

Gould Street at Site Driveway / Wingate Driveway

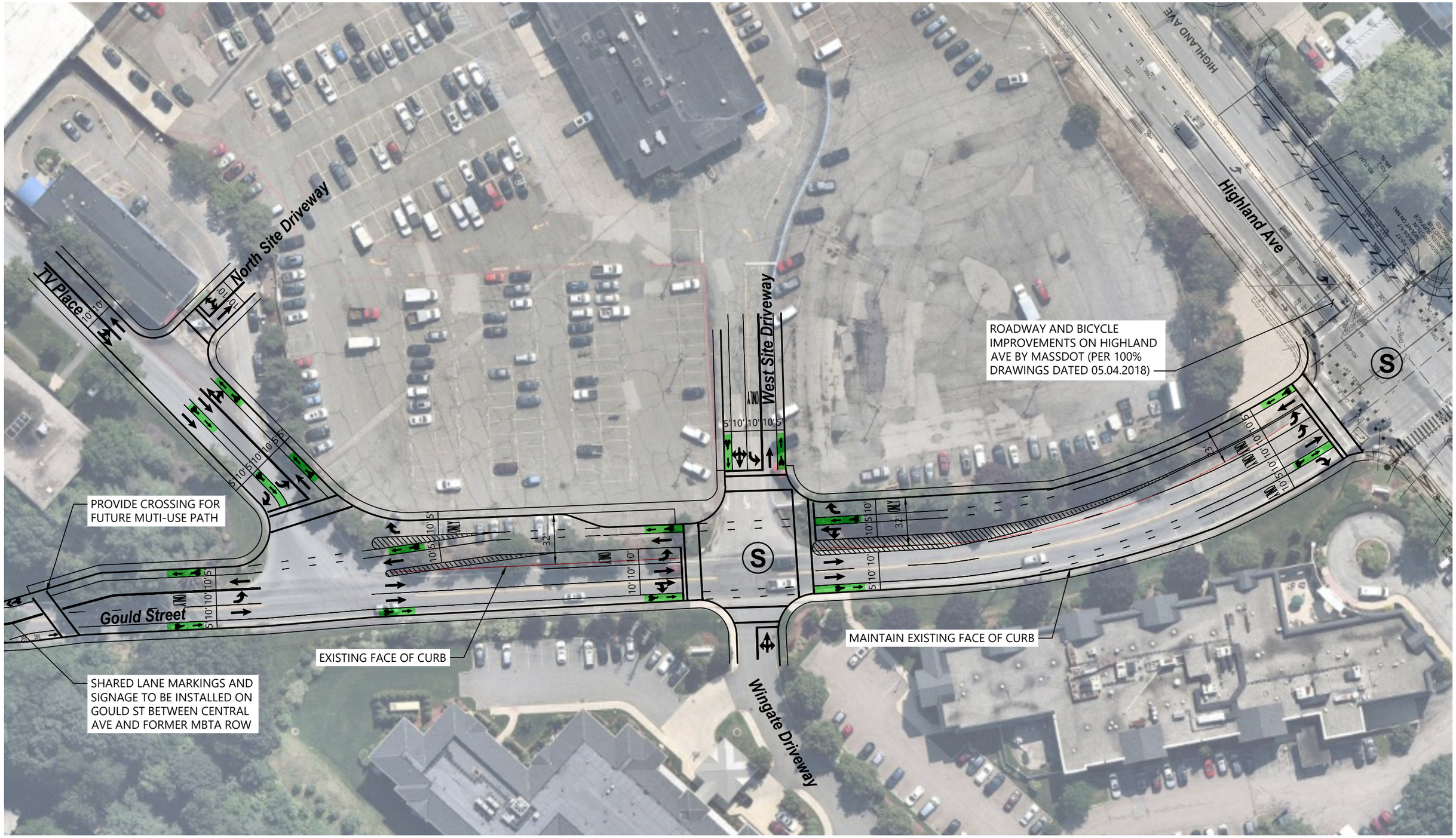
Based on the analyses presented previously, without mitigation, the Project Site driveway approach is expected to operate at LOS F during the weekday morning and weekday evening peak hours under the 2029 Build Condition, with v/c ratios greater than 1.00. Also as reported previously, this location meets 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 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.



NOT FOR CONSTRUCTION

0 30 60 120 Feet

Proposed Intersection Improvements **Figure 16**
Gould Street between TV Place and Highland Avenue
Highland Science Center
Needham, Massachusetts 03.30.22

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 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 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.

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 15 and 16 summarize the intersection capacity analyses for the signalized and unsignalized mitigated study area intersections, respectively, and the capacity analysis worksheets are included in the Appendix to this report.

Table 15 Signalized Intersection Capacity Analysis Summary - with Proposed Mitigation

Location / Movement	2029 No-Build Conditions					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
Central Avenue at Gould Street															
Weekday Morning															
Central Ave EB T/R											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	*Intersection unsignalized under 2029 No Build Conditions*					*Intersection unsignalized under 2029 Build without Mitigation Conditions*					**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											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	*Intersection unsignalized under 2029 No Build Conditions*					*Intersection unsignalized under 2029 Build without Mitigation Conditions*					**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 15 Signalized Intersection Capacity Analysis Summary - with Proposed Mitigation (cont.)

Location / Movement	2029 No-Build Conditions					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	0.97	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 16 Unsignalized Intersection Capacity Analysis Summary - with Proposed Mitigation

Location / Movement	2029 No-Build Conditions				2029 Build Without Mitigation				2029 Build With Mitigation			
	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 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 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.

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 mid day trip making;
- Telecommuting and compressed workweeks, when feasible;
- Display in the Main Lobby transportation-related information for tenants' employees and visitors; and
- Promotional efforts.

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.

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.

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.

BARRETT
PLANNING GROUP LLC

March 20, 2021

Lee Newman
Planning Director
500 Dedham Avenue
Needham, MA 02492

Reference: 2021 Fiscal Impact Analysis, Highway Commercial I Rezoning

Dear Lee,

I am submitting a revised report on the fiscal impact of commercial and mixed-use development options for the proposed Highway I Commercial District. The purposes of this revision are to address comments you provided to us by email on Tuesday, March 16. As noted in the enclosed report, we find that development in the proposed district would lead to the following fiscal outcome for the Town:

1. At maximum buildout with a floor area ratio (FAR) of 1.0, development in the new district would provide $6,733,100 in tax revenue per year and create demands on municipal services of approximately $381,000 per year. For development at this level, the net revenue would be $6,352,100, for a cost-revenue ratio of 0.060.

2. In addition, if development occurs at 1.35 FAR, development in the new district would provide $8,844,400 in tax revenue per year and create demands on municipal services of approximately $502,000 per year. The net revenue would be $8,342,400, for a cost-revenue ratio would be 0.060.

3. As for the mixed-use development options, a project comprised of multiple nonresidential uses (retail, lab space, and offices) and 170 apartments, with a combined total FAR of 1.0, would generate $5,807,600 in taxes per year and create demands on municipal and school services of approximately $1,154,900. The net revenue would be $4,652,700 for a cost-revenue ratio of 0.199.

4. A project comprised of multiple nonresidential uses and 226 apartments, with a combined total FAR of 1.35, would generate $7,508,500 in taxes per year and create demands on municipal and school services of approximately $1,479,600. The net revenue would be $6,028,900 for a cost-revenue ratio of 0.197.

5. Finally, you asked us to evaluate a potential mix of warehouse/distribution space and television studio. We estimate that the Town would receive $922,900 in tax revenue and spend approximately $179,000 for municipal services to meet the demands of these two uses. The net revenue would be $743,900, for a cost-revenue ratio of 0.241.

Under existing conditions, the parcels in the proposed district pay the Town about $490,500 in taxes per year. As a result, the gain in tax revenue from the new nonresidential options or the mixed-use development options will be anywhere from 11 to 18 times what the Town receives today.

Sincerely,

Judith A. Barrett

Judi Barrett
Barrett Planning Group LLC

FISCAL IMPACT ANALYSIS: HIGHWAY COMMERCIAL I

INTRODUCTION

In September 2019, the Needham Planning Department asked Barrett Planning Group to review a potential rezoning of four parcels (15 acres) at Highland Avenue and Gould Street west of the Route 128 highway layout. The Town subsequently decided to study the proposal further before presenting the proposed Highway Commercial I District to Town Meeting. We were asked to update our analysis in February 2021, and to expand it by including other uses not contemplated in the original concept for this district. For the new study, we reviewed and considered the following information:

1. Highway Commercial 1 Zoning District Planning Presentation, February 3, 2021;
2. Property Assessment and Tax Information, provided by the Needham Planning Department;
3. CoStar Office, Industrial, Retail, and Multifamily Market Data and Trends, Newton-Needham-Brookline-Dover Submarkets;
4. Town of Needham, FY 2021 Operating Budget;
5. Department of Revenue, Municipal Data Bank, Misc. Financial Data (Tax Rates, Assessed Values, Revenue Sources, Tax Levy); and
6. Buildout Analysis prepared by John Connery for Needham Planning Department (2015).

SUMMARY

The following chart compares the current assessed values and tax payments for the area included in our analysis to the estimated values and tax revenue of the same area, assuming the parcels are assembled and redeveloped under the proposed Highway Commercial I zoning.

TABLE 1. ASSESSED VALUE AND REVENUE CHANGE, 2021 PROPOSED HIGHWAY COMMERCIAL I

	Existing Conditions	If Redeveloped at 1.0 FAR for Nonresidential Uses	Gain/Loss at 1.0 FAR Outcome	If Redeveloped at 1.35 FAR for Nonresidential Uses	Gain/Loss at 1.35 FAR Outcome
Assessed Value	$19,087,100	$261,582,100	$242,495,000	$343,604,200	$324,517,100
Tax Revenue	$490,500	$6,733,100	$6,242,600	$8,844,400	$8,353,900
	Existing Conditions	**If Redeveloped at 1.0 FAR as Mixed-Use Option**	**Gain/Loss at 1.0 FAR Outcome**	**If Redeveloped at 1.35 FAR as Mixed-Use Option**	**Gain/Loss at 1.35 FAR Outcome**
Assessed Value	$19,087,100	$262,226,000	$243,138,900	$340,356,200	$321,269,100
Tax Revenue	$490,500	$5,807,600	$5,317,100	$7,508,500	$7,018,000
	Existing Conditions	**If Redeveloped at as Warehouse/TV Studio**	**Gain/Loss**		
Assessed Value	$19,087,100	$35,854,000	$16,766,900		
Tax Revenue	$490,500	$922,900	$432,400		

Source: Barrett Planning Group, with data from Town of Needham, Municipal Data Bank, and CoStar.

APPROACH AND METHODOLOGY

Proportional Valuation

Nonresidential development places different demands on municipal services depending on the class of use. For example, retail uses usually demand more from public safety personnel than any other municipal department, but industrial uses tend to require higher expenditures for public works. Food service establishments also require periodic inspections by the health department, and uses ranging from nursing homes and day care centers to performing arts centers require semiannual or more frequent inspections by health, fire, and building authorities. In some towns, nonresidential development of all types places demands on services traditionally thought of as "residential," e.g., public libraries. When a community invests in waterworks and sewer system upgrades, the benefits are often shared by residential and nonresidential ratepayers.

Recognizing that each class of use has both unique needs and needs common to all uses, fiscal impact analysts have developed models to identify, estimate, and assign service costs to various types of development. The most widely used model for estimating the cost to serve nonresidential land uses is known as *proportional valuation*. This two-part model embraces a long-standing fiscal impact principle: the average cost of nonresidential municipal services can be inferred from the relationship between nonresidential real property values and the total value of real property in a community, adjusted for type of community and size of tax base.

TABLE 2. PROPORTIONAL VALUATION ANALYSIS: EXISTING CONDITIONS, NEEDHAM

A	2021 General Fund Operating Budget	$190,247,800	*Town of Needham*
B	Less Education	$81,835,000	*Town of Needham*
C	Less Education Debt	$10,766,800	*Town of Needham*
D	Less Education Fixed Costs	$26,592,400	*Consultant Estimate*
E	Total Municipal	$71,053,600	*Town of Needham*
F	Non-Residential Real Property Value	$1,153,202,700	*Dept. of Revenue*
G	Total Real Property Assessed Value	$10,742,368,800	*Dept. of Revenue*
H	Ratio	0.107	*F/G*
I	Non-Residential Parcels	441	*Dept. of Revenue*
J	Total Parcels	10,211	*Dept. of Revenue*
K	Average Value: Non-Residential Parcel	$2,615,000	*FI*
L	Average Value: All Parcels	$1,052,000	*G/J*
M	Ratio	2.49	*K/L*
N	Refinement Coefficient	0.686	*Consultant (Burchell)*
O	Non-Residential Expenditures	$5,232,600	*Consultant*
P	Residential Expenditures	$185,015,200	*Consultant*

Average Cost Per Capita/Student, Adjusted

After establishing the approximate share of nonresidential expenditures under existing conditions, analysts can use a similar process to estimate the cost of services that will be used by new growth. For our 2019 study of Highway Commercial I, we applied the principles of proportional valuation to estimate the revenue and cost of services impact of new development under that plan. People familiar with that study may remember that a critical step in proportional valuation involves using a *refinement coefficient* to modify the average cost of nonresidential services in order to adjust for significant differences in scale between the proposed project and existing conditions in the tax base as a whole. We repeated the process for this report. However, since the new plan for the district includes options for mixed-use development with housing, the updated study is more complicated.

The development scenarios that could occur under the proposed zoning include multifamily units in mixed-use projects. This means the fiscal impact analysis must also consider the net new cost of residential demands on municipal services and schools. To estimate these costs, we used the following procedures.

The average cost of non-school services used by Needham residents is $2,130. This represents the total cost of residential non-school services, $65,821,000, divided by the Town's estimated 2019 population, 30,970.[1] When we prepare a fiscal impact analysis, our goal is to simulate as much as possible what the Town's *net new cost of services* will be – that is, the *incremental cost* of services associated with growth. Toward that end, we adjusted the average cost of municipal services per capita, just as we modified the average cost for the nonresidential portion of this study. For the residential analysis, we eliminated costs that would not necessarily change just because the Town attracts a modest number of new residents. For example, the Town would not hire more personnel in the Town Manager's office or the management/administrative tiers of other general government offices or the public safety and public works departments just because the Town gained 330-400 new residents. Still, population growth will impose some additional burdens on day-to-day service delivery, and those burdens come with some costs.

To account for these new demands, we assumed the *average variable cost* in municipal departments is approximately 18 percent, so we used 82 percent of the average municipal cost of services to estimate the cost of new growth:

Average cost of new municipal services =	Existing cost of municipal services	X 82%	/ Existing Population
$1,740 =	$65,821,000	$53,973,200	30,970

**Numbers may not total due to rounding.*

The cost of new services was multiplied by the new household population assumptions for each mixed-use scenario to arrive at the estimated cost of new demands on town services.

[1] U.S. Census Bureau, 2015-2019 American Community Survey (ACS) Five-Year Estimates).

The potential cost of new school services was estimated in a similar way. We consulted the detailed version of Needham's most recent Per Pupil Cost report from the Massachusetts Department of Elementary and Secondary Education (DESE) and identified what we assumed would be costs most directly affected by enrollment growth: teachers, instructional support personnel, instructional materials, and pupil services, including transportation. On a per-student basis, the sum of these expenditures is $7,530. Since the most recent report reflects FY 2019 conditions, we adjusted for inflation and non-inflation spending growth with a multiplier of 1.12. This explains how we arrived at the average cost per student for our study, $8,400.

We used the following procedures and data sources to estimate the new household population:

- The Town supplied us with the school enrollment counts for three existing Chapter 40B mixed-income developments: Charles River Landing, Modera Needham, and The Kendrick. The total number of units in these developments is 943 and total number of school students, 105 (October 1, 2020). Since 70 percent of the apartments at Charles River Landing are one-bedroom units, the number of school-age children is very low (18). We eliminated Charles River Landing from our analysis and focused on the other projects. The average number of students living at Modera Needham (136 units) and The Kendrick (390 units) is 87, or an average of 0.165 per unit. We used that number to estimate the school enrollment impact of the mixed-use options for the subject property: 28 students in 170 units or 38 students in 226 units.
- The household population estimate is based on the average household size of two-bedroom apartments per the U.S. Census Bureau, *American Housing Survey*: 1.945 persons per unit. For 170 units, the result is 331 new residents and for 226 units, 440.

The proportional valuation models for each of the development options the Town asked us to evaluate are presented on the following pages. They are:

1. **A nonresidential project with a maximum floor area ratio (FAR) of 1.0., comprised of:**
- Office: 280,305 sq. ft.
- Research Center/Lab: 280,305 sq. ft.
- Retail: 98,925 sq. ft.
- Total: 659,535 sq. ft.

2. **A nonresidential project with a maximum floor area ratio (FAR) of 1.35., comprised of:**
- Office: 368,200 sq. ft.
- Research Center/Lab: 368,200 sq. ft.
- Retail: 129,940 sq. ft.
- Total: 866,340 sq. ft.

3. **A mixed-use project with a maximum floor area ratio (FAR) of 1.0, comprised of:**
- Office: 197,860 sq. ft.
- Research Center/Lab: 197,860 sq. ft.
- Retail: 69,250 sq. ft.

- Apartments: 170
- Total: 659,535 sq. ft.

4. A mixed-use project with a maximum floor area ratio (FAR) of 1.35., comprised of:

- Office: 259,130 sq. ft.
- Research Center/Lab: 259,130 sq. ft.
- Retail: 91,460 sq. ft.
- Apartments: 226
- Total: 866,340 sq. ft.

5. A warehouse/distribution facility and television studio mix as of right:

- Warehouse: 158,900 sq. ft.
- TV studio: 90,002
- Total: 248,902 sq. ft.

Part II. Est. Impact of Five Development Scenarios
II.A. Office/Research/Retail Mix @ 1.0 FAR

	NEW PROJECT VALUE (Z)	$261,582,100	NOTES
A	New Value / Total Nonresidential Value	0.23	
B	Refinement Coefficient	0.321	
C	New Nonresidential Service Costs	$381,000	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$6,733,100	*Value/1000/*$25.74*
E	New Residential Service Costs		
F	Est. Residential Tax Revenue		
G	Net Revenue	$6,352,100	*D-C*
H	Cost/Revenue Ratio	0.060	*C/D*
	Project Use(s)		
I	Total Sq. Ft.	659,535	*From Town*
J	Office	280,305	*From Town*
K	Research Center	280,305	*From Town*
L	Retail	98,925	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	0	*From Town*
	Rent		
O	Office sq. ft.	$42.00	*CoStar*
P	Research Center sq. ft.	$60.00	*CoStar*
Q	Retail sq. ft.	$36.80	*CoStar*
R	Warehouse sq. ft.	$19.61	*Loopnet*
S	Residential (per unit)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$32,231,550	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$13,920,800	*CoStar*
V	Nonresidential NOI	$18,310,750	*T-U*
W	Residential Income	$0	
X	Residential Exp. Ratio 38%	$0	
Y	Residential NOI	$0	
Z	Submarket NonRes. Cap Rate 7%	$261,582,100	*Town; consultant modified*
AA	Submarket Res. Cap Rate 4.50%	$0	
AB	Total Value	$261,582,100	(Z+AA)

Part II. Est. Impact of Five Development Scenarios
II.B. Office/Research/Retail Mix @ 1.35 FAR

	NEW PROJECT VALUE (Z)	$343,604,200	NOTES
A	New Value / Total Nonresidential Value	0.30	
B	Refinement Coefficient	0.322	
C	New Nonresidential Service Costs	$502,000	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$8,844,400	*Value/1000/*$25.74*
E	New Residential Service Costs		
F	Est. Residential Tax Revenue		
G	Net Revenue	$8,342,400	*D-C*
H	Cost/Revenue Ratio	0.060	*C/D*
	Project Use(s)		
I	Total Sq. Ft.	866,340	*From Town*
J	Office	368,200	*From Town*
K	Research Center	368,200	*From Town*
L	Retail	129,940	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	0	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$42,338,192	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$18,285,900	*CoStar*
V	Nonresidential NOI	$24,052,292	*T-U*
W	Residential Income	$0	
X	Residential Exp. Ratio 38%	$0	
Y	Residential NOI	$0	
Z	Submarket NonRes. Cap Rate 7%	$343,604,200	*Town; consultant modified*
AA	Submarket Res. Cap Rate 4.50%	$0	
AB	Total Value	$343,604,200	

Part II. Est. Impact of Five Development Scenarios
II.C. Office/Research/Retail/Residential Mix @ 1.0 FAR

	NEW PROJECT VALUE (Z)	$262,226,000	NOTES
A	New Value / Total Nonresidential Value	0.23	
B	Refinement Coefficient	0.289	
C	New Nonresidential Service Costs	$343,900	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$4,841,900	*Value/1000/*$25.74*
E	New Residential Service Costs[2]	$810,951	*See Assumptions*
F	Est. Residential Tax Revenue	$965,700	*Value/1000/*$13.03*
G	Net Revenue	$4,652,749	*(D+F)-(C+E)*
H	Cost/Revenue Ratio	0.199	*(C+E)/(D+F)*
	Project Use(s)		
I	Total Sq. Ft.*	659,535	*From Town*
J	Office	197,860	*From Town*
K	Research Center	197,860	*From Town*
L	Retail	69,250	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	170	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$23,178,410	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$10,010,800	*CoStar for exp. ratio*
V	Nonresidential NOI	$13,167,610	*T-U*
W	Residential Income	$5,379,480	*Units * rents*
X	Residential Exp. Ratio 38%	$2,044,200	*CoStar for exp. ratio*
Y	Residential NOI	$3,335,280	*W-X*
Z	Submarket NonRes. Cap Rate 5.90%	$188,108,700	*CoStar for cap rate*
AA	Submarket Res. Cap Rate 4.50%	$74,117,300	*CoStar for cap rate*
AB	Total Value	$262,226,000	*Z+AA*

[2] 331 residents, 28 students

Part II. Est. Impact of Five Development Scenarios
II.D. Office/Research/Retail/Residential Mix @ 1.35 FAR

	NEW PROJECT VALUE (AB)	$340,356,200	NOTES
A	New Value / Total Nonresidential Value	0.30	
B	Refinement Coefficient	0.26	
C	New Nonresidential Service Costs	$401,500	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$6,224,600	*Value/1000/*$25.74*
E	New Residential Service Costs[3]	$1,078,100	*See Assumptions*
F	Est. Residential Tax Revenue	$1,283,900	*Value/1000/*$13.03*
G	Net Revenue	$6,028,900	*(D+F)-(C+E)*
H	Cost/Revenue Ratio	0.197	*(C+E)/(D+F)*
	Project Use(s)		
I	Total Sq. Ft.*	863,010	*From Town*
J	Office	259,130	*From Town*
K	Research Center	259,130	*From Town*
L	Retail	91,460	*From Town*
M	Warehouse	0	*From Town*
N	Residential (Units)	226	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$29,796,988	*Sq. ft.*rents*
U	Nonresidential Exp. Ratio 39.2%	$12,869,300	*CoStar for exp. ratio*
V	Nonresidential NOI	$16,927,688	*T-U*
W	Residential Income	$7,151,544	*Units * rents*
X	Residential Exp. Ratio 38%	$2,717,600	*CoStar for exp. ratio*
Y	Residential NOI	$4,433,944	*W-X*
Z	NonRes Value: NonRes. Cap Rate 7%	$241,824,100	*Town; consultant modified*
AA	ResValue: Submarket Res. Cap Rate 4.50%	$98,532,100	*CoStar for cap rate*
AB	Total Value	$340,356,200	*Z+AA*

[3] 440 residents, 38 students.

Part II. Est. Impact of Five Development Scenarios
II.E. Warehouse/Distribution

	NEW PROJECT VALUE (AB)	$35,854,000	NOTES
A	New Value / Total Nonresidential Value	0.03	
B	Refinement Coefficient	0.55	
C	New Nonresidential Service Costs	$179,000	*(A*B*NonResTot)*
D	Est. Nonresidential Tax Revenue	$922,900	*Value/1000/*$25.74*
E	New Residential Service Costs	N/A	
F	Est. Residential Tax Revenue	N/A	
G	Net Revenue	$743,900	*D-C*
H	Cost/Revenue Ratio	0.241	*C/D*
	Project Use(s)		
I	Total Sq. Ft.	0	*From Town*
J	Office	0	*From Town*
K	Research Center	0	*From Town*
L	Retail	0	*From Town*
M	Warehouse	158,900	*From Town*
M.1	TV Studio (No Change)	90,002	*From Town*
N	Residential (Units)	0	*From Town*
	Rent		
O	Office	$42.00	*CoStar*
P	Research Center	$60.00	*CoStar*
Q	Retail	$36.80	*CoStar*
R	Warehouse	$19.61	*Loopnet*
S	Residential (Units)	$2,637	*CoStar*
	Income & Value		
T	Gross Nonresidential Income	$3,116,000	*Warehouse only*
U	Nonresidential Exp. Ratio 35%	$1,345,800	*CoStar for exp. ratio*
V	Nonresidential NOI	$1,770,200	*T-U*
W	Residential Income	$0	*Units * rents*
X	Residential Exp. Ratio 38%	$0	*CoStar for exp. ratio*
Y	Residential NOI	$0	*W-X*
Z	Submarket NonRes. Cap Rate 5.50%	$35,854,000	*Warehouse + TV Studio*
AA	Submarket Res. Cap Rate 4.50%		*CoStar for cap rate*
AB	Total Value	$35,854,000	*Z+AA*

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

Appendices

List of Tables

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

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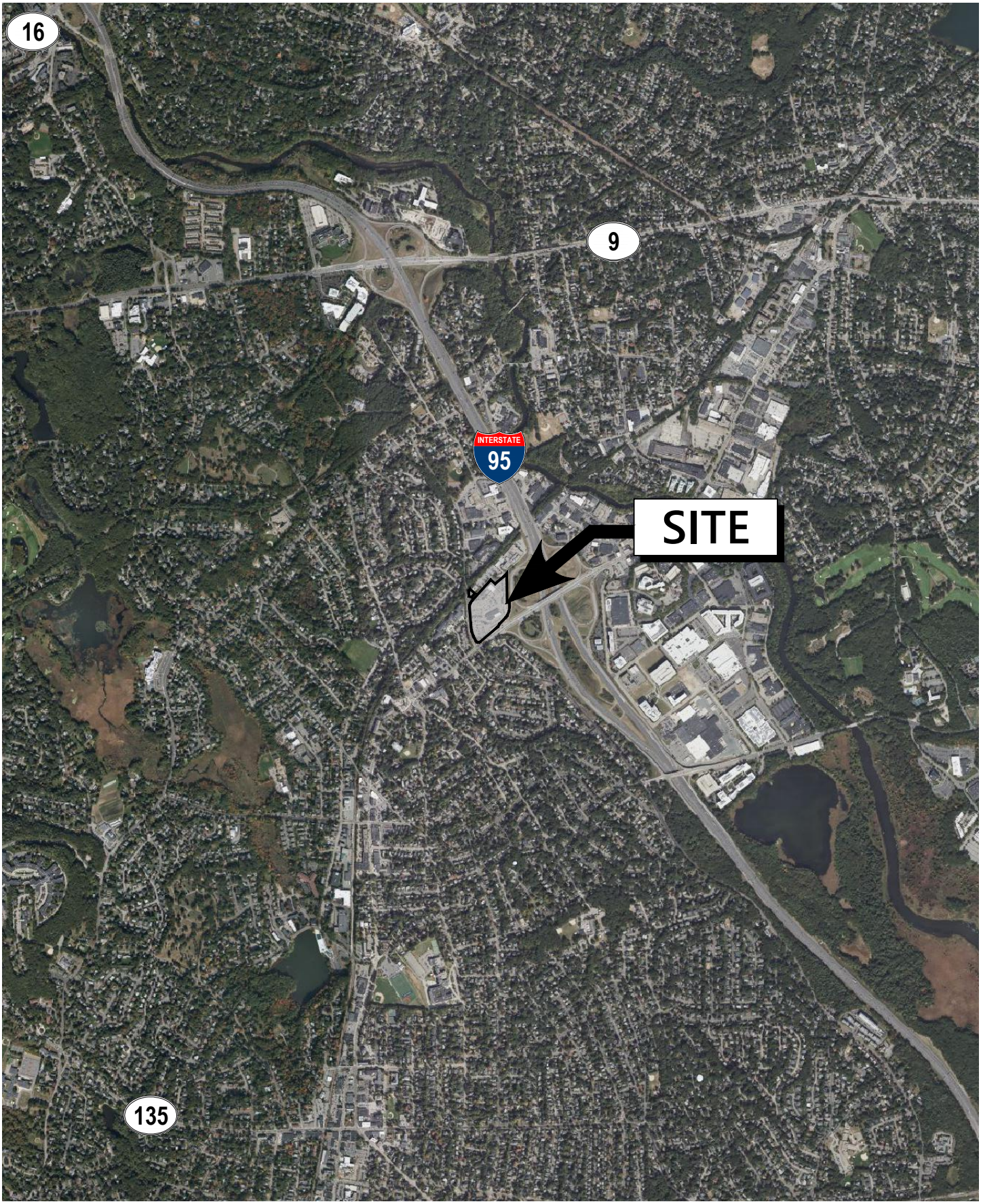


0 1,000 2,000 Feet

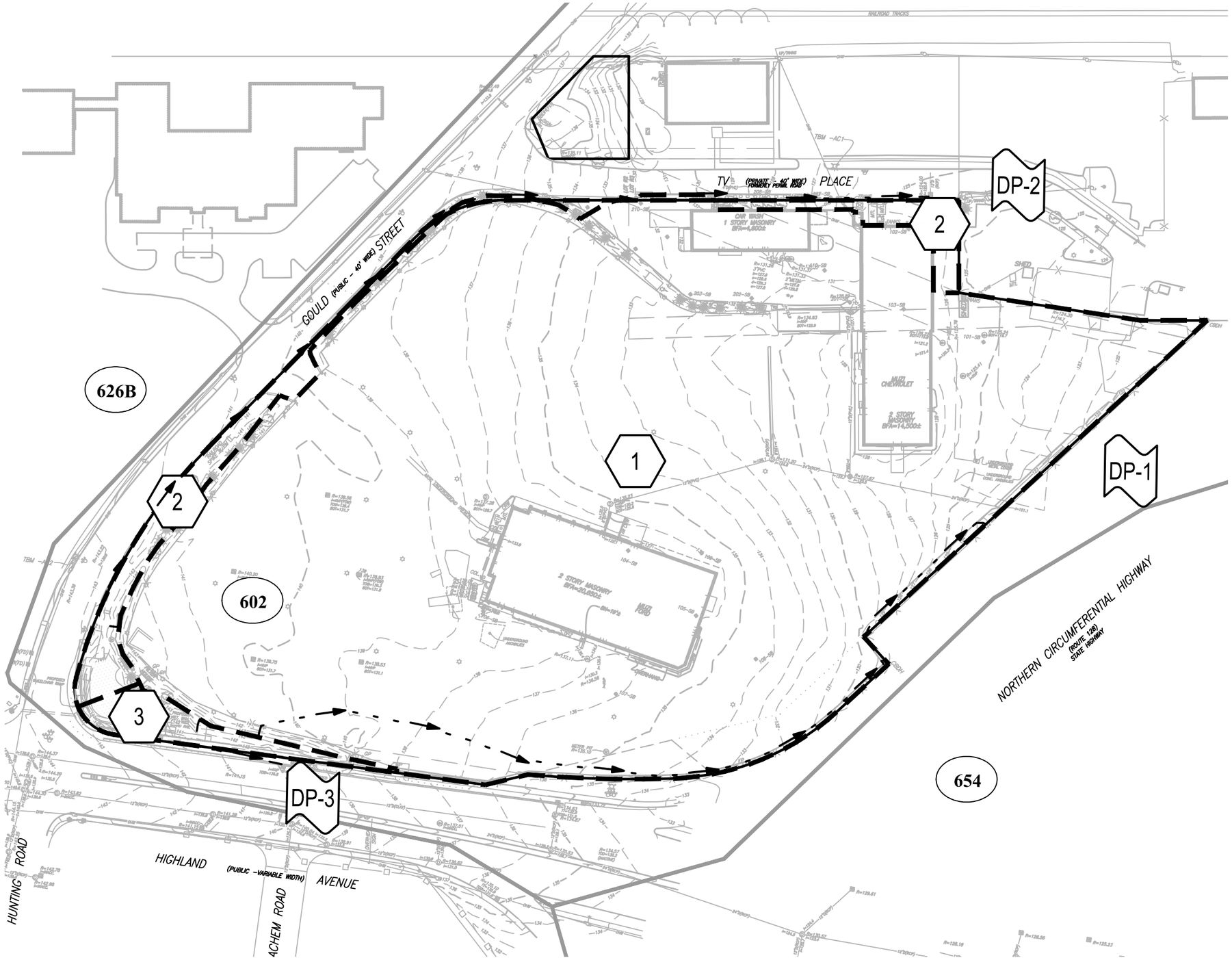
Site Locus Map

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

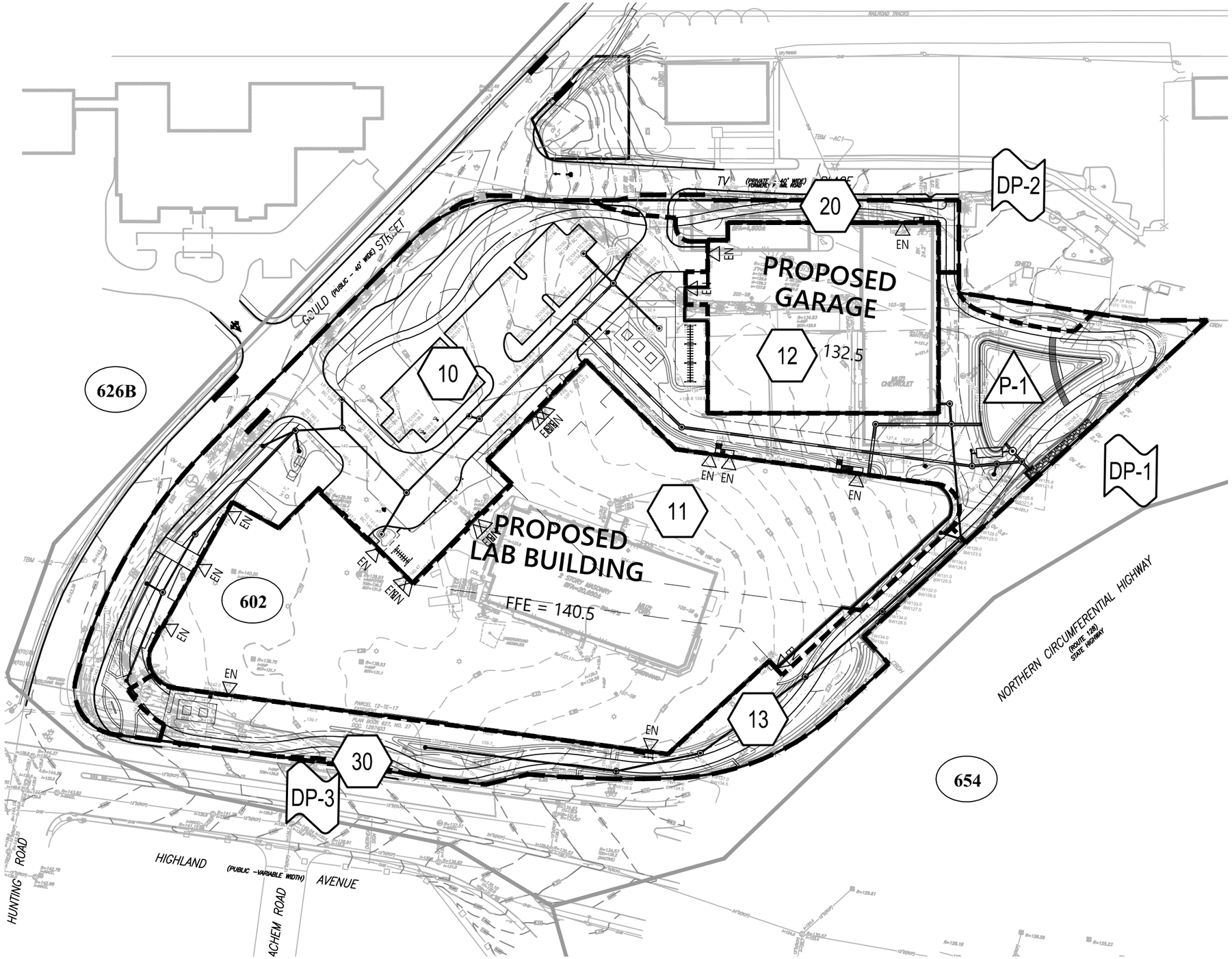
557 Highland Avenue
Needham, MA

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

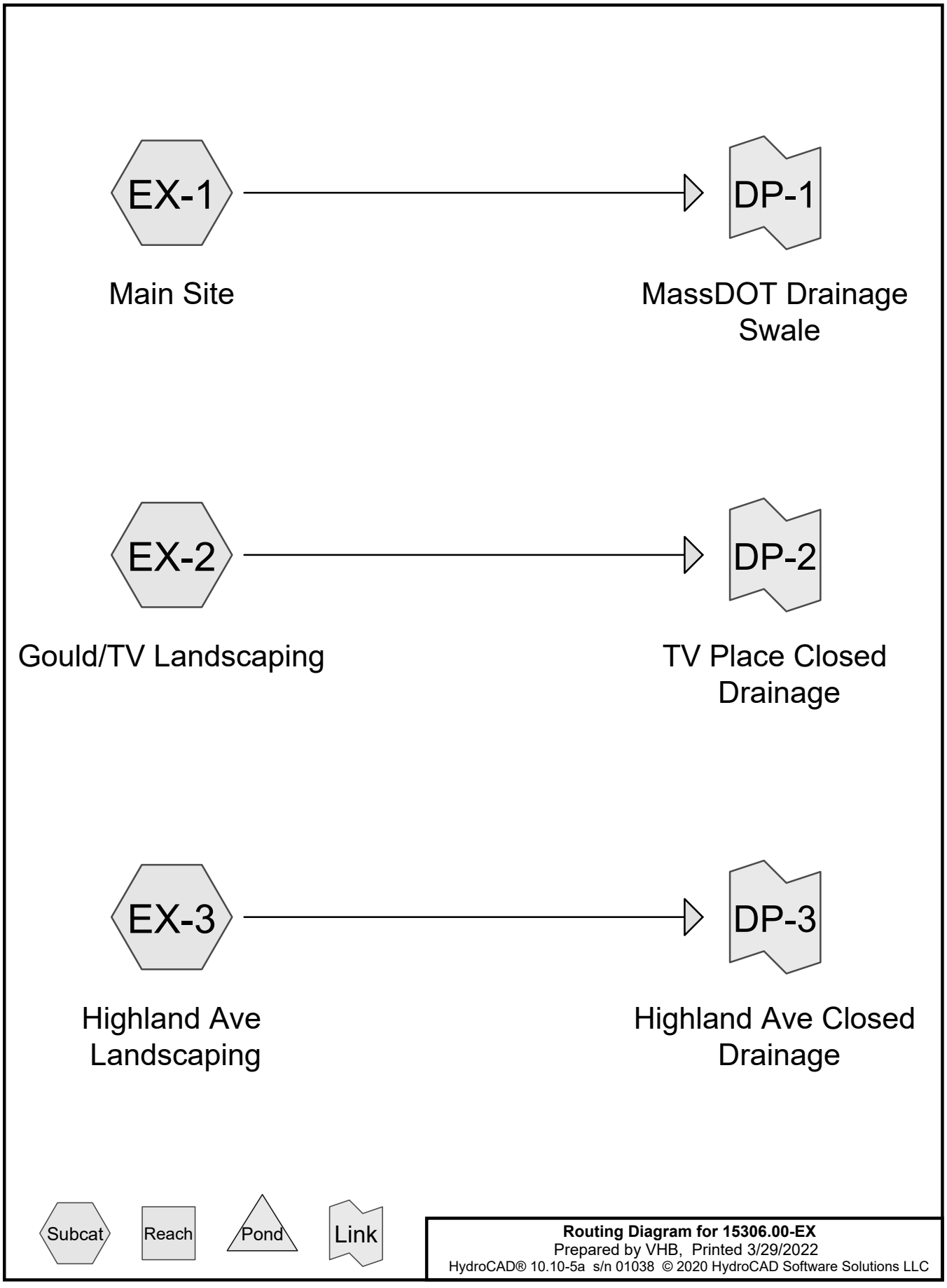
[1] SCS-TP-61
[2] Increase values 25 percent when the anticipated average use of the spillway is not more frequent than once in 10 years.
[3] Those with a high clay content and high plasticity. Typical soil textures are silty clay, sandy clay, and clay.
[4] Those with a high content of fine sand or silty 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

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

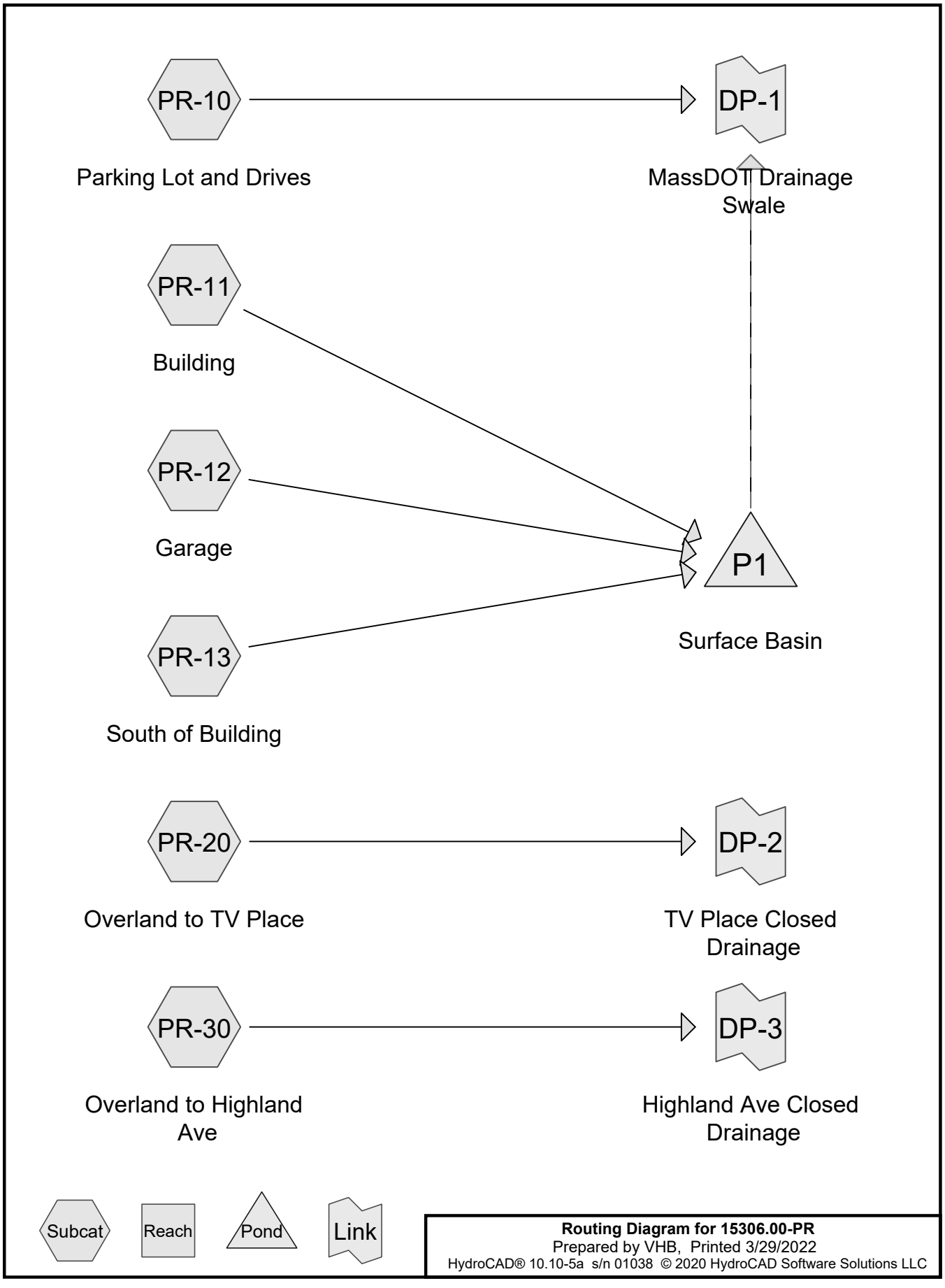
Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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

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.

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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 _____

REF.: NEX-2200133.00

May 27, 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
Traffic Peer Review

Dear Ms. Newman:

On behalf of the Town of Needham, ***Greenman-Pedersen Inc.*** (GPI) performed a review of the *Transportation Impact and Access Study*[1] (TIAS) prepared by Vanasse Hangen Brustlin, Inc. (VHB) for review by the Town of Needham 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 TIAS 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 TIAS.

General Comments

1. As the project directly abuts the state highway layout (SHLO) on Interstate 95 / Route 128 and is anticipated to generate more than 3,000 vehicle trips per day (vpd), the project will require review by the Massachusetts Environmental Policy Act (MEPA) office in the form of a Environmental Notification Form (ENF) and a mandatory Environmental Impact Report (EIR). An ENF was prepared by the Applicant and noticed in the Environmental Monitor on April 8, 2022. The TIAS was included as a chapter within the ENF. A Certificate on the ENF was issued by MEPA on May 9, 2022. GPI previously provided comments to the MEPA office on behalf of the Town of Needham regarding the ENF, and a copy of these comments in included as an Attachment for reference. Many of GPI's comments were incorporated into the recommendations of the ENF Certificate, which include:
    a) Table 2-9 of the ENF indicates that the traffic operations at the intersections of Highland Avenue / West Street will drop from LOS C to D and the operations of Highland Avenue / Gould Street / Hunting Road will degrade from LOS E to F as a result of the additional traffic generated by the project. The Applicant is requested to explore the feasibility of implementing additional measures to improve operations at these locations, including an additional northbound lane on Hunting Road.
    b) Collision diagrams should be prepared for any study area intersections experiencing an average of more than 3.0 collisions per year and a crash rate higher than the statewide or district-wide average. The Applicant should investigate measures to improve safety and mitigate collision occurrence at any locations where five or more collisions of a similar type have occurred over the analysis period.

[1] *Transportation Impact and Access Study, Highland Science Center, Needham, Massachusetts;* prepared by Vanasse Hangen Brustlin, Inc. (VHB); March 2022.

c) The Applicant should perform an estimate of the potential bicycle parking demand generated by the project to ensure adequate bicycle parking is provided for an effective Transportation Demand Management (TDM) program.

2. The project will also require a Vehicular Access Permit from MassDOT for the proposed change-in-use of the property, as well as for the construction of off-site roadway improvements within the SHLO. As such, the ENF was reviewed by the MassDOT District 6 office, as well as the Public-Private Development Unit (PPDU). The following comments from MassDOT were incorporated into the ENF Certificate issued by MEPA:

   a) The Applicant should evaluate queuing at the study area intersections to ensure that lengthier queues do not impact the operation of roadways and railways within the study area.

   b) The Applicant should perform an analysis of the existing and proposed weave conditions on Highland Avenue to ensure that the increased traffic volumes will not lead to degraded safety conditions in the area of the I-95 / Highland Avenue interchange.

   c) The Applicant should coordinate with the Massachusetts Bay Transit Authority (MBTA) to determine the feasibility of additional MBTA Bus Route 59 service closer to the project site and include feasible options in the Draft EIR.

   d) MassDOT requests that the Applicant consider installing bicycle and pedestrian improvements on Highland Avenue at the I-95 Interchange to connect with the proposed Complete Streets improvements being installed as part of MassDOT Project #606635 along Highland Avenue.

   e) The Applicant should provide a description of the methodology to be used to estimate the effectiveness of the proposed Transportation Demand Management (TDM) measures and discuss what remedial measures will be taken if the monitoring program indicates that the TDM program is less effective than anticipated in reducing single-occupant vehicle (SOV) trips and encouraging alternative means of travel to/from the site.

   f) The proposed Transportation Monitoring Program should include a travel survey of employees and patrons of the site. Although MassDOT did not provide any further details on this request, it is assumed that the travel survey will be designed to verify the distribution of site-generated trips and mode share in order to assess the efficacy of the proposed TDM program.

Study Area

3. The TIAS includes an evaluation of the impact to traffic operations associated with the project at a total of twenty (20) intersections, which include all nine of the study intersections included as part of the *Traffic Impact Study*[2] prepared for the original rezoning. GPI concurs that the study area is appropriate for the size and scale of the development and includes those intersections which are likely to experience a measurable impact from the proposed redevelopment.

Existing Conditions

4. The TIAS included an evaluation of the operations of the study area intersections during the weekday AM and PM peak periods, which are consistent with typical commuter peaks on the adjacent roadway networks. GPI concurs that these time periods represent the critical time periods for analysis as they represent the peak hours of both adjacent street traffic and site-generated vehicle trips.

[2] *Traffic Impact Study, Muzi Motors Rezoning, Gould Street & Highland Avenue – Needham, Massachusetts;* prepared by Greenman-Pedersen, Inc. (GPI); October 2020.

5. The Existing Conditions Vehicle Volumes were derived from traffic counts obtained from a number of sources, many of which were collected prior to the COVID-19 pandemic. New traffic counts were collected in July 2021 at the following intersections:
    - Central Avenue at Cedar Street
    - Central Avenue at Webster Street
    - Highland Avenue at Hunnewell Street

   All other traffic counts contained within the traffic study were collected pre-pandemic and adjusted to existing conditions utilizing MassDOT's approved Yearly Growth Factors and balancing between intersections. Regardless of which traffic count was collected more recently, the traffic volumes between intersections were always balanced upward to the higher traffic count. GPI concurs that this methodology is acceptable and will result in the most conservative (highest) estimate of existing traffic conditions through the study area intersections.

6. Traffic counts at many of the study area intersections were obtained from previously seasonally-adjusted traffic volumes from other traffic studies. However, raw traffic counts collected in April 2017 were obtained from the *Highland Avenue Reconstruction Functional Design Report*[3] for the Highland Avenue / Webster Street intersection. Similarly, raw traffic counts collected in January 2018 were obtained from the *Northland Newton Development DEIR*[4] for the Highland Avenue intersections with the I-95 Northbound and Southbound ramps. MassDOT Weekday Seasonal Factors data was provided in the TIAS Appendix for the 2019 year only. Since the traffic counts were collected in 2017 and 2018, it would be expected that seasonal adjustment factors for those years would have been used to seasonally adjust the raw traffic volumes. MassDOT's Weekday Seasonal Factors data for 2017 and 2019 both indicate that traffic volumes in April represent above-average conditions for Group Factors U3-U7. Therefore, no seasonal adjustment would be required for the Highland Avenue / Webster Street intersection. It is unclear what, if any, seasonal adjustment factor was applied to the volumes at the Highland Avenue intersections with the I-95 ramps. However, the MassDOT Weekday Seasonal Factors data for 2018 indicates that January traffic volumes for Factor Group U3 represent above-average month conditions. Therefore, no seasonal adjustment factor would be required for the Highland Avenue intersections with the I-95 ramps.

7. No adjustment was applied to the traffic volumes collected in July 2021 to account for any variations due to COVID-19. However, these traffic counts were balanced upward with traffic counts collected at adjacent intersections under pre-COVID conditions. GPI concurs that this methodology for adjustment is acceptable.

Collision History

8. 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 intersection of Highland Avenue / West Street experienced an average of 4.4 crashes per year and a crash rate higher than the state and district-wide averages. Similarly, the Highland Avenue / Second Avenue intersection experiences an average of 6.6 collisions per year and a crash rate above the state and district-wide averages. Therefore, the Applicant should obtain detailed collision reports for these intersections and prepare collision diagrams to identify any collision patterns occurring at these locations, as well as potential measures to reduce the occurrence of such collisions.

9. The following additional intersections also experienced an average of more than three (3) collisions per year, and collision diagrams should be prepared to identify any collision patterns or potential mitigating measures at these intersections:
    - Highland Avenue / First Avenue
    - Hunting Road / Kendrick Street

[3] *Highland Avenue Reconstruction Functional Design Report*; Prepared by Stantec, Inc.; August 2017.
[4] *The Northland Newton Draft Environmental Impact Report*; Prepared by Vanasse Hangen Brustlin, Inc. (VHB); August 2020.

10. Although the intersection of Highland Avenue / Gould Street / Hunting Road also experienced more than three collisions per year, the crash rate was well below the state and district-wide averages. In addition, significant improvements were recently constructed by MassDOT that may reduce collisions at this location. Further, additional improvements are proposed at this intersection as mitigation for the proposed development, which may also impact collision occurrence. Therefore, preparation of a collision diagram for this location is not required. However, GPI recommends that the proposed Post-Occupancy Monitoring Program include a review of collisions occurring at this location following construction of the proposed mitigation measures to ensure that a new safety issue is not introduced.

2029 No-Build Conditions

11. The Applicant has projected traffic volumes to a seven-year design horizon consistent with MassDOT guidelines utilizing a background growth rate of 1.0 percent per year and adding traffic to be generated by other proposed or approved developments in the surrounding area. GPI concurs with this methodology.

Trip Generation

12. Table 3 of the TIAS 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.

13. The Applicant has estimated the site-generated vehicle trips based on Institute of Transportation Engineers (ITE) trip generation rates for Land Use Codes (LUC) 710 (General Office Building), 760 (Research and Development Center) and 822 (Strip Retail Plaza (<40,000 sf)) and applied a modest credit for internal capture of trips shared between uses on the site. In addition, the Applicant has assumed that 25 to 40 percent of the retail trips will be from pass-by trips (vehicles already on the adjacent roadway network passing by the site while traveling to another destination). GPI concurs with this methodology.

14. Although the Applicant has proposed a significant Transportation Demand Management (TDM) program, the Applicant has not applied any reduction in vehicle trips generated by the project for the implementation of the TDM program. While GPI agrees that this methodology will result in the most conservative (worst case) estimate of project's impacts on traffic operations through the study area, it should not excuse the Applicant from developing an effective TDM program or identify target mode share goals for the proposed TDM program. The Applicant should estimate the potential mode share and vehicle trip reduction anticipated from implementing the proposed TDM program and identify mode share goals to be monitored and evaluated as part of the Post-Occupancy Monitoring Program.

Transportation Demand Management (TDM) Measures

15. The Applicant has proposed the following transit-related measures as part of the TDM program:
    - 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.

Bicycle Accommodations

16. Section 2.3.4.1 of the ENF notes that a total of 89 bicycle parking spaces will be provided indoors and outdoors, while the TIAS describes a total of only 70 bicycle parking spaces proposed on the site. The Applicant should clarify this discrepancy.

17. No description has been provided within the ENF or TIAS on how many bicycle parking spaces will be indoors and how many will be outdoors. The studies also do 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. The Applicant should provide an evaluation of the potential bicycle parking demand to ensure that adequate bicycle parking is provided to encourage use of bicycle as a means of traveling to/from the site.

Proposed Mitigation

18. The TIAS describes geometric improvements that are proposed at the intersection of Highland Avenue / Gould Street / Hunting Road as mitigation for the project, which are shown graphically in Figure 16. 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 was provided in the TIAS and no signal improvements are shown in Figure 16.

19. Figure 16 of the TIAS 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. The Figure does not include the Highland Avenue eastbound or Hunting Road northbound approaches to the intersection, so it is difficult to identify what, if any, improvements are proposed on those approaches. However, Figure 1.4 of the ENF also provides a similar graphic that includes all approaches to the intersection. 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 15 of the TIAS 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.

20. Figure 15 of the TIAS depicts improvements to be constructed at the Central Avenue / Gould Street intersection as mitigation for the project, which include restriping of Central Avenue to provide a westbound left-turn lane and installation of a fully-actuated traffic signal. The proposed signal equipment is not depicted on the plans. The Applicant should obtain survey information at this location to verify whether the proposed improvements can be constructed within the publicly-available right-of-way and whether any easements will

be required for the proposed signal equipment. In addition, the Applicant should perform vehicle turning movement analysis to verify that that the proposed curb radii and STOP line locations will allow emergency vehicles and trucks to safely navigate the intersection without encroaching on opposing traffic flows.

Transportation Operations Analysis

21. According to Table 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.

22. 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.

23. 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.

24. 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.

25. 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.

26. As noted in Comment 19, 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

27. The TIAS 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.

28. 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.

Site Access and Circulation

29. Figure 2 of the TIAS provides a site plan depicting the proposed layout and traffic circulation on the site. The plan appears to indicate that a loading/unloading area will be provided at the front of the site between Buildings A and B. This loading area is located in close proximity of the signalized intersection of the main site driveway and Gould Street. Vehicles, particularly trucks, stopped in this area could cause a back up of traffic into Gould Street. The Applicant should consider modifications to the site plan that provide a clear separation of loading/unloading areas and through traffic access to the parking fields to ensure traffic does not back up onto Gould Street. In addition, the Applicant should consider limiting hours of deliveries to the site, as a condition of approval, to avoid deliveries occurring between 7:00 AM and 9:00 AM when a high volume of traffic may be entering the site from Gould Street to access the parking garage.

30. A large parking garage is proposed at the northerly end of the site, as well as a small surface parking lot near Gould Street. The Applicant should clearly define who will utilize the surface parking lot. In order to avoid congestion along the main drive aisle through the site, the surface parking lot should be restricted to use by accessible parking spaces, visitors, and brewery patrons (if a brewery is provided) only. All employees of both buildings, including brewery employees, should be directed to park in the parking garage.

31. The site plan included in Figure 2 does not depict any pedestrian connections between the proposed surface parking lot and the buildings. The Applicant should modify the site plan to provide fully accessible pedestrian routes between the surface parking lot and both buildings, as well as to the pedestrian loops around the site.

32. The entering travel lane on TV Place is aligned with the sidewalk as it passes by the proposed site driveway. In addition, the exiting lane west of the site driveway is aligned with the entering lane east of the driveway. This has the potential to create a head-on collision between drivers entering and exiting the site as they cross between lanes through the site driveway intersection with TV Place. It also has the potential for entering vehicles on TV Place to drive onto the sidewalk. The Applicant should modify the layout of TV Place to provide better alignment of entering and exiting travel lanes, which may involve additional widening of TV Place to the east of the site driveway and introduction of a raised or striped median island.

33. The Applicant should perform a vehicle turning movement analysis to verify that emergency vehicles and trucks can safely access and navigate the site. This includes delivery, postal, and trash removal vehicles. The Applicant should provide this turning analysis to the Needham Police and Fire Departments for verification that safe and adequate access is provided.

34. Table 15 of the TIAS indicates that queues of nearly 200 feet (eight vehicles) could occur in each lane exiting the site driveway during the weekday PM peak hour. Although the provided plan on Figure 2 is not scaled to be able to accurately measure the available stacking distance, it appears that only 60 feet of stacking distance is proposed in each lane on the site driveway approaching Gould Street before reaching the loading area. Therefore, the queues exiting the site will regularly back up into the loading area and around the corner beyond the driveway to the surface parking lot during the weekday PM peak hour. The Applicant should consider

modifications to the site plan to provide additional vehicle stacking exiting the site without interference with the loading area, parking areas, or on-site circulation.

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

Attachments:

- MEPA ENF – Traffic Peer Review Comment Letter
- MassDOT Weekly Seasonal Factors

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

Massachusetts Highway Department

Statewide Traffic Data Collection

2017 Weekday Seasonal Factors

Factor Group	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Axle Factor
R1	1.30	1.23	1.21	1.04	0.98	0.92	0.86	0.81	0.95	0.99	1.03	1.10	0.80
R2	0.95	0.96	0.98	0.97	0.97	0.93	0.97	0.94	0.96	0.90	0.92	0.93	0.96
R3	1.05	1.01	1.04	0.99	0.94	0.93	0.91	0.92	0.96	0.94	1.01	1.03	0.97
R4-R7	1.10	1.07	1.09	1.00	0.95	0.89	0.88	0.87	0.92	0.95	1.04	1.09	0.93
U1-Boston	1.01	1.04	0.99	0.94	0.93	0.92	0.96	0.93	0.94	0.93	0.95	0.98	0.95
U1-Essex	1.04	1.05	1.00	0.96	0.93	0.89	0.90	0.90	0.93	0.93	0.98	1.03	0.90
U1-Southeast	1.07	1.05	1.02	0.97	0.95	0.90	0.89	0.88	0.92	0.94	0.98	1.01	0.97
U1-West	1.00	0.96	0.94	0.92	0.93	0.92	0.95	0.93	0.92	0.92	0.97	0.97	0.89
U1-Worcester	1.10	1.10	1.04	0.97	0.95	0.94	0.93	0.91	0.95	0.96	0.98	1.04	0.89
U2	1.01	1.03	0.98	0.95	0.93	0.91	0.94	0.92	0.95	0.95	0.95	0.97	0.98
U3	1.03	1.05	1.01	0.95	0.92	0.90	0.94	0.93	0.93	0.92	0.96	0.99	0.96
U4-U7	1.06	1.05	1.02	0.96	0.92	0.89	0.95	0.95	0.92	0.92	0.98	1.03	0.98
Rec - East	1.18	1.17	1.08	1.03	0.95	0.87	0.83	0.83	0.97	0.98	1.19	1.19	0.98
Rec - West	1.30	1.23	1.32	1.18	0.95	0.82	0.70	0.69	0.97	0.96	1.16	1.15	0.95

Round off:
0-999 = 10
>1000 = 100

U = Urban
R = Rural

1 - Interstate
2 - Freeway and Expressway
3 - Other Principal Arterial
4 - Minor Arterial
5 - Major Collector
6 - Minor Collector
7 - Local Road and Street

Recreational - East Group - Cape Cod (all towns) including the town of Plymouth south of Route 3A (stations 7014,7079,7080,7090,7091,7092,7093,7094,7095,7096,7097,7108 and 7178), Martha's Vineyard and Nantucket.

Recreational - West Group - Continuous Stations 2 and 189 including stations 1066,1067,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1113,1114,1116,2196,2197 and 2198.

5/26/2020

Massachusetts Highway Department

Statewide Traffic Data Collection

2018 Weekday Seasonal Factors

Factor Group	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Axle Factor
R1	1.37	1.26	1.30	1.08	0.97	0.93	0.87	0.83	0.96	0.98	1.05	1.13	0.78
R2	0.95	0.96	0.98	0.97	0.97	0.93	0.97	0.94	0.96	0.90	0.92	0.93	0.96
R3	1.15	1.06	1.07	1.00	0.89	0.88	0.89	0.89	0.95	0.92	1.02	1.01	0.98
R4-R7	1.10	1.07	1.03	1.00	0.90	0.92	0.94	0.94	0.96	0.94	1.03	1.02	0.93
U1-Boston	1.05	0.98	1.01	0.93	0.92	0.91	0.95	0.93	0.94	0.92	0.96	0.99	0.96
U1-Essex	1.05	1.01	1.04	0.93	0.92	0.89	0.90	0.90	0.94	0.93	0.98	1.01	0.91
U1-Southeast	1.11	1.05	1.07	0.99	0.93	0.89	0.88	0.87	0.93	0.95	1.01	1.05	0.98
U1-West	1.15	1.08	1.07	0.98	0.94	0.92	0.92	0.88	0.92	0.91	1.00	1.06	0.83
U1-Worcester	1.18	1.11	1.09	0.99	0.95	0.94	0.95	0.91	0.97	0.97	1.01	1.05	0.87
U2	1.04	0.99	0.99	0.94	0.92	0.90	0.93	0.91	0.94	0.92	0.96	0.98	0.99
U3	0.99	1.00	1.02	0.96	0.91	0.89	0.92	0.90	0.95	0.92	1.01	0.97	0.97
U4-U7	1.03	1.02	0.97	0.95	0.88	0.89	0.96	0.93	0.94	0.93	1.00	1.00	0.99
Rec - East	1.22	1.15	1.09	1.12	0.90	0.89	0.82	0.83	0.92	0.98	1.06	1.08	0.99
Rec - West	1.30	1.23	1.32	1.18	0.95	0.82	0.70	0.69	0.97	0.96	1.16	1.15	0.97

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5/26/2020

Massachusetts Highway Department

Statewide Traffic Data Collection

2019 Weekday Seasonal Factors

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R2	0.95	0.96	0.98	0.97	0.97	0.93	0.97	0.94	0.96	0.90	0.92	0.93	0.96
R3	1.15	1.06	1.07	1.00	0.89	0.88	0.89	0.89	0.95	0.92	1.02	1.01	0.97
R4-R7	1.09	1.09	1.11	1.02	0.96	0.92	0.89	0.89	0.99	0.98	1.09	1.13	0.98
U1-Boston	1.03	1.01	0.98	0.94	0.94	0.92	0.95	0.93	0.94	0.94	0.97	1.04	0.96
U1-Essex	1.09	1.06	1.03	0.99	0.94	0.90	0.88	0.86	0.93	0.94	0.99	1.06	0.93
U1-Southeast	1.06	1.05	1.01	0.97	0.95	0.93	0.93	0.90	0.94	0.94	0.98	1.04	0.98
U1-West	1.19	1.14	1.09	0.95	0.92	0.89	0.89	0.86	0.91	0.95	0.97	1.07	0.84
U1-Worcester	1.02	1.04	0.97	0.94	0.93	0.91	0.95	0.91	0.93	0.92	0.95	1.10	0.88
U2	1.01	1.00	0.94	0.93	0.91	0.89	0.93	0.90	0.90	0.91	0.94	1.02	0.99
U3	1.06	1.03	0.98	0.94	0.93	0.91	0.95	0.91	0.92	0.93	0.97	1.00	0.98
U4-U7	1.01	1.00	0.95	0.92	0.88	0.86	0.92	0.91	0.92	0.94	0.99	1.04	0.99
Rec - East	1.04	1.16	1.12	0.98	0.92	0.88	0.77	0.81	0.94	1.02	1.08	1.12	0.99
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5/26/2020

TOWN OF NEEDHAM
TOWN HALL
1471 Highland Avenue
Needham, MA 02492-2669

Design Review Board

Memo: Project review, 557 Highland Avenue

May 16, 2022

The Board reviewed the design drawings for the development at 557 Highland Avenue, the former Muzi Motors site.

The DRB reviewed the project from the perspectives of overall site organization, general landscape concepts and amenities; building massing, materials, fenestration; Parking garage design, and site and building lighting.

The Board approved of the general site organization and building locations. The organization allowed for landscaping amenities at various locations that will be accessible to the public. The Board discussed the main entrance location off of Gould Street. There was some question about the closeness of the site entrance to Highland Ave intersection. The applicant noted the proposed installation of turning lanes, signalization of the entrance intersection and the alignment with the Wingate entrance as key reasons for that entry location. The Board agreed with the decision.

The DRB believed the paved plaza related to the proposed retail area was a good design element. The Board expressed some concern with the required setbacks on Gould and Highland not being utilized well, and the development of the plaza adjacent to the proposed retail area will be a good use of the setback area. The applicant proposes a walking path with fitness stops around the entire site. The path material is not yet determined but is expected to be some sort of pervious surface. Other amenities include using a retention pond in the rear of the site to create a water feature. They also propose a small water feature at the corner of Highland and Gould, a remake of a feature the previous site had at that location. The buffer zone area next to the surface parking area is also planned to have an area for use by the public. The applicant is having discussions with the neighborhood about what exactly it may be. The DRB considers all these elements helpful to integrate the development into the town.

The DRB reviewed the general landscaping concepts illustrated in the presentation. While they did review the plant list with the applicant, there was not a lot of detail shown on the plan. The applicant explained that they are working with the neighborhood on landscaping issues and will have more detail once that work is complete. The development will strive to have plant varieties that will provide seasonal color, not just summer vegetation. The Board asked that they return to the DRB once a more detailed plan is developed. The DRB asked that native species be used as much as possible.

The applicant stated the trees will be 3.5-4” caliper. The Board agrees this will provide more of an impact right from the beginning rather than planting saplings. The exact species and locations are being discussed with the neighborhood at this time.

The plan at this time illustrates large areas of lawn, and the Board recommends more of a mix of different grasses and planting beds rather than simply grass lawn areas.

The Board suggested that plant screening on areas along the walking path would be beneficial. Especially along Highland Avenue where the walk is close to the street. It is a very busy street, and some screening would make pedestrians more comfortable. Screening could also be useful along the plaza space.

Site lighting will be a mix of pedestrian and parking area lighting. Fixtures will be dark sky compliant. The Board asked that information on the final fixture selection be submitted to the DRB. The applicant did not expect much lighting on the building itself. The Board did not review any information on lighting on the building.

The building design and massing was approved by the Board. The design has a mix of precast GFRC finish, which can be colored and textured in a variety of ways, and metal / glass curtain wall. The applicant will supply a sample of the material to the Community Development office and DRB members can see the sample there.

The design does well breaking up long facades with changes in materials and with the insertion of small outdoor spaces on the upper floors. One suggestion was to consider using a lighter colored mechanical screen. A lighter color could help moderate the mass of the building as a transition to the lighter sky.

There was a discussion of the garage doors on the ground level walls each side of the main entrance. They appear to be a large single panel. The Board suggested the applicant could consider something with more detail to break it up.

The Parking Garage is a precast concrete structure. The design proposes a finish look with similar colors to those on the buildings. The columns will not be flush with the panels to break up the horizontal lines. Decorative fabric panels will be added to create visual interest and screen the garage. The elevator/stair tower would be finished in a different color, with a perforated metal panel accent.

The DRB discussed some of the issues they had with a similar structure in the N2 district. They suggested that the screens not simply be rectangles on frames attached to the façade. The frame could be designed as more of an architectural feature, possibly extending beyond the banners, or above the height of the garage. Screening could be more than one layer, of different heights, or of varied shapes. The applicant should pay special attention to the Gould Street side of the building and consider where the banners are placed, not simply the centers of each side of the garage structure.

Garage lighting needs to be carefully considered. The installation should be done in a way that minimizes the lighting being viewed from outside the site. The applicant stated the lights will be installed in the recessed portions of the precast structure, limiting their visibility. The fixtures themselves will have stages of brightness related to the activity level; low for pedestrian, medium for few cars, brightest for the most activity. The Board believes the proposed lighting and installation should help mitigate the amount of visibility the garage lighting will have off the site.

Overall the Board approved of the project design. They asked the applicant to provide an update on the landscape plan at some point during the Planning Board review process, to provide information on site lighting fixtures, and to provide a sample of the exterior finishes.

End of comments

Town of Needham
Building Department
500 Dedham Ave.
Needham, MA 02492

Tel.781-455-7550 x 308

May 25, 2022

Town of Needham
Planning Board
500 Dedham Avenue
Needham, MA. 02492

Re: 557 Highland Ave./ Highland Innovation Center

Dear Board Members,

Please be advised that The Building Department has been part of several meetings between the applicant The Bulfinch Companies and town staff and consultants. Many of the questions that we had during this process have been addressed as far as the site is concerned. The project is still under design and in the early stages for Building, Fire and Mechanical questions currently.

As stated, before site access for pedestrian and vehicle traffic were addressed, fire access around the site was addressed, surface and garage parking were addressed. Water supply and flow for fire protection, and hydrants are under design, locations of hydrants were discussed with the Needham fire consultant.

The site as presented appears to meet the zoning regulations for the site, Special Permits are required for some dimensional requirements based on the design of the structures. The Building Department has no additional questions or comments currently and will continue to work with the applicant on the technical designs of the project.

David A Roche
Building Commissioner
Town of Needham

From: Tara Gurge
To: Alexandra Clee
Cc: Timothy McDonald
Subject: RE: Public Health Division"s comments RE: #577 Highland Ave. proposal
Date: Friday, May 27, 2022 5:45:09 PM
Attachments: image002.png
image003.png

Hello Alex –

Here are the Public Health Division comments for the proposal located at #557 Highland Avenue. See below:

- Any retail/food establishments proposed in the buildings located on this property would need an online Food Permit Plan Review application completed, along with proposed food establishment design plans, which will need to be submitted and reviewed and approved by the Public Health Division prior to start of construction. Here is the direct link to the online Food Establishment Permit Plan Review application - https://needhamma.viewpointcloud.com/categories/1073/record-types/1006516 .
- Please keep in mind, if a food establishment plan review is approved, sufficient space must be made available in the parking lot for both a solid waste (trash) dumpster and a separate recycling dumpster, for each food establishment, along with waste oil/grease containment (if applicable.) These dumpsters must be placed in an easily accessible area outside the facility, close to each food establishment. An exterior grease interceptor may also need to be installed.
- The following info. was previously provided to Robert Schlager, Bulfinch President, back on 4/26/22, re: his inquiry on his wastewater reuse proposal for this project - Here is the Massachusetts Dept. of Environmental Protection's (MassDEP) direct website link to their wastewater reuse program - https://www.mass.gov/service-details/wastewater-reclaimed-water. This proposal would need to meet MassDEP's approval for reclaiming water, specifically for - Cooling tower water, toilet and urinal flushing, boiler feed, industrial process water and irrigation for landscaped areas, etc. All these uses are allowed under 314 CMR 20.00., if approved.
- If a Biotech laboratory is proposed for this site, please ensure that the following online permit application is submitted to the Public Health Division for our review and approval - https://needhamma.viewpointcloud.com/categories/1073/record-types/1006513 . Proper Biohazardous waste containment will need to be provided on site.
- Due to the environmental soil contamination that was discovered on the property during your environmental assessment that was conducted that you informed us about, we advise you to continue working with William Burns, Licensed Site Professional (LSP), LEP with McPHAIL ASSOCIATES, LLC on your ongoing clean-up protocols, and copies of these clean-up reports must continue to be submitted to the Public Health Division for our review for our files. Any updates or changes to your current LSP that is overseeing this clean-up, must be provided for our records.

Please let us know if you need additional information or have any follow-up questions on those requirements.

Thanks,

TARA E. GURGE, R.S., C.E.H.T., M.S. (she/her/hers)
ASSISTANT PUBLIC HEALTH DIRECTOR
Needham Public Health Division
Health and Human Services Department
178 Rosemary Street
Needham, MA 02494
Ph- (781) 455-7940; Ext. 211/Fax- (781) 455-7922
Mobile- (781) 883-0127
Email - tgurge@needhamma.gov
Web- www.needhamma.gov/health

please consider the environment before printing this email

Follow Needham Public Health on Twitter!

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Wednesday, May 25, 2022 1:49 PM
To: Carys Lustig <clustig@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Dennis Condon <DCondon@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Deb Anderson <andersond@needhamma.gov>; David Roche <droche@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>; Elisa Litchman <elitchman@needhamma.gov>
Subject: RE: request for comment - 577 Highland Ave

Dear all,

As a reminder, we would appreciate your comments on this application as soon as you are able.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271

From:	Dennis Condon
To:	Alexandra Clee
Cc:	Lee Newman
Subject:	RE: request for comment - 577 Highland Ave
Date:	Wednesday, June 1, 2022 2:39:14 PM
Attachments:	image001.png image002.png

Hi Alex,

The Fire dept. has met with the development team for this site to express our concerns and made a number of recommendations, which are to be addressed. Of prime concern was circulation for fire apparatus and the ability of fire crews to be able to access various locations of each building from the exterior. This is especially true of the South and North buildings along Highland Avenue and the Rte 128 ramp areas. Initial plans had the fire responding units to stage remotely from the building on Highland Avenue or the off ramp this would create a safety issue for both responding personnel and building occupants and was considered to be inadequate. Since these are State roads MA DOT might have also had objections with this staging plan. A solution was arrived at by incorporating the proposed fitness path to be dual purposed to accommodate fire apparatus. This would include paving wide enough for ladder truck operations. By revising the plan this way will allow responding units sufficient circulation to reach at least three side of each building. While full access around each building is ideal, it is not always practical. We feel the solution arrived at will remedy what might be a significant public safety issue in the event of a major response to this large site. We further requested that this pathway be kept free of snow throughout the winter, so that responding apparatus be able to gain sufficient access regardless of time of year. We will continue to work with the developer throughout the project construction to ensure all code and safety regulations are met.

Thanks,
Dennis

Dennis Condon
Chief of Department
Needham Fire Department
Town of Needham
(W) 781-455-7580
(C) 508-813-5107
Dcondon@needhamma.gov

Follow on Twitter: Chief Condon@NeedhamFire

Watch Needham Fire Related Videos on YouTube @ Chief Condon

TOWN OF NEEDHAM, MASSACHUSETTS
PUBLIC WORKS DEPARTMENT
500 Dedham Avenue, Needham, MA 02492
Telephone (781) 455-7550 FAX (781) 449-9023

June 2, 2022

Needham Planning Board
Needham Public Service Administration Building
Needham, MA 02492

RE: Major Project Special Permit No. 2022-02
557 Highland Avenue- Bullfinch Companies

Dear Members of the Board,

The Department of Public Works has completed its review of the above referenced request for a Special Permit. The applicant requests to redevelop the former Muzi Ford and Chevrolet automotive dealerships and service centers and Muzi car wash.

The proposed project will const 2-buildings of a 497,694 sf office, laboratory, research and development, as well as 10,000 sf for retail uses. A proposed one level parking garage for each building as well as a separate stand alone garage to accommodate the parking needs.

The review was conducted in accordance with the Planning Board's regulations and standard engineering practice. The documents submitted for review are as follows:

1. Application for the Major Project Special Permit No. 2022-02, Applicant 557 Highland, LLC, dated April 7, 2022.

2. Letter directed to Planning Board Members, from Timothy Sullivan, dated April 5, 2022.

3. Plan set consisting of 44 pages, dated March 30, 2022.

4. Transportation Impact and Access Study, prepared by VHB, 101 Walnut Street, PO Box 9151, Watertown, MA, dated March 2022. (Appendices only sent to Engineering)

5. Stormwater Report, prepared by VHB, 101 Walnut Street, PO Box 9151, Watertown, MA, dated March 2022.

Our comments and recommendations are as follows:

Water Supply:

- We are seeking clarification for the facility's proposed water use of 129,172 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.

Traffic at the Intersection of Highland and Gould

- We concur with traffic comments/recommendations prepared by GPI in their April 25, 2022 letter to the Planning and Community Development Office.

- 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 approximately 32-feet from 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 providing an alteration/taking plan and recordings for a new Road Right of Way layout on Gould Street and to optimize of the traffic signals at Highland at Gould.

Wastewater:

- According to the ENF filed by the applicant, the proposed project will generate a total of 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 I/I program (attached regulations).

- 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.

Stormwater Report:

- As part of the NPDES requirements, the applicant must comply with the Public Outreach & Education and Public Participation & Involvement control measures. The applicant shall submit a letter to the town identifying the measures selected and dates by which the measures will be completed in order to incorporate it into the Planning Board's decision.

Other:

- If emergency generators are proposed, they should indicate on the plans with proper screening and noise reduction according to a sound study for the proposed generators.

If you have any questions regarding the above, please contact our office at 781-455-7550.

Truly yours,

Thomas Ryder
Town Engineer

From: John Schlittler
To: Alexandra Clee
Cc: Lee Newman
Subject: RE: request for comment - 577 Highland Ave
Date: Friday, June 3, 2022 3:37:20 PM

I have a couple of concerns regarding traffic.
Gould at Central, looks like one lane getting out to Central. I am concerned that traffic will back up and create a scenario where vehicles will use cut through streets that are off Gould.

I am also concerned that vehicles will use Noanett, Ellis, Kearney, Beech, and Arnold St daily to beat the light at Gould and Central. I think the first step would be to place signage at these locations restricting traffic between commuting hours in the morning and afternoon.

I am also concerned about the impact that this project will have on Hunting/Greendale Ave. Although the RT 128 on/off ramps are very close this stretch of RT 128 tends to be stop and go during peak hours. I often see vehicles getting off RT 128 to use surface streets Hunting/Greendale to bypass traffic delays. What can be done to address impact to those neighborhoods?

If there are going to be walking paths, bike access around the building then there should be enough space for emergency vehicle access around the entire project.

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Tuesday, April 19, 2022 4:17 PM
To: Carys Lustig <clustig@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Dennis Condon <DCondon@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Deb Anderson <andersond@needhamma.gov>; David Roche <droche@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>; Elisa Litchman <elitchman@needhamma.gov>
Subject: RE: request for comment - 577 Highland Ave

Apologies, one additional application item:

6. Fiscal Impact Analysis, prepared for rezoning, prepared by Barrett Planning Group, Inc., dated March 20, 2021.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov

From: Alexandra Clee
Sent: Tuesday, April 19, 2022 4:08 PM

To: Carys Lustig <clustig@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Dennis Condon <DCondon@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Deb Anderson <andersond@needhamma.gov>; David Roche (droche@needhamma.gov) <droche@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>; Elisa Litchman <elitchman@needhamma.gov>
Subject: request for comment - 577 Highland Ave

Dear all,

We have received the application materials for the proposal to redevelop 557 Highland Avenue. the information can be found on the website: https://www.needhamma.gov/Archive.aspx?ADID=9611

Although we operate electronically much of the time lately, I am sending hard copies for this project.

The Planning Board has scheduled this matter for June 7, 2022. Please send your comments by Wednesday May 25, 2022 at the latest.

Please note: These are the same materials that we distributed (electronically) for the Development Review Team meeting to be held April 26. We are also seeking staff comment, which can arrive after the DRT meeting.

The documents attached for your review are as follows:

1. Application for the Major Project Special Permit No. 2022-02, Applicant 557 Highland, LLC, dated April 7, 2022.

2. Letter directed to Planning Board Members, from Timothy Sullivan, dated April 5, 2022.

3. Plan set consisting of 44 pages, dated March 30, 2022.

4. Transportation Impact and Access Study, prepared by VHB, 101 Walnut Street, PO Box 9151, Watertown, MA, dated March 2022. (Appendices only sent to Engineering)

5. Stormwater Report, prepared by VHB, 101 Walnut Street, PO Box 9151, Watertown, MA, dated March 2022.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA

Bay Colony Rail Trail

May 17, 2022

Mr. Paul Alpert, Chairman
Needham Planning Board
Public Services Administration Building
500 Dedham Ave.
Needham, MA 02492

RE: Traffic Planning for Development at 557 Highland Avenue

Dear Mr. Alpert,

On behalf of the Bay Colony Rail Trail Association (BCRTA), a 501(c)3 non-profit organization that partnered with the Town to create the Needham Rail Trail, we are writing in regard to the planning efforts associated with the proposed Highland Science Center at 557 Highland Avenue, the site of the former Muzi Motors property. Specifically, the BCRTA is interested in the planning discussions underway involving bicycle and pedestrian traffic around the proposed site.

While we are encouraged that some bicycle and pedestrian accommodations were included in the Environmental Notification Form (ENF) submitted by VHB on behalf of Bullfinch, we are concerned that inadequate attention was given to the active initiatives to evaluate and develop the former MBTA ROW that crosses Gould St just north of the 557 Highland Ave property.

In fact, in promising to "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", the authors of the 591-page ENF report seem to be unaware of the passage of Massachusetts Bill H.4269 in December 2021, in which $200,000 of the State's ARPA funding has been allocated for a "feasibility and preliminary design study for a bicycle and pedestrian trail between the town of Needham and the city of Newton via a new community bridge spanning state highway route 128, the existing rail bridge spanning the Charles River and connecting to the Newton Upper Falls Greenway and Needham Heights." Note: we believe the language of the bill has been expanded to consider buses on the corridor.

We feel that it would be short-sighted to consider the scope of the 557 Highland Avenue project without due consideration of the adjacent former MBTA ROW property and the

possibility of converting the ROW to a community trail. The mutual benefits to each initiative are considerable and failure to coordinate the efforts could result in a lost opportunity for a major community amenity and alternative non-automobile link to the Highland Science Center and beyond.

For example, the Environmental Notification Form mentions a Gould St. pedestrian crossing at the site of the MBTA ROW, yet this reference does not consider the requirements for such a crossing in the context of a shared-use path linking Needham Heights and Newton Upper Falls.

The BCRTA was founded in 2010 with a vision to convert the unused railway corridor, on both the south side of Needham, as well as the north, connecting with Newton. We have worked collaboratively with the Town ever since, focusing first on the south section of the unused MBTA ROW between High Rock St. and the Charles River. With the ARPA funding, as well as the development of 557 Highland Ave. property, the time has come to focus on the north section of the unused corridor.

As dedicated and successful advocates for shared-use paths in Needham and nearby communities, experienced in coordinating the many factors in their design and development, we are eager to continue our collaboration with the Town in this effort. We would respectfully request the opportunity to participate in a coordinated design effort around Gould St., particularly as it relates to the broader multi-modal traffic considerations in the area and the development of a Needham Heights community trail on the former MBTA ROW.

We very much appreciate the opportunity to inform the Planning Board of our concerns and would welcome the opportunity to discuss these issues with the Board at the appropriate time.

Sincerely,

James Goldstein and Tad Staley

James Goldstein and Tad Staley
Current President and Founder, Bay Colony Rail Trail Association

cc. Needham Board of Selectmen
Needham Town Manager

The following information is regarding the

Environmental Notification Form (ENF)

for 557 Highland Avenue.

cc: SB DPW Planning

March 24, 2022

Office of the Town Manager
Needham Town Hall
1471 Highland Avenue
Needham, MA 02492

Reference: 557 Highland Avenue, Needham, Massachusetts;
Notification of the submittal of a Release Notification Form;
Release Tracking Number (RTN) 3-37285

Pursuant to the Massachusetts Contingency Plan, 310 CMR 40.1403 (3) (h), you are hereby notified of the submittal of a Release Notification Form (RNF) to the Massachusetts Department of Environmental Protection for the above referenced location, a copy of which is attached. A release of oil and/or hazardous material (OHM), as defined by M.G.L. c. 21E, has occurred at the above referenced location and constituted a 72-hour release notification condition as defined in 310 CMR 40.0315 of the Massachusetts Contingency Plan (MCP). Response actions at this site are being conducted on behalf of 557 Highland Avenue, LLC, which has employed William J. Burns, L.S.P. of McPhail Associates, LLC to manage response actions in accordance with the Massachusetts Contingency Plan (310 CMR 40.0000).

Local officials have the right to request from the person conducting response actions an opportunity for Public Involvement Activities under 310 CMR 40.1403 (9) and upon tier classification under 310 CMR 40.1404.

We trust that the above is sufficient for your present requirements. Should you have any questions concerning the above, please call us.

Very truly yours,

McPHAIL ASSOCIATES, LLC

William J. Burns, L.S.P.

N:\Working Documents\Jobs\7307 - 557 Highland\Environmental\7307_557Highland_RNF Notice_Health_032422.docx

WJB
cc: 557 Highland, LLC
Town of Needham – Public Health

GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERS
2269 Massachusetts Avenue
Cambridge, Massachusetts 02140
(617) 868-1420

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup
RELEASE NOTIFICATION & NOTIFICATION RETRACTION FORM
Pursuant to 310 CMR 40.0335 and 310 CMR 40.0371 (Subpart C)

BWSC 103

Release Tracking Number
3 - 37285

A. RELEASE OR THREAT OF RELEASE LOCATION:

1. Release Name/Location Aid: COMMERCIAL PROPERTY
2. Street Address: 557 HIGHLAND AVENUE
3. City/Town: NEEDHAM 4. ZIP Code: 024940000
5. Coordinates: a. Latitude: N 42.30270 b. Longitude: W 71.22875

B. THIS FORM IS BEING USED TO: (check one)

- [x] 1. Submit a **Release Notification**
- [ ] 2. Submit a **Revised Release Notification**
- [ ] 3. Submit a **Retraction of a Previously Reported Notification** of a release or threat of release including supporting documentation required pursuant to 310 CMR 40.0335 (Section C is not required)

(All sections of this transmittal form must be filled out unless otherwise noted above)

C. INFORMATION DESCRIBING THE RELEASE OR THREAT OF RELEASE (TOR):

1. Date and time of Oral Notification, if applicable: 1/21/2022 (mm/dd/yyyy) Time: 12:30 (hh:mm) [ ] AM [x] PM
2. Date and time you obtained knowledge of the Release or TOR: 1/20/2022 (mm/dd/yyyy) Time: 11:30 (hh:mm) [ ] AM [x] PM
3. Date and time release or TOR occurred, if known: (mm/dd/yyyy) Time: (hh:mm) [ ] AM [ ] PM

Check all Notification Thresholds that apply to the Release or Threat of Release:
(for more information see 310 CMR 40.0310 - 40.0315)

4. 2 HOUR REPORTING CONDITIONS

- [ ] a. Sudden Release
- [ ] b. Threat of Sudden Release
- [ ] c. Oil Sheen on Surface Water
- [ ] d. Poses Imminent Hazard
- [ ] e. Could Pose Imminent Hazard
- [ ] f. Release Detected in Private Well
- [ ] g. Release to Storm Drain
- [ ] h. Sanitary Sewer Release (Imminent Hazard Only)

5. 72 HOUR REPORTING CONDITIONS

- [ ] a. Subsurface Non-Aqueous Phase Liquid (NAPL) Equal to or Greater than 1/2 Inch (.04 feet)
- [x] b. Underground Storage Tank (UST) Release
- [ ] c. Threat of UST Release
- [ ] d. Release to Groundwater near Water Supply
- [ ] e. Substantial Release Migration

6. 120 DAY REPORTING CONDITIONS

- [ ] a. Release of Hazardous Material(s) to Soil or Groundwater Exceeding Reportable Concentration(s)
- [ ] b. Release of Oil to Soil Exceeding Reportable Concentration(s) and Affecting More than 2 Cubic Yards
- [ ] c. Release of Oil to Groundwater Exceeding Reportable Concentration(s)
- [ ] d. Subsurface Non-Aqueous Phase Liquid (NAPL) Equal to or Greater than 1/8 Inch (.01 feet) and Less than 1/2 Inch (.04 feet)

C. INFORMATION DESCRIBING THE RELEASE OR THREAT OF RELEASE (TOR): (cont.)

7. List below the Oils (O) or Hazardous Materials (HM) that exceed their Reportable Concentration (RC) or Reportable Quantity (RQ) by the greatest amount.

☐ Check here if an amount or concentration is unknown or less than detectable.

O or HM Released	CAS Number, if known	O or HM	Amount or Concentration	Units	RCs Exceeded, if Applicable (RCS-1, RCS-2,RCGW-1, RCGW-2)
GASOLINE		O	387	PPMV	N/A
C5-C8 ALIPHATICS		O	1130	MG/KG	RCS-1
C9-C10 AROMATICS		O	662	MG/KG	RCS-1
ETHYLBENZENE		O	44	MG/KG	RCS-1

☑ Check here if a list of additional Oil and Hazardous Materials subject to reporting, or any other documentation relating to this notification is attached.

D. PERSON REQUIRED TO NOTIFY:

1. Check all that apply: ☐ a. change in contact name ☐ b. change of address ☑ c. change in the person notifying

2. Name of Organization: 557 HIGHLAND, LLC

3. Contact First Name: ROBERT 4. Last Name: SCHLAGER

5. Street: 116 HUNTINGTON AVE, SUITE 600 6. Title: AUTHORIZED REPRESENTATIVE

7. City/Town: BOSTON 8. State: MA 9. ZIP Code: 021160000

10. Telephone: 781-707-4000 11. Ext.: 12. Email: RAS@bulfinch.com

☐ 13. Check here if attaching names and addresses of owners of properties affected by the Release or Threat of Release, other than an owner who is submitting this Release Notification (required).

E. RELATIONSHIP OF PERSON TO RELEASE OR THREAT OF RELEASE: ☐ Check here to change relationship

☑ 1. RP or PRP ☐ a. Owner ☐ b. Operator ☐ c. Generator ☐ d. Transporter

☑ e. Other RP or PRP Specify: ELIGIBLE PERSON

☐ 2. Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ 3. Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ 4. Any Other Person Otherwise Required to Notify Specify Relationship:

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

RELEASE NOTIFICATION & NOTIFICATION RETRACTION FORM

Pursuant to 310 CMR 40.0335 and 310 CMR 40.0371 (Subpart C)

BWSC 103

Release Tracking Number
3 - 37285

F. CERTIFICATION OF PERSON REQUIRED TO NOTIFY:

1. I, ROBERT SCHLAGER, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

2. By: ROBERT SCHLAGER (Signature) 3. Title: AUTHORIZED REPRESENTATIVE

4. For: 557 HIGHLAND, LLC (Name of person or entity recorded in Section D) 5. Date: 3/22/2022 mm/dd/yyyy

☐ 6. Check here if the address of the person providing certification is different from address recorded in Section D.

7. Street:

8. City/Town: 9. State: 10. ZIP Code:

11. Telephone: 12. Ext.: 13. Email:

YOU ARE SUBJECT TO ANNUAL COMPLIANCE ASSURANCE FEES FOR EACH BILLABLE YEAR FOR TIER CLASSIFIED DISPOSAL SITES. YOU MUST LEGIBLY COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

Date Stamp (DEP USE ONLY:)

Received by DEP on 3/22/2022 9:57:57 AM

Attachment to BWSC-103, Release Notification Form

Former Wash World, 557 Highland Avenue, Needham

RTN 3-37285

Part C. Information Describing the Release

7. List of Additional Oil and Hazardous Materials:

O or HM Released	O or HM	Amount or Concentration	Units	RCs Exceeded, if Applicable (RCS-1, RCS-2, RCGW-1, RCGW-2)
p/m-xylenes	O	210	mg/kg	RCS-1
1,3,5 Trimethylbenzene	O	49	mg/kg	RCS-1

Part E. Relationship of Person to Release or Threat of Release

4. Mr. Robert Schlager is listed on the electronically submitted BWSC-103 form as the Authorized Representative in connection with this submittal. Mr. Schlager has electronically signed the BWSC form as an Authorized Representative on behalf of 557 Highland, LLC and not individually.

ENVIRONMENTAL NOTIFICATION FORM

Highland Science Center

Needham Heights, Massachusetts

CLIENT

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

March 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

Bulfinch

116 Huntington Avenue
Suite 600
Boston, MA 02116

March 31, 2022

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

Re: Environmental Notification Form
557 Highland Avenue
Needham, MA

Dear Secretary Theoharides:

557 Highland, LLC, an affiliate of The Bulfinch Companies, Inc. (the "Proponent") is pleased to submit this Environmental Notification Form 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 (the "Project") in Needham.

The Proponent is proposing an approximately 531,000-SF office/laboratory/research and development building on the former site of the Muzi Ford and Chevrolet Dealership. The new building varying in height from 3-5 stories and associated landscape and hardscape improvements, including a fitness trail, are 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-SF below-grade parking garage and a six-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.

We look forward to working with you and your staff during your review of the Project. We anticipate that the ENF will be noticed in the April 8th 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.

Bulfinch

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.

March 31, 2022

Table of Contents

Appendices

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List of Tables

Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act (MEPA) Office

Environmental Notification Form

For Office Use Only

EEA#: _____

MEPA Analyst: _____

The information requested on this form must be completed in order to submit a document electronically for review under the Massachusetts Environmental Policy Act, 301 CMR 11.00.

Project Name: **Highland Science Center**		
Street Address: **557 Highland Avenue**		
Municipality: **Needham**	Watershed: **Charles**	
Universal Transverse Mercator Coordinates: **4,685,694.931 Northing 316,337.653 Easting**	Latitude: **42.301846** Longitude: **-71.228180**	
Estimated commencement date: **April 1, 2023**	Estimated completion date: **December 31 2025**	
Project Type: **Mixed-Use**	Status of project design: **15** %complete	
Proponent: **557 Highland, LLC**		
Street Address: **116 Huntington Ave. Suite 600**		
Municipality: **Boston**	State: **MA**	Zip Code: **02116**
Name of Contact Person: **Samhita Saquib**		
Firm/Agency: **VHB**	Street Address:**99 High St. 10th Fl**	
Municipality: **Boston**	State: **MA**	Zip Code: **02110**
Phone:**617-607-2147**	Fax:	E-mail: **ssaquib@vhb.com**

Does this project meet or exceed a mandatory EIR threshold (see 301 CMR 11.03)?
☒**Yes** ☐No

If this is an Expanded Environmental Notification Form (ENF) (see 301 CMR 11.05(7)) or a Notice of Project Change (NPC), are you requesting:

a Single EIR? (see 301 CMR 11.06(8))	☐Yes ☒No
a Rollover EIR? (see 301 CMR 11.06(13))	☐Yes ☒No
a Special Review Procedure? (see 301CMR 11.09)	☐Yes ☒No
a Waiver of mandatory EIR? (see 301 CMR 11.11)	☐Yes ☒No
a Phase I Waiver? (see 301 CMR 11.11)	☐Yes ☒No

(Note: Greenhouse Gas Emissions analysis must be included in the Expanded ENF.)

Which MEPA review threshold(s) does the project meet or exceed (see 301 CMR 11.03)?

- **301 CMR 11.03(6)(a)(6): Generation of 3,000 or more New average daily trips (adt) providing access to a single location**
- **301 CMR 11.03(6)(a)(7): Construction of 1,000 or more New parking spaces at a single location**

Which State Agency Permits will the project require?
MassDOT Vehicular Access Permit,

Identify any financial assistance or land transfer from an Agency of the Commonwealth, including the Agency name and the amount of funding or land area in acres: **N/A**

Summary of Project Size & Environmental Impacts	**Existing**	**Change**	**Total**
LAND			
Total site acreage	**9.27**		
New acres of land altered		**0**	
Acres of impervious area	**8.53**	**-1.83**	**6.7**
Square feet of new bordering vegetated wetlands alteration		**0**	
Square feet of new other wetland alteration		**0**	

Acres of new non-water dependent use of tidelands or waterways		**0**	
STRUCTURES			
Gross square footage	**39,750 SF**	**+491,250 SF**	**531,000 SF**
Number of housing units	**0**	**0**	**0**
Maximum height (feet)	**25 feet**	**45 feet**	**70 feet**
TRANSPORTATION			
Vehicle trips per day	**887** [a]	**+5,005**	**5,892**
Vehicle trips per AM peak hour	**61** [a]	**+584**	**645**
Vehicle trips per PM peak hour	**86** [a]	**+565**	**651**
Parking spaces	**532** [b]	**+up to 1,238**	**Up to 1,770**[c]
WASTEWATER			
Water Use (Gallons per day)	**25,358**	**+103,814**	**129,172**
Water withdrawal (GPD)	**2,305**	**+72,313**	**74,618**
Wastewater generation/treatment (GPD)	**23,053**	**+31,501**	**54,554**
Length of water mains (miles)			**0.2**
Length of sewer mains (miles)			**0.1**

Has this project been filed with MEPA before?
☐ Yes (EEA #_____) ☒**No**

Has any project on this site been filed with MEPA before?
☐ Yes (EEA #_____) ☒**No**

a Existing Site trips based on empirical counts conducted by VHB in July 2021. Due to the seasonality of the former car wash and car dealership businesses, Site generated traffic may have been higher if reported during the Winter months and therefore traffic counts conducted in July represent a conservative trip-generation for the former uses.

b Existing Site consists of a former car dealership and car wash. Existing parking supply of 532 spaces 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.

c There will be two below-grade parking garages that will be 155,000 SF, each. There will also be a free-standing parking garage that will be 297,000 SF.

GENERAL PROJECT INFORMATION – all proponents must fill out this section

PROJECT DESCRIPTION:

Describe the existing conditions and land uses on the project site:_____
Refer to Section 1.1 of Chapter 1, *Project Description.*

Describe the proposed project and its programmatic and physical elements: _____
Refer to Section 1.2 of Chapter 1, *Project Description.*

NOTE: The project description should summarize both the project's direct and indirect impacts (including construction period impacts) in terms of their magnitude, geographic extent, duration and frequency, and reversibility, as applicable. It should also discuss the infrastructure requirements of the project and the capacity of the municipal and/or regional infrastructure to sustain these requirements into the future.

Describe the on-site project alternatives (and alternative off-site locations, if applicable), considered by the proponent, including at least one feasible alternative that is allowed under current zoning, and the reasons(s) that they were not selected as the preferred alternative:
Refer to Section 1.5 of Chapter 1, *Project Description.*

_____

NOTE*: The purpose of the alternatives analysis is to consider what effect changing the parameters and/or siting of a project, or components thereof, will have on the environment, keeping in mind that the objective of the MEPA review process is to avoid or minimize damage to the environment to the greatest extent feasible. Examples of alternative projects include alternative site locations, alternative site uses, and alternative site configurations.*

Summarize the mitigation measures proposed to offset the impacts of the preferred alternative:

_____
Refer to Section 1.6 of Chapter 1, *Project Description,* for climate mitigation strategy. Refer to Section 2.1 of Chapter 2, *Transportation,* for traffic and transportation related mitigation measures.

If the project is proposed to be constructed in phases, please describe each phase:
Refer to Section 1.2.6 of Chapter 1,
Project Description.

AREAS OF CRITICAL ENVIRONMENTAL CONCERN:
Is the project within or adjacent to an Area of Critical Environmental Concern?
☐Yes (Specify_____)
☒**No**
if yes, does the ACEC have an approved Resource Management Plan? ___ Yes __**X**_ **No**;
If yes, describe how the project complies with this plan.

_____
Will there be stormwater runoff or discharge to the designated ACEC? ___ Yes __**X**_ **No**;
If yes, describe and assess the potential impacts of such stormwater runoff/discharge to the designated ACEC.

_____

RARE SPECIES:
Does the project site include Estimated and/or Priority Habitat of State-Listed Rare Species? (see http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/priority_habitat/priority_habitat_home.htm)
☐Yes (Specify_____) ☒**No**

HISTORICAL /ARCHAEOLOGICAL RESOURCES:
Does the project site include any structure, site or district listed in the State Register of Historic Place

or the inventory of Historic and Archaeological Assets of the Commonwealth?
☐Yes (Specify_____) ☒**No**

If yes, does the project involve any demolition or destruction of any listed or inventoried historic or archaeological resources? ☐Yes (Specify_____) ☒No

WATER RESOURCES:

Is there an Outstanding Resource Water (ORW) on or within a half-mile radius of the project site? ___Yes **X No**; if yes, identify the ORW and its location. _____

(NOTE: Outstanding Resource Waters include Class A public water supplies, their tributaries, and bordering wetlands; active and inactive reservoirs approved by MassDEP; certain waters within Areas of Critical Environmental Concern, and certified vernal pools. Outstanding resource waters are listed in the Surface Water Quality Standards, 314 CMR 4.00.)

Are there any impaired water bodies on or within a half-mile radius of the project site? _**X**__**Yes** _No**;** if yes, identify the water body and pollutant(s) causing the impairment: **Charles River** _____**.**
MA72-07 – Curly-leaf Pondweed, Eurasian Water Milfoil, Fish Passage Barrier, Flow Regime Modification, Water Chestnut, Benthic Macroinvertebrates, DDT in Fish Tissue, Escherichia Coli (E. Coli), Fish Bioassessments, Harmful Algae Blooms, Nutrient/Eutrophication Biological Indicators, PCBs in Fish Tissue, Total Phosphorus, Temperature

Is the project within a medium or high stress basin, as established by the Massachusetts Water Resources Commission? ___Yes _**X**_**No**

STORMWATER MANAGEMENT:

Generally describe the project's stormwater impacts and measures that the project will take to comply with the standards found in MassDEP's Stormwater Management Regulations:
The Project results in a decrease in impervious area compared to the existing conditions. The Project will utilize a wet pond and structural water quality devices to meet the required water quality volume. The overall Project will result in a decrease in peak rate of runoff as well as runoff volume for the site.

MASSACHUSETTS CONTINGENCY PLAN:

Has the project site been, or is it currently being, regulated under M.G.L.c.21E or the Massachusetts Contingency Plan? Yes _X_ No ___ ; if yes, please describe the current status of the site (including Release Tracking Number (RTN), cleanup phase, and Response Action Outcome classification):
Due to the former uses as automobile dealerships and service center, coupled with historical filling of the 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. The LSP overseeing MCP compliance and remediation is William J. Burns, LSP of McPhail Associates, LLC.
Is there an Activity and Use Limitation (AUL) on any portion of the project site? Yes ___ **No** _**X**_; if yes, describe which portion of the site and how the project will be consistent with the AUL: _____.

Are you aware of any Reportable Conditions at the property that have not yet been assigned an RTN? **Yes** _**X**__ No ___ ; if yes, please describe:
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). 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 PSS is anticipated to be filed for the 120-day reporting condition.

SOLID AND HAZARDOUS WASTE:

If the project will generate solid waste during demolition or construction, describe alternatives considered for re-use, recycling, and disposal of, e.g., asphalt, brick, concrete, gypsum, metal, wood:_____

(NOTE: Asphalt pavement, brick, concrete and metal are banned from disposal at Massachusetts landfills and waste combustion facilities and wood is banned from disposal at Massachusetts landfills. See 310 CMR 19.017 for the complete list of banned materials.)

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. Asphalt brick and concrete will be recycled per MassDEP Policy and applicable Land Ban regulations. Metal and wood waste will also be recycled. Wood waste may be chipped and burned at a waste to energy facility.

Will your project disturb asbestos containing materials? Yes ___ **No** _**X**_ ;
if yes, please consult state asbestos requirements at http://mass.gov/MassDEP/air/asbhom01.htm.

Describe anti-idling and other measures to limit emissions from construction equipment:
Equipment will be required to abide by the Massachusetts anti-idling regulation, which limits idling of motor vehicles to five minutes (310 CMR 7.11).

DESIGNATED WILD AND SCENIC RIVER:

Is this project site located wholly or partially within a defined river corridor of a federally designated Wild and Scenic River or a state designated Scenic River? Yes ___ **No** _**X**__ ;
if yes, specify name of river and designation:

If yes, does the project have the potential to impact any of the "outstandingly remarkable" resources of a federally Wild and Scenic River or the stated purpose of a state designated Scenic River?
Yes ___ **No** _**X**__ ; if yes, specify name of river and designation: _____;
if yes, will the project result in any impacts to any of the designated "outstandingly remarkable" resources of the Wild and Scenic River or the stated purposes of a Scenic River.
Yes ___ **No** _**X**__ ;
if yes, describe the potential impacts to one or more of the "outstandingly remarkable" resources or stated purposes and mitigation measures proposed.

ATTACHMENTS:

1. List of all attachments to this document.
   Chapter 1 – Project Description
   Chapter 2 – Transportation
   Appendix A – MEPA Distribution List
   Appendix B – RMAT Tool
   Appendix C – Transportation Supporting Documentation
   Appendix D – Utility Supporting Documentation
   Appendix E – FAA Documentation
2. U.S.G.S. map (good quality color copy, 8-½ x 11 inches or larger, at a scale of 1:24,000) indicating the project location and boundaries.
   Refer to Figure 1-1.
3. Plan, at an appropriate scale, of existing conditions on the project site and its immediate environs, showing all known structures, roadways and parking lots, railroad rights-of-way, wetlands and water bodies, wooded areas, farmland, steep slopes, public open spaces, and major utilities.
   Refer to Figure 1-2.
4. Plan, at an appropriate scale, depicting environmental constraints on or adjacent to the project site such as Priority and/or Estimated Habitat of state-listed rare species, Areas of Critical Environmental Concern, Chapter 91 jurisdictional areas, Article 97 lands, wetland resource area delineations, water supply protection areas, and historic resources and/or districts.
   Refer to Figure 1-3.
5. Plan, at an appropriate scale, of proposed conditions upon completion of project (if construction of the project is proposed to be phased, there should be a site plan showing conditions upon the completion of each phase).
   Refer to Figure 1-4.
6. List of all agencies and persons to whom the proponent circulated the ENF, in accordance with 301 CMR 11.16(2).
   Refer to Appendix A.
7. List of municipal and federal permits and reviews required by the project, as applicable.
   Refer to Section 1.4 of Chapter 1, *Project Description.*
8. Printout of output report from RMAT Climate Resilience Design Standards Tool, available here.
   Refer to Appendix B.
9. Printout from the EEA EJ Maps Viewer showing the project location relative to Environmental Justice (EJ) Populations located in whole or in part within a 1-mile and 5-mile radius of the project site.
   Refer to Figure 1-5.

LAND SECTION – all proponents must fill out this section

I. Thresholds / Permits

A. Does the project meet or exceed any review thresholds related to **land** (see 301 CMR 11.03(1) ___ Yes **_X__ No**; if yes, specify each threshold:

II. Impacts and Permits

A. Describe, in acres, the current and proposed character of the project site, as follows:

	Existing	Change	Total
Footprint of buildings	**.92**	**+3.57**	**4.49**
Internal roadways	**0**	**+0.49**	**0.49**
Parking and other paved areas	**7.51**	**-6.99**	**0.52**
Other altered areas	**0.04**	+2.93	2.97
Undeveloped areas	**0.80**	+0	0.80
Total: Project Site Acreage	**9.27**	**0**	**9.27**

B. Has any part of the project site been in active agricultural use in the last five years? ___ Yes **_X__ No**; if yes, how many acres of land in agricultural use (with prime state or locally important agricultural soils) will be converted to nonagricultural use?

C. Is any part of the project site currently or proposed to be in active forestry use? **___** Yes **_X__ No**; if yes, please describe current and proposed forestry activities and indicate whether any part of the site is the subject of a forest management plan approved by the Department of Conservation and Recreation:

D. Does any part of the project involve conversion of land held for natural resources purposes in accordance with Article 97 of the Amendments to the Constitution of the Commonwealth to any purpose not in accordance with Article 97? ___ Yes **__X_ No**; if yes, describe:

E. Is any part of the project site currently subject to a conservation restriction, preservation restriction, agricultural preservation restriction or watershed preservation restriction? ___ Yes**_X__ No**; if yes, does the project involve the release or modification of such restriction? ___ Yes ___ No; if yes, describe:

F. Does the project require approval of a new urban redevelopment project or a fundamental change in an existing urban redevelopment project under M.G.L.c.121A? **___** Yes **__X_ No**; if yes, describe:

G. Does the project require approval of a new urban renewal plan or a major modification of an existing urban renewal plan under M.G.L.c.121B? Yes **___ No X** ; if yes, describe:

III. Consistency

A. Identify the current municipal comprehensive land use plan
Title:_ **Needham Community Development Plan Date June 2004**

B. Describe the project's consistency with that plan with regard to:

1) economic development

This Project meets the municipal plan by creating fiscal benefits through an increased tax base, providing job opportunities, enhancement of the appearance of the community. By redeveloping an underutilized car lot, the Project will greatly improve the character of the direct area. Meeting the needs of the Highland Corridor, with goals of igniting economic potential, this Project will spur future development in the prioritized location.

2) adequacy of infrastructure _

The Project Site is located directly off I-95 (Rt 128), providing easy access for those commuting by car. Additionally, bike infrastructure is present directly adjacent to

the site, as well as a commuter train station less than a mile away. This provides viable transportation options for those traveling to the site. Because the Project will be built on currently developed land, municipal utilities are already serving the site.

3) open space impacts

Because the Project does not require the development of undeveloped land, open space will not be impacted from this Project.

4) compatibility with adjacent land uses

The proposed redevelopment of the existing car lot is a radical improvement to the surrounding land uses. The improved use allows for job opportunities, increased open space for public benefit, a significant decrease in impervious area as well as retail uses open to the community. The Project also creates an enhanced aesthetic appeal compared to the existing paved lot.

1. Identify the current Regional Policy Plan of the applicable Regional Planning Agency (RPA)
   RPA: Metropolitan Area Planning Council

   Title:_**MetroFuture** Date_**2008**

2. Describe the project's consistency with that plan with regard to:
   1) economic development
      The Project is consistent with MetroFuture's goals of companies locating themselves on the outer ring of the metropolitan area, as well as growth occurring through reuse of previously developed land. Along with tax revenue generated from this development, this Project exhibits one of the fastest growing industries in the region and will continue to attract a high number of companies as well as a skilled labor force.

   2) adequacy of infrastructure
      The Project Site is located directly off I-95 (Rt 128), providing easy access for those commuting by car. Additionally, bike infrastructure is present directly adjacent to the site, as well as a commuter train station less than a mile away. This provides viable transportation options for those traveling to the site. Because the Project will be built on currently developed land, municipal utilities are already serving the site.

   3) open space impacts
      Because the Project does not require the development of undeveloped land, open space will not be impacted from this Project.

RARE SPECIES SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **rare species or habitat** (see 301 CMR 11.03(2))? ___ Yes **_X_ No**; if yes, specify, in quantitative terms:

(NOTE: If you are uncertain, it is recommended that you consult with the Natural Heritage and Endangered Species Program (NHESP) prior to submitting the ENF.)

B. Does the project require any state permits related to **rare species or habitat**? ___ Yes **_X_No**

C. Does the project site fall within mapped rare species habitat (Priority or Estimated Habitat?) in the current Massachusetts Natural Heritage Atlas (attach relevant page)? ___ Yes **__X_ No**.

D. If you answered "No" to all questions A, B and C, proceed to the **Wetlands, Waterways, and Tidelands Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Rare Species section below.

II. Impacts and Permits

A. Does the project site fall within Priority or Estimated Habitat in the current Massachusetts Natural Heritage Atlas (attach relevant page)? ___ Yes ___ No. If yes,

1. Have you consulted with the Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP)? ___Yes ___No; if yes, have you received a determination as to whether the project will result in the "take" of a rare species? ___ Yes ___ No; if yes, attach the letter of determination to this submission.

2. Will the project "take" an endangered, threatened, and/or species of special concern in accordance with M.G.L. c.131A (see also 321 CMR 10.04)? ___ Yes ___ No; if yes, provide a summary of proposed measures to minimize and mitigate rare species impacts

3. Which rare species are known to occur within the Priority or Estimated Habitat?

4. Has the site been surveyed for rare species in accordance with the Massachusetts Endangered Species Act? ___ Yes ___ No

4. If your project is within Estimated Habitat, have you filed a Notice of Intent or received an Order of Conditions for this project? ___ Yes ___ No; if yes, did you send a copy of the Notice of Intent to the Natural Heritage and Endangered Species Program, in accordance with the Wetlands Protection Act regulations? ___ Yes ___ No

B. Will the project "take" an endangered, threatened, and/or species of special concern in accordance with M.G.L. c.131A (see also 321 CMR 10.04)? ___ Yes ___ No; if yes, provide a summary of proposed measures to minimize and mitigate impacts to significant habitat:

WETLANDS, WATERWAYS, AND TIDELANDS SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **wetlands, waterways, and tidelands** (see 301 CMR 11.03(3))? ___ Yes __**X**_ **No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits (or a local Order of Conditions) related to **wetlands, waterways, or tidelands**? _ Yes _**X**__ **No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Water Supply Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Wetlands, Waterways, and Tidelands Section below.

II. Wetlands Impacts and Permits

A. Does the project require a new or amended Order of Conditions under the Wetlands Protection Act (M.G.L. c.131A)? _ Yes ___ No; if yes, has a Notice of Intent been filed? ___ Yes ___ No; if yes, list the date and MassDEP file number: _____; if yes, has a local Order of Conditions been issued? ___ Yes ___ No; Was the Order of Conditions appealed? ___ Yes ___ No. Will the project require a Variance from the Wetlands regulations? ___ Yes ___ No.

B. Describe any proposed permanent or temporary impacts to wetland resource areas located on the project site:

C. Estimate the extent and type of impact that the project will have on wetland resources, and indicate whether the impacts are temporary or permanent:

Coastal Wetlands	Area (square feet) or Length (linear feet)	Temporary or Permanent Impact?
Land Under the Ocean	_____	_____
Designated Port Areas	_____	_____
Coastal Beaches	_____	_____
Coastal Dunes	_____	_____
Barrier Beaches	_____	_____
Coastal Banks	_____	_____
Rocky Intertidal Shores	_____	_____
Salt Marshes	_____	_____
Land Under Salt Ponds	_____	_____
Land Containing Shellfish	_____	_____
Fish Runs	_____	_____
Land Subject to Coastal Storm Flowage	_____	_____
Inland Wetlands		
Bank (lf)	_____	_____
Bordering Vegetated Wetlands	_____	_____
Isolated Vegetated Wetlands	_____	_____
Land under Water	_____	_____
Isolated Land Subject to Flooding	_____	_____
Bordering Land Subject to Flooding	_____	_____
Riverfront Area	_____	_____

D. Is any part of the project:

1. proposed as a **limited project**? ___ Yes __ _ No; if yes, what is the area (in sf)?____
2. the construction or alteration of a **dam**? ___ Yes _ __ No; if yes, describe:
3. fill or structure in a **velocity zone** or **regulatory floodway**? ___ Yes _ __ No
4. dredging or disposal of dredged material? ___ Yes _ __ No; if yes, describe the volume

of dredged material and the proposed disposal site:

5. a discharge to an **Outstanding Resource Water (ORW)** or an **Area of Critical Environmental Concern (ACEC)**? ___ Yes ___ No
6. subject to a wetlands restriction order? ___ Yes ___ No; if yes, identify the area (in sf):
7. located in buffer zones? ___Yes ___No; if yes, how much (in sf) _____

E. Will the project:

1. be subject to a local wetlands ordinance or bylaw? __ Yes ___ No
2. alter any federally-protected wetlands not regulated under state law? ___ Yes _ __ No; if yes, what is the area (sf)?

III. Waterways and Tidelands Impacts and Permits

A. Does the project site contain waterways or tidelands (including filled former tidelands) that are subject to the Waterways Act, M.G.L.c.91? ___ Yes _ __ No; if yes, is there a current Chapter 91 License or Permit affecting the project site? ___ Yes __ _ No; if yes, list the date and license or permit number and provide a copy of the historic map used to determine extent of filled tidelands:

B. Does the project require a new or modified license or permit under M.G.L.c.91? ___ Yes _ _ No; if yes, how many acres of the project site subject to M.G.L.c.91 will be for non-water-dependent use? Current ___ Change ___ Total ___

If yes, how many square feet of solid fill or pile-supported structures (in sf)?

C. For non-water-dependent use projects, indicate the following:

Area of filled tidelands on the site:_____

Area of filled tidelands covered by buildings:_____

For portions of site on filled tidelands, list ground floor uses and area of each use:

_____

Does the project include new non-water-dependent uses located over flowed tidelands? Yes ___ No ___

Height of building on filled tidelands_____

Also show the following on a site plan: Mean High Water, Mean Low Water, Water-dependent Use Zone, location of uses within buildings on tidelands, and interior and exterior areas and facilities dedicated for public use, and historic high and historic low water marks.

D. Is the project located on landlocked tidelands? ___ Yes ___ No; if yes, describe the project's impact on the public's right to access, use and enjoy jurisdictional tidelands and describe measures the project will implement to avoid, minimize or mitigate any adverse impact:

E. Is the project located in an area where low groundwater levels have been identified by a municipality or by a state or federal agency as a threat to building foundations? ___Yes ___ No; if yes, describe the project's impact on groundwater levels and describe measures the project will implement to avoid, minimize or mitigate any adverse impact:

F. Is the project non-water-dependent **and** located on landlocked tidelands **or** waterways or tidelands subject to the Waterways Act **and** subject to a mandatory EIR? ___ Yes ___ No;

(NOTE: If yes, then the project will be subject to Public Benefit Review and Determination.)

G. Does the project include dredging? ___ Yes ___ No; if yes, answer the following questions:

What type of dredging? Improvement ___ Maintenance ___ Both ____

What is the proposed dredge volume, in cubic yards (cys) _____

What is the proposed dredge footprint ____length (ft) ___width (ft)____depth (ft);
Will dredging impact the following resource areas?

Intertidal Yes__ No__; if yes, ___ sq ft
Outstanding Resource Waters Yes__ No__; if yes, ___ sq ft
Other resource area (i.e. shellfish beds, eel grass beds) Yes__ No__; if yes __ sq ft
If yes to any of the above, have you evaluated appropriate and practicable steps to: 1) avoidance; 2) if avoidance is not possible, minimization; 3) if either avoidance or minimize is not possible, mitigation?
If no to any of the above, what information or documentation was used to support this determination?

Provide a comprehensive analysis of practicable alternatives for improvement dredging in accordance with 314 CMR 9.07(1)(b). Physical and chemical data of the sediment shall be included in the comprehensive analysis.
Sediment Characterization

Existing gradation analysis results? __Yes ___No: if yes, provide results.
Existing chemical results for parameters listed in 314 CMR 9.07(2)(b)6? ___Yes ____No; if yes, provide results.

Do you have sufficient information to evaluate feasibility of the following management options for dredged sediment? If yes, check the appropriate option.

Beach Nourishment ___
Unconfined Ocean Disposal ___
Confined Disposal:
Confined Aquatic Disposal (CAD) ___
Confined Disposal Facility (CDF) ___
Landfill Reuse in accordance with COMM-97-001 ___
Shoreline Placement ___
Upland Material Reuse____
In-State landfill disposal____
Out-of-state landfill disposal ____
(NOTE: This information is required for a 401 Water Quality Certification.)

IV. Consistency:

A. Does the project have effects on the coastal resources or uses, and/or is the project located within the Coastal Zone? ___ Yes _ _ No; if yes, describe these effects and the projects consistency with the policies of the Office of Coastal Zone Management:

B. Is the project located within an area subject to a Municipal Harbor Plan? ___ Yes ___ No; if yes, identify the Municipal Harbor Plan and describe the project's consistency with that plan:

WATER SUPPLY SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **water supply** (see 301 CMR 11.03(4))? ___ Yes **_X**__ **No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **water supply**? ___ Yes **_X**__ **No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Wastewater Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Water Supply Section below.

II. Impacts and Permits

A. Describe, in gallons per day (gpd), the volume and source of water use for existing and proposed activities at the project site:

	Existing	Change	Total
Municipal or regional water supply			
Withdrawal from groundwater			
Withdrawal from surface water			
Interbasin transfer			

(NOTE: Interbasin Transfer approval will be required if the basin and community where the proposed water supply source is located is different from the basin and community where the wastewater from the source will be discharged.)

B. If the source is a municipal or regional supply, has the municipality or region indicated that there is adequate capacity in the system to accommodate the project? **_X**__ **Yes** ___ No

C. If the project involves a new or expanded withdrawal from a groundwater or surface water source, has a pumping test been conducted? ___ Yes ___ No; if yes, attach a map of the drilling sites and a summary of the alternatives considered and the results. _____

D. What is the currently permitted withdrawal at the proposed water supply source (in gallons per day)? _____Will the project require an increase in that withdrawal? ___Yes ___No; if yes, then how much of an increase (gpd)? _____

E. Does the project site currently contain a water supply well, a drinking water treatment facility, water main, or other water supply facility, or will the project involve construction of a new facility? ___ Yes **_X**__**No**. If yes, describe existing and proposed water supply facilities at the project site:

	Permitted Flow	Existing Avg Daily Flow	Project Flow	Total
Capacity of water supply well(s) (gpd)	_____	_____	_____	_____
Capacity of water treatment plant (gpd)	_____	_____	_____	_____

F. If the project involves a new interbasin transfer of water, which basins are involved, what is the direction of the transfer, and is the interbasin transfer existing or proposed?

G. Does the project involve:

1. new water service by the Massachusetts Water Resources Authority or other agency of the Commonwealth to a municipality or water district? ___ Yes **_X**__ **No**
2. a Watershed Protection Act variance? ___ Yes **_X**__ **No**; if yes, how many acres of alteration?
3. a non-bridged stream crossing 1,000 or less feet upstream of a public surface drinking water supply for purpose of forest harvesting activities? ___ Yes **_X**__ **No**

III. Consistency

Describe the project's consistency with water conservation plans or other plans to enhance water resources, quality, facilities and services:

WASTEWATER SECTION CIVIL

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **wastewater** (see 301 CMR 11.03(5))? ___ Yes __**X**_ **No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **wastewater**? ___ Yes _**X**__ **No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Transportation -- Traffic Generation Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Wastewater Section below.

II. Impacts and Permits

A. Describe the volume (in gallons per day) and type of disposal of wastewater generation for existing and proposed activities at the project site (calculate according to 310 CMR 15.00 for septic systems or 314 CMR 7.00 for sewer systems):

	Existing	Change	Total
Discharge of sanitary wastewater			
Discharge of industrial wastewater			
TOTAL			

	Existing	Change	Total
Discharge to groundwater			
Discharge to outstanding resource water			
Discharge to surface water			
Discharge to municipal or regional wastewater facility			
TOTAL			

B. Is the existing collection system at or near its capacity? ___ Yes _ __ No; if yes, then describe the measures to be undertaken to accommodate the project's wastewater flows:

C. Is the existing wastewater disposal facility at or near its permitted capacity? ___ Yes __ _ No; if yes, then describe the measures to be undertaken to accommodate the project's wastewater flows:

D. Does the project site currently contain a wastewater treatment facility, sewer main, or other wastewater disposal facility, or will the project involve construction of a new facility? ___ Yes _**X**__ **No**; if yes, describe as follows:

	Permitted	Existing Avg Daily Flow	Project Flow	Total
Wastewater treatment plant capacity (in gallons per day)	_____	_____	_____	_____

E. If the project requires an interbasin transfer of wastewater, which basins are involved, what is the direction of the transfer, and is the interbasin transfer existing or new?

(NOTE: Interbasin Transfer approval may be needed if the basin and community where wastewater

will be discharged is different from the basin and community where the source of water supply is located.)

F. Does the project involve new sewer service by the Massachusetts Water Resources Authority (MWRA) or other Agency of the Commonwealth to a municipality or sewer district? _ _ Yes ___ No

G. Is there an existing facility, or is a new facility proposed at the project site for the storage, treatment, processing, combustion or disposal of sewage sludge, sludge ash, grit, screenings, wastewater reuse (gray water) or other sewage residual materials? ___ Yes _ __ No; if yes, what is the capacity (tons per day):

	Existing	Change	Total
Storage	_____	_____	_____
Treatment	_____	_____	_____
Processing	_____	_____	_____
Combustion	_____	_____	_____
Disposal	_____	_____	_____

H. Describe the water conservation measures to be undertaken by the project, and other wastewater mitigation, such as infiltration and inflow removal.

III. Consistency

A. Describe measures that the proponent will take to comply with applicable state, regional, and local plans and policies related to wastewater management:

B. If the project requires a sewer extension permit, is that extension included in a comprehensive wastewater management plan? ___ Yes __ _ No; if yes, indicate the EEA number for the plan and whether the project site is within a sewer service area recommended or approved in that plan:

TRANSPORTATION SECTION (TRAFFIC GENERATION)

I. Thresholds / Permit

A. Will the project meet or exceed any review thresholds related to **traffic generation** (see 301 CMR 11.03(6))? __X_ Yes ___ No; if yes, specify, in quantitative terms:

- **301 CMR 11.03(6)(a)(6): Generation of 3,000 or more New average daily trips (adt) providing access to a single location**
- **301 CMR 11.03(6)(a)(7): Construction of 1,000 or more New parking spaces at a single location**

B. Does the project require any state permits related to **state-controlled roadways**? _X__ Yes ___ No; if yes, specify which permit:

- **MassDOT Vehicular Access Permit, per 720 CMR 13.00, for the potential need to modify roadway intersection geometry (if necessary)**

C. If you answered "No" to both questions A and B, proceed to the **Roadways and Other Transportation Facilities Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Traffic Generation Section below.

II. Traffic Impacts and Permits

A. Describe existing and proposed vehicular traffic generated by activities at the project site:

	Existing	Change	Total
Number of parking spaces	__532 [a]_	_+1,238 [b]__	__1,770 [b]_____
Number of vehicle trips per day	___887____	_+5,005__	__5,892_____
ITE Land Use Code(s):	___n/a [c]____	__710, 760, 822___	_____

a Existing Site consists of a former car dealership and car wash. Existing parking supply of 532 spaces 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).
b Proposed Project will include up to 1,770 parking spaces
c Empirical counts conducted for existing land use

B. What is the estimated average daily traffic on roadways serving the site?

Roadway	Existing	Change	Total
1. __Gould Street [a]_____	__9,000__	__4,800__	__13,800___
2. ___Highland Avenue [a]___	__23,300_	__4,000__	__27,300__
3. _____	_____	_____	_____

a Existing and future ADT estimated based on PM peak hour volumes and assumed K-factor of 0.10

C. If applicable, describe proposed mitigation measures on state-controlled roadways that the project proponent will implement:

The Proponent expects to evaluate the potential need to modify roadway intersection geometry, replace or install traffic signal equipment, or adjust traffic signal timing at the intersection of Highland Avenue at Gould Street/Hunting Road, a MassDOT-owned roadway.

D. How will the project implement and/or promote the use of transit, pedestrian and bicycle facilities and services to provide access to and from the project site?

The Project will promote the use of transit, pedestrian, and bicycle facilities through new pedestrian and bicycle accommodations and through a robust TDM program. The Project site is well connected to the pedestrian network of Needham with sidewalk connections on all abutting roadways. The Proponent will

fund the construction of new on-road bicycle accommodations along Gould Street 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. The Project is located along Highland Avenue, which is currently being reconstructed by MassDOT as part of the Needham-Newton Corridor Project and will include protected bicycle accommodations along Highland Avenue and Needham Street from Webster Street in Needham to Route 9 in Newton. The Proponent will also work with the Town of Needham to fund a feasibility study of converting the former MBTA railroad ROW north of the 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. Secure and covered bicycle parking will be provided on-Site for employees and visitors. In addition, the Proponent will evaluate the feasibility of providing shuttle service between the Site and nearby transit stations, such as Newton Highlands Station on the MBTA Green Line D Branch. Private shuttle service is currently provided by the 128 Business Council to the nearby Founders Park development on the east side of I-95 (Rt 128) in Needham.

C. Is there a Transportation Management Association (TMA) that provides transportation demand management (TDM) services in the area of the project site? __X__ Yes ____ No; if yes, describe if and how will the project participate in the TMA:

Developments in this area of Needham are served by the 128 Business Council. The Proponent is committed to joining the 128 Business Council and participating in the TDM services that the TMA provides.

D. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation facilities? ____ Yes __X__ No; if yes, generally describe:

E. If the project will penetrate approach airspace of a nearby airport, has the proponent filed a Massachusetts Aeronautics Commission Airspace Review Form (780 CMR 111.7) and a Notice of Proposed Construction or Alteration with the Federal Aviation Administration (FAA) (CFR Title 14 Part 77.13, forms 7460-1 and 7460-2)?

The Project triggered the following criteria: *Construction or alteration in proximity to a navigation facility that may impact the assurance of navigation signal reception.* Therefore, the Project will be required to file a Notice of Proposed Construction or Alteration with the FAA. Filing does not necessarily result in the FAA limiting a structure's height; however, it triggers an FAA evaluation of the proposed structure's characteristics. An FAA evaluation submission includes a completed FAA 7460-1 Notice of Proposed Construction or Alteration form. Next steps include: requesting additional data on the Project, including structure(s) and temporary construction equipment information/data; conducting a full airspace analysis relative to the standard FAA Part 77 airspace; and completing the FAA Form 7460-1, Notice of Proposed Construction/Alteration, along with completing FAA Form 7460-2, Notice of Actual Construction/Alteration when the Project is complete, as necessary. Refer to Appendix E for the results of the Notice Criteria Tool.

III. Consistency

Describe measures that the proponent will take to comply with municipal, regional, state, and federal plans and policies related to traffic, transit, pedestrian and bicycle transportation facilities and services:

The Project will include a robust TDM plan that will encourage employees and visitors to travel to and from the site via alternative modes of transportation. In addition, the site will include ground floor retail that will provide opportunities for employees of the lab and office space to use the retail space without

leaving the site. The Proponent is also committed to joining the 128 Business Council TMA. A portion of the proposed mitigation for the Project will focus on improving pedestrian and bicycle accommodations, including new on-road bicycle accommodations along Gould Street between Highland Avenue and Central Avenue and working with the Town of Needham to fund a feasibility study of converting the former MBTA railroad ROW north of the 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.

TRANSPORTATION SECTION (ROADWAYS AND OTHER TRANSPORTATION FACILITIES)

I. Thresholds

A. Will the project meet or exceed any review thresholds related to **roadways or other transportation facilities** (see 301 CMR 11.03(6))? ___ Yes **_X_ No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **roadways or other transportation facilities**? ___ Yes **_X_ No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Energy Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Roadways Section below.

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II. Transportation Facility Impacts

A. Describe existing and proposed transportation facilities in the immediate vicinity of the project site:

B. Will the project involve any

1. Alteration of bank or terrain (in linear feet)? _____
2. Cutting of living public shade trees (number)? _____
3. Elimination of stone wall (in linear feet)? _____

III. Consistency -- Describe the project's consistency with other federal, state, regional, and local plans and policies related to traffic, transit, pedestrian and bicycle transportation facilities and services, including consistency with the applicable regional transportation plan and the Transportation Improvements Plan (TIP), the State Bicycle Plan, and the State Pedestrian Plan:

ENERGY SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **energy** (see 301 CMR 11.03(7))? ___ Yes __**X**_ **No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **energy**? ___ Yes __**X**_ **No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Air Quality Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Energy Section below.

II. Impacts and Permits

A. Describe existing and proposed energy generation and transmission facilities at the project site:

	Existing	Change	Total
Capacity of electric generating facility (megawatts)	_____	_____	_____
Length of fuel line (in miles)	_____	_____	_____
Length of transmission lines (in miles)	_____	_____	_____
Capacity of transmission lines (in kilovolts)	_____	_____	_____

B. If the project involves construction or expansion of an electric generating facility, what are:

1. the facility's current and proposed fuel source(s)?
2. the facility's current and proposed cooling source(s)?

C. If the project involves construction of an electrical transmission line, will it be located on a new, unused, or abandoned right of way? ___Yes __No; if yes, please describe:

D. Describe the project's other impacts on energy facilities and services:

III. Consistency

Describe the project's consistency with state, municipal, regional, and federal plans and policies for enhancing energy facilities and services:

AIR QUALITY SECTION

I. Thresholds

A. Will the project meet or exceed any review thresholds related to **air quality** (see 301 CMR 11.03(8))? ___ Yes **_X__ No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **air quality**? ___ Yes **_X__ No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Solid and Hazardous Waste Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Air Quality Section below.

II. Impacts and Permits

A. Does the project involve construction or modification of a major stationary source (see 310 CMR 7.00, Appendix A)? ___ Yes ___ No; if yes, describe existing and proposed emissions (in tons per day) of:

	Existing	Change	Total
Particulate matter	_____	_____	_____
Carbon monoxide	_____	_____	_____
Sulfur dioxide	_____	_____	_____
Volatile organic compounds	_____	_____	_____
Oxides of nitrogen	_____	_____	_____
Lead	_____	_____	_____
Any hazardous air pollutant	_____	_____	_____
Carbon dioxide	_____	_____	_____

B. Describe the project's other impacts on air resources and air quality, including noise impacts:

III. Consistency

A. Describe the project's consistency with the State Implementation Plan:

B. Describe measures that the proponent will take to comply with other federal, state, regional, and local plans and policies related to air resources and air quality:

SOLID AND HAZARDOUS WASTE SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **solid or hazardous waste** (see 301 CMR 11.03(9))? ___ Yes _**X__ No**; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **solid and hazardous waste**? ___ Yes **X___ No**; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Historical and Archaeological Resources Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Solid and Hazardous Waste Section below.

II. Impacts and Permits

A. Is there any current or proposed facility at the project site for the storage, treatment, processing, combustion or disposal of solid waste? ___ Yes ___ No; if yes, what is the volume (in tons per day) of the capacity:

	Existing	Change	Total
Storage	_____	_____	_____
Treatment, processing	_____	_____	_____
Combustion	_____	_____	_____
Disposal	_____	_____	_____

B. Is there any current or proposed facility at the project site for the storage, recycling, treatment or disposal of hazardous waste? ___ Yes ___ No; if yes, what is the volume (in tons or gallons per day) of the capacity:

	Existing	Change	Total
Storage	_____	_____	_____
Recycling	_____	_____	_____
Treatment	_____	_____	_____
Disposal	_____	_____	_____

C. If the project will generate solid waste (for example, during demolition or construction), describe alternatives considered for re-use, recycling, and disposal:

D. If the project involves demolition, do any buildings to be demolished contain asbestos? ___ Yes ___ No

E. Describe the project's other solid and hazardous waste impacts (including indirect impacts):

III. Consistency

Describe measures that the proponent will take to comply with the State Solid Waste Master Plan:

HISTORICAL AND ARCHAEOLOGICAL RESOURCES SECTION

I. Thresholds / Impacts

A. Have you consulted with the Massachusetts Historical Commission? ___ Yes _**X**_ **No**; if yes, attach correspondence. For project sites involving lands under water, have you consulted with the Massachusetts Board of Underwater Archaeological Resources? ____Yes _**X**_ **No**; if yes, attach correspondence

B. Is any part of the project site a historic structure, or a structure within a historic district, in either case listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth? ___ Yes _**X**_ **No**; if yes, does the project involve the demolition of all or any exterior part of such historic structure? ___ Yes _**X**_ **No**; if yes, please describe:

C. Is any part of the project site an archaeological site listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth? ___ Yes _**X**_ **No**; if yes, does the project involve the destruction of all or any part of such archaeological site? __ Yes _**X**__ **No;** if yes, please describe:

D. If you answered "No" to all parts of both questions A, B and C, proceed to the **Attachments and Certifications** Sections. If you answered "Yes" to any part of either question A or question B, fill out the remainder of the Historical and Archaeological Resources Section below.

II. Impacts

Describe and assess the project's impacts, direct and indirect, on listed or inventoried historical and archaeological resources:

III. Consistency

Describe measures that the proponent will take to comply with federal, state, regional, and local plans and policies related to preserving historical and archaeological resources:

CLIMATE CHANGE ADAPTATION AND RESILIENCY SECTION

This section of the Environmental Notification Form (ENF) solicits information and disclosures related to climate change adaptation and resiliency, in accordance with the MEPA Interim Protocol on Climate Change Adaptation and Resiliency (the "MEPA Interim Protocol"), effective October 1, 2021. The Interim Protocol builds on the analysis and recommendations of the 2018 Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), and incorporates the efforts of the Resilient Massachusetts Action Team (RMAT), the inter-agency steering committee responsible for implementation, monitoring, and maintenance of the SHMCAP, including the "Climate Resilience Design Standards and Guidelines" project. The RMAT team recently released the RMAT Climate Resilience Design Standards Tool, which is available here.

The MEPA Interim Protocol is intended to gather project-level data in a standardized manner that will both inform the MEPA review process and assist the RMAT team in evaluating the accuracy and effectiveness of the RMAT Climate Resilience Design Standards Tool. Once this testing process is completed, the MEPA Office anticipates developing a formal Climate Change Adaptation and Resiliency Policy through a public stakeholder process. Questions about the RMAT Climate Resilience Design Standards Tool can be directed to rmat@mass.gov.

All Proponents must complete the following section, referencing as appropriate the results of the output report generated by the RMAT Climate Resilience Design Standards Tool and attached to the ENF. In completing this section, Proponents are encouraged, but not required at this time, to utilize the recommended design standards and associated Tier 1/2/3 methodologies outlined in the RMAT Climate Resilience Design Standards Tool to analyze the project design. However, Proponents are requested to respond to a respond to a user feedback survey on the RMAT website or to provide feedback to rmat@mass.gov, which will be used by the RMAT team to further refine the tool. Proponents are also encouraged to consult general guidance and best practices as described in the RMAT Climate Resilience Design Guidelines.

Climate Change Adaptation and Resiliency Strategies

I. Has the project taken measures to adapt to climate change for all of the climate parameters analyzed in the RMAT Climate Resilience Design Standards Tool (sea level rise/storm surge, extreme precipitation (urban or riverine flooding), extreme heat)? **_X__Yes** __ No

Note: Climate adaptation and resiliency strategies include actions that seek to reduce vulnerability to anticipated climate risks and improve resiliency for future climate conditions. Examples of climate adaptation and resiliency strategies include flood barriers, increased stormwater infiltration, living shorelines, elevated infrastructure, increased tree canopy, etc. Projects should address any planning priorities identified by the affected municipality through the Municipal Vulnerability Preparedness (MVP) program or other planning efforts, and should consider a flexible adaptive pathways approach, an adaptation best practice that encourages design strategies that adapt over time to respond to changing climate conditions. General guidance and best practices for designing for climate risk are described in the RMAT Climate Resilience Design Guidelines*.*

A. If no, explain why.

B. If yes, describe the measures the project will take, including identifying the planning horizon and climate data used in designing project components. If applicable, specify the return period and design storm used (e.g., 100-year, 24-hour storm).

The Project will incorporate design features such as landscaping throughout the Project Site, Best Management Practices in stormwater improvements, open space improvements, including a recreation track around the site for tenants and others to use, an atrium, and a greatly reduced total impervious surface. Because the Project Site is currently nearly entirely impervious surface

parking, the Project will bring climate resilient features to the site. With a higher risk of urban flooding and extreme heat anticipated, the Project will implement strategies to reduce these impacts.

C. Is the project contributing to regional adaptation strategies? _**X**_ **Yes** __ No; If yes, describe. Refer to Section 1.6 of Chapter 1, *Project Description,* for a discussion of climate change mitigation and adaptation. Refer to Appendix B for the RMAT tool.

II. Has the Proponent considered alternative locations for the project in light of climate change risks? ___ Yes _**X**__ **No**

A. If no, explain why.

As the site is already developed, it is a prime location for redevelopment and will be well served by I-95.

B. If yes, describe alternatives considered.

III. Is the project located in Land Subject to Coastal Storm Flowage (LSCSF) or Bordering Land Subject to Flooding (BLSF) as defined in the Wetlands Protection Act? ____Yes __**X**__**No**

If yes, describe how/whether proposed changes to the site's topography (including the addition of fill) will result in changes to floodwater flow paths and/or velocities that could impact adjacent properties or the functioning of the floodplain. General guidance on providing this analysis can be found in the CZM/MassDEP Coastal Wetlands Manual, available here.

ENVIRONMENTAL JUSTICE SECTION

I. Identifying Characteristics of EJ Populations

A. If an Environmental Justice (EJ) population has been identified as located in whole or in part within 5 miles of the project site, describe the characteristics of each EJ populations as identified in the EJ Maps Viewer (i.e., the census block group identification number and EJ characteristics of "Minority," "Minority and Income," etc.). Provide a breakdown of those EJ populations within 1 mile of the project site, and those within 5 miles of the site.

The Project does not contain any EJ populations in a one-mile radius and Project impacts will not impact populations outside of the immediate Project Site.

B. Identify all languages identified in the "Languages Spoken in Massachusetts" tab of the EJ Maps Viewer as spoken by 5 percent or more of the EJ population who also identify as not speaking English "very well." The languages should be identified for each census tract located in whole or in part within 1 mile and 5 miles of the project site, regardless of whether such census tract contains any designated EJ populations.

The Project does not contain any EJ populations in a one-mile radius and Project impacts will not impact populations outside of the immediate Project Site. Thus, languages outside of this range have not been identified.

C. If the list of languages identified under Section I.B. has been modified with approval of the EEA EJ Director, provide a list of approved languages that the project will use to provide public involvement opportunities during the course of MEPA review. If the list has been expanded by the Proponent (without input from the EEA EJ Director), provide a list of the additional languages that will be used to provide public involvement opportunities during the course of MEPA review as required by Part II of the MEPA Public Involvement Protocol for Environmental Justice Populations ("MEPA EJ Public Involvement Protocol"). If the project is exempt from Part II of the protocol, please specify.

The Project does not contain any EJ populations in a one-mile radius and Project impacts will not impact populations outside of the immediate Project Site. Thus, languages outside of this range have not been identified.

II. Potential Effects on EJ Populations

A. If an EJ population has been identified using the EJ Maps Viewer within 1 mile of the project site, describe the likely effects of the project (both adverse and beneficial) on the identified EJ population(s).

The Project does not contain any EJ populations in a one-mile radius and Project impacts will not impact populations outside of the immediate Project Site.

B. If an EJ population has been identified using the EJ Maps Viewer within 5 miles of the project site, will the project: (i) meet or exceed MEPA review thresholds under 301 CMR 11.03(8)(a)-(b) __ Yes **_X_ No**; or (ii) generate150 or more new average daily trips (adt) of diesel vehicle traffic, excluding public transit trips, over a duration of 1 year or more. ___ Yes **_X__ No**

C. If you answered “Yes” to either question in Section II.B., describe the likely effects of the project (both adverse and beneficial) on the identified EJ population(s).

III. Public Involvement Activities

A. Provide a description of activities conducted prior to filing to promote public involvement by EJ populations, in accordance with Part II of the MEPA EJ Public Involvement Protocol. In particular:

1. If advance notification was provided under Part II.A., attach a copy of the Environmental Justice Screening Form and provide list of CBOs/tribes contacted (with dates). Copies of email correspondence can be attached in lieu of a separate list.

2. State how CBOs and tribes were informed of ways to request a community meeting, and if any meeting was requested. If public meetings were held, describe any issues of concern that were raised at such meetings, and any steps taken (including modifications to the project design) to address such concerns.

3. If the project is exempt from Part II of the protocol, please specify.

The Project does not contain any EJ populations in a one-mile radius and Project impacts will not impact populations outside of the immediate Project Site. Because of this, the Proponent was not required to deliver the ENF to the MEPA provided CBO list.

B. Provide below (or attach) a distribution list (if different from the list in Section III.A. above) of CBOs and tribes, or other individuals or entities the Proponent intends to maintain for the notice of the MEPA Site Visit and circulation of other materials and notices during the course of MEPA review.

A distribution list will be attached as Appendix A. CBO’S and Tribal Organizations were not included because this Project is not within one-mile of an EJ population.

C. Describe (or submit as a separate document) the Proponent’s plan to maintain the same level of community engagement throughout the MEPA review process, as conducted prior to filing.

Coordination with the Town of Needham was conducted prior to this filing. This coordination and engagement will continue throughout the MEPA process

CERTIFICATIONS:

1. The Public Notice of Environmental Review has been/will be published in the following newspapers in accordance with 301 CMR 11.15(1):

   (Name) **Needham Times** (Date) **April 7, 2022**

2. This form has been circulated to Agencies and Persons in accordance with 301 CMR 11.16(2).

Signatures:

03/31/22 DocuSigned by: 0615938352F8420...	**03/31/22**
Date Signature of Responsible Officer or Proponent	Date Signature of person preparing ENF (if different from above)
Robert A. Schlager	**Samhita Saquib**
Name (print or type)	Name (print or type)
557 Highland, LLC	**VHB**
Firm/Agency	Firm/Agency
116 Huntington Avenue, Suite 600	**99 High Street #10**
Street	Street
Boston, MA 02116	**Boston, MA 02110**
Municipality/State/Zip	Municipality/State/Zip
781-707-4000	**617-607-2147**
Phone	Phone

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Project Description

557 Highland Avenue, LLC, an affiliate of The Bulfinch Companies, Inc. (the "Proponent") is pleased to submit this Environmental Notification Form (ENF) 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, the Highland Science Center (the "Project") in Needham. 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.

1.1 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 the off-ramp Exit 35C and along a commercial corridor on Highland Avenue.

The existing site currently 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 existing site conditions, and Figure 1.3 for environmental constraints.

1.2 Project Description

The Proponent is proposing to build a new office/laboratory building complex on the former site of the 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.

1.2.1 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[2] SF		55′
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 garages that will be 155,000 SF each.

1.2.2 Description of Project Components, Uses

The office/lab buildings will total 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 one level 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 1.4 for a proposed site plan.

1.2.3 Description of Overall Design Approach

The building arrangement conforms with the allowable Special Permit dimensional guidelines adopted as part of the recently updated site zoning. The office/lab buildings are conceived as one structure articulated as three distinct parts:

- South Building – 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;
- 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.

1.2.4 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, and has very minor landscape treatments with 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 (the "Town") 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 within the southeast and northeast portions of the Project Site, including an 8-foot-wide 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 development consists of a two office/lab structures with a central enclosed atrium that will contain flexible space. Project amenities that 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 for community-based retail and will also include a hardscape and softscape plaza space for the retail tenants to offer outdoor seating.

1.2.5 Description of Site Access/Circulation and Parking

Primary access to the Project Site will be from a signalized intersection on Gould Street and a secondary entrance on TV Place. Below-grade parking will be accessed from the Gould Street entrance drive. A free-standing parking structure will be located near the secondary entrance off of TV Place. These entrances will be connected by a loop road and wide pedestrian sidewalks and will include dedicated bicycle lanes. 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 44 spaces for visitors 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.

1.2.6 Anticipated Project Schedule/Phasing

Construction is expected to commence in April 2023. The garage will be constructed first, and will take approximately six months, 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. Construction is expected to be complete in December 2025.

1.3 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:

- Improved water quality and stormwater management;
- Improved open space along Highland Avenue;
- 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;
- Potential for community and education connections in both construction trades and life science studies;
- Provide 300 temporary construction jobs for approximately three years, associated with construction of the garage, buildings, hardscape, and landscape;
- Provide approximately 1,250 permanent jobs at full occupancy, with employees working on staggered schedules;
- Opportunities to connect with future projects and help create a critical mass of redevelopment; and
- Substantial additional annual tax revenue in the amount of approximately $2.3 million, which will support the Town of Needham's educational and recreational programs, housing initiatives, community and open spaces, and other Town priorities.

The Proponent is also committed to implementing the following transportation-specific measures:

- Installation of on-road bicycle lanes in each direction of Gould Street between Highland Avenue and the former MBTA railroad ROW just north of TV Place;
- Addition of shared lane pavement markings and signage in each direction for bicyclists along Gould Street for approximately a half-mile between the former MBTA railroad ROW 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;
- Connections to the future bicycle accommodations on Highland Avenue that will extend toward Newton to the east and toward Needham Heights to the west;
- Construction of an approximately half-mile walking path around the Project Site with landscaping, lighting, and other public amenities that will be open to employees and visitors on the Project Site, as well as to members of the general public;
- 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 Proponent will work with the Town of Needham to fund a feasibility study 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 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 Site;
- The Project will generate significantly less traffic (44-percent less daily traffic) than what was estimated in the 2020 traffic study supporting the rezoning effort; and
- 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.

1.4 Anticipated Permits and Approvals

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.

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

1.5 Project Alternatives

The following section provides a description and evaluation of project alternatives that were considered in the site design process to work towards the project goals and intentions of the Proponent. Table 1-3 below compares the project alternatives. No alternative additional land uses have been or are being considered due to the development objectives set forth by the Proponent.

Table 1-3 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 (555 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.

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 car wash that occupied approximately 39,750 SF. Although the No-Build Alternative would not result in any new impacts, the existing uses were dated, and did 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. 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.

As-of-Right Build Alternative

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 height restrictions of the Town of Needham. Further constraints of this alternative on the site include the massing and placement of the parking garage.

Residential Build Alternative

The Residential Build Alternative was initially considered to construct up to 555 dwelling units, along with 833 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 would also not generate anywhere near the tax revenue Needham anticipated when it created the Highway Commercial 1 Zoning District in which the Project

Site is located. For example, typical lab/office commercial buildings in Needham have an average tax revenue generator of approximately $5 per square foot. Based on the total building inclusive of the land and parking garage, real estate taxes would expect to be approximately $2.6 million annually. Needham did amend its Zoning By-Laws in 2016 to create a Mixed-Use Overlay District, to encourage multifamily residential development, by itself or in combination with retail and office uses, in 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.

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 approximately $3 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.

1.6 Climate Change Mitigation and Adaptation

The Proponent has utilized the Resilience Massachusetts Action Team (RMAT) tool to measure the Project's impacts and benefits to the Project Site. As noted in the attached RMAT Climate Resilience Design Standards Tool, the report indicates that 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 combat a future of climate risks, the Project will include 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.

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 almost an entirely impervious surface parking lot, the Project will make dramatic improvements to the existing conditions.

1.7 Sustainability Approach

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 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.

1.8 Compliance with Environmental Justice Policy

This section provides an assessment of the Project's potential impacts on surrounding Environmental Justice (EJ) populations. Following the direction of 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.

1.8.1 Demographics Immediately Adjacent to the Project Site

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- and 5-mile radius of the Project Site. Figure 5 presents the 1- and 5-mile radius 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).

EJ Populations in Massachusetts are defined as:

› A neighborhood that meets 1 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;

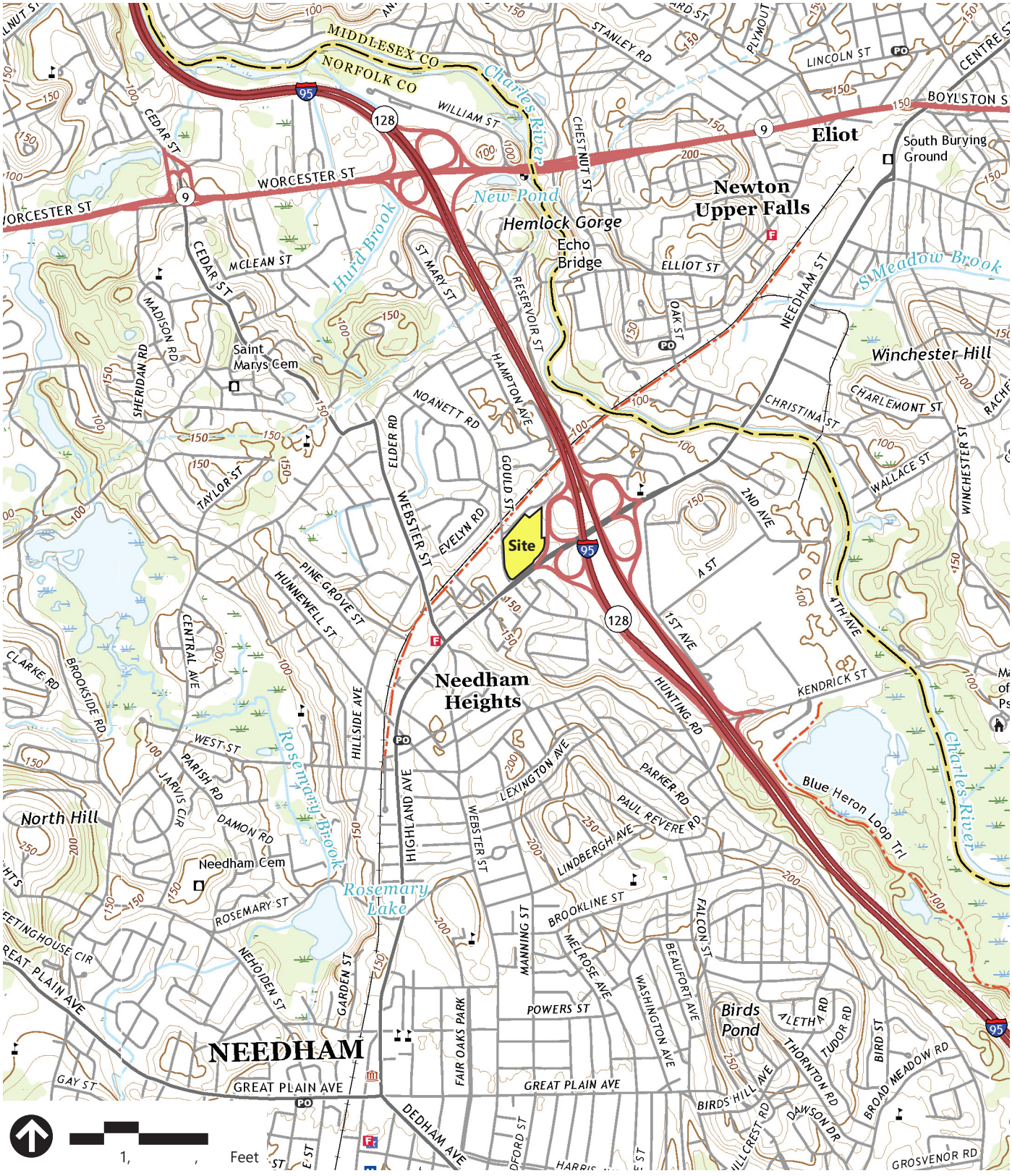
ii. Minorities comprise 40 per cent or more of the population;

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

› 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 1.5.



Source: SGS 1

Prepared By: VHB, Inc.

Figure 1.1 Project Site Location

Highland Science Center
Needham, Massachusetts

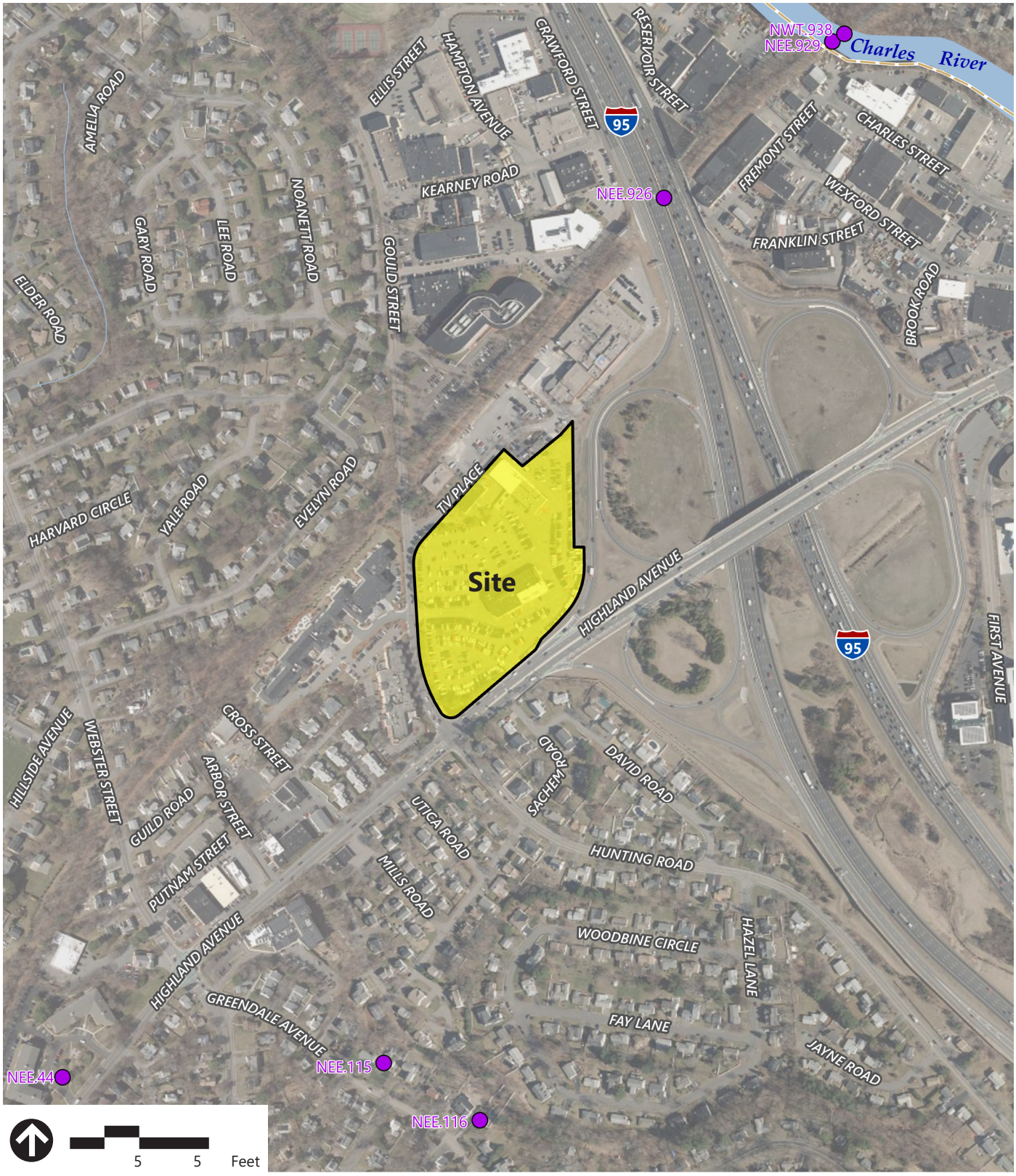
Source: Bing Aerial

Prepared By: VHB, Inc.

Figure 1.2

Existing Conditions

Highland Science Center
Needham, Massachusetts



Source: MassGIS

Prepared By: VHB, Inc..

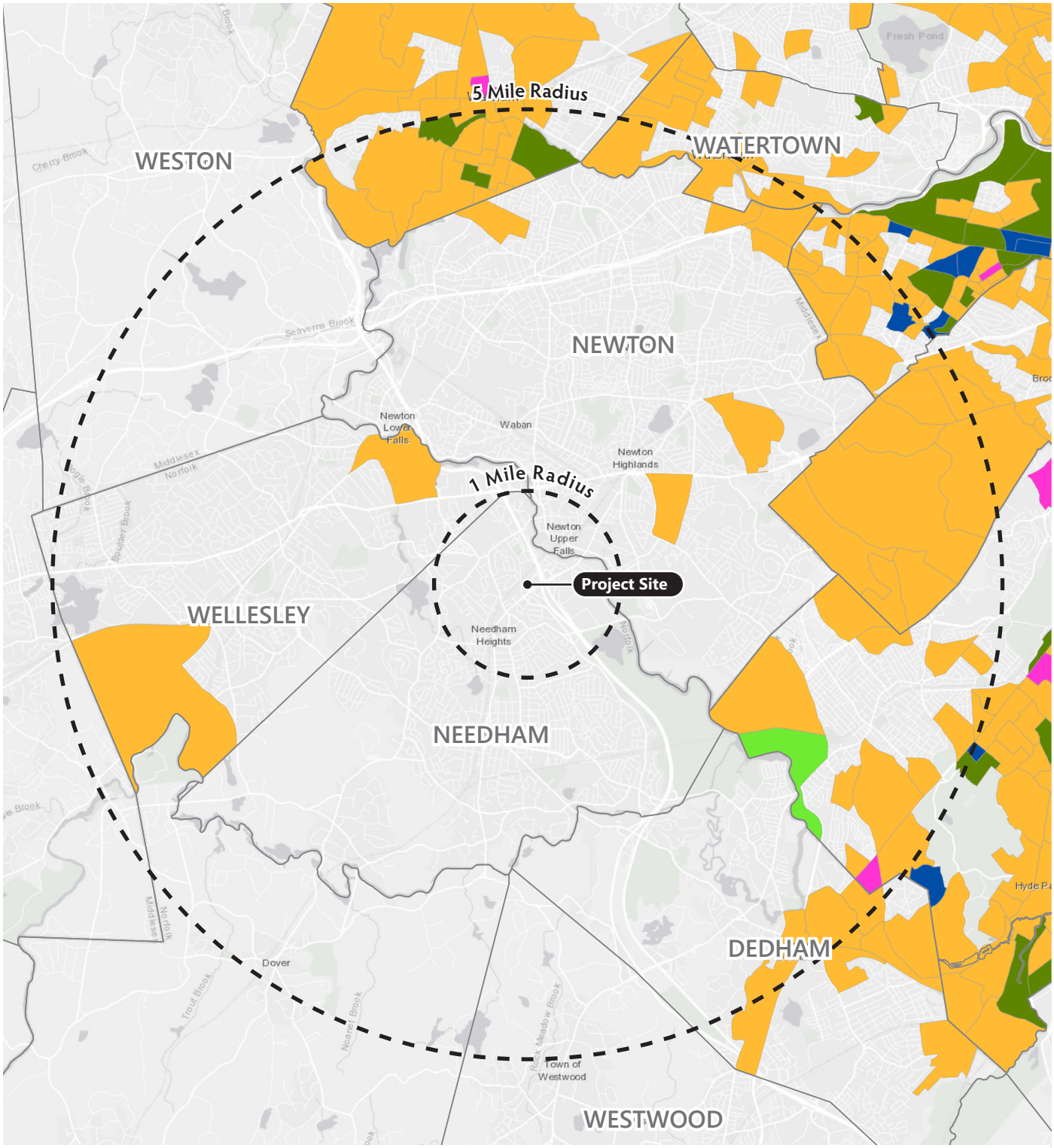
Historic Resource

Note: Priority and Estimated Habitat offState Listed are Species, areas offCritical Environmental Concern, Chapter 1 Jurisdictional areas, article Lands, and Water Supply Protection areas are not within the site location.

Figure 1.3 Environmental Constraints

Highland Science Center
Needham, Massachusetts

Figure 1.4 Proposed Site Plan



4, , Feet

Source: The Environmental Justice Map Viewer, an interactive map that uses population data from the 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.

1.5 Environmental Justice Populations
Highland Science Center
Needham, Massachusetts

Figure 1.6a Proposed Site Aerial

Highland Science Center
Needham, Massachusetts

Stantec

Figure 1.6b Proposed Site Aerial

Highland Science Center
Needham, Massachusetts

Stantec

Figure 1.6c Proposed Site Entry Render

Highland Science Center
Needham, Massachusetts

Stantec

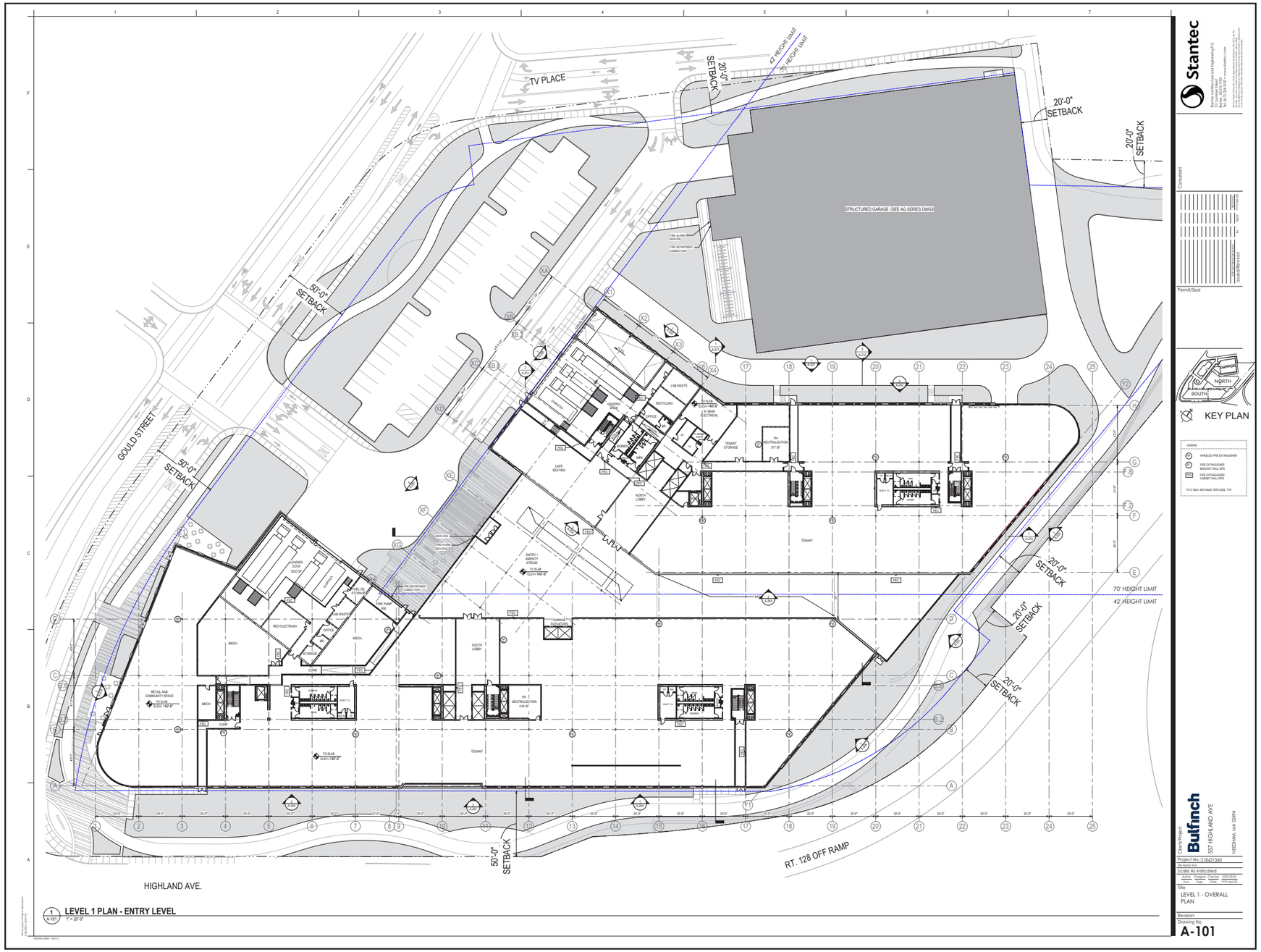


Figure 1.6d Proposed Site Ground Floor Plan

0 40 80 160'

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.

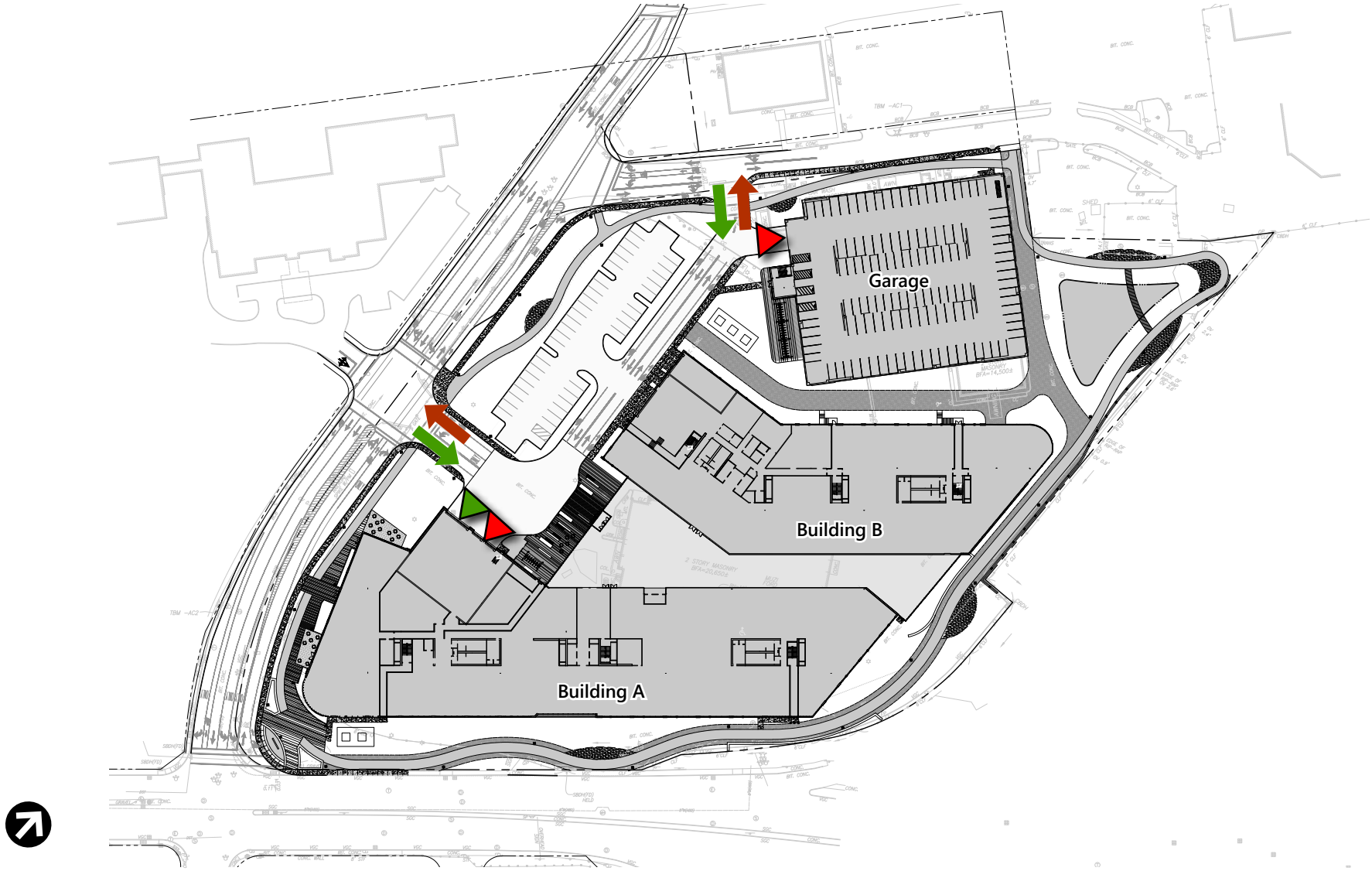
These counts will be collected on a non-holiday week, during midweek days.

Source: NearMap

Figure 2.1

Site Location Map

Highland Science Center
Needham, Massachusetts

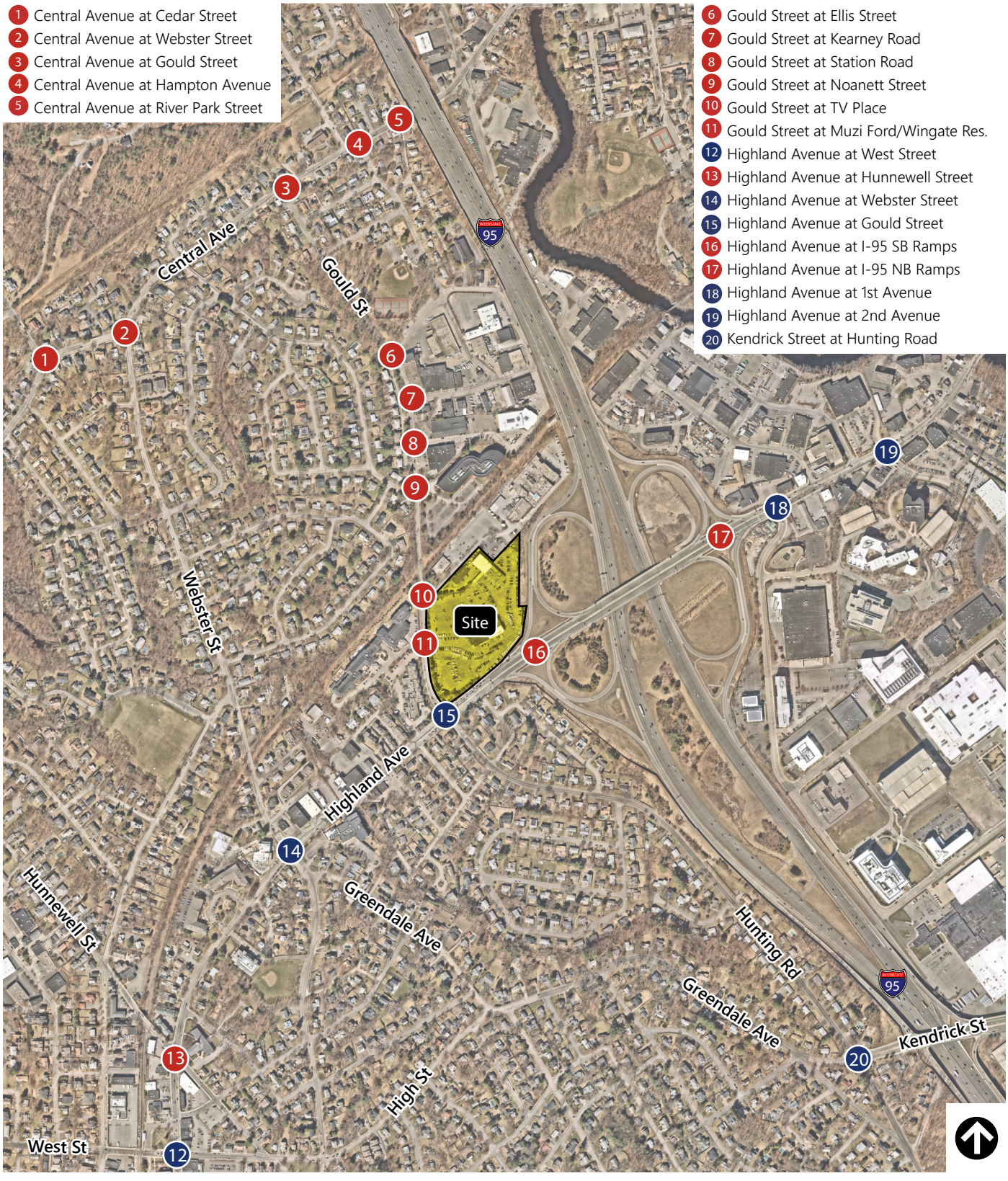


Source: Paul Finger Associates

- Vehicle Access
- Vehicle Egress
- Garage Access
- Loadings Access

Figure 2.2
Site Plan & Circulation

Highland Science Center
Needham, Massachusetts



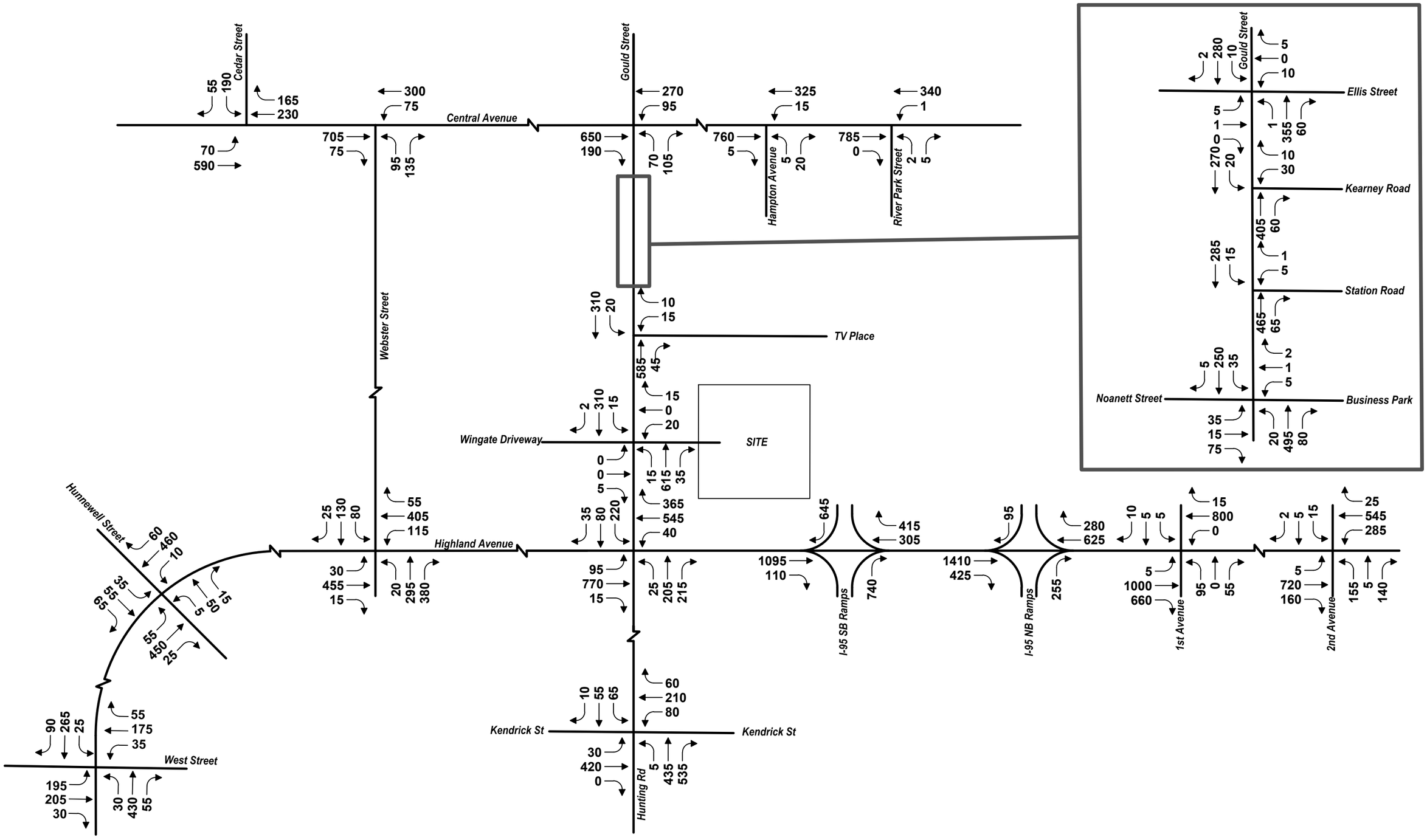
Source: NearMap

- Unsignalized Intersection
- Signalized Intersection

Figure 2.3

Study Area Intersections

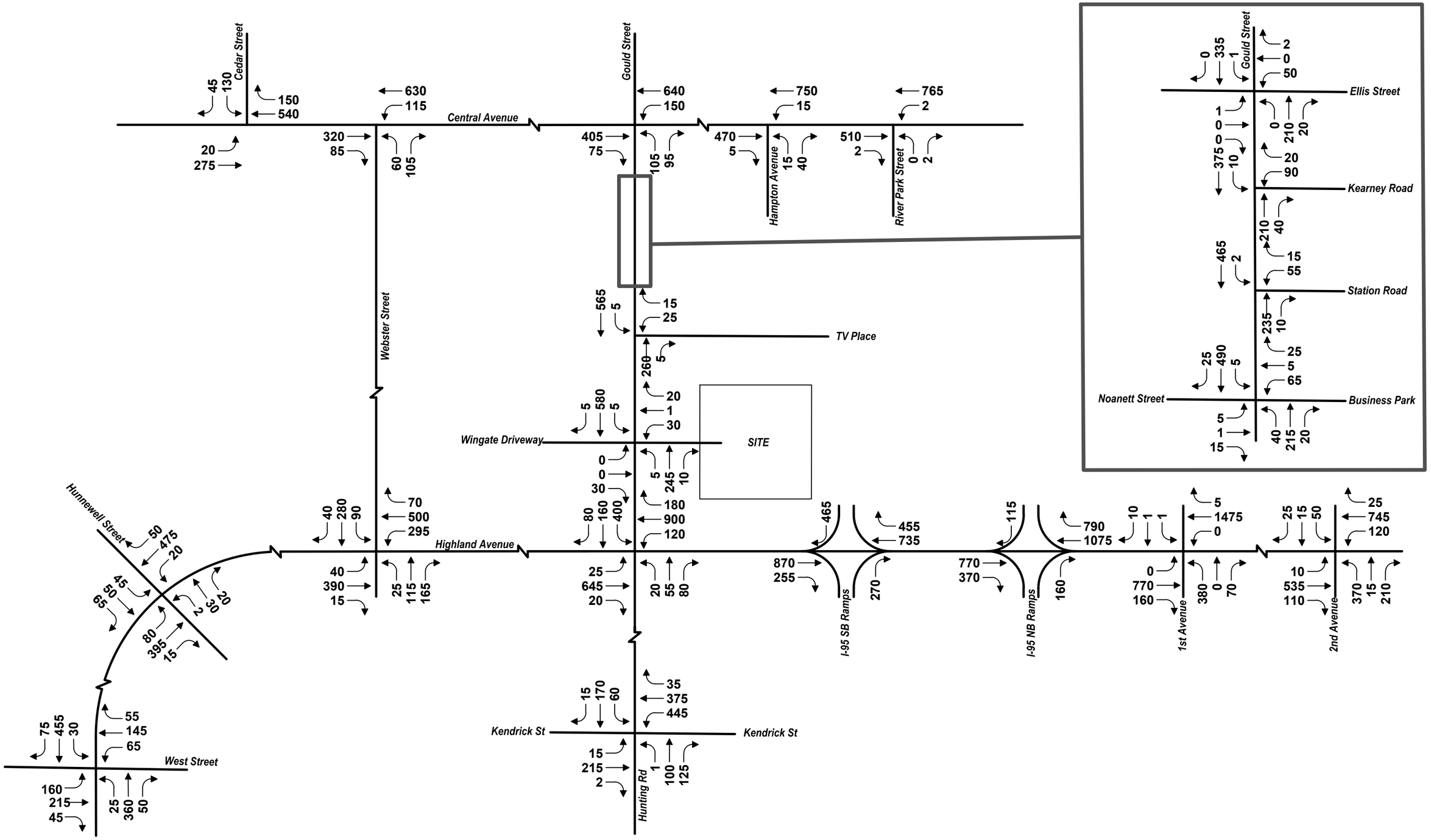
Highland Science Center
Needham, Massachusetts



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

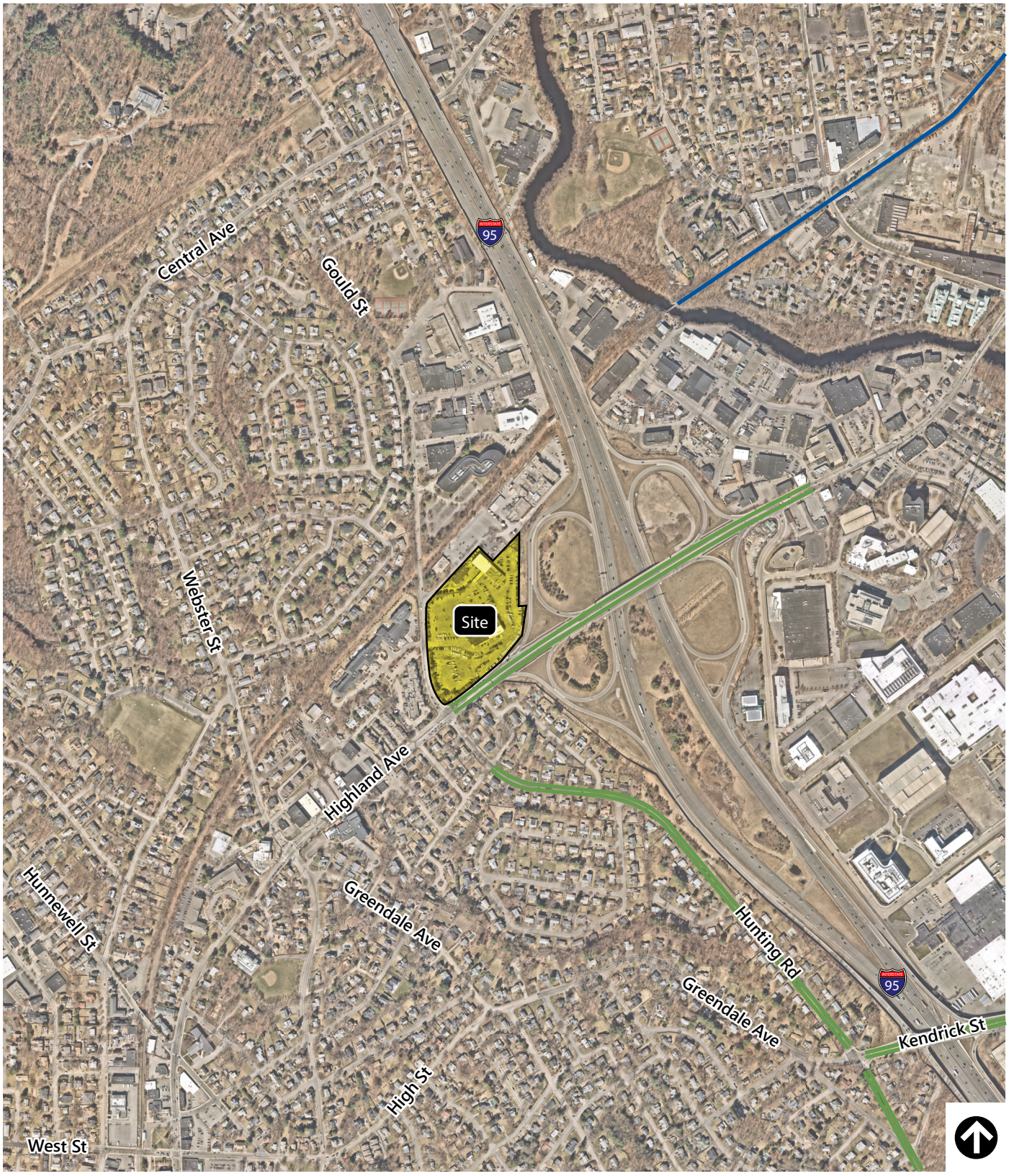
Source: NearMap / MBTA 2021 Sytem Map

- 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

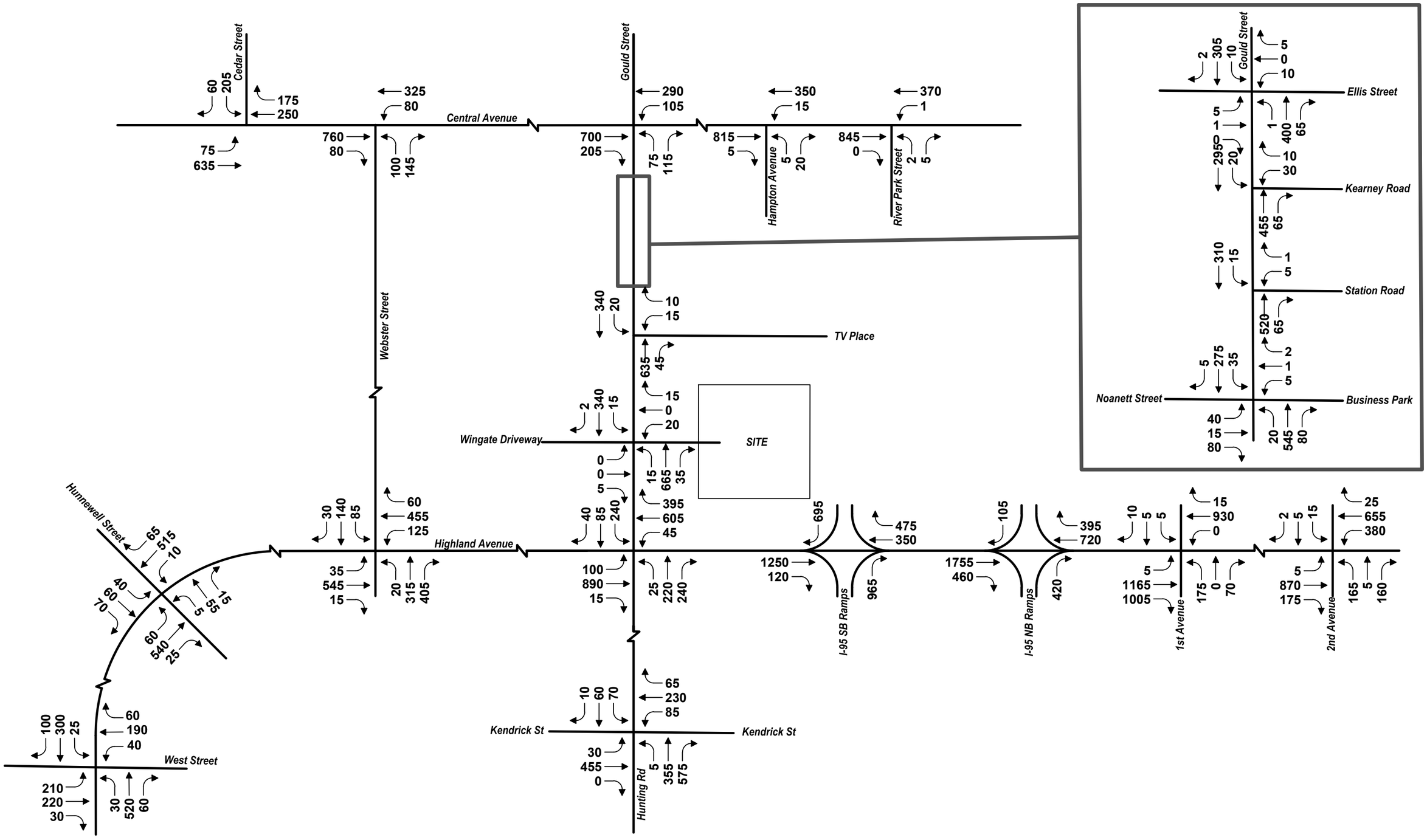
Bike Lane

Trail

Figure 2.7

Existing Bicycle Facilities

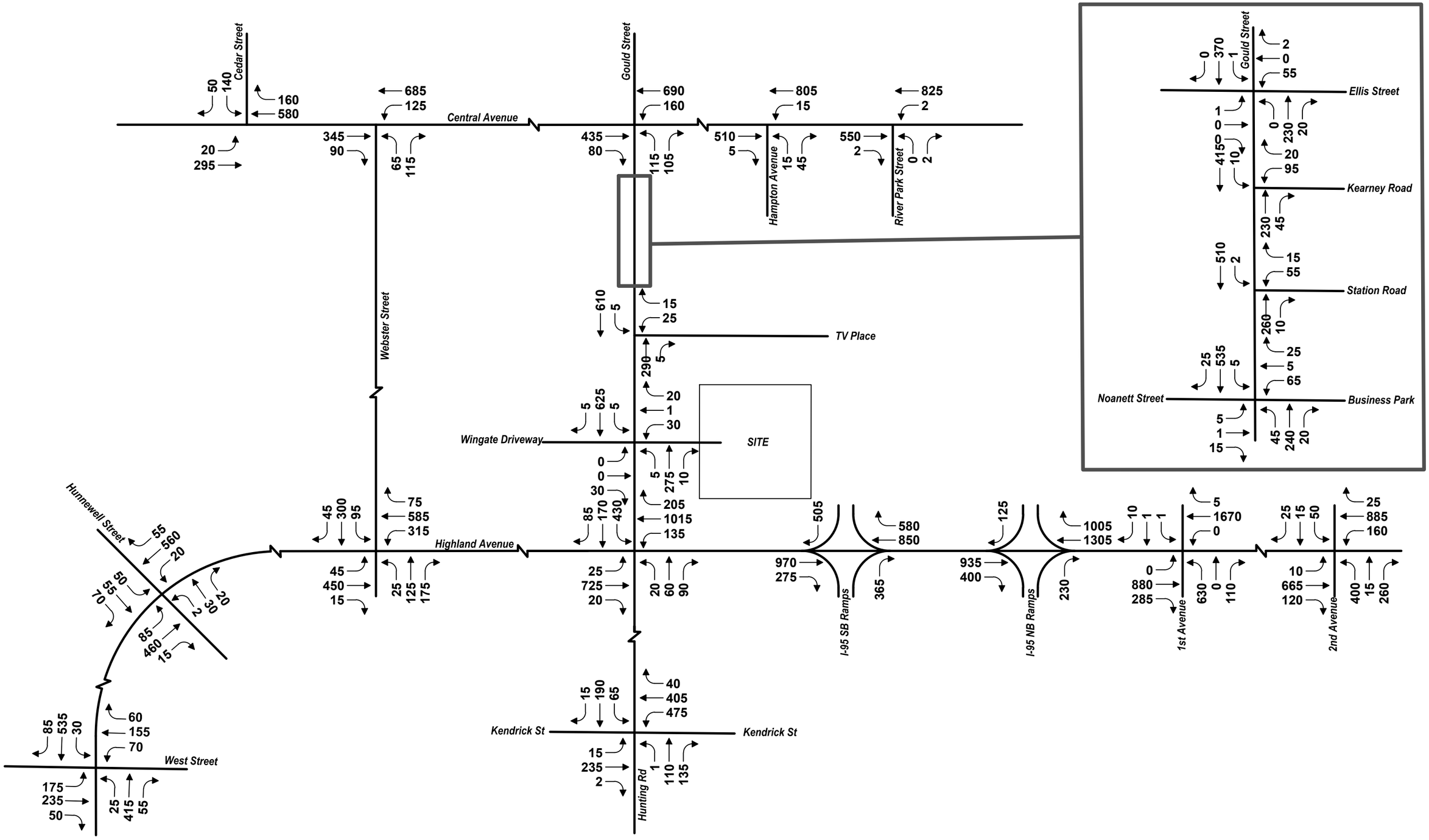
Highland Science Center
Needham, Massachusetts



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

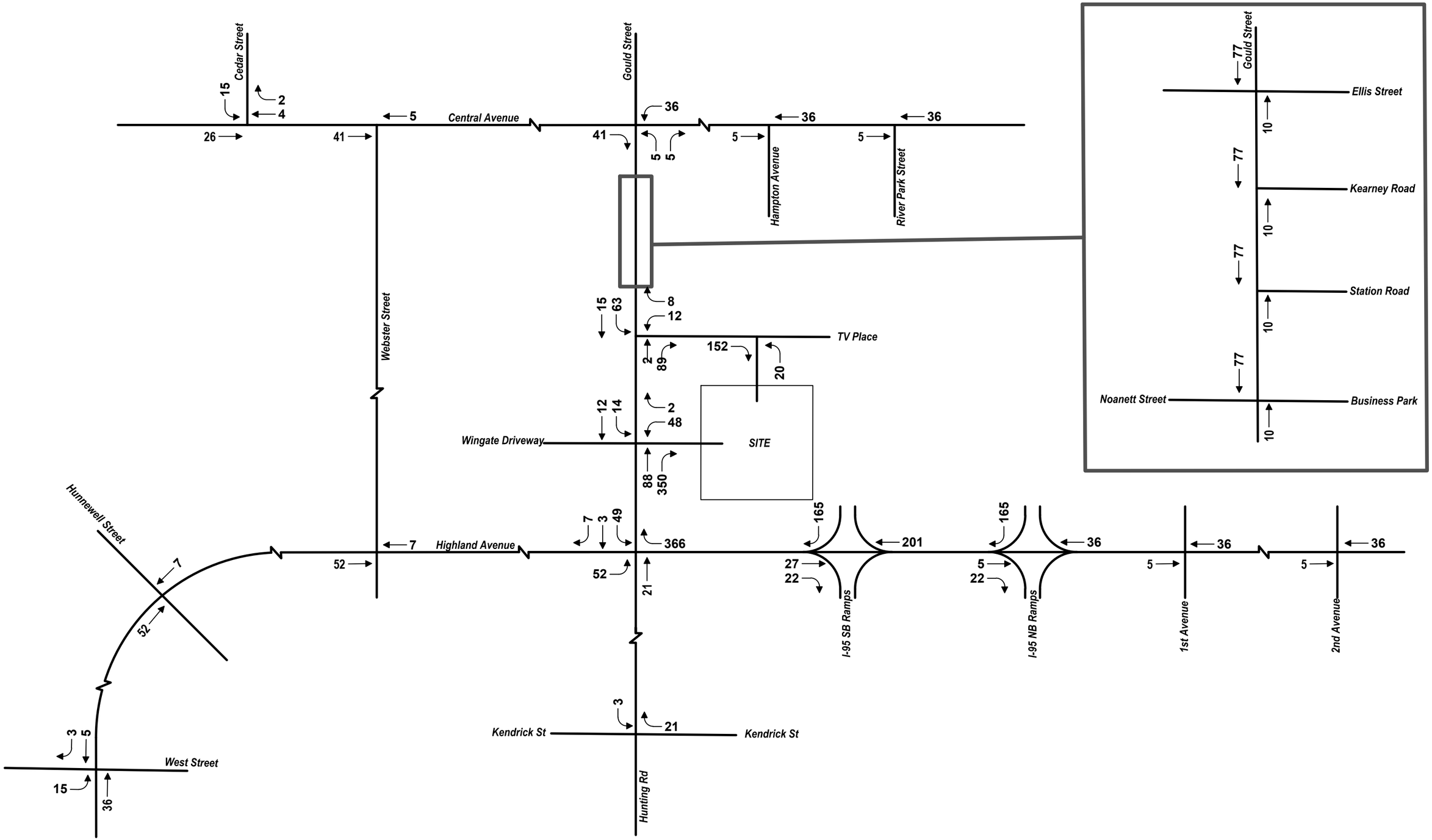
% Outbound

% Inbound

Figure 2.10

Trip Distribution

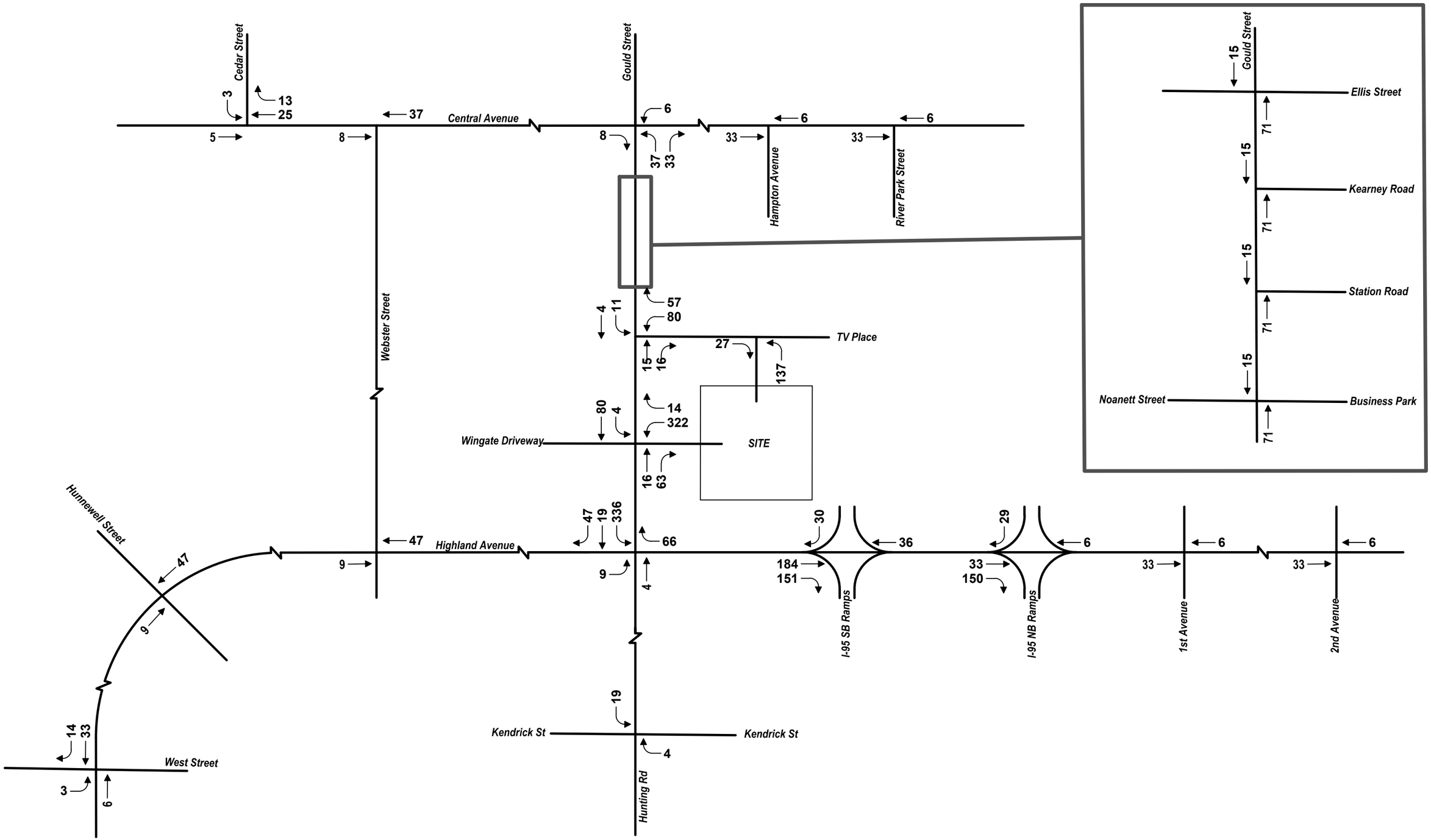
Highland Science Center
Needham, Massachusetts



Not to Scale

Project Generated Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

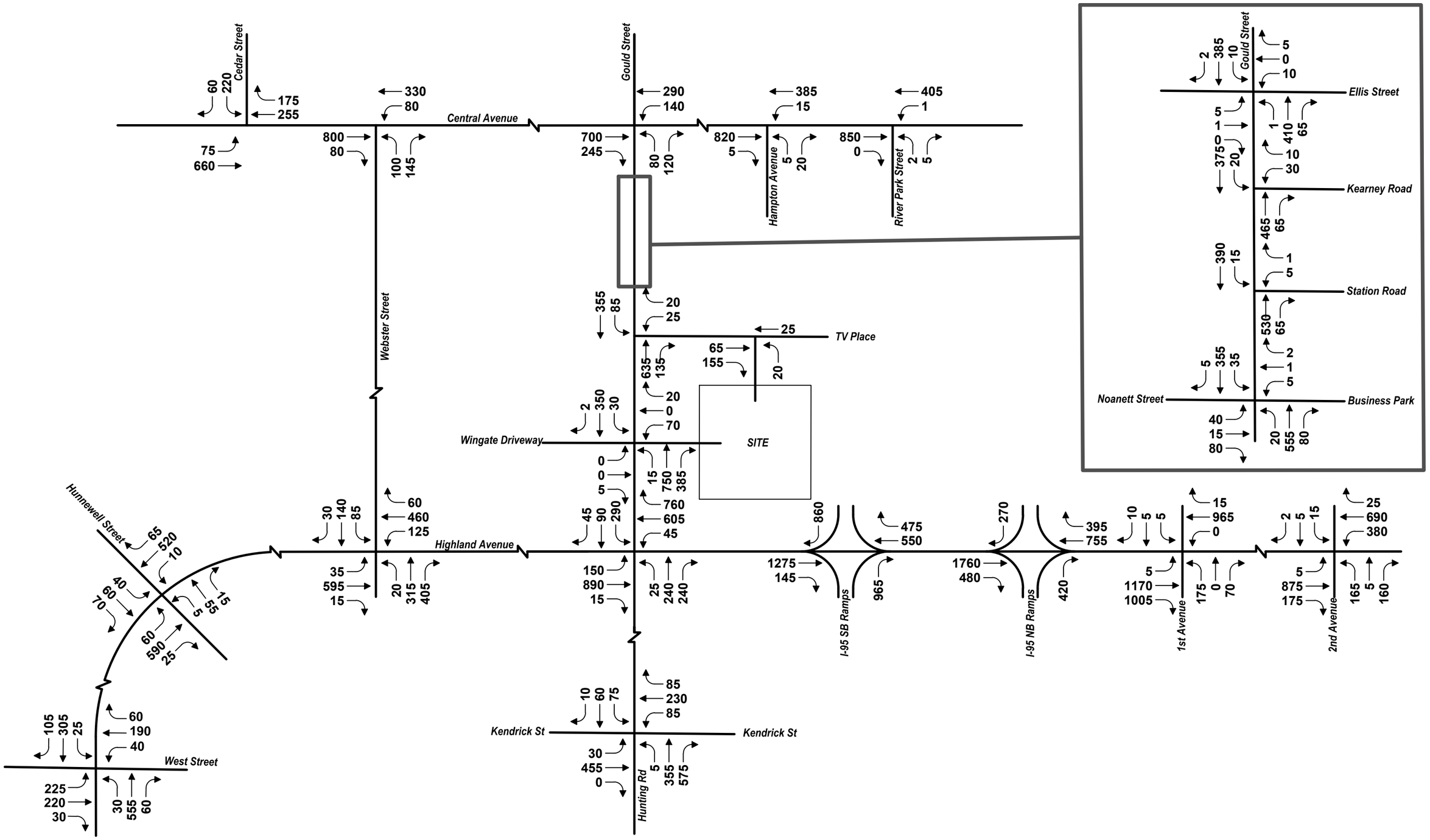
Figure 2.11



Not to Scale

Project Generated Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

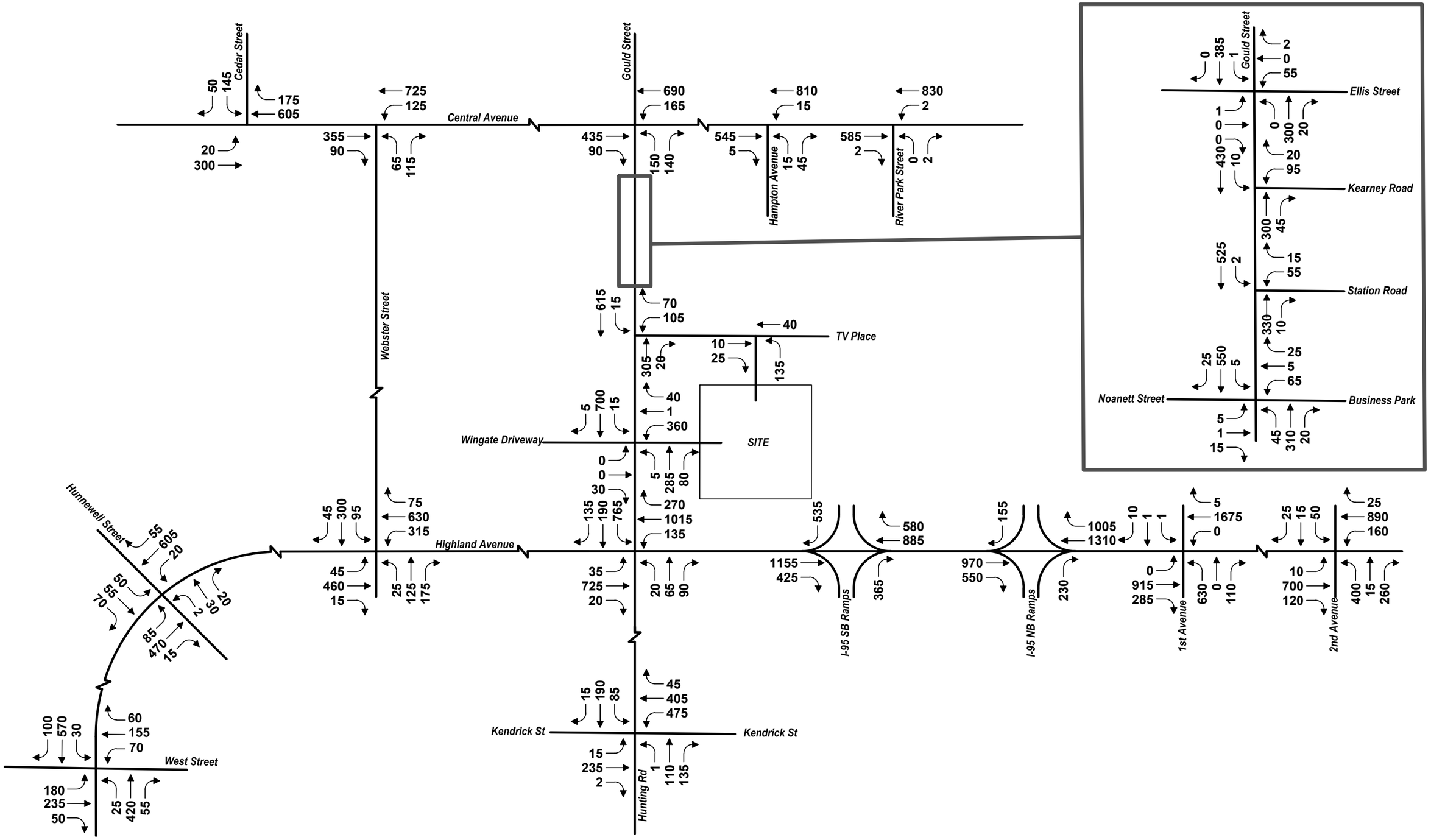
Figure 2.12



Not to Scale

Build Conditions Vehicle Volumes
Weekday Morning Peak Hour
Highland Science Center
Needham, Massachusetts

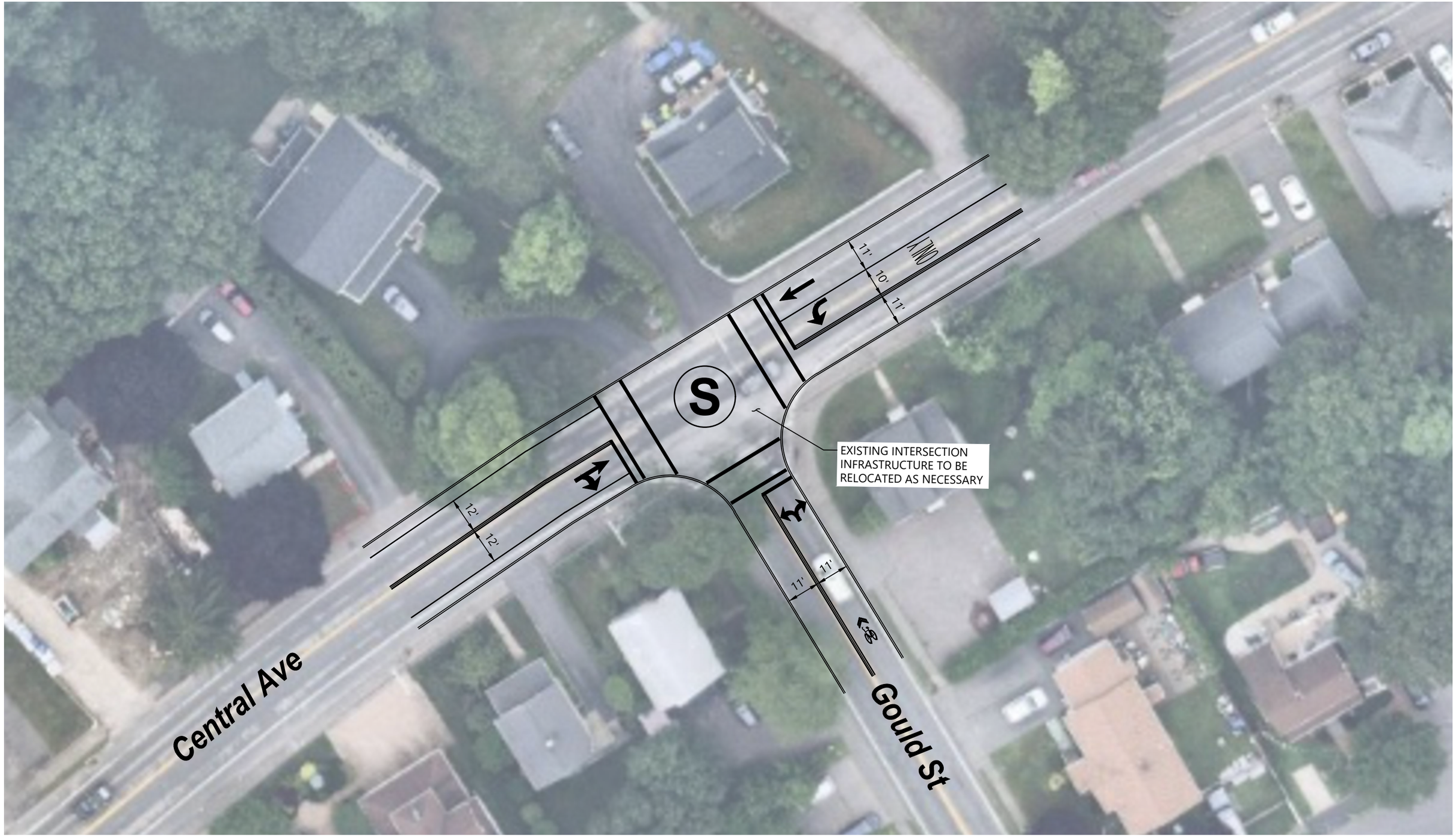
Figure 2.13



Not to Scale

Build Conditions Vehicle Volumes
Weekday Evening Peak Hour
Highland Science Center
Needham, Massachusetts

Figure 2.14



NOT FOR CONSTRUCTION

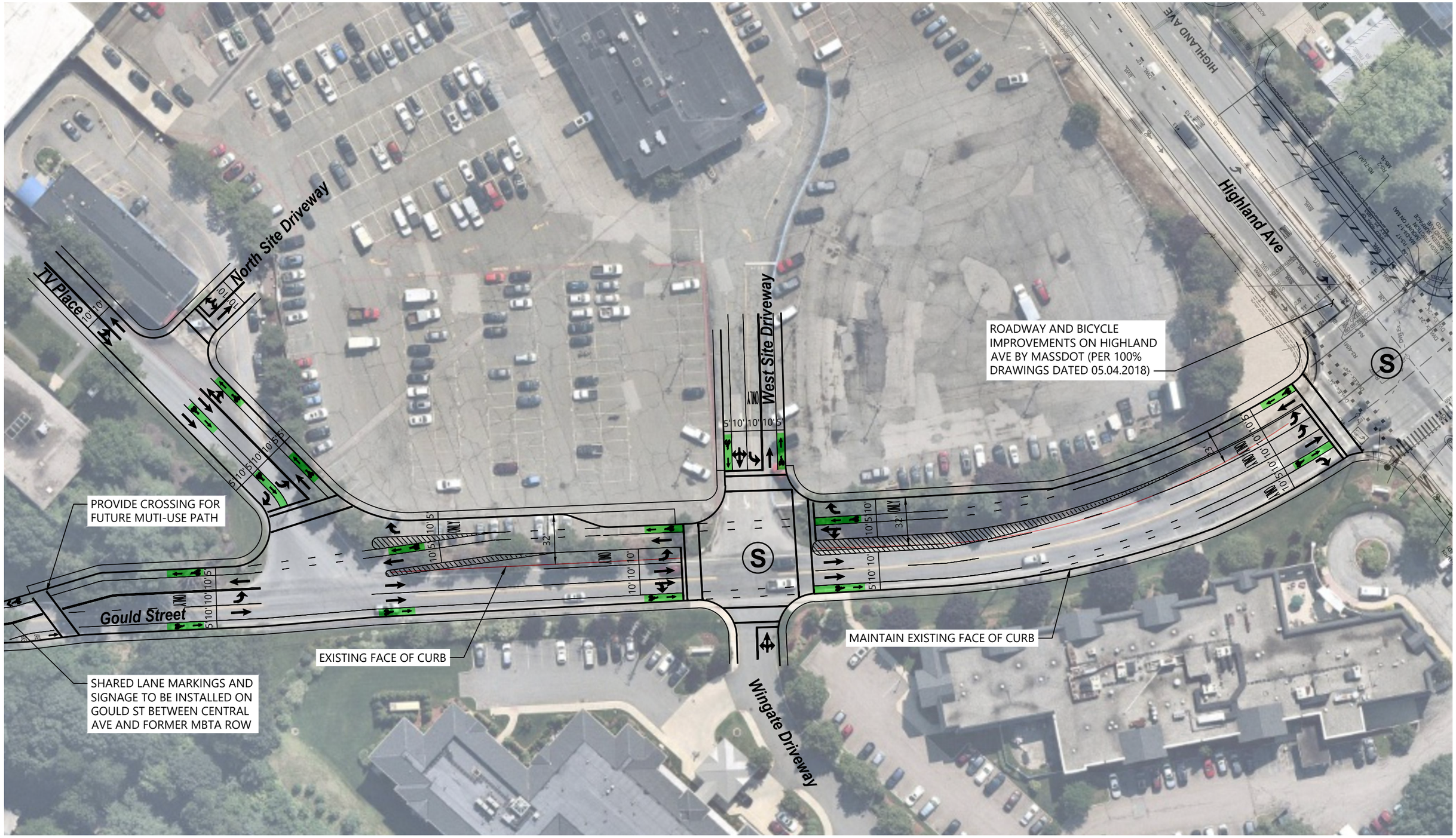
0 15 30 60 Feet

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

APPENDIX A: MEPA Distribution List

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 ENF is required to be circulated.

State and Regional Agencies and Officials

Secretary Kathleen Theoharides
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

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 Resource 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

brendan.place@mass.gov
paul.ormond@mass.gov

Town of Needham

Planning Department
Attn: Director of Planning
Public Services Administration Building
500 Dedham Avenue
Needham, MA 02492
planning@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

APPENDIX B: RMAT Climate Resilience Design Standards Tool Project Report

RMAT Climate Resilience Design Standards Tool Project Report

Highland Science Center
Date Created: 3/3/2022 1:29:10 PM

Created By: VHB

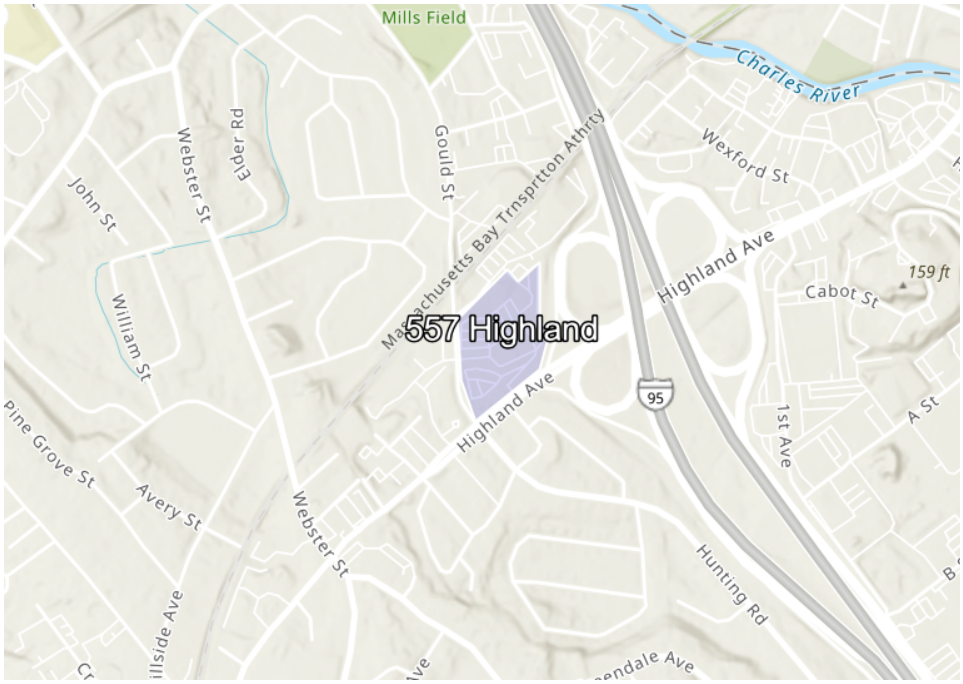
Download

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: Transportation Supporting Documentation

Appendix C: Transportation

- Transportation Scoping Letter
  - VHB Letter
  - MassDOT Correspondence
- Existing Site Plan
- Traffic Volume Count Data
- Seasonal Adjustment Factors
- MassDOT Yearly Growth Rate Factors
- Public Transportation Schedules
- Vehicular Crash Data
  - Raw Crash Data
  - Crash Rate Worksheets
- Background Developments
- Trip Generation Data
  - Existing Site Empirical Data
  - Unadjusted ITE Worksheets
  - Internal Captures Worksheets
- Trip Distribution Calculations
- Intersection Capacity Analysis Worksheets
- Merge / Diverge / Weave Segment Analysis Worksheets
- Signal Warrant Analyses
  - Hourly Volume Projections
  - Signal Warrant Analysis Worksheets

November 2, 2021

Ref: 15306.00

J. Lionel Lucien, P.E.
Manager, Public/Private Development Unit
Massachusetts Department of Transportation (MassDOT)
Office of Transportation Planning
10 Park Plaza, Room 4150
Boston, MA 02116

Re: Transportation Impact Analysis (TIA) Scoping Request
Proposed Development of 557 Highland Avenue, Needham, MA

Dear Mr. Lucien:

On behalf of John Muzi Associates Limited Partnership of Owner ("the Proponent"), VHB requests your review and approval of the proposed scope of work for a Transportation Impact Assessment (TIA) supporting the Proponent's planned redevelopment at 557 Highland Avenue in Needham, Massachusetts. The site is located adjacent to Exit 35 on Interstate 95 on the corner of Highland Avenue and Gould Street. Figure 1 provides a site location map.

VHB outlines in this Transportation Scoping Letter (TSL) the technical assumptions and key travel demand and transportation elements that the TIA will address. The suggested scope outlined below was developed based on MassDOT's transportation impact assessment guidelines, VHB's experience in this area, and ongoing consultation with the Town of Needham and Department of Planning and Community Development as part of the local project permitting and development review.

Development Proposal

The Site is currently occupied by a car dealership (Muzi Motors) and a car wash (WashWorld Complete Car Care). The proposed Project will replace the existing uses with approximately 520,000 square feet (sf) of development located in two proposed buildings on-Site. The building space will be devoted to a mix of research & development space (approximately 208,000 sf) and office space (approximately 312,000 sf). The Project will also be supported with approximately 1,732 parking spaces, of which approximately 661 spaces will be located below the proposed buildings, 1,006 spaces will be located in a structured parking garage, and the remaining 65 spaces will be located in a surface parking lot.

www.vhb.com
Engineers | Scientists | Planners | Designers
99 High Street
10th Floor
Boston, Massachusetts 02110
P 617.728.7777
F 617.728.7782

A preliminary Project Site plan is attached for reference. A more detailed discussion of the planned access improvements and any associated changes to the surrounding roadway network will be included in the TIA.

MEPA Transportation Thresholds

Based on Section 11.03.06.a of the MEPA regulations, the Project exceeds the following thresholds for an Environmental Impact Report (EIR) review related to traffic generation and parking:

- 301 CMR 11.03(6)(a)(6) – Generation of 3,000 or more new ADT by motor vehicles on roadways providing access to a single location.
- 301 CMR 11.03(6)(a)(7) – Construction of 1,000 or more new parking spaces at a single location Both transportation-related MEPA review thresholds would require a mandatory filing of an Environmental Impact Report (EIR).

The Project will also be undergoing concurrent review under the Town of Needham Special Permit process.

Trip Generation

Trip generation estimates for the Project will be based on standard Institute of Transportation Engineers' (ITE) data from the 11th Edition of the Trip Generation Manual[1]. The following section discusses how the unadjusted trip generation will be converted to new trips on the surrounding roadway networks for the purpose of conducting the transportation analysis.

The Project will consist of approximately 520,000 sf of building space containing approximately 208,000 sf of research & development space and approximately 312,000 sf of office space. The ITE Trip Generation Manual categorizes various land uses and provides weekday daily, weekday morning peak hour, and weekday evening peak hour unadjusted vehicle trip generation estimates for each use. Trip generation estimates for the proposed uses were projected using data published in the ITE data for LUC 710 (General Office Building) and LUC 760 (Research and Development). The unadjusted new vehicle trip estimates are included in the Attachments for reference purposes.

Person Trips

The unadjusted vehicle trips estimated using the ITE data were subsequently converted into person trips by applying average vehicle occupancy rates (VOR) based on national data[2] for each use. The national average vehicle occupancy rates applied were 1.18 persons/vehicle for the office and research and development trips. The national rates are applied when converting to person trips to be consistent with ITE data, which is also based on national data.

---

1 *Trip Generation Manual – 11th Edition*; Institute of Transportation Engineers; Washington, D.C.; 2021.

2 *Summary of Travel Trends – National Household Travel Survey*; USDOT Federal Highway Administration (Washington, DC), 2017.

Mode Split

The future mode shares for the Project were developed based on census data for the Town of Needham. Based on the U.S Census Bureau's Journey to Work data for the Town of Needham[3], the mode shares presented in Table 1 were determined to be appropriate.

Table 1 Town of Needham Mode Shares

Use	Vehicle	Transit	Bike/Walk
Office/R&D	95%	2%	3%

Vehicle Trips

The mode shares presented in Table 1 were applied to the net-new person trips to generate the adjusted Project person trips by mode. To reflect the number of vehicle trips generated by the Site, the adjusted person trips are converted back to vehicle trips by applying the local average vehicle occupancy rates (VOR). The local average vehicle occupancy rate applied was 1.15 persons/vehicle for office/R&D trips based on U.S Census Data

Net New Vehicle Trips

The existing trips generated by the Project Site will be eliminated and replaced by the Project, and as a result, the net increase in the trips associated with the Project represent the additional impact of the Project over existing conditions. Trips generated by the existing land uses on Site (the car dealership and the car wash) were counted by VHB staff on Wednesday, July 14, 2021.

Based on the existing Site-generated trips and the adjusted proposed Site-generated trips, the net new Project-generated vehicle trips have been estimated. Table 2 below summarizes the net-new Project-generated vehicle trips and Table 3 summarizes the adjusted Project-generated trips by mode.

3 US Census Bureau, American Community Survey (2012-2016) five-year estimates for the Town of Needham.

Table 2 Project Trip Generation – Net New Vehicle Trips

Time Period / Direction	Existing Vehicle Trips [1]	Proposed Vehicle Trips			Net New Vehicle Trips
		Office [2]	*R&D* [3]	Total	
Weekday Daily					
Enter	410	*1,522*	*1,104*	2,626	**2,216**
Exit	477	*1,522*	*1,104*	2,626	**2,149**
Total	887	*3,044*	*2,208*	5,252	**4,365**
Weekday Morning Peak Hour					
Enter	37	*382*	*168*	550	**513**
Exit	24	*52*	*37*	89	**65**
Total	61	*434*	*205*	639	**578**
Weekday Evening Peak Hour					
Enter	29	*71*	*31*	102	**73**
Exit	57	*345*	*164*	509	**452**
Total	86	*416*	*195*	611	**525**

1 – Based on counts conducted by VHB staff on July 14, 2021
2 – Based on ITE LUC 710 (General Office) for 312,000 sf using regression equations. Vehicle mode shares from Table 1 applied.
3 – Based on ITE LUC 760 (R&D) for 208,000 sf using regression equations. Vehicle mode shares from Table 1 applied.

Table 3 Project-Generated Net-New Trips by Mode

Time Period / Direction	Vehicle Trips [1]	Transit Trips	Bike/Walk Trips
Weekday Daily			
Enter	2,216	64	95
Exit	2,149	64	95
Total	4,365	128	190
Weekday Morning Peak Hour			
Enter	513	13	20
Exit	65	2	3
Total	578	15	23
Weekday Evening Peak Hour			
Enter	73	3	4
Exit	452	12	18
Total	525	15	22

1 – Existing Vehicle trips removed.

Traffic Study Area Network

Based on VHB's knowledge of the area transportation network and the operational characteristics of the Project, the following intersections and their approach roadways are proposed to be included in the assessment. The following proposed study area intersections are highlighted in Figure 2.

1. Central Avenue at Cedar Street - *unsignalized*
2. Central Avenue at Webster Street - *unsignalized*
3. Central Avenue at Gould Street - *unsignalized*
4. Central Avenue at Hampton Avenue - *unsignalized*
5. Central Avenue at River Park Street - *unsignalized*
6. Gould Street at Ellis Street - *unsignalized*
7. Gould Street at Kearney Road - *unsignalized*
8. Gould Street at Station Road - *unsignalized*
9. Gould Street at Noanett Street - *unsignalized*
10. Gould Street at TV Place - *unsignalized*
11. Gould Street at Muzi Motors Driveway /Wingate Residences Driveway - *unsignalized*
12. Highland Avenue at West Street - *signalized*
13. Highland Avenue at Hunnewell Street - *unsignalized*
14. Highland Avenue at Webster Street - *signalized*
15. Highland Avenue at Gould Street/Hunting Road - *signalized*
16. Highland Avenue at I-95 Southbound Ramps - *unsignalized*
17. Highland Avenue at I-95 Northbound Ramps – *partially signalized*
18. Highland Avenue at First Avenue - *signalized*
19. Highland Avenue at Second Avenue - *signalized*
20. Kendrick Street at Hunting Road/Greendale Avenue - *signalized*

Consistent with study periods review for other nearby commercial projects, the traffic analysis for the Project will focus on the critical weekday morning and weekday evening peak hours.

Analysis Periods

The analysis will consist of a 2022 base year (using adjusted traffic counts collected in 2015 through 2021) and a future year 2029 condition reflecting a seven-year planning horizon. The 2029 conditions will

include the incorporation of expected traffic from known approved or planned projects and those under construction plus general traffic growth volume. The future year condition will be evaluated for both a No Build Condition (without the construction of the proposed Project) and a Build Condition (with the construction and full occupancy of the proposed Project). Upon comparing the changes in traffic operations between the 2022 Existing, 2029 No Build, and 2029 Build Conditions, if traffic mitigation measures are proposed, then a 2029 Build with Mitigation Condition will also be evaluated.

Traffic Count Data

Traffic conditions resulting from the COVID-19 virus pandemic are atypical, and thus, collecting all new traffic data is not recommended at this time. VHB is following MassDOT's *Guidance on Traffic Count Data*, as detailed in the Engineering Directive number E-20-005, issued by the Chief Engineer on May 11, 2020, which allows for the use of historical traffic data (no older than 2014) on any project to supplement and/or replace existing traffic counts. Accordingly, VHB expects to use publicly available traffic counts previously conducted for the nearby projects in the immediate area (traffic counts that are not publicly available will be purchased directly from a traffic count vendor). The traffic count data will be adjusted using MassDOT's adjustment factors to determine increases (or changes) in traffic volumes since these counts were conducted and collectively make up the 2022 Baseline Condition. In addition, the existing counts will be reviewed for seasonality to determine if any seasonal adjustment factors will need to be applied to any of the count data.

Trip Distribution

The directional distribution of traffic approaching and departing the Project Site is a function of several variables. These include population densities, existing travel patterns, and the efficiency of the roadways leading to and from the Project Site. The anticipated trip distribution will be based on a review of U.S. census journey-to-work data, with consideration to the proposed Site uses. Using this data, vehicle trips can then be assigned to the roadway network.

Crash Analysis

For each study area intersection, a crash analysis will be completed using the MassDOT crash database for the most recent five years of accepted/available data. A summary of these crashes will be provided along with key crash factors such as time of day, collision type, weather conditions, and non-motorist involved crashes (pedestrian/bicyclist).

Additionally, study area intersections that are identified as Highway Safety Improvement Program (HSIP) clusters will be reviewed to determine whether further actions may be taken to improve safety. Upon initial review, none of the intersections in the study area appear to qualify as a HSIP-eligible intersection based on the MassDOT HSIP Top Crash Locations map and therefore no additional coordination will be necessary.

Bicycle and Pedestrian Accommodations

The study will also include a thorough inventory of bicycle and pedestrian accommodations in the immediate study area and potential improvements to the existing pedestrian and bicycle infrastructure will be recommended.

Parking

The TIA will include a comprehensive parking evaluation demonstrating both the adequacy and appropriateness of the proposed 1,732-space parking supply.

Travel Demand Management (TDM) Plan

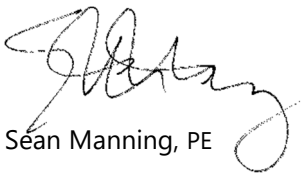
The Proponent is exploring a wide array of TDM measures to offer as a means to reduce single occupant driving and increase use of alternative forms of transportation to access the workplace. All Project transportation infrastructure improvements and TDM measures will be reflected in the TIA.

Final Remarks

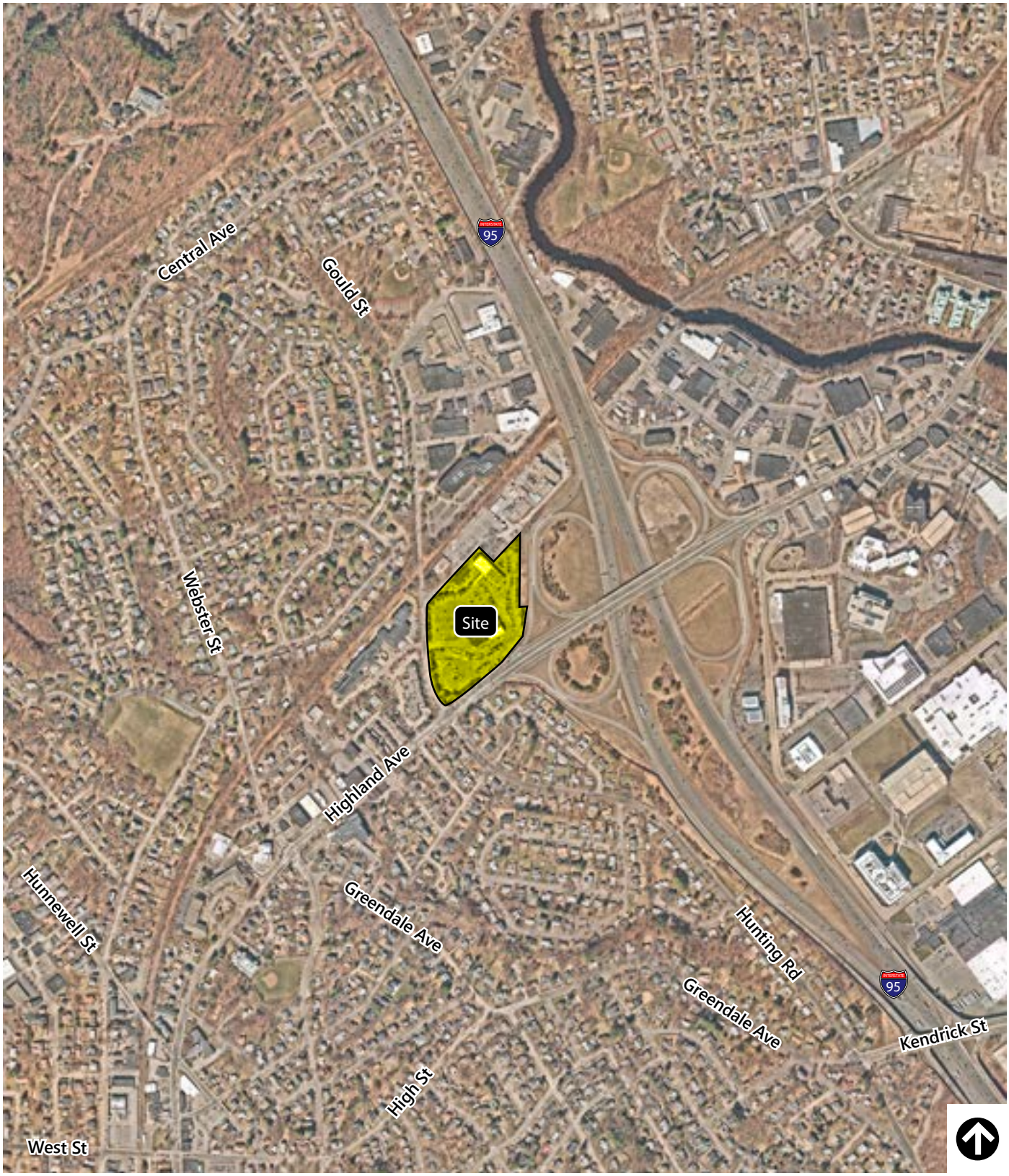
In this TSL, we outline the main assumptions and methods to be used in this project's TIA. The proposed study will provide insight to how the Project may impact the surrounding area and existing transportation infrastructure and operations. We respectfully request your feedback on the suggested transportation study scope of work, assumptions, data sources, and approaches. If you have any questions or need additional information, please contact me at 617-607-2971 or *smanning@VHB.com*.

Sincerely,

Vanasse Hangen Brustlin, Inc.



Sean Manning, PE
Principal
Director of Transportation Planning and Operations

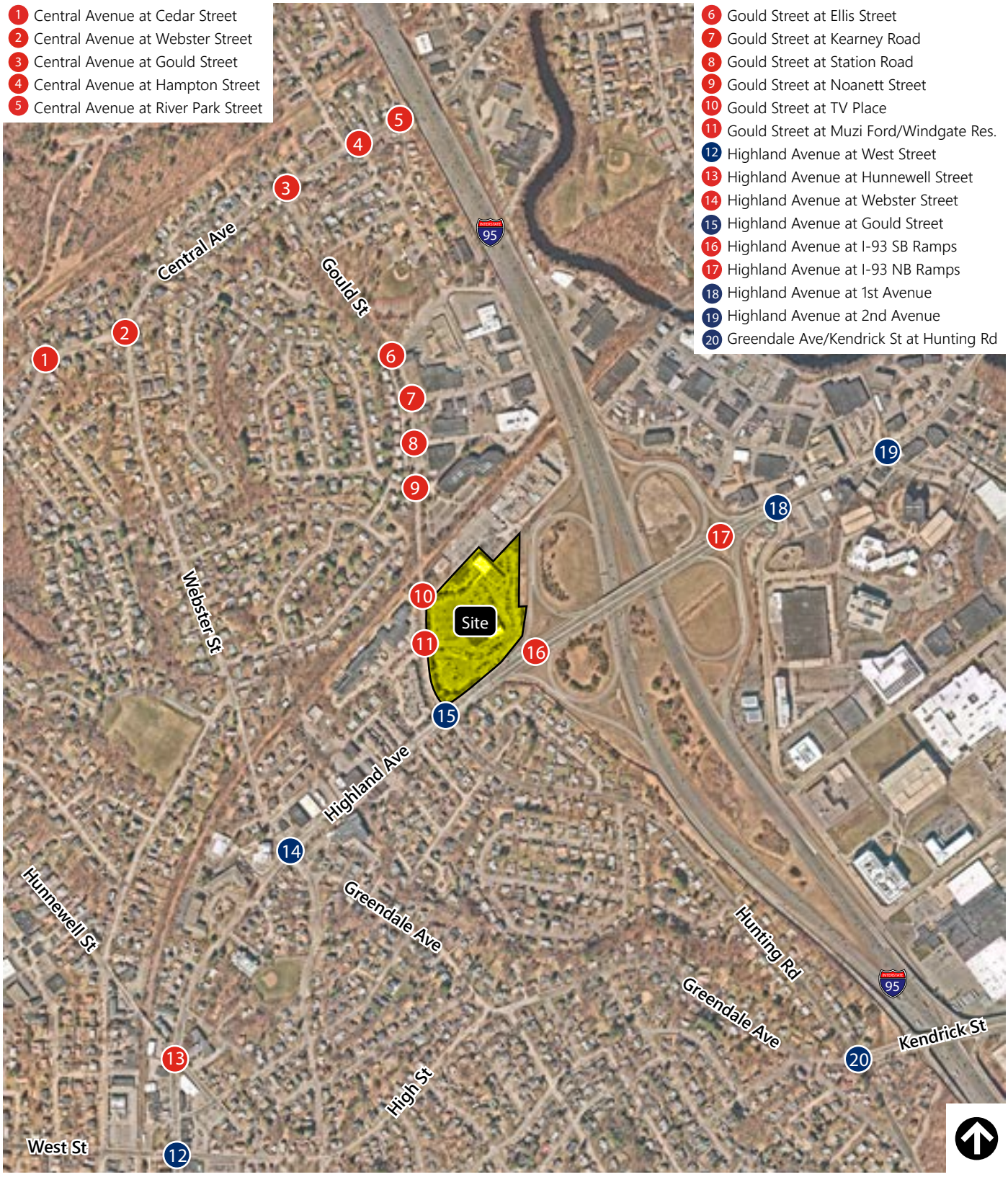


Source: NearMap

Figure 1

Site Location Map

557 Highland Ave Redevelopment
Needham, Massachusetts



Source: NearMap

Unsignalized Intersection

Signalized Intersection

Figure 2

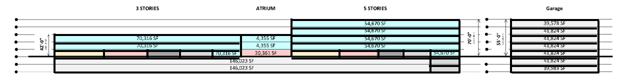
Proposed Study Area Intersections

557 Highland Ave Redevelopment
Needham, Massachusetts

Attachments

- Preliminary Site Plan
- ITE Trip Generation Worksheets

Zoning Requirements			
	Required	Proposed	Compliance
Min Lot Area SF	20,000	403,933	yes
Min Lot Frontage	100'	varies	yes
Setbacks	Highland Ave and Gould St	varies	yes
Building Height	56'	42' and 70'	**SP required**
Max Stories	4	5	**SP required**
Max Lot Coverage	65%	62%	yes
Min Open Space	25%	38%	yes
FAR	0.7	1.27	**SP required**
Garage Height	44'	55'	**SP required**
Max Façade Length	200'	200'	yes
Number of Spaces	1 SP per 300SF: **1,722**	1732	yes
Parking Lot Illunmination	Av. Illumination of 1 FC	yes	yes
Loading	Off-site loading	yes	yes
Handicap Parking	Meet MAAB regs	yes	yes
Driveway Openings	min conflict with traffic	yes	yes
Compact Spaces	max 50%	30%	yes
Parking Space Size	9'x18.5'	yes	yes
Bumper overhang	1' front and rear	yes	yes
Parking space layout	no movement of other vehicles required	yes	yes
Width of aisle	24'	24'	yes
Parking setbacks	20' front, 5' side/rear	yes	yes
Landscaped areas	see 5.1.3(k)	yes	yes
Trees	1 per 10 parking	yes	yes
Location	same lot	yes	yes
Bicycle Space Parking	1 per 20 parking	87	yes



Building A	
Program	SF
Lobby	0 SF
Amenity - Fitness	20,361 SF
Office/Lab	493,008 SF
Loading	0 SF
Lab Support	0 SF
Parking (664 spaces)	292,046 SF
Total FAR SF	**513,369 SF**

Building Parking Count			
Level	Standard	Compact	HC
Level G1	227	89	8*
Level G2	259	70	8*
Total by Type	**486**	**159**	**16***
Total Parking		**661**	
% Compact		**24%**	

Garage	
Program	SF
Garage	**288,681 SF**

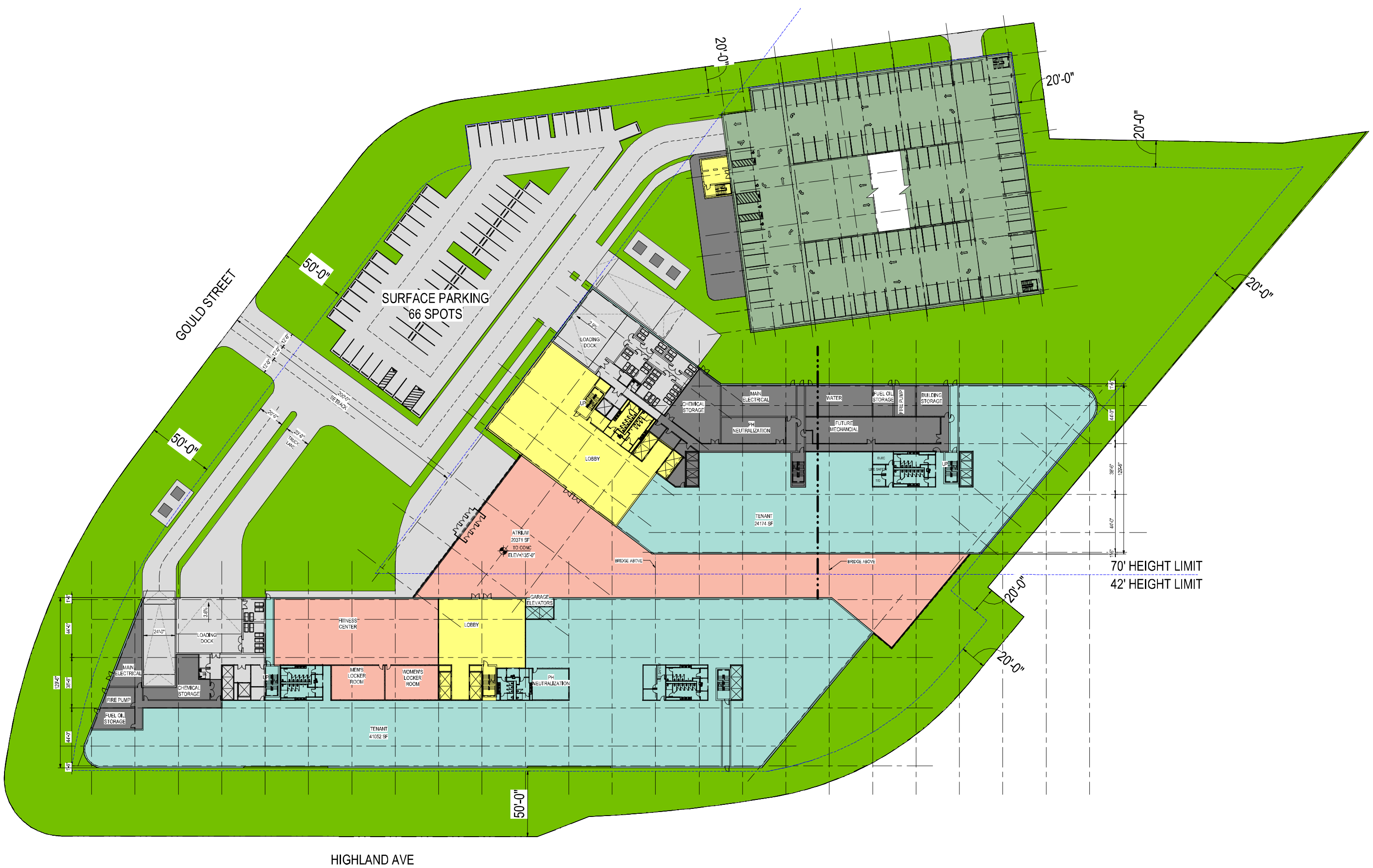
Garage Parking Count			
Level	Standard	Compact	HC
Level G2	47	48	3
Level G1	67	49	3*
Level 1	64	62	4*
Level 2	72	59	3
Level 3	73	59	2
Level 4	73	59	2
Level 5	74	59	2
Roof	68	52	2
Total by Type	**538**	**447**	**21**
Total Parking		**1006**	
% Compact		**44%**	

* includes handicapped van accesible space

Site Totals

Program	
	Proposed
Total FAR SF	**513,369 SF**
Total Office/Lab SF	**493,008 SF**
Parking and Drive Aisles	51,598 SF
Total Lot Coverage	249,066 SF
Total Open Space	154,867 SF
Parking Spaces Required at 1/300sf	1711.2
TOTAL SITE SF	**403,933 SF**
SITE FAR	**1.27**

Site Parking Totals	
	Proposed
Surface Parking	65
Office/Lab Building	661
Garage	1006
Total Parking	**1732**
Total allowable SF based on 1 space/300 SF	**519,600 SF**



1 PROJECT SITE PLAN
A100
1" = 30'-0"

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.

SITE PARKING TOTALS	
SURFACE PARKING	65
BUILDING PARKING	661
GARAGE PARKING	1,006
TOTAL SITE PARKING	1,732

Issued/Revision

Title
SITE PLAN

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: General Office Building
LANDUSE CODE: 710
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **557 Highland Avenue, Needham**
JOB NUMBER: **15306.00**

Trip Type --- Vehicle
Independent Variable --- 1,000 Sq. Feet Gross Floor Area

FLOOR AREA (KSF): 312

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends			Independent Variable Range			Directional Distribution	
			Average	Low	High	Average	Low	High	Enter	Exit
DAILY	59	0.78	10.84	3.27	27.56	163	14	677	50%	50%
AM PEAK (ADJACENT ST)	221	0.78	1.52	0.32	4.93	201	10	815	88%	12%
PM PEAK (ADJACENT ST)	232	0.77	1.44	0.26	6.20	199	10	1,092	17%	83%

TRIPS:

	BY AVERAGE			BY REGRESSION		
	Total	Enter	Exit	Total	Enter	Exit
DAILY	3,382	1,691	1,691	3,123	1,561	1,561
AM PEAK (ADJACENT ST)	474	417	57	445	392	53
PM PEAK (ADJACENT ST)	449	76	373	427	73	354

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends			Independent Variable Range			Directional Distribution	
			Average	Low	High	Average	Low	High	Enter	Exit
DAILY	5	--	2.21	1.24	7.46	94	28	183	50%	50%
PEAK OF GENERATOR	3	--	0.53	0.30	1.57	82	28	183	54%	46%

TRIPS:

	BY AVERAGE			BY REGRESSION		
	Total	Enter	Exit	Total	Enter	Exit
DAILY	690	345	345	N/A	N/A	N/A
PEAK OF GENERATOR	165	89	76	N/A	N/A	N/A

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends			Independent Variable Range			Directional Distribution	
			Average	Low	High	Average	Low	High	Enter	Exit
DAILY	5	--	0.70	0.19	3.05	94	28	183	50%	50%
PEAK OF GENERATOR	3	--	0.21	0.11	0.68	82	28	183	58%	42%

TRIPS:

	BY AVERAGE			BY REGRESSION		
	Total	Enter	Exit	Total	Enter	Exit
DAILY	218	109	109	N/A	N/A	N/A
PEAK OF GENERATOR	66	38	28	N/A	N/A	N/A

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: Research & Development Center
LANDUSE CODE: 760
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **557 Highland Avenue, Needham**
JOB NUMBER: **15306.00**

Trip Type --- Vehicle
Independent Variable --- 1,000 Sq. Feet Gross Floor Area

FLOOR AREA (KSF): 208

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	22	0.89	11.08	3.48	24.95	179	22	705	50%	50%
AM PEAK (ADJACENT ST)	39	0.70	1.03	0.17	3.73	173	10	800	82%	18%
PM PEAK (ADJACENT ST)	39	0.70	0.98	0.13	4.13	173	10	800	16%	84%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	2,305	1,152	1,152	2,265	1,133	1,133
AM PEAK (ADJACENT ST)	214	176	39	210	172	38
PM PEAK (ADJACENT ST)	204	33	171	200	32	168

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	19	0.68	1.91	0.18	6.96	165	22	650	50%	50%
PEAK OF GENERATOR	13	0.65	0.24	0.08	0.71	146	46	608	Not Available	

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	397	199	199	367	184	184
PEAK OF GENERATOR	50	N/A	N/A	44	N/A	N/A

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	19	--	1.18	0.13	4.18	165	22	650	50%	50%
PEAK OF GENERATOR	13	--	0.16	0.05	0.64	146	46	608	Not Available	

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	245	123	123	N/A	N/A	N/A
PEAK OF GENERATOR	33	N/A	N/A	N/A	N/A	N/A

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Jamey Tesler, Secretary & CEO

massDOT
Massachusetts Department of Transportation

MEMORANDUM

TO: Sean Manning, P.E., Principal
Vanasse Hangen Brustlin

FROM: J. Lionel Lucien, P.E, Manager
Public/Private Development Unit

DATE: February 2, 2022

RE: Needham: 557 Highland Avenue Redevelopment – TSL

MassDOT is in receipt of your Transportation Scoping Letter (TSL) for the Proposed Development at 557 Highland Avenue in Needham by John Muzi Associates Limited Partnership of Owner ("the Proponent"). The site is located adjacent to Exit 35 on Interstate 95 (I-05) on the corner of Highland Avenue and Gould Street. The Site is currently occupied by a car dealership (Muzi Motors) and a car wash (WashWorld Complete Car Care). The proposed Project will replace the existing uses with approximately 520,000 square feet (sf) of development located in two proposed buildings on-Site. The building space will be devoted to a mix of research & development space (approximately 208,000 sf) and office space (approximately 312,000 sf). The Project will also be supported with approximately 1,732 parking spaces.

Access to the site would be provided by a full-access driveway on Gould Street but the Project abuts the I-95)/Route 128/Highland Street interchange. The Project is estimated to generate more than 3,000 vehicle trips on average weekday; therefore, a Vehicle Access Permit will be required from MassDOT. The Project also triggers MEPA EIR thresholds for trip generation and parking spaces.

The EIR should include a Transportation Impact Assessment (TIA) prepared in conformance with the current MassDOT/EOEEA *Transportation Impact Assessment Guidelines*. The TIA should provide capacity analyses of existing conditions, future No-Build conditions, and future Build conditions, particularly at state highway locations. The future Build conditions should include an analysis of operations both with and without any improvements suggested to mitigate project impacts. The study should propose an integrated multimodal mitigation package intended to improve vehicular traffic operations while supporting increased use of walking, bicycling, and transit by residents. Items listed below should be accounted for in preparing the TIA.

We find that the TSL provides a good basis for the preparation of the TIA for the Project. We generally concur with the assumptions and methods included in the TSL regarding trip generation methodology, traffic study area, analysis period, trip distribution,

crash analysis, multimodal infrastructure condition, and parking. We offer the following comments that should be addressed in the EIR.

Trip Generation

The TSL determined that trip generation rates using Institute of Transportation Engineers (ITE) Trip Generation Manual (11th edition) land use codes (LUCs) 710 – General Office and LUC 760 – Research and Development would most accurately reflect the proposed development. Trip reduction estimates are applied to the unadjusted trips based on mode share for transit and bike\walk trips. The TIA should include adequate documentation to justify the credits for those trips. Transit services does not seem currently available near the site.

Traffic Count Data

The TSL has acknowledged the atypical traffic conditions resulting from the COVID-19 virus pandemic and plans to follow MassDOT's *Guidance on Traffic Count Data*, as detailed in the Engineering Directive number E-20-005, issued by the Chief Engineer on May 11, 2020, which allows for the use of historical traffic data (no older than 2014) on any project to supplement and/or replace existing traffic counts. The Proponent should consult with the Highway Division Traffic and Safety Section on the most recent updates of the MassDOT guidance on traffic count data.

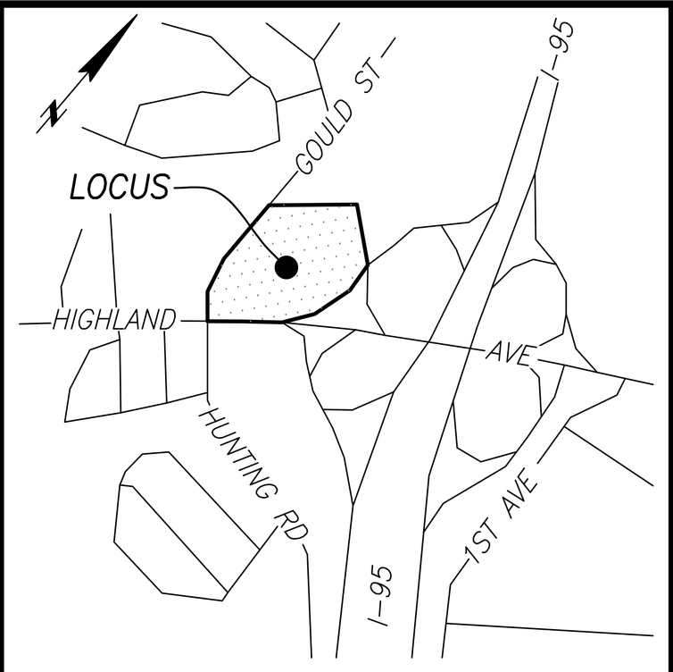
Safety

The TIA will include crash analyses for all intersections in the study area using the MassDOT crash database for the most recent five years of accepted/available data. The study area intersections that are identified as Highway Safety Improvement Program (HSIP) clusters will be reviewed to determine whether further actions may be taken to improve safety. Additionally, the Highland Avenue study corridor should be reviewed in the MassDOT Impact portal and specifically look at the crash based and risk-based screening tools. The mitigation proposed should reduce the number of crashes along high crash corridors as well as any risks identified. Please see https://apps.im-pact.dot.state.ma.us/cdp/home as a reference.

Traffic Operations

Capacity analyses should be conducted for the weekday AM and weekday PM for both existing and future conditions. In addition, capacity analyses for Build with mitigation conditions should be provided for all intersections. The analysis should also include weaving analysis between the ramps (locations 16 & 17) on Highland Avenue.

We look forward to working with you on this Project. Please continue consultation with appropriate MassDOT units, including PPDU and the District 6 Office, to discuss preparation of the EIR. If you have any questions regarding these comments, please contact me at *Lionel.Lucien@dot.state.ma.us*.



LOCUS MAP – NOT TO SCALE

NOTES:

1. THE PROPERTY SHOWN HEREON IS THE SAME PROPERTY DESCRIBED IN TITLE COMMITMENT CASE NUMBER BLC-28081 ISSUED BY COMMONWEALTH LAND TITLE INSURANCE COMPANY HAVING AN EFFECTIVE DATE OF MAY 25, 2021.
2. THE SUBJECT PROPERTY HAS DIRECT ACCESS TO GOULD STREET, A DEDICATED PUBLIC STREET, AND TV PLACE, A PRIVATE STREET.
3. 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.
4. ZONING INFORMATION AS SHOWN HEREON WAS NOT PROVIDED BY THE TITLE INSURER AS REQUIRED BY ITEM 6 (A OR B) OF TABLE "A" IN THE 2016 ALTA SURVEY REQUIREMENTS.
5. BUILDING HEIGHT SHOWN HEREON IS CALCULATED FROM GRADE AND TO THE HIGHEST POINT OF THE ROOF.
6. NO EVIDENCE OF RECENT EARTH MOVING WORK, BUILDING CONSTRUCTION, OR BUILDING ADDITIONS WAS OBSERVED AT THE TIME OF SURVEY.
7. TO THE BEST OF OUR KNOWLEDGE, THERE ARE NO PROPOSED CHANGES IN STREET RIGHT OF WAY LINES. NO EVIDENCE OF STREET OR SIDEWALK CONSTRUCTION OR REPAIRS WERE OBSERVED AT THE TIME OF SURVEY.
8. 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.
9. 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.
10. 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.
11. LOT 12 IS CONTIGUOUS TO PARCEL LS-1, AND BOTH LOT 12 AND LOT 5 ARE CONTIGUOUS TO TV PLACE ALONG THEIR COMMON BOUNDARY LINES.

LEGEND

Symbol	Description
Ⓢ	SEWER MANHOLE
Ⓓ	DRAIN MANHOLE
Ⓔ	ELECTRIC MANHOLE
Ⓦ	WATER MANHOLE
Ⓣ	TELEPHONE MANHOLE
MH	MANHOLE
	HYDRANT
	WATER SHUT OFF/WATER GATE
	GAS SHUT OFF/GAS GATE
	CATCH BASIN
	GUY WIRE
	TRAFFIC SIGNAL
	UTILITY POLE
	LIGHT POLE
	WALK LIGHT
HH	ELECTRIC HANDHOLE
	BOLLARD
P	POST
	SIGN
FA	FIRE ALARM
	BOUND FOUND WITH DRILL HOLE
SP	STAND PIPE/SIAMESE CONNECTION
	UTILITY POLE W/ LIGHT
	TRANSFORMER
GM	GAS METER
EM	ELECTRIC METER
TR	TRASH RECEPTACLE
	DISABLED PARKING SPACE
	DECIDUOUS TREE
	CONIFEROUS TREE
	BUSH
	SHRUB
(X)	EXCEPTION NUMBER LISTED IN TITLE COMMITMENT
• GP	GATE POST
ICV	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(CI)——	PIPE SIZE AND MATERIAL
——PVC——	POLYVINYL CHLORIDE
——RCP——	REINFORCED CONCRETE PIPE
—X——X—	METAL FENCE
——DSE——	DIGSAFE ELECTRIC
——DSET——	DIGSAFE ELECTRIC & TELEPHONE
——DSG——	DIGSAFE GAS
——DSST——	DIGSAFE STEAM
——DST——	DIGSAFE TELEPHONE

EXCEPTIONS FROM COVERAGE (SURVEY RELATED ONLY) SCHEDULE B, PART II, LISTED IN TITLE COMMITMENT NO. BLC-28081 ISSUED BY COMMONWEALTH TITLE INSURANCE COMPANY HAVING AN EFFECTIVE DATE OF DECEMBER 10, 2021 (REVISED DECEMBER 14, 2021).

(6) RESERVATIONS SET FORTH IN AN INSTRUMENT FILED AS DOCUMENT NO. 98277. (NOT PLOTTABLE – NO UTILITY POLES OBSERVED)

(7) INTENTIONALLY OMITTED.

(8) NOTICE OF LEASE, BY AND BETWEEN FREDERICK O. J. MUZI AND WILLIAM D. CAMMARANO, TRUSTEES OF F & B REALTY TRUST AND MUZI MOTORS, INC., DATED SEPTEMBER 18, 1969, RECORDED IN BOOK 4623, PAGE 215, AS AFFECTED BY AN ASSIGNMENT OF LEASE, DATED SEPTEMBER 23, 1969, RECORDED IN BOOK 4623, PAGE 218. (NOT PLOTTABLE)

NOTE: LEASE IS LISTED ON THE FACE OF CERTIFICATE 167967 AND THE COMPANY INSURES THAT IT HAS EXPIRED BY ITS TERMS. AN S-PETITION WOULD BE REQUIRED TO REMOVE THIS DOCUMENT FROM THE CERTIFICATE OF TITLE.

(9) WHILE EXCLUDED FROM COVERAGE, THIS NOTICE OF VARIANCE BY THE TOWN OF NEEDHAM BOARD OF APPEALS, RECORDED IN BOOK 4584, PAGE 550, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(10) INTENTIONALLY OMITTED.

(11) WHILE EXCLUDED FROM COVERAGE, THIS NOTICE OF VARIANCE BY THE TOWN OF NEEDHAM BOARD OF APPEALS, RECORDED IN BOOK 4135, PAGE 372, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(12) WHILE EXCLUDED FROM COVERAGE, THIS NOTICE OF VARIANCE BY THE TOWN OF NEEDHAM BOARD OF APPEALS, FILED AS DOCUMENT NO. 268691, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(13) ORDER OF SEWER CONSTRUCTION BY THE TOWN OF NEEDHAM BOARD OF PUBLIC WORKS, FILED AS DOCUMENT NO. 273400. (AS SHOWN HEREON)

NOTE: THE ORDER IS LISTED ON THE FACE OF CERTIFICATE 167967 AND HAS EXPIRED. AN S-PETITION WOULD BE REQUIRED TO REMOVE THIS DOCUMENT FROM THE CERTIFICATE OF TITLE.

(14) WHILE EXCLUDED FROM COVERAGE, THIS NOTICE OF VARIANCE BY THE TOWN OF NEEDHAM BOARD OF APPEALS, FILED AS DOCUMENT NO. 298921, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(15) GRANT OF EASEMENT BY AND BETWEEN JOHN MUZI AND THE INHABITANTS OF THE TOWN OF NEEDHAM, FILED AS DOCUMENT NO. 305135, AS AFFECTED BY AN ORDER OF COURT FILED AS DOCUMENT NOS. 1227990 AND 1027991, AND AS SHOWN ON LAND COURT PLAN 18430N. THIS ITEM IS APPROXIMATELY SHOWN ON THE SURVEY. (AFFECTS LOT 12 ONLY) (AS SHOWN HEREON)

(16) INTENTIONALLY OMITTED.

(17) WHILE EXCLUDED FROM COVERAGE, THIS SPECIAL PERMIT BY THE TOWN OF NEEDHAM BOARD OF APPEALS, RECORDED IN BOOK 5607, PAGE 736, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(18) INTENTIONALLY OMITTED.

(19) LACK OF ACCESS WITH RESPECTED TO NORTHERN CIRCUMFERENTIAL HIGHWAY (AKA ROUTE 128), AS SET FORTH IN A DEED DATED, JANUARY 21, 1981, RECORDED IN BOOK 5878, PAGE 214, AND SHOWN ON LAND COURT PLANS 18430M AND 37005A, PLAN BOOK 198, PLAN 850 OF 1955 AND PLAN BOOK 284, PLAN 760 OF 1980, AND AS APPROXIMATELY SHOWN ON THE SURVEY. (THIS ITEM IS LIMITED TO THE ACCESS RESTRICTIONS ONLY) (AS SHOWN HEREON)

(20) WHILE EXCLUDED FROM COVERAGE, THIS DECISION BY THE TOWN OF NEEDHAM BOARD OF APPEALS, RECORDED IN BOOK 6921, PAGE 661, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(21) WHILE EXCLUDED FROM COVERAGE, THIS SPECIAL PERMIT BY THE TOWN OF NEEDHAM PLANNING BOARD, RECORDED IN BOOK 6957, PAGE 671, AS AFFECTED BY AN AMENDMENT, RECORDED IN BOOK 7352, PAGE 701, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(22) WHILE EXCLUDED FROM COVERAGE, THIS SPECIAL PERMIT BY THE TOWN OF NEEDHAM BOARD OF APPEALS, RECORDED IN BOOK 6957, PAGE 676, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(23) WHILE EXCLUDED FROM COVERAGE, THIS SPECIAL PERMIT BY THE TOWN OF NEEDHAM PLANNING BOARD, FILED AS DOCUMENT NO. 869100, IS LISTED FOR INFORMATIONAL PURPOSES ONLY. (NOT PLOTTABLE)

(24) EASEMENT AGREEMENT BY AND BETWEEN JOHN MUZI ASSOCIATES LIMITED PARTNERSHIP, HEARST STATIONS, INC., AND WHC NEEDHAM II, LIMITED PARTNERSHIP, DATED JANUARY 4, 2012, FILED AS DOCUMENT NO. 1245300 AND RECORDED IN BOOK 29852, PAGE 359, AS AFFECTED BY AN AFFIDAVIT, RECORDED IN BOOK 29827, PAGE 62, AND AS APPROXIMATELY SHOWN ON THE SURVEY. (AFFECTS LOT 5 ONLY) (AS SHOWN HEREON)

(25) LAYOUT 8321 AND ORDER OF TAKING OF ROUTE 128 & I-95 BY THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION, DATED NOVEMBER 14, 2013, FILED AS DOCUMENT NO. 1297433 AND SHOWN ON PLAN BOOK 6274, PLAN 27 OF 2013. (AS SHOWN HEREON, EXPIRED)

NOTE: THE ORDER IS LISTED ON THE FACE OF CERTIFICATE 167967 AND HAS EXPIRED. AN S-PETITION WOULD BE REQUIRED TO REMOVE THIS DOCUMENT FROM THE CERTIFICATE OF TITLE.

(26) LAYOUT 8729 AND ORDER OF TAKING HIGHLAND AVENUE BY THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION, DATED MARCH 18, 2020, FILED AS DOCUMENT NO. 1442474 AND SHOWN ON PLAN BOOK 690, PLANS 34-39 OF 2020, AND AS APPROXIMATELY SHOWN ON THE SURVEY. (AFFECTS LOT 12 ONLY) (AS SHOWN HEREON)

(27) RIGHTS OF OTHERS TO USE THE RIGHT OF WAY AS SHOWN ON LAND COURT PLAN NOS. 18430J, K AND L, AND ANY EXTENSION THEREOF, FOR ALL PURPOSES FOR WHICH STREETS MAY NOW OR HEREAFTER BE CUSTOMARILY USED IN THE TOWN OF NEEDHAM (AS SHOWN HEREON)

(28) INTENTIONALLY MOVED TO ITEM 19 ABOVE.

(29) INTENTIONALLY MOVED TO ITEM 15 ABOVE.

(30) INTENTIONALLY OMITTED.

(31) INTENTIONALLY OMITTED.

TABLE 1

HIGHWAY EASEMENT TAKINGS FROM STATE HIGHWAY LAYOUT 8729, STATE HIGHWAY LAYOUT 5929, AND STATE HIGHWAY LAYOUT 8321.

PARCEL	STATE HIGHWAY LAYOUT NO.	AREA	EASEMENT TYPE	EASEMENT DESCRIPTION	EXCEPTION
PARCEL 15-E-19-T	8729	65± SQ. FT	PERMANENT	CONSTRUCTION	26
PARCEL 15-GR-W-1-T	8729	122± SQ. FT.	PERMANENT UTILITY TEMPORARY CONSTRUCTION	UTILITY & CONSTRUCTION	26
PARCEL 15-TE-12	8729	6,160± SQ. FT.	TEMPORARY	CONSTRUCTION	26
PARCEL 15-GR-W-2	8729	987± SQ. FT.	PERMANENT	CONSTRUCTION & MAINTAINING GUARD RAILS & WALLS	26
PARCEL 15-E-18	8729	1,857± SQ. FT.	PERMANENT	HIGHWAY PURPOSES	26
PARCEL 15-GR-1	8729	174± SQ. FT.	PERMANENT	CONSTRUCTION & MAINTAINING GUARD RAILS & WALLS	26
PARCEL 7-TE-1	5929	4,540± SQ. FT.	TEMPORARY	CONSTRUCTION	16
PARCEL 12-TE-17	8321	4,663± SQ. FT.	TEMPORARY-EXPIRED	CONSTRUCTION	25
PARCEL 7-1	5929	2,680± SQ. FT.	PERMANENT TAKING	HIGHWAY PURPOSES	16

BOUNDARY DESCRIPTION PER TITLE COMMITMENT NO. BLC-28081 ISSUED BY COMMONWEALTH TITLE INSURANCE COMPANY HAVING AN EFFECTIVE DATE OF DECEMBER 10, 2021 (REVISED DECEMBER 14, 2021).

EXHIBIT "A"

LOT 5 SHOWN ON LAND COURT PLAN NO. 18430K, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 58581.

LOT 12, SHOWN ON LAND COURT PLAN NO. 18430N, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 182483.

LOT LS-1, SHOWN ON A PLAN RECORDED WITH SAID DEEDS, PLAN BOOK 284, PLAN 760 OF 1980.

A MAJORITY OF LOCUS IS ALSO SHOWN ON A PLAN RECORDED WITH SAID DEEDS, PLAN BOOK 489, PLAN 564 OF 2001.

LOT 12 IS MADE UP OF THE FOLLOWING LOTS:

LOT 4 SHOWN ON LAND COURT PLAN NO. 18430J, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 54251.

LOTS 6 AND 7, SHOWN ON LAND COURT PLAN NO. 18430K, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 58581.

AN UN-NUMBERED LOT SHOWN ON LAND COURT PLAN 37005A, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 97504.

LOTS 9 AND 10, SHOWN ON LAND COURT PLAN NO. 18430L, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 110971.

LOT LS-2, SHOWN ON LAND COURT PLAN NO. 18430M, A COPY OF WHICH IS FILED WITH CERTIFICATE OF TITLE NO. 112849.

TOGETHER WITH THE BENEFIT OF THAT CERTAIN RESERVATION OF AND RIGHT TO USE THE WAY AS SET FORTH IN INSTRUMENTS FILED AS DOCUMENT NOS. 174924 AND 402661.

TOGETHER WITH THE BENEFIT OF THAT CERTAIN RIGHT OF WAY AND OF OTHERS OVER THE SAME TO THE EXISTING WAY AS SHOWN ON LAND COURT PLAN NOS. 18430J, K AND L.

NOTE: THE ADDRESS OF THE INSURED PREMISES IS KNOWN AS 557 HIGHLAND AVENUE AND 0 GOULD STREET, NEEDHAM, NORFOLK COUNTY, MASSACHUSETTS.

ASSESSOR'S PARCEL NOS. 076-003-000 AND 076-008-000

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

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

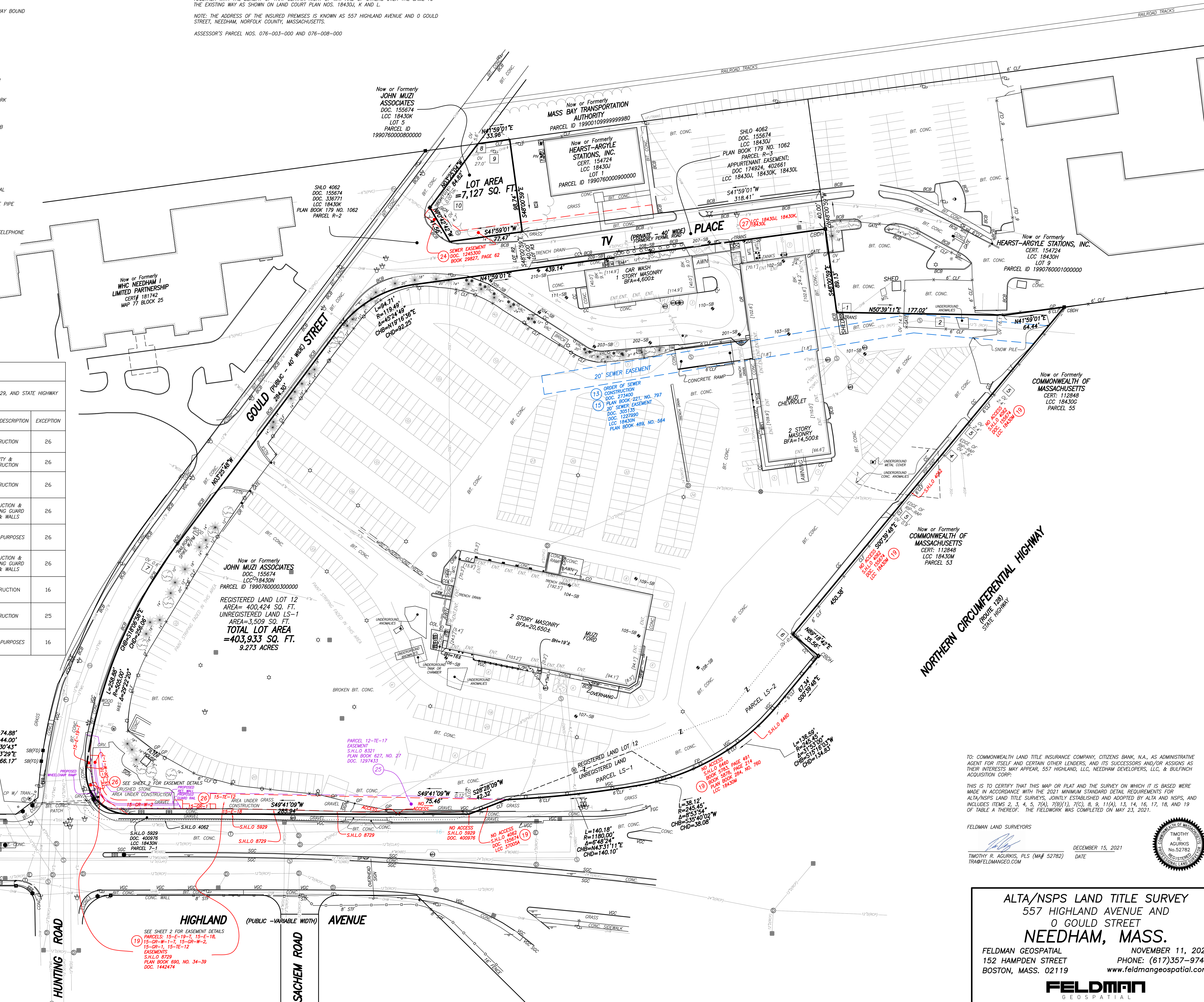
[9] UTILITY POLE AND OVERHEAD WIRES OVER 27.0'

HEARST-ARGYLE STATIONS, INC.

[10] SIGN OVER 4.7'

PARKING SUMMARY

530 STANDARD SPACES
2 HANDICAP SPACES
532 TOTAL SPACES



TO: COMMONWEALTH LAND TITLE INSURANCE COMPANY, CITIZENS BANK, N.A., AS ADMINISTRATIVE AGENT FOR ITSELF AND CERTAIN OTHER LENDERS, AND ITS SUCCESSORS AND/OR ASSIGNS AS THEIR INTERESTS MAY APPEAR, 557 HIGHLAND, LLC, NEEDHAM DEVELOPERS, LLC, & BULFINCH ACQUISITION CORP:

THIS IS TO CERTIFY THAT THIS MAP OR PLAT AND THE SURVEY ON WHICH IT IS BASED WERE MADE IN ACCORDANCE WITH THE 2021 MINIMUM STANDARD DETAIL REQUIREMENTS FOR ALTA/NSPS LAND TITLE SURVEYS, JOINTLY ESTABLISHED AND ADOPTED BY ALTA AND NSPS, AND INCLUDES ITEMS 2, 3, 4, 5, 7(A), 7(B)(1), 7(C), 8, 9, 11(A), 13, 14, 16, 17, 18, AND 19 OF TABLE A THEREOF. THE FIELDWORK WAS COMPLETED ON MAY 23, 2021.

FELDMAN LAND SURVEYORS

TIMOTHY R. AGURKIS, PLS (MA# 52782)
TRA@FELDMANGEO.COM

DECEMBER 15, 2021
DATE

COMMONWEALTH OF MASSACHUSETTS TIMOTHY R. AGURKIS No.52782 REGISTERED PROFESSIONAL LAND SURVEYOR

ALTA/NSPS LAND TITLE SURVEY
557 HIGHLAND AVENUE AND
0 GOULD STREET
NEEDHAM, MASS.

FELDMAN GEOSPATIAL
152 HAMPDEN STREET
BOSTON, MASS. 02119

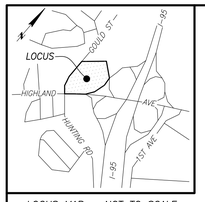
NOVEMBER 11, 2021
PHONE: (617)357-9740
www.feldmangeospatial.com

FELDMAN GEOSPATIAL

40 0 20 40 80 160
SCALE: 1"=40'

RESEARCH	FIELD CHIEF	PROJ MGR TRA	APPROVED	SHEET NO. 1 OF 2
CALC MAM	CADD MAM, MDH	FIELD CHECKED	CRD FILE 18000	JOB NO. 18000

FILENAME: S:\PROJECTS\18000\18000\DWG\18000-ALTA-11-11-2021.dwg



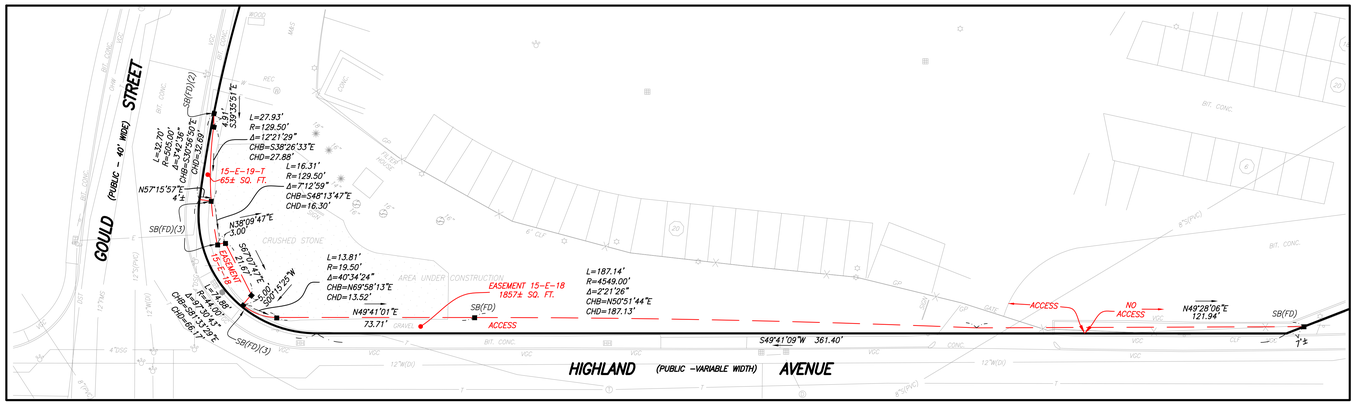
LOCUS MAP – NOT TO SCALE

S.M.L.O. NO. 4662

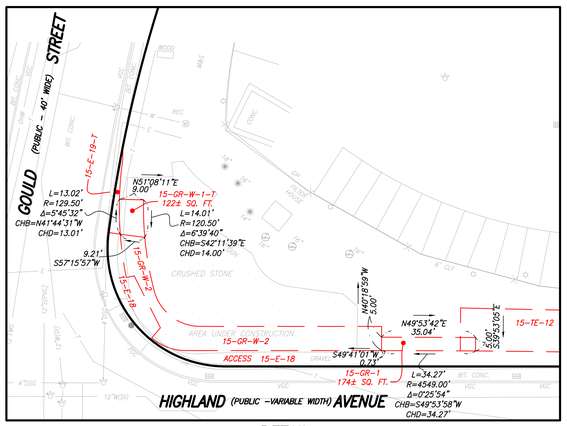
LEGEND

- SEWER MANHOLE
- DRAIN MANHOLE
- ELECTRIC MANHOLE
- WATER MANHOLE
- TELEPHONE MANHOLE
- 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/SIMIESE CONNECTION
- UTILITY POLE W/ LIGHT
- TRANSFORMER
- GAS METER
- ELECTRIC METER
- TRASH RECEPTACLE
- DISABLED PARKING SPACE
- DECIDUOUS TREE
- CONIFEROUS TREE
- BUSH
- SHRUB
- X 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
- BOUND FOUND

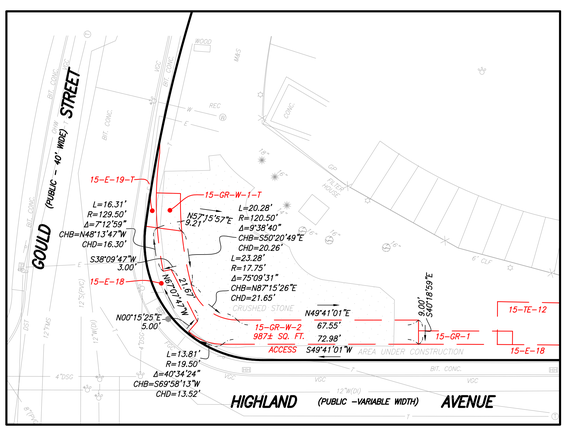
AWN	AWNING
B	BOTTOM
BC	BOTTOM OF CURB
BCB	BIT. CONC. BERM
[X.X']	BUILDING DIMENSION
BFA	BUILDING FOOTPRINT AREA
BH	BUILDING HEIGHT
BIT	BITUMINOUS
BK	BACK
BOT=	BOTTOM ELEVATION
BW	BOTTOM OF WALL
(C)	CALCULATED
CC	CONCRETE CURB
CHB	CHORD BEARING
CHD	CHORD DISTANCE
CLF	CHAIN LINK FENCE
COL	COLUMN
CONC	CONCRETE
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
SB	STONE BOUND
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(CI)—	PIPE SIZE AND MATERIAL
—PVC—	POLYVINYL CHLORIDE
—RCP—	REINFORCED CONCRETE PIPE
—X—X—	METAL FENCE
—DSE—	DIGSAFE ELECTRIC
—DSET—	DIGSAFE ELECTRIC & TELEPHONE
—DSG—	DIGSAFE GAS
—DSST—	DIGSAFE STEAM
DST	DIGSAFE TELEPHONE



DETAIL
SCALE: 1"=20'



DETAIL
SCALE: 1"=20'



DETAIL
SCALE: 1"=20'

COMMONWEALTH OF MASSACHUSETTS
TIMOTHY M. ACURIO No.52782 REGISTERED PROFESSIONAL LAND SURVEYOR

12/15/2021

ALTA/NSPS LAND TITLE SURVEY
557 HIGHLAND AVENUE AND 0 GOULD STREET
NEEDHAM, MASS.

FELDMAN GEOSPATIAL
152 HAMPDEN STREET
BOSTON, MASS. 02119
PHONE: (617)357-9740
www.feldmangeospatial.com

NOVEMBER 11, 2021

FELDMAN GEOSPATIAL

40 0 20 40 80 160

SCALE: 1"=40'

RESEARCH	FIELD CHIEF	PROJ MGR TRA	APPROVED	SHEET NO. 2 OF 2
CALC MAM	CADD MAM, MDH	FIELD CHECKED	CRD FILE 18000	JOB NO. 18000
FILENAME: S:\PROJECTS\18000\18000\DWG\18000-ALTA-11-11-2021.dwg				

557 Highland Avenue
Intersection TMC Sources

#	Intersection			Data Source
1	Central Ave	at	Cedar St	New Counts - VHB (July 2021)
2	Central Ave	at	Webster St	New Counts - VHB (July 2021)
3	Central Ave	at	Gould St	Muzi Motors Redevelopment TIS - GPI (November 2020)
4	Central Ave	at	Hampton Ave	Muzi Motors Redevelopment TIS - GPI (November 2020)
5	Central Ave	at	River Park St	Muzi Motors Redevelopment TIS - GPI (November 2020)
6	Gould St	at	Ellis St	Muzi Motors Redevelopment TIS - GPI (November 2020)
7	Gould St	at	Kearney Rd	Muzi Motors Redevelopment TIS - GPI (November 2020)
8	Gould St	at	Station St	Gould and Reservoir Industrial Districts TIS - BETA (December 2015)
9	Gould St	at	Noanett Rd / Dwy	Gould and Reservoir Industrial Districts TIS - BETA (December 2015)
10	Gould St	at	TV Place	Muzi Motors Redevelopment TIS - GPI (November 2020)
11	Gould St	at	Site Dwy / Wingate Dwy	Muzi Motors Redevelopment TIS - GPI (November 2020)
12	Highland Ave	at	West St	100 West Street TIS - McMahon (April 2020)
13	Highland Ave	at	Hunnewell St	New Counts - VHB (July 2021)
14	Highland Ave	at	Webster St	Highland Avenue Reconstruction FDR - Stantec (August 2017)
15	Highland Ave	at	Gould St / Hunting Rd	Rte 128 Add-a-Lane Post Construction Study - McMahon (November 2019)
16	Highland Ave	at	I-95 SB Ramps	The Northland Newton Development DEIR - VHB (August 2020)
17	Highland Ave	at	I-95 NB Ramps	The Northland Newton Development DEIR - VHB (August 2020)
18	Highland Ave	at	1st Ave	Rte 128 Add-a-Lane Post Construction Study - McMahon (November 2019)
19	Highland Ave	at	2nd Ave	Rte 128 Add-a-Lane Post Construction Study - McMahon (November 2019)
20	Hunting Road	at	Kendrick St	Rte 128 Add-a-Lane Post Construction Study - McMahon (November 2019)

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Cars and Heavy Vehicles (Combined)

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	12	21	0	0	33	0	0	0	0	0	0	71	7	0	78	6	0	15	0	21	132
7:15 AM	23	33	0	0	56	0	0	0	0	0	0	86	7	0	93	5	0	12	0	17	166
7:30 AM	26	31	0	0	57	0	0	0	0	0	0	94	11	0	105	5	0	16	0	21	183
7:45 AM	32	39	0	0	71	0	0	0	0	0	0	86	11	0	97	10	0	34	0	44	212
Total	93	124	0	0	217	0	0	0	0	0	0	337	36	0	373	26	0	77	0	103	693
8:00 AM	19	51	0	0	70	0	0	0	0	0	0	94	17	0	111	3	0	20	0	23	204
8:15 AM	31	47	0	0	78	0	0	0	0	0	0	98	10	0	108	5	0	27	0	32	218
8:30 AM	61	71	0	0	132	0	0	0	0	0	0	121	29	0	150	31	0	49	0	80	362
8:45 AM	53	61	0	0	114	0	0	0	0	0	0	116	12	0	128	18	0	46	0	64	306
Total	164	230	0	0	394	0	0	0	0	0	0	429	68	0	497	57	0	142	0	199	1090
Grand Total	257	354	0	0	611	0	0	0	0	0	0	766	104	0	870	83	0	219	0	302	1783
Approach %	42.1	57.9	0.0	0.0		0.0	0.0	0.0	0.0		0.0	88.0	12.0	0.0		27.5	0.0	72.5	0.0		
Total %	14.4	19.9	0.0	0.0	34.3	0.0	0.0	0.0	0.0	0.0	0.0	43.0	5.8	0.0	48.8	4.7	0.0	12.3	0.0	16.9	
Exiting Leg Total					985					0					437					361	1783
Cars	248	332	0	0	580	0	0	0	0	0	0	741	102	0	843	81	0	210	0	291	1714
% Cars	96.5	93.8	0.0	0.0	94.9	0.0	0.0	0.0	0.0	0.0	0.0	96.7	98.1	0.0	96.9	97.6	0.0	95.9	0.0	96.4	96.1
Exiting Leg Total					951					0					413					350	1714
Heavy Vehicles	9	22	0	0	31	0	0	0	0	0	0	25	2	0	27	2	0	9	0	11	69
% Heavy Vehicles	3.5	6.2	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	3.3	1.9	0.0	3.1	2.4	0.0	4.1	0.0	3.6	3.9
Exiting Leg Total					34					0					24					11	69

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	19	51	0	0	70	0	0	0	0	0	0	94	17	0	111	3	0	20	0	23	204
8:15 AM	31	47	0	0	78	0	0	0	0	0	0	98	10	0	108	5	0	27	0	32	218
8:30 AM	61	71	0	0	132	0	0	0	0	0	0	121	29	0	150	31	0	49	0	80	362
8:45 AM	53	61	0	0	114	0	0	0	0	0	0	116	12	0	128	18	0	46	0	64	306
Total Volume	164	230	0	0	394	0	0	0	0	0	0	429	68	0	497	57	0	142	0	199	1090
% Approach Total	41.6	58.4	0.0	0.0		0.0	0.0	0.0	0.0		0.0	86.3	13.7	0.0		28.6	0.0	71.4	0.0		
PHF	0.672	0.810	0.000	0.000	0.746	0.000	0.000	0.000	0.000	0.000	0.000	0.886	0.586	0.000	0.828	0.460	0.000	0.724	0.000	0.622	0.753
Cars	158	214	0	0	372	0	0	0	0	0	0	421	67	0	488	56	0	137	0	193	1053
Cars %	96.3	93.0	0.0	0.0	94.4	0.0	0.0	0.0	0.0	0.0	0.0	98.1	98.5	0.0	98.2	98.2	0.0	96.5	0.0	97.0	96.6
Heavy Vehicles	6	16	0	0	22	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	37
Heavy Vehicles %	3.7	7.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.5	0.0	1.8	1.8	0.0	3.5	0.0	3.0	3.4
Cars Enter Leg	158	214	0	0	372	0	0	0	0	0	0	421	67	0	488	56	0	137	0	193	1053
Heavy Enter Leg	6	16	0	0	22	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	37
Total Entering Leg	164	230	0	0	394	0	0	0	0	0	0	429	68	0	497	57	0	142	0	199	1090
Cars Exiting Leg					558					0					270					225	1053
Heavy Exiting Leg					13					0					17					7	37
Total Exiting Leg					571					0					287					232	1090

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Cars

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	12	21	0	0	33	0	0	0	0	0	0	69	7	0	76	5	0	13	0	18	127
7:15 AM	22	31	0	0	53	0	0	0	0	0	0	81	7	0	88	5	0	12	0	17	158
7:30 AM	25	28	0	0	53	0	0	0	0	0	0	92	10	0	102	5	0	15	0	20	175
7:45 AM	31	38	0	0	69	0	0	0	0	0	0	78	11	0	89	10	0	33	0	43	201
Total	90	118	0	0	208	0	0	0	0	0	0	320	35	0	355	25	0	73	0	98	661
8:00 AM	19	45	0	0	64	0	0	0	0	0	0	92	16	0	108	3	0	20	0	23	195
8:15 AM	29	44	0	0	73	0	0	0	0	0	0	97	10	0	107	5	0	26	0	31	211
8:30 AM	60	69	0	0	129	0	0	0	0	0	0	120	29	0	149	31	0	49	0	80	358
8:45 AM	50	56	0	0	106	0	0	0	0	0	0	112	12	0	124	17	0	42	0	59	289
Total	158	214	0	0	372	0	0	0	0	0	0	421	67	0	488	56	0	137	0	193	1053
Grand Total	248	332	0	0	580	0	0	0	0	0	0	741	102	0	843	81	0	210	0	291	1714
Approach %	42.8	57.2	0.0	0.0		0.0	0.0	0.0	0.0		0.0	87.9	12.1	0.0		27.8	0.0	72.2	0.0		
Total %	14.5	19.4	0.0	0.0	33.8	0.0	0.0	0.0	0.0	0.0	0.0	43.2	6.0	0.0	49.2	4.7	0.0	12.3	0.0	17.0	
Exiting Leg Total					951					0					413					350	1714

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	19	45	0	0	64	0	0	0	0	0	0	92	16	0	108	3	0	20	0	23	195
8:15 AM	29	44	0	0	73	0	0	0	0	0	0	97	10	0	107	5	0	26	0	31	211
8:30 AM	60	69	0	0	129	0	0	0	0	0	0	120	29	0	149	31	0	49	0	80	358
8:45 AM	50	56	0	0	106	0	0	0	0	0	0	112	12	0	124	17	0	42	0	59	289
Total Volume	158	214	0	0	372	0	0	0	0	0	0	421	67	0	488	56	0	137	0	193	1053
% Approach Total	42.5	57.5	0.0	0.0		0.0	0.0	0.0	0.0		0.0	86.3	13.7	0.0		29.0	0.0	71.0	0.0		
PHF	0.658	0.775	0.000	0.000	0.721	0.000	0.000	0.000	0.000	0.000	0.000	0.877	0.578	0.000	0.819	0.452	0.000	0.699	0.000	0.603	0.735
Entering Leg	158	214	0	0	372	0	0	0	0	0	0	421	67	0	488	56	0	137	0	193	1053
Exiting Leg					558					0					270					225	1053
Total					930					0					758					418	2106

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1	0	2	0	3	5
7:15 AM	1	2	0	0	3	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	8
7:30 AM	1	3	0	0	4	0	0	0	0	0	0	2	1	0	3	0	0	1	0	1	8
7:45 AM	1	1	0	0	2	0	0	0	0	0	0	8	0	0	8	0	0	1	0	1	11
Total	3	6	0	0	9	0	0	0	0	0	0	17	1	0	18	1	0	4	0	5	32
8:00 AM	0	6	0	0	6	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	9
8:15 AM	2	3	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	7
8:30 AM	1	2	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
8:45 AM	3	5	0	0	8	0	0	0	0	0	0	4	0	0	4	1	0	4	0	5	17
Total	6	16	0	0	22	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	37
Grand Total	9	22	0	0	31	0	0	0	0	0	0	25	2	0	27	2	0	9	0	11	69
Approach %	29.0	71.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	92.6	7.4	0.0		18.2	0.0	81.8	0.0		
Total %	13.0	31.9	0.0	0.0	44.9	0.0	0.0	0.0	0.0	0.0	0.0	36.2	2.9	0.0	39.1	2.9	0.0	13.0	0.0	15.9	
Exiting Leg Total					34					0					24					11	69
Buses	2	2	0	0	4	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	6
% Buses	22.2	9.1	0.0	0.0	12.9	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	3.7	50.0	0.0	0.0	0.0	9.1	8.7
Exiting Leg Total					1					0					3					2	6
Single-Unit Trucks	4	15	0	0	19	0	0	0	0	0	0	17	1	0	18	1	0	6	0	7	44
% Single-Unit	44.4	68.2	0.0	0.0	61.3	0.0	0.0	0.0	0.0	0.0	0.0	68.0	50.0	0.0	66.7	50.0	0.0	66.7	0.0	63.6	63.8
Exiting Leg Total					23					0					16					5	44
Articulated Trucks	3	5	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	3	0	3	19
% Articulated	33.3	22.7	0.0	0.0	25.8	0.0	0.0	0.0	0.0	0.0	0.0	28.0	50.0	0.0	29.6	0.0	0.0	33.3	0.0	27.3	27.5
Exiting Leg Total					10					0					5					4	19

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	6	0	0	6	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	9
8:15 AM	2	3	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	7
8:30 AM	1	2	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
8:45 AM	3	5	0	0	8	0	0	0	0	0	0	4	0	0	4	1	0	4	0	5	17
Total Volume	6	16	0	0	22	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	37
% Approach Total	27.3	72.7	0.0	0.0		0.0	0.0	0.0	0.0		0.0	88.9	11.1	0.0		16.7	0.0	83.3	0.0		
PHF	0.500	0.667	0.000	0.000	0.688	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.000	0.563	0.250	0.000	0.313	0.000	0.300	0.544
Buses	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	4
Buses %	16.7	6.3	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	11.1	100.0	0.0	0.0	0.0	16.7	10.8
Single-Unit Trucks	4	11	0	0	15	0	0	0	0	0	0	6	1	0	7	0	0	5	0	5	27
Single-Unit %	66.7	68.8	0.0	0.0	68.2	0.0	0.0	0.0	0.0	0.0	0.0	75.0	100.0	0.0	77.8	0.0	0.0	100.0	0.0	83.3	73.0
Articulated Trucks	1	4	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	6
Articulated %	16.7	25.0	0.0	0.0	22.7	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	16.2
Buses	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	4
Single-Unit Trucks	4	11	0	0	15	0	0	0	0	0	0	6	1	0	7	0	0	5	0	5	27
Articulated Trucks	1	4	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	6
Total Entering Leg	6	16	0	0	22	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	37
Buses					1					0					2					1	4
Single-Unit Trucks					11					0					11					5	27
Articulated Trucks					1					0					4					1	6
Total Exiting Leg					13					0					17					7	37

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Buses

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8:00 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	3
Total	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	4
Grand Total	2	2	0	0	4	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	6
Approach %	50.0	50.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		100.0	0.0	0.0	0.0		
Total %	33.3	33.3	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	16.7	16.7	0.0	0.0	0.0	16.7	
Exiting Leg Total					1					0					3					2	6

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	3
Total Volume	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	4
% Approach Total	50.0	50.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		100.0	0.0	0.0	0.0		
PHF	0.250	0.250	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.250	0.333
Entering Leg	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	4
Exiting Leg					1					0					2					1	4
Total					3					0					3					2	8

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Single-Unit Trucks

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	2
7:15 AM	0	1	0	0	1	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	5
7:30 AM	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	4
7:45 AM	0	1	0	0	1	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	6
Total	0	4	0	0	4	0	0	0	0	0	0	11	0	0	11	1	0	1	0	2	17
8:00 AM	0	2	0	0	2	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	5
8:15 AM	2	3	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	7
8:30 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:45 AM	2	5	0	0	7	0	0	0	0	0	0	3	0	0	3	0	0	4	0	4	14
Total	4	11	0	0	15	0	0	0	0	0	0	6	1	0	7	0	0	5	0	5	27
Grand Total	4	15	0	0	19	0	0	0	0	0	0	17	1	0	18	1	0	6	0	7	44
Approach %	21.1	78.9	0.0	0.0		0.0	0.0	0.0	0.0		0.0	94.4	5.6	0.0		14.3	0.0	85.7	0.0		
Total %	9.1	34.1	0.0	0.0	43.2	0.0	0.0	0.0	0.0	0.0	0.0	38.6	2.3	0.0	40.9	2.3	0.0	13.6	0.0	15.9	
Exiting Leg Total					23					0					16					5	44

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	2	0	0	2	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	5
8:15 AM	2	3	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	7
8:30 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:45 AM	2	5	0	0	7	0	0	0	0	0	0	3	0	0	3	0	0	4	0	4	14
Total Volume	4	11	0	0	15	0	0	0	0	0	0	6	1	0	7	0	0	5	0	5	27
% Approach Total	26.7	73.3	0.0	0.0		0.0	0.0	0.0	0.0		0.0	85.7	14.3	0.0		0.0	0.0	100.0	0.0		
PHF	0.500	0.550	0.000	0.000	0.536	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.000	0.583	0.000	0.000	0.313	0.000	0.313	0.482
Entering Leg	4	11	0	0	15	0	0	0	0	0	0	6	1	0	7	0	0	5	0	5	27
Exiting Leg					11					0					11					5	27
Total					26					0					18					10	54

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Articulated Trucks**

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	3
7:15 AM	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	2
7:45 AM	1	0	0	0	1	0	0	0	0	0	0	3	0	0	3	0	0	1	0	1	5
Total	2	1	0	0	3	0	0	0	0	0	0	6	1	0	7	0	0	3	0	3	13
8:00 AM	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	4	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	6
Grand Total	3	5	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	3	0	3	19
Approach %	37.5	62.5	0.0	0.0		0.0	0.0	0.0	0.0		0.0	87.5	12.5	0.0		0.0	0.0	100.0	0.0		
Total %	15.8	26.3	0.0	0.0	42.1	0.0	0.0	0.0	0.0	0.0	0.0	36.8	5.3	0.0	42.1	0.0	0.0	15.8	0.0	15.8	
Exiting Leg Total					10					0					5					4	19

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	3
7:15 AM	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	2
7:45 AM	1	0	0	0	1	0	0	0	0	0	0	3	0	0	3	0	0	1	0	1	5
Total Volume	2	1	0	0	3	0	0	0	0	0	0	6	1	0	7	0	0	3	0	3	13
% Approach Total	66.7	33.3	0.0	0.0		0.0	0.0	0.0	0.0		0.0	85.7	14.3	0.0		0.0	0.0	100.0	0.0		
PHF	0.500	0.250	0.000	0.000	0.375	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.000	0.583	0.000	0.000	0.750	0.000	0.750	0.650
Entering Leg	2	1	0	0	3	0	0	0	0	0	0	6	1	0	7	0	0	3	0	3	13
Exiting Leg					9					0					1					3	13
Total					12					0					8					6	26

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Bicycles (on Roadway and Crosswalks)

	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	2
7:15 AM	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	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	2
7:45 AM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2	1	0	0	1	4	0	0	0	0	0	0	0	5
8:00 AM	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	1	0	0	0	1	5
8:15 AM	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	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	3	0	0	0	0	0	0	0	3
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	2
Total	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	5	2	0	0	0	7	0	0	1	0	0	0	1	10
Grand Total	1	1	0	0	0	1	3	0	0	0	0	0	0	0	0	7	3	0	0	1	11	0	0	1	0	0	0	1	15
Approach %	33.3	33.3	0.0	0.0	0.0	33.3		0.0	0.0	0.0	0.0	0.0	0.0		0.0	63.6	27.3	0.0	0.0	9.1		0.0	0.0	100.0	0.0	0.0	0.0		
Total %	6.7	6.7	0.0	0.0	0.0	6.7	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.7	20.0	0.0	0.0	6.7	73.3	0.0	0.0	6.7	0.0	0.0	0.0	6.7	
Exiting Leg Total							9							0							2							4	15

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
8:00 AM	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	1	0	0	0	1	5
8:15 AM	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	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	3	0	0	0	0	0	0	0	3
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	2
Total Volume	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	5	2	0	0	0	7	0	0	1	0	0	0	1	10
% Approach Total	50.0	0.0	0.0	0.0	0.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	71.4	28.6	0.0	0.0	0.0		0.0	0.0	100.0	0.0	0.0	0.0		
PHF	0.250	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.625	0.250	0.000	0.000	0.000	0.583	0.000	0.000	0.250	0.000	0.000	0.000	0.250	0.500
Entering Leg	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	5	2	0	0	0	7	0	0	1	0	0	0	1	10
Exiting Leg							7							0							0							3	10
Total							9							0							7							4	20

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Pedestrians

	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	0	0	0	0	1	1	2	0	0	0	0	2	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Total	0	0	0	0	1	1	2	0	0	0	0	3	7	10	0	0	0	0	1	0	1	0	0	0	0	0	2	2	15
8:00 AM	0	0	0	0	0	1	1	0	0	0	0	2	3	5	0	0	0	0	0	0	0	0	0	0	0	0	1	1	7
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	2	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3	6
8:45 AM	0	0	0	0	1	0	1	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	2	0	2	6
Total	0	0	0	0	1	3	4	0	0	0	0	4	6	10	0	0	0	0	0	0	0	0	0	0	0	3	3	6	20
Grand Total	0	0	0	0	2	4	6	0	0	0	0	7	13	20	0	0	0	0	1	0	1	0	0	0	0	3	5	8	35
Approach %	0	0	0	0	33.3	66.7		0	0	0	0	35	65		0	0	0	0	100	0		0	0	0	0	37.5	62.5		
Total %	0	0	0	0	5.71	11.4	17.1	0	0	0	0	20	37.1	57.1	0	0	0	0	2.86	0	2.86	0	0	0	0	8.57	14.3	22.9	
Exiting Leg Total							6							20							1							8	35

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
8:00 AM	0	0	0	0	0	1	1	0	0	0	0	2	3	5	0	0	0	0	0	0	0	0	0	0	0	0	1	1	7
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	2	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3	6
8:45 AM	0	0	0	0	1	0	1	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	2	0	2	6
Total Volume	0	0	0	0	1	3	4	0	0	0	0	4	6	10	0	0	0	0	0	0	0	0	0	0	0	3	3	6	20
% Approach Total	0.0	0.0	0.0	0.0	25.0	75.0		0.0	0.0	0.0	0.0	40.0	60.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	50.0	50.0		
PHF	0.000	0.000	0.000	0.000	0.250	0.375	0.500	0.000	0.000	0.000	0.000	0.500	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.375	0.375	0.500	0.714
Entering Leg	0	0	0	0	1	3	4	0	0	0	0	4	6	10	0	0	0	0	0	0	0	0	0	0	0	3	3	6	20
Exiting Leg							4							10							0							6	20
Total							8							20							0							12	40

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Cars and Heavy Vehicles (Combined)

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	31	107	0	0	138	0	0	0	0	0	0	65	10	0	75	2	0	36	0	38	251
4:15 PM	27	111	0	0	138	1	0	0	0	1	0	71	8	0	79	11	0	36	0	47	265
4:30 PM	25	96	0	0	121	0	0	0	0	0	0	65	6	0	71	13	0	32	0	45	237
4:45 PM	27	90	0	0	117	0	0	0	0	0	0	63	2	0	65	14	0	33	0	47	229
Total	110	404	0	0	514	1	0	0	0	1	0	264	26	0	290	40	0	137	0	177	982
5:00 PM	37	116	0	0	153	0	0	0	0	0	0	72	5	0	77	6	0	31	0	37	267
5:15 PM	36	102	0	0	138	0	0	0	0	0	0	39	8	0	47	15	0	32	0	47	232
5:30 PM	22	83	0	0	105	0	0	0	0	0	0	60	7	0	67	11	0	30	0	41	213
5:45 PM	22	79	0	0	101	0	0	0	0	0	0	53	7	0	60	12	0	26	0	38	199
Total	117	380	0	0	497	0	0	0	0	0	0	224	27	0	251	44	0	119	0	163	911
Grand Total	227	784	0	0	1011	1	0	0	0	1	0	488	53	0	541	84	0	256	0	340	1893
Approach %	22.5	77.5	0.0	0.0		100.0	0.0	0.0	0.0		0.0	90.2	9.8	0.0		24.7	0.0	75.3	0.0		
Total %	12.0	41.4	0.0	0.0	53.4	0.1	0.0	0.0	0.0	0.1	0.0	25.8	2.8	0.0	28.6	4.4	0.0	13.5	0.0	18.0	
Exiting Leg Total					745					0					868					280	1893
Cars	223	775	0	0	998	1	0	0	0	1	0	480	52	0	532	83	0	251	0	334	1865
% Cars	98.2	98.9	0.0	0.0	98.7	100.0	0.0	0.0	0.0	100.0	0.0	98.4	98.1	0.0	98.3	98.8	0.0	98.0	0.0	98.2	98.5
Exiting Leg Total					732					0					858					275	1865
Heavy Vehicles	4	9	0	0	13	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	28
% Heavy Vehicles	1.8	1.1	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.9	0.0	1.7	1.2	0.0	2.0	0.0	1.8	1.5
Exiting Leg Total					13					0					10					5	28

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:15 PM	27	111	0	0	138	1	0	0	0	1	0	71	8	0	79	11	0	36	0	47	265
4:30 PM	25	96	0	0	121	0	0	0	0	0	0	65	6	0	71	13	0	32	0	45	237
4:45 PM	27	90	0	0	117	0	0	0	0	0	0	63	2	0	65	14	0	33	0	47	229
5:00 PM	37	116	0	0	153	0	0	0	0	0	0	72	5	0	77	6	0	31	0	37	267
Total Volume	116	413	0	0	529	1	0	0	0	1	0	271	21	0	292	44	0	132	0	176	998
% Approach Total	21.9	78.1	0.0	0.0		100.0	0.0	0.0	0.0		0.0	92.8	7.2	0.0		25.0	0.0	75.0	0.0		
PHF	0.784	0.890	0.000	0.000	0.864	0.250	0.000	0.000	0.000	0.250	0.000	0.941	0.656	0.000	0.924	0.786	0.000	0.917	0.000	0.936	0.934
Cars	113	408	0	0	521	1	0	0	0	1	0	264	20	0	284	44	0	129	0	173	979
Cars %	97.4	98.8	0.0	0.0	98.5	100.0	0.0	0.0	0.0	100.0	0.0	97.4	95.2	0.0	97.3	100.0	0.0	97.7	0.0	98.3	98.1
Heavy Vehicles	3	5	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	3	0	3	19
Heavy Vehicles %	2.6	1.2	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	2.6	4.8	0.0	2.7	0.0	0.0	2.3	0.0	1.7	1.9
Cars Enter Leg	113	408	0	0	521	1	0	0	0	1	0	264	20	0	284	44	0	129	0	173	979
Heavy Enter Leg	3	5	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	3	0	3	19
Total Entering Leg	116	413	0	0	529	1	0	0	0	1	0	271	21	0	292	44	0	132	0	176	998
Cars Exiting Leg					394					0					452					133	979
Heavy Exiting Leg					10					0					5					4	19
Total Exiting Leg					404					0					457					137	998

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Cars

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	31	106	0	0	137	0	0	0	0	0	0	64	10	0	74	2	0	36	0	38	249
4:15 PM	26	109	0	0	135	1	0	0	0	1	0	68	8	0	76	11	0	36	0	47	259
4:30 PM	25	93	0	0	118	0	0	0	0	0	0	63	5	0	68	13	0	32	0	45	231
4:45 PM	26	90	0	0	116	0	0	0	0	0	0	62	2	0	64	14	0	31	0	45	225
Total	108	398	0	0	506	1	0	0	0	1	0	257	25	0	282	40	0	135	0	175	964
5:00 PM	36	116	0	0	152	0	0	0	0	0	0	71	5	0	76	6	0	30	0	36	264
5:15 PM	36	101	0	0	137	0	0	0	0	0	0	39	8	0	47	14	0	31	0	45	229
5:30 PM	22	82	0	0	104	0	0	0	0	0	0	60	7	0	67	11	0	29	0	40	211
5:45 PM	21	78	0	0	99	0	0	0	0	0	0	53	7	0	60	12	0	26	0	38	197
Total	115	377	0	0	492	0	0	0	0	0	0	223	27	0	250	43	0	116	0	159	901
Grand Total	223	775	0	0	998	1	0	0	0	1	0	480	52	0	532	83	0	251	0	334	1865
Approach %	22.3	77.7	0.0	0.0		100.0	0.0	0.0	0.0		0.0	90.2	9.8	0.0		24.9	0.0	75.1	0.0		
Total %	12.0	41.6	0.0	0.0	53.5	0.1	0.0	0.0	0.0	0.1	0.0	25.7	2.8	0.0	28.5	4.5	0.0	13.5	0.0	17.9	
Exiting Leg Total					732					0					858					275	1865

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:15 PM	26	109	0	0	135	1	0	0	0	1	0	68	8	0	76	11	0	36	0	47	259
4:30 PM	25	93	0	0	118	0	0	0	0	0	0	63	5	0	68	13	0	32	0	45	231
4:45 PM	26	90	0	0	116	0	0	0	0	0	0	62	2	0	64	14	0	31	0	45	225
5:00 PM	36	116	0	0	152	0	0	0	0	0	0	71	5	0	76	6	0	30	0	36	264
Total Volume	113	408	0	0	521	1	0	0	0	1	0	264	20	0	284	44	0	129	0	173	979
% Approach Total	21.7	78.3	0.0	0.0		100.0	0.0	0.0	0.0		0.0	93.0	7.0	0.0		25.4	0.0	74.6	0.0		
PHF	0.785	0.879	0.000	0.000	0.857	0.250	0.000	0.000	0.000	0.250	0.000	0.930	0.625	0.000	0.934	0.786	0.000	0.896	0.000	0.920	0.927
Entering Leg	113	408	0	0	521	1	0	0	0	1	0	264	20	0	284	44	0	129	0	173	979
Exiting Leg					394					0					452					133	979
Total					915					1					736					306	1958

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
4:15 PM	1	2	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	6
4:30 PM	0	3	0	0	3	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	6
4:45 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	4
Total	2	6	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	2	0	2	18
5:00 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	3
5:15 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	3
5:30 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
5:45 PM	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	2	3	0	0	5	0	0	0	0	0	0	1	0	0	1	1	0	3	0	4	10
Grand Total	4	9	0	0	13	0	0	0	0	0	0	8	1	0	9	1	0	5	0	6	28
Approach %	30.8	69.2	0.0	0.0		0.0	0.0	0.0	0.0		0.0	88.9	11.1	0.0		16.7	0.0	83.3	0.0		
Total %	14.3	32.1	0.0	0.0	46.4	0.0	0.0	0.0	0.0	0.0	0.0	28.6	3.6	0.0	32.1	3.6	0.0	17.9	0.0	21.4	
Exiting Leg Total					13					0					10					5	28
Buses	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
% Buses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	22.2	0.0	0.0	0.0	0.0	0.0	7.1
Exiting Leg Total					2					0					0					0	2
Single-Unit Trucks	2	8	0	0	10	0	0	0	0	0	0	5	0	0	5	0	0	4	0	4	19
% Single-Unit	50.0	88.9	0.0	0.0	76.9	0.0	0.0	0.0	0.0	0.0	0.0	62.5	0.0	0.0	55.6	0.0	0.0	80.0	0.0	66.7	67.9
Exiting Leg Total					9					0					8					2	19
Articulated Trucks	2	1	0	0	3	0	0	0	0	0	0	1	1	0	2	1	0	1	0	2	7
% Articulated	50.0	11.1	0.0	0.0	23.1	0.0	0.0	0.0	0.0	0.0	0.0	12.5	100.0	0.0	22.2	100.0	0.0	20.0	0.0	33.3	25.0
Exiting Leg Total					2					0					2					3	7

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:15 PM	1	2	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	6
4:30 PM	0	3	0	0	3	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	6
4:45 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	4
5:00 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	3
Total Volume	3	5	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	3	0	3	19
% Approach Total	37.5	62.5	0.0	0.0		0.0	0.0	0.0	0.0		0.0	87.5	12.5	0.0		0.0	0.0	100.0	0.0		
PHF	0.750	0.417	0.000	0.000	0.667	0.000	0.000	0.000	0.000	0.000	0.000	0.583	0.250	0.000	0.667	0.000	0.000	0.375	0.000	0.375	0.792
Buses	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
Buses %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	10.5
Single-Unit Trucks	2	5	0	0	7	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3	14
Single-Unit %	66.7	100.0	0.0	0.0	87.5	0.0	0.0	0.0	0.0	0.0	0.0	57.1	0.0	0.0	50.0	0.0	0.0	100.0	0.0	100.0	73.7
Articulated Trucks	1	0	0	0	1	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	3
Articulated %	33.3	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	14.3	100.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	15.8
Buses	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
Single-Unit Trucks	2	5	0	0	7	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3	14
Articulated Trucks	1	0	0	0	1	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	3
Total Entering Leg	3	5	0	0	8	0	0	0	0	0	0	7	1	0	8	0	0	3	0	3	19
Buses					2					0					0					0	2
Single-Unit Trucks					7					0					5					2	14
Articulated Trucks					1					0					0					2	3
Total Exiting Leg					10					0					5					4	19

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Buses**

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
Approach %	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total					2					0					0					0	2

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total Volume	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
% Approach Total	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.500
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
Exiting Leg					2					0					0					0	2
Total					2					0					2					0	4

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Single-Unit Trucks

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
4:15 PM	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
4:30 PM	0	3	0	0	3	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	5
4:45 PM	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	3
Total	1	6	0	0	7	0	0	0	0	0	0	4	0	0	4	0	0	2	0	2	13
5:00 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	3
5:15 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:30 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	2	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	6
Grand Total	2	8	0	0	10	0	0	0	0	0	0	5	0	0	5	0	0	4	0	4	19
Approach %	20.0	80.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		
Total %	10.5	42.1	0.0	0.0	52.6	0.0	0.0	0.0	0.0	0.0	0.0	26.3	0.0	0.0	26.3	0.0	0.0	21.1	0.0	21.1	
Exiting Leg Total					9					0					8					2	19

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:15 PM	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
4:30 PM	0	3	0	0	3	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	5
4:45 PM	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	3
5:00 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	3
Total Volume	2	5	0	0	7	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3	14
% Approach Total	28.6	71.4	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		
PHF	0.500	0.417	0.000	0.000	0.583	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.500	0.000	0.000	0.375	0.000	0.375	0.700
Entering Leg	2	5	0	0	7	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3	14
Exiting Leg					7					0					5					2	14
Total					14					0					9					5	28

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Articulated Trucks

	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	3
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	4
Grand Total	2	1	0	0	3	0	0	0	0	0	0	1	1	0	2	1	0	1	0	2	7
Approach %	66.7	33.3	0.0	0.0		0.0	0.0	0.0	0.0		0.0	50.0	50.0	0.0		50.0	0.0	50.0	0.0		
Total %	28.6	14.3	0.0	0.0	42.9	0.0	0.0	0.0	0.0	0.0	0.0	14.3	14.3	0.0	28.6	14.3	0.0	14.3	0.0	28.6	
Exiting Leg Total					2					0					2					3	7

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

5:00 PM	Central Avenue from North					Driveway from East					Central Avenue from South					Cedar Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total Volume	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	4
% Approach Total	50.0	50.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		50.0	0.0	50.0	0.0		
PHF	0.250	0.250	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.000	0.250	0.500
Entering Leg	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	4
Exiting Leg					1					0					2					1	4
Total					3					0					2					3	8

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Bicycles (on Roadway and Crosswalks)

	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
4:30 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4:45 PM	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	0	0	0
Total	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	3
5:00 PM	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	0	0	0
5:15 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:30 PM	0	8	0	0	0	0	8	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1	0	0	0	0	0	1	11
5:45 PM	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	3
Total	0	11	0	0	0	0	11	0	0	0	0	0	0	0	0	1	2	0	0	0	3	1	0	0	0	0	0	1	15
Grand Total	0	12	0	0	0	0	12	0	0	0	0	0	0	0	0	1	3	0	0	0	4	1	0	1	0	0	0	2	18
Approach %	0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	25.0	75.0	0.0	0.0	0.0		50.0	0.0	50.0	0.0	0.0	0.0		
Total %	0.0	66.7	0.0	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	16.7	0.0	0.0	0.0	22.2	5.6	0.0	5.6	0.0	0.0	0.0	11.1	
Exiting Leg Total							2							0							13							3	18

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

5:00 PM	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
5:00 PM	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	0	0	0
5:15 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:30 PM	0	8	0	0	0	0	8	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1	0	0	0	0	0	1	11
5:45 PM	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	3
Total Volume	0	11	0	0	0	0	11	0	0	0	0	0	0	0	0	1	2	0	0	0	3	1	0	0	0	0	0	1	15
% Approach Total	0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	33.3	66.7	0.0	0.0	0.0		100.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.344	0.000	0.000	0.000	0.000	0.344	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.375	0.250	0.000	0.000	0.000	0.000	0.000	0.250	0.341
Entering Leg	0	11	0	0	0	0	11	0	0	0	0	0	0	0	0	1	2	0	0	0	3	1	0	0	0	0	0	1	15
Exiting Leg							1							0							12							2	15
Total							12							0							15							3	30

PDI File #: **218064 A**
Location: **N: Central Avenue S: Central Avenue**
Location: **E: Driveway W: Cedar Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Pedestrians

	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:00 PM	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	2	2	2
4:15 PM	0	0	0	0	0	1	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
4:30 PM	0	0	0	0	2	0	2	0	0	0	0	0	1	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	5
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	2	1	3	0	0	0	0	1	4	5	0	0	0	0	1	1	2	0	0	0	0	0	2	2	12
5:00 PM	0	0	0	0	4	0	4	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5:30 PM	0	0	0	0	0	2	2	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	4	2	6	0	0	0	0	5	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Grand Total	0	0	0	0	6	3	9	0	0	0	0	6	9	15	0	0	0	0	1	1	2	0	0	0	0	0	2	2	28
Approach %	0	0	0	0	66.7	33.3		0	0	0	0	40	60		0	0	0	0	50	50		0	0	0	0	0	100		
Total %	0	0	0	0	21.4	10.7	32.1	0	0	0	0	21.4	32.1	53.6	0	0	0	0	3.57	3.57	7.14	0	0	0	0	0	7.14	7.14	
Exiting Leg Total							9							15							2							2	28

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Avenue from North							Driveway from East							Central Avenue from South							Cedar Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:15 PM	0	0	0	0	0	1	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
4:30 PM	0	0	0	0	2	0	2	0	0	0	0	0	1	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	5
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5:00 PM	0	0	0	0	4	0	4	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Total Volume	0	0	0	0	6	1	7	0	0	0	0	5	4	9	0	0	0	0	1	1	2	0	0	0	0	0	0	0	18
% Approach Total	0.0	0.0	0.0	0.0	85.7	14.3		0.0	0.0	0.0	0.0	55.6	44.4		0.0	0.0	0.0	0.0	50.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.375	0.250	0.438	0.000	0.000	0.000	0.000	0.313	0.500	0.563	0.000	0.000	0.000	0.000	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.563
Entering Leg	0	0	0	0	6	1	7	0	0	0	0	5	4	9	0	0	0	0	1	1	2	0	0	0	0	0	0	0	18
Exiting Leg							7							9							2							0	18
Total							14							18							4							0	36

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Cars and Heavy Vehicles (Combined)

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	30	6	0	36	7	3	0	10	3	81	0	84	130
7:15 AM	47	19	0	66	12	10	0	22	10	89	0	99	187
7:30 AM	40	7	0	47	15	17	0	32	10	106	0	116	195
7:45 AM	52	17	0	69	20	20	0	40	6	112	0	118	227
Total	169	49	0	218	54	50	0	104	29	388	0	417	739
8:00 AM	55	20	0	75	24	13	0	37	6	108	0	114	226
8:15 AM	58	20	0	78	25	20	1	46	16	111	0	127	251
8:30 AM	98	20	0	118	26	35	0	61	28	138	0	166	345
8:45 AM	86	17	0	103	20	29	0	49	25	137	0	162	314
Total	297	77	0	374	95	97	1	193	75	494	0	569	1136
Grand Total	466	126	0	592	149	147	1	297	104	882	0	986	1875
Approach %	78.7	21.3	0.0		50.2	49.5	0.3		10.5	89.5	0.0		
Total %	24.9	6.7	0.0	31.6	7.9	7.8	0.1	15.8	5.5	47.0	0.0	52.6	
Exiting Leg Total				1031				231				613	1875
Cars	438	117	0	555	136	143	1	280	93	858	0	951	1786
% Cars	94.0	92.9	0.0	93.8	91.3	97.3	100.0	94.3	89.4	97.3	0.0	96.5	95.3
Exiting Leg Total				994				211				581	1786
Heavy Vehicles	28	9	0	37	13	4	0	17	11	24	0	35	89
% Heavy Vehicles	6.0	7.1	0.0	6.3	8.7	2.7	0.0	5.7	10.6	2.7	0.0	3.5	4.7
Exiting Leg Total				37				20				32	89

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
8:00 AM	55	20	0	75	24	13	0	37	6	108	0	114	226
8:15 AM	58	20	0	78	25	20	1	46	16	111	0	127	251
8:30 AM	98	20	0	118	26	35	0	61	28	138	0	166	345
8:45 AM	86	17	0	103	20	29	0	49	25	137	0	162	314
Total Volume	297	77	0	374	95	97	1	193	75	494	0	569	1136
% Approach Total	79.4	20.6	0.0		49.2	50.3	0.5		13.2	86.8	0.0		
PHF	0.758	0.963	0.000	0.792	0.913	0.693	0.250	0.791	0.670	0.895	0.000	0.857	0.823
Cars	280	75	0	355	89	95	1	185	70	487	0	557	1097
Cars %	94.3	97.4	0.0	94.9	93.7	97.9	100.0	95.9	93.3	98.6	0.0	97.9	96.6
Heavy Vehicles	17	2	0	19	6	2	0	8	5	7	0	12	39
Heavy Vehicles %	5.7	2.6	0.0	5.1	6.3	2.1	0.0	4.1	6.7	1.4	0.0	2.1	3.4
Cars Enter Leg	280	75	0	355	89	95	1	185	70	487	0	557	1097
Heavy Enter Leg	17	2	0	19	6	2	0	8	5	7	0	12	39
Total Entering Leg	297	77	0	374	95	97	1	193	75	494	0	569	1136
Cars Exiting Leg				576				146				375	1097
Heavy Exiting Leg				13				7				19	39
Total Exiting Leg				589				153				394	1136

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Cars**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	30	6	0	36	7	3	0	10	2	76	0	78	124
7:15 AM	43	14	0	57	11	9	0	20	8	88	0	96	173
7:30 AM	35	7	0	42	13	17	0	30	9	102	0	111	183
7:45 AM	50	15	0	65	16	19	0	35	4	105	0	109	209
Total	158	42	0	200	47	48	0	95	23	371	0	394	689
8:00 AM	52	19	0	71	22	12	0	34	6	107	0	113	218
8:15 AM	54	20	0	74	24	20	1	45	16	109	0	125	244
8:30 AM	95	19	0	114	24	35	0	59	28	138	0	166	339
8:45 AM	79	17	0	96	19	28	0	47	20	133	0	153	296
Total	280	75	0	355	89	95	1	185	70	487	0	557	1097
Grand Total	438	117	0	555	136	143	1	280	93	858	0	951	1786
Approach %	78.9	21.1	0.0		48.6	51.1	0.4		9.8	90.2	0.0		
Total %	24.5	6.6	0.0	31.1	7.6	8.0	0.1	15.7	5.2	48.0	0.0	53.2	
Exiting Leg Total				994				211				581	1786

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
8:00 AM	52	19	0	71	22	12	0	34	6	107	0	113	218
8:15 AM	54	20	0	74	24	20	1	45	16	109	0	125	244
8:30 AM	95	19	0	114	24	35	0	59	28	138	0	166	339
8:45 AM	79	17	0	96	19	28	0	47	20	133	0	153	296
Total Volume	280	75	0	355	89	95	1	185	70	487	0	557	1097
% Approach Total	78.9	21.1	0.0		48.1	51.4	0.5		12.6	87.4	0.0		
PHF	0.737	0.938	0.000	0.779	0.927	0.679	0.250	0.784	0.625	0.882	0.000	0.839	0.809
Entering Leg	280	75	0	355	89	95	1	185	70	487	0	557	1097
Exiting Leg				576				146				375	1097
Total				931				331				932	2194

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	1	5	0	6	6
7:15 AM	4	5	0	9	1	1	0	2	2	1	0	3	14
7:30 AM	5	0	0	5	2	0	0	2	1	4	0	5	12
7:45 AM	2	2	0	4	4	1	0	5	2	7	0	9	18
Total	11	7	0	18	7	2	0	9	6	17	0	23	50
8:00 AM	3	1	0	4	2	1	0	3	0	1	0	1	8
8:15 AM	4	0	0	4	1	0	0	1	0	2	0	2	7
8:30 AM	3	1	0	4	2	0	0	2	0	0	0	0	6
8:45 AM	7	0	0	7	1	1	0	2	5	4	0	9	18
Total	17	2	0	19	6	2	0	8	5	7	0	12	39
Grand Total	28	9	0	37	13	4	0	17	11	24	0	35	89
Approach %	75.7	24.3	0.0		76.5	23.5	0.0		31.4	68.6	0.0		
Total %	31.5	10.1	0.0	41.6	14.6	4.5	0.0	19.1	12.4	27.0	0.0	39.3	
Exiting Leg Total				37				20				32	89
Buses	5	3	0	8	3	0	0	3	0	1	0	1	12
% Buses	17.9	33.3	0.0	21.6	23.1	0.0	0.0	17.6	0.0	4.2	0.0	2.9	13.5
Exiting Leg Total				4				3				5	12
Single-Unit Trucks	17	4	0	21	7	3	0	10	6	17	0	23	54
% Single-Unit	60.7	44.4	0.0	56.8	53.8	75.0	0.0	58.8	54.5	70.8	0.0	65.7	60.7
Exiting Leg Total				24				10				20	54
Articulated Trucks	6	2	0	8	3	1	0	4	5	6	0	11	23
% Articulated	21.4	22.2	0.0	21.6	23.1	25.0	0.0	23.5	45.5	25.0	0.0	31.4	25.8
Exiting Leg Total				9				7				7	23

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:15 AM	4	5	0	9	1	1	0	2	2	1	0	3	14
7:30 AM	5	0	0	5	2	0	0	2	1	4	0	5	12
7:45 AM	2	2	0	4	4	1	0	5	2	7	0	9	18
8:00 AM	3	1	0	4	2	1	0	3	0	1	0	1	8
Total Volume	14	8	0	22	9	3	0	12	5	13	0	18	52
% Approach Total	63.6	36.4	0.0		75.0	25.0	0.0		27.8	72.2	0.0		
PHF	0.700	0.400	0.000	0.611	0.563	0.750	0.000	0.600	0.625	0.464	0.000	0.500	0.722
Buses	3	2	0	5	2	0	0	2	0	0	0	0	7
Buses %	21.4	25.0	0.0	22.7	22.2	0.0	0.0	16.7	0.0	0.0	0.0	0.0	13.5
Single-Unit Trucks	6	4	0	10	6	2	0	8	2	11	0	13	31
Single-Unit %	42.9	50.0	0.0	45.5	66.7	66.7	0.0	66.7	40.0	84.6	0.0	72.2	59.6
Articulated Trucks	5	2	0	7	1	1	0	2	3	2	0	5	14
Articulated %	35.7	25.0	0.0	31.8	11.1	33.3	0.0	16.7	60.0	15.4	0.0	27.8	26.9
Buses	3	2	0	5	2	0	0	2	0	0	0	0	7
Single-Unit Trucks	6	4	0	10	6	2	0	8	2	11	0	13	31
Articulated Trucks	5	2	0	7	1	1	0	2	3	2	0	5	14
Total Entering Leg	14	8	0	22	9	3	0	12	5	13	0	18	52
Buses				2				2				3	7
Single-Unit Trucks				17				6				8	31
Articulated Trucks				3				5				6	14
Total Exiting Leg				22				13				17	52

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Buses**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	1	0	1	1	0	0	1	0	0	0	0	2
7:30 AM	2	0	0	2	0	0	0	0	0	0	0	0	2
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	0	3	1	0	0	1	0	0	0	0	4
8:00 AM	1	1	0	2	1	0	0	1	0	0	0	0	3
8:15 AM	1	0	0	1	0	0	0	0	0	0	0	0	1
8:30 AM	0	1	0	1	1	0	0	1	0	0	0	0	2
8:45 AM	1	0	0	1	0	0	0	0	0	1	0	1	2
Total	3	2	0	5	2	0	0	2	0	1	0	1	8
Grand Total	5	3	0	8	3	0	0	3	0	1	0	1	12
Approach %	62.5	37.5	0.0		100.0	0.0	0.0		0.0	100.0	0.0		
Total %	41.7	25.0	0.0	66.7	25.0	0.0	0.0	25.0	0.0	8.3	0.0	8.3	
Exiting Leg Total				4				3				5	12

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
8:00 AM	1	1	0	2	1	0	0	1	0	0	0	0	3
8:15 AM	1	0	0	1	0	0	0	0	0	0	0	0	1
8:30 AM	0	1	0	1	1	0	0	1	0	0	0	0	2
8:45 AM	1	0	0	1	0	0	0	0	0	1	0	1	2
Total Volume	3	2	0	5	2	0	0	2	0	1	0	1	8
% Approach Total	60.0	40.0	0.0		100.0	0.0	0.0		0.0	100.0	0.0		
PHF	0.750	0.500	0.000	0.625	0.500	0.000	0.000	0.500	0.000	0.250	0.000	0.250	0.667
Entering Leg	3	2	0	5	2	0	0	2	0	1	0	1	8
Exiting Leg				3				2				3	8
Total				8				4				4	16

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Single-Unit Trucks**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	2	0	2	2
7:15 AM	0	2	0	2	0	1	0	1	2	1	0	3	6
7:30 AM	3	0	0	3	2	0	0	2	0	3	0	3	8
7:45 AM	2	2	0	4	4	0	0	4	0	6	0	6	14
Total	5	4	0	9	6	1	0	7	2	12	0	14	30
8:00 AM	1	0	0	1	0	1	0	1	0	1	0	1	3
8:15 AM	3	0	0	3	1	0	0	1	0	2	0	2	6
8:30 AM	2	0	0	2	0	0	0	0	0	0	0	0	2
8:45 AM	6	0	0	6	0	1	0	1	4	2	0	6	13
Total	12	0	0	12	1	2	0	3	4	5	0	9	24
Grand Total	17	4	0	21	7	3	0	10	6	17	0	23	54
Approach %	81.0	19.0	0.0		70.0	30.0	0.0		26.1	73.9	0.0		
Total %	31.5	7.4	0.0	38.9	13.0	5.6	0.0	18.5	11.1	31.5	0.0	42.6	
Exiting Leg Total				24				10				20	54

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:15 AM	0	2	0	2	0	1	0	1	2	1	0	3	6
7:30 AM	3	0	0	3	2	0	0	2	0	3	0	3	8
7:45 AM	2	2	0	4	4	0	0	4	0	6	0	6	14
8:00 AM	1	0	0	1	0	1	0	1	0	1	0	1	3
Total Volume	6	4	0	10	6	2	0	8	2	11	0	13	31
% Approach Total	60.0	40.0	0.0		75.0	25.0	0.0		15.4	84.6	0.0		
PHF	0.500	0.500	0.000	0.625	0.375	0.500	0.000	0.500	0.250	0.458	0.000	0.542	0.554
Entering Leg	6	4	0	10	6	2	0	8	2	11	0	13	31
Exiting Leg				17				6				8	31
Total				27				14				21	62

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Articulated Trucks**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	1	3	0	4	4
7:15 AM	4	2	0	6	0	0	0	0	0	0	0	0	6
7:30 AM	0	0	0	0	0	0	0	0	1	1	0	2	2
7:45 AM	0	0	0	0	0	1	0	1	2	1	0	3	4
Total	4	2	0	6	0	1	0	1	4	5	0	9	16
8:00 AM	1	0	0	1	1	0	0	1	0	0	0	0	2
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	1	0	0	1	1	0	0	1	0	0	0	0	2
8:45 AM	0	0	0	0	1	0	0	1	1	1	0	2	3
Total	2	0	0	2	3	0	0	3	1	1	0	2	7
Grand Total	6	2	0	8	3	1	0	4	5	6	0	11	23
Approach %	75.0	25.0	0.0		75.0	25.0	0.0		45.5	54.5	0.0		
Total %	26.1	8.7	0.0	34.8	13.0	4.3	0.0	17.4	21.7	26.1	0.0	47.8	
Exiting Leg Total				9				7				7	23

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	1	3	0	4	4
7:15 AM	4	2	0	6	0	0	0	0	0	0	0	0	6
7:30 AM	0	0	0	0	0	0	0	0	1	1	0	2	2
7:45 AM	0	0	0	0	0	1	0	1	2	1	0	3	4
Total Volume	4	2	0	6	0	1	0	1	4	5	0	9	16
% Approach Total	66.7	33.3	0.0		0.0	100.0	0.0		44.4	55.6	0.0		
PHF	0.250	0.250	0.000	0.250	0.000	0.250	0.000	0.250	0.500	0.417	0.000	0.563	0.667
Entering Leg	4	2	0	6	0	1	0	1	4	5	0	9	16
Exiting Leg				5				6				5	16
Total				11				7				14	32

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Bicycles (on Roadway and Crosswalks)**

	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
7:45 AM	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	1	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	2	3
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	3	3
Grand Total	1	0	0	0	0	1	0	0	0	0	0	0	1	4	0	0	0	5	6
Approach %	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		20.0	80.0	0.0	0.0	0.0		
Total %	16.7	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	16.7	66.7	0.0	0.0	0.0	83.3	
Exiting Leg Total						4						1						1	6

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
7:45 AM	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
Total Volume	1	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	4	5
% Approach Total	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0		
PHF	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.000	0.500	0.625
Entering Leg	1	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	4	5
Exiting Leg						4						0						1	5
Total						5						0						5	10

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Pedestrians

	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2
8:00 AM	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	3
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0	4
Grand Total	0	0	0	0	0	0	0	0	0	3	3	6	0	0	0	0	0	0	6
Approach %	0	0	0	0	0		0	0	0	50	50		0	0	0	0	0		
Total %	0	0	0	0	0	0	0	0	0	50	50	100	0	0	0	0	0	0	
Exiting Leg Total						0						6						0	6

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:45 AM	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	3
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
Total Volume	0	0	0	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0	4
% Approach Total	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	50.0	50.0		0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.333
Entering Leg	0	0	0	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0	4
Exiting Leg						0						4						0	4
Total						0						8						0	8

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Cars and Heavy Vehicles (Combined)**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	121	36	0	157	24	15	0	39	24	77	0	101	297
4:15 PM	131	29	0	160	25	7	0	32	21	88	0	109	301
4:30 PM	109	32	0	141	30	11	0	41	20	75	0	95	277
4:45 PM	103	25	0	128	27	14	0	41	24	73	0	97	266
Total	464	122	0	586	106	47	0	153	89	313	0	402	1141
5:00 PM	144	27	0	171	21	11	0	32	20	84	0	104	307
5:15 PM	125	16	0	141	21	11	0	32	20	55	0	75	248
5:30 PM	96	20	0	116	14	7	0	21	15	72	0	87	224
5:45 PM	87	14	0	101	18	14	0	32	17	59	0	76	209
Total	452	77	0	529	74	43	0	117	72	270	0	342	988
Grand Total	916	199	0	1115	180	90	0	270	161	583	0	744	2129
Approach %	82.2	17.8	0.0		66.7	33.3	0.0		21.6	78.4	0.0		
Total %	43.0	9.3	0.0	52.4	8.5	4.2	0.0	12.7	7.6	27.4	0.0	34.9	
Exiting Leg Total				763				360				1006	2129
Cars	907	191	0	1098	175	87	0	262	158	573	0	731	2091
% Cars	99.0	96.0	0.0	98.5	97.2	96.7	0.0	97.0	98.1	98.3	0.0	98.3	98.2
Exiting Leg Total				748				349				994	2091
Heavy Vehicles	9	8	0	17	5	3	0	8	3	10	0	13	38
% Heavy Vehicles	1.0	4.0	0.0	1.5	2.8	3.3	0.0	3.0	1.9	1.7	0.0	1.7	1.8
Exiting Leg Total				15				11				12	38

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:15 PM	131	29	0	160	25	7	0	32	21	88	0	109	301
4:30 PM	109	32	0	141	30	11	0	41	20	75	0	95	277
4:45 PM	103	25	0	128	27	14	0	41	24	73	0	97	266
5:00 PM	144	27	0	171	21	11	0	32	20	84	0	104	307
Total Volume	487	113	0	600	103	43	0	146	85	320	0	405	1151
% Approach Total	81.2	18.8	0.0		70.5	29.5	0.0		21.0	79.0	0.0		
PHF	0.845	0.883	0.000	0.877	0.858	0.768	0.000	0.890	0.885	0.909	0.000	0.929	0.937
Cars	482	109	0	591	101	41	0	142	83	314	0	397	1130
Cars %	99.0	96.5	0.0	98.5	98.1	95.3	0.0	97.3	97.6	98.1	0.0	98.0	98.2
Heavy Vehicles	5	4	0	9	2	2	0	4	2	6	0	8	21
Heavy Vehicles %	1.0	3.5	0.0	1.5	1.9	4.7	0.0	2.7	2.4	1.9	0.0	2.0	1.8
Cars Enter Leg	482	109	0	591	101	41	0	142	83	314	0	397	1130
Heavy Enter Leg	5	4	0	9	2	2	0	4	2	6	0	8	21
Total Entering Leg	487	113	0	600	103	43	0	146	85	320	0	405	1151
Cars Exiting Leg				415				192				523	1130
Heavy Exiting Leg				8				6				7	21
Total Exiting Leg				423				198				530	1151

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Cars**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	120	34	0	154	23	15	0	38	23	76	0	99	291
4:15 PM	129	28	0	157	25	7	0	32	21	86	0	107	296
4:30 PM	107	31	0	138	30	11	0	41	20	73	0	93	272
4:45 PM	102	24	0	126	26	13	0	39	22	72	0	94	259
Total	458	117	0	575	104	46	0	150	86	307	0	393	1118
5:00 PM	144	26	0	170	20	10	0	30	20	83	0	103	303
5:15 PM	124	16	0	140	21	11	0	32	20	53	0	73	245
5:30 PM	95	18	0	113	13	7	0	20	15	71	0	86	219
5:45 PM	86	14	0	100	17	13	0	30	17	59	0	76	206
Total	449	74	0	523	71	41	0	112	72	266	0	338	973
Grand Total	907	191	0	1098	175	87	0	262	158	573	0	731	2091
Approach %	82.6	17.4	0.0		66.8	33.2	0.0		21.6	78.4	0.0		
Total %	43.4	9.1	0.0	52.5	8.4	4.2	0.0	12.5	7.6	27.4	0.0	35.0	
Exiting Leg Total				748				349				994	2091

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:15 PM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:15 PM	129	28	0	157	25	7	0	32	21	86	0	107	296
4:30 PM	107	31	0	138	30	11	0	41	20	73	0	93	272
4:45 PM	102	24	0	126	26	13	0	39	22	72	0	94	259
5:00 PM	144	26	0	170	20	10	0	30	20	83	0	103	303
Total Volume	482	109	0	591	101	41	0	142	83	314	0	397	1130
% Approach Total	81.6	18.4	0.0		71.1	28.9	0.0		20.9	79.1	0.0		
PHF	0.837	0.879	0.000	0.869	0.842	0.788	0.000	0.866	0.943	0.913	0.000	0.928	0.932
Entering Leg	482	109	0	591	101	41	0	142	83	314	0	397	1130
Exiting Leg				415				192				523	1130
Total				1006				334				920	2260

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	1	2	0	3	1	0	0	1	1	1	0	2	6
4:15 PM	2	1	0	3	0	0	0	0	0	2	0	2	5
4:30 PM	2	1	0	3	0	0	0	0	0	2	0	2	5
4:45 PM	1	1	0	2	1	1	0	2	2	1	0	3	7
Total	6	5	0	11	2	1	0	3	3	6	0	9	23
5:00 PM	0	1	0	1	1	1	0	2	0	1	0	1	4
5:15 PM	1	0	0	1	0	0	0	0	0	2	0	2	3
5:30 PM	1	2	0	3	1	0	0	1	0	1	0	1	5
5:45 PM	1	0	0	1	1	1	0	2	0	0	0	0	3
Total	3	3	0	6	3	2	0	5	0	4	0	4	15
Grand Total	9	8	0	17	5	3	0	8	3	10	0	13	38
Approach %	52.9	47.1	0.0		62.5	37.5	0.0		23.1	76.9	0.0		
Total %	23.7	21.1	0.0	44.7	13.2	7.9	0.0	21.1	7.9	26.3	0.0	34.2	
Exiting Leg Total				15				11				12	38
Buses	0	3	0	3	3	0	0	3	0	1	0	1	7
% Buses	0.0	37.5	0.0	17.6	60.0	0.0	0.0	37.5	0.0	10.0	0.0	7.7	18.4
Exiting Leg Total				4				3				0	7
Single-Unit Trucks	8	2	0	10	2	1	0	3	3	5	0	8	21
% Single-Unit	88.9	25.0	0.0	58.8	40.0	33.3	0.0	37.5	100.0	50.0	0.0	61.5	55.3
Exiting Leg Total				7				5				9	21
Articulated Trucks	1	3	0	4	0	2	0	2	0	4	0	4	10
% Articulated	11.1	37.5	0.0	23.5	0.0	66.7	0.0	25.0	0.0	40.0	0.0	30.8	26.3
Exiting Leg Total				4				3				3	10

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	1	2	0	3	1	0	0	1	1	1	0	2	6
4:15 PM	2	1	0	3	0	0	0	0	0	2	0	2	5
4:30 PM	2	1	0	3	0	0	0	0	0	2	0	2	5
4:45 PM	1	1	0	2	1	1	0	2	2	1	0	3	7
Total Volume	6	5	0	11	2	1	0	3	3	6	0	9	23
% Approach Total	54.5	45.5	0.0		66.7	33.3	0.0		33.3	66.7	0.0		
PHF	0.750	0.625	0.000	0.917	0.500	0.250	0.000	0.375	0.375	0.750	0.000	0.750	0.821
Buses	0	1	0	1	1	0	0	1	0	1	0	1	3
Buses %	0.0	20.0	0.0	9.1	50.0	0.0	0.0	33.3	0.0	16.7	0.0	11.1	13.0
Single-Unit Trucks	6	1	0	7	1	0	0	1	3	3	0	6	14
Single-Unit %	100.0	20.0	0.0	63.6	50.0	0.0	0.0	33.3	100.0	50.0	0.0	66.7	60.9
Articulated Trucks	0	3	0	3	0	1	0	1	0	2	0	2	6
Articulated %	0.0	60.0	0.0	27.3	0.0	100.0	0.0	33.3	0.0	33.3	0.0	22.2	26.1
Buses	0	1	0	1	1	0	0	1	0	1	0	1	3
Single-Unit Trucks	6	1	0	7	1	0	0	1	3	3	0	6	14
Articulated Trucks	0	3	0	3	0	1	0	1	0	2	0	2	6
Total Entering Leg	6	5	0	11	2	1	0	3	3	6	0	9	23
Buses				2				1				0	3
Single-Unit Trucks				4				4				6	14
Articulated Trucks				2				3				1	6
Total Exiting Leg				8				8				7	23

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Buses**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	0	0	0	0	1	0	0	1	0	0	0	0	1
4:15 PM	0	1	0	1	0	0	0	0	0	0	0	0	1
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	1	0	1	1
Total	0	1	0	1	1	0	0	1	0	1	0	1	3
5:00 PM	0	1	0	1	1	0	0	1	0	0	0	0	2
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	1	0	1	1	0	0	1	0	0	0	0	2
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	2	0	2	2	0	0	2	0	0	0	0	4
Grand Total	0	3	0	3	3	0	0	3	0	1	0	1	7
Approach %	0.0	100.0	0.0		100.0	0.0	0.0		0.0	100.0	0.0		
Total %	0.0	42.9	0.0	42.9	42.9	0.0	0.0	42.9	0.0	14.3	0.0	14.3	
Exiting Leg Total				4				3				0	7

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:45 PM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:45 PM	0	0	0	0	0	0	0	0	0	1	0	1	1
5:00 PM	0	1	0	1	1	0	0	1	0	0	0	0	2
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	1	0	1	1	0	0	1	0	0	0	0	2
Total Volume	0	2	0	2	2	0	0	2	0	1	0	1	5
% Approach Total	0.0	100.0	0.0		100.0	0.0	0.0		0.0	100.0	0.0		
PHF	0.000	0.500	0.000	0.500	0.500	0.000	0.000	0.500	0.000	0.250	0.000	0.250	0.625
Entering Leg	0	2	0	2	2	0	0	2	0	1	0	1	5
Exiting Leg				3				2				0	5
Total				5				4				1	10

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Single-Unit Trucks**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	1	1	0	2	0	0	0	0	1	1	0	2	4
4:15 PM	2	0	0	2	0	0	0	0	0	0	0	0	2
4:30 PM	2	0	0	2	0	0	0	0	0	2	0	2	4
4:45 PM	1	0	0	1	1	0	0	1	2	0	0	2	4
Total	6	1	0	7	1	0	0	1	3	3	0	6	14
5:00 PM	0	0	0	0	0	1	0	1	0	1	0	1	2
5:15 PM	1	0	0	1	0	0	0	0	0	0	0	0	1
5:30 PM	1	1	0	2	0	0	0	0	0	1	0	1	3
5:45 PM	0	0	0	0	1	0	0	1	0	0	0	0	1
Total	2	1	0	3	1	1	0	2	0	2	0	2	7
Grand Total	8	2	0	10	2	1	0	3	3	5	0	8	21
Approach %	80.0	20.0	0.0		66.7	33.3	0.0		37.5	62.5	0.0		
Total %	38.1	9.5	0.0	47.6	9.5	4.8	0.0	14.3	14.3	23.8	0.0	38.1	
Exiting Leg Total				7				5				9	21

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	1	1	0	2	0	0	0	0	1	1	0	2	4
4:15 PM	2	0	0	2	0	0	0	0	0	0	0	0	2
4:30 PM	2	0	0	2	0	0	0	0	0	2	0	2	4
4:45 PM	1	0	0	1	1	0	0	1	2	0	0	2	4
Total Volume	6	1	0	7	1	0	0	1	3	3	0	6	14
% Approach Total	85.7	14.3	0.0		100.0	0.0	0.0		50.0	50.0	0.0		
PHF	0.750	0.250	0.000	0.875	0.250	0.000	0.000	0.250	0.375	0.375	0.000	0.750	0.875
Entering Leg	6	1	0	7	1	0	0	1	3	3	0	6	14
Exiting Leg				4				4				6	14
Total				11				5				12	28

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Articulated Trucks**

	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	0	1	0	1	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	0	0	0	2	0	2	2
4:30 PM	0	1	0	1	0	0	0	0	0	0	0	0	1
4:45 PM	0	1	0	1	0	1	0	1	0	0	0	0	2
Total	0	3	0	3	0	1	0	1	0	2	0	2	6
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	2	0	2	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	1	0	0	1	0	1	0	1	0	0	0	0	2
Total	1	0	0	1	0	1	0	1	0	2	0	2	4
Grand Total	1	3	0	4	0	2	0	2	0	4	0	4	10
Approach %	25.0	75.0	0.0		0.0	100.0	0.0		0.0	100.0	0.0		
Total %	10.0	30.0	0.0	40.0	0.0	20.0	0.0	20.0	0.0	40.0	0.0	40.0	
Exiting Leg Total				4				3				3	10

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Central Street from North				Webster Street from East				Central Street from South				
	Thru	Left	U-Turn	Total	Right	Left	U-Turn	Total	Right	Thru	U-Turn	Total	Total
4:00 PM	0	1	0	1	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	0	0	0	2	0	2	2
4:30 PM	0	1	0	1	0	0	0	0	0	0	0	0	1
4:45 PM	0	1	0	1	0	1	0	1	0	0	0	0	2
Total Volume	0	3	0	3	0	1	0	1	0	2	0	2	6
% Approach Total	0.0	100.0	0.0		0.0	100.0	0.0		0.0	100.0	0.0		
PHF	0.000	0.750	0.000	0.750	0.000	0.250	0.000	0.250	0.000	0.250	0.000	0.250	0.750
Entering Leg	0	3	0	3	0	1	0	1	0	2	0	2	6
Exiting Leg				2				3				1	6
Total				5				4				3	12

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Bicycles (on Roadway and Crosswalks)**

	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
4:15 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
4:30 PM	1	0	0	0	0	1	1	0	0	0	1	2	0	0	0	0	0	0	3
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	1	1	0	0	0	2	3	0	1	0	0	0	1	5
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
5:30 PM	9	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	9
5:45 PM	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	12	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	12
Grand Total	13	0	0	0	0	13	1	0	0	0	2	3	0	1	0	0	0	1	17
Approach %	100.0	0.0	0.0	0.0	0.0		33.3	0.0	0.0	0.0	66.7		0.0	100.0	0.0	0.0	0.0		
Total %	76.5	0.0	0.0	0.0	0.0	76.5	5.9	0.0	0.0	0.0	11.8	17.6	0.0	5.9	0.0	0.0	0.0	5.9	
Exiting Leg Total						2						2						13	17

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

5:00 PM	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
5:30 PM	9	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	9
5:45 PM	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Total Volume	12	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	12
% Approach Total	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		
PHF	0.333	0.000	0.000	0.000	0.000	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333
Entering Leg	12	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	12
Exiting Leg						0						0						12	12
Total						12						0						12	24

PDI File #: **218064 B**
Location: **N: Central Street S: Central Street**
Location: **E: Webster Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Pedestrians**

	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
4:00 PM	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	1	0	0	0	1	1	2	0	0	0	0	0	0	3
5:00 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2
Grand Total	0	0	0	0	1	1	0	0	0	1	3	4	0	0	0	0	0	0	5
Approach %	0	0	0	0	100		0	0	0	25	75		0	0	0	0	0		
Total %	0	0	0	0	20	20	0	0	0	20	60	80	0	0	0	0	0	0	
Exiting Leg Total						1						4						0	5

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Central Street from North						Webster Street from East						Central Street from South						
	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	U-Turn	CW-WB	CW-EB	Total	Total
4:00 PM	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	1	1	0	0	0	1	1	2	0	0	0	0	0	0	3
% Approach Total	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	50.0	50.0		0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.375
Entering Leg	0	0	0	0	1	1	0	0	0	1	1	2	0	0	0	0	0	0	3
Exiting Leg						1						2						0	3
Total						2						4						0	6

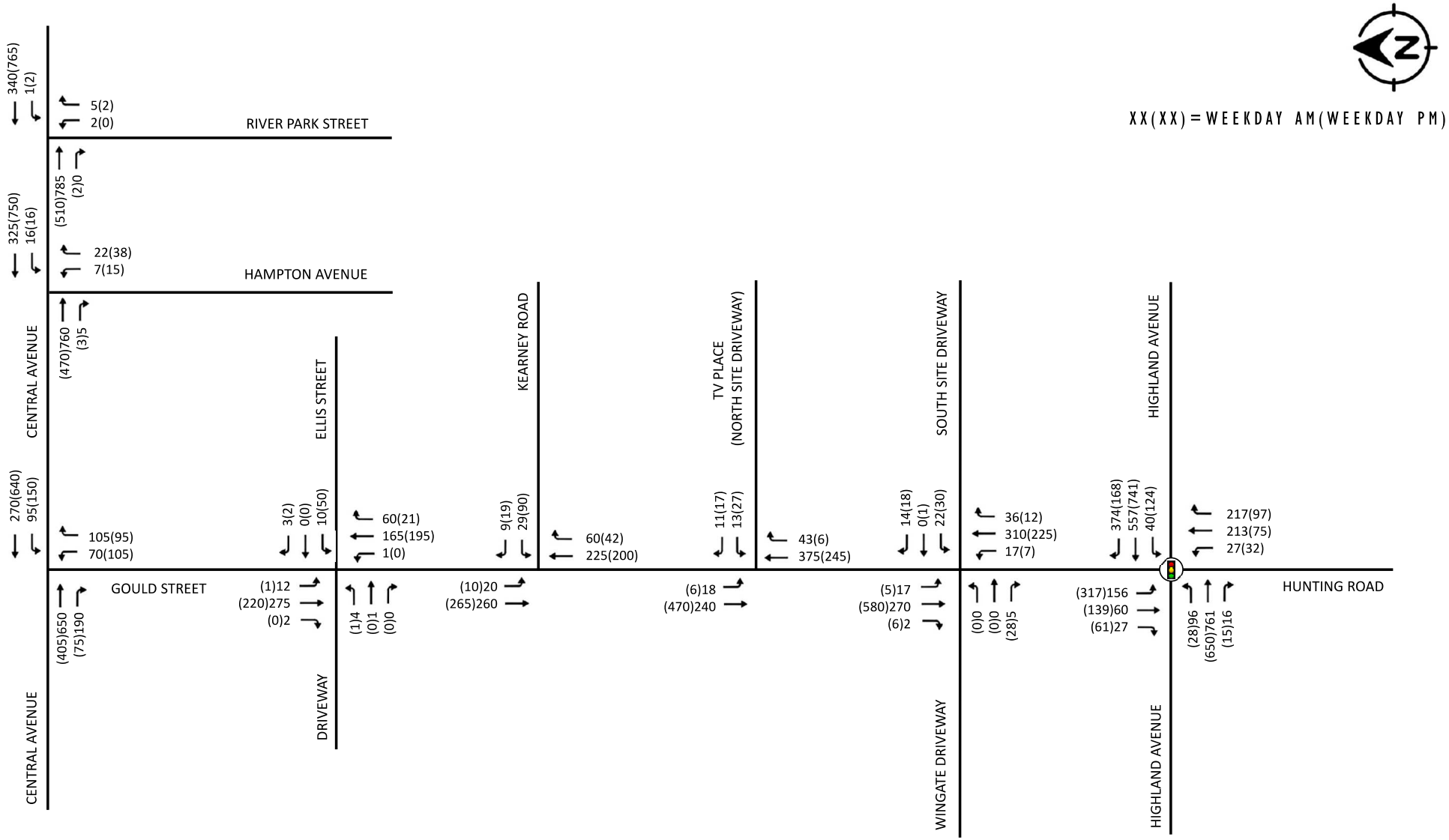
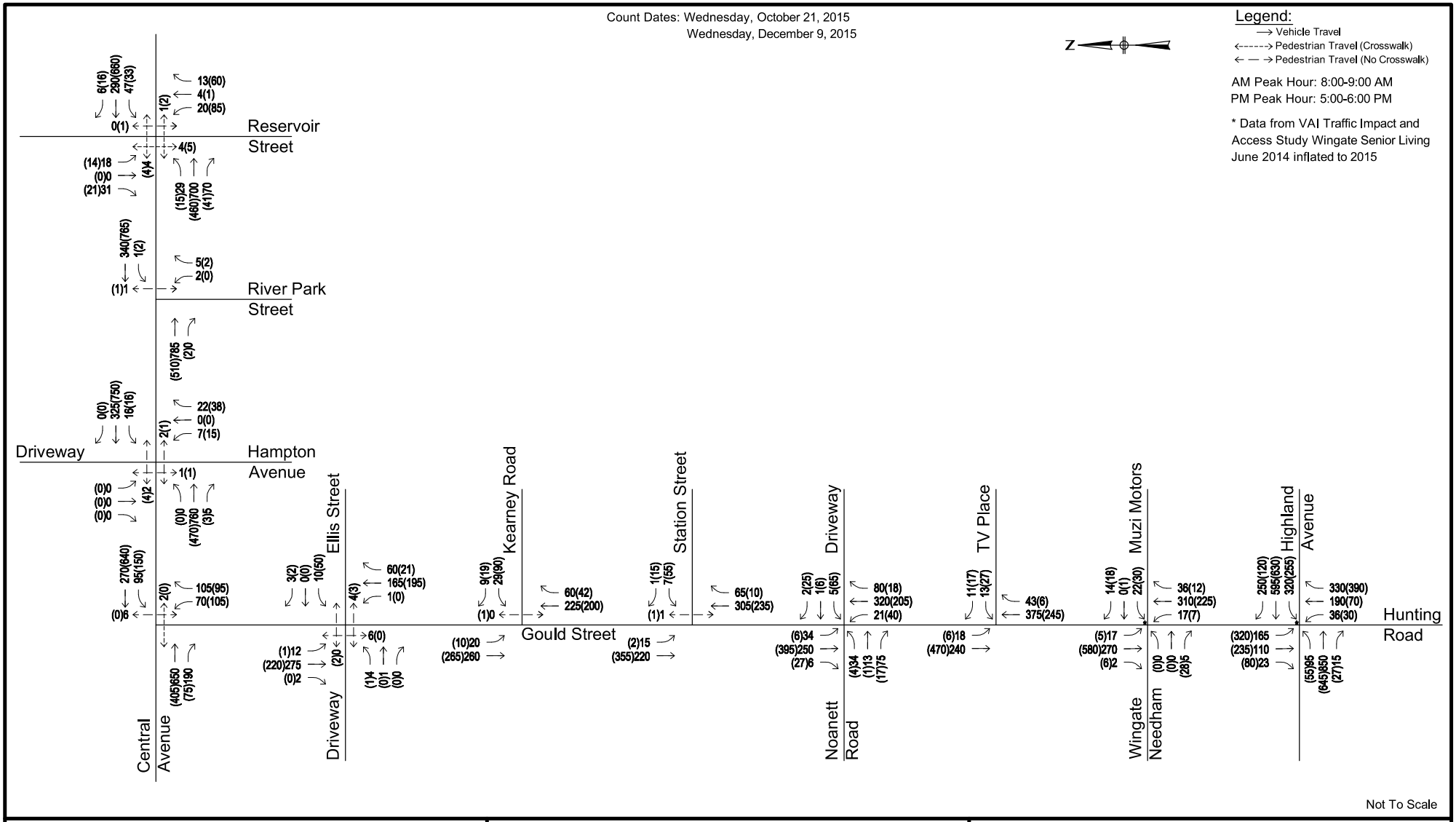


FIGURE 2

2020 EXISTING TRAFFIC VOLUMES



BETA
www.BETA-Inc.com

TRAFFIC IMPACT STUDY GOULD AND RESERVOIR INDUSTRIAL DISTRICT
Needham, MA

Figure 2
Study Area Intersection
AM(PM) Peak Hour Volumes
2015 Existing

0:\5100s\5178 - Needham - Gould St Traffic\Drawing Files\Miscellaneous\5178 TMC.dwg Dec 18,2015 8:32am

McMAHON
TRANSPORTATION ENGINEERS & PLANNERS
120 Water Street, 4th Floor
Boston, MA 02109
p. 617-556-0020

N/S: Highland Avenue
E/W: West Street
City, State: Needham, MA
Client: LCB Senior Living

File Name : Highland at West AM
Site Code : 12052019
Start Date : 12/5/2019
Page No : 1

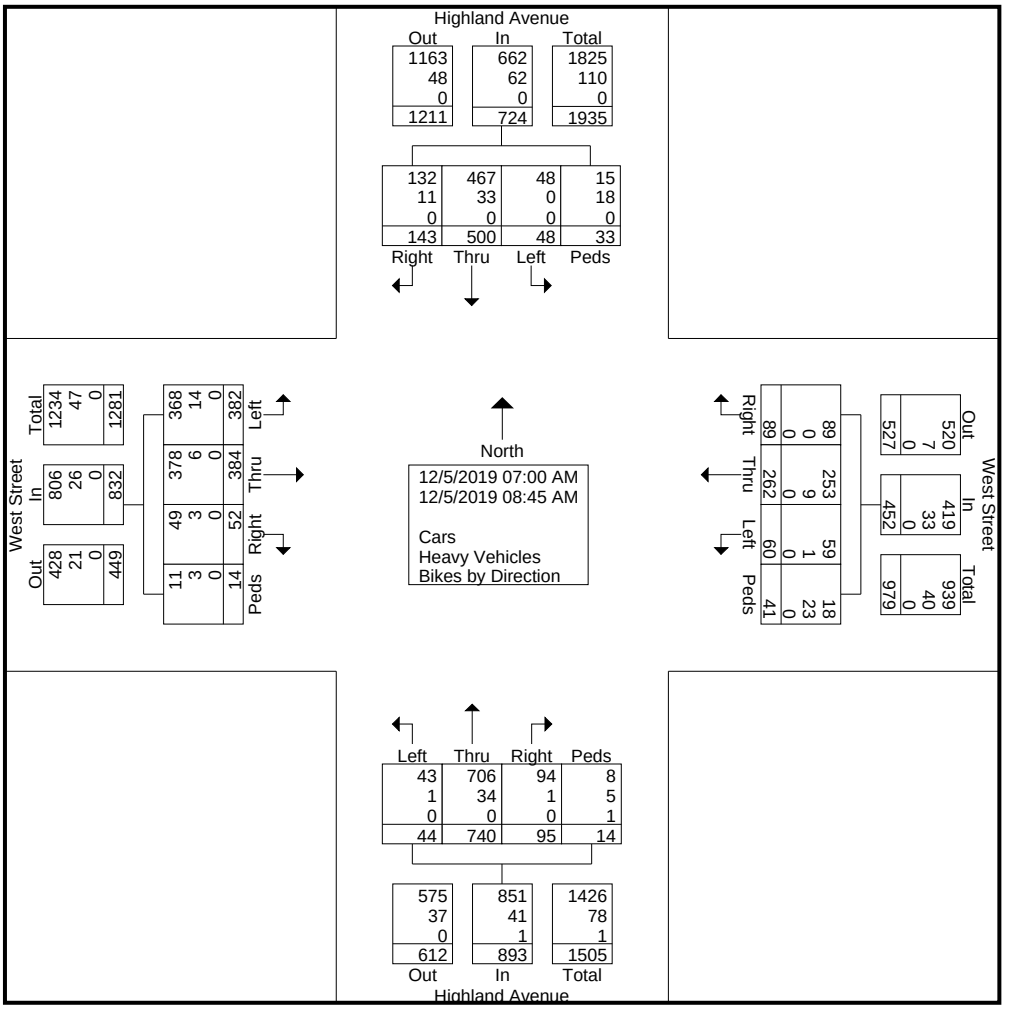
Groups Printed- Cars - Heavy Vehicles - Bikes by Direction

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	14	44	7	3	68	6	15	3	0	24	3	64	3	3	73	5	39	49	1	94	259
07:15 AM	9	75	3	12	99	11	15	6	1	33	8	81	2	1	92	8	48	54	3	113	337
07:30 AM	16	71	5	1	93	8	22	11	8	49	17	87	5	1	110	5	53	48	1	107	359
07:45 AM	21	55	4	3	83	14	36	9	10	69	10	122	8	5	145	8	52	42	5	107	404
Total	60	245	19	19	343	39	88	29	19	175	38	354	18	10	420	26	192	193	10	421	1359
08:00 AM	27	66	3	4	100	8	52	13	10	83	11	117	7	1	136	5	46	46	1	98	417
08:15 AM	21	65	6	5	97	18	37	4	6	65	19	85	5	0	109	8	52	46	1	107	378
08:30 AM	17	69	10	4	100	11	43	9	3	66	12	89	8	3	112	7	46	55	2	110	388
08:45 AM	18	55	10	1	84	13	42	5	3	63	15	95	6	0	116	6	48	42	0	96	359
Total	83	255	29	14	381	50	174	31	22	277	57	386	26	4	473	26	192	189	4	411	1542
Grand Total	143	500	48	33	724	89	262	60	41	452	95	740	44	14	893	52	384	382	14	832	2901
Apprch %	19.8	69.1	6.6	4.6		19.7	58	13.3	9.1		10.6	82.9	4.9	1.6		6.2	46.2	45.9	1.7		
Total %	4.9	17.2	1.7	1.1	25	3.1	9	2.1	1.4	15.6	3.3	25.5	1.5	0.5	30.8	1.8	13.2	13.2	0.5	28.7	
Cars	132	467	48	15	662	89	253	59	18	419	94	706	43	8	851	49	378	368	11	806	2738
% Cars	92.3	93.4	100	45.5	91.4	100	96.6	98.3	43.9	92.7	98.9	95.4	97.7	57.1	95.3	94.2	98.4	96.3	78.6	96.9	94.4
Heavy Vehicles																					
% Heavy Vehicles	7.7	6.6	0	54.5	8.6	0	3.4	1.7	56.1	7.3	1.1	4.6	2.3	35.7	4.6	5.8	1.6	3.7	21.4	3.1	5.6
Bikes by Direction	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
% Bikes by Direction	0	0	0	0	0	0	0	0	0	0	0	0	0	7.1	0.1	0	0	0	0	0	0

120 Water Street, 4th Floor
Boston, MA 02109
p. 617-556-0020

N/S: Highland Avenue
E/W: West Street
City, State: Needham, MA
Client: LCB Senior Living

File Name : Highland at West AM
Site Code : 12052019
Start Date : 12/5/2019
Page No : 2



	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:45 AM																					
07:45 AM	21	55	4	3	83	14	36	9	**10**	69	10	**122**	**8**	**5**	**145**	**8**	**52**	42	**5**		
08:00 AM	**27**	**66**	**3**	**4**	**100**	8	**52**	**13**	**10**	**83**	11	117	7	1	136	5	46	46	1	98	**417**
08:15 AM	21	65	6	**5**		**18**	37	4	6	65	**19**										
08:30 AM	**17**	**69**	**10**	**4**	**100**	**11**	**43**	**9**	**3**	**66**	**12**	**89**	**8**	**3**	**112**	**7**	**46**	**55**	**2**	**110**	388
Total Volume	86	255	23	16	380	51	168	35	29	283	52	413	28	9	502	28	196	189	9	422	1587
% App. Total	22.6	67.1	6.1	4.2		18	59.4	12.4	10.2		10.4	82.3	5.6	1.8		6.6	46.4	44.8	2.1		
PHF	.796	.924	.575	.800	.950	.708	.808	.673	.725	.852	.684	.846	.875	.450	.866	.875	.942	.859	.450	.959	.951

McMAHON TRANSPORTATION ENGINEERS & PLANNERS
120 Water Street, 4th Floor
Boston, MA 02109
p. 617-556-0020

N/S: Highland Avenue
E/W: West Street
City, State: Needham, MA
Client: LCB Senior Living

File Name : Highland at West AM
Site Code : 12052019
Start Date : 12/5/2019
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Groups Printed- Cars

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	12	40	7	2	61	6	12	3	0	21	3	59	3	1	66	3	39	45	1	88	236
07:15 AM	7	70	3	6	86	11	13	6	0	30	8	74	2	1	85	8	48	53	3	112	313
07:30 AM	15	64	5	0	84	8	22	10	3	43	16	85	5	0	106	5	53	47	0	105	338
07:45 AM	19	55	4	2	80	14	36	9	3	62	10	118	8	3	139	8	49	42	4	103	384
Total	53	229	19	10	311	39	83	28	6	156	37	336	18	5	396	24	189	187	8	408	1271
08:00 AM	26	63	3	2	94	8	51	13	5	77	11	113	6	1	131	4	45	45	1	95	397
08:15 AM	19	62	6	2	89	18	37	4	4	63	19	81	5	0	105	8	51	43	0	102	359
08:30 AM	17	64	10	0	91	11	42	9	1	63	12	84	8	2	106	7	45	51	2	105	365
08:45 AM	17	49	10	1	77	13	40	5	2	60	15	92	6	0	113	6	48	42	0	96	346
Total	79	238	29	5	351	50	170	31	12	263	57	370	25	3	455	25	189	181	3	398	1467
Grand Total	132	467	48	15	662	89	253	59	18	419	94	706	43	8	851	49	378	368	11	806	2738
Apprch %	19.9	70.5	7.3	2.3		21.2	60.4	14.1	4.3		11	83	5.1	0.9		6.1	46.9	45.7	1.4		
Total %	4.8	17.1	1.8	0.5	24.2	3.3	9.2	2.2	0.7	15.3	3.4	25.8	1.6	0.3	31.1	1.8	13.8	13.4	0.4	29.4	

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:45 AM																					
07:45 AM	19	55	4	**2**								**118**	**8**	**3**	**139**	**8**			**4**		
08:00 AM	**26**	**63**	**3**	**2**	**94**	8	**51**	**13**	**5**	**77**	11	113	6	1	131	4	45	45	1	95	**397**
08:15 AM	19	62	6	2	89	**18**	37	4	4	63	**19**						**51**	43	0	102	359
08:30 AM	17	**64**	**10**															**51**		**105**	365
Total Volume	81	244	23	6	354	51	166	35	13	265	52	396	27	6	481	27	190	181	7	405	1505
% App. Total	22.9	68.9	6.5	1.7		19.2	62.6	13.2	4.9		10.8	82.3	5.6	1.2		6.7	46.9	44.7	1.7		
PHF	.779	.953	.575	.750	.941	.708	.814	.673	.650	.860	.684	.839	.844	.500	.865	.844	.931	.887	.438	.964	.948

120 Water Street, 4th Floor
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p. 617-556-0020

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Site Code : 12052019
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Groups Printed- Heavy Vehicles

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	2	4	0	1	7	0	3	0	0	3	0	5	0	2	7	2	0	4	0	6	23
07:15 AM	2	5	0	6	13	0	2	0	1	3	0	7	0	0	7	0	0	1	0	1	24
07:30 AM	1	7	0	1	9	0	0	1	5	6	1	2	0	1	4	0	0	1	1	2	21
07:45 AM	2	0	0	1	3	0	0	0	7	7	0	4	0	1	5	0	3	0	1	4	19
Total	7	16	0	9	32	0	5	1	13	19	1	18	0	4	23	2	3	6	2	13	87
08:00 AM	1	3	0	2	6	0	1	0	5	6	0	4	1	0	5	1	1	1	0	3	20
08:15 AM	2	3	0	3	8	0	0	0	2	2	0	4	0	0	4	0	1	3	1	5	19
08:30 AM	0	5	0	4	9	0	1	0	2	3	0	5	0	1	6	0	1	4	0	5	23
08:45 AM	1	6	0	0	7	0	2	0	1	3	0	3	0	0	3	0	0	0	0	0	13
Total	4	17	0	9	30	0	4	0	10	14	0	16	1	1	18	1	3	8	1	13	75
Grand Total	11	33	0	18	62	0	9	1	23	33	1	34	1	5	41	3	6	14	3	26	162
Apprch %	17.7	53.2	0	29		0	27.3	3	69.7		2.4	82.9	2.4	12.2		11.5	23.1	53.8	11.5		
Total %	6.8	20.4	0	11.1	38.3	0	5.6	0.6	14.2	20.4	0.6	21	0.6	3.1	25.3	1.9	3.7	8.6	1.9	16	

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	**2**						**3**							**2**	**7**	**2**		**4**		**6**	23
07:15 AM	2	5	0	**6**	**13**	0	2	0	1	3	0	**7**									**24**
07:30 AM	1	**7**	0	1	9	0	0	**1**			**1**								**1**		
07:45 AM	**2**	**0**	**0**	**1**	**3**	**0**	**0**	**0**	**7**	**7**	0	4	0	1	5	0	**3**	0	1	4	19
Total Volume	7	16	0	9	32	0	5	1	13	19	1	18	0	4	23	2	3	6	2	13	87
% App. Total	21.9	50	0	28.1		0	26.3	5.3	68.4		4.3	78.3	0	17.4		15.4	23.1	46.2	15.4		
PHF	.875	.571	.000	.375	.615	.000	.417	.250	.464	.679	.250	.643	.000	.500	.821	.250	.250	.375	.500	.542	.906

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Site Code : 12052019
Start Date : 12/5/2019
Page No : 1

Groups Printed- Bikes by Direction

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
Apprch %	0	0	0	0		0	0	0	0		0	0	0	100		0	0	0	0		
Total %	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	0	0	0	0	0	

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0	0	**1**
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
% App. Total	0	0	0	0		0	0	0	0		0	0	0	100		0	0	0	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.250	.250	.000	.000	.000	.000	.000	.250

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N/S: Highland Avenue
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Client: LCB Senior Living

File Name : Highland at West PM
Site Code : 12042019
Start Date : 12/4/2019
Page No : 1

Groups Printed- Cars - Heavy Vehicles - Bikes by Direction

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	11	84	10	1	106	14	38	10	3	65	16	90	2	7	115	11	50	43	4	108	394
04:15 PM	15	105	12	5	137	11	30	14	12	67	13	61	9	6	89	7	37	42	3	89	382
04:30 PM	13	101	5	3	122	12	34	16	21	83	9	101	6	6	122	5	53	36	0	94	421
04:45 PM	12	118	2	2	134	15	26	11	7	59	20	84	4	1	109	12	57	43	1	113	415
Total	51	408	29	11	499	52	128	51	43	274	58	336	21	20	435	35	197	164	8	404	1612
05:00 PM	16	113	14	1	144	13	39	22	5	79	11	71	9	0	91	12	62	43	1	118	432
05:15 PM	30	106	9	1	146	14	40	12	3	69	7	89	4	1	101	16	36	32	2	86	402
05:30 PM	8	116	8	1	133	14	33	8	3	58	10	70	7	0	87	15	38	30	0	83	361
05:45 PM	20	98	13	8	139	14	31	18	13	76	8	80	2	2	92	9	52	28	2	91	398
Total	74	433	44	11	562	55	143	60	24	282	36	310	22	3	371	52	188	133	5	378	1593
Grand Total	125	841	73	22	1061	107	271	111	67	556	94	646	43	23	806	87	385	297	13	782	3205
Apprch %	11.8	79.3	6.9	2.1		19.2	48.7	20	12.1		11.7	80.1	5.3	2.9		11.1	49.2	38	1.7		
Total %	3.9	26.2	2.3	0.7	33.1	3.3	8.5	3.5	2.1	17.3	2.9	20.2	1.3	0.7	25.1	2.7	12	9.3	0.4	24.4	
Cars	118	823	73	17	1031	105	265	110	44	524	94	637	41	15	787	86	384	291	8	769	3111
% Cars	94.4	97.9	100	77.3	97.2	98.1	97.8	99.1	65.7	94.2	100	98.6	95.3	65.2	97.6	98.9	99.7	98	61.5	98.3	97.1
Heavy Vehicles																					
% Heavy Vehicles	5.6	2.1	0	22.7	2.8	1.9	2.2	0.9	34.3	5.8	0	1.4	4.7	34.8	2.4	1.1	0.3	2	38.5	1.7	2.9
Bikes by Direction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bikes by Direction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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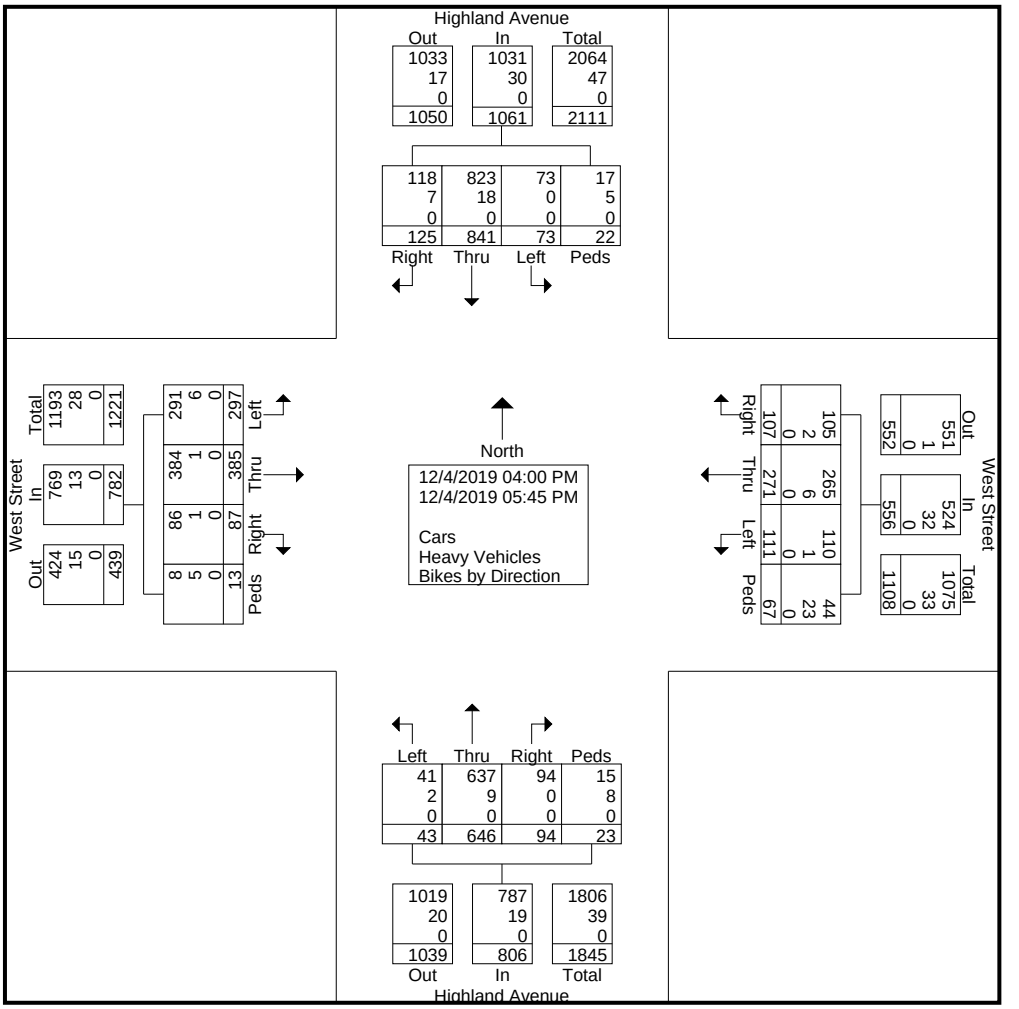

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	13	101	5	**3**					**21**	**83**	9	**101**		**6**	**122**	5	53	36	0	94	421
04:45 PM	12	**118**	2	2	134	**15**	26	11	7	59	**20**							**43**			
05:00 PM	**16**	**113**	**14**	**1**	**144**	**13**	**39**	**22**	**5**	**79**	**11**	**71**	**9**	0	91	12	**62**	43	1	**118**	**432**
05:15 PM	**30**				**146**	14	**40**									**16**			**2**		
Total Volume	71	438	30	7	546	54	139	61	36	290	47	345	23	8	423	45	208	154	4	411	1670
% App. Total	13	80.2	5.5	1.3		18.6	47.9	21	12.4		11.1	81.6	5.4	1.9		10.9	50.6	37.5	1		
PHF	.592	.928	.536	.583	.935	.900	.869	.693	.429	.873	.588	.854	.639	.333	.867	.703	.839	.895	.500	.871	.966

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Groups Printed- Cars

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	11	82	10	1	104	14	37	10	1	62	16	89	2	4	111	11	50	41	3	105	382
04:15 PM	13	104	12	4	133	10	30	13	6	59	13	60	9	5	87	7	36	42	3	88	367
04:30 PM	11	98	5	1	115	12	32	16	11	71	9	97	5	5	116	5	53	34	0	92	394
04:45 PM	11	117	2	2	132	15	25	11	6	57	20	83	3	1	107	12	57	43	1	113	409
Total	46	401	29	8	484	51	124	50	24	249	58	329	19	15	421	35	196	160	7	398	1552
05:00 PM	16	108	14	0	138	13	39	22	4	78	11	71	9	0	91	12	62	41	0	115	422
05:15 PM	29	103	9	1	142	13	40	12	3	68	7	89	4	0	100	16	36	32	1	85	395
05:30 PM	8	116	8	0	132	14	31	8	2	55	10	68	7	0	85	14	38	30	0	82	354
05:45 PM	19	95	13	8	135	14	31	18	11	74	8	80	2	0	90	9	52	28	0	89	388
Total	72	422	44	9	547	54	141	60	20	275	36	308	22	0	366	51	188	131	1	371	1559
Grand Total	118	823	73	17	1031	105	265	110	44	524	94	637	41	15	787	86	384	291	8	769	3111
Apprch %	11.4	79.8	7.1	1.6		20	50.6	21	8.4		11.9	80.9	5.2	1.9		11.2	49.9	37.8	1		
Total %	3.8	26.5	2.3	0.5	33.1	3.4	8.5	3.5	1.4	16.8	3	20.5	1.3	0.5	25.3	2.8	12.3	9.4	0.3	24.7	

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	11	98	5	1	115	12	32	16	**11**	71	9	**97**		**5**	**116**	5	53	34	0	92	394
04:45 PM	11	**117**	2	**2**		**15**	25	11	6	57	**20**							**43**	**1**		
05:00 PM	**16**	**108**	**14**	**0**	**138**	**13**	**39**	**22**	**4**	**78**	11	71	**9**	0	91	12	**62**	41	0	**115**	**422**
05:15 PM	**29**				**142**	13	**40**									**16**					
Total Volume	67	426	30	4	527	53	136	61	24	274	47	340	21	6	414	45	208	150	2	405	1620
% App. Total	12.7	80.8	5.7	0.8		19.3	49.6	22.3	8.8		11.4	82.1	5.1	1.4		11.1	51.4	37	0.5		
PHF	.578	.910	.536	.500	.928	.883	.850	.693	.545	.878	.588	.876	.583	.300	.892	.703	.839	.872	.500	.880	.960

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TRANSPORTATION ENGINEERS & PLANNERS
120 Water Street, 4th Floor
Boston, MA 02109
p. 617-556-0020

N/S: Highland Avenue
E/W: West Street
City, State: Needham, MA
Client: LCB Senior Living

File Name : Highland at West PM
Site Code : 12042019
Start Date : 12/4/2019
Page No : 1

Groups Printed- Heavy Vehicles

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	0	2	0	0	2	0	1	0	2	3	0	1	0	3	4	0	0	2	1	3	12
04:15 PM	2	1	0	1	4	1	0	1	6	8	0	1	0	1	2	0	1	0	0	1	15
04:30 PM	2	3	0	2	7	0	2	0	10	12	0	4	1	1	6	0	0	2	0	2	27
04:45 PM	1	1	0	0	2	0	1	0	1	2	0	1	1	0	2	0	0	0	0	0	6
Total	5	7	0	3	15	1	4	1	19	25	0	7	2	5	14	0	1	4	1	6	60
05:00 PM	0	5	0	1	6	0	0	0	1	1	0	0	0	0	0	0	0	2	1	3	10
05:15 PM	1	3	0	0	4	1	0	0	0	1	0	0	0	1	1	0	0	0	1	1	7
05:30 PM	0	0	0	1	1	0	2	0	1	3	0	2	0	0	2	1	0	0	0	1	7
05:45 PM	1	3	0	0	4	0	0	0	2	2	0	0	0	2	2	0	0	0	2	2	10
Total	2	11	0	2	15	1	2	0	4	7	0	2	0	3	5	1	0	2	4	7	34
Grand Total	7	18	0	5	30	2	6	1	23	32	0	9	2	8	19	1	1	6	5	13	94
Apprch %	23.3	60	0	16.7		6.2	18.8	3.1	71.9		0	47.4	10.5	42.1		7.7	7.7	46.2	38.5		
Total %	7.4	19.1	0	5.3	31.9	2.1	6.4	1.1	24.5	34	0	9.6	2.1	8.5	20.2	1.1	1.1	6.4	5.3	13.8	

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	2	0	0	2	0	1	0	2	3	0	1	0	**3**				**2**	**1**	**3**	12
04:15 PM	**2**					**1**	0	**1**									**1**	0	0	1	15
04:30 PM	2	**3**	0	**2**	**7**	0	**2**		**10**	**12**	0	**4**	**1**	1	**6**	0	0	2	0	2	**27**
04:45 PM	1	1	0	0	2	0	1	0	1	2	0	1	1	0	2	0	0	0	0	0	6
Total Volume	5	7	0	3	15	1	4	1	19	25	0	7	2	5	14	0	1	4	1	6	60
% App. Total	33.3	46.7	0	20		4	16	4	76		0	50	14.3	35.7		0	16.7	66.7	16.7		
PHF	.625	.583	.000	.375	.536	.250	.500	.250	.475	.521	.000	.438	.500	.417	.583	.000	.250	.500	.250	.500	.556

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N/S: Highland Avenue
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File Name : Highland at West PM
Site Code : 12042019
Start Date : 12/4/2019
Page No : 1

Groups Printed- Bikes by Direction

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apprch %	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0		
Total %																					

	Highland Avenue From North					West Street From East					Highland Avenue From South					West Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% App. Total	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Cars and Heavy Vehicles (Combined)

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	8	56	2	0	66	2	2	1	0	5	0	46	0	0	46	7	1	10	0	18	135
7:15 AM	12	78	4	0	94	5	4	0	0	9	1	63	8	0	72	17	8	8	0	33	208
7:30 AM	10	100	2	0	112	9	2	2	0	13	0	90	9	0	99	8	7	7	0	22	246
7:45 AM	16	105	1	0	122	4	12	0	0	16	1	79	12	0	92	18	8	5	0	31	261
Total	46	339	9	0	394	20	20	3	0	43	2	278	29	0	309	50	24	30	0	104	850
8:00 AM	19	112	3	0	134	7	8	0	0	15	4	83	14	0	101	18	10	7	0	35	285
8:15 AM	15	109	2	0	126	3	14	2	0	19	4	84	17	0	105	5	19	10	0	34	284
8:30 AM	14	119	3	0	136	0	13	1	0	14	10	84	9	0	103	25	13	12	0	50	303
8:45 AM	14	118	3	0	135	6	15	2	0	23	7	109	14	0	130	17	12	6	0	35	323
Total	62	458	11	0	531	16	50	5	0	71	25	360	54	0	439	65	54	35	0	154	1195
Grand Total	108	797	20	0	925	36	70	8	0	114	27	638	83	0	748	115	78	65	0	258	2045
Approach %	11.7	86.2	2.2	0.0		31.6	61.4	7.0	0.0		3.6	85.3	11.1	0.0		44.6	30.2	25.2	0.0		
Total %	5.3	39.0	1.0	0.0	45.2	1.8	3.4	0.4	0.0	5.6	1.3	31.2	4.1	0.0	36.6	5.6	3.8	3.2	0.0	12.6	
Exiting Leg Total					739					125					920					261	2045
Cars	102	756	20	0	878	31	67	8	0	106	27	606	76	0	709	107	74	58	0	239	1932
% Cars	94.4	94.9	100.0	0.0	94.9	86.1	95.7	100.0	0.0	93.0	100.0	95.0	91.6	0.0	94.8	93.0	94.9	89.2	0.0	92.6	94.5
Exiting Leg Total					695					121					871					245	1932
Heavy Vehicles	6	41	0	0	47	5	3	0	0	8	0	32	7	0	39	8	4	7	0	19	113
% Heavy Vehicles	5.6	5.1	0.0	0.0	5.1	13.9	4.3	0.0	0.0	7.0	0.0	5.0	8.4	0.0	5.2	7.0	5.1	10.8	0.0	7.4	5.5
Exiting Leg Total					44					4					49					16	113

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	19	112	3	0	134	7	8	0	0	15	4	83	14	0	101	18	10	7	0	35	285
8:15 AM	15	109	2	0	126	3	14	2	0	19	4	84	17	0	105	5	19	10	0	34	284
8:30 AM	14	119	3	0	136	0	13	1	0	14	10	84	9	0	103	25	13	12	0	50	303
8:45 AM	14	118	3	0	135	6	15	2	0	23	7	109	14	0	130	17	12	6	0	35	323
Total Volume	62	458	11	0	531	16	50	5	0	71	25	360	54	0	439	65	54	35	0	154	1195
% Approach Total	11.7	86.3	2.1	0.0		22.5	70.4	7.0	0.0		5.7	82.0	12.3	0.0		42.2	35.1	22.7	0.0		
PHF	0.816	0.962	0.917	0.000	0.976	0.571	0.833	0.625	0.000	0.772	0.625	0.826	0.794	0.000	0.844	0.650	0.711	0.729	0.000	0.770	0.925
Cars	60	436	11	0	507	16	49	5	0	70	25	344	49	0	418	62	53	32	0	147	1142
Cars %	96.8	95.2	100.0	0.0	95.5	100.0	98.0	100.0	0.0	98.6	100.0	95.6	90.7	0.0	95.2	95.4	98.1	91.4	0.0	95.5	95.6
Heavy Vehicles	2	22	0	0	24	0	1	0	0	1	0	16	5	0	21	3	1	3	0	7	53
Heavy Vehicles %	3.2	4.8	0.0	0.0	4.5	0.0	2.0	0.0	0.0	1.4	0.0	4.4	9.3	0.0	4.8	4.6	1.9	8.6	0.0	4.5	4.4
Cars Enter Leg	60	436	11	0	507	16	49	5	0	70	25	344	49	0	418	62	53	32	0	147	1142
Heavy Enter Leg	2	22	0	0	24	0	1	0	0	1	0	16	5	0	21	3	1	3	0	7	53
Total Entering Leg	62	458	11	0	531	16	50	5	0	71	25	360	54	0	439	65	54	35	0	154	1195
Cars Exiting Leg					392					89					503					158	1142
Heavy Exiting Leg					19					1					25					8	53
Total Exiting Leg					411					90					528					166	1195

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Cars

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	8	50	2	0	60	2	2	1	0	5	0	44	0	0	44	6	1	8	0	15	124
7:15 AM	11	74	4	0	89	5	3	0	0	8	1	54	7	0	62	15	6	8	0	29	188
7:30 AM	10	95	2	0	107	4	2	2	0	8	0	89	8	0	97	7	6	6	0	19	231
7:45 AM	13	101	1	0	115	4	11	0	0	15	1	75	12	0	88	17	8	4	0	29	247
Total	42	320	9	0	371	15	18	3	0	36	2	262	27	0	291	45	21	26	0	92	790
8:00 AM	18	105	3	0	126	7	8	0	0	15	4	80	13	0	97	16	9	7	0	32	270
8:15 AM	15	104	2	0	121	3	14	2	0	19	4	79	15	0	98	5	19	7	0	31	269
8:30 AM	14	116	3	0	133	0	13	1	0	14	10	81	7	0	98	24	13	12	0	49	294
8:45 AM	13	111	3	0	127	6	14	2	0	22	7	104	14	0	125	17	12	6	0	35	309
Total	60	436	11	0	507	16	49	5	0	70	25	344	49	0	418	62	53	32	0	147	1142
Grand Total	102	756	20	0	878	31	67	8	0	106	27	606	76	0	709	107	74	58	0	239	1932
Approach %	11.6	86.1	2.3	0.0		29.2	63.2	7.5	0.0		3.8	85.5	10.7	0.0		44.8	31.0	24.3	0.0		
Total %	5.3	39.1	1.0	0.0	45.4	1.6	3.5	0.4	0.0	5.5	1.4	31.4	3.9	0.0	36.7	5.5	3.8	3.0	0.0	12.4	
Exiting Leg Total					695					121					871					245	1932

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	18	105	3	0	126	7	8	0	0	15	4	80	13	0	97	16	9	7	0	32	270
8:15 AM	15	104	2	0	121	3	14	2	0	19	4	79	15	0	98	5	19	7	0	31	269
8:30 AM	14	116	3	0	133	0	13	1	0	14	10	81	7	0	98	24	13	12	0	49	294
8:45 AM	13	111	3	0	127	6	14	2	0	22	7	104	14	0	125	17	12	6	0	35	309
Total Volume	60	436	11	0	507	16	49	5	0	70	25	344	49	0	418	62	53	32	0	147	1142
% Approach Total	11.8	86.0	2.2	0.0		22.9	70.0	7.1	0.0		6.0	82.3	11.7	0.0		42.2	36.1	21.8	0.0		
PHF	0.833	0.940	0.917	0.000	0.953	0.571	0.875	0.625	0.000	0.795	0.625	0.827	0.817	0.000	0.836	0.646	0.697	0.667	0.000	0.750	0.924
Entering Leg	60	436	11	0	507	16	49	5	0	70	25	344	49	0	418	62	53	32	0	147	1142
Exiting Leg					392					89					503					158	1142
Total					899					159					921					305	2284

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
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City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	6	0	0	6	0	0	0	0	0	0	2	0	0	2	1	0	2	0	3	11
7:15 AM	1	4	0	0	5	0	1	0	0	1	0	9	1	0	10	2	2	0	0	4	20
7:30 AM	0	5	0	0	5	5	0	0	0	5	0	1	1	0	2	1	1	1	0	3	15
7:45 AM	3	4	0	0	7	0	1	0	0	1	0	4	0	0	4	1	0	1	0	2	14
Total	4	19	0	0	23	5	2	0	0	7	0	16	2	0	18	5	3	4	0	12	60
8:00 AM	1	7	0	0	8	0	0	0	0	0	0	3	1	0	4	2	1	0	0	3	15
8:15 AM	0	5	0	0	5	0	0	0	0	0	0	5	2	0	7	0	0	3	0	3	15
8:30 AM	0	3	0	0	3	0	0	0	0	0	0	3	2	0	5	1	0	0	0	1	9
8:45 AM	1	7	0	0	8	0	1	0	0	1	0	5	0	0	5	0	0	0	0	0	14
Total	2	22	0	0	24	0	1	0	0	1	0	16	5	0	21	3	1	3	0	7	53
Grand Total	6	41	0	0	47	5	3	0	0	8	0	32	7	0	39	8	4	7	0	19	113
Approach %	12.8	87.2	0.0	0.0		62.5	37.5	0.0	0.0		0.0	82.1	17.9	0.0		42.1	21.1	36.8	0.0		
Total %	5.3	36.3	0.0	0.0	41.6	4.4	2.7	0.0	0.0	7.1	0.0	28.3	6.2	0.0	34.5	7.1	3.5	6.2	0.0	16.8	
Exiting Leg Total					44					4					49					16	113
Buses	0	0	0	0	0	0	0	0	0	0	0	1	3	0	4	4	0	0	0	4	8
% Buses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	42.9	0.0	10.3	50.0	0.0	0.0	0.0	21.1	7.1
Exiting Leg Total					1					0					4					3	8
Single-Unit Trucks	4	37	0	0	41	5	3	0	0	8	0	28	4	0	32	3	4	6	0	13	94
% Single-Unit	66.7	90.2	0.0	0.0	87.2	100.0	100.0	0.0	0.0	100.0	0.0	87.5	57.1	0.0	82.1	37.5	100.0	85.7	0.0	68.4	83.2
Exiting Leg Total					39					4					40					11	94
Articulated Trucks	2	4	0	0	6	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	11
% Articulated	33.3	9.8	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0	0.0	9.4	0.0	0.0	7.7	12.5	0.0	14.3	0.0	10.5	9.7
Exiting Leg Total					4					0					5					2	11

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:15 AM	1	4	0	0	5	0	1	0	0	1	0	9	1	0	10	2	2	0	0	4	20
7:30 AM	0	5	0	0	5	5	0	0	0	5	0	1	1	0	2	1	1	1	0	3	15
7:45 AM	3	4	0	0	7	0	1	0	0	1	0	4	0	0	4	1	0	1	0	2	14
8:00 AM	1	7	0	0	8	0	0	0	0	0	0	3	1	0	4	2	1	0	0	3	15
Total Volume	5	20	0	0	25	5	2	0	0	7	0	17	3	0	20	6	4	2	0	12	64
% Approach Total	20.0	80.0	0.0	0.0		71.4	28.6	0.0	0.0		0.0	85.0	15.0	0.0		50.0	33.3	16.7	0.0		
PHF	0.417	0.714	0.000	0.000	0.781	0.250	0.500	0.000	0.000	0.350	0.000	0.472	0.750	0.000	0.500	0.750	0.500	0.500	0.000	0.750	0.800
Buses	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0	0	2	4
Buses %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0	10.0	33.3	0.0	0.0	0.0	16.7	6.3
Single-Unit Trucks	4	19	0	0	23	5	2	0	0	7	0	14	1	0	15	3	4	1	0	8	53
Single-Unit %	80.0	95.0	0.0	0.0	92.0	100.0	100.0	0.0	0.0	100.0	0.0	82.4	33.3	0.0	75.0	50.0	100.0	50.0	0.0	66.7	82.8
Articulated Trucks	1	1	0	0	2	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	7
Articulated %	20.0	5.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	0.0	0.0	15.0	16.7	0.0	50.0	0.0	16.7	10.9
Buses	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0	0	2	4
Single-Unit Trucks	4	19	0	0	23	5	2	0	0	7	0	14	1	0	15	3	4	1	0	8	53
Articulated Trucks	1	1	0	0	2	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	7
Total Entering Leg	5	20	0	0	25	5	2	0	0	7	0	17	3	0	20	6	4	2	0	12	64
Buses					0					0					2					2	4
Single-Unit Trucks					20					4					22					7	53
Articulated Trucks					4					0					2					1	7
Total Exiting Leg					24					4					26					10	64

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Buses**

	Highland Avenue					Hunnewell Street					Highland Avenue					Hunnewell Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0	0	2	3
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	2	0	0	0	2	5
Grand Total	0	0	0	0	0	0	0	0	0	0	0	1	3	0	4	4	0	0	0	4	8
Approach %	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	25.0	75.0	0.0		100.0	0.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	37.5	0.0	50.0	50.0	0.0	0.0	0.0	50.0	
Exiting Leg Total					1					0					4					3	8

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Highland Avenue					Hunnewell Street					Highland Avenue					Hunnewell Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total Volume	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	2	0	0	0	2	5
% Approach Total	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	33.3	66.7	0.0		100.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.000	0.750	0.500	0.000	0.000	0.000	0.500	0.625
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	2	0	0	0	2	5
Exiting Leg					1					0					2					2	5
Total					1					0					5					4	10

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Single-Unit Trucks**

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	5	0	0	5	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	9
7:15 AM	1	4	0	0	5	0	1	0	0	1	0	8	0	0	8	1	2	0	0	3	17
7:30 AM	0	5	0	0	5	5	0	0	0	5	0	1	1	0	2	0	1	1	0	2	14
7:45 AM	2	4	0	0	6	0	1	0	0	1	0	2	0	0	2	1	0	0	0	1	10
Total	3	18	0	0	21	5	2	0	0	7	0	13	1	0	14	2	3	3	0	8	50
8:00 AM	1	6	0	0	7	0	0	0	0	0	0	3	0	0	3	1	1	0	0	2	12
8:15 AM	0	4	0	0	4	0	0	0	0	0	0	5	2	0	7	0	0	3	0	3	14
8:30 AM	0	3	0	0	3	0	0	0	0	0	0	3	1	0	4	0	0	0	0	0	7
8:45 AM	0	6	0	0	6	0	1	0	0	1	0	4	0	0	4	0	0	0	0	0	11
Total	1	19	0	0	20	0	1	0	0	1	0	15	3	0	18	1	1	3	0	5	44
Grand Total	4	37	0	0	41	5	3	0	0	8	0	28	4	0	32	3	4	6	0	13	94
Approach %	9.8	90.2	0.0	0.0		62.5	37.5	0.0	0.0		0.0	87.5	12.5	0.0		23.1	30.8	46.2	0.0		
Total %	4.3	39.4	0.0	0.0	43.6	5.3	3.2	0.0	0.0	8.5	0.0	29.8	4.3	0.0	34.0	3.2	4.3	6.4	0.0	13.8	
Exiting Leg Total					39					4					40					11	94

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:15 AM	1	4	0	0	5	0	1	0	0	1	0	8	0	0	8	1	2	0	0	3	17
7:30 AM	0	5	0	0	5	5	0	0	0	5	0	1	1	0	2	0	1	1	0	2	14
7:45 AM	2	4	0	0	6	0	1	0	0	1	0	2	0	0	2	1	0	0	0	1	10
8:00 AM	1	6	0	0	7	0	0	0	0	0	0	3	0	0	3	1	1	0	0	2	12
Total Volume	4	19	0	0	23	5	2	0	0	7	0	14	1	0	15	3	4	1	0	8	53
% Approach Total	17.4	82.6	0.0	0.0		71.4	28.6	0.0	0.0		0.0	93.3	6.7	0.0		37.5	50.0	12.5	0.0		
PHF	0.500	0.792	0.000	0.000	0.821	0.250	0.500	0.000	0.000	0.350	0.000	0.438	0.250	0.000	0.469	0.750	0.500	0.250	0.000	0.667	0.779
Entering Leg	4	19	0	0	23	5	2	0	0	7	0	14	1	0	15	3	4	1	0	8	53
Exiting Leg					20					4					22					7	53
Total					43					11					37					15	106

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Articulated Trucks

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
7:45 AM	1	0	0	0	1	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	4
Total	1	1	0	0	2	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	7
8:00 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	1	3	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Grand Total	2	4	0	0	6	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	11
Approach %	33.3	66.7	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		50.0	0.0	50.0	0.0		
Total %	18.2	36.4	0.0	0.0	54.5	0.0	0.0	0.0	0.0	0.0	0.0	27.3	0.0	0.0	27.3	9.1	0.0	9.1	0.0	18.2	
Exiting Leg Total					4					0					5					2	11

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
7:45 AM	1	0	0	0	1	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	4
Total Volume	1	1	0	0	2	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	7
% Approach Total	50.0	50.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		50.0	0.0	50.0	0.0		
PHF	0.250	0.250	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.375	0.000	0.000	0.375	0.250	0.000	0.250	0.000	0.500	0.438
Entering Leg	1	1	0	0	2	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	7
Exiting Leg					4					0					2					1	7
Total					6					0					5					3	14

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Bicycles (on Roadway and Crosswalks)

	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	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	0	0	0
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
Total	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	0	0	0
8:00 AM	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	0	0	0
8:15 AM	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	0	0	0
8:30 AM	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	0	0	0
8:45 AM	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Grand Total	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Approach %	0.0	0.0	0.0	0.0	0.0	0.0		50.0	0.0	0.0	0.0	0.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	50.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total							1							1							0							0	2

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
8:00 AM	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	0	0	0
8:15 AM	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	0	0	0
8:30 AM	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	0	0	0
8:45 AM	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total Volume	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
% Approach Total	0.0	0.0	0.0	0.0	0.0	0.0		50.0	0.0	0.0	0.0	0.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Entering Leg	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Exiting Leg							1							1							0							0	2
Total							1							3							0							0	4

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Pedestrians

	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	2	2	4	0	0	0	0	1	0	1	0	0	0	0	0	0	0	5
7:30 AM	0	0	0	0	1	1	2	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	5
7:45 AM	0	0	0	0	0	3	3	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5
Total	0	0	0	0	2	4	6	0	0	0	0	5	3	8	0	0	0	0	1	0	1	0	0	0	0	1	1	2	17
8:00 AM	0	0	0	0	0	2	2	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6
8:15 AM	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	5
8:30 AM	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8:45 AM	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3
Total	0	0	0	0	1	7	8	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	2	2	4	16
Grand Total	0	0	0	0	3	11	14	0	0	0	0	5	7	12	0	0	0	0	1	0	1	0	0	0	0	3	3	6	33
Approach %	0	0	0	0	21.4	78.6		0	0	0	0	41.7	58.3		0	0	0	0	100	0		0	0	0	0	50	50		
Total %	0	0	0	0	9.09	33.3	42.4	0	0	0	0	15.2	21.2	36.4	0	0	0	0	3.03	0	3.03	0	0	0	0	9.09	9.09	18.2	
Exiting Leg Total							14							12							1							6	33

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	2	2	4	0	0	0	0	1	0	1	0	0	0	0	0	0	0	5
7:30 AM	0	0	0	0	1	1	2	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	5
7:45 AM	0	0	0	0	0	3	3	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5
8:00 AM	0	0	0	0	0	2	2	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6
Total Volume	0	0	0	0	1	6	7	0	0	0	0	4	6	10	0	0	0	0	1	0	1	0	0	0	0	1	2	3	21
% Approach Total	0.0	0.0	0.0	0.0	14.3	85.7		0.0	0.0	0.0	0.0	40.0	60.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	33.3	66.7		
PHF	0.000	0.000	0.000	0.000	0.250	0.500	0.583	0.000	0.000	0.000	0.000	0.500	0.500	0.625	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.500	0.750	0.875
Entering Leg	0	0	0	0	1	6	7	0	0	0	0	4	6	10	0	0	0	0	1	0	1	0	0	0	0	1	2	3	21
Exiting Leg							7							10							1							3	21
Total							14							20							2							6	42

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Cars and Heavy Vehicles (Combined)

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	16	144	4	0	164	2	11	5	0	18	4	106	20	0	130	21	12	7	0	40	352
4:15 PM	9	127	5	0	141	2	10	1	0	13	9	69	14	0	92	15	18	9	0	42	288
4:30 PM	10	104	11	0	125	7	5	0	0	12	3	97	24	0	124	12	15	8	0	35	296
4:45 PM	12	112	5	0	129	4	10	0	0	14	5	95	17	0	117	14	8	9	0	31	291
Total	47	487	25	0	559	15	36	6	0	57	21	367	75	0	463	62	53	33	0	148	1227
5:00 PM	14	130	1	0	145	7	4	2	0	13	7	96	22	0	125	20	10	18	0	48	331
5:15 PM	13	130	5	0	148	1	11	0	0	12	2	106	18	0	126	19	15	8	0	42	328
5:30 PM	9	102	3	0	114	1	9	2	0	12	5	79	22	0	106	12	9	6	0	27	259
5:45 PM	8	113	1	0	122	4	7	1	0	12	2	72	13	0	87	21	9	10	0	40	261
Total	44	475	10	0	529	13	31	5	0	49	16	353	75	0	444	72	43	42	0	157	1179
Grand Total	91	962	35	0	1088	28	67	11	0	106	37	720	150	0	907	134	96	75	0	305	2406
Approach %	8.4	88.4	3.2	0.0		26.4	63.2	10.4	0.0		4.1	79.4	16.5	0.0		43.9	31.5	24.6	0.0		
Total %	3.8	40.0	1.5	0.0	45.2	1.2	2.8	0.5	0.0	4.4	1.5	29.9	6.2	0.0	37.7	5.6	4.0	3.1	0.0	12.7	
Exiting Leg Total					823					168					1107					308	2406
Cars	91	951	35	0	1077	27	65	10	0	102	37	702	147	0	886	130	93	74	0	297	2362
% Cars	100.0	98.9	100.0	0.0	99.0	96.4	97.0	90.9	0.0	96.2	100.0	97.5	98.0	0.0	97.7	97.0	96.9	98.7	0.0	97.4	98.2
Exiting Leg Total					803					165					1091					303	2362
Heavy Vehicles	0	11	0	0	11	1	2	1	0	4	0	18	3	0	21	4	3	1	0	8	44
% Heavy Vehicles	0.0	1.1	0.0	0.0	1.0	3.6	3.0	9.1	0.0	3.8	0.0	2.5	2.0	0.0	2.3	3.0	3.1	1.3	0.0	2.6	1.8
Exiting Leg Total					20					3					16					5	44

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:30 PM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:30 PM	10	104	11	0	125	7	5	0	0	12	3	97	24	0	124	12	15	8	0	35	296
4:45 PM	12	112	5	0	129	4	10	0	0	14	5	95	17	0	117	14	8	9	0	31	291
5:00 PM	14	130	1	0	145	7	4	2	0	13	7	96	22	0	125	20	10	18	0	48	331
5:15 PM	13	130	5	0	148	1	11	0	0	12	2	106	18	0	126	19	15	8	0	42	328
Total Volume	49	476	22	0	547	19	30	2	0	51	17	394	81	0	492	65	48	43	0	156	1246
% Approach Total	9.0	87.0	4.0	0.0		37.3	58.8	3.9	0.0		3.5	80.1	16.5	0.0		41.7	30.8	27.6	0.0		
PHF	0.875	0.915	0.500	0.000	0.924	0.679	0.682	0.250	0.000	0.911	0.607	0.929	0.844	0.000	0.976	0.813	0.800	0.597	0.000	0.813	0.941
Cars	49	474	22	0	545	19	28	2	0	49	17	383	80	0	480	63	47	42	0	152	1226
Cars %	100.0	99.6	100.0	0.0	99.6	100.0	93.3	100.0	0.0	96.1	100.0	97.2	98.8	0.0	97.6	96.9	97.9	97.7	0.0	97.4	98.4
Heavy Vehicles	0	2	0	0	2	0	2	0	0	2	0	11	1	0	12	2	1	1	0	4	20
Heavy Vehicles %	0.0	0.4	0.0	0.0	0.4	0.0	6.7	0.0	0.0	3.9	0.0	2.8	1.2	0.0	2.4	3.1	2.1	2.3	0.0	2.6	1.6
Cars Enter Leg	49	474	22	0	545	19	28	2	0	49	17	383	80	0	480	63	47	42	0	152	1226
Heavy Enter Leg	0	2	0	0	2	0	2	0	0	2	0	11	1	0	12	2	1	1	0	4	20
Total Entering Leg	49	476	22	0	547	19	30	2	0	51	17	394	81	0	492	65	48	43	0	156	1246
Cars Exiting Leg					444					86					539					157	1226
Heavy Exiting Leg					12					1					4					3	20
Total Exiting Leg					456					87					543					160	1246

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Cars

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	16	139	4	0	159	2	11	5	0	18	4	102	19	0	125	21	11	7	0	39	341
4:15 PM	9	124	5	0	138	2	10	1	0	13	9	68	14	0	91	14	17	9	0	40	282
4:30 PM	10	104	11	0	125	7	5	0	0	12	3	93	24	0	120	12	15	7	0	34	291
4:45 PM	12	112	5	0	129	4	8	0	0	12	5	94	16	0	115	14	8	9	0	31	287
Total	47	479	25	0	551	15	34	6	0	55	21	357	73	0	451	61	51	32	0	144	1201
5:00 PM	14	130	1	0	145	7	4	2	0	13	7	91	22	0	120	19	10	18	0	47	325
5:15 PM	13	128	5	0	146	1	11	0	0	12	2	105	18	0	125	18	14	8	0	40	323
5:30 PM	9	102	3	0	114	1	9	1	0	11	5	79	21	0	105	11	9	6	0	26	256
5:45 PM	8	112	1	0	121	3	7	1	0	11	2	70	13	0	85	21	9	10	0	40	257
Total	44	472	10	0	526	12	31	4	0	47	16	345	74	0	435	69	42	42	0	153	1161
Grand Total	91	951	35	0	1077	27	65	10	0	102	37	702	147	0	886	130	93	74	0	297	2362
Approach %	8.4	88.3	3.2	0.0		26.5	63.7	9.8	0.0		4.2	79.2	16.6	0.0		43.8	31.3	24.9	0.0		
Total %	3.9	40.3	1.5	0.0	45.6	1.1	2.8	0.4	0.0	4.3	1.6	29.7	6.2	0.0	37.5	5.5	3.9	3.1	0.0	12.6	
Exiting Leg Total					803					165					1091					303	2362

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:30 PM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:30 PM	10	104	11	0	125	7	5	0	0	12	3	93	24	0	120	12	15	7	0	34	291
4:45 PM	12	112	5	0	129	4	8	0	0	12	5	94	16	0	115	14	8	9	0	31	287
5:00 PM	14	130	1	0	145	7	4	2	0	13	7	91	22	0	120	19	10	18	0	47	325
5:15 PM	13	128	5	0	146	1	11	0	0	12	2	105	18	0	125	18	14	8	0	40	323
Total Volume	49	474	22	0	545	19	28	2	0	49	17	383	80	0	480	63	47	42	0	152	1226
% Approach Total	9.0	87.0	4.0	0.0		38.8	57.1	4.1	0.0		3.5	79.8	16.7	0.0		41.4	30.9	27.6	0.0		
PHF	0.875	0.912	0.500	0.000	0.933	0.679	0.636	0.250	0.000	0.942	0.607	0.912	0.833	0.000	0.960	0.829	0.783	0.583	0.000	0.809	0.943
Entering Leg	49	474	22	0	545	19	28	2	0	49	17	383	80	0	480	63	47	42	0	152	1226
Exiting Leg					444					86					539					157	1226
Total					989					135					1019					309	2452

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	5	0	0	5	0	0	0	0	0	0	4	1	0	5	0	1	0	0	1	11
4:15 PM	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	1	1	0	0	2	6
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	1	0	1	5
4:45 PM	0	0	0	0	0	0	2	0	0	2	0	1	1	0	2	0	0	0	0	0	4
Total	0	8	0	0	8	0	2	0	0	2	0	10	2	0	12	1	2	1	0	4	26
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5	1	0	0	0	1	6
5:15 PM	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	1	1	0	0	2	5
5:30 PM	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	1	3
5:45 PM	0	1	0	0	1	1	0	0	0	1	0	2	0	0	2	0	0	0	0	0	4
Total	0	3	0	0	3	1	0	1	0	2	0	8	1	0	9	3	1	0	0	4	18
Grand Total	0	11	0	0	11	1	2	1	0	4	0	18	3	0	21	4	3	1	0	8	44
Approach %	0.0	100.0	0.0	0.0		25.0	50.0	25.0	0.0		0.0	85.7	14.3	0.0		50.0	37.5	12.5	0.0		
Total %	0.0	25.0	0.0	0.0	25.0	2.3	4.5	2.3	0.0	9.1	0.0	40.9	6.8	0.0	47.7	9.1	6.8	2.3	0.0	18.2	
Exiting Leg Total					20					3					16					5	44
Buses	0	0	0	0	0	0	2	0	0	2	0	0	3	0	3	3	1	0	0	4	9
% Buses	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	50.0	0.0	0.0	100.0	0.0	14.3	75.0	33.3	0.0	0.0	50.0	20.5
Exiting Leg Total					0					1					3					5	9
Single-Unit Trucks	0	8	0	0	8	1	0	1	0	2	0	15	0	0	15	1	2	1	0	4	29
% Single-Unit	0.0	72.7	0.0	0.0	72.7	100.0	0.0	100.0	0.0	50.0	0.0	83.3	0.0	0.0	71.4	25.0	66.7	100.0	0.0	50.0	65.9
Exiting Leg Total					17					2					10					0	29
Articulated Trucks	0	3	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	6
% Articulated	0.0	27.3	0.0	0.0	27.3	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	13.6
Exiting Leg Total					3					0					3					0	6

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	5	0	0	5	0	0	0	0	0	0	4	1	0	5	0	1	0	0	1	11
4:15 PM	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	1	1	0	0	2	6
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	1	0	1	5
4:45 PM	0	0	0	0	0	0	2	0	0	2	0	1	1	0	2	0	0	0	0	0	4
Total Volume	0	8	0	0	8	0	2	0	0	2	0	10	2	0	12	1	2	1	0	4	26
% Approach Total	0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	83.3	16.7	0.0		25.0	50.0	25.0	0.0		
PHF	0.000	0.400	0.000	0.000	0.400	0.000	0.250	0.000	0.000	0.250	0.000	0.625	0.500	0.000	0.600	0.250	0.500	0.250	0.000	0.500	0.591
Buses	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	1	0	0	0	1	5
Buses %	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	16.7	100.0	0.0	0.0	0.0	25.0	19.2
Single-Unit Trucks	0	7	0	0	7	0	0	0	0	0	0	9	0	0	9	0	2	1	0	3	19
Single-Unit %	0.0	87.5	0.0	0.0	87.5	0.0	0.0	0.0	0.0	0.0	0.0	90.0	0.0	0.0	75.0	0.0	100.0	100.0	0.0	75.0	73.1
Articulated Trucks	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
Articulated %	0.0	12.5	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	7.7
Buses	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	1	0	0	0	1	5
Single-Unit Trucks	0	7	0	0	7	0	0	0	0	0	0	9	0	0	9	0	2	1	0	3	19
Articulated Trucks	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
Total Entering Leg	0	8	0	0	8	0	2	0	0	2	0	10	2	0	12	1	2	1	0	4	26
Buses					0					0					1					4	5
Single-Unit Trucks					10					2					7					0	19
Articulated Trucks					1					0					1					0	2
Total Exiting Leg					11					2					9					4	26

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Buses

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	0	0	0	0	0	3
Total	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	1	0	0	0	1	5
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	1	0	0	3	4
Grand Total	0	0	0	0	0	0	2	0	0	2	0	0	3	0	3	3	1	0	0	4	9
Approach %	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		75.0	25.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	22.2	0.0	0.0	33.3	0.0	33.3	33.3	11.1	0.0	0.0	44.4	
Exiting Leg Total					0					1					3					5	9

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:45 PM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	0	0	0	0	0	3
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	2
Total Volume	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	2	1	0	0	3	7
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		66.7	33.3	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.250	0.000	0.000	0.500	0.000	0.500	0.500	0.250	0.000	0.000	0.750	0.583
Entering Leg	0	0	0	0	0	0	2	0	0	2	0	0	2	0	2	2	1	0	0	3	7
Exiting Leg					0					1					2					4	7
Total					0					3					4					7	14

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Single-Unit Trucks

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	4	0	0	4	0	0	0	0	0	0	4	0	0	4	0	1	0	0	1	9
4:15 PM	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	5
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	1	0	1	4
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total	0	7	0	0	7	0	0	0	0	0	0	9	0	0	9	0	2	1	0	3	19
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	4
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	2
5:30 PM	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
5:45 PM	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	3
Total	0	1	0	0	1	1	0	1	0	2	0	6	0	0	6	1	0	0	0	1	10
Grand Total	0	8	0	0	8	1	0	1	0	2	0	15	0	0	15	1	2	1	0	4	29
Approach %	0.0	100.0	0.0	0.0		50.0	0.0	50.0	0.0		0.0	100.0	0.0	0.0		25.0	50.0	25.0	0.0		
Total %	0.0	27.6	0.0	0.0	27.6	3.4	0.0	3.4	0.0	6.9	0.0	51.7	0.0	0.0	51.7	3.4	6.9	3.4	0.0	13.8	
Exiting Leg Total					17					2					10					0	29

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:00 PM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	4	0	0	4	0	0	0	0	0	0	4	0	0	4	0	1	0	0	1	9
4:15 PM	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	5
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	1	0	1	4
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total Volume	0	7	0	0	7	0	0	0	0	0	0	9	0	0	9	0	2	1	0	3	19
% Approach Total	0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	66.7	33.3	0.0		
PHF	0.000	0.438	0.000	0.000	0.438	0.000	0.000	0.000	0.000	0.000	0.000	0.563	0.000	0.000	0.563	0.000	0.500	0.250	0.000	0.750	0.528
Entering Leg	0	7	0	0	7	0	0	0	0	0	0	9	0	0	9	0	2	1	0	3	19
Exiting Leg					10					2					7					0	19
Total					17					2					16					3	38

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Class:

Articulated Trucks

	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:00 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
5:15 PM	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	4
Grand Total	0	3	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	6
Approach %	0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		
Total %	0.0	50.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total					3					0					3					0	6

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:30 PM	Highland Avenue from North					Hunnewell Street from East					Highland Avenue from South					Hunnewell Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
5:15 PM	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total Volume	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	4
% Approach Total	0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		
PHF	0.000	0.250	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.500
Entering Leg	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	4
Exiting Leg					2					0					2					0	4
Total					4					0					4					0	8

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Bicycles (on Roadway and Crosswalks)

	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:00 PM	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	0	0	0
4:15 PM	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	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	2
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	0	0	0	1	0	0	0	0	0	1	1	4
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	4
5:45 PM	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
Total	1	0	0	0	3	0	4	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	6
Grand Total	1	0	0	0	3	0	4	0	0	0	0	2	0	2	0	2	0	0	0	0	2	1	0	0	0	0	1	2	10
Approach %	25.0	0.0	0.0	0.0	75.0	0.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		50.0	0.0	0.0	0.0	0.0	50.0		
Total %	10.0	0.0	0.0	0.0	30.0	0.0	40.0	0.0	0.0	0.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0	10.0	0.0	0.0	0.0	0.0	10.0	20.0	
Exiting Leg Total							5							2							1							2	10

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:45 PM	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	4
Total Volume	0	0	0	0	3	0	3	0	0	0	0	2	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	6
% Approach Total	0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.375
Entering Leg	0	0	0	0	3	0	3	0	0	0	0	2	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	6
Exiting Leg							4							2							0							0	6
Total							7							4							1							0	12

PDI File #: **218064 D**
Location: **N: Highland Avenue S: Highland Avenue**
Location: **E: Hunnewell Street W: Hunnewell Street**
City, State: **Needham, MA**
Client: **VHB/M. Duranleau**
Site Code: **15306.00**
Count Date: **Tuesday, July 13, 2021**
Start Time: **4:00 PM**
End Time: **6:00 PM**
Class:

PRECISION DATA INDUSTRIES, LLC
157 Washington Street, Suite 2
Hudson, MA 01749
Office: 508-875-0100 Fax: 508-875-0118

Pedestrians

	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:00 PM	0	0	0	0	2	0	2	0	0	0	0	0	1	1	0	0	0	0	2	0	2	0	0	0	0	0	0	0	5
4:15 PM	0	0	0	0	1	1	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	2	5
4:30 PM	0	0	0	0	2	1	3	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0	2	6
4:45 PM	0	0	0	0	0	2	2	0	0	0	0	3	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Total	0	0	0	0	5	4	9	0	0	0	0	4	5	9	0	0	0	0	2	0	2	0	0	0	0	4	0	4	24
5:00 PM	0	0	0	0	1	0	1	0	0	0	0	2	1	3	0	0	0	0	1	0	1	0	0	0	0	0	0	0	5
5:15 PM	0	0	0	0	2	0	2	0	0	0	0	4	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
5:30 PM	0	0	0	0	2	0	2	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
5:45 PM	0	0	0	0	1	0	1	0	0	0	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	1	2	3	7
Total	0	0	0	0	6	0	6	0	0	0	0	10	3	13	0	0	0	0	1	0	1	0	0	0	0	1	2	3	23
Grand Total	0	0	0	0	11	4	15	0	0	0	0	14	8	22	0	0	0	0	3	0	3	0	0	0	0	5	2	7	47
Approach %	0	0	0	0	73.3	26.7		0	0	0	0	63.6	36.4		0	0	0	0	100	0		0	0	0	0	71.4	28.6		
Total %	0	0	0	0	23.4	8.51	31.9	0	0	0	0	29.8	17	46.8	0	0	0	0	6.38	0	6.38	0	0	0	0	10.6	4.26	14.9	
Exiting Leg Total							15							22							3							7	47

Peak Hour Analysis from 04:00 PM to 06:00 PM begins at:

4:30 PM	Highland Avenue from North							Hunnewell Street from East							Highland Avenue from South							Hunnewell Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:30 PM	0	0	0	0	2	1	3	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0	2	6
4:45 PM	0	0	0	0	0	2	2	0	0	0	0	3	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
5:00 PM	0	0	0	0	1	0	1	0	0	0	0	2	1	3	0	0	0	0	1	0	1	0	0	0	0	0	0	0	5
5:15 PM	0	0	0	0	2	0	2	0	0	0	0	4	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Total Volume	0	0	0	0	5	3	8	0	0	0	0	9	6	15	0	0	0	0	1	0	1	0	0	0	0	2	0	2	26
% Approach Total	0.0	0.0	0.0	0.0	62.5	37.5		0.0	0.0	0.0	0.0	60.0	40.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	100.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.625	0.375	0.667	0.000	0.000	0.000	0.000	0.563	0.500	0.625	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.813
Entering Leg	0	0	0	0	5	3	8	0	0	0	0	9	6	15	0	0	0	0	1	0	1	0	0	0	0	2	0	2	26
Exiting Leg							8							15							1							2	26
Total							16							30							2							4	52

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017
Page No : 1

Groups Printed- Cars - Trucks

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	19	19	5	40	81	4	0	32	60	4	113	1	378
07:15 AM	21	31	4	48	92	5	2	37	84	3	108	4	439
07:30 AM	24	62	7	31	112	8	1	39	99	9	126	3	521
07:45 AM	23	45	4	26	102	22	3	67	93	8	119	5	517
Total	87	157	20	145	387	39	6	175	336	24	466	13	1855
08:00 AM	21	25	8	27	91	17	3	64	82	9	110	1	458
08:15 AM	25	35	5	19	99	12	2	60	86	5	122	3	473
08:30 AM	17	42	5	30	118	13	9	83	101	2	103	8	531
08:45 AM	14	25	6	37	89	13	8	83	106	12	115	4	512
Total	77	127	24	113	397	55	22	290	375	28	450	16	1974
Grand Total	164	284	44	258	784	94	28	465	711	52	916	29	3829
Apprch %	33.3	57.7	8.9	22.7	69	8.3	2.3	38.6	59.1	5.2	91.9	2.9	
Total %	4.3	7.4	1.1	6.7	20.5	2.5	0.7	12.1	18.6	1.4	23.9	0.8	
Cars	163	281	44	256	762	91	28	461	705	51	896	29	3767
% Cars	99.4	98.9	100	99.2	97.2	96.8	100	99.1	99.2	98.1	97.8	100	98.4
Trucks	1	3	0	2	22	3	0	4	6	1	20	0	62
% Trucks	0.6	1.1	0	0.8	2.8	3.2	0	0.9	0.8	1.9	2.2	0	1.6

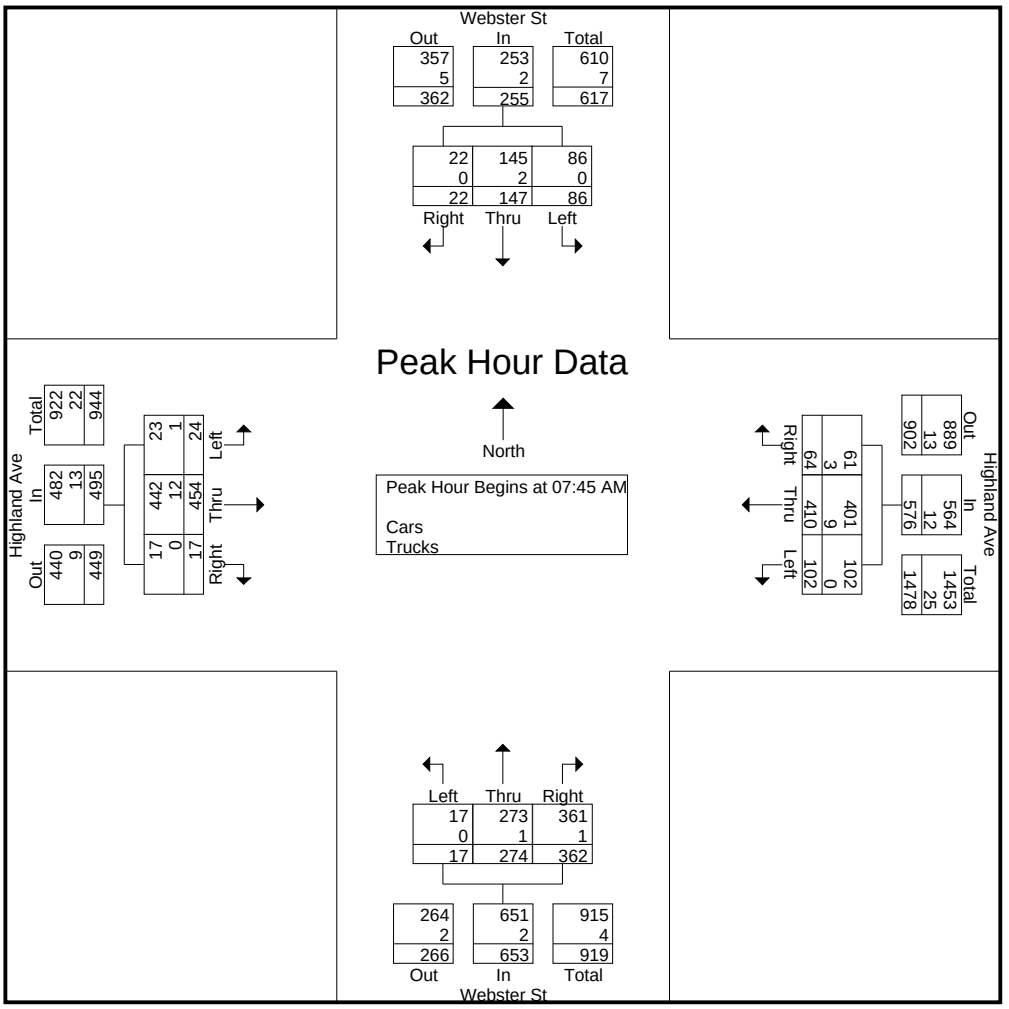
Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017
Page No : 2

	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	23	**45**	4	**72**	26	102	**22**	150	3	67	93	163	8	119	5	**132**	517
08:00 AM	21	25	**8**	54	27	91	17	135	3	64	82	149	**9**	110	1	120	458
08:15 AM	**25**	35	5	65	19	99	12	130	2	60	86	148	5	**122**	3	130	473
08:30 AM	17	42	5	64	**30**	**118**	13	**161**	**9**	**83**	**101**	**193**	2	103	**8**	113	**531**
Total Volume	86	147	22	255	102	410	64	576	17	274	362	653	24	454	17	495	1979
% App. Total	33.7	57.6	8.6		17.7	71.2	11.1		2.6	42	55.4		4.8	91.7	3.4		
PHF	.860	.817	.688	.885	.850	.869	.727	.894	.472	.825	.896	.846	.667	.930	.531	.938	.932
Cars	86	145	22	253	102	401	61	564	17	273	361	651	23	442	17	482	1950
% Cars	100	98.6	100	99.2	100	97.8	95.3	97.9	100	99.6	99.7	99.7	95.8	97.4	100	97.4	98.5
Trucks	0	2	0	2	0	9	3	12	0	1	1	2	1	12	0	13	29
% Trucks	0	1.4	0	0.8	0	2.2	4.7	2.1	0	0.4	0.3	0.3	4.2	2.6	0	2.6	1.5



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017
Page No : 4

Groups Printed- Cars

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	19	19	5	38	74	4	0	32	60	4	112	1	368
07:15 AM	21	30	4	48	91	5	2	36	83	3	106	4	433
07:30 AM	23	62	7	31	108	8	1	38	97	9	125	3	512
07:45 AM	23	44	4	26	99	21	3	67	93	8	116	5	509
Total	86	155	20	143	372	38	6	173	333	24	459	13	1822
08:00 AM	21	24	8	27	90	15	3	63	82	9	109	1	452
08:15 AM	25	35	5	19	95	12	2	60	85	4	118	3	463
08:30 AM	17	42	5	30	117	13	9	83	101	2	99	8	526
08:45 AM	14	25	6	37	88	13	8	82	104	12	111	4	504
Total	77	126	24	113	390	53	22	288	372	27	437	16	1945
Grand Total	163	281	44	256	762	91	28	461	705	51	896	29	3767
Apprch %	33.4	57.6	9	23.1	68.7	8.2	2.3	38.6	59	5.2	91.8	3	
Total %	4.3	7.5	1.2	6.8	20.2	2.4	0.7	12.2	18.7	1.4	23.8	0.8	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017

Groups Printed- Trucks

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	0	0	0	2	7	0	0	0	0	0	1	0	10
07:15 AM	0	1	0	0	1	0	0	1	1	0	2	0	6
07:30 AM	1	0	0	0	4	0	0	1	2	0	1	0	9
07:45 AM	0	1	0	0	3	1	0	0	0	0	3	0	8
Total	1	2	0	2	15	1	0	2	3	0	7	0	33
08:00 AM	0	1	0	0	1	2	0	1	0	0	1	0	6
08:15 AM	0	0	0	0	4	0	0	0	1	1	4	0	10
08:30 AM	0	0	0	0	1	0	0	0	0	0	4	0	5
08:45 AM	0	0	0	0	1	0	0	1	2	0	4	0	8
Total	0	1	0	0	7	2	0	2	3	1	13	0	29
Grand Total	1	3	0	2	22	3	0	4	6	1	20	0	62
Apprch %	25	75	0	7.4	81.5	11.1	0	40	60	4.8	95.2	0	
Total %	1.6	4.8	0	3.2	35.5	4.8	0	6.5	9.7	1.6	32.3	0	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017

Groups Printed- Bikes Peds

	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West						
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Exclu. Total	Inclu. Total	Int. Total
07:00 AM	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	2
07:15 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
Total	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	1	4	0	4
08:00 AM	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	3	0	3
08:15 AM	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	2
08:30 AM	0	0	0	2	0	0	0	5	0	0	0	0	0	0	0	0	7	0	7
08:45 AM	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	2	1	3
Total	0	0	0	7	0	0	0	7	0	0	0	0	0	1	0	0	14	1	15
Grand Total	0	0	0	9	0	0	0	8	0	0	0	0	0	1	0	1	18	1	19
Apprch %	0	0	0		0	0	0		0	0	0		0	100	0				
Total %	0	0	0		0	0	0		0	0	0		0	100	0		94.7	5.3	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017
Page No : 1

Groups Printed- Cars - Trucks

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
04:00 PM	25	61	9	47	89	9	2	30	38	5	117	5	437
04:15 PM	22	64	3	38	109	14	6	39	42	4	99	0	440
04:30 PM	21	78	12	41	87	25	1	32	37	3	99	5	441
04:45 PM	27	78	9	48	124	22	6	19	43	6	88	1	471
Total	95	281	33	174	409	70	15	120	160	18	403	11	1789
05:00 PM	25	62	7	73	123	15	7	33	47	8	106	7	513
05:15 PM	30	73	12	78	124	18	5	25	52	8	105	4	534
05:30 PM	19	67	10	75	111	18	6	29	37	11	85	2	470
05:45 PM	15	74	10	66	134	20	7	28	28	11	90	4	487
Total	89	276	39	292	492	71	25	115	164	38	386	17	2004
Grand Total	184	557	72	466	901	141	40	235	324	56	789	28	3793
Apprch %	22.6	68.5	8.9	30.9	59.7	9.4	6.7	39.2	54.1	6.4	90.4	3.2	
Total %	4.9	14.7	1.9	12.3	23.8	3.7	1.1	6.2	8.5	1.5	20.8	0.7	
Cars	184	557	72	465	897	140	40	235	323	56	786	28	3783
% Cars	100	100	100	99.8	99.6	99.3	100	100	99.7	100	99.6	100	99.7
Trucks	0	0	0	1	4	1	0	0	1	0	3	0	10
% Trucks	0	0	0	0.2	0.4	0.7	0	0	0.3	0	0.4	0	0.3

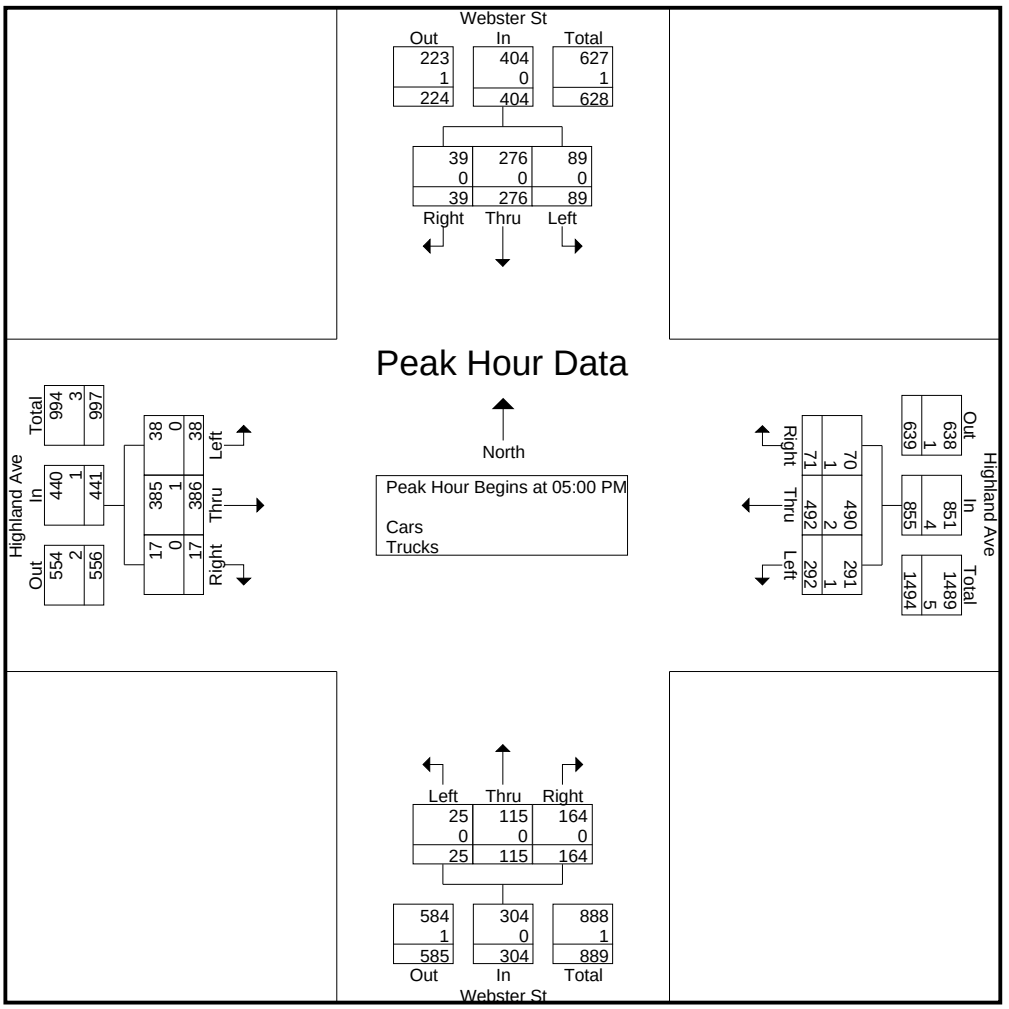
Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017
Page No : 2

	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	25	62	7	94	73	123	15	211	**7**	**33**	47	**87**	8	**106**	**7**	**121**	513
05:15 PM	**30**	73	**12**	**115**	**78**	124	18	**220**	5	25	**52**	82	8	105	4	117	**534**
05:30 PM	19	67	10	96	75	111	18	204	6	29	37	72	**11**	85	2	98	470
05:45 PM	15	**74**	10	99	66	**134**	**20**	220	7	28	28	63	11	90	4	105	487
Total Volume	89	276	39	404	292	492	71	855	25	115	164	304	38	386	17	441	2004
% App. Total	22	68.3	9.7		34.2	57.5	8.3		8.2	37.8	53.9		8.6	87.5	3.9		
PHF	.742	.932	.813	.878	.936	.918	.888	.972	.893	.871	.788	.874	.864	.910	.607	.911	.938
Cars	89	276	39	404	291	490	70	851	25	115	164	304	38	385	17	440	1999
% Cars	100	100	100	100	99.7	99.6	98.6	99.5	100	100	100	100	100	99.7	100	99.8	99.8
Trucks	0	0	0	0	1	2	1	4	0	0	0	0	0	1	0	1	5
% Trucks	0	0	0	0	0.3	0.4	1.4	0.5	0	0	0	0	0	0.3	0	0.2	0.2



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017

Groups Printed- Cars

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
04:00 PM	25	61	9	47	89	9	2	30	38	5	116	5	436
04:15 PM	22	64	3	38	108	14	6	39	41	4	98	0	437
04:30 PM	21	78	12	41	86	25	1	32	37	3	99	5	440
04:45 PM	27	78	9	48	124	22	6	19	43	6	88	1	471
Total	95	281	33	174	407	70	15	120	159	18	401	11	1784
05:00 PM	25	62	7	73	122	15	7	33	47	8	106	7	512
05:15 PM	30	73	12	78	124	17	5	25	52	8	105	4	533
05:30 PM	19	67	10	74	111	18	6	29	37	11	84	2	468
05:45 PM	15	74	10	66	133	20	7	28	28	11	90	4	486
Total	89	276	39	291	490	70	25	115	164	38	385	17	1999
Grand Total	184	557	72	465	897	140	40	235	323	56	786	28	3783
Apprch %	22.6	68.5	8.9	31	59.7	9.3	6.7	39.3	54	6.4	90.3	3.2	
Total %	4.9	14.7	1.9	12.3	23.7	3.7	1.1	6.2	8.5	1.5	20.8	0.7	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017

Groups Printed- Trucks

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
04:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	1
04:15 PM	0	0	0	0	1	0	0	0	1	0	1	0	3
04:30 PM	0	0	0	0	1	0	0	0	0	0	0	0	1
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	2	0	0	0	1	0	2	0	5
05:00 PM	0	0	0	0	1	0	0	0	0	0	0	0	1
05:15 PM	0	0	0	0	0	1	0	0	0	0	0	0	1
05:30 PM	0	0	0	1	0	0	0	0	0	0	1	0	2
05:45 PM	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	0	0	0	1	2	1	0	0	0	0	1	0	5
Grand Total	0	0	0	1	4	1	0	0	1	0	3	0	10
Apprch %	0	0	0	16.7	66.7	16.7	0	0	100	0	100	0	
Total %	0	0	0	10	40	10	0	0	10	0	30	0	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Rain

File Name : 17640001
Site Code : 17640001
Start Date : 4/26/2017

Groups Printed- Bikes Peds

	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West						
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Exclu. Total	Inclu. Total	Int. Total
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
04:30 PM	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	3	0	3
04:45 PM	0	0	0	3	0	0	0	1	0	0	0	1	0	0	0	1	6	0	6
Total	0	0	0	3	0	0	0	4	0	0	0	2	0	0	0	1	10	0	10
05:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:15 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
05:30 PM	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	2
05:45 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Total	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	4	0	4
Grand Total	0	0	0	5	0	0	0	6	0	0	0	2	0	0	0	1	14	0	14
Apprch %	0	0	0		0	0	0		0	0	0		0	0	0				
Total %																	100	0	

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

Cars and Heavy Vehicles (Combined)

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	4	14	30	0	48	50	111	12	2	175	31	12	6	0	49	1	176	7	1	185	457
7:15 AM	7	7	28	0	42	50	138	16	1	205	44	20	9	0	73	2	180	13	0	195	515
7:30 AM	4	7	37	0	48	45	154	9	0	208	41	24	13	0	78	4	249	10	0	263	597
7:45 AM	5	9	36	0	50	81	144	14	0	239	49	25	2	0	76	7	214	18	0	239	604
Total	20	37	131	0	188	226	547	51	3	827	165	81	30	0	276	14	819	48	1	882	2173
8:00 AM	7	15	33	0	55	76	140	10	2	228	49	41	9	0	99	3	212	23	0	238	620
8:15 AM	5	10	43	0	58	94	116	10	2	222	67	47	7	0	121	8	176	21	0	205	606
8:30 AM	6	14	37	0	57	85	133	10	2	230	42	46	4	0	92	3	158	17	0	178	557
8:45 AM	8	18	36	0	62	101	141	8	2	252	49	69	6	0	124	1	179	30	0	210	648
Total	26	57	149	0	232	356	530	38	8	932	207	203	26	0	436	15	725	91	0	831	2431
Grand Total	46	94	280	0	420	582	1077	89	11	1759	372	284	56	0	712	29	1544	139	1	1713	4604
Approach %	11.0	22.4	66.7	0.0		33.1	61.2	5.1	0.6		52.2	39.9	7.9	0.0		1.7	90.1	8.1	0.1		
Total %	1.0	2.0	6.1	0.0	9.1	12.6	23.4	1.9	0.2	38.2	8.1	6.2	1.2	0.0	15.5	0.6	33.5	3.0	0.0	37.2	
Exiting Leg Total					1005					2207					212					1180	4604
Cars	44	93	269	0	406	571	1026	85	11	1693	370	280	55	0	705	28	1514	135	1	1678	4482
% Cars	95.7	98.9	96.1	0.0	96.7	98.1	95.3	95.5	100.0	96.2	99.5	98.6	98.2	0.0	99.0	96.6	98.1	97.1	100.0	98.0	97.4
Exiting Leg Total					986					2164					206					1126	4482
Heavy Vehicles	2	1	11	0	14	11	51	4	0	66	2	4	1	0	7	1	30	4	0	35	122
% Heavy Vehicles	4.3	1.1	3.9	0.0	3.3	1.9	4.7	4.5	0.0	3.8	0.5	1.4	1.8	0.0	1.0	3.4	1.9	2.9	0.0	2.0	2.6
Exiting Leg Total					19					43					6					54	122

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	7	15	33	0	55	76	140	10	2	228	49	41	9	0	99	3	212	23	0	238	620
8:15 AM	5	10	43	0	58	94	116	10	2	222	67	47	7	0	121	8	176	21	0	205	606
8:30 AM	6	14	37	0	57	85	133	10	2	230	42	46	4	0	92	3	158	17	0	178	557
8:45 AM	8	18	36	0	62	101	141	8	2	252	49	69	6	0	124	1	179	30	0	210	648
Total Volume	26	57	149	0	232	356	530	38	8	932	207	203	26	0	436	15	725	91	0	831	2431
% Approach Total	11.2	24.6	64.2	0.0		38.2	56.9	4.1	0.9		47.5	46.6	6.0	0.0		1.8	87.2	11.0	0.0		
PHF	0.813	0.792	0.866	0.000	0.935	0.881	0.940	0.950	1.000	0.925	0.772	0.736	0.722	0.000	0.879	0.469	0.855	0.758	0.000	0.873	0.938
Cars	26	56	145	0	227	354	506	38	8	906	206	201	26	0	433	15	707	88	0	810	2376
Cars %	100.0	98.2	97.3	0.0	97.8	99.4	95.5	100.0	100.0	97.2	99.5	99.0	100.0	0.0	99.3	100.0	97.5	96.7	0.0	97.5	97.7
Heavy Vehicles	0	1	4	0	5	2	24	0	0	26	1	2	0	0	3	0	18	3	0	21	55
Heavy Vehicles %	0.0	1.8	2.7	0.0	2.2	0.6	4.5	0.0	0.0	2.8	0.5	1.0	0.0	0.0	0.7	0.0	2.5	3.3	0.0	2.5	2.3
Cars Enter Leg	26	56	145	0	227	354	506	38	8	906	206	201	26	0	433	15	707	88	0	810	2376
Heavy Enter Leg	0	1	4	0	5	2	24	0	0	26	1	2	0	0	3	0	18	3	0	21	55
Total Entering Leg	26	57	149	0	232	356	530	38	8	932	207	203	26	0	436	15	725	91	0	831	2431
Cars Exiting Leg					643					1066					109					558	2376
Heavy Exiting Leg					7					23					1					24	55
Total Exiting Leg					650					1089					110					582	2431

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**

Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	3	14	30	0	47	45	105	12	2	164	31	12	5	0	48	0	175	7	1	183	442
7:15 AM	7	7	27	0	41	50	131	15	1	197	43	20	9	0	72	2	178	12	0	192	502
7:30 AM	3	7	34	0	44	42	147	9	0	198	41	24	13	0	78	4	241	10	0	255	575
7:45 AM	5	9	33	0	47	80	137	11	0	228	49	23	2	0	74	7	213	18	0	238	587
Total	18	37	124	0	179	217	520	47	3	787	164	79	29	0	272	13	807	47	1	868	2106
8:00 AM	7	15	33	0	55	76	137	10	2	225	48	41	9	0	98	3	206	22	0	231	609
8:15 AM	5	10	40	0	55	94	108	10	2	214	67	45	7	0	119	8	173	20	0	201	589
8:30 AM	6	14	37	0	57	83	131	10	2	226	42	46	4	0	92	3	155	16	0	174	549
8:45 AM	8	17	35	0	60	101	130	8	2	241	49	69	6	0	124	1	173	30	0	204	629
Total	26	56	145	0	227	354	506	38	8	906	206	201	26	0	433	15	707	88	0	810	2376
Grand Total	44	93	269	0	406	571	1026	85	11	1693	370	280	55	0	705	28	1514	135	1	1678	4482
Approach %	10.8	22.9	66.3	0.0		33.7	60.6	5.0	0.6		52.5	39.7	7.8	0.0		1.7	90.2	8.0	0.1		
Total %	1.0	2.1	6.0	0.0	9.1	12.7	22.9	1.9	0.2	37.8	8.3	6.2	1.2	0.0	15.7	0.6	33.8	3.0	0.0	37.4	
Exiting Leg Total					986					2164					206					1126	4482

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	7	15	33	0	55	76	137	10	2	225	48	41	9	0	98	3	206	22	0	231	609
8:15 AM	5	10	40	0	55	94	108	10	2	214	67	45	7	0	119	8	173	20	0	201	589
8:30 AM	6	14	37	0	57	83	131	10	2	226	42	46	4	0	92	3	155	16	0	174	549
8:45 AM	8	17	35	0	60	101	130	8	2	241	49	69	6	0	124	1	173	30	0	204	629
Total Volume	26	56	145	0	227	354	506	38	8	906	206	201	26	0	433	15	707	88	0	810	2376
% Approach Total	11.5	24.7	63.9	0.0		39.1	55.8	4.2	0.9		47.6	46.4	6.0	0.0		1.9	87.3	10.9	0.0		
PHF	0.813	0.824	0.906	0.000	0.946	0.876	0.923	0.950	1.000	0.940	0.769	0.728	0.722	0.000	0.873	0.469	0.858	0.733	0.000	0.877	0.944
Entering Leg	26	56	145	0	227	354	506	38	8	906	206	201	26	0	433	15	707	88	0	810	2376
Exiting Leg					643					1066					109					558	2376
Total					870					1972					542					1368	4752

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	0	0	0	1	5	6	0	0	11	0	0	1	0	1	1	1	0	0	2	15
7:15 AM	0	0	1	0	1	0	7	1	0	8	1	0	0	0	1	0	2	1	0	3	13
7:30 AM	1	0	3	0	4	3	7	0	0	10	0	0	0	0	0	0	8	0	0	8	22
7:45 AM	0	0	3	0	3	1	7	3	0	11	0	2	0	0	2	0	1	0	0	1	17
Total	2	0	7	0	9	9	27	4	0	40	1	2	1	0	4	1	12	1	0	14	67
8:00 AM	0	0	0	0	0	0	3	0	0	3	1	0	0	0	1	0	6	1	0	7	11
8:15 AM	0	0	3	0	3	0	8	0	0	8	0	2	0	0	2	0	3	1	0	4	17
8:30 AM	0	0	0	0	0	2	2	0	0	4	0	0	0	0	0	0	3	1	0	4	8
8:45 AM	0	1	1	0	2	0	11	0	0	11	0	0	0	0	0	0	6	0	0	6	19
Total	0	1	4	0	5	2	24	0	0	26	1	2	0	0	3	0	18	3	0	21	55
Grand Total	2	1	11	0	14	11	51	4	0	66	2	4	1	0	7	1	30	4	0	35	122
Approach %	14.3	7.1	78.6	0.0		16.7	77.3	6.1	0.0		28.6	57.1	14.3	0.0		2.9	85.7	11.4	0.0		
Total %	1.6	0.8	9.0	0.0	11.5	9.0	41.8	3.3	0.0	54.1	1.6	3.3	0.8	0.0	5.7	0.8	24.6	3.3	0.0	28.7	
Exiting Leg Total					19					43					6					54	122
Buses	1	0	2	0	3	1	4	1	0	6	0	2	1	0	3	0	4	0	0	4	16
% Buses	50.0	0.0	18.2	0.0	21.4	9.1	7.8	25.0	0.0	9.1	0.0	50.0	100.0	0.0	42.9	0.0	13.3	0.0	0.0	11.4	13.1
Exiting Leg Total					3					6					1					6	16
Single-Unit Trucks	1	1	8	0	10	8	39	3	0	50	2	2	0	0	4	1	20	3	0	24	88
% Single-Unit	50.0	100.0	72.7	0.0	71.4	72.7	76.5	75.0	0.0	75.8	100.0	50.0	0.0	0.0	57.1	100.0	66.7	75.0	0.0	68.6	72.1
Exiting Leg Total					13					30					5					40	88
Articulated Trucks	0	0	1	0	1	2	8	0	0	10	0	0	0	0	0	0	6	1	0	7	18
% Articulated	0.0	0.0	9.1	0.0	7.1	18.2	15.7	0.0	0.0	15.2	0.0	0.0	0.0	0.0	0.0	0.0	20.0	25.0	0.0	20.0	14.8
Exiting Leg Total					3					7					0					8	18

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	0	0	0	1	5	6	0	0	11	0	0	1	0	1	1	1	0	0	2	15
7:15 AM	0	0	1	0	1	0	7	1	0	8	1	0	0	0	1	0	2	1	0	3	13
7:30 AM	1	0	3	0	4	3	7	0	0	10	0	0	0	0	0	0	8	0	0	8	22
7:45 AM	0	0	3	0	3	1	7	3	0	11	0	2	0	0	2	0	1	0	0	1	17
Total Volume	2	0	7	0	9	9	27	4	0	40	1	2	1	0	4	1	12	1	0	14	67
% Approach Total	22.2	0.0	77.8	0.0		22.5	67.5	10.0	0.0		25.0	50.0	25.0	0.0		7.1	85.7	7.1	0.0		
PHF	0.500	0.000	0.583	0.000	0.563	0.450	0.964	0.333	0.000	0.909	0.250	0.250	0.250	0.000	0.500	0.250	0.375	0.250	0.000	0.438	0.761
Buses	1	0	1	0	2	1	2	1	0	4	0	2	1	0	3	0	0	0	0	0	9
Buses %	50.0	0.0	14.3	0.0	22.2	11.1	7.4	25.0	0.0	10.0	0.0	100.0	100.0	0.0	75.0	0.0	0.0	0.0	0.0	0.0	13.4
Single-Unit Trucks	1	0	6	0	7	6	21	3	0	30	1	0	0	0	1	1	9	1	0	11	49
Single-Unit %	50.0	0.0	85.7	0.0	77.8	66.7	77.8	75.0	0.0	75.0	100.0	0.0	0.0	0.0	25.0	100.0	75.0	100.0	0.0	78.6	73.1
Articulated Trucks	0	0	0	0	0	2	4	0	0	6	0	0	0	0	0	0	3	0	0	3	9
Articulated %	0.0	0.0	0.0	0.0	0.0	22.2	14.8	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	21.4	13.4
Buses	1	0	1	0	2	1	2	1	0	4	0	2	1	0	3	0	0	0	0	0	9
Single-Unit Trucks	1	0	6	0	7	6	21	3	0	30	1	0	0	0	1	1	9	1	0	11	49
Articulated Trucks	0	0	0	0	0	2	4	0	0	6	0	0	0	0	0	0	3	0	0	3	9
Total Entering Leg	2	0	7	0	9	9	27	4	0	40	1	2	1	0	4	1	12	1	0	14	67
Buses					3					1					1					4	9
Single-Unit Trucks					7					16					4					22	49
Articulated Trucks					2					3					0					4	9
Total Exiting Leg					12					20					5					30	67

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	14	25	0	40	36	97	10	2	145	25	12	4	0	41	0	161	6	1	168	394
7:15 AM	4	5	21	0	30	45	121	14	1	181	40	16	8	0	64	2	165	11	0	178	453
7:30 AM	3	7	30	0	40	41	130	8	0	179	36	21	13	0	70	4	227	10	0	241	530
7:45 AM	5	6	28	0	39	73	127	9	0	209	43	21	2	0	66	6	196	18	0	220	534
Total	13	32	104	0	149	195	475	41	3	714	144	70	27	0	241	12	749	45	1	807	1911
8:00 AM	4	12	28	0	44	68	126	10	2	206	46	40	9	0	95	3	198	20	0	221	566
8:15 AM	4	9	36	0	49	85	99	10	2	196	67	42	6	0	115	8	162	18	0	188	548
8:30 AM	6	14	34	0	54	74	122	8	2	206	39	44	4	0	87	3	149	14	0	166	513
8:45 AM	8	16	31	0	55	91	130	7	2	230	48	66	5	0	119	0	160	27	0	187	591
Total	22	51	129	0	202	318	477	35	8	838	200	192	24	0	416	14	669	79	0	762	2218
Grand Total	35	83	233	0	351	513	952	76	11	1552	344	262	51	0	657	26	1418	124	1	1569	4129
Approach %	10.0	23.6	66.4	0.0		33.1	61.3	4.9	0.7		52.4	39.9	7.8	0.0		1.7	90.4	7.9	0.1		
Total %	0.8	2.0	5.6	0.0	8.5	12.4	23.1	1.8	0.3	37.6	8.3	6.3	1.2	0.0	15.9	0.6	34.3	3.0	0.0	38.0	
Exiting Leg Total					899					2006					185					1039	4129

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	4	12	28	0	44	68	126	10	2	206	46	40	9	0	95	3	198	20	0	221	566
8:15 AM	4	9	36	0	49	85	99	10	2	196	67	42	6	0	115	8	162	18	0	188	548
8:30 AM	6	14	34	0	54	74	122	8	2	206	39	44	4	0	87	3	149	14	0	166	513
8:45 AM	8	16	31	0	55	91	130	7	2	230	48	66	5	0	119	0	160	27	0	187	591
Total Volume	22	51	129	0	202	318	477	35	8	838	200	192	24	0	416	14	669	79	0	762	2218
% Approach Total	10.9	25.2	63.9	0.0		37.9	56.9	4.2	1.0		48.1	46.2	5.8	0.0		1.8	87.8	10.4	0.0		
PHF	0.688	0.797	0.896	0.000	0.918	0.874	0.917	0.875	1.000	0.911	0.746	0.727	0.667	0.000	0.874	0.438	0.845	0.731	0.000	0.862	0.938
Entering Leg	22	51	129	0	202	318	477	35	8	838	200	192	24	0	416	14	669	79	0	762	2218
Exiting Leg					589					1006					100					523	2218
Total					791					1844					516					1285	4436

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Light Goods Vehicle**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	2	0	5	0	7	9	8	2	0	19	6	0	1	0	7	0	14	1	0	15	48
7:15 AM	3	2	6	0	11	5	10	1	0	16	3	4	1	0	8	0	13	1	0	14	49
7:30 AM	0	0	4	0	4	1	17	1	0	19	5	3	0	0	8	0	14	0	0	14	45
7:45 AM	0	3	5	0	8	7	10	2	0	19	6	2	0	0	8	1	17	0	0	18	53
Total	5	5	20	0	30	22	45	6	0	73	20	9	2	0	31	1	58	2	0	61	195
8:00 AM	3	3	5	0	11	8	11	0	0	19	2	1	0	0	3	0	8	2	0	10	43
8:15 AM	1	1	4	0	6	9	9	0	0	18	0	3	1	0	4	0	11	2	0	13	41
8:30 AM	0	0	3	0	3	9	9	2	0	20	3	2	0	0	5	0	6	2	0	8	36
8:45 AM	0	1	4	0	5	10	0	1	0	11	1	3	1	0	5	1	13	3	0	17	38
Total	4	5	16	0	25	36	29	3	0	68	6	9	2	0	17	1	38	9	0	48	158
Grand Total	9	10	36	0	55	58	74	9	0	141	26	18	4	0	48	2	96	11	0	109	353
Approach %	16.4	18.2	65.5	0.0		41.1	52.5	6.4	0.0		54.2	37.5	8.3	0.0		1.8	88.1	10.1	0.0		
Total %	2.5	2.8	10.2	0.0	15.6	16.4	21.0	2.5	0.0	39.9	7.4	5.1	1.1	0.0	13.6	0.6	27.2	3.1	0.0	30.9	
Exiting Leg Total					87					158					21					87	353

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	2	0	5	0	7	9	8	2	0	19	6	0	1	0	7	0	14	1	0	15	48
7:15 AM	3	2	6	0	11	5	10	1	0	16	3	4	1	0	8	0	13	1	0	14	49
7:30 AM	0	0	4	0	4	1	17	1	0	19	5	3	0	0	8	0	14	0	0	14	45
7:45 AM	0	3	5	0	8	7	10	2	0	19	6	2	0	0	8	1	17	0	0	18	53
Total Volume	5	5	20	0	30	22	45	6	0	73	20	9	2	0	31	1	58	2	0	61	195
% Approach Total	16.7	16.7	66.7	0.0		30.1	61.6	8.2	0.0		64.5	29.0	6.5	0.0		1.6	95.1	3.3	0.0		
PHF	0.417	0.417	0.833	0.000	0.682	0.611	0.662	0.750	0.000	0.961	0.833	0.563	0.500	0.000	0.969	0.250	0.853	0.500	0.000	0.847	0.920
Entering Leg	5	5	20	0	30	22	45	6	0	73	20	9	2	0	31	1	58	2	0	61	195
Exiting Leg					33					98					12					52	195
Total					63					171					43					113	390

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Buses**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	3
7:15 AM	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	2
7:30 AM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
Total	1	0	1	0	2	1	2	1	0	4	0	2	1	0	3	0	0	0	0	0	9
8:00 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
8:15 AM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	3
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Total	0	0	1	0	1	0	2	0	0	2	0	0	0	0	0	0	4	0	0	4	7
Grand Total	1	0	2	0	3	1	4	1	0	6	0	2	1	0	3	0	4	0	0	4	16
Approach %	33.3	0.0	66.7	0.0		16.7	66.7	16.7	0.0		0.0	66.7	33.3	0.0		0.0	100.0	0.0	0.0		
Total %	6.3	0.0	12.5	0.0	18.8	6.3	25.0	6.3	0.0	37.5	0.0	12.5	6.3	0.0	18.8	0.0	25.0	0.0	0.0	25.0	
Exiting Leg Total					3					6					1					6	16

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	3
7:15 AM	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	2
7:30 AM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
Total Volume	1	0	1	0	2	1	2	1	0	4	0	2	1	0	3	0	0	0	0	0	9
% Approach Total	50.0	0.0	50.0	0.0		25.0	50.0	25.0	0.0		0.0	66.7	33.3	0.0		0.0	0.0	0.0	0.0		
PHF	0.250	0.000	0.250	0.000	0.500	0.250	0.500	0.250	0.000	0.500	0.000	0.250	0.250	0.000	0.375	0.000	0.000	0.000	0.000	0.000	0.750
Entering Leg	1	0	1	0	2	1	2	1	0	4	0	2	1	0	3	0	0	0	0	0	9
Exiting Leg					3					1					1					4	9
Total					5					5					4					4	18

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Single-Unit Trucks**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	3	4	0	0	7	0	0	0	0	0	1	1	0	0	2	9
7:15 AM	0	0	1	0	1	0	5	0	0	5	1	0	0	0	1	0	1	1	0	2	9
7:30 AM	1	0	2	0	3	2	5	0	0	7	0	0	0	0	0	0	6	0	0	6	16
7:45 AM	0	0	3	0	3	1	7	3	0	11	0	0	0	0	0	0	1	0	0	1	15
Total	1	0	6	0	7	6	21	3	0	30	1	0	0	0	1	1	9	1	0	11	49
8:00 AM	0	0	0	0	0	0	2	0	0	2	1	0	0	0	1	0	3	1	0	4	7
8:15 AM	0	0	1	0	1	0	5	0	0	5	0	2	0	0	2	0	2	0	0	2	10
8:30 AM	0	0	0	0	0	2	2	0	0	4	0	0	0	0	0	0	2	1	0	3	7
8:45 AM	0	1	1	0	2	0	9	0	0	9	0	0	0	0	0	0	4	0	0	4	15
Total	0	1	2	0	3	2	18	0	0	20	1	2	0	0	3	0	11	2	0	13	39
Grand Total	1	1	8	0	10	8	39	3	0	50	2	2	0	0	4	1	20	3	0	24	88
Approach %	10.0	10.0	80.0	0.0		16.0	78.0	6.0	0.0		50.0	50.0	0.0	0.0		4.2	83.3	12.5	0.0		
Total %	1.1	1.1	9.1	0.0	11.4	9.1	44.3	3.4	0.0	56.8	2.3	2.3	0.0	0.0	4.5	1.1	22.7	3.4	0.0	27.3	
Exiting Leg Total					13					30					5					40	88

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	3	4	0	0	7	0	0	0	0	0	1	1	0	0	2	9
7:15 AM	0	0	1	0	1	0	5	0	0	5	1	0	0	0	1	0	1	1	0	2	9
7:30 AM	1	0	2	0	3	2	5	0	0	7	0	0	0	0	0	0	6	0	0	6	16
7:45 AM	0	0	3	0	3	1	7	3	0	11	0	0	0	0	0	0	1	0	0	1	15
Total Volume	1	0	6	0	7	6	21	3	0	30	1	0	0	0	1	1	9	1	0	11	49
% Approach Total	14.3	0.0	85.7	0.0		20.0	70.0	10.0	0.0		100.0	0.0	0.0	0.0		9.1	81.8	9.1	0.0		
PHF	0.250	0.000	0.500	0.000	0.583	0.500	0.750	0.250	0.000	0.682	0.250	0.000	0.000	0.000	0.250	0.250	0.375	0.250	0.000	0.458	0.766
Entering Leg	1	0	6	0	7	6	21	3	0	30	1	0	0	0	1	1	9	1	0	11	49
Exiting Leg					7					16					4					22	49
Total					14					46					5					33	98

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Articulated Trucks**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	0	0	0	0	0	3
7:15 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
7:30 AM	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	2	0	0	2	4
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	2	4	0	0	6	0	0	0	0	0	0	3	0	0	3	9
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
8:15 AM	0	0	1	0	1	0	2	0	0	2	0	0	0	0	0	0	0	1	0	1	4
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	3
Total	0	0	1	0	1	0	4	0	0	4	0	0	0	0	0	0	3	1	0	4	9
Grand Total	0	0	1	0	1	2	8	0	0	10	0	0	0	0	0	0	6	1	0	7	18
Approach %	0.0	0.0	100.0	0.0		20.0	80.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	85.7	14.3	0.0		
Total %	0.0	0.0	5.6	0.0	5.6	11.1	44.4	0.0	0.0	55.6	0.0	0.0	0.0	0.0	0.0	0.0	33.3	5.6	0.0	38.9	
Exiting Leg Total					3					7					0					8	18

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:30 AM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:30 AM	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	2	0	0	2	4
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
8:15 AM	0	0	1	0	1	0	2	0	0	2	0	0	0	0	0	0	0	1	0	1	4
Total Volume	0	0	1	0	1	1	3	0	0	4	0	0	0	0	0	0	4	1	0	5	10
% Approach Total	0.0	0.0	100.0	0.0		25.0	75.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	80.0	20.0	0.0		
PHF	0.000	0.000	0.250	0.000	0.250	0.250	0.375	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.000	0.625	0.625
Entering Leg	0	0	1	0	1	1	3	0	0	4	0	0	0	0	0	0	4	1	0	5	10
Exiting Leg					2					5					0					3	10
Total					3					9					0					8	20

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Bicycles (on Roadway and Crosswalks)**

	Gould Street							Highland Avenue							Hunting Road							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
Total	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
8:15 AM	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	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
8:45 AM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0	0	2
Grand Total	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0	0	3
Approach %	0.0	0.0	100.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	50.0	0.0	0.0	0.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		
Total %	0.0	0.0	33.3	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total							1							1							1							0	3

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Gould Street							Highland Avenue							Hunting Road							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:15 AM	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Total Volume	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2
% Approach Total	0.0	0.0	100.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.250	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500
Entering Leg	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2
Exiting Leg							0							1							1							0	2
Total							1							1							2							0	4

PDI File #: **196735 F**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Pedestrians**

	Gould Street							Highland Avenue							Hunting Road							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
Total	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
8:30 AM	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	0	0	0
8:45 AM	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	0	0	0
Total	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2
Grand Total	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3
Approach %	0	0	0	0	50	50		0	0	0	0	0	0		0	0	0	0	0	100		0	0	0	0	0	0		
Total %	0	0	0	0	33.3	33.3	66.7	0	0	0	0	0	0	0	0	0	0	0	0	33.3	33.3	0	0	0	0	0	0	0	
Exiting Leg Total							2							0							1							0	3

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Gould Street							Highland Avenue							Hunting Road							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:15 AM	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
8:00 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
% Approach Total	0.0	0.0	0.0	0.0	50.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.250	0.250	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500
Entering Leg	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Exiting Leg							2							0							0							0	2
Total							4							0							0							0	4

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Cars and Heavy Vehicles (Combined)

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	12	27	54	0	93	47	163	23	3	236	26	20	4	0	50	6	182	16	0	204	583
3:15 PM	15	18	70	0	103	46	135	18	2	201	23	13	6	0	42	7	170	10	0	187	533
3:30 PM	17	27	69	0	113	48	169	23	1	241	24	16	8	0	48	5	175	6	0	186	588
3:45 PM	7	18	58	0	83	36	177	21	2	236	19	18	2	0	39	4	152	14	0	170	528
Total	51	90	251	0	392	177	644	85	8	914	92	67	20	0	179	22	679	46	0	747	2232
4:00 PM	17	39	92	0	148	44	155	30	0	229	29	23	6	0	58	1	172	10	0	183	618
4:15 PM	12	27	69	0	108	30	187	32	0	249	16	15	8	0	39	7	144	4	0	155	551
4:30 PM	17	38	94	0	149	36	174	27	1	238	26	12	9	0	47	3	135	8	0	146	580
4:45 PM	12	28	47	0	87	50	190	29	1	270	21	21	7	0	49	3	168	5	0	176	582
Total	58	132	302	0	492	160	706	118	2	986	92	71	30	0	193	14	619	27	0	660	2331
5:00 PM	27	30	111	0	168	33	241	32	2	308	18	12	4	0	34	5	152	2	0	159	669
5:15 PM	7	46	73	0	126	48	224	25	2	299	17	12	7	0	36	3	136	9	0	148	609
5:30 PM	17	29	85	0	131	47	207	30	0	284	26	13	6	0	45	6	140	6	0	152	612
5:45 PM	13	28	72	0	113	49	203	30	1	283	11	20	4	0	35	6	106	9	0	121	552
Total	64	133	341	0	538	177	875	117	5	1174	72	57	21	0	150	20	534	26	0	580	2442
Grand Total	173	355	894	0	1422	514	2225	320	15	3074	256	195	71	0	522	56	1832	99	0	1987	7005
Approach %	12.2	25.0	62.9	0.0		16.7	72.4	10.4	0.5		49.0	37.4	13.6	0.0		2.8	92.2	5.0	0.0		
Total %	2.5	5.1	12.8	0.0	20.3	7.3	31.8	4.6	0.2	43.9	3.7	2.8	1.0	0.0	7.5	0.8	26.2	1.4	0.0	28.4	
Exiting Leg Total					808					2997					731					2469	7005
Cars	168	353	879	0	1400	502	2198	319	15	3034	252	189	70	0	511	55	1808	96	0	1959	6904
% Cars	97.1	99.4	98.3	0.0	98.5	97.7	98.8	99.7	100.0	98.7	98.4	96.9	98.6	0.0	97.9	98.2	98.7	97.0	0.0	98.6	98.6
Exiting Leg Total					787					2954					727					2436	6904
Heavy Vehicles	5	2	15	0	22	12	27	1	0	40	4	6	1	0	11	1	24	3	0	28	101
% Heavy Vehicles	2.9	0.6	1.7	0.0	1.5	2.3	1.2	0.3	0.0	1.3	1.6	3.1	1.4	0.0	2.1	1.8	1.3	3.0	0.0	1.4	1.4
Exiting Leg Total					21					43					4					33	101

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	12	28	47	0	87	50	190	29	1	270	21	21	7	0	49	3	168	5	0	176	582
5:00 PM	27	30	111	0	168	33	241	32	2	308	18	12	4	0	34	5	152	2	0	159	669
5:15 PM	7	46	73	0	126	48	224	25	2	299	17	12	7	0	36	3	136	9	0	148	609
5:30 PM	17	29	85	0	131	47	207	30	0	284	26	13	6	0	45	6	140	6	0	152	612
Total Volume	63	133	316	0	512	178	862	116	5	1161	82	58	24	0	164	17	596	22	0	635	2472
% Approach Total	12.3	26.0	61.7	0.0		15.3	74.2	10.0	0.4		50.0	35.4	14.6	0.0		2.7	93.9	3.5	0.0		
PHF	0.583	0.723	0.712	0.000	0.762	0.890	0.894	0.906	0.625	0.942	0.788	0.690	0.857	0.000	0.837	0.708	0.887	0.611	0.000	0.902	0.924
Cars	63	132	312	0	507	174	855	115	5	1149	82	57	24	0	163	17	592	22	0	631	2450
Cars %	100.0	99.2	98.7	0.0	99.0	97.8	99.2	99.1	100.0	99.0	100.0	98.3	100.0	0.0	99.4	100.0	99.3	100.0	0.0	99.4	99.1
Heavy Vehicles	0	1	4	0	5	4	7	1	0	12	0	1	0	0	1	0	4	0	0	4	22
Heavy Vehicles %	0.0	0.8	1.3	0.0	1.0	2.2	0.8	0.9	0.0	1.0	0.0	1.7	0.0	0.0	0.6	0.0	0.7	0.0	0.0	0.6	0.9
Cars Enter Leg	63	132	312	0	507	174	855	115	5	1149	82	57	24	0	163	17	592	22	0	631	2450
Heavy Enter Leg	0	1	4	0	5	4	7	1	0	12	0	1	0	0	1	0	4	0	0	4	22
Total Entering Leg	63	133	316	0	512	178	862	116	5	1161	82	58	24	0	164	17	596	22	0	635	2472
Cars Exiting Leg					253					991					264					942	2450
Heavy Exiting Leg					5					8					2					7	22
Total Exiting Leg					258					999					266					949	2472

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	11	27	53	0	91	46	161	23	3	233	25	16	4	0	45	5	178	14	0	197	566
3:15 PM	15	18	68	0	101	44	131	18	2	195	22	12	6	0	40	7	167	9	0	183	519
3:30 PM	15	26	68	0	109	48	163	23	1	235	24	16	8	0	48	5	170	6	0	181	573
3:45 PM	7	18	56	0	81	33	175	21	2	231	19	18	1	0	38	4	148	14	0	166	516
Total	48	89	245	0	382	171	630	85	8	894	90	62	19	0	171	21	663	43	0	727	2174
4:00 PM	17	39	91	0	147	44	152	30	0	226	29	23	6	0	58	1	170	10	0	181	612
4:15 PM	12	27	66	0	105	30	185	32	0	247	15	15	8	0	38	7	142	4	0	153	543
4:30 PM	16	38	94	0	148	34	173	27	1	235	25	12	9	0	46	3	135	8	0	146	575
4:45 PM	12	28	46	0	86	47	187	29	1	264	21	20	7	0	48	3	165	5	0	173	571
Total	57	132	297	0	486	155	697	118	2	972	90	70	30	0	190	14	612	27	0	653	2301
5:00 PM	27	29	110	0	166	33	239	32	2	306	18	12	4	0	34	5	151	2	0	158	664
5:15 PM	7	46	72	0	125	47	223	24	2	296	17	12	7	0	36	3	136	9	0	148	605
5:30 PM	17	29	84	0	130	47	206	30	0	283	26	13	6	0	45	6	140	6	0	152	610
5:45 PM	12	28	71	0	111	49	203	30	1	283	11	20	4	0	35	6	106	9	0	121	550
Total	63	132	337	0	532	176	871	116	5	1168	72	57	21	0	150	20	533	26	0	579	2429
Grand Total	168	353	879	0	1400	502	2198	319	15	3034	252	189	70	0	511	55	1808	96	0	1959	6904
Approach %	12.0	25.2	62.8	0.0		16.5	72.4	10.5	0.5		49.3	37.0	13.7	0.0		2.8	92.3	4.9	0.0		
Total %	2.4	5.1	12.7	0.0	20.3	7.3	31.8	4.6	0.2	43.9	3.7	2.7	1.0	0.0	7.4	0.8	26.2	1.4	0.0	28.4	
Exiting Leg Total					787					2954					727					2436	6904

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	12	28	46	0	86	47	187	29	1	264	21	20	7	0	48	3	165	5	0	173	571
5:00 PM	27	29	110	0	166	33	239	32	2	306	18	12	4	0	34	5	151	2	0	158	664
5:15 PM	7	46	72	0	125	47	223	24	2	296	17	12	7	0	36	3	136	9	0	148	605
5:30 PM	17	29	84	0	130	47	206	30	0	283	26	13	6	0	45	6	140	6	0	152	610
Total Volume	63	132	312	0	507	174	855	115	5	1149	82	57	24	0	163	17	592	22	0	631	2450
% Approach Total	12.4	26.0	61.5	0.0		15.1	74.4	10.0	0.4		50.3	35.0	14.7	0.0		2.7	93.8	3.5	0.0		
PHF	0.583	0.717	0.709	0.000	0.764	0.926	0.894	0.898	0.625	0.939	0.788	0.713	0.857	0.000	0.849	0.708	0.897	0.611	0.000	0.912	0.922
Entering Leg	63	132	312	0	507	174	855	115	5	1149	82	57	24	0	163	17	592	22	0	631	2450
Exiting Leg					253					991					264					942	2450
Total					760					2140					427					1573	4900

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	1	0	2	1	2	0	0	3	1	4	0	0	5	1	4	2	0	7	17
3:15 PM	0	0	2	0	2	2	4	0	0	6	1	1	0	0	2	0	3	1	0	4	14
3:30 PM	2	1	1	0	4	0	6	0	0	6	0	0	0	0	0	0	5	0	0	5	15
3:45 PM	0	0	2	0	2	3	2	0	0	5	0	0	1	0	1	0	4	0	0	4	12
Total	3	1	6	0	10	6	14	0	0	20	2	5	1	0	8	1	16	3	0	20	58
4:00 PM	0	0	1	0	1	0	3	0	0	3	0	0	0	0	0	0	2	0	0	2	6
4:15 PM	0	0	3	0	3	0	2	0	0	2	1	0	0	0	1	0	2	0	0	2	8
4:30 PM	1	0	0	0	1	2	1	0	0	3	1	0	0	0	1	0	0	0	0	0	5
4:45 PM	0	0	1	0	1	3	3	0	0	6	0	1	0	0	1	0	3	0	0	3	11
Total	1	0	5	0	6	5	9	0	0	14	2	1	0	0	3	0	7	0	0	7	30
5:00 PM	0	1	1	0	2	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	5
5:15 PM	0	0	1	0	1	1	1	1	0	3	0	0	0	0	0	0	0	0	0	0	4
5:30 PM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
5:45 PM	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	1	1	4	0	6	1	4	1	0	6	0	0	0	0	0	0	1	0	0	1	13
Grand Total	5	2	15	0	22	12	27	1	0	40	4	6	1	0	11	1	24	3	0	28	101
Approach %	22.7	9.1	68.2	0.0		30.0	67.5	2.5	0.0		36.4	54.5	9.1	0.0		3.6	85.7	10.7	0.0		
Total %	5.0	2.0	14.9	0.0	21.8	11.9	26.7	1.0	0.0	39.6	4.0	5.9	1.0	0.0	10.9	1.0	23.8	3.0	0.0	27.7	
Exiting Leg Total					21					43					4					33	101
Buses	3	0	0	0	3	2	4	0	0	6	2	1	0	0	3	0	6	2	0	8	20
% Buses	60.0	0.0	0.0	0.0	13.6	16.7	14.8	0.0	0.0	15.0	50.0	16.7	0.0	0.0	27.3	0.0	25.0	66.7	0.0	28.6	19.8
Exiting Leg Total					5					8					0					7	20
Single-Unit Trucks	1	2	13	0	16	9	19	1	0	29	2	5	1	0	8	1	14	1	0	16	69
% Single-Unit	20.0	100.0	86.7	0.0	72.7	75.0	70.4	100.0	0.0	72.5	50.0	83.3	100.0	0.0	72.7	100.0	58.3	33.3	0.0	57.1	68.3
Exiting Leg Total					15					29					4					21	69
Articulated Trucks	1	0	2	0	3	1	4	0	0	5	0	0	0	0	0	0	4	0	0	4	12
% Articulated	20.0	0.0	13.3	0.0	13.6	8.3	14.8	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	14.3	11.9
Exiting Leg Total					1					6					0					5	12

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	1	0	2	1	2	0	0	3	1	4	0	0	5	1	4	2	0	7	17
3:15 PM	0	0	2	0	2	2	4	0	0	6	1	1	0	0	2	0	3	1	0	4	14
3:30 PM	2	1	1	0	4	0	6	0	0	6	0	0	0	0	0	0	5	0	0	5	15
3:45 PM	0	0	2	0	2	3	2	0	0	5	0	0	1	0	1	0	4	0	0	4	12
Total Volume	3	1	6	0	10	6	14	0	0	20	2	5	1	0	8	1	16	3	0	20	58
% Approach Total	30.0	10.0	60.0	0.0		30.0	70.0	0.0	0.0		25.0	62.5	12.5	0.0		5.0	80.0	15.0	0.0		
PHF	0.375	0.250	0.750	0.000	0.625	0.500	0.583	0.000	0.000	0.833	0.500	0.313	0.250	0.000	0.400	0.250	0.800	0.375	0.000	0.714	0.853
Buses	2	0	0	0	2	2	1	0	0	3	1	1	0	0	2	0	3	2	0	5	12
Buses %	66.7	0.0	0.0	0.0	20.0	33.3	7.1	0.0	0.0	15.0	50.0	20.0	0.0	0.0	25.0	0.0	18.8	66.7	0.0	25.0	20.7
Single-Unit Trucks	1	1	6	0	8	3	11	0	0	14	1	4	1	0	6	1	11	1	0	13	41
Single-Unit %	33.3	100.0	100.0	0.0	80.0	50.0	78.6	0.0	0.0	70.0	50.0	80.0	100.0	0.0	75.0	100.0	68.8	33.3	0.0	65.0	70.7
Articulated Trucks	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	0	2	0	0	2	5
Articulated %	0.0	0.0	0.0	0.0	0.0	16.7	14.3	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	10.0	8.6
Buses	2	0	0	0	2	2	1	0	0	3	1	1	0	0	2	0	3	2	0	5	12
Single-Unit Trucks	1	1	6	0	8	3	11	0	0	14	1	4	1	0	6	1	11	1	0	13	41
Articulated Trucks	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	0	2	0	0	2	5
Total Entering Leg	3	1	6	0	10	6	14	0	0	20	2	5	1	0	8	1	16	3	0	20	58
Buses					5					4					0					3	12
Single-Unit Trucks					8					18					2					13	41
Articulated Trucks					1					2					0					2	5
Total Exiting Leg					14					24					2					18	58

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	10	22	47	0	79	36	147	20	2	205	19	14	2	0	35	5	162	12	0	179	498
3:15 PM	15	16	56	0	87	38	116	17	2	173	21	11	4	0	36	6	147	9	0	162	458
3:30 PM	10	18	57	0	85	46	146	20	1	213	24	15	6	0	45	5	155	5	0	165	508
3:45 PM	7	16	49	0	72	31	168	20	2	221	13	15	1	0	29	4	131	13	0	148	470
Total	42	72	209	0	323	151	577	77	7	812	77	55	13	0	145	20	595	39	0	654	1934
4:00 PM	16	35	83	0	134	40	145	30	0	215	23	21	6	0	50	1	159	8	0	168	567
4:15 PM	12	24	59	0	95	27	170	31	0	228	14	13	8	0	35	6	133	4	0	143	501
4:30 PM	15	35	89	0	139	31	163	25	1	220	22	11	9	0	42	3	122	8	0	133	534
4:45 PM	12	27	43	0	82	44	180	28	0	252	18	20	7	0	45	3	159	5	0	167	546
Total	55	121	274	0	450	142	658	114	1	915	77	65	30	0	172	13	573	25	0	611	2148
5:00 PM	27	28	103	0	158	33	228	31	1	293	18	12	4	0	34	5	144	2	0	151	636
5:15 PM	7	44	67	0	118	45	213	24	2	284	17	12	7	0	36	3	131	9	0	143	581
5:30 PM	16	27	79	0	122	47	204	29	0	280	25	13	6	0	44	6	137	5	0	148	594
5:45 PM	11	28	68	0	107	48	199	30	1	278	11	20	4	0	35	5	105	8	0	118	538
Total	61	127	317	0	505	173	844	114	4	1135	71	57	21	0	149	19	517	24	0	560	2349
Grand Total	158	320	800	0	1278	466	2079	305	12	2862	225	177	64	0	466	52	1685	88	0	1825	6431
Approach %	12.4	25.0	62.6	0.0		16.3	72.6	10.7	0.4		48.3	38.0	13.7	0.0		2.8	92.3	4.8	0.0		
Total %	2.5	5.0	12.4	0.0	19.9	7.2	32.3	4.7	0.2	44.5	3.5	2.8	1.0	0.0	7.2	0.8	26.2	1.4	0.0	28.4	
Exiting Leg Total					731					2722					677					2301	6431

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	12	27	43	0	82	44	180	28	0	252	18	20	7	0	45	3	159	5	0	167	546
5:00 PM	27	28	103	0	158	33	228	31	1	293	18	12	4	0	34	5	144	2	0	151	636
5:15 PM	7	44	67	0	118	45	213	24	2	284	17	12	7	0	36	3	131	9	0	143	581
5:30 PM	16	27	79	0	122	47	204	29	0	280	25	13	6	0	44	6	137	5	0	148	594
Total Volume	62	126	292	0	480	169	825	112	3	1109	78	57	24	0	159	17	571	21	0	609	2357
% Approach Total	12.9	26.3	60.8	0.0		15.2	74.4	10.1	0.3		49.1	35.8	15.1	0.0		2.8	93.8	3.4	0.0		
PHF	0.574	0.716	0.709	0.000	0.759	0.899	0.905	0.903	0.375	0.946	0.780	0.713	0.857	0.000	0.883	0.708	0.898	0.583	0.000	0.912	0.926
Entering Leg	62	126	292	0	480	169	825	112	3	1109	78	57	24	0	159	17	571	21	0	609	2357
Exiting Leg					247					944					255					911	2357
Total					727					2053					414					1520	4714

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Light Goods Vehicle**

	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	5	6	0	12	10	14	3	1	28	6	2	2	0	10	0	16	2	0	18	68
3:15 PM	0	2	12	0	14	6	15	1	0	22	1	1	2	0	4	1	20	0	0	21	61
3:30 PM	5	8	11	0	24	2	17	3	0	22	0	1	2	0	3	0	15	1	0	16	65
3:45 PM	0	2	7	0	9	2	7	1	0	10	6	3	0	0	9	0	17	1	0	18	46
Total	6	17	36	0	59	20	53	8	1	82	13	7	6	0	26	1	68	4	0	73	240
4:00 PM	1	4	8	0	13	4	7	0	0	11	6	2	0	0	8	0	11	2	0	13	45
4:15 PM	0	3	7	0	10	3	15	1	0	19	1	2	0	0	3	1	9	0	0	10	42
4:30 PM	1	3	5	0	9	3	10	2	0	15	3	1	0	0	4	0	13	0	0	13	41
4:45 PM	0	1	3	0	4	3	7	1	1	12	3	0	0	0	3	0	6	0	0	6	25
Total	2	11	23	0	36	13	39	4	1	57	13	5	0	0	18	1	39	2	0	42	153
5:00 PM	0	1	7	0	8	0	11	1	1	13	0	0	0	0	0	0	7	0	0	7	28
5:15 PM	0	2	5	0	7	2	10	0	0	12	0	0	0	0	0	0	5	0	0	5	24
5:30 PM	1	2	5	0	8	0	2	1	0	3	1	0	0	0	1	0	3	1	0	4	16
5:45 PM	1	0	3	0	4	1	4	0	0	5	0	0	0	0	0	1	1	1	0	3	12
Total	2	5	20	0	27	3	27	2	1	33	1	0	0	0	1	1	16	2	0	19	80
Grand Total	10	33	79	0	122	36	119	14	3	172	27	12	6	0	45	3	123	8	0	134	473
Approach %	8.2	27.0	64.8	0.0		20.9	69.2	8.1	1.7		60.0	26.7	13.3	0.0		2.2	91.8	6.0	0.0		
Total %	2.1	7.0	16.7	0.0	25.8	7.6	25.2	3.0	0.6	36.4	5.7	2.5	1.3	0.0	9.5	0.6	26.0	1.7	0.0	28.3	
Exiting Leg Total					56					232					50					135	473

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Gould Street from North					Highland Avenue from East					Hunting Road from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	5	6	0	12	10	14	3	1	28	6	2	2	0	10	0	16	2	0	18	68
3:15 PM	0	2	12	0	14	6	15	1	0	22	1	1	2	0	4	1	20	0	0	21	61
3:30 PM	5	8	11	0	24	2	17	3	0	22	0	1	2	0	3	0	15	1	0	16	65
3:45 PM	0	2	7	0	9	2	7	1	0	10	6	3	0	0	9	0	17	1	0	18	46
Total Volume	6	17	36	0	59	20	53	8	1	82	13	7	6	0	26	1	68	4	0	73	240
% Approach Total	10.2	28.8	61.0	0.0		24.4	64.6	9.8	1.2		50.0	26.9	23.1	0.0		1.4	93.2	5.5	0.0		
PHF	0.300	0.531	0.750	0.000	0.615	0.500	0.779	0.667	0.250	0.732	0.542	0.583	0.750	0.000	0.650	0.250	0.850	0.500	0.000	0.869	0.882
Entering Leg	6	17	36	0	59	20	53	8	1	82	13	7	6	0	26	1	68	4	0	73	240
Exiting Leg					31					118					26					65	240
Total					90					200					52					138	480

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Buses**

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	1	0	2	4
3:15 PM	0	0	0	0	0	2	0	0	0	2	1	0	0	0	1	0	1	1	0	2	5
3:30 PM	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	3
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	2	2	1	0	0	3	1	1	0	0	2	0	3	2	0	5	12
4:00 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
4:15 PM	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	2	0	0	2	4
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	3	0	0	3	1	0	0	0	1	0	2	0	0	2	6
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2
Grand Total	3	0	0	0	3	2	4	0	0	6	2	1	0	0	3	0	6	2	0	8	20
Approach %	100.0	0.0	0.0	0.0		33.3	66.7	0.0	0.0		66.7	33.3	0.0	0.0		0.0	75.0	25.0	0.0		
Total %	15.0	0.0	0.0	0.0	15.0	10.0	20.0	0.0	0.0	30.0	10.0	5.0	0.0	0.0	15.0	0.0	30.0	10.0	0.0	40.0	
Exiting Leg Total					5					8					0					7	20

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	1	0	2	4
3:15 PM	0	0	0	0	0	2	0	0	0	2	1	0	0	0	1	0	1	1	0	2	5
3:30 PM	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	3
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	2	0	0	0	2	2	1	0	0	3	1	1	0	0	2	0	3	2	0	5	12
% Approach Total	100.0	0.0	0.0	0.0		66.7	33.3	0.0	0.0		50.0	50.0	0.0	0.0		0.0	60.0	40.0	0.0		
PHF	0.500	0.000	0.000	0.000	0.500	0.250	0.250	0.000	0.000	0.375	0.250	0.250	0.000	0.000	0.500	0.000	0.750	0.500	0.000	0.625	0.600
Entering Leg	2	0	0	0	2	2	1	0	0	3	1	1	0	0	2	0	3	2	0	5	12
Exiting Leg					5					4					0					3	12
Total					7					7					2					8	24

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Single-Unit Trucks**

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	1	0	1	1	2	0	0	3	1	3	0	0	4	1	2	1	0	4	12
3:15 PM	0	0	2	0	2	0	3	0	0	3	0	1	0	0	1	0	2	0	0	2	8
3:30 PM	1	1	1	0	3	0	5	0	0	5	0	0	0	0	0	0	3	0	0	3	11
3:45 PM	0	0	2	0	2	2	1	0	0	3	0	0	1	0	1	0	4	0	0	4	10
Total	1	1	6	0	8	3	11	0	0	14	1	4	1	0	6	1	11	1	0	13	41
4:00 PM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	2	4
4:15 PM	0	0	3	0	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	4
4:30 PM	0	0	0	0	0	2	0	0	0	2	1	0	0	0	1	0	0	0	0	0	3
4:45 PM	0	0	1	0	1	3	3	0	0	6	0	1	0	0	1	0	1	0	0	1	9
Total	0	0	5	0	5	5	5	0	0	10	1	1	0	0	2	0	3	0	0	3	20
5:00 PM	0	1	1	0	2	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	4
5:15 PM	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	2
5:30 PM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	2	0	3	1	3	1	0	5	0	0	0	0	0	0	0	0	0	0	8
Grand Total	1	2	13	0	16	9	19	1	0	29	2	5	1	0	8	1	14	1	0	16	69
Approach %	6.3	12.5	81.3	0.0		31.0	65.5	3.4	0.0		25.0	62.5	12.5	0.0		6.3	87.5	6.3	0.0		
Total %	1.4	2.9	18.8	0.0	23.2	13.0	27.5	1.4	0.0	42.0	2.9	7.2	1.4	0.0	11.6	1.4	20.3	1.4	0.0	23.2	
Exiting Leg Total					15					29					4					21	69

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	1	0	1	1	2	0	0	3	1	3	0	0	4	1	2	1	0	4	12
3:15 PM	0	0	2	0	2	0	3	0	0	3	0	1	0	0	1	0	2	0	0	2	8
3:30 PM	1	1	1	0	3	0	5	0	0	5	0	0	0	0	0	0	3	0	0	3	11
3:45 PM	0	0	2	0	2	2	1	0	0	3	0	0	1	0	1	0	4	0	0	4	10
Total Volume	1	1	6	0	8	3	11	0	0	14	1	4	1	0	6	1	11	1	0	13	41
% Approach Total	12.5	12.5	75.0	0.0		21.4	78.6	0.0	0.0		16.7	66.7	16.7	0.0		7.7	84.6	7.7	0.0		
PHF	0.250	0.250	0.750	0.000	0.667	0.375	0.550	0.000	0.000	0.700	0.250	0.333	0.250	0.000	0.375	0.250	0.688	0.250	0.000	0.813	0.854
Entering Leg	1	1	6	0	8	3	11	0	0	14	1	4	1	0	6	1	11	1	0	13	41
Exiting Leg					8					18					2					13	41
Total					16					32					8					26	82

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Articulated Trucks**

	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
3:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
3:45 PM	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	0	2	0	0	2	5
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
Total	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	2	4
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	2	0	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3
Grand Total	1	0	2	0	3	1	4	0	0	5	0	0	0	0	0	0	4	0	0	4	12
Approach %	33.3	0.0	66.7	0.0		20.0	80.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		
Total %	8.3	0.0	16.7	0.0	25.0	8.3	33.3	0.0	0.0	41.7	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	33.3	
Exiting Leg Total					1					6					0					5	12

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:30 PM	Gould Street					Highland Avenue					Hunting Road					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:30 PM	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Total Volume	1	0	1	0	2	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	6
% Approach Total	50.0	0.0	50.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.250	0.000	0.250	0.000	0.500	0.000	0.500	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.250	0.750
Entering Leg	1	0	1	0	2	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	6
Exiting Leg					0					3					0					3	6
Total					2					5					0					5	12

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Bicycles (on Roadway and Crosswalks)

	Gould Street							Highland Avenue							Hunting Road							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total	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	0	0	0
4:00 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	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	0	0	0
4:30 PM	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	0	0	0
4:45 PM	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	0	0	0
Total	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Grand Total	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Approach %	0.0	100.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
Total %	0.0	50.0	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total							0							0							1							1	2

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:15 PM	Gould Street							Highland Avenue							Hunting Road							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
4:00 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Volume	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% Approach Total	0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Entering Leg	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Exiting Leg							0							0							1							0	1
Total							1							0							1							0	2

PDI File #: **196735 FF**
Location: **N: Gould Street S: Hunting Road**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Pedestrians**

	Gould Street from North							Highland Avenue from East							Hunting Road from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	1	1	1
3:30 PM	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	0	0	0
3:45 PM	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	1	0	1	1
Total	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	1	1	2	2
4:00 PM	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	0	0	0
4:15 PM	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	0	0	0
4:30 PM	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	0	0	0
4:45 PM	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	0	0	0
Total	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	0	0	0
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	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	0	0	0
Total	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	0	0	0
Grand Total	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	1	1	2	2
Approach %	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	50	50		
Total %	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	50	50	100	
Exiting Leg Total							0							0							0							2	2

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Gould Street from North							Highland Avenue from East							Hunting Road from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	1	1	1
3:30 PM	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	0	0	0
3:45 PM	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	1	0	1	1
Total Volume	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	1	1	2	2
% Approach Total	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	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	50.0	50.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.500	0.500
Entering Leg	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	1	1	2	2
Exiting Leg							0							0							0							2	2
Total							0							0							0							4	4

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 3
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 SB On Ramp/ SB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

BOSTON TRAFFIC DATA
PO BOX 1723, Framingham, MA 01701
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TOTAL (CARS & TRUCKS)

	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	139	0	0	0	0	0	0	211	0	0	0	78	52
7:15 AM	0	0	0	125	0	0	0	0	0	0	245	0	0	0	81	56
7:30 AM	0	0	0	106	0	0	0	0	0	0	269	0	0	0	90	55
7:45 AM	0	0	0	129	0	0	0	0	0	0	264	0	0	0	98	53
8:00 AM	0	0	0	146	0	0	0	0	0	0	253	0	0	0	101	58
8:15 AM	0	0	0	172	0	0	0	0	0	0	260	0	0	0	99	60
8:30 AM	0	0	0	191	0	0	0	0	0	0	262	0	0	0	97	59
8:45 AM	0	0	0	187	0	0	0	0	0	0	254	0	0	0	95	57

	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	49	0	0	0	0	0	0	231	0	0	0	144	56
4:15 PM	0	0	0	53	0	0	0	0	0	0	222	0	0	0	149	58
4:30 PM	0	0	0	52	0	0	0	0	0	0	204	0	0	0	143	63
4:45 PM	0	0	0	60	0	0	0	0	0	0	211	0	0	0	135	66
5:00 PM	0	0	0	66	0	0	0	0	0	0	209	0	0	0	151	92
5:15 PM	0	0	0	65	0	0	0	0	0	0	210	0	0	0	162	114
5:30 PM	0	0	0	63	0	0	0	0	0	0	203	0	0	0	163	113
5:45 PM	0	0	0	59	0	0	0	0	0	0	197	0	0	0	157	108

AM PEAK HOUR 8:00 AM to 9:00 AM	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**696**	**0**	**0**	**0**	**0**	**0**	**0**	**1029**	**0**	**0**	**0**	**392**	**234**
PHF	**0.91**				**0.00**				**0.98**				**0.98**			
HV %	**0.0%**	**0.0%**	**0.0%**	**1.7%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.7%**	**0.0%**	**0.0%**	**0.0%**	**2.3%**	**3.4%**

PM PEAK HOUR 5:00 PM to 6:00 PM	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**253**	**0**	**0**	**0**	**0**	**0**	**0**	**819**	**0**	**0**	**0**	**633**	**427**
PHF	**0.96**				**0.00**				**0.98**				**0.96**			
HV %	**0.0%**	**0.0%**	**0.0%**	**1.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.2%**	**0.0%**	**0.0%**	**0.0%**	**0.3%**	**0.9%**

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 3
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 SB On Ramp/ SB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

BOSTON TRAFFIC DATA
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TRUCKS

	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	2
7:15 AM	0	0	0	5	0	0	0	0	0	0	1	0	0	0	1	2
7:30 AM	0	0	0	3	0	0	0	0	0	0	2	0	0	0	1	3
7:45 AM	0	0	0	4	0	0	0	0	0	0	1	0	0	0	5	1
8:00 AM	0	0	0	3	0	0	0	0	0	0	1	0	0	0	4	1
8:15 AM	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	2
8:30 AM	0	0	0	4	0	0	0	0	0	0	2	0	0	0	1	3
8:45 AM	0	0	0	3	0	0	0	0	0	0	2	0	0	0	2	2

	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3
4:15 PM	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0
4:30 PM	0	0	0	2	0	0	0	0	0	0	3	0	0	0	1	1
4:45 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
5:00 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2
5:15 PM	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	1
5:30 PM	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

AM PEAK HOUR 7:15 AM to 8:15 AM	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**11**	**7**
PHF	**0.75**				**0.00**				**0.63**				**0.75**			

PM PEAK HOUR 4:00 PM to 5:00 PM	I-95 SB Off Ramp Northbound				I-95 SB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**2**	**6**
PHF	**0.42**				**0.00**				**0.50**				**0.50**			

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 3
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 SB On Ramp/ SB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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PEDESTRIANS & BICYCLES

	I-95 SB Off Ramp Northbound					I-95 SB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
7:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:15 AM	0	0	0	0		0	0	0	0		0	1	0	0		0	0	0	0	
7:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	
8:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:15 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	

	I-95 SB Off Ramp Northbound					I-95 SB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
4:00 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
4:15 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:30 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:45 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:00 PM	0	0	0	0		0	0	0	2		0	0	0	0		0	0	0	0	
5:15 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:30 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:45 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	

AM PEAK HOUR[1] 8:00 AM to 9:00 AM	I-95 SB Off Ramp Northbound					I-95 SB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	

PM PEAK HOUR[1] 5:00 PM to 6:00 PM	I-95 SB Off Ramp Northbound					I-95 SB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
	0	0	0	0		0	0	0	2		0	0	0	0		0	0	0	0	

[1] *Peak hours corresponds to vehicular peak hours.*

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 4
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 SB On Ramp/ SB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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TOTAL (CARS & TRUCKS)

	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	0	0	0	0	105	0	0	213	25	0	0	79	0
7:15 AM	0	0	0	0	0	0	0	111	0	0	244	29	0	0	83	0
7:30 AM	0	0	0	0	0	0	0	112	0	0	268	31	0	0	89	0
7:45 AM	0	0	0	0	0	0	0	119	0	0	266	28	0	0	97	0
8:00 AM	0	0	0	0	0	0	0	121	0	0	254	23	0	0	102	0
8:15 AM	0	0	0	0	0	0	0	124	0	0	259	27	0	0	98	0
8:30 AM	0	0	0	0	0	0	0	126	0	0	263	28	0	0	99	0
8:45 AM	0	0	0	0	0	0	0	122	0	0	256	26	0	0	94	0

	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	0	0	0	0	54	0	0	229	47	0	0	142	0
4:15 PM	0	0	0	0	0	0	0	64	0	0	223	40	0	0	148	0
4:30 PM	0	0	0	0	0	0	0	71	0	0	207	49	0	0	144	0
4:45 PM	0	0	0	0	0	0	0	92	0	0	209	57	0	0	138	0
5:00 PM	0	0	0	0	0	0	0	109	0	0	210	63	0	0	149	0
5:15 PM	0	0	0	0	0	0	0	104	0	0	212	62	0	0	161	0
5:30 PM	0	0	0	0	0	0	0	95	0	0	204	58	0	0	164	0
5:45 PM	0	0	0	0	0	0	0	92	0	0	196	56	0	0	155	0

AM PEAK HOUR 7:45 AM to 8:45 AM	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**490**	**0**	**0**	**1042**	**106**	**0**	**0**	**396**	**0**
PHF	**0.00**				**0.97**				**0.98**				**0.97**			
HV %	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**2.4%**	**0.0%**	**0.0%**	**0.6%**	**5.7%**	**0.0%**	**0.0%**	**3.0%**	**0.0%**

PM PEAK HOUR 5:00 PM to 6:00 PM	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**400**	**0**	**0**	**822**	**239**	**0**	**0**	**629**	**0**
PHF	**0.00**				**0.92**				**0.97**				**0.96**			
HV %	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.3%**	**0.0%**	**0.0%**	**0.2%**	**0.8%**	**0.0%**	**0.0%**	**0.3%**	**0.0%**

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 4
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 SB On Ramp/ SB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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TRUCKS

	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0
7:15 AM	0	0	0	0	0	0	0	5	0	0	1	0	0	0	1	0
7:30 AM	0	0	0	0	0	0	0	2	0	0	2	3	0	0	1	0
7:45 AM	0	0	0	0	0	0	0	5	0	0	1	2	0	0	5	0
8:00 AM	0	0	0	0	0	0	0	2	0	0	2	1	0	0	4	0
8:15 AM	0	0	0	0	0	0	0	3	0	0	2	2	0	0	2	0
8:30 AM	0	0	0	0	0	0	0	2	0	0	1	1	0	0	1	0
8:45 AM	0	0	0	0	0	0	0	1	0	0	2	1	0	0	2	0

	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
4:15 PM	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	0
4:45 PM	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AM PEAK HOUR 7:30 AM to 8:30 AM	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**12**	**0**	**0**	**7**	**8**	**0**	**0**	**12**	**0**
PHF	**0.00**				**0.60**				**0.75**				**0.60**			

PM PEAK HOUR 4:00 PM to 5:00 PM	I-95 SB On Ramp Northbound				I-95 SB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**6**	**2**	**0**	**0**	**2**	**0**
PHF	**0.00**				**0.50**				**0.67**				**0.50**			

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 4
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 SB On Ramp/ SB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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PEDESTRIANS & BICYCLES

	I-95 SB On Ramp Northbound					I-95 SB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
7:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:15 AM	0	0	0	0		0	0	0	0		0	1	0	0		0	0	0	0	
7:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	
8:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:15 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	

	I-95 SB On Ramp Northbound					I-95 SB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
4:00 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
4:15 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:30 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:45 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:00 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
5:15 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
5:30 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:45 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	

AM PEAK HOUR[1]	I-95 SB On Ramp Northbound					I-95 SB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
7:45 AM																				
to	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
8:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	

PM PEAK HOUR[1]	I-95 SB On Ramp Northbound					I-95 SB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
5:00 PM																				
to	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
6:00 PM	0	0	0	0		0	0	0	2		0	0	0	0		0	0	0	0	

[1] *Peak hours corresponds to vehicular peak hours.*

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 1
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 NB On Ramp/ NB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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TOTAL (CARS & TRUCKS)

	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	81	0	0	0	0	0	0	213	0	0	0	98	72
7:15 AM	0	0	0	84	0	0	0	0	0	0	242	0	0	0	113	74
7:30 AM	0	0	0	75	0	0	0	0	0	0	256	0	0	0	123	80
7:45 AM	0	0	0	63	0	0	0	0	0	0	285	0	0	0	135	82
8:00 AM	0	0	0	64	0	0	0	0	0	0	291	0	0	0	139	77
8:15 AM	0	0	0	62	0	0	0	0	0	0	326	0	0	0	135	68
8:30 AM	0	0	0	65	0	0	0	0	0	0	347	0	0	0	133	67
8:45 AM	0	0	0	61	0	0	0	0	0	0	339	0	0	0	129	65

	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	33	0	0	0	0	0	0	161	0	0	0	186	166
4:15 PM	0	0	0	35	0	0	0	0	0	0	162	0	0	0	188	169
4:30 PM	0	0	0	37	0	0	0	0	0	0	140	0	0	0	185	168
4:45 PM	0	0	0	34	0	0	0	0	0	0	159	0	0	0	179	161
5:00 PM	0	0	0	39	0	0	0	0	0	0	178	0	0	0	220	186
5:15 PM	0	0	0	43	0	0	0	0	0	0	189	0	0	0	247	203
5:30 PM	0	0	0	41	0	0	0	0	0	0	182	0	0	0	249	198
5:45 PM	0	0	0	37	0	0	0	0	0	0	177	0	0	0	242	192

AM PEAK HOUR 8:00 AM to 9:00 AM	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**252**	**0**	**0**	**0**	**0**	**0**	**0**	**1303**	**0**	**0**	**0**	**536**	**277**
PHF	**0.97**				**0.00**				**0.94**				**0.94**			
HV %	**0.0%**	**0.0%**	**0.0%**	**1.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.2%**	**0.0%**	**0.0%**	**0.0%**	**3.0%**	**4.3%**

PM PEAK HOUR 5:00 PM to 6:00 PM	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**160**	**0**	**0**	**0**	**0**	**0**	**0**	**726**	**0**	**0**	**0**	**958**	**779**
PHF	**0.93**				**0.00**				**0.96**				**0.97**			
HV %	**0.0%**	**0.0%**	**0.0%**	**0.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.6%**	**0.0%**	**0.0%**	**0.0%**	**0.5%**	**0.3%**

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 1
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 NB On Ramp/ NB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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TRUCKS

	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	2	0	0	0	0	0	0	1	0	0	0	4	0
7:15 AM	0	0	0	1	0	0	0	0	0	0	5	0	0	0	2	1
7:30 AM	0	0	0	1	0	0	0	0	0	0	4	0	0	0	4	0
7:45 AM	0	0	0	1	0	0	0	0	0	0	3	0	0	0	5	3
8:00 AM	0	0	0	2	0	0	0	0	0	0	4	0	0	0	5	2
8:15 AM	0	0	0	1	0	0	0	0	0	0	3	0	0	0	4	3
8:30 AM	0	0	0	0	0	0	0	0	0	0	5	0	0	0	3	4
8:45 AM	0	0	0	1	0	0	0	0	0	0	4	0	0	0	4	3

	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	2
4:30 PM	0	0	0	1	0	0	0	0	0	0	4	0	0	0	1	2
4:45 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	1
5:15 PM	0	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

AM PEAK HOUR 7:45 AM to 8:45 AM	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**15**	**0**	**0**	**0**	**17**	**12**
PHF	**0.50**				**0.00**				**0.75**				**0.91**			

PM PEAK HOUR 4:15 PM to 5:15 PM	I-95 NB Off Ramp Northbound				I-95 NB On Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**9**	**0**	**0**	**0**	**7**	**5**
PHF	**0.50**				**0.00**				**0.56**				**0.75**			

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 1
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 NB On Ramp/ NB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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PEDESTRIANS & BICYCLES

	I-95 NB Off Ramp Northbound					I-95 NB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
7:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:15 AM	0	0	0	0		0	0	0	0		0	1	0	0		0	0	0	0	
7:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:45 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:15 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	
8:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	

	I-95 NB Off Ramp Northbound					I-95 NB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
4:00 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
4:15 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:30 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:45 PM	0	0	0	0		0	0	0	2		0	0	0	0		0	0	0	0	
5:00 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:15 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:30 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:45 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	

AM PEAK HOUR[1] 8:00 AM to 9:00 AM	I-95 NB Off Ramp Northbound					I-95 NB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
	0	0	0	2		0	0	0	0		0	0	0	0		0	0	0	0	

PM PEAK HOUR[1] 5:00 PM to 6:00 PM	I-95 NB Off Ramp Northbound					I-95 NB On Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	

[1] *Peak hours corresponds to vehicular peak hours.*

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 2
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 NB On Ramp/ NB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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TOTAL (CARS & TRUCKS)

	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	0	0	0	0	33	0	0	211	139	0	0	97	0
7:15 AM	0	0	0	0	0	0	0	26	0	0	242	128	0	0	111	0
7:30 AM	0	0	0	0	0	0	0	22	0	0	255	120	0	0	123	0
7:45 AM	0	0	0	0	0	0	0	17	0	0	286	107	0	0	134	0
8:00 AM	0	0	0	0	0	0	0	20	0	0	290	109	0	0	139	0
8:15 AM	0	0	0	0	0	0	0	23	0	0	326	106	0	0	136	0
8:30 AM	0	0	0	0	0	0	0	22	0	0	349	104	0	0	134	0
8:45 AM	0	0	0	0	0	0	0	21	0	0	339	102	0	0	131	0

	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	0	0	0	0	14	0	0	163	117	0	0	186	0
4:15 PM	0	0	0	0	0	0	0	18	0	0	160	115	0	0	189	0
4:30 PM	0	0	0	0	0	0	0	21	0	0	140	116	0	0	185	0
4:45 PM	0	0	0	0	0	0	0	23	0	0	158	113	0	0	178	0
5:00 PM	0	0	0	0	0	0	0	26	0	0	176	99	0	0	217	0
5:15 PM	0	0	0	0	0	0	0	27	0	0	191	84	0	0	249	0
5:30 PM	0	0	0	0	0	0	0	25	0	0	183	83	0	0	251	0
5:45 PM	0	0	0	0	0	0	0	24	0	0	175	81	0	0	241	0

AM PEAK HOUR 8:00 AM to 9:00 AM	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**86**	**0**	**0**	**1304**	**421**	**0**	**0**	**540**	**0**
PHF	**0.00**				**0.93**				**0.95**				**0.97**			
HV %	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.2%**	**0.0%**	**0.0%**	**1.2%**	**0.7%**	**0.0%**	**0.0%**	**3.0%**	**0.0%**

PM PEAK HOUR 5:00 PM to 6:00 PM	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**102**	**0**	**0**	**725**	**347**	**0**	**0**	**958**	**0**
PHF	**0.00**				**0.94**				**0.97**				**0.95**			
HV %	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.0%**	**0.0%**	**0.0%**	**0.6%**	**0.6%**	**0.0%**	**0.0%**	**0.5%**	**0.0%**

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 2
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 NB On Ramp/ NB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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TRUCKS

	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
7:00 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0
7:15 AM	0	0	0	0	0	0	0	1	0	0	5	1	0	0	2	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	4	1	0	0	4	0
7:45 AM	0	0	0	0	0	0	0	1	0	0	3	2	0	0	5	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	4	0	0	0	5	0
8:15 AM	0	0	0	0	0	0	0	1	0	0	3	1	0	0	3	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	5	1	0	0	4	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	4	1	0	0	4	0

	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
Start Time	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	1	0	0	4	1	0	0	1	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0
5:15 PM	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

AM PEAK HOUR 7:15 AM to 8:15 AM	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**16**	**4**	**0**	**0**	**16**	**0**
PHF	**0.00**				**0.50**				**0.83**				**0.80**			

PM PEAK HOUR 4:00 PM to 5:00 PM	I-95 NB On Ramp Northbound				I-95 NB Off Ramp Southbound				Highland Avenue Eastbound				Highland Avenue Westbound			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right
	0	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**9**	**2**	**0**	**0**	**7**	**0**
PHF	**0.00**				**0.25**				**0.55**				**0.44**			

Client:	Matthew Duranleau
Project #:	168_030_VHB
BTD #:	Location 2
Location:	Needham, MA
Street 1:	Highland Avenue
Street 2:	I-95 NB On Ramp/ NB Off Ramp
Count Date:	1/31/2018
Day of Week:	Wednesday
Weather:	Sun w/ Clouds, 30°F

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PEDESTRIANS & BICYCLES

	I-95 NB On Ramp Northbound					I-95 NB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
7:00 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:15 AM	0	0	0	0		0	0	0	0		0	1	0	0		0	0	0	0	
7:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
7:45 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:00 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	
8:15 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:30 AM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
8:45 AM	0	0	0	1		0	0	0	0		0	0	0	0		0	0	0	0	

	I-95 NB On Ramp Northbound					I-95 NB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
Start Time	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
4:00 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:15 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
4:30 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
4:45 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
5:00 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	
5:15 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:30 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
5:45 PM	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	

AM PEAK HOUR[1]	I-95 NB On Ramp Northbound					I-95 NB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
8:00 AM																				
to	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
9:00 AM	0	0	0	2		0	0	0	0		0	0	0	0		0	0	0	0	

PM PEAK HOUR[1]	I-95 NB On Ramp Northbound					I-95 NB Off Ramp Southbound					Highland Avenue Eastbound					Highland Avenue Westbound				
5:00 PM																				
to	Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED		Left	Thru	Right	PED	
6:00 PM	0	0	0	0		0	0	0	1		0	0	0	0		0	0	0	0	

[1] *Peak hours corresponds to vehicular peak hours.*

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

Cars and Heavy Vehicles (Combined)

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	1	0	0	1	1	114	0	0	115	6	0	8	0	14	74	287	0	0	361	491
7:15 AM	1	0	0	0	1	0	162	0	0	162	6	0	11	0	17	95	255	0	0	350	530
7:30 AM	2	1	0	0	3	2	188	0	0	190	8	0	11	0	19	109	274	0	0	383	595
7:45 AM	0	0	0	0	0	2	202	1	0	205	7	0	18	0	25	123	236	0	0	359	589
Total	3	2	0	0	5	5	666	1	0	672	27	0	48	0	75	401	1052	0	0	1453	2205
8:00 AM	0	2	0	0	2	1	173	0	0	174	11	0	27	0	38	151	227	0	0	378	592
8:15 AM	1	0	2	0	3	1	177	0	0	178	12	0	17	0	29	140	262	2	0	404	614
8:30 AM	0	1	0	0	1	4	176	0	0	180	19	0	16	0	35	195	278	0	0	473	689
8:45 AM	8	2	1	0	11	7	182	0	0	189	12	0	25	0	37	171	228	2	0	401	638
Total	9	5	3	0	17	13	708	0	0	721	54	0	85	0	139	657	995	4	0	1656	2533
Grand Total	12	7	3	0	22	18	1374	1	0	1393	81	0	133	0	214	1058	2047	4	0	3109	4738
Approach %	54.5	31.8	13.6	0.0		1.3	98.6	0.1	0.0		37.9	0.0	62.1	0.0		34.0	65.8	0.1	0.0		
Total %	0.3	0.1	0.1	0.0	0.5	0.4	29.0	0.0	0.0	29.4	1.7	0.0	2.8	0.0	4.5	22.3	43.2	0.1	0.0	65.6	
Exiting Leg Total					22					2131					1066					1519	4738
Cars	12	7	2	0	21	18	1290	1	0	1309	74	0	117	0	191	1035	1964	4	0	3003	4524
% Cars	100.0	100.0	66.7	0.0	95.5	100.0	93.9	100.0	0.0	94.0	91.4	0.0	88.0	0.0	89.3	97.8	95.9	100.0	0.0	96.6	95.5
Exiting Leg Total					22					2040					1043					1419	4524
Heavy Vehicles	0	0	1	0	1	0	84	0	0	84	7	0	16	0	23	23	83	0	0	106	214
% Heavy Vehicles	0.0	0.0	33.3	0.0	4.5	0.0	6.1	0.0	0.0	6.0	8.6	0.0	12.0	0.0	10.7	2.2	4.1	0.0	0.0	3.4	4.5
Exiting Leg Total					0					91					23					100	214

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	2	0	0	2	1	173	0	0	174	11	0	27	0	38	151	227	0	0	378	592
8:15 AM	1	0	2	0	3	1	177	0	0	178	12	0	17	0	29	140	262	2	0	404	614
8:30 AM	0	1	0	0	1	4	176	0	0	180	19	0	16	0	35	195	278	0	0	473	689
8:45 AM	8	2	1	0	11	7	182	0	0	189	12	0	25	0	37	171	228	2	0	401	638
Total Volume	9	5	3	0	17	13	708	0	0	721	54	0	85	0	139	657	995	4	0	1656	2533
% Approach Total	52.9	29.4	17.6	0.0		1.8	98.2	0.0	0.0		38.8	0.0	61.2	0.0		39.7	60.1	0.2	0.0		
PHF	0.281	0.625	0.375	0.000	0.386	0.464	0.973	0.000	0.000	0.954	0.711	0.000	0.787	0.000	0.914	0.842	0.895	0.500	0.000	0.875	0.919
Cars	9	5	2	0	16	13	671	0	0	684	51	0	76	0	127	646	953	4	0	1603	2430
Cars %	100.0	100.0	66.7	0.0	94.1	100.0	94.8	0.0	0.0	94.9	94.4	0.0	89.4	0.0	91.4	98.3	95.8	100.0	0.0	96.8	95.9
Heavy Vehicles	0	0	1	0	1	0	37	0	0	37	3	0	9	0	12	11	42	0	0	53	103
Heavy Vehicles %	0.0	0.0	33.3	0.0	5.9	0.0	5.2	0.0	0.0	5.1	5.6	0.0	10.6	0.0	8.6	1.7	4.2	0.0	0.0	3.2	4.1
Cars Enter Leg	9	5	2	0	16	13	671	0	0	684	51	0	76	0	127	646	953	4	0	1603	2430
Heavy Enter Leg	0	0	1	0	1	0	37	0	0	37	3	0	9	0	12	11	42	0	0	53	103
Total Entering Leg	9	5	3	0	17	13	708	0	0	721	54	0	85	0	139	657	995	4	0	1656	2533
Cars Exiting Leg					17					1006					651					756	2430
Heavy Exiting Leg					0					46					11					46	103
Total Exiting Leg					17					1052					662					802	2533

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	1	0	0	1	1	106	0	0	107	6	0	7	0	13	73	280	0	0	353	474
7:15 AM	1	0	0	0	1	0	152	0	0	152	6	0	7	0	13	91	239	0	0	330	496
7:30 AM	2	1	0	0	3	2	178	0	0	180	5	0	10	0	15	105	262	0	0	367	565
7:45 AM	0	0	0	0	0	2	183	1	0	186	6	0	17	0	23	120	230	0	0	350	559
Total	3	2	0	0	5	5	619	1	0	625	23	0	41	0	64	389	1011	0	0	1400	2094
8:00 AM	0	2	0	0	2	1	164	0	0	165	9	0	23	0	32	150	221	0	0	371	570
8:15 AM	1	0	1	0	2	1	168	0	0	169	12	0	15	0	27	133	250	2	0	385	583
8:30 AM	0	1	0	0	1	4	163	0	0	167	18	0	15	0	33	193	262	0	0	455	656
8:45 AM	8	2	1	0	11	7	176	0	0	183	12	0	23	0	35	170	220	2	0	392	621
Total	9	5	2	0	16	13	671	0	0	684	51	0	76	0	127	646	953	4	0	1603	2430
Grand Total	12	7	2	0	21	18	1290	1	0	1309	74	0	117	0	191	1035	1964	4	0	3003	4524
Approach %	57.1	33.3	9.5	0.0		1.4	98.5	0.1	0.0		38.7	0.0	61.3	0.0		34.5	65.4	0.1	0.0		
Total %	0.3	0.2	0.0	0.0	0.5	0.4	28.5	0.0	0.0	28.9	1.6	0.0	2.6	0.0	4.2	22.9	43.4	0.1	0.0	66.4	
Exiting Leg Total					22					2040					1043					1419	4524

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	2	0	0	2	1	164	0	0	165	9	0	23	0	32	150	221	0	0	371	570
8:15 AM	1	0	1	0	2	1	168	0	0	169	12	0	15	0	27	133	250	2	0	385	583
8:30 AM	0	1	0	0	1	4	163	0	0	167	18	0	15	0	33	193	262	0	0	455	656
8:45 AM	8	2	1	0	11	7	176	0	0	183	12	0	23	0	35	170	220	2	0	392	621
Total Volume	9	5	2	0	16	13	671	0	0	684	51	0	76	0	127	646	953	4	0	1603	2430
% Approach Total	56.3	31.3	12.5	0.0		1.9	98.1	0.0	0.0		40.2	0.0	59.8	0.0		40.3	59.5	0.2	0.0		
PHF	0.281	0.625	0.500	0.000	0.364	0.464	0.953	0.000	0.000	0.934	0.708	0.000	0.826	0.000	0.907	0.837	0.909	0.500	0.000	0.881	0.926
Entering Leg	9	5	2	0	16	13	671	0	0	684	51	0	76	0	127	646	953	4	0	1603	2430
Exiting Leg					17					1006					651					756	2430
Total					33					1690					778					2359	4860

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	8	0	0	8	0	0	1	0	1	1	7	0	0	8	17
7:15 AM	0	0	0	0	0	0	10	0	0	10	0	0	4	0	4	4	16	0	0	20	34
7:30 AM	0	0	0	0	0	0	10	0	0	10	3	0	1	0	4	4	12	0	0	16	30
7:45 AM	0	0	0	0	0	0	19	0	0	19	1	0	1	0	2	3	6	0	0	9	30
Total	0	0	0	0	0	0	47	0	0	47	4	0	7	0	11	12	41	0	0	53	111
8:00 AM	0	0	0	0	0	0	9	0	0	9	2	0	4	0	6	1	6	0	0	7	22
8:15 AM	0	0	1	0	1	0	9	0	0	9	0	0	2	0	2	7	12	0	0	19	31
8:30 AM	0	0	0	0	0	0	13	0	0	13	1	0	1	0	2	2	16	0	0	18	33
8:45 AM	0	0	0	0	0	0	6	0	0	6	0	0	2	0	2	1	8	0	0	9	17
Total	0	0	1	0	1	0	37	0	0	37	3	0	9	0	12	11	42	0	0	53	103
Grand Total	0	0	1	0	1	0	84	0	0	84	7	0	16	0	23	23	83	0	0	106	214
Approach %	0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0		30.4	0.0	69.6	0.0		21.7	78.3	0.0	0.0		
Total %	0.0	0.0	0.5	0.0	0.5	0.0	39.3	0.0	0.0	39.3	3.3	0.0	7.5	0.0	10.7	10.7	38.8	0.0	0.0	49.5	
Exiting Leg Total					0					91					23					100	214
Buses	0	0	1	0	1	0	8	0	0	8	2	0	0	0	2	5	11	0	0	16	27
% Buses	0.0	0.0	100.0	0.0	100.0	0.0	9.5	0.0	0.0	9.5	28.6	0.0	0.0	0.0	8.7	21.7	13.3	0.0	0.0	15.1	12.6
Exiting Leg Total					0					14					5					8	27
Single-Unit Trucks	0	0	0	0	0	0	64	0	0	64	1	0	8	0	9	10	63	0	0	73	146
% Single-Unit	0.0	0.0	0.0	0.0	0.0	0.0	76.2	0.0	0.0	76.2	14.3	0.0	50.0	0.0	39.1	43.5	75.9	0.0	0.0	68.9	68.2
Exiting Leg Total					0					64					10					72	146
Articulated Trucks	0	0	0	0	0	0	12	0	0	12	4	0	8	0	12	8	9	0	0	17	41
% Articulated	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	14.3	57.1	0.0	50.0	0.0	52.2	34.8	10.8	0.0	0.0	16.0	19.2
Exiting Leg Total					0					13					8					20	41

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:15 AM	0	0	0	0	0	0	10	0	0	10	0	0	4	0	4	4	16	0	0	20	34
7:30 AM	0	0	0	0	0	0	10	0	0	10	3	0	1	0	4	4	12	0	0	16	30
7:45 AM	0	0	0	0	0	0	19	0	0	19	1	0	1	0	2	3	6	0	0	9	30
8:00 AM	0	0	0	0	0	0	9	0	0	9	2	0	4	0	6	1	6	0	0	7	22
Total Volume	0	0	0	0	0	0	48	0	0	48	6	0	10	0	16	12	40	0	0	52	116
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		37.5	0.0	62.5	0.0		23.1	76.9	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.632	0.000	0.000	0.632	0.500	0.000	0.625	0.000	0.667	0.750	0.625	0.000	0.000	0.650	0.853
Buses	0	0	0	0	0	0	6	0	0	6	1	0	0	0	1	1	4	0	0	5	12
Buses %	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	12.5	16.7	0.0	0.0	0.0	6.3	8.3	10.0	0.0	0.0	9.6	10.3
Single-Unit Trucks	0	0	0	0	0	0	36	0	0	36	1	0	6	0	7	5	31	0	0	36	79
Single-Unit %	0.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0	0.0	75.0	16.7	0.0	60.0	0.0	43.8	41.7	77.5	0.0	0.0	69.2	68.1
Articulated Trucks	0	0	0	0	0	0	6	0	0	6	4	0	4	0	8	6	5	0	0	11	25
Articulated %	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	12.5	66.7	0.0	40.0	0.0	50.0	50.0	12.5	0.0	0.0	21.2	21.6
Buses	0	0	0	0	0	0	6	0	0	6	1	0	0	0	1	1	4	0	0	5	12
Single-Unit Trucks	0	0	0	0	0	0	36	0	0	36	1	0	6	0	7	5	31	0	0	36	79
Articulated Trucks	0	0	0	0	0	0	6	0	0	6	4	0	4	0	8	6	5	0	0	11	25
Total Entering Leg	0	0	0	0	0	0	48	0	0	48	6	0	10	0	16	12	40	0	0	52	116
Buses					0					5					1					6	12
Single-Unit Trucks					0					32					5					42	79
Articulated Trucks					0					9					6					10	25
Total Exiting Leg					0					46					12					58	116

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars**

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	1	0	0	1	1	94	0	0	95	6	0	6	0	12	67	243	0	0	310	418
7:15 AM	0	0	0	0	0	0	134	0	0	134	6	0	6	0	12	84	220	0	0	304	450
7:30 AM	0	1	0	0	1	2	167	0	0	169	5	0	8	0	13	100	233	0	0	333	516
7:45 AM	0	0	0	0	0	2	169	1	0	172	6	0	16	0	22	118	214	0	0	332	526
Total	0	2	0	0	2	5	564	1	0	570	23	0	36	0	59	369	910	0	0	1279	1910
8:00 AM	0	2	0	0	2	1	148	0	0	149	9	0	21	0	30	141	203	0	0	344	525
8:15 AM	0	0	0	0	0	1	156	0	0	157	11	0	13	0	24	127	228	1	0	356	537
8:30 AM	0	1	0	0	1	4	147	0	0	151	16	0	15	0	31	189	243	0	0	432	615
8:45 AM	7	2	1	0	10	7	158	0	0	165	10	0	19	0	29	165	198	2	0	365	569
Total	7	5	1	0	13	13	609	0	0	622	46	0	68	0	114	622	872	3	0	1497	2246
Grand Total	7	7	1	0	15	18	1173	1	0	1192	69	0	104	0	173	991	1782	3	0	2776	4156
Approach %	46.7	46.7	6.7	0.0		1.5	98.4	0.1	0.0		39.9	0.0	60.1	0.0		35.7	64.2	0.1	0.0		
Total %	0.2	0.2	0.0	0.0	0.4	0.4	28.2	0.0	0.0	28.7	1.7	0.0	2.5	0.0	4.2	23.8	42.9	0.1	0.0	66.8	
Exiting Leg Total					21					1852					999					1284	4156

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	2	0	0	2	1	148	0	0	149	9	0	21	0	30	141	203	0	0	344	525
8:15 AM	0	0	0	0	0	1	156	0	0	157	11	0	13	0	24	127	228	1	0	356	537
8:30 AM	0	1	0	0	1	4	147	0	0	151	16	0	15	0	31	189	243	0	0	432	615
8:45 AM	7	2	1	0	10	7	158	0	0	165	10	0	19	0	29	165	198	2	0	365	569
Total Volume	7	5	1	0	13	13	609	0	0	622	46	0	68	0	114	622	872	3	0	1497	2246
% Approach Total	53.8	38.5	7.7	0.0		2.1	97.9	0.0	0.0		40.4	0.0	59.6	0.0		41.5	58.2	0.2	0.0		
PHF	0.250	0.625	0.250	0.000	0.325	0.464	0.964	0.000	0.000	0.942	0.719	0.000	0.810	0.000	0.919	0.823	0.897	0.375	0.000	0.866	0.913
Entering Leg	7	5	1	0	13	13	609	0	0	622	46	0	68	0	114	622	872	3	0	1497	2246
Exiting Leg					16					919					627					684	2246
Total					29					1541					741					2181	4492

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Light Goods Vehicle**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	12	0	0	12	0	0	1	0	1	6	37	0	0	43	56
7:15 AM	1	0	0	0	1	0	18	0	0	18	0	0	1	0	1	7	19	0	0	26	46
7:30 AM	2	0	0	0	2	0	11	0	0	11	0	0	2	0	2	5	29	0	0	34	49
7:45 AM	0	0	0	0	0	0	14	0	0	14	0	0	1	0	1	2	16	0	0	18	33
Total	3	0	0	0	3	0	55	0	0	55	0	0	5	0	5	20	101	0	0	121	184
8:00 AM	0	0	0	0	0	0	16	0	0	16	0	0	2	0	2	9	18	0	0	27	45
8:15 AM	1	0	1	0	2	0	12	0	0	12	1	0	2	0	3	6	22	1	0	29	46
8:30 AM	0	0	0	0	0	0	16	0	0	16	2	0	0	0	2	4	19	0	0	23	41
8:45 AM	1	0	0	0	1	0	18	0	0	18	2	0	4	0	6	5	22	0	0	27	52
Total	2	0	1	0	3	0	62	0	0	62	5	0	8	0	13	24	81	1	0	106	184
Grand Total	5	0	1	0	6	0	117	0	0	117	5	0	13	0	18	44	182	1	0	227	368
Approach %	83.3	0.0	16.7	0.0		0.0	100.0	0.0	0.0		27.8	0.0	72.2	0.0		19.4	80.2	0.4	0.0		
Total %	1.4	0.0	0.3	0.0	1.6	0.0	31.8	0.0	0.0	31.8	1.4	0.0	3.5	0.0	4.9	12.0	49.5	0.3	0.0	61.7	
Exiting Leg Total					1					188					44					135	368

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	12	0	0	12	0	0	1	0	1	6	37	0	0	43	56
7:15 AM	1	0	0	0	1	0	18	0	0	18	0	0	1	0	1	7	19	0	0	26	46
7:30 AM	2	0	0	0	2	0	11	0	0	11	0	0	2	0	2	5	29	0	0	34	49
7:45 AM	0	0	0	0	0	0	14	0	0	14	0	0	1	0	1	2	16	0	0	18	33
Total Volume	3	0	0	0	3	0	55	0	0	55	0	0	5	0	5	20	101	0	0	121	184
% Approach Total	100.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		16.5	83.5	0.0	0.0		
PHF	0.375	0.000	0.000	0.000	0.375	0.000	0.764	0.000	0.000	0.764	0.000	0.000	0.625	0.000	0.625	0.714	0.682	0.000	0.000	0.703	0.821
Entering Leg	3	0	0	0	3	0	55	0	0	55	0	0	5	0	5	20	101	0	0	121	184
Exiting Leg					0					101					20					63	184
Total					3					156					25					184	368

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Buses**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
7:15 AM	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	4
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Total	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	1	3	0	0	4	8
8:00 AM	0	0	0	0	0	0	3	0	0	3	1	0	0	0	1	0	2	0	0	2	6
8:15 AM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	3	1	0	0	4	6
8:30 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	4	0	0	5	6
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Total	0	0	1	0	1	0	4	0	0	4	2	0	0	0	2	4	8	0	0	12	19
Grand Total	0	0	1	0	1	0	8	0	0	8	2	0	0	0	2	5	11	0	0	16	27
Approach %	0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0		100.0	0.0	0.0	0.0		31.3	68.8	0.0	0.0		
Total %	0.0	0.0	3.7	0.0	3.7	0.0	29.6	0.0	0.0	29.6	7.4	0.0	0.0	0.0	7.4	18.5	40.7	0.0	0.0	59.3	
Exiting Leg Total					0					14					5					8	27

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:45 AM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
8:00 AM	0	0	0	0	0	0	3	0	0	3	1	0	0	0	1	0	2	0	0	2	6
8:15 AM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	3	1	0	0	4	6
8:30 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	4	0	0	5	6
Total Volume	0	0	1	0	1	0	4	0	0	4	2	0	0	0	2	5	7	0	0	12	19
% Approach Total	0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0		100.0	0.0	0.0	0.0		41.7	58.3	0.0	0.0		
PHF	0.000	0.000	0.250	0.000	0.250	0.000	0.333	0.000	0.000	0.333	0.500	0.000	0.000	0.000	0.500	0.417	0.438	0.000	0.000	0.600	0.792
Entering Leg	0	0	1	0	1	0	4	0	0	4	2	0	0	0	2	5	7	0	0	12	19
Exiting Leg					0					10					5					4	19
Total					1					14					7					16	38

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Single-Unit Trucks**

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	1	6	0	0	7	13
7:15 AM	0	0	0	0	0	0	5	0	0	5	0	0	3	0	3	1	14	0	0	15	23
7:30 AM	0	0	0	0	0	0	9	0	0	9	0	0	1	0	1	3	10	0	0	13	23
7:45 AM	0	0	0	0	0	0	16	0	0	16	0	0	0	0	0	1	4	0	0	5	21
Total	0	0	0	0	0	0	36	0	0	36	0	0	4	0	4	6	34	0	0	40	80
8:00 AM	0	0	0	0	0	0	6	0	0	6	1	0	2	0	3	0	3	0	0	3	12
8:15 AM	0	0	0	0	0	0	7	0	0	7	0	0	0	0	0	2	10	0	0	12	19
8:30 AM	0	0	0	0	0	0	9	0	0	9	0	0	1	0	1	1	11	0	0	12	22
8:45 AM	0	0	0	0	0	0	6	0	0	6	0	0	1	0	1	1	5	0	0	6	13
Total	0	0	0	0	0	0	28	0	0	28	1	0	4	0	5	4	29	0	0	33	66
Grand Total	0	0	0	0	0	0	64	0	0	64	1	0	8	0	9	10	63	0	0	73	146
Approach %	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		11.1	0.0	88.9	0.0		13.7	86.3	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	43.8	0.0	0.0	43.8	0.7	0.0	5.5	0.0	6.2	6.8	43.2	0.0	0.0	50.0	
Exiting Leg Total					0					64					10					72	146

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	1	6	0	0	7	13
7:15 AM	0	0	0	0	0	0	5	0	0	5	0	0	3	0	3	1	14	0	0	15	23
7:30 AM	0	0	0	0	0	0	9	0	0	9	0	0	1	0	1	3	10	0	0	13	23
7:45 AM	0	0	0	0	0	0	16	0	0	16	0	0	0	0	0	1	4	0	0	5	21
Total Volume	0	0	0	0	0	0	36	0	0	36	0	0	4	0	4	6	34	0	0	40	80
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		15.0	85.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.563	0.000	0.000	0.563	0.000	0.000	0.333	0.000	0.333	0.500	0.607	0.000	0.000	0.667	0.870
Entering Leg	0	0	0	0	0	0	36	0	0	36	0	0	4	0	4	6	34	0	0	40	80
Exiting Leg					0					34					6					40	80
Total					0					70					10					80	160

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Articulated Trucks**

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	2
7:15 AM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	3	1	0	0	4	7
7:30 AM	0	0	0	0	0	0	1	0	0	1	3	0	0	0	3	1	1	0	0	2	6
7:45 AM	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	1	2	0	0	3	8
Total	0	0	0	0	0	0	7	0	0	7	4	0	3	0	7	5	4	0	0	9	23
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	1	1	0	0	2	4
8:15 AM	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	2	1	0	0	3	6
8:30 AM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	1	0	0	1	5
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	2	3
Total	0	0	0	0	0	0	5	0	0	5	0	0	5	0	5	3	5	0	0	8	18
Grand Total	0	0	0	0	0	0	12	0	0	12	4	0	8	0	12	8	9	0	0	17	41
Approach %	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		33.3	0.0	66.7	0.0		47.1	52.9	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	29.3	0.0	0.0	29.3	9.8	0.0	19.5	0.0	29.3	19.5	22.0	0.0	0.0	41.5	
Exiting Leg Total					0					13					8					20	41

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:15 AM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	3	1	0	0	4	7
7:30 AM	0	0	0	0	0	0	1	0	0	1	3	0	0	0	3	1	1	0	0	2	6
7:45 AM	0	0	0	0	0	0	3	0	0	3	1	0	1	0	2	1	2	0	0	3	8
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	1	1	0	0	2	4
Total Volume	0	0	0	0	0	0	6	0	0	6	4	0	4	0	8	6	5	0	0	11	25
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		50.0	0.0	50.0	0.0		54.5	45.5	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.500	0.333	0.000	0.500	0.000	0.667	0.500	0.625	0.000	0.000	0.688	0.781
Entering Leg	0	0	0	0	0	0	6	0	0	6	4	0	4	0	8	6	5	0	0	11	25
Exiting Leg					0					9					6					10	25
Total					0					15					14					21	50

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Bicycles (on Roadway and Crosswalks)**

	Driveway							Highland Avenue							1st Avenue							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
8:30 AM	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	0	0	0
8:45 AM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2
Grand Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	3
Approach %	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	0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		
Total %	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	
Exiting Leg Total							0							3							0							0	3

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Driveway							Highland Avenue							1st Avenue							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2
% Approach Total	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	0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.000	0.000	0.000	0.000	0.500	0.500
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2
Exiting Leg							0							2							0							0	2
Total							0							2							0							2	4

PDI File #: **196735 G**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Pedestrians**

	Driveway from North							Highland Avenue from East							1st Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
7:15 AM	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	0	0	0
7:30 AM	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	0	0	0
7:45 AM	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	1	1	0	0	0	0	0	0	0	5
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
8:45 AM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0	0	0	0	0	1	1	0	0	0	0	0	0	0	9
Grand Total	0	0	0	0	0	1	1	0	0	0	0	0	9	9	0	0	0	0	0	2	2	0	0	0	0	0	0	0	12
Approach %	0	0	0	0	0	100		0	0	0	0	0	100		0	0	0	0	0	100		0	0	0	0	0	0		
Total %	0	0	0	0	0	8.33	8.33	0	0	0	0	0	75	75	0	0	0	0	0	16.7	16.7	0	0	0	0	0	0	0	
Exiting Leg Total							1							9							2							0	12

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:45 AM	Driveway from North							Highland Avenue from East							1st Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:45 AM	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	1	1	0	0	0	0	0	0	0	5
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total Volume	0	0	0	0	0	1	1	0	0	0	0	0	9	9	0	0	0	0	0	1	1	0	0	0	0	0	0	0	11
% Approach Total	0.0	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.563	0.563	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.550
Entering Leg	0	0	0	0	0	1	1	0	0	0	0	0	9	9	0	0	0	0	0	1	1	0	0	0	0	0	0	0	11
Exiting Leg							1							9							1							0	11
Total							2							18							2							0	22

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Cars and Heavy Vehicles (Combined)

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	7	0	2	0	9	1	272	0	0	273	10	0	35	0	45	23	167	1	0	191	518
3:15 PM	7	0	0	0	7	0	278	0	0	278	8	0	36	0	44	28	183	0	0	211	540
3:30 PM	2	0	0	0	2	2	305	2	0	309	15	0	28	0	43	25	194	0	0	219	573
3:45 PM	3	0	2	0	5	3	289	0	0	292	14	0	38	0	52	24	173	0	0	197	546
Total	19	0	4	0	23	6	1144	2	0	1152	47	0	137	0	184	100	717	1	0	818	2177
4:00 PM	7	0	1	0	8	1	287	0	0	288	8	0	47	0	55	28	172	0	0	200	551
4:15 PM	5	0	2	0	7	2	304	0	0	306	15	0	54	0	69	29	166	0	0	195	577
4:30 PM	1	0	4	0	5	0	300	0	0	300	18	0	42	0	60	27	156	0	0	183	548
4:45 PM	3	0	0	0	3	1	309	0	0	310	16	0	71	0	87	39	174	0	0	213	613
Total	16	0	7	0	23	4	1200	0	0	1204	57	0	214	0	271	123	668	0	0	791	2289
5:00 PM	3	0	0	0	3	1	370	0	1	372	14	0	89	0	103	32	169	0	1	202	680
5:15 PM	1	1	1	0	3	1	330	0	0	331	13	0	104	0	117	43	167	0	0	210	661
5:30 PM	4	0	0	0	4	0	317	0	0	317	21	0	80	0	101	29	165	0	0	194	616
5:45 PM	0	0	0	0	0	1	309	0	0	310	23	0	73	0	96	32	148	0	0	180	586
Total	8	1	1	0	10	3	1326	0	1	1330	71	0	346	0	417	136	649	0	1	786	2543
Grand Total	43	1	12	0	56	13	3670	2	1	3686	175	0	697	0	872	359	2034	1	1	2395	7009
Approach %	76.8	1.8	21.4	0.0		0.4	99.6	0.1	0.0		20.1	0.0	79.9	0.0		15.0	84.9	0.0	0.0		
Total %	0.6	0.0	0.2	0.0	0.8	0.2	52.4	0.0	0.0	52.6	2.5	0.0	9.9	0.0	12.4	5.1	29.0	0.0	0.0	34.2	
Exiting Leg Total					14					2222					362					4411	7009
Cars	42	1	12	0	55	11	3589	2	1	3603	172	0	685	0	857	335	1993	1	1	2330	6845
% Cars	97.7	100.0	100.0	0.0	98.2	84.6	97.8	100.0	100.0	97.7	98.3	0.0	98.3	0.0	98.3	93.3	98.0	100.0	100.0	97.3	97.7
Exiting Leg Total					12					2178					338					4317	6845
Heavy Vehicles	1	0	0	0	1	2	81	0	0	83	3	0	12	0	15	24	41	0	0	65	164
% Heavy Vehicles	2.3	0.0	0.0	0.0	1.8	15.4	2.2	0.0	0.0	2.3	1.7	0.0	1.7	0.0	1.7	6.7	2.0	0.0	0.0	2.7	2.3
Exiting Leg Total					2					44					24					94	164

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	3	0	0	0	3	1	309	0	0	310	16	0	71	0	87	39	174	0	0	213	613
5:00 PM	3	0	0	0	3	1	370	0	1	372	14	0	89	0	103	32	169	0	1	202	680
5:15 PM	1	1	1	0	3	1	330	0	0	331	13	0	104	0	117	43	167	0	0	210	661
5:30 PM	4	0	0	0	4	0	317	0	0	317	21	0	80	0	101	29	165	0	0	194	616
Total Volume	11	1	1	0	13	3	1326	0	1	1330	64	0	344	0	408	143	675	0	1	819	2570
% Approach Total	84.6	7.7	7.7	0.0		0.2	99.7	0.0	0.1		15.7	0.0	84.3	0.0		17.5	82.4	0.0	0.1		
PHF	0.688	0.250	0.250	0.000	0.813	0.750	0.896	0.000	0.250	0.894	0.762	0.000	0.827	0.000	0.872	0.831	0.970	0.000	0.250	0.961	0.945
Cars	11	1	1	0	13	3	1302	0	1	1306	63	0	340	0	403	136	672	0	1	809	2531
Cars %	100.0	100.0	100.0	0.0	100.0	100.0	98.2	0.0	100.0	98.2	98.4	0.0	98.8	0.0	98.8	95.1	99.6	0.0	100.0	98.8	98.5
Heavy Vehicles	0	0	0	0	0	0	24	0	0	24	1	0	4	0	5	7	3	0	0	10	39
Heavy Vehicles %	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	1.8	1.6	0.0	1.2	0.0	1.2	4.9	0.4	0.0	0.0	1.2	1.5
Cars Enter Leg	11	1	1	0	13	3	1302	0	1	1306	63	0	340	0	403	136	672	0	1	809	2531
Heavy Enter Leg	0	0	0	0	0	0	24	0	0	24	1	0	4	0	5	7	3	0	0	10	39
Total Entering Leg	11	1	1	0	13	3	1326	0	1	1330	64	0	344	0	408	143	675	0	1	819	2570
Cars Exiting Leg					3					737					137					1654	2531
Heavy Exiting Leg					0					4					7					28	39
Total Exiting Leg					3					741					144					1682	2570

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	6	0	2	0	8	0	262	0	0	262	10	0	34	0	44	23	159	1	0	183	497
3:15 PM	7	0	0	0	7	0	266	0	0	266	8	0	35	0	43	26	174	0	0	200	516
3:30 PM	2	0	0	0	2	2	299	2	0	303	15	0	28	0	43	19	186	0	0	205	553
3:45 PM	3	0	2	0	5	3	279	0	0	282	13	0	38	0	51	21	168	0	0	189	527
Total	18	0	4	0	22	5	1106	2	0	1113	46	0	135	0	181	89	687	1	0	777	2093
4:00 PM	7	0	1	0	8	1	281	0	0	282	7	0	46	0	53	28	171	0	0	199	542
4:15 PM	5	0	2	0	7	1	299	0	0	300	15	0	54	0	69	27	161	0	0	188	564
4:30 PM	1	0	4	0	5	0	296	0	0	296	18	0	40	0	58	24	154	0	0	178	537
4:45 PM	3	0	0	0	3	1	301	0	0	302	16	0	71	0	87	34	174	0	0	208	600
Total	16	0	7	0	23	3	1177	0	0	1180	56	0	211	0	267	113	660	0	0	773	2243
5:00 PM	3	0	0	0	3	1	366	0	1	368	14	0	88	0	102	31	167	0	1	199	672
5:15 PM	1	1	1	0	3	1	325	0	0	326	13	0	102	0	115	43	166	0	0	209	653
5:30 PM	4	0	0	0	4	0	310	0	0	310	20	0	79	0	99	28	165	0	0	193	606
5:45 PM	0	0	0	0	0	1	305	0	0	306	23	0	70	0	93	31	148	0	0	179	578
Total	8	1	1	0	10	3	1306	0	1	1310	70	0	339	0	409	133	646	0	1	780	2509
Grand Total	42	1	12	0	55	11	3589	2	1	3603	172	0	685	0	857	335	1993	1	1	2330	6845
Approach %	76.4	1.8	21.8	0.0		0.3	99.6	0.1	0.0		20.1	0.0	79.9	0.0		14.4	85.5	0.0	0.0		
Total %	0.6	0.0	0.2	0.0	0.8	0.2	52.4	0.0	0.0	52.6	2.5	0.0	10.0	0.0	12.5	4.9	29.1	0.0	0.0	34.0	
Exiting Leg Total					12					2178					338					4317	6845

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	3	0	0	0	3	1	301	0	0	302	16	0	71	0	87	34	174	0	0	208	600
5:00 PM	3	0	0	0	3	1	366	0	1	368	14	0	88	0	102	31	167	0	1	199	672
5:15 PM	1	1	1	0	3	1	325	0	0	326	13	0	102	0	115	43	166	0	0	209	653
5:30 PM	4	0	0	0	4	0	310	0	0	310	20	0	79	0	99	28	165	0	0	193	606
Total Volume	11	1	1	0	13	3	1302	0	1	1306	63	0	340	0	403	136	672	0	1	809	2531
% Approach Total	84.6	7.7	7.7	0.0		0.2	99.7	0.0	0.1		15.6	0.0	84.4	0.0		16.8	83.1	0.0	0.1		
PHF	0.688	0.250	0.250	0.000	0.813	0.750	0.889	0.000	0.250	0.887	0.788	0.000	0.833	0.000	0.876	0.791	0.966	0.000	0.250	0.968	0.942
Entering Leg	11	1	1	0	13	3	1302	0	1	1306	63	0	340	0	403	136	672	0	1	809	2531
Exiting Leg					3					737					137					1654	2531
Total					16					2043					540					2463	5062

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	0	0	1	1	10	0	0	11	0	0	1	0	1	0	8	0	0	8	21
3:15 PM	0	0	0	0	0	0	12	0	0	12	0	0	1	0	1	2	9	0	0	11	24
3:30 PM	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	8	0	0	14	20
3:45 PM	0	0	0	0	0	0	10	0	0	10	1	0	0	0	1	3	5	0	0	8	19
Total	1	0	0	0	1	1	38	0	0	39	1	0	2	0	3	11	30	0	0	41	84
4:00 PM	0	0	0	0	0	0	6	0	0	6	1	0	1	0	2	0	1	0	0	1	9
4:15 PM	0	0	0	0	0	1	5	0	0	6	0	0	0	0	0	2	5	0	0	7	13
4:30 PM	0	0	0	0	0	0	4	0	0	4	0	0	2	0	2	3	2	0	0	5	11
4:45 PM	0	0	0	0	0	0	8	0	0	8	0	0	0	0	0	5	0	0	0	5	13
Total	0	0	0	0	0	1	23	0	0	24	1	0	3	0	4	10	8	0	0	18	46
5:00 PM	0	0	0	0	0	0	4	0	0	4	0	0	1	0	1	1	2	0	0	3	8
5:15 PM	0	0	0	0	0	0	5	0	0	5	0	0	2	0	2	0	1	0	0	1	8
5:30 PM	0	0	0	0	0	0	7	0	0	7	1	0	1	0	2	1	0	0	0	1	10
5:45 PM	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3	1	0	0	0	1	8
Total	0	0	0	0	0	0	20	0	0	20	1	0	7	0	8	3	3	0	0	6	34
Grand Total	1	0	0	0	1	2	81	0	0	83	3	0	12	0	15	24	41	0	0	65	164
Approach %	100.0	0.0	0.0	0.0		2.4	97.6	0.0	0.0		20.0	0.0	80.0	0.0		36.9	63.1	0.0	0.0		
Total %	0.6	0.0	0.0	0.0	0.6	1.2	49.4	0.0	0.0	50.6	1.8	0.0	7.3	0.0	9.1	14.6	25.0	0.0	0.0	39.6	
Exiting Leg Total					2					44					24					94	164
Buses	1	0	0	0	1	1	10	0	0	11	1	0	4	0	5	0	7	0	0	7	24
% Buses	100.0	0.0	0.0	0.0	100.0	50.0	12.3	0.0	0.0	13.3	33.3	0.0	33.3	0.0	33.3	0.0	17.1	0.0	0.0	10.8	14.6
Exiting Leg Total					1					8					0					15	24
Single-Unit Trucks	0	0	0	0	0	1	60	0	0	61	2	0	7	0	9	10	29	0	0	39	109
% Single-Unit	0.0	0.0	0.0	0.0	0.0	50.0	74.1	0.0	0.0	73.5	66.7	0.0	58.3	0.0	60.0	41.7	70.7	0.0	0.0	60.0	66.5
Exiting Leg Total					1					31					10					67	109
Articulated Trucks	0	0	0	0	0	0	11	0	0	11	0	0	1	0	1	14	5	0	0	19	31
% Articulated	0.0	0.0	0.0	0.0	0.0	0.0	13.6	0.0	0.0	13.3	0.0	0.0	8.3	0.0	6.7	58.3	12.2	0.0	0.0	29.2	18.9
Exiting Leg Total					0					5					14					12	31

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	0	0	1	1	10	0	0	11	0	0	1	0	1	0	8	0	0	8	21
3:15 PM	0	0	0	0	0	0	12	0	0	12	0	0	1	0	1	2	9	0	0	11	24
3:30 PM	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	8	0	0	14	20
3:45 PM	0	0	0	0	0	0	10	0	0	10	1	0	0	0	1	3	5	0	0	8	19
Total Volume	1	0	0	0	1	1	38	0	0	39	1	0	2	0	3	11	30	0	0	41	84
% Approach Total	100.0	0.0	0.0	0.0		2.6	97.4	0.0	0.0		33.3	0.0	66.7	0.0		26.8	73.2	0.0	0.0		
PHF	0.250	0.000	0.000	0.000	0.250	0.250	0.792	0.000	0.000	0.813	0.250	0.000	0.500	0.000	0.750	0.458	0.833	0.000	0.000	0.732	0.875
Buses	1	0	0	0	1	1	7	0	0	8	0	0	0	0	0	0	5	0	0	5	14
Buses %	100.0	0.0	0.0	0.0	100.0	100.0	18.4	0.0	0.0	20.5	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	12.2	16.7
Single-Unit Trucks	0	0	0	0	0	0	25	0	0	25	1	0	2	0	3	5	21	0	0	26	54
Single-Unit %	0.0	0.0	0.0	0.0	0.0	0.0	65.8	0.0	0.0	64.1	100.0	0.0	100.0	0.0	100.0	45.5	70.0	0.0	0.0	63.4	64.3
Articulated Trucks	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	4	0	0	10	16
Articulated %	0.0	0.0	0.0	0.0	0.0	0.0	15.8	0.0	0.0	15.4	0.0	0.0	0.0	0.0	0.0	54.5	13.3	0.0	0.0	24.4	19.0
Buses	1	0	0	0	1	1	7	0	0	8	0	0	0	0	0	0	5	0	0	5	14
Single-Unit Trucks	0	0	0	0	0	0	25	0	0	25	1	0	2	0	3	5	21	0	0	26	54
Articulated Trucks	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	4	0	0	10	16
Total Entering Leg	1	0	0	0	1	1	38	0	0	39	1	0	2	0	3	11	30	0	0	41	84
Buses					1					5					0					8	14
Single-Unit Trucks					0					22					5					27	54
Articulated Trucks					0					4					6					6	16
Total Exiting Leg					1					31					11					41	84

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	6	0	2	0	8	0	224	0	0	224	10	0	30	0	40	22	148	1	0	171	443
3:15 PM	5	0	0	0	5	0	236	0	0	236	6	0	32	0	38	24	164	0	0	188	467
3:30 PM	2	0	0	0	2	2	269	2	0	273	13	0	27	0	40	17	180	0	0	197	512
3:45 PM	3	0	2	0	5	3	252	0	0	255	12	0	35	0	47	21	153	0	0	174	481
Total	16	0	4	0	20	5	981	2	0	988	41	0	124	0	165	84	645	1	0	730	1903
4:00 PM	7	0	1	0	8	1	253	0	0	254	7	0	44	0	51	25	156	0	0	181	494
4:15 PM	5	0	1	0	6	1	275	0	0	276	12	0	52	0	64	25	150	0	0	175	521
4:30 PM	1	0	4	0	5	0	274	0	0	274	17	0	35	0	52	23	145	0	0	168	499
4:45 PM	3	0	0	0	3	1	284	0	0	285	13	0	69	0	82	31	162	0	0	193	563
Total	16	0	6	0	22	3	1086	0	0	1089	49	0	200	0	249	104	613	0	0	717	2077
5:00 PM	3	0	0	0	3	1	343	0	1	345	14	0	84	0	98	26	157	0	1	184	630
5:15 PM	1	1	1	0	3	0	297	0	0	297	13	0	96	0	109	42	163	0	0	205	614
5:30 PM	4	0	0	0	4	0	293	0	0	293	20	0	76	0	96	25	163	0	0	188	581
5:45 PM	0	0	0	0	0	1	285	0	0	286	23	0	67	0	90	31	144	0	0	175	551
Total	8	1	1	0	10	2	1218	0	1	1221	70	0	323	0	393	124	627	0	1	752	2376
Grand Total	40	1	11	0	52	10	3285	2	1	3298	160	0	647	0	807	312	1885	1	1	2199	6356
Approach %	76.9	1.9	21.2	0.0		0.3	99.6	0.1	0.0		19.8	0.0	80.2	0.0		14.2	85.7	0.0	0.0		
Total %	0.6	0.0	0.2	0.0	0.8	0.2	51.7	0.0	0.0	51.9	2.5	0.0	10.2	0.0	12.7	4.9	29.7	0.0	0.0	34.6	
Exiting Leg Total					11					2057					315					3973	6356

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	3	0	0	0	3	1	284	0	0	285	13	0	69	0	82	31	162	0	0	193	563
5:00 PM	3	0	0	0	3	1	343	0	1	345	14	0	84	0	98	26	157	0	1	184	630
5:15 PM	1	1	1	0	3	0	297	0	0	297	13	0	96	0	109	42	163	0	0	205	614
5:30 PM	4	0	0	0	4	0	293	0	0	293	20	0	76	0	96	25	163	0	0	188	581
Total Volume	11	1	1	0	13	2	1217	0	1	1220	60	0	325	0	385	124	645	0	1	770	2388
% Approach Total	84.6	7.7	7.7	0.0		0.2	99.8	0.0	0.1		15.6	0.0	84.4	0.0		16.1	83.8	0.0	0.1		
PHF	0.688	0.250	0.250	0.000	0.813	0.500	0.887	0.000	0.250	0.884	0.750	0.000	0.846	0.000	0.883	0.738	0.989	0.000	0.250	0.939	0.948
Entering Leg	11	1	1	0	13	2	1217	0	1	1220	60	0	325	0	385	124	645	0	1	770	2388
Exiting Leg					2					707					125					1554	2388
Total					15					1927					510					2324	4776

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Light Goods Vehicle**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	38	0	0	38	0	0	4	0	4	1	11	0	0	12	54
3:15 PM	2	0	0	0	2	0	30	0	0	30	2	0	3	0	5	2	10	0	0	12	49
3:30 PM	0	0	0	0	0	0	30	0	0	30	2	0	1	0	3	2	6	0	0	8	41
3:45 PM	0	0	0	0	0	0	27	0	0	27	1	0	3	0	4	0	15	0	0	15	46
Total	2	0	0	0	2	0	125	0	0	125	5	0	11	0	16	5	42	0	0	47	190
4:00 PM	0	0	0	0	0	0	28	0	0	28	0	0	2	0	2	3	15	0	0	18	48
4:15 PM	0	0	1	0	1	0	24	0	0	24	3	0	2	0	5	2	11	0	0	13	43
4:30 PM	0	0	0	0	0	0	22	0	0	22	1	0	5	0	6	1	9	0	0	10	38
4:45 PM	0	0	0	0	0	0	17	0	0	17	3	0	2	0	5	3	12	0	0	15	37
Total	0	0	1	0	1	0	91	0	0	91	7	0	11	0	18	9	47	0	0	56	166
5:00 PM	0	0	0	0	0	0	23	0	0	23	0	0	4	0	4	5	10	0	0	15	42
5:15 PM	0	0	0	0	0	1	28	0	0	29	0	0	6	0	6	1	3	0	0	4	39
5:30 PM	0	0	0	0	0	0	17	0	0	17	0	0	3	0	3	3	2	0	0	5	25
5:45 PM	0	0	0	0	0	0	20	0	0	20	0	0	3	0	3	0	4	0	0	4	27
Total	0	0	0	0	0	1	88	0	0	89	0	0	16	0	16	9	19	0	0	28	133
Grand Total	2	0	1	0	3	1	304	0	0	305	12	0	38	0	50	23	108	0	0	131	489
Approach %	66.7	0.0	33.3	0.0		0.3	99.7	0.0	0.0		24.0	0.0	76.0	0.0		17.6	82.4	0.0	0.0		
Total %	0.4	0.0	0.2	0.0	0.6	0.2	62.2	0.0	0.0	62.4	2.5	0.0	7.8	0.0	10.2	4.7	22.1	0.0	0.0	26.8	
Exiting Leg Total					1					121					23					344	489

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	38	0	0	38	0	0	4	0	4	1	11	0	0	12	54
3:15 PM	2	0	0	0	2	0	30	0	0	30	2	0	3	0	5	2	10	0	0	12	49
3:30 PM	0	0	0	0	0	0	30	0	0	30	2	0	1	0	3	2	6	0	0	8	41
3:45 PM	0	0	0	0	0	0	27	0	0	27	1	0	3	0	4	0	15	0	0	15	46
Total Volume	2	0	0	0	2	0	125	0	0	125	5	0	11	0	16	5	42	0	0	47	190
% Approach Total	100.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		31.3	0.0	68.8	0.0		10.6	89.4	0.0	0.0		
PHF	0.250	0.000	0.000	0.000	0.250	0.000	0.822	0.000	0.000	0.822	0.625	0.000	0.688	0.000	0.800	0.625	0.700	0.000	0.000	0.783	0.880
Entering Leg	2	0	0	0	2	0	125	0	0	125	5	0	11	0	16	5	42	0	0	47	190
Exiting Leg					0					47					5					138	190
Total					2					172					21					185	380

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Buses**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	0	0	1	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	4
3:15 PM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	0	3	0	0	3	8
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
Total	1	0	0	0	1	1	7	0	0	8	0	0	0	0	0	0	5	0	0	5	14
4:00 PM	0	0	0	0	0	0	2	0	0	2	1	0	0	0	1	0	0	0	0	0	3
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	2
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	2	0	0	2	1	0	2	0	3	0	1	0	0	1	6
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	2
5:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	0	1	0	0	1	4
Grand Total	1	0	0	0	1	1	10	0	0	11	1	0	4	0	5	0	7	0	0	7	24
Approach %	100.0	0.0	0.0	0.0		9.1	90.9	0.0	0.0		20.0	0.0	80.0	0.0		0.0	100.0	0.0	0.0		
Total %	4.2	0.0	0.0	0.0	4.2	4.2	41.7	0.0	0.0	45.8	4.2	0.0	16.7	0.0	20.8	0.0	29.2	0.0	0.0	29.2	
Exiting Leg Total					1					8					0					15	24

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	1	0	0	0	1	1	1	0	0	2	0	0	0	0	0	0	1	0	0	1	4
3:15 PM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	0	3	0	0	3	8
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
Total Volume	1	0	0	0	1	1	7	0	0	8	0	0	0	0	0	0	5	0	0	5	14
% Approach Total	100.0	0.0	0.0	0.0		12.5	87.5	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.250	0.000	0.000	0.000	0.250	0.250	0.350	0.000	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.417	0.000	0.000	0.417	0.438
Entering Leg	1	0	0	0	1	1	7	0	0	8	0	0	0	0	0	0	5	0	0	5	14
Exiting Leg					1					5					0					8	14
Total					2					13					0					13	28

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Single-Unit Trucks**

	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	8	0	0	8	0	0	1	0	1	0	5	0	0	5	14
3:15 PM	0	0	0	0	0	0	7	0	0	7	0	0	1	0	1	1	6	0	0	7	15
3:30 PM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	2	6	0	0	8	13
3:45 PM	0	0	0	0	0	0	5	0	0	5	1	0	0	0	1	2	4	0	0	6	12
Total	0	0	0	0	0	0	25	0	0	25	1	0	2	0	3	5	21	0	0	26	54
4:00 PM	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	4
4:15 PM	0	0	0	0	0	1	5	0	0	6	0	0	0	0	0	1	4	0	0	5	11
4:30 PM	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	2	0	0	2	5
4:45 PM	0	0	0	0	0	0	8	0	0	8	0	0	0	0	0	2	0	0	0	2	10
Total	0	0	0	0	0	1	19	0	0	20	0	0	0	0	0	3	7	0	0	10	30
5:00 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	1	0	0	0	1	5
5:15 PM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	0	1	0	0	1	4
5:30 PM	0	0	0	0	0	0	6	0	0	6	1	0	1	0	2	0	0	0	0	0	8
5:45 PM	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3	1	0	0	0	1	8
Total	0	0	0	0	0	0	16	0	0	16	1	0	5	0	6	2	1	0	0	3	25
Grand Total	0	0	0	0	0	1	60	0	0	61	2	0	7	0	9	10	29	0	0	39	109
Approach %	0.0	0.0	0.0	0.0		1.6	98.4	0.0	0.0		22.2	0.0	77.8	0.0		25.6	74.4	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.9	55.0	0.0	0.0	56.0	1.8	0.0	6.4	0.0	8.3	9.2	26.6	0.0	0.0	35.8	
Exiting Leg Total					1					31					10					67	109

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Driveway					Highland Avenue					1st Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	8	0	0	8	0	0	1	0	1	0	5	0	0	5	14
3:15 PM	0	0	0	0	0	0	7	0	0	7	0	0	1	0	1	1	6	0	0	7	15
3:30 PM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	2	6	0	0	8	13
3:45 PM	0	0	0	0	0	0	5	0	0	5	1	0	0	0	1	2	4	0	0	6	12
Total Volume	0	0	0	0	0	0	25	0	0	25	1	0	2	0	3	5	21	0	0	26	54
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		33.3	0.0	66.7	0.0		19.2	80.8	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.781	0.000	0.000	0.781	0.250	0.000	0.500	0.000	0.750	0.625	0.875	0.000	0.000	0.813	0.900
Entering Leg	0	0	0	0	0	0	25	0	0	25	1	0	2	0	3	5	21	0	0	26	54
Exiting Leg					0					22					5					27	54
Total					0					47					8					53	108

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Articulated Trucks**

	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0	2	3
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
3:30 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4	2	0	0	6	7
3:45 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	1	0	0	0	1	5
Total	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	4	0	0	10	16
4:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	2
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
4:30 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3	0	0	0	3	4
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	3
Total	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	7	0	0	0	7	10
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
5:15 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
5:30 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	2
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	1	1	0	0	2	5
Grand Total	0	0	0	0	0	0	11	0	0	11	0	0	1	0	1	14	5	0	0	19	31
Approach %	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	100.0	0.0		73.7	26.3	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	35.5	0.0	0.0	35.5	0.0	0.0	3.2	0.0	3.2	45.2	16.1	0.0	0.0	61.3	
Exiting Leg Total					0					5					14					12	31

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Driveway from North					Highland Avenue from East					1st Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0	2	3
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
3:30 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4	2	0	0	6	7
3:45 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	1	0	0	0	1	5
Total Volume	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	4	0	0	10	16
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		60.0	40.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.375	0.000	0.000	0.375	0.000	0.000	0.000	0.000	0.000	0.375	0.500	0.000	0.000	0.417	0.571
Entering Leg	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6	4	0	0	10	16
Exiting Leg					0					4					6					6	16
Total					0					10					6					16	32

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Bicycles (on Roadway and Crosswalks)**

	Driveway							Highland Avenue							1st Avenue							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total	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	0	0	0
4:00 PM	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	0	0	0
4:15 PM	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	0	0	0
4:30 PM	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	0	0	0
4:45 PM	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	0	0	0
Total	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	0	0	0
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Grand Total	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Approach %	0.0	0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total							0							0							0							1	1

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

5:00 PM	Driveway							Highland Avenue							1st Avenue							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% Approach Total	0.0	0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Entering Leg	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Exiting Leg							0							0							0							1	1
Total							0							1							0							1	2

PDI File #: **196735 GG**
Location: **N: Driveway S: 1st Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Pedestrians**

	Driveway from North							Highland Avenue from East							1st Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total	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	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	4	0	4	0	0	0	0	0	0	0	7
4:15 PM	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	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	6	0	6	0	0	0	0	0	0	0	11
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Grand Total	0	0	0	0	0	0	0	0	0	0	0	6	0	6	0	0	0	0	6	0	6	0	0	0	0	0	0	0	12
Approach %	0	0	0	0	0	0		0	0	0	0	100	0		0	0	0	0	100	0		0	0	0	0	0	0		
Total %	0	0	0	0	0	0	0	0	0	0	0	50	0	50	0	0	0	0	50	0	50	0	0	0	0	0	0	0	
Exiting Leg Total							0							6							6							0	12

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:00 PM	Driveway from North							Highland Avenue from East							1st Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	4	0	4	0	0	0	0	0	0	0	7
4:15 PM	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	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
Total Volume	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	6	0	6	0	0	0	0	0	0	0	11
% Approach Total	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.417	0.000	0.417	0.000	0.000	0.000	0.000	0.375	0.000	0.375	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.393
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	6	0	6	0	0	0	0	0	0	0	11
Exiting Leg							0							5							6							0	11
Total							0							10							12							0	22

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**

Class: **Cars and Heavy Vehicles (Combined)**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	2	5	0	7	3	75	34	0	112	19	4	30	0	53	26	225	1	0	252	424
7:15 AM	0	1	4	0	5	1	111	30	0	142	25	1	30	0	56	31	199	0	0	230	433
7:30 AM	1	2	5	0	8	0	143	31	0	174	24	2	31	0	57	32	196	0	0	228	467
7:45 AM	1	3	4	0	8	1	160	44	0	205	31	2	45	0	78	27	159	0	0	186	477
Total	2	8	18	0	28	5	489	139	0	633	99	9	136	0	244	116	779	1	0	896	1801
8:00 AM	0	2	4	0	6	6	130	70	0	206	25	2	46	0	73	29	185	0	0	214	499
8:15 AM	0	1	4	0	5	5	132	79	0	216	38	0	41	0	79	45	187	3	0	235	535
8:30 AM	2	3	4	0	9	8	140	60	0	208	40	1	31	0	72	47	190	0	0	237	526
8:45 AM	0	1	3	0	4	7	142	77	0	226	35	1	36	0	72	36	158	1	0	195	497
Total	2	7	15	0	24	26	544	286	0	856	138	4	154	0	296	157	720	4	0	881	2057
Grand Total	4	15	33	0	52	31	1033	425	0	1489	237	13	290	0	540	273	1499	5	0	1777	3858
Approach %	7.7	28.8	63.5	0.0		2.1	69.4	28.5	0.0		43.9	2.4	53.7	0.0		15.4	84.4	0.3	0.0		
Total %	0.1	0.4	0.9	0.0	1.3	0.8	26.8	11.0	0.0	38.6	6.1	0.3	7.5	0.0	14.0	7.1	38.9	0.1	0.0	46.1	
Exiting Leg Total					49					1769					713					1327	3858
Cars	4	13	26	0	43	31	982	414	0	1427	222	12	270	0	504	263	1436	4	0	1703	3677
% Cars	100.0	86.7	78.8	0.0	82.7	100.0	95.1	97.4	0.0	95.8	93.7	92.3	93.1	0.0	93.3	96.3	95.8	80.0	0.0	95.8	95.3
Exiting Leg Total					47					1684					690					1256	3677
Heavy Vehicles	0	2	7	0	9	0	51	11	0	62	15	1	20	0	36	10	63	1	0	74	181
% Heavy Vehicles	0.0	13.3	21.2	0.0	17.3	0.0	4.9	2.6	0.0	4.2	6.3	7.7	6.9	0.0	6.7	3.7	4.2	20.0	0.0	4.2	4.7
Exiting Leg Total					2					85					23					71	181

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	2	4	0	6	6	130	70	0	206	25	2	46	0	73	29	185	0	0	214	499
8:15 AM	0	1	4	0	5	5	132	79	0	216	38	0	41	0	79	45	187	3	0	235	535
8:30 AM	2	3	4	0	9	8	140	60	0	208	40	1	31	0	72	47	190	0	0	237	526
8:45 AM	0	1	3	0	4	7	142	77	0	226	35	1	36	0	72	36	158	1	0	195	497
Total Volume	2	7	15	0	24	26	544	286	0	856	138	4	154	0	296	157	720	4	0	881	2057
% Approach Total	8.3	29.2	62.5	0.0		3.0	63.6	33.4	0.0		46.6	1.4	52.0	0.0		17.8	81.7	0.5	0.0		
PHF	0.250	0.583	0.938	0.000	0.667	0.813	0.958	0.905	0.000	0.947	0.863	0.500	0.837	0.000	0.937	0.835	0.947	0.333	0.000	0.929	0.961
Cars	2	7	13	0	22	26	517	279	0	822	128	3	151	0	282	152	691	4	0	847	1973
Cars %	100.0	100.0	86.7	0.0	91.7	100.0	95.0	97.6	0.0	96.0	92.8	75.0	98.1	0.0	95.3	96.8	96.0	100.0	0.0	96.1	95.9
Heavy Vehicles	0	0	2	0	2	0	27	7	0	34	10	1	3	0	14	5	29	0	0	34	84
Heavy Vehicles %	0.0	0.0	13.3	0.0	8.3	0.0	5.0	2.4	0.0	4.0	7.2	25.0	1.9	0.0	4.7	3.2	4.0	0.0	0.0	3.9	4.1
Cars Enter Leg	2	7	13	0	22	26	517	279	0	822	128	3	151	0	282	152	691	4	0	847	1973
Heavy Enter Leg	0	0	2	0	2	0	27	7	0	34	10	1	3	0	14	5	29	0	0	34	84
Total Entering Leg	2	7	15	0	24	26	544	286	0	856	138	4	154	0	296	157	720	4	0	881	2057
Cars Exiting Leg					33					832					438					670	1973
Heavy Exiting Leg					1					41					12					30	84
Total Exiting Leg					34					873					450					700	2057

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	2	4	0	6	3	70	33	0	106	18	4	28	0	50	26	220	0	0	246	408
7:15 AM	0	1	4	0	5	1	104	29	0	134	23	1	26	0	50	27	187	0	0	214	403
7:30 AM	1	2	4	0	7	0	137	31	0	168	23	2	29	0	54	32	187	0	0	219	448
7:45 AM	1	1	1	0	3	1	154	42	0	197	30	2	36	0	68	26	151	0	0	177	445
Total	2	6	13	0	21	5	465	135	0	605	94	9	119	0	222	111	745	0	0	856	1704
8:00 AM	0	2	4	0	6	6	124	69	0	199	24	2	45	0	71	28	179	0	0	207	483
8:15 AM	0	1	3	0	4	5	123	76	0	204	35	0	41	0	76	43	179	3	0	225	509
8:30 AM	2	3	4	0	9	8	133	58	0	199	40	1	29	0	70	45	179	0	0	224	502
8:45 AM	0	1	2	0	3	7	137	76	0	220	29	0	36	0	65	36	154	1	0	191	479
Total	2	7	13	0	22	26	517	279	0	822	128	3	151	0	282	152	691	4	0	847	1973
Grand Total	4	13	26	0	43	31	982	414	0	1427	222	12	270	0	504	263	1436	4	0	1703	3677
Approach %	9.3	30.2	60.5	0.0		2.2	68.8	29.0	0.0		44.0	2.4	53.6	0.0		15.4	84.3	0.2	0.0		
Total %	0.1	0.4	0.7	0.0	1.2	0.8	26.7	11.3	0.0	38.8	6.0	0.3	7.3	0.0	13.7	7.2	39.1	0.1	0.0	46.3	
Exiting Leg Total					47					1684					690					1256	3677

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	2	4	0	6	6	124	69	0	199	24	2	45	0	71	28	179	0	0	207	483
8:15 AM	0	1	3	0	4	5	123	76	0	204	35	0	41	0	76	43	179	3	0	225	509
8:30 AM	2	3	4	0	9	8	133	58	0	199	40	1	29	0	70	45	179	0	0	224	502
8:45 AM	0	1	2	0	3	7	137	76	0	220	29	0	36	0	65	36	154	1	0	191	479
Total Volume	2	7	13	0	22	26	517	279	0	822	128	3	151	0	282	152	691	4	0	847	1973
% Approach Total	9.1	31.8	59.1	0.0		3.2	62.9	33.9	0.0		45.4	1.1	53.5	0.0		17.9	81.6	0.5	0.0		
PHF	0.250	0.583	0.813	0.000	0.611	0.813	0.943	0.918	0.000	0.934	0.800	0.375	0.839	0.000	0.928	0.844	0.965	0.333	0.000	0.941	0.969
Entering Leg	2	7	13	0	22	26	517	279	0	822	128	3	151	0	282	152	691	4	0	847	1973
Exiting Leg					33					832					438					670	1973
Total					55					1654					720					1517	3946

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	1	0	1	0	5	1	0	6	1	0	2	0	3	0	5	1	0	6	16
7:15 AM	0	0	0	0	0	0	7	1	0	8	2	0	4	0	6	4	12	0	0	16	30
7:30 AM	0	0	1	0	1	0	6	0	0	6	1	0	2	0	3	0	9	0	0	9	19
7:45 AM	0	2	3	0	5	0	6	2	0	8	1	0	9	0	10	1	8	0	0	9	32
Total	0	2	5	0	7	0	24	4	0	28	5	0	17	0	22	5	34	1	0	40	97
8:00 AM	0	0	0	0	0	0	6	1	0	7	1	0	1	0	2	1	6	0	0	7	16
8:15 AM	0	0	1	0	1	0	9	3	0	12	3	0	0	0	3	2	8	0	0	10	26
8:30 AM	0	0	0	0	0	0	7	2	0	9	0	0	2	0	2	2	11	0	0	13	24
8:45 AM	0	0	1	0	1	0	5	1	0	6	6	1	0	0	7	0	4	0	0	4	18
Total	0	0	2	0	2	0	27	7	0	34	10	1	3	0	14	5	29	0	0	34	84
Grand Total	0	2	7	0	9	0	51	11	0	62	15	1	20	0	36	10	63	1	0	74	181
Approach %	0.0	22.2	77.8	0.0		0.0	82.3	17.7	0.0		41.7	2.8	55.6	0.0		13.5	85.1	1.4	0.0		
Total %	0.0	1.1	3.9	0.0	5.0	0.0	28.2	6.1	0.0	34.3	8.3	0.6	11.0	0.0	19.9	5.5	34.8	0.6	0.0	40.9	
Exiting Leg Total					2					85					23					71	181
Buses	0	0	2	0	2	0	4	8	0	12	5	1	1	0	7	1	10	1	0	12	33
% Buses	0.0	0.0	28.6	0.0	22.2	0.0	7.8	72.7	0.0	19.4	33.3	100.0	5.0	0.0	19.4	10.0	15.9	100.0	0.0	16.2	18.2
Exiting Leg Total					2					17					9					5	33
Single-Unit Trucks	0	1	5	0	6	0	40	3	0	43	9	0	14	0	23	9	44	0	0	53	125
% Single-Unit	0.0	50.0	71.4	0.0	66.7	0.0	78.4	27.3	0.0	69.4	60.0	0.0	70.0	0.0	63.9	90.0	69.8	0.0	0.0	71.6	69.1
Exiting Leg Total					0					58					13					54	125
Articulated Trucks	0	1	0	0	1	0	7	0	0	7	1	0	5	0	6	0	9	0	0	9	23
% Articulated	0.0	50.0	0.0	0.0	11.1	0.0	13.7	0.0	0.0	11.3	6.7	0.0	25.0	0.0	16.7	0.0	14.3	0.0	0.0	12.2	12.7
Exiting Leg Total					0					10					1					12	23

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:45 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:45 AM	0	2	3	0	5	0	6	2	0	8	1	0	9	0	10	1	8	0	0	9	32
8:00 AM	0	0	0	0	0	0	6	1	0	7	1	0	1	0	2	1	6	0	0	7	16
8:15 AM	0	0	1	0	1	0	9	3	0	12	3	0	0	0	3	2	8	0	0	10	26
8:30 AM	0	0	0	0	0	0	7	2	0	9	0	0	2	0	2	2	11	0	0	13	24
Total Volume	0	2	4	0	6	0	28	8	0	36	5	0	12	0	17	6	33	0	0	39	98
% Approach Total	0.0	33.3	66.7	0.0		0.0	77.8	22.2	0.0		29.4	0.0	70.6	0.0		15.4	84.6	0.0	0.0		
PHF	0.000	0.250	0.333	0.000	0.300	0.000	0.778	0.667	0.000	0.750	0.417	0.000	0.333	0.000	0.425	0.750	0.750	0.000	0.000	0.750	0.766
Buses	0	0	1	0	1	0	2	6	0	8	3	0	1	0	4	1	6	0	0	7	20
Buses %	0.0	0.0	25.0	0.0	16.7	0.0	7.1	75.0	0.0	22.2	60.0	0.0	8.3	0.0	23.5	16.7	18.2	0.0	0.0	17.9	20.4
Single-Unit Trucks	0	1	3	0	4	0	22	2	0	24	1	0	6	0	7	5	21	0	0	26	61
Single-Unit %	0.0	50.0	75.0	0.0	66.7	0.0	78.6	25.0	0.0	66.7	20.0	0.0	50.0	0.0	41.2	83.3	63.6	0.0	0.0	66.7	62.2
Articulated Trucks	0	1	0	0	1	0	4	0	0	4	1	0	5	0	6	0	6	0	0	6	17
Articulated %	0.0	50.0	0.0	0.0	16.7	0.0	14.3	0.0	0.0	11.1	20.0	0.0	41.7	0.0	35.3	0.0	18.2	0.0	0.0	15.4	17.3
Buses	0	0	1	0	1	0	2	6	0	8	3	0	1	0	4	1	6	0	0	7	20
Single-Unit Trucks	0	1	3	0	4	0	22	2	0	24	1	0	6	0	7	5	21	0	0	26	61
Articulated Trucks	0	1	0	0	1	0	4	0	0	4	1	0	5	0	6	0	6	0	0	6	17
Total Entering Leg	0	2	4	0	6	0	28	8	0	36	5	0	12	0	17	6	33	0	0	39	98
Buses					0					10					7					3	20
Single-Unit Trucks					0					25					8					28	61
Articulated Trucks					0					7					1					9	17
Total Exiting Leg					0					42					16					40	98

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	2	4	0	6	3	63	33	0	99	17	4	27	0	48	22	191	0	0	213	366
7:15 AM	0	1	3	0	4	1	95	29	0	125	21	1	23	0	45	25	172	0	0	197	371
7:30 AM	1	2	3	0	6	0	130	30	0	160	23	2	28	0	53	31	164	0	0	195	414
7:45 AM	1	1	0	0	2	1	143	41	0	185	28	2	32	0	62	26	135	0	0	161	410
Total	2	6	10	0	18	5	431	133	0	569	89	9	110	0	208	104	662	0	0	766	1561
8:00 AM	0	1	4	0	5	6	110	66	0	182	23	2	44	0	69	26	159	0	0	185	441
8:15 AM	0	1	2	0	3	5	115	74	0	194	33	0	38	0	71	39	155	2	0	196	464
8:30 AM	2	3	4	0	9	8	125	54	0	187	37	1	27	0	65	40	167	0	0	207	468
8:45 AM	0	1	2	0	3	7	128	74	0	209	26	0	33	0	59	31	136	1	0	168	439
Total	2	6	12	0	20	26	478	268	0	772	119	3	142	0	264	136	617	3	0	756	1812
Grand Total	4	12	22	0	38	31	909	401	0	1341	208	12	252	0	472	240	1279	3	0	1522	3373
Approach %	10.5	31.6	57.9	0.0		2.3	67.8	29.9	0.0		44.1	2.5	53.4	0.0		15.8	84.0	0.2	0.0		
Total %	0.1	0.4	0.7	0.0	1.1	0.9	26.9	11.9	0.0	39.8	6.2	0.4	7.5	0.0	14.0	7.1	37.9	0.1	0.0	45.1	
Exiting Leg Total					46					1509					653					1165	3373

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	1	4	0	5	6	110	66	0	182	23	2	44	0	69	26	159	0	0	185	441
8:15 AM	0	1	2	0	3	5	115	74	0	194	33	0	38	0	71	39	155	2	0	196	464
8:30 AM	2	3	4	0	9	8	125	54	0	187	37	1	27	0	65	40	167	0	0	207	468
8:45 AM	0	1	2	0	3	7	128	74	0	209	26	0	33	0	59	31	136	1	0	168	439
Total Volume	2	6	12	0	20	26	478	268	0	772	119	3	142	0	264	136	617	3	0	756	1812
% Approach Total	10.0	30.0	60.0	0.0		3.4	61.9	34.7	0.0		45.1	1.1	53.8	0.0		18.0	81.6	0.4	0.0		
PHF	0.250	0.500	0.750	0.000	0.556	0.813	0.934	0.905	0.000	0.923	0.804	0.375	0.807	0.000	0.930	0.850	0.924	0.375	0.000	0.913	0.968
Entering Leg	2	6	12	0	20	26	478	268	0	772	119	3	142	0	264	136	617	3	0	756	1812
Exiting Leg					32					748					410					622	1812
Total					52					1520					674					1378	3624

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**

Class: **Light Goods Vehicle**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	7	0	0	7	1	0	1	0	2	4	29	0	0	33	42
7:15 AM	0	0	1	0	1	0	9	0	0	9	2	0	3	0	5	2	15	0	0	17	32
7:30 AM	0	0	1	0	1	0	7	1	0	8	0	0	1	0	1	1	23	0	0	24	34
7:45 AM	0	0	1	0	1	0	11	1	0	12	2	0	4	0	6	0	16	0	0	16	35
Total	0	0	3	0	3	0	34	2	0	36	5	0	9	0	14	7	83	0	0	90	143
8:00 AM	0	1	0	0	1	0	14	3	0	17	1	0	1	0	2	2	20	0	0	22	42
8:15 AM	0	0	1	0	1	0	8	2	0	10	2	0	3	0	5	4	24	1	0	29	45
8:30 AM	0	0	0	0	0	0	8	4	0	12	3	0	2	0	5	5	12	0	0	17	34
8:45 AM	0	0	0	0	0	0	9	2	0	11	3	0	3	0	6	5	18	0	0	23	40
Total	0	1	1	0	2	0	39	11	0	50	9	0	9	0	18	16	74	1	0	91	161
Grand Total	0	1	4	0	5	0	73	13	0	86	14	0	18	0	32	23	157	1	0	181	304
Approach %	0.0	20.0	80.0	0.0		0.0	84.9	15.1	0.0		43.8	0.0	56.3	0.0		12.7	86.7	0.6	0.0		
Total %	0.0	0.3	1.3	0.0	1.6	0.0	24.0	4.3	0.0	28.3	4.6	0.0	5.9	0.0	10.5	7.6	51.6	0.3	0.0	59.5	
Exiting Leg Total					1					175					37					91	304

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	1	0	0	1	0	14	3	0	17	1	0	1	0	2	2	20	0	0	22	42
8:15 AM	0	0	1	0	1	0	8	2	0	10	2	0	3	0	5	4	24	1	0	29	45
8:30 AM	0	0	0	0	0	0	8	4	0	12	3	0	2	0	5	5	12	0	0	17	34
8:45 AM	0	0	0	0	0	0	9	2	0	11	3	0	3	0	6	5	18	0	0	23	40
Total Volume	0	1	1	0	2	0	39	11	0	50	9	0	9	0	18	16	74	1	0	91	161
% Approach Total	0.0	50.0	50.0	0.0		0.0	78.0	22.0	0.0		50.0	0.0	50.0	0.0		17.6	81.3	1.1	0.0		
PHF	0.000	0.250	0.250	0.000	0.500	0.000	0.696	0.688	0.000	0.735	0.750	0.000	0.750	0.000	0.750	0.800	0.771	0.250	0.000	0.784	0.894
Entering Leg	0	1	1	0	2	0	39	11	0	50	9	0	9	0	18	16	74	1	0	91	161
Exiting Leg					1					84					28					48	161
Total					3					134					46					139	322

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Buses**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	2
7:15 AM	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	1	0	0	1	3
7:30 AM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	3
7:45 AM	0	0	1	0	1	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	3
Total	0	0	2	0	2	0	2	3	0	5	0	0	0	0	0	0	3	1	0	4	11
8:00 AM	0	0	0	0	0	0	1	1	0	2	1	0	1	0	2	0	2	0	0	2	6
8:15 AM	0	0	0	0	0	0	1	1	0	2	2	0	0	0	2	0	1	0	0	1	5
8:30 AM	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	1	3	0	0	4	6
8:45 AM	0	0	0	0	0	0	0	1	0	1	2	1	0	0	3	0	1	0	0	1	5
Total	0	0	0	0	0	0	2	5	0	7	5	1	1	0	7	1	7	0	0	8	22
Grand Total	0	0	2	0	2	0	4	8	0	12	5	1	1	0	7	1	10	1	0	12	33
Approach %	0.0	0.0	100.0	0.0		0.0	33.3	66.7	0.0		71.4	14.3	14.3	0.0		8.3	83.3	8.3	0.0		
Total %	0.0	0.0	6.1	0.0	6.1	0.0	12.1	24.2	0.0	36.4	15.2	3.0	3.0	0.0	21.2	3.0	30.3	3.0	0.0	36.4	
Exiting Leg Total					2					17					9					5	33

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	0	0	0	0	0	1	1	0	2	1	0	1	0	2	0	2	0	0	2	6
8:15 AM	0	0	0	0	0	0	1	1	0	2	2	0	0	0	2	0	1	0	0	1	5
8:30 AM	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	1	3	0	0	4	6
8:45 AM	0	0	0	0	0	0	0	1	0	1	2	1	0	0	3	0	1	0	0	1	5
Total Volume	0	0	0	0	0	0	2	5	0	7	5	1	1	0	7	1	7	0	0	8	22
% Approach Total	0.0	0.0	0.0	0.0		0.0	28.6	71.4	0.0		71.4	14.3	14.3	0.0		12.5	87.5	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.625	0.000	0.875	0.625	0.250	0.250	0.000	0.583	0.250	0.583	0.000	0.000	0.500	0.917
Entering Leg	0	0	0	0	0	0	2	5	0	7	5	1	1	0	7	1	7	0	0	8	22
Exiting Leg					1					12					6					3	22
Total					1					19					13					11	44

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Single-Unit Trucks**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	1	0	1	0	4	1	0	5	1	0	2	0	3	0	5	0	0	5	14
7:15 AM	0	0	0	0	0	0	4	0	0	4	2	0	4	0	6	4	10	0	0	14	24
7:30 AM	0	0	0	0	0	0	5	0	0	5	1	0	2	0	3	0	6	0	0	6	14
7:45 AM	0	1	2	0	3	0	6	0	0	6	0	0	5	0	5	1	6	0	0	7	21
Total	0	1	3	0	4	0	19	1	0	20	4	0	13	0	17	5	27	0	0	32	73
8:00 AM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	1	3	0	0	4	9
8:15 AM	0	0	1	0	1	0	6	2	0	8	1	0	0	0	1	2	5	0	0	7	17
8:30 AM	0	0	0	0	0	0	5	0	0	5	0	0	1	0	1	1	7	0	0	8	14
8:45 AM	0	0	1	0	1	0	5	0	0	5	4	0	0	0	4	0	2	0	0	2	12
Total	0	0	2	0	2	0	21	2	0	23	5	0	1	0	6	4	17	0	0	21	52
Grand Total	0	1	5	0	6	0	40	3	0	43	9	0	14	0	23	9	44	0	0	53	125
Approach %	0.0	16.7	83.3	0.0		0.0	93.0	7.0	0.0		39.1	0.0	60.9	0.0		17.0	83.0	0.0	0.0		
Total %	0.0	0.8	4.0	0.0	4.8	0.0	32.0	2.4	0.0	34.4	7.2	0.0	11.2	0.0	18.4	7.2	35.2	0.0	0.0	42.4	
Exiting Leg Total					0					58					13					54	125

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	1	0	1	0	4	1	0	5	1	0	2	0	3	0	5	0	0	5	14
7:15 AM	0	0	0	0	0	0	4	0	0	4	2	0	4	0	6	4	10	0	0	14	24
7:30 AM	0	0	0	0	0	0	5	0	0	5	1	0	2	0	3	0	6	0	0	6	14
7:45 AM	0	1	2	0	3	0	6	0	0	6	0	0	5	0	5	1	6	0	0	7	21
Total Volume	0	1	3	0	4	0	19	1	0	20	4	0	13	0	17	5	27	0	0	32	73
% Approach Total	0.0	25.0	75.0	0.0		0.0	95.0	5.0	0.0		23.5	0.0	76.5	0.0		15.6	84.4	0.0	0.0		
PHF	0.000	0.250	0.375	0.000	0.333	0.000	0.792	0.250	0.000	0.833	0.500	0.000	0.650	0.000	0.708	0.313	0.675	0.000	0.000	0.571	0.760
Entering Leg	0	1	3	0	4	0	19	1	0	20	4	0	13	0	17	5	27	0	0	32	73
Exiting Leg					0					34					7					32	73
Total					4					54					24					64	146

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Articulated Trucks**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	3
7:30 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
7:45 AM	0	1	0	0	1	0	0	0	0	0	1	0	4	0	5	0	2	0	0	2	8
Total	0	1	0	0	1	0	3	0	0	3	1	0	4	0	5	0	4	0	0	4	13
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
8:15 AM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	4
8:30 AM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	0	1	0	0	1	4
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Total	0	0	0	0	0	0	4	0	0	4	0	0	1	0	1	0	5	0	0	5	10
Grand Total	0	1	0	0	1	0	7	0	0	7	1	0	5	0	6	0	9	0	0	9	23
Approach %	0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		16.7	0.0	83.3	0.0		0.0	100.0	0.0	0.0		
Total %	0.0	4.3	0.0	0.0	4.3	0.0	30.4	0.0	0.0	30.4	4.3	0.0	21.7	0.0	26.1	0.0	39.1	0.0	0.0	39.1	
Exiting Leg Total					0					10					1					12	23

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:45 AM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:45 AM	0	1	0	0	1	0	0	0	0	0	1	0	4	0	5	0	2	0	0	2	8
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
8:15 AM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	4
8:30 AM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	0	1	0	0	1	4
Total Volume	0	1	0	0	1	0	4	0	0	4	1	0	5	0	6	0	6	0	0	6	17
% Approach Total	0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		16.7	0.0	83.3	0.0		0.0	100.0	0.0	0.0		
PHF	0.000	0.250	0.000	0.000	0.250	0.000	0.500	0.000	0.000	0.500	0.250	0.000	0.313	0.000	0.300	0.000	0.750	0.000	0.000	0.750	0.531
Entering Leg	0	1	0	0	1	0	4	0	0	4	1	0	5	0	6	0	6	0	0	6	17
Exiting Leg					0					7					1					9	17
Total					1					11					7					15	34

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Bicycles (on Roadway and Crosswalks)**

	Plaza Driveway from North							Highland Avenue from East							2nd Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
8:30 AM	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	0	0	0
8:45 AM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2
Grand Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	2	3
Approach %	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	0.0	0.0	0.0	0.0	100.0		0.0	100.0	0.0	0.0	0.0	0.0		
Total %	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	0.0	0.0	0.0	0.0	0.0	0.0	33.3	33.3	0.0	66.7	0.0	0.0	0.0	0.0	66.7	
Exiting Leg Total							0							2							1							0	3

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Plaza Driveway from North							Highland Avenue from East							2nd Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	2
% Approach Total	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	0.0	0.0	0.0	0.0	100.0		0.0	100.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.500
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	2
Exiting Leg							0							1							1							0	2
Total							0							1							2							1	4

PDI File #: **196735 H**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Pedestrians**

	Plaza Driveway							Highland Avenue							2nd Avenue							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
7:30 AM	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	2	2	0	0	0	0	2	1	3	0	0	0	0	2	0	2	0	0	0	0	0	0	0	7
8:00 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	3
8:15 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:30 AM	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	0	0	0
8:45 AM	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3
Total	0	0	0	0	0	3	3	0	0	0	0	1	0	1	0	0	0	0	1	1	2	0	0	0	0	0	1	1	7
Grand Total	0	0	0	0	0	5	5	0	0	0	0	3	1	4	0	0	0	0	3	1	4	0	0	0	0	0	1	1	14
Approach %	0	0	0	0	0	100		0	0	0	0	75	25		0	0	0	0	75	25		0	0	0	0	0	100		
Total %	0	0	0	0	0	35.7	35.7	0	0	0	0	21.4	7.14	28.6	0	0	0	0	21.4	7.14	28.6	0	0	0	0	0	7.14	7.14	
Exiting Leg Total							5							4							4							1	14

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:15 AM	Plaza Driveway							Highland Avenue							2nd Avenue							Highland Avenue							
	from North							from East							from South							from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
7:30 AM	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	3
Total Volume	0	0	0	0	0	3	3	0	0	0	0	2	0	2	0	0	0	0	3	0	3	0	0	0	0	0	1	1	9
% Approach Total	0.0	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0	0.0	100.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.375	0.375	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.000	0.000	0.000	0.000	0.750	0.000	0.750	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.750
Entering Leg	0	0	0	0	0	3	3	0	0	0	0	2	0	2	0	0	0	0	3	0	3	0	0	0	0	0	1	1	9
Exiting Leg							3							2							3							1	9
Total							6							4							6							2	18

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Cars and Heavy Vehicles (Combined)

	Plaza Driveway					Highland Avenue					2nd Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	5	6	6	0	17	11	175	29	0	215	27	0	59	0	86	29	127	4	0	160	478
3:15 PM	3	3	10	0	16	8	197	30	0	235	21	2	48	0	71	34	122	0	0	156	478
3:30 PM	4	3	15	0	22	17	191	33	0	241	44	4	74	0	122	22	150	1	0	173	558
3:45 PM	3	2	17	0	22	7	204	32	0	243	35	4	43	0	82	25	140	2	0	167	514
Total	15	14	48	0	77	43	767	124	0	934	127	10	224	0	361	110	539	7	0	656	2028
4:00 PM	0	1	11	0	12	12	192	26	0	230	44	4	79	0	127	29	120	0	0	149	518
4:15 PM	0	6	17	0	23	7	175	34	0	216	40	0	70	0	110	20	117	2	0	139	488
4:30 PM	2	4	12	0	18	8	181	27	0	216	44	1	80	0	125	17	135	0	0	152	511
4:45 PM	0	1	9	0	10	11	198	31	0	240	49	0	59	0	108	24	157	1	0	182	540
Total	2	12	49	0	63	38	746	118	0	902	177	5	288	0	470	90	529	3	0	622	2057
5:00 PM	6	1	19	0	26	10	196	19	0	225	47	5	93	0	145	28	132	1	0	161	557
5:15 PM	7	4	5	0	16	4	184	28	0	216	51	5	107	0	163	32	127	3	0	162	557
5:30 PM	9	8	16	0	33	6	194	34	0	234	60	2	83	0	145	24	121	2	0	147	559
5:45 PM	3	3	11	0	17	6	169	39	0	214	49	2	84	0	135	28	153	3	0	184	550
Total	25	16	51	0	92	26	743	120	0	889	207	14	367	0	588	112	533	9	0	654	2223
Grand Total	42	42	148	0	232	107	2256	362	0	2725	511	29	879	0	1419	312	1601	19	0	1932	6308
Approach %	18.1	18.1	63.8	0.0		3.9	82.8	13.3	0.0		36.0	2.0	61.9	0.0		16.1	82.9	1.0	0.0		
Total %	0.7	0.7	2.3	0.0	3.7	1.7	35.8	5.7	0.0	43.2	8.1	0.5	13.9	0.0	22.5	4.9	25.4	0.3	0.0	30.6	
Exiting Leg Total					155					2260					716					3177	6308
Cars	41	41	146	0	228	107	2200	343	0	2650	502	29	872	0	1403	307	1577	18	0	1902	6183
% Cars	97.6	97.6	98.6	0.0	98.3	100.0	97.5	94.8	0.0	97.2	98.2	100.0	99.2	0.0	98.9	98.4	98.5	94.7	0.0	98.4	98.0
Exiting Leg Total					154					2225					691					3113	6183
Heavy Vehicles	1	1	2	0	4	0	56	19	0	75	9	0	7	0	16	5	24	1	0	30	125
% Heavy Vehicles	2.4	2.4	1.4	0.0	1.7	0.0	2.5	5.2	0.0	2.8	1.8	0.0	0.8	0.0	1.1	1.6	1.5	5.3	0.0	1.6	2.0
Exiting Leg Total					1					35					25					64	125

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

5:00 PM	Plaza Driveway					Highland Avenue					2nd Avenue					Highland Avenue					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
5:00 PM	6	1	19	0	26	10	196	19	0	225	47	5	93	0	145	28	132	1	0	161	557
5:15 PM	7	4	5	0	16	4	184	28	0	216	51	5	107	0	163	32	127	3	0	162	557
5:30 PM	9	8	16	0	33	6	194	34	0	234	60	2	83	0	145	24	121	2	0	147	559
5:45 PM	3	3	11	0	17	6	169	39	0	214	49	2	84	0	135	28	153	3	0	184	550
Total Volume	25	16	51	0	92	26	743	120	0	889	207	14	367	0	588	112	533	9	0	654	2223
% Approach Total	27.2	17.4	55.4	0.0		2.9	83.6	13.5	0.0		35.2	2.4	62.4	0.0		17.1	81.5	1.4	0.0		
PHF	0.694	0.500	0.671	0.000	0.697	0.650	0.948	0.769	0.000	0.950	0.863	0.700	0.857	0.000	0.902	0.875	0.871	0.750	0.000	0.889	0.994
Cars	24	16	50	0	90	26	735	112	0	873	201	14	365	0	580	112	529	9	0	650	2193
Cars %	96.0	100.0	98.0	0.0	97.8	100.0	98.9	93.3	0.0	98.2	97.1	100.0	99.5	0.0	98.6	100.0	99.2	100.0	0.0	99.4	98.7
Heavy Vehicles	1	0	1	0	2	0	8	8	0	16	6	0	2	0	8	0	4	0	0	4	30
Heavy Vehicles %	4.0	0.0	2.0	0.0	2.2	0.0	1.1	6.7	0.0	1.8	2.9	0.0	0.5	0.0	1.4	0.0	0.8	0.0	0.0	0.6	1.3
Cars Enter Leg	24	16	50	0	90	26	735	112	0	873	201	14	365	0	580	112	529	9	0	650	2193
Heavy Enter Leg	1	0	1	0	2	0	8	8	0	16	6	0	2	0	8	0	4	0	0	4	30
Total Entering Leg	25	16	51	0	92	26	743	120	0	889	207	14	367	0	588	112	533	9	0	654	2223
Cars Exiting Leg					49					780					240					1124	2193
Heavy Exiting Leg					0					11					8					11	30
Total Exiting Leg					49					791					248					1135	2223

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	5	6	6	0	17	11	165	28	0	204	27	0	58	0	85	28	122	4	0	154	460
3:15 PM	3	3	10	0	16	8	188	28	0	224	20	2	46	0	68	31	118	0	0	149	457
3:30 PM	4	3	15	0	22	17	186	33	0	236	44	4	74	0	122	21	146	1	0	168	548
3:45 PM	3	2	16	0	21	7	198	32	0	237	34	4	43	0	81	25	138	1	0	164	503
Total	15	14	47	0	76	43	737	121	0	901	125	10	221	0	356	105	524	6	0	635	1968
4:00 PM	0	0	11	0	11	12	185	25	0	222	44	4	78	0	126	29	120	0	0	149	508
4:15 PM	0	6	17	0	23	7	171	31	0	209	40	0	70	0	110	20	114	2	0	136	478
4:30 PM	2	4	12	0	18	8	177	26	0	211	43	1	79	0	123	17	135	0	0	152	504
4:45 PM	0	1	9	0	10	11	195	28	0	234	49	0	59	0	108	24	155	1	0	180	532
Total	2	11	49	0	62	38	728	110	0	876	176	5	286	0	467	90	524	3	0	617	2022
5:00 PM	6	1	19	0	26	10	194	17	0	221	45	5	93	0	143	28	130	1	0	159	549
5:15 PM	6	4	5	0	15	4	183	27	0	214	50	5	106	0	161	32	126	3	0	161	551
5:30 PM	9	8	16	0	33	6	191	32	0	229	58	2	82	0	142	24	120	2	0	146	550
5:45 PM	3	3	10	0	16	6	167	36	0	209	48	2	84	0	134	28	153	3	0	184	543
Total	24	16	50	0	90	26	735	112	0	873	201	14	365	0	580	112	529	9	0	650	2193
Grand Total	41	41	146	0	228	107	2200	343	0	2650	502	29	872	0	1403	307	1577	18	0	1902	6183
Approach %	18.0	18.0	64.0	0.0		4.0	83.0	12.9	0.0		35.8	2.1	62.2	0.0		16.1	82.9	0.9	0.0		
Total %	0.7	0.7	2.4	0.0	3.7	1.7	35.6	5.5	0.0	42.9	8.1	0.5	14.1	0.0	22.7	5.0	25.5	0.3	0.0	30.8	
Exiting Leg Total					154					2225					691					3113	6183

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

5:00 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
5:00 PM	6	1	19	0	26	10	194	17	0	221	45	5	93	0	143	28	130	1	0	159	549
5:15 PM	6	4	5	0	15	4	183	27	0	214	50	5	106	0	161	32	126	3	0	161	551
5:30 PM	9	8	16	0	33	6	191	32	0	229	58	2	82	0	142	24	120	2	0	146	550
5:45 PM	3	3	10	0	16	6	167	36	0	209	48	2	84	0	134	28	153	3	0	184	543
Total Volume	24	16	50	0	90	26	735	112	0	873	201	14	365	0	580	112	529	9	0	650	2193
% Approach Total	26.7	17.8	55.6	0.0		3.0	84.2	12.8	0.0		34.7	2.4	62.9	0.0		17.2	81.4	1.4	0.0		
PHF	0.667	0.500	0.658	0.000	0.682	0.650	0.947	0.778	0.000	0.953	0.866	0.700	0.861	0.000	0.901	0.875	0.864	0.750	0.000	0.883	0.995
Entering Leg	24	16	50	0	90	26	735	112	0	873	201	14	365	0	580	112	529	9	0	650	2193
Exiting Leg					49					780					240					1124	2193
Total					139					1653					820					1774	4386

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	10	1	0	11	0	0	1	0	1	1	5	0	0	6	18
3:15 PM	0	0	0	0	0	0	9	2	0	11	1	0	2	0	3	3	4	0	0	7	21
3:30 PM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	1	4	0	0	5	10
3:45 PM	0	0	1	0	1	0	6	0	0	6	1	0	0	0	1	0	2	1	0	3	11
Total	0	0	1	0	1	0	30	3	0	33	2	0	3	0	5	5	15	1	0	21	60
4:00 PM	0	1	0	0	1	0	7	1	0	8	0	0	1	0	1	0	0	0	0	0	10
4:15 PM	0	0	0	0	0	0	4	3	0	7	0	0	0	0	0	0	3	0	0	3	10
4:30 PM	0	0	0	0	0	0	4	1	0	5	1	0	1	0	2	0	0	0	0	0	7
4:45 PM	0	0	0	0	0	0	3	3	0	6	0	0	0	0	0	0	2	0	0	2	8
Total	0	1	0	0	1	0	18	8	0	26	1	0	2	0	3	0	5	0	0	5	35
5:00 PM	0	0	0	0	0	0	2	2	0	4	2	0	0	0	2	0	2	0	0	2	8
5:15 PM	1	0	0	0	1	0	1	1	0	2	1	0	1	0	2	0	1	0	0	1	6
5:30 PM	0	0	0	0	0	0	3	2	0	5	2	0	1	0	3	0	1	0	0	1	9
5:45 PM	0	0	1	0	1	0	2	3	0	5	1	0	0	0	1	0	0	0	0	0	7
Total	1	0	1	0	2	0	8	8	0	16	6	0	2	0	8	0	4	0	0	4	30
Grand Total	1	1	2	0	4	0	56	19	0	75	9	0	7	0	16	5	24	1	0	30	125
Approach %	25.0	25.0	50.0	0.0		0.0	74.7	25.3	0.0		56.3	0.0	43.8	0.0		16.7	80.0	3.3	0.0		
Total %	0.8	0.8	1.6	0.0	3.2	0.0	44.8	15.2	0.0	60.0	7.2	0.0	5.6	0.0	12.8	4.0	19.2	0.8	0.0	24.0	
Exiting Leg Total					1					35					25					64	125
Buses	0	0	1	0	1	0	7	9	0	16	9	0	2	0	11	3	5	1	0	9	37
% Buses	0.0	0.0	50.0	0.0	25.0	0.0	12.5	47.4	0.0	21.3	100.0	0.0	28.6	0.0	68.8	60.0	20.8	100.0	0.0	30.0	29.6
Exiting Leg Total					1					15					12					9	37
Single-Unit Trucks	1	1	1	0	3	0	42	6	0	48	0	0	1	0	1	2	13	0	0	15	67
% Single-Unit	100.0	100.0	50.0	0.0	75.0	0.0	75.0	31.6	0.0	64.0	0.0	0.0	14.3	0.0	6.3	40.0	54.2	0.0	0.0	50.0	53.6
Exiting Leg Total					0					14					9					44	67
Articulated Trucks	0	0	0	0	0	0	7	4	0	11	0	0	4	0	4	0	6	0	0	6	21
% Articulated	0.0	0.0	0.0	0.0	0.0	0.0	12.5	21.1	0.0	14.7	0.0	0.0	57.1	0.0	25.0	0.0	25.0	0.0	0.0	20.0	16.8
Exiting Leg Total					0					6					4					11	21

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	10	1	0	11	0	0	1	0	1	1	5	0	0	6	18
3:15 PM	0	0	0	0	0	0	9	2	0	11	1	0	2	0	3	3	4	0	0	7	21
3:30 PM	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	1	4	0	0	5	10
3:45 PM	0	0	1	0	1	0	6	0	0	6	1	0	0	0	1	0	2	1	0	3	11
Total Volume	0	0	1	0	1	0	30	3	0	33	2	0	3	0	5	5	15	1	0	21	60
% Approach Total	0.0	0.0	100.0	0.0		0.0	90.9	9.1	0.0		40.0	0.0	60.0	0.0		23.8	71.4	4.8	0.0		
PHF	0.000	0.000	0.250	0.000	0.250	0.000	0.750	0.375	0.000	0.750	0.500	0.000	0.375	0.000	0.417	0.417	0.750	0.250	0.000	0.750	0.714
Buses	0	0	1	0	1	0	4	1	0	5	2	0	2	0	4	3	3	1	0	7	17
Buses %	0.0	0.0	100.0	0.0	100.0	0.0	13.3	33.3	0.0	15.2	100.0	0.0	66.7	0.0	80.0	60.0	20.0	100.0	0.0	33.3	28.3
Single-Unit Trucks	0	0	0	0	0	0	22	1	0	23	0	0	0	0	0	2	8	0	0	10	33
Single-Unit %	0.0	0.0	0.0	0.0	0.0	0.0	73.3	33.3	0.0	69.7	0.0	0.0	0.0	0.0	0.0	40.0	53.3	0.0	0.0	47.6	55.0
Articulated Trucks	0	0	0	0	0	0	4	1	0	5	0	0	1	0	1	0	4	0	0	4	10
Articulated %	0.0	0.0	0.0	0.0	0.0	0.0	13.3	33.3	0.0	15.2	0.0	0.0	33.3	0.0	20.0	0.0	26.7	0.0	0.0	19.0	16.7
Buses	0	0	1	0	1	0	4	1	0	5	2	0	2	0	4	3	3	1	0	7	17
Single-Unit Trucks	0	0	0	0	0	0	22	1	0	23	0	0	0	0	0	2	8	0	0	10	33
Articulated Trucks	0	0	0	0	0	0	4	1	0	5	0	0	1	0	1	0	4	0	0	4	10
Total Entering Leg	0	0	1	0	1	0	30	3	0	33	2	0	3	0	5	5	15	1	0	21	60
Buses					1					6					4					6	17
Single-Unit Trucks					0					8					3					22	33
Articulated Trucks					0					4					1					5	10
Total Exiting Leg					1					18					8					33	60

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	5	5	5	0	15	10	146	27	0	183	26	0	52	0	78	27	119	4	0	150	426
3:15 PM	3	3	10	0	16	6	164	28	0	198	19	2	41	0	62	29	110	0	0	139	415
3:30 PM	4	3	14	0	21	15	171	32	0	218	42	4	64	0	110	20	142	1	0	163	512
3:45 PM	3	2	16	0	21	7	177	32	0	216	33	3	40	0	76	24	129	1	0	154	467
Total	15	13	45	0	73	38	658	119	0	815	120	9	197	0	326	100	500	6	0	606	1820
4:00 PM	0	0	11	0	11	12	164	25	0	201	44	4	74	0	122	29	117	0	0	146	480
4:15 PM	0	5	17	0	22	7	158	30	0	195	36	0	68	0	104	20	108	2	0	130	451
4:30 PM	2	4	12	0	18	8	164	25	0	197	43	1	74	0	118	15	127	0	0	142	475
4:45 PM	0	1	9	0	10	11	186	27	0	224	47	0	55	0	102	24	139	1	0	164	500
Total	2	10	49	0	61	38	672	107	0	817	170	5	271	0	446	88	491	3	0	582	1906
5:00 PM	6	1	18	0	25	10	184	17	0	211	45	5	91	0	141	28	122	1	0	151	528
5:15 PM	6	4	5	0	15	4	176	27	0	207	49	5	103	0	157	30	123	3	0	156	535
5:30 PM	9	8	15	0	32	6	185	32	0	223	58	2	79	0	139	24	114	2	0	140	534
5:45 PM	3	3	8	0	14	6	162	34	0	202	48	2	83	0	133	28	152	3	0	183	532
Total	24	16	46	0	86	26	707	110	0	843	200	14	356	0	570	110	511	9	0	630	2129
Grand Total	41	39	140	0	220	102	2037	336	0	2475	490	28	824	0	1342	298	1502	18	0	1818	5855
Approach %	18.6	17.7	63.6	0.0		4.1	82.3	13.6	0.0		36.5	2.1	61.4	0.0		16.4	82.6	1.0	0.0		
Total %	0.7	0.7	2.4	0.0	3.8	1.7	34.8	5.7	0.0	42.3	8.4	0.5	14.1	0.0	22.9	5.1	25.7	0.3	0.0	31.1	
Exiting Leg Total					148					2132					673					2902	5855

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

5:00 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
5:00 PM	6	1	18	0	25	10	184	17	0	211	45	5	91	0	141	28	122	1	0	151	528
5:15 PM	6	4	5	0	15	4	176	27	0	207	49	5	103	0	157	30	123	3	0	156	535
5:30 PM	9	8	15	0	32	6	185	32	0	223	58	2	79	0	139	24	114	2	0	140	534
5:45 PM	3	3	8	0	14	6	162	34	0	202	48	2	83	0	133	28	152	3	0	183	532
Total Volume	24	16	46	0	86	26	707	110	0	843	200	14	356	0	570	110	511	9	0	630	2129
% Approach Total	27.9	18.6	53.5	0.0		3.1	83.9	13.0	0.0		35.1	2.5	62.5	0.0		17.5	81.1	1.4	0.0		
PHF	0.667	0.500	0.639	0.000	0.672	0.650	0.955	0.809	0.000	0.945	0.862	0.700	0.864	0.000	0.908	0.917	0.840	0.750	0.000	0.861	0.995
Entering Leg	24	16	46	0	86	26	707	110	0	843	200	14	356	0	570	110	511	9	0	630	2129
Exiting Leg					49					757					236					1087	2129
Total					135					1600					806					1717	4258

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Light Goods Vehicle**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	1	1	0	2	1	19	1	0	21	1	0	6	0	7	1	3	0	0	4	34
3:15 PM	0	0	0	0	0	2	24	0	0	26	1	0	5	0	6	2	8	0	0	10	42
3:30 PM	0	0	1	0	1	2	15	1	0	18	2	0	10	0	12	1	4	0	0	5	36
3:45 PM	0	0	0	0	0	0	21	0	0	21	1	1	3	0	5	1	9	0	0	10	36
Total	0	1	2	0	3	5	79	2	0	86	5	1	24	0	30	5	24	0	0	29	148
4:00 PM	0	0	0	0	0	0	21	0	0	21	0	0	4	0	4	0	3	0	0	3	28
4:15 PM	0	1	0	0	1	0	13	1	0	14	4	0	2	0	6	0	6	0	0	6	27
4:30 PM	0	0	0	0	0	0	13	1	0	14	0	0	5	0	5	2	8	0	0	10	29
4:45 PM	0	0	0	0	0	0	9	1	0	10	2	0	4	0	6	0	16	0	0	16	32
Total	0	1	0	0	1	0	56	3	0	59	6	0	15	0	21	2	33	0	0	35	116
5:00 PM	0	0	1	0	1	0	10	0	0	10	0	0	2	0	2	0	8	0	0	8	21
5:15 PM	0	0	0	0	0	0	7	0	0	7	1	0	3	0	4	2	3	0	0	5	16
5:30 PM	0	0	1	0	1	0	6	0	0	6	0	0	3	0	3	0	6	0	0	6	16
5:45 PM	0	0	1	0	1	0	5	2	0	7	0	0	1	0	1	0	1	0	0	1	10
Total	0	0	3	0	3	0	28	2	0	30	1	0	9	0	10	2	18	0	0	20	63
Grand Total	0	2	5	0	7	5	163	7	0	175	12	1	48	0	61	9	75	0	0	84	327
Approach %	0.0	28.6	71.4	0.0		2.9	93.1	4.0	0.0		19.7	1.6	78.7	0.0		10.7	89.3	0.0	0.0		
Total %	0.0	0.6	1.5	0.0	2.1	1.5	49.8	2.1	0.0	53.5	3.7	0.3	14.7	0.0	18.7	2.8	22.9	0.0	0.0	25.7	
Exiting Leg Total					6					92					18					211	327

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	1	1	0	2	1	19	1	0	21	1	0	6	0	7	1	3	0	0	4	34
3:15 PM	0	0	0	0	0	2	24	0	0	26	1	0	5	0	6	2	8	0	0	10	42
3:30 PM	0	0	1	0	1	2	15	1	0	18	2	0	10	0	12	1	4	0	0	5	36
3:45 PM	0	0	0	0	0	0	21	0	0	21	1	1	3	0	5	1	9	0	0	10	36
Total Volume	0	1	2	0	3	5	79	2	0	86	5	1	24	0	30	5	24	0	0	29	148
% Approach Total	0.0	33.3	66.7	0.0		5.8	91.9	2.3	0.0		16.7	3.3	80.0	0.0		17.2	82.8	0.0	0.0		
PHF	0.000	0.250	0.500	0.000	0.375	0.625	0.823	0.500	0.000	0.827	0.625	0.250	0.600	0.000	0.625	0.625	0.667	0.000	0.000	0.725	0.881
Entering Leg	0	1	2	0	3	5	79	2	0	86	5	1	24	0	30	5	24	0	0	29	148
Exiting Leg					6					31					8					103	148
Total					9					117					38					132	296

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Buses**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
3:15 PM	0	0	0	0	0	0	2	1	0	3	1	0	2	0	3	3	1	0	0	4	10
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
3:45 PM	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	3
Total	0	0	1	0	1	0	4	1	0	5	2	0	2	0	4	3	3	1	0	7	17
4:00 PM	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0	3
4:15 PM	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	1	2
4:30 PM	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	2
4:45 PM	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	0	3	4	0	7	1	0	0	0	1	0	1	0	0	1	9
5:00 PM	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	1	0	0	1	3
5:15 PM	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	2
5:30 PM	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	2
5:45 PM	0	0	0	0	0	0	0	3	0	3	1	0	0	0	1	0	0	0	0	0	4
Total	0	0	0	0	0	0	0	4	0	4	6	0	0	0	6	0	1	0	0	1	11
Grand Total	0	0	1	0	1	0	7	9	0	16	9	0	2	0	11	3	5	1	0	9	37
Approach %	0.0	0.0	100.0	0.0		0.0	43.8	56.3	0.0		81.8	0.0	18.2	0.0		33.3	55.6	11.1	0.0		
Total %	0.0	0.0	2.7	0.0	2.7	0.0	18.9	24.3	0.0	43.2	24.3	0.0	5.4	0.0	29.7	8.1	13.5	2.7	0.0	24.3	
Exiting Leg Total					1					15					12					9	37

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:15 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:15 PM	0	0	0	0	0	0	2	1	0	3	1	0	2	0	3	3	1	0	0	4	10
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
3:45 PM	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	3
4:00 PM	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0	3
Total Volume	0	0	1	0	1	0	4	2	0	6	2	0	2	0	4	3	3	1	0	7	18
% Approach Total	0.0	0.0	100.0	0.0		0.0	66.7	33.3	0.0		50.0	0.0	50.0	0.0		42.9	42.9	14.3	0.0		
PHF	0.000	0.000	0.250	0.000	0.250	0.000	0.500	0.500	0.000	0.500	0.500	0.000	0.250	0.000	0.333	0.250	0.375	0.250	0.000	0.438	0.450
Entering Leg	0	0	1	0	1	0	4	2	0	6	2	0	2	0	4	3	3	1	0	7	18
Exiting Leg					1					6					5					6	18
Total					2					12					9					13	36

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Single-Unit Trucks**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	8	0	0	8	0	0	0	0	0	1	2	0	0	3	11
3:15 PM	0	0	0	0	0	0	6	1	0	7	0	0	0	0	0	0	2	0	0	2	9
3:30 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	1	2	0	0	3	7
3:45 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	2	0	0	2	6
Total	0	0	0	0	0	0	22	1	0	23	0	0	0	0	0	2	8	0	0	10	33
4:00 PM	0	1	0	0	1	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	4
4:15 PM	0	0	0	0	0	0	3	2	0	5	0	0	0	0	0	0	2	0	0	2	7
4:30 PM	0	0	0	0	0	0	3	1	0	4	0	0	1	0	1	0	0	0	0	0	5
4:45 PM	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	2	0	0	2	5
Total	0	1	0	0	1	0	12	3	0	15	0	0	1	0	1	0	4	0	0	4	21
5:00 PM	0	0	0	0	0	0	2	2	0	4	0	0	0	0	0	0	0	0	0	0	4
5:15 PM	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	3
5:30 PM	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	3
5:45 PM	0	0	1	0	1	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	3
Total	1	0	1	0	2	0	8	2	0	10	0	0	0	0	0	0	1	0	0	1	13
Grand Total	1	1	1	0	3	0	42	6	0	48	0	0	1	0	1	2	13	0	0	15	67
Approach %	33.3	33.3	33.3	0.0		0.0	87.5	12.5	0.0		0.0	0.0	100.0	0.0		13.3	86.7	0.0	0.0		
Total %	1.5	1.5	1.5	0.0	4.5	0.0	62.7	9.0	0.0	71.6	0.0	0.0	1.5	0.0	1.5	3.0	19.4	0.0	0.0	22.4	
Exiting Leg Total					0					14					9					44	67

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	8	0	0	8	0	0	0	0	0	1	2	0	0	3	11
3:15 PM	0	0	0	0	0	0	6	1	0	7	0	0	0	0	0	0	2	0	0	2	9
3:30 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	1	2	0	0	3	7
3:45 PM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	2	0	0	2	6
Total Volume	0	0	0	0	0	0	22	1	0	23	0	0	0	0	0	2	8	0	0	10	33
% Approach Total	0.0	0.0	0.0	0.0		0.0	95.7	4.3	0.0		0.0	0.0	0.0	0.0		20.0	80.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.688	0.250	0.000	0.719	0.000	0.000	0.000	0.000	0.000	0.500	1.000	0.000	0.000	0.833	0.750
Entering Leg	0	0	0	0	0	0	22	1	0	23	0	0	0	0	0	2	8	0	0	10	33
Exiting Leg					0					8					3					22	33
Total					0					31					3					32	66

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Articulated Trucks**

	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	3	0	0	3	5
3:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
3:30 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
3:45 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Total	0	0	0	0	0	0	4	1	0	5	0	0	1	0	1	0	4	0	0	4	10
4:00 PM	0	0	0	0	0	0	2	0	0	2	0	0	1	0	1	0	0	0	0	0	3
4:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	3	1	0	4	0	0	1	0	1	0	0	0	0	0	5
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1
5:30 PM	0	0	0	0	0	0	0	2	0	2	0	0	1	0	1	0	1	0	0	1	4
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	2	0	2	0	0	2	0	2	0	2	0	0	2	6
Grand Total	0	0	0	0	0	0	7	4	0	11	0	0	4	0	4	0	6	0	0	6	21
Approach %	0.0	0.0	0.0	0.0		0.0	63.6	36.4	0.0		0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	33.3	19.0	0.0	52.4	0.0	0.0	19.0	0.0	19.0	0.0	28.6	0.0	0.0	28.6	
Exiting Leg Total					0					6					4					11	21

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Plaza Driveway from North					Highland Avenue from East					2nd Avenue from South					Highland Avenue from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	3	0	0	3	5
3:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	2
3:30 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
3:45 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Total Volume	0	0	0	0	0	0	4	1	0	5	0	0	1	0	1	0	4	0	0	4	10
% Approach Total	0.0	0.0	0.0	0.0		0.0	80.0	20.0	0.0		0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.000	0.625	0.000	0.000	0.250	0.000	0.250	0.000	0.333	0.000	0.000	0.333	0.500
Entering Leg	0	0	0	0	0	0	4	1	0	5	0	0	1	0	1	0	4	0	0	4	10
Exiting Leg					0					4					1					5	10
Total					0					9					2					9	20

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Bicycles (on Roadway and Crosswalks)

	Plaza Driveway from North							Highland Avenue from East							2nd Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total	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	0	0	0
4:00 PM	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	0	0	0
4:15 PM	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	0	0	0
4:30 PM	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	0	0	0
4:45 PM	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	0	0	0
Total	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	0	0	0
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	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	0	0	0
Total	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	0	0	0
Grand Total	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	0	0	0
Approach %	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	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
Total %	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	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	0.0	0.0	
Exiting Leg Total							0							0							0							0	0

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Plaza Driveway from North							Highland Avenue from East							2nd Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total Volume	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	0	0	0
% Approach Total	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	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Entering Leg	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	0	0	0
Exiting Leg							0							0							0							0	0
Total							0							0							0							0	0

PDI File #: **196735 HH**
Location: **N: Plaza Driveway S: 2nd Avenue**
Location: **E: Highland Avenue W: Highland Avenue**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Pedestrians**

	Plaza Driveway from North							Highland Avenue from East							2nd Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
3:15 PM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	3
3:30 PM	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	0	0	0
3:45 PM	0	0	0	0	1	1	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total	0	0	0	0	1	2	3	0	0	0	0	1	3	4	0	0	0	0	1	1	2	0	0	0	0	0	0	0	9
4:00 PM	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	0	0	0
4:15 PM	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	0	0	0
4:30 PM	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3
4:45 PM	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	0	0	0
Total	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3
5:00 PM	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	0	0	0
5:15 PM	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5:30 PM	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5:45 PM	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	0	0	0
Total	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Grand Total	0	0	0	0	5	4	9	0	0	0	0	1	3	4	0	0	0	0	1	2	3	0	0	0	0	0	0	0	16
Approach %	0	0	0	0	55.6	44.4		0	0	0	0	25	75		0	0	0	0	33.3	66.7		0	0	0	0	0	0		
Total %	0	0	0	0	31.3	25	56.3	0	0	0	0	6.25	18.8	25	0	0	0	0	6.25	12.5	18.8	0	0	0	0	0	0	0	
Exiting Leg Total							9							4							3							0	16

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Plaza Driveway from North							Highland Avenue from East							2nd Avenue from South							Highland Avenue from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
3:15 PM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	3
3:30 PM	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	0	0	0
3:45 PM	0	0	0	0	1	1	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total Volume	0	0	0	0	1	2	3	0	0	0	0	1	3	4	0	0	0	0	1	1	2	0	0	0	0	0	0	0	9
% Approach Total	0.0	0.0	0.0	0.0	33.3	66.7		0.0	0.0	0.0	0.0	25.0	75.0		0.0	0.0	0.0	0.0	50.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.250	0.500	0.375	0.000	0.000	0.000	0.000	0.250	0.375	0.333	0.000	0.000	0.000	0.000	0.250	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.750
Entering Leg	0	0	0	0	1	2	3	0	0	0	0	1	3	4	0	0	0	0	1	1	2	0	0	0	0	0	0	0	9
Exiting Leg							3							4							2							0	9
Total							6							8							4							0	18

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class:

Cars and Heavy Vehicles (Combined)

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	6	14	5	0	25	4	35	23	0	62	105	35	0	0	140	0	83	8	0	91	318
7:15 AM	3	15	9	0	27	5	40	24	0	69	105	43	1	0	149	0	87	6	0	93	338
7:30 AM	9	14	10	0	33	5	46	23	0	74	120	53	0	0	173	0	94	8	0	102	382
7:45 AM	6	17	9	0	32	10	32	28	0	70	106	47	2	0	155	1	93	11	0	105	362
Total	24	60	33	0	117	24	153	98	0	275	436	178	3	0	617	1	357	33	0	391	1400
8:00 AM	3	18	13	0	34	12	55	23	0	90	136	75	1	0	212	0	94	11	0	105	441
8:15 AM	2	8	19	0	29	12	46	23	0	81	149	86	2	0	237	0	128	7	0	135	482
8:30 AM	2	16	16	0	34	20	55	15	0	90	112	77	0	0	189	0	90	7	0	97	410
8:45 AM	5	15	16	0	36	17	51	19	0	87	138	88	3	0	229	0	105	7	0	112	464
Total	12	57	64	0	133	61	207	80	0	348	535	326	6	0	867	0	417	32	0	449	1797
Grand Total	36	117	97	0	250	85	360	178	0	623	971	504	9	0	1484	1	774	65	0	840	3197
Approach %	14.4	46.8	38.8	0.0		13.6	57.8	28.6	0.0		65.4	34.0	0.6	0.0		0.1	92.1	7.7	0.0		
Total %	1.1	3.7	3.0	0.0	7.8	2.7	11.3	5.6	0.0	19.5	30.4	15.8	0.3	0.0	46.4	0.0	24.2	2.0	0.0	26.3	
Exiting Leg Total					654					1842					296					405	3197
Cars	33	113	95	0	241	83	348	172	0	603	961	501	9	0	1471	1	761	63	0	825	3140
% Cars	91.7	96.6	97.9	0.0	96.4	97.6	96.7	96.6	0.0	96.8	99.0	99.4	100.0	0.0	99.1	100.0	98.3	96.9	0.0	98.2	98.2
Exiting Leg Total					647					1817					286					390	3140
Heavy Vehicles	3	4	2	0	9	2	12	6	0	20	10	3	0	0	13	0	13	2	0	15	57
% Heavy Vehicles	8.3	3.4	2.1	0.0	3.6	2.4	3.3	3.4	0.0	3.2	1.0	0.6	0.0	0.0	0.9	0.0	1.7	3.1	0.0	1.8	1.8
Exiting Leg Total					7					25					10					15	57

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	3	18	13	0	34	12	55	23	0	90	136	75	1	0	212	0	94	11	0	105	441
8:15 AM	2	8	19	0	29	12	46	23	0	81	149	86	2	0	237	0	128	7	0	135	482
8:30 AM	2	16	16	0	34	20	55	15	0	90	112	77	0	0	189	0	90	7	0	97	410
8:45 AM	5	15	16	0	36	17	51	19	0	87	138	88	3	0	229	0	105	7	0	112	464
Total Volume	12	57	64	0	133	61	207	80	0	348	535	326	6	0	867	0	417	32	0	449	1797
% Approach Total	9.0	42.9	48.1	0.0		17.5	59.5	23.0	0.0		61.7	37.6	0.7	0.0		0.0	92.9	7.1	0.0		
PHF	0.600	0.792	0.842	0.000	0.924	0.763	0.941	0.870	0.000	0.967	0.898	0.926	0.500	0.000	0.915	0.000	0.814	0.727	0.000	0.831	0.932
Cars	11	56	63	0	130	59	198	77	0	334	535	324	6	0	865	0	411	32	0	443	1772
Cars %	91.7	98.2	98.4	0.0	97.7	96.7	95.7	96.3	0.0	96.0	100.0	99.4	100.0	0.0	99.8	0.0	98.6	100.0	0.0	98.7	98.6
Heavy Vehicles	1	1	1	0	3	2	9	3	0	14	0	2	0	0	2	0	6	0	0	6	25
Heavy Vehicles %	8.3	1.8	1.6	0.0	2.3	3.3	4.3	3.8	0.0	4.0	0.0	0.6	0.0	0.0	0.2	0.0	1.4	0.0	0.0	1.3	1.4
Cars Enter Leg	11	56	63	0	130	59	198	77	0	334	535	324	6	0	865	0	411	32	0	443	1772
Heavy Enter Leg	1	1	1	0	3	2	9	3	0	14	0	2	0	0	2	0	6	0	0	6	25
Total Entering Leg	12	57	64	0	133	61	207	80	0	348	535	326	6	0	867	0	417	32	0	449	1797
Cars Exiting Leg					415					1009					133					215	1772
Heavy Exiting Leg					4					7					4					10	25
Total Exiting Leg					419					1016					137					225	1797

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	5	13	5	0	23	4	35	23	0	62	104	35	0	0	139	0	82	7	0	89	313
7:15 AM	3	14	9	0	26	5	40	22	0	67	105	43	1	0	149	0	83	6	0	89	331
7:30 AM	9	14	10	0	33	5	44	23	0	72	115	53	0	0	168	0	93	8	0	101	374
7:45 AM	5	16	8	0	29	10	31	27	0	68	102	46	2	0	150	1	92	10	0	103	350
Total	22	57	32	0	111	24	150	95	0	269	426	177	3	0	606	1	350	31	0	382	1368
8:00 AM	3	17	13	0	33	11	54	23	0	88	136	74	1	0	211	0	93	11	0	104	436
8:15 AM	2	8	19	0	29	12	44	22	0	78	149	85	2	0	236	0	126	7	0	133	476
8:30 AM	2	16	16	0	34	20	51	15	0	86	112	77	0	0	189	0	89	7	0	96	405
8:45 AM	4	15	15	0	34	16	49	17	0	82	138	88	3	0	229	0	103	7	0	110	455
Total	11	56	63	0	130	59	198	77	0	334	535	324	6	0	865	0	411	32	0	443	1772
Grand Total	33	113	95	0	241	83	348	172	0	603	961	501	9	0	1471	1	761	63	0	825	3140
Approach %	13.7	46.9	39.4	0.0		13.8	57.7	28.5	0.0		65.3	34.1	0.6	0.0		0.1	92.2	7.6	0.0		
Total %	1.1	3.6	3.0	0.0	7.7	2.6	11.1	5.5	0.0	19.2	30.6	16.0	0.3	0.0	46.8	0.0	24.2	2.0	0.0	26.3	
Exiting Leg Total					647					1817					286					390	3140

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	3	17	13	0	33	11	54	23	0	88	136	74	1	0	211	0	93	11	0	104	436
8:15 AM	2	8	19	0	29	12	44	22	0	78	149	85	2	0	236	0	126	7	0	133	476
8:30 AM	2	16	16	0	34	20	51	15	0	86	112	77	0	0	189	0	89	7	0	96	405
8:45 AM	4	15	15	0	34	16	49	17	0	82	138	88	3	0	229	0	103	7	0	110	455
Total Volume	11	56	63	0	130	59	198	77	0	334	535	324	6	0	865	0	411	32	0	443	1772
% Approach Total	8.5	43.1	48.5	0.0		17.7	59.3	23.1	0.0		61.8	37.5	0.7	0.0		0.0	92.8	7.2	0.0		
PHF	0.688	0.824	0.829	0.000	0.956	0.738	0.917	0.837	0.000	0.949	0.898	0.920	0.500	0.000	0.916	0.000	0.815	0.727	0.000	0.833	0.931
Entering Leg	11	56	63	0	130	59	198	77	0	334	535	324	6	0	865	0	411	32	0	443	1772
Exiting Leg					415					1009					133					215	1772
Total					545					1343					998					658	3544

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	1	0	0	2	0	0	0	0	0	1	0	0	0	1	0	1	1	0	2	5
7:15 AM	0	1	0	0	1	0	0	2	0	2	0	0	0	0	0	0	4	0	0	4	7
7:30 AM	0	0	0	0	0	0	2	0	0	2	5	0	0	0	5	0	1	0	0	1	8
7:45 AM	1	1	1	0	3	0	1	1	0	2	4	1	0	0	5	0	1	1	0	2	12
Total	2	3	1	0	6	0	3	3	0	6	10	1	0	0	11	0	7	2	0	9	32
8:00 AM	0	1	0	0	1	1	1	0	0	2	0	1	0	0	1	0	1	0	0	1	5
8:15 AM	0	0	0	0	0	0	2	1	0	3	0	1	0	0	1	0	2	0	0	2	6
8:30 AM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	1	0	0	1	5
8:45 AM	1	0	1	0	2	1	2	2	0	5	0	0	0	0	0	0	2	0	0	2	9
Total	1	1	1	0	3	2	9	3	0	14	0	2	0	0	2	0	6	0	0	6	25
Grand Total	3	4	2	0	9	2	12	6	0	20	10	3	0	0	13	0	13	2	0	15	57
Approach %	33.3	44.4	22.2	0.0		10.0	60.0	30.0	0.0		76.9	23.1	0.0	0.0		0.0	86.7	13.3	0.0		
Total %	5.3	7.0	3.5	0.0	15.8	3.5	21.1	10.5	0.0	35.1	17.5	5.3	0.0	0.0	22.8	0.0	22.8	3.5	0.0	26.3	
Exiting Leg Total					7					25					10					15	57
Buses	2	1	0	0	3	0	2	1	0	3	6	1	0	0	7	0	4	2	0	6	19
% Buses	66.7	25.0	0.0	0.0	33.3	0.0	16.7	16.7	0.0	15.0	60.0	33.3	0.0	0.0	53.8	0.0	30.8	100.0	0.0	40.0	33.3
Exiting Leg Total					3					10					2					4	19
Single-Unit Trucks	1	3	2	0	6	2	9	5	0	16	4	2	0	0	6	0	9	0	0	9	37
% Single-Unit	33.3	75.0	100.0	0.0	66.7	100.0	75.0	83.3	0.0	80.0	40.0	66.7	0.0	0.0	46.2	0.0	69.2	0.0	0.0	60.0	64.9
Exiting Leg Total					4					15					8					10	37
Articulated Trucks	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
% Articulated	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Exiting Leg Total					0					0					0					1	1

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	1	0	0	2	0	0	0	0	0	1	0	0	0	1	0	1	1	0	2	5
7:15 AM	0	1	0	0	1	0	0	2	0	2	0	0	0	0	0	0	4	0	0	4	7
7:30 AM	0	0	0	0	0	0	2	0	0	2	5	0	0	0	5	0	1	0	0	1	8
7:45 AM	1	1	1	0	3	0	1	1	0	2	4	1	0	0	5	0	1	1	0	2	12
Total Volume	2	3	1	0	6	0	3	3	0	6	10	1	0	0	11	0	7	2	0	9	32
% Approach Total	33.3	50.0	16.7	0.0		0.0	50.0	50.0	0.0		90.9	9.1	0.0	0.0		0.0	77.8	22.2	0.0		
PHF	0.500	0.750	0.250	0.000	0.500	0.000	0.375	0.375	0.000	0.750	0.500	0.250	0.000	0.000	0.550	0.000	0.438	0.500	0.000	0.563	0.667
Buses	2	1	0	0	3	0	1	1	0	2	6	1	0	0	7	0	2	2	0	4	16
Buses %	100.0	33.3	0.0	0.0	50.0	0.0	33.3	33.3	0.0	33.3	60.0	100.0	0.0	0.0	63.6	0.0	28.6	100.0	0.0	44.4	50.0
Single-Unit Trucks	0	2	1	0	3	0	1	2	0	3	4	0	0	0	4	0	5	0	0	5	15
Single-Unit %	0.0	66.7	100.0	0.0	50.0	0.0	33.3	66.7	0.0	50.0	40.0	0.0	0.0	0.0	36.4	0.0	71.4	0.0	0.0	55.6	46.9
Articulated Trucks	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Articulated %	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Buses	2	1	0	0	3	0	1	1	0	2	6	1	0	0	7	0	2	2	0	4	16
Single-Unit Trucks	0	2	1	0	3	0	1	2	0	3	4	0	0	0	4	0	5	0	0	5	15
Articulated Trucks	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total Entering Leg	2	3	1	0	6	0	3	3	0	6	10	1	0	0	11	0	7	2	0	9	32
Buses					3					8					2					3	16
Single-Unit Trucks					0					10					4					1	15
Articulated Trucks					0					0					0					1	1
Total Exiting Leg					3					18					6					5	32

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Cars**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	5	13	4	0	22	3	35	19	0	57	99	28	0	0	127	0	79	7	0	86	292
7:15 AM	3	13	8	0	24	5	37	20	0	62	101	40	1	0	142	0	81	5	0	86	314
7:30 AM	7	14	9	0	30	5	43	19	0	67	112	52	0	0	164	0	88	8	0	96	357
7:45 AM	4	13	6	0	23	9	28	26	0	63	98	44	2	0	144	1	89	8	0	98	328
Total	19	53	27	0	99	22	143	84	0	249	410	164	3	0	577	1	337	28	0	366	1291
8:00 AM	3	14	12	0	29	11	54	23	0	88	133	74	1	0	208	0	90	10	0	100	425
8:15 AM	2	7	18	0	27	11	43	21	0	75	135	82	1	0	218	0	119	6	0	125	445
8:30 AM	2	15	16	0	33	20	51	13	0	84	106	75	0	0	181	0	83	6	0	89	387
8:45 AM	4	15	13	0	32	14	45	14	0	73	129	86	3	0	218	0	97	7	0	104	427
Total	11	51	59	0	121	56	193	71	0	320	503	317	5	0	825	0	389	29	0	418	1684
Grand Total	30	104	86	0	220	78	336	155	0	569	913	481	8	0	1402	1	726	57	0	784	2975
Approach %	13.6	47.3	39.1	0.0		13.7	59.1	27.2	0.0		65.1	34.3	0.6	0.0		0.1	92.6	7.3	0.0		
Total %	1.0	3.5	2.9	0.0	7.4	2.6	11.3	5.2	0.0	19.1	30.7	16.2	0.3	0.0	47.1	0.0	24.4	1.9	0.0	26.4	
Exiting Leg Total					616					1725					260					374	2975

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	3	14	12	0	29	11	54	23	0	88	133	74	1	0	208	0	90	10	0	100	425
8:15 AM	2	7	18	0	27	11	43	21	0	75	135	82	1	0	218	0	119	6	0	125	445
8:30 AM	2	15	16	0	33	20	51	13	0	84	106	75	0	0	181	0	83	6	0	89	387
8:45 AM	4	15	13	0	32	14	45	14	0	73	129	86	3	0	218	0	97	7	0	104	427
Total Volume	11	51	59	0	121	56	193	71	0	320	503	317	5	0	825	0	389	29	0	418	1684
% Approach Total	9.1	42.1	48.8	0.0		17.5	60.3	22.2	0.0		61.0	38.4	0.6	0.0		0.0	93.1	6.9	0.0		
PHF	0.688	0.850	0.819	0.000	0.917	0.700	0.894	0.772	0.000	0.909	0.931	0.922	0.417	0.000	0.946	0.000	0.817	0.725	0.000	0.836	0.946
Entering Leg	11	51	59	0	121	56	193	71	0	320	503	317	5	0	825	0	389	29	0	418	1684
Exiting Leg					402					951					122					209	1684
Total					523					1271					947					627	3368

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Light Goods Vehicle**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	1	0	1	1	0	4	0	5	5	7	0	0	12	0	3	0	0	3	21
7:15 AM	0	1	1	0	2	0	3	2	0	5	4	3	0	0	7	0	2	1	0	3	17
7:30 AM	2	0	1	0	3	0	1	4	0	5	3	1	0	0	4	0	5	0	0	5	17
7:45 AM	1	3	2	0	6	1	3	1	0	5	4	2	0	0	6	0	3	2	0	5	22
Total	3	4	5	0	12	2	7	11	0	20	16	13	0	0	29	0	13	3	0	16	77
8:00 AM	0	3	1	0	4	0	0	0	0	0	3	0	0	0	3	0	3	1	0	4	11
8:15 AM	0	1	1	0	2	1	1	1	0	3	14	3	1	0	18	0	7	1	0	8	31
8:30 AM	0	1	0	0	1	0	0	2	0	2	6	1	0	0	7	0	6	1	0	7	17
8:45 AM	0	0	2	0	2	2	4	3	0	9	9	2	0	0	11	0	6	0	0	6	28
Total	0	5	4	0	9	3	5	6	0	14	32	6	1	0	39	0	22	3	0	25	87
Grand Total	3	9	9	0	21	5	12	17	0	34	48	19	1	0	68	0	35	6	0	41	164
Approach %	14.3	42.9	42.9	0.0		14.7	35.3	50.0	0.0		70.6	27.9	1.5	0.0		0.0	85.4	14.6	0.0		
Total %	1.8	5.5	5.5	0.0	12.8	3.0	7.3	10.4	0.0	20.7	29.3	11.6	0.6	0.0	41.5	0.0	21.3	3.7	0.0	25.0	
Exiting Leg Total					30					92					26					16	164

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	3	1	0	4	0	0	0	0	0	3	0	0	0	3	0	3	1	0	4	11
8:15 AM	0	1	1	0	2	1	1	1	0	3	14	3	1	0	18	0	7	1	0	8	31
8:30 AM	0	1	0	0	1	0	0	2	0	2	6	1	0	0	7	0	6	1	0	7	17
8:45 AM	0	0	2	0	2	2	4	3	0	9	9	2	0	0	11	0	6	0	0	6	28
Total Volume	0	5	4	0	9	3	5	6	0	14	32	6	1	0	39	0	22	3	0	25	87
% Approach Total	0.0	55.6	44.4	0.0		21.4	35.7	42.9	0.0		82.1	15.4	2.6	0.0		0.0	88.0	12.0	0.0		
PHF	0.000	0.417	0.500	0.000	0.563	0.375	0.313	0.500	0.000	0.389	0.571	0.500	0.250	0.000	0.542	0.000	0.786	0.750	0.000	0.781	0.702
Entering Leg	0	5	4	0	9	3	5	6	0	14	32	6	1	0	39	0	22	3	0	25	87
Exiting Leg					12					58					11					6	87
Total					21					72					50					31	174

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Buses**

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	3
7:15 AM	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	1	3
7:30 AM	0	0	0	0	0	0	1	0	0	1	4	0	0	0	4	0	1	0	0	1	6
7:45 AM	1	0	0	0	1	0	0	0	0	0	1	1	0	0	2	0	0	1	0	1	4
Total	2	1	0	0	3	0	1	1	0	2	6	1	0	0	7	0	2	2	0	4	16
8:00 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0	2	3
Grand Total	2	1	0	0	3	0	2	1	0	3	6	1	0	0	7	0	4	2	0	6	19
Approach %	66.7	33.3	0.0	0.0		0.0	66.7	33.3	0.0		85.7	14.3	0.0	0.0		0.0	66.7	33.3	0.0		
Total %	10.5	5.3	0.0	0.0	15.8	0.0	10.5	5.3	0.0	15.8	31.6	5.3	0.0	0.0	36.8	0.0	21.1	10.5	0.0	31.6	
Exiting Leg Total					3					10					2					4	19

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	3
7:15 AM	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	1	3
7:30 AM	0	0	0	0	0	0	1	0	0	1	4	0	0	0	4	0	1	0	0	1	6
7:45 AM	1	0	0	0	1	0	0	0	0	0	1	1	0	0	2	0	0	1	0	1	4
Total Volume	2	1	0	0	3	0	1	1	0	2	6	1	0	0	7	0	2	2	0	4	16
% Approach Total	66.7	33.3	0.0	0.0		0.0	50.0	50.0	0.0		85.7	14.3	0.0	0.0		0.0	50.0	50.0	0.0		
PHF	0.500	0.250	0.000	0.000	0.750	0.000	0.250	0.250	0.000	0.500	0.375	0.250	0.000	0.000	0.438	0.000	0.500	0.500	0.000	1.000	0.667
Entering Leg	2	1	0	0	3	0	1	1	0	2	6	1	0	0	7	0	2	2	0	4	16
Exiting Leg					3					8					2					3	16
Total					6					10					9					7	32

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Single-Unit Trucks**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2
7:15 AM	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3	0	0	3	4
7:30 AM	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	2
7:45 AM	0	1	1	0	2	0	0	1	0	1	3	0	0	0	3	0	1	0	0	1	7
Total	0	2	1	0	3	0	1	2	0	3	4	0	0	0	4	0	5	0	0	5	15
8:00 AM	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	0	0	1	4
8:15 AM	0	0	0	0	0	0	2	1	0	3	0	1	0	0	1	0	0	0	0	0	4
8:30 AM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	1	0	0	1	5
8:45 AM	1	0	1	0	2	1	2	2	0	5	0	0	0	0	0	0	2	0	0	2	9
Total	1	1	1	0	3	2	8	3	0	13	0	2	0	0	2	0	4	0	0	4	22
Grand Total	1	3	2	0	6	2	9	5	0	16	4	2	0	0	6	0	9	0	0	9	37
Approach %	16.7	50.0	33.3	0.0		12.5	56.3	31.3	0.0		66.7	33.3	0.0	0.0		0.0	100.0	0.0	0.0		
Total %	2.7	8.1	5.4	0.0	16.2	5.4	24.3	13.5	0.0	43.2	10.8	5.4	0.0	0.0	16.2	0.0	24.3	0.0	0.0	24.3	
Exiting Leg Total					4					15					8					10	37

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
8:00 AM	0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	0	0	1	4
8:15 AM	0	0	0	0	0	0	2	1	0	3	0	1	0	0	1	0	0	0	0	0	4
8:30 AM	0	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	1	0	0	1	5
8:45 AM	1	0	1	0	2	1	2	2	0	5	0	0	0	0	0	0	2	0	0	2	9
Total Volume	1	1	1	0	3	2	8	3	0	13	0	2	0	0	2	0	4	0	0	4	22
% Approach Total	33.3	33.3	33.3	0.0		15.4	61.5	23.1	0.0		0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.250	0.250	0.250	0.000	0.375	0.500	0.500	0.375	0.000	0.650	0.000	0.500	0.000	0.000	0.500	0.000	0.500	0.000	0.000	0.500	0.611
Entering Leg	1	1	1	0	3	2	8	3	0	13	0	2	0	0	2	0	4	0	0	4	22
Exiting Leg					4					5					4					9	22
Total					7					18					6					13	44

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Articulated Trucks**

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Approach %	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total					0					0					0					1	1

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
% Approach Total	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Entering Leg	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Exiting Leg					0					0					0					1	1
Total					0					1					0					1	2

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Bicycles (on Roadway and Crosswalks)**

	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	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	0	0	0
7:30 AM	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	0	0	0
7:45 AM	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	0	0	0
Total	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	0	0	0
8:00 AM	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	0	0	0
8:15 AM	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	0	0	0
8:30 AM	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	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Grand Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Approach %	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	0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		
Total %	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	
Exiting Leg Total							0							1							0							0	1

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

8:00 AM	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
8:00 AM	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	0	0	0
8:15 AM	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	0	0	0
8:30 AM	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	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
% Approach Total	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	0.0	0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.250
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Exiting Leg							0							1							0							0	1
Total							0							1							0							1	2

PDI File #: **196735 A**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **7:00 AM**
End Time: **9:00 AM**
Class: **Pedestrians**

	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:30 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:45 AM	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	0	0	0
Total	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8:00 AM	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	0	0	0
8:15 AM	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	0	0	0
8:30 AM	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	1	0	1	1
8:45 AM	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	1	1	1
Total	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	1	1	2	2
Grand Total	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4
Approach %	0	0	0	0	50	50		0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	50	50		
Total %	0	0	0	0	25	25	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	25	50	
Exiting Leg Total							2							0							0							2	4

Peak Hour Analysis from 07:00 AM to 09:00 AM begins at:

7:00 AM	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
7:00 AM	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	0	0	0
7:15 AM	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:30 AM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:45 AM	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	0	0	0
Total Volume	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
% Approach Total	0.0	0.0	0.0	0.0	50.0	50.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.250	0.250	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500
Entering Leg	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Exiting Leg							2							0							0							0	2
Total							4							0							0							0	4

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Cars and Heavy Vehicles (Combined)

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	2	32	13	0	47	15	47	48	0	110	22	30	0	0	52	2	70	4	0	76	285
3:15 PM	0	24	13	0	37	7	63	62	0	132	32	31	1	0	64	0	63	1	0	64	297
3:30 PM	5	36	11	0	52	12	80	83	0	175	38	20	1	0	59	0	73	7	0	80	366
3:45 PM	3	21	17	0	41	4	78	75	0	157	24	32	0	0	56	1	46	4	0	51	305
Total	10	113	54	0	177	38	268	268	0	574	116	113	2	0	231	3	252	16	0	271	1253
4:00 PM	2	48	11	0	61	18	69	84	0	171	30	28	1	0	59	0	42	4	0	46	337
4:15 PM	5	52	10	0	67	6	76	88	0	170	27	19	0	0	46	1	44	2	0	47	330
4:30 PM	6	43	11	0	60	13	83	98	0	194	20	32	0	0	52	0	65	2	0	67	373
4:45 PM	4	36	9	0	49	13	84	102	0	199	36	25	1	0	62	1	67	5	0	73	383
Total	17	179	41	0	237	50	312	372	0	734	113	104	2	0	219	2	218	13	0	233	1423
5:00 PM	3	47	14	0	64	6	92	108	0	206	16	25	0	0	41	2	49	1	0	52	363
5:15 PM	2	42	15	0	59	10	89	124	0	223	39	25	0	0	64	0	57	6	0	63	409
5:30 PM	9	43	14	0	66	11	103	113	0	227	41	26	1	0	68	0	53	2	0	55	416
5:45 PM	1	39	18	0	58	9	88	100	0	197	29	24	0	0	53	0	53	5	0	58	366
Total	15	171	61	0	247	36	372	445	0	853	125	100	1	0	226	2	212	14	0	228	1554
Grand Total	42	463	156	0	661	124	952	1085	0	2161	354	317	5	0	676	7	682	43	0	732	4230
Approach %	6.4	70.0	23.6	0.0		5.7	44.1	50.2	0.0		52.4	46.9	0.7	0.0		1.0	93.2	5.9	0.0		
Total %	1.0	10.9	3.7	0.0	15.6	2.9	22.5	25.7	0.0	51.1	8.4	7.5	0.1	0.0	16.0	0.2	16.1	1.0	0.0	17.3	
Exiting Leg Total					484					1192					1555					999	4230
Cars	42	462	154	0	658	124	944	1078	0	2146	350	311	5	0	666	7	678	43	0	728	4198
% Cars	100.0	99.8	98.7	0.0	99.5	100.0	99.2	99.4	0.0	99.3	98.9	98.1	100.0	0.0	98.5	100.0	99.4	100.0	0.0	99.5	99.2
Exiting Leg Total					478					1182					1547					991	4198
Heavy Vehicles	0	1	2	0	3	0	8	7	0	15	4	6	0	0	10	0	4	0	0	4	32
% Heavy Vehicles	0.0	0.2	1.3	0.0	0.5	0.0	0.8	0.6	0.0	0.7	1.1	1.9	0.0	0.0	1.5	0.0	0.6	0.0	0.0	0.5	0.8
Exiting Leg Total					6					10					8					8	32

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	4	36	9	0	49	13	84	102	0	199	36	25	1	0	62	1	67	5	0	73	383
5:00 PM	3	47	14	0	64	6	92	108	0	206	16	25	0	0	41	2	49	1	0	52	363
5:15 PM	2	42	15	0	59	10	89	124	0	223	39	25	0	0	64	0	57	6	0	63	409
5:30 PM	9	43	14	0	66	11	103	113	0	227	41	26	1	0	68	0	53	2	0	55	416
Total Volume	18	168	52	0	238	40	368	447	0	855	132	101	2	0	235	3	226	14	0	243	1571
% Approach Total	7.6	70.6	21.8	0.0		4.7	43.0	52.3	0.0		56.2	43.0	0.9	0.0		1.2	93.0	5.8	0.0		
PHF	0.500	0.894	0.867	0.000	0.902	0.769	0.893	0.901	0.000	0.942	0.805	0.971	0.500	0.000	0.864	0.375	0.843	0.583	0.000	0.832	0.944
Cars	18	167	51	0	236	40	368	447	0	855	132	100	2	0	234	3	226	14	0	243	1568
Cars %	100.0	99.4	98.1	0.0	99.2	100.0	100.0	100.0	0.0	100.0	100.0	99.0	100.0	0.0	99.6	100.0	100.0	100.0	0.0	100.0	99.8
Heavy Vehicles	0	1	1	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
Heavy Vehicles %	0.0	0.6	1.9	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.2
Cars Enter Leg	18	167	51	0	236	40	368	447	0	855	132	100	2	0	234	3	226	14	0	243	1568
Heavy Enter Leg	0	1	1	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
Total Entering Leg	18	168	52	0	238	40	368	447	0	855	132	101	2	0	235	3	226	14	0	243	1571
Cars Exiting Leg					154					409					617					388	1568
Heavy Exiting Leg					1					1					1					0	3
Total Exiting Leg					155					410					618					388	1571

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars-Combined (Motorcycles, Cars, Light Goods)**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	2	32	13	0	47	15	47	47	0	109	21	29	0	0	50	2	69	4	0	75	281
3:15 PM	0	24	12	0	36	7	63	62	0	132	31	29	1	0	61	0	63	1	0	64	293
3:30 PM	5	36	11	0	52	12	79	83	0	174	36	20	1	0	57	0	72	7	0	79	362
3:45 PM	3	21	17	0	41	4	77	73	0	154	24	31	0	0	55	1	44	4	0	49	299
Total	10	113	53	0	176	38	266	265	0	569	112	109	2	0	223	3	248	16	0	267	1235
4:00 PM	2	48	11	0	61	18	67	84	0	169	30	28	1	0	59	0	42	4	0	46	335
4:15 PM	5	52	10	0	67	6	73	86	0	165	27	18	0	0	45	1	44	2	0	47	324
4:30 PM	6	43	11	0	60	13	82	96	0	191	20	32	0	0	52	0	65	2	0	67	370
4:45 PM	4	36	9	0	49	13	84	102	0	199	36	24	1	0	61	1	67	5	0	73	382
Total	17	179	41	0	237	50	306	368	0	724	113	102	2	0	217	2	218	13	0	233	1411
5:00 PM	3	47	13	0	63	6	92	108	0	206	16	25	0	0	41	2	49	1	0	52	362
5:15 PM	2	42	15	0	59	10	89	124	0	223	39	25	0	0	64	0	57	6	0	63	409
5:30 PM	9	42	14	0	65	11	103	113	0	227	41	26	1	0	68	0	53	2	0	55	415
5:45 PM	1	39	18	0	58	9	88	100	0	197	29	24	0	0	53	0	53	5	0	58	366
Total	15	170	60	0	245	36	372	445	0	853	125	100	1	0	226	2	212	14	0	228	1552
Grand Total	42	462	154	0	658	124	944	1078	0	2146	350	311	5	0	666	7	678	43	0	728	4198
Approach %	6.4	70.2	23.4	0.0		5.8	44.0	50.2	0.0		52.6	46.7	0.8	0.0		1.0	93.1	5.9	0.0		
Total %	1.0	11.0	3.7	0.0	15.7	3.0	22.5	25.7	0.0	51.1	8.3	7.4	0.1	0.0	15.9	0.2	16.2	1.0	0.0	17.3	
Exiting Leg Total					478					1182					1547					991	4198

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	4	36	9	0	49	13	84	102	0	199	36	24	1	0	61	1	67	5	0	73	382
5:00 PM	3	47	13	0	63	6	92	108	0	206	16	25	0	0	41	2	49	1	0	52	362
5:15 PM	2	42	15	0	59	10	89	124	0	223	39	25	0	0	64	0	57	6	0	63	409
5:30 PM	9	42	14	0	65	11	103	113	0	227	41	26	1	0	68	0	53	2	0	55	415
Total Volume	18	167	51	0	236	40	368	447	0	855	132	100	2	0	234	3	226	14	0	243	1568
% Approach Total	7.6	70.8	21.6	0.0		4.7	43.0	52.3	0.0		56.4	42.7	0.9	0.0		1.2	93.0	5.8	0.0		
PHF	0.500	0.888	0.850	0.000	0.908	0.769	0.893	0.901	0.000	0.942	0.805	0.962	0.500	0.000	0.860	0.375	0.843	0.583	0.000	0.832	0.945
Entering Leg	18	167	51	0	236	40	368	447	0	855	132	100	2	0	234	3	226	14	0	243	1568
Exiting Leg					154					409					617					388	1568
Total					390					1264					851					631	3136

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**

Class: **Heavy Vehicles-Combined (Buses, Single-Unit Trucks, Articulated Trucks)**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	1	0	1	1	1	0	0	2	0	1	0	0	1	4
3:15 PM	0	0	1	0	1	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	4
3:30 PM	0	0	0	0	0	0	1	0	0	1	2	0	0	0	2	0	1	0	0	1	4
3:45 PM	0	0	0	0	0	0	1	2	0	3	0	1	0	0	1	0	2	0	0	2	6
Total	0	0	1	0	1	0	2	3	0	5	4	4	0	0	8	0	4	0	0	4	18
4:00 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2
4:15 PM	0	0	0	0	0	0	3	2	0	5	0	1	0	0	1	0	0	0	0	0	6
4:30 PM	0	0	0	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	3
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total	0	0	0	0	0	0	6	4	0	10	0	2	0	0	2	0	0	0	0	0	12
5:00 PM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Grand Total	0	1	2	0	3	0	8	7	0	15	4	6	0	0	10	0	4	0	0	4	32
Approach %	0.0	33.3	66.7	0.0		0.0	53.3	46.7	0.0		40.0	60.0	0.0	0.0		0.0	100.0	0.0	0.0		
Total %	0.0	3.1	6.3	0.0	9.4	0.0	25.0	21.9	0.0	46.9	12.5	18.8	0.0	0.0	31.3	0.0	12.5	0.0	0.0	12.5	
Exiting Leg Total					6					10					8					8	32
Buses	0	1	1	0	2	0	3	3	0	6	2	1	0	0	3	0	2	0	0	2	13
% Buses	0.0	100.0	50.0	0.0	66.7	0.0	37.5	42.9	0.0	40.0	50.0	16.7	0.0	0.0	30.0	0.0	50.0	0.0	0.0	50.0	40.6
Exiting Leg Total					1					5					4					3	13
Single-Unit Trucks	0	0	1	0	1	0	5	4	0	9	2	5	0	0	7	0	2	0	0	2	19
% Single-Unit	0.0	0.0	50.0	0.0	33.3	0.0	62.5	57.1	0.0	60.0	50.0	83.3	0.0	0.0	70.0	0.0	50.0	0.0	0.0	50.0	59.4
Exiting Leg Total					5					5					4					5	19
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Articulated	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exiting Leg Total					0					0					0					0	0

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	1	0	1	1	1	0	0	2	0	1	0	0	1	4
3:15 PM	0	0	1	0	1	0	0	0	0	0	1	2	0	0	3	0	0	0	0	0	4
3:30 PM	0	0	0	0	0	0	1	0	0	1	2	0	0	0	2	0	1	0	0	1	4
3:45 PM	0	0	0	0	0	0	1	2	0	3	0	1	0	0	1	0	2	0	0	2	6
Total Volume	0	0	1	0	1	0	2	3	0	5	4	4	0	0	8	0	4	0	0	4	18
% Approach Total	0.0	0.0	100.0	0.0		0.0	40.0	60.0	0.0		50.0	50.0	0.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.000	0.000	0.250	0.000	0.250	0.000	0.500	0.375	0.000	0.417	0.500	0.500	0.000	0.000	0.667	0.000	0.500	0.000	0.000	0.500	0.750
Buses	0	0	1	0	1	0	1	2	0	3	2	1	0	0	3	0	2	0	0	2	9
Buses %	0.0	0.0	100.0	0.0	100.0	0.0	50.0	66.7	0.0	60.0	50.0	25.0	0.0	0.0	37.5	0.0	50.0	0.0	0.0	50.0	50.0
Single-Unit Trucks	0	0	0	0	0	0	1	1	0	2	2	3	0	0	5	0	2	0	0	2	9
Single-Unit %	0.0	0.0	0.0	0.0	0.0	0.0	50.0	33.3	0.0	40.0	50.0	75.0	0.0	0.0	62.5	0.0	50.0	0.0	0.0	50.0	50.0
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Articulated %	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buses	0	0	1	0	1	0	1	2	0	3	2	1	0	0	3	0	2	0	0	2	9
Single-Unit Trucks	0	0	0	0	0	0	1	1	0	2	2	3	0	0	5	0	2	0	0	2	9
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Entering Leg	0	0	1	0	1	0	2	3	0	5	4	4	0	0	8	0	4	0	0	4	18
Buses					1					5					2					1	9
Single-Unit Trucks					3					4					1					1	9
Articulated Trucks					0					0					0					0	0
Total Exiting Leg					4					9					3					2	18

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Cars**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	2	27	12	0	41	14	44	37	0	95	20	23	0	0	43	2	68	4	0	74	253
3:15 PM	0	22	12	0	34	5	61	56	0	122	28	29	1	0	58	0	59	1	0	60	274
3:30 PM	3	27	11	0	41	12	79	71	0	162	33	20	1	0	54	0	70	6	0	76	333
3:45 PM	3	20	16	0	39	4	75	67	0	146	22	25	0	0	47	1	40	4	0	45	277
Total	8	96	51	0	155	35	259	231	0	525	103	97	2	0	202	3	237	15	0	255	1137
4:00 PM	2	43	11	0	56	17	64	80	0	161	30	26	0	0	56	0	41	4	0	45	318
4:15 PM	5	49	10	0	64	6	69	85	0	160	27	13	0	0	40	1	43	2	0	46	310
4:30 PM	6	42	10	0	58	12	81	95	0	188	20	32	0	0	52	0	64	2	0	66	364
4:45 PM	4	35	9	0	48	12	80	94	0	186	35	23	1	0	59	1	67	5	0	73	366
Total	17	169	40	0	226	47	294	354	0	695	112	94	1	0	207	2	215	13	0	230	1358
5:00 PM	2	46	12	0	60	6	91	108	0	205	16	23	0	0	39	2	47	1	0	50	354
5:15 PM	2	41	15	0	58	8	85	116	0	209	37	25	0	0	62	0	55	4	0	59	388
5:30 PM	8	40	10	0	58	11	101	111	0	223	38	26	0	0	64	0	51	2	0	53	398
5:45 PM	1	38	17	0	56	9	80	96	0	185	29	24	0	0	53	0	52	5	0	57	351
Total	13	165	54	0	232	34	357	431	0	822	120	98	0	0	218	2	205	12	0	219	1491
Grand Total	38	430	145	0	613	116	910	1016	0	2042	335	289	3	0	627	7	657	40	0	704	3986
Approach %	6.2	70.1	23.7	0.0		5.7	44.6	49.8	0.0		53.4	46.1	0.5	0.0		1.0	93.3	5.7	0.0		
Total %	1.0	10.8	3.6	0.0	15.4	2.9	22.8	25.5	0.0	51.2	8.4	7.3	0.1	0.0	15.7	0.2	16.5	1.0	0.0	17.7	
Exiting Leg Total					445					1137					1453					951	3986

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

4:45 PM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
4:45 PM	4	35	9	0	48	12	80	94	0	186	35	23	1	0	59	1	67	5	0	73	366
5:00 PM	2	46	12	0	60	6	91	108	0	205	16	23	0	0	39	2	47	1	0	50	354
5:15 PM	2	41	15	0	58	8	85	116	0	209	37	25	0	0	62	0	55	4	0	59	388
5:30 PM	8	40	10	0	58	11	101	111	0	223	38	26	0	0	64	0	51	2	0	53	398
Total Volume	16	162	46	0	224	37	357	429	0	823	126	97	1	0	224	3	220	12	0	235	1506
% Approach Total	7.1	72.3	20.5	0.0		4.5	43.4	52.1	0.0		56.3	43.3	0.4	0.0		1.3	93.6	5.1	0.0		
PHF	0.500	0.880	0.767	0.000	0.933	0.771	0.884	0.925	0.000	0.923	0.829	0.933	0.250	0.000	0.875	0.375	0.821	0.600	0.000	0.805	0.946
Entering Leg	16	162	46	0	224	37	357	429	0	823	126	97	1	0	224	3	220	12	0	235	1506
Exiting Leg					146					392					594					374	1506
Total					370					1215					818					609	3012

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Light Goods Vehicle**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	5	1	0	6	1	3	10	0	14	1	6	0	0	7	0	1	0	0	1	28
3:15 PM	0	2	0	0	2	2	2	6	0	10	3	0	0	0	3	0	4	0	0	4	19
3:30 PM	2	9	0	0	11	0	0	12	0	12	3	0	0	0	3	0	2	1	0	3	29
3:45 PM	0	1	1	0	2	0	2	6	0	8	2	6	0	0	8	0	4	0	0	4	22
Total	2	17	2	0	21	3	7	34	0	44	9	12	0	0	21	0	11	1	0	12	98
4:00 PM	0	5	0	0	5	1	3	4	0	8	0	2	1	0	3	0	1	0	0	1	17
4:15 PM	0	3	0	0	3	0	4	1	0	5	0	5	0	0	5	0	1	0	0	1	14
4:30 PM	0	1	1	0	2	1	1	1	0	3	0	0	0	0	0	0	1	0	0	1	6
4:45 PM	0	1	0	0	1	1	4	8	0	13	1	1	0	0	2	0	0	0	0	0	16
Total	0	10	1	0	11	3	12	14	0	29	1	8	1	0	10	0	3	0	0	3	53
5:00 PM	1	1	1	0	3	0	1	0	0	1	0	2	0	0	2	0	2	0	0	2	8
5:15 PM	0	1	0	0	1	2	4	8	0	14	2	0	0	0	2	0	2	2	0	4	21
5:30 PM	1	2	4	0	7	0	2	2	0	4	3	0	1	0	4	0	2	0	0	2	17
5:45 PM	0	1	1	0	2	0	8	4	0	12	0	0	0	0	0	0	1	0	0	1	15
Total	2	5	6	0	13	2	15	14	0	31	5	2	1	0	8	0	7	2	0	9	61
Grand Total	4	32	9	0	45	8	34	62	0	104	15	22	2	0	39	0	21	3	0	24	212
Approach %	8.9	71.1	20.0	0.0		7.7	32.7	59.6	0.0		38.5	56.4	5.1	0.0		0.0	87.5	12.5	0.0		
Total %	1.9	15.1	4.2	0.0	21.2	3.8	16.0	29.2	0.0	49.1	7.1	10.4	0.9	0.0	18.4	0.0	9.9	1.4	0.0	11.3	
Exiting Leg Total					33					45					94					40	212

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	5	1	0	6	1	3	10	0	14	1	6	0	0	7	0	1	0	0	1	28
3:15 PM	0	2	0	0	2	2	2	6	0	10	3	0	0	0	3	0	4	0	0	4	19
3:30 PM	2	9	0	0	11	0	0	12	0	12	3	0	0	0	3	0	2	1	0	3	29
3:45 PM	0	1	1	0	2	0	2	6	0	8	2	6	0	0	8	0	4	0	0	4	22
Total Volume	2	17	2	0	21	3	7	34	0	44	9	12	0	0	21	0	11	1	0	12	98
% Approach Total	9.5	81.0	9.5	0.0		6.8	15.9	77.3	0.0		42.9	57.1	0.0	0.0		0.0	91.7	8.3	0.0		
PHF	0.250	0.472	0.500	0.000	0.477	0.375	0.583	0.708	0.000	0.786	0.750	0.500	0.000	0.000	0.656	0.000	0.688	0.250	0.000	0.750	0.845
Entering Leg	2	17	2	0	21	3	7	34	0	44	9	12	0	0	21	0	11	1	0	12	98
Exiting Leg					16					22					51					9	98
Total					37					66					72					21	196

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Buses**

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	1	0	0	1	3
3:15 PM	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
3:45 PM	0	0	0	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	3
Total	0	0	1	0	1	0	1	2	0	3	2	1	0	0	3	0	2	0	0	2	9
4:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	2
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0	3
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Grand Total	0	1	1	0	2	0	3	3	0	6	2	1	0	0	3	0	2	0	0	2	13
Approach %	0.0	50.0	50.0	0.0		0.0	50.0	50.0	0.0		66.7	33.3	0.0	0.0		0.0	100.0	0.0	0.0		
Total %	0.0	7.7	7.7	0.0	15.4	0.0	23.1	23.1	0.0	46.2	15.4	7.7	0.0	0.0	23.1	0.0	15.4	0.0	0.0	15.4	
Exiting Leg Total					1					5					4					3	13

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	1	0	0	1	3
3:15 PM	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
3:45 PM	0	0	0	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	3
Total Volume	0	0	1	0	1	0	1	2	0	3	2	1	0	0	3	0	2	0	0	2	9
% Approach Total	0.0	0.0	100.0	0.0		0.0	33.3	66.7	0.0		66.7	33.3	0.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.000	0.000	0.250	0.000	0.250	0.000	0.250	0.250	0.000	0.250	0.500	0.250	0.000	0.000	0.375	0.000	0.500	0.000	0.000	0.500	0.750
Entering Leg	0	0	1	0	1	0	1	2	0	3	2	1	0	0	3	0	2	0	0	2	9
Exiting Leg					1					5					2					1	9
Total					2					8					5					3	18

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**

Class: **Single-Unit Trucks**

	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2
3:30 PM	0	0	0	0	0	0	1	0	0	1	2	0	0	0	2	0	0	0	0	0	3
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0	0	2	3
Total	0	0	0	0	0	0	1	1	0	2	2	3	0	0	5	0	2	0	0	2	9
4:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	2	1	0	3	0	1	0	0	1	0	0	0	0	0	4
4:30 PM	0	0	0	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	3
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
Total	0	0	0	0	0	0	4	3	0	7	0	2	0	0	2	0	0	0	0	0	9
5:00 PM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Grand Total	0	0	1	0	1	0	5	4	0	9	2	5	0	0	7	0	2	0	0	2	19
Approach %	0.0	0.0	100.0	0.0		0.0	55.6	44.4	0.0		28.6	71.4	0.0	0.0		0.0	100.0	0.0	0.0		
Total %	0.0	0.0	5.3	0.0	5.3	0.0	26.3	21.1	0.0	47.4	10.5	26.3	0.0	0.0	36.8	0.0	10.5	0.0	0.0	10.5	
Exiting Leg Total					5					5					4					5	19

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:30 PM	Hunting Road					Kendrick Street					Hunting Road					Kenrick Street					
	from North					from East					from South					from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:30 PM	0	0	0	0	0	0	1	0	0	1	2	0	0	0	2	0	0	0	0	0	3
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0	0	2	3
4:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	0	0	0	0	0	0	2	1	0	3	0	1	0	0	1	0	0	0	0	0	4
Total Volume	0	0	0	0	0	0	4	1	0	5	2	2	0	0	4	0	2	0	0	2	11
% Approach Total	0.0	0.0	0.0	0.0		0.0	80.0	20.0	0.0		50.0	50.0	0.0	0.0		0.0	100.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.250	0.000	0.417	0.250	0.500	0.000	0.000	0.500	0.000	0.250	0.000	0.000	0.250	0.688
Entering Leg	0	0	0	0	0	0	4	1	0	5	2	2	0	0	4	0	2	0	0	2	11
Exiting Leg					2					4					1					4	11
Total					2					9					5					6	22

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Articulated Trucks**

	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach %	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	0.0	0.0	0.0		
Total %	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total					0					0					0					0	0

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:00 PM	Hunting Road from North					Kendrick Street from East					Hunting Road from South					Kenrick Street from West					
	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Right	Thru	Left	U-Turn	Total	Total
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Approach Total	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	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Entering Leg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exiting Leg					0					0					0					0	0
Total					0					0					0					0	0

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class:

Bicycles (on Roadway and Crosswalks)

	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total	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	0	0	0
4:00 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	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	0	0	0
4:30 PM	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	0	0	0
4:45 PM	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	0	0	0
Total	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
5:45 PM	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	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Grand Total	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Approach %	0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		100.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
Total %	0.0	50.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exiting Leg Total							0							1							1							0	2

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:15 PM	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
4:00 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Volume	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% Approach Total	0.0	100.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.250	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Entering Leg	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Exiting Leg							0							0							1							0	1
Total							1							0							1							0	2

PDI File #: **196735 AA**
Location: **N: Hunting Road S: Hunting Road**
Location: **E: Kendrick Street W: Kenrick Street**
City, State: **Needham, MA**
Client: **McMahon Associates/ E. Buck**
Site Code: **Y13327.61**
Count Date: **Wednesday, February 27, 2019**
Start Time: **3:00 PM**
End Time: **6:00 PM**
Class: **Pedestrians**

	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:00 PM	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	0	0	0
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
Total	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	0	0	0
4:00 PM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4:15 PM	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	0	0	0
4:30 PM	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	0	0	0
4:45 PM	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	0	0	0
Total	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:00 PM	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	0	0	0
5:15 PM	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	0	0	0
5:30 PM	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	0	0	0
5:45 PM	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	0	0	0
Total	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	0	0	0
Grand Total	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Approach %	0	0	0	0	0	100		0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0		
Total %	0	0	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Exiting Leg Total							1							0							0							0	1

Peak Hour Analysis from 03:00 PM to 06:00 PM begins at:

3:15 PM	Hunting Road from North							Kendrick Street from East							Hunting Road from South							Kenrick Street from West							
	Right	Thru	Left	U-Turn	CW-EB	CW-WB	Total	Right	Thru	Left	U-Turn	CW-SB	CW-NB	Total	Right	Thru	Left	U-Turn	CW-WB	CW-EB	Total	Right	Thru	Left	U-Turn	CW-NB	CW-SB	Total	Total
3:15 PM	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	0	0	0
3:30 PM	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	0	0	0
3:45 PM	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	0	0	0
4:00 PM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% Approach Total	0.0	0.0	0.0	0.0	0.0	100.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0		
PHF	0.000	0.000	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250
Entering Leg	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Exiting Leg							1							0							0							0	1
Total							2							0							0							0	2

Massachusetts Highway Department
Statewide Traffic Data Collection
2019 Weekday Seasonal Factors

Factor Group	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Axle Factor
R1	1.22	1.14	1.12	1.06	1.00	0.96	0.87	0.85	0.96	0.99	1.04	1.12	0.85
R2	0.95	0.96	0.98	0.97	0.97	0.93	0.97	0.94	0.96	0.90	0.92	0.93	0.96
R3	1.15	1.06	1.07	1.00	0.89	0.88	0.89	0.89	0.95	0.92	1.02	1.01	0.97
R4-R7	1.09	1.09	1.11	1.02	0.96	0.92	0.89	0.89	0.99	0.98	1.09	1.13	0.98
U1-Boston	1.03	1.01	0.98	0.94	0.94	0.92	0.95	0.93	0.94	0.94	0.97	1.04	0.96
U1-Essex	1.09	1.06	1.03	0.99	0.94	0.90	0.88	0.86	0.93	0.94	0.99	1.06	0.93
U1-Southeast	1.06	1.05	1.01	0.97	0.95	0.93	0.93	0.90	0.94	0.94	0.98	1.04	0.98
U1-West	1.19	1.14	1.09	0.95	0.92	0.89	0.89	0.86	0.91	0.95	0.97	1.07	0.84
U1-Worcester	1.02	1.04	0.97	0.94	0.93	0.91	0.95	0.91	0.93	0.92	0.95	1.10	0.88
U2	1.01	1.00	0.94	0.93	0.91	0.89	0.93	0.90	0.90	0.91	0.94	1.02	0.99
U3	1.06	1.03	0.98	0.94	0.93	0.91	0.95	0.91	0.92	0.93	0.97	1.00	0.98
U4-U7	1.01	1.00	0.95	0.92	0.88	0.86	0.92	0.91	0.92	0.94	0.99	1.04	0.99
Rec - East	1.04	1.16	1.12	0.98	0.92	0.88	0.77	0.81	0.94	1.02	1.08	1.12	0.99
Rec - West	1.30	1.23	1.32	1.18	0.95	0.82	0.70	0.69	0.97	0.96	1.16	1.15	0.98

Round off:
0-999 = 10
>1000 = 100

U = Urban
R = Rural

1 - Interstate
2 - Freeway and Expressway
3 - Other Principal Arterial
4 - Minor Arterial
5 - Major Collector
6 - Minor Collector
7 - Local Road and Street

Recreational - East Group - Cape Cod (all towns) including the town of Plymouth south of Route 3A (stations 7014,7079,7080,7090,7091,7092,7093,7094,7095,7096,7097,7108 and 7178), Martha's Vineyard and Nantucket.

Recreational - West Group - Continuous Stations 2 and 189 including stations 1066,1067,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1113, 1114,1116,2196,2197 and 2198.

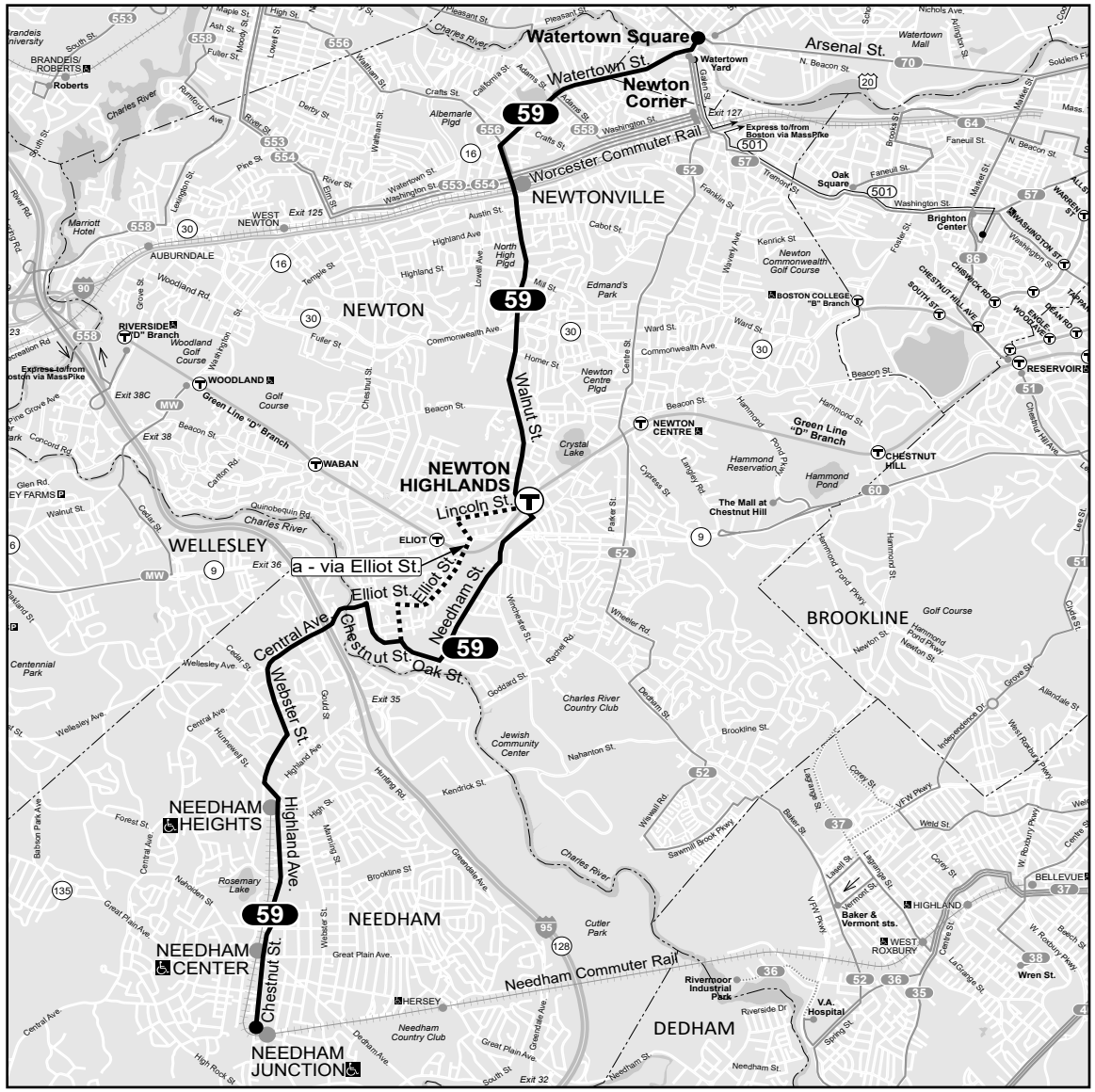
MassDOT Yearly Growth Rates

for data from 2014 to 2018

Growth Group	Grow 2014 to 2015	Grow 2015 to 2016	Grow 2016 to 2017	Grow 2017 to 2018	Grow 2018 to 2019
R1	0	0.023	0.004	0.018	0.016
R2	0.05	0.068	0.004	0.014	0.014
R3	-0.038	0.002	0.008	0.011	0.06
R4-7	-0.01	0.003	0.001	0.011	0.012
Rec - East		0.032	0.02	0.041	0.025
Rec - West		0.051	-0.008	0.029	0
U1-Boston	0.061	0.07	-0.003	0.012	0.006
U1-Essex	0.024	0.025	0.007	0.014	0.011
U1-Southeast	0.05	0.062	0.021	0.014	0
U1-West	0.03	-0.027	0.02	0.028	0.013
U1-Worcester	0.042	0.005	0.018	0.01	0.01
U2	0.04	0.048	0.008	0.01	0.02
U3	0.011	0.013	0.011	0.014	0.004
U4-7	0.023	0.062	0.017	0.003	**0.000**

updated 5/1/2020

-0.004



⚠ Information in this timetable is subject to change without notice. Traffic conditions and weather can affect running time.

Effective **Aug 29, 2021**

59

Needham Junction - Watertown Square

mbta.com
617-222-3200
617-222-5146 (TTY)

Lost & Found
617-222-2399

59 Weekday

Inbound			Outbound		
Leave Needham Junction	Arrive Newton Highlands	Arrive Watertown Square	Leave Watertown Square	Arrive Newton Highlands	Arrive Needham Junction
6:20A	6:38A	6:55A	6:05A	6:18A	6:37A
6:50	7:09	7:30	6:35	6:48	7:07
a7:20	7:41	8:02	7:05	7:25	7:44
7:55	8:17	8:39	7:35	7:55	8:15
a 8:25	8:51	9:10	8:10	8:30	8:50
9:00	9:19	9:36	8:45	9:04	9:24
9:35	9:54	10:11	9:25	9:44	10:04
10:10	10:29	10:46	10:05	10:22	10:42
10:55	11:14	11:31	10:55	11:12	11:33
11:45	**12:04P**	**12:21P**	11:45	**12:02P**	**12:23P**
12:35P	**12:54**	**1:11**	**12:35P**	**12:52**	**1:13**
1:25	**1:44**	**2:01**	**1:25**	**1:42**	**2:03**
2:15	**2:34**	**2:51**	**2:10**	**2:27**	**2:52**
3:10	**3:33**	**3:56**	**3:00**	**3:20**	**3:45**
4:00	**4:22**	**4:44**	**3:50**	**4:10**	**4:35**
4:50	**5:13**	**5:33**	**a 4:30**	**4:50**	**5:14**
5:25	**5:48**	**6:08**	**5:05**	**5:28**	**5:53**
6:05	**6:28**	**6:46**	**a 5:45**	**6:08**	**6:32**
6:40	**6:58**	**7:16**	**6:25**	**6:42**	**7:05**
7:15	**7:31**	**7:46**	**7:00**	**7:16**	**7:39**
7:50	**8:07**	**8:22**			

a - Via Elliot St.

59 Saturday

Inbound			Outbound		
Leave Needham Junction	Arrive Newton Highlands	Arrive Watertown Square	Leave Watertown Square	Arrive Newton Highlands	Arrive Needham Junction
7:05A	7:23A	7:36A	6:20A	6:35A	6:49A
8:35	8:55	9:10	7:50	8:05	8:22
10:05	10:28	10:45	9:20	9:35	9:56
11:36	**12:01P**	**12:18P**	10:50	11:05	11:30
1:10P	**1:35P**	**1:50P**	**12:22P**	**12:37P**	**1:02P**
2:40	**3:02**	**3:17**	**1:55**	**2:10**	**2:31**
4:10	**4:31**	**4:46**	**3:25**	**3:40**	**3:59**
5:40	**6:01**	**6:15**	**4:55**	**5:10**	**5:29**
7:05	**7:25**	**7:39**	**6:25**	**6:40**	**6:57**

59 Sunday

Inbound			Outbound		
Leave Needham Junction	Arrive Newton Highlands	Arrive Watertown Square	Leave Watertown Square	Arrive Newton Highlands	Arrive Needham Junction
7:50A	8:07A	8:20A	7:05A	7:17A	7:33A
9:20	9:39	9:53	8:35	8:47	9:05
10:50	11:09	11:23	10:05	10:18	10:38
			11:35	11:48	12:08
12:20P	**12:40P**	**12:56P**			
1:50	**2:08**	**2:24**	**1:05P**	**1:18P**	**1:38P**
3:20	**3:39**	**3:56**	**2:35**	**2:48**	**3:08**
4:50	**5:09**	**5:25**	**4:05**	**4:18**	**4:38**
6:20	**6:39**	**6:55**	**5:35**	**5:49**	**6:09**

Fare	Local Bus	Bus + Bus	Subway	Bus + Subway
CharlieCard	$1.70	$1.70	$2.40	$2.40
CharlieTicket	$1.70	$1.70	$2.40	$4.10*
Cash-on-Board	$1.70	$3.40	$2.40	$4.10
Student/Youth**	$0.85	$0.85	$1.10	$1.10
Senior/TAP***	$0.85	$0.85	$1.10	$1.10

FREE FARES: Children 11 and under ride free when accompanied by a paying customer; Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.

* Transfers Subway to Silver Line SL4 or SL5 pay $2.40

** Requires Student CharlieCard or Youth CharlieCard. Student CharlieCards available to students through participating middle and high schools. Youth CharlieCards available through community partners across Greater Boston.

*** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

Holidays Fall 2021/Winter 2022

Saturday
Christmas Eve; NY Eve; MLK Day; President's Day

Sunday
Labor Day; Thanksgiving; Christmas Day; NY Day

All MBTA buses accessible to persons with disabilities

Route 59
Needham Junction-
Watertown Square

NEEDHAM LINE 2021 Fall/Winter Schedule

Effective October 11, 2021

Keep in Mind:

This schedule will be effective from October 11, 2021 and will replace the schedule of June 28, 2021.

Monday to Friday (except when Storm Service is operating)

Inbound to Boston

ZONE	STATION	TRAIN #	AM 600	602	604	606	608	610	612	PM 614	616	618	620	622	624	626	628	630
	Bikes Allowed																	
2	Needham Heights		5:05	6:05	7:05	8:05	9:05	10:05	11:05	12:05	1:05	2:05	3:05	4:05	5:05	6:05	7:05	8:50
2	Needham Center		5:09	6:09	7:09	8:09	9:09	10:09	11:09	12:09	1:09	2:09	3:09	4:09	5:09	6:09	7:09	8:54
2	Needham Junction		5:13	6:13	7:13	8:13	9:13	10:13	11:13	12:13	1:13	2:13	3:13	4:13	5:13	6:13	7:13	8:58
2	Hersey		5:16	6:16	7:16	8:16	9:16	10:16	11:16	12:16	1:16	2:16	3:16	4:16	5:16	6:16	7:16	9:01
1	West Roxbury		5:21	6:22	7:22	8:22	9:21	10:21	11:21	12:21	1:21	2:26	3:26	4:26	5:26	6:26	7:26	9:06
1	Highland		5:23	6:24	7:24	8:24	9:23	10:23	11:23	12:23	1:23	2:28	3:28	4:28	5:28	6:28	7:28	9:08
1	Bellevue		5:25	6:27	7:27	8:27	9:25	10:25	11:25	12:25	1:25	2:30	3:30	4:30	5:30	6:30	7:30	9:10
1	Roslindale Village		5:28	6:30	7:30	8:30	9:28	10:28	11:28	12:28	1:28	2:33	3:33	4:33	5:33	6:33	7:33	9:13
1A	Forest Hills		5:31	6:34	7:34	8:34	9:31	10:31	11:31	12:31	1:31	2:36	3:36	4:36	5:36	6:36	7:36	9:16
1A	Ruggles		L 5:37	L 6:40	L 7:40	L 8:40	L 9:37	L 10:37	L 11:37	L 12:37	L 1:37	L 2:42	L 3:42	L 4:42	L 5:42	L 6:42	L 7:42	L 9:22
1A	Back Bay		L 5:41	L 6:44	L 7:44	L 8:44	L 9:40	L 10:40	L 11:40	L 12:40	L 1:40	L 2:45	L 3:45	L 4:45	L 5:45	L 6:45	L 7:45	L 9:25
1A	South Station		5:47	6:50	7:50	8:50	9:46	10:45	11:45	12:45	1:45	2:50	3:50	4:51	5:51	6:50	7:50	9:30

Monday to Friday (except when Storm Service is operating)

Outbound from Boston

ZONE	STATION	TRAIN #	AM 603	605	607	609	611	613	PM 615	617	619	621	623	625	627	629	631	Providence 839	633
	Bikes Allowed																		
1A	South Station		6:50	7:50	8:50	9:50	10:50	11:50	12:50	1:55	2:55	3:55	4:55	5:55	6:55	7:55	9:20	11:00	Board Providence Train 839 and change trains at Forest Hills for a Needham connection
1A	Back Bay		6:55	7:55	8:55	9:55	10:55	11:55	12:55	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:25	11:05	
1A	Ruggles		6:58	7:58	8:58	9:58	10:58	11:58	12:58	2:03	3:03	4:03	5:03	6:03	7:03	8:03	9:28	11:08	
1A	Forest Hills		7:03	8:03	9:03	10:03	11:03	12:03	1:03	2:08	3:08	4:08	5:08	6:08	7:08	8:08	9:33	11:13 →	11:18
1	Roslindale Village		7:06	8:06	9:06	10:06	11:06	12:06	1:06	2:11	3:11	4:11	5:11	6:11	7:11	8:11	9:36	-	11:21
1	Bellevue		7:09	8:09	9:09	10:09	11:09	12:09	1:09	2:14	3:14	4:14	5:14	6:14	7:14	8:14	9:39	-	11:24
1	Highland		7:11	8:11	9:11	10:11	11:11	12:11	1:11	2:16	3:16	4:16	5:16	6:16	7:16	8:16	9:41	-	11:26
1	West Roxbury		7:13	8:13	9:13	10:13	11:13	12:13	1:13	2:18	3:18	4:18	5:18	6:18	7:18	8:18	9:43	-	11:28
2	Hersey		7:23	8:23	9:23	10:23	11:23	12:23	1:23	2:23	3:23	4:24	5:24	6:24	7:23	8:23	9:48	-	11:33
2	Needham Junction		7:26	8:26	9:26	10:26	11:26	12:26	1:26	2:26	3:26	4:27	5:27	6:27	7:26	8:26	9:51	-	11:36
2	Needham Center		7:29	8:29	9:29	10:29	11:29	12:29	1:29	2:29	3:29	4:31	5:31	6:31	7:29	8:29	9:54	-	11:39
2	Needham Heights		7:35	8:35	9:35	10:35	11:35	12:35	1:35	2:35	3:35	4:38	5:38	6:38	7:35	8:35	10:00	-	11:44

Weekend & Storm Service ⚠

Inbound to Boston

ZONE	STATION	AM SATURDAY TRAIN # 1600	1602	1604	PM 1606	1608	1610	1612	1614
		SUNDAY TRAIN # 2600	2602	2604	2606	2608	2610	2612	2614
	Bikes Allowed								
2	Needham Heights	6:10	8:10	10:10	12:10	2:10	4:10	6:10	8:10
2	Needham Center	6:14	8:14	10:14	12:14	2:14	4:14	6:14	8:14
2	Needham Junction	6:18	8:18	10:18	12:18	2:18	4:18	6:18	8:18
2	Hersey	6:21	8:21	10:21	12:21	2:21	4:21	6:21	8:21
1	West Roxbury	6:26	8:26	10:26	12:26	2:26	4:26	6:26	8:26
1	Highland	6:28	8:28	10:28	12:28	2:28	4:28	6:28	8:28
1	Bellevue	6:30	8:30	10:30	12:30	2:30	4:30	6:30	8:30
1	Roslindale Village	6:33	8:33	10:33	12:33	2:33	4:33	6:33	8:33
1A	Forest Hills	6:36	8:36	10:36	12:36	2:36	4:36	6:36	8:36
1A	Ruggles	L 6:41	L 8:41	L 10:41	L 12:41	L 2:41	L 4:41	L 6:41	L 8:41
1A	Back Bay	L 6:45	L 8:45	L 10:45	L 12:45	L 2:45	L 4:45	L 6:45	L 8:45
1A	South Station	6:50	8:50	10:50	12:50	2:50	4:50	6:50	8:50

Weekend & Storm Service ⚠

Outbound from Boston

ZONE	STATION	AM SATURDAY TRAIN # 1601	1603	1605	PM 1607	1609	1611	1613	1615
		SUNDAY TRAIN # 2601	2603	2605	2607	2609	2611	2613	2615
	Bikes Allowed								
1A	South Station	7:15	9:15	11:15	1:15	3:15	5:15	7:15	10:15
1A	Back Bay	7:20	9:20	11:20	1:20	3:20	5:20	7:20	10:20
1A	Ruggles	7:23	9:23	11:23	1:23	3:23	5:23	7:23	10:23
1A	Forest Hills	7:28	9:28	11:28	1:28	3:28	5:28	7:28	10:28
1	Roslindale Village	7:31	9:31	11:31	1:31	3:31	5:31	7:31	10:31
1	Bellevue	7:34	9:34	11:34	1:34	3:34	5:34	7:34	10:34
1	Highland	7:36	9:36	11:36	1:36	3:36	5:36	7:36	10:36
1	West Roxbury	7:38	9:38	11:38	1:38	3:38	5:38	7:38	10:38
2	Hersey	7:43	9:43	11:43	1:43	3:43	5:43	7:43	10:43
2	Needham Junction	7:46	9:46	11:46	1:46	3:46	5:46	7:46	10:46
2	Needham Center	7:50	9:50	11:50	1:50	3:50	5:50	7:50	10:50
2	Needham Heights	7:55	9:55	11:55	1:55	3:55	5:55	7:55	10:55

Times in blue with "L" indicate an early departure: The train may leave ahead of schedule at these stops.

Bikes: Bicycles are allowed on trains with the bicycle symbol shown below the train number.

Connect to a different train for continued service outbound.

High level platform and bridge plate available. Visit **mbta.com/accessibility** for more information.

Holiday Service

On Thursday, November 25th 2021 (Thanksgiving Day), Saturday, December 25th 2021 (Christmas Day), and Saturday, January 1st 2022 (New Year's day), all lines will operate on a weekend schedule. On Friday, November 26th 2021, Friday, December 24th 2021 (Christmas Eve) and Friday, December 31st 2021 (New Year's Eve), all lines will operate on a regular weekday schedule. For all holiday schedules, please check MBTA.com/holidays or call 617-222-3200.

For additional service to Ruggles, refer to the Franklin and Providence line schedules for particular trains.

Masks are federally required on board and in station. Visit MBTA.com/covid19 for the latest updates.

Schedules may change in the event of severe weather

During weather events, these symbols will communicate service level and impact on passengers. Service level for the following day will be announced mid afternoon on the prior day.

REGULAR SERVICE Trains will operate on a normal schedule.

STORM SERVICE Trains will operate on a weekend schedule.

NO SERVICE No passenger service on Commuter Rail.

Massachusetts Bay Transportation Authority

KEOLIS

Visit **MBTA.com** | Customer Service **617-222-3200** | Follow **@MBTA_CR** | Download the **mTicket App**

AD101121V1

SILVER LINE

Weekday

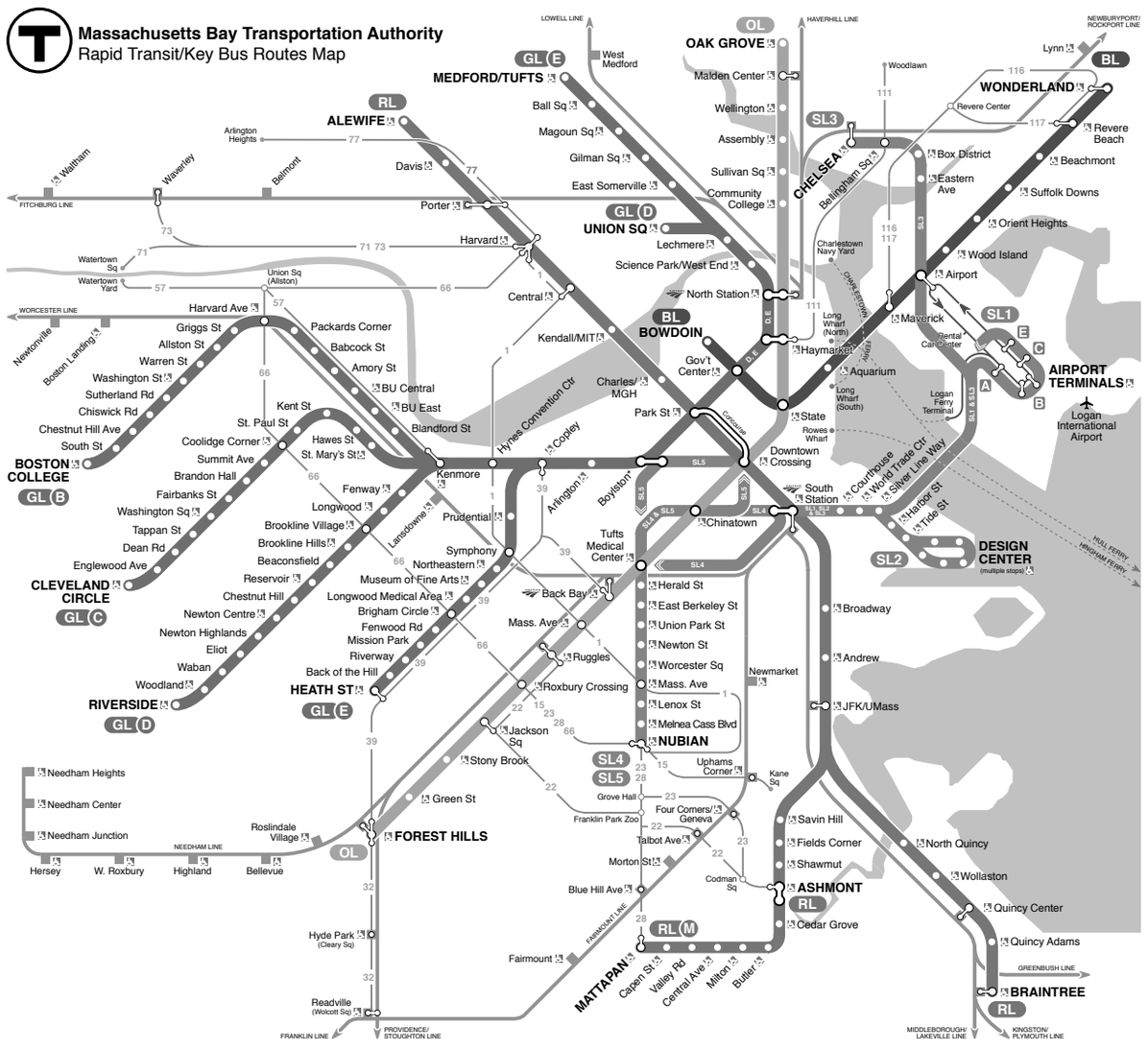
		First	Every...	Last
SL1	Logan Airport	5:51 AM	10-15	1:18 AM*
	South Station	5:32 AM	min	1:00 AM^
SL2	Design Center	5:52 AM	5-18	12:21 AM
	South Station	5:34 AM	min	12:40 AM
SL3	Chelsea	4:55 AM	6-15	12:57 AM*
	South Station	4:20 AM	min	12:35 AM^
SL4	Nubian	5:17 AM	9-20	12:34 AM
	South Station	5:40 AM	min	12:37 AM
SL5	Nubian	5:15 AM	6-20	12:44 AM
	Downtown Xing	5:32 AM	min	1:07 AM^

Saturday

		First	Every...	Last
SL1	Logan Airport	5:48 AM	10-12	1:15 AM*
	South Station	5:45 AM	min	12:59 AM^
SL2	Design Center	6:09 AM	14-16	12:38 AM
	South Station	5:47 AM	min	12:25 AM
SL3	Chelsea	5:30 AM	8-16	1:22 AM*
	South Station	4:56 AM	min	12:27 AM^
SL4	Nubian	5:23 AM	13-20	12:20 AM
	South Station	5:40 AM	min	12:40 AM^
SL5	Nubian	5:19 AM	6-11	12:43 AM
	Downtown Xing	5:34 AM	min	1:00 AM^

Sunday

		First	Every...	Last
SL1	Logan Airport	5:50 AM	8-17	1:12 AM*
	South Station	6:12 AM	min	1:00 AM^
SL2	Design Center	6:54 AM	15-26	12:56 AM
	South Station	6:35 AM	min	12:39 AM
SL3	Chelsea	6:26 AM	12-17	1:25 AM*
	South Station	5:53 AM	min	12:55 AM^
SL4	Nubian	6:02 AM	15-20	12:20 AM
	South Station	6:20 AM	min	12:40 AM
SL5	Nubian	6:00 AM	6-11	12:25 AM
	Downtown Xing	6:16 AM	min	12:47 AM^



Effective **Dec 19, 2021**

Rapid Transit

RED LINE

ORANGE LINE

GREEN LINE

BLUE LINE

SILVER LINE

mbta.com
@mbta
617-222-3200
617-222-5146 (TTY)

Massachusetts Bay Transportation Authority

RED LINE (M)

Weekday

peak RL trains every **9-10 min,** M trains every **6 min**
off peak RL trains every **12-13 min** M, trains every **13 min**

		First	Last
	Alewife	5:23 AM	12:25 AM
	Braintree	5:08 AM	12:16 AM
	Alewife	5:16 AM	12:30 AM^
	Ashmont	5:16 AM	12:30 AM^
M	Ashmont	5:17 AM	1:05 AM^
M	Mattapan	5:05 AM	12:53 AM

Saturday

RL trains every **13-14 min,** M trains every **13 min**

		First	Last
	Alewife	5:24 AM	12:20 AM
	Braintree	5:09 AM	12:17 AM
	Alewife	5:16 AM	12:27 AM^
	Ashmont	5:16 AM	12:30 AM^
M	Ashmont	5:15 AM	1:05 AM^
M	Mattapan	5:05 AM	12:53 AM

Sunday

RL trains every **13-14 min,** M trains every **13 min**

		First	Last
	Alewife	6:08 AM	12:20 AM
	Braintree	5:56 AM	12:17 AM
	Alewife	6:00 AM	12:27 AM^
	Ashmont	6:00 AM	12:30 AM^
M	Ashmont	6:03 AM	1:05 AM^
M	Mattapan	5:51 AM	12:55 AM

ORANGE LINE

Weekday

peak trains every **6-7 min**
off peak trains every **7-10 min**

	First	Last
Oak Grove	5:16 AM	12:30 AM^
Forest Hills	5:16 AM	12:28 AM^

Saturday

trains every **8-15 min**

	First	Last
Oak Grove	5:16 AM	12:30 AM^
Forest Hills	5:16 AM	12:28 AM^

Sunday

trains every **11-15 min**

	First	Last
Oak Grove	6:00 AM	12:30 AM^
Forest Hills	6:00 AM	12:28 AM^

BLUE LINE

Weekday

peak trains every **5 min**
off peak trains every **9-10 min**

	First	Last
Wonderland	5:13 AM	12:28 AM
Bowdoin	5:30 AM	1:00 AM^

Saturday

trains every **9-14 min**

	First	Last
Wonderland	5:25 AM	12:30 AM
Bowdoin	5:30 AM	1:00 AM^

Sunday

trains every **9-15 min**

	First	Last
Wonderland	5:58 AM	12:30 AM
Bowdoin	6:23 AM	1:00 AM^

GREEN LINE (B C D E)

Weekday

peak trains every **6-8 min**
off peak trains every **7-12 min**

		First	Last
B	Boston College	5:01 AM	12:14 AM
B	Gov't Center	5:43 AM	12:57 AM^
C	Cleveland Circ	5:00 AM	12:21 AM
C	Gov't Center	5:32 AM	12:52 AM^
D	Riverside	4:56 AM	12:05 AM
D	North Station	5:48 AM	12:54 AM^
E	Lechmere***	4:54 AM	12:36 AM
E	Heath Street	5:45 AM	12:40 AM**

Saturday

trains every **8-12 min**

		First	Last
B	Boston College	4:45 AM	12:16 AM
B	Gov't Center	5:26 AM	12:52 AM
C	Cleveland Circ	4:50 AM	12:22 AM
C	Gov't Center	5:21 AM	12:52 AM
D	Riverside	4:51 AM	12:00 AM
D	North Station	5:41 AM	12:50 AM
E	Lechmere***	5:00 AM	12:37 AM
E	Heath Street	5:38 AM	12:40 AM**

Sunday

trains every **8-13 min**

		First	Last
B	Boston College	5:20 AM	12:17 AM
B	Gov't Center	6:00 AM	12:54 AM^
C	Cleveland Circ	5:30 AM	12:25 AM
C	Gov't Center	6:02 AM	12:35 AM^
D	Riverside	5:25 AM	12:00 AM
D	North Station	6:14 AM	12:48 AM^
E	Lechmere***	5:32 AM	12:39 AM
E	Heath Street	6:16 AM	12:49 AM**

Service Notes

Weekday peak service: 7-9 AM and 4-6:30 PM

^ - waits at some downtown stations for connecting service. Departure times approximate

GREEN LINE

First D train leaves North Station at 5 AM

*** - E trains begin/end at North Station for Green Line Extension work. Use shuttle bus between North Station and Lechmere

** - Last northbound E trains with guaranteed connections:

Weekday	Saturday	Sunday
12:23 AM	12:25 AM	12:26 AM

SILVER LINE

* SL1 serves only World Trade Center and South Station after exiting Ted Williams Tunnel.

2021-2022 Holidays

Saturday or Sunday service

Dec 24 Christmas Eve SAT	**Jan 1, 2022** New Year's Day SUN
Dec 25 Christmas Day SUN	**Jan 17, 2022** MLK, Jr. Day SAT
Dec 31 New Year's Eve SAT	**Feb 21, 2022** Presidents' Day SAT

Fare	Local Bus	Bus + Bus	Subway	Bus + Subway
CharlieCard	$1.70	$1.70	$2.40	$2.40
CharlieTicket	$1.70	$1.70	$2.40	$4.10*
Cash-on-Board	$1.70	$3.40	$2.40	$4.10
Student/Youth**	$0.85	$0.85	$1.10	$1.10
Senior/TAP***	$0.85	$0.85	$1.10	$1.10

FREE FARES: Children 11 and under ride free when accompanied by a paying customer; Blind Access CharlieCard holders ride free and if using a guide, the guide rides free.

* Transfers Subway to Silver Line SL4 or SL5 pay $2.40

** Requires Student CharlieCard or Youth CharlieCard. Student CharlieCards available to students through participating middle and high schools. Youth CharlieCards available through community partners across Greater Boston.

*** Requires Senior/TAP CharlieCard, available to Medicare cardholders, seniors 65+, and persons with disabilities.

128 NDH THE GRID NEEDHAM SHUTTLE

Green Line

59

A.M.

DEPART	Newton Highlands (Corner of Lincoln & Walnut)	6:30	7:20	8:10	9:00
ARRIVE	254 Second Ave	6:38	7:29	8:20	9:10
ARRIVE	89 A St (MCPF-Needham, LLC)	6:40	7:31	8:22	9:12
ARRIVE	110 A St (Intex)	6:41	7:32	8:23	9:13
ARRIVE	250 First Ave (Bulfinch)	6:42	7:33	8:24	9:14
ARRIVE	200 First Ave (Homewood Suites)	6:43	7:34	8:25	9:15
ARRIVE	400 First Ave (Tripadvisor)	6:45	7:36	8:27	9:17
ARRIVE	189 B St (NBC Universal)	6:47	7:38	8:29	9:19
ARRIVE	117 Kendrick St (Bulfinch)	6:48	7:39	8:30	9:20
ARRIVE	140 Kendrick St (Boston Properties)	6:50	7:41	8:32	9:22

Shuttle operates **Monday-Friday** only

Shuttle dispatch **781-890-0093** x 3

Questions? **128bc@128bc.org**

128bc.org

P.M.

DEPART	140 Kendrick St (Boston Properties)	3:15	4:10	5:05	6:00
DEPART	117 Kendrick St (Bulfinch)	3:17	4:12	5:07	6:02
DEPART	189 B St (NBC Universal)	3:19	4:14	5:09	6:04
DEPART	89 A St (MCPF-Needham, LLC)	3:20	4:15	5:10	6:05
DEPART	254 Second Ave	3:22	4:17	5:12	6:07
DEPART	110 A St (Intex)	3:23	4:18	5:13	6:08
DEPART	400 First Ave (Tripadvisor)	3:25	4:20	5:15	6:10
DEPART	250 First Ave (Bulfinch)	3:27	4:22	5:17	6:12
DEPART	200 First Ave (Homewood Suites)	3:28	4:23	5:18	6:13
ARRIVE	Newton Highlands	3:41	4:38	5:33	6:25

effective date 01.24.2022

YOUR SHUTTLE'S DEDICATED PAGE

SCAN ME

- Live shuttle tracking
- Most up-to-date schedule
- Shuttle pickup area map & video
- Route map
- Route-specific notifications

128bc.org/schedules/needham

FARES

exact cash or app	Single Ride (full price)	$4
only sold in the app	10-ride Pass (full price)	$40
	20-ride Pass (full price)	$80
	Single Ride (member price)	FREE

FREE FARES?

Only riders who are affiliated with a 128 Business Council member company (through their employer or their employer's property owner) are eligible to ride at the free (member) fare. Ask your property manager, facilities manager, or human resources department if your site is a member! Or contact us at 128bc@128bc.org.

MOBILE APP INFO

SCAN ME

128bc.org/riders > click "Mobile App"

PROCEDURES

- **If you are ill, stay home.** Your driver cannot offer a seat on the shuttle to anyone clearly displaying COVID-19 or other contagious disease symptoms.
- **Wear a mask per FTA/CDC mandate**. You must wear a mask even if you feel healthy and even if you are vaccinated.
- **Make sure your mask fits properly.** Your mask should fit snugly over the bridge of your nose and extend down under your chin, covering your mouth & nose completely.
- **In the morning, head to the shuttle stop located on Walnut Street** after you arrive at Newton Highlands. The boarding area is curbside in front of a small park.
- **Arrive 5+ minutes early to the shuttle waiting area.** Give yourself plenty of time so that you don't have to rush.
- **Do not eat or drink on the shuttle**. Eating or drinking would compromise your mask.
- **Minimize conversation in waiting areas and on the shuttle.** Talking less & talking more quietly limit the production of the droplets & aerosols that spread the virus.
- **Double-check approaching shuttle's destination sign** before attempting to board.
- **Inform the driver of your stop as you enter the vehicle.** Quickly and safely take a seat after informing the driver of your destination.
- **Do not tamper with cracked windows.** Some windows must remain cracked at all times for ventilation.
- **Always treat the driver and your fellow riders with respect.**

557 HIGHLAND AVENUE
CRASH DATA

Crash Number	Crash Date	Crash Severity	Crash Time	Crash Year	Light Conditions	Manner of Collision	Non-Motorist Type (All Persons)	Road Surface Condition	Weather Conditions	X	Y	Latitude	Longitude
Central Avenue at Cedar Street													
4158651	09/09/2015	Property damage only (none injured)	7:29 PM	2015	Dark - lighted roadway	Single vehicle crash		Dry	Clear/Unknown	221609.7705	895147.2267	42.306507	-71.2378988
4400575	04/18/2017	Property damage only (none injured)	12:32 AM	2017	Dark - lighted roadway	Single vehicle crash		Dry	Clear	221578.9128	895116.4791	42.306229	-71.2382759
4459326	10/15/2017	Property damage only (none injured)	7:02 PM	2017	Daylight	Rear-end		Dry	Clear	221596.7186	895137.1444	42.306418	-71.2380568
4613324	09/14/2018	Property damage only (none injured)	2:27 PM	2018	Daylight	Rear-end		Dry	Clear	221592.6263	895133.9324	42.30639	-71.23811
Central Avenue at Webster Street													
4074556	04/15/2015	Property damage only (none injured)	3:37 PM	2015	Daylight	Angle		Dry	Clear	221727.6569	895194.3288	42.306927	-71.2364659
Central Avenue at Gould Street													
4073318	02/05/2015	Not Reported	7:29 AM	2015	Daylight	Rear-end		Snow	Snow/Sleet, hail (freezing r	222024.4638	895460.7239	42.309323	-71.2328656
4078697	06/20/2015	Property damage only (none injured)	8:59 AM	2015	Daylight	Angle		Dry	Clear	222047.9772	895474.4816	42.309439	-71.232574
4159161	09/03/2015	Non-fatal injury	1:35 PM	2015	Daylight	Angle		Dry	Clear	222047.9772	895474.4816	42.309439	-71.232574
4400567	05/27/2017	Non-fatal injury	12:16 PM	2017	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.309323	-71.2328656
4400586	05/11/2017	Property damage only (none injured)	10:42 AM	2017	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.309323	-71.2328656
4400895	05/26/2017	Property damage only (none injured)	4:44 PM	2017	Daylight	Angle		Wet	Clear	222047.9772	895474.4816	42.309439	-71.232574
4400914	05/11/2017	Property damage only (none injured)	12:59 PM	2017	Daylight	Rear-end		Dry	Clear	222024.4638	895460.7239	42.309323	-71.2328656
4450544	09/25/2017	Property damage only (none injured)	12:36 PM	2017	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.309323	-71.2328656
4480174	12/06/2017	Property damage only (none injured)	4:58 PM	2017	Dark - lighted roadway	Angle		Dry	Clear	222024.4638	895460.7239	42.309323	-71.2328656
4592081	07/11/2018	Property damage only (none injured)	4:16 PM	2018	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.30932	-71.23286
4592094	07/24/2018	Property damage only (none injured)	4:15 PM	2018	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.30932	-71.23286
4613216	09/05/2018	Property damage only (none injured)	5:21 PM	2018	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.30932	-71.23286
4730610	06/07/2019	Property damage only (none injured)	10:25 AM	2019	Daylight	Angle			Clear	222024.4638	895460.7239	42.30932	-71.23286
4771711	07/15/2019	Property damage only (none injured)	12:45 PM	2019	Daylight	Angle		Dry	Clear	222024.4638	895460.7239	42.30932	-71.23286
Central Avenue at Hampton Avenue													
4731074	05/30/2019	Non-fatal injury	9:13 AM	2019	Daylight	Rear-end			Cloudy	222184.8513	895553.0517	42.310147	-71.2309111
Central Avenue at River Park Street													
4072841	01/26/2015	Property damage only (none injured)	9:50 AM	2015	Daylight	Rear-end		Dry	Cloudy/Cloudy	222243.3745	895585.8183	42.310442	-71.2302045
4094717	08/04/2015	Property damage only (none injured)	7:04 PM	2015	Other	Rear-end		Wet	Rain/Severe crosswinds	222247.7422	895588.4001	42.31046	-71.2301438
4200828	04/04/2016	Property damage only (none injured)	1:12 PM	2016	Daylight	Single vehicle crash		Snow	Snow/Sleet, hail (freezing r	222247.7422	895588.4001	42.31046	-71.2301438
Gould Street at Ellis Street													
4184955	02/05/2016	Property damage only (none injured)	12:14 PM	2016	Daylight	Angle		Snow	Snow	222231.5703	895147.0303	42.30649	-71.2303548
4536337	04/14/2018	Property damage only (none injured)	11:31 AM	2018	Daylight	Angle		Dry	Clear	222231.5704	895147.0303	42.30649	-71.23036

Gould Street at Kearney Road

No Crashes Reported between 2015 and 2019

Gould Street at Station Road

No Crashes Reported between 2015 and 2019

Gould Street at Noanett Road

No Crashes Reported between 2015 and 2019

Gould Street at TV Place

No Crashes Reported between 2015 and 2019

Source: Crash data obtained from MassDOT Crash Portal

557 HIGHLAND AVENUE
CRASH DATA

Crash Number	Crash Date	Crash Severity	Crash Time	Crash Year	Light Conditions	Manner of Collision	Non-Motorist Type (All Persons)	Road Surface Condition	Weather Conditions	X	Y	Latitude	Longitude
Gould Street at Site Driveway / Wingate Driveway													
4536433	04/07/2018	Unknown	12:17 PM	2018	Daylight	Head-on		Dry	Clear/Cloudy	222295.2593	894600.5062	42.301568	-71.2296086
4613217	09/04/2018	Non-fatal injury	8:49 AM	2018	Daylight	Rear-end		Dry	Clear	222295.2593	894600.5062	42.301568	-71.2296086
Highland Avenue at West Street													
4072824	01/16/2015	Non-fatal injury	9:07 PM	2015	Dark - lighted roadway	Angle		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4072830	01/20/2015	Property damage only (none injured)	2:01 PM	2015	Daylight	Angle		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4073342	02/20/2015	Property damage only (none injured)	5:58 PM	2015	Dark - lighted roadway	Rear-end		Dry	Clear/Clear	221832.9983	893662.9189	42.293141	-71.23525
4074535	03/21/2015	Property damage only (none injured)	2:40 PM	2015	Daylight	Rear-end		Wet	Cloudy/Cloudy	221832.9983	893662.9189	42.293141	-71.23525
4074539	03/26/2015	Property damage only (none injured)	8:53 PM	2015	Dark - roadway not lighted	Sideswipe, same direction		Wet	Rain/Fog, smog, smoke	221832.9983	893662.9189	42.293141	-71.23525
4158665	09/25/2015	Non-fatal injury	7:25 AM	2015	Daylight	Rear-end	P2: Cyclist	Dry	Clear/Cloudy	221832.9983	893662.9189	42.293141	-71.23525
4184982	02/22/2016	Property damage only (none injured)	4:02 PM	2016	Daylight	Angle		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4184999	03/05/2016	Unknown	9:54 AM	2016	Daylight	Single vehicle crash		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4285243	09/28/2016	Property damage only (none injured)	1:10 PM	2016	Daylight	Angle		Dry	Cloudy	221832.9983	893662.9189	42.293141	-71.23525
4366983	02/03/2017	Property damage only (none injured)	4:11 PM	2017	Dusk	Single vehicle crash		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4400584	05/07/2017	Property damage only (none injured)	3:27 PM	2017	Daylight	Rear-end		Dry	Clear	221832.9823	893663.4743	42.293141	-71.23525
4400921	05/19/2017	Property damage only (none injured)	2:09 PM	2017	Daylight	Angle		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4407097	07/19/2017	Property damage only (none injured)	3:59 PM	2017	Daylight	Sideswipe, same direction		Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4427229	08/28/2017	Property damage only (none injured)	10:45 AM	2017	Daylight	Angle	P1: Cyclist	Dry	Clear	221832.9983	893662.9189	42.293141	-71.23525
4536361	03/02/2018	Property damage only (none injured)	10:28 AM	2018	Daylight	Sideswipe, same direction		Wet	Sleet, hail (freezing rain or	221832.9823	893663.4743	42.293145	-71.2352502
4592038	06/01/2018	Property damage only (none injured)	6:38 AM	2018	Daylight	Head-on		Dry	Clear	221832.9983	893662.9189	42.29314	-71.23525
4592384	08/21/2018	Property damage only (none injured)	11:34 AM	2018	Daylight	Single vehicle crash		Dry	Cloudy	221832.7394	893671.8831	42.293221	-71.2352528
4731082	02/07/2019	Property damage only (none injured)	8:41 PM	2019	Dark - lighted roadway	Sideswipe, same direction			Rain	221832.9983	893662.9189	42.29314	-71.23525
4771741	08/15/2019	Property damage only (none injured)	2:57 PM	2019	Daylight	Sideswipe, same direction		Dry	Clear	221832.9983	893662.9189	42.29314	-71.23525
4771750	08/21/2019	Property damage only (none injured)	8:57 AM	2019	Daylight	Sideswipe, same direction		Dry	Clear	221832.7394	893671.883	42.293221	-71.2352528
4771754	08/23/2019	Property damage only (none injured)	12:09 PM	2019	Daylight	Angle	P2: Cyclist	Dry	Cloudy	221832.9983	893662.9189	42.29314	-71.23525
4799772	12/07/2019	Property damage only (none injured)	8:00 AM	2019	Daylight	Angle		Dry	Clear	221832.9983	893662.9189	42.29314	-71.23525
Highland Avenue at Hunnewell Street													
4074564	04/25/2015	Property damage only (none injured)	11:57 AM	2015	Daylight	Angle		Dry	Clear	221831.6011	893847.3003	42.294797	-71.2352552
4185005	03/14/2016	Property damage only (none injured)	8:28 AM	2016	Daylight	Angle		Dry	Cloudy	221831.6011	893847.3004	42.294797	-71.2352552
4450630	09/16/2017	Property damage only (none injured)	10:42 AM	2017	Daylight	Rear-end		Dry	Cloudy/Clear	221831.6011	893847.3003	42.294797	-71.2352552
4592088	07/19/2018	Property damage only (none injured)	5:10 PM	2018	Daylight	Angle		Dry	Clear	221831.6011	893847.3004	42.2948	-71.23526
4592090	07/22/2018	Property damage only (none injured)	5:18 PM	2018	Daylight	Angle		Dry	Cloudy	221831.6011	893847.3003	42.2948	-71.23526
4630339	10/01/2018	Property damage only (none injured)	5:59 PM	2018	Daylight	Rear-end		Wet	Rain/Cloudy	221829.8547	893829.4404	42.294639	-71.2352819
4701918	04/03/2019	Property damage only (none injured)	10:01 PM	2019	Dark - lighted roadway	Single vehicle crash		Dry	Clear	221829.8547	893829.4404	42.294639	-71.2352819
4799690	12/24/2019	Property damage only (none injured)	3:14 PM	2019	Daylight	Angle		Dry	Clear	221831.6011	893847.3003	42.2948	-71.23526
Highland Avenue at Webster Street													
4072809	01/04/2015	Property damage only (none injured)	7:26 PM	2015	Dark - lighted roadway	Rear-end		Wet	Sleet, hail (freezing rain or	222047.298	894225.631	42.298203	-71.2326336
4072810	01/05/2015	Property damage only (none injured)	3:22 PM	2015	Daylight	Single vehicle crash		Dry	Clear/Clear	222047.298	894225.631	42.298203	-71.2326336
4184975	01/10/2016	Non-fatal injury	4:43 PM	2016	Dusk	Single vehicle crash	P2: Pedestrian	Wet	Rain/Cloudy	222047.298	894225.631	42.298203	-71.2326336
4186112	01/07/2016	Non-fatal injury	10:50 AM	2016	Daylight	Angle		Dry	Clear	222047.298	894225.631	42.298203	-71.2326336
4255477	07/19/2016	Property damage only (none injured)	10:15 PM	2016	Dark - lighted roadway	Rear-end		Dry	Clear	222047.298	894225.631	42.298203	-71.2326336
4523776	01/13/2018	Property damage only (none injured)	3:00 PM	2018	Daylight	Rear-end		Unknown	Unknown	222047.298	894225.631	42.2982	-71.23263
4556272	05/12/2018	Property damage only (none injured)	1:18 PM	2018	Daylight	Rear-end		Wet	Rain	222047.298	894225.631	42.2982	-71.23263
4771758	08/26/2019	Property damage only (none injured)	9:08 AM	2019	Daylight	Rear-end		Dry	Clear	222047.298	894225.631	42.2982	-71.23263
4787821	11/19/2019	Non-fatal injury	12:15 PM	2019	Daylight	Rear-end		Wet	Rain/Cloudy	222047.298	894225.631	42.2982	-71.23263

Source: Crash data obtained from MassDOT Crash Portal

557 HIGHLAND AVENUE
CRASH DATA

Crash Number	Crash Date	Crash Severity	Crash Time	Crash Year	Light Conditions	Manner of Collision	Non-Motorist Type (All Persons)	Road Surface Condition	Weather Conditions	X	Y	Latitude	Longitude
Highland Avenue at Gould Street / Hunting Road													
4072819	01/10/2015	Property damage only (none injured)	10:16 PM	2015	Dark - lighted roadway	Rear-end		Sand, mud, di	Clear	222335.9231	894480.9054	42.300491	-71.2291191
4073336	02/16/2015	Property damage only (none injured)	2:01 PM	2015	Daylight	Rear-end		Wet	Clear	222335.9231	894480.9054	42.300491	-71.2291191
4095261	08/05/2015	Property damage only (none injured)	11:03 AM	2015	Daylight	Rear-end		Dry	Clear	222346.1318	894490.0782	42.300572	-71.2289974
4095264	08/18/2015	Property damage only (none injured)	12:02 PM	2015	Daylight	Angle		Dry	Clear	222335.9231	894480.9054	42.300491	-71.2291191
4173160	11/05/2015	Property damage only (none injured)	6:00 PM	2015	Dark - lighted roadway	Rear-end		Dry	Clear	222343.2349	894474.8671	42.300437	-71.2290344
4184947	01/27/2016	Not Reported	6:42 PM	2016	Dark - lighted roadway	Single vehicle crash		Dry	Clear	222346.1318	894490.0782	42.300572	-71.2289974
4186103	01/11/2016	Property damage only (none injured)	3:31 PM	2016	Daylight	Unknown		Dry	Clear	222346.1318	894490.0782	42.300572	-71.2289974
4200732	04/05/2016	Property damage only (none injured)	11:22 AM	2016	Daylight	Angle		Dry	Clear	222335.9231	894480.9054	42.300491	-71.2291191
4255474	07/13/2016	Non-fatal injury	9:09 PM	2016	Dark - lighted roadway	Single vehicle crash		Dry	Clear	222343.2349	894474.8671	42.300437	-71.2290344
4285239	09/24/2016	Property damage only (none injured)	1:58 PM	2016	Unknown	Unknown		Dry	Clear	222346.1318	894490.0782	42.300572	-71.2289974
4323746	11/11/2016	Property damage only (none injured)	1:49 PM	2016	Daylight	Sideswipe, same direction		Dry	Clear	222335.9231	894480.9054	42.30049	-71.22912
4400899	03/01/2017	Property damage only (none injured)	1:31 PM	2017	Daylight	Sideswipe, same direction		Dry	Clear	222335.9232	894480.9055	42.300491	-71.2291191
4459320	10/04/2017	Property damage only (none injured)	7:06 AM	2017	Daylight	Sideswipe, same direction		Dry	Clear	222346.1318	894490.0782	42.300572	-71.2289974
4480154	11/18/2017	Property damage only (none injured)	10:55 PM	2017	Dark - lighted roadway	Angle		Wet	Rain	222335.9232	894480.9055	42.300491	-71.2291191
4480163	11/22/2017	Property damage only (none injured)	5:32 PM	2017	Dark - lighted roadway	Rear-end		Wet	Rain	222346.1318	894490.0782	42.300572	-71.2289974
4592062	06/27/2018	Non-fatal injury	7:23 AM	2018	Daylight	Angle		Dry	Clear	222349.0191	894479.9156	42.300481	-71.2289612
4592082	07/13/2018	Non-fatal injury	5:59 PM	2018	Dusk	Rear-end		Dry	Clear	222342.5413	894474.2617	42.30043	-71.22904
4592095	07/26/2018	Property damage only (none injured)	8:20 AM	2018	Daylight	Sideswipe, same direction		Dry	Cloudy	222335.9231	894480.9054	42.30049	-71.22912
4667338	12/12/2018	Property damage only (none injured)	12:11 PM	2018	Daylight	Sideswipe, same direction		Dry	Clear	222335.9231	894480.9054	42.30049	-71.22912
4684379	03/23/2019	Property damage only (none injured)	11:04 AM	2019	Daylight	Sideswipe, same direction		Dry	Clear	222335.9231	894480.9054	42.30049	-71.22912
4701915	04/30/2019	Non-fatal injury	4:49 AM	2019	Dark - lighted roadway	Angle		Wet	Rain	222335.9231	894480.9054	42.30049	-71.22912
4771722	07/31/2019	Unknown	4:35 PM	2019	Daylight	Sideswipe, same direction		Wet	Clear	222342.5413	894474.2617	42.30043	-71.22904
4771729	08/03/2019	Property damage only (none injured)	2:55 PM	2019	Daylight	Angle		Dry	Clear	222335.9231	894480.9054	42.30049	-71.22912
4799773	12/09/2019	Property damage only (none injured)	11:10 AM	2019	Daylight	Sideswipe, same direction		Wet	Rain/Cloudy	222342.5413	894474.2617	42.30043	-71.22904
Highland Avenue at I-95 SB Ramps													
4220787	06/16/2016	Property damage only (none injured)	7:48 AM	2016	Daylight	Rear-end		Dry	Clear	222567.662	894664.4933	42.302132	-71.2262984
4352824	04/10/2017	Property damage only (none injured)	1:29 PM	2017	Daylight	Rear-end		Dry	Clear	222567.662	894664.4933	42.302132	-71.2262984
4356982	04/09/2017	Non-fatal injury	2:50 PM	2017	Daylight	Single vehicle crash		Dry	Clear	222422.3078	894542.2717	42.301038	-71.2280738
4459230	10/10/2017	Property damage only (none injured)	7:50 AM	2017	Daylight	Rear-end		Dry	Clear	222567.662	894664.4933	42.302132	-71.2262984
4731067	05/21/2019	Property damage only (none injured)	8:21 AM	2019	Daylight	Rear-end			Clear	222515.0867	894597.8132	42.301537	-71.2269427
4787867	10/07/2019	Property damage only (none injured)	8:57 AM	2019	Daylight	Rear-end		Dry	Clear	222514.4312	894592.6938	42.301491	-71.2269508
Highland Avenue at I-95 NB Ramps													
4072844	01/03/2015	Property damage only (none injured)	12:02 PM	2015	Daylight	Rear-end		Dry	Clear/Clear	222746.1201	894774.3951	42.303117	-71.2241353
4074526	03/08/2015	Property damage only (none injured)	10:10 AM	2015	Daylight	Rear-end		Dry	Cloudy/Cloudy	222900.4037	894842.6068	42.303734	-71.2222649
4074562	04/24/2015	Property damage only (none injured)	8:40 AM	2015	Daylight	Rear-end		Dry	Clear/Clear	222900.4037	894842.6068	42.303734	-71.2222649
4075394	06/03/2015	Property damage only (none injured)	8:39 AM	2015	Daylight	Rear-end		Dry	Clear/Clear	222900.4037	894842.6068	42.303734	-71.2222649
4075398	04/30/2015	Property damage only (none injured)	9:10 AM	2015	Daylight	Rear-end		Dry	Clear/Clear	222900.4037	894842.6068	42.303734	-71.2222649
4084174	07/25/2015	Non-fatal injury	3:51 PM	2015	Daylight	Rear-end		Dry	Clear	222900.4037	894842.6068	42.303734	-71.2222649
4146864	01/18/2016	Property damage only (none injured)	8:08 PM	2016	Dark - roadway not lighted	Rear-end		Dry	Cloudy	222900.4037	894842.6068	42.303734	-71.2222649
4173197	11/30/2015	Non-fatal injury	7:07 PM	2015	Dark - lighted roadway	Rear-end		Dry	Clear	222900.4037	894842.6068	42.303734	-71.2222649
4173561	12/01/2015	Non-fatal injury	5:10 PM	2015	Dark - lighted roadway	Rear-end		Dry	Clear	222900.4037	894842.6068	42.303734	-71.2222649
4232469	08/03/2016	Non-fatal injury	11:23 PM	2016	Dark - roadway not lighted	Single vehicle crash		Dry	Clear	222793.6229	894811.9909	42.303458	-71.2235517
4407079	06/12/2017	Property damage only (none injured)	3:27 PM	2017	Daylight	Rear-end		Dry	Clear	222900.4037	894842.6068	42.303734	-71.2222649
4407093	07/08/2017	Property damage only (none injured)	9:44 AM	2017	Daylight	Rear-end		Dry	Cloudy	222900.4037	894842.6068	42.303734	-71.2222649
4639482	12/14/2018	Property damage only (none injured)	8:20 AM	2018	Daylight	Rear-end		Dry	Clear	222900.4037	894842.6068	42.30373	-71.22226

Source: Crash data obtained from MassDOT Crash Portal

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CRASH DATA

Crash Number	Crash Date	Crash Severity	Crash Time	Crash Year	Light Conditions	Manner of Collision	Non-Motorist Type (All Persons)	Road Surface Condition	Weather Conditions	X	Y	Latitude	Longitude
Highland Avenue at 1st Avenue													
4173558	11/24/2015	Property damage only (none injured)	6:50 PM	2015	Dark - lighted roadway	Angle		Dry	Clear	222948.9745	894866.0912	42.303939	-71.2216697
4184931	01/11/2016	Non-fatal injury	12:56 PM	2016	Daylight	Unknown		Dry	Clear	222948.9745	894866.0912	42.303939	-71.2216697
4184945	01/06/2016	Non-fatal injury	10:35 AM	2016	Daylight	Rear-end		Dry	Clear	222959.191	894872.2462	42.303993	-71.2215482
4239037	05/19/2016	Property damage only (none injured)	12:12 PM	2016	Daylight	Sideswipe, same direction		Dry	Clear	222948.9745	894866.0912	42.303939	-71.2216697
4255605	07/05/2016	Property damage only (none injured)	3:41 PM	2016	Daylight	Rear-end		Dry	Clear	222943.7043	894873.7333	42.304011	-71.22173
4323696	10/20/2016	Property damage only (none injured)	1:19 PM	2016	Daylight	Sideswipe, same direction		Dry	Clear	222948.9745	894866.0912	42.303939	-71.2216697
4323697	10/20/2016	Property damage only (none injured)	3:51 PM	2016	Daylight	Angle		Dry	Clear	222952.8139	894859.1599	42.303877	-71.2216237
4323705	12/09/2016	Property damage only (none injured)	12:21 PM	2016	Daylight	Sideswipe, same direction		Dry	Clear	222964.195	894875.2609	42.304022	-71.221485
4323758	11/19/2016	Non-fatal injury	3:59 PM	2016	Daylight	Single vehicle crash		Dry	Clear	222964.195	894875.2609	42.304022	-71.221485
4366969	01/10/2017	Property damage only (none injured)	8:46 AM	2017	Daylight	Sideswipe, same direction		Wet	Clear	222948.9745	894866.0912	42.303939	-71.2216697
4400559	03/20/2017	Property damage only (none injured)	8:58 AM	2017	Daylight	Rear-end		Dry	Clear	222950.2624	894863.7662	42.303921	-71.2216577
4407249	06/02/2017	Property damage only (none injured)	7:44 AM	2017	Daylight	Rear-end		Dry	Clear	222950.2624	894863.7662	42.303921	-71.2216577
4407733	07/17/2017	Property damage only (none injured)	8:01 AM	2017	Daylight	Sideswipe, same direction		Dry	Clear	222959.191	894872.2462	42.303993	-71.2215482
4523779	01/25/2018	Property damage only (none injured)	1:49 PM	2018	Daylight	Sideswipe, same direction		Dry	Clear	222950.2624	894863.7662	42.303919	-71.2216545
4536444	02/08/2018	Property damage only (none injured)	8:21 AM	2018	Daylight	Sideswipe, same direction		Dry	Clear	222959.191	894872.2462	42.303995	-71.2215459
4613335	09/21/2018	Property damage only (none injured)	4:41 PM	2018	Daylight	Sideswipe, same direction		Dry	Clear	222948.9745	894866.0912	42.30394	-71.22167
4702345	04/10/2019	Property damage only (none injured)	8:07 AM	2019	Daylight	Angle		Wet	Cloudy	222948.9745	894866.0912	42.30394	-71.22167
4730613	06/11/2019	Property damage only (none injured)	6:16 PM	2019	Daylight	Angle			Clear	222949.4166	894876.3868	42.304033	-71.2216642
4731054	05/11/2019	Property damage only (none injured)	1:58 AM	2019	Dark - lighted roadway	Rear-end			Cloudy	222949.7735	894866.5726	42.303944	-71.2216603
4771782	09/18/2019	Property damage only (none injured)	10:32 AM	2019	Daylight	Angle		Dry	Clear	222949.7735	894866.5726	42.303944	-71.2216603
4771783	09/18/2019	Property damage only (none injured)	3:51 PM	2019	Daylight	Rear-end		Dry	Clear	222948.9745	894866.0912	42.30394	-71.22167
4787874	10/11/2019	Property damage only (none injured)	8:33 AM	2019	Daylight	Sideswipe, same direction		Dry	Cloudy	222949.7735	894866.5726	42.303944	-71.2216603
4799692	12/26/2019	Property damage only (none injured)	12:37 PM	2019	Daylight	Angle		Dry	Clear	222969.8138	894878.646	42.304052	-71.2214168
4799778	12/12/2019	Non-fatal injury	7:57 AM	2019	Daylight	Rear-end		Dry	Clear	222949.7735	894866.5726	42.303944	-71.2216603

Source: Crash data obtained from MassDOT Crash Portal

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CRASH DATA

Crash Number	Crash Date	Crash Severity	Crash Time	Crash Year	Light Conditions	Manner of Collision	Non-Motorist Type (All Persons)	Road Surface Condition	Weather Conditions	X	Y	Latitude	Longitude
Highland Avenue at 2nd Avenue													
4072829	01/20/2015	Property damage only (none injured)	1:40 PM	2015	Daylight	Angle		Dry	Clear	223147.7524	894973.4351	42.304897	-71.2192519
4073341	02/20/2015	Property damage only (none injured)	3:22 PM	2015	Daylight	Head-on		Dry	Clear/Clear	223147.7524	894973.4351	42.304897	-71.2192519
4075405	05/03/2015	Property damage only (none injured)	6:28 PM	2015	Daylight	Sideswipe, opposite direction		Dry	Clear/Clear	223147.7524	894973.4351	42.304897	-71.2192519
4173155	11/02/2015	Property damage only (none injured)	9:34 AM	2015	Daylight	Unknown	P2: Pedestrian	Dry	Clear	223166.1044	894982.859	42.304986	-71.2190332
4200740	04/14/2016	Property damage only (none injured)	12:32 PM	2016	Daylight	Rear-to-rear		Dry	Clear	223166.1044	894982.859	42.304986	-71.2190332
4238646	05/06/2016	Property damage only (none injured)	3:14 PM	2016	Daylight	Angle		Wet	Cloudy	223175.8722	894952.116	42.304707	-71.2189132
4240249	06/25/2016	Property damage only (none injured)	2:34 PM	2016	Daylight	Single vehicle crash		Dry	Clear	223166.1044	894982.859	42.304986	-71.2190332
4255528	07/29/2016	Property damage only (none injured)	9:05 AM	2016	Daylight	Rear-end		Other	Cloudy/Unknown	223147.7524	894973.4351	42.304897	-71.2192519
4284259	08/26/2016	Property damage only (none injured)	10:37 AM	2016	Daylight	Angle		Dry	Clear	223155.9193	894977.6289	42.304941	-71.2191547
4323677	10/01/2016	Property damage only (none injured)	12:17 PM	2016	Daylight	Rear-end		Wet	Rain/Cloudy	223163.4531	894981.4975	42.304973	-71.2190642
4323691	10/14/2016	Property damage only (none injured)	9:27 AM	2016	Daylight	Sideswipe, same direction		Dry	Clear	223163.4531	894981.4975	42.304973	-71.2190642
4366738	01/09/2017	Property damage only (none injured)	2:11 PM	2017	Unknown	Sideswipe, same direction		Unknown	Unknown	223175.8722	894952.116	42.304707	-71.2189132
4366751	02/03/2017	Property damage only (none injured)	12:47 PM	2017	Daylight	Single vehicle crash		Dry	Clear	223166.1044	894982.859	42.304986	-71.2190332
4459325	10/13/2017	Property damage only (none injured)	10:46 AM	2017	Daylight	Single vehicle crash		Dry	Clear	223166.1044	894982.859	42.304986	-71.2190332
4480151	11/16/2017	Property damage only (none injured)	5:56 PM	2017	Dark - lighted roadway	Angle		Wet	Rain	223147.7524	894973.4351	42.304897	-71.2192519
4522174	01/10/2018	Property damage only (none injured)	2:33 PM	2018	Daylight	Angle		Wet	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4536333	04/03/2018	Property damage only (none injured)	1:33 PM	2018	Daylight	Rear-end		Dry	Cloudy	223155.9193	894977.6289	42.304938	-71.2191557
4536432	04/02/2018	Property damage only (none injured)	9:00 AM	2018	Daylight	Sideswipe, same direction		Wet	Snow	223147.7524	894973.4351	42.304901	-71.2192549
4536448	02/09/2018	Property damage only (none injured)	7:13 PM	2018	Dark - lighted roadway	Head-on		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4556269	05/10/2018	Property damage only (none injured)	8:00 AM	2018	Daylight	Single vehicle crash		Dry	Clear	223155.9193	894977.6289	42.304938	-71.2191557
4592060	06/26/2018	Property damage only (none injured)	3:53 PM	2018	Daylight	Sideswipe, same direction		Dry	Clear	223163.4531	894981.4975	42.304973	-71.2190642
4592078	07/07/2018	Property damage only (none injured)	4:14 PM	2018	Daylight	Rear-end		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4613211	09/26/2018	Non-fatal injury	4:54 PM	2018	Daylight	Rear-end		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4645028	11/06/2018	Property damage only (none injured)	3:47 PM	2018	Daylight	Sideswipe, same direction		Wet	Rain	223163.4531	894981.4975	42.304973	-71.2190642
4701898	04/10/2019	Non-fatal injury	7:28 AM	2019	Daylight	Single vehicle crash	P2: Cyclist	Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4771723	07/31/2019	Property damage only (none injured)	3:05 PM	2019	Daylight	Angle		Dry	Cloudy	223147.7524	894973.4351	42.304901	-71.2192549
4771752	08/22/2019	Property damage only (none injured)	7:18 AM	2019	Daylight	Sideswipe, opposite direction		Dry	Clear	223165.6667	894982.6342	42.304983	-71.2190373
4771761	08/27/2019	Property damage only (none injured)	1:09 PM	2019	Daylight	Angle		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4787788	10/02/2019	Property damage only (none injured)	7:25 AM	2019	Daylight	Sideswipe, same direction		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4787795	10/23/2019	Property damage only (none injured)	1:56 PM	2019	Daylight	Rear-end		Dry	Clear	223163.4494	894981.4956	42.304973	-71.2190642
4787798	10/24/2019	Property damage only (none injured)	10:06 AM	2019	Daylight	Sideswipe, same direction		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4787879	10/15/2019	Property damage only (none injured)	11:33 PM	2019	Daylight	Angle		Dry	Clear	223147.7524	894973.4351	42.304901	-71.2192549
4799674	12/10/2019	Property damage only (none injured)	3:47 PM	2019	Daylight	Angle		Wet	Clear	223164.0984	894981.8289	42.304976	-71.2190563

Source: Crash data obtained from MassDOT Crash Portal

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CRASH DATA

Crash Number	Crash Date	Crash Severity	Crash Time	Crash Year	Light Conditions	Manner of Collision	Non-Motorist Type (All Persons)	Road Surface Condition	Weather Conditions	X	Y	Latitude	Longitude
Hunting Road at Kendrick Street													
4072813	01/08/2015	Property damage only (none injured)	9:56 AM	2015	Daylight	Rear-end		Dry	Clear/Clear	223101.5644	893845.8063	42.294752	-71.2198547
4073339	02/17/2015	Unknown	7:28 PM	2015	Dark - lighted roadway	Angle		Slush	Snow/Snow	223101.5644	893845.8063	42.294752	-71.2198547
4158663	09/24/2015	Property damage only (none injured)	9:18 AM	2015	Daylight	Angle		Dry	Clear	223101.5644	893845.8063	42.294752	-71.2198547
4173141	10/18/2015	Property damage only (none injured)	4:32 PM	2015	Daylight	Rear-end		Dry	Clear/Cloudy	223096.5864	893853.7933	42.294824	-71.219915
4173559	12/01/2015	Non-fatal injury	6:57 AM	2015	Daylight	Rear-end	P1: Cyclist	Wet	Cloudy/Rain	223101.5644	893845.8063	42.294752	-71.2198547
4240240	06/10/2016	Non-fatal injury	8:42 AM	2016	Daylight	Single vehicle crash	P2: Cyclist	Dry	Clear	223101.5644	893845.8063	42.294752	-71.2198547
4240568	06/17/2016	Non-fatal injury	5:28 PM	2016	Daylight	Angle		Dry	Clear	223096.5864	893853.7933	42.294824	-71.219915
4284728	08/05/2016	Property damage only (none injured)	1:23 PM	2016	Daylight	Rear-end		Dry	Clear/Unknown	223096.5864	893853.7933	42.294824	-71.219915
4366754	02/08/2017	Non-fatal injury	6:30 AM	2017	Dawn	Single vehicle crash		Ice	Sleet, hail (freezing rain or	223101.5643	893845.8064	42.294752	-71.2198547
4459231	10/10/2017	Property damage only (none injured)	8:33 AM	2017	Daylight	Sideswipe, same direction		Dry	Clear	223101.5644	893845.8063	42.294752	-71.2198547
4480146	11/10/2017	Property damage only (none injured)	10:57 AM	2017	Daylight	Angle		Dry	Clear/Cloudy	223101.5644	893845.8063	42.294752	-71.2198547
4536325	03/16/2018	Property damage only (none injured)	7:43 PM	2018	Dark - lighted roadway	Angle		Dry	Clear	223101.5644	893845.8063	42.29475	-71.21986
4592052	06/18/2018	Property damage only (none injured)	9:37 PM	2018	Dark - lighted roadway	Angle		Wet	Rain	223101.5644	893845.8063	42.29475	-71.21986
4645024	11/03/2018	Property damage only (none injured)	8:41 PM	2018	Dark - lighted roadway	Sideswipe, same direction		Dry	Clear	223101.5644	893845.8063	42.29475	-71.21986
4645047	11/21/2018	Property damage only (none injured)	2:44 PM	2018	Daylight	Single vehicle crash		Dry	Clear	223101.5644	893845.8063	42.29475	-71.21986
4730734	06/28/2019	Property damage only (none injured)	7:50 PM	2019	Daylight	Angle			Clear	223101.5644	893845.8063	42.29475	-71.21986
4787825	11/21/2019	Property damage only (none injured)	9:24 AM	2019	Daylight	Angle		Dry	Clear	223101.5644	893845.8063	42.29475	-71.21986
4787881	10/20/2019	Property damage only (none injured)	10:45 PM	2019	Dark - lighted roadway	Single vehicle crash		Wet	Rain/Cloudy	223101.5644	893845.8063	42.29475	-71.21986
4799767	12/01/2019	Non-fatal injury	8:48 AM	2019	Daylight	Unknown		Dry	Cloudy	223101.5644	893845.8063	42.29475	-71.21986
4799783	12/28/2019	Property damage only (none injured)	3:48 PM	2019	Daylight	Angle		Dry	Clear	223101.5644	893845.8063	42.29475	-71.21986

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Jul-21

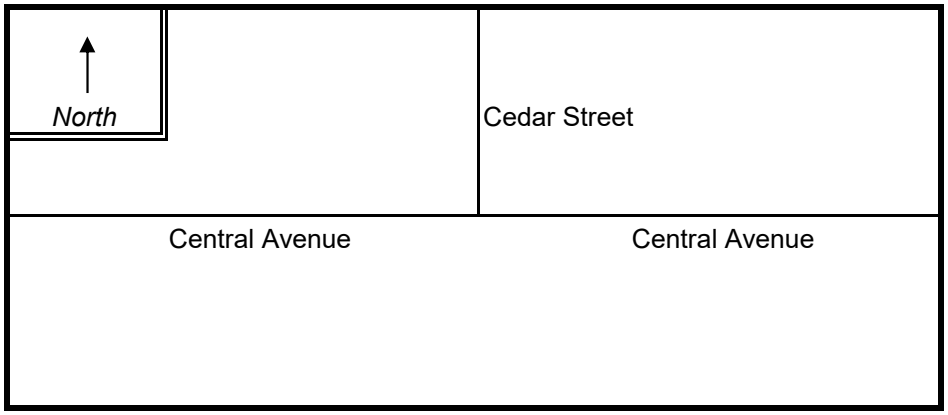
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Central Avenue

MINOR STREET(S) : Cedar Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	0	160	270	485		**915**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **10,167**

TOTAL # OF CRASHES : 4 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.80**

CRASH RATE CALCULATION : **0.22** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Jul-21

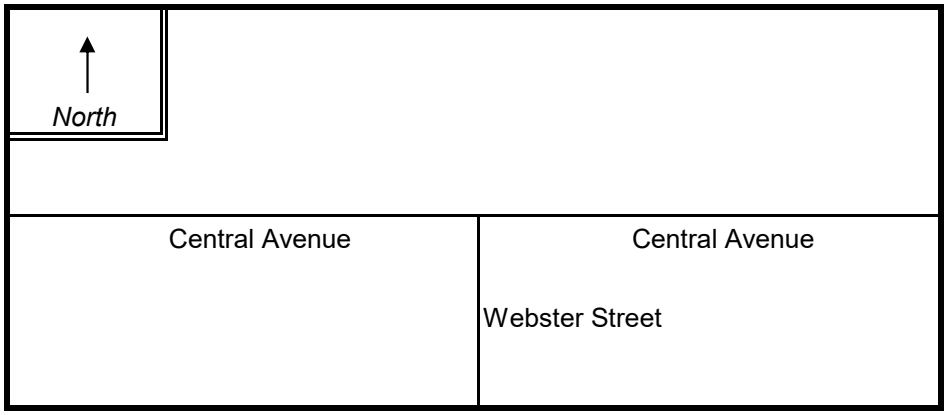
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Central Avenue

MINOR STREET(S) : Webster Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	205	0	375	540		**1,120**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **12,444**

TOTAL # OF CRASHES : 1 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.20**

CRASH RATE CALCULATION : **0.04** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

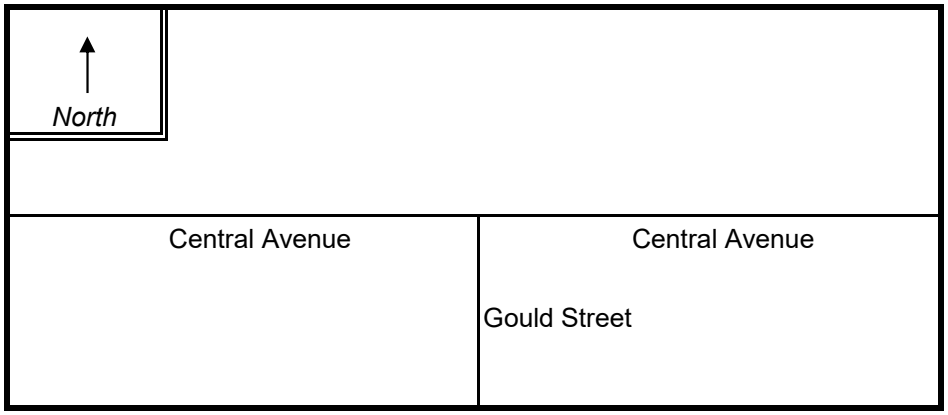
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Central Avenue

MINOR STREET(S) : Gould Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	210	0	470	810		**1,490**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **16,556**

TOTAL # OF CRASHES : 14 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **2.80**

CRASH RATE CALCULATION : **0.46** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

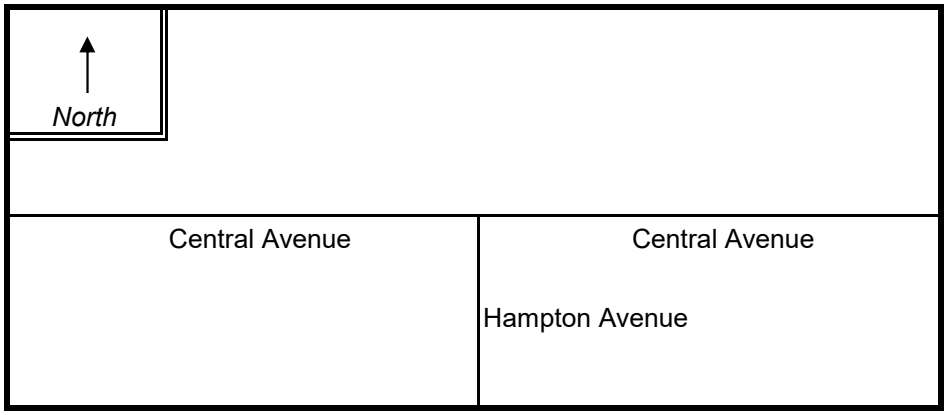
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Central Avenue

MINOR STREET(S) : Hampton Avenue

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	50	0	480	785		**1,315**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **14,611**

TOTAL # OF CRASHES : 1 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.20**

CRASH RATE CALCULATION : **0.04** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

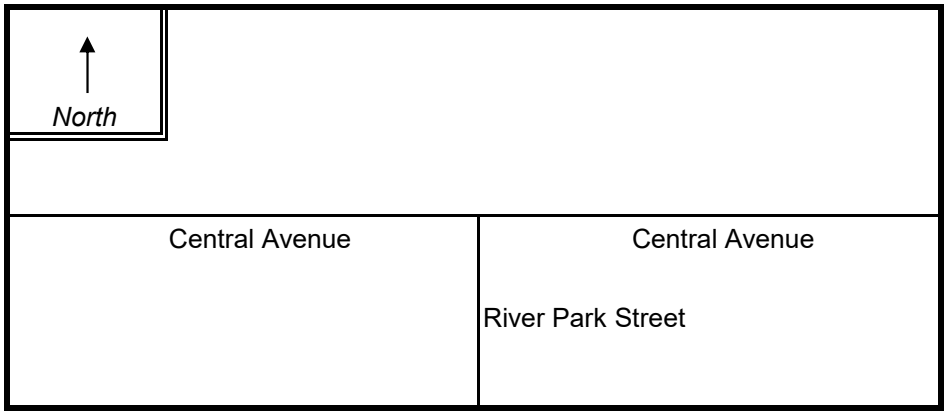
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Central Avenue

MINOR STREET(S) : River Park Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	2	0	512	787		**1,301**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **14,456**

TOTAL # OF CRASHES : 3 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.60**

CRASH RATE CALCULATION : **0.11** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Gould Street

MINOR STREET(S) : Ellis Street

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	225	296	1	47		**569**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **6,322**

TOTAL # OF CRASHES : 2

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **0.40**

CRASH RATE CALCULATION : **0.26**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Gould Street

MINOR STREET(S) : Kearney Road

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	245	340	0	105		**690**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **7,667**

TOTAL # OF CRASHES : 0

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **0.00**

CRASH RATE CALCULATION : **0.00**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Gould Street

MINOR STREET(S) : Station Road

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	240	417	0	75		**732**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **8,133**

TOTAL # OF CRASHES : 0 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.00**

CRASH RATE CALCULATION : **0.00** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Gould Street

MINOR STREET(S) : Noanett Street

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	270	475	26	110		**881**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **9,789**

TOTAL # OF CRASHES : 0 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.00**

CRASH RATE CALCULATION : **0.00** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

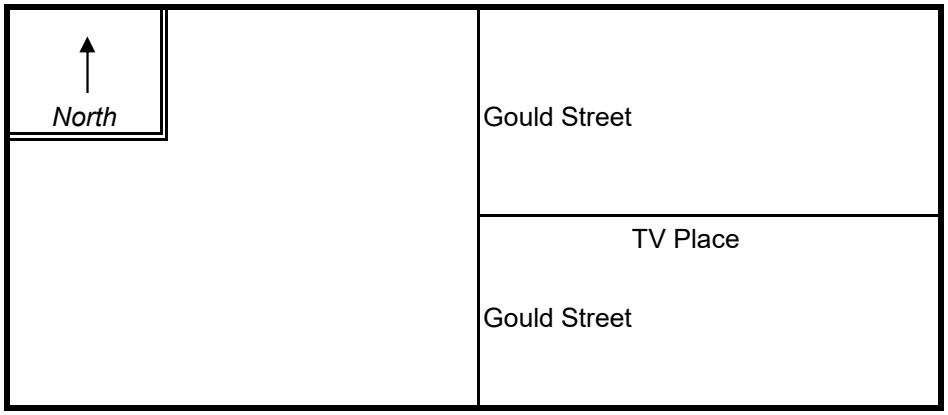
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Gould Street

MINOR STREET(S) : TV Place

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	260	535	0	40		**835**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **9,278**

TOTAL # OF CRASHES : 0 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.00**

CRASH RATE CALCULATION : **0.00** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Dec-15

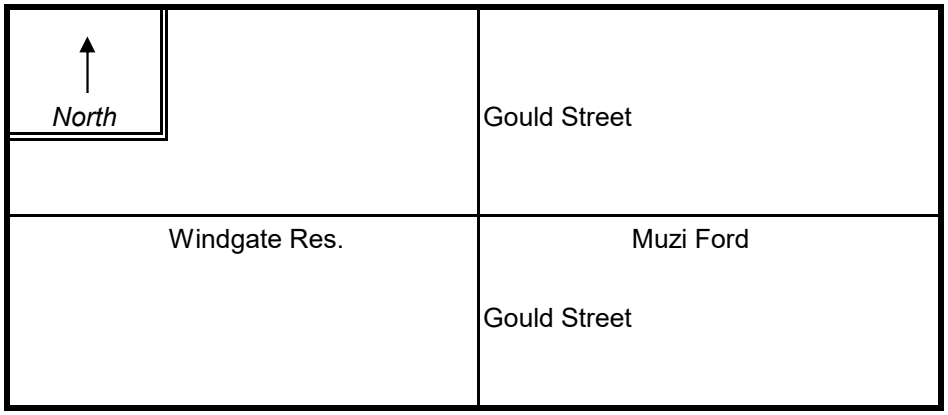
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Gould Street

MINOR STREET(S) : Muzi Ford/Windgate Res.

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	260	555	25	46		**886**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **9,844**

TOTAL # OF CRASHES : 2 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.40**

CRASH RATE CALCULATION : **0.11** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Apr-20

DISTRICT : 6 UNSIGNALIZED : [ ] SIGNALIZED : [X]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : West Street

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	210	315	325	415		**1,265**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **14,056**

TOTAL # OF CRASHES : 22 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **4.40**

CRASH RATE CALCULATION : **0.86** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Jul-21

DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Hunnewell Street

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	435	505	135	55		**1,130**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **12,556**

TOTAL # OF CRASHES : 8

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **1.60**

CRASH RATE CALCULATION : **0.35**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Jan-18

DISTRICT : 6 UNSIGNALIZED : [ ] SIGNALIZED : [X]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Webster Street

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	305	410	445	865		**2,025**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **22,500**

TOTAL # OF CRASHES : 9 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **1.80**

CRASH RATE CALCULATION : **0.29** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Feb-19

DISTRICT : 6 UNSIGNALIZED : [ ] SIGNALIZED : [X]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Gould Street

INTERSECTION DIAGRAM (Label Approaches)

PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	160	600	700	1,200		**2,660**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **29,556**

TOTAL # OF CRASHES : 24 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **4.80**

CRASH RATE CALCULATION : **0.44** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Jan-18

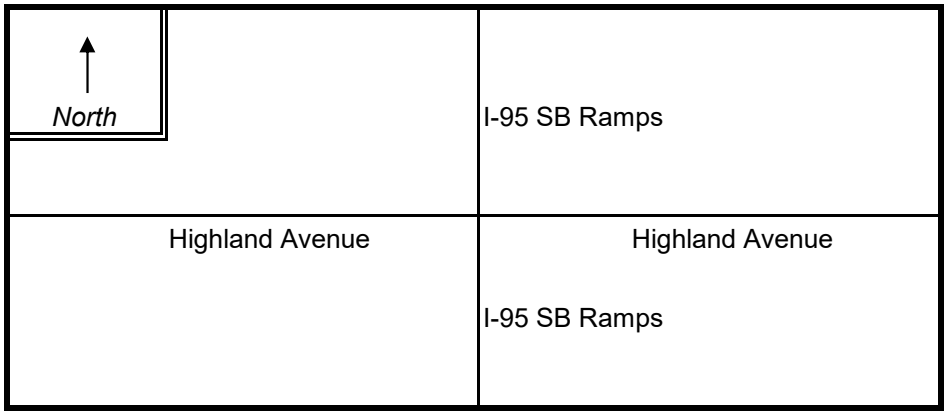
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : I-95 SB Ramps

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	270	475	1,125	1,180		**3,050**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **33,889**

TOTAL # OF CRASHES : 6

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **1.20**

CRASH RATE CALCULATION : **0.10**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments :

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Jan-18

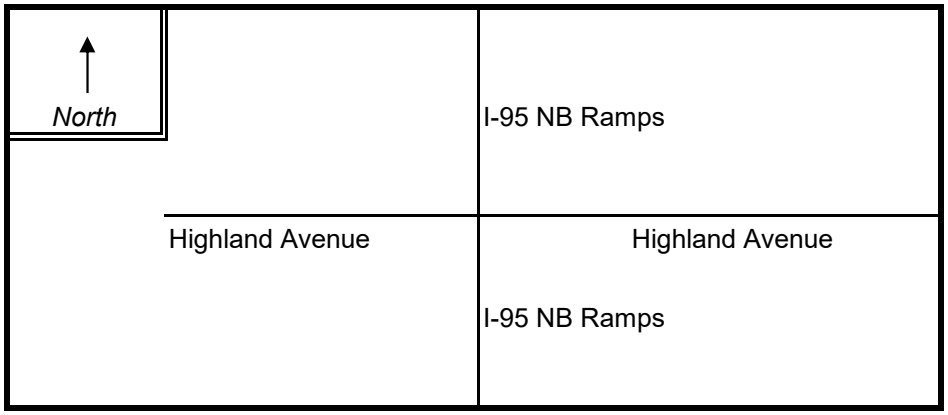
DISTRICT : 6 UNSIGNALIZED : [X] SIGNALIZED : [ ]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : I-95 NB Ramps

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		Total Peak Hourly Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :	160	105	1,140	1,860		**3,265**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **36,278**

TOTAL # OF CRASHES : 13

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **2.60**

CRASH RATE CALCULATION : **0.20**

$$\text{RATE} = \frac{(A * 1{,}000{,}000)}{(V * 365)}$$

Comments : PM

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Feb-19

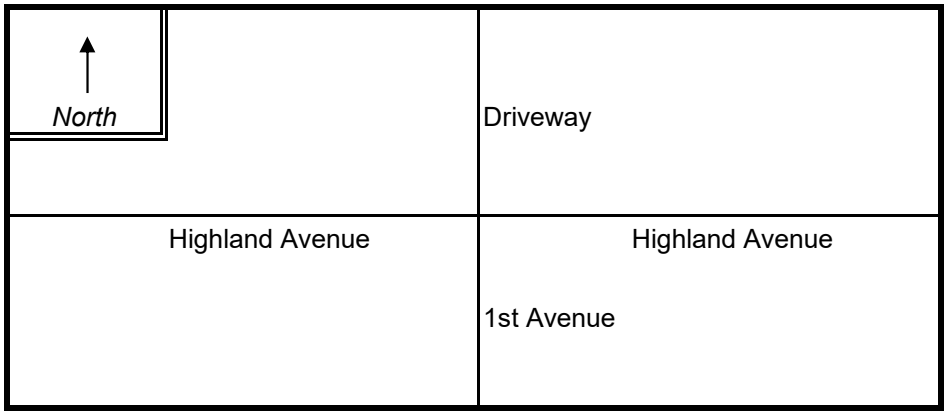
DISTRICT : 6 UNSIGNALIZED : [ ] SIGNALIZED : [X]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : 1st Avenue

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	435	12	930	1,490		**2,867**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **31,856**

TOTAL # OF CRASHES : 24

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **4.80**

CRASH RATE CALCULATION : **0.41**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments :

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Feb-19

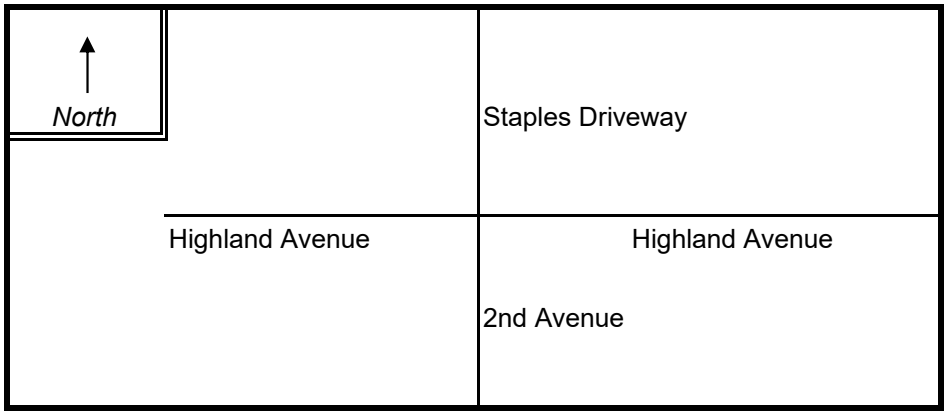
DISTRICT : 6 UNSIGNALIZED : [ ] SIGNALIZED : [X]

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : 2nd Avenue

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	595	90	800	1,045		**2,530**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **28,111**

TOTAL # OF CRASHES : 33 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **6.60**

CRASH RATE CALCULATION : **0.64** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments :

Project Title & Date: 557 Highland Ave Redevelopment Project

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham, MA COUNT DATE : Feb-19

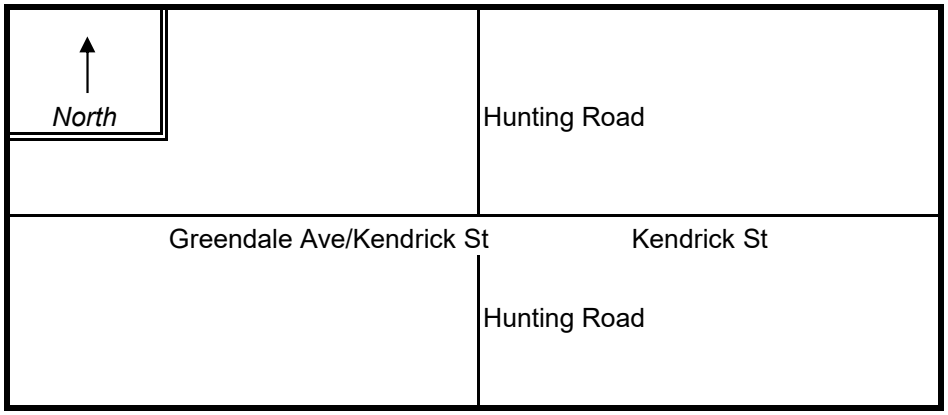
DISTRICT : 6 UNSIGNALIZED : [ ] SIGNALIZED : [X]

~ INTERSECTION DATA ~

MAJOR STREET : Greendale Ave/Kendrick St

MINOR STREET(S) : Hunting Road

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

approach:	NB	SB	EB	WB		**Total Peak Hourly Approach Volume**
PEAK HOURLY VOLUMES (AM/PM) :	226	250	232	855		**1,563**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **17,367**

TOTAL # OF CRASHES : 20 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **4.00**

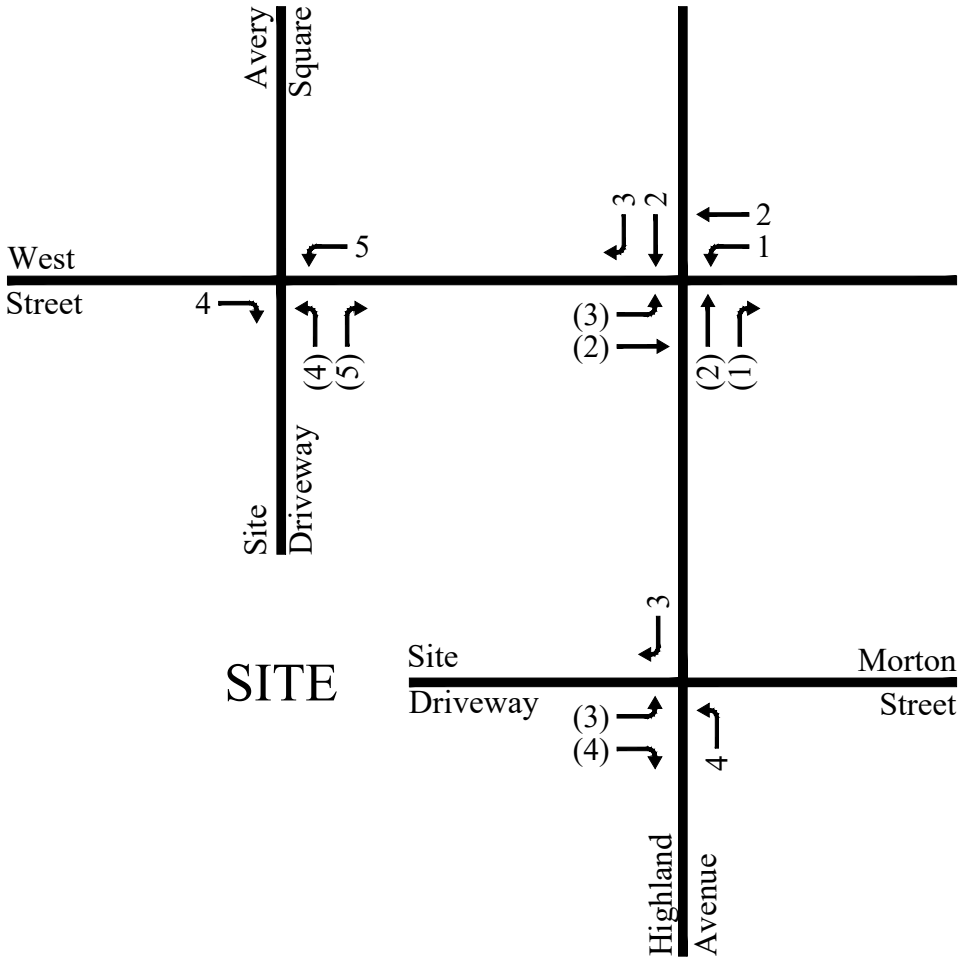
CRASH RATE CALCULATION : **0.63** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments :

Project Title & Date: 557 Highland Ave Redevelopment Project

J:\Analysis\LCB Senior Living\Needham\Traffic\Graphics\LCB Needham_Volume Schematics.DWG 7/9/2019

SCHEMATIC-
NOT TO SCALE



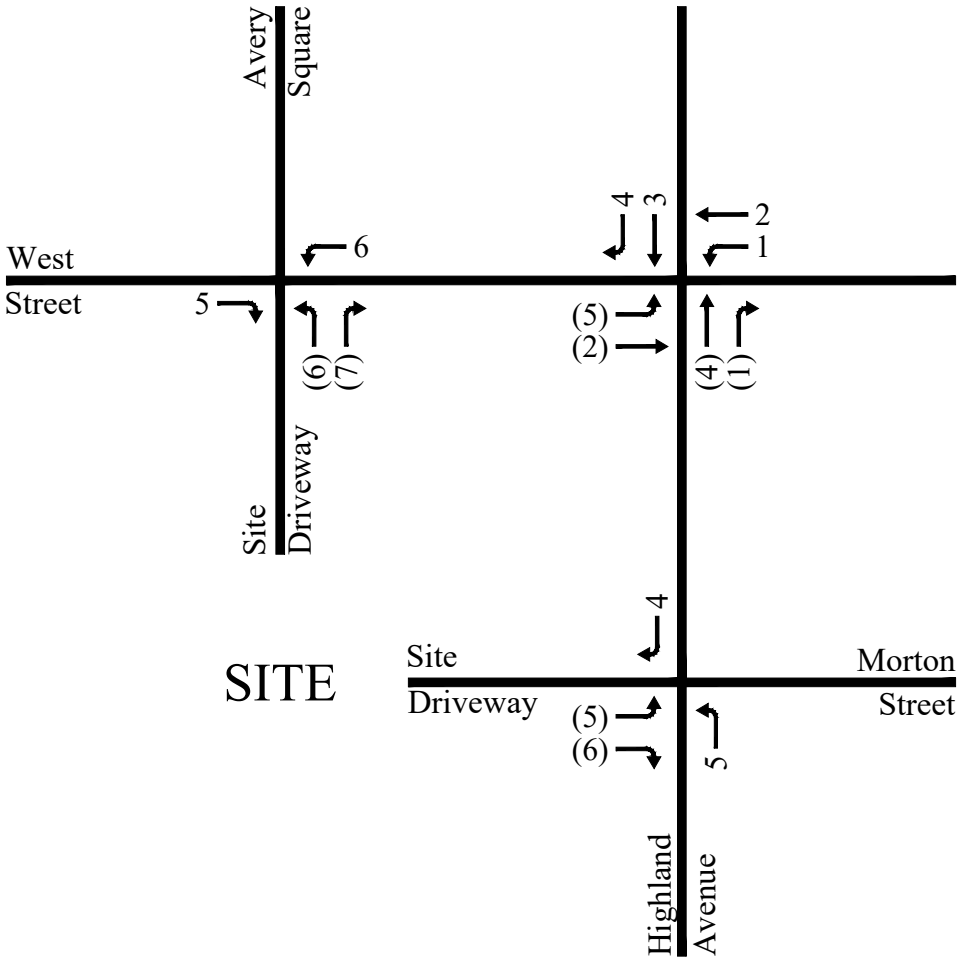
Legend
Entering (Exiting)

McMAHON
TRANSPORTATION ENGINEERS & PLANNERS

Figure 7
Weekday Morning Peak Hour
New Project Trips
Senior Living Residential Redevelopment
Needham, Massachusetts

J:\Analysis\LCB Senior Living\Needham\Traffic\Graphics\LCB Needham_Volume Schematics.DWG 7/9/2019

SCHEMATIC-
NOT TO SCALE



Legend
Entering (Exiting)

Figure 8
Weekday Afternoon Peak Hour
New Project Trips
Senior Living Residential Redevelopment
Needham, Massachusetts

McMAHON
TRANSPORTATION ENGINEERS & PLANNERS

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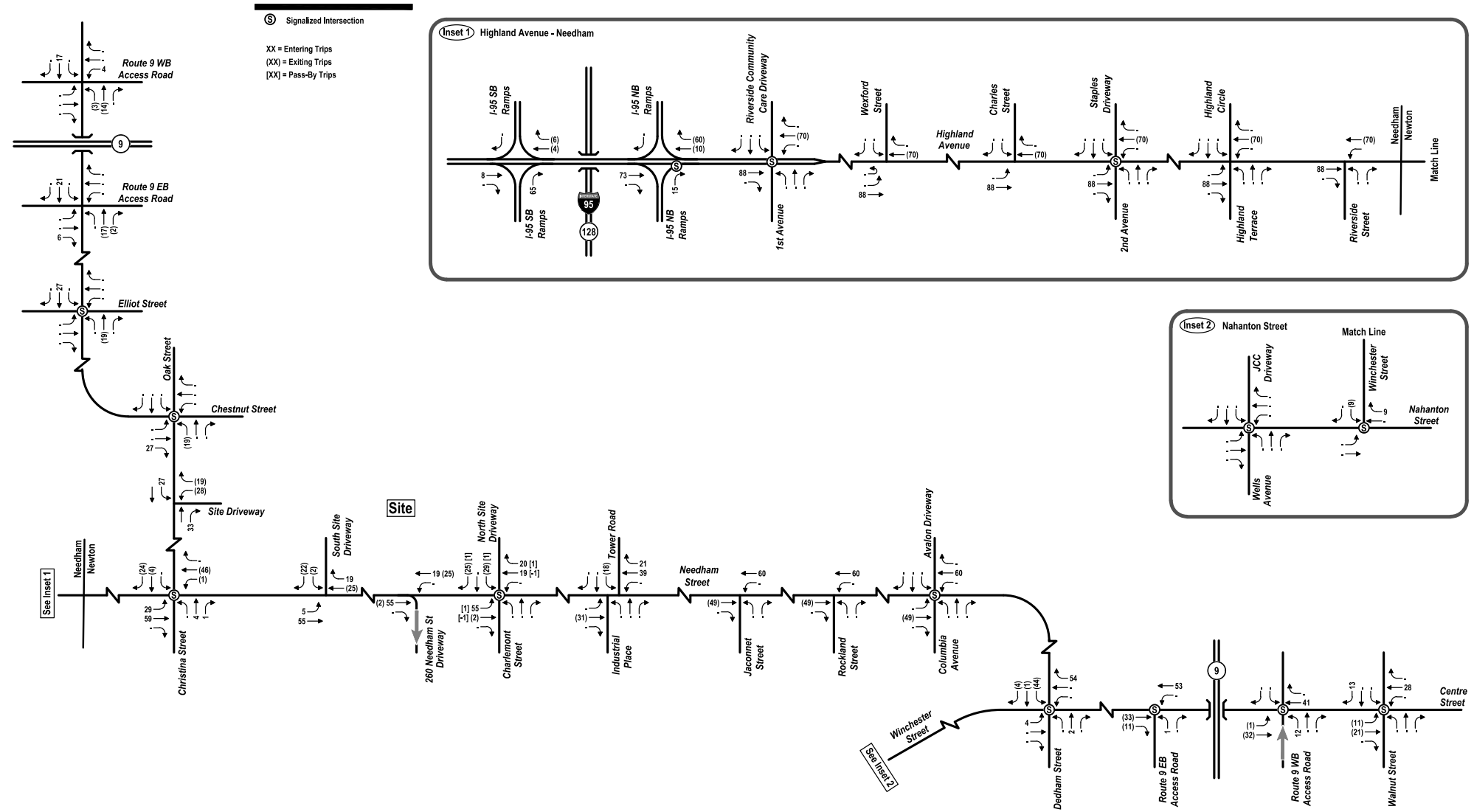
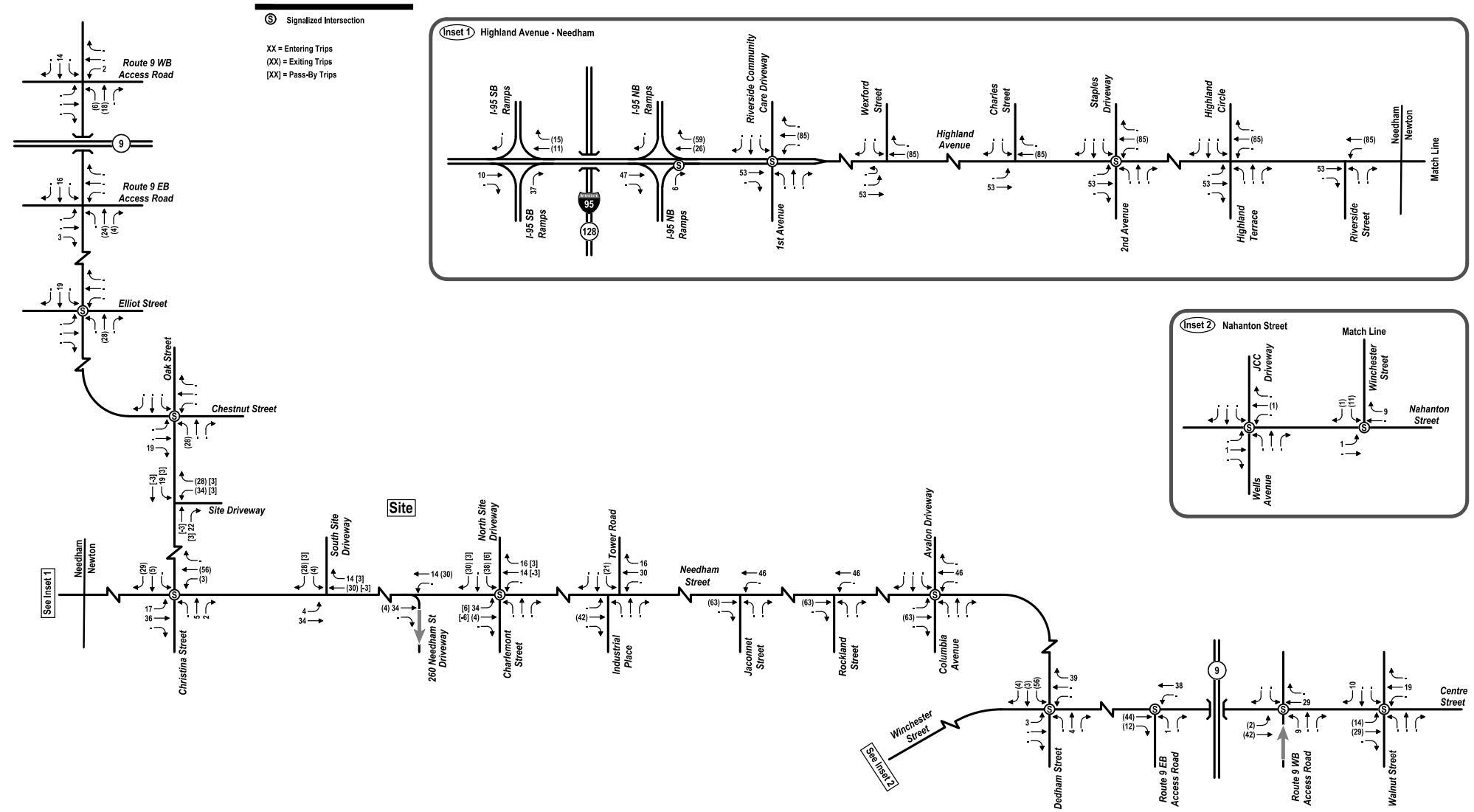


Site-Generated Traffic Volumes
With Robust Shuttle Service
Weekday Morning Peak Hour
The Northland Newton Development

\\vhb\gbl\proj\Wat-LD\12239.00\graphics\FIGURES\MEPA_2020\Networks.dwg



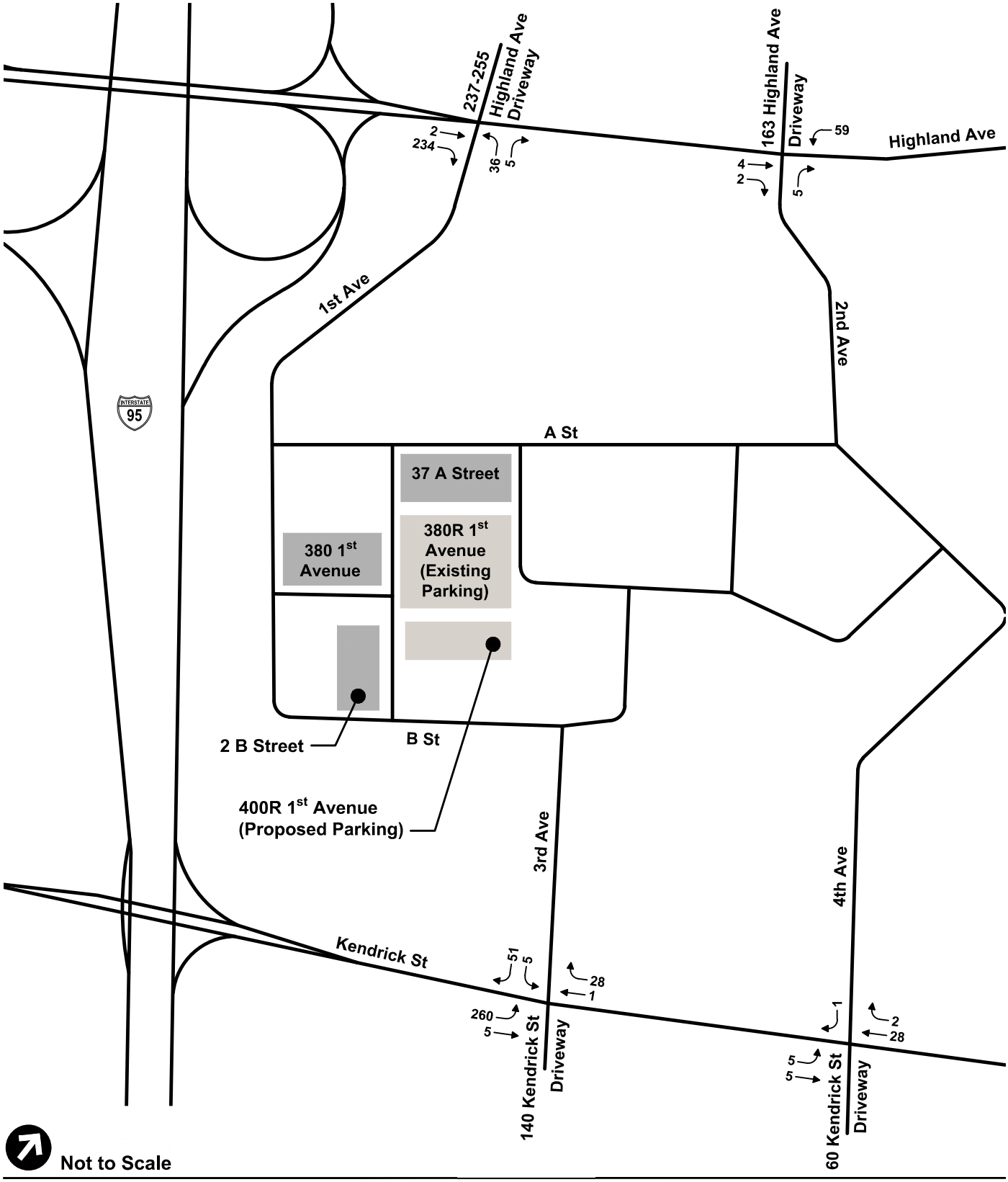


Figure 11

Approved Project Generated Trips
Morning Peak Hour

BCH Needham at Founders Park
Needham, Massachusetts

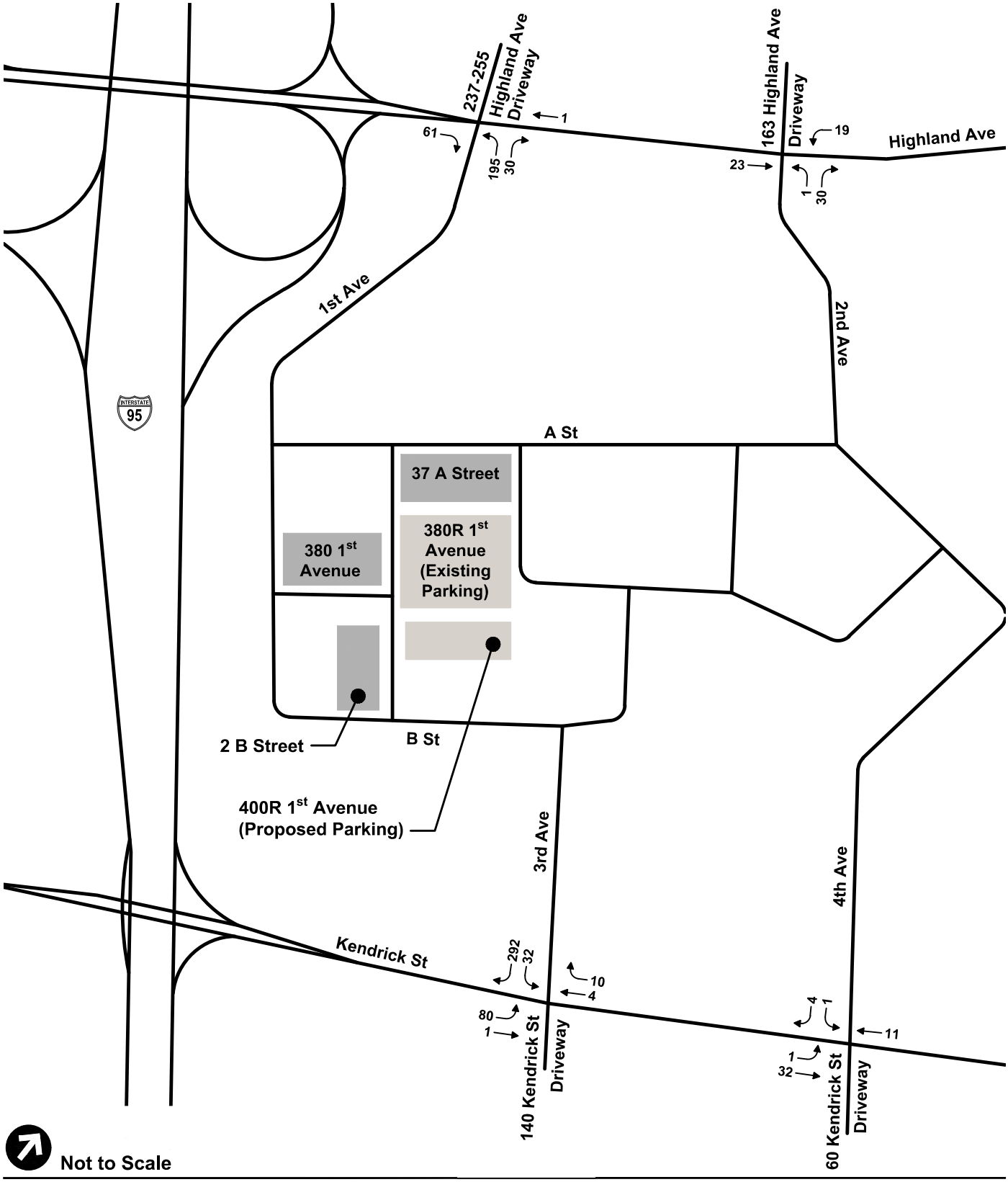


Figure 12

Approved Project Generated Trips
Evening Peak Hour

BCH Needham at Founders Park
Needham, Massachusetts

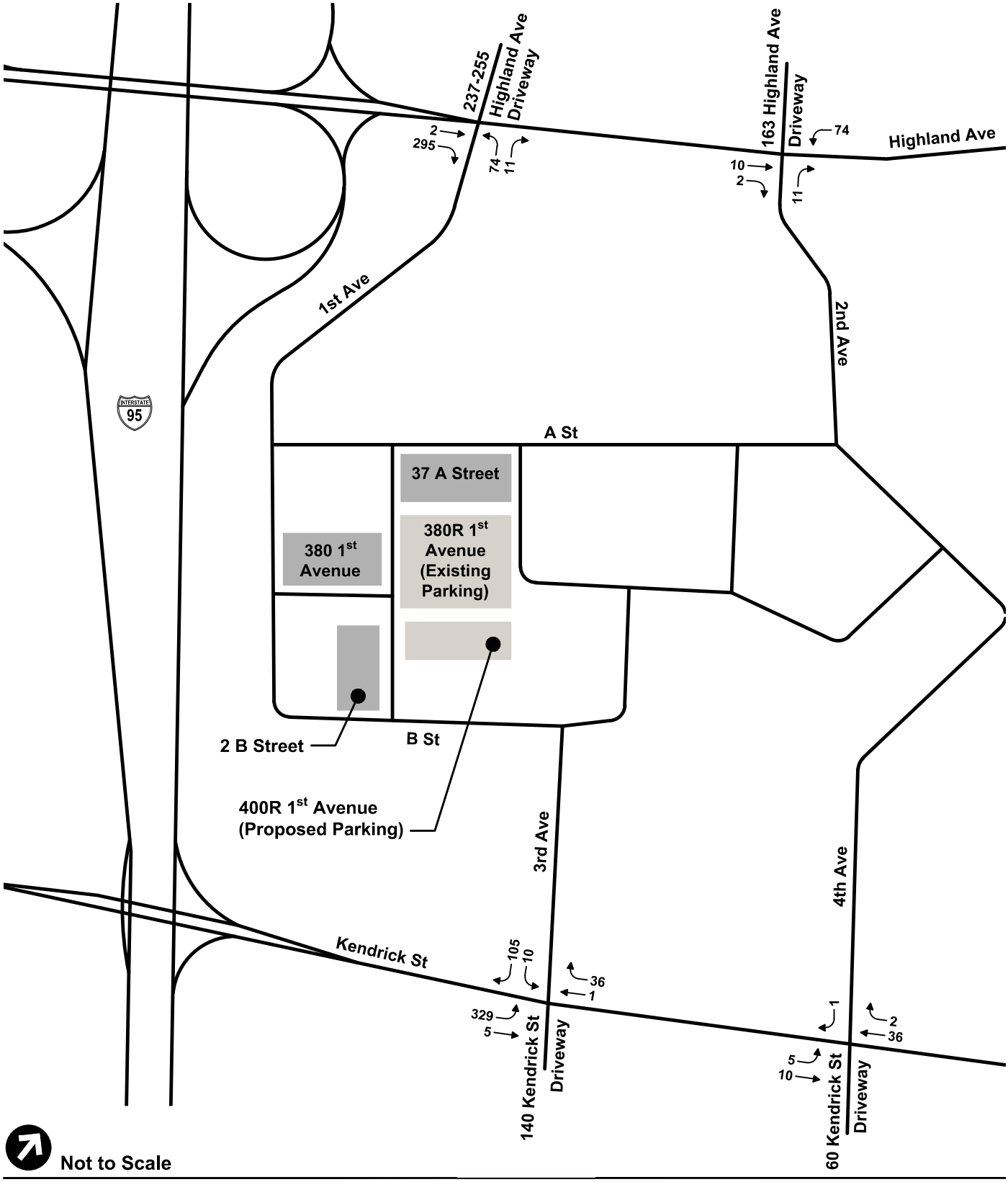


Figure 13

Proposed BCH Project Generated Trips
Morning Peak Hour

BCH Needham at Founders Park
Needham, Massachusetts

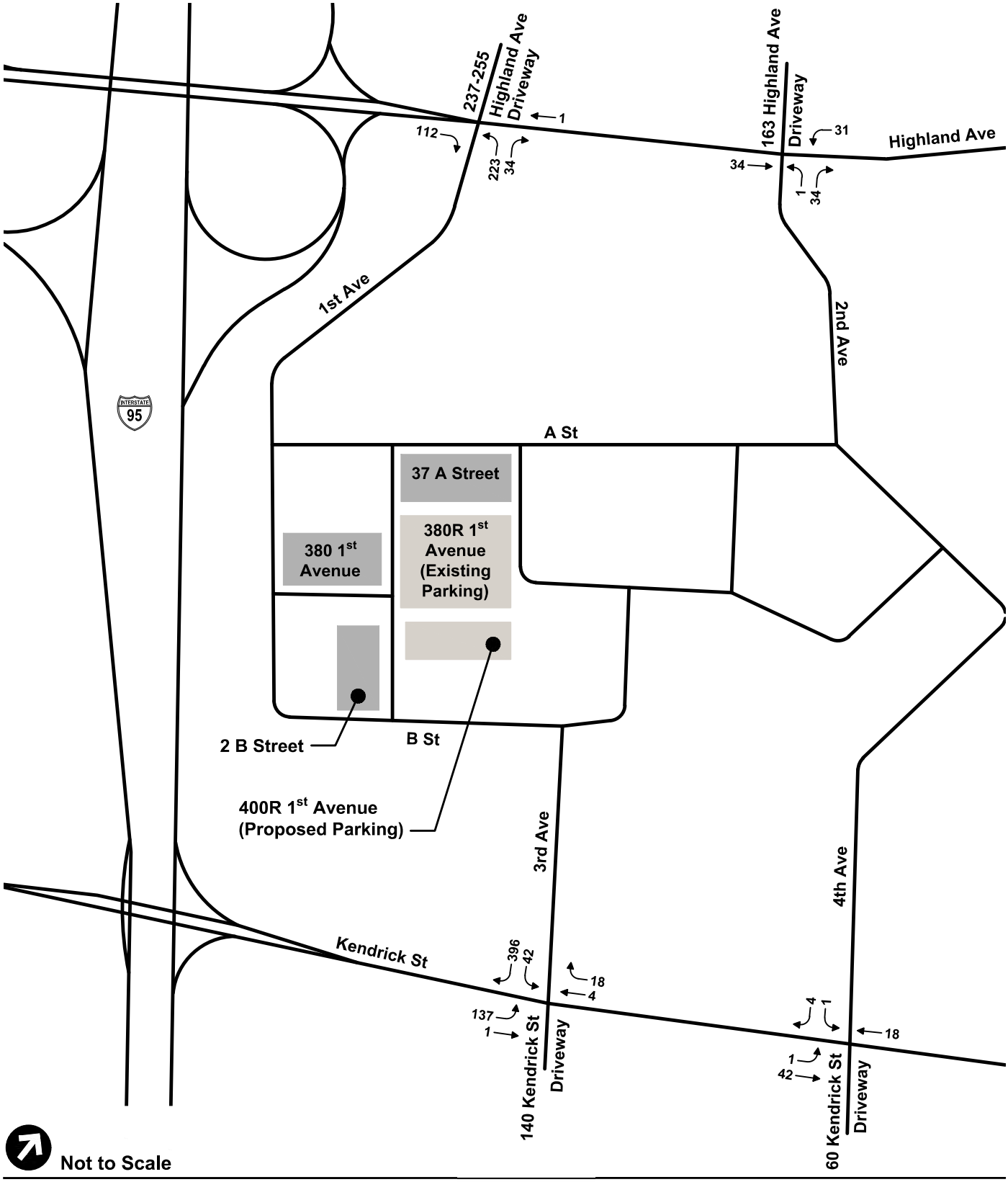


Figure 14

Proposed BCH Project Generated Trips
Evening Peak Hour

BCH Needham at Founders Park
Needham, Massachusetts

ITE TRIP GENERATION WORKSHEET **WINGATE FACILITY - 589 HIGHLAND AVENUE**

(11th Edition, Updated 2021) **PROPOSED CONVERSION OF 142-BED SKILLED NURSING FACILITY TO 50 INDEPENDENT LIVING UNIT**

LANDUSE: Senior Adult Housing - Multifamily
LANDUSE CODE: 252 Independent Variable ---
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **DWELLING UNITS (#):** 50
JOB NUMBER:

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends			Independent Variable Range			Directional Distribution	
			Average	Low	High	Average	Low	High	Enter	Exit
DAILY	6	0.99	3.24	2.59	4.79	72	28	205	50%	50%
AM PEAK (ADJACENT ST)	9	0.85	0.20	0.13	0.27	73	28	150	34%	66%
PM PEAK (ADJACENT ST)	9	0.84	0.25	0.16	0.36	73	28	150	56%	44%

TRIPS:

	BY AVERAGE			BY REGRESSION		
	Total	Enter	Exit	Total	Enter	Exit
DAILY	162	81	81	170	85	85
AM PEAK (ADJACENT ST)	10	3	7	10	4	7
PM PEAK (ADJACENT ST)	13	7	6	13	7	6

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends			Independent Variable Range			Directional Distribution	
			Average	Low	High	Average	Low	High	Enter	Exit
DAILY	8	0.90	2.74	1.84	4.07	76	28	205	50%	50%
PEAK OF GENERATOR	9	0.87	0.32	0.23	0.50	9	28	205	54%	46%

TRIPS:

	BY AVERAGE			BY REGRESSION		
	Total	Enter	Exit	Total	Enter	Exit
DAILY	138	69	69	148	74	74
PEAK OF GENERATOR	16	9	7	17	9	8

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends			Independent Variable Range			Directional Distribution	
			Average	Low	High	Average	Low	High	Enter	Exit
DAILY	8	0.91	2.70	2.15	4.25	76	28	205	50%	50%
PEAK OF GENERATOR	8	0.8	0.34	0.25	0.55	76	28	205	51%	49%

TRIPS:

	BY AVERAGE			BY REGRESSION		
	Total	Enter	Exit	Total	Enter	Exit
DAILY	136	68	68	154	77	77
PEAK OF GENERATOR	17	9	8	20	10	10

ITE TRIP GENERATION WORKSHEET **WINGATE FACILITY - 589 HIGHLAND AVENUE**

(11th Edition, Updated 2021) **PROPOSED CONVERSION OF 142-BED SKILLED NURSING FACILITY TO 50 INDEPENDENT LIVING UNIT**

LANDUSE: Nursing Home
LANDUSE CODE: 620
SETTING/LOCATION: General Urban/Suburban
JOB NAME:
JOB NUMBER:

Independent Variable --- Beds

BEDS (#): 142

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	3	--	3.06	2.60	3.25	160	60	300	50%	50%
AM PEAK OF GENERATOR	7	0.85	0.20	0.13	0.30	176	55	300	63%	37%
PM PEAK OF GENERATOR	8	0.62	0.33	0.17	0.51	169	55	300	41%	59%
AM PEAK (ADJACENT ST)	8	0.63	0.14	0.05	0.35	157	36	382	72%	28%
PM PEAK (ADJACENT ST)	8	0.72	0.14	0.07	0.27	144	36	382	33%	67%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	436	218	218	--	--	--
AM PEAK OF GENERATOR	28	18	11	27	17	10
PM PEAK OF GENERATOR	47	19	28	46	19	27
AM PEAK (ADJACENT ST)	20	14	6	20	14	5
PM PEAK (ADJACENT ST)	20	7	13	20	6	13

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	--	2.32	2.32	2.32	300	300	300	50%	50%
PEAK OF GENERATOR	1	--	0.36	0.36	0.36	300	300	300	n/a	n/a

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	330	165	165	--	--	--
PEAK OF GENERATOR	51	26	26	--	--	--

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	--	2.41	2.41	2.41	300	300	300	50%	50%
PEAK OF GENERATOR	1	--	0.40	0.40	0.40	300	300	300	57%	43%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	344	172	172	--	--	--
PEAK OF GENERATOR	57	32	24	--	--	--

557 HIGHLAND AVENUE Counted by: VHB
EMPIRICAL SITE COUNTS Date: 7/14/2021

	Car Wash Driveway		Muzi Motors Rear Dwy		Muzi Motors Main Dwy		Total	
Time	**Entering**	**Exiting**	**Entering**	**Exiting**	**Entering**	**Exiting**	**Entering**	**Exiting**
7:00-7:15AM	1		2		3	0	6	0
7:15-7:30AM	1	1			9	3	10	4
7:30-7:45AM	1				1	4	2	4
7:45-8:00AM	2		1		10	3	13	3
8:00-8:15AM	1		1		1	1	3	1
8:15-8:30AM	3	3	4	4	5	2	12	9
8:30-8:45AM	4	2	1	1	4	8	9	11
8:45-9:00AM	4	5	1		3	2	8	7
9:00-9:15AM	4	4	1		2	7	7	11
9:15-9:30AM	3	3		1	11	2	14	6
9:30-9:45AM	4	5	1		4	3	9	8
9:45-10:00AM	4	2		1	6	7	10	10
10:00-10:15AM	6	5	2	2	7	7	15	14
10:15-10:30AM	6	4	1	2	7	5	14	11
10:30-10:45AM	4	3	2	1	8	4	14	8
10:45-11:00AM	4	6		1	6	3	10	10
11:00-11:15AM	5	4	1	1	8	15	14	20
11:15-11:30AM	4	5	2	1	2	12	8	18
11:30-11:45AM	3	6	1	1	2	6	6	13
11:45-12:00PM	4	4	1		8	4	13	8
12:00-12:15PM	5	5			8	9	13	14
12:15-12:30PM	10	3	1	2	3	11	14	16
12:30-12:45PM	5	6	4	2	3	6	12	14
12:45-1:00PM	3	5		1	10	8	13	14
1:00-1:15PM	4	7			3	4	7	11
1:15-1:30PM	4	5			3	7	7	12
1:30-1:45PM	2	1	2		4	3	8	4
1:45-2:00PM	4	6		1	5	3	9	10
2:00-2:15PM	6	2		1	6	6	12	9
2:15-2:30PM	6	7	1	1	6	4	13	12
2:30-2:45PM	5	8		1	1	12	6	21
2:45-3:00PM	4	3		1	3	6	7	10
3:00-3:15PM	3	3	2	3	3	4	8	10
3:15-3:30PM	12	10			6	6	18	16
3:30-3:45PM	2	3			6	3	8	6
3:45-4:00PM	4	5			5	12	9	17
4:00-4:15PM	4	4	1	3	3	6	8	13
4:15-4:30PM	7	9			3	8	10	17
4:30-4:45PM	6	6			4	11	10	17
4:45-5:00PM	2	2		1		3	2	6
5:00-5:15PM	6	7		2	1	8	7	17
5:15-5:30PM	2	4			3	9	5	13
5:30-5:45PM	3	2		1	2	2	5	5
5:45-6:00PM		1		4	2	4	2	9
6:00-6:15PM		1		3		2	0	6
6:15-6:30PM						2	0	2
Totals	177	177	33	43	200	257	410	477

Note: Counts conducted starting 60 minutes before opening of car wash and/or car dealership until 30 minutes after closing. Uses assumed to generate negligible trips outside of normal business hours.

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: Research & Development Center — Trip Type --- Vehicle
LANDUSE CODE: 760 — Independent Variable --- 1,000 Sq. Feet Gross Floor Area
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **557 Highland Avenue, Needham** **FLOOR AREA (KSF):** 260.5
JOB NUMBER: **15306.00**

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	22	0.89	11.08	3.48	24.95	179	22	705	50%	50%
AM PEAK (ADJACENT ST)	39	0.70	1.03	0.17	3.73	173	10	800	82%	18%
PM PEAK (ADJACENT ST)	39	0.70	0.98	0.13	4.13	173	10	800	16%	84%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	2,886	1,443	1,443	2,775	1,387	1,387
AM PEAK (ADJACENT ST)	268	220	48	256	210	46
PM PEAK (ADJACENT ST)	255	41	214	244	39	205

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	19	0.68	1.91	0.18	6.96	165	22	650	50%	50%
PEAK OF GENERATOR	13	0.65	0.24	0.08	0.71	146	46	608	Not Available	

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	498	249	249	432	216	216
PEAK OF GENERATOR	63	N/A	N/A	52	N/A	N/A

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	19	--	1.18	0.13	4.18	165	22	650	50%	50%
PEAK OF GENERATOR	13	--	0.16	0.05	0.64	146	46	608	Not Available	

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	307	154	154	N/A	N/A	N/A
PEAK OF GENERATOR	42	N/A	N/A	N/A	N/A	N/A

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: General Office Building
LANDUSE CODE: 710
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **557 Highland Avenue, Needham**
JOB NUMBER: **15306.00**

Trip Type --- Vehicle
Independent Variable --- 1,000 Sq. Feet Gross Floor Area

FLOOR AREA (KSF): 260.5

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	59	0.78	10.84	3.27	27.56	163	14	677	50%	50%
AM PEAK (ADJACENT ST)	221	0.78	1.52	0.32	4.93	201	10	815	88%	12%
PM PEAK (ADJACENT ST)	232	0.77	1.44	0.26	6.20	199	10	1,092	17%	83%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	2,824	1,412	1,412	2,669	1,335	1,335
AM PEAK (ADJACENT ST)	396	348	48	381	336	46
PM PEAK (ADJACENT ST)	375	64	311	368	62	305

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	5	--	2.21	1.24	7.46	94	28	183	50%	50%
PEAK OF GENERATOR	3	--	0.53	0.30	1.57	82	28	183	54%	46%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	576	288	288	N/A	N/A	N/A
PEAK OF GENERATOR	138	75	64	N/A	N/A	N/A

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	5	--	0.70	0.19	3.05	94	28	183	50%	50%
PEAK OF GENERATOR	3	--	0.21	0.11	0.68	82	28	183	58%	42%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	182	91	91	N/A	N/A	N/A
PEAK OF GENERATOR	55	32	23	N/A	N/A	N/A

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: Strip Retail Plaza (<40k)
LANDUSE CODE: 822 — Independent Variable --- 1,000 Sq. Feet Gross Floor Area
SETTING/LOCATION: General Urban/Suburban
JOB NAME: **557 Highland Avenue, Needham** **FLOOR AREA (KSF):** 10.0
JOB NUMBER: **15306.00**

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Low	High	Independent Variable Range Average	Low	High	Directional Distribution Enter	Exit
DAILY	4	0.96	54.45	47.86	65.07	19	9	35	50%	50%
AM PEAK (ADJACENT ST)	5	0.57	2.36	1.60	3.73	18	9	35	60%	40%
PM PEAK (ADJACENT ST)	25	0.56	6.59	2.81	15.20	21	3	39	50%	50%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	546	273	273	652	326	326
AM PEAK (ADJACENT ST)	24	14	9	29	17	12
PM PEAK (ADJACENT ST)	66	33	33	78	39	39

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	12	--	6.57	1.88	14.23	27	8	39	51%	49%

TRIPS:

	BY AVERAGE Total	Enter	Exit	BY REGRESSION Total	Enter	Exit
DAILY	--	--	--	--	--	--
PEAK OF GENERATOR	66	34	32	--	--	--

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	--	--	--	--	--	--

SHARED TRIP CALCULATIONS

RETAIL - OFFICE [1]

WEEKDAY DAILY

RETAIL	%	#	BALANCED	#	%	OFFICE
EXIT ->	3%	326	**10**	2,722	15%	-> ENTER
ENTER <-	4%	326	**13**	2,722	22%	<- EXIT

TOTAL SHARED TRIPS - WEEKDAY DAILY

	ENTER	EXIT	TOTAL
R&D	5	7	12
OFFICE	5	6	11
RETAIL	13	10	23
TOTAL	23	23	46

RETAIL - OFFICE

WEEKDAY MORNING

RETAIL	%	#	BALANCED	#	%	OFFICE
EXIT ->	29%	12	**3**	546	4%	-> ENTER
ENTER <-	32%	17	**6**	92	28%	<- EXIT

TOTAL SHARED TRIPS - WEEKDAY MORNING

	ENTER	EXIT	TOTAL
R&D	1	2	4
OFFICE	2	4	5
RETAIL	6	3	9
TOTAL	9	9	18

RETAIL - OFFICE

WEEKDAY EVENING

RETAIL	%	#	BALANCED	#	%	OFFICE
EXIT ->	2%	39	**1**	102	31%	-> ENTER
ENTER <-	8%	39	**3**	510	20%	<- EXIT

TOTAL SHARED TRIPS - WEEKDAY EVENING

	ENTER	EXIT	TOTAL
R&D	0	1	2
OFFICE	1	2	2
RETAIL	3	1	4
TOTAL	4	4	8

Note: Weekday morning and evening internal capture rates based on NCHRP Report 684. Weekday daily internal capture rates based on ITE Trip Generation Handbook, 2nd Edition

1 Office internal capture rates used for proposed research and development space due to lack of data for R&D and shared characteristics between office and R&D.

Riverside Redevelopment
January 2018

TRIP GENERATION SUMMARY

	PROPOSED DEVELOPMENT											TOTAL					
	R&D [1]			Office [2]			Retail [3]										
SIZE	260.5 ksf			260.5 ksf			10.0 ksf										
	Gross Trips	Internal Capture [4]	Net Vehicle Trips	Gross Trips	Internal Capture [4]	Net Vehicle Trips	Gross Trips	Internal Capture [4]	Net Vehicle Trips	Pass-By Trips [5]	Net Vehicle Trips	Total Gross Trips	Total Internal Capture	Pass-By	Total Net Vehicle Trips	*Existing Trips* [6]	Total Net New Vehicle Trips
Weekday Daily										25%							
Enter	1,387	5	1,382	1,335	5	1,330	326	13	313	79	234	3,048	23	79	2,946	*410*	**2,536**
Exit	1,387	7	1,381	1,335	6	1,328	326	10	316	79	237	3,048	23	79	2,946	*477*	**2,469**
Total	2,775	12	2,763	2,669	11	2,658	652	23	629	158	471	6,096	46	158	5,892	*887*	**5,005**
Weekday Morning Peak Hour										25%							
Enter	210	1	209	336	2	334	17	6	11	2	9	563	9	2	552	*37*	**515**
Exit	46	2	44	46	4	42	12	3	9	2	7	103	9	2	92	*24*	**68**
Total	256	4	253	381	5	376	29	9	20	4	16	667	18	4	645	*61*	**584**
Weekday Evening Peak Hour										40%							
Enter	39	0	39	62	1	62	39	3	36	15	21	140	4	15	121	*29*	**92**
Exit	205	1	204	305	2	303	39	1	38	15	23	549	4	15	530	*57*	**473**
Total	244	2	242	368	2	365	78	4	74	30	44	689	8	30	651	*86*	**565**

1 Trip generation estimate based on ITE LUC 760 (Research and Development Center), using regression equations.
2 Trip generation estimate based on ITE LUC 710 (Office), using regression equations.
3 Trip generation estimate based on ITE LUC 822 (Strip Retail Plaza) using average rates.
4 Internal capture rates based on NCHRP Report 684.
5 Pass-by rates based on ITE LUC 821 (Shopping Plaza), 25-percent pass-by rate assumed for time periods with no available data.
6 Existing trip generation based on counts conducted by VHB on July 14, 2021

A302103 - Means of transportation (18) (Workers 16 years and over)

Current date: 5/21/2021 3:51:08 PM (Eastern Daylight Time)

U.S. Census Bureau, American Community Survey 2012-2016 Five-year estimates. Special Tabulation: Census Transportation Planning

Total Vehicles
19530

Measures - Workers 16 and Over					
Means of Transportation 18	WORKPLACE - Needham town, Norfolk County, Massachusetts			Total, means of transportation	
Output		Route		Estimate	Margin of Error
RESIDENCE	Direction	To Site	From Site		
Attleboro city, Bristol County, Massachusetts	South	I-95 North	I-95 South	50	38
Easton town, Bristol County, Massachusetts	South	I-95 North	I-95 South	110	68
Mansfield town, Bristol County, Massachusetts	South	I-95 North	I-95 South	110	59
North Attleborough town, Bristol County, Massachusetts	South	I-95 North	I-95 South	180	141
Norton town, Bristol County, Massachusetts	South	I-95 North	I-95 South	135	82
Taunton city, Bristol County, Massachusetts	South	I-95 North	I-95 South	175	96
Andover town, Essex County, Massachusetts	North	I-95 South	I-95 North	50	38
Beverly city, Essex County, Massachusetts	North	I-95 South	I-95 North	20	27
Danvers town, Essex County, Massachusetts	North	I-95 South	I-95 North	20	34
Georgetown town, Essex County, Massachusetts	North	I-95 South	I-95 North	10	16
Gloucester city, Essex County, Massachusetts	North	I-95 South	I-95 North	10	13
Groveland town, Essex County, Massachusetts	North	I-95 South	I-95 North	25	30
Hamilton town, Essex County, Massachusetts	North	I-95 South	I-95 North	10	14
Haverhill city, Essex County, Massachusetts	North	I-95 South	I-95 North	95	113
Lawrence city, Essex County, Massachusetts	North	I-95 South	I-95 North	30	32
Lynn city, Essex County, Massachusetts	North	I-95 South	I-95 North	105	91
Lynnfield town, Essex County, Massachusetts	North	I-95 South	I-95 North	10	13
Marblehead town, Essex County, Massachusetts	Northeast	I-95 South	I-95 North	4	15
Merrimac town, Essex County, Massachusetts	North	I-95 South	I-95 North	15	25
Methuen Town city, Essex County, Massachusetts	North	I-95 South	I-95 North	15	24
North Andover town, Essex County, Massachusetts	North	I-95 South	I-95 North	85	65
Peabody city, Essex County, Massachusetts	North	I-95 South	I-95 North	45	51
Saugus town, Essex County, Massachusetts	North	I-95 South	I-95 North	60	51
Wenham town, Essex County, Massachusetts	North	I-95 South	I-95 North	10	13
West Newbury town, Essex County, Massachusetts	North	I-95 South	I-95 North	10	14
Acton town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	30	31
Arlington town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	85	52
Ashland town, Middlesex County, Massachusetts	West	I-95 S or Gould to Central to Cedar	I-95 N or Gould to Central to Cedar	90	56
Ayer town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	15	24
Bedford town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	25	34
Belmont town, Middlesex County, Massachusetts	Northeast	I-95 S or Highland Ave	I-95 N or Gould to Central to Chestnut	115	67
Billerica town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	145	85
Boxborough town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	10	16
Burlington town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	65	49
Cambridge city, Middlesex County, Massachusetts	Northeast	I-95 S or Highland to Needham	I-95 N or Gould to Elliot or Cedar	160	102
Chelmsford town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	30	22
Concord town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	45	44
Dracut town, Middlesex County, Massachusetts	North	I-95 South	I-96 North	10	25
Everett city, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 N or Gould to Central to Elliot	135	107
Framingham town, Middlesex County, Massachusetts	West	I-95 South	I-95 N or Gould to Central to Cedar	530	177
Groton town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	10	20
Holliston town, Middlesex County, Massachusetts	Southeast	I-95 S; Gould to Wellesley; or Gould to Central to Charles River St	Gould to Central	155	74
Hopkinton town, Middlesex County, Massachusetts	West	I-95 South	I-95 N or Gould to Central to Cedar	80	55
Hudson town, Middlesex County, Massachusetts	Northwest	I-95 South	I-95 North	50	36
Lexington town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	55	34
Littleton town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	10	14
Lowell city, Middlesex County, Massachusetts	North	I-95 South	I-95 North	30	28
Malden city, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 North	95	58
Marlborough city, Middlesex County, Massachusetts	West	I-95 South	I-95 N or Gould to Central to Cedar	345	190
Maynard town, Middlesex County, Massachusetts	Northwest	I-95 South	I-95 North	50	49
Medford city, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 North	140	78
Melrose city, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 North	15	28
Natick town, Middlesex County, Massachusetts	West	I-95 S or Gould to Wellesley	Gould to Central	440	125
Newton city, Middlesex County, Massachusetts	Northeast	Gould to Central to Chestnut	Gould to Chestnut or Walnut; Highland	610	138
North Reading town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	30	36
Reading town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	30	28
Sherborn town, Middlesex County, Massachusetts	Southwest	Gould to Central; Highland to Webster	Gould to Central	30	40
Somerville city, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 N; Gould to Central to Cedar	240	96
Stow town, Middlesex County, Massachusetts	Northwest	I-95 South	I-95 North	15	25
Sudbury town, Middlesex County, Massachusetts	Northwest	I-95 South	I-95 N or Gould to Central to Cedar	90	50
Tewksbury town, Middlesex County, Massachusetts	North	I-95 South	I-95 North	10	14
Wakefield town, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 North	15	24
Waltham city, Middlesex County, Massachusetts	North	I-95 South	I-95 North	575	190
Watertown Town city, Middlesex County, Massachusetts	Northeast	I-95 S or Highland to Needham	I-95 N; Highland to Needham; Gould to Central to Elliot	220	152

A302103 - Means of transportation (18) (Workers 16 years and over)

Current date: 5/21/2021 3:51:08 PM (Eastern Daylight Time)

U.S. Census Bureau, American Community Survey 2012-2016 Five-year estimates. Special Tabulation: Census Transportation Planning

Total Vehicles
19530

Measures - Workers 16 and Over					
Means of Transportation 18	WORKPLACE - Needham town, Norfolk County, Massachusetts			Total, means of transportation	
Output		Route		Estimate	Margin of Error
RESIDENCE	Direction	To Site	From Site		
Wayland town, Middlesex County, Massachusetts	Northwest	I-95 South	I-95 N; Gould to Central to Cedar	75	45
Weston town, Middlesex County, Massachusetts	Northwest	I-95 South	I-95 N; Gould to Central to Cedar	20	24
Winchester town, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 North	95	50
Woburn city, Middlesex County, Massachusetts	Northeast	I-95 South	I-95 N; Gould to Central to Boylston	60	48
Avon town, Norfolk County, Massachusetts	Southeast	I-95 North	I-95 S; Hunting to Kendrick	65	59
Bellingham town, Norfolk County, Massachusetts	Southwest	I-95 N; I-95 S; Highland to West to Central	I-95 N; I-95 S	125	67
Braintree Town city, Norfolk County, Massachusetts	Southeast	I-95 North	I-95 S; Hunting to Kendrick	160	70
Brookline town, Norfolk County, Massachusetts	East	Boyslton to Central to Gould; Boylston to Highland; Kendrick to Hunting	Gould to Boylston; Highland to Boylston; Hunting to Kendrick	275	132
Canton town, Norfolk County, Massachusetts	South	I-95 North	I-95 South	125	67
Cohasset town, Norfolk County, Massachusetts	East	I-95 N; I-95 S	I-95 N; I-95 S	20	32
Dedham town, Norfolk County, Massachusetts	Southeast	I-95 N; West to Greendale to Hunting	I-95 South	530	139
Dover town, Norfolk County, Massachusetts	Southwest	Central to West to Highland	Gould to Central; I-95 S	85	47
Foxborough town, Norfolk County, Massachusetts	South	I-95 North	I-95 South	160	75
Franklin Town city, Norfolk County, Massachusetts	Southwest	I-95 N; Central to West to Highland	I-95 South	185	87
Holbrook town, Norfolk County, Massachusetts	Southeast	I-95 North	I-95 S; Hunting to Kendrick	30	50
Medfield town, Norfolk County, Massachusetts	Southwest	I-95 N; Central to West to Highland	I-95 S; Gould to Central to Centre	315	124
Medway town, Norfolk County, Massachusetts	Southwest	I-95 N; Central to West to Highland; Wellsley to Cedar to Central to Gould	Gould to Central; I-95 S	200	107
Millis town, Norfolk County, Massachusetts	Southwest	I-95 N; Central to West to Highland	Gould to Central; I-95 S	220	111
Milton town, Norfolk County, Massachusetts	Southeast	I-95 N; Kendrick to Hunting	I-95 S; Hunting to Kendrick	225	113
Needham town, Norfolk County, Massachusetts	Same town	Split in 4 directions	Split in 4 directions	3,310	369
Norfolk town, Norfolk County, Massachusetts	Southwest	I-95 N; Central to Gould; Central to West to Highland	I-95 S; Gould to Central	120	65
Norwood town, Norfolk County, Massachusetts	South	I-95 North	I-95 South	525	199
Plainville town, Norfolk County, Massachusetts	South	I-95 North	I-95 South	65	48
Quincy city, Norfolk County, Massachusetts	Southeast	I-95 N; Kendrick to Hunting	I-95 S; I-95 N	325	143
Randolph town, Norfolk County, Massachusetts	Southeast	I-95 North	I-95 South	245	107
Sharon town, Norfolk County, Massachusetts	South	I-95 N; Central to West to Highland	I-95 South	170	75
Stoughton town, Norfolk County, Massachusetts	Southeast	I-95 North	I-95 South	85	48
Walpole town, Norfolk County, Massachusetts	South	I-95 North	I-95 South	390	139
Wellesley town, Norfolk County, Massachusetts	West	I-95 S; Wellesly to Cedar to Central to Gould; Central to West to Highland	Gould to Central to Cedar to Wellesley; Gould to Central striaght; Highland to West to Central	300	85
Westwood town, Norfolk County, Massachusetts	South	I-95 N; Webster to Highland	I-95 S; Highland to Webster	275	101
Weymouth Town city, Norfolk County, Massachusetts	Southeast	I-95 North	I-95 S; Hunting to Kendrick	190	93
Wrentham town, Norfolk County, Massachusetts	Southwest	I-95 North	I-95 South	145	74
Abington town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	90	63
Bridgewater town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	105	77
Brockton city, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	440	152
Duxbury town, Plymouth County, Massachusetts	Southeast	I-95 S; I-95 N	I-95 N; I-95 S	20	23
East Bridgewater town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	15	23
Hanover town, Plymouth County, Massachusetts	Southeast	I-95 S; I-95 N	I-95 S; I-95 N	15	29
Hanson town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 S; I-95 N	30	32
Hingham town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 S; I-95 N	35	38
Hull town, Plymouth County, Massachusetts	East	I-95 N; Kendrick to Hunting	I-95 N; I-95 S; Hunting to Kendrick	10	14
Kingston town, Plymouth County, Massachusetts	Southeast	I-95 N; I-95 S	I-95 N; I-95 S	75	98
Lakeville town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	10	15
Marshfield town, Plymouth County, Massachusetts	Southeast	I-95 N; I-95 S	I-95 N; I-95 S; Hunting to Kendrick	95	67
Middleborough town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	4	15
Pembroke town, Plymouth County, Massachusetts	Southeast	I-95 N; I-95 S	I-95 N; I-95 S; Hunting to Kendrick	100	75
Plymouth town, Plymouth County, Massachusetts	Southeast	I-95 N; I-95 S	I-95 N; I-95 S	30	31
Scituate town, Plymouth County, Massachusetts	Southeast	I-95 N; I-95 S	I-95 N; I-95 S; Hunting to Kendrick	55	55
West Bridgewater town, Plymouth County, Massachusetts	Southeast	I-95 North	I-95 South	10	16
Whitman town, Plymouth County, Massachusetts	Southeast	I-95 N; I-95 S	I-95 N; Hunting to Kendrick; Hunting to Greendale	25	38
Boston city, Suffolk County, Massachusetts	Northeast	I-95 S; Highland to Needham	I-95 N; Gould to Central to Elliot; Gould to Central to Cedar	1,980	351
Chelsea city, Suffolk County, Massachusetts	Northeast	I-95 S; Highland to Needham	I-95 N; Gould to Central to Elliot	10	21
Revere city, Suffolk County, Massachusetts	Northeast	I-95 S; Needham to Highland	I-95 N; Gould to Central to Elliot	50	51
Winthrop Town city, Suffolk County, Massachusetts	Northeast	I-95 S; Needham to Highland	I-95 N; Gould to Central to Elliot	50	43
Athol town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	10	20
Auburn town, Worcester County, Massachusetts	West	I-95 South	I-95 North	10	16

A302103 - Means of transportation (18) (Workers 16 years and over)

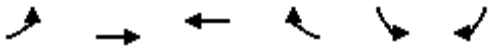
Current date: 5/21/2021 3:51:08 PM (Eastern Daylight Time)

U.S. Census Bureau, American Community Survey 2012-2016 Five-year estimates. Special Tabulation: Census Transportation Planning

Total Vehicles
19530

Measures - Workers 16 and Over					
Means of Transportation 18	WORKPLACE - Needham town, Norfolk County, Massachusetts			Total, means of transportation	
Output		Route		Estimate	Margin of Error
RESIDENCE	Direction	To Site	From Site		
Berlin town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	10	15
Bolton town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	10	15
Boylston town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	4	11
Charlton town, Worcester County, Massachusetts	Southwest	I-95 South	I-95 North	10	21
Dudley town, Worcester County, Massachusetts	Southwest	I-95 South	I-95 North	35	36
East Brookfield town, Worcester County, Massachusetts	West	I-95 South	I-95 North	10	16
Grafton town, Worcester County, Massachusetts	Southwest	I-95 South	I-95 N; Gould to Central	35	27
Harvard town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	15	25
Holden town, Worcester County, Massachusetts	West	I-95 South	I-95 North	10	22
Hopedale town, Worcester County, Massachusetts	Southwest	I-95 N; I-95 S; Wellesley to Cedar to Central to Gould	I-95 N; I-95 S; Gould to Central	35	40
Leicester town, Worcester County, Massachusetts	West	I-95 South	I-95 North	15	23
Leominster city, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	25	32
Lunenburg town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	10	13
Milford town, Worcester County, Massachusetts	Southwest	I-95 S; Central to West to Highland; Wellesley to Cedar to Central to Gould	I-95 N; I-95 S; Gould to Central	80	44
Northborough town, Worcester County, Massachusetts	West	I-95 South	I-95 North	45	45
Oxford town, Worcester County, Massachusetts	Southwest	I-95 South	I-95 North	15	27
Rutland town, Worcester County, Massachusetts	West	I-95 South	I-95 North	20	32
Shrewsbury town, Worcester County, Massachusetts	West	I-95 South	I-95 North	60	50
Southborough town, Worcester County, Massachusetts	West	I-95 South	I-95 N; Gould to Central to Cedar	15	22
Sterling town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	40	43
Upton town, Worcester County, Massachusetts	Southwest	I-95 S; Wellesly to Cedar to Central to Gould	I-95 N; Gould to Central to Pine	15	23
Webster town, Worcester County, Massachusetts	Southwest	I-95 South	I-95 N; I-95 S	20	36
Westborough town, Worcester County, Massachusetts	West	I-95 South	I-95 North	45	44
Winchendon town, Worcester County, Massachusetts	Northwest	I-95 South	I-95 North	4	11
Worcester city, Worcester County, Massachusetts	West	I-95 South	I-95 North	100	63
Hudson town, Hillsborough County, New Hampshire	Northwest	I-95 South	I-95 North	15	22
Manchester city, Hillsborough County, New Hampshire	North	I-95 South	I-95 North	15	22
Nashua city, Hillsborough County, New Hampshire	Northwest	I-95 South	I-95 North	20	26
New Ipswich town, Hillsborough County, New Hampshire	Northwest	I-95 South	I-95 North	15	23
Pelham town, Hillsborough County, New Hampshire	North	I-95 South	I-95 North	20	18
Derry town, Rockingham County, New Hampshire	North	I-95 South	I-95 North	10	13
Londonderry town, Rockingham County, New Hampshire	North	I-95 South	I-95 North	10	15
Windham town, Rockingham County, New Hampshire	North	I-95 South	I-95 North	10	16
Cumberland town, Providence County, Rhode Island	Southwest	I-95 S; I-95 N	I-95 South	85	72
North Smithfield town, Providence County, Rhode Island	Southwest	I-95 N; I-95 S	I-95 S; I-95 N	4	11
Woonsocket city, Providence County, Rhode Island	Southwest	I-95 North	I-95 South	35	32

	To Site (Inbound)			From Site (Outbound)			From/To Site Combined		
	Route	# of travelers	%	Route	# of travelers	%	Route	# of travelers	%
	all routes	19,530	100%	all routes	19,530	100%	all routes	39,060	100%
on	I-95 North	5,324	27%	I-95 North	6,811	35%	I-95 North	12,135	31%
on	I-95 South	7,017	36%	I-95 South	5,373	28%	I-95 South	12,389	32%
	Needham to Highland	1,831	9%	Highland to Needham	1,084	6%	Needham East	2,916	7%
	Cedar to Central to Gould	0	0%	Gould to Central to Cedar	261	1%	Cedar	1,219	3%
	Chestnut to Elliot to Central to Gould	1,016	5%	Gould to Central to Elliot to Chestnut	707	4%	Central East	2,908	7%
	Wellesley to Cedar to Central to Gould	565	3%	Gould to Central to Cedar to Wellesley	393	2%	Central West	2,005	5%
	Charles River St to Central to Gould	52	0%	Gould to Central	1,255	6%	Kendrick St	1,618	4%
	Boylston to Elliot to Central to Gould	92	0%	Gould to Central to Elliot	778	4%	West	1,196	3%
	Webster to Highland	102	1%	Gould to Central to Elliot to Boylston	315	2%	Highland West	2,593	7%
	Kendrick to Hunting	777	4%	Gould to Central to Pine	5	0%			
	Central to West to Highland	1,019	5%	Highland to Walnut	203	1%			
	West to Greendale to Hunting	177	1%	Highland to Webster	183	1%			
	Central to Gould	408	2%	Hunting to Kendrick	841	4%			
	Highland West	1,103	6%	Hunting to Greendale	8	0%			
				Highland West	1,103	6%			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	70	590	230	165	190	55
Future Volume (Veh/h)	70	590	230	165	190	55
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.83	0.83	0.75	0.75	0.62	0.62
Hourly flow rate (vph)	84	711	307	220	306	89
Pedestrians			4		6	
Lane Width (ft)			12.0		12.0	
Walking Speed (ft/s)			3.5		3.5	
Percent Blockage			0		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	533				1306	423
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	533				1306	423
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	92				0	86
cM capacity (veh/h)	1034				159	627

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	795	527	395
Volume Left	84	0	306
Volume Right	0	220	89
cSH	1034	1700	191
Volume to Capacity	0.08	0.31	2.07
Queue Length 95th (ft)	7	0	759
Control Delay (s)	2.0	0.0	537.8
Lane LOS	A		F
Approach Delay (s)	2.0	0.0	537.8
Approach LOS			F

Intersection Summary			
Average Delay	124.7		
Intersection Capacity Utilization	81.3%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	705	75	75	300	95	135
Future Volume (Veh/h)	705	75	75	300	95	135
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	820	87	95	380	120	171
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			911		1438	868
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			911		1438	868
tC, single (s)			4.1		6.4	6.3
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.4
p0 queue free %			87		6	50
cM capacity (veh/h)			745		128	345

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	907	475	291
Volume Left	0	95	120
Volume Right	87	0	171
cSH	1700	745	203
Volume to Capacity	0.53	0.13	1.44
Queue Length 95th (ft)	0	11	434
Control Delay (s)	0.0	3.5	266.4
Lane LOS		A	F
Approach Delay (s)	0.0	3.5	266.4
Approach LOS			F

Intersection Summary			
Average Delay	47.3		
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	650	190	95	270	70	105
Future Volume (Veh/h)	650	190	95	270	70	105
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.89	0.89	0.76	0.76
Hourly flow rate (vph)	699	204	107	303	92	138
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			903		1318	801
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			903		1318	801
tC, single (s)			4.2		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			85		38	64
cM capacity (veh/h)			732		147	381

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	903	410	230
Volume Left	0	107	92
Volume Right	204	0	138
cSH	1700	732	233
Volume to Capacity	0.53	0.15	0.99
Queue Length 95th (ft)	0	13	227
Control Delay (s)	0.0	4.2	100.1
Lane LOS		A	F
Approach Delay (s)	0.0	4.2	100.1
Approach LOS			F

Intersection Summary			
Average Delay	16.0		
Intersection Capacity Utilization	85.6%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	760	5	15	325	5	20
Future Volume (Veh/h)	760	5	15	325	5	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	826	5	16	353	5	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			831		1214	828
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			831		1214	828
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		97	94
cM capacity (veh/h)			801		197	371

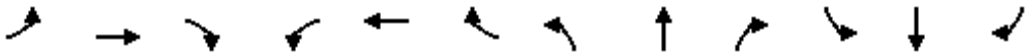
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	831	369	27
Volume Left	0	16	5
Volume Right	5	0	22
cSH	1700	801	319
Volume to Capacity	0.49	0.02	0.08
Queue Length 95th (ft)	0	2	7
Control Delay (s)	0.0	0.6	17.3
Lane LOS		A	C
Approach Delay (s)	0.0	0.6	17.3
Approach LOS			C

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	785	0	1	340	2	5
Future Volume (Veh/h)	785	0	1	340	2	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	853	0	1	370	2	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			853		1225	853
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			853		1225	853
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	99
cM capacity (veh/h)			786		197	359

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	853	371	7
Volume Left	0	1	2
Volume Right	0	0	5
cSH	1700	786	291
Volume to Capacity	0.50	0.00	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.0	17.7
Lane LOS		A	C
Approach Delay (s)	0.0	0.0	17.7
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	51.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	1	0	10	0	5	1	355	60	10	280	2
Future Volume (Veh/h)	5	1	0	10	0	5	1	355	60	10	280	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.63	0.63	0.63	0.65	0.65	0.65	0.82	0.82	0.82	0.81	0.81	0.81
Hourly flow rate (vph)	8	2	0	15	0	8	1	433	73	12	346	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	850	879	347	844	844	470	348			506		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	850	879	347	844	844	470	348			506		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	97	99	100	94	100	99	100			99		
cM capacity (veh/h)	276	285	701	270	297	594	1211			1069		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	10	23	507	360
Volume Left	8	15	1	12
Volume Right	0	8	73	2
cSH	278	334	1211	1069
Volume to Capacity	0.04	0.07	0.00	0.01
Queue Length 95th (ft)	3	6	0	1
Control Delay (s)	18.4	16.6	0.0	0.4
Lane LOS	C	C	A	A
Approach Delay (s)	18.4	16.6	0.0	0.4
Approach LOS	C	C		

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	32.7%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	30	10	405	60	20	270
Future Volume (Veh/h)	30	10	405	60	20	270
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.79	0.79	0.90	0.90	0.80	0.80
Hourly flow rate (vph)	38	13	450	67	25	338
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	872	484			517	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	872	484			517	
tC, single (s)	6.5	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.6	3.3			2.2	
p0 queue free %	87	98			98	
cM capacity (veh/h)	299	587			1059	

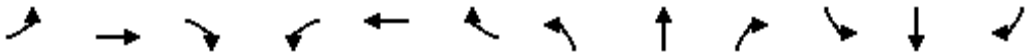
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	51	517	363
Volume Left	38	0	25
Volume Right	13	67	0
cSH	342	1700	1059
Volume to Capacity	0.15	0.30	0.02
Queue Length 95th (ft)	13	0	2
Control Delay (s)	17.4	0.0	0.8
Lane LOS	C		A
Approach Delay (s)	17.4	0.0	0.8
Approach LOS	C		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	1	465	65	15	285
Future Volume (Veh/h)	5	1	465	65	15	285
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	1	505	71	16	310
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	882	540			576	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	882	540			576	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	100			98	
cM capacity (veh/h)	311	541			997	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	6	576	326
Volume Left	5	0	16
Volume Right	1	71	0
cSH	335	1700	997
Volume to Capacity	0.02	0.34	0.02
Queue Length 95th (ft)	1	0	1
Control Delay (s)	15.9	0.0	0.6
Lane LOS	C		A
Approach Delay (s)	15.9	0.0	0.6
Approach LOS	C		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	38.4%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	35	15	75	5	1	2	20	495	80	35	250	5
Future Volume (Veh/h)	35	15	75	5	1	2	20	495	80	35	250	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	38	16	82	5	1	2	22	538	87	38	272	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								1234				
pX, platoon unblocked	0.98	0.98		0.98	0.98	0.98				0.98		
vC, conflicting volume	978	1020	274	1066	978	582	277			625		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	969	1011	274	1058	969	565	277			609		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	83	93	89	97	100	100	98			96		
cM capacity (veh/h)	217	222	764	161	235	515	1286			952		

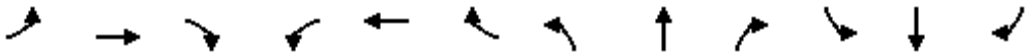
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	136	8	647	315
Volume Left	38	5	22	38
Volume Right	82	2	87	5
cSH	384	204	1286	952
Volume to Capacity	0.35	0.04	0.02	0.04
Queue Length 95th (ft)	39	3	1	3
Control Delay (s)	19.4	23.4	0.5	1.5
Lane LOS	C	C	A	A
Approach Delay (s)	19.4	23.4	0.5	1.5
Approach LOS	C	C		

Intersection Summary				
Average Delay	3.2			
Intersection Capacity Utilization	48.7%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	15	10	585	45	20	310
Future Volume (Veh/h)	15	10	585	45	20	310
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.60	0.60	0.95	0.95	0.91	0.91
Hourly flow rate (vph)	25	17	616	47	22	341
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			713			
pX, platoon unblocked	0.91	0.91			0.91	
vC, conflicting volume	1024	640			663	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	978	556			582	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	90	97			98	
cM capacity (veh/h)	249	487			914	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	42	663	363
Volume Left	25	0	22
Volume Right	17	47	0
cSH	310	1700	914
Volume to Capacity	0.14	0.39	0.02
Queue Length 95th (ft)	12	0	2
Control Delay (s)	18.4	0.0	0.8
Lane LOS	C		A
Approach Delay (s)	18.4	0.0	0.8
Approach LOS	C		

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	43.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	5	20	0	15	15	615	35	15	310	2
Future Volume (Veh/h)	0	0	5	20	0	15	15	615	35	15	310	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	0	8	22	0	17	17	683	39	18	373	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								398				
pX, platoon unblocked	0.88	0.88		0.88	0.88	0.88				0.88		
vC, conflicting volume	1164	1166	374	1154	1148	702	375			722		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1117	1120	374	1107	1099	592	375			614		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	86	100	96	99			98		
cM capacity (veh/h)	152	175	672	158	180	445	1183			848		

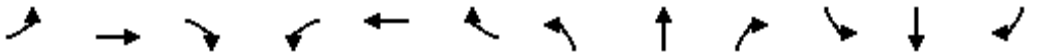
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	8	22	17	739	393
Volume Left	0	22	0	17	18
Volume Right	8	0	17	39	2
cSH	672	158	445	1183	848
Volume to Capacity	0.01	0.14	0.04	0.01	0.02
Queue Length 95th (ft)	1	12	3	1	2
Control Delay (s)	10.4	31.4	13.4	0.4	0.7
Lane LOS	B	D	B	A	A
Approach Delay (s)	10.4	23.5		0.4	0.7
Approach LOS	B	C			

Intersection Summary				
Average Delay	1.3			
Intersection Capacity Utilization	54.1%	ICU Level of Service		A
Analysis Period (min)	15			

Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	207	250	40	264	591	396
v/c Ratio	0.61	0.36	0.16	0.68	0.81	0.57
Control Delay	33.9	25.5	36.1	46.2	33.3	23.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.9	25.5	36.1	46.2	33.3	23.8
Queue Length 50th (ft)	83	102	19	141	265	150
Queue Length 95th (ft)	#210	236	58	286	#648	376
Internal Link Dist (ft)		238		291	396	469
Turn Bay Length (ft)	120		100			
Base Capacity (vph)	339	888	383	599	952	903
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	0.61	0.28	0.10	0.44	0.62	0.44

Intersection Summary

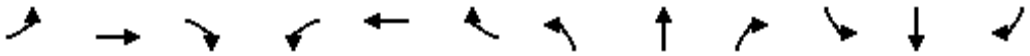
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	195	205	30	35	175	55	30	430	55	25	265	90
Future Volume (vph)	195	205	30	35	175	55	30	430	55	25	265	90
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)	1728	1817		1793	1782			1602			1546	
Flt Permitted	0.37	1.00		0.60	1.00			0.96			0.95	
Satd. Flow (perm)	671	1817		1140	1782			1545			1466	
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)	207	218	32	40	201	63	34	494	63	26	276	94
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	207	250	0	40	264	0	0	591	0	0	396	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)	31.0	36.0		20.5	20.5			44.5			44.5	
Effective Green, g (s)	31.0	36.0		20.5	20.5			44.5			44.5	
Actuated g/C Ratio	0.33	0.38		0.22	0.22			0.47			0.47	
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)	335	687		245	384			722			685	
v/s Ratio Prot	c0.07	0.14			c0.15							
v/s Ratio Perm	0.13			0.04				c0.38			0.27	
v/c Ratio	0.62	0.36		0.16	0.69			0.82			0.58	
Uniform Delay, d1	24.9	21.3		30.3	34.4			21.8			18.5	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	3.4	0.3		0.3	5.1			7.2			1.2	
Delay (s)	28.3	21.6		30.6	39.4			29.0			19.6	
Level of Service	C	C		C	D			C			B	
Approach Delay (s)		24.7			38.3			29.0			19.6	
Approach LOS		C			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	27.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	95.1	Sum of lost time (s)	17.0
Intersection Capacity Utilization	71.1%	ICU Level of Service	C
Analysis Period (min)	15		

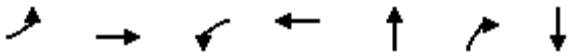
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	35	55	65	5	50	15	55	450	25	10	460	60
Future Volume (Veh/h)	35	55	65	5	50	15	55	450	25	10	460	60
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.84	0.84	0.84	0.98	0.98	0.98
Hourly flow rate (vph)	45	71	84	6	65	19	65	536	30	10	469	61
Pedestrians		4			4						8	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		3.5			3.5						3.5	
Percent Blockage		0			0						1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								549				
pX, platoon unblocked	0.71	0.71		0.71	0.71	0.71				0.71		
vC, conflicting volume	1264	1224	504	1324	1239	563	534			570		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1169	1112	504	1253	1134	186	534			196		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	31	48	85	88	51	97	93			99		
cM capacity (veh/h)	65	137	560	51	133	607	995			987		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	200	90	631	540
Volume Left	45	6	65	10
Volume Right	84	19	30	61
cSH	147	141	995	987
Volume to Capacity	1.36	0.64	0.07	0.01
Queue Length 95th (ft)	314	86	5	1
Control Delay (s)	257.2	67.7	1.7	0.3
Lane LOS	F	F	A	A
Approach Delay (s)	257.2	67.7	1.7	0.3
Approach LOS	F	F		

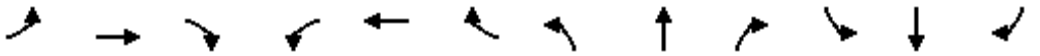
Intersection Summary				
Average Delay	40.2			
Intersection Capacity Utilization	78.0%	ICU Level of Service	D	
Analysis Period (min)	15			



Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	32	500	131	523	362	437	267
v/c Ratio	0.11	0.79	0.43	0.56	0.66	0.61	0.38
Control Delay	12.5	26.0	11.2	11.5	25.2	9.8	17.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.5	26.0	11.2	11.5	25.2	9.8	17.8
Queue Length 50th (ft)	7	138	20	102	105	45	36
Queue Length 95th (ft)	22	#236	40	167	#204	105	66
Internal Link Dist (ft)		1245		611	311		2903
Turn Bay Length (ft)	150		150			150	
Base Capacity (vph)	352	759	304	1058	545	722	698
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	0.09	0.66	0.43	0.49	0.66	0.61	0.38

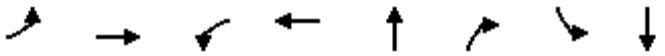
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	455	15	115	405	55	20	295	380	80	130	25
Future Volume (vph)	30	455	15	115	405	55	20	295	380	80	130	25
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		5.0	
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	0.97		1.00	
Flpb, ped/bikes	0.99	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)	1726	1837		1805	1819			1875	1574		3459	
Flt Permitted	0.47	1.00		0.20	1.00			0.97	1.00		0.66	
Satd. Flow (perm)	854	1837		386	1819			1817	1574		2326	
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)	32	484	16	131	460	62	23	339	437	91	148	28
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	132	0	0	0
Lane Group Flow (vph)	32	498	0	131	523	0	0	362	305	0	267	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)	18.4	18.4		27.4	27.4			16.1	20.1		16.1	
Effective Green, g (s)	18.4	18.4		27.4	27.4			16.1	20.1		16.1	
Actuated g/C Ratio	0.34	0.34		0.51	0.51			0.30	0.38		0.30	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	293	631		303	931			546	738		699	
v/s Ratio Prot		c0.27		0.03	c0.29				0.03			
v/s Ratio Perm	0.04			0.19				c0.20	0.16		0.11	
v/c Ratio	0.11	0.79		0.43	0.56			0.66	0.41		0.38	
Uniform Delay, d1	12.0	15.8		8.9	8.9			16.3	12.3		14.8	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.2	6.5		1.0	0.8			3.0	0.4		0.3	
Delay (s)	12.1	22.3		9.8	9.7			19.4	12.7		15.1	
Level of Service	B	C		A	A			B	B		B	
Approach Delay (s)		21.7			9.7			15.7			15.1	
Approach LOS		C			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	15.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	53.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

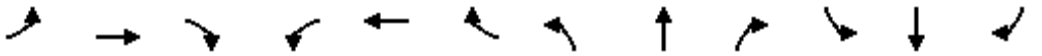


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	109	902	43	989	261	244	178	178
v/c Ratio	1.10	0.69	0.29	0.83	0.76	0.43	0.68	0.66
Control Delay	164.0	30.3	50.7	31.3	53.8	5.7	53.5	49.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	164.0	30.3	50.7	31.3	53.8	5.7	53.5	49.4
Queue Length 50th (ft)	~68	232	23	220	137	0	96	91
Queue Length 95th (ft)	#235	413	72	410	#395	46	#246	#224
Internal Link Dist (ft)		265		665	2948			318
Turn Bay Length (ft)	200		350			200	200	
Base Capacity (vph)	99	1306	431	1736	344	572	359	372
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.10	0.69	0.10	0.57	0.76	0.43	0.50	0.48

Intersection Summary

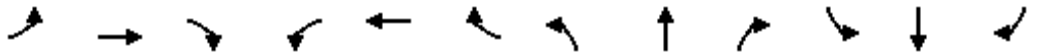
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	95	770	15	40	545	365	25	205	215	220	80	35
Future Volume (vph)	95	770	15	40	545	365	25	205	215	220	80	35
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	5.0	5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.95	0.95	
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	0.94			1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.98	
Satd. Flow (prot)	1752	3529		1805	3253			1873	1598	1665	1690	
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00	0.95	0.98	
Satd. Flow (perm)	1752	3529		1805	3253			1782	1598	1665	1690	
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)	109	885	17	43	592	397	28	233	244	234	85	37
RTOR Reduction (vph)	0	1	0	0	94	0	0	0	187	0	8	0
Lane Group Flow (vph)	109	901	0	43	895	0	0	261	57	178	170	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		Perm	NA	pm+ov	Split	NA	
Protected Phases	1	6		5	2			8	5	4	4	
Permitted Phases							8		8			
Actuated Green, G (s)	5.2	33.8		4.5	33.1			17.7	22.2	14.3	14.3	
Effective Green, g (s)	5.2	33.8		4.5	33.1			17.7	22.2	14.3	14.3	
Actuated g/C Ratio	0.05	0.36		0.05	0.35			0.19	0.23	0.15	0.15	
Clearance Time (s)	5.0	5.0		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	2.0	2.0	
Lane Grp Cap (vph)	96	1258		85	1135			332	374	251	254	
v/s Ratio Prot	c0.06	0.26		0.02	c0.28				0.01	c0.11	0.10	
v/s Ratio Perm								c0.15	0.03			
v/c Ratio	1.14	0.72		0.51	0.79			0.79	0.15	0.71	0.67	
Uniform Delay, d1	44.8	26.4		44.1	27.7			36.7	28.8	38.3	38.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	133.0	1.6		1.7	3.4			10.8	0.1	7.3	5.4	
Delay (s)	177.8	28.0		45.8	31.1			47.5	28.9	45.6	43.4	
Level of Service	F	C		D	C			D	C	D	D	
Approach Delay (s)		44.1			31.8			38.5			44.5	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	38.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	94.8	Sum of lost time (s)	22.0
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	1095	110	0	305	415	0	0	740	0	0	645
Future Volume (Veh/h)	0	1095	110	0	305	415	0	0	740	0	0	645
Sign Control		Free			Free			Yield			Yield	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.98	0.98	0.98	0.92	0.96	0.98	0.92	0.92	0.92	0.98	0.98	0.98
Hourly flow rate (vph)	0	1117	112	0	318	423	0	0	804	0	0	658
Pedestrians								1				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								0				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		745										
pX, platoon unblocked				0.80			0.80	0.80	0.80	0.80	0.80	
vC, conflicting volume	318			1118			1333	1492	616	876	1436	159
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	318			643			913	1112	14	341	1042	159
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	5	100	100	23
cM capacity (veh/h)	1239			748			42	166	847	24	182	858

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	745	484	159	159	423	804	658
Volume Left	0	0	0	0	0	0	0
Volume Right	0	112	0	0	423	804	658
cSH	1700	1700	1700	1700	1700	847	858
Volume to Capacity	0.44	0.28	0.09	0.09	0.25	0.95	0.77
Queue Length 95th (ft)	0	0	0	0	0	372	189
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	41.9	21.5
Lane LOS						E	C
Approach Delay (s)	0.0		0.0			41.9	21.5
Approach LOS						E	C

Intersection Summary				
Average Delay	13.9			
Intersection Capacity Utilization	86.3%	ICU Level of Service		E
Analysis Period (min)	15			

Lane Group	EBT	EBR	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	1142	750	858	85	79	52
v/c Ratio	0.57	0.56	0.41	0.45	0.28	0.27
Control Delay	16.3	2.4	10.2	44.0	5.2	24.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.3	2.4	10.2	44.0	5.2	24.3
Queue Length 50th (ft)	181	0	55	49	0	15
Queue Length 95th (ft)	#470	35	226	91	18	10
Internal Link Dist (ft)	96		601		420	187
Turn Bay Length (ft)				75		
Base Capacity (vph)	2013	1366	2115	282	359	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	0.57	0.55	0.41	0.30	0.22	0.12

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	1000	660	0	800	15	95	0	55	5	5	10
Future Volume (vph)	5	1000	660	0	800	15	95	0	55	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	0.98			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	0.89			0.93	
Flt Protected		1.00	1.00		1.00		0.95	0.99			0.99	
Satd. Flow (prot)		3471	1553		3432		1545	1439			1617	
Flt Permitted		0.95	1.00		1.00		0.95	0.99			0.99	
Satd. Flow (perm)		3302	1553		3432		1545	1439			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	1136	750	0	842	16	104	0	60	13	13	26
RTOR Reduction (vph)	0	0	206	0	1	0	0	69	0	0	24	0
Lane Group Flow (vph)	0	1142	544	0	857	0	85	10	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	Perm	NA	pm+ov		NA		Split	NA		Split	NA	
Protected Phases		6	8		2		8	8		4	4	
Permitted Phases	6		6									
Actuated Green, G (s)		56.1	67.5		56.1		11.4	11.4			8.5	
Effective Green, g (s)		56.1	67.5		56.1		11.4	11.4			8.5	
Actuated g/C Ratio		0.60	0.73		0.60		0.12	0.12			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)		1991	1227		2070		189	176			147	
v/s Ratio Prot			c0.05		0.25		0.06	0.01			c0.02	
v/s Ratio Perm		c0.35	0.30									
v/c Ratio		0.57	0.44		0.41		0.45	0.06			0.19	
Uniform Delay, d1		11.2	5.2		9.8		37.9	36.0			39.1	
Progression Factor		1.00	1.00		0.80		1.00	1.00			1.00	
Incremental Delay, d2		1.2	0.1		0.5		0.6	0.0			0.2	
Delay (s)		12.4	5.2		8.3		38.5	36.1			39.3	
Level of Service		B	A		A		D	D			D	
Approach Delay (s)		9.6			8.3			37.3			39.3	
Approach LOS		A			A			D			D	

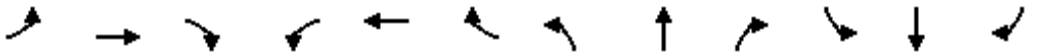
Intersection Summary			
HCM 2000 Control Delay	11.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	56.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	951	900	84	86	149	29	3
v/c Ratio	0.45	0.94dl	0.41	0.42	0.42	0.26	0.01
Control Delay	6.8	18.2	43.4	43.8	6.0	46.4	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.8	18.2	43.4	43.8	6.0	46.4	0.0
Queue Length 50th (ft)	42	184	49	51	0	17	0
Queue Length 95th (ft)	143	#383	91	93	27	32	0
Internal Link Dist (ft)	601	248		256		190	
Turn Bay Length (ft)			150		100		50
Base Capacity (vph)	2091	1226	298	295	423	367	502
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	0.45	0.73	0.28	0.29	0.35	0.08	0.01

Intersection Summary

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.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	720	160	285	545	25	155	5	140	15	5	2
Future Volume (vph)	5	720	160	285	545	25	155	5	140	15	5	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.5			6.5		6.5	6.5	6.5		6.5	6.5
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00		1.00	1.00
Frpb, ped/bikes		1.00			1.00		1.00	1.00	0.99		1.00	0.98
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00		1.00	1.00
Frt		0.97			1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected		1.00			0.98		0.95	0.96	1.00		0.96	1.00
Satd. Flow (prot)		3366			3400		1681	1668	1489		1666	1585
Flt Permitted		0.95			0.55		0.95	0.96	1.00		0.96	1.00
Satd. Flow (perm)		3202			1885		1681	1668	1489		1666	1585
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.94	0.94	0.94	0.67	0.67	0.67
Adj. Flow (vph)	5	774	172	300	574	26	165	5	149	22	7	3
RTOR Reduction (vph)	0	11	0	0	2	0	0	0	131	0	0	3
Lane Group Flow (vph)	0	940	0	0	898	0	84	86	18	0	29	0
Confl. Peds. (#/hr)	3		2	2		3	1		1	1		1
Confl. Bikes (#/hr)			2									
Heavy Vehicles (%)	0%	4%	3%	2%	5%	0%	2%	25%	7%	13%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases		6		5	2		8	8		4	4	
Permitted Phases	6			2					8			4
Actuated Green, G (s)		57.8			57.8		11.4	11.4	11.4		4.3	4.3
Effective Green, g (s)		57.8			57.8		11.4	11.4	11.4		4.3	4.3
Actuated g/C Ratio		0.62			0.62		0.12	0.12	0.12		0.05	0.05
Clearance Time (s)		6.5			6.5		6.5	6.5	6.5		6.5	6.5
Vehicle Extension (s)		2.0			2.0		2.0	2.0	2.0		2.0	2.0
Lane Grp Cap (vph)		1990			1171		206	204	182		77	73
v/s Ratio Prot							0.05	c0.05			c0.02	
v/s Ratio Perm		0.29			c0.48				0.01			0.00
v/c Ratio		0.47			0.94dl		0.41	0.42	0.10		0.38	0.00
Uniform Delay, d1		9.4			12.7		37.7	37.7	36.2		43.0	42.3
Progression Factor		0.66			1.00		1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.1			2.8		0.5	0.5	0.1		1.1	0.0
Delay (s)		6.2			15.5		38.2	38.3	36.3		44.2	42.3
Level of Service		A			B		D	D	D		D	D
Approach Delay (s)		6.2			15.5			37.3			44.0	
Approach LOS		A			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	15.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	26.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	542	82	278	483	588	71	71
v/c Ratio	0.38	0.20	0.29	1.43	0.36	0.33	0.14
Control Delay	22.4	14.8	14.2	242.5	0.6	34.2	21.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.4	14.8	14.2	242.5	0.6	34.2	21.0
Queue Length 50th (ft)	102	19	66	~390	0	29	25
Queue Length 95th (ft)	#226	68	195	#579	0	62	57
Internal Link Dist (ft)	362		363	827			2948
Turn Bay Length (ft)		190			400	125	
Base Capacity (vph)	1441	420	975	337	1615	216	547
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	0.38	0.20	0.29	1.43	0.36	0.33	0.13

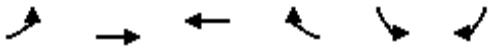
Intersection Summary

~ 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.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	420	0	80	210	60	5	435	535	65	55	10
Future Volume (vph)	30	420	0	80	210	60	5	435	535	65	55	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	0.97			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	1770			1880	1615	1770	1797	
Flt Permitted		0.92		0.33	1.00			1.00	1.00	0.19	1.00	
Satd. Flow (perm)		3276		611	1770			1876	1615	351	1797	
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	506	0	82	216	62	5	478	588	71	60	11
RTOR Reduction (vph)	0	0	0	0	8	0	0	0	0	0	7	0
Lane Group Flow (vph)	0	542	0	82	270	0	0	483	588	71	64	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)		35.2		45.8	45.8			16.2	90.0	26.8	26.8	
Effective Green, g (s)		35.2		45.8	45.8			16.2	90.0	26.8	26.8	
Actuated g/C Ratio		0.39		0.51	0.51			0.18	1.00	0.30	0.30	
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)		1281		380	900			337	1615	192	535	
v/s Ratio Prot				0.01	0.15					0.02	0.04	
v/s Ratio Perm		c0.17		0.10				c0.26	c0.36	0.09		
v/c Ratio		0.42		0.22	0.30			1.43	0.36	0.37	0.12	
Uniform Delay, d1		20.0		12.0	12.8			36.9	0.0	36.8	23.0	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.0		0.1	0.9			211.3	0.6	0.4	0.0	
Delay (s)		21.0		12.2	13.7			248.2	0.6	37.2	23.0	
Level of Service		C		B	B			F	A	D	C	
Approach Delay (s)		21.0			13.3			112.3			30.1	
Approach LOS		C			B			F			C	

Intersection Summary			
HCM 2000 Control Delay	66.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	625	280	0	95
Future Volume (Veh/h)	0	0	625	280	0	95
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.97	0.97	0.92	0.92
Hourly flow rate (vph)	0	0	644	289	0	103
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	644				788	466
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	644				788	466
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	81
cM capacity (veh/h)	937				328	543

Direction, Lane #	WB 1	WB 2	SB 1
Volume Total	429	504	103
Volume Left	0	0	0
Volume Right	0	289	103
cSH	1700	1700	543
Volume to Capacity	0.25	0.30	0.19
Queue Length 95th (ft)	0	0	17
Control Delay (s)	0.0	0.0	13.2
Lane LOS			B
Approach Delay (s)	0.0		13.2
Approach LOS			B

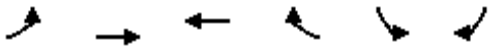
Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBT	EBR	NBR
Lane Group Flow (vph)	1484	447	280
v/c Ratio	0.68	0.40	0.55
Control Delay	9.5	1.6	29.7
Queue Delay	0.0	0.0	0.0
Total Delay	9.5	1.6	29.7
Queue Length 50th (ft)	165	0	53
Queue Length 95th (ft)	232	25	118
Internal Link Dist (ft)	162		
Turn Bay Length (ft)			100
Base Capacity (vph)	3539	1541	609
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.42	0.29	0.46

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1410	425	0	0	0	255
Future Volume (vph)	1410	425	0	0	0	255
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0				6.0
Lane Util. Factor	0.95	1.00				0.88
Frpb, ped/bikes	1.00	0.98				1.00
Flpb, ped/bikes	1.00	1.00				1.00
Frt	1.00	0.85				0.85
Flt Protected	1.00	1.00				1.00
Satd. Flow (prot)	3539	1546				2787
Flt Permitted	1.00	1.00				1.00
Satd. Flow (perm)	3539	1546				2787
Peak-hour factor, PHF	0.95	0.95	0.92	0.92	0.91	0.91
Adj. Flow (vph)	1484	447	0	0	0	280
RTOR Reduction (vph)	0	170	0	0	0	0
Lane Group Flow (vph)	1484	277	0	0	0	280
Confl. Peds. (#/hr)		2	2			
Turn Type	NA	Perm				Prot
Protected Phases	1					2
Permitted Phases		1				
Actuated Green, G (s)	37.9	37.9				11.3
Effective Green, g (s)	37.9	37.9				11.3
Actuated g/C Ratio	0.62	0.62				0.18
Clearance Time (s)	6.0	6.0				6.0
Vehicle Extension (s)	2.0	2.0				2.0
Lane Grp Cap (vph)	2191	957				514
v/s Ratio Prot	c0.42					c0.10
v/s Ratio Perm		0.18				
v/c Ratio	0.68	0.29				0.54
Uniform Delay, d1	7.6	5.4				22.6
Progression Factor	1.00	1.00				1.00
Incremental Delay, d2	0.7	0.1				0.6
Delay (s)	8.3	5.5				23.3
Level of Service	A	A				C
Approach Delay (s)	7.6			0.0	23.3	
Approach LOS	A			A	C	

Intersection Summary			
HCM 2000 Control Delay	9.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	61.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	20	275	540	150	130	45
Future Volume (Veh/h)	20	275	540	150	130	45
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.86	0.86	0.94	0.94
Hourly flow rate (vph)	22	299	628	174	138	48
Pedestrians		2	7			
Lane Width (ft)		12.0	12.0			
Walking Speed (ft/s)		3.5	3.5			
Percent Blockage		0	1			
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	802				1065	717
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	802				1065	717
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				42	89
cM capacity (veh/h)	826				237	432

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	321	802	186
Volume Left	22	0	138
Volume Right	0	174	48
cSH	826	1700	268
Volume to Capacity	0.03	0.47	0.69
Queue Length 95th (ft)	2	0	116
Control Delay (s)	0.9	0.0	43.9
Lane LOS	A		E
Approach Delay (s)	0.9	0.0	43.9
Approach LOS			E

Intersection Summary			
Average Delay	6.5		
Intersection Capacity Utilization	54.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	320	85	115	630	60	105
Future Volume (Veh/h)	320	85	115	630	60	105
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.71	0.71	0.89	0.89
Hourly flow rate (vph)	344	91	162	887	67	118
Pedestrians					3	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			438		1604	392
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			438		1604	392
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			85		32	82
cM capacity (veh/h)			1108		99	654

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	435	1049	185
Volume Left	0	162	67
Volume Right	91	0	118
cSH	1700	1108	216
Volume to Capacity	0.26	0.15	0.86
Queue Length 95th (ft)	0	13	166
Control Delay (s)	0.0	3.6	76.2
Lane LOS		A	F
Approach Delay (s)	0.0	3.6	76.2
Approach LOS			F

Intersection Summary			
Average Delay		10.7	
Intersection Capacity Utilization		81.4%	ICU Level of Service D
Analysis Period (min)		15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	405	75	150	640	105	95
Future Volume (Veh/h)	405	75	150	640	105	95
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.82	0.82	0.61	0.61
Hourly flow rate (vph)	450	83	183	780	172	156
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			533		1638	492
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			533		1638	492
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			82		0	73
cM capacity (veh/h)			1040		92	573

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	533	963	328
Volume Left	0	183	172
Volume Right	83	0	156
cSH	1700	1040	153
Volume to Capacity	0.31	0.18	2.14
Queue Length 95th (ft)	0	16	662
Control Delay (s)	0.0	4.2	581.4
Lane LOS		A	F
Approach Delay (s)	0.0	4.2	581.4
Approach LOS			F

Intersection Summary			
Average Delay	106.8		
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	470	5	15	750	15	40
Future Volume (Veh/h)	470	5	15	750	15	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	511	5	16	815	16	43
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			516		1360	514
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			516		1360	514
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		90	92
cM capacity (veh/h)			1050		161	561

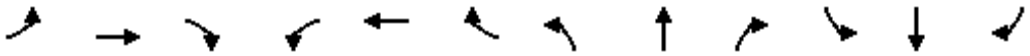
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	516	831	59
Volume Left	0	16	16
Volume Right	5	0	43
cSH	1700	1050	335
Volume to Capacity	0.30	0.02	0.18
Queue Length 95th (ft)	0	1	16
Control Delay (s)	0.0	0.4	18.0
Lane LOS		A	C
Approach Delay (s)	0.0	0.4	18.0
Approach LOS			C

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	510	2	2	765	0	2
Future Volume (Veh/h)	510	2	2	765	0	2
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	554	2	2	832	0	2
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			556		1391	555
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			556		1391	555
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			1015		156	531

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	556	834	2
Volume Left	0	2	0
Volume Right	2	0	2
cSH	1700	1015	531
Volume to Capacity	0.33	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	0.1	11.8
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	11.8
Approach LOS			B

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	51.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	0	0	50	0	2	0	210	20	1	335	0
Future Volume (Veh/h)	1	0	0	50	0	2	0	210	20	1	335	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.25	0.25	0.25	0.76	0.76	0.76	0.83	0.83	0.83	0.66	0.66	0.66
Hourly flow rate (vph)	4	0	0	66	0	3	0	253	24	2	508	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	780	789	508	777	777	265	508			277		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	780	789	508	777	777	265	508			277		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	100	79	100	100	100			100		
cM capacity (veh/h)	314	325	569	316	330	779	1067			1298		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	4	69	277	510
Volume Left	4	66	0	2
Volume Right	0	3	24	0
cSH	314	325	1067	1298
Volume to Capacity	0.01	0.21	0.00	0.00
Queue Length 95th (ft)	1	20	0	0
Control Delay (s)	16.6	19.1	0.0	0.0
Lane LOS	C	C		A
Approach Delay (s)	16.6	19.1	0.0	0.0
Approach LOS	C	C		

Intersection Summary				
Average Delay	1.6			
Intersection Capacity Utilization	28.4%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	90	20	210	40	10	375
Future Volume (Veh/h)	90	20	210	40	10	375
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.80	0.80	0.90	0.90	0.66	0.66
Hourly flow rate (vph)	113	25	233	44	15	568
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	853	255			277	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	853	255			277	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	65	97			99	
cM capacity (veh/h)	327	789			1298	

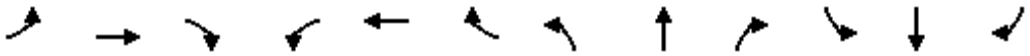
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	138	277	583
Volume Left	113	0	15
Volume Right	25	44	0
cSH	366	1700	1298
Volume to Capacity	0.38	0.16	0.01
Queue Length 95th (ft)	43	0	1
Control Delay (s)	20.7	0.0	0.3
Lane LOS	C		A
Approach Delay (s)	20.7	0.0	0.3
Approach LOS	C		

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	55	15	235	10	2	465
Future Volume (Veh/h)	55	15	235	10	2	465
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	60	16	255	11	2	505
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	770	260			266	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	770	260			266	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	84	98			100	
cM capacity (veh/h)	369	778			1298	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	76	266	507
Volume Left	60	0	2
Volume Right	16	11	0
cSH	414	1700	1298
Volume to Capacity	0.18	0.16	0.00
Queue Length 95th (ft)	17	0	0
Control Delay (s)	15.6	0.0	0.0
Lane LOS	C		A
Approach Delay (s)	15.6	0.0	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	1	15	65	5	25	40	215	20	5	490	25
Future Volume (Veh/h)	5	1	15	65	5	25	40	215	20	5	490	25
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	1	16	71	5	27	43	234	22	5	533	27
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								1234				
pX, platoon unblocked												
vC, conflicting volume	917	898	546	904	901	245	560			256		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	917	898	546	904	901	245	560			256		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	97	70	98	97	96			100		
cM capacity (veh/h)	232	266	537	241	265	794	1011			1309		

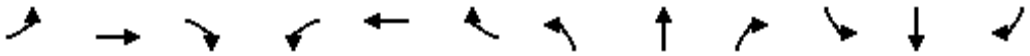
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	22	103	299	565
Volume Left	5	71	43	5
Volume Right	16	27	22	27
cSH	399	296	1011	1309
Volume to Capacity	0.06	0.35	0.04	0.00
Queue Length 95th (ft)	4	38	3	0
Control Delay (s)	14.5	23.5	1.6	0.1
Lane LOS	B	C	A	A
Approach Delay (s)	14.5	23.5	1.6	0.1
Approach LOS	B	C		

Intersection Summary				
Average Delay	3.3			
Intersection Capacity Utilization	58.7%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	25	15	260	5	5	565
Future Volume (Veh/h)	25	15	260	5	5	565
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.81	0.81	0.75	0.75	0.73	0.73
Hourly flow rate (vph)	31	19	347	7	7	774
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			713			
pX, platoon unblocked						
vC, conflicting volume	1138	350			354	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1138	350			354	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	86	97			99	
cM capacity (veh/h)	223	697			1216	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	50	354	781
Volume Left	31	0	7
Volume Right	19	7	0
cSH	301	1700	1216
Volume to Capacity	0.17	0.21	0.01
Queue Length 95th (ft)	15	0	0
Control Delay (s)	19.3	0.0	0.2
Lane LOS	C		A
Approach Delay (s)	19.3	0.0	0.2
Approach LOS	C		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	30	30	1	20	5	245	10	5	580	5
Future Volume (Veh/h)	0	0	30	30	1	20	5	245	10	5	580	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	0	40	42	1	28	6	285	12	5	630	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								398				
pX, platoon unblocked	1.00	1.00		1.00	1.00	1.00				1.00		
vC, conflicting volume	974	952	632	986	948	291	635			297		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	972	950	632	984	946	287	635			293		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	92	80	100	96	99			100		
cM capacity (veh/h)	220	257	480	206	258	749	948			1264		

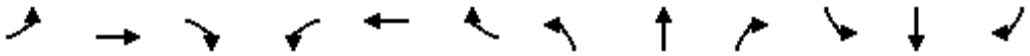
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	40	42	29	303	640
Volume Left	0	42	0	6	5
Volume Right	40	0	28	12	5
cSH	480	206	703	948	1264
Volume to Capacity	0.08	0.20	0.04	0.01	0.00
Queue Length 95th (ft)	7	19	3	0	0
Control Delay (s)	13.2	26.9	10.3	0.2	0.1
Lane LOS	B	D	B	A	A
Approach Delay (s)	13.2	20.1		0.2	0.1
Approach LOS	B	C			

Intersection Summary				
Average Delay	2.0			
Intersection Capacity Utilization	Err%	ICU Level of Service		H
Analysis Period (min)	15			

Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	184	299	76	233	488	602
v/c Ratio	0.55	0.44	0.34	0.64	0.70	0.82
Control Delay	27.7	23.6	34.4	40.2	27.8	33.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	27.7	23.6	34.4	40.2	27.8	33.3
Queue Length 50th (ft)	64	110	33	108	175	236
Queue Length 95th (ft)	142	228	84	213	#547	#726
Internal Link Dist (ft)		238		291	396	469
Turn Bay Length (ft)	120		100			
Base Capacity (vph)	333	971	399	650	700	736
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	0.31	0.19	0.36	0.70	0.82

Intersection Summary

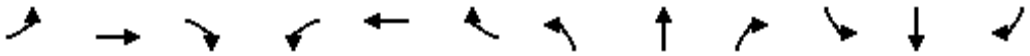
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	160	215	45	65	145	55	25	360	50	30	455	75
Future Volume (vph)	160	215	45	65	145	55	25	360	50	30	455	75
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			0.98			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1748	1841		1782	1768			1550			1615	
Flt Permitted	0.39	1.00		0.58	1.00			0.95			0.96	
Satd. Flow (perm)	724	1841		1083	1768			1477			1554	
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)	184	247	52	76	169	64	28	404	56	32	489	81
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	184	299	0	76	233	0	0	488	0	0	602	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)	27.5	33.0		17.8	17.8			40.9			40.9	
Effective Green, g (s)	27.5	33.0		17.8	17.8			40.9			40.9	
Actuated g/C Ratio	0.31	0.38		0.20	0.20			0.47			0.47	
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)	340	693		220	359			689			725	
v/s Ratio Prot	0.06	c0.16			c0.13							
v/s Ratio Perm	0.11			0.07				0.33			c0.39	
v/c Ratio	0.54	0.43		0.35	0.65			0.71			0.83	
Uniform Delay, d1	23.3	20.3		29.9	32.0			18.6			20.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	1.8	0.4		0.9	4.0			3.3			8.0	
Delay (s)	25.1	20.8		30.9	36.0			21.9			28.3	
Level of Service	C	C		C	D			C			C	
Approach Delay (s)		22.4			34.8			21.9			28.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	26.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	87.6	Sum of lost time (s)	16.5
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

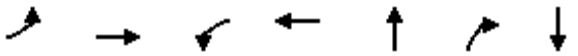
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	45	50	65	5	30	20	80	395	15	20	475	50
Future Volume (Veh/h)	45	50	65	5	30	20	80	395	15	20	475	50
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.81	0.81	0.81	0.91	0.91	0.91	0.98	0.98	0.98	0.92	0.92	0.92
Hourly flow rate (vph)	56	62	80	5	33	22	82	403	15	22	516	54
Pedestrians		4			5			9			8	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								549				
pX, platoon unblocked	0.96	0.96		0.96	0.96	0.96				0.96		
vC, conflicting volume	1212	1178	556	1286	1198	424	574			423		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1200	1165	556	1278	1185	380	574			380		
tC, single (s)	7.1	6.5	6.2	7.1	6.6	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.1	3.3	2.2			2.2		
p0 queue free %	51	63	85	93	79	97	92			98		
cM capacity (veh/h)	115	167	522	76	158	637	995			1138		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	198	60	500	592
Volume Left	56	5	82	22
Volume Right	80	22	15	54
cSH	195	195	995	1138
Volume to Capacity	1.01	0.31	0.08	0.02
Queue Length 95th (ft)	220	31	7	1
Control Delay (s)	118.2	31.6	2.3	0.5
Lane LOS	F	D	A	A
Approach Delay (s)	118.2	31.6	2.3	0.5
Approach LOS	F	D		

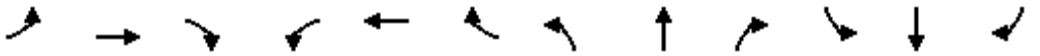
Intersection Summary				
Average Delay	19.8			
Intersection Capacity Utilization	79.9%	ICU Level of Service	D	
Analysis Period (min)	15			



Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	44	445	304	587	161	190	465
v/c Ratio	0.18	0.79	0.86	0.63	0.32	0.23	0.51
Control Delay	16.5	30.3	36.5	13.5	16.2	8.0	17.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.5	30.3	36.5	13.5	16.2	8.0	17.4
Queue Length 50th (ft)	10	125	51	117	39	30	62
Queue Length 95th (ft)	32	#275	#171	229	75	56	96
Internal Link Dist (ft)		1245		611	311		2903
Turn Bay Length (ft)	150		150			150	
Base Capacity (vph)	251	566	354	927	1017	830	1839
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	0.18	0.79	0.86	0.63	0.16	0.23	0.25

Intersection Summary

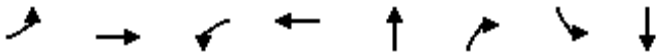
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	390	15	295	500	70	25	115	165	90	280	40
Future Volume (vph)	40	390	15	295	500	70	25	115	165	90	280	40
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		5.0	
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	0.99		1.00	0.98			1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00		0.99	
Satd. Flow (prot)	1802	1890		1787	1826			1882	1615		3511	
Flt Permitted	0.44	1.00		0.21	1.00			0.87	1.00		0.84	
Satd. Flow (perm)	841	1890		393	1826			1651	1615		2984	
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)	44	429	16	304	515	72	29	132	190	102	318	45
RTOR Reduction (vph)	0	1	0	0	6	0	0	0	0	0	0	0
Lane Group Flow (vph)	44	444	0	304	581	0	0	161	190	0	465	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)	16.0	16.0		27.0	27.0			16.5	22.5		16.5	
Effective Green, g (s)	16.0	16.0		27.0	27.0			16.5	22.5		16.5	
Actuated g/C Ratio	0.30	0.30		0.50	0.50			0.31	0.42		0.31	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	251	565		354	921			509	830		920	
v/s Ratio Prot		0.23		c0.10	0.32				0.03			
v/s Ratio Perm	0.05			c0.34				0.10	0.09		c0.16	
v/c Ratio	0.18	0.79		0.86	0.63			0.32	0.23		0.51	
Uniform Delay, d1	13.9	17.2		10.0	9.6			14.2	9.9		15.2	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.3	7.1		18.3	1.4			0.4	0.1		0.4	
Delay (s)	14.2	24.2		28.2	11.0			14.5	10.1		15.6	
Level of Service	B	C		C	B			B	B		B	
Approach Delay (s)		23.3			16.9			12.1			15.6	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM 2000 Control Delay	17.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	53.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

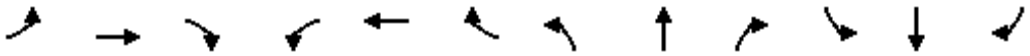


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	27	731	126	1136	90	96	386	385
v/c Ratio	0.23	0.57	0.53	0.66	0.94	0.20	1.09	1.05
Control Delay	44.0	25.4	43.9	19.8	121.5	5.2	110.1	94.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	44.0	25.4	43.9	19.8	121.5	5.2	110.1	94.7
Queue Length 50th (ft)	15	173	67	206	52	0	~262	~244
Queue Length 95th (ft)	40	242	120	368	#130	23	#393	#377
Internal Link Dist (ft)		265		665	2948			318
Turn Bay Length (ft)	200		350			200	200	
Base Capacity (vph)	116	1285	239	1734	96	489	354	368
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.23	0.57	0.53	0.66	0.94	0.20	1.09	1.05

Intersection Summary

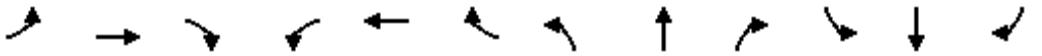
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	645	20	120	900	180	20	55	80	400	160	80
Future Volume (vph)	25	645	20	120	900	180	20	55	80	400	160	80
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	5.0	5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.95	0.95	
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	0.98			1.00	0.85	1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.99	
Satd. Flow (prot)	1770	3523		1770	3439			1838	1583	1681	1682	
Flt Permitted	0.95	1.00		0.95	1.00			0.77	1.00	0.95	0.99	
Satd. Flow (perm)	1770	3523		1770	3439			1443	1583	1681	1682	
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)	27	709	22	126	947	189	24	66	96	482	193	96
RTOR Reduction (vph)	0	2	0	0	12	0	0	0	77	0	13	0
Lane Group Flow (vph)	27	729	0	126	1124	0	0	90	19	386	372	0
Confl. Bikes (#/hr)						1						
Turn Type	Prot	NA		Prot	NA		Perm	NA	pm+ov	Split	NA	
Protected Phases	1	6		5	2			8	5	4	4	
Permitted Phases							8		8			
Actuated Green, G (s)	2.9	32.8		12.2	42.1			6.0	18.2	19.0	19.0	
Effective Green, g (s)	2.9	32.8		12.2	42.1			6.0	18.2	19.0	19.0	
Actuated g/C Ratio	0.03	0.36		0.14	0.47			0.07	0.20	0.21	0.21	
Clearance Time (s)	5.0	5.0		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	2.0	2.0	
Lane Grp Cap (vph)	57	1283		239	1608			96	408	354	355	
v/s Ratio Prot	0.02	0.21		c0.07	c0.33				0.01	c0.23	0.22	
v/s Ratio Perm								c0.06	0.01			
v/c Ratio	0.47	0.57		0.53	0.70			0.94	0.05	1.09	1.05	
Uniform Delay, d1	42.8	22.9		36.2	18.9			41.8	28.9	35.5	35.5	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.3	1.8		1.0	2.5			70.3	0.0	74.3	60.5	
Delay (s)	45.1	24.8		37.2	21.5			112.1	28.9	109.8	96.0	
Level of Service	D	C		D	C			F	C	F	F	
Approach Delay (s)		25.5			23.1			69.2			102.9	
Approach LOS		C			C			E			F	

Intersection Summary			
HCM 2000 Control Delay	47.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	70.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	870	255	0	735	455	0	0	270	0	0	465
Future Volume (Veh/h)	0	870	255	0	735	455	0	0	270	0	0	465
Sign Control		Free			Free			Yield			Yield	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	946	277	0	799	495	0	0	293	0	0	505
Pedestrians											2	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		745										
pX, platoon unblocked				0.85			0.85	0.85	0.85	0.85	0.85	
vC, conflicting volume	801			946			1484	1886	612	1274	1747	402
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	801			591			1222	1693	199	976	1531	402
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	58	100	100	15
cM capacity (veh/h)	816			836			18	78	690	100	99	597

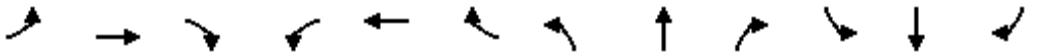
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	631	592	400	400	495	293	505
Volume Left	0	0	0	0	0	0	0
Volume Right	0	277	0	0	495	293	505
cSH	1700	1700	1700	1700	1700	690	597
Volume to Capacity	0.37	0.35	0.23	0.23	0.29	0.42	0.85
Queue Length 95th (ft)	0	0	0	0	0	53	229
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	14.0	35.5
Lane LOS						B	E
Approach Delay (s)	0.0		0.0			14.0	35.5
Approach LOS						B	E

Intersection Summary				
Average Delay	6.6			
Intersection Capacity Utilization	55.8%	ICU Level of Service	B	
Analysis Period (min)	15			

Lane Group	EBT	EBR	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	865	180	1663	256	250	20
v/c Ratio	0.39	0.13	0.76	0.74	0.58	0.16
Control Delay	13.0	0.6	17.6	46.4	21.7	25.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.0	0.6	17.6	46.4	21.7	25.0
Queue Length 50th (ft)	101	0	163	149	71	2
Queue Length 95th (ft)	273	10	#674	210	134	15
Internal Link Dist (ft)	96		601		420	187
Turn Bay Length (ft)				75		
Base Capacity (vph)	2193	1410	2197	430	504	429
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	0.39	0.13	0.76	0.60	0.50	0.05

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



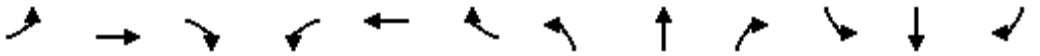
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	770	160	0	1475	5	380	0	70	1	1	10
Future Volume (vph)	0	770	160	0	1475	5	380	0	70	1	1	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	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		3537		1681	1628			1686	
Flt Permitted		1.00	1.00		1.00		0.95	0.97			1.00	
Satd. Flow (perm)		3610	1583		3537		1681	1628			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	865	180	0	1657	6	427	0	79	2	2	16
RTOR Reduction (vph)	0	0	43	0	0	0	0	93	0	0	16	0
Lane Group Flow (vph)	0	865	137	0	1663	0	256	157	0	0	4	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)		51.3	70.6		54.2		19.3	19.3			2.5	
Effective Green, g (s)		51.3	70.6		54.2		19.3	19.3			2.5	
Actuated g/C Ratio		0.55	0.76		0.58		0.21	0.21			0.03	
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)		1991	1201		2061		348	337			45	
v/s Ratio Prot		0.24	0.02		c0.47		c0.15	0.10			c0.00	
v/s Ratio Perm			0.06									
v/c Ratio		0.43	0.11		0.81		0.74	0.47			0.10	
Uniform Delay, d1		12.3	3.0		15.3		34.5	32.3			44.2	
Progression Factor		1.00	1.00		0.92		1.00	1.00			1.00	
Incremental Delay, d2		0.7	0.0		3.1		6.8	0.4			0.3	
Delay (s)		13.0	3.0		17.2		41.3	32.7			44.5	
Level of Service		B	A		B		D	C			D	
Approach Delay (s)		11.3			17.2			37.0			44.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	18.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	69.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	697	936	214	214	233	92	36
v/c Ratio	0.40	0.72	0.69	0.68	0.49	0.52	0.11
Control Delay	6.0	23.9	46.1	45.8	7.7	49.7	0.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	6.0	23.9	46.1	45.8	7.7	49.7	0.7
Queue Length 50th (ft)	129	220	125	125	0	53	0
Queue Length 95th (ft)	34	#420	187	187	56	74	0
Internal Link Dist (ft)	601	248		256		190	
Turn Bay Length (ft)			150		100		50
Base Capacity (vph)	1755	1305	345	347	504	397	493
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	0.40	0.72	0.62	0.62	0.46	0.23	0.07

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



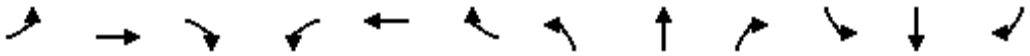
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	535	110	120	745	25	370	15	210	50	15	25
Future Volume (vph)	10	535	110	120	745	25	370	15	210	50	15	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.5			6.5		6.5	6.5	6.5		6.5	6.5
Lane Util. Factor		0.95			0.95		0.95	0.95	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		0.97			1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected		1.00			0.99		0.95	0.96	1.00		0.96	1.00
Satd. Flow (prot)		3488			3506		1698	1710	1568		1802	1553
Flt Permitted		0.94			0.69		0.95	0.96	1.00		0.96	1.00
Satd. Flow (perm)		3266			2443		1698	1710	1568		1802	1553
Peak-hour factor, PHF	0.94	0.94	0.94	0.95	0.95	0.95	0.90	0.90	0.90	0.70	0.70	0.70
Adj. Flow (vph)	11	569	117	126	784	26	411	17	233	71	21	36
RTOR Reduction (vph)	0	12	0	0	2	0	0	0	190	0	0	33
Lane Group Flow (vph)	0	685	0	0	934	0	214	214	43	0	92	3
Confl. Peds. (#/hr)	4					4						
Heavy Vehicles (%)	0%	1%	0%	7%	1%	0%	1%	0%	3%	2%	0%	4%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases		6		5	2		8	8		4	4	
Permitted Phases	6			2					8			4
Actuated Green, G (s)		48.3			48.3		17.1	17.1	17.1		8.1	8.1
Effective Green, g (s)		48.3			48.3		17.1	17.1	17.1		8.1	8.1
Actuated g/C Ratio		0.52			0.52		0.18	0.18	0.18		0.09	0.09
Clearance Time (s)		6.5			6.5		6.5	6.5	6.5		6.5	6.5
Vehicle Extension (s)		2.0			2.0		2.0	2.0	2.0		2.0	2.0
Lane Grp Cap (vph)		1696			1268		312	314	288		156	135
v/s Ratio Prot							c0.13	0.13			c0.05	
v/s Ratio Perm		0.21			c0.38				0.03			0.00
v/c Ratio		0.40			0.74		0.69	0.68	0.15		0.59	0.02
Uniform Delay, d1		13.6			17.4		35.4	35.4	31.8		40.9	38.8
Progression Factor		0.36			1.00		1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		0.1			2.0		4.9	4.8	0.1		3.6	0.0
Delay (s)		4.9			19.4		40.4	40.2	31.9		44.5	38.9
Level of Service		A			B		D	D	C		D	D
Approach Delay (s)		4.9			19.4			37.3			42.9	
Approach LOS		A			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	26.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	254	468	432	121	151	64	197
v/c Ratio	0.43	0.53	0.37	0.52	0.10	0.23	0.44
Control Delay	30.2	10.6	8.8	41.7	0.1	24.2	27.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.2	10.6	8.8	41.7	0.1	24.2	27.5
Queue Length 50th (ft)	59	115	100	58	0	24	77
Queue Length 95th (ft)	86	180	157	100	0	54	136
Internal Link Dist (ft)	362		363	827			2948
Turn Bay Length (ft)		190			400	125	
Base Capacity (vph)	592	890	1172	231	1583	273	509
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	0.43	0.53	0.37	0.52	0.10	0.23	0.39

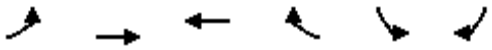
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	215	2	445	375	35	1	100	125	60	170	15
Future Volume (vph)	15	215	2	445	375	35	1	100	125	60	170	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)		3524		1770	1839			1862	1583	1770	1840	
Flt Permitted		0.91		0.44	1.00			1.00	1.00	0.42	1.00	
Satd. Flow (perm)		3218		813	1839			1856	1583	782	1840	
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	236	2	468	395	37	1	120	151	64	181	16
RTOR Reduction (vph)	0	1	0	0	2	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	253	0	468	430	0	0	121	151	64	193	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)		14.7		50.9	50.9			8.5	80.0	19.1	19.1	
Effective Green, g (s)		14.7		50.9	50.9			8.5	80.0	19.1	19.1	
Actuated g/C Ratio		0.18		0.64	0.64			0.11	1.00	0.24	0.24	
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)		591		890	1170			197	1583	255	439	
v/s Ratio Prot				c0.21	0.23					0.02	c0.10	
v/s Ratio Perm		0.08		c0.13				c0.07	0.10	0.04		
v/c Ratio		0.43		0.53	0.37			0.61	0.10	0.25	0.44	
Uniform Delay, d1		28.9		7.5	6.9			34.2	0.0	24.2	25.9	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		2.3		0.3	0.1			4.0	0.1	0.2	0.3	
Delay (s)		31.2		7.8	7.0			38.1	0.1	24.4	26.2	
Level of Service		C		A	A			D	A	C	C	
Approach Delay (s)		31.2			7.4			17.0			25.7	
Approach LOS		C			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	23.0
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	1075	790	0	115
Future Volume (Veh/h)	0	0	1075	790	0	115
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	1168	859	0	125
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1168				1598	1014
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1168				1598	1014
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	47
cM capacity (veh/h)	594				97	237

Direction, Lane #	WB 1	WB 2	SB 1
Volume Total	779	1248	125
Volume Left	0	0	0
Volume Right	0	859	125
cSH	1700	1700	237
Volume to Capacity	0.46	0.73	0.53
Queue Length 95th (ft)	0	0	70
Control Delay (s)	0.0	0.0	36.1
Lane LOS			E
Approach Delay (s)	0.0		36.1
Approach LOS			E

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	68.8%	ICU Level of Service	C
Analysis Period (min)	15		

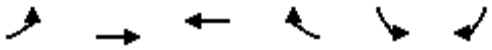
Lane Group	EBT	EBR	NBR
Lane Group Flow (vph)	837	402	174
v/c Ratio	0.40	0.37	0.28
Control Delay	6.4	1.9	15.3
Queue Delay	0.0	0.0	0.0
Total Delay	6.4	1.9	15.3
Queue Length 50th (ft)	50	0	16
Queue Length 95th (ft)	89	27	44
Internal Link Dist (ft)	162		
Turn Bay Length (ft)			100
Base Capacity (vph)	3539	1583	1201
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.24	0.25	0.14

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	770	370	0	0	0	160
Future Volume (vph)	770	370	0	0	0	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0				6.0
Lane Util. Factor	0.95	1.00				0.88
Frt	1.00	0.85				0.85
Flt Protected	1.00	1.00				1.00
Satd. Flow (prot)	3539	1583				2787
Flt Permitted	1.00	1.00				1.00
Satd. Flow (perm)	3539	1583				2787
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	837	402	0	0	0	174
RTOR Reduction (vph)	0	199	0	0	0	0
Lane Group Flow (vph)	837	203	0	0	0	174
Turn Type	NA	Perm				Prot
Protected Phases	1					2
Permitted Phases		1				
Actuated Green, G (s)	17.5	17.5				5.1
Effective Green, g (s)	17.5	17.5				5.1
Actuated g/C Ratio	0.51	0.51				0.15
Clearance Time (s)	6.0	6.0				6.0
Vehicle Extension (s)	2.0	2.0				2.0
Lane Grp Cap (vph)	1789	800				410
v/s Ratio Prot	c0.24					c0.06
v/s Ratio Perm		0.13				
v/c Ratio	0.47	0.25				0.42
Uniform Delay, d1	5.5	4.8				13.4
Progression Factor	1.00	1.00				1.00
Incremental Delay, d2	0.1	0.1				0.3
Delay (s)	5.6	4.9				13.7
Level of Service	A	A				B
Approach Delay (s)	5.4			0.0	13.7	
Approach LOS	A			A	B	

Intersection Summary			
HCM 2000 Control Delay	6.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	34.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	75	635	250	175	205	60
Future Volume (Veh/h)	75	635	250	175	205	60
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.83	0.83	0.75	0.75	0.62	0.62
Hourly flow rate (vph)	90	765	333	233	331	97
Pedestrians			4		6	
Lane Width (ft)			12.0		12.0	
Walking Speed (ft/s)			3.5		3.5	
Percent Blockage			0		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	572				1404	456
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	572				1404	456
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	91				0	84
cM capacity (veh/h)	1000				137	601

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	855	566	428
Volume Left	90	0	331
Volume Right	0	233	97
cSH	1000	1700	166
Volume to Capacity	0.09	0.33	2.57
Queue Length 95th (ft)	7	0	926
Control Delay (s)	2.3	0.0	769.1
Lane LOS	A		F
Approach Delay (s)	2.3	0.0	769.1
Approach LOS			F

Intersection Summary			
Average Delay	179.1		
Intersection Capacity Utilization	86.7%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	760	80	80	325	100	145
Future Volume (Veh/h)	760	80	80	325	100	145
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	884	93	101	411	127	184
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			981		1548	934
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			981		1548	934
tC, single (s)			4.1		6.4	6.3
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.4
p0 queue free %			86		0	42
cM capacity (veh/h)			701		107	315

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	977	512	311
Volume Left	0	101	127
Volume Right	93	0	184
cSH	1700	701	176
Volume to Capacity	0.57	0.14	1.77
Queue Length 95th (ft)	0	13	554
Control Delay (s)	0.0	3.8	413.4
Lane LOS		A	F
Approach Delay (s)	0.0	3.8	413.4
Approach LOS			F

Intersection Summary			
Average Delay	72.5		
Intersection Capacity Utilization	90.9%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	700	205	105	290	75	115
Future Volume (Veh/h)	700	205	105	290	75	115
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.89	0.89	0.76	0.76
Hourly flow rate (vph)	753	220	118	326	99	151
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			973		1425	863
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			973		1425	863
tC, single (s)			4.2		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			83		20	57
cM capacity (veh/h)			689		123	351

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	973	444	250
Volume Left	0	118	99
Volume Right	220	0	151
cSH	1700	689	203
Volume to Capacity	0.57	0.17	1.23
Queue Length 95th (ft)	0	15	327
Control Delay (s)	0.0	4.8	187.8
Lane LOS		A	F
Approach Delay (s)	0.0	4.8	187.8
Approach LOS			F

Intersection Summary			
Average Delay	29.4		
Intersection Capacity Utilization	91.6%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	815	5	15	350	5	20
Future Volume (Veh/h)	815	5	15	350	5	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	886	5	16	380	5	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			891		1300	888
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			891		1300	888
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		97	94
cM capacity (veh/h)			761		174	342

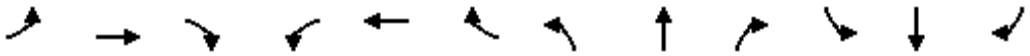
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	891	396	27
Volume Left	0	16	5
Volume Right	5	0	22
cSH	1700	761	290
Volume to Capacity	0.52	0.02	0.09
Queue Length 95th (ft)	0	2	8
Control Delay (s)	0.0	0.7	18.7
Lane LOS		A	C
Approach Delay (s)	0.0	0.7	18.7
Approach LOS			C

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	53.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	845	0	1	370	2	5
Future Volume (Veh/h)	845	0	1	370	2	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	918	0	1	402	2	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			918		1322	918
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			918		1322	918
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	98
cM capacity (veh/h)			743		172	329

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	918	403	7
Volume Left	0	1	2
Volume Right	0	0	5
cSH	1700	743	261
Volume to Capacity	0.54	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.0	19.2
Lane LOS		A	C
Approach Delay (s)	0.0	0.0	19.2
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	1	0	10	0	5	1	400	65	10	305	2
Future Volume (Veh/h)	5	1	0	10	0	5	1	400	65	10	305	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.63	0.63	0.63	0.65	0.65	0.65	0.82	0.82	0.82	0.81	0.81	0.81
Hourly flow rate (vph)	8	2	0	15	0	8	1	488	79	12	377	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	940	971	378	932	932	528	379			567		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	940	971	378	932	932	528	379			567		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	97	99	100	94	100	99	100			99		
cM capacity (veh/h)	240	252	673	235	263	551	1179			1015		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	10	23	568	391
Volume Left	8	15	1	12
Volume Right	0	8	79	2
cSH	242	293	1179	1015
Volume to Capacity	0.04	0.08	0.00	0.01
Queue Length 95th (ft)	3	6	0	1
Control Delay (s)	20.5	18.3	0.0	0.4
Lane LOS	C	C	A	A
Approach Delay (s)	20.5	18.3	0.0	0.4
Approach LOS	C	C		

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	35.4%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	30	10	455	65	20	295
Future Volume (Veh/h)	30	10	455	65	20	295
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.79	0.79	0.90	0.90	0.80	0.80
Hourly flow rate (vph)	38	13	506	72	25	369
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	961	542			578	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	961	542			578	
tC, single (s)	6.5	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.6	3.3			2.2	
p0 queue free %	86	98			98	
cM capacity (veh/h)	264	544			1006	

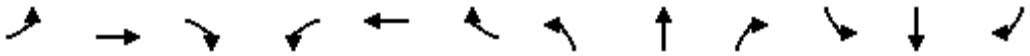
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	51	578	394
Volume Left	38	0	25
Volume Right	13	72	0
cSH	304	1700	1006
Volume to Capacity	0.17	0.34	0.02
Queue Length 95th (ft)	15	0	2
Control Delay (s)	19.2	0.0	0.8
Lane LOS	C		A
Approach Delay (s)	19.2	0.0	0.8
Approach LOS	C		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	41.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	1	520	65	15	310
Future Volume (Veh/h)	5	1	520	65	15	310
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	1	565	71	16	337
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	970	600			636	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	970	600			636	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	100			98	
cM capacity (veh/h)	276	501			947	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	6	636	353
Volume Left	5	0	16
Volume Right	1	71	0
cSH	299	1700	947
Volume to Capacity	0.02	0.37	0.02
Queue Length 95th (ft)	2	0	1
Control Delay (s)	17.3	0.0	0.6
Lane LOS	C		A
Approach Delay (s)	17.3	0.0	0.6
Approach LOS	C		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	41.3%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	40	15	80	5	1	2	20	545	80	35	275	5
Future Volume (Veh/h)	40	15	80	5	1	2	20	545	80	35	275	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	43	16	87	5	1	2	22	592	87	38	299	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								1234				
pX, platoon unblocked	0.94	0.94		0.94	0.94	0.94				0.94		
vC, conflicting volume	1060	1100	302	1152	1060	636	304			679		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1029	1073	302	1128	1029	577	304			623		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	77	92	88	96	100	100	98			96		
cM capacity (veh/h)	188	194	738	134	206	484	1257			897		

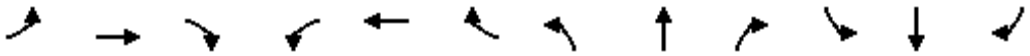
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	146	8	701	342
Volume Left	43	5	22	38
Volume Right	87	2	87	5
cSH	340	173	1257	897
Volume to Capacity	0.43	0.05	0.02	0.04
Queue Length 95th (ft)	52	4	1	3
Control Delay (s)	23.3	26.8	0.5	1.4
Lane LOS	C	D	A	A
Approach Delay (s)	23.3	26.8	0.5	1.4
Approach LOS	C	D		

Intersection Summary				
Average Delay	3.7			
Intersection Capacity Utilization	52.2%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	15	10	635	45	20	340
Future Volume (Veh/h)	15	10	635	45	20	340
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.60	0.60	0.95	0.95	0.91	0.91
Hourly flow rate (vph)	25	17	668	47	22	374
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			713			
pX, platoon unblocked	0.89	0.89			0.89	
vC, conflicting volume	1110	692			715	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1060	588			615	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	88	96			97	
cM capacity (veh/h)	216	454			864	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	42	715	396
Volume Left	25	0	22
Volume Right	17	47	0
cSH	275	1700	864
Volume to Capacity	0.15	0.42	0.03
Queue Length 95th (ft)	13	0	2
Control Delay (s)	20.5	0.0	0.8
Lane LOS	C		A
Approach Delay (s)	20.5	0.0	0.8
Approach LOS	C		

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	5	20	0	15	15	665	35	15	340	2
Future Volume (Veh/h)	0	0	5	20	0	15	15	665	35	15	340	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	0	8	22	0	17	17	739	39	18	410	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								398				
pX, platoon unblocked	0.86	0.86		0.86	0.86	0.86				0.86		
vC, conflicting volume	1256	1259	411	1248	1240	758	412			778		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1218	1220	411	1207	1199	640	412			662		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	83	100	96	99			98		
cM capacity (veh/h)	126	149	641	132	154	410	1147			798		

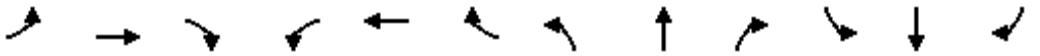
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	8	22	17	795	430
Volume Left	0	22	0	17	18
Volume Right	8	0	17	39	2
cSH	641	132	410	1147	798
Volume to Capacity	0.01	0.17	0.04	0.01	0.02
Queue Length 95th (ft)	1	14	3	1	2
Control Delay (s)	10.7	37.5	14.2	0.4	0.7
Lane LOS	B	E	B	A	A
Approach Delay (s)	10.7	27.3		0.4	0.7
Approach LOS	B	D			

Intersection Summary				
Average Delay	1.4			
Intersection Capacity Utilization	57.0%	ICU Level of Service	B	
Analysis Period (min)	15			

Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	223	266	46	287	701	443
v/c Ratio	0.82	0.42	0.20	0.77	0.87	0.58
Control Delay	52.5	29.2	38.0	55.1	37.1	24.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	52.5	29.2	38.0	55.1	37.1	24.0
Queue Length 50th (ft)	105	128	25	176	367	183
Queue Length 95th (ft)	#225	252	65	313	#842	439
Internal Link Dist (ft)		238		291	396	469
Turn Bay Length (ft)	120		100			
Base Capacity (vph)	273	778	320	508	810	763
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	0.82	0.34	0.14	0.56	0.87	0.58

Intersection Summary

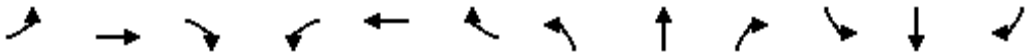
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	210	220	30	40	190	60	30	520	60	25	300	100
Future Volume (vph)	210	220	30	40	190	60	30	520	60	25	300	100
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			1605			1546	
Flt Permitted	0.29	1.00		0.60	1.00			0.96			0.94	
Satd. Flow (perm)	524	1819		1123	1781			1551			1461	
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)	223	234	32	46	218	69	34	598	69	26	312	104
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	223	266	0	46	287	0	0	701	0	0	443	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			800			754	
v/s Ratio Prot	c0.08	0.15			0.16							
v/s Ratio Perm	c0.17			0.04				c0.45			0.30	
v/c Ratio	0.83	0.42		0.20	0.78			0.88			0.59	
Uniform Delay, d1	32.1	27.1		35.5	40.6			23.1			18.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	18.6	0.5		0.4	10.5			10.6			1.2	
Delay (s)	50.7	27.5		35.9	51.1			33.7			19.3	
Level of Service	D	C		D	D			C			B	
Approach Delay (s)		38.1			49.0			33.7			19.3	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	34.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	107.9	Sum of lost time (s)	17.0
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

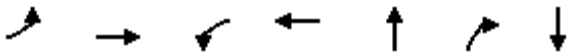
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	40	60	70	5	55	15	60	540	25	10	515	65
Future Volume (Veh/h)	40	60	70	5	55	15	60	540	25	10	515	65
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.84	0.84	0.84	0.98	0.98	0.98
Hourly flow rate (vph)	52	78	91	6	71	19	71	643	30	10	526	66
Pedestrians		4			4						8	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		3.5			3.5						3.5	
Percent Blockage		0			0						1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								549				
pX, platoon unblocked	0.61	0.61		0.61	0.61	0.61				0.61		
vC, conflicting volume	1446	1402	563	1513	1420	670	596			677		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1410	1338	563	1521	1368	129	596			141		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	0	7	82	29	12	97	92			99		
cM capacity (veh/h)	15	84	518	8	81	554	943			878		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	221	96	744	602
Volume Left	52	6	71	10
Volume Right	91	19	30	66
cSH	48	59	943	878
Volume to Capacity	4.56	1.62	0.08	0.01
Queue Length 95th (ft)	Err	218	6	1
Control Delay (s)	Err	460.1	1.9	0.3
Lane LOS	F	F	A	A
Approach Delay (s)	Err	460.1	1.9	0.3
Approach LOS	F	F		

Intersection Summary				
Average Delay	1356.3			
Intersection Capacity Utilization	87.3%	ICU Level of Service	E	
Analysis Period (min)	15			

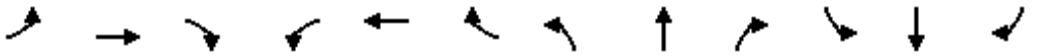


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	37	596	142	585	385	466	290
v/c Ratio	0.13	0.94	0.51	0.60	0.84	0.59	0.92dl
Control Delay	25.4	54.7	20.4	19.3	51.3	7.9	37.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.4	54.7	20.4	19.3	51.3	7.9	37.1
Queue Length 50th (ft)	13	290	32	180	189	25	69
Queue Length 95th (ft)	50	#745	109	473	#471	122	#160
Internal Link Dist (ft)		1245		611	311		2903
Turn Bay Length (ft)	150		150			150	
Base Capacity (vph)	277	633	291	991	456	805	489
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	0.13	0.94	0.49	0.59	0.84	0.58	0.59

Intersection Summary

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.

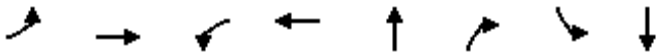


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	545	15	125	455	60	20	315	405	85	140	30
Future Volume (vph)	35	545	15	125	455	60	20	315	405	85	140	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost 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)	1727	1838		1805	1820			1875	1581		3453	
Flt Permitted	0.44	1.00		0.10	1.00			0.96	1.00		0.55	
Satd. Flow (perm)	807	1838		199	1820			1809	1581		1942	
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	580	16	142	517	68	23	362	466	97	159	34
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	251	0	0	0
Lane Group Flow (vph)	37	595	0	142	585	0	0	385	215	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)	30.6	30.6		47.5	47.5			22.3	31.7		22.3	
Effective Green, g (s)	30.6	30.6		47.5	47.5			22.3	31.7		22.3	
Actuated g/C Ratio	0.33	0.33		0.50	0.50			0.24	0.34		0.24	
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)	262	597		260	918			428	532		460	
v/s Ratio Prot		c0.32		0.05	c0.32				0.04			
v/s Ratio Perm	0.05			0.22				c0.21	0.10		0.15	
v/c Ratio	0.14	1.00		0.55	0.64			0.90	0.40		0.92dl	
Uniform Delay, d1	22.5	31.7		18.5	17.0			34.8	23.9		32.2	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.2	35.9		2.3	1.5			21.1	0.5		2.8	
Delay (s)	22.7	67.6		20.9	18.5			56.0	24.4		35.0	
Level of Service	C	E		C	B			E	C		D	
Approach Delay (s)		64.9			18.9			38.7			35.0	
Approach LOS		E			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	39.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	94.1	Sum of lost time (s)	28.5
Intersection Capacity Utilization	84.8%	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

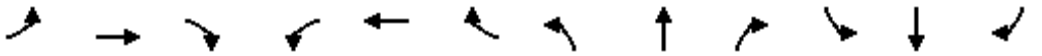


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	115	1040	49	1087	278	273	194	194
v/c Ratio	1.06	0.87	0.60	0.96	0.98	0.62	0.83	0.79
Control Delay	153.3	44.6	83.7	51.6	97.0	17.2	76.6	69.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	153.3	44.6	83.7	51.6	97.0	17.2	76.6	69.0
Queue Length 50th (ft)	~93	364	36	362	206	48	145	137
Queue Length 95th (ft)	#234	#512	83	#545	#434	102	#281	#264
Internal Link Dist (ft)		265		665	2948			318
Turn Bay Length (ft)	175		165			150	200	
Base Capacity (vph)	109	1335	275	1586	285	594	262	273
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.06	0.78	0.18	0.69	0.98	0.46	0.74	0.71

Intersection Summary

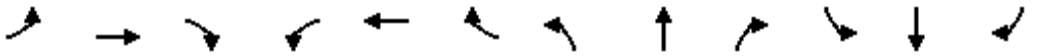
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	100	890	15	45	605	395	25	220	240	240	85	40
Future Volume (vph)	100	890	15	45	605	395	25	220	240	240	85	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	9.0	8.0		9.0	8.0			9.0	9.0	9.0	9.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.95	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			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	0.94			1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.98	
Satd. Flow (prot)	1752	3530		1805	3253			1874	1615	1665	1686	
Flt Permitted	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.98	
Satd. Flow (perm)	1752	3530		1805	3253			1874	1615	1665	1686	
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)	115	1023	17	49	658	429	28	250	273	255	90	43
RTOR Reduction (vph)	0	1	0	0	89	0	0	0	117	0	8	0
Lane Group Flow (vph)	115	1039	0	49	998	0	0	278	156	194	186	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	pt+ov	Split	NA	
Protected Phases	1	6		5	2		3	3	3 5	4	4	
Permitted Phases												
Actuated Green, G (s)	10.1	41.2		8.2	39.3			20.2	28.4	18.9	18.9	
Effective Green, g (s)	7.1	38.2		5.2	36.3			17.2	22.4	15.9	15.9	
Actuated g/C Ratio	0.06	0.34		0.05	0.33			0.15	0.20	0.14	0.14	
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)	111	1209		84	1059			289	324	237	240	
v/s Ratio Prot	c0.07	0.29		0.03	c0.31			c0.15	0.10	c0.12	0.11	
v/s Ratio Perm												
v/c Ratio	1.04	0.86		0.58	0.94			0.96	0.48	0.82	0.78	
Uniform Delay, d1	52.2	34.2		52.1	36.6			46.8	39.4	46.4	46.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	95.4	6.1		6.5	15.5			42.2	0.4	18.4	13.3	
Delay (s)	147.6	40.2		58.6	52.1			89.0	39.8	64.8	59.4	
Level of Service	F	D		E	D			F	D	E	E	
Approach Delay (s)		50.9			52.4			64.6			62.1	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	55.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	111.5	Sum of lost time (s)	39.0
Intersection Capacity Utilization	87.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	1250	120	0	350	475	0	0	965	0	0	695
Future Volume (Veh/h)	0	1250	120	0	350	475	0	0	965	0	0	695
Sign Control		Free			Free			Yield			Yield	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.98	0.98	0.98	0.92	0.96	0.98	0.92	0.92	0.92	0.98	0.98	0.98
Hourly flow rate (vph)	0	1276	122	0	365	485	0	0	1049	0	0	709
Pedestrians								1				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								0				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		745										
pX, platoon unblocked				0.74			0.74	0.74	0.74	0.74	0.74	
vC, conflicting volume	365			1277			1520	1703	700	1003	1642	182
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	365			668			998	1245	0	297	1162	182
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	0	0	100	14
cM capacity (veh/h)	1190			677			21	128	800	0	143	829

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	851	547	182	182	485	1049	709
Volume Left	0	0	0	0	0	0	0
Volume Right	0	122	0	0	485	1049	709
cSH	1700	1700	1700	1700	1700	800	829
Volume to Capacity	0.50	0.32	0.11	0.11	0.29	1.31	0.86
Queue Length 95th (ft)	0	0	0	0	0	1018	261
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	166.2	29.1
Lane LOS						F	D
Approach Delay (s)	0.0		0.0			166.2	29.1
Approach LOS						F	D

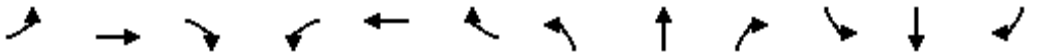
Intersection Summary				
Average Delay	48.7			
Intersection Capacity Utilization	104.8%	ICU Level of Service	G	
Analysis Period (min)	15			

Lane Group	EBT	EBR	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	1330	1142	995	138	131	52
v/c Ratio	1.68	0.81	0.54	0.44	0.33	0.27
Control Delay	330.9	7.4	18.8	36.1	9.9	24.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	330.9	7.4	18.8	36.1	9.9	24.3
Queue Length 50th (ft)	~607	11	193	73	7	15
Queue Length 95th (ft)	#802	#103	337	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	0.54	0.40	0.31	0.12

Intersection Summary

~ 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.



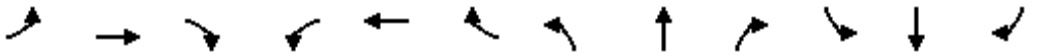
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	1165	1005	0	930	15	175	0	70	5	5	10
Future Volume (vph)	5	1165	1005	0	930	15	175	0	70	5	5	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		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		3432		1545	1472			1617	
Flt Permitted		0.95	1.00		1.00		0.95	0.98			0.99	
Satd. Flow (perm)		3301	1557		3432		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	1324	1142	0	979	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	1330	862	0	994	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)		1725	1230		1793		313	299			147	
v/s Ratio Prot			c0.14		0.29		0.09	0.03			c0.02	
v/s Ratio Perm		c0.40	0.41									
v/c Ratio		0.77	0.70		0.55		0.44	0.13			0.19	
Uniform Delay, d1		17.8	7.1		14.9		32.4	30.3			39.1	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		3.4	1.5		1.2		0.4	0.1			0.2	
Delay (s)		21.2	8.6		16.2		32.8	30.4			39.3	
Level of Service		C	A		B		C	C			D	
Approach Delay (s)		15.4			16.2			31.6			39.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	17.0	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	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	5	1123	1115	90	91	170	29	3
v/c Ratio	0.02	0.61	1.72dl	0.41	0.42	0.36	0.20	0.01
Control Delay	16.0	18.0	37.7	47.2	47.4	8.0	45.1	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.0	18.0	37.7	47.2	47.4	8.0	45.1	0.0
Queue Length 50th (ft)	1	201	157	52	53	0	16	0
Queue Length 95th (ft)	11	485	#672	126	127	57	36	0
Internal Link Dist (ft)		601	248		256		190	
Turn Bay Length (ft)	125			150		100		50
Base Capacity (vph)	256	1878	1272	587	583	670	223	349
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.60	0.88	0.15	0.16	0.25	0.13	0.01

Intersection Summary

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.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	870	175	380	655	25	165	5	160	15	5	2
Future Volume (vph)	5	870	175	380	655	25	165	5	160	15	5	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		5.0	5.0	2.0		5.0	5.0
Lane Util. Factor	1.00	0.95			0.95		0.95	0.95	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00			1.00		1.00	1.00	0.99		1.00	0.99
Flpb, ped/bikes	1.00	1.00			1.00		1.00	1.00	1.00		1.00	1.00
Frt	1.00	0.97			1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00			0.98		0.95	0.95	1.00		0.96	1.00
Satd. Flow (prot)	1802	3375			3402		1681	1669	1496		1666	1594
Flt Permitted	0.24	1.00			0.51		0.95	0.95	1.00		0.96	1.00
Satd. Flow (perm)	462	3375			1769		1681	1669	1496		1666	1594
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.94	0.94	0.94	0.67	0.67	0.67
Adj. Flow (vph)	5	935	188	400	689	26	176	5	170	22	7	3
RTOR Reduction (vph)	0	9	0	0	1	0	0	0	137	0	0	3
Lane Group Flow (vph)	5	1114	0	0	1114	0	90	91	33	0	29	0
Confl. Peds. (#/hr)	3		2	2		3	1		1	1		1
Confl. Bikes (#/hr)			2									
Heavy Vehicles (%)	0%	4%	3%	2%	5%	0%	2%	25%	7%	13%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pm+ov	Split	NA	Perm
Protected Phases		6		5	2		3	3	5	4	4	
Permitted Phases	6			2					3			4
Actuated Green, G (s)	49.3	49.3			57.1		11.8	11.8	17.6		5.5	5.5
Effective Green, g (s)	49.3	49.3			57.1		11.8	11.8	17.6		5.5	5.5
Actuated g/C Ratio	0.55	0.55			0.63		0.13	0.13	0.19		0.06	0.06
Clearance Time (s)	6.0	6.0			6.0		5.0	5.0	2.0		5.0	5.0
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0	3.0		2.0	2.0
Lane Grp Cap (vph)	251	1840			1222		219	217	291		101	96
v/s Ratio Prot		c0.33			c0.06		0.05	c0.05	0.01		c0.02	
v/s Ratio Perm	0.01				0.52				0.01			0.00
v/c Ratio	0.02	0.61			1.72dl		0.41	0.42	0.11		0.29	0.00
Uniform Delay, d1	9.4	13.9			14.5		36.1	36.1	30.0		40.6	39.9
Progression Factor	1.00	1.00			1.00		1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.0	0.4			10.1		0.5	0.5	0.2		0.6	0.0
Delay (s)	9.5	14.3			24.6		36.6	36.6	30.2		41.1	39.9
Level of Service	A	B			C		D	D	C		D	D
Approach Delay (s)		14.3			24.6			33.5			41.0	
Approach LOS		B			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	21.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.4	Sum of lost time (s)	24.0
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		

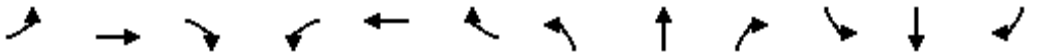
dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	584	88	304	395	632	76	76
v/c Ratio	0.39	0.21	0.30	1.25	0.39	0.39	0.16
Control Delay	22.2	14.3	13.8	171.2	0.7	36.5	21.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.2	14.3	13.8	171.2	0.7	36.5	21.5
Queue Length 50th (ft)	109	20	72	~285	0	32	28
Queue Length 95th (ft)	#252	71	213	#461	0	65	60
Internal Link Dist (ft)	362		363	827			2948
Turn Bay Length (ft)		190			400	125	
Base Capacity (vph)	1502	425	1011	315	1615	216	547
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	0.39	0.21	0.30	1.25	0.39	0.35	0.14

Intersection Summary

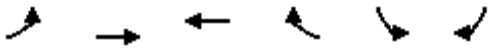
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	30	455	0	85	230	65	5	355	575	70	60	10
Future Volume (vph)	30	455	0	85	230	65	5	355	575	70	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	0.97			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	1770			1880	1615	1770	1801	
Flt Permitted		0.92		0.32	1.00			1.00	1.00	0.20	1.00	
Satd. Flow (perm)		3279		589	1770			1875	1615	369	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	67	5	390	632	76	65	11
RTOR Reduction (vph)	0	0	0	0	7	0	0	0	0	0	7	0
Lane Group Flow (vph)	0	584	0	88	297	0	0	395	632	76	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)		37.6		48.4	48.4			15.2	90.0	25.2	25.2	
Effective Green, g (s)		37.6		48.4	48.4			15.2	90.0	25.2	25.2	
Actuated g/C Ratio		0.42		0.54	0.54			0.17	1.00	0.28	0.28	
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)		1369		390	951			316	1615	181	504	
v/s Ratio Prot				0.01	0.17					0.02	0.04	
v/s Ratio Perm		0.18		0.11				c0.21	c0.39	0.09		
v/c Ratio		0.43		0.23	0.31			1.25	0.39	0.42	0.14	
Uniform Delay, d1		18.6		10.9	11.6			37.4	0.0	37.5	24.3	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.0		0.1	0.9			136.1	0.7	0.6	0.0	
Delay (s)		19.5		11.0	12.4			173.5	0.7	38.0	24.3	
Level of Service		B		B	B			F	A	D	C	
Approach Delay (s)		19.5			12.1			67.2			31.2	
Approach LOS		B			B			E			C	

Intersection Summary			
HCM 2000 Control Delay	41.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	720	395	0	105
Future Volume (Veh/h)	0	0	720	395	0	105
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.97	0.97	0.92	0.92
Hourly flow rate (vph)	0	0	742	407	0	114
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	742				946	574
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	742				946	574
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	75
cM capacity (veh/h)	861				260	461

Direction, Lane #	WB 1	WB 2	SB 1
Volume Total	495	654	114
Volume Left	0	0	0
Volume Right	0	407	114
cSH	1700	1700	461
Volume to Capacity	0.29	0.38	0.25
Queue Length 95th (ft)	0	0	24
Control Delay (s)	0.0	0.0	15.3
Lane LOS			C
Approach Delay (s)	0.0		15.3
Approach LOS			C

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBT	EBR	NBR
Lane Group Flow (vph)	1847	484	462
v/c Ratio	0.76	0.40	1.03
Control Delay	10.1	1.3	90.2
Queue Delay	0.0	0.0	0.0
Total Delay	10.1	1.3	90.2
Queue Length 50th (ft)	268	0	~146
Queue Length 95th (ft)	327	20	#371
Internal Link Dist (ft)	162		
Turn Bay Length (ft)			100
Base Capacity (vph)	3382	1494	447
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.55	0.32	1.03

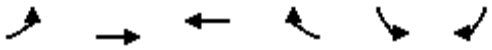
Intersection Summary

~ 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.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1755	460	0	0	0	420
Future Volume (vph)	1755	460	0	0	0	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0				6.0
Lane Util. Factor	0.95	1.00				0.88
Frpb, ped/bikes	1.00	0.97				1.00
Flpb, ped/bikes	1.00	1.00				1.00
Frt	1.00	0.85				0.85
Flt Protected	1.00	1.00				1.00
Satd. Flow (prot)	3539	1544				2787
Flt Permitted	1.00	1.00				1.00
Satd. Flow (perm)	3539	1544				2787
Peak-hour factor, PHF	0.95	0.95	0.92	0.92	0.91	0.91
Adj. Flow (vph)	1847	484	0	0	0	462
RTOR Reduction (vph)	0	147	0	0	0	0
Lane Group Flow (vph)	1847	337	0	0	0	462
Confl. Peds. (#/hr)		2	2			
Turn Type	NA	Perm				Prot
Protected Phases	1					2
Permitted Phases		1				
Actuated Green, G (s)	58.2	58.2				13.5
Effective Green, g (s)	58.2	58.2				13.5
Actuated g/C Ratio	0.70	0.70				0.16
Clearance Time (s)	6.0	6.0				6.0
Vehicle Extension (s)	2.0	2.0				2.0
Lane Grp Cap (vph)	2460	1073				449
v/s Ratio Prot	c0.52					c0.17
v/s Ratio Perm		0.22				
v/c Ratio	0.75	0.31				1.03
Uniform Delay, d1	8.1	5.0				35.1
Progression Factor	1.00	1.00				1.00
Incremental Delay, d2	1.2	0.1				50.1
Delay (s)	9.3	5.0				85.2
Level of Service	A	A				F
Approach Delay (s)	8.4			0.0	85.2	
Approach LOS	A			A	F	

Intersection Summary			
HCM 2000 Control Delay	21.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	83.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	20	295	580	160	140	50
Future Volume (Veh/h)	20	295	580	160	140	50
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.86	0.86	0.94	0.94
Hourly flow rate (vph)	22	321	674	186	149	53
Pedestrians		2	7			
Lane Width (ft)		12.0	12.0			
Walking Speed (ft/s)		3.5	3.5			
Percent Blockage		0	1			
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	860				1139	769
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	860				1139	769
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				30	87
cM capacity (veh/h)	786				214	404

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	343	860	202
Volume Left	22	0	149
Volume Right	0	186	53
cSH	786	1700	244
Volume to Capacity	0.03	0.51	0.83
Queue Length 95th (ft)	2	0	162
Control Delay (s)	0.9	0.0	64.7
Lane LOS	A		F
Approach Delay (s)	0.9	0.0	64.7
Approach LOS			F

Intersection Summary			
Average Delay	9.5		
Intersection Capacity Utilization	57.9%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	345	90	125	685	65	115
Future Volume (Veh/h)	345	90	125	685	65	115
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.71	0.71	0.89	0.89
Hourly flow rate (vph)	371	97	176	965	73	129
Pedestrians					3	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			471		1740	422
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			471		1740	422
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			84		9	80
cM capacity (veh/h)			1077		80	629

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	468	1141	202
Volume Left	0	176	73
Volume Right	97	0	129
cSH	1700	1077	180
Volume to Capacity	0.28	0.16	1.12
Queue Length 95th (ft)	0	15	254
Control Delay (s)	0.0	4.3	155.6
Lane LOS		A	F
Approach Delay (s)	0.0	4.3	155.6
Approach LOS			F

Intersection Summary			
Average Delay	20.0		
Intersection Capacity Utilization	87.3%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	435	80	160	690	115	105
Future Volume (Veh/h)	435	80	160	690	115	105
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.82	0.82	0.61	0.61
Hourly flow rate (vph)	483	89	195	841	189	172
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			572		1758	528
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			572		1758	528
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			81		0	69
cM capacity (veh/h)			1006		76	547

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	572	1036	361
Volume Left	0	195	189
Volume Right	89	0	172
cSH	1700	1006	129
Volume to Capacity	0.34	0.19	2.80
Queue Length 95th (ft)	0	18	828
Control Delay (s)	0.0	4.7	885.7
Lane LOS		A	F
Approach Delay (s)	0.0	4.7	885.7
Approach LOS			F

Intersection Summary			
Average Delay	164.9		
Intersection Capacity Utilization	95.7%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	510	5	15	805	15	45
Future Volume (Veh/h)	510	5	15	805	15	45
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	554	5	16	875	16	49
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			559		1464	556
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			559		1464	556
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		89	91
cM capacity (veh/h)			1012		139	530

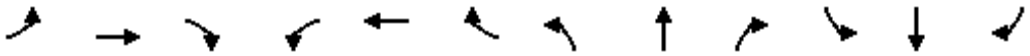
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	559	891	65
Volume Left	0	16	16
Volume Right	5	0	49
cSH	1700	1012	314
Volume to Capacity	0.33	0.02	0.21
Queue Length 95th (ft)	0	1	19
Control Delay (s)	0.0	0.4	19.5
Lane LOS		A	C
Approach Delay (s)	0.0	0.4	19.5
Approach LOS			C

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	550	2	2	825	0	2
Future Volume (Veh/h)	550	2	2	825	0	2
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	598	2	2	897	0	2
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			600		1500	599
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			600		1500	599
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			977		134	502

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	600	899	2
Volume Left	0	2	0
Volume Right	2	0	2
cSH	1700	977	502
Volume to Capacity	0.35	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	0.1	12.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	12.2
Approach LOS			B

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	55.0%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	0	0	55	0	2	0	230	20	1	370	0
Future Volume (Veh/h)	1	0	0	55	0	2	0	230	20	1	370	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.25	0.25	0.25	0.76	0.76	0.76	0.83	0.83	0.83	0.66	0.66	0.66
Hourly flow rate (vph)	4	0	0	72	0	3	0	277	24	2	561	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	857	866	561	854	854	289	561			301		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	857	866	561	854	854	289	561			301		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	100	100	74	100	100	100			100		
cM capacity (veh/h)	278	293	531	281	298	755	1020			1272		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	4	75	301	563
Volume Left	4	72	0	2
Volume Right	0	3	24	0
cSH	278	288	1020	1272
Volume to Capacity	0.01	0.26	0.00	0.00
Queue Length 95th (ft)	1	25	0	0
Control Delay (s)	18.1	21.9	0.0	0.0
Lane LOS	C	C		A
Approach Delay (s)	18.1	21.9	0.0	0.0
Approach LOS	C	C		

Intersection Summary				
Average Delay	1.8			
Intersection Capacity Utilization	30.3%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	95	20	230	45	10	415
Future Volume (Veh/h)	95	20	230	45	10	415
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.80	0.80	0.90	0.90	0.66	0.66
Hourly flow rate (vph)	119	25	256	50	15	629
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	940	281			306	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	940	281			306	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	59	97			99	
cM capacity (veh/h)	290	763			1266	

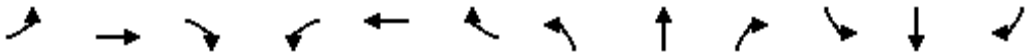
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	144	306	644
Volume Left	119	0	15
Volume Right	25	50	0
cSH	325	1700	1266
Volume to Capacity	0.44	0.18	0.01
Queue Length 95th (ft)	54	0	1
Control Delay (s)	24.6	0.0	0.3
Lane LOS	C		A
Approach Delay (s)	24.6	0.0	0.3
Approach LOS	C		

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	55	15	260	10	2	510
Future Volume (Veh/h)	55	15	260	10	2	510
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	60	16	283	11	2	554
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	846	288			294	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	846	288			294	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	82	98			100	
cM capacity (veh/h)	332	751			1268	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	76	294	556
Volume Left	60	0	2
Volume Right	16	11	0
cSH	376	1700	1268
Volume to Capacity	0.20	0.17	0.00
Queue Length 95th (ft)	19	0	0
Control Delay (s)	17.0	0.0	0.0
Lane LOS	C		A
Approach Delay (s)	17.0	0.0	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	1	15	65	5	25	45	240	20	5	535	25
Future Volume (Veh/h)	5	1	15	65	5	25	45	240	20	5	535	25
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	1	16	71	5	27	49	261	22	5	582	27
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								1234				
pX, platoon unblocked												
vC, conflicting volume	1005	986	596	992	989	272	609			283		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1005	986	596	992	989	272	609			283		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	97	66	98	96	95			100		
cM capacity (veh/h)	200	234	504	208	233	767	970			1279		

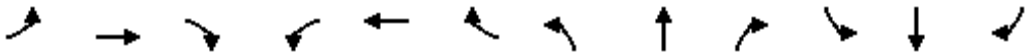
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	22	103	332	614
Volume Left	5	71	49	5
Volume Right	16	27	22	27
cSH	361	259	970	1279
Volume to Capacity	0.06	0.40	0.05	0.00
Queue Length 95th (ft)	5	45	4	0
Control Delay (s)	15.6	27.8	1.8	0.1
Lane LOS	C	D	A	A
Approach Delay (s)	15.6	27.8	1.8	0.1
Approach LOS	C	D		

Intersection Summary				
Average Delay	3.6			
Intersection Capacity Utilization	63.9%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	25	15	290	5	5	610
Future Volume (Veh/h)	25	15	290	5	5	610
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.81	0.81	0.75	0.75	0.73	0.73
Hourly flow rate (vph)	31	19	387	7	7	836
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			713			
pX, platoon unblocked						
vC, conflicting volume	1240	390			394	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1240	390			394	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	84	97			99	
cM capacity (veh/h)	194	662			1176	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	50	394	843
Volume Left	31	0	7
Volume Right	19	7	0
cSH	265	1700	1176
Volume to Capacity	0.19	0.23	0.01
Queue Length 95th (ft)	17	0	0
Control Delay (s)	21.7	0.0	0.2
Lane LOS	C		A
Approach Delay (s)	21.7	0.0	0.2
Approach LOS	C		

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	30	30	1	20	5	275	10	5	625	5
Future Volume (Veh/h)	0	0	30	30	1	20	5	275	10	5	625	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	0	40	42	1	28	6	320	12	5	679	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								398				
pX, platoon unblocked	0.98	0.98		0.98	0.98	0.98				0.98		
vC, conflicting volume	1058	1036	682	1070	1032	326	684			332		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1049	1026	682	1061	1023	303	684			309		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	91	76	100	96	99			100		
cM capacity (veh/h)	191	228	450	179	229	723	909			1227		

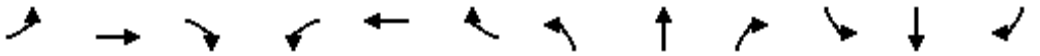
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	40	42	29	338	689
Volume Left	0	42	0	6	5
Volume Right	40	0	28	12	5
cSH	450	179	673	909	1227
Volume to Capacity	0.09	0.24	0.04	0.01	0.00
Queue Length 95th (ft)	7	22	3	0	0
Control Delay (s)	13.8	31.2	10.6	0.2	0.1
Lane LOS	B	D	B	A	A
Approach Delay (s)	13.8	22.8		0.2	0.1
Approach LOS	B	C			

Intersection Summary				
Average Delay	2.0			
Intersection Capacity Utilization	Err%	ICU Level of Service		H
Analysis Period (min)	15			

Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	201	327	81	250	556	698
v/c Ratio	0.61	0.47	0.35	0.65	0.80	0.96
Control Delay	29.6	24.0	34.3	40.2	33.6	51.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	29.6	24.0	34.3	40.2	33.6	51.3
Queue Length 50th (ft)	70	123	35	117	225	320
Queue Length 95th (ft)	154	251	88	229	#664	#889
Internal Link Dist (ft)		238		291	396	469
Turn Bay Length (ft)	120		100			
Base Capacity (vph)	331	957	384	640	692	727
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	0.61	0.34	0.21	0.39	0.80	0.96

Intersection Summary

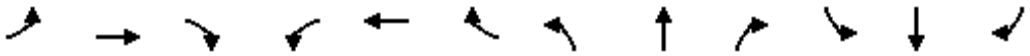
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	175	235	50	70	155	60	25	415	55	30	535	85
Future Volume (vph)	175	235	50	70	155	60	25	415	55	30	535	85
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			0.98			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1748	1841		1784	1767			1551			1617	
Flt Permitted	0.37	1.00		0.56	1.00			0.95			0.96	
Satd. Flow (perm)	687	1841		1057	1767			1481			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)	201	270	57	81	180	70	28	466	62	32	575	91
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	201	327	0	81	250	0	0	556	0	0	698	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)	28.7	34.2		19.0	19.0			40.9			40.9	
Effective Green, g (s)	28.7	34.2		19.0	19.0			40.9			40.9	
Actuated g/C Ratio	0.32	0.39		0.21	0.21			0.46			0.46	
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)	337	709		226	378			682			716	
v/s Ratio Prot	0.06	c0.18			c0.14							
v/s Ratio Perm	0.13			0.08				0.38			c0.45	
v/c Ratio	0.60	0.46		0.36	0.66			0.82			0.97	
Uniform Delay, d1	23.3	20.4		29.7	32.0			20.7			23.4	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	2.8	0.5		1.0	4.3			7.4			27.2	
Delay (s)	26.2	20.9		30.7	36.3			28.1			50.7	
Level of Service	C	C		C	D			C			D	
Approach Delay (s)		22.9			34.9			28.1			50.7	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	35.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	88.8	Sum of lost time (s)	16.5
Intersection Capacity Utilization	79.5%	ICU Level of Service	D
Analysis Period (min)	15		

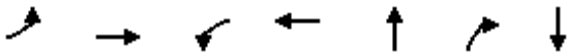
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	50	55	70	2	30	20	85	460	15	20	560	55
Future Volume (Veh/h)	50	55	70	2	30	20	85	460	15	20	560	55
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.81	0.81	0.81	0.91	0.91	0.91	0.98	0.98	0.98	0.92	0.92	0.92
Hourly flow rate (vph)	62	68	86	2	33	22	87	469	15	22	609	60
Pedestrians		4			5			9			8	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								549				
pX, platoon unblocked	0.89	0.89		0.89	0.89	0.89				0.89		
vC, conflicting volume	1384	1350	652	1468	1372	490	673			489		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1369	1331	652	1463	1356	360	673			359		
tC, single (s)	7.1	6.5	6.2	7.1	6.6	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.1	3.3	2.2			2.2		
p0 queue free %	16	43	81	95	71	96	90			98		
cM capacity (veh/h)	74	120	460	39	113	603	914			1068		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	216	57	571	691
Volume Left	62	2	87	22
Volume Right	86	22	15	60
cSH	136	150	914	1068
Volume to Capacity	1.59	0.38	0.10	0.02
Queue Length 95th (ft)	383	40	8	2
Control Delay (s)	356.3	42.9	2.5	0.5
Lane LOS	F	E	A	A
Approach Delay (s)	356.3	42.9	2.5	0.5
Approach LOS	F	E		

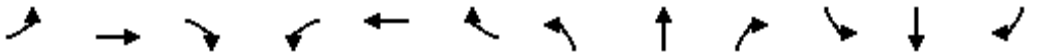
Intersection Summary				
Average Delay	52.9			
Intersection Capacity Utilization	88.8%	ICU Level of Service	E	
Analysis Period (min)	15			



Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	49	511	325	680	173	201	500
v/c Ratio	0.20	0.83	0.83	0.65	0.53	0.27	0.75
Control Delay	30.1	44.6	39.2	20.5	39.9	18.2	42.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.1	44.6	39.2	20.5	39.9	18.2	42.8
Queue Length 50th (ft)	19	260	109	231	83	62	134
Queue Length 95th (ft)	67	#656	#399	#672	191	162	#271
Internal Link Dist (ft)		1245		611	311		2903
Turn Bay Length (ft)	150		150			150	
Base Capacity (vph)	249	614	392	1041	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	0.20	0.83	0.83	0.65	0.46	0.27	0.65

Intersection Summary

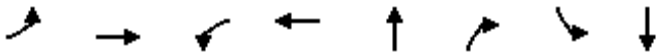
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	450	15	315	585	75	25	125	175	95	300	45
Future Volume (vph)	45	450	15	315	585	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	1829			1884	1615		3508	
Flt Permitted	0.41	1.00		0.13	1.00			0.74	1.00		0.80	
Satd. Flow (perm)	771	1891		252	1829			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	495	16	325	603	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	510	0	325	677	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)	236	580		370	980			308	603		624	
v/s Ratio Prot		0.27		c0.13	0.37				0.05			
v/s Ratio Perm	0.06			c0.33				0.12	0.07		c0.18	
v/c Ratio	0.21	0.88		0.88	0.69			0.56	0.33		0.80	
Uniform Delay, d1	25.5	32.8		23.7	17.0			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	0.4	14.2		20.3	2.1			2.3	0.3		7.3	
Delay (s)	26.0	47.0		44.0	19.1			36.9	22.7		44.1	
Level of Service	C	D		D	B			D	C		D	
Approach Delay (s)		45.2			27.2			29.3			44.1	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	35.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	99.6	Sum of lost time (s)	28.5
Intersection Capacity Utilization	87.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

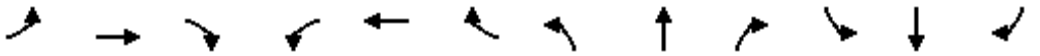


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	27	819	142	1284	96	108	414	411
v/c Ratio	0.44	0.88	0.86	0.99	0.56	0.26	0.90	0.87
Control Delay	80.0	51.9	91.9	59.2	63.3	6.5	64.5	60.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	80.0	51.9	91.9	59.2	63.3	6.5	64.5	60.1
Queue Length 50th (ft)	19	287	100	~535	66	4	295	284
Queue Length 95th (ft)	57	440	194	#774	127	24	#574	#554
Internal Link Dist (ft)		265		665	2948			318
Turn Bay Length (ft)	175		165			100	100	
Base Capacity (vph)	113	1195	275	1494	336	547	461	470
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.24	0.69	0.52	0.86	0.29	0.20	0.90	0.87

Intersection Summary

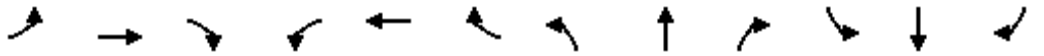
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	725	20	135	1015	205	20	60	90	430	170	85
Future Volume (vph)	25	725	20	135	1015	205	20	60	90	430	170	85
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	9.0	8.0		9.0	8.0			6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.95	0.95	
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	0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.99	
Satd. Flow (prot)	1770	3525		1770	3438			1840	1583	1681	1682	
Flt Permitted	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.99	
Satd. Flow (perm)	1770	3525		1770	3438			1840	1583	1681	1682	
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)	27	797	22	142	1068	216	24	72	108	518	205	102
RTOR Reduction (vph)	0	1	0	0	11	0	0	0	74	0	8	0
Lane Group Flow (vph)	27	818	0	142	1273	0	0	96	34	414	403	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)	4.1	35.1		13.5	44.5			10.4	23.9	30.5	30.5	
Effective Green, g (s)	1.1	32.1		10.5	41.5			10.4	23.9	30.5	30.5	
Actuated g/C Ratio	0.01	0.29		0.09	0.37			0.09	0.21	0.27	0.27	
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)	17	1005		165	1268			170	336	455	456	
v/s Ratio Prot	0.02	0.23		c0.08	c0.37			c0.05	0.02	c0.25	0.24	
v/s Ratio Perm												
v/c Ratio	1.59	0.81		0.86	1.00			0.56	0.10	0.91	0.88	
Uniform Delay, d1	55.7	37.4		50.3	35.5			48.9	35.7	39.7	39.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	437.6	4.9		33.0	26.2			2.5	0.0	21.4	17.6	
Delay (s)	493.3	42.3		83.3	61.7			51.4	35.7	61.1	56.9	
Level of Service	F	D		F	E			D	D	E	E	
Approach Delay (s)		56.7			63.8			43.1			59.0	
Approach LOS		E			E			D			E	

Intersection Summary			
HCM 2000 Control Delay	59.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	112.5	Sum of lost time (s)	33.0
Intersection Capacity Utilization	84.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	970	275	0	850	580	0	0	365	0	0	505
Future Volume (Veh/h)	0	970	275	0	850	580	0	0	365	0	0	505
Sign Control		Free			Free			Yield			Yield	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	1054	299	0	924	630	0	0	397	0	0	549
Pedestrians											2	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		745										
pX, platoon unblocked				0.79			0.79	0.79	0.79	0.79	0.79	
vC, conflicting volume	926			1054			1666	2130	676	1453	1980	464
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	926			552			1321	1905	77	1054	1717	464
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			0	100	48	100	100	0
cM capacity (veh/h)	732			806			0	54	770	69	71	544

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	703	650	462	462	630	397	549
Volume Left	0	0	0	0	0	0	0
Volume Right	0	299	0	0	630	397	549
cSH	1700	1700	1700	1700	1700	770	544
Volume to Capacity	0.41	0.38	0.27	0.27	0.37	0.52	1.01
Queue Length 95th (ft)	0	0	0	0	0	75	367
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	14.5	68.6
Lane LOS						B	F
Approach Delay (s)	0.0		0.0			14.5	68.6
Approach LOS						B	F

Intersection Summary				
Average Delay	11.3			
Intersection Capacity Utilization	64.9%	ICU Level of Service		C
Analysis Period (min)	15			

Lane Group	EBT	EBR	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	989	320	1882	425	407	20
v/c Ratio	0.60	0.22	1.16	0.69	0.60	0.16
Control Delay	23.9	0.6	103.6	30.8	20.3	25.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.9	0.6	103.6	30.8	20.3	25.0
Queue Length 50th (ft)	192	0	~626	222	144	2
Queue Length 95th (ft)	#418	12	#975	296	216	15
Internal Link Dist (ft)	96		601		420	187
Turn Bay Length (ft)				75		
Base Capacity (vph)	1638	1459	1629	619	673	429
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	0.60	0.22	1.16	0.69	0.60	0.05

Intersection Summary

~ 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.

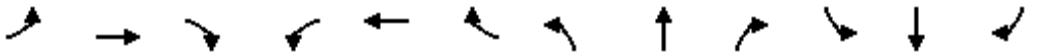
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	880	285	0	1670	5	630	0	110	1	1	10
Future Volume (vph)	0	880	285	0	1670	5	630	0	110	1	1	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		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	1631			1686	
Flt Permitted		1.00	1.00		1.00		0.95	0.97			1.00	
Satd. Flow (perm)		3610	1583		3538		1681	1631			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	989	320	0	1876	6	708	0	124	2	2	16
RTOR Reduction (vph)	0	0	67	0	0	0	0	74	0	0	16	0
Lane Group Flow (vph)	0	989	253	0	1882	0	425	333	0	0	4	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)		39.2	73.5		39.2		34.3	34.3			2.5	
Effective Green, g (s)		39.2	73.5		39.2		34.3	34.3			2.5	
Actuated g/C Ratio		0.42	0.79		0.42		0.37	0.37			0.03	
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)		1521	1353		1491		619	601			45	
v/s Ratio Prot		0.27	0.07		c0.53		c0.25	0.20			c0.00	
v/s Ratio Perm			0.09									
v/c Ratio		0.65	0.19		1.26		0.69	0.55			0.10	
Uniform Delay, d1		21.4	2.4		26.9		24.8	23.3			44.2	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		2.2	0.0		123.6		2.5	0.6			0.3	
Delay (s)		23.6	2.4		150.5		27.3	23.9			44.5	
Level of Service		C	A		F		C	C			D	
Approach Delay (s)		18.4			150.5			25.7			44.5	
Approach LOS		B			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	81.5	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	11	835	1126	231	230	289	92	36
v/c Ratio	0.06	0.54	0.90	0.73	0.73	0.48	0.48	0.11
Control Delay	24.9	24.2	32.3	51.9	51.3	13.3	50.8	0.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.9	24.2	32.3	51.9	51.3	13.3	50.8	0.6
Queue Length 50th (ft)	4	179	211	135	134	44	52	0
Queue Length 95th (ft)	22	389	#722	268	266	142	91	0
Internal Link Dist (ft)		601	248		256		190	
Turn Bay Length (ft)	125			150		100		50
Base Capacity (vph)	184	1542	1248	557	561	602	228	366
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.54	0.90	0.41	0.41	0.48	0.40	0.10

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



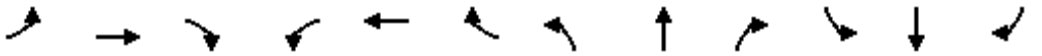
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	665	120	160	885	25	400	15	260	50	15	25
Future Volume (vph)	10	665	120	160	885	25	400	15	260	50	15	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			5.0		5.0	5.0	4.5		5.0	5.0
Lane Util. Factor	1.00	0.95			0.95		0.95	0.95	1.00		1.00	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	0.98			1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	0.96	1.00		0.96	1.00
Satd. Flow (prot)	1801	3497			3503		1698	1709	1568		1802	1553
Flt Permitted	0.22	1.00			0.59		0.95	0.96	1.00		0.96	1.00
Satd. Flow (perm)	421	3497			2074		1698	1709	1568		1802	1553
Peak-hour factor, PHF	0.94	0.94	0.94	0.95	0.95	0.95	0.90	0.90	0.90	0.70	0.70	0.70
Adj. Flow (vph)	11	707	128	168	932	26	444	17	289	71	21	36
RTOR Reduction (vph)	0	11	0	0	1	0	0	0	142	0	0	33
Lane Group Flow (vph)	11	824	0	0	1125	0	231	230	147	0	92	3
Confl. Peds. (#/hr)	4					4						
Heavy Vehicles (%)	0%	1%	0%	7%	1%	0%	1%	0%	3%	2%	0%	4%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pm+ov	Split	NA	Perm
Protected Phases		6		5	2		3	3	5	4	4	
Permitted Phases	6			2					3			4
Actuated Green, G (s)	41.5	41.5			52.7		17.5	17.5	23.2		8.7	8.7
Effective Green, g (s)	41.5	41.5			52.7		17.5	17.5	23.2		8.7	8.7
Actuated g/C Ratio	0.44	0.44			0.56		0.19	0.19	0.25		0.09	0.09
Clearance Time (s)	6.0	6.0			5.0		5.0	5.0	4.5		5.0	5.0
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0	3.0		2.0	2.0
Lane Grp Cap (vph)	186	1545			1250		316	318	387		166	143
v/s Ratio Prot		0.24			c0.05		c0.14	0.13	0.02		c0.05	
v/s Ratio Perm	0.03				c0.45				0.07			0.00
v/c Ratio	0.06	0.53			0.90		0.73	0.72	0.38		0.55	0.02
Uniform Delay, d1	15.0	19.1			18.3		36.0	35.9	29.4		40.7	38.7
Progression Factor	1.00	1.00			1.00		1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.0	0.2			8.7		7.3	6.7	0.6		2.3	0.0
Delay (s)	15.1	19.3			26.9		43.3	42.7	30.0		43.0	38.8
Level of Service	B	B			C		D	D	C		D	D
Approach Delay (s)		19.3			26.9			38.0			41.8	
Approach LOS		B			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	28.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	93.9	Sum of lost time (s)	26.5
Intersection Capacity Utilization	83.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	276	500	468	134	163	69	218
v/c Ratio	0.53	0.57	0.40	0.58	0.10	0.26	0.48
Control Delay	33.7	11.3	9.1	43.8	0.1	24.7	28.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.7	11.3	9.1	43.8	0.1	24.7	28.4
Queue Length 50th (ft)	68	126	112	64	0	26	87
Queue Length 95th (ft)	97	196	174	109	0	57	150
Internal Link Dist (ft)	362		363	827			2948
Turn Bay Length (ft)		190			400	125	
Base Capacity (vph)	523	878	1164	232	1583	276	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	0.40	0.58	0.10	0.25	0.43

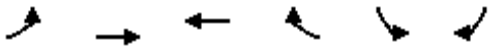
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	235	2	475	405	40	1	110	135	65	190	15
Future Volume (vph)	15	235	2	475	405	40	1	110	135	65	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	1838			1862	1583	1770	1842	
Flt Permitted		0.91		0.38	1.00			1.00	1.00	0.42	1.00	
Satd. Flow (perm)		3205		706	1838			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	42	1	133	163	69	202	16
RTOR Reduction (vph)	0	1	0	0	2	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	275	0	500	466	0	0	134	163	69	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)		12.1		49.6	49.6			10.0	80.0	20.4	20.4	
Effective Green, g (s)		12.1		49.6	49.6			10.0	80.0	20.4	20.4	
Actuated g/C Ratio		0.15		0.62	0.62			0.12	1.00	0.25	0.25	
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)		484		869	1139			232	1583	265	469	
v/s Ratio Prot				c0.23	0.25					0.02	c0.12	
v/s Ratio Perm		0.09		c0.12				c0.07	0.10	0.05		
v/c Ratio		0.57		0.58	0.41			0.58	0.10	0.26	0.46	
Uniform Delay, d1		31.5		8.5	7.7			33.0	0.0	23.3	25.1	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		4.8		0.6	0.1			2.2	0.1	0.2	0.3	
Delay (s)		36.3		9.0	7.8			35.2	0.1	23.5	25.4	
Level of Service		D		A	A			D	A	C	C	
Approach Delay (s)		36.3			8.5			15.9			24.9	
Approach LOS		D			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	16.5	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	58.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	1305	1005	0	125
Future Volume (Veh/h)	0	0	1305	1005	0	125
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	1418	1092	0	136
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1418				1964	1255
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1418				1964	1255
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	16
cM capacity (veh/h)	476				55	163

Direction, Lane #	WB 1	WB 2	SB 1
Volume Total	945	1565	136
Volume Left	0	0	0
Volume Right	0	1092	136
cSH	1700	1700	163
Volume to Capacity	0.56	0.92	0.84
Queue Length 95th (ft)	0	0	141
Control Delay (s)	0.0	0.0	88.4
Lane LOS			F
Approach Delay (s)	0.0		88.4
Approach LOS			F

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

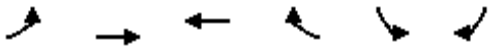
Lane Group	EBT	EBR	NBR
Lane Group Flow (vph)	1016	435	250
v/c Ratio	0.56	0.43	0.44
Control Delay	8.5	2.2	19.0
Queue Delay	0.0	0.0	0.0
Total Delay	8.5	2.2	19.0
Queue Length 50th (ft)	75	0	30
Queue Length 95th (ft)	129	29	70
Internal Link Dist (ft)	162		
Turn Bay Length (ft)			100
Base Capacity (vph)	3539	1583	868
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.29	0.27	0.29

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	935	400	0	0	0	230
Future Volume (vph)	935	400	0	0	0	230
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0				6.0
Lane Util. Factor	0.95	1.00				0.88
Frt	1.00	0.85				0.85
Flt Protected	1.00	1.00				1.00
Satd. Flow (prot)	3539	1583				2787
Flt Permitted	1.00	1.00				1.00
Satd. Flow (perm)	3539	1583				2787
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1016	435	0	0	0	250
RTOR Reduction (vph)	0	212	0	0	0	0
Lane Group Flow (vph)	1016	223	0	0	0	250
Turn Type	NA	Perm				Prot
Protected Phases	1					2
Permitted Phases		1				
Actuated Green, G (s)	21.8	21.8				8.7
Effective Green, g (s)	21.8	21.8				8.7
Actuated g/C Ratio	0.51	0.51				0.20
Clearance Time (s)	6.0	6.0				6.0
Vehicle Extension (s)	2.0	2.0				2.0
Lane Grp Cap (vph)	1815	811				570
v/s Ratio Prot	c0.29					c0.09
v/s Ratio Perm		0.14				
v/c Ratio	0.56	0.28				0.44
Uniform Delay, d1	7.1	5.9				14.8
Progression Factor	1.00	1.00				1.00
Incremental Delay, d2	0.2	0.1				0.2
Delay (s)	7.3	5.9				15.0
Level of Service	A	A				B
Approach Delay (s)	6.9			0.0	15.0	
Approach LOS	A			A	B	

Intersection Summary			
HCM 2000 Control Delay	8.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	42.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	43.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	75	660	255	175	220	60
Future Volume (Veh/h)	75	660	255	175	220	60
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.83	0.83	0.75	0.75	0.62	0.62
Hourly flow rate (vph)	90	795	340	233	355	97
Pedestrians			4		6	
Lane Width (ft)			12.0		12.0	
Walking Speed (ft/s)			3.5		3.5	
Percent Blockage			0		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	579				1442	462
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	579				1442	462
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	91				0	84
cM capacity (veh/h)	994				130	596

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	885	573	452
Volume Left	90	0	355
Volume Right	0	233	97
cSH	994	1700	156
Volume to Capacity	0.09	0.34	2.89
Queue Length 95th (ft)	7	0	1027
Control Delay (s)	2.3	0.0	913.0
Lane LOS	A		F
Approach Delay (s)	2.3	0.0	913.0
Approach LOS			F

Intersection Summary			
Average Delay	217.1		
Intersection Capacity Utilization	89.1%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	800	80	80	330	100	145
Future Volume (Veh/h)	800	80	80	330	100	145
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	930	93	101	418	127	184
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1027		1600	980
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1027		1600	980
tC, single (s)			4.1		6.4	6.3
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.4
p0 queue free %			85		0	38
cM capacity (veh/h)			674		99	296

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	1023	519	311
Volume Left	0	101	127
Volume Right	93	0	184
cSH	1700	674	163
Volume to Capacity	0.60	0.15	1.91
Queue Length 95th (ft)	0	13	587
Control Delay (s)	0.0	4.0	477.3
Lane LOS		A	F
Approach Delay (s)	0.0	4.0	477.3
Approach LOS			F

Intersection Summary			
Average Delay	81.2		
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	700	245	140	290	80	120
Future Volume (Veh/h)	700	245	140	290	80	120
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.89	0.89	0.76	0.76
Hourly flow rate (vph)	753	263	157	326	105	158
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1016		1524	884
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1016		1524	884
tC, single (s)			4.2		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			76		0	54
cM capacity (veh/h)			663		99	341

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	1016	483	263
Volume Left	0	157	105
Volume Right	263	0	158
cSH	1700	663	172
Volume to Capacity	0.60	0.24	1.53
Queue Length 95th (ft)	0	23	428
Control Delay (s)	0.0	6.3	313.6
Lane LOS		A	F
Approach Delay (s)	0.0	6.3	313.6
Approach LOS			F

Intersection Summary			
Average Delay	48.5		
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	820	5	15	385	5	20
Future Volume (Veh/h)	820	5	15	385	5	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	891	5	16	418	5	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			896		1344	894
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			896		1344	894
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		97	94
cM capacity (veh/h)			757		164	340

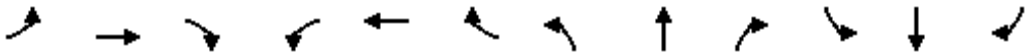
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	896	434	27
Volume Left	0	16	5
Volume Right	5	0	22
cSH	1700	757	284
Volume to Capacity	0.53	0.02	0.10
Queue Length 95th (ft)	0	2	8
Control Delay (s)	0.0	0.6	19.0
Lane LOS		A	C
Approach Delay (s)	0.0	0.6	19.0
Approach LOS			C

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	53.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	850	0	1	405	2	5
Future Volume (Veh/h)	850	0	1	405	2	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	924	0	1	440	2	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			924		1366	924
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			924		1366	924
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	98
cM capacity (veh/h)			739		162	327

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	924	441	7
Volume Left	0	1	2
Volume Right	0	0	5
cSH	1700	739	253
Volume to Capacity	0.54	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.0	19.6
Lane LOS		A	C
Approach Delay (s)	0.0	0.0	19.6
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	54.7%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	1	0	10	0	5	1	410	65	10	385	2
Future Volume (Veh/h)	5	1	0	10	0	5	1	410	65	10	385	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.63	0.63	0.63	0.65	0.65	0.65	0.82	0.82	0.82	0.81	0.81	0.81
Hourly flow rate (vph)	8	2	0	15	0	8	1	500	79	12	475	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1050	1081	476	1042	1042	540	477			579		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1050	1081	476	1042	1042	540	477			579		
tC, single (s)	7.1	6.5	6.2	7.2	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.0	3.3	2.2			2.2		
p0 queue free %	96	99	100	92	100	99	100			99		
cM capacity (veh/h)	202	217	593	197	227	542	1085			1005		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	10	23	580	489
Volume Left	8	15	1	12
Volume Right	0	8	79	2
cSH	205	253	1085	1005
Volume to Capacity	0.05	0.09	0.00	0.01
Queue Length 95th (ft)	4	7	0	1
Control Delay (s)	23.5	20.6	0.0	0.4
Lane LOS	C	C	A	A
Approach Delay (s)	23.5	20.6	0.0	0.4
Approach LOS	C	C		

Intersection Summary				
Average Delay	0.8			
Intersection Capacity Utilization	38.0%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	30	10	465	65	20	375
Future Volume (Veh/h)	30	10	465	65	20	375
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.79	0.79	0.90	0.90	0.80	0.80
Hourly flow rate (vph)	38	13	517	72	25	469
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1072	553			589	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1072	553			589	
tC, single (s)	6.5	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.6	3.3			2.2	
p0 queue free %	83	98			97	
cM capacity (veh/h)	226	537			996	

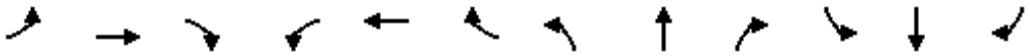
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	51	589	494
Volume Left	38	0	25
Volume Right	13	72	0
cSH	265	1700	996
Volume to Capacity	0.19	0.35	0.03
Queue Length 95th (ft)	17	0	2
Control Delay (s)	21.8	0.0	0.7
Lane LOS	C		A
Approach Delay (s)	21.8	0.0	0.7
Approach LOS	C		

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	1	530	65	15	390
Future Volume (Veh/h)	5	1	530	65	15	390
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	1	576	71	16	424
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1068	612			647	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1068	612			647	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	100			98	
cM capacity (veh/h)	241	493			939	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	6	647	440
Volume Left	5	0	16
Volume Right	1	71	0
cSH	264	1700	939
Volume to Capacity	0.02	0.38	0.02
Queue Length 95th (ft)	2	0	1
Control Delay (s)	19.0	0.0	0.5
Lane LOS	C		A
Approach Delay (s)	19.0	0.0	0.5
Approach LOS	C		

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	40	15	80	5	1	2	20	555	80	35	355	5
Future Volume (Veh/h)	40	15	80	5	1	2	20	555	80	35	355	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	43	16	87	5	1	2	22	603	87	38	386	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								1234				
pX, platoon unblocked												
vC, conflicting volume	1158	1198	388	1250	1158	646	391			690		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1158	1198	388	1250	1158	646	391			690		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	74	91	87	96	99	100	98			96		
cM capacity (veh/h)	164	174	660	115	184	471	1168			905		

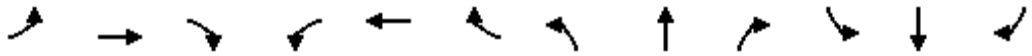
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	146	8	712	429
Volume Left	43	5	22	38
Volume Right	87	2	87	5
cSH	300	151	1168	905
Volume to Capacity	0.49	0.05	0.02	0.04
Queue Length 95th (ft)	63	4	1	3
Control Delay (s)	27.8	30.2	0.5	1.3
Lane LOS	D	D	A	A
Approach Delay (s)	27.8	30.2	0.5	1.3
Approach LOS	D	D		

Intersection Summary				
Average Delay	4.0			
Intersection Capacity Utilization	53.4%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	25	20	635	135	85	355
Future Volume (Veh/h)	25	20	635	135	85	355
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.60	0.60	0.95	0.95	0.91	0.91
Hourly flow rate (vph)	42	33	668	142	93	390
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			713			
pX, platoon unblocked	0.93	0.93			0.93	
vC, conflicting volume	1315	739			810	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1302	684			760	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	72	92			88	
cM capacity (veh/h)	148	422			803	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	75	810	483
Volume Left	42	0	93
Volume Right	33	142	0
cSH	207	1700	803
Volume to Capacity	0.36	0.48	0.12
Queue Length 95th (ft)	39	0	10
Control Delay (s)	32.0	0.0	3.2
Lane LOS	D		A
Approach Delay (s)	32.0	0.0	3.2
Approach LOS	D		

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	5	70	0	20	15	750	385	30	350	2
Future Volume (Veh/h)	0	0	5	70	0	20	15	750	385	30	350	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	0	8	78	0	22	17	833	428	36	422	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								398				
pX, platoon unblocked	0.86	0.86		0.86	0.86	0.86				0.86		
vC, conflicting volume	1598	1790	423	1584	1577	1047	424			1261		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1614	1837	423	1598	1589	974	424			1222		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	0	100	92	99			93		
cM capacity (veh/h)	62	59	631	68	85	263	1135			491		

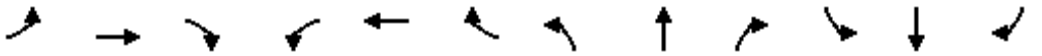
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	8	78	22	1278	460
Volume Left	0	78	0	17	36
Volume Right	8	0	22	428	2
cSH	631	68	263	1135	491
Volume to Capacity	0.01	1.15	0.08	0.01	0.07
Queue Length 95th (ft)	1	152	7	1	6
Control Delay (s)	10.8	259.0	19.9	0.6	2.2
Lane LOS	B	F	C	A	A
Approach Delay (s)	10.8	206.4		0.6	2.2
Approach LOS	B	F			

Intersection Summary				
Average Delay	12.2			
Intersection Capacity Utilization	83.9%	ICU Level of Service		E
Analysis Period (min)	15			

Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	239	266	46	287	741	453
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

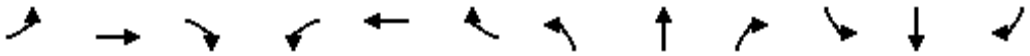
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



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		

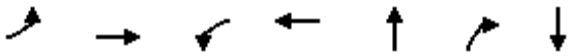
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	40	60	70	5	55	15	60	590	25	10	520	65
Future Volume (Veh/h)	40	60	70	5	55	15	60	590	25	10	520	65
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.77	0.77	0.77	0.84	0.84	0.84	0.98	0.98	0.98
Hourly flow rate (vph)	52	78	91	6	71	19	71	702	30	10	531	66
Pedestrians		4			4						8	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		3.5			3.5						3.5	
Percent Blockage		0			0						1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								549				
pX, platoon unblocked	0.55	0.55		0.55	0.55	0.55				0.55		
vC, conflicting volume	1510	1466	568	1577	1484	729	601			736		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1517	1438	568	1641	1471	86	601			98		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	0	0	82	0	0	96	92			99		
cM capacity (veh/h)	0	66	515	0	63	527	939			818		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	221	96	803	607
Volume Left	52	6	71	10
Volume Right	91	19	30	66
cSH	0	0	939	818
Volume to Capacity	Err	Err	0.08	0.01
Queue Length 95th (ft)	Err	Err	6	1
Control Delay (s)	Err	Err	1.9	0.3
Lane LOS	F	F	A	A
Approach Delay (s)	Err	Err	1.9	0.3
Approach LOS	F	F		

Intersection Summary				
Average Delay	Err			
Intersection Capacity Utilization	89.9%	ICU Level of Service	E	
Analysis Period (min)	15			

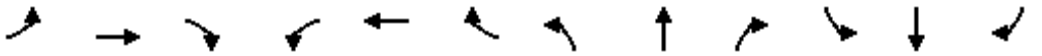


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	37	649	142	591	385	466	290
v/c Ratio	0.13	1.03	0.51	0.60	0.84	0.59	0.92dl
Control Delay	25.4	73.5	20.4	19.5	51.3	7.9	37.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.4	73.5	20.4	19.5	51.3	7.9	37.1
Queue Length 50th (ft)	13	330	32	182	189	25	69
Queue Length 95th (ft)	50	#830	109	480	#471	122	#160
Internal Link Dist (ft)		1245		611	311		2903
Turn Bay Length (ft)	150		150			150	
Base Capacity (vph)	276	633	291	991	456	805	489
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	0.13	1.03	0.49	0.60	0.84	0.58	0.59

Intersection Summary

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.

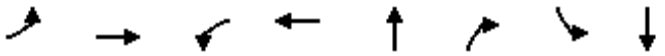


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	595	15	125	460	60	20	315	405	85	140	30
Future Volume (vph)	35	595	15	125	460	60	20	315	405	85	140	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost 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)	1727	1839		1805	1821			1875	1581		3453	
Flt Permitted	0.44	1.00		0.10	1.00			0.96	1.00		0.55	
Satd. Flow (perm)	803	1839		199	1821			1809	1581		1942	
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	251	0	0	0
Lane Group Flow (vph)	37	648	0	142	591	0	0	385	215	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)	30.6	30.6		47.5	47.5			22.3	31.7		22.3	
Effective Green, g (s)	30.6	30.6		47.5	47.5			22.3	31.7		22.3	
Actuated g/C Ratio	0.33	0.33		0.50	0.50			0.24	0.34		0.24	
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)	261	598		260	919			428	532		460	
v/s Ratio Prot		c0.35		0.05	c0.32				0.04			
v/s Ratio Perm	0.05			0.22				c0.21	0.10		0.15	
v/c Ratio	0.14	1.08		0.55	0.64			0.90	0.40		0.92dl	
Uniform Delay, d1	22.5	31.7		19.2	17.1			34.8	23.9		32.2	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.3	61.7		2.3	1.6			21.1	0.5		2.8	
Delay (s)	22.7	93.4		21.5	18.6			56.0	24.4		35.0	
Level of Service	C	F		C	B			E	C		D	
Approach Delay (s)		89.6			19.2			38.7			35.0	
Approach LOS		F			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	46.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	94.1	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

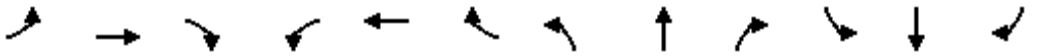


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	172	1040	49	1484	301	273	226	227
v/c Ratio	1.70	0.80	0.63	1.14	1.14	0.65	0.93	0.89
Control Delay	387.5	40.5	89.1	103.1	144.6	18.7	93.0	84.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	387.5	40.5	89.1	103.1	144.6	18.7	93.0	84.3
Queue Length 50th (ft)	~190	364	38	~616	~263	52	182	175
Queue Length 95th (ft)	#353	#512	83	#841	#480	102	#347	#335
Internal Link Dist (ft)		265		665	2948			318
Turn Bay Length (ft)	175		165			150	200	
Base Capacity (vph)	101	1298	255	1531	264	561	244	254
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.70	0.80	0.19	0.97	1.14	0.49	0.93	0.89

Intersection Summary

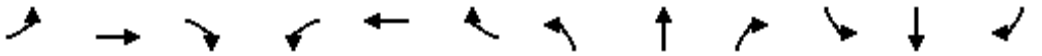
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



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)	9.0	8.0		9.0	8.0			9.0	9.0	9.0	9.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.95	0.95	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			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	0.92			1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.98	
Satd. Flow (prot)	1752	3530		1805	3176			1874	1615	1665	1684	
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	0.98	
Satd. Flow (perm)	1752	3530		1805	3176			1874	1615	1665	1684	
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	178	0	0	0	119	0	7	0
Lane Group Flow (vph)	172	1039	0	49	1306	0	0	301	154	226	220	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	pt+ov	Split	NA	
Protected Phases	1	6		5	2		3	3	3 5	4	4	
Permitted Phases												
Actuated Green, G (s)	10.0	47.2		8.3	45.5			20.0	28.3	20.7	20.7	
Effective Green, g (s)	7.0	44.2		5.3	42.5			17.0	22.3	17.7	17.7	
Actuated g/C Ratio	0.06	0.37		0.04	0.36			0.14	0.19	0.15	0.15	
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)	102	1308		80	1132			267	302	247	250	
v/s Ratio Prot	c0.10	0.29		0.03	c0.41			c0.16	0.10	c0.14	0.13	
v/s Ratio Perm												
v/c Ratio	1.69	0.79		0.61	1.15			1.13	0.51	0.91	0.88	
Uniform Delay, d1	56.1	33.5		55.9	38.4			51.1	43.5	50.0	49.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	347.4	3.2		9.4	79.5			93.8	0.5	34.5	27.5	
Delay (s)	403.5	36.6		65.3	117.8			144.9	44.0	84.5	77.3	
Level of Service	F	D		E	F			F	D	F	E	
Approach Delay (s)		88.7			116.1			96.9			80.9	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	100.2	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.20		
Actuated Cycle Length (s)	119.2	Sum of lost time (s)	39.0
Intersection Capacity Utilization	104.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	1275	145	0	550	475	0	0	965	0	0	860
Future Volume (Veh/h)	0	1275	145	0	550	475	0	0	965	0	0	860
Sign Control		Free			Free			Yield			Yield	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.98	0.98	0.98	0.92	0.96	0.98	0.92	0.92	0.92	0.98	0.98	0.98
Hourly flow rate (vph)	0	1301	148	0	573	485	0	0	1049	0	0	878
Pedestrians								1				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								0				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		745										
pX, platoon unblocked				0.75			0.75	0.75	0.75	0.75	0.75	
vC, conflicting volume	573			1302			1662	1949	726	1224	1875	286
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	573			735			1216	1598	0	630	1499	286
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			0	100	0	0	100	0
cM capacity (veh/h)	996			649			0	79	812	0	91	710

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	867	582	286	286	485	1049	878
Volume Left	0	0	0	0	0	0	0
Volume Right	0	148	0	0	485	1049	878
cSH	1700	1700	1700	1700	1700	812	710
Volume to Capacity	0.51	0.34	0.17	0.17	0.29	1.29	1.24
Queue Length 95th (ft)	0	0	0	0	0	989	786
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	158.1	138.3
Lane LOS						F	F
Approach Delay (s)	0.0		0.0			158.1	138.3
Approach LOS						F	F

Intersection Summary				
Average Delay	64.8			
Intersection Capacity Utilization	106.3%	ICU Level of Service	G	
Analysis Period (min)	15			

Lane Group	EBT	EBR	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	1336	1142	1032	138	131	52
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

~ 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.

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	

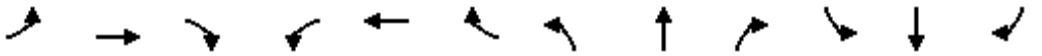
Intersection Summary			
HCM 2000 Control Delay	17.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	77.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	5	1129	1152	90	91	170	29	3
v/c Ratio	0.02	0.58	1.65dl	0.43	0.44	0.37	0.21	0.01
Control Delay	16.0	17.5	41.3	48.4	48.7	8.1	45.6	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.0	17.5	41.3	48.4	48.7	8.1	45.6	0.0
Queue Length 50th (ft)	1	203	164	52	53	0	16	0
Queue Length 95th (ft)	11	488	#731	126	127	57	36	0
Internal Link Dist (ft)		601	248		256		190	
Turn Bay Length (ft)	125			150		100		50
Base Capacity (vph)	249	1930	1174	547	543	637	210	338
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.02	0.58	0.98	0.16	0.17	0.27	0.14	0.01

Intersection Summary

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.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	875	175	380	690	25	165	5	160	15	5	2
Future Volume (vph)	5	875	175	380	690	25	165	5	160	15	5	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		5.0	5.0	2.0		5.0	5.0
Lane Util. Factor	1.00	0.95			0.95		0.95	0.95	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00			1.00		1.00	1.00	0.99		1.00	0.99
Flpb, ped/bikes	1.00	1.00			1.00		1.00	1.00	1.00		1.00	1.00
Frt	1.00	0.98			1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00			0.98		0.95	0.95	1.00		0.96	1.00
Satd. Flow (prot)	1802	3376			3403		1681	1669	1496		1666	1593
Flt Permitted	0.23	1.00			0.51		0.95	0.95	1.00		0.96	1.00
Satd. Flow (perm)	438	3376			1750		1681	1669	1496		1666	1593
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.94	0.94	0.94	0.67	0.67	0.67
Adj. Flow (vph)	5	941	188	400	726	26	176	5	170	22	7	3
RTOR Reduction (vph)	0	9	0	0	1	0	0	0	139	0	0	3
Lane Group Flow (vph)	5	1120	0	0	1151	0	90	91	31	0	29	0
Confl. Peds. (#/hr)	3		2	2		3	1		1	1		1
Confl. Bikes (#/hr)			2									
Heavy Vehicles (%)	0%	4%	3%	2%	5%	0%	2%	25%	7%	13%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pm+ov	Split	NA	Perm
Protected Phases		6		5	2		3	3	5	4	4	
Permitted Phases	6			2					3			4
Actuated Green, G (s)	53.9	53.9			61.5		11.7	11.7	17.3		5.8	5.8
Effective Green, g (s)	53.9	53.9			61.5		11.7	11.7	17.3		5.8	5.8
Actuated g/C Ratio	0.57	0.57			0.65		0.12	0.12	0.18		0.06	0.06
Clearance Time (s)	6.0	6.0			6.0		5.0	5.0	2.0		5.0	5.0
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0	3.0		2.0	2.0
Lane Grp Cap (vph)	248	1915			1230		207	205	272		101	97
v/s Ratio Prot		c0.33			c0.06		0.05	c0.05	0.01		c0.02	
v/s Ratio Perm	0.01				0.55				0.01			0.00
v/c Ratio	0.02	0.59			1.65dl		0.43	0.44	0.11		0.29	0.00
Uniform Delay, d1	9.0	13.3			15.0		38.6	38.6	32.4		42.6	41.9
Progression Factor	1.00	1.00			1.00		1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.0	0.3			12.9		0.5	0.6	0.2		0.6	0.0
Delay (s)	9.0	13.6			27.9		39.1	39.2	32.6		43.2	41.9
Level of Service	A	B			C		D	D	C		D	D
Approach Delay (s)		13.6			27.9			36.0			43.1	
Approach LOS		B			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	95.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		

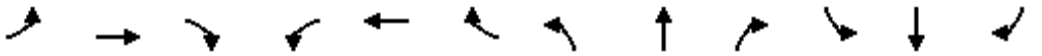
dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	584	88	325	395	632	82	76
v/c Ratio	0.39	0.21	0.32	1.25	0.39	0.41	0.15
Control Delay	22.3	14.4	13.9	172.5	0.7	37.2	21.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.3	14.4	13.9	172.5	0.7	37.2	21.5
Queue Length 50th (ft)	110	20	78	~285	0	34	27
Queue Length 95th (ft)	#253	71	227	#461	0	69	60
Internal Link Dist (ft)	362		363	827			2948
Turn Bay Length (ft)		190			400	125	
Base Capacity (vph)	1496	425	1005	315	1615	216	547
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	0.39	0.21	0.32	1.25	0.39	0.38	0.14

Intersection Summary

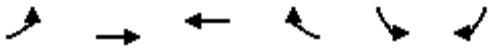
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



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		0.32	1.00			1.00	1.00	0.20	1.00	
Satd. Flow (perm)		3272		589	1757			1875	1615	371	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)		37.6		48.4	48.4			15.1	90.0	25.2	25.2	
Effective Green, g (s)		37.6		48.4	48.4			15.1	90.0	25.2	25.2	
Actuated g/C Ratio		0.42		0.54	0.54			0.17	1.00	0.28	0.28	
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)		1366		390	944			314	1615	183	504	
v/s Ratio Prot				0.01	0.18					0.03	0.04	
v/s Ratio Perm		0.18		0.11				c0.21	c0.39	0.10		
v/c Ratio		0.43		0.23	0.33			1.26	0.39	0.45	0.14	
Uniform Delay, d1		18.6		10.9	11.7			37.5	0.0	37.5	24.3	
Progression Factor		1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.0		0.1	1.0			139.4	0.7	0.6	0.0	
Delay (s)		19.6		11.0	12.7			176.8	0.7	38.2	24.3	
Level of Service		B		B	B			F	A	D	C	
Approach Delay (s)		19.6			12.3			68.4			31.5	
Approach LOS		B			B			E			C	

Intersection Summary			
HCM 2000 Control Delay	42.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.68		
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			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	755	395	0	270
Future Volume (Veh/h)	0	0	755	395	0	270
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.97	0.97	0.92	0.92
Hourly flow rate (vph)	0	0	778	407	0	293
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	778				982	592
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	778				982	592
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	35
cM capacity (veh/h)	834				246	449

Direction, Lane #	WB 1	WB 2	SB 1
Volume Total	519	666	293
Volume Left	0	0	0
Volume Right	0	407	293
cSH	1700	1700	449
Volume to Capacity	0.31	0.39	0.65
Queue Length 95th (ft)	0	0	114
Control Delay (s)	0.0	0.0	26.8
Lane LOS			D
Approach Delay (s)	0.0		26.8
Approach LOS			D

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		

Lane Group	EBT	EBR	NBR
Lane Group Flow (vph)	1853	505	462
v/c Ratio	0.75	0.41	1.05
Control Delay	10.0	1.3	94.1
Queue Delay	0.0	0.0	0.0
Total Delay	10.0	1.3	94.1
Queue Length 50th (ft)	270	0	~151
Queue Length 95th (ft)	328	20	#380
Internal Link Dist (ft)	162		
Turn Bay Length (ft)			100
Base Capacity (vph)	3362	1489	442
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.55	0.34	1.05

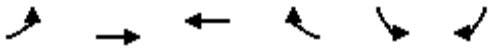
Intersection Summary

~ 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.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1760	480	0	0	0	420
Future Volume (vph)	1760	480	0	0	0	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0				6.0
Lane Util. Factor	0.95	1.00				0.88
Frpb, ped/bikes	1.00	0.97				1.00
Flpb, ped/bikes	1.00	1.00				1.00
Frt	1.00	0.85				0.85
Flt Protected	1.00	1.00				1.00
Satd. Flow (prot)	3539	1543				2787
Flt Permitted	1.00	1.00				1.00
Satd. Flow (perm)	3539	1543				2787
Peak-hour factor, PHF	0.95	0.95	0.92	0.92	0.91	0.91
Adj. Flow (vph)	1853	505	0	0	0	462
RTOR Reduction (vph)	0	152	0	0	0	0
Lane Group Flow (vph)	1853	353	0	0	0	462
Confl. Peds. (#/hr)		2	2			
Turn Type	NA	Perm				Prot
Protected Phases	1					2
Permitted Phases		1				
Actuated Green, G (s)	59.3	59.3				13.6
Effective Green, g (s)	59.3	59.3				13.6
Actuated g/C Ratio	0.70	0.70				0.16
Clearance Time (s)	6.0	6.0				6.0
Vehicle Extension (s)	2.0	2.0				2.0
Lane Grp Cap (vph)	2471	1077				446
v/s Ratio Prot	c0.52					c0.17
v/s Ratio Perm		0.23				
v/c Ratio	0.75	0.33				1.04
Uniform Delay, d1	8.1	5.0				35.7
Progression Factor	1.00	1.00				1.00
Incremental Delay, d2	1.1	0.1				52.2
Delay (s)	9.2	5.1				87.8
Level of Service	A	A				F
Approach Delay (s)	8.3			0.0	87.8	
Approach LOS	A			A	F	

Intersection Summary			
HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	84.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	20	300	605	175	145	50
Future Volume (Veh/h)	20	300	605	175	145	50
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.86	0.86	0.94	0.94
Hourly flow rate (vph)	22	326	703	203	154	53
Pedestrians		2	7			
Lane Width (ft)		12.0	12.0			
Walking Speed (ft/s)		3.5	3.5			
Percent Blockage		0	1			
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	906				1182	806
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	906				1182	806
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				24	86
cM capacity (veh/h)	755				201	384

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	348	906	207
Volume Left	22	0	154
Volume Right	0	203	53
cSH	755	1700	229
Volume to Capacity	0.03	0.53	0.90
Queue Length 95th (ft)	2	0	188
Control Delay (s)	1.0	0.0	81.6
Lane LOS	A		F
Approach Delay (s)	1.0	0.0	81.6
Approach LOS			F

Intersection Summary			
Average Delay		11.8	
Intersection Capacity Utilization		60.4%	ICU Level of Service B
Analysis Period (min)		15	

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	355	90	125	725	65	115
Future Volume (Veh/h)	355	90	125	725	65	115
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.93	0.93	0.71	0.71	0.89	0.89
Hourly flow rate (vph)	382	97	176	1021	73	129
Pedestrians					3	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			482		1806	434
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			482		1806	434
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			84		0	79
cM capacity (veh/h)			1067		72	621

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	479	1197	202
Volume Left	0	176	73
Volume Right	97	0	129
cSH	1700	1067	166
Volume to Capacity	0.28	0.16	1.22
Queue Length 95th (ft)	0	15	281
Control Delay (s)	0.0	4.5	194.6
Lane LOS		A	F
Approach Delay (s)	0.0	4.5	194.6
Approach LOS			F

Intersection Summary			
Average Delay	23.8		
Intersection Capacity Utilization	90.0%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	435	90	165	690	150	140
Future Volume (Veh/h)	435	90	165	690	150	140
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.82	0.82	0.61	0.61
Hourly flow rate (vph)	483	100	201	841	246	230
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			583		1776	533
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			583		1776	533
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			80		0	58
cM capacity (veh/h)			996		73	543

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	583	1042	476
Volume Left	0	201	246
Volume Right	100	0	230
cSH	1700	996	126
Volume to Capacity	0.34	0.20	3.78
Queue Length 95th (ft)	0	19	Err
Control Delay (s)	0.0	4.9	Err
Lane LOS		A	F
Approach Delay (s)	0.0	4.9	Err
Approach LOS			F

Intersection Summary			
Average Delay	2267.8		
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	545	5	15	810	15	45
Future Volume (Veh/h)	545	5	15	810	15	45
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	592	5	16	880	16	49
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			597		1506	594
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			597		1506	594
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		88	90
cM capacity (veh/h)			980		131	505

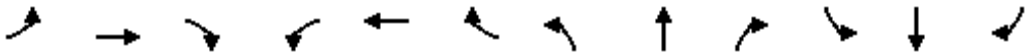
Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	597	896	65
Volume Left	0	16	16
Volume Right	5	0	49
cSH	1700	980	296
Volume to Capacity	0.35	0.02	0.22
Queue Length 95th (ft)	0	1	20
Control Delay (s)	0.0	0.4	20.5
Lane LOS		A	C
Approach Delay (s)	0.0	0.4	20.5
Approach LOS			C

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	64.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	585	2	2	830	0	2
Future Volume (Veh/h)	585	2	2	830	0	2
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	636	2	2	902	0	2
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			638		1543	637
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			638		1543	637
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	100
cM capacity (veh/h)			946		126	477

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	638	904	2
Volume Left	0	2	0
Volume Right	2	0	2
cSH	1700	946	477
Volume to Capacity	0.38	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	0.1	12.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	12.6
Approach LOS			B

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	0	0	55	0	2	0	300	20	1	385	0
Future Volume (Veh/h)	1	0	0	55	0	2	0	300	20	1	385	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.25	0.25	0.25	0.76	0.76	0.76	0.83	0.83	0.83	0.66	0.66	0.66
Hourly flow rate (vph)	4	0	0	72	0	3	0	361	24	2	583	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	963	972	583	960	960	373	583			385		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	963	972	583	960	960	373	583			385		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	100	70	100	100	100			100		
cM capacity (veh/h)	236	254	516	238	258	678	1001			1185		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	4	75	385	585
Volume Left	4	72	0	2
Volume Right	0	3	24	0
cSH	236	244	1001	1185
Volume to Capacity	0.02	0.31	0.00	0.00
Queue Length 95th (ft)	1	31	0	0
Control Delay (s)	20.5	26.1	0.0	0.0
Lane LOS	C	D		A
Approach Delay (s)	20.5	26.1	0.0	0.0
Approach LOS	C	D		

Intersection Summary				
Average Delay	2.0			
Intersection Capacity Utilization	31.1%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	95	20	300	45	10	430
Future Volume (Veh/h)	95	20	300	45	10	430
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.80	0.80	0.90	0.90	0.66	0.66
Hourly flow rate (vph)	119	25	333	50	15	652
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1040	358			383	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1040	358			383	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	53	96			99	
cM capacity (veh/h)	253	691			1187	

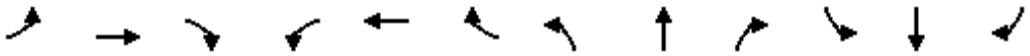
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	144	383	667
Volume Left	119	0	15
Volume Right	25	50	0
cSH	284	1700	1187
Volume to Capacity	0.51	0.23	0.01
Queue Length 95th (ft)	67	0	1
Control Delay (s)	30.0	0.0	0.3
Lane LOS	D		A
Approach Delay (s)	30.0	0.0	0.3
Approach LOS	D		

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	43.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	55	15	330	10	2	525
Future Volume (Veh/h)	55	15	330	10	2	525
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	60	16	359	11	2	571
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	940	364			370	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	940	364			370	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	79	98			100	
cM capacity (veh/h)	292	680			1189	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	76	370	573
Volume Left	60	0	2
Volume Right	16	11	0
cSH	332	1700	1189
Volume to Capacity	0.23	0.22	0.00
Queue Length 95th (ft)	22	0	0
Control Delay (s)	19.0	0.0	0.0
Lane LOS	C		A
Approach Delay (s)	19.0	0.0	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	39.8%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	1	15	65	5	25	45	310	20	5	550	25
Future Volume (Veh/h)	5	1	15	65	5	25	45	310	20	5	550	25
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	1	16	71	5	27	49	337	22	5	598	27
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								1234				
pX, platoon unblocked												
vC, conflicting volume	1097	1078	612	1084	1081	348	625			359		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1097	1078	612	1084	1081	348	625			359		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	97	60	98	96	95			100		
cM capacity (veh/h)	172	206	493	180	206	695	956			1200		

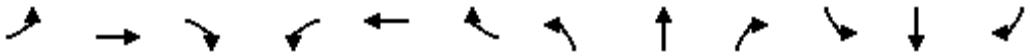
Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	22	103	408	630
Volume Left	5	71	49	5
Volume Right	16	27	22	27
cSH	332	225	956	1200
Volume to Capacity	0.07	0.46	0.05	0.00
Queue Length 95th (ft)	5	55	4	0
Control Delay (s)	16.6	33.9	1.6	0.1
Lane LOS	C	D	A	A
Approach Delay (s)	16.6	33.9	1.6	0.1
Approach LOS	C	D		

Intersection Summary				
Average Delay	3.9			
Intersection Capacity Utilization	67.3%	ICU Level of Service	C	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	105	70	305	20	15	615
Future Volume (Veh/h)	105	70	305	20	15	615
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.81	0.81	0.75	0.75	0.73	0.73
Hourly flow rate (vph)	130	86	407	27	21	842
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			713			
pX, platoon unblocked						
vC, conflicting volume	1304	420			434	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1304	420			434	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	26	87			98	
cM capacity (veh/h)	175	637			1136	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	216	434	863
Volume Left	130	0	21
Volume Right	86	27	0
cSH	246	1700	1136
Volume to Capacity	0.88	0.26	0.02
Queue Length 95th (ft)	183	0	1
Control Delay (s)	72.7	0.0	0.5
Lane LOS	F		A
Approach Delay (s)	72.7	0.0	0.5
Approach LOS	F		

Intersection Summary			
Average Delay	10.7		
Intersection Capacity Utilization	61.2%	ICU Level of Service	B
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	30	360	1	40	5	285	80	15	700	5
Future Volume (Veh/h)	0	0	30	360	1	40	5	285	80	15	700	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
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
Hourly flow rate (vph)	0	0	40	500	1	56	6	331	93	16	761	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								398				
pX, platoon unblocked	0.97	0.97		0.97	0.97	0.97				0.97		
vC, conflicting volume	1242	1232	764	1225	1188	378	766			424		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1235	1225	764	1218	1179	348	766			396		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	90	0	99	92	99			99		
cM capacity (veh/h)	134	171	404	136	182	677	847			1133		

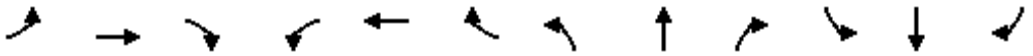
Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	40	500	57	430	782
Volume Left	0	500	0	6	16
Volume Right	40	0	56	93	5
cSH	404	136	646	847	1133
Volume to Capacity	0.10	3.68	0.09	0.01	0.01
Queue Length 95th (ft)	8	Err	7	1	1
Control Delay (s)	14.9	Err	11.1	0.2	0.4
Lane LOS	B	F	B	A	A
Approach Delay (s)	14.9	8976.9		0.2	0.4
Approach LOS	B	F			

Intersection Summary				
Average Delay	2764.6			
Intersection Capacity Utilization	Err%	ICU Level of Service		H
Analysis Period (min)	15			

Lane Group	EBL	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	207	327	81	250	562	753
v/c Ratio	0.63	0.47	0.35	0.65	0.82	1.03
Control Delay	30.4	24.0	34.3	40.2	34.4	69.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.4	24.0	34.3	40.2	34.4	69.1
Queue Length 50th (ft)	73	123	35	117	229	369
Queue Length 95th (ft)	159	251	88	229	#675	#978
Internal Link Dist (ft)		238		291	396	469
Turn Bay Length (ft)	120		100			
Base Capacity (vph)	331	957	384	640	689	728
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	0.63	0.34	0.21	0.39	0.82	1.03

Intersection Summary

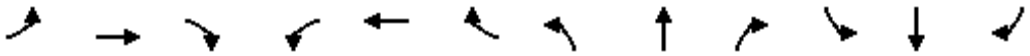
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



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)	1748	1841		1784	1767			1551			1613	
Flt Permitted	0.37	1.00		0.56	1.00			0.95			0.96	
Satd. Flow (perm)	687	1841		1057	1767			1478			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)	28.7	34.2		19.0	19.0			40.9			40.9	
Effective Green, g (s)	28.7	34.2		19.0	19.0			40.9			40.9	
Actuated g/C Ratio	0.32	0.39		0.21	0.21			0.46			0.46	
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)	337	709		226	378			680			716	
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	0.61	0.46		0.36	0.66			0.83			1.05	
Uniform Delay, d1	23.4	20.4		29.7	32.0			20.9			23.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	3.3	0.5		1.0	4.3			8.1			48.0	
Delay (s)	26.7	20.9		30.7	36.3			29.0			72.0	
Level of Service	C	C		C	D			C			E	
Approach Delay (s)		23.2			34.9			29.0			72.0	
Approach LOS		C			C			C			E	

Intersection Summary			
HCM 2000 Control Delay	43.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	88.8	Sum of lost time (s)	16.5
Intersection Capacity Utilization	82.3%	ICU Level of Service	E
Analysis Period (min)	15		

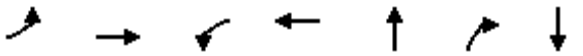
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	50	55	70	2	30	20	85	470	15	20	605	55
Future Volume (Veh/h)	50	55	70	2	30	20	85	470	15	20	605	55
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.81	0.81	0.81	0.91	0.91	0.91	0.98	0.98	0.98	0.92	0.92	0.92
Hourly flow rate (vph)	62	68	86	2	33	22	87	480	15	22	658	60
Pedestrians		4			5			9			8	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								549				
pX, platoon unblocked	0.84	0.84		0.84	0.84	0.84				0.84		
vC, conflicting volume	1444	1410	701	1528	1432	500	722			500		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1433	1393	701	1533	1420	311	722			310		
tC, single (s)	7.1	6.5	6.2	7.1	6.6	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.1	3.3	2.2			2.2		
p0 queue free %	0	35	80	93	66	96	90			98		
cM capacity (veh/h)	60	104	432	28	98	609	877			1055		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	216	57	582	740
Volume Left	62	2	87	22
Volume Right	86	22	15	60
cSH	115	128	877	1055
Volume to Capacity	1.88	0.44	0.10	0.02
Queue Length 95th (ft)	433	49	8	2
Control Delay (s)	492.3	53.9	2.6	0.5
Lane LOS	F	F	A	A
Approach Delay (s)	492.3	53.9	2.6	0.5
Approach LOS	F	F		

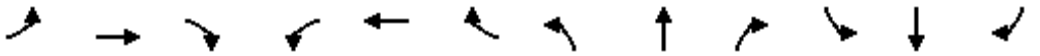
Intersection Summary				
Average Delay	69.8			
Intersection Capacity Utilization	90.4%	ICU Level of Service	E	
Analysis Period (min)	15			



Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	49	521	325	726	173	201	500
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

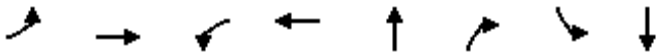
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



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

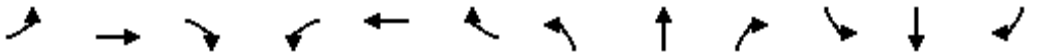


Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	38	819	142	1352	102	108	664	650
v/c Ratio	0.56	0.88	0.86	1.06	0.57	0.26	1.45	1.40
Control Delay	87.3	52.1	92.9	78.5	63.6	6.5	245.5	225.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	87.3	52.1	92.9	78.5	63.6	6.5	245.5	225.9
Queue Length 50th (ft)	27	290	101	~599	70	4	~681	~653
Queue Length 95th (ft)	72	442	196	#861	134	24	#1051	#1022
Internal Link Dist (ft)		265		665	2948			318
Turn Bay Length (ft)	175		165			100	100	
Base Capacity (vph)	112	1188	273	1474	335	545	459	464
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.34	0.69	0.52	0.92	0.30	0.20	1.45	1.40

Intersection Summary

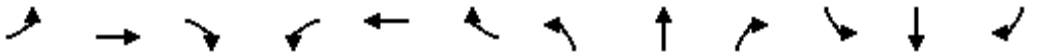
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



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)	9.0	8.0		9.0	8.0			6.0	6.0	6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.95	0.95	
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	0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.98	
Satd. Flow (prot)	1770	3525		1770	3413			1841	1583	1681	1670	
Flt Permitted	0.95	1.00		0.95	1.00			0.99	1.00	0.95	0.98	
Satd. Flow (perm)	1770	3525		1770	3413			1841	1583	1681	1670	
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	1	0	0	17	0	0	0	74	0	8	0
Lane Group Flow (vph)	38	818	0	142	1335	0	0	102	34	664	642	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)	4.6	35.3		13.5	44.2			10.8	24.3	30.5	30.5	
Effective Green, g (s)	1.6	32.3		10.5	41.2			10.8	24.3	30.5	30.5	
Actuated g/C Ratio	0.01	0.29		0.09	0.36			0.10	0.21	0.27	0.27	
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)	25	1006		164	1243			175	340	453	450	
v/s Ratio Prot	0.02	0.23		c0.08	c0.39			c0.06	0.02	c0.39	0.38	
v/s Ratio Perm												
v/c Ratio	1.52	0.81		0.87	1.07			0.58	0.10	1.47	1.43	
Uniform Delay, d1	55.8	37.6		50.6	35.9			49.0	35.6	41.3	41.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	367.9	4.8		33.9	48.0			3.2	0.0	221.4	204.5	
Delay (s)	423.6	42.4		84.5	84.0			52.2	35.7	262.7	245.8	
Level of Service	F	D		F	F			D	D	F	F	
Approach Delay (s)		59.3			84.0			43.7			254.4	
Approach LOS		E			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	134.1	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.28		
Actuated Cycle Length (s)	113.1	Sum of lost time (s)	33.0
Intersection Capacity Utilization	97.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	1155	425	0	885	580	0	0	365	0	0	535
Future Volume (Veh/h)	0	1155	425	0	885	580	0	0	365	0	0	535
Sign Control		Free			Free			Yield			Yield	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	1255	462	0	962	630	0	0	397	0	0	582
Pedestrians											2	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		745										
pX, platoon unblocked				0.80			0.80	0.80	0.80	0.80	0.80	
vC, conflicting volume	964			1255			1967	2450	858	1592	2219	483
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	964			809			1703	2309	311	1232	2019	483
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			0	100	27	100	100	0
cM capacity (veh/h)	709			647			0	30	545	29	46	529

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	837	880	481	481	630	397	582
Volume Left	0	0	0	0	0	0	0
Volume Right	0	462	0	0	630	397	582
cSH	1700	1700	1700	1700	1700	545	529
Volume to Capacity	0.49	0.52	0.28	0.28	0.37	0.73	1.10
Queue Length 95th (ft)	0	0	0	0	0	151	462
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	27.3	96.9
Lane LOS						D	F
Approach Delay (s)	0.0		0.0			27.3	96.9
Approach LOS						D	F

Intersection Summary				
Average Delay	15.7			
Intersection Capacity Utilization	74.8%	ICU Level of Service	D	
Analysis Period (min)	15			

Lane Group	EBT	EBR	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	1028	320	1888	425	407	20
v/c Ratio	0.63	0.22	1.16	0.69	0.60	0.16
Control Delay	24.4	0.6	105.1	30.8	20.3	25.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.4	0.6	105.1	30.8	20.3	25.0
Queue Length 50th (ft)	203	0	~630	222	144	2
Queue Length 95th (ft)	#444	12	#980	296	216	15
Internal Link Dist (ft)	96		601		420	187
Turn Bay Length (ft)				75		
Base Capacity (vph)	1638	1459	1629	619	673	429
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	0.63	0.22	1.16	0.69	0.60	0.05

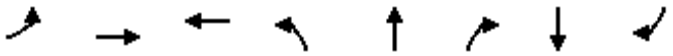
Intersection Summary

~ 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.

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	1631			1686	
Flt Permitted		1.00	1.00		1.00		0.95	0.97			1.00	
Satd. Flow (perm)		3610	1583		3538		1681	1631			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	67	0	0	0	0	74	0	0	16	0
Lane Group Flow (vph)	0	1028	253	0	1888	0	425	333	0	0	4	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)		39.2	73.5		39.2		34.3	34.3			2.5	
Effective Green, g (s)		39.2	73.5		39.2		34.3	34.3			2.5	
Actuated g/C Ratio		0.42	0.79		0.42		0.37	0.37			0.03	
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)		1521	1353		1491		619	601			45	
v/s Ratio Prot		0.28	0.07		c0.53		c0.25	0.20			c0.00	
v/s Ratio Perm			0.09									
v/c Ratio		0.68	0.19		1.27		0.69	0.55			0.10	
Uniform Delay, d1		21.8	2.4		26.9		24.8	23.3			44.2	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		2.4	0.0		125.3		2.5	0.6			0.3	
Delay (s)		24.2	2.4		152.2		27.3	23.9			44.5	
Level of Service		C	A		F		C	C			D	
Approach Delay (s)		19.0			152.2			25.7			44.5	
Approach LOS		B			F			C			D	

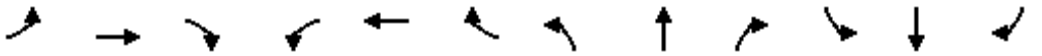
Intersection Summary			
HCM 2000 Control Delay	82.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	WBT	NBL	NBT	NBR	SBT	SBR
Lane Group Flow (vph)	11	873	1131	231	230	289	92	36
v/c Ratio	0.06	0.57	0.92	0.73	0.73	0.48	0.48	0.11
Control Delay	24.9	24.7	34.5	51.9	51.3	14.1	50.8	0.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.9	24.7	34.5	51.9	51.3	14.1	50.8	0.6
Queue Length 50th (ft)	4	190	213	135	134	48	52	0
Queue Length 95th (ft)	22	412	#733	268	266	148	91	0
Internal Link Dist (ft)		601	248		256		190	
Turn Bay Length (ft)	125			150		100		50
Base Capacity (vph)	182	1543	1228	557	561	597	228	366
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.06	0.57	0.92	0.41	0.41	0.48	0.40	0.10

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



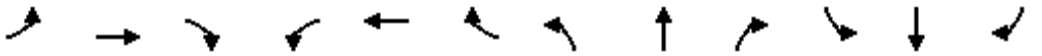
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	700	120	160	890	25	400	15	260	50	15	25
Future Volume (vph)	10	700	120	160	890	25	400	15	260	50	15	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			5.0		5.0	5.0	4.5		5.0	5.0
Lane Util. Factor	1.00	0.95			0.95		0.95	0.95	1.00		1.00	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	0.98			1.00		1.00	1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	0.96	1.00		0.96	1.00
Satd. Flow (prot)	1801	3501			3503		1698	1709	1568		1802	1553
Flt Permitted	0.22	1.00			0.58		0.95	0.96	1.00		0.96	1.00
Satd. Flow (perm)	418	3501			2035		1698	1709	1568		1802	1553
Peak-hour factor, PHF	0.94	0.94	0.94	0.95	0.95	0.95	0.90	0.90	0.90	0.70	0.70	0.70
Adj. Flow (vph)	11	745	128	168	937	26	444	17	289	71	21	36
RTOR Reduction (vph)	0	11	0	0	1	0	0	0	136	0	0	33
Lane Group Flow (vph)	11	862	0	0	1130	0	231	230	153	0	92	3
Confl. Peds. (#/hr)	4					4						
Heavy Vehicles (%)	0%	1%	0%	7%	1%	0%	1%	0%	3%	2%	0%	4%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pm+ov	Split	NA	Perm
Protected Phases		6		5	2		3	3	5	4	4	
Permitted Phases	6			2					3			4
Actuated Green, G (s)	41.5	41.5			52.7		17.5	17.5	23.2		8.7	8.7
Effective Green, g (s)	41.5	41.5			52.7		17.5	17.5	23.2		8.7	8.7
Actuated g/C Ratio	0.44	0.44			0.56		0.19	0.19	0.25		0.09	0.09
Clearance Time (s)	6.0	6.0			5.0		5.0	5.0	4.5		5.0	5.0
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0	3.0		2.0	2.0
Lane Grp Cap (vph)	184	1547			1231		316	318	387		166	143
v/s Ratio Prot		0.25			c0.06		c0.14	0.13	0.02		c0.05	
v/s Ratio Perm	0.03				c0.46				0.07			0.00
v/c Ratio	0.06	0.56			0.92		0.73	0.72	0.40		0.55	0.02
Uniform Delay, d1	15.0	19.4			18.6		36.0	35.9	29.5		40.7	38.7
Progression Factor	1.00	1.00			1.00		1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.0	0.2			10.6		7.3	6.7	0.7		2.3	0.0
Delay (s)	15.1	19.6			29.3		43.3	42.7	30.2		43.0	38.8
Level of Service	B	B			C		D	D	C		D	D
Approach Delay (s)		19.6			29.3			38.0			41.8	
Approach LOS		B			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	29.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	93.9	Sum of lost time (s)	26.5
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	276	500	473	134	163	90	218
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

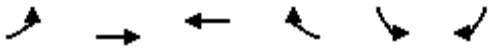
Intersection Summary



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



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	1310	1005	0	155
Future Volume (Veh/h)	0	0	1310	1005	0	155
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	1424	1092	0	168
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1424				1970	1258
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1424				1970	1258
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	0
cM capacity (veh/h)	474				55	162

Direction, Lane #	WB 1	WB 2	SB 1
Volume Total	949	1567	168
Volume Left	0	0	0
Volume Right	0	1092	168
cSH	1700	1700	162
Volume to Capacity	0.56	0.92	1.04
Queue Length 95th (ft)	0	0	208
Control Delay (s)	0.0	0.0	137.5
Lane LOS			F
Approach Delay (s)	0.0		137.5
Approach LOS			F

Intersection Summary			
Average Delay	8.6		
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		

Lane Group	EBT	EBR	NBR
Lane Group Flow (vph)	1054	598	250
v/c Ratio	0.55	0.53	0.46
Control Delay	8.2	2.5	21.2
Queue Delay	0.0	0.0	0.0
Total Delay	8.2	2.5	21.2
Queue Length 50th (ft)	82	0	33
Queue Length 95th (ft)	138	32	77
Internal Link Dist (ft)	162		
Turn Bay Length (ft)			100
Base Capacity (vph)	3539	1583	807
Starvation Cap Reductn	0	0	0
Spillback Cap Reductn	0	0	0
Storage Cap Reductn	0	0	0
Reduced v/c Ratio	0.30	0.38	0.31

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	970	550	0	0	0	230
Future Volume (vph)	970	550	0	0	0	230
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0				6.0
Lane Util. Factor	0.95	1.00				0.88
Frt	1.00	0.85				0.85
Flt Protected	1.00	1.00				1.00
Satd. Flow (prot)	3539	1583				2787
Flt Permitted	1.00	1.00				1.00
Satd. Flow (perm)	3539	1583				2787
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1054	598	0	0	0	250
RTOR Reduction (vph)	0	273	0	0	0	0
Lane Group Flow (vph)	1054	325	0	0	0	250
Turn Type	NA	Perm				Prot
Protected Phases	1					2
Permitted Phases		1				
Actuated Green, G (s)	25.0	25.0				9.0
Effective Green, g (s)	25.0	25.0				9.0
Actuated g/C Ratio	0.54	0.54				0.20
Clearance Time (s)	6.0	6.0				6.0
Vehicle Extension (s)	2.0	2.0				2.0
Lane Grp Cap (vph)	1923	860				545
v/s Ratio Prot	c0.30					c0.09
v/s Ratio Perm		0.21				
v/c Ratio	0.55	0.38				0.46
Uniform Delay, d1	6.8	6.0				16.3
Progression Factor	1.00	1.00				1.00
Incremental Delay, d2	0.2	0.1				0.2
Delay (s)	7.0	6.1				16.6
Level of Service	A	A				B
Approach Delay (s)	6.7			0.0	16.6	
Approach LOS	A			A	B	

Intersection Summary			
HCM 2000 Control Delay	8.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

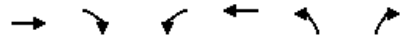
c Critical Lane Group

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	700	245	140	290	80	120
Future Volume (vph)	700	245	140	290	80	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	11	11	12	12
Storage Length (ft)		0	200		0	0
Storage Lanes		0	1		1	0
Taper Length (ft)			25		25	
Right Turn on Red		Yes				Yes
Link Speed (mph)	30			30	30	
Link Distance (ft)	1170			491	1121	
Travel Time (s)	26.6			11.2	25.5	
Confl. Bikes (#/hr)		2				
Peak Hour Factor	0.93	0.93	0.89	0.89	0.76	0.76
Heavy Vehicles (%)	2%	2%	7%	3%	3%	4%
Bus Blockages (#/hr)	2	2	2	2	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1016	0	157	326	263	0
v/c Ratio	1.01		0.70	0.26	0.86	
Control Delay	50.7		30.4	6.1	51.5	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	50.7		30.4	6.1	51.5	
Queue Length 50th (ft)	368		18	36	82	
Queue Length 95th (ft)	#960		#151	141	#199	
Internal Link Dist (ft)	1090			411	1041	
Turn Bay Length (ft)			200			
Base Capacity (vph)	1003		224	1231	306	
Starvation Cap Reductn	0		0	0	0	
Spillback Cap Reductn	0		0	0	0	
Storage Cap Reductn	0		0	0	0	
Reduced v/c Ratio	1.01		0.70	0.26	0.86	

Intersection Summary

Area Type: Other

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	700	245	140	290	80	120
Future Volume (vph)	700	245	140	290	80	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	11	11	12	12
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.97		1.00	1.00	0.92	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1773		1618	1769	1652	
Flt Permitted	1.00		0.09	1.00	0.98	
Satd. Flow (perm)	1773		150	1769	1652	
Peak-hour factor, PHF	0.93	0.93	0.89	0.89	0.76	0.76
Adj. Flow (vph)	753	263	157	326	105	158
RTOR Reduction (vph)	12	0	0	0	59	0
Lane Group Flow (vph)	1004	0	157	326	204	0
Confl. Bikes (#/hr)		2				
Heavy Vehicles (%)	2%	2%	7%	3%	3%	4%
Bus Blockages (#/hr)	2	2	2	2	0	0
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	4	
Permitted Phases			6			
Actuated Green, G (s)	41.4		51.5	51.5	11.1	
Effective Green, g (s)	41.4		51.5	51.5	11.1	
Actuated g/C Ratio	0.54		0.67	0.67	0.15	
Clearance Time (s)	4.0		4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	960		218	1192	240	
v/s Ratio Prot	c0.57		c0.06	0.18	c0.12	
v/s Ratio Perm			0.43			
v/c Ratio	1.05		0.72	0.27	0.85	
Uniform Delay, d1	17.5		17.6	5.0	31.8	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	41.8		11.1	0.1	23.9	
Delay (s)	59.3		28.7	5.1	55.7	
Level of Service	E		C	A	E	
Approach Delay (s)	59.3			12.8	55.7	
Approach LOS	E			B	E	

Intersection Summary				
HCM 2000 Control Delay	46.0	HCM 2000 Level of Service	D	
HCM 2000 Volume to Capacity ratio	0.93			
Actuated Cycle Length (s)	76.4	Sum of lost time (s)	15.0	
Intersection Capacity Utilization	81.3%	ICU Level of Service	D	
Analysis Period (min)	15			

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	25	20	635	135	85	355
Future Volume (Veh/h)	25	20	635	135	85	355
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.60	0.60	0.95	0.95	0.91	0.91
Hourly flow rate (vph)	42	33	668	142	93	390
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		6				
Median type			None			None
Median storage veh)						
Upstream signal (ft)			315			
pX, platoon unblocked	0.83	0.83			0.83	
vC, conflicting volume	1244	668			810	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1191	496			668	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	72	93			88	
cM capacity (veh/h)	152	479			772	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	75	668	142	93	390
Volume Left	42	0	0	93	0
Volume Right	33	0	142	0	0
cSH	272	1700	1700	772	1700
Volume to Capacity	0.28	0.39	0.08	0.12	0.23
Queue Length 95th (ft)	27	0	0	10	0
Control Delay (s)	26.7	0.0	0.0	10.3	0.0
Lane LOS	D			B	
Approach Delay (s)	26.7	0.0		2.0	
Approach LOS	D				

Intersection Summary				
Average Delay	2.2			
Intersection Capacity Utilization	51.5%	ICU Level of Service	A	
Analysis Period (min)	15			

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		0	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
v/c Ratio		0.06		0.40	0.34			0.56	0.32	0.09	0.15	
Control Delay		0.7		61.2	39.4			4.1	0.8	6.5	4.5	
Queue Delay		0.0		0.0	0.0			2.3	0.8	0.0	0.0	
Total Delay		0.7		61.2	39.4			6.4	1.6	6.5	4.5	
Queue Length 50th (ft)		0		40	22			172	19	3	19	
Queue Length 95th (ft)		0		82	63			m202	m17	25	89	
Internal Link Dist (ft)		71			145			318			235	
Turn Bay Length (ft)										150		
Base Capacity (vph)		351		364	377			1509	1328	422	2896	
Starvation Cap Reductn		0		0	0			501	590	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		0.14	0.13			0.84	0.58	0.09	0.15	

Intersection Summary

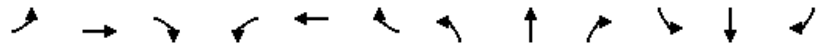
Area Type: Other

m Volume for 95th percentile queue is metered by upstream signal.

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	0.28	1.00	
Satd. Flow (perm)		1645		1681	1663			1842	1551	516	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	70	0	0	0
Lane Group Flow (vph)	0	0	0	51	29	0	0	850	358	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		7.9	7.9			94.3	94.3	94.3	94.3	
Effective Green, g (s)		5.8		7.9	7.9			94.3	94.3	94.3	94.3	
Actuated g/C Ratio		0.05		0.07	0.07			0.79	0.79	0.79	0.79	
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)		79		110	109			1447	1218	405	2779	
v/s Ratio Prot		c0.00		c0.03	0.02						0.12	
v/s Ratio Perm								c0.46	0.23	0.07		
v/c Ratio		0.01		0.46	0.27			0.59	0.29	0.09	0.15	
Uniform Delay, d1		54.4		54.0	53.3			5.1	3.6	3.0	3.1	
Progression Factor		1.00		1.00	1.00			0.48	0.36	1.00	1.00	
Incremental Delay, d2		0.0		3.1	1.3			0.4	0.1	0.4	0.1	
Delay (s)		54.4		57.1	54.6			2.9	1.4	3.4	3.2	
Level of Service		D		E	D			A	A	A	A	
Approach Delay (s)		54.4			55.9			2.4			3.3	
Approach LOS		D			E			A			A	

Intersection Summary			
HCM 2000 Control Delay	5.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	120.0	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
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		1
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	96	48
v/c Ratio	0.97	0.68		0.38	1.01			1.02	0.62	0.67	0.38	0.14
Control Delay	114.5	31.0		60.7	54.2			106.8	21.9	59.3	54.7	5.0
Queue Delay	0.0	0.0		0.0	8.6			0.0	0.0	0.0	0.0	0.0
Total Delay	114.5	31.0		60.7	62.8			106.8	21.9	59.3	54.7	5.0
Queue Length 50th (ft)	~148	336		37	510			~241	81	105	64	0
Queue Length 95th (ft)	#277	433		76	#718			#409	130	180	136	10
Internal Link Dist (ft)		265			665			2948			318	
Turn Bay Length (ft)	175			165					150	200		200
Base Capacity (vph)	177	1528		180	1472			296	481	466	255	346
Starvation Cap Reductn	0	0		0	0			0	0	0	0	0
Spillback Cap Reductn	0	0		0	39			0	0	0	0	0
Storage Cap Reductn	0	0		0	0			0	0	0	0	0
Reduced v/c Ratio	0.97	0.68		0.27	1.04			1.02	0.57	0.66	0.38	0.14

Intersection Summary

Area Type: Other

~ 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.

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	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.97	1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	0.99			1.00	0.99	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	1.00
Frt	1.00	1.00		1.00	0.92			1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1752	3530		1805	3195			1874	1601	3400	1863	1615
Flt Permitted	0.95	1.00		0.95	1.00			1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1752	3530		1805	3195			1874	1601	3400	1863	1615
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	178	0	0	0	70	0	0	42
Lane Group Flow (vph)	172	1039	0	49	1306	0	0	301	203	309	96	6
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	Perm
Protected Phases	1	6		5	2		3	3	5	4	4	
Permitted Phases									3			4
Actuated Green, G (s)	12.2	51.9		8.6	50.6			19.0	27.6	15.2	15.2	15.2
Effective Green, g (s)	12.2	51.9		8.6	50.6			19.0	27.6	15.2	15.2	15.2
Actuated g/C Ratio	0.10	0.43		0.07	0.42			0.16	0.23	0.13	0.13	0.13
Clearance Time (s)	6.0	5.0		6.0	5.0			6.0	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	2.0
Lane Grp Cap (vph)	178	1526		129	1347			296	368	430	235	204
v/s Ratio Prot	c0.10	0.29		0.03	c0.41			c0.16	0.04	c0.09	0.05	
v/s Ratio Perm									0.09			0.00
v/c Ratio	0.97	0.68		0.38	0.97			1.02	0.55	0.72	0.41	0.03
Uniform Delay, d1	53.7	27.4		53.2	34.0			50.5	40.7	50.3	48.3	45.9
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.04	1.06	1.00
Incremental Delay, d2	56.7	1.0		0.7	17.5			56.7	1.0	9.9	5.2	0.3
Delay (s)	110.4	28.4		53.8	51.4			107.2	41.8	62.3	56.1	46.2
Level of Service	F	C		D	D			F	D	E	E	D
Approach Delay (s)		40.0			51.5			76.1			59.3	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	52.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	120.0	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	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	435	90	165	690	150	140
Future Volume (vph)	435	90	165	690	150	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	11	11	12	12
Storage Length (ft)		0	200		0	0
Storage Lanes		0	1		1	0
Taper Length (ft)			25		25	
Right Turn on Red		Yes				Yes
Link Speed (mph)	30			30	30	
Link Distance (ft)	1170			491	1121	
Travel Time (s)	26.6			11.2	25.5	
Confl. Bikes (#/hr)		3				
Peak Hour Factor	0.90	0.90	0.82	0.82	0.61	0.61
Heavy Vehicles (%)	1%	0%	1%	2%	0%	4%
Bus Blockages (#/hr)	2	2	2	2	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	583	0	201	841	476	0
v/c Ratio	0.79		0.65	0.84	0.89	
Control Delay	31.8		22.4	25.7	47.0	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	31.8		22.4	25.7	47.0	
Queue Length 50th (ft)	228		41	287	206	
Queue Length 95th (ft)	#554		#130	#661	242	
Internal Link Dist (ft)	1090			411	1041	
Turn Bay Length (ft)			200			
Base Capacity (vph)	797		311	1065	537	
Starvation Cap Reductn	0		0	0	0	
Spillback Cap Reductn	0		0	0	0	
Storage Cap Reductn	0		0	0	0	
Reduced v/c Ratio	0.73		0.65	0.79	0.89	

Intersection Summary

Area Type: Other

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	435	90	165	690	150	140
Future Volume (vph)	435	90	165	690	150	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	11	11	12	12
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frpb, ped/bikes	1.00		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.98		1.00	1.00	0.93	
Flt Protected	1.00		0.95	1.00	0.97	
Satd. Flow (prot)	1819		1714	1786	1698	
Flt Permitted	1.00		0.15	1.00	0.97	
Satd. Flow (perm)	1819		266	1786	1698	
Peak-hour factor, PHF	0.90	0.90	0.82	0.82	0.61	0.61
Adj. Flow (vph)	483	100	201	841	246	230
RTOR Reduction (vph)	7	0	0	0	31	0
Lane Group Flow (vph)	576	0	201	841	445	0
Confl. Bikes (#/hr)		3				
Heavy Vehicles (%)	1%	0%	1%	2%	0%	4%
Bus Blockages (#/hr)	2	2	2	2	0	0
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	4	
Permitted Phases			6			
Actuated Green, G (s)	32.7		45.8	45.8	24.3	
Effective Green, g (s)	32.7		45.8	45.8	24.3	
Actuated g/C Ratio	0.39		0.55	0.55	0.29	
Clearance Time (s)	4.0		4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	708		302	974	491	
v/s Ratio Prot	0.32		0.07	c0.47	c0.26	
v/s Ratio Perm			0.29			
v/c Ratio	0.81		0.67	0.86	0.91	
Uniform Delay, d1	22.9		14.6	16.4	28.7	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	7.1		5.4	8.0	20.1	
Delay (s)	30.0		20.0	24.4	48.8	
Level of Service	C		C	C	D	
Approach Delay (s)	30.0			23.5	48.8	
Approach LOS	C			C	D	

Intersection Summary			
HCM 2000 Control Delay	31.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	83.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	105	70	305	20	15	615
Future Volume (Veh/h)	105	70	305	20	15	615
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.81	0.81	0.75	0.75	0.73	0.73
Hourly flow rate (vph)	130	86	407	27	21	842
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		6				
Median type			None			None
Median storage veh)						
Upstream signal (ft)			315			
pX, platoon unblocked	0.91	0.91			0.91	
vC, conflicting volume	1291	407			434	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1271	304			333	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	22	87			98	
cM capacity (veh/h)	168	677			1131	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	216	407	27	21	842
Volume Left	130	0	0	21	0
Volume Right	86	0	27	0	0
cSH	279	1700	1700	1131	1700
Volume to Capacity	0.78	0.24	0.02	0.02	0.50
Queue Length 95th (ft)	148	0	0	1	0
Control Delay (s)	50.2	0.0	0.0	8.2	0.0
Lane LOS	F			A	
Approach Delay (s)	50.2	0.0		0.2	
Approach LOS	F				

Intersection Summary				
Average Delay	7.3			
Intersection Capacity Utilization	44.9%	ICU Level of Service		A
Analysis Period (min)	15			

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		0	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
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			13.4	6.9	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			14.0	6.9	15.4	14.0	
Queue Length 50th (ft)		0		174	163			48	0	4	124	
Queue Length 95th (ft)		12		187	176			m245	m25	21	270	
Internal Link Dist (ft)		71			145			318			235	
Turn Bay Length (ft)										150		
Base Capacity (vph)		413		487	503			1112	992	568	2134	
Starvation Cap Reductn		0		0	0			444	0	0	0	
Spillback Cap Reductn		3		0	0			0	0	0	241	
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	0.40	

Intersection Summary	
Area Type:	Other

m Volume for 95th percentile queue is metered by upstream signal.

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	38	0	0	0
Lane Group Flow (vph)	0	3	0	280	267	0	0	337	55	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	0.03	0.02		
v/c Ratio		0.03		0.75	0.70			0.31	0.06	0.03	0.37	
Uniform Delay, d1		43.3		36.2	35.8			10.4	8.8	8.7	10.9	
Progression Factor		1.00		1.00	1.00			0.94	1.66	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			10.2	14.7	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	21.7	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
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		1
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	229	163
v/c Ratio	0.36	0.77		0.78	0.99			0.93	0.28	0.91	0.42	0.26
Control Delay	55.0	38.1		71.9	54.8			117.0	2.9	50.7	32.1	5.4
Queue Delay	0.0	0.0		0.0	0.2			12.0	0.0	5.1	0.0	0.0
Total Delay	55.0	38.1		71.9	54.9			128.9	2.9	55.8	32.1	5.4
Queue Length 50th (ft)	24	248		89	~515			66	0	307	134	12
Queue Length 95th (ft)	57	#360		#182	#689			#150	6	#364	134	22
Internal Link Dist (ft)		265			665			2948			318	
Turn Bay Length (ft)	175			165					150	200		200
Base Capacity (vph)	106	1062		194	1360			110	396	1008	547	619
Starvation Cap Reductn	0	0		0	0			0	0	56	0	0
Spillback Cap Reductn	0	0		0	1			6	0	0	0	0
Storage Cap Reductn	0	0		0	0			0	0	0	0	0
Reduced v/c Ratio	0.36	0.77		0.73	0.99			0.98	0.27	0.97	0.42	0.26

Intersection Summary

Area Type: Other

~ 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.

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	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	0.97	1.00	1.00
Frpb, ped/bikes	1.00	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	1.00
Frt	1.00	1.00		1.00	0.97			1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3525		1770	3419			1841	1583	3433	1863	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3525		1770	3419			1841	1583	3433	1863	1583
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	21	0	0	0	90	0	0	117
Lane Group Flow (vph)	38	817	0	142	1331	0	0	102	18	922	229	46
Confl. Bikes (#/hr)						1						
Turn Type	Prot	NA		Prot	NA		Split	NA	pm+ov	Split	NA	Perm
Protected Phases	1	6		5	2		3	3	5	4	4	
Permitted Phases									3			4
Actuated Green, G (s)	3.6	32.5		10.3	39.2			6.0	16.3	28.2	28.2	28.2
Effective Green, g (s)	3.6	32.5		10.3	39.2			6.0	16.3	28.2	28.2	28.2
Actuated g/C Ratio	0.04	0.32		0.10	0.39			0.06	0.16	0.28	0.28	0.28
Clearance Time (s)	6.0	5.0		6.0	5.0			6.0	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	2.0
Lane Grp Cap (vph)	63	1145		182	1340			110	258	968	525	446
v/s Ratio Prot	0.02	0.23		c0.08	c0.39			c0.06	0.01	c0.27	0.12	
v/s Ratio Perm									0.00			0.03
v/c Ratio	0.60	0.71		0.78	0.99			0.93	0.07	0.95	0.44	0.10
Uniform Delay, d1	47.5	29.7		43.7	30.3			46.8	35.4	35.2	29.4	26.5
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00	1.08	1.02	3.05
Incremental Delay, d2	10.7	1.8		17.8	22.8			61.8	0.0	18.4	2.4	0.4
Delay (s)	58.2	31.4		61.6	53.0			108.6	35.5	56.5	32.5	81.4
Level of Service	E	C		E	D			F	D	E	C	F
Approach Delay (s)		32.6			53.8			71.0			55.4	
Approach LOS		C			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	50.6	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			

557 Highland Avenue TIS
Merge Analysis

					Step 1: Specify Inputs and Convert Demand Volumes to Demand Flow															Step 2: Estimate the Approaching Flow Rate in Lanes 1 and 2 of the Freeway Immediately Upstream of the Ramp Influence Area			Step 3: Estimate the Capacity of the Ramp-Freeway Junction and Compare with Demand Flow Rates					Step 4: Estimate Density in the Ramp Influence Area and Determine the Prevailing LOS	
						Equation 12-10				Equation 14-1						Inputs				Exhibit 14-8	Equation 14-2	Equations 14-14 to 14-19	Equation 14-20	Exhibit 14-10		Exhibit 14-12		Equation 14-22	Exhibit 14-3
Scenario	Direction	Road	Exit	Road Type	Proportion of Heavy Vehicles for Freeway, $P_{T,F}$	Proportion of Heavy Vehicles for Ramp, $P_{T,R}$	Terrain Type	Passenger Car Equivalent of Heavy Vehicle for Freeway, $E_{T,F}$	Passenger Car Equivalent of Heavy Vehicle for Ramp, $E_{T,R}$	Heavy Vehicle Factor for Freeway, $f_{HV,F}$	Heavy Vehicle Factor for Ramp, $f_{HV,R}$	Demand Volume for Freeway, V_F	Demand Volume for Ramp, V_R	Peak Hour Factor for Freeway, PHF_F	Peak Hour Factor for Ramp, PHF_R	Demand Flow Rate for Freeway, v_F	Demand Flow Rate for Ramp, v_R	No. of Freeway Lanes (per direction)	Length of Acceleration Lane (ft), L_A	FFS of Freeway	FFS of ramp, S_{FR}	Proportion of Vehicles in Lanes 1 and 2, P_{FM}	v_{12}	Flow rate in Lanes 1 and 2, v_{12a}	Flow Rate Entering Influence Area from Ramp, v_{R12}	Capacity of Downstream Segment	LOS F Capacity Check	Capacity of Ramp Roadways	LOS F Capacity Check	Density of Merge Influence Area, D_R	LOS
2022 EXISTING ANALYSIS																													
Existing AM	WB	Highland Avenue	I-95 SB Off-Ramp	Highway	0.03	0.02	Level	2	2	0.97	0.98	305	645	0.97	0.97	324	678	2	150	45	35	1.000	324	324	1002	3800	NOT F	2000	NOT F	12.1	B
Existing PM	WB	Highland Avenue	I-95 SB Off-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	735	465	0.96	0.92	773	510	2	150	45	35	1.000	773	773	1284	3800	NOT F	2000	NOT F	14.4	B
2029 NO BUILD ANALYSIS																													
No Build AM	WB	Highland Avenue	I-95 SB Off-Ramp	Highway	0.03	0.02	Level	2	2	0.97	0.98	350	695	0.92	0.92	392	771	2	150	45	35	1.000	392	392	1162	3800	NOT F	2000	NOT F	13.3	B
No Build PM	WB	Highland Avenue	I-95 SB Off-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	850	505	0.92	0.92	933	554	2	150	45	35	1.000	933	933	1488	3800	NOT F	2000	NOT F	16.0	B
2029 BUILD ANALYSIS																													
Build AM	WB	Highland Avenue	I-95 SB Off-Ramp	Highway	0.03	0.02	Level	2	2	0.97	0.98	550	860	0.92	0.92	616	953	2	150	45	35	1.000	616	616	1569	3800	NOT F	2000	NOT F	16.4	B
Build PM	WB	Highland Avenue	I-95 SB Off-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	885	535	0.92	0.92	972	587	2	150	45	35	1.000	972	972	1559	3800	NOT F	2000	NOT F	16.5	B

Source: Based on methodology presented in the Highway Capacity Manual: 6th Edition (HCM 6)

557 Highland Avenue TIS
Diverge Analysis

					Step 1: Specify Inputs and Convert Demand Volumes to Demand Flow																Step 2: Estimate the Approaching Flow Rate in Lanes 1 and 2 of the Freeway Immediately Upstream of the Ramp Influence Area			Step 3: Estimate the Capacity of the Ramp-Freeway Junction and Compare with Demand Flow Rates				Step 4: Estimate Density in the Ramp Influence Area and Determine the Prevailing LOS	
						Equation 12-10						Equation 14-1						Inputs				Exhibit 14-9	Equation 14-8	Equations 14-14 to 14		Exhibit 14-10		Exhibit 14-12		Equation 14-23	Exhibit 14-3
Scenario	Direction	Road	Exit	Road Type	Proportion of Heavy Vehicles for Freeway, $P_{T,F}$	Proportion of Heavy Vehicles for Ramp, $P_{T,R}$	Terrain Type	Passenger Car Equivalent of Heavy Vehicle for Freeway, $E_{T,F}$	Passenger Car Equivalent of Heavy Vehicle for Ramp, $E_{T,R}$	Heavy Vehicle Factor for Freeway, $f_{HV,F}$	Heavy Vehicle Factor for Ramp, $f_{HV,R}$	Demand Volume for Freeway, V_F	Demand Volume for Ramp, V_R	Peak Hour Factor for Freeway, PHF_F	Peak Hour Factor for Ramp, PHF_R	Demand Flow Rate for Freeway, v_F	Demand Flow Rate for Ramp, v_R	No. of Freeway Lanes (per direction)	Length of Deceleration Lane, L_D	FFS of Freeway	FFS of ramp, S_{FR}	Proportion of Vehicles in Lanes 1 and 2, P_{FD}	v_{12}	Flow rate in Lanes 1 and 2, v12a		Capacity of Downstream Segment	LOS F Capacity Check	Capacity of Ramp Roadways	LOS F Capacity Check	Density of Diverge Influence Area, D_R	LOS
2022 EXISTING ANALYSIS																														
Existing AM	EB	Highland Avenue	I-95 SB On-Ramp	Highway	0.01	0.06	Level	2	2	0.99	0.94	1,095	110	0.98	0.98	1129	119	2	50	45	35	1.000	1129	1129		3800	NOT F	2000	NOT F	13.5	B
Existing AM	WB	Highland Avenue	I-95 NB On-Ramp	Highway	0.03	0.04	Level	2	2	0.97	0.96	625	280	0.94	0.94	685	310	2	40	45	35	1.000	685	685		3800	NOT F	2000	NOT F	9.8	A
Existing PM	EB	Highland Avenue	I-95 SB On-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	870	265	0.97	0.97	906	276	2	50	45	35	1.000	906	906		3800	NOT F	2000	NOT F	11.6	B
Existing PM	WB	Highland Avenue	I-95 NB On-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	1,075	790	0.97	0.97	1119	823	2	40	45	35	1.000	1119	1119		3800	NOT F	2000	NOT F	13.5	B
2029 NO BUILD ANALYSIS																														
No Build AM	EB	Highland Avenue	I-95 SB On-Ramp	Highway	0.01	0.06	Level	2	2	0.99	0.94	1,250	120	0.92	0.92	1372	138	2	50	45	35	1.000	1372	1372		3800	NOT F	2000	NOT F	15.6	B
No Build AM	WB	Highland Avenue	I-95 NB On-Ramp	Highway	0.03	0.04	Level	2	2	0.97	0.96	720	395	0.92	0.92	806	447	2	40	45	35	1.000	806	806		3800	NOT F	2000	NOT F	10.8	B
No Build PM	EB	Highland Avenue	I-95 SB On-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	970	275	0.92	0.92	1065	302	2	50	45	35	1.000	1065	1065		3800	NOT F	2000	NOT F	13.0	B
No Build PM	WB	Highland Avenue	I-95 NB On-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	1,305	1,005	0.92	0.92	1433	1103	2	40	45	35	1.000	1433	1433		3800	NOT F	2000	NOT F	16.2	B
2029 BUILD ANALYSIS																														
No Build AM	EB	Highland Avenue	I-95 SB On-Ramp	Highway	0.01	0.06	Level	2	2	0.99	0.94	1,275	145	0.92	0.92	1400	167	2	50	45	35	1.000	1400	1400		3800	NOT F	2000	NOT F	15.8	B
No Build AM	WB	Highland Avenue	I-95 NB On-Ramp	Highway	0.03	0.04	Level	2	2	0.97	0.96	755	395	0.92	0.92	845	447	2	40	45	35	1.000	845	845		3800	NOT F	2000	NOT F	11.2	B
No Build PM	EB	Highland Avenue	I-95 SB On-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	1,155	425	0.92	0.92	1268	467	2	50	45	35	1.000	1268	1268		3800	NOT F	2000	NOT F	14.7	B
No Build PM	WB	Highland Avenue	I-95 NB On-Ramp	Highway	0.01	0.01	Level	2	2	0.99	0.99	1,310	1,005	0.92	0.92	1438	1103	2	40	45	35	1.000	1438	1438		3800	NOT F	2000	NOT F	16.3	B

Source: Based on methodology presented in the Highway Capacity Manual: 6th Edition (HCM 6)

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)

Massachusetts Highway Department
6697_EB Weekly Volume Report - Mon 03/06/2017 - Sun 03/12/2017

Location ID:	6697_EB	**Type:**	SPOT
Located On:	HIGHLAND AVENUE	**WEST OF:**	GOULD STREET
Direction	EB		
Community:	Needham	**Period:**	Mon 03/06/2017 - Sun 03/12/2017
AADT:	9659		

Start Time	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Avg
12:00 AM			30	38				34
1:00 AM			18	14				16
2:00 AM			13	13				13
3:00 AM			12	14				13
4:00 AM			43	34				39
5:00 AM			126	129				128
6:00 AM			422	432				427
7:00 AM			829	895				862
8:00 AM			863	872				868
9:00 AM			648	679				664
10:00 AM			524	604				564
11:00 AM			610	576				593
12:00 PM			581	603				592
1:00 PM		571	585					578
2:00 PM		611	605					608
3:00 PM		674	740					707
4:00 PM		696	649					673
5:00 PM		571	514					543
6:00 PM		526	516					521
7:00 PM		391	438					415
8:00 PM		295	335					315
9:00 PM		203	240					222
10:00 PM		110	140					125
11:00 PM		58	67					63
Total	**0**	**4706**	**9548**	**4903**	**0**	**0**	**0**	
24HrTotal			9425	9732				9579
AM Pk Hr			8:00					
AM Peak			863					863
PM Pk Hr			3:00					
PM Peak			740					740
% Peak Hr			9.04%					9.00%
% Peak Hr			7.38%	8.87%				8.13%

Massachusetts Highway Department
6697_WB Weekly Volume Report - Mon 03/06/2017 - Sun 03/12/2017

Location ID:	6697_WB	**Type:**	SPOT
Located On:	HIGHLAND AVENUE	**WEST OF:**	GOULD STREET
Direction	WB		
Community:	Needham	**Period:**	Mon 03/06/2017 - Sun 03/12/2017
AADT:	9860		

Start Time	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Avg
12:00 AM			26	37				32
1:00 AM			23	14				19
2:00 AM			15	10				13
3:00 AM			19	22				21
4:00 AM			25	24				25
5:00 AM			106	128				117
6:00 AM			297	336				317
7:00 AM			579	600				590
8:00 AM			590	612				601
9:00 AM			568	556				562
10:00 AM			531	632				582
11:00 AM			648	619				634
12:00 PM			667	623				645
1:00 PM		637	648					643
2:00 PM		652	616					634
3:00 PM		587	591					589
4:00 PM		614	740					677
5:00 PM		815	916					866
6:00 PM		728	781					755
7:00 PM		517	549					533
8:00 PM		388	373					381
9:00 PM		241	257					249
10:00 PM		134	168					151
11:00 PM		94	120					107
Total	**0**	**5407**	**9853**	**4213**	**0**	**0**	**0**	
24HrTotal			9501	9972				9737
AM Pk Hr			11:00					
AM Peak			648					648
PM Pk Hr			5:00					
PM Peak			916					916
% Peak Hr			9.30%					9.00%
% Peak Hr			8.58%	9.19%				8.88%

Hourly Roadway Traffic Volumes

Daily Distributions
MassDOT Count Station 6697
Highland Avenue (west of Gould Street)
March 2017 (avg of Tues 3/7 - Wed 3/8)

Time	EB	WB	Total
6:00 AM	427	317	744
7:00 AM	862	590	1452
8:00 AM	868	601	1469
9:00 AM	664	562	1226
10:00 AM	564	582	1146
11:00 AM	593	634	1227
12:00 PM	592	645	1237
1:00 PM	578	643	1221
2:00 PM	608	634	1242
3:00 PM	707	589	1296
4:00 PM	673	677	1350
5:00 PM	543	866	1409
6:00 PM	521	755	1276
7:00 PM	415	533	948
Total	*9583*	*9743*	*19326*

AM Peak / PM Off Peak Direction
PM Peak / AM Off-Peak Direction

Hourly Distribution
(Based on Avg Daily Volumes)

Time	EB	WB	Total
6:00 AM	4.5%	3.3%	3.8%
7:00 AM	9.0%	6.1%	7.5%
8:00 AM	9.1%	6.2%	7.6%
9:00 AM	6.9%	5.8%	6.3%
10:00 AM	5.9%	6.0%	5.9%
11:00 AM	6.2%	6.5%	6.3%
12:00 PM	6.2%	6.6%	6.4%
1:00 PM	6.0%	6.6%	6.3%
2:00 PM	6.3%	6.5%	6.4%
3:00 PM	7.4%	6.0%	6.7%
4:00 PM	7.0%	6.9%	7.0%
5:00 PM	5.7%	8.9%	7.3%
6:00 PM	5.4%	7.7%	6.6%
7:00 PM	4.3%	5.5%	4.9%

Daily Distribution
Gould Street at Site Driveway

	NO BUILD VOLUMES											
	Eastbound			Westbound			Northbound			Southbound		
Time	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right
6:00 AM	0	n/a	3	n/a	n/a	n/a	7	327	n/a	n/a	179	1
7:00 AM	1	n/a	5	n/a	n/a	n/a	15	660	n/a	n/a	334	2
8:00 AM	1	0	5	20	0	15	15	665	35	15	340	2
9:00 AM	1	n/a	5	n/a	n/a	n/a	11	509	n/a	n/a	318	2
10:00 AM	1	n/a	5	n/a	n/a	n/a	10	432	n/a	n/a	329	2
11:00 AM	1	n/a	5	n/a	n/a	n/a	10	454	n/a	n/a	359	2
12:00 PM	1	n/a	5	n/a	n/a	n/a	10	454	n/a	n/a	365	2
1:00 PM	1	n/a	22	n/a	n/a	n/a	5	293	n/a	n/a	464	4
2:00 PM	1	n/a	22	n/a	n/a	n/a	6	308	n/a	n/a	458	4
3:00 PM	1	n/a	20	n/a	n/a	n/a	7	358	n/a	n/a	425	3
4:00 PM	1	n/a	23	n/a	n/a	n/a	6	341	n/a	n/a	489	4
5:00 PM	1	0	30	30	1	20	5	275	10	5	625	5
6:00 PM	1	n/a	26	n/a	n/a	n/a	5	264	n/a	n/a	545	4
7:00 PM	1	n/a	18	n/a	n/a	n/a	4	210	n/a	n/a	385	3
Estimated ADT (Based on AM Peak)	*11*	*n/a*	*81*	*n/a*	*n/a*	*n/a*	*166*	*7342*	*n/a*	*n/a*	*5512*	*32*
Estimated ADT (Based on PM Peak)	*18*	*n/a*	*338*	*n/a*	*n/a*	*n/a*	*88*	*4853*	*n/a*	*n/a*	*7032*	*56*

Note: Estimated ADT based on AM Peak used for hours between 6:00 AM - 12:00 PM. Estimated ADT based on PM Peak used for hours between 1:00 - 7:00 PM
Note: Hourly 2022 Existing volumes not projected for signal warrant analyses

See "Site" sheet for site entering and exiting volumes

Daily Distribution
Gould Street at Central Street

	EXISTING VOLUMES						NO BUILD VOLUMES					
	Easbound		Westbound		Northbound		Easbound		Westbound		Northbound	
Time	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right
6:00 AM	320	93	50	142	37	52	344	101	55	153	40	57
7:00 AM	646	189	93	265	69	104	695	204	103	285	74	114
8:00 AM	650	190	95	270	70	105	700	205	105	290	75	115
9:00 AM	497	145	89	252	65	80	535	157	98	271	70	88
10:00 AM	422	123	92	261	68	68	455	133	102	281	73	75
11:00 AM	444	130	100	285	74	72	478	140	111	306	79	79
12:00 PM	443	130	102	290	75	72	477	140	113	311	80	78
1:00 PM	431	80	111	475	78	101	463	85	119	512	85	112
2:00 PM	453	84	110	469	77	106	487	90	117	505	84	118
3:00 PM	527	98	102	435	71	124	566	104	109	469	78	137
4:00 PM	502	93	117	500	82	118	539	99	125	539	90	130
5:00 PM	405	75	150	640	105	95	435	80	160	690	115	105
6:00 PM	389	72	131	558	92	91	417	77	139	602	100	101
7:00 PM	310	57	92	394	65	73	332	61	98	425	71	80
Estimated ADT (Based on AM Peak)	*7176*	*2098*	*1540*	*4377*	*1135*	*1159*	*7728*	*2263*	*1702*	*4701*	*1216*	*1270*
Estimated ADT (Based on PM Peak)	*7148*	*1324*	*1688*	*7200*	*1181*	*1677*	*7677*	*1412*	*1800*	*7763*	*1294*	*1853*

Note: Estimated ADT based on AM Peak used for hours between 6:00 AM - 12:00 PM. Estimated ADT based on PM Peak used for hours between 1:00 - 7:00 PM

See "Site" sheet for site entering and exiting volumes

Future Site Traffic Volumes
2029 Build Condition

Daily Distributions

	LUC 710 (Office)		LUC 820 (Shopping Center)	
Time	In	Out	In	Out
6:00 AM	4.8%	0.5%	0.9%	0.5%
7:00 AM	13.6%	2.0%	1.9%	1.2%
8:00 AM	14.3%	3.4%	2.9%	1.8%
9:00 AM	6.3%	4.4%	4.9%	3.2%
10:00 AM	5.5%	6.0%	7.0%	5.3%
11:00 AM	6.0%	10.3%	8.5%	7.3%
12:00 PM	10.2%	10.1%	9.6%	8.9%
1:00 PM	9.0%	6.6%	8.7%	9.0%
2:00 PM	8.3%	6.5%	7.8%	8.6%
3:00 PM	7.3%	8.4%	8.1%	8.5%
4:00 PM	5.4%	15.2%	8.6%	8.7%
5:00 PM	4.0%	15.8%	8.7%	8.9%
6:00 PM	1.7%	2.6%	7.7%	7.8%
7:00 PM	0.9%	2.3%	6.5%	7.0%

Based on ITE Trip Gen Manual, 11th Edition
Note: No data for LUC 760, assume same as 710
Note: LUC 820 used over 822 due to inclusion of in/out data

Site-Generated Traffic

	R&D		Office		Retail		**Total**		*Pass-By*		*Existing Site*	
Time	In	Out	In	Out	In	Out	**In**	**Out**	*In*	*Out*	*In*	*Out*
6:00 AM	66	7	63	7	2	1	**131**	**15**	*1*	*0*	*4*	*2*
7:00 AM	188	27	181	26	5	3	**373**	**56**	*2*	*1*	*8*	*6*
8:00 AM	209	44	334	42	9	7	**552**	**93**	*2*	*2*	*37*	*24*
9:00 AM	86	60	83	58	12	7	**181**	**126**	*4*	*2*	*20*	*15*
10:00 AM	76	83	73	80	16	12	**165**	**175**	*6*	*4*	*29*	*25*
11:00 AM	83	142	80	136	20	17	**183**	**296**	*7*	*6*	*35*	*35*
12:00 PM	141	140	136	135	23	21	**299**	**295**	*8*	*7*	*39*	*42*
1:00 PM	124	92	119	88	20	21	**264**	**201**	*7*	*7*	*36*	*43*
2:00 PM	114	89	110	86	18	20	**242**	**196**	*6*	*7*	*32*	*41*
3:00 PM	101	116	97	111	19	20	**217**	**247**	*6*	*7*	*33*	*40*
4:00 PM	74	210	72	202	20	21	**166**	**433**	*7*	*7*	*35*	*42*
5:00 PM	39	204	62	303	21	23	**122**	**530**	*15*	*15*	*29*	*57*
6:00 PM	23	36	22	35	18	19	**63**	**90**	*6*	*6*	*31*	*37*
7:00 PM	13	32	13	31	15	16	**41**	**80**	*5*	*5*	*27*	*33*

Site Trip Gen	R&D		Office		Retail		*Pass-By*		*Existing*	
Time	In	Out	In	Out	In	Out	*In*	*Out*	*In*	*Out*
Daily	1382	1381	1330	1328	234	237	*79*	*79*	*410*	*477*
AM	209	44	334	42	9	7	*2*	*2*	*37*	*24*
PM	39	204	62	303	21	23	*15*	*15*	*29*	*57*

Does not subtract out Existing Site traffic

Existing based on counts conducted by VHB in July 2021.
Existing hourly distrubtion for site assumed to follow same patterns as LUC 820.

Site-Generated Traffic - Daily Distribution
Gould Street at Site Driveway

	SITE-GENERATED TRIPS						**PASS-BY**						**EXISTING SITE-GENERATED TRIPS**						**TOTAL**					
	Northbound		Southbound		Westbound		Northbound		Southbound		Westbound		Northbound		Southbound		Westbound		Northbound		Southbound		Westbound	
Time	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right
6:00 AM	22	89	4	3	10	0	0	0	0	0	0	0	-1	0	0	0	0	0	21	89	4	2	11	1
7:00 AM	63	254	11	10	38	2	-1	1	1	-1	0	0	-1	0	0	-1	0	0	61	254	12	8	39	2
8:00 AM	94	375	17	16	63	3	-1	1	1	-1	1	1	-6	0	0	-4	0	0	87	376	18	11	64	4
9:00 AM	31	123	5	21	85	4	-2	2	2	-2	1	1	-3	0	0	-3	0	0	25	125	7	17	87	5
10:00 AM	28	112	5	30	119	5	-3	3	3	-3	2	2	-5	0	0	-4	0	0	20	115	8	23	121	7
11:00 AM	31	124	5	50	201	9	-3	3	3	-3	3	3	-6	0	0	-6	0	0	22	128	9	41	204	12
12:00 PM	51	204	9	50	201	9	-4	4	4	-4	3	3	-7	0	0	-7	0	0	40	207	13	39	204	12
1:00 PM	45	179	8	34	137	6	-3	3	3	-3	4	4	-6	0	0	-7	0	0	35	183	11	23	140	10
2:00 PM	41	165	7	33	133	6	-3	3	3	-3	3	3	-5	0	0	-7	0	0	33	168	10	23	136	9
3:00 PM	37	148	7	42	168	7	-3	3	3	-3	3	3	-6	0	0	-7	0	0	28	151	10	32	171	11
4:00 PM	28	113	5	74	295	13	-3	3	3	-3	3	3	-6	0	0	-7	0	0	19	116	8	63	298	16
5:00 PM	21	83	4	90	360	16	-8	8	8	-8	8	8	-5	0	0	-10	0	0	8	90	11	73	368	23
6:00 PM	11	43	2	15	61	3	-3	3	3	-3	3	3	-5	0	0	-6	0	0	2	46	5	6	64	6
7:00 PM	7	28	1	14	54	2	-3	3	3	-3	3	3	-5	0	0	-6	0	0	0	30	4	5	57	5
Enter	17%	68%	3%				-50%	50%	50%	-50%			17%											
Exit				17%	68%	3%					50%	50%				17%								

Existing Trips removed from NB through and SB through movements only.
Direct turning movements in and out of Site driveway used for non-peak hour volumes and therefore no existing trips to be removed

Site-Generated Traffic - Daily Distribution
Gould Street at Central Street

	SITE-GENERATED TRIPS						**PASS-BY**						**EXISTING SITE-GENERATED TRIPS**						**TOTAL**					
	Eastbound		Westbound		Northbound		Eastbound		Westbound		Northbound		Eastbound		Westbound		Northbound		Eastbound		Westbound		Northbound	
Time	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right	Through	Right	Left	Through	Left	Right
6:00 AM	0	10	9	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	9	0	1	1
7:00 AM	0	30	26	0	5	4	0	0	0	0	0	0	0	-1	-1	0	0	0	0	29	26	0	4	4
8:00 AM	0	44	39	0	7	7	0	0	0	0	0	0	0	-3	-3	0	-2	-2	0	41	36	0	6	5
9:00 AM	0	14	13	0	10	9	0	0	0	0	0	0	0	-2	-1	0	-1	-1	0	13	11	0	9	8
10:00 AM	0	13	12	0	14	12	0	0	0	0	0	0	0	-2	-2	0	-2	-2	0	11	10	0	12	10
11:00 AM	0	15	13	0	24	21	0	0	0	0	0	0	0	-3	-2	0	-3	-2	0	12	10	0	21	18
12:00 PM	0	24	21	0	24	21	0	0	0	0	0	0	0	-3	-3	0	-3	-3	0	21	18	0	20	18
1:00 PM	0	21	18	0	16	14	0	0	0	0	0	0	0	-3	-2	0	-3	-3	0	18	16	0	13	11
2:00 PM	0	19	17	0	16	14	0	0	0	0	0	0	0	-3	-2	0	-3	-3	0	17	15	0	12	11
3:00 PM	0	17	15	0	20	17	0	0	0	0	0	0	0	-3	-2	0	-3	-3	0	15	13	0	17	14
4:00 PM	0	13	12	0	35	30	0	0	0	0	0	0	0	-3	-2	0	-3	-3	0	10	9	0	31	27
5:00 PM	0	10	9	0	42	37	0	0	0	0	0	0	0	-2	-2	0	-5	-4	0	7	7	0	38	33
6:00 PM	0	5	4	0	7	6	0	0	0	0	0	0	0	-3	-2	0	-3	-3	0	3	2	0	4	4
7:00 PM	0	3	3	0	6	6	0	0	0	0	0	0	0	-2	-2	0	-3	-2	0	1	1	0	4	3
Enter		8%	7%											8%	7%									
Exit					8%	7%											8%	7%						

No Pass-by impacts at this location

Need to remove existing site trips from the No Build peak hour volumes used to estimate the hourly distributior

Signal Warrant Analysis Worksheets

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Central Street at Gould 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	50	320	192	512	No	No	No	No	No
7:00 - 8:00 AM	95	646	358	1004	No	Yes	No	No	No
8:00 - 9:00 AM	96	650	365	1015	No	Yes	No	No	No
9:00 - 10:00 AM	85	497	341	838	No	Yes	No	No	No
10:00 - 11:00 AM	85	422	353	775	No	Yes	No	No	No
11:00 - 12:00 AM	92	444	385	829	No	Yes	No	No	No
12:00 - 1:00 PM	93	443	392	835	No	Yes	No	No	No
1:00 - 2:00 PM	103	431	586	1017	No	Yes	No	Yes	No
2:00 - 3:00 PM	104	453	579	1032	No	Yes	No	Yes	No
3:00 - 4:00 PM	102	527	537	1064	No	Yes	No	Yes	No
4:00 - 5:00 PM	112	502	617	1119	No	Yes	No	Yes	No
5:00 - 6:00 PM	129	405	745	1150	No	Yes	Yes	Yes	No
6:00 - 7:00 PM	115	389	689	1078	No	Yes	No	Yes	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: 14

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 Gould 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	54	344	208	552	No	No	No	No	No
7:00 - 8:00 AM	103	695	388	1083	No	Yes	No	Verify	No
8:00 - 9:00 AM	104	700	395	1095	No	Yes	No	Verify	No
9:00 - 10:00 AM	92	535	369	904	No	Yes	No	No	No
10:00 - 11:00 AM	92	455	383	838	No	Yes	No	No	No
11:00 - 12:00 AM	99	478	417	895	No	Yes	No	No	No
12:00 - 1:00 PM	100	477	424	901	No	Yes	No	Verify	No
1:00 - 2:00 PM	113	463	631	1094	No	Yes	No	Yes	No
2:00 - 3:00 PM	114	487	622	1109	No	Yes	No	Yes	No
3:00 - 4:00 PM	112	566	578	1144	No	Yes	No	Yes	No
4:00 - 5:00 PM	123	539	664	1203	No	Yes	Yes	Yes	No
5:00 - 6:00 PM	141	435	850	1285	No	Yes	Yes	Yes	Yes
6:00 - 7:00 PM	125	417	741	1158	No	Yes	Yes	Yes	No
					No	**Yes**	**No**	**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)

Total Crashes 2015-2019: 14

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 Gould 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	56	344	217	561	No	No	No	No	No
7:00 - 8:00 AM	107	695	414	1109	No	Yes	No	Verify	No
8:00 - 9:00 AM	150	700	430	1130	No	Yes	Yes	Yes	Verify
9:00 - 10:00 AM	103	535	380	915	No	Yes	No	Verify	No
10:00 - 11:00 AM	106	455	393	848	No	Yes	No	No	No
11:00 - 12:00 AM	124	478	427	905	No	Yes	Yes	Verify	No
12:00 - 1:00 PM	124	477	442	919	No	Yes	Yes	Verify	No
1:00 - 2:00 PM	128	463	647	1110	No	Yes	Yes	Yes	No
2:00 - 3:00 PM	129	487	637	1124	No	Yes	Yes	Yes	No
3:00 - 4:00 PM	132	566	591	1157	No	Yes	Yes	Yes	No
4:00 - 5:00 PM	161	539	673	1212	Yes	Yes	Yes	Yes	Verify
5:00 - 6:00 PM	185	435	855	1290	Yes	Yes	Yes	Yes	Yes
6:00 - 7:00 PM	130	417	743	1160	No	Yes	Yes	Yes	No
					No	**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 14

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: Gould Street at Site Driveway / Wingate Driveway

Major Street Direction: Northbound-Southbound

Year: 2029 **Condition:** Build Conditions

Operating speed on major roadway: 35 mph

Number of approaches: 4

		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 Northbound	Entering Vol. on Major Road Southbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	11	355	185	540	No	No	No	No	No
7:00 - 8:00 AM	39	736	354	1090	No	No	No	No	No
8:00 - 9:00 AM	70	765	380	1145	No	No	No	No	No
9:00 - 10:00 AM	87	545	342	888	No	Yes	No	No	No
10:00 - 11:00 AM	121	462	359	822	No	Yes	Yes	Verify	No
11:00 - 12:00 AM	204	486	409	895	Yes	Yes	Yes	Yes	No
12:00 - 1:00 PM	204	504	417	921	Yes	Yes	Yes	Yes	No
1:00 - 2:00 PM	140	333	499	832	No	Yes	Yes	Verify	No
2:00 - 3:00 PM	136	347	492	838	No	Yes	Yes	Verify	No
3:00 - 4:00 PM	171	393	467	860	Yes	Yes	Yes	Yes	No
4:00 - 5:00 PM	298	366	561	926	Yes	Yes	Yes	Yes	Yes
5:00 - 6:00 PM	360	295	715	1010	Yes	Yes	Yes	Yes	Yes
6:00 - 7:00 PM	64	271	556	827	No	No	No	No	No
					No	**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 left-turning volumes only out of Site driveway

*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: 2

based on MassDOT crash portal

Warrant 9, Grade Crossing: No

last updated: 08/05/05 [version]

APPENDIX D: Utility Plans

DRAIN MANHOLE (TYP)

POTENTIAL SUBSURFACE INFILTRATION SYSTEM

CONNECT TO EXIST 8" WATER MAIN

CONNECT TO EXIST SEWER LINE

SEWER MANHOLE (TYP)

CATCH BASIN (TYP)

TEL MANHOLE (TYP)

ELEC MANHOLE (TYP)

TRENCH DRAIN (TYP)

FIRE HYDRANT (TYP)

CONNECT TO EXIST GAS MAIN

CONNECT TO EXIST 12" WATER MAIN

CONNECT TO EXIST TEL MANHOLE

CONNECT TO EXIST ELEC MANHOLE

CONNECT TO EXIST DRAIN LINE

PROP TRANSFORMERS (TYP)

CONNECT TO EXIST SEWER LINE

GOULD (PUBLIC – 40' WIDE) STREET

TV PLACE (PRIVATE – 40' WIDE) FORMERLY PERMIL ROAD

PROPOSED GARAGE

PROPOSED LAB BUILDING

NORTHERN CIRCUMFERENTIAL HIGHWAY (ROUTE 128) STATE HIGHWAY

Conceptual Utility Plan

Highland Science Center

Needham, MA

Source: **VHB**
Prepared for:
Date: **2022-03-03**

UTILITY DESCRIPTION

- 030: SANITARY SEWER / FORCE MAIN
- 104: STORM DRAIN
- 160: WATER DISTRIBUTION/ FIRE PROTECTION
- 001: ELECTRIC (ALL PHASES), OHW, UPs, SIGNAL
- 233: TELECOMMUNICATIONS/FIBER/CATV
- 040: GAS/OIL

0 20 40 80 Feet

CONNECT TO EXIST
8" WATER MAIN

CONNECT TO EXIST SEWER LINE

SEWER MANHOLE (TYP)

FIRE HYDRANT (TYP)

TEL MANHOLE (TYP)

ELEC MANHOLE (TYP)

CONNECT TO EXIST
GAS MAIN

CONNECT TO EXIST
12" WATER MAIN

CONNECT TO EXIST
TEL MANHOLE

PROP TRANSFORMERS (TYP)

CONNECT TO EXIST SEWER LINE

CONNECT TO EXIST
ELEC MANHOLE

GOULD (PUBLIC – 40' WIDE) STREET

TV PLACE (PRIVATE – 40' WIDE) FORMERLY PERMIL ROAD

PROPOSED GARAGE
BFA=4,600±

PROPOSED LAB BUILDING
5 STORY MASONRY
BFA=20,650±

NORTHERN CIRCUMFERENTIAL HIGHWAY (ROUTE 128) STATE HIGHWAY

MUZI CHEVROLET

MUZI FORD

Conceptual Utility Plan

Highland Science Center

Needham, MA

Source: **VHB**
Prepared for:
Date: **2022-03-03**

UTILITY DESCRIPTION

- 030: SANITARY SEWER / FORCE MAIN
- 160: WATER DISTRIBUTION/ FIRE PROTECTION
- 001: ELECTRIC (ALL PHASES), OHW, UPs, SIGNAL
- 233: TELECOMMUNICATIONS/FIBER/CATV
- 040: GAS/OIL

0 20 40 80 Feet

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DRAIN MANHOLE (TYP)

POTENTIAL SUBSURFACE INFILTRATION SYSTEM

CATCH BASIN (TYP)

TRENCH DRAIN (TYP)

CONNECT TO EXIST DRAIN LINE

GOULD (PUBLIC – 40' WIDE) STREET

TV PLACE (PRIVATE – 40' WIDE) FORMERLY PERMIL ROAD

PROPOSED GARAGE

PROPOSED LAB BUILDING

CAR WASH BFA=4,600±

MUZI CHEVROLET 3 STORY MASONRY BFA=14,500±

MUZI FORD 1 STORY MASONRY BFA=20,650±

NORTHERN CIRCUMFERENTIAL HIGHWAY (ROUTE 128) STATE HIGHWAY

ELEVATION CALL OUTS IN THE AREA UNDER CONSTRUCTION ARE NOT UP TO DATE

UTILITY DESCRIPTION

12"D — 104: STORM DRAIN

0 20 40 80 Feet

Conceptual Stormwater Plan

Highland Science Center

Needham, MA

Source: **VHB**
Prepared for:
Date: **2022-03-03**

APPENDIX E: Federal Aviation Administration

- Notice Criteria Tool

Federal Aviation Administration

« OE/AAA

Notice Criteria Tool

Notice Criteria Tool - Desk Reference Guide V_2018.2.0

The requirements for filing with the Federal Aviation Administration for proposed structures vary based on a number of factors: height, proximity to an airport, location, and frequencies emitted from the structure, etc. For more details, please reference CFR Title 14 Part 77.9.

You must file with the FAA at least 45 days prior to construction if:

- your structure will exceed 200ft above ground level
- your structure will be in proximity to an airport and will exceed the slope ratio
- your structure involves construction of a traverseway (i.e. highway, railroad, waterway etc...) and once adjusted upward with the appropriate vertical distance would exceed a standard of 77.9(a) or (b)
- your structure will emit frequencies, and does not meet the conditions of the FAA Co-location Policy
- your structure will be in an instrument approach area and might exceed part 77 Subpart C
- your proposed structure will be in proximity to a navigation facility and may impact the assurance of navigation signal reception
- your structure will be on an airport or heliport
- filing has been requested by the FAA

If you require additional information regarding the filing requirements for your structure, please identify and contact the appropriate FAA representative using the Air Traffic Areas of Responsibility map for Off Airport construction, or contact the FAA Airports Region / District Office for On Airport construction.

The tool below will assist in applying Part 77 Notice Criteria.

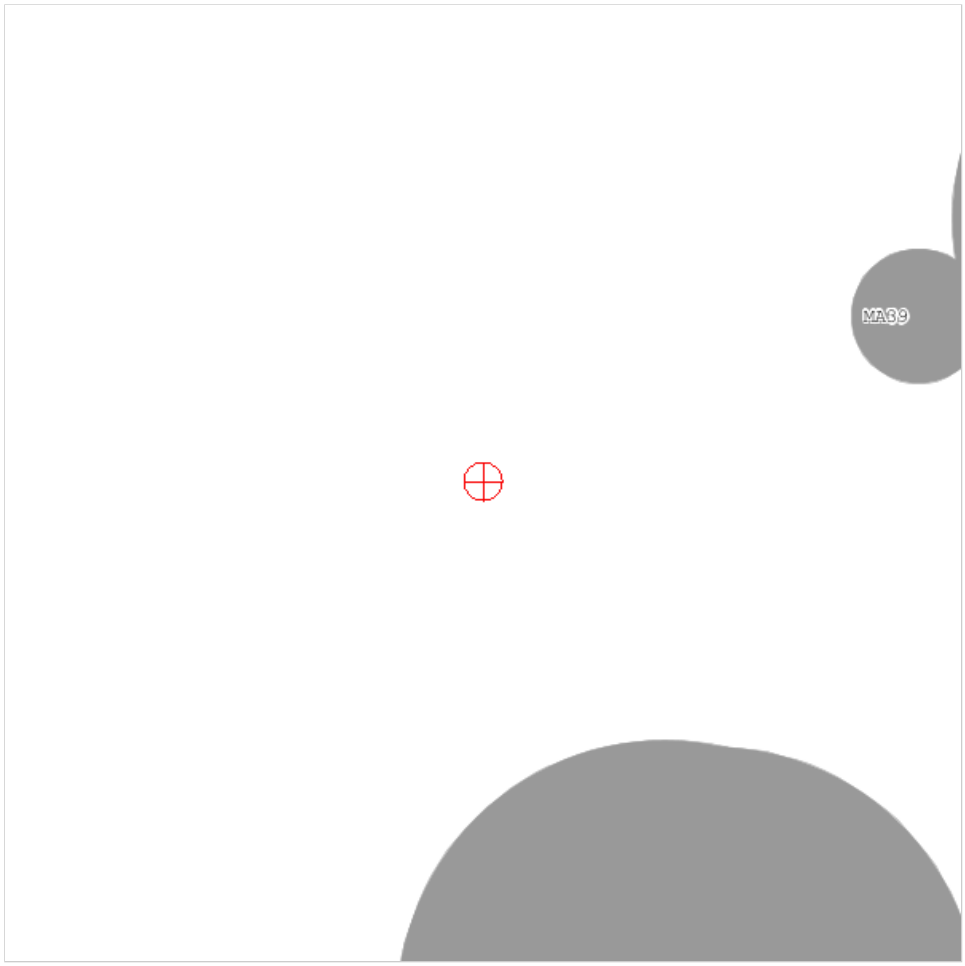
Latitude:	42 Deg 18 M 06.97 S N
Longitude:	71 Deg 13 M 41.18 S W
Horizontal Datum:	NAD83
Site Elevation (SE):	130 (nearest foot)
Structure Height :	70 (nearest foot)
Traverseway:	No Traverseway (Additional height is added to certain structures under 77.9(c)) User can increase the default height adjustment for Traverseway, Private Roadway and Waterway
Is structure on airport:	(•) No ( ) Yes

Results

You exceed the following Notice Criteria:

Your proposed structure is in proximity to a navigation facility and may impact the assurance of navigation signal reception. The FAA, in accordance with 77.9, requests that you file.

The FAA requests that you file


MA89

ENVIRONMENTAL JUSTICE SECTION

I. Identifying Characteristics of EJ Populations

A. If an Environmental Justice (EJ) population has been identified as located in whole or in part within 5 miles of the project site, describe the characteristics of each EJ populations as identified in the EJ Maps Viewer (i.e., the census block group identification number and EJ characteristics of "Minority," "Minority and Income," etc.). Provide a breakdown of those EJ populations within 1 mile of the project site, and those within 5 miles of the site.

Within one mile of the Project Site

The Project does not contain any EJ populations in a one-mile radius and the Project impacts will not impact populations outside of the immediate Project Site.

Within five miles of the Project Site

Minority Population

Block Group 5, Census Tract 4044, Norfolk County, Massachusetts
Block Group 2, Census Tract 4041, Norfolk County, Massachusetts
Block Group 1, Census Tract 3740, Middlesex County, Massachusetts
Block Group 6, Census Tract 1301, Suffolk County, Massachusetts
Block Group 1, Census Tract 4025, Norfolk County, Massachusetts
Block Group 1, Census Tract 4024, Norfolk County, Massachusetts
Block Group 4, Census Tract 4021.02, Norfolk County, Massachusetts
Block Group 2, Census Tract 1304.06, Suffolk County, Massachusetts
Block Group 3, Census Tract 1304.04, Suffolk County, Massachusetts
Block Group 1, Census Tract 1304.04, Suffolk County, Massachusetts
Block Group 5, Census Tract 1304.02, Suffolk County, Massachusetts
Block Group 4, Census Tract 1303, Suffolk County, Massachusetts
Block Group 6, Census Tract 1301, Suffolk County, Massachusetts
Block Group 2, Census Tract 1105.01, Suffolk County, Massachusetts
Block Group 2, Census Tract 1301, Suffolk County, Massachusetts
Block Group 1, Census Tract 1301, Suffolk County, Massachusetts
Block Group 2, Census Tract 4012, Norfolk County, Massachusetts
Block Group 3, Census Tract 4012, Norfolk County, Massachusetts
Block Group 4, Census Tract 4012, Norfolk County, Massachusetts
Block Group 1, Census Tract 4012, Norfolk County, Massachusetts
Block Group 1, Census Tract 4011, Norfolk County, Massachusetts
Block Group 2, Census Tract 4011, Norfolk County, Massachusetts
Block Group 3, Census Tract 4011, Norfolk County, Massachusetts
Block Group 3, Census Tract 4006, Norfolk County, Massachusetts
Block Group 2, Census Tract 5.02, Suffolk County, Massachusetts
Block Group 4, Census Tract 5.02, Suffolk County, Massachusetts
Block Group 2, Census Tract 4.02, Suffolk County, Massachusetts
Block Group 3, Census Tract 4.02, Suffolk County, Massachusetts
Block Group 1, Census Tract 3.02, Suffolk County, Massachusetts
Block Group 2, Census Tract 2.02, Suffolk County, Massachusetts
Block Group 4, Census Tract 3.01, Suffolk County, Massachusetts
Block Group 1, Census Tract 3.01, Suffolk County, Massachusetts
Block Group 1, Census Tract 3731, Middlesex County, Massachusetts
Block Group 5, Census Tract 3731, Middlesex County, Massachusetts
Block Group 4, Census Tract 3704, Middlesex County, Massachusetts
Block Group 4, Census Tract 3701.02, Middlesex County, Massachusetts
Block Group 1, Census Tract 3701.02, Middlesex County, Massachusetts

Block Group 1, Census Tract 3686, Middlesex County, Massachusetts
Block Group 1, Census Tract 3685, Middlesex County, Massachusetts
Block Group 3, Census Tract 3685, Middlesex County, Massachusetts
Block Group 2, Census Tract 3684, Middlesex County, Massachusetts
Block Group 3, Census Tract 3684, Middlesex County, Massachusetts

Minority and Income

Block Group 2, Census Tract 3687, Middlesex County, Massachusetts
Block Group 3, Census Tract 3686, Middlesex County, Massachusetts
Block Group 1, Census Tract 3684, Middlesex County, Massachusetts
Block Group 1, Census Tract 1401.06, Suffolk County, Massachusetts
Minority Income English Isolation
Block Group 4, Census Tract 4.01, Suffolk County, Massachusetts
Block Group 2, Census Tract 1401.06, Suffolk County, Massachusetts

Income

Block Group 2, Census Tract 1304.02, Suffolk County, Massachusetts

Minority, Income, and English Isolation

Block Group 4, Census Tract 4161.01, Norfolk County, Massachusetts

Minority and English Isolation

Block Group 3, Census Tract 1304.06, Suffolk County, Massachusetts

B. Identify all languages identified in the "Languages Spoken in Massachusetts" tab of the EJ Maps Viewer as spoken by 5 percent or more of the EJ population who also identify as not speaking English "very well." The languages should be identified for each census tract located in whole or in part within 1 mile and 5 miles of the project site, regardless of whether such census tract contains any designated EJ populations.

Within one mile of the Project Site

Tract 4041 in Wellesley Chinese 8.5%

Within five miles of the Project Site

Tract 1304.06 in Boston: Spanish or Spanish Creole 11.2% French Creole: 6.4%
Tract 1304.04 in Boston: Spanish or Spanish Creole 5.5%
Tract 1105.02 in Boston: Spanish or Spanish Creole 6.6%
Tract 5.04 in Boston: Russian 8.4%
Tract 4.01 in Boston: Russian 9.9% Chinese 8.7%
Tract 4.02 in Boston: Chinese 5%
Tract 3.02 in Boston: Chinese 7%
Tract 2.02 in Boston: Chinese 8.6%
Tract 3688 in Waltham: Spanish or Spanish Creole 11.5%
Tract 3687 in Waltham: Spanish or Spanish Creole 19.1
Tract 3685 in Waltham: Spanish or Spanish Creole 12%
Tract 3684 in Waltham: Chinese 5.8%

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

TOWN OF NEEDHAM
SEWER SYSTEM IMPACT PROGRAM REGULATIONS
Approved: October 18, 2016

I. SCOPE OF SEWER SYSTEM IMPACT PROGRAM

A. All activities, not exempted, requiring connection to, or a major increase in the use of the sanitary sewer system shall be subject to the requirements of these regulations.

II. ACTIVITIES SUBJECT TO THE SEWER SYSTEM IMPACT PROGRAM

A. All activities, not exempted, requiring an extension of the sewer system are subject to these regulations.

B. All activities, not exempted, requiring connection to, or a major increase in the use of the sewer system are subject to these regulations, including:

i. the development of a subdivision, where approval under the Subdivision Control Law, MGL, Ch. 41 is required;

ii. the development of a "Flexible Development," as defined in Section 4.2.4 of the Town of Needham Zoning By-Law, consistent with subdivision control law;

iii. the development of a "Planned Residential Development, " as defined in Section 4.2.5 of the Town of Needham Zoning By-Law;

iv. the development of a "Residential Compound," as defined in Section 4.2.6 of the Town of Needham Zoning By-Law; and

v. the development of a "Major Project," as defined in Section 7.4 of the Town of Needham Zoning By-Law, including projects of 20,000 S.F. or more of gross floor area, or an increase of 10,000 S.F. or more of gross floor area, or the creation of 50 or more off street parking spaces, or the creation of a restaurant with 101 or more seats.

C. All activities, not exempted, requiring a connection to, or an increase in the use of the sewer system whose total discharge:

i. will add 750 gallons per day (GPD), or more; and/or

ii. will increase by 750 GPD or greater above the "designated calculation of sewage flow" for the category of use existing prior to the proposed discharge increase (as set forth in 310 CMR 15:02, as amended);

are subject to these regulations,

D. Certain activities may also require that a DEP "Sewer Extension Permit" and/or "Sewer Connection Permit" be obtained.

III. ACTIVITIES EXEMPT FROM SEWER IMPACT PROGRAM REGULATIONS

A. Construction of a single family home on an existing lot is exempt from these regulations.

B. Development activities on property not currently benefiting from a common sewer are exempt in their entirety. Any such property later requiring connection to a common sewer, by whatever means available, shall become subject to the usual assessment for betterments under M.G.L. Ch. 83 and may also be subject to the requirements of these regulations, as applicable.

C. Development activities on property benefiting from a common sewer and having been assessed for a betterment under M.G.L. Ch. 83 but not yet connected to the sewer system are exempted as follows: initial connection to the system shall be exempt up to the limit total of 750 G.P.D. for each separate parcel of property as originally described in the Assessment Order when levied.

D. Major Project Site Plan projects of less than 20,000 S.F. or more of gross floor area, or an increase of less than 10,000 S.F. or more of gross floor area, or the creation of less than 50 or more off street parking spaces, or the creation of a restaurant with fewer than 101 seats.

IV. REQUIREMENTS OF SEWER IMPACT PROGRAM REGULATIONS

A. A property owner or developer, whose activity is not exempted, requiring connection to, or an increase in use of , the sewer system shall be required to:

i. Perform work upon the sewer system, as designated by the Director of Public Works, to relieve flow restrictions or eliminate a volume of excessive flow by a volume equal to two hundred percent (200%) of the proposed volume of discharge if the proposed discharge is less than 15,000 GPD, or four hundred percent (400%) of the proposed volume of discharge if the proposed discharge is 15,000 GPD or more;

ii. Pay a determined sewer impact charge. The rate to be used to determine the charge will be Eight Dollars ($8.00) per gallon. This rate is intended to equal the sum of the per gallon cost of

1. identifying and documenting the amount of infiltration to be removed;

2. designing plans and creating bid packages for the physical removal of the infiltration;
3. removing the required amount of infiltration; and
4. verifying and documenting the amount of infiltration removed.

V. ACCEPTANCE AND EXPENDITURE OF CHARGE AND CONTRIBUTIONS AND THE ESTABLISHMENT OF THE IMPROVEMENT FUND

A. Payments offered in lieu of actual inflow and infiltration removal work must be accepted by the Board of Selectmen and upon acceptance, shall be deposited with the Treasurer and credited to the Sewer Enterprise Fund, held in a separate account reserved for future appropriation for the sole purposes intended.

B. Authorization to expend said funds shall be by a majority vote of Town Meeting for a project submitted by the Board of Selectmen upon the recommendation of the Town Manager.

VI. AMMENDMENTS TO SEWER IMPACT PROGRAM REGULATIONS

A. The Board of Selectman reserves the right to add, delete, rescind, modify or otherwise amend the requirements of these regulations.

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

Public Comments on 557 Highland Avenue

Received between the packets for 6/7/22 meeting closed on June 2, 2022 and 3 p.m. on June 7, 2022.

1. Email from Carlos Agualimpia, Town Meeting Member - Precinct C, dated June 4, 2022.
2. Email from Steven Sussman, 30 Davenport Road, dated June 6, 2022.
3. Email form Henry Ragin, 25 Bennington Street, dated June 6, 2022.
4. Email from Casey Fedde, 16 Mills Rd, dated June 6, 2022.
5. Email from Avery, dated June 6, 2022.
6. Email from Karen Quigley, dated June 6, 2022/
7. Email from Kim Stone, Kim Stone, 45 Greendale Ave, dated June 6, 2022.
8. Email from MaeLynn Patten, 16 Ledge Street, dated June 6, 2022.
9. Email from Valerie Maio, 15 Park Ave., dated June 6, 2022.
10. Email from Maggie Flanagan, dated June 6, 2022.
11. Email from Nicole Nasson, dated June 6, 2022.
12. Email from Brooke Reilly, 41 Pine Grove Street, dated June 6, 2022.
13. Email from Jennie Jonas, 93 Sachem Road, dated June 6, 2022.
14. Email from Shannon Shavor, dated June 6, 2022.
15. Email from Matt Flanagan, 54 Sachem Road, dated June 6, 2022.
16. Email from Holly Charbonnier, Town Meeting Member, Precinct J, 94 Sachem Road, dated June 6, 2022.
17. Email from Joanne Garabedian, dated June 6, 2022.
18. Email from Ali Dabuzhsky, 42 Aletha Road, dated June 6, 2022.
19. Email from Ashly Scheufele, 52 Greendale Avenue, dated June 6, 2022.
20. Letter from the Needham Heights Alliance, dated June 6, 2022.
21. Email from Paul Charbonnier, 94 Sachem Road, dated June 6, 2022.
22. Email from Emily Pick, 12 Mills Road, dated June 6, 2022.
23. Email from Natalie and Eugene Ho, 21 Utica Rd, dated June 26, 2022.

24. Email from Russell Smith, dated June 6, 2022.
25. Email from Julie Tracey, Beech Street, dated June 6, 2022.
26. Email from Ada Lei Chan, dated June 6, 2022.
27. Email from Elizabeth C Rich, 323 West Street, dated June 6, 202.
28. Email from Alanna Burke, dated June 6, 2022.
29. Email from Maureen and Jim DiMeo, 442 Central Avenue, dated June 6, 2022.
30. Email from Larry Tobin, 31 Greendale Ave, dated June 6, 2022.
31. Email from Michael Diener, dated June 7, 2022.
32. Email from Laura Ruch, dated June 7, 2022.
33. Email from Kelly Close, dated June 7, 2022.
34. Email from Robert Deutsch, dated June 7, 2022.

PLANNING & COMMUNITY DEVELOPMENT
PLANNING DIVISION

MEMORANDUM

TO: David Roche, Building Dept.
Tom Ryder, Engineering Dept.
Carys Lustig, Public Works Dept.
Chief John Schlittler, Police Dept.
Chief Dennis Condon, Fire Dept.
Tim McDonald, Health Dept.

FROM: Planning Department

DATE: May 24, 2022

SUBJECT: **INSIGNIFICANT CHANGE - Major Project Special Permit 2022-01**
Needham Farmers Market, Inc.
Greene's Field, a Needham Park Facility, at Great Plain Avenue and Pickering Street

---

Reference is made to Major Project Site Plan Special Permit No. 2022-01, dated April 5, 2022. The Petitioner for the above-named project provided a request for an Insignificant Change to the Planning Department on May 17, 2022. The Petitioner has requested to alter the location of some of the vendor and artist locations, namely, to utilize the tent that the Town has installed on Greene's Field (see the plan provided). The number of vendors and artists is not changing and the area of Greene's Field where the Market is to be located also remains unchanged.

1. Email from Jeffrey Friedman, President, Needham Farmers Market, dated May 17, 2022.

2. Needham Farmers Market Greene's Field Layout, version 5.23. Please note that this plan supersedes and replaces the plan noted in Exhibit 6 of the Decision entitled "Proposed Placement of Tents/Spaces on Greene's Field", prepared for NFM, dated March 7, 2022.

3. Email from Myles Tucker dated May 17, 2022.

The above described changes as shown on the plans detailed in items 1, 2 and 3 above were approved by the Director of Planning and Community Development, Lee Newman, on May 24, 2022 under the Planning Board's insignificant modifications policy and are hereby transmitted to your department as the Board's approved plan at the property.

Thank you for your attention to this matter.

cc: Planning Board

From:	friedmanesq@aol.com
To:	Lee Newman; Alexandra Clee
Cc:	Myles Tucker; Stacey Mulroy; Edward Olsen; Amy Haelsen; fundamentallynuts@gmail.com; johnaterry15@gmail.com
Subject:	Needham Farmers Market, Special Permit 2022-01
Date:	Tuesday, May 17, 2022 2:49:35 PM
Attachments:	Greene"s Field Layout Map 5.16.22.pdf image003.png image002.png image001.png

---

May 17, 2022

Needham Planning Board
500 Dedham Avenue
PSAB Bldg.
Needham, MA 02492

Re: Needham Farmers Market
Major Project Site Plan Special Permit 2022-01 for Greene's Field

Dear Planning Board:

Needham Farmers Market ("NFM") is writing to inform you that the Town of Needham has agreed to offer NFM the exclusive use of its tent on Greene's Field during the hours of licensed use of the Field, under the License Agreement and the Special Permit. I have attached NFM's Layout Map for Greene's Field (updated May 16, 2022), with the Town's tent located at the right end of the long walkway on the site. This tent will be occupied by The Neighborhood Farm, NFM's vendor. This is an Insignificant Change to the Special Permit, and is not an addition to the number of vendors. NFM opens on June 12th. See below email from Myles Tucker, Support Services Manager for the Town of Needham.

Sincerely,
Jeffrey Friedman
President, Needham Farmers Market

-----Original Message-----
From: Myles Tucker <mtucker@needhamma.gov>
To: friedmanesq@aol.com <friedmanesq@aol.com>
Cc: fundamentallynuts@gmail.com <fundamentallynuts@gmail.com>; johnaterry15@gmail.com <johnaterry15@gmail.com>; Stacey Mulroy <smulroy@needhamma.gov>; Edward Olsen <eolsen@needhamma.gov>; Amy Haelsen <ahaelsen@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>
Sent: Tue, May 17, 2022 9:10 am
Subject: RE: Update to Meeting on May 5th re: Farmer's Market on Green's Field

Hi Jeff,

This email confirms that the Needham Farmer's Market will have exclusive use of the tent on Green's Field during the hours that it has licensed use of the field. Moveable furniture in the tent may be moved or utilized by the Farmer's Market, so long that it is returned to the place it was found prior to use or moving in the same condition it was found.

For the RTS sign, please submit a request on the Town website and we'll make sure it gets done. The

link is here: http://www.needhamma.gov/forms.aspx?FID=418

--
Myles Tucker
He/Him/His
Support Services Manager

Town of Needham
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From: friedmanesq@aol.com <friedmanesq@aol.com>
Sent: Tuesday, May 17, 2022 6:45 AM
To: Myles Tucker <mtucker@needhamma.gov>
Cc: fundamentallynuts@gmail.com; johnaterry15@gmail.com; Stacey Mulroy <smulroy@needhamma.gov>; Edward Olsen <eolsen@needhamma.gov>; Amy Haelsen <ahaelsen@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>
Subject: Update to Meeting on May 5th re: Farmer's Market on Green's Field

Hi Myles,

I have attached an update to Needham Farmers Market's Layout Map on Greene's Field. Could you please send me a brief letter or email that the Town allows NFM's exclusive use of its tent for a vendor on Greene's Field during Market hours? I will notify the Planning Board of this Insignificant Change to the Special Permit.

Also, prior to June 12th, could you please post a notice on the Town's digital signboard at the Transfer Station to announce NFM's opening at Greene's Field, 11 a.m. to 3 p.m.?

Thanks,
Jeff

Jeff Friedman
President, Needham Farmers Market

-----Original Message-----

From: Myles Tucker <mtucker@needhamma.gov>
To: Jeff Friedman <friedmanesq@aol.com>; Lisa C <fundamentallynuts@gmail.com>; johnaterry15@gmail.com <johnaterry15@gmail.com>; Stacey Mulroy <smulroy@needhamma.gov>; Edward Olsen <eolsen@needhamma.gov>; Amy Haelsen <ahaelsen@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>
Sent: Fri, May 6, 2022 10:36 am
Subject: RE: Summary of Meeting on May 5th re: Farmer's Market on Green's Field

Hi All,

Adding in a note I forgot:

The Farmer's Market will submit to Planning (Alex, cc'd) a brief letter requesting an "Insignificant Change" to the Special Permit, noting the use of the tent and that there will be no change to the number of vendors.

--
Myles Tucker
He/Him/His
Support Services Manager

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From: Myles Tucker
Sent: Friday, May 6, 2022 9:02 AM
To: Jeff Friedman <friedmanesq@aol.com>; Lisa C <fundamentallynuts@gmail.com>; johnaterry15@gmail.com; Stacey Mulroy <smulroy@needhamma.gov>; Edward Olsen <eolsen@needhamma.gov>; Amy Haelsen <ahaelsen@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>
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Hi All,

Below is a summary of the meeting that everyone in the "to" line participated in yesterday for reference through the summer. Again, thank you all for the flexibility as we work together through another unique year!

The Town has one action item outstanding, which is to confirm electrical outlets.

Tent Use

- Farmer's Market will have exclusive use of the tent during the licensed time
- Plans to place a vendor under the tent
- OK to move tables or use tables

Vendor Unload Blocking

- Market manager will cone off spaces on GPA and Pickering for duration of the licensed market use period (including set up and tear down time)

Refuse Bins

- No extra barrel required
- Farmer's Market will let Town know if trash is present prior to set up

Bike Rack

- If it needs to be moved, can be moved so long as it is put it back when done

Electricity (location and power)

- Town needs to confirm placement of outlets on the Field

Are there scheduled activities on Greene's Field during Market Days

- Little League for the first few weeks, Town will try and deconflict

--
Myles Tucker
He/Him/His
Support Services Manager

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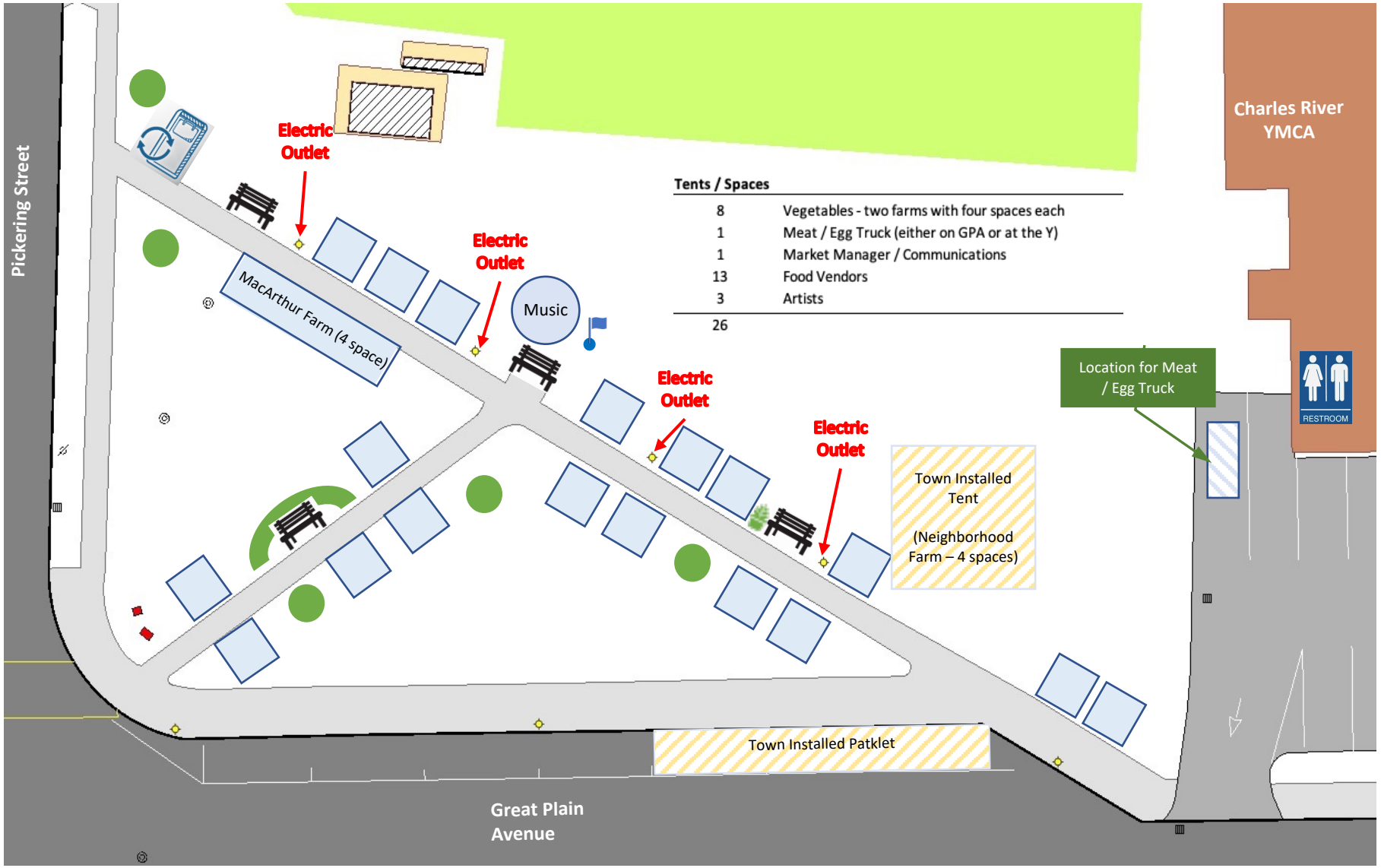
Needham Farmers Market Layout - Greene's Field

V.05.23

Each single tent space represents a 10 ft x 10 ft space. Vendor layout is approximate and subject to refinement



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To:	friedmanesq@aol.com
Cc:	fundamentallynuts@gmail.com; johnaterry15@gmail.com; Stacey Mulroy; Edward Olsen; Amy Haelsen; Alexandra Clee; Lee Newman
Subject:	RE: Update to Meeting on May 5th re: Farmer"s Market on Green"s Field
Date:	Tuesday, May 17, 2022 9:10:05 AM
Attachments:	image001.png image002.png image003.png

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To: Jeff Friedman <friedmanesq@aol.com>; Lisa C <fundamentallynuts@gmail.com>; johnaterry15@gmail.com <johnaterry15@gmail.com>; Stacey Mulroy <smulroy@needhamma.gov>; Edward Olsen <eolsen@needhamma.gov>; Amy Haelsen <ahaelsen@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>
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He/Him/His
Support Services Manager

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