NEEDHAM PLANNING BOARD
Tuesday, October 17, 2023
7:00 p.m.

Charles River Room
Public Services Administration Building, 500 Dedham Avenue
AND
Virtual Meeting using Zoom
Meeting ID: **880 4672 5264**
(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: 880 4672 5264

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: 880 4672 5264

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: 880 4672 5264

Direct Link to meeting: https://us02web.zoom.us/j/88046725264

1. Discuss Open Meeting Law Complaint filed by Gregg Darish on October 11, 2023.

2. 117 Kendrick – discussion of proposed new loading access.

3. Public Hearing:

   7:30 p.m. Major Project Site Plan Special Permit No. 2023-03: Neehigh LLC, 93 Union Street, Suite 315, Newton Center, Petitioner. (Property located at 629-661 Highland Avenue, Needham, Massachusetts). Regarding request to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. *Please note: This hearing has been continued from the September 5, 2023 and October 3, 2023 Planning Board meetings.*

4. ANR Plan – 969 South Street LLC, Petitioner, (Property located at 969 South Street, Needham, MA).

5. Request to extend subdivision plan submittal: 920 South Street Definitive Subdivision: Brian Connaughton, 920 South Street, Needham, MA, Petitioner, (Property located at 920 South Street, Needham, MA).

6. HONE Advisory Group Status Report.

7. Minutes.

8. Report from Planning Director and Board members.

9. Correspondence.

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

The Commonwealth of Massachusetts
Office of the Attorney General
One Ashburton Place
Boston, Massachusetts 02108

OPEN MEETING LAW COMPLAINT FORM

Instructions for completing the Open Meeting Law Complaint Form

The Attorney General's Division of Open Government interprets and enforces the Open Meeting Law, Chapter 30A of the Massachusetts General Laws, Sections 18-25. Below is the procedure for filing and responding to an Open Meeting Law complaint.

Instructions for filing a complaint:

- Fill out the attached two-page form completely and sign it. File the complaint with the public body within 30 days of the alleged violation. If the violation was not reasonably discoverable at the time it occurred, you must file the complaint within 30 days of the date the violation was reasonably discoverable. A violation that occurs during an open session of a meeting is reasonably discoverable on the date of the meeting.
- To file the complaint:
  - For a local or municipal public body, you must submit a copy of the complaint to the chair of the public body **AND** to the municipal clerk.
  - For all other public bodies, you must submit a copy of the complaint to the chair of the public body.
  - Complaints may be filed by mail, email, or by hand. Please retain a copy for your records.
- If the public body does not respond within 14 business days and does not request an extension to respond, contact the Division for further assistance.

Instructions for a public body that receives a complaint:

- The chair must disseminate the complaint to the members of the public body.
- The public body must meet to review the complaint within 14 business days (usually 20-22 calendar days).
- After review, but within 14 business days, the public body must respond to the complaint in writing and must send the complainant a response and a description of any action the public body has taken to address it. At the same time, the body must send the Attorney General a copy of the response. The public body may delegate this responsibility to its counsel or a staff member, but only after it has met to review the complaint.
- If a public body requires more time to review the complaint and respond, it may request an extension of time for good cause by contacting the Division of Open Government.

Once the public body has responded to the complaint:

- If you are not satisfied with that the public body's response to your complaint, you may file a copy of the complaint with the Division by mail, e-mail, or by hand, but only once you have waited for 30 days after filing the complaint with the public body.
- When you file your complaint with the Division, please include the complaint form and all documentation relevant to the alleged violation. You may wish to attach a cover letter explaining why the public body's response does not adequately address your complaint.
- The Division will not review complaints filed with us more than 90 days after the violation, unless we granted an extension to the public body or you can demonstrate good cause for the delay.

If you have questions concerning the Open Meeting Law complaint process, we encourage you to contact the Division of Open Government by phone at (617) 963-2540 or by e-mail at openmeeting@state.ma.us.

OPEN MEETING LAW COMPLAINT FORM

Office of the Attorney General
One Ashburton Place
Boston, MA 02108

Please note that all fields are required unless otherwise noted.

Your Contact Information:

First Name: Gregg Last Name: Darish

Address: 34 Country Way

City: Needham State: MA Zip Code: 02492

Phone Number: +1 (617) 306-4011 Ext.

Email: gjdarish@gmail.com

Organization or Media Affiliation (if any):

Are you filing the complaint in your capacity as an individual, representative of an organization, or media?

(For statistical purposes only)

☒ Individual ☐ Organization ☐ Media

Public Body that is the subject of this complaint:

☒ City/Town ☐ County ☐ Regional/District ☐ State

Name of Public Body (including city/ town, county or region, if applicable): Needham Planning Board

Specific person(s), if any, you allege committed the violation:

Date of alleged violation: 09/11/2023

Description of alleged violation:

Describe the alleged violation that this complaint is about. If you believe the alleged violation was intentional, please say so and include the reasons supporting your belief.

Note: This text field has a maximum of 3000 characters.

See attached.

What action do you want the public body to take in response to your complaint?

Note: This text field has a maximum of 500 characters.

Given that the PB apparently voted not to appeal the decision of the Land Court, and that no attorney client privilege can attach to this meeting, I would like the PB to create and release full and accurate minutes of this meeting and the executive session detailing who was present, what was discussed, who spoke and what they said. To the extent that any notes or recordings of the Executive Session exist, I would like the Planning Board to provide a copy of those notes and/or recordings.

Review, sign, and submit your complaint

I. Disclosure of Your Complaint.

Public Record. Under most circumstances, your complaint, and any documents submitted with your complaint, is considered a public record and will be available to any member of the public upon request.

Publication to Website. As part of the Open Data Initiative, the AGO will publish to its website certain information regarding your complaint, including your name and the name of the public body. The AGO will not publish your contact information.

II. Consulting With a Private Attorney.

The AGO cannot give you legal advice and is not able to be your private attorney, but represents the public interest. If you have any questions concerning your individual legal rights or responsibilities you should contact a private attorney.

III. Submit Your Complaint to the Public Body.

The complaint must be filed first with the public body. If you have any questions, please contact the Division of Open Government by calling (617) 963-2540 or by email to openmeeting@state.ma.us.

By signing below, I acknowledge that I have read and understood the provisions above and certify that the information I have provided is true and correct to the best of my knowledge.

Signed: _____ **Date:** 10/11/23

For Use By Public Body	*For Use By AGO*
Date Received by Public Body:	*Date Received by AGO:*

At 5:00 p.m. on September 11, 2023, the Planning Board held a public meeting where it discussed two items, one in open session and then one for which it took a vote and entered Executive Session under Exception 3 of the OML. This public session, and the Executive Session wherein it apparently was decided not to pursue a valid appeal of a Land Court judgment against the Planning Board, is a violation of OML because the Planning Board did not post any notice of this meeting. In fact, on information and belief at least one member of the Planning Board was unaware of the non-executive session agenda item and another member of the Planning Board was not even told of the meeting at all.

The Select Board issued a notice on its own behalf that there would be a joint meeting of the Select Board and the Planning Board; however, the Planning Board was required to issue its own notice of a meeting both for the open session and for the Executive Session. Its failure to do so is a violation of OML.

The Select Board's notice was not sufficient to serve as a Planning Board notice and it was also deficient. The Select Board notice did not properly identify what the Executive Session was about. The Select Board notice vaguely referred to "potential litigation" regarding 1688 Central Avenue when in fact the purpose of the session was to discuss strategy with respect to specific pending litigation against the Planning Board, namely whether the Planning Board would continue defending the suit, including by appealing the adverse judgment of the Land Court.

The September 11, 2023 meeting was held outside of the regular meeting schedule exacerbating the lack of notice and the Planning Board did not issue any minutes of the meeting in violation of OML.

Additionally, the decision to hold a joint session with the Select Board was apparently deliberated and decided outside of an open meeting in violation of OML. The Planning Board never deliberated about or took a vote in open session regarding any proposal to have a joint session with the Select Board about the litigation pending against the Planning Board.

Although counsel to the Planning Board, Jay Talerman, was present at the Executive Session, no attorney-client privilege can attach to this meeting since several people present were not clients of Mr. Talerman with regard to the suit against the Planning Board. In fact, not only is the Select Board and Town Manager not a client of Mr. Talerman, the members of the Select Board, Town Manager and Town Counsel are adverse parties to the Planning Board on this matter since the Select Board/Town Manager itself, through its Town Counsel, brings applications before the Planning Board which could be affected by the outcome of the subject litigation.

SELECT BOARD AGENDA
Special Joint Meeting With Planning Board
5:00 p.m. September 11, 2023

Needham Town Hall
Great Plain Room & Zoom

Pursuant to Chapter 2 of the Acts of 2023, meetings of public bodies may be conducted virtually provided that adequate access is provided to the public.

To listen and view this virtual meeting on a phone, computer, laptop, or tablet, download the "Zoom Cloud Meeting" app in any app store or at www.zoom.us. At the above date and time, click on "Join a Meeting" and enter the meeting or click the link below to join the webinar:

Link:
https://us02web.zoom.us/j/81845936322?pwd=ZHNkeERYTlprTE45eWlpd3lsNkdTZz09
Webinar ID: 818 4593 6322
Passcode: 052151

1.	**5:00**	Discuss Special Town Meeting Draft Warrant Article: "Foster Property Open Space Zoning Non-Binding Resolution"
2.	**5:10**	Executive Session, Exception 3: To Discuss Potential Litigation Relative to 1688 Central Avenue

From:	Sullivan, Timothy
To:	Alexandra Clee; Lee Newman
Cc:	Mark DiOrio; Michael Wilcox; Manning, Sean
Subject:	RE: 117 Kendrick Street
Date:	Wednesday, October 11, 2023 7:11:06 PM

Hi Alex,

Yes, the following is a brief explanation:

There is an existing Special Permit for the office/life science building located at 117 Kendrick Street. The property owner would like to amend the special permit to allow for the addition of a loading dock bay to accommodate special deliveries to one of the office/life science suites from 3rd Avenue. This bay is needed because servicing this particular suite from the existing loading dock is not a workable arrangement and will render this suite difficult to market to prospective lab/R&D tenants.

Prior to formally submitting this request, we would like to meet with the Planning Board to review the proposal and answer questions. To facilitate this discussion, we have provided the Board with information to identify the location of the new loading bay, the type of delivery vehicles that will be utilizing the loading bay, the expected frequency of deliveries and the details regarding the 3rd Avenue traffic operations in relation to a new bay at this location. As you will note from these materials, we expect that this bay will be used infrequently, there is no impact to the Third Avenue traffic operations, the property remains compliant with zoning and there is no change in gross floor area of the building. As a result, we are hopeful that this could be treated as a minor amendment.

Again, the project team, including VHB, looks forward to meeting with the Board to discuss any comments and questions prior to filing.

Thank you ,
Tim

Timothy W. Sullivan
Direct (617) 574-4179
Mobile (617) 645-4361
goulston&storrs

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Wednesday, October 11, 2023 5:00 PM
To: Sullivan, Timothy <TSullivan@GOULSTONSTORRS.com>; Lee Newman <LNewman@needhamma.gov>
Cc: Mark DiOrio <mrd@Bulfinch.com>; Michael Wilcox <MBW@Bulfinch.com>; Manning, Sean <smanning@VHB.com>
Subject: Re: 117 Kendrick Street

Received. Could you please provide a cover letter that explains briefly what is being proposed?

Thank you.

Alexandra Clee

Assistant Town Planner

Needham, MA

781-455-7550 ext. 271

www.needhamma.gov

From: Sullivan, Timothy <TSullivan@GOULSTONSTORRS.com>
Sent: Wednesday, October 11, 2023 4:12:07 PM
To: Lee Newman <LNewman@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>
Cc: Mark DiOrio <mrd@Bulfinch.com>; Michael Wilcox <MBW@Bulfinch.com>; Manning, Sean <smanning@VHB.com>
Subject: 117 Kendrick Street

Lee and Alex,

I hope all is well with you! In anticipation of an informal discussion with the Planning Board next week regarding 117 Kendrick Street, attached is a PDF with slides we would like to review.

Please let us know if you have any questions, we look forward to the discussion.

Thanks,
Tim

Timothy W. Sullivan
Direct (617) 574-4179
Mobile (617) 645-4361
Bio
***goulston*&storrs**
400 Atlantic Avenue Boston, MA 02110
goulstonstorrs.com
tsullivan@goulstonstorrs.com
****

117 Kendrick Street

Suite 350 & Third Avenue Loading Dock

October 17, 2023

1. SITE LOCATION AND PLAN

2. PROJECT OVERVIEW

3. BUILDING FLOORPLAN UPDATES

4. PROJECT SITE IMPROVEMENTS

5. LOADING AND SERVICE OPERATIONS

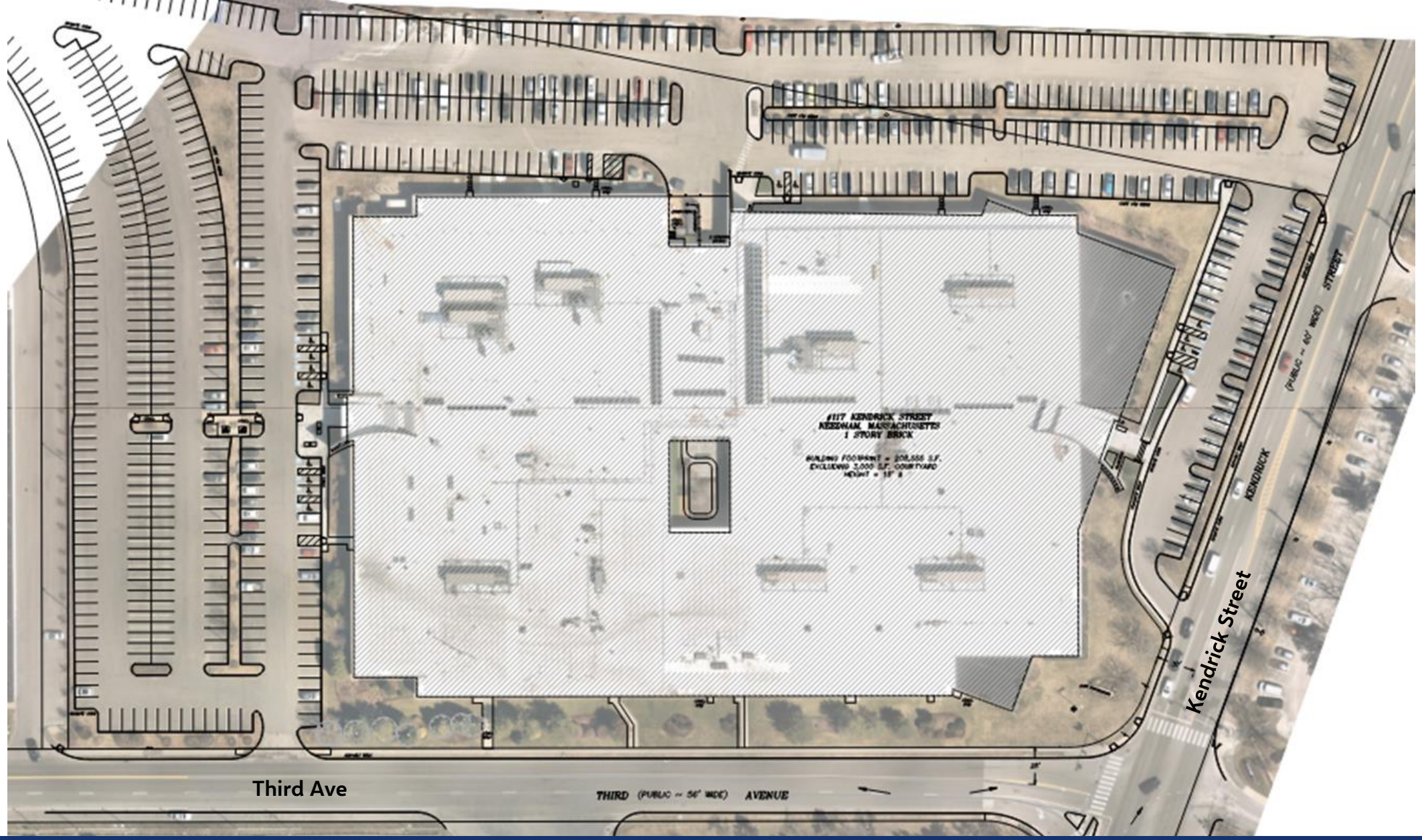
6. THIRD AVENUE IMPACTS

7. SPECIAL PERMIT AMENDMENT AND SCHEDULE

8. COMMENTS AND NEXT STEPS

Site Location

117 Kendrick Street | Bulfinch



Existing Site Plan

117 Kendrick Street | Bulfinch

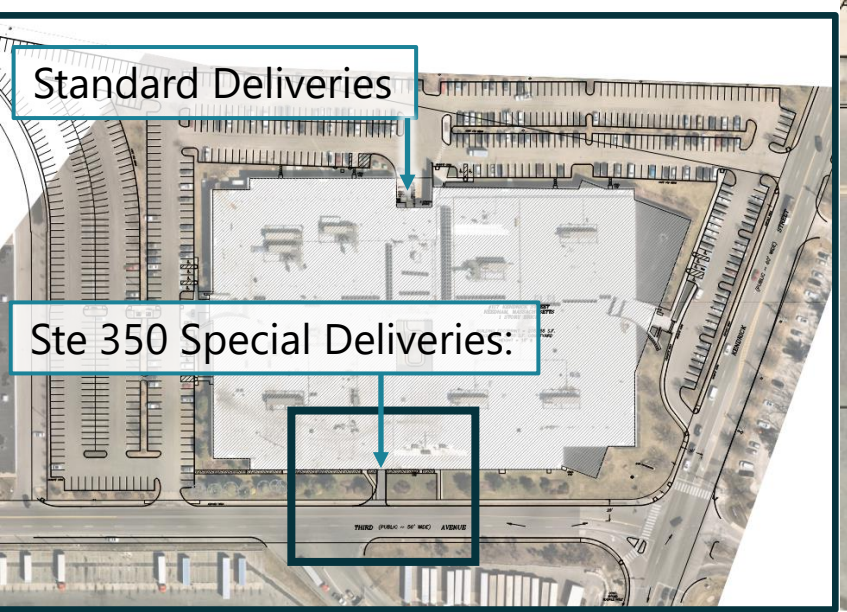
Suite Update

Proposed Loading Area

12’ Loading Bay to be accessed via Third Ave

To be used exclusively for special deliveries for Suite 350

Standard deliveries to use existing loading bay



SUITE 350

TOTAL SITE AREA
526,618 S.F.± 12.089 Acres

12'

408.8'

CONC. PAD

47.5'

39.5'

LAWN

40'

THIRD (PUBLIC ~ 56’ WIDE) AVENUE

Loading Dock Operations and Characteristics Comparison

Location	Building Size (KSF)	Special Deliveries Directly to Lab (i.e new dock)
20 Cambridge Discovery Park	175	2 / day
30 Cambridge Discovery Park	110	3 / day
Candel Tx **117 Kendrick Ste 450**	15	1-2 / week
Organogenesis **333 Providence Hwy, Norwood**	85	1-2 / week
117 Kendrick Ste 350	**18**	**1-2 / week**

Only special deliveries will utilize Suite 350 loading bay

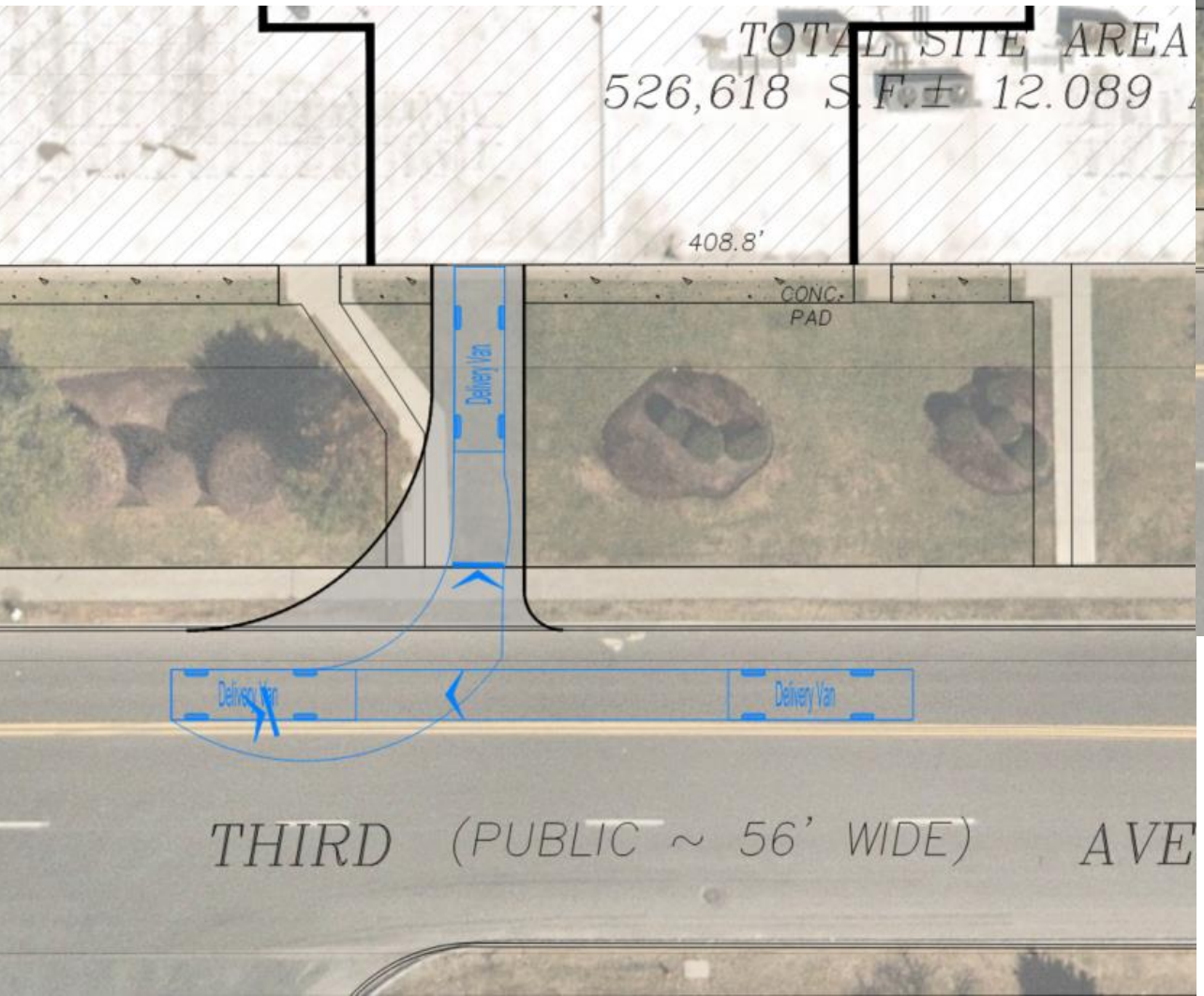
Typical Delivery Vehicles

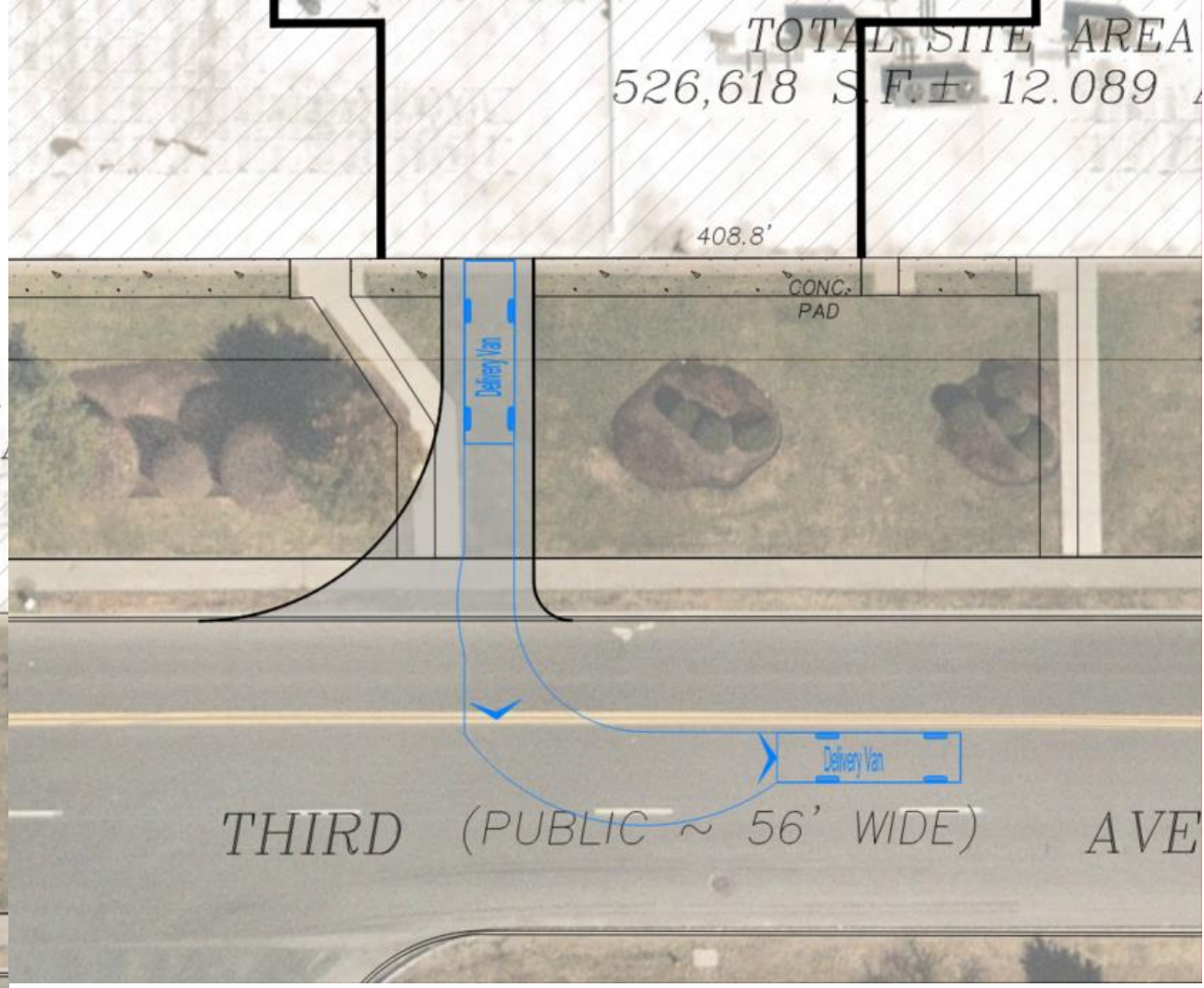
Delivery Vehicles

Vans are by far the most common delivery vehicle

SU trucks are most common for large deliveries

Typical Delivery Vehicles

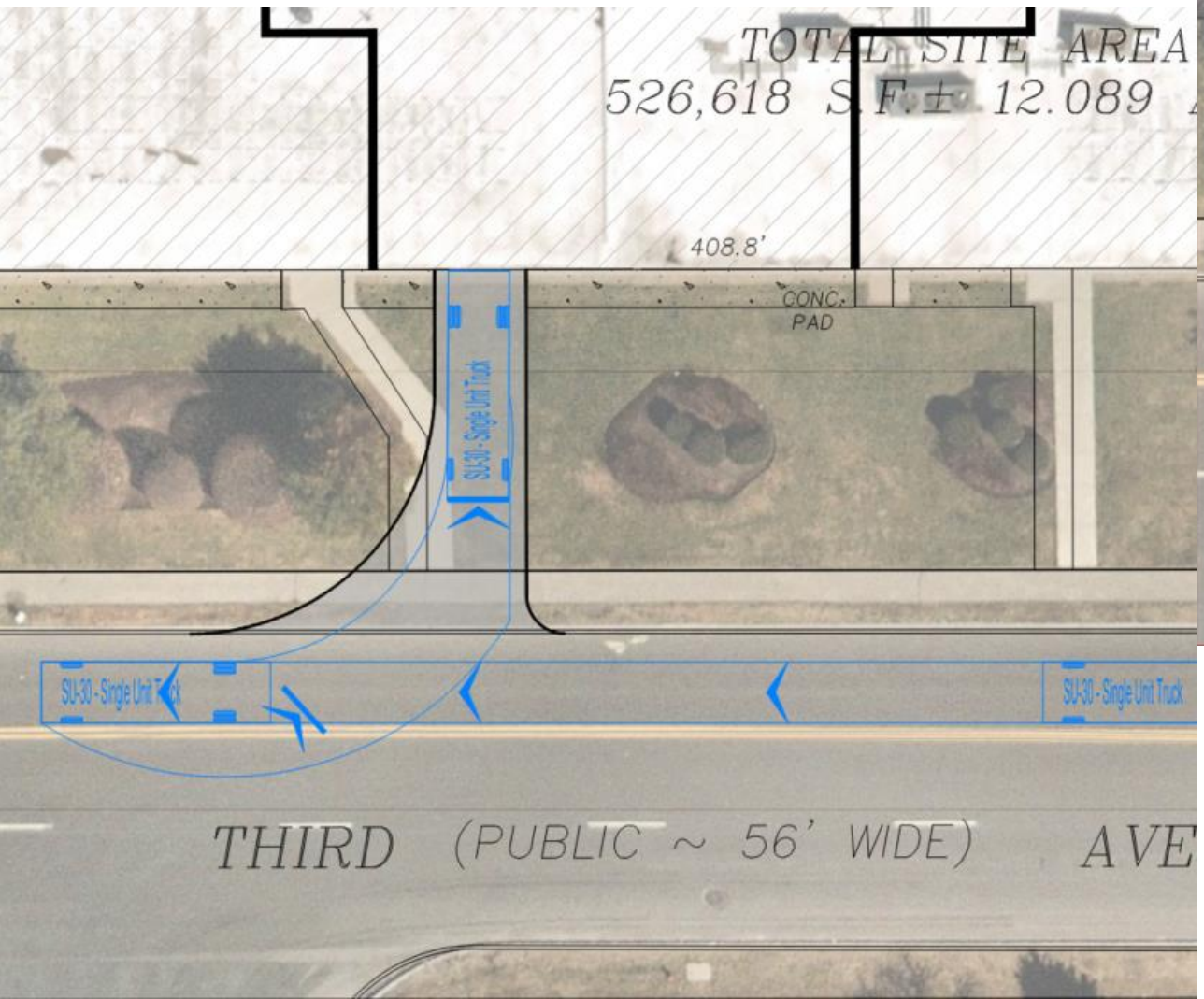


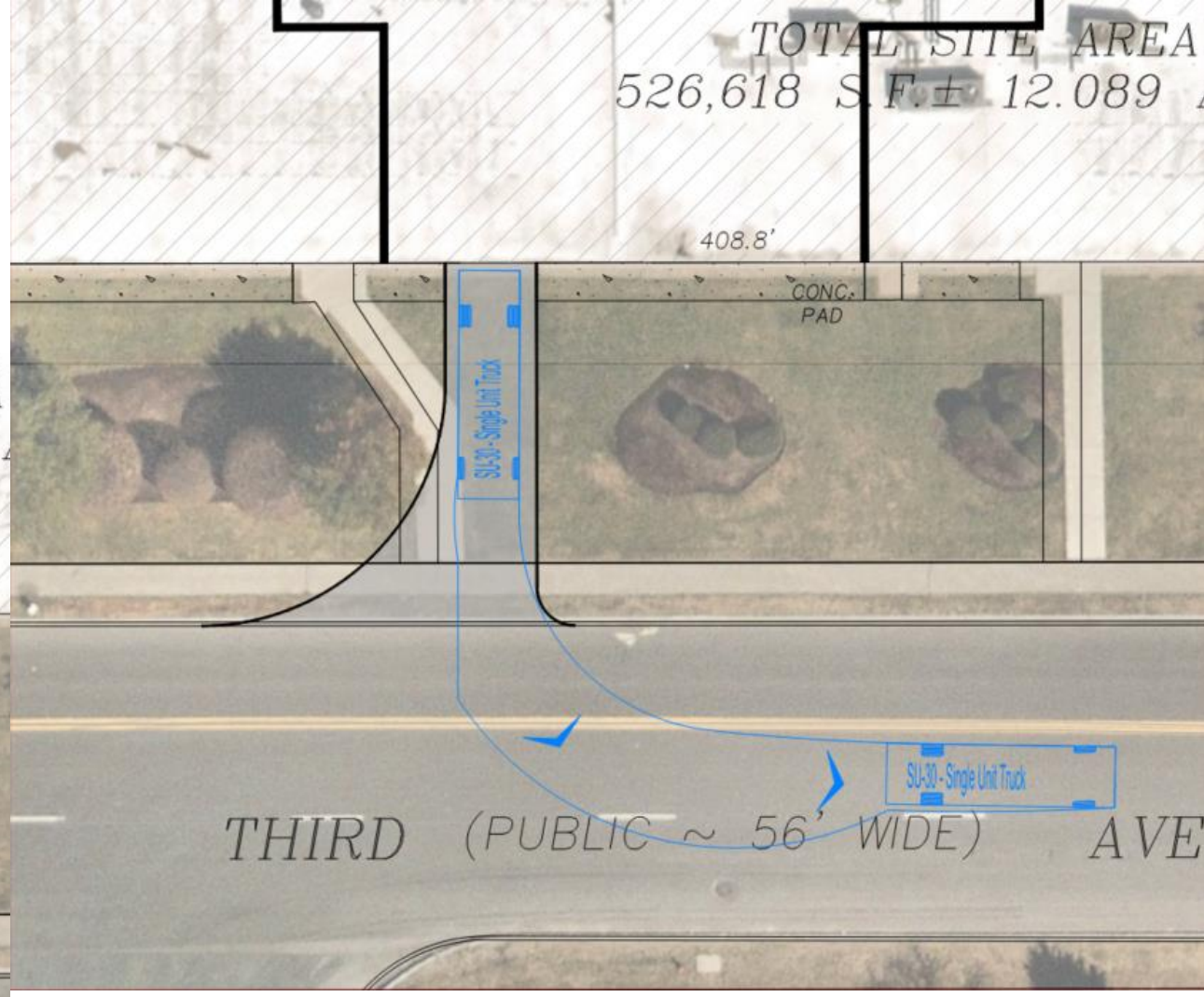


Vans

Vans are the most common delivery vehicle.
Expected to comprise about 2/3 of all deliveries

Typical Delivery Vehicles





SU-30

Smaller truck, about 30’ in length are expected to comprise about 30% of all deliveries

Exterior - Existing Condition (from Third Ave)

Exterior - Proposed Condition (from Third Ave)

Exterior - Existing Condition (from Third Ave)

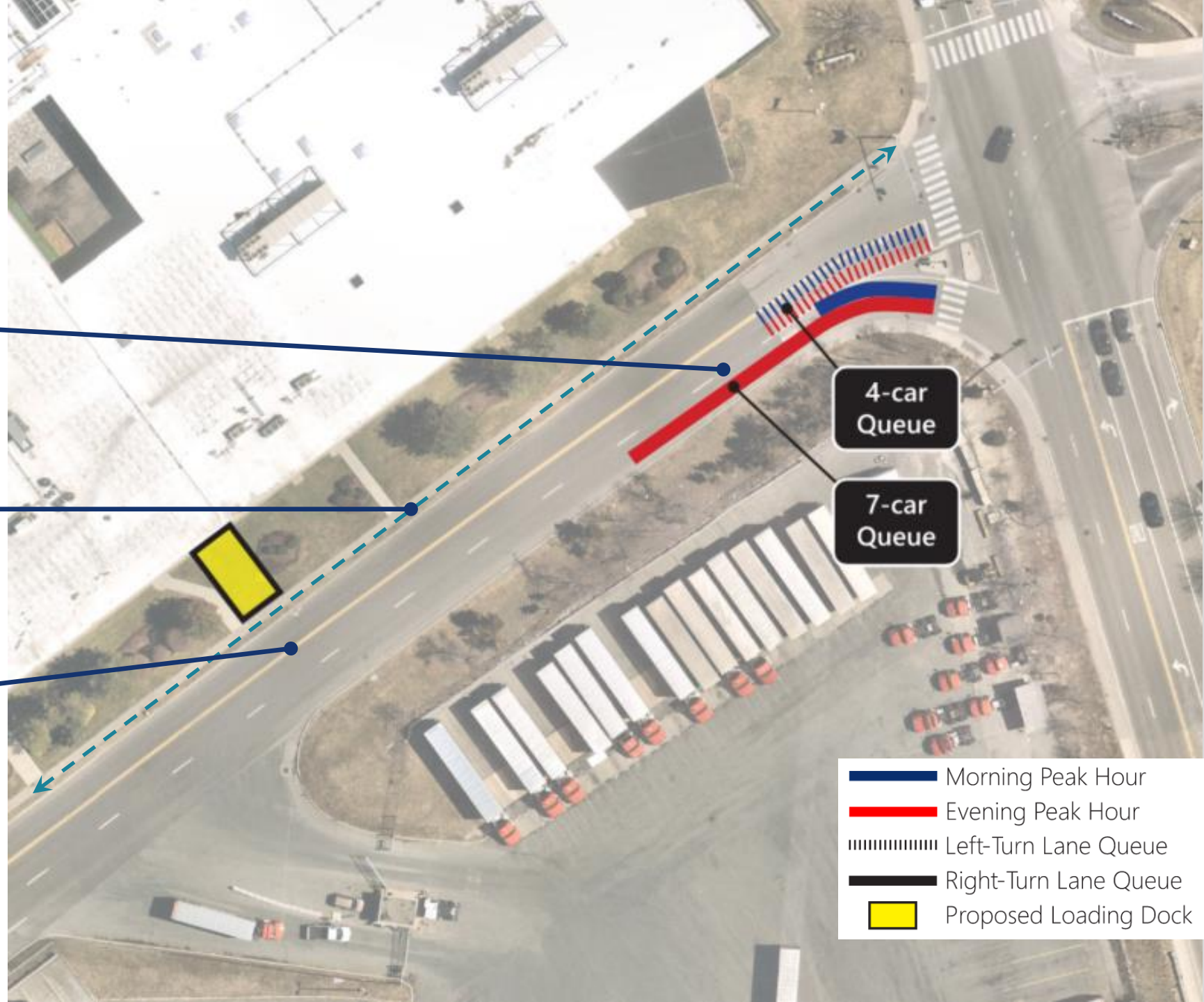
Exterior - Proposed Condition (from Third Ave)

Third Avenue Traffic Operations

Intersection queuing: no conflicts with proposed loading dock.

Pedestrian Impacts: sidewalks will remain open, and disruptions minimized

Gap Study: ample gaps of 15+ seconds observed on Third Street



Third Avenue Gap Study

- A gap study measures the size and frequency of gaps in traffic flow
  - Gaps are the time clearance intervals between vehicles passing a point on the road.
- A gap study was conducted to verify trucks will have ample time to maneuver along Third Avenue into and out of the proposed Suite 350 loading bay
  - Approx. gap required for loading dock entry: up to 15 seconds
- 72 such gaps were observed on Third Avenue during the morning peak hour
- Reminder: 1-2 special deliveries per week destined for Suite 350 loading bay
  - Loading dock will cease operation before evening peak hour of traffic

Special Permit Amendment and Schedule

- Minor Amendment to the Special Permit
  - No Traffic Impacts to 3rd Avenue
  - New Loading Dock entrance and overall parking supply compliant with Zoning Bylaw
  - Minor exterior building alterations subject to design review
  - No change in gross floor area
- Next Steps
  - Respond to Board questions and comments
  - File application materials

Next Steps

Comments?

Questions?

Next Steps

The following materials were previously distributed in the September 5, 2023 Planning Board packets

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 629-661 Highland Avenue
Name of Applicant Neehigh LLC
Applicant's Address 93 Union Street, Suite 315, Newton Center, MA 02459
Phone Number 617-332-6400

Applicant is: Owner X by Tenant _____
Agent/Attorney X Purchaser _____

Property Owner's Name Neehigh LLC
Property Owner's Address 93 Union Street, Suite 315, Newton Center, MA 02459
Telephone Number 617-332-6400

Characteristics of Property: Lot Area 81,973 s.f Present Use Commerical Buildings
Map #77 Parcel #* Zoning District IND
* 62 & 63

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

See Exhibit A attached hereto.

Signature of Applicant (or representative) _____
Address if not applicant Frieze Cramer, et al, 62 Walnut St., Suite 6, Wellesley, MA 02481
Telephone # 781-943-4000
Owner's permission if other than applicant N/A

SUMMARY OF PLANNING BOARD ACTION

Received by Planning Board _____ Date _____
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.

EXHIBIT A

The applicant intends to demolish the five existing buildings on the property and build a single two-story 50,000 s.f. Medical Office Building (25,000 s.f. footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. The two stories of the building itself are located directly above a parking area that is partially above grade and thus for zoning purposes counts as an additional story; and a three-story building is allowed in this zoning district. The proposed project will result in a substantial increase in unpaved, green space when compared to existing conditions. Details of the project are set forth in the various documents filed herewith.

NEEHIGH LLC
93 UNION STREET SUITE 315
NEWTON, MA 02459

August 3, 2023

Lee Newman, Planning Director

Needham Planning Department

500 Dedham Ave

Needham, MA 02492

RE: 629-661 Highland Ave, Needham, MA

Dear Ms Newman:

Please consider this letter as formal authorization for our attorney, Evans Huber, to sign/ submit Planning Board application on behalf of NEEHIGH, LLC.

Thank you

James Curtin

Authorized Signatory of Neehigh LLC

FRIEZE CRAMER ROSEN & HUBER LLP
COUNSELLORS AT LAW

62 WALNUT STREET, SUITE 6, WELLESLEY, MASSACHUSETTS 02481
781-943-4000 • FAX 781-943-4040

August 4, 2023

Via Electronic Mail and Hand Delivery

Members of the
Needham Planning Board

And

Lee Newman
Director of Planning and Community Development
Public Services Administration Building
500 Dedham Ave
Needham, MA 02492

Re: 629-661 Highland Ave, Needham, Application for Site Plan Review Special Permit

Dear Planning Board Members and Ms. Newman:

I am writing on behalf of Neehigh LLC with respect to the proposed redevelopment of the property at 629-661 Highland Avenue in Needham. The property is a parcel comprised of 81,973 square feet located on Highland Avenue between Cross Street and Arbor Street (the "Property"). The Property is located in the Industrial ("IND") zoning district and is currently improved with four commercial buildings and a small garage.

The applicant intends to demolish the five existing buildings on the property and build a single two-story 50,000 s.f. Medical Office Building (25,000 s.f. footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. The two stories of the building itself are located directly above a parking area that is partially above grade and thus for zoning purposes counts as an additional story; and a three-story building is allowed in this zoning district. The proposed project will result in a substantial increase in unpaved, green space when compared to existing conditions. Details of the project are set forth in the various documents filed herewith.

The proposed use (medical office building) is allowed by right pursuant to the Table of Uses found in section 3.2.1 of the zoning bylaw, specifically "craft, consumer, professional or commercial service establish[ment] dealing directly with the general public and not enumerated elsewhere in this section."

Also please note that, per the Transportation Impact Assessment ("TIA") submitted herewith, (1) the project is anticipated to generate 129 vehicle trips (combined entering and exiting) during the weekday morning peak hour, and 200 vehicle trips (combined entering and exiting) during the weekday evening peak hour (*see* TIA Table 6 and p. 17); and (2)"project-related traffic volume changes outside of the study area relative to 2030 no-build conditions are anticipated to range from a decrease of 2.9 percent to an increase of 3.4 percent during the peak period . . . . When distributed over the peak hour, the predicted traffic volume increases would not result in a significant impact (increase) on motorist delays or vehicle queueing outside of the immediate study area that is the subject of this assessment." (*see* TIA Table 7 and p. 19).

Pursuant to Chapter 40A of the Massachusetts General Laws, the Needham Zoning By-Law, the Needham Planning Board Rules, the Applicant, Neehigh LLC, hereby submits an application, of which this letter is a part, requesting that the Planning Board approve the proposed project through the Site Plan Review process, and issue a Special Permit to that effect.

Major Project Site Plan Review and a new Special Permit are sought because the project will result in the construction of a 50,000 square foot building and the creation of 250 off-street parking spaces. The zoning relief required for this proposal is approval pursuant to the Site Plan Review process, and issuance of a Special Permit to allow the proposed project, in accordance with the plans, drawings, renderings, and other documents submitted herewith. No other zoning relief is required, because, as noted above and in the zoning and parking tables filed herewith, the proposed use is allowed by right in this zoning district; the proposed building will comply with all dimensional and setback requirements in the Bylaw, and the proposed parking areas include the required number of parking spaces and will comply with all dimensional and other requirements of sections 5.12 and 5.1.3 of the Zoning Bylaw.

With respect to the floor plans, the Applicant reserves the right to revise said floor plans without the need for additional hearings or approvals, provided that the total square footage of the building does not increase.

The Applicant certifies pursuant to the Zoning By-Law, Section 7.4 that the project can be constructed and/or that the proposed uses thereof can be commenced without need for the issuance of any variance from any provisions of the Zoning By-Law by the Zoning Board of Appeals.

This Application for Site Plan Review and Special Permit includes the following documents:

1. This letter dated August 4, 2023 to the Planning Board and Planning Director.

2. Another letter from this office, also dated August 4, 2023, discussing how this project meets the Site Plan Review criteria in the Bylaw.

3. The completed application form signed by myself on behalf of the Applicant.

4. A letter from the Applicant, Neehigh LLC, authorizing me to sign the Application on its behalf.

5. A Transportation Impact Assessment for the Proposed Medical Office Building, 629-661 Highland Avenue, Needham Massachusetts, prepared by Vanasse & Associates, Inc., 35 New England Business Center Drive, Suite 140, Andover, MA 01810, stamped July 27, 2023.

6. A combined set of plans and drawings dated August 4, 2023 for the Highland Avenue Medical Office Building at 629-661 Highland Avenue, prepared by the Applicant's Project Team, including

    a. Civil and Engineering Plans (including zoning table) prepared by Vanasse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472.

    b. Landscaping Plans (including Rendered Material, Grading, Planting, and Detail Plans), prepared by Ground, Inc., 285 Washington Street, Unit G, Somerville MA, 02143.

    c. Architectural plans and drawings (including Lighting, Parking, Floor and Roof Plans, Elevations, Sections and Renderings), prepared by Maugel Destefano Architects, 200 Ayer Road Suite 200, Harvard, MA 01451.

7. Stormwater Report dated August 4, 2023 prepared by Vanasse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472.

8. Application fee payable to the Town of Needham in the amount of $ 5,000.00.

Pursuant to the Board's Covid-19 procedures, these documents are being submitted electronically; additionally three (3) hard copies of the application (with original signatures) and all supporting materials, including wet-stamped plans, are being hand delivered to the Planning Department along with the application fee; and, lastly, one hard copy of items 1 through 7, above (all the plans 11 x 17), is being mailed to each Board member, and delivered to Lee Newman.

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

As previously discussed, I would appreciate your scheduling this matter for hearing at the Board's September 5; 2023 meeting. Thank you for your cooperation.

Sincerely,

Evans Huber

EH:sfc

FRIEZE CRAMER ROSEN & HUBER LLP
COUNSELLORS AT LAW

62 WALNUT STREET, SUITE 6, WELLESLEY, MASSACHUSETTS 02481
781-943-4000 • FAX 781-943-4040

August 7, 2023

Via hand delivery and overnight mail
Members of the
Needham Planning Board

And

Lee Newman
Director of Planning and Community Development
Public Services Administration Building
500 Dedham Ave
Needham, MA 02492

Re: 629-661 Highland Ave, Needham

Dear Planning Board Members and Ms. Newman:

I am writing on behalf of the Applicant, Neehigh LLC, with respect to the Application for Site Plan Review/Special Permit for the proposed project at 629-661 Highland Avenue. The purpose of this letter is to provide the Planning Board with additional information in connection with this Project and, in particular, to discuss how the project will conform to the review criteria for Site Plan Review, as set forth in Section 7.4.6 of the Zoning By-Law.

This letter is intended as a replacement for the letter on the same topic dated August 4 that was included in the filing package submitted electronically on August 3 and in hard copy on August 4. It is identical to that prior ;letter except that is contains some additional information at the end of subsections (a)

The following are the criteria for the Planning Board to consider during the site plan review process pursuant to Section 7.4.6 of the Zoning By-Law, and the description of how the Project meets those criteria.

(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 proposed project has been designed to protect adjoining premises from detrimental impacts as follows:

The Site's stormwater management system has been designed to prevent adverse impacts to offsite areas. The system has been designed to meet the Town of Needham's requirements and the MassDEP Stormwater Standards, including no increase in peak runoff rates from the Site between the existing and proposed conditions for the requisite storm events. The stormwater management system also provides a treatment train of Best Management Practices, including a heavy emphasis on stormwater infiltration that will serve to remove potential pollutants such as TSS and phosphorus, provide improved groundwater recharge, and manage stormwater runoff to protect onsite facilities as well as adjacent properties. Proposed layout plans, details, and a Stormwater Management Plan are included as part of this Application.

With the exception of driveway or pedestrian entrances, the entire perimeter of the site has been comprehensively landscaped. Half of the parking is entirely below grade, and another 25% (approximately) is situated beneath the proposed building. The remainder of the at-grade parking is situated behind the proposed building, so that all of the upper level of parking is screened from Highland Avenue and minimally visible from Cross and Arbor Streets. Parking and deliveries below the building are enclosed behind solid walls or louvered screening and spaces behind the building have a 4-foot high perimeter wall for safety and to screen headlights. The parking spaces below the building itself are fully concealed in a parking structure, mostly below grade, and with its access/egress at the rear of the site and facing away from any residential properties. A loading/ delivery area is concealed beneath the building. Site lighting has been kept to a minimum, with downward-facing light sources and zero light spill to neighboring properties (see photometric plan). The building and landscape plan significantly enhance the Highland Ave. corridor while also reducing street noise to the rear.

The proposed site plan provides for substantial landscape screening opportunities. Generous setbacks on Highland and Cross provide green space for shade trees, ornamental trees and landscape planting. The tree canopy on the site is currently less than 10 trees. The proposed plan would see over 50 trees added to the site, the majority of these between the building and adjacent properties improving views for abutters.

(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 project has been designed to ensure that there will be safe vehicular and pedestrian circulation throughout the site. The access to the property will be via four (4) driveways configured as follows: the existing driveway that intersects the west side of Cross Street approximately 280 feet north of Highland Avenue and opposite Putnam Street; a new driveway that will intersect the west side of Cross Street approximately 80 feet north of Highland Avenue; and two (2) new driveways that will intersect the east side of Arbor Street approximately 290 feet and 370 feet north of Highland Avenue. Both Cross Street and Arbor Street have been reconstructed approaching Highland Avenue as a part of the recently

completed Highland Avenue improvement project and include appropriate geometry to accommodate emergency vehicles and delivery trucks accessing the project site. The individual driveways that will serve the project have also been designed to accommodate safe and efficient access to the parking areas that will serve the project.

Available sight distances at the site driveways will exceed required sight distances for safe operation.

New sidewalks have been constructed along Highland Avenue as a part of the Highland Avenue improvement project that include ADA accommodations for crossing Cross Street and Arbor Street. A sidewalk has been provided within the project site that links the proposed building to the sidewalk along Highland Avenue, with additional sidewalks and pedestrian paths within the project site to convey pedestrians to the building entrances.

Handicap access and parking is provided in both the surface parking lot and in the below-grade garage, and bicycle parking will be provided.

The building and parking areas are designed to be fully accessible. Because the building will serve medical uses, the amount of accessible parking spaces exceeds the requirements of 521 CMR, Massachusetts Architectural Access Board Regulations. The building's main entrance is located below the building on the upper parking level. This sheltered entrance environment allows for safe and convenient drop-off and pick-up for building patrons and staff.

An accessible pathway is situated at the southeast corner of the site, providing accessible access to the building entrance for pedestrians from Highland Avenue, and a direct accessible connection to a landscaped outdoor plaza. Sheltered parking for bicycles is provided near the building entrance.

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

The proposed parking areas comply with all design requirements of the Town of Needham By-Law, including those for lighting, landscaping, handicapped spaces, loading, layout, driveway openings, parking space size, maneuvering width in aisles, setbacks, compact vehicles, bumper overhangs, and bicycle racks. The parking areas include two hundred and fifty (250) spaces, which meets the requirements for number of spaces for this proposed 50,000 s.f. building. Parking is distributed below and behind the proposed building. The majority of spaces are covered and protected from weather. The layout of parking and building access provides convenience for employees and visitors. Please see the Layout and Zoning Plan for additional details of the parking layout.

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

The site has been designed to provide adequate methods of refuse disposal and recycling. A dumpster enclosure is located at the rear, northeast corner of the site and is screened with solid walls and decorative louvers on three sides, and a louvered gate. Refuse and recycling will be removed from the site by a licensed hauler.

(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 proposed building is intentionally sited to enhance the Highland Avenue corridor, screen parking and deliveries, allow for extensive perimeter landscaping, and mitigate impact to neighboring properties. The development plan dramatically increases greenspace on the property (compared to existing conditions) and reduces paved areas by more than 30 percent. The project provides natural landscape and open space that do not currently exist on the property. Cross and Arbor streets are improved to provide better access, drainage, and softscape within the neighborhood.

The relationship of the proposed building to Highland Ave greatly improves the landscape opportunities on the site. Setback of over fifty feet from the curb allows for generous accommodation of not only pedestrian and cycling circulation but also a row of canopy shade trees as well as a row of ornamental flowering trees. The landscape is terraced up to the building with retaining walls creating more opportunities to add interest to the site with both hardscaping and planting. Similar terraced setbacks on both Arbor and Cross Street will make for consistently landscaped approaches to the building. The setback on Cross Street is generous enough to host an outdoor amenity space. This plaza will be paved with permeable pavers and will be furnished with movable tables and as well as fixed seating. The plaza is over 2400 sq ft with the ability to host small groups or large gatherings.

(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.

No adverse impacts to the Town's resources – such as the Town's water supply and distribution system, sewer collection, fire protection, or public streets – are anticipated as a result of the redevelopment of the Site. The proposed utility design focuses on connecting services to existing utility infrastructure and minimizing impacts to the improvements along Highland Avenue recently performed by MassDOT. The Project proposes to connect domestic and fire water services to the Town's existing water system located in Cross Street. The proposed water service layout and design has been provided to the Engineering Department to confirm there are no concerns regarding water pressure and flow for this area. The project proposes to connect to an existing sewer service to route wastewater to the Town's sewer system via a sewer main located in Highland Avenue. As part of the Site Plan

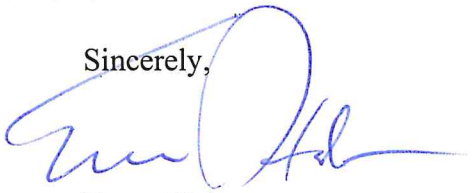
Review process, the site plans will be submitted to the Fire Department for review of the proposed fire truck access and hydrant coverage.

The proposed site layout plans will continue to maintain the existing access and circulation for emergency and fire protection vehicles.

The project includes specific measures that are designed to reduce traffic and parking demands, and off-set the predicted impact of the project on the transportation infrastructure with consideration of approved development in the area. These measures include physical improvements such as traffic signal timing optimization and the implementation of a comprehensive Transportation Demand Management (TDM) program, and are more fully described in the Transportation Impact Assessment (TIA) that has been prepared by Vanasse & Associates, Inc. (VAI) and is included as a part of the Application.

If you have any questions, please do not hesitate to contact me.

Sincerely,



Evans Huber

EH:sfc

Highland Ave Medical Office Building

Zoning Table (See Note 1)				
Zoning District(S): Industrial				
Zoning Regulation Requirements	**Minimum Required Or Maximum Allowed (Note 2)**	**Existing (Multiple Buildings)**	**Proposed**	**Compliance**
Min. Lot Area	10,000 SF	81,973 SF	No Change	YES
Min. Frontage	80 Feet	294.1 Feet	No Change	YES
Min. Yard Setbacks				
Min. Front - Highland Avenue	20 Feet (Note 3)	0.5 Feet (633 Highland) (Note 6)	22 Feet	YES
Min. Front - Arbor Street	10 Feet (Note 4)	7.9 Feet (661 Highland) (Note 6)	12 Feet	YES
Min. Front - Cross Street	10 Feet (Note 4)	8.5 Feet (633 Highland) (Note 6)	16 Feet	YES
Min. Side	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Min. Rear	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Max Building Height	40 Feet	Varies (< 40-ft)	40'	YES
Max. Stories	3 Stories	Varies (1-2 Stories)	3 Stories	YES
Max. Lot Coverage	35% (See Note 5)	30%	31%	YES
Zoning Bylaw 5.1.3 Parking Plan and Design Requirements	**Minimum Required or Maximum Allowed (See Note 1)**	**Existing (Multiple Buildings)**	**Proposed**	**Compliance**
Parking Total	250	120 (See Note 7 and 8)	250 (See Note 8)	YES
A) Parking Illumination	1 Foot Candle Average	Not Measured	0.99	YES
B) Loading Requirements	Adequate Loading Area	Meets Requirements	17' x 38'	YES
C) Accessible Parking	7	5	8	YES
D) Driveway Openings				
Max. Driveway Openings - Cross Street	4	3	2	YES
Max. Driveway Openings - Arbor Street	4	1	2	YES
E) COMPACT CARS	Max. 50%	Not Applicable	124	YES
F) STANDARD PARKING SPACE SIZE	9' X 18.5'	Varies	9' X 18.5'	YES
G) BUMPER OVERHANG	Max. 1' Overhang	Not Applicable	Not Applicable	NA
H) PARKING SPACE LAYOUT	See Section 5.1.3 (h)	Not in compliance	Section 5.1.3 (h)	YES
I) Aisle Width				
Min. Aisle Width - 90 Degree Stall, Two-Way	24 Feet	16 Feet	24' Minimum	YES
Min. Aisle Width - 45 degree Stall, Two-Way	14 Feet	14 Feet	Not Applicable	NA
J) Parking Setback				
Min. Front Yard - Highland Avenue	10 Feet	0.4 Feet	22 Feet	YES
Min. Front Yard - Arbor Street	10 Feet	-13 Feet	10 Feet	YES
Min. Front Yard - Cross Street	10 Feet	-11 Feet	26 Feet	YES
Min. Side Yard	4 Feet	Not Applicable	Not Applicable	YES
Min. Rear Yard	4 Feet	-27 Feet	36 Feet	YES
Min. Building	5 Feet	0-5 Feet	NA (See Note 9)	NA
K) Landscaped Areas				
Min. % of Parking Area (Total)	10%	Not Measured	11% (See Note 9)	
Min. % of Parking Area (Interior)	2.5%	Not Measured	7.6% (See Note 9)	
L) Trees	9)	8	12+	YES
N) Bicycle Racks	1 Per 20 Spaces	0	13	YES
O) EV Charging Stations	20% EV-Ready	None	15% EV-Ready, 5% Level 2 Charging Stations	YES

Note 1: Zoning Table assumes Tract 1 and Tract 2 will be consolidated into a single lot.
Note 2: Zoning regulation requirements as specified in the Zoning By-Law of the Town of Needham, amended October 2021
Note 3: From 4.7.1(a), on the Northwesterly side of Highland Avenue between Cross Street and Arbor Street, there shall be a twenty (20) foot building setback line.
Note 4: There shall be a minimum front setback of ten (10) feet for all zoned to a manufacturing district prior to April 15, 1952 and of twenty (20) feet for all other lots.
Note 5: From 4.4.7, whenever a business use as listed in Schedule of Use Regulations is to be located or expanded in other than a business district..., whether permitted by a Board of Appeals Special Permit or variance or otherwise, the percentage area requirements specified in Table 1 in Section 4.4.2 shall be applicable, unless a variance has also been granted from the provisions of this Section.

From 4.4.2, Table 1, for "Other Uses Permitted in Business Districts" Use / Corner Lot Type / 3 Story = 35% building coverage.
Note 6: Dimensions identified are the most extreme value of all of the existing buildings for the project site.
Note 7: Existing parking total includes 3 off-site parking spaces that serve 26 Cross Street and 40 Arbor Street.
Note 8: Parking total includes accessible parking spaces.
Note 9: All parking is within or on a parking structure
Note 10: Required trees based on quantity of open-air parking spaces

LIST OF DRAWINGS

Project Address:
629-661 Highland Ave
Needham, MA 02494

Architects Project # 22090
Issue Date: 08/04/2023

Project Team:

Architect:
Maugel DeStefano Architects, Inc
200 Ayer Road
Harvard, MA 01451
Tel: (978) 456-2800
Fax: (978) 456-2801

Client:
Boston Development Group
93 Union Street
Newton, MA 02459
Tel: (617) 332-6400

Civil Engineer:
Vanesse Hangen Brustlin
101 Walnut Street
Watertown, MA 02472
Tel: (617) 607-6197

Landscape Architect:
Ground, INC.
285 Washington Street, Unit G
Somerville, MA 02143
Tel: (617) 718-0889

Structural Engineer:
TF Moran, INC.
48 Constitution Drive,
Bedford, NH 03110
Tel: (603) 472-4488

MEP/FP Engineer:
BR+A Consulting Engineers
10 Guest Street
Boston, MA 02135
Tel: (617) 254-0016

Traffic Engineer:
Vanasse & Associates Inc
35 New Engand Business Center Drive
Andover, MA 01810
Tel: (978) 474-8800

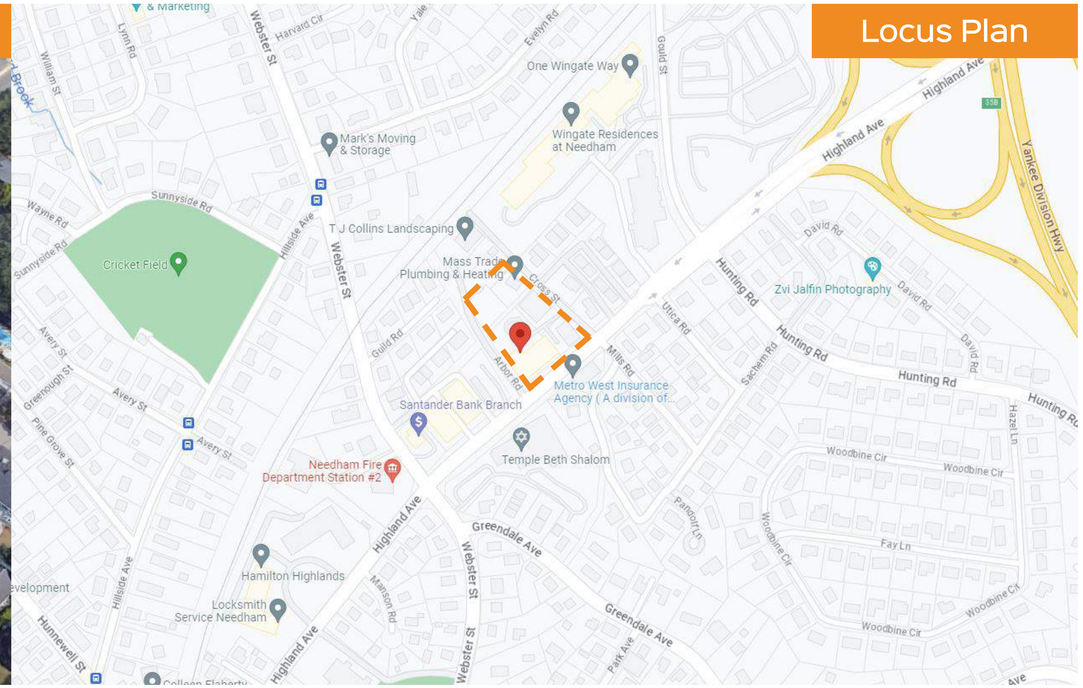
REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON, MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

PLANNING BOARD SUBMISSION

MAUGEL DESTEFANO
ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM

Aerial View

Locus Plan



1. Highland Ave (Northeast View)

2. Arbor Street (Northwest View)

3. Guild Road (Northeast View)

4. Highland Ave (Southwest View)

5. Cross Street (Northwest View)

6. Cross Street (Southeast View)

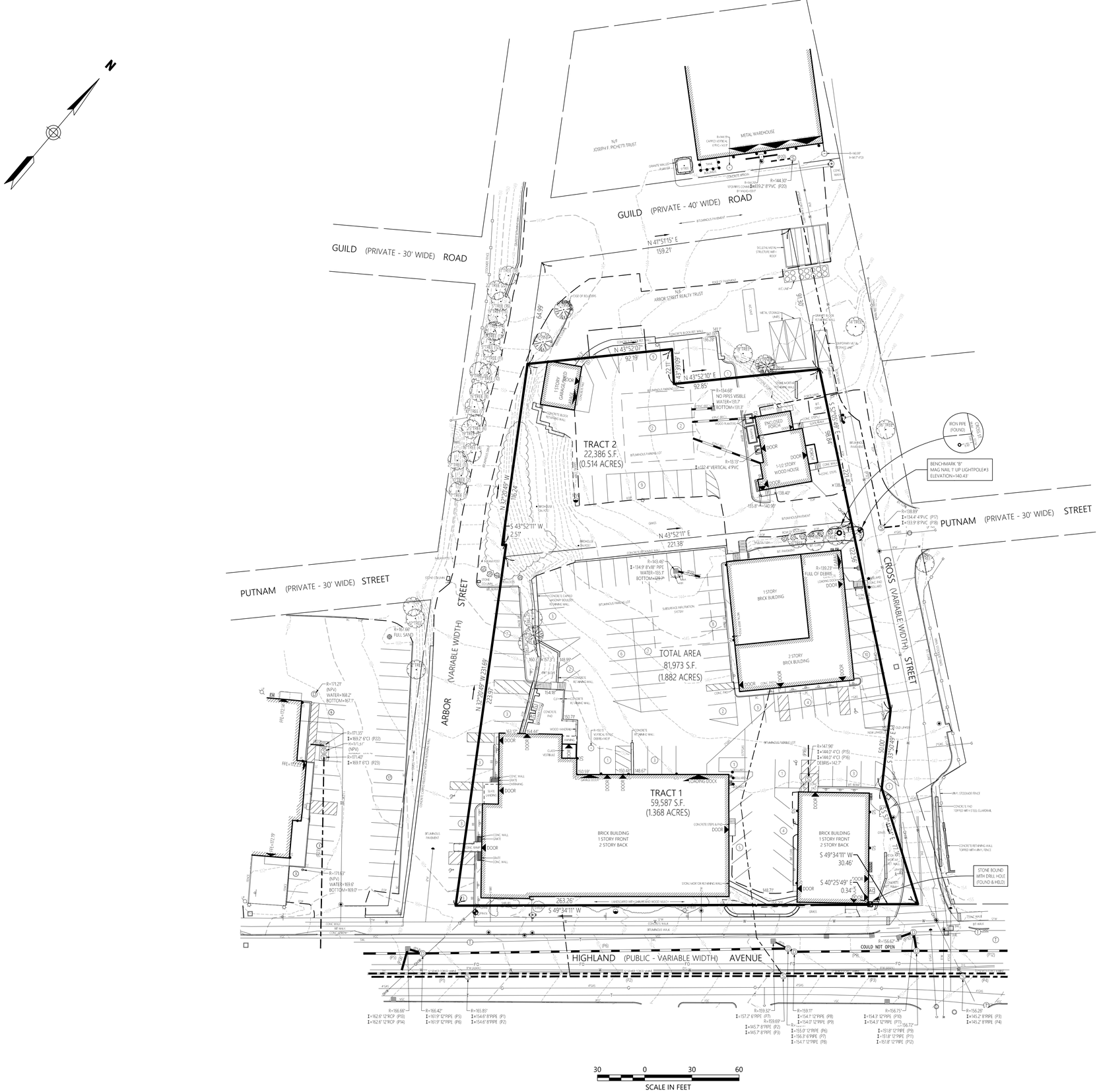
Key Benefits of Proposed Plan

1. Parking behind and under building (70% is concealed)
2. Additional 30' of landscaped frontage along Highland Ave.
3. Circulation below building accommodates deliveries and ambulances
4. Overall green space & pervious area is increased by 82%
5. Visible paved areas are reduced by 31%
6. High quality development of medical office space
7. Enhancement of Highland Ave. Corridor consistent with Needham's goals

	Bldg. Setback from Highland Ave. *Min. / Max Feet*	**Bldg. Length at Street** *Feet*	**Bldg. Footprint** *Square Feet*	**Paved Area** *Square Feet*	**Pervious / Green Space** *Square Feet*
Existing	22 / 30.1	203'-9"	25,308	40,271	14,597
Proposed	57.75 / 62.25	188'-7"	24,988	27,676	26,561
IMPROVEMENT	INCREASE **35.75** / **32**	DECREASE **15'-2"**	DECREASE **320**	DECREASE **12,595**	INCREASE **11,964**

Total Existing Parking Spaces **152**

Proposed Parking Spaces **250**



Legend

- DRAIN MANHOLE
- CATCH BASIN
- SEWER MANHOLE
- ELECTRIC MANHOLE
- TELEPHONE MANHOLE
- MANHOLE
- HH HANDHOLE
- WATER GATE
- FIRE HYDRANT
- GAS GATE
- BOLLARD w/LIGHT
- TRAFFIC SIGNAL LIGHT
- PEDESTRIAN SIGNAL LIGHT
- STREET SIGN
- LIGHT POLE
- UTILITY POLE
- GUY POLE
- GUY WIRE
- MONITORING WELL
- FLOOD LIGHT
- WELL
- MARSH
- DOOR/ENTRANCE
- FFE FINISHED FLOOR ELEVATION
- CNO COULD NOT OPEN
- NPV NO PIPES VISIBLE
- DYL DOUBLE YELLOW LINE
- DWL DASHED WHITE LINE
- SYL SINGLE WHITE LINE
- LSA LANDSCAPED AREA
- EOP EDGE OF PAVEMENT
- CC CONCRETE CURB
- VGC VERTICAL GRANITE CURB
- SGE SLOPED GRANITE EDGE
- BB BITUMINOUS BERM
- BC BITUMINOUS CURB
- METAL GUARDRAIL
- WOOD GUARDRAIL
- WOOD FENCE
- CHAIN LINK FENCE
- DRAINAGE LINE
- SEWER LINE
- OHW OVERHEAD WIRE
- E UNDERGROUND ELECTRIC
- T TELEPHONE LINE
- G GAS LINE
- W WATER LINE
- STONE WALL
- TREE LINE
- 100'BZ 100-FT BUFFER ZONE
- 100'RA 100-FT RIVER FRONT AREA
- 200'RA 200-FT RIVER FRONT AREA
- AF1-100 LIMIT MEAN ANNUAL HIGH WATER
- BF1-100 LIMIT OF BANK
- WF1-100 VEGETATED WETLAND BOUNDARY

Record Owner

TRACT 1
NEEHIGH, LLC
#629, 633 & 659 HIGHLAND AVENUE
NEEDHAM, MASS.
LAND COURT BOOK 784, PAGE 109

TRACT 2
J & C NOMINEE TRUST
0 ARBOR STREET & 26 CROSS STREET
NEEDHAM, MA
BOOK 14091, PAGE 452

General Notes

1) THE PROPERTY LINES SHOWN ON THIS PLAN ARE BASED UPON AN ACTUAL FIELD SURVEY CONDUCTED BY VHB, INC. IN NOVEMBER, 2020 AND FROM DEEDS AND PLANS OF RECORD.
2) THE EXISTING CONDITIONS SHOWN ON THIS PLAN ARE BASED UPON AN ACTUAL ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BY VHB, INC. IN NOVEMBER, 2020 AND UPDATED IN APRIL, 2023.
3) THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES SHOWN ON THIS PLAN ARE BASED ON FIELD OBSERVATIONS AND INFORMATION OF RECORD. THEY ARE NOT WARRANTED TO BE EXACTLY LOCATED NOR IS IT WARRANTED THAT ALL UNDERGROUND UTILITIES OR OTHER STRUCTURES ARE SHOWN ON THIS PLAN.
4) HORIZONTAL DATUM IS BASED ON MASS. GRID SYSTEM, NAD 1983. ELEVATIONS SHOWN ON THIS PLAN REFER TO NAVD OF 1988.
5) THE TREE SYMBOL OUTLINE SHOWN ON THIS PLAN DOES NOT REPRESENT THE ACTUAL TREE CANOPY.
6) THIS SURVEY WAS PREPARED WITHOUT THE BENEFIT OF A CURRENT TITLE REPORT AND MAY BE SUBJECT TO ADDITIONAL INFORMATION DISCLOSED IN SUCH.
7) THE LOT LIES ZONE X (UNSHADED) (AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN) AS SHOWN ON THE FLOOD INSURANCE RATE MAP FOR SUFFOLK COUNTY, MASSACHUSETTS, MAP NUMBER 25025C0038J, EFFECTIVE DATE MARCH 16, 2016.
8) THE LOT LIES ENTIRELY WITHIN THE INDUSTRIAL ZONE (I) AS SHOWN ON THE TOWN OF NEEDHAM ZONING MAP.

	REQUIRED
MINIMUM LOT AREA	10,000 S.F.
MINIMUM FRONTAGE	80 FEET
MINIMUM FRONT YARD SETBACK	20 FEET
MINIMUM SIDE YARD SETBACK	10 FEET
MINIMUM REAR YARD SETBACK	N/A
MAXIMUM BUILDING HEIGHT	40 FEET

9) SEE LAND COURT JUDGEMENT, DATED SEPTEMBER 29, 2020, FILED AS DOCUMENT NO. 1461440 ON NOVEMBER 19, 2020 WITH CERTIFICATE OF TITLE NO. 156709 AND RECORDED IN BOOK 38632, PAGE 59, BEING INSTRUMENT NO. 129538, ON NOVEMBER 19, 2020, AT 1:48 P.M.

Surveyor's Stamp:

COMMONWEALTH OF MASSACHUSETTS
RUSSELL J. BOUSQUET
NO. 35389
REGISTERED
PROFESSIONAL LAND SURVEYOR

08/04/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: 1"=30'

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Existing Conditions
Plan of Land

Sheet Number:
SV1.00

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Legend

Exist.	Prop.	
		PROPERTY LINE
		PROJECT LIMIT LINE
		RIGHT-OF-WAY/PROPERTY LINE
		EASEMENT
		BUILDING SETBACK
		PARKING SETBACK
10+00	10+00	BASELINE
		CONSTRUCTION LAYOUT
		ZONING LINE
		TOWN LINE
		LIMIT OF DISTURBANCE
		WETLAND LINE WITH FLAG
		FLOODPLAIN
BLSF	BLSF	BORDERING LAND SUBJECT TO FLOODING
BZ	BZ	WETLAND BUFFER ZONE
NDZ	NDZ	NO DISTURB ZONE
200'RA	200'RA	200' RIVERFRONT AREA
		GRAVEL ROAD
EOP	EOP	EDGE OF PAVEMENT
BB	BB	BITUMINOUS BERM
BC	BC	BITUMINOUS CURB
CC	CC	CONCRETE CURB
	CG	CURB AND GUTTER
CC	ECC	EXTRUDED CONCRETE CURB
CC	MCC	MONOLITHIC CONCRETE CURB
CC	PCC	PRECAST CONC. CURB
SGE	SGE	SLOPED GRAN. EDGING
VGC	VGC	VERT. GRAN. CURB
		LIMIT OF CURB TYPE
		SAWCUT
		BUILDING
	EN	BUILDING ENTRANCE
	LD	LOADING DOCK
		BOLLARD
D	D	DUMPSTER PAD
		SIGN
		DOUBLE SIGN
		STEEL GUARDRAIL
		WOOD GUARDRAIL
		PATH
		TREE LINE
		WIRE FENCE
		FENCE
		STOCKADE FENCE
		STONE WALL
		RETAINING WALL
		STREAM / POND / WATER COURSE
		DETENTION BASIN
		HAY BALES
		SILT FENCE
		SILT SOCK / STRAW WATTLE
4	4	MINOR CONTOUR
20	20	MAJOR CONTOUR
10	10	PARKING COUNT
	C10	COMPACT PARKING STALLS
DYL	DYL	DOUBLE YELLOW LINE
SL	SL	STOP LINE
		CROSSWALK
		ACCESSIBLE CURB RAMP
		ACCESSIBLE PARKING
VAN	VAN	VAN-ACCESSIBLE PARKING

Exist.	Prop.	
		CONCRETE
		HEAVY DUTY PAVEMENT
		BUILDINGS
		RIPRAP
		CONSTRUCTION EXIT
27.35 TC×	27.35 TC×	TOP OF CURB ELEVATION
26.85 BC×	26.85 BC×	BOTTOM OF CURB ELEVATION
132.75×	132.75×	SPOT ELEVATION
45.0 TW× 38.5 BW×	45.0 TW× 38.5 BW×	TOP & BOTTOM OF WALL ELEVATION
		BORING LOCATION
		TEST PIT LOCATION
MW	MW	MONITORING WELL
UD	UD	UNDERDRAIN
12"D	12"D	DRAIN
6"RD	6"RD	ROOF DRAIN
		SWALE FLOWLINE
12"S	12"S	SEWER
FM	FM	FORCE MAIN
OHW	OHW	OVERHEAD WIRE
6"W	6"W	WATER
4"FP	4"FP	FIRE PROTECTION
	2"DW	DOMESTIC WATER
3"G	G	GAS
E	E	ELECTRIC
STM	STM	STEAM
T	T	TELEPHONE
FA	FA	FIRE ALARM
CATV	CATV	CABLE TV
		CATCH BASIN CONCENTRIC
		CATCH BASIN ECCENTRIC
		DOUBLE CATCH BASIN CONCENTRIC
		DOUBLE CATCH BASIN ECCENTRIC
		GUTTER INLET
		DRAIN MANHOLE CONCENTRIC
		DRAIN MANHOLE ECCENTRIC
TD		TRENCH DRAIN
		PLUG OR CAP
CO	CO	CLEANOUT
		FLARED END SECTION
		HEADWALL
		SEWER MANHOLE CONCENTRIC
		SEWER MANHOLE ECCENTRIC
CS	CS	CURB STOP & BOX
WV	WV	WATER VALVE & BOX
TSV	TSV	TAPPING SLEEVE, VALVE & BOX
		FIRE DEPARTMENT CONNECTION
HYD	HYD	FIRE HYDRANT
WM	WM	WATER METER
PIV	PIV	POST INDICATOR VALVE
W	W	WATER WELL
GG	GG	GAS GATE
GM	GM	GAS METER
	DMH	ELECTRIC MANHOLE
EM	EM	ELECTRIC METER
		LIGHT POLE
	TMH	TELEPHONE MANHOLE
T	T	TRANSFORMER PAD
		UTILITY POLE
		GUY POLE
		GUY WIRE & ANCHOR
HH	HH	HAND HOLE
PB	PB	PULL BOX
		MATCHLINE

Abbreviations

General

ABAN	ABANDON
ACR	ACCESSIBLE CURB RAMP
ADJ	ADJUST
APPROX	APPROXIMATE
BIT	BITUMINOUS
BS	BOTTOM OF SLOPE
BWLL	BROKEN WHITE LANE LINE
CONC	CONCRETE
DYCL	DOUBLE YELLOW CENTER LINE
EL	ELEVATION
ELEV	ELEVATION
EX	EXISTING
FDN	FOUNDATION
FFE	FIRST FLOOR ELEVATION
GRAN	GRANITE
GTD	GRADE TO DRAIN
LA	LANDSCAPE AREA
LOD	LIMIT OF DISTURBANCE
MAX	MAXIMUM
MIN	MINIMUM
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
PERF	PERFORATED
PROP	PROPOSED
REM	REMOVE
RET	RETAIN
R&D	REMOVE AND DISPOSE
R&R	REMOVE AND RESET
SWEL	SOLID WHITE EDGE LINE
SWLL	SOLID WHITE LANE LINE
TS	TOP OF SLOPE
TW	TOP OF WALL
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 SIX INCHES (6") 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. WORK WITHIN PRIVATE RIGHTS-OF-WAY SHALL BE COORDINATED AMONG SHARED OWNERS/ACCESS HOLDERS.
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.
15. THE PLANS INCLUDED HEREIN ASSUME THAT TRACT 1 AND TRACT 2 ON THE FOLLOWING PLANS WILL BE CONSOLIDATED INTO A SINGLE LOT.

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 THICKNESS CLASS 52 DUCTILE IRON (DI) PIPE.
   B. SANITARY SEWER PIPES SHALL BE SDR 35 POLYVINYL CHLORIDE (PVC) SEWER PIPE.
   C. STORM DRAINAGE PIPES SHALL BE DOUBLE-WALL, TYPE S, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.
   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 THREE FEET (3') UNLESS OTHERWISE NOTED.
3. CURBING SHALL BE VERTICAL GRANITE CURB (VGC) 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. 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 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 SHOWN WERE DETERMINED BY AN ACTUAL FIELD SURVEY CONDUCTED BY VHB IN NOVEMBER, 2020 AND FROM DEEDS AND PLANS OF RECORD. THE EXISTING CONDITIONS SHOWN ON THIS PLAN ARE BASED ON AN ACTUAL ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BY VHB IN NOVEMBER, 2020 AND UPDATED IN APRIL AND JUNE, 2023.
2. TOPOGRAPHY: ELEVATIONS ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.
3. GEOTECHNICAL DATA INCLUDING TEST PIT AND BORING LOCATIONS AND ELEVATIONS WERE OBTAINED FROM McPHAIL ASSOCIATES, LLC. THE GEOTECHNICAL INFORMATION IS AVAILABLE TO THE CONTRACTOR UPON REQUEST.

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.

Civil Sheet Index

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.

Notes:

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER
8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: N/A

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Legend and General Notes

Sheet Number:
C1.01

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Legend

- BITUMINOUS PAVEMENT AND CURB TO BE DEMOLISHED AND REMOVED
- CONCRETE PAVEMENT AND STAIRS TO BE DEMOLISHED AND REMOVED
- EXISTING STRUCTURE TO BE REMOVED
- SAWCUT LINE
- EXISTING UTILITY TO BE REMOVED
- EXISTING UTILITY TO BE ABANDONED
- SILT FENCE
- SILTSOCK
- SILT SACK SEDIMENT TRAP

CROSS ST
IRON PIPE (FOUND)
98.84' 3.89' 92.56'
3.95'
BENCHMARK 'B'
MAG NAIL 'T' UP LIGHTPOLE#3
ELEVATION= 140.43'
PUTNAM (PRIVAT
RELOCATE EX UP
REM EX HYDRANT
REM EX RET WALL
MAINTAIN EX RET WALL
CROSS (VARIABLE WIDTH) STREET
REM EX CB
122.50
221.40'
S 52°05'49" E
98.84'
91.30'
REM EX FORCE MAIN
REM EX WOOD WALK AND STEPS
REM EX CB AND PIPE
REM EX PLANTERS
REM EX DRAIN PIPES AND STRUCTURES (TYP)
REM EX RET WALL
GUILD (PRIVATE - 40' WIDE) ROAD
N/F ARBOR STREET REALTY TRUST
S 41°39'09" E
22.11'
3.40.25
S 39°27' N
3.45/45.49" N
SILTSOCK WITH SILT FENCE BARRIER (TYP)
N/F JOSEPH F. PICHETTI TRUST
65.05'
3.40.26
BUILDING MAINTENANCE EASEMENT
REM EX GRAVEL STRIP
TRACT 2
22,386 S.F.
(0.514 ACRES)
REM EX RET WALL
REM EX TREES
64.99'
SAWCUT (TYP)
116.24'
N 32°20'49" W
S 43°52'11" W
2.31'
REM EX SUBSURFACE INFILTRATION SYSTEM
REM EX LIGHT POLE
N 43°52'11" E
22.38'
REM EX RET WALL
REM EX BIRDHOUSE
REM EX RET WALLS AND FENCES
REM EX BOULDER (TYP)
REM EX TREE (TYP)
TOTAL AREA
81,973 S.F.
(1.882 ACRES)
REM EX RISER POLE
REM EX HANDHOLE
REM EX BIT CONC AND BIT CURB
REM EX MH
REM EX SIGN (TYP)
REM EX RET WALL AND GRADE
ARBOR STREET (VARIABLE WIDTH)
231.69'
223.97'
N 32°20'49" W
REM EX WATER GATE
SAWCUT (TYP)
STONE BOUND WITH DRILL HOLE (FOUND & HELD)
REM EX RET WALL
REM EX ELECTRIC METER (TYP)
REM EX AC UNIT (TYP)
S 33°50'49" E
50.00'
S 53°41'24" E
77.16'
REM EX GAS GATE
REM EX GAS METER (TYP)
REM EX SIGN (TYP)
REM EX GAS PIPE (TYP)
REM EX SEWER PIPE (TYP)
REM EX BOLLARD (TYP)
REM EX DOWNSPOUT (TYP)
REM EX RET WALL
TRACT 1
59,593 S.F.
(1.368 ACRES)
REM EX GRAVEL
SILT SACK SEDIMENT TRAP (TYP)
REM EX RET WALL
PLUG EX SEWER CONNECTION
REM EX CHAIN LINK FENCE
ABANDON EX WATER LINE
REM EX SHRUBS
HIGHLAND (PUBLIC - VARIABLE WIDTH) AVENUE
S 43°52'11" W
2.26'
REM EX SHRUBS
SAWCUT (TYP)
GUILD (PRIVATE - 30' WIDE) ROAD
(PRIVATE - 30' WIDE) STREET

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.

Notes:

1. ELEVATIONS SHOWN REFER TO NAVD '88 VERTICAL DATUM

2. PROVIDE AND MAINTAIN EROSION CONTROL MEASURES UNTIL SITE IS FULLY STABILIZED, INCLUDING INLET PROTECTION, PERIMETER CONTROLS, AND STABILIZED CONSTRUCTION EXIT(S). CONTRACTOR SHALL PROVIDE PERIMETER EROSION CONTROLS AS NEEDED TO PREVENT SEDIMENTATION ONTO ADJACENT PROPERTIES AND RIGHTS-OF-WAY.

3. PROVIDE SILT SACKS AT EXISTING AND PROPOSED STORMWATER INLETS UNTIL UPSTREAM AREA HAS BEEN STABILIZED.

4. CONTRACTOR SHALL LOCATE AND MAINTAIN CONSTRUCTION EXIT(S) AND WHEEL WASHES TO CONTROL SEDIMENT TRACKING ONTO ADJACENT RIGHTS-OF-WAY.

0 10 20 40 Feet

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER
8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: 1" = 20'

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Site Preparation Plan

Sheet Number:
C2.01

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Sign Summary

M.U.T.C.D. Number	Specification Width	Specification Height	Desc.
R1-1	30"	30"	STOP

Putnam Street

Cross Street

Guild Road

Highland Avenue

Arbor Street

HEAVY DUTY BIT CONC PAVEMENT

SAWCUT (TYP)

PERVIOUS PAVER PATIO SEE LA PLANS

TRANSFORMER PAD, AND BOLLARDS PER UTILITY COMPANY REQUIREMENTS

TERRACE WALL (TYP) SEE LA PLANS

MEET EX EDGE OF PAVEMENT

EDGE OF PAVEMENT (TYP)

BOLLARD (TYP)

DUMPSTER ON CONC PAD WITH ENCLOSURE

10' FRONT YARD AND PARKING SETBACK

8' CROSSWALK

MEET EX BB

R1-1

5' CONC WALK

MEET EX WALK

6' CONC WALK

RELOCATE EX USPS COLLECTION BOX RECEPTACLE ON NEW CONC PAD (SEE NOTE 4)

GAS METER PAD

P-2 UPPER PARKING

BUILDING STAIR

DETECTABLE WARNINGS

CONCRETE STEPS WITH HANDRAILS

DIRECTIONAL ARROWS FOR REFERENCE ONLY. NOT PAINTED

P-1 LOWER PARKING

TWO LEVELS OF PARKING - PARKING AT EXPOSED GARAGE LEVEL DRAWN FOR REFERENCE, SEE ARCH PLANS FOR PLANS AND DETAILS

MEDICAL OFFICE BUILDING
WITH PARKING BELOW
50,000± SF

BUILDING EXTENTS OF LOWER LEVEL PARKING

4 REAR PARKING SETBACK

BUILDING MAINTENANCE EASEMENT

STANDARD DUTY BIT CONC PAVEMENT

MEET EX EDGE OF PAVEMENT

SAWCUT (TYP)

HEAVY-DUTY BIT CONC PAVEMENT

RET WALL

TIE INTO EX RET WALL

2" CRUSHED STONE

MASSDOT CROSSWALK

SAWCUT (TYP)

MASSDOT WHEELCHAIR RAMP

5' MASSDOT CONC SIDEWALK

5' MASSDOT BIT CONC BIKE LANE

MEET EX WALK AND BIKE LANE

TERRACE WALL SEE LANDSCAPE PLANS (TYP)

20' FRONT YARD SETBACK

10' FRONT PARKING SETBACK

N/F ARBOR STREET REALTY TRUST

N/F JOSEPH E. PACIFETTI TRUST

Notes:

1. LIMITS OF VEGETATION SHOWN FOR REFERENCE ONLY. REFER TO LANDSCAPE PLANTING PLANS FOR LIMITS OF LANDSCAPE AREAS, TREE LOCATIONS, AND OTHER VEGETATION, AS INDICATED.

2. REFER TO LIGHTING PLANS FOR PROPOSED SITE LIGHTING TYPES, LOCATIONS, HEIGHTS, AND FIXTURES.

3. PARKING SETBACK DIMENSION PROVIDED TO NEAREST PARKING SPACE LOCATED ON LOWER PARKING LEVEL.

4. CONTRACTOR SHALL WORK WITH OWNER TO RELOCATE EX USPS COLLECTION BOX RECEPTACLE.

5. LANDSCAPED AREAS SHOWN FOR REFERENCE ONLY. REFER TO LANDSCAPE ARCHITECTURE PLANS FOR LIMITS OF LANDSCAPED AREAS, LAND AREAS, TREE LOCATIONS, OTHER VEGETATION, AND IRRIGATION REQUIREMENTS.

6. SITE CONTRACTOR TO PROVIDE SLEEVES WHERE IRRIGATION LINES CROSS PAVED AREAS.

0 10 20 40

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER

8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: 1" = 20'

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

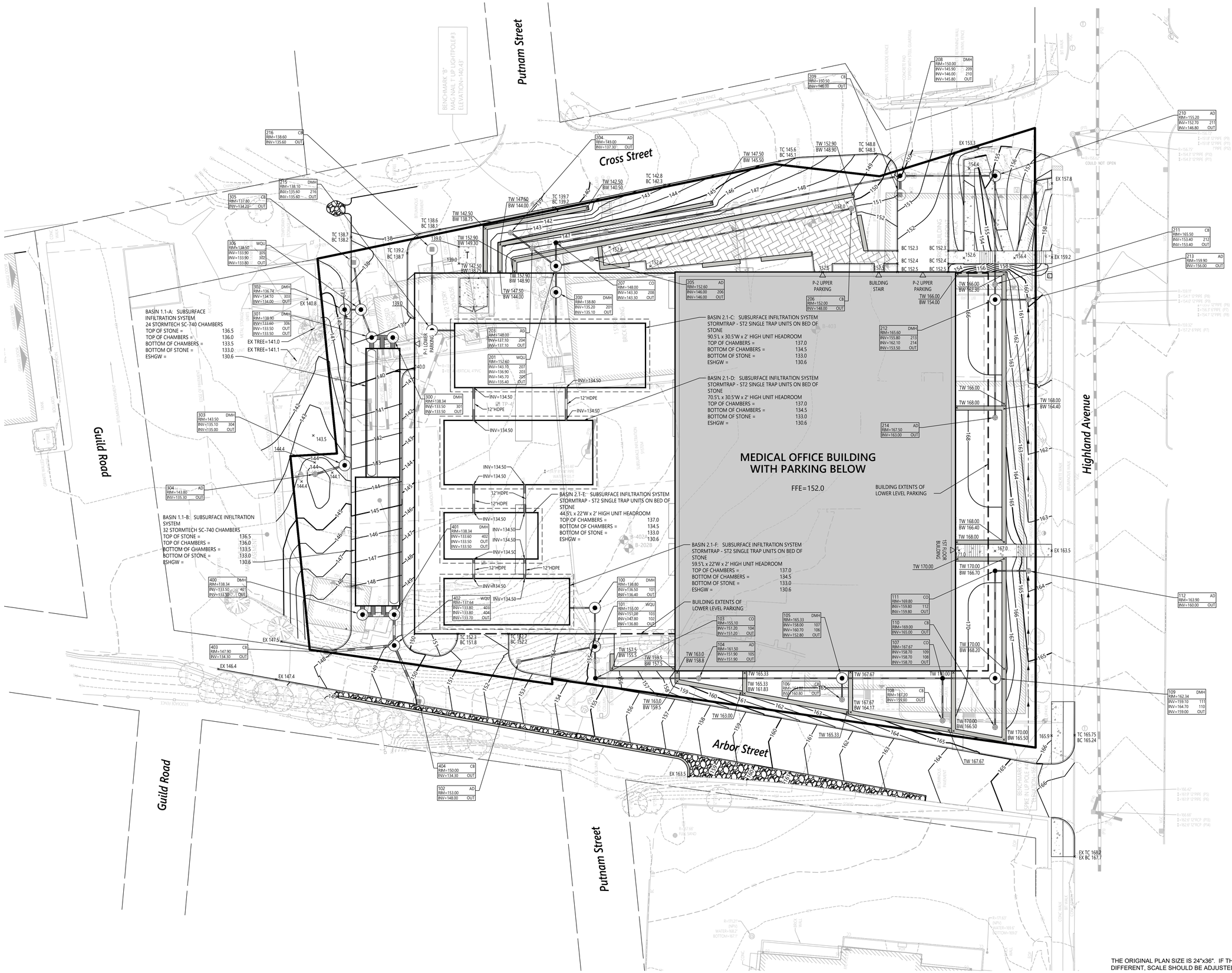
Revisions:	Date:

Drawing Title:
Layout and Materials Plan

Sheet Number:
C3.01

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.



THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.

Notes:

1. ELEVATIONS SHOWN REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988.
2. REFER TO SHEET C2.01 FOR MINIMUM EROSION CONTROL REQUIREMENTS.
3. ROOF DRAINS CONNECTED INTERNALLY THROUGH BUILDING TO STORMTRAP UNITS.

0 10 20 40 Feet

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER
8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: 1" = 20'

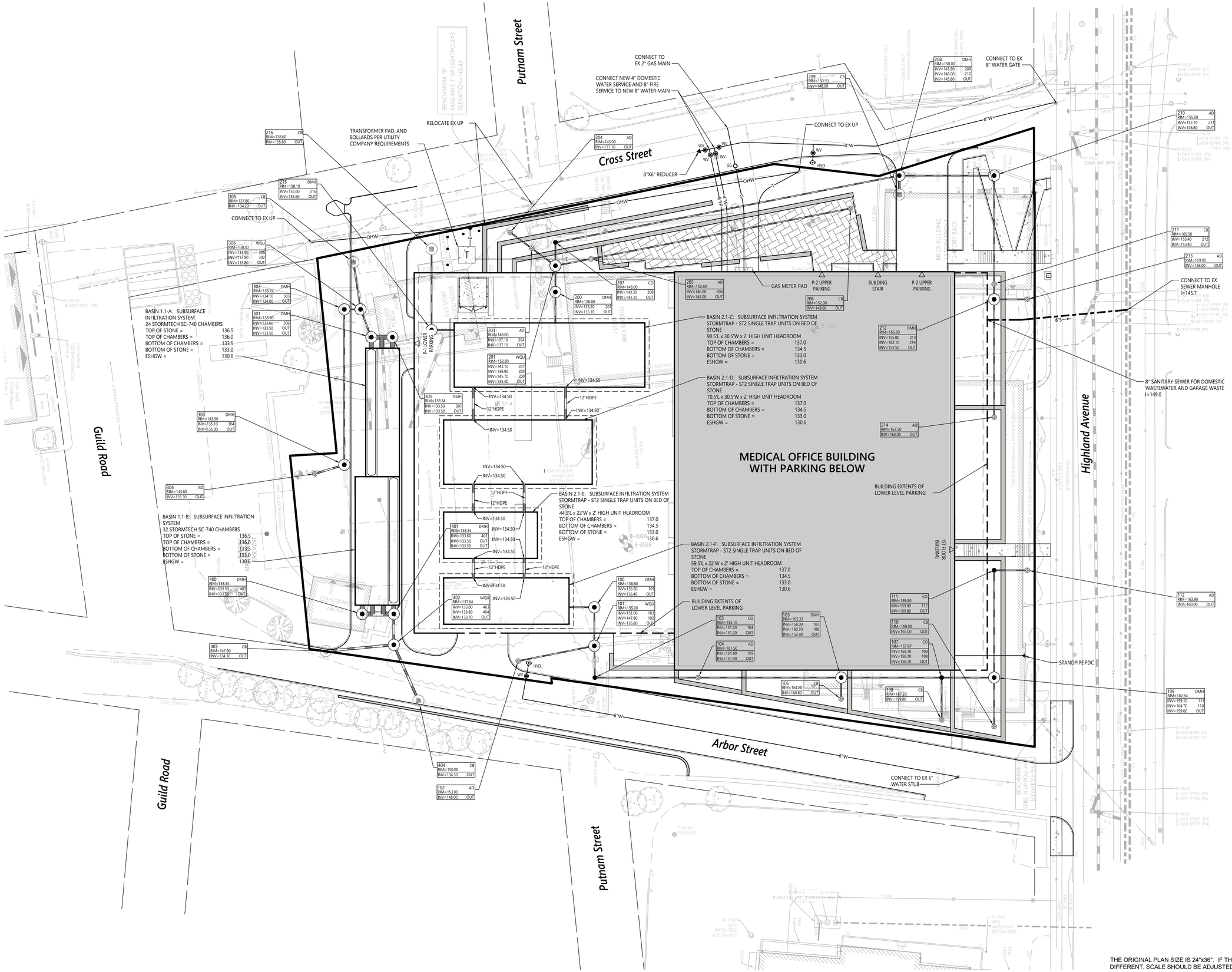
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Grading and Drainage Plan

Sheet Number:
C4.01

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770



Notes:

1. ELEVATIONS SHOWN REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988.

2. ELECTRICAL, TELECOMMUNICATIONS, LIGHTING, AND NATURAL GAS UTILITIES AND EQUIPMENT SHOWN FOR REFERENCE ONLY. DESIGN BY OTHERS.

3. REFER TO LANDSCAPE PLANS FOR IRRIGATION REQUIREMENTS. PROVIDE SLEEVES FOR IRRIGATION WHERE IRRIGATION LINES CROSS PAVED AREAS.

4. INFILTRATION SYSTEM INSTALLATION TO BE WITNESSED BY THE PROJECT GEOTECHNICAL ENGINEER. CONTRACTOR TO COORDINATE INSTALLATION WITH AT LEAST 30 DAYS NOTICE PER PROJECT APPROVALS.

5. SEE ELECTRICAL PLANS FOR ELECTRIC DUCT BANK SIZE AND NUMBER OF CONDUITS.

6. SEE PLUMBING PLANS FOR SANITARY SEWER PIPE DIAMETERS. VERIFY SANDITARY SEWER PIPE INVERT ELEVATIONS AT ALL BUILDING SEWER EXIT LOCATIONS WITH PLUMBING PLANS PRIOR TO CONSTRUCTION.

0 10 20 40 Feet

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER

8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: 1" = 20'

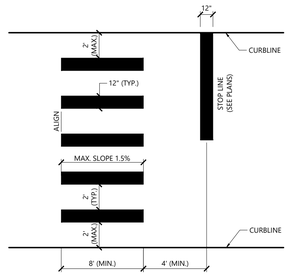
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Utilities Plan

Sheet Number:
C5.01

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770



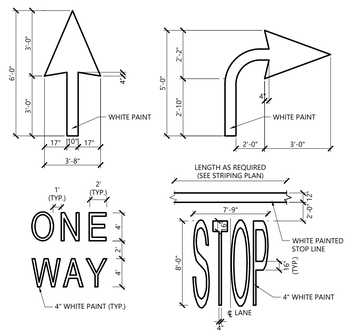
NOTES

1. TWELVE INCH (12") LINES SHALL BE APPLIED IN ONE APPLICATION, NO COMBINATION OF LINES (TWO - 6 INCH LINES) WILL BE ACCEPTED.
2. LONGITUDINAL CROSSWALK LINES TO BE PARALLEL TO CURBLINE.
3. ALL LONGITUDINAL CROSSWALK LINES SHALL BE THE SAME LENGTH AND PROPERLY ALIGNED.
4. CROSS WALK SIDESLOPE SHALL NOT EXCEED 1.5%.

Crosswalk

12/19

N.T.S. Source: VHB LD_553A



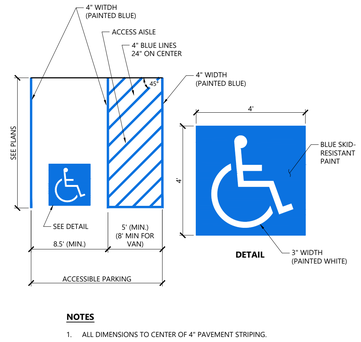
NOTES

1. PAVEMENT MARKINGS TO BE INSTALLED FOR ON SITE WORK IN LOCATIONS SHOWN.

Painted Pavement Markings - On Site

1/16

N.T.S. Source: VHB LD_554



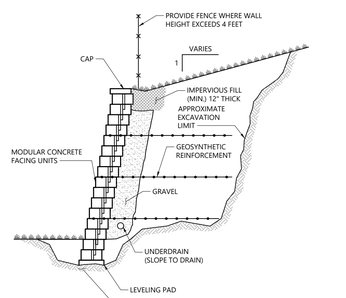
NOTES

1. ALL DIMENSIONS TO CENTER OF 4" PAVEMENT STRIPING.
2. ALL SLOPES THROUGHOUT THE ACCESSIBLE PARKING AND AISLE AREAS SHALL NOT EXCEED 1.5%.

Accessible Parking Space

12/19

N.T.S. Source: VHB LD_552B



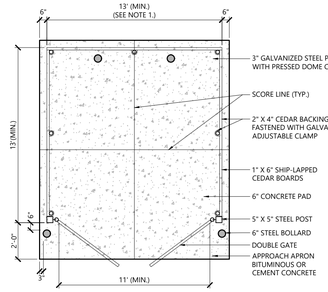
NOTES

DETAIL PROVIDED FOR GENERAL INFORMATION ONLY. STAMPED FINAL DESIGN OF MODULAR WALL SYSTEM TO BE PROVIDED BY CONTRACTOR BASED ON GEOTECHNICAL ENGINEER'S RECOMMENDATIONS.

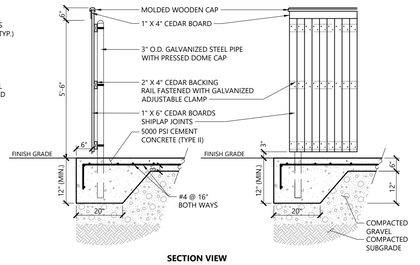
Modular Retaining Wall

10/20

N.T.S. Source: VHB LD_750



PLAN VIEW



SECTION VIEW

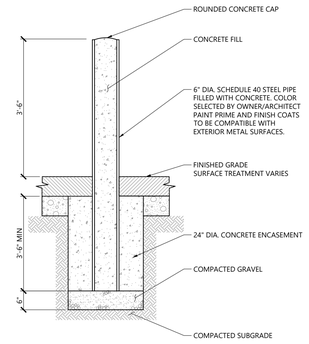
NOTES

1. DUMPSTER PAD DIMENSIONS SHOWN AS MINIMUM. REFER TO PLAN FOR ACTUAL DIMENSION.
2. PAD DESIGNED FOR 6 YARD DUMPSTER.

Dumpster Pad w/ Enclosure

1/20

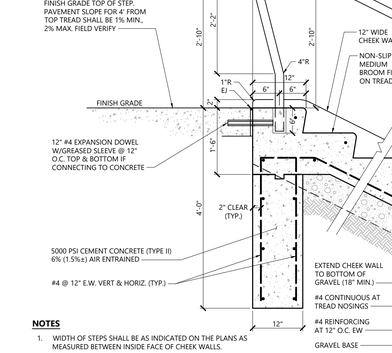
N.T.S. Source: VHB LD_713



Bollard

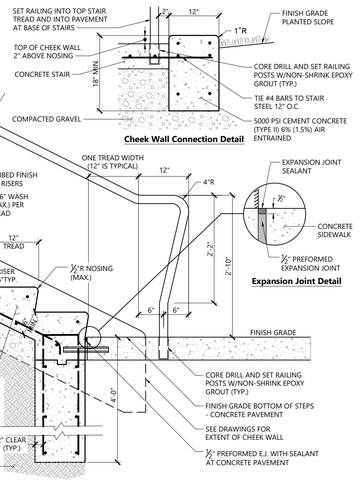
12/19

N.T.S. Source: VHB LD_700



NOTES

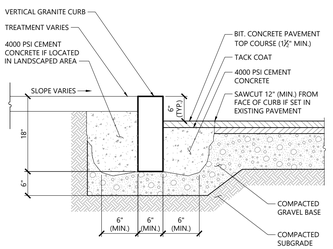
1. WIDTH OF STEPS SHALL BE AS INDICATED ON THE PLANS AS MEASURED BETWEEN INSIDE FACE OF CHEEK WALLS.
2. CONTINUOUS RAILING (POSTS @ 5' O.C.) SHALL BE USED ON BOTH SIDES OF STAIRS.
3. A MINIMUM OF 4' IS REQUIRED BETWEEN FACE OF RAILINGS.



Concrete Steps with Handrails

2/20

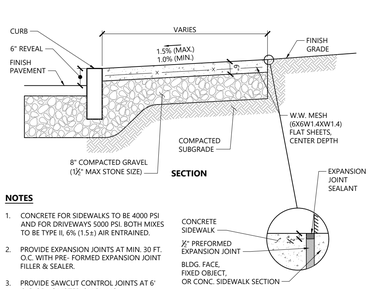
N.T.S. Source: VHB LD_765_MA



Vertical Granite Curb (VGC)

3/20

N.T.S. Source: VHB LD_402



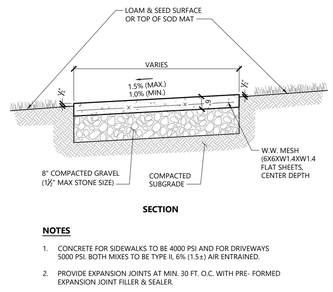
NOTES

1. CONCRETE FOR SIDEWALKS TO BE 4000 PSI AND FOR DRIVEWAYS 5000 PSI. BOTH MIXES TO BE TYPE II, 6% (1.5±) AIR ENTRAINED.
2. PROVIDE EXPANSION JOINTS AT MIN. 30 FT. O.C. WITH PRE- FORMED EXPANSION JOINT FILLER & SEALER.
3. PROVIDE SAWCUT CONTROL JOINTS AT 6' O.C. OR AS NOTED ON PLANS.
4. PROVIDE MEDIUM BROOM FINISH IN DIRECTION PERPENDICULAR TO CURB.
5. ALL EXPOSED CONCRETE SURFACES SHALL BE SEALED WITH A SILANE-SILOXANE PRODUCT.

Concrete Sidewalk

3/20

N.T.S. Source: VHB LD_420



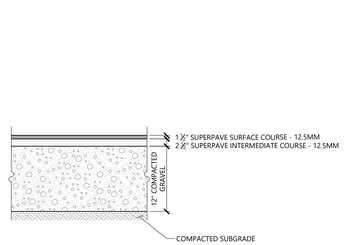
NOTES

1. CONCRETE FOR SIDEWALKS TO BE 4000 PSI AND FOR DRIVEWAYS 5000 PSI. BOTH MIXES TO BE TYPE II, 6% (1.5±) AIR ENTRAINED.
2. PROVIDE EXPANSION JOINTS AT MIN. 30 FT. O.C. WITH PRE- FORMED EXPANSION JOINT FILLER & SEALER.
3. PROVIDE SAWCUT CONTROL JOINTS AT 6' O.C. OR AS NOTED ON PLANS.
4. PROVIDE MEDIUM BROOM FINISH IN DIRECTION PERPENDICULAR TO CURB.
5. ALL EXPOSED CONCRETE SURFACES SHALL BE SEALED WITH A SILANE-SILOXANE PRODUCT.

Concrete Sidewalk in Landscape Area

3/21

N.T.S. Source: VHB LD_426



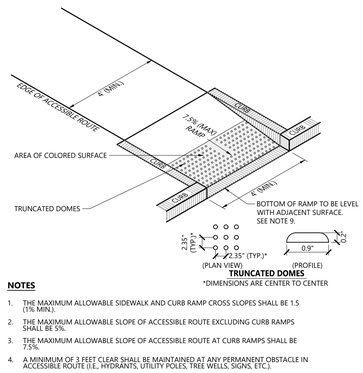
NOTES

PAVEMENT SECTIONS ARE SUBJECT TO CHANGE AND WILL BE BASED ON THE RESULTS OF FURTHER GEOTECHNICAL INVESTIGATIONS.

Bituminous Concrete Pavement Sections

7/22

N.T.S. Source: VHB REV LD_430



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 AT 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 SECTION CONSTRUCTION.
8. WHERE ACCESSIBLE ROUTES ARE LESS THAN 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 WHERE IT ABUTS ROADWAY, EXCEPT WHERE VERTICAL CURBING IS INDICATED ON THE DRAWINGS TO BE INSTALLED AND SET FLUSH.
10. DETECTABLE WARNINGS SHALL CONTRAST VISUALLY WITH ADJOINING SURFACES.
11. DETECTABLE WARNINGS SHALL BE INSTALLED PERPENDICULAR TO THE ACCESSIBLE ROUTE.

Accessible Curb Ramp (ACR) Type 'J-D'

12/20

N.T.S. Source: VHB LD_509

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.

Notes:

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER
8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: N/A

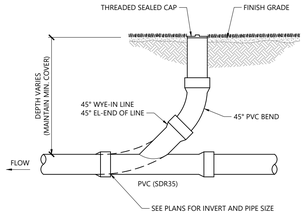
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Site Details 1

Sheet Number:
C6.01

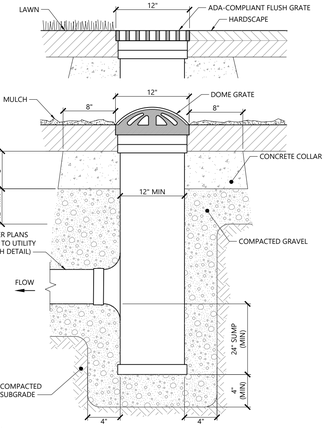
vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770



Cleanout (CO) - Landscape Area

11/19

N.T.S. | Source: VHB | LD_302



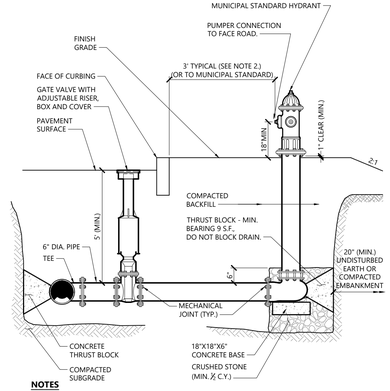
NOTES:

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



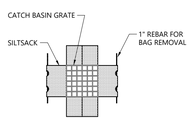
NOTES

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.

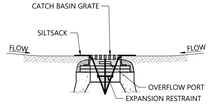
Hydrant Construction

12/19

N.T.S. | Source: VHB | LD_250



PLAN VIEW



SECTION VIEW

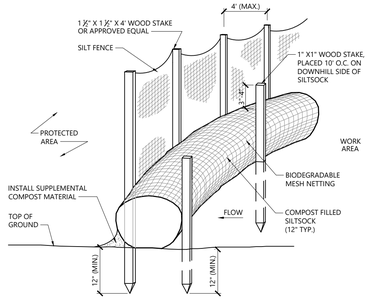
NOTES

1. INSTALL SILTSACK IN ALL CATCH BASINS WHERE INDICATED ON THE PLAN BEFORE COMMENCING WORK OR IN PAVED AREAS AFTER BINDER COURSE IS PLACED AND HAY BALES HAVE BEEN REMOVED.
2. GRATE TO BE PLACED OVER SILTSACK.
3. SILTSACK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS AND CLEANING OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED. MAINTAIN UNTIL UPSTREAM AREAS HAVE BEEN PERMANENTLY STABILIZED

Siltsack Sediment Trap

1/20

N.T.S. | Source: VHB | LD_674



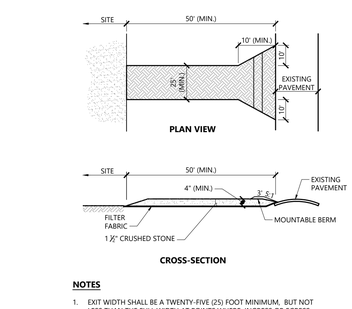
NOTES

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



CROSS-SECTION

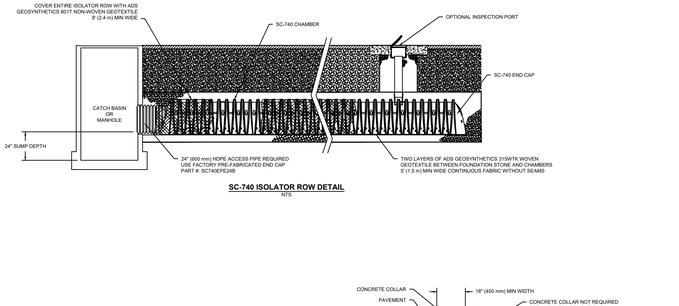
NOTES

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

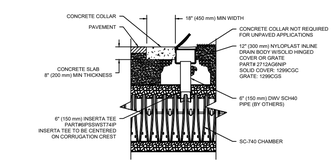


SC-740 ISOLATOR ROW DETAIL
NTS

StormTech SC-740 Isolator Row Profile

10/20

N.T.S. | Source: StormTech | LD_182-740I

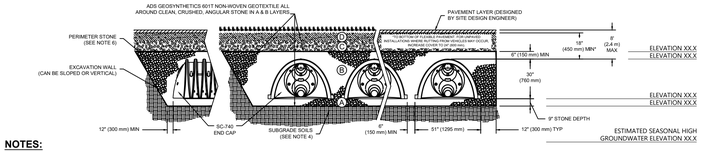


SC-740 6" INSPECTION PORT DETAIL
NTS

ACCEPTABLE FILL MATERIALS: STORMTECH SC-740 CHAMBER SYSTEMS

	MATERIAL LOCATION	DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF THE FINAL PAVEMENT OR GROUND SURFACE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS, CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY REQUIRE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 18" (450 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145* A-1, A-2-4, A-3 OR AASHTO M43* 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 12" (300 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 6" (150 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL-GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. ROLLER GROSS VEHICLE WEIGHT NOT TO EXCEED 12,000 lbs (53 kN). DYNAMIC FORCE NOT TO EXCEED 20,000 lbs (89 kN).
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43* 3, 357, 4, 467, 5, 56, 57	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43* 3, 357, 4, 467, 5, 56, 57	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. **

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 6" (150 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



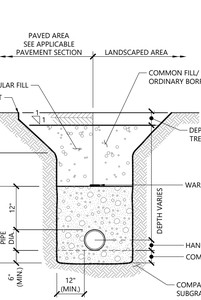
NOTES:

1. SC-740 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS", OR ASTM F2922 "STANDARD SPECIFICATION FOR POLYETHYLENE (PE) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. SC-740 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
5. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
6. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.

Subsurface Detention/Infiltration System (StormTech SC-740)

10/20

N.T.S. | Source: StormTech | LD_182-740



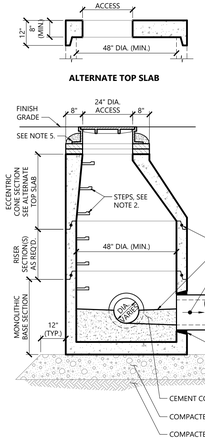
NOTES

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



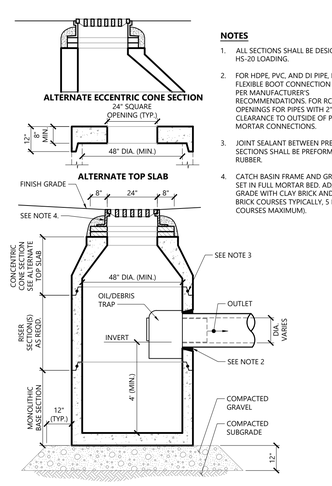
NOTES

1. 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. 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).

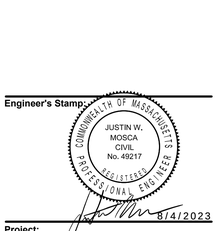
Catch Basin (CB) With Oil/Debris Trap

3/21

N.T.S. | Source: VHB | LD_101

Notes:

Engineer's Stamp:



Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: N/A

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

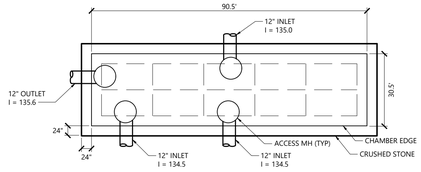
Revisions:	Date:

Drawing Title:
Site Details 2

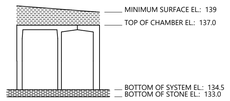
Sheet Number:
C6.02

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.



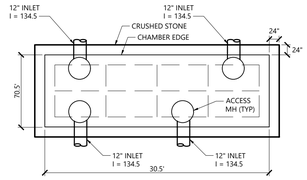
BASIN 2.1-C LAYOUT



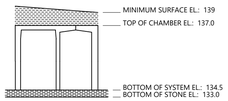
BASIN 2.1-CSYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-C

N.T.S. Source: VHB



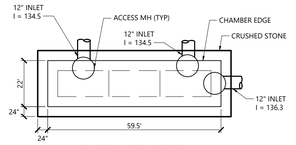
BASIN 2.1-D LAYOUT



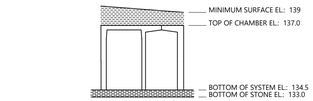
BASIN 2.1-CSYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-D

N.T.S. Source: VHB



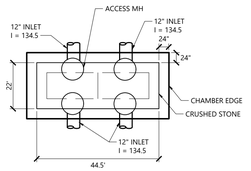
BASIN 2.1-F LAYOUT



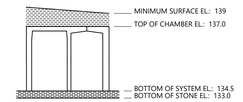
BASIN 2.1-CSYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-E

N.T.S. Source: VHB



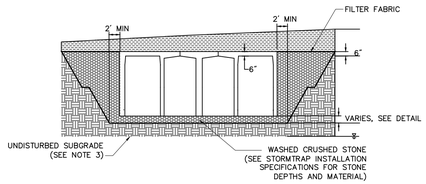
BASIN 2.1-E LAYOUT



BASIN 2.1-CSYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-F

N.T.S. Source: VHB



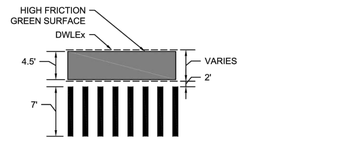
SINGLE TRAP (NO SLAB) - TYPICAL DETAIL

NOTES:

1. ALL DIMENSIONS TO BE VERIFIED IN THE FIELD BY CONTRACTOR PRIOR TO INSTALLATION.
2. CONTRACTOR'S RESPONSIBILITY TO ENSURE CONSISTENCY WITH FINAL ENGINEER OF RECORD PLAN SET.
3. BOTTOM OF STONE FOR ALL SYSTEMS TO BE INSTALLED WITHIN UNDISTURBED GLACIOFLUVIAL SOILS. CONTRACTOR TO COORDINATE WITH GEOTECHNICAL ENGINEER DURING INSTALLATION TO CONFIRM DESIGN ELEVATIONS. REPORT ANY DISCREPANCY TO THE ENGINEER FOR RESOLUTION.
4. REFER TO MANUFACTURER'S REQUIREMENTS FOR INSTALLATION SPECIFICATIONS AND PROCEDURES.

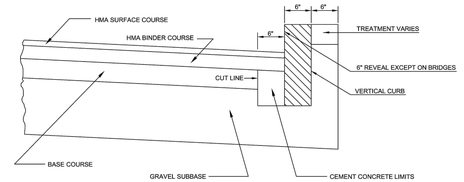
StormTrap Infiltration Systems - Basins 2.1-C, 2.1-D, 2.1-E, 2.1-F

N.T.S. Source: VHB



Crosswalk and Bike Lane Crossing 7/19

N.T.S. Source: MassDOT



NOTES:

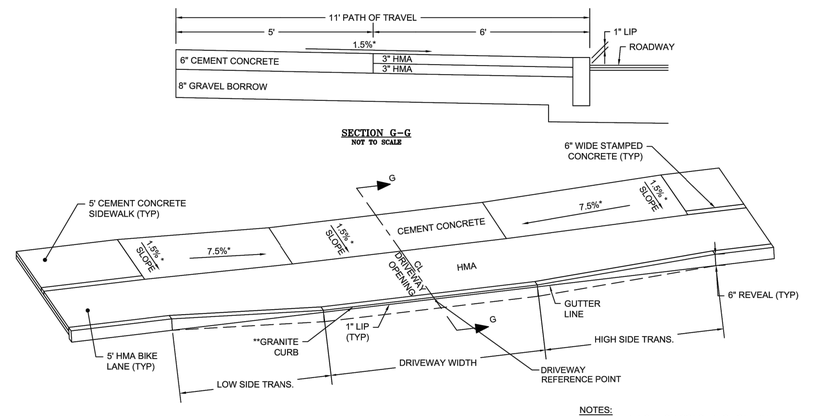
1. THIS PROCEDURE IS APPLICABLE ONLY IF CURB IS TO BE SET AFTER BASE COURSE IS IN PLACE PRIOR TO BINDER AND TOP PLACEMENT.
2. CUT NEAT LINE 6" FROM CURB LINE AND REMOVE BASE AND GRAVEL. REPLACE WITH CEMENT CONCRETE.
3. ANY DESIGNATED CEMENT CONCRETE THAT IS ACCEPTABLE UNDER SECTION M4 OF THE STANDARD SPECIFICATIONS MAY BE USED; ALL TEST REQUIREMENTS ARE WAIVED. HOT MIX ASPHALT SHALL NOT TO BE USED AS A SUBSTITUTE.

Method of Setting Vertical Curb 10/17

N.T.S. Source: MassDOT

Wheelchair Ramp Type C 7/19

N.T.S. Source: MassDOT



NOTES:

1. *TOLERANCE FOR CONSTRUCTION = 0.5%±.
2. **GRANITE CURB SHALL BE CONTINUED THROUGH DRIVEWAY OPENING TO ESTABLISH 1" LIP. (TYPE G)
3. ADA/MA AAB REQUIREMENTS SHALL BE FOLLOWED.

Cement Concrete Sidewalk Through Driveway with Straight Transistions - Type G 7/19

N.T.S. Source: MassDOT

THE ORIGINAL PLAN SIZE IS 24"x36". IF THE PRINTED PLAN IS DIFFERENT, SCALE SHOULD BE ADJUSTED ACCORDINGLY.

Notes:

Engineer's Stamp:

COMMONWEALTH OF MASSACHUSETTS
JUSTIN W. MOSCA
CIVIL
No. 49217
REGISTERED PROFESSIONAL ENGINEER
8/4/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: N/A

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
Site Details 3

Sheet Number:
C6.03

vhb
101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: SCALE:1/16"=1'-0"

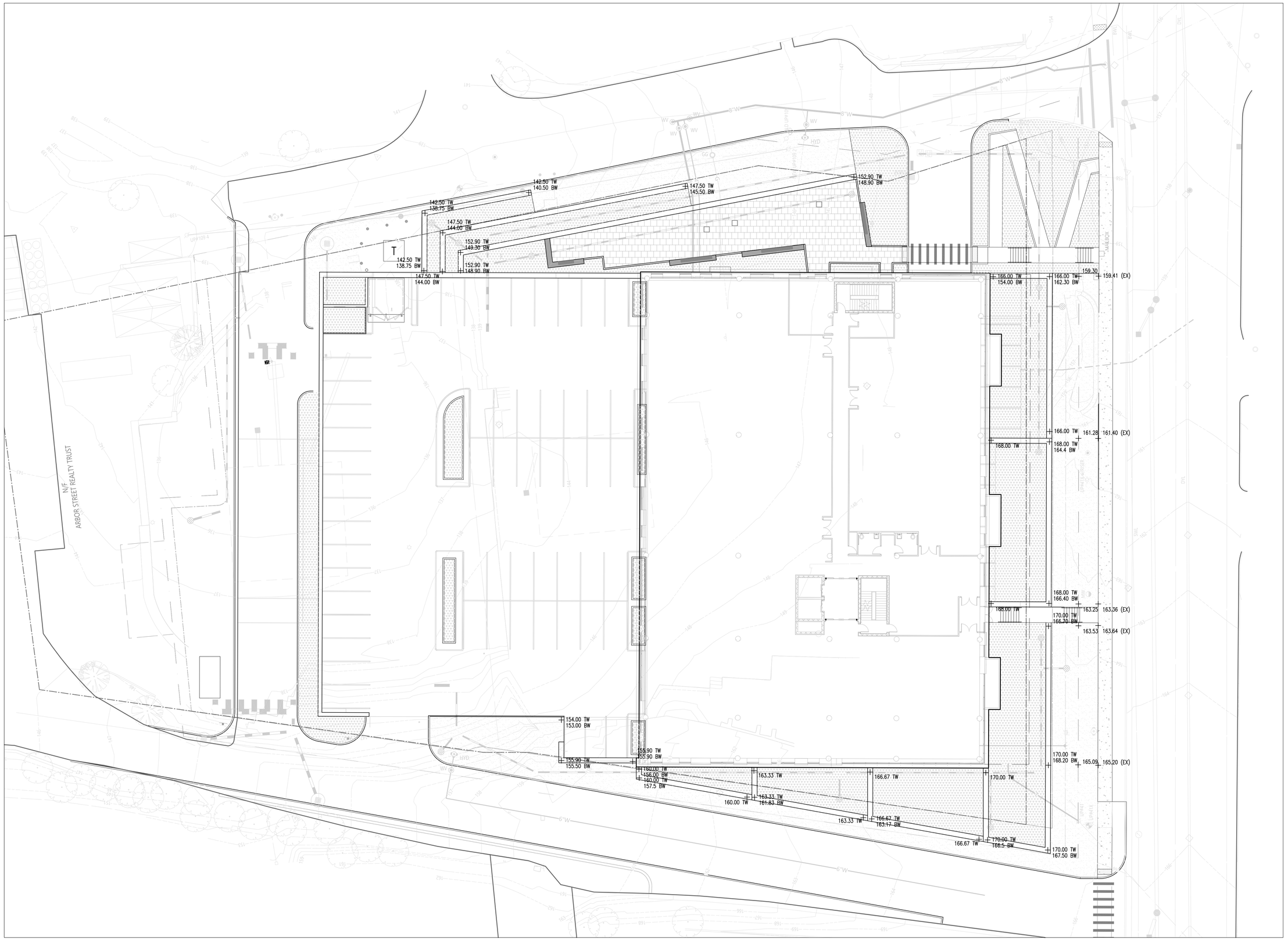
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
RENDERED MATERIAL PLAN

Sheet Number:
L102

Ground Inc.
295 Washington St. Somerville, MA 02143
617.718.0889 www.groundinc.com



Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre,
MA 02459

Project #: 22090

Scale: 1:16

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

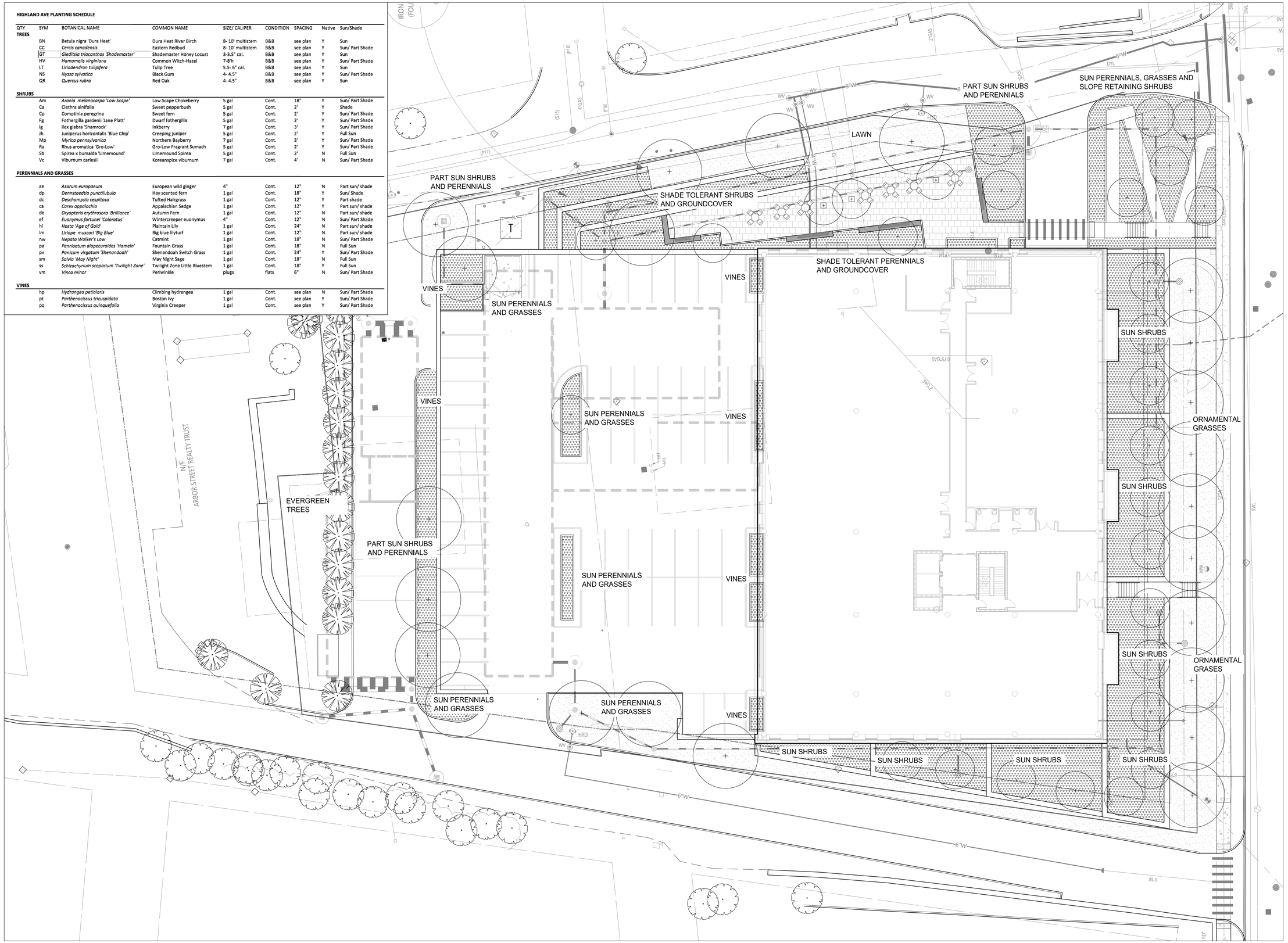
Drawing Title:
GRADING PLAN

Sheet Number:
L103

Ground Inc.
280 Washington St, Somerville, MA 02143
617.718.0809 www.groundinc.com

HIGHLAND AVE PLANTING SCHEDULE

QTY	SYM	BOTANICAL NAME	COMMON NAME	SIZE/ CALIPER	CONDITION	SPACING	Native	Sun/Shade
TREES								
	BN	Betula nigra 'Dura Heat'	Dura Heat River Birch	8- 10' multistem	B&B	see plan	Y	Sun
	CC	*Cercis canadensis*	Eastern Redbud	8- 10' multistem	B&B	see plan	Y	Sun/ Part Shade
	GT	*Gleditsia triacanthos 'Shademaster'*	Shademaster Honey Locust	3-3.5" cal.	B&B	see plan	Y	Sun
	HV	*Hamamelis virginiana*	Common Witch-Hazel	7-8'h	B&B	see plan	Y	Sun/ Part Shade
	LT	*Liriodendron tulipifera*	Tulip Tree	5.5- 6" cal.	B&B	see plan	Y	Sun
	NS	*Nyssa sylvatica*	Black Gum	4- 4.5"	B&B	see plan	Y	Sun/ Part Shade
	QR	*Quercus rubra*	Red Oak	4- 4.5"	B&B	see plan	Y	Sun
SHRUBS								
	Am	*Aronia melanocarpa 'Low Scape'*	Low Scape Chokeberry	5 gal	Cont.	18"	Y	Sun/ Part Shade
	Ca	Clethra alnifolia	Sweet pepperbush	5 gal	Cont.	2'	Y	Shade
	Cp	Comptinia peregrina	Sweet fern	5 gal	Cont.	2'	Y	Sun/ Part Shade
	Fg	Fothergilla gardenii 'Jane Platt'	Dwarf fothergilla	5 gal	Cont.	2'	Y	Sun/ Part Shade
	Ig	Ilex glabra 'Shamrock'	Inkberry	7 gal	Cont.	3'	Y	Sun/ Part Shade
	Jh	Juniperus horizontalis 'Blue Chip'	Creeping Juniper	5 gal	Cont.	2'	Y	Full Sun
	Mp	*Myrica pennsylvanica*	Northern Bayberry	7 gal	Cont.	3'	Y	Sun/ Part Shade
	Ra	Rhus aromatica 'Gro-Low'	Gro-Low Fragrant Sumach	5 gal	Cont.	2'	Y	Sun/ Part Shade
	Sb	Spirea x bumalda 'Limemound'	Limemound Spirea	5 gal	Cont.	2'	N	Full Sun
	Vc	Viburnum carlesii	Koreanspice viburnum	7 gal	Cont.	4'	N	Sun/ Part Shade
PERENNIALS AND GRASSES								
	ae	*Asarum europaeum*	European wild ginger	4"	Cont.	12"	N	Part sun/ shade
	dp	*Dennstaedtia punctilubula*	Hay scented fern	1 gal	Cont.	18"	Y	Sun/ Shade
	dc	*Deschampsia cespitosa*	Tufted Haigrass	1 gal	Cont.	12"	Y	Part shade
	ca	*Carex appalachia*	Appalachian Sedge	1 gal	Cont.	12"	Y	Part sun/ shade
	de	*Dryopteris erythrosora 'Brilliance'*	Autumn Fern	1 gal	Cont.	12"	N	Part sun/ shade
	ef	*Euonymus fortunei 'Coloratus'*	Wintercreeper euonymus	4"	Cont.	12"	N	Sun/ Part Shade
	hl	*Hosta 'Age of Gold'*	Plaintain Lily	1 gal	Cont.	24"	N	Part sun/ shade
	lm	*Liriope muscari 'Big Blue'*	Big blue lilyturf	1 gal	Cont.	12"	N	Part sun/ shade
	nw	*Nepata Walker's Low*	Catmint	1 gal	Cont.	18"	N	Sun/ Part Shade
	pa	*Pennisetum alopecuroides 'Hameln'*	Fountain Grass	1 gal	Cont.	18"	N	Full Sun
	pv	*Panicum virgatum 'Shenandoah'*	Shenandoah Switch Grass	1 gal	Cont.	24"	Y	Sun/ Part Shade
	sm	*Salvia 'May Night'*	May Night Sage	1 gal	Cont.	18"	N	Full Sun
	ss	*Schizachyrium scoparium 'Twilight Zone'*	Twilight Zone Little Bluestem	1 gal	Cont.	18"	Y	Full Sun
	vm	*Vinca minor*	Periwinkle	plugs	flats	6"	N	Sun/ Part Shade
VINES								
	hp	*Hydrangea petiolaris*	Climbing hydrangea	1 gal	Cont.	see plan	N	Sun/ Part Shade
	pt	*Parthenocissus tricuspidata*	Boston Ivy	1 gal	Cont.	see plan	Y	Sun/ Part Shade
	pq	*Parthenocissus quinquefolia*	Virginia Creeper	1 gal	Cont.	see plan	Y	Sun/ Part Shade



Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale:

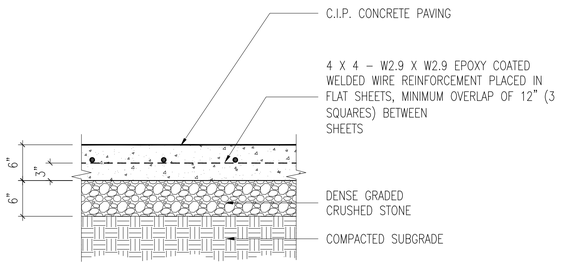
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
PLANTING PLAN

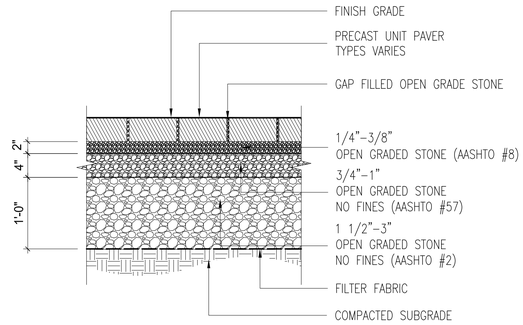
Sheet Number:
L104

Ground Inc.
295 Washington St. Somerville, MA 02143
617.718.0889 www.groundinc.com



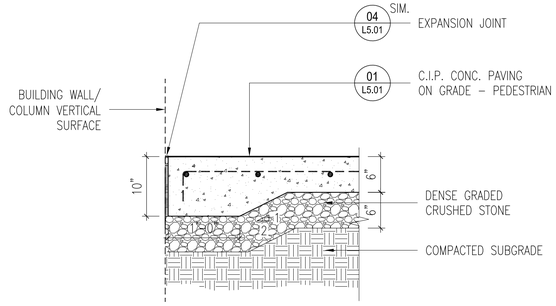
01 C.I.P CONC. PAVING - PEDESTRIAN

SCALE: 1" = 1'-0"



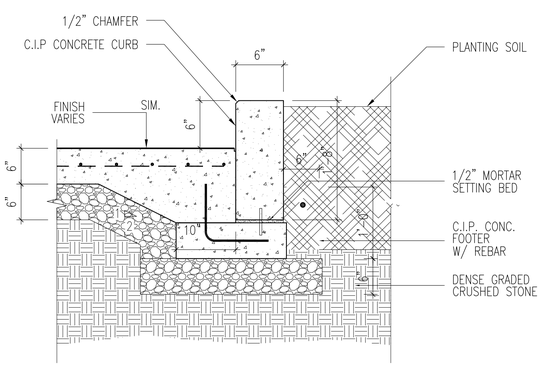
02 PERMEABLE PAVER ON CONCRETE SLAB

SCALE: 1" = 1'-0"



03 C.I.P CONCRETE EDGE CONDITION

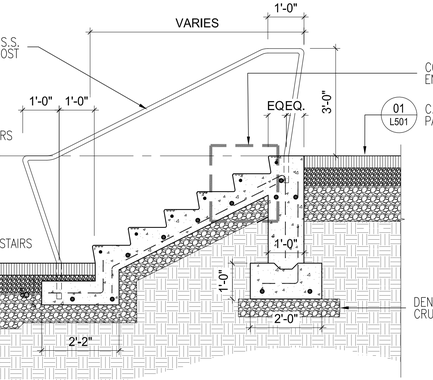
SCALE: 1" = 1'-0"



04 EXPANSION JOINT

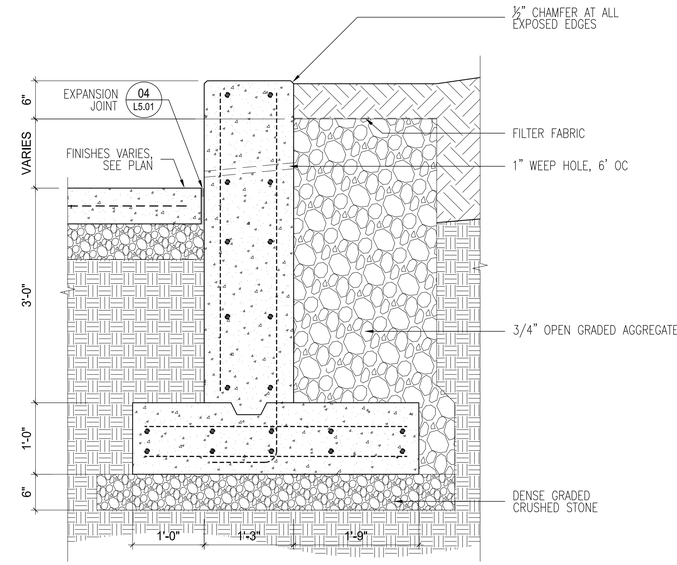
SCALE: 2" = 1'-0"

NOTE:
CONTROL JOINT TO BE ¼ OF THE SLAB THICKNESS: 1 ½" FOR 6" THICK SLAB.



05 CONTROL JOINT

SCALE: 2" = 1'-0"



06 C.I.P. CONCRETE WALL

SCALE: 1" = 1'-0"

07 PRECAST CONCRETE CURB

SCALE: 1" = 1'-0"

08 C.I.P. CONCRETE STAIRS WITH HANDRAILS ON BOTH SIDES

SCALE: 1/2" = 1'-0"

Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale:

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

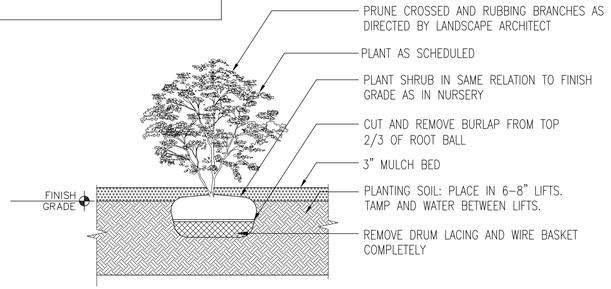
Drawing Title:
DETAILS

Sheet Number:

L501

Ground Inc.
285 Washington St, Somerville, MA 02143
617.718.0889 www.groundinc.com

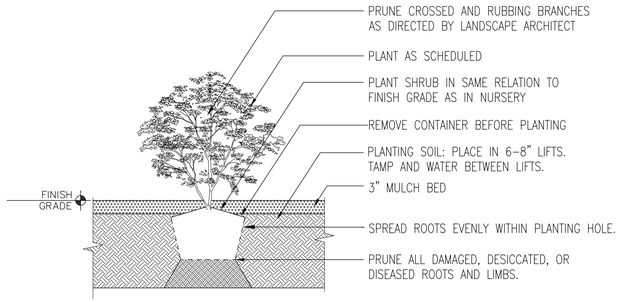
NOTES:
– CLEANLY PRUNE ALL ROOT ENDS.
– DO NOT ALLOW ROOTS TO DRY OUT DURING THE INSTALLATION PROCESS.
– SOAK ROOTS OVERNIGHT BEFORE PLANTING.
– INSTALL BALLED AND BURLAPPED SHRUBS SIMULTANEOUSLY W/ INSTALLATION OF PLANTING SOIL



01 SHRUB PLANTING - B&B

SCALE: 3/4" = 1'-0"

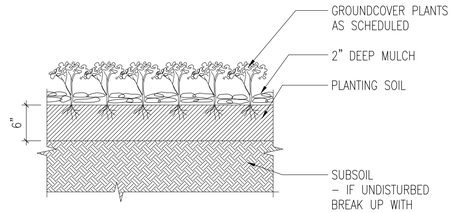
NOTE:
CLEANLY PRUNE ALL ROOT ENDS.
DO NOT ALLOW ROOTS TO DRY OUT DURING THE INSTALLATION PROCESS.
SOAK ROOTS OVERNIGHT BEFORE PLANTING.



02 SHRUB/PERENNIAL - CONTAINER

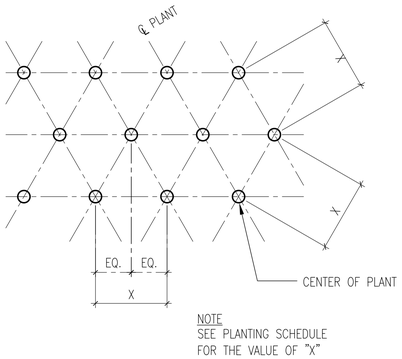
SCALE: 3/4" = 1'-0"

NOTE:
SEE PLANT SPACING DIAGRAM FOR GROUNDCOVER SPACING



03 GROUNDCOVER PLANTING

SCALE: 1" = 1'-0"



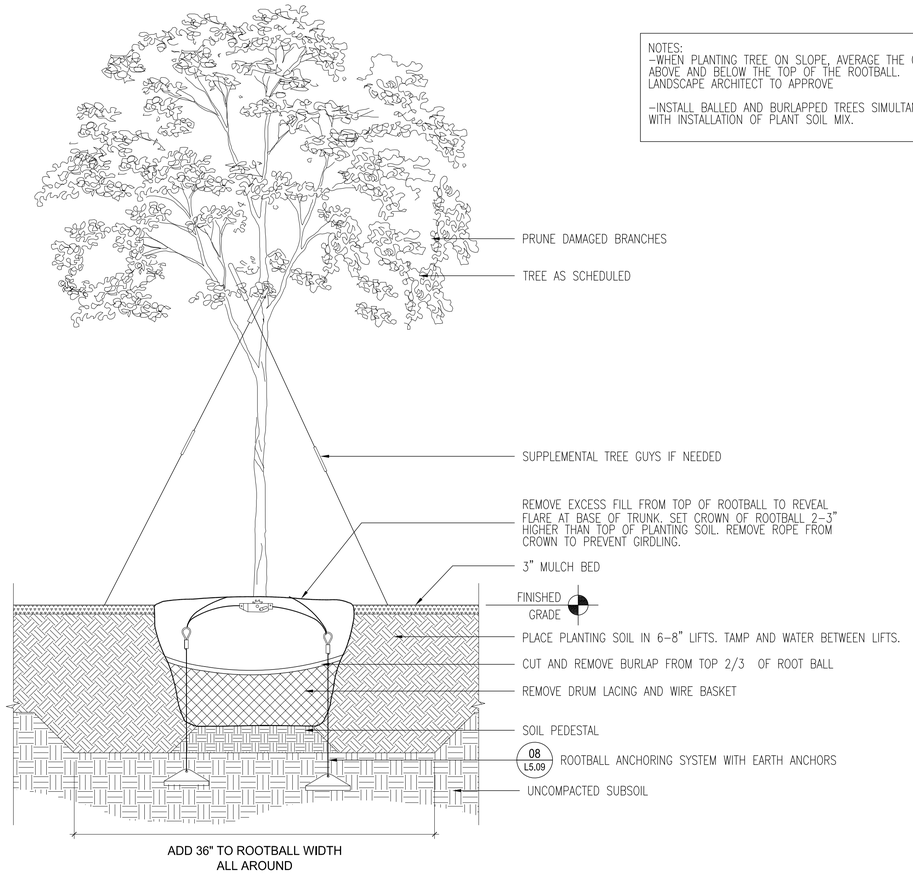
NOTE
SEE PLANTING SCHEDULE FOR THE VALUE OF "X"

04 PLANT SPACING DIAGRAM

SCALE: 1" = 1'-0"

NOTES:
–WHEN PLANTING TREE ON SLOPE, AVERAGE THE GRADE ABOVE AND BELOW THE TOP OF THE ROOTBALL. LANDSCAPE ARCHITECT TO APPROVE

–INSTALL BALLED AND BURLAPPED TREES SIMULTANEOUSLY WITH INSTALLATION OF PLANT SOIL MIX.



05 TREE PLANTING IN PLANTING BED

SCALE: 3/4" = 1'-0"

Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale:

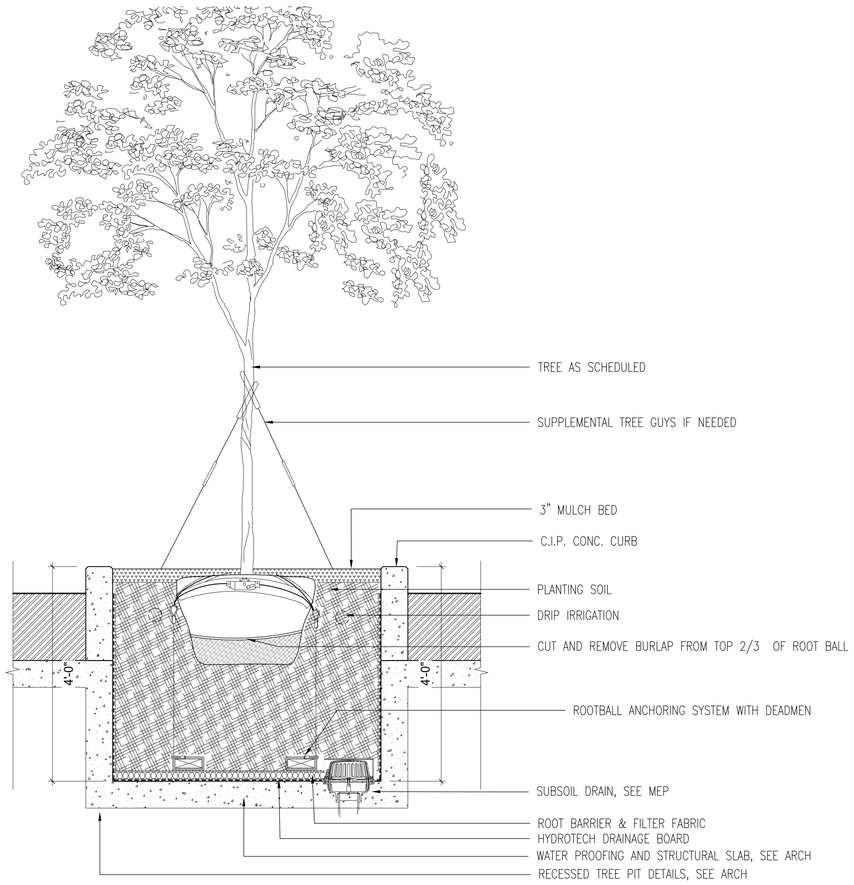
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
PLANTING DETAILS

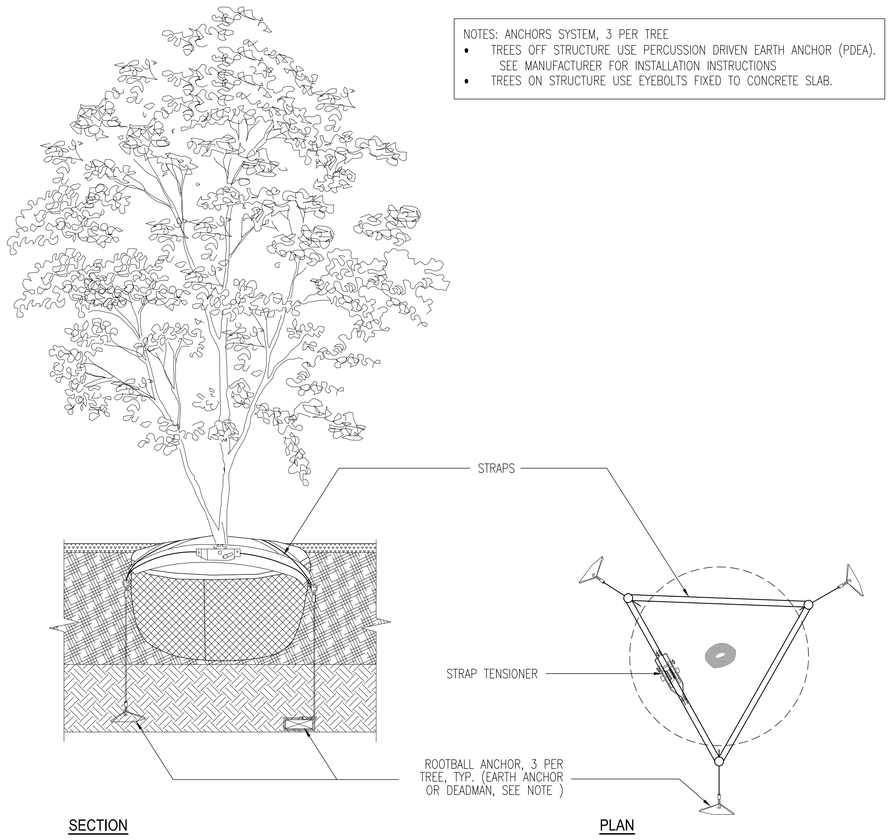
Sheet Number:
L520

Ground Inc.
285 Washington St. Somerville, MA 02143
617.718.0889 www.groundinc.com



01 TREE PLANTING AT PRECAST PAVER - ON STRUCTURE

SCALE: 3/4" = 1'-0"



02 TREE ANCHORING SYSTEM

SCALE: 3/4" = 1'-0"

Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale:

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
PLANTING DETAILS

Sheet Number:
L521

Ground Inc.
285 Washington St. Somerville, MA 02143
617.718.0889 www.groundinc.com

JOB NAME: HIGHLAND M.O.B.
DATE: 8/2/2023
APEX LIGHTING SOLUTIONS
REFLECTANCES: PARKING SURFACE & WALLS=20%; CEILING IN COVERED PARKING=80%
WORKPLANE: @ GRADE

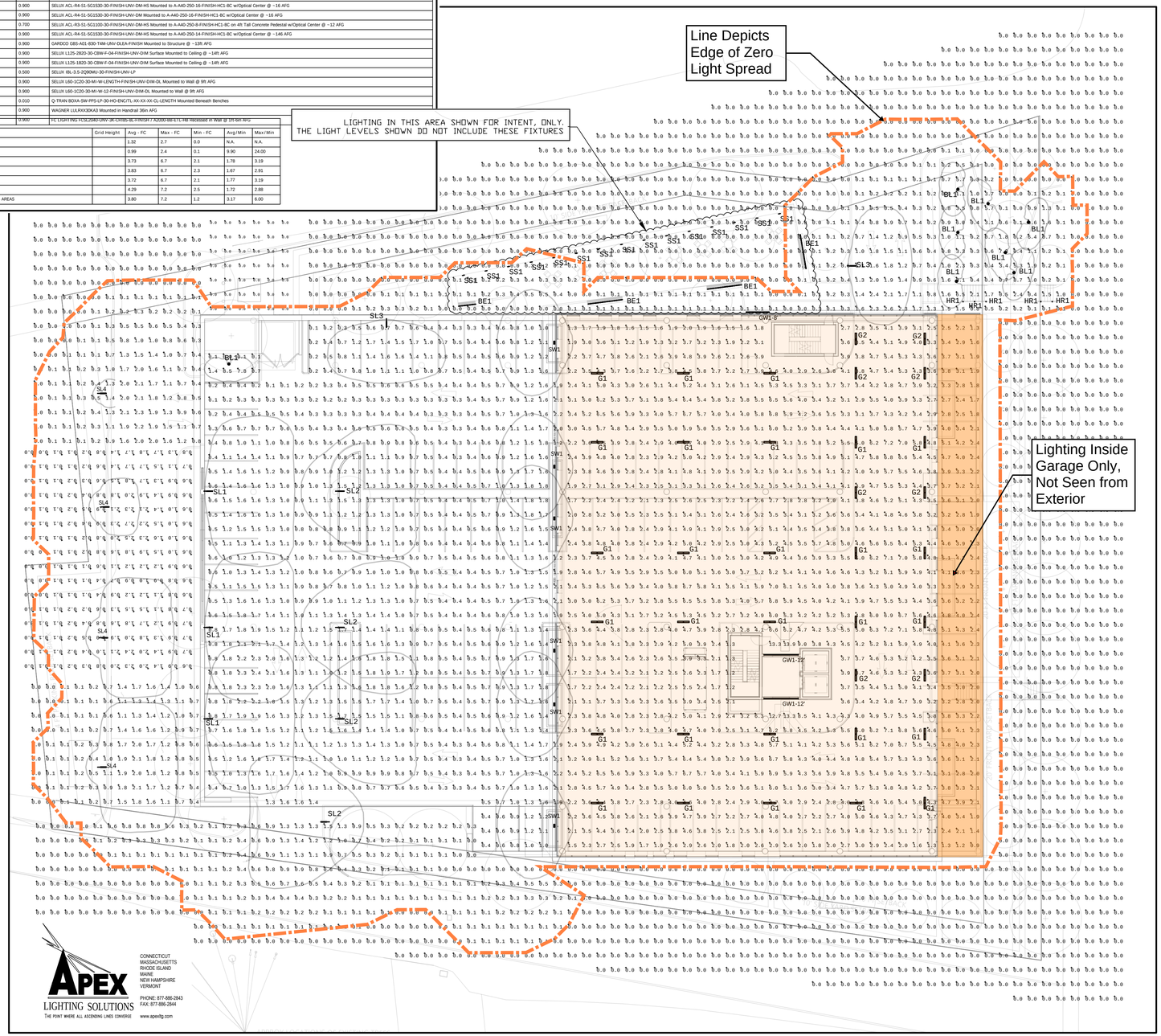
Luminaire Schedule

Qty	Label	Wattage	Luminaire Lumens	LLF	Description
3	SL1	36	2379	0.900	SELUX ACL-R4-S1-SG1530-30-FINISH-UNV-DM-HS Mounted to A-A40-250-16-FINISH-HC1-BC w/Optical Center @ ~16 AFG
4	SL2	24	2362	0.900	SELUX ACL-R4-S1-SG1530-30-FINISH-UNV-DM Mounted to A-A40-250-16-FINISH-HC1-BC w/Optical Center @ ~16 AFG
2	SL3	24	1612	0.700	SELUX ACL-R3-S1-SG1030-30-FINISH-UNV-DM-HS Mounted to A-A40-250-B-FINISH-HC1-BC on 4ft Tall Concrete Pedestal w/Optical Center @ ~12 AFG
4	SL4	36	2379	0.900	SELUX ACL-R4-S1-SG1530-30-FINISH-UNV-DM-HS Mounted to A-A40-250-14-FINISH-HC1-BC w/Optical Center @ ~146 AFG
6	SW1	10.2	1467	0.900	GARDCO GBS-A01-830-T4M-UNV-DLEA-FINISH Mounted to Structure @ ~13ft AFG
28	G1	40.4	3452	0.900	SELUX L125-2820-30-CBW-F-04-FINISH-UNV-DIM Surface Mounted to Ceiling @ ~14ft AFG
8	G2	20.4	1904	0.900	SELUX L125-1820-30-CBW-F-04-FINISH-UNV-DIM Surface Mounted to Ceiling @ ~14ft AFG
8	BL1	14.1	798	0.500	SELUX IBL-3.5-2Q90MU-30-FINISH-UNV-LP
1	GW1-8'	38.6	3848	0.900	SELUX L60-1C20-30-MI-W-LENGTH-FINISH-UNV-DIM-DL Mounted to Wall @ 9ft AFG
2	GW1-12'	57.9	5772	0.900	SELUX L60-1C20-30-MI-W-L2-FINISH-UNV-DIM-DL Mounted to Wall @ 9ft AFG
42	BE1	107	10768	0.010	Q-TRAN BOXA-SW-PR-LP-30-HO-ENCTL-XX-XX-XX-CL-LENGTH Mounted Beneath Benches
5	HR1	2.89	100	0.900	WAGNER LULRX30KA3 Mounted in Handrail 36in AFG
15	SS1	9.379	785	0.900	TC LIGHTING FCSLD06-UNV-3K-CH85-BL-FINISH / XD00-BE-ETL-HR Recessed in Wall @ 1ft 6in AFG

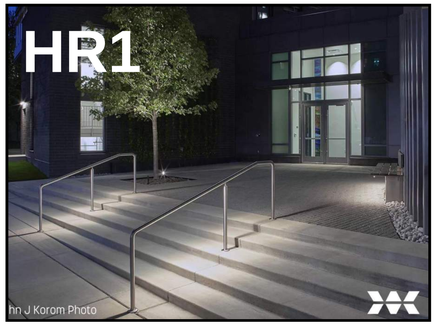
Calculation Summary

Label	Grid Height	Avg - FC	Max - FC	Min - FC	Avg/Min	Max/Min
RAMP TO UNDERGROUND PARKING		1.32	2.7	0.0	N.A.	N.A.
OPEN AIR PARKING - DRIVE AISLES & PARKING AREAS		0.99	2.4	0.1	9.90	24.00
COVERED PARKING - VEHICULAR ENTRY #4		3.73	6.7	2.1	1.78	3.19
COVERED PARKING - VEHICULAR ENTRY #3		3.83	6.7	2.3	1.67	2.91
COVERED PARKING - VEHICULAR ENTRY #2		3.72	6.7	2.1	1.77	3.19
COVERED PARKING - VEHICULAR ENTRY #1		4.29	7.2	2.5	1.72	2.88
COVERED PARKING - DEDICATED CORNERS, DRIVE AISLES, PARKING AREAS		3.80	7.2	1.2	3.17	6.00

LIGHTING IN THIS AREA SHOWN FOR INTENT, ONLY.
THE LIGHT LEVELS SHOWN DO NOT INCLUDE THESE FIXTURES

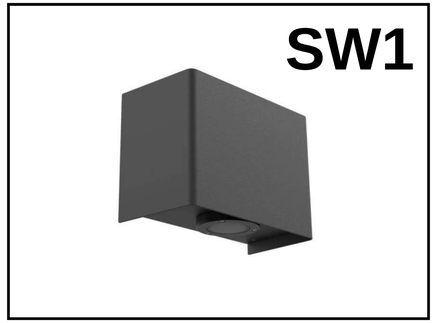


BL1 Accessible Route Lighting and Landscaped Corner at Upper Parking



HR1 Stair Lighting Concealed beneath Handrails

SL1-4 Parking & Drive Pole-Mounted Downlights



SW1 Parking Downlights Mounted below Shelf on Building

BE1 Plaza Lighting Concealed beneath Benches

SW1 Parking Downlights Mounted below Shelf on Building

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Site Lighting Photometric Plan / 14 July 2023

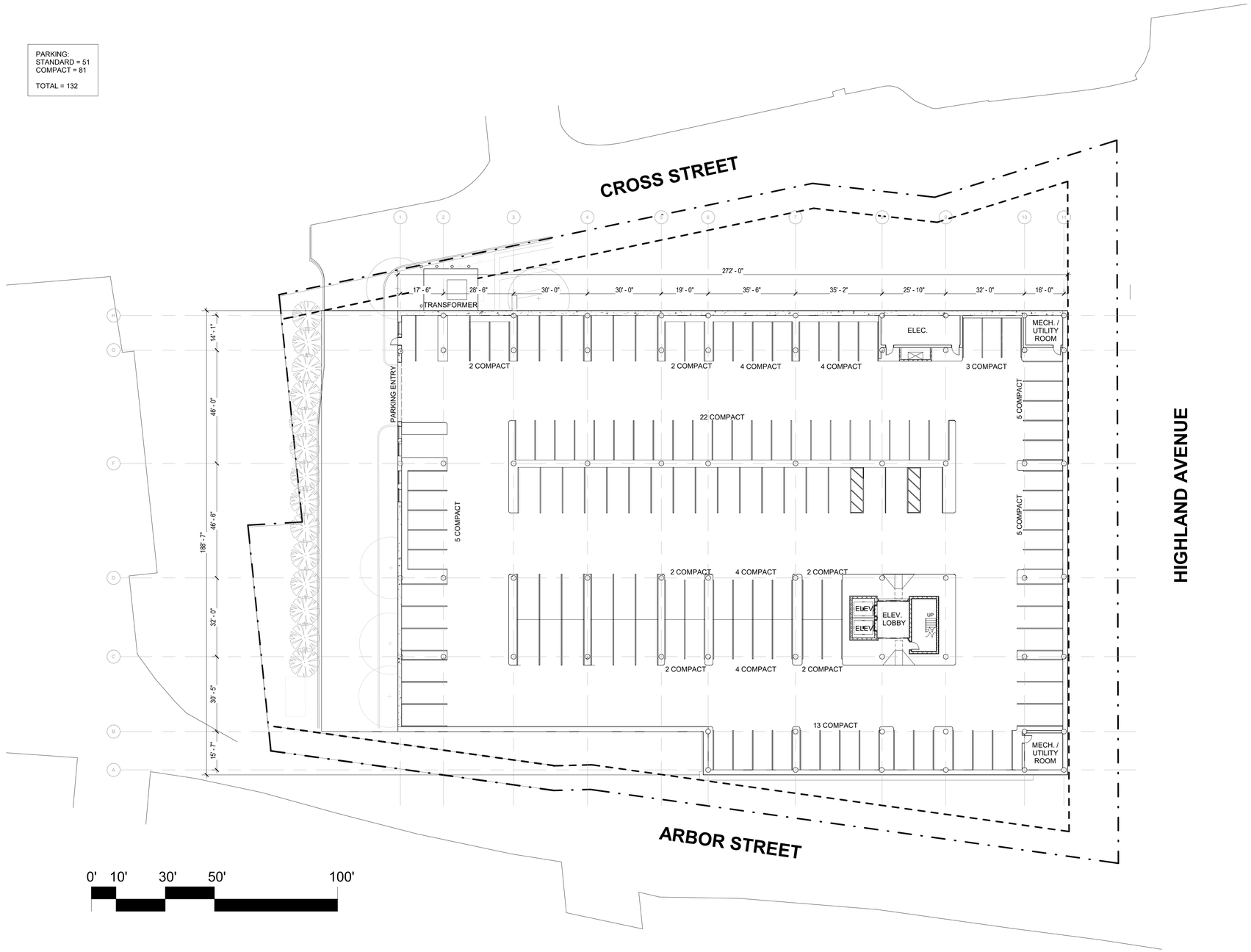
Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

PARKING:
STANDARD = 51
COMPACT = 81

TOTAL = 132



1 P-1 LOWER PARKING
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON
MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 3/64" = 1'-0"

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

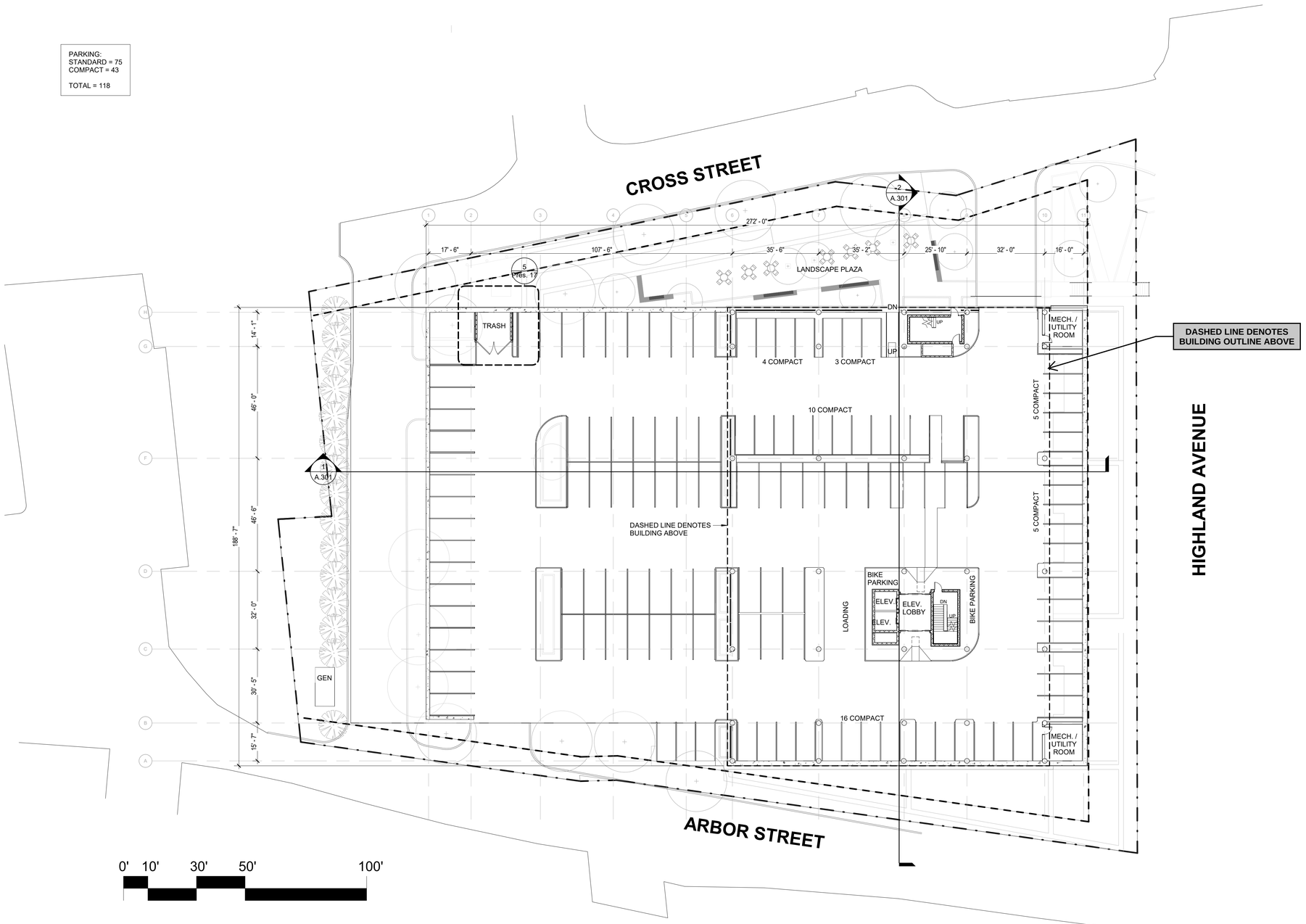
Drawing Title:
P-1 Lower Parking Plan

Sheet Number:
A.101

MAUGEL ARCHITECTS
200 AYER ROAD | SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM

PARKING:
STANDARD = 75
COMPACT = 43

TOTAL = 118



1 P-2 UPPER PARKING
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON, MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 3/64" = 1'-0"

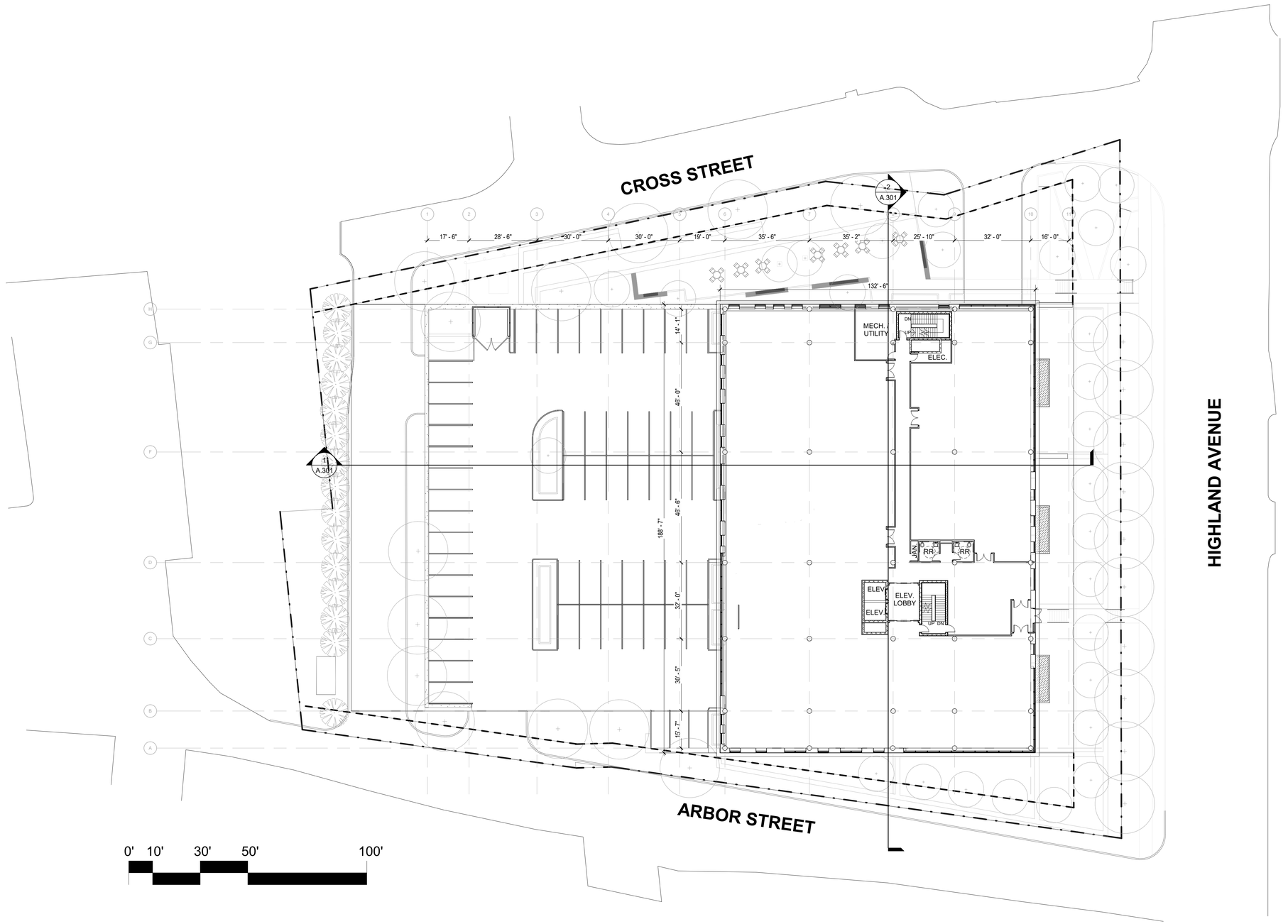
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
P-2 Upper Parking Plan

Sheet Number:
A.102

MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM



1 FIRST FLOOR PLAN
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON, MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 3/64" = 1'-0"

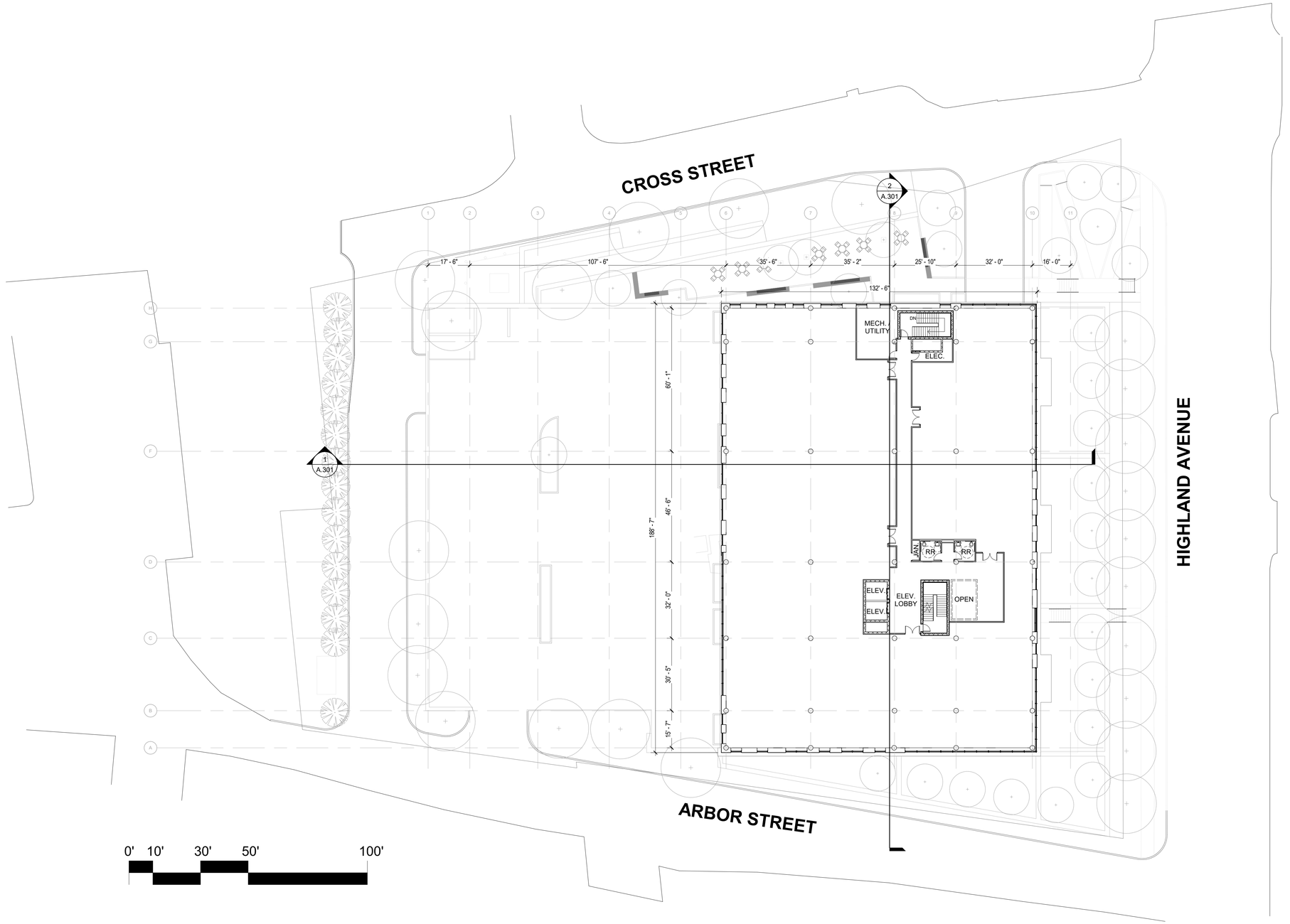
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
First Floor Plan

Sheet Number:
A.103

MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM



1 SECOND FLOOR PLAN
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON
MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 3/64" = 1'-0"

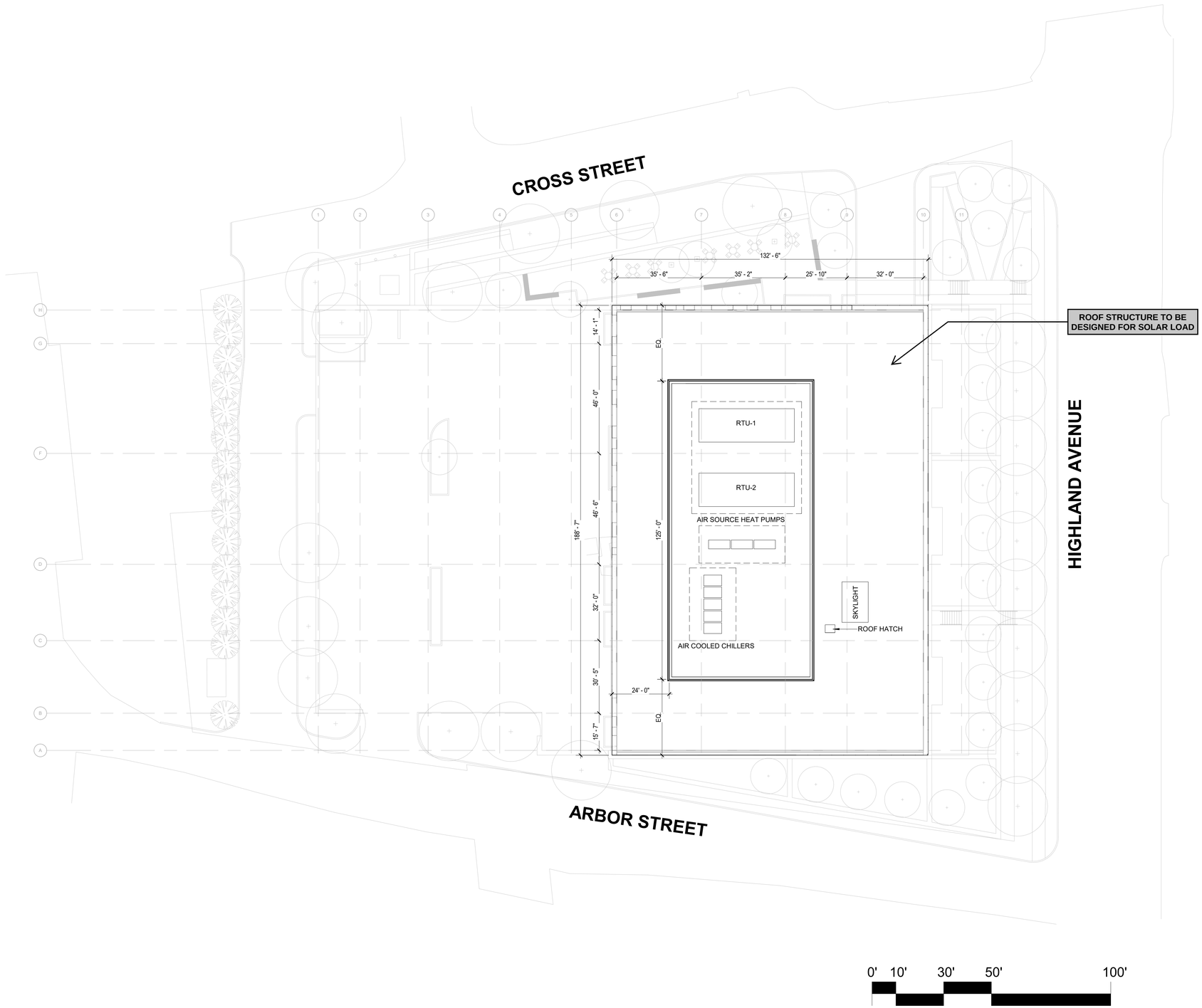
Issue:	**Date:**
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	**Date:**

Drawing Title:
Second Floor Plan

Sheet Number:
A.104

MAUGEL ARCHITECTS
200 AYER ROAD | SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM



1 ROOF
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON
MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 3/64" = 1'-0"

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

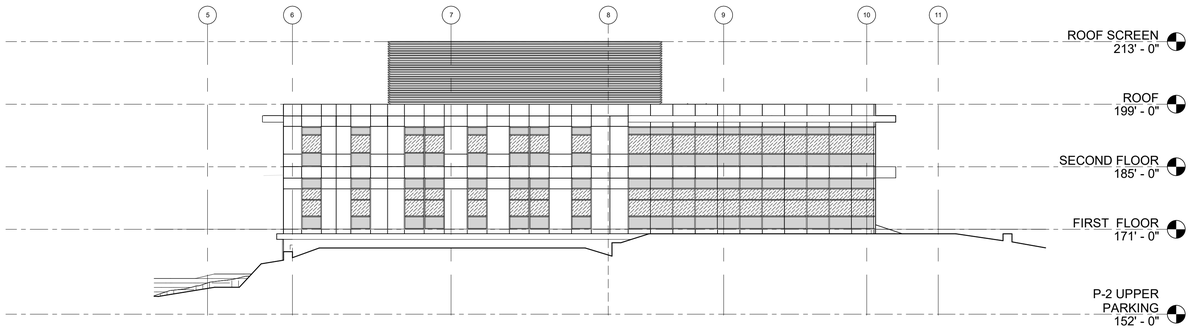
Revisions:	Date:

Drawing Title:
Roof Plan

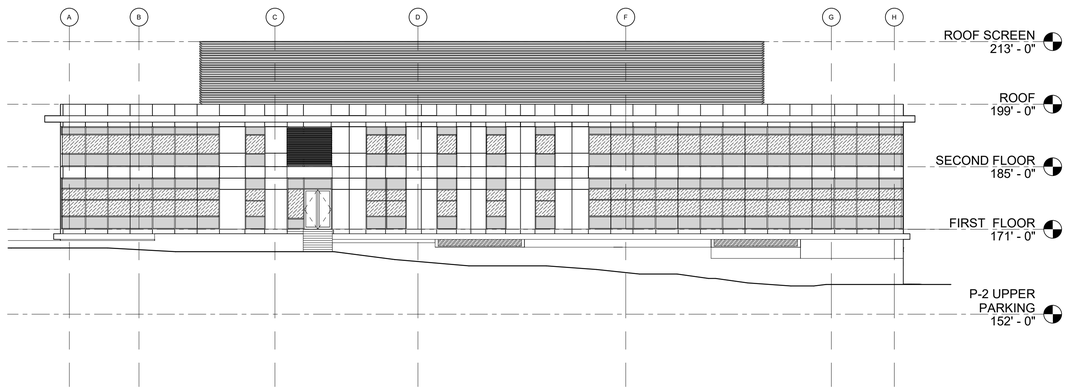
Sheet Number:

A.105

MAUGEL ARCHITECTS
200 AYER ROAD | SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM

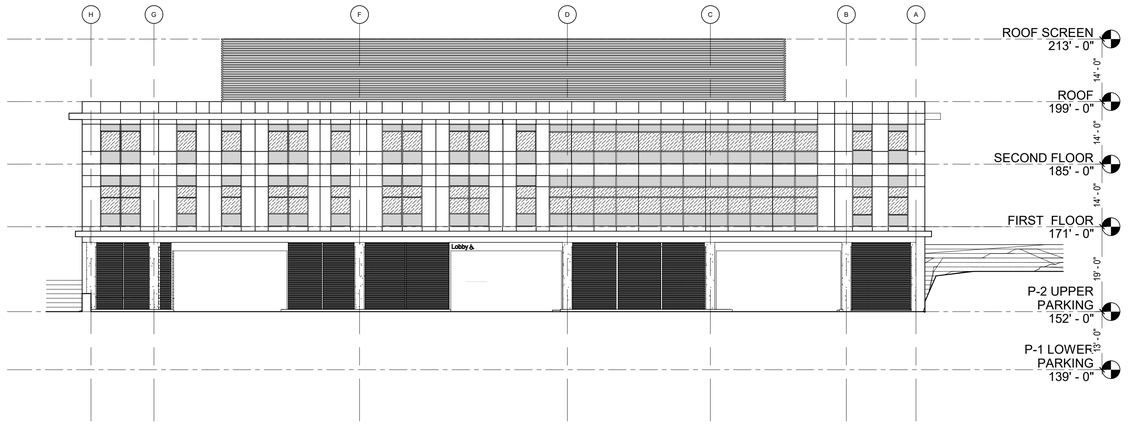


4 ARBOR STREET (SOUTH WEST) ELEVATION
SCALE: 1/16" = 1'-0"



3 HIGHLAND AVE (SOUTH EAST) ELEVATION
SCALE: 1/16" = 1'-0"

34 CROSS STREET (NORTH EAST) ELEVATION
SCALE: 1/16" = 1'-0"



1 GUILD ROAD (NORTH WEST) ELEVATION
SCALE: 1/16" = 1'-0"

0' 10' 30' 50' 100'

Notes:

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON
MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 1/16" = 1'-0"

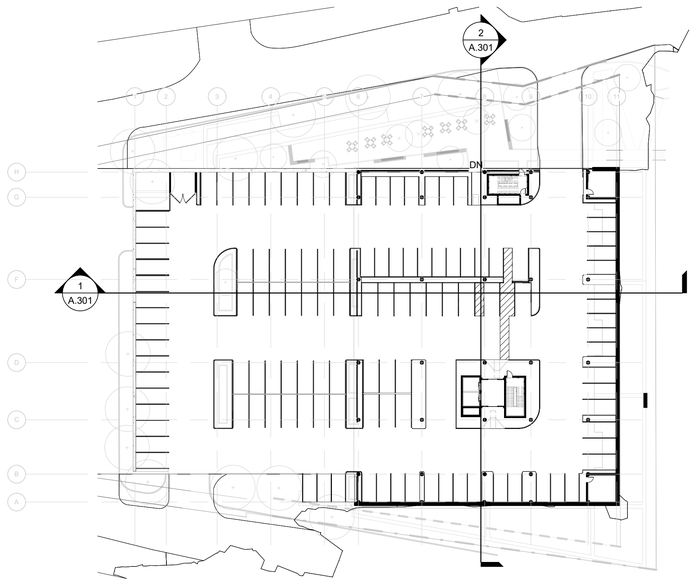
Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

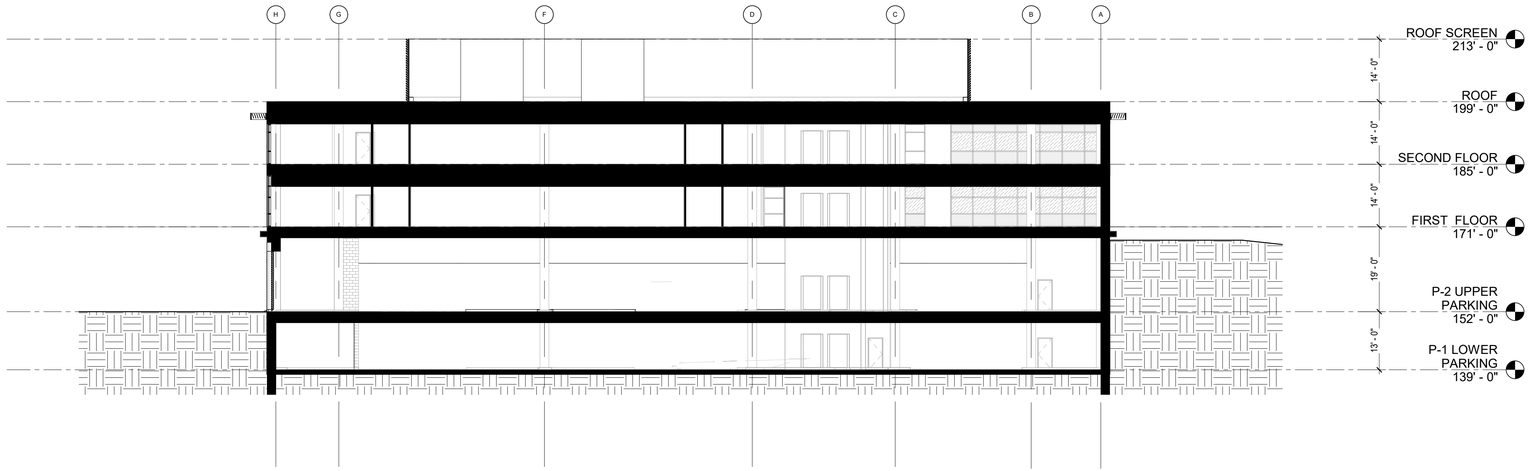
Drawing Title:
Elevations

Sheet Number:
A.201

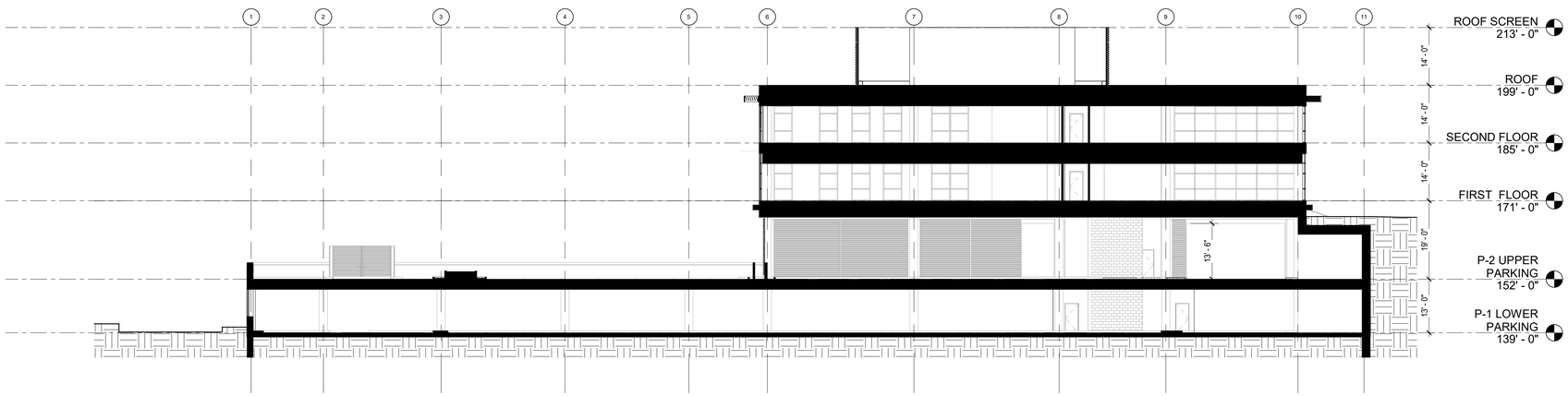
MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM



3 SECTION KEY PLAN
SCALE: 1" = 40'-0"



2 BUILDING SECTION 2
SCALE: 1/16" = 1'-0"



1 BUILDING SECTION 1
SCALE: 1/16" = 1'-0"

0' 10' 30' 50' 100'

Notes:

Key Plan:

Architect's Stamp:

REGISTERED ARCHITECT
MARK PELLETIER
No. 20053
BOSTON, MASSACHUSETTS
COMMONWEALTH OF MASSACHUSETTS

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: As indicated

Issue:	**Date:**
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	**Date:**

Drawing Title:
Building Sections

Sheet Number:

A.301

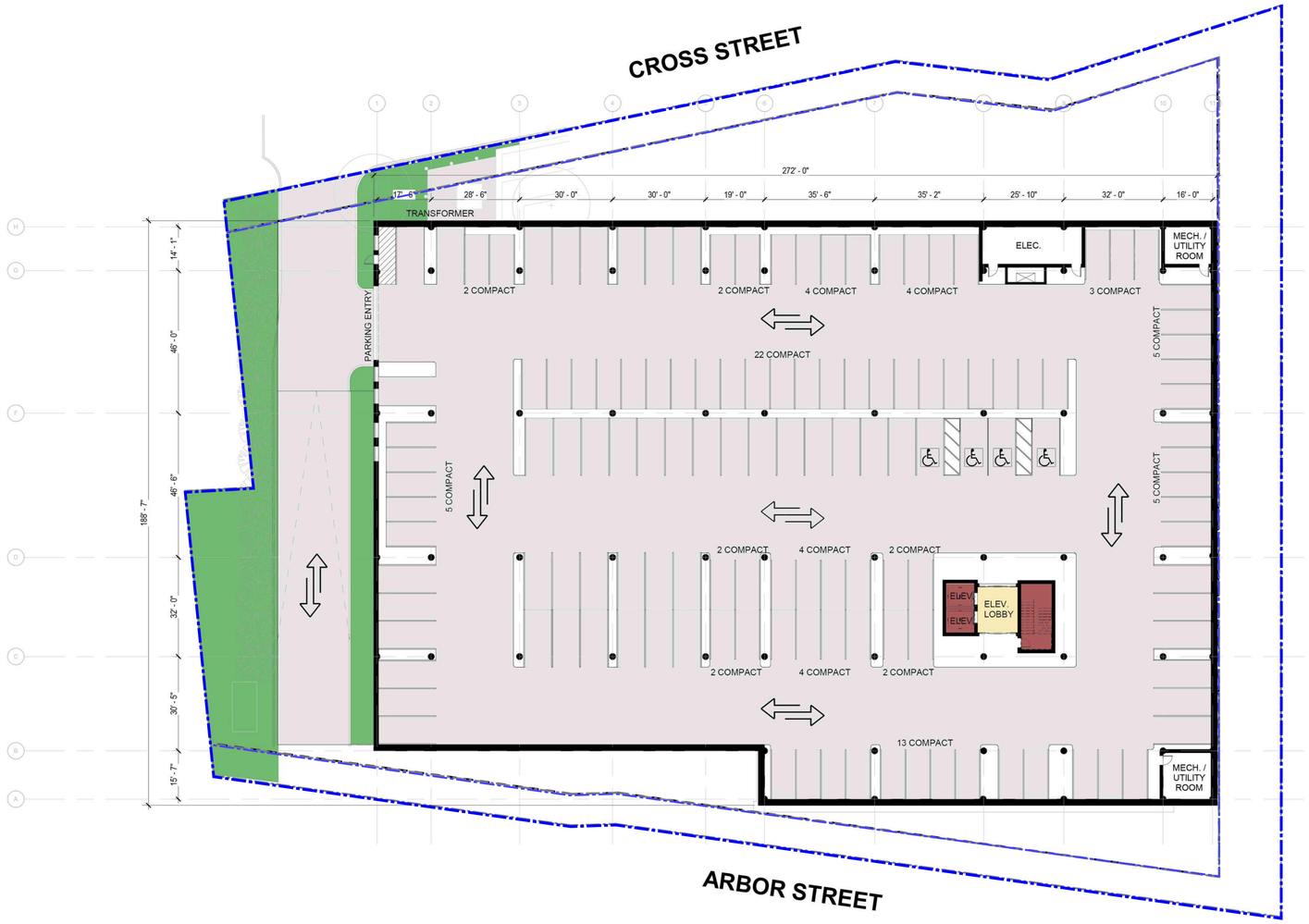
MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM

Date Plotted: 8/4/2023 8:45:46 AM
C:\Users\mpelletier\Documents\22090_Highland Medical Office Building_mpelletier.rvt

Medical Office Building

50,000 SF

250 Parking Spaces



BOSTON DEVELOPMENT GROUP

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

Medical Office Building
50,000 SF
250 Parking Spaces

PARKING:
STANDARD = 75
COMPACT = 43

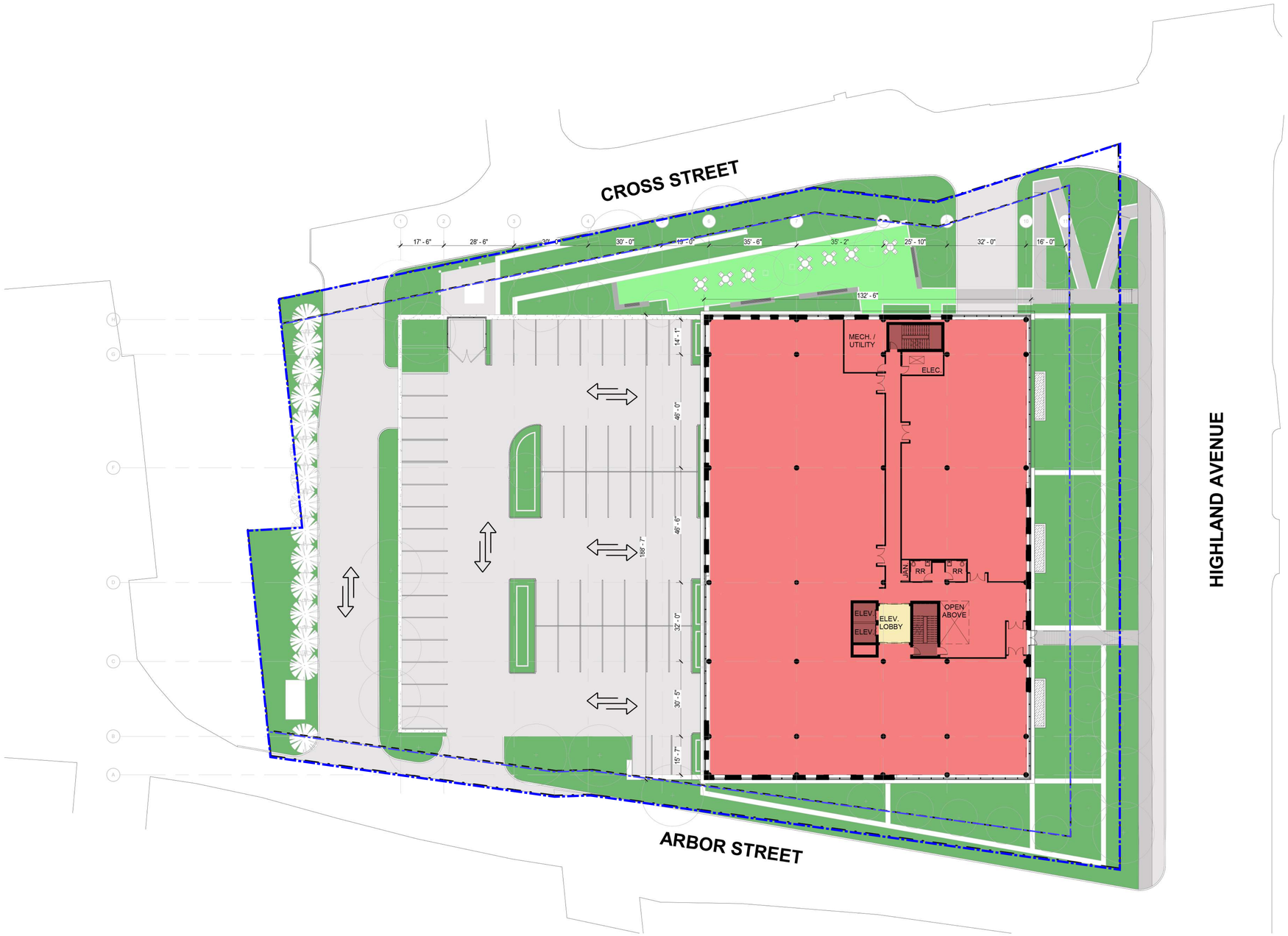
TOTAL = 118

Highland Ave MOB / P-2 Upper Parking / 14 July 2023

Medical Office Building

50,000 SF

250 Parking Spaces



Highland Ave MOB / First Floor Plan / 14 July 2023

BOSTON DEVELOPMENT GROUP

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

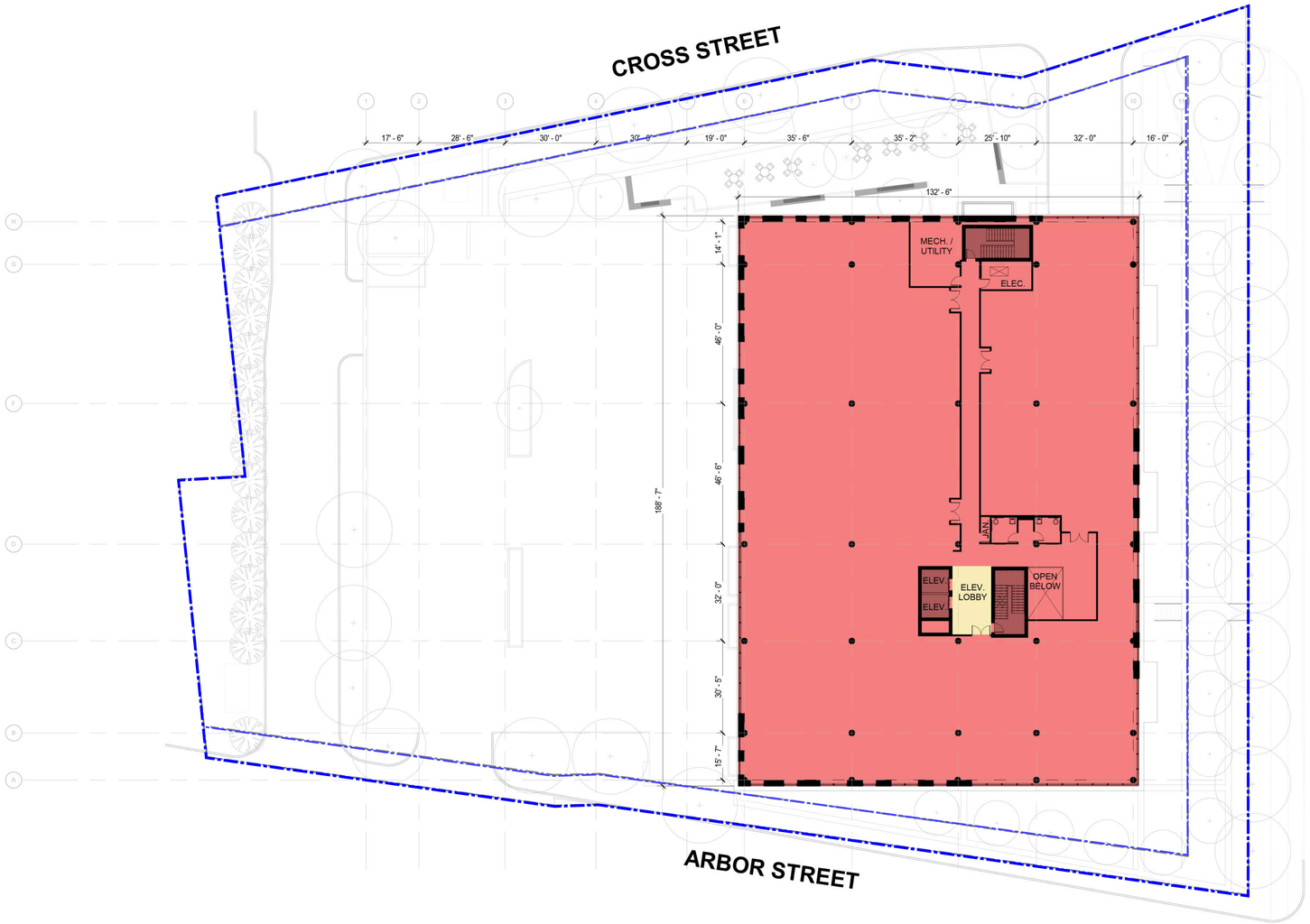
REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

Medical Office Building

50,000 SF

250 Parking Spaces

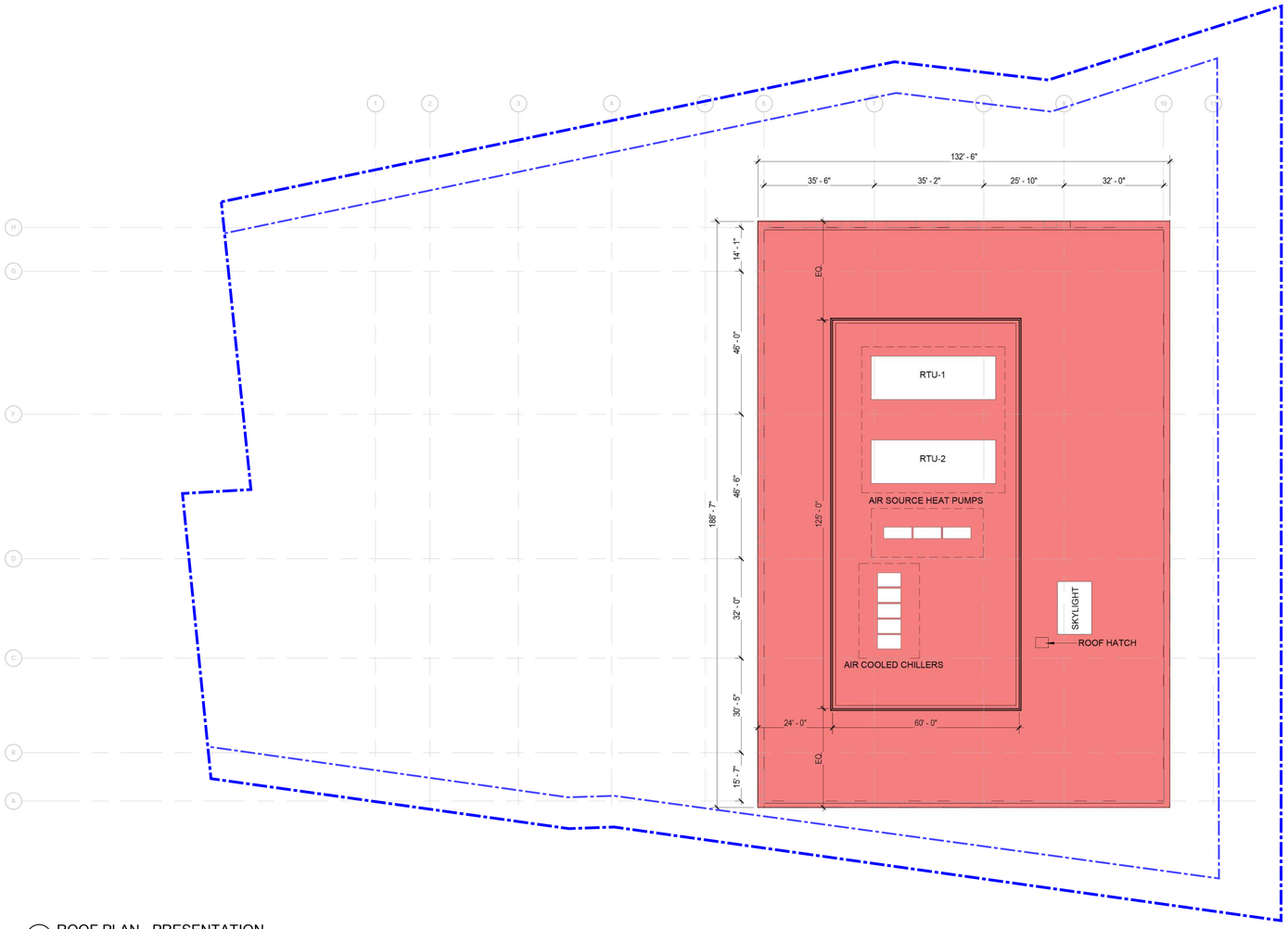


Highland Ave MOB / Second Floor Plan / 14 July 2023

Medical Office Building

50,000 SF

250 Parking Spaces

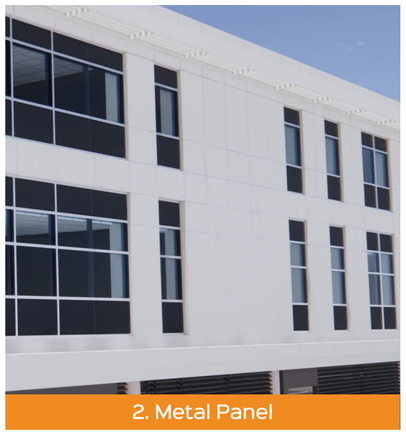


1 ROOF PLAN - PRESENTATION
SCALE: 3/64" = 1'-0"

1. Roof Screening

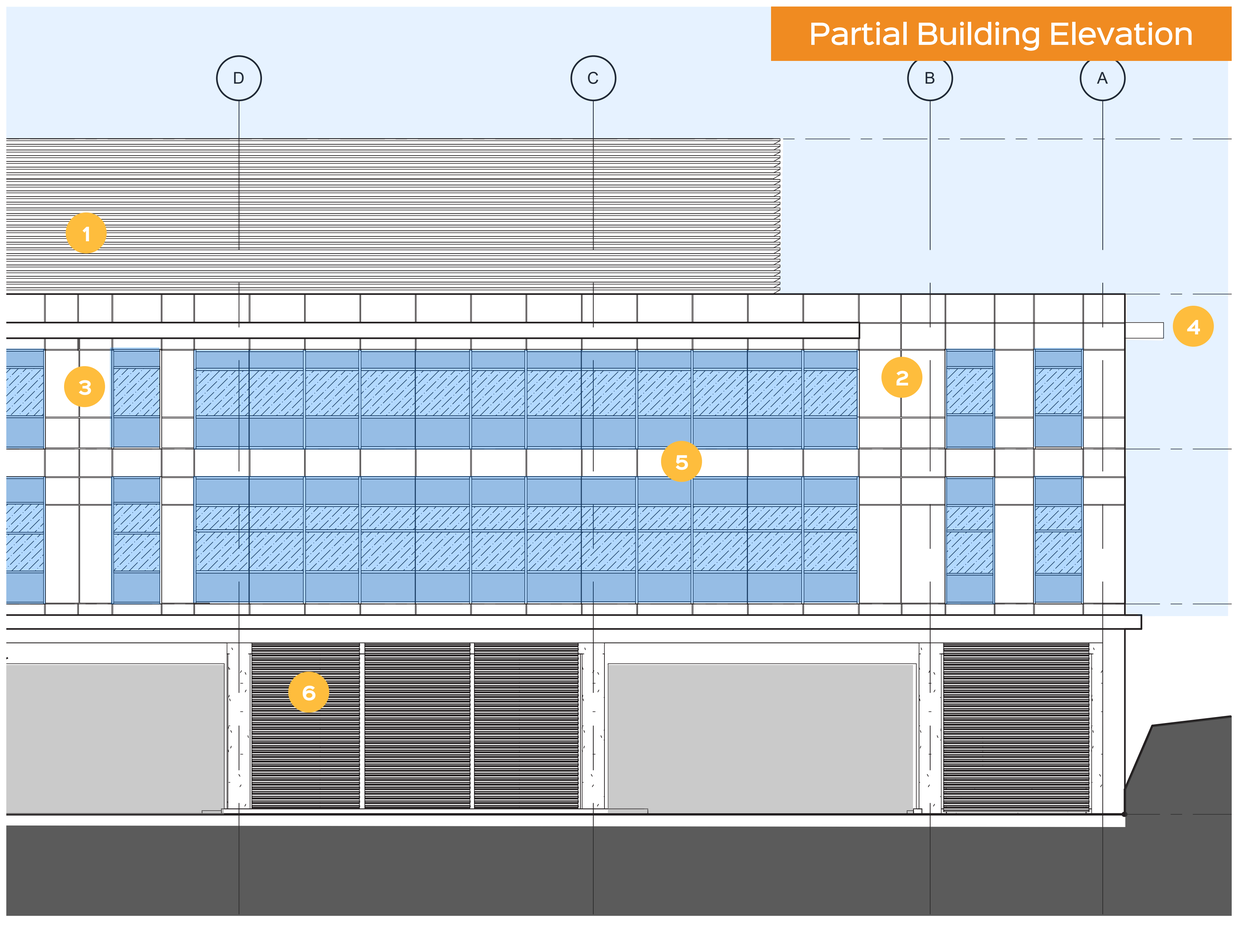
4. Sunscreen

5. Curtainwall



2. Metal Panel

3. Windows



6. Architectural Screening

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Materials of Major Architectural Elements / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View at Highland Ave & Cross Street

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Concept Renderings / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View at P-2 Parking Level (South)

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Concept Renderings / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View at P-2 Parking Level (West)

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Concept Renderings / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View along Highland Ave (North)

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Concept Renderings / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View at Cross Street Below Grade Garage Entrance

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Concept Renderings / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON, MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View at Arbor Street Above Grade Parking Entrance

BOSTON DEVELOPMENT GROUP

Highland Ave MOB / Concept Renderings / 14 July 2023

Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / M A U G E L . C O M

REGISTERED ARCHITECT MARK PELLETIER No. 20053 BOSTON MASSACHUSETTS COMMONWEALTH OF MASSACHUSETTS

MAUGEL DESTEFANO ARCHITECTS

View at Landscape Plaza

Transportation Impact Assessment

Proposed Medical Office Building
629-661 Highland Avenue
Needham, Massachusetts

Prepared for:

BOSTON DEVELOPMENT GROUP

Newton Center, Massachusetts

July 2023

Prepared by:

Vanasse & Associates inc
Transportation Engineers & Planners

35 New England Business Center Drive
Suite 140
Andover, MA 01810

Vanasse & Associates inc
Transportation Engineers & Planners

35 New England Business Center Drive
Suite 140
Andover, MA 01810

Dear Reviewer:

This letter shall certify that this *Transportation Impact Assessment* has been prepared under my direct supervision and responsible charge. I am a Registered Professional Engineer (P.E.) in the Commonwealth of Massachusetts (Massachusetts P.E. No. 38871, Civil) and hold Certification as a Professional Traffic Operations Engineer (PTOE) from the Transportation Professional Certification Board, Inc. (TPCB), an independent affiliate of the Institute of Transportation Engineers (ITE) (PTOE Certificate No. 993). I am also a Fellow of the Institute of Transportation Engineers (FITE).

Sincerely,

VANASSE & ASSOCIATES, INC.

Jeffrey S. Dirk

Jeffrey S. Dirk, P.E., PTOE, FITE
Managing Partner

CONTENTS

CONTENTS (Continued)

FIGURES

TABLES

EXECUTIVE SUMMARY

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) in order to determine the potential impacts on the transportation infrastructure associated with the proposed redevelopment of 629-661 Highland Avenue in Needham, Massachusetts, to accommodate an medical office building (hereafter referred to as the "Project"). This assessment was prepared in consultation with the Town of Needham and the Massachusetts Department of Transportation (MassDOT), and was performed in accordance with MassDOT's *Transportation Impact Assessment (TIA) Guidelines* and the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports.

Based on this assessment, we have concluded the following with respect to the Project:

1. Using trip-generation statistics published by the Institute of Transportation Engineers (ITE),[1] the Project is expected to generate approximately 1,800 vehicle trips on an average weekday (two-way volume over the operational day of the Project), with 129 vehicle trips expected during the weekday morning peak-hour and 200 vehicle trips expected during the weekday evening peak-hour;

2. In comparison to the existing uses that currently occupy the Project site, the Project is expected to generate approximately 1,166 additional vehicle trips on an average weekday, with 101 additional vehicle trips expected during the weekday morning peak-hour and 168 additional vehicle trips expected during the weekday evening peak-hour;

3. The Project will not result in a significant impact (increase) on motorist delays or vehicle queuing over Existing or anticipated future conditions without the Project (No-Build conditions); however, it was noted that one or more movements at the study intersections are currently operating at or over capacity (defined as a level-of-service (LOS) "E" or "F", respectively) independent of the Project. Project-related impacts were generally defined as an increase in average motorist delay that resulted in a corresponding increase in vehicle queuing of up to four (4) vehicles;

4. No apparent safety deficiencies were noted with respect to the motor vehicle crash history at the study area intersections; and

[1] *Trip Generation*, 11th Edition; Institute of Transportation Engineers; Washington, DC; 2021.

5. Lines of sight to and from the Project site driveway intersections were found to meet or exceed or could be made to meet or exceed the recommended minimum distances for safe operation based on the appropriate approach speed.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with implementation of the recommendations that follow.

RECOMMENDATIONS

A detailed transportation improvement program has been developed that is designed to provide safe and efficient access to the Project site and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The following improvements have been recommended as a part of this evaluation and, where applicable, will be completed in conjunction with the Project subject to receipt of all necessary rights, permits, and approvals.

Project Access

Access to the Project site will be provided by way of four (4) driveways configured as follows: the existing driveway that intersects the west side of Cross Street approximately 280 feet north of Highland Avenue and opposite Putnam Street; a new driveway that will intersect the west side of Cross Street approximately 80 feet north of Highland Avenue; and two (2) new driveways that will intersect the east side of Arbor Street approximately 290 feet and 370 feet north of Highland Avenue. The following recommendations are offered with respect to the design and operation of the Project site access and internal circulation, many of which are reflected on the site plans.

- The Project site driveways and internal circulating aisles should be a minimum of 24 feet in width and designed to accommodate the turning and maneuvering requirements of the largest anticipated responding emergency vehicle as defined by the Needham Fire Department.

- Where perpendicular parking is proposed, the drive aisle behind the parking should be a minimum of 23 feet in order to facilitate parking maneuvers.

- Vehicles exiting the Project site should be placed under STOP-sign control with a marked STOP-line provided.

- All signs and pavement markings to be installed within the Project site should conform to the applicable standards of the *Manual on Uniform Traffic Control Devices* (MUTCD).[2]

- A sidewalk has been provided that links the proposed building to the sidewalk infrastructure along Highland Avenue and includes Americans with Disabilities Act (ADA)-compliant wheelchair ramps.

- Signs and landscaping to be installed as a part of the Project within the intersection sight triangle areas should be designed and maintained so as not to restrict lines of sight.

[2]*Manual on Uniform Traffic Control Devices (MUTCD)*; Federal Highway Administration; Washington, D.C.; 2009.

- Existing vegetation located along the Project site frontage on Arbor Street should selectively trimmed or removed so that no portion of the vegetation is located within the sight triangle areas of the Project site driveways.

- Snow accumulations (windrows) within the sight triangle areas should be promptly removed where such accumulations would impede sight lines.

Off Site

Highland Avenue at Webster Street

Independent of the Project, overall operating conditions at the intersection of Highland Avenue at Webster Street were predicted to be at capacity (i.e., LOS "E") during the weekday morning peak-hour under 2030 No-Build conditions. In order to improve operating conditions at the intersection and to off-set the predicted impact of the Project, the Project proponent will design and implement an optimal traffic signal timing and phasing plan. With the implementation of the recommended traffic signal timing improvements, motorist delays and vehicle queuing will be reduced such that intersection operations will be improved (over No-Build conditions) to an overall LOS D during the weekday morning peak-hour and the intersection will continue to operate at an overall LOS C during the weekday evening peak-hour. These improvements will be designed and constructed by the Project proponent prior to the issuance of a Certificate of Occupancy for the Project subject to receipt of all necessary rights, permits and approvals.

Highland Avenue at Gould Street and Hunting Road

Independent of the Project, overall operating conditions at the intersection of Highland Avenue at Gould Street and Hunting Road were predicted to be at capacity during the weekday morning peak-hour under 2030 No-Build conditions. In order to improve operating conditions at the intersection and to off-set the predicted impact of the Project, the Project proponent will design and implement an optimal traffic signal timing and phasing plan. With the implementation of the recommended traffic signal timing improvements, overall motorist delays and vehicle queuing will be reduced to the extent that there will be a general improvement over No-Build conditions. These improvements will be designed and constructed by the Project proponent prior to the issuance of a Certificate of Occupancy for the Project subject to receipt of all necessary rights, permits and approvals.

Transportation Demand Management

Regularly scheduled public transportation services are not currently provided in the immediate vicinity of the Project site. To the west of the Project site, the MBTA provides commuter rail service to South Station in Boston on the Needham Line by way of Needham Heights Station, which is located at 95 Avery Square in Needham (an approximate 3 minute driving distance of the Project site). In an effort to encourage the use of alternative modes of transportation to single-occupant vehicles, the following Transportation Demand Management (TDM) measures will be implemented as a part of the Project:

- The Project proponent will become a member of the Route 128 Business Council Transportation Management Association (TMA) who will manage and coordinate the TDM program for the Project;

- A transportation coordinator will be assigned for the Project to coordinate the TDM program and to serve as the point of contact for the TMA;

- The TMA will facilitate a rideshare matching program for employees to encourage carpooling;

- A "guaranteed-ride-home" program will be offered through the TMA to employees that use public transportation, carpool, vanpool, walk or bicycle to the Project site, and that register with the transportation coordinator and the TMA;

- A "welcome packet" will be provided to employees detailing available commuter options and will include the contact information for the transportation coordinator and information to enroll in the employee rideshare program;

- Specific amenities will be provided to discourage off-site trips which may include providing a breakroom equipped with a microwave and refrigerator; offering direct deposit of paychecks; and other such measures to reduce overall traffic volumes and travel during peak-traffic-volume periods;

- Pedestrian accommodations have been incorporated within the Project site; and

- Secure bicycle parking will be provided at an appropriate location within the Project site.

With implementation of the aforementioned recommendations, safe and efficient access will be provided to the Project site and the Project can be accommodated within the confines of the existing transportation system.

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) in order to determine the potential impacts on the transportation infrastructure associated with the proposed redevelopment of 629-661 Highland Avenue in Needham, Massachusetts, to accommodate an medical office building (hereafter referred to as the "Project"). This study evaluates the following specific areas as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; and identifies and analyzes existing traffic conditions and future traffic conditions, both with and without the Project, along Highland Avenue, Arbor Street and Cross Street, and at major intersections located along these roadways through which Project-related traffic will travel.

PROJECT DESCRIPTION

The Project will entail the redevelopment of the existing commercial properties located at 629-661 Highland Avenue in Needham, Massachusetts, to accommodate a 50,000± square foot (sf) medical office building. The Project site encompasses approximately 2.1± acres of land that is bounded by a commercial property to the north; Highland Avenue to the south; Cross Street to the east; and Arbor Street to the west. The Project site currently contains four (4) commercial buildings that will be removed to accommodate the Project. Figure 1 depicts the Project site location in relation to the existing roadway network.

Access to the Project site will be provided by way of four (4) driveways configured as follows: the existing driveway that intersects the west side of Cross Street approximately 280 feet north of Highland Avenue and opposite Putnam Street; a new driveway that will intersect the west side of Cross Street approximately 80 feet north of Highland Avenue; and two (2) new driveways that will intersect the east side of Arbor Street approximately 290 feet and 370 feet north of Highland Avenue.

On-site parking will be provided for 250 vehicles, or a parking ratio of 1.0 parking spaces per 200 sf, which meets the minimum parking requirements of Section 5.1 *Off-Street Parking Requirements*, of the Town of Needham Zoning Bylaw.[3]

[3]The ordinance requires a minimum of 1 space per 200 sf of gross floor area for medical, dental and related health service structures or clinics.

Figure 1

Site Location Map

Vanasse & Associates inc

STUDY METHODOLOGY

This study was prepared in consultation with the Town of Needham, the City of Newton and MassDOT; was performed in accordance with MassDOT's *Transportation Impact Assessment (TIA) Guidelines* and the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports; and was conducted in three distinct stages.

The first stage involved an assessment of existing conditions in the study area and included an inventory of roadway geometrics; pedestrian and bicycle facilities; on-street parking; public transportation services; observations of traffic flow; and collection of pedestrian, bicycle and vehicle counts.

In the second stage of the study, future traffic conditions were projected and analyzed. Specific travel demand forecasts for the Project were assessed along with future traffic demands due to expected traffic growth independent of the Project. A seven-year time horizon was selected for analyses consistent with MassDOT's *Transportation Impact Assessment (TIA) Guidelines*. The traffic analysis conducted in stage two identifies existing or projected future roadway capacity, traffic safety, and site access issues.

The third stage of the study presents and evaluates measures to address traffic and safety issues, if any, identified in stage two of the study.

EXISTING CONDITIONS

A comprehensive field inventory of existing conditions within the study area was conducted in September 2019 and updated in March 2023. The field investigation consisted of an inventory of existing roadway geometrics; pedestrian and bicycle facilities; public transportation services; traffic volumes; and operating characteristics; as well as posted speed limits and land use information within the study area. The study area that was assessed for the Project consisted of Highland Avenue, Arbor Street and Cross Street, and the following specific intersections: Highland Avenue at Webster Street; Highland Avenue at Arbor Street; Highland Avenue at Cross Street and Mills Road; Highland Avenue at Gould Street and Hunting Road; and Cross Street at Putnam Street and the Project site driveway.

The following describes the study area roadways and intersections.

ROADWAYS

Highland Avenue

- Four-lane, urban principal arterial roadway that is under MassDOT jurisdiction east of Webster Street and under town jurisdiction west of Webster Street.
- Traverses the study area in a general east-west direction.
- Provides four 11- to 12-foot-wide travel lanes that are separated by a double-yellow centerline or raised median with 2-foot wide marked shoulders and 5-foot wide bicycle lanes provided along both sides of the roadway and additional turning lanes provided at major intersections.
- A posted speed limit is not provided and, as such, the statutory or "prima facie" speed limit pursuant to M.G.L. c 90 § 17 is 30 miles per hour (mph).[4]
- Sidewalks are provided along both sides of the roadway.
- Illumination is provided by way of street-lights mounted on wood poles.

[4]The statutory or "prima facie" speed is defined in M.G.L. Chapter 90, Section 17, as the speed which would be deemed reasonable and proper to operate a motor vehicle.

- Land use within the study area consists of the Project site and residential and commercial properties.

Arbor Street

- Two-lane private roadway that traverses the study area in a general north-south alignment for a distance of approximately 400-feet north of Highland Avenue.
- Provides an approximate 24 to 26 foot-wide traveled way with no pavement markings and parking provided along the east side of the roadway.
- A posted speed limit is not provided and, as such, the statutory speed limit is 30 mph.
- Sidewalks and illumination are not provided along the roadway.
- Land use within the study area consists of the Project site and commercial properties.

Cross Street

- Two-lane private roadway that traverses the study area in a general north-south alignment for a distance of approximately 300-feet north of Highland Avenue.
- Provides an approximate 22 foot-wide traveled way with parking provided along both sides of the roadway.
- A posted speed limit is not provided and, as such, the statutory speed limit is 30 mph.
- Sidewalks and illumination are not provided along the roadway.
- Land use within the study area consists of the Project site, and residential and commercial properties.

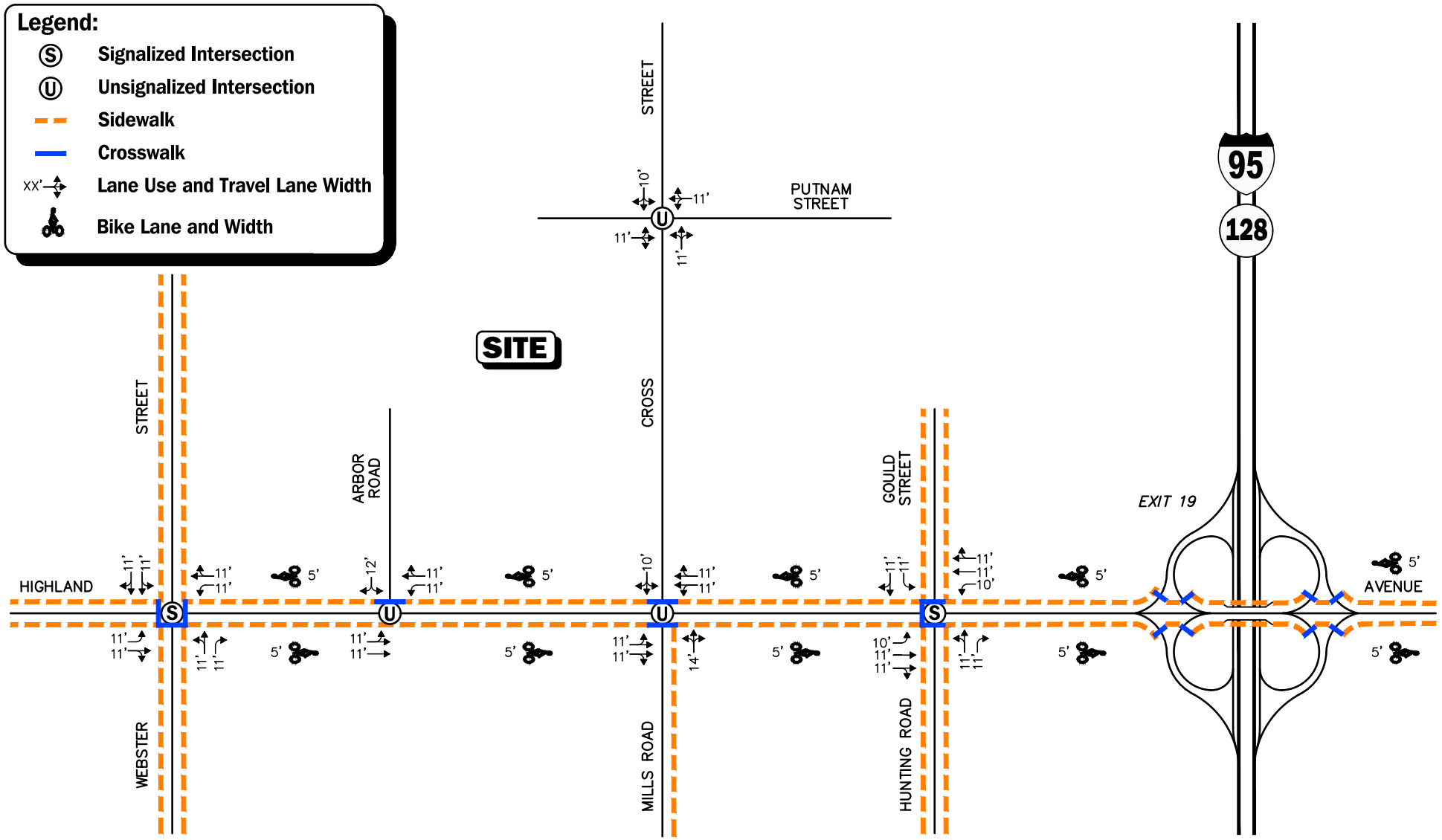
INTERSECTIONS

Table 1 and Figure 2 summarize existing lane use, traffic control, and pedestrian and bicycle accommodations at the study area intersections as observed in March 2023.

Table 1
STUDY AREA INTERSECTION DESCRIPTION

Intersection	Traffic Control Type[a]	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
Highland Ave./ Webster St.	TS	1 left-turn lane and 1 through/right-turn lane on Highland Ave.; 1 left-turn/through lane and 1 right-turn lane on Webster St. northbound; 2 general purpose lanes on Webster St. southbound	Yes; 1-2 feet on Highland Ave.; 2-3 feet on Webster St.	Yes; both sides of the intersecting roadways; crosswalks provided across both Highland Ave. legs and the Webster St. south leg; pedestrian traffic signal equipment and phasing (exclusive) are provided as a part of traffic signal system	Yes; 5-foot bicycle lanes along Highland Ave. east of the intersection; shared traveled-way[b] along Webster St.; bicycle detection provided as a part of the traffic signal system
Highland Ave./ Arbor Rd.	S	2 general purpose travel lanes on Highland Ave.; 1 general purpose lane on Arbor Rd.	Yes; 2-feet on Highland Ave.	Yes; Sidewalks along both sides of Highland Ave.; crosswalk provided across Arbor Rd.	Yes; 5-foot wide bicycle lanes on Highland Ave.
Highland Ave./ Cross St./ Mills Rd.	S	2 general purpose travel lanes on Highland Ave.; 1 general purpose travel lane on Cross St. and Mills Rd.	Yes; 2 feet on Highland Ave.	Yes; Sidewalks along both sides of Highland Ave. and along the east side of Mills Rd.; crosswalks provided for crossing Cross St. and Mills Rd.	Yes; 5-foot wide bicycle lanes on Highland Ave.; shared traveled-way on Mills Rd.
Highland Ave./ Gould St./ Hunting Rd.	TS	1 left-turn lane, 1 through lane and 1 through/right-turn lane on Highland Ave.; 1 left-turn lane and 1 general purpose lane on Gould St.; 1 left-turn/through lane and 1 right-turn lane on Hunting Rd.	Yes; 2 feet on Highland Ave. and 1-foot on Gould St. and Hunting Rd.	Yes; both sides of the intersecting roadways; crosswalks provided across the Highland Ave. west leg, Gould St. leg and Hunting Rd. leg; pedestrian traffic signal equipment and phasing (exclusive) provided as a part of traffic signal system	Yes; 5-foot wide bicycle lanes on Highland Ave.; bicycle detection provided as a part of the traffic signal system
Cross St./ Putnam St./ Project Site Driveway	S	1 general purpose travel lane on all approaches	No	No	No

[a]TS = traffic signal control; S = STOP control.
[b]Combined shoulder and travel lane width equal to or exceed 14 feet.



Not To Scale

Figure 2

Existing Intersection Lane Use, Travel Lane Width, and Pedestrian Facilities

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig 2, 5/28/2023 12:02:25 PM

TRAFFIC VOLUMES

In order to determine existing traffic-volume demands and flow patterns within the study area, automatic traffic recorder (ATR) counts, turning movement counts (TMCs) and vehicle classification counts were completed in September 2019, prior to the COVID-19 pandemic and while public schools were in regular session. The ATR counts were conducted on Highland Avenue in the vicinity of the Project site on September 4th through 5th, 2019 (Wednesday through Thursday, inclusive) in order to record weekday traffic conditions over an extended period, with weekday morning (7:00 to 9:00 AM) and evening (4:00 to 6:00 PM) peak-period manual TMCs performed at the study intersections on September 4, 2019 (Wednesday). These time periods were selected for analysis purposes as they are representative of the peak-traffic-volume hours for both the Project and the adjacent roadway network.

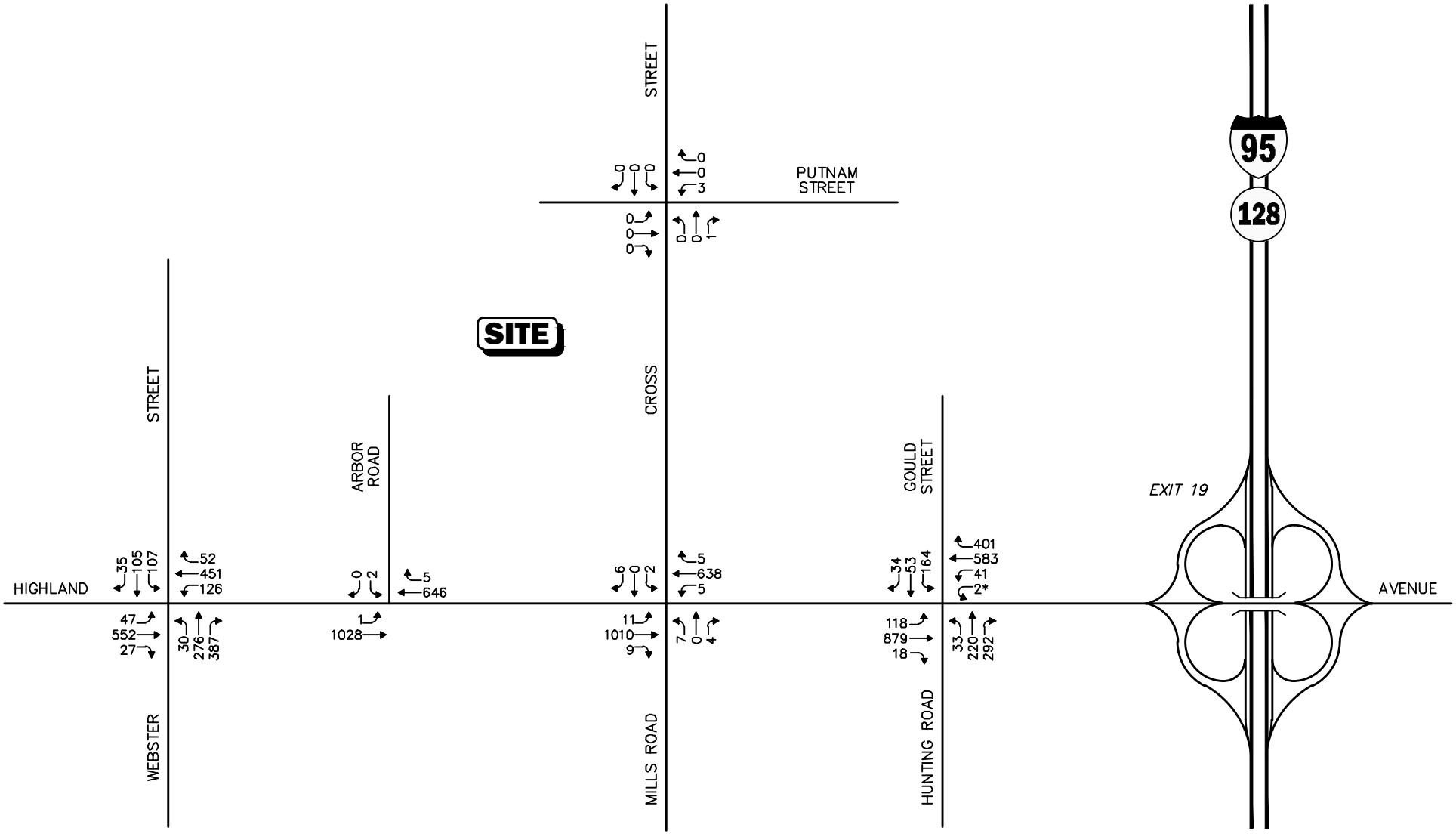
Traffic-Volume Adjustments

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, MassDOT weekday seasonal factors for Urban Group 3 roadways (principal arterials, the functional classification of Highland Avenue) were reviewed.[5] Based on a review of this data, it was determined that traffic volumes for the month of January are approximately 8.0 percent above average-month conditions. As such, no adjustment was applied to the September traffic volumes as they are representative of traffic volume conditions that are higher than those under average-month conditions.

In order to ascertain the change in traffic volumes and travel patterns that have occurred since 2019, a supplemental ATR was conducted on Highland Avenue in the vicinity of the Project site on March 28th through 29th, 2023 (Tuesday through Wednesday, inclusive). Based on a comparison of the 2023 and 2019 traffic volumes, the 2023 volumes were found to be significantly lower than those observed in 2019. As such, the higher 2019 traffic volumes were used as basis of this assessment and were adjusted to 2023 conditions by applying a general background traffic growth rate of 1.0 percent (discussed in further detail in the *General Background Traffic Growth* section of this report).

The 2023 Existing traffic volumes are summarized in Table 2, with the weekday morning and evening peak-hour traffic volumes graphically depicted on Figures 3 and 4, respectively. Note that the peak-hour traffic volumes that are presented in Table 2 were obtained from the aforementioned figures.

[5]MassDOT Statewide Traffic Data Collection; 2019 Weekday Seasonal Factors, Group U4-7.



*Illegal maneuver

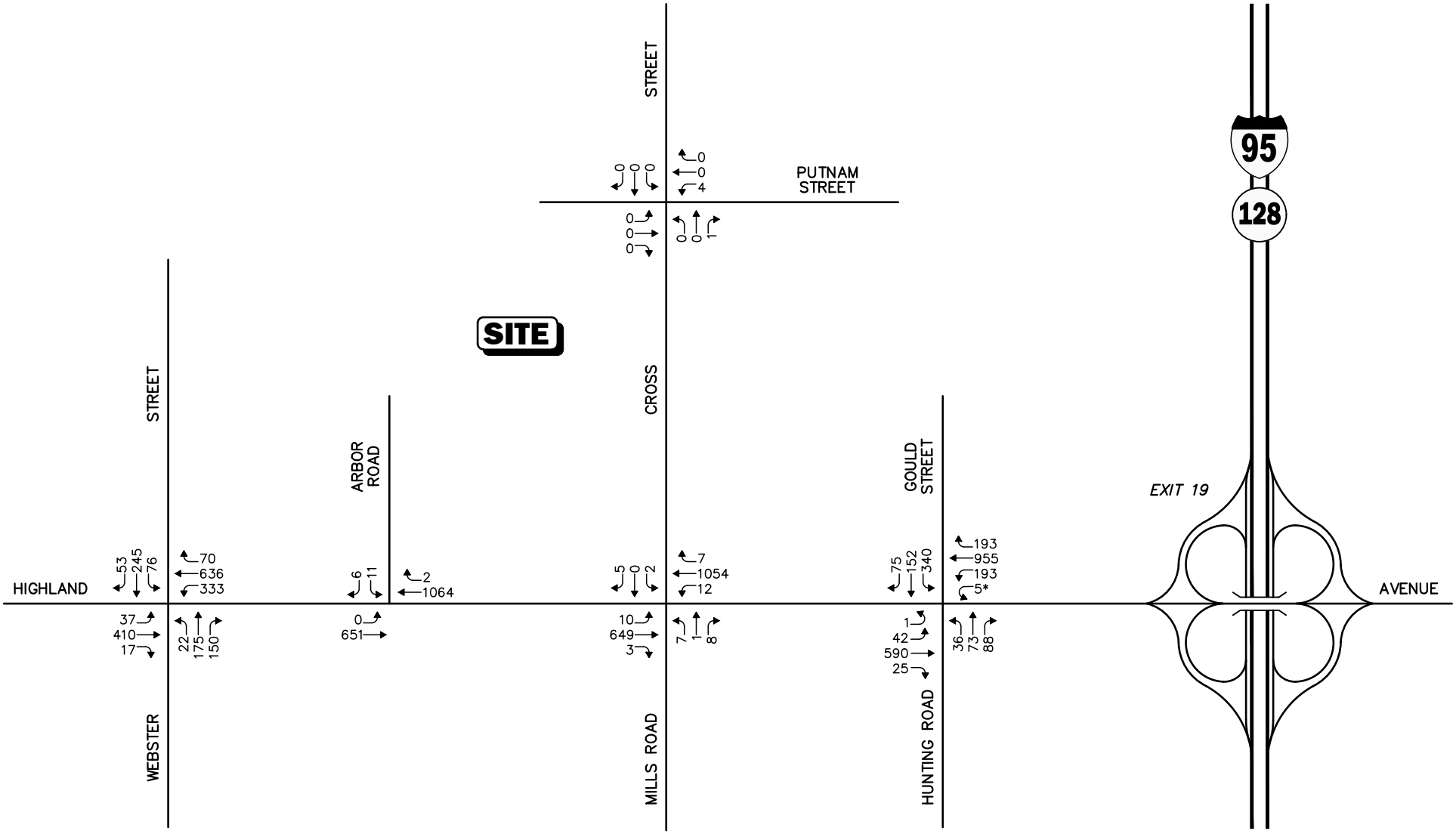
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 3

2023 Existing
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc



*Illegal maneuver

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 4

2023 Existing
Weekday Evening
Peak Hour Traffic Volumes

Vanasse & Associates inc

Table 2
2023 EXISTING TRAFFIC VOLUMES

Location/Peak-Hour	AWT[a]	VPH[b]	K Factor[c]	Directional Distribution[d]
Highland Avenue, west of Cross Street	20,035	--	--	--
Weekday Morning (7:15 – 8:15 AM)	--	1,681	8.4	61.3% EB
Weekday Evening (4:15 – 5:15 PM)	--	1,728	8.6	61.9% WB

[a]Average weekday traffic in vehicles per day.
[b]Vehicles per hour.
[c]Percent of daily traffic occurring during the peak-hour.
[d]Percent traveling in peak direction.
EB = eastbound; WB = westbound.

As can be seen in Table 2, Highland Avenue in the vicinity of the Project site was found to accommodate approximately 20,035 vehicles on an average weekday (two-way, 24-hour volume), with approximately 1,681 vehicles per hour (vph) during the weekday morning peak-hour and 1,728 vph during the weekday evening peak-hour.

PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in March 2023. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study roadways and at the study area intersections. As detailed on Figure 2, sidewalks are provided along both sides of Highland Avenue, Webster Street, Gould Street and Hunting Street, and along the east side of Mills Road. With the exception of the Cross Street/Putnam Street/Project site driveway intersection, marked crosswalks are provided for crossing one or more of the approaches to the study area intersections, with pedestrian traffic signal equipment and phasing provided at the signalized study area intersections.

Bicycle lanes are provided along Highland Avenue, with the remaining study area roadways generally providing sufficient width (combined travel lane and paved shoulder) to support bicycle travel in a shared traveled-way configuration.[6]

PUBLIC TRANSPORTATION

Regularly scheduled public transportation services are not currently provided in the immediate vicinity of the Project site. To the west of the Project site, the Massachusetts Bay Transportation Authority (MBTA) provides commuter rail service to South Station in Boston on the Needham Line by way of Needham Heights Station, which is located at 95 Avery Square in Needham (an approximate 3 minute driving distance of the Project site).

In addition, the MBTA provides The RIDE paratransit services to eligible persons who cannot use fixed-route transit (bus, subway, trolley) due to a physical, cognitive or mental disability in

[6]A minimum combined travel lane and paved shoulder width of 14-feet is required to support bicycle travel in a shared traveled-way condition.

compliance with Americans with Disabilities Act (ADA) requirements. The public transportation schedules and fare information are provided in the Appendix.

SPOT SPEED MEASUREMENTS

Vehicle travel speed measurements were performed on Highland Avenue in the vicinity of the Project site in conjunction with the ATR counts. Table 3 summarizes the vehicle travel speed measurements.

Table 3
VEHICLE TRAVEL SPEED MEASUREMENTS

	Highland Avenue	
	Eastbound	Westbound
Mean Travel Speed (mph)	29	24
85th Percentile Speed (mph)	32	31
Statutory Speed Limit (mph)	30	30

mph = miles per hour.

As can be seen in Table 3, the mean vehicle travel speed along Highland Avenue in the vicinity of the Project site was found to be 29 mph in the eastbound direction and 24 mph westbound. The measured 85th percentile vehicle travel speed, or the speed at which 85 percent of the observed vehicles traveled at or below, was found to be 32 mph in the eastbound direction and 31 mph westbound, which is generally consistent with the statutory speed limit in the vicinity of the Project site (30 mph). The 85th percentile speed is used as the basis of engineering design and in the evaluation of sight distances and is often used in establishing posted speed limits.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash information for the study area intersections was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2016 through 2020, inclusive) in order to examine motor vehicle crash trends occurring within the study area. The data is summarized by intersection, type, severity, roadway and weather conditions, and day of occurrence, and presented in Table 4.

Table 4
MOTOR VEHICLE CRASH DATA SUMMARY[a]

	Highland Ave./ Webster St.	Highland Ave./ Arbor Rd.	Highland Ave./ Cross St./ Mills Rd.	Highland Ave./ Gould St./ Hunting Rd.	Cross St./ Putnam St./ Project Site Driveway
Traffic Control Type:[b]	TS	S	S	TS	S
Year:					
2016	3	0	1	5	0
2017	0	1	1	3	0
2018	2	0	0	4	0
2019	2	0	1	5	0
2020	3	0	0	2	0
Total	10	1	3	19	0
Average	2.0	0.2	0.6	3.8	0.0
Rate[c]	0.22	0.03	0.08	0.42	0.00
MassDOT Crash Rate:[d]	0.78/0.71	0.57/0.52	0.57/0.52	0.78/0.71	0.57/0.52
Significant?[e]	No	No	No	No	No
Type:					
Angle	3	0	1	6	0
Rear-End	6	1	1	2	0
Head-On	0	0	0	0	0
Sideswipe	0	0	1	9	0
Fixed Object	0	0	0	2	0
Pedestrian/Bicycle	1	0	0	0	0
Unknown/Other	0	0	0	0	0
Total	10	1	3	19	0
Conditions:					
Clear	6	1	1	14	0
Cloudy	1	0	2	1	0
Rain	3	0	0	4	0
Snow/Ice	0	0	0	0	0
Total	10	1	3	19	0
Lighting:					
Daylight	8	1	3	12	0
Dawn/Dusk	1	0	0	1	0
Dark (Road Lit)	1	0	0	6	0
Dark (Road Unlit)	0	0	0	0	0
Total	10	1	3	19	0
Day of Week:					
Monday through Friday	6	1	3	16	0
Saturday	3	0	0	3	0
Sunday	1	0	0	0	0
Total	10	1	3	19	0
Severity:					
Property Damage Only	7	1	3	13	0
Personal Injury	3	0	0	4	0
Fatality	0	0	0	0	0
Unknown	0	0	0	2	0
Total	10	1	3	19	0

[a]Source: MassDOT Safety Management/Traffic Operations Unit records, 2016 through 2020.
[b]Traffic Control Type: TS = traffic signal control; S = stop control.
[c]Crash rate per million vehicles entering the intersection.
[d]Statewide/District crash rate.
[e]The intersection crash rate is significant if it is found to exceed the MassDOT crash rate for the MassDOT Highway Division District in which the Project is located (District 6).

As can be seen in Table 4, the study area intersections experienced an average of 3.8 or fewer reported motor vehicle crashes per year over the five-year review period and were found to have motor vehicle crash rates *below* both the MassDOT statewide and District averages for the MassDOT Highway Division District in which the intersections are located (District 6). The majority of the crashes were reported to have occurred on a weekday; under clear weather conditions; during daylight; and were reported as angle, rear-end or sideswipe type collisions that resulted in property damage only. No (0) motor vehicle crashes were reported to have occurred at the Cross Street/Putnam Street/Project site driveway intersection based on a review of the MassDOT crash data. The detailed MassDOT Crash Rate Worksheets are provided in the Appendix.

A review of the MassDOT statewide High Crash Location List indicated that there are no Highway Safety Improvement Program (HSIP) eligible high crash locations in the vicinity of the Project site. In addition, no fatal motor vehicle crashes were reported to have occurred at the study area intersections over the five-year review period.

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2030, which reflects a seven-year planning horizon consistent with MassDOT's *Transportation Impact Assessment (TIA) Guidelines*. Independent of the Project, traffic volumes on the roadway network in the year 2030 under No-Build conditions include all existing traffic and new traffic resulting from background traffic growth. Anticipated Project-generated traffic volumes superimposed upon the 2030 No-Build traffic volumes reflect 2030 Build traffic-volume conditions with the Project.

FUTURE TRAFFIC GROWTH

Future traffic growth is a function of the expected land development in the immediate area and the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may actually grow at either a higher or a lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This procedure produces a more realistic estimate of growth for local traffic; however, potential population growth and development external to the study area would not be accounted for in the resulting traffic projections.

To provide a conservative analysis framework, both procedures were used, the salient components of which are described below.

Specific Development by Others

The Town of Needham Department of Planning and Community Development and the City of Newton Planning Department was contacted in order to determine if there were any projects planned within the study area that would have an impact on future traffic volumes at the study intersections. Based on this consultation, the following projects were identified for review in conjunction with this assessment:

- ***Highland Science Center, 557 Highland Avenue, Needham, Massachusetts.*** This project entails the construction of a 506,694± sf office/laboratory building to be located at 557 Highland Avenue, east of the Project site.

- ***Boston Children's Hospital Development, First Avenue, Needham, Massachusetts.*** This project entails the construction of a mixed-use development consisting of a 224,000± sf hospital and 228,000± sf of office space to be located off First Avenue, east of the Project site.

Traffic volumes associated with the aforementioned specific development projects by others were estimated using trip generation statistics published by the Institute of Transportation Engineers (ITE)[7] for the appropriate land use(s) or were obtained from the traffic study conducted for the specific development,[8] and were assigned onto the study area roadway network based on existing traffic patterns where no other information was available. No other developments were identified at this time that are expected to result in an increase in traffic within the study area beyond the general background traffic growth rate.

General Background Traffic Growth

Traffic-volume data compiled by MassDOT from permanent count stations located in Needham were reviewed in order to determine general traffic growth trends in the area. This data indicates that traffic volumes have fluctuated over the 10-year period between 2009 and 2019, with an average traffic growth rate of 0.60 percent per year. In order to provide a prudent planning condition for the Project, a slightly higher 1.0 percent per year compounded annual background traffic growth rate was used in order to account for future traffic growth and presently unforeseen development within the study area.

Roadway Improvement Projects

The Town of Needham and MassDOT were contacted in order to determine if there were any planned future roadway improvement projects expected to be complete by 2030 within the study area. Based on these discussions, the following roadway improvement project was identified:

- ***Highland Avenue/Gould Street/Hunting Road Improvements.*** In conjunction with the Highland Science Center office/laboratory development project, the proponent of the development has committed to the following improvements at the Highland Avenue/ Gould Street/Hunting Road intersection:

  - Widening the Gould Street approach to accommodate two left-turn lanes, a through lane and a right-turn lane;
  - Providing bicycle lanes along Gould Street; and
  - Designing and implementing an optimal traffic signal timing and phasing plan.

  These improvements are expected to be complete by 2030, the horizon year of this assessment, and are reflected in both the 2030 No-Build and 2030 Build condition analysis.

No other roadway improvement projects aside from routine maintenance activities were identified to be planned within the study area at this time.

[7] Ibid 1.

[8] *Transportation Impact and Access Study;* Highland Innovation Center, 557 Highland Avenue, Needham, Massachusetts; VHB Inc.; March 2022.

No-Build Traffic Volumes

The 2029 No-Build condition peak-hour traffic volumes were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2023 Existing peak-hour traffic volumes and then adding the traffic volumes associated with the identified specific development project by others. The resulting 2030 No-Build weekday morning and evening peak-hour traffic volumes are shown on Figures 5 and 6, respectively.

PROJECT-GENERATED TRAFFIC

Design year (2030 Build) traffic volumes for the study area roadways were determined by estimating Project-generated traffic volumes and assigning those volumes on the study roadways. The following sections describe the methodology used to develop the anticipated traffic characteristics of the Project.

As proposed, the Project will entail the construction of a 50,000± sf medical office building. In order to develop the traffic characteristics of the Project, trip-generation statistics published by the ITE[9] for a similar land use as that proposed Project were used. ITE Land Use Code 720, *Medical-Dental Office Building*, was used to establish the traffic characteristics of the Project, the results of which are summarized in Table 5.

Table 5
TRIP GENERATION SUMMARY

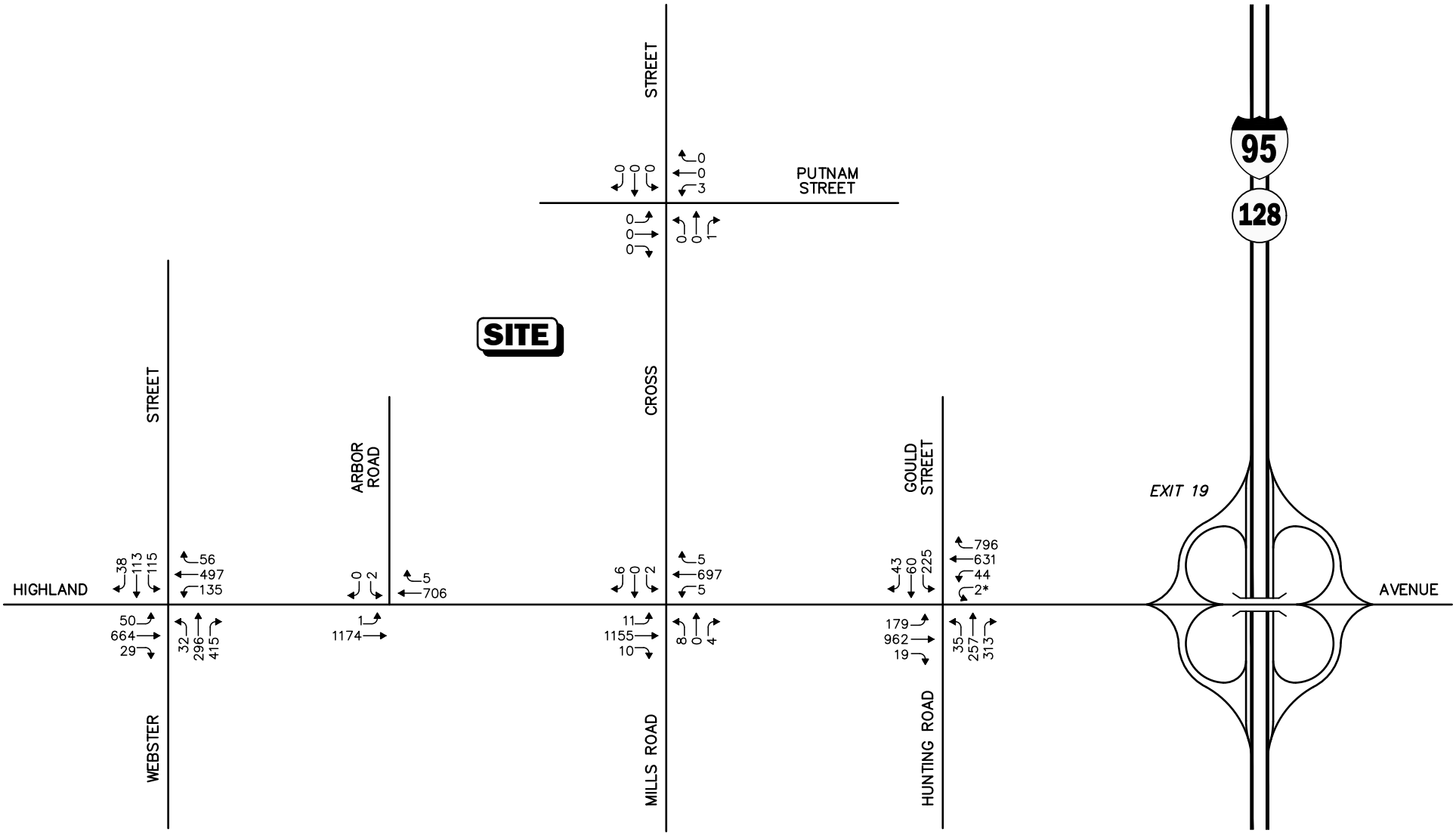
Time Period	Vehicle Trips[a]		
	Entering	Exiting	Total
Average Weekday:	900	900	1,800
Weekday Morning Peak-Hour:	102	27	129
Weekday Evening Peak-Hour:	60	140	200

[a]Based on ITE LUC 720, *Medical-Dental Office Building;* 50,000 sf.

Project-Generated Traffic-Volume Summary

As can be seen in Table 5, the Project is expected to generate approximately 1,800 vehicle trips on an average weekday (two-way volume over the operational day of the Project, or 900 vehicles entering and 900 exiting), with 129 vehicle trips (102 vehicles entering and 27 exiting) expected during the weekday morning peak-hour and 200 vehicle trips (60 vehicles entering and 140 exiting) expected during the weekday evening peak-hour.

[9]Ibid 1.



*Illegal maneuver

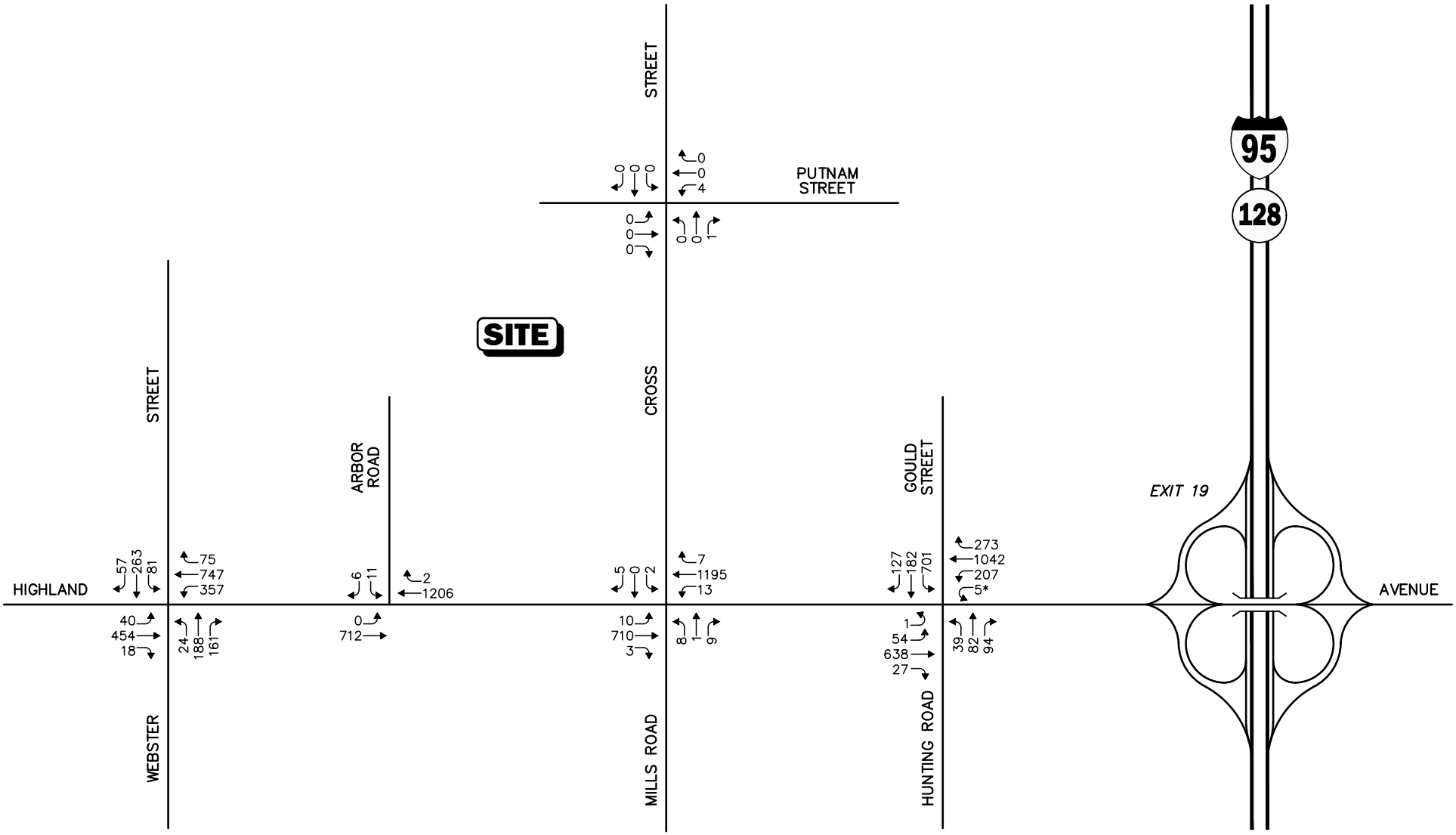
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 5

2030 No-Build
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc



*Illegal maneuver

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 6

2030 No-Build
Weekday Evening
Peak Hour Traffic Volumes

Vanasse & Associates inc

As mentioned previously, the Project site contains four existing commercial buildings containing a mix of general business space, light industrial/warehouse space, medical office space and a yoga studio that will be removed to accommodate the Project. Table 6 compares the traffic volumes of the Project to those of the existing uses that occupy (currently or formerly) the Project site. The detailed trip-generation calculations for the existing uses are provided in the Appendix.

Table 6
TRAFFIC VOLUME COMPARISON

	Vehicle Trips		
Time Period/Direction	(A) Proposed Medical Office Building[a]	(B) Existing Land Uses	(A-B) Difference
Average Weekday Daily:	1,800	634[b]	+1,166
Weekday Morning Peak-Hour:	129	28[c]	+101
Weekday Evening Peak-Hour:	200	32[c]	+168

[a]See Table 5.
[b]Based on ITE LUCs 110, *General Light Industrial;* 150, *Warehouse;* 495, *Recreational Community Center;* 710, *General Office Building;* and 720, *Medical-Dental Office Building*.
[c]As counted on Wednesday, September 4, 2019.

Traffic Volume Comparison

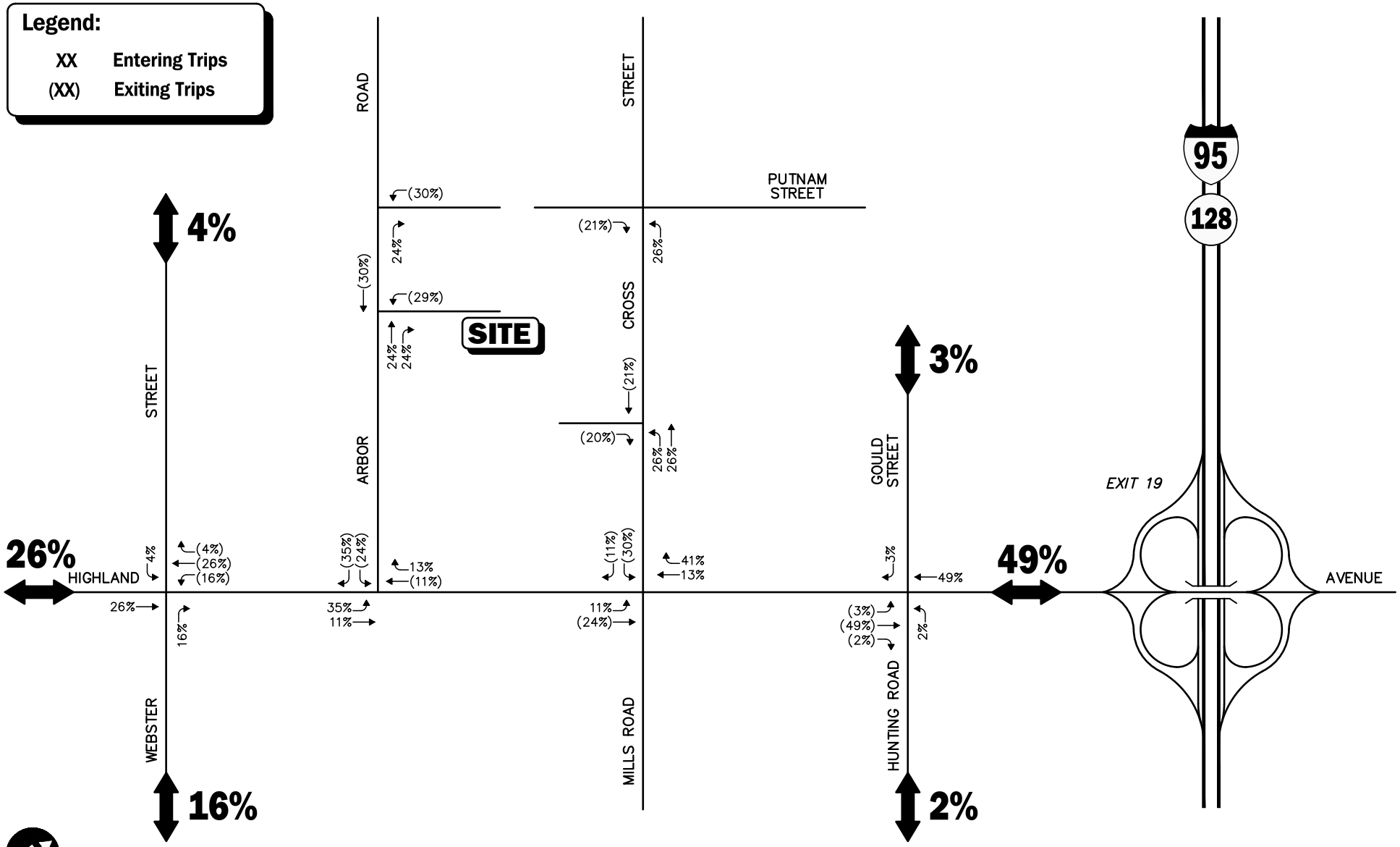
As can be seen in Table 6, in comparison to the existing uses that occupy the Project site, the Project is expected to generate approximately 1,166 additional vehicle trips on an average weekday, with 101 additional vehicle trips expected during the weekday morning peak-hour and 168 additional vehicle trips expected during the weekday evening peak-hour.

TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution of generated trips to and from the Project site was developed based on a review of existing traffic patterns within the study area. The general trip distribution for the Project is graphically depicted on Figure 7. The additional traffic expected to be generated by the Project was assigned on the study area roadway network as shown on Figures 8 and 9.

FUTURE TRAFFIC VOLUMES - BUILD CONDITION

The 2030 Build condition traffic volumes consist of the 2030 No-Build traffic volumes with: i) the removal of the traffic associated with the existing uses that occupy the Project site; and ii) the addition of the traffic expected to be generated by the Project. The 2030 Build weekday morning and evening peak-hour traffic volumes are graphically depicted on Figures 10 and 11, respectively.



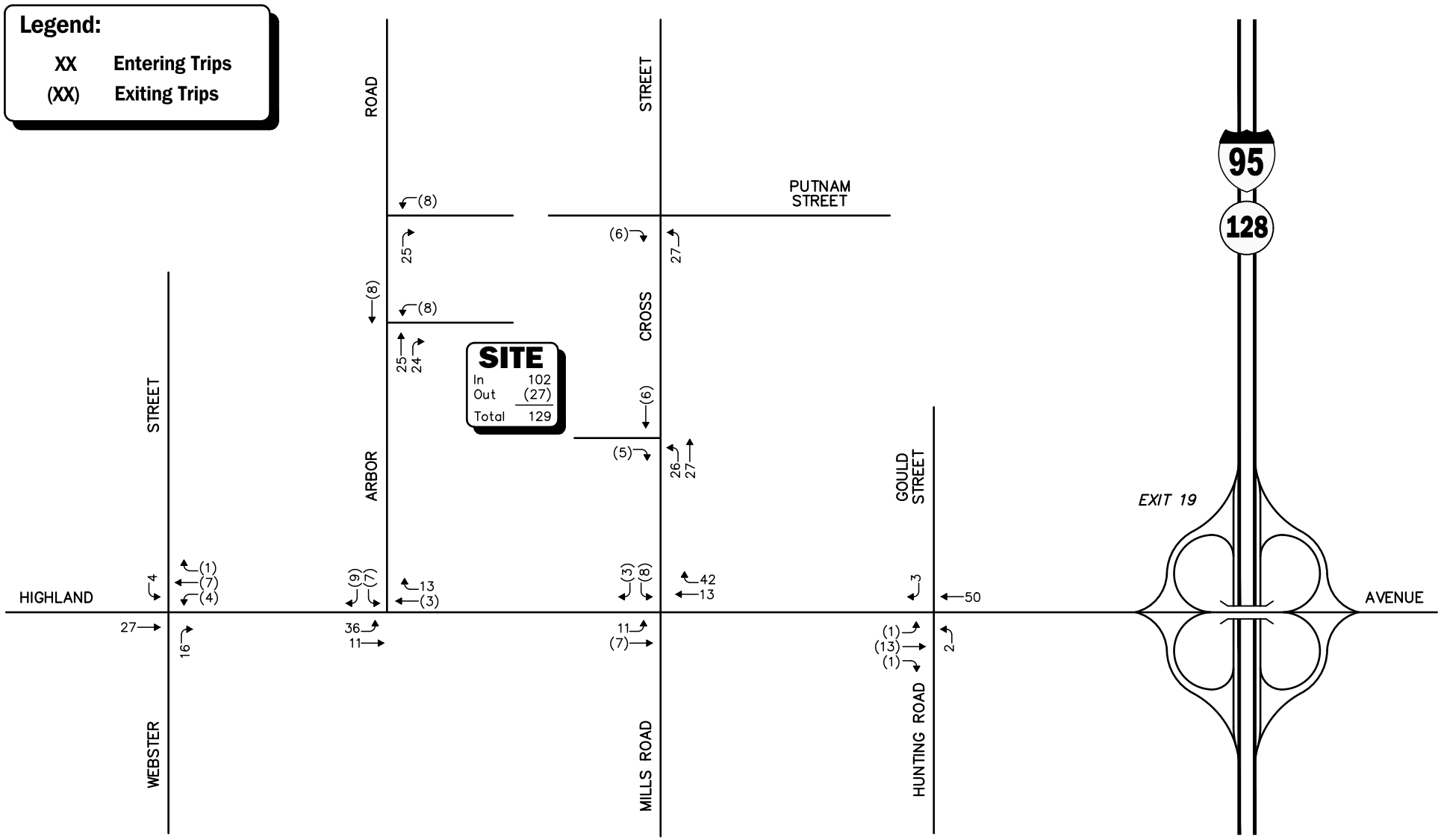
Not To Scale

Figure 7

Trip Distribution Map

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig 7, 5/29/2023 11:23:16 AM

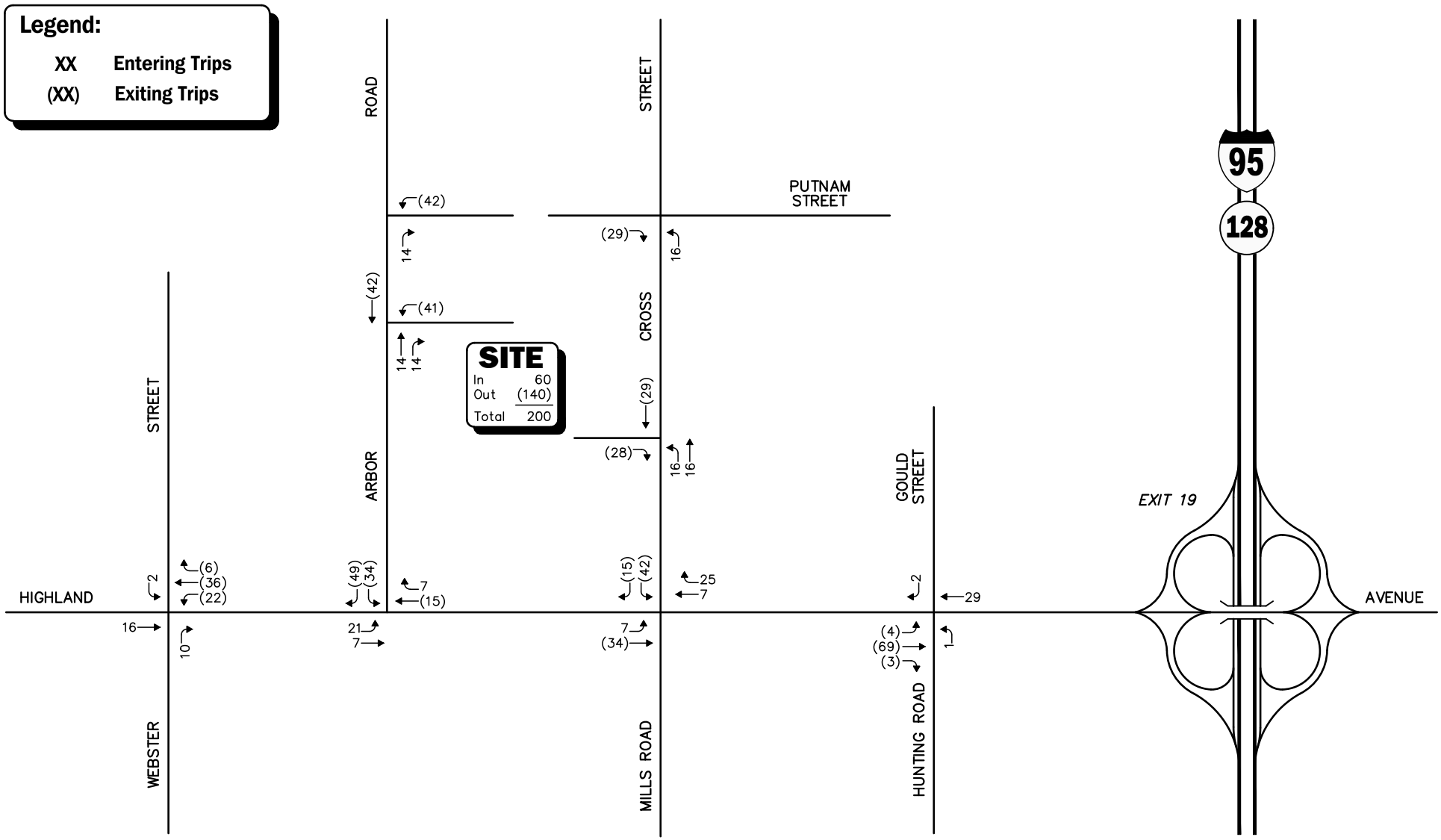


Not To Scale

Figure 8

Project Generated
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc

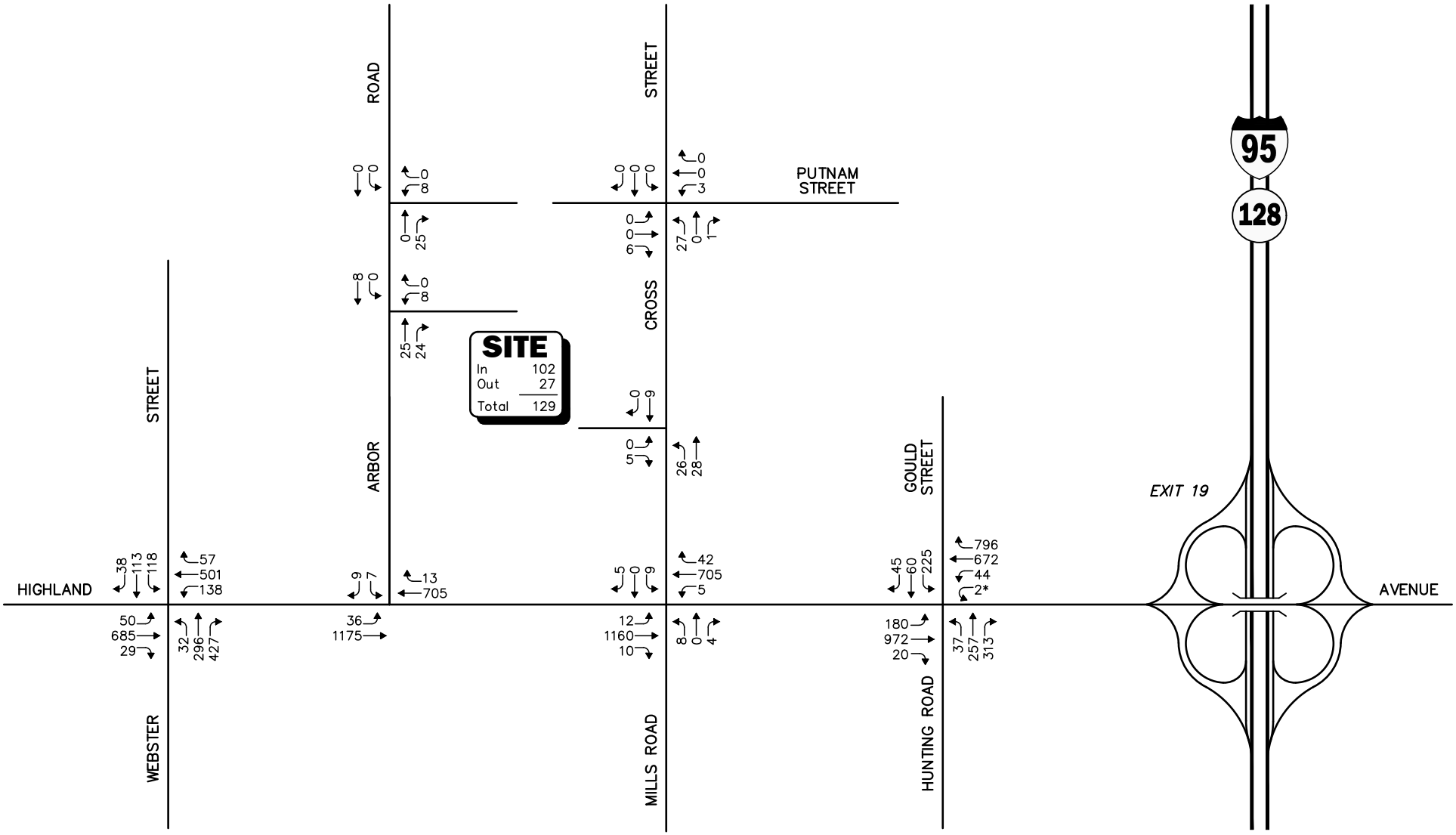


Not To Scale

Figure 9

Project Generated
Weekday Evening
Peak Hour Traffic Volumes

Vanasse & Associates inc



*Illegal maneuver

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

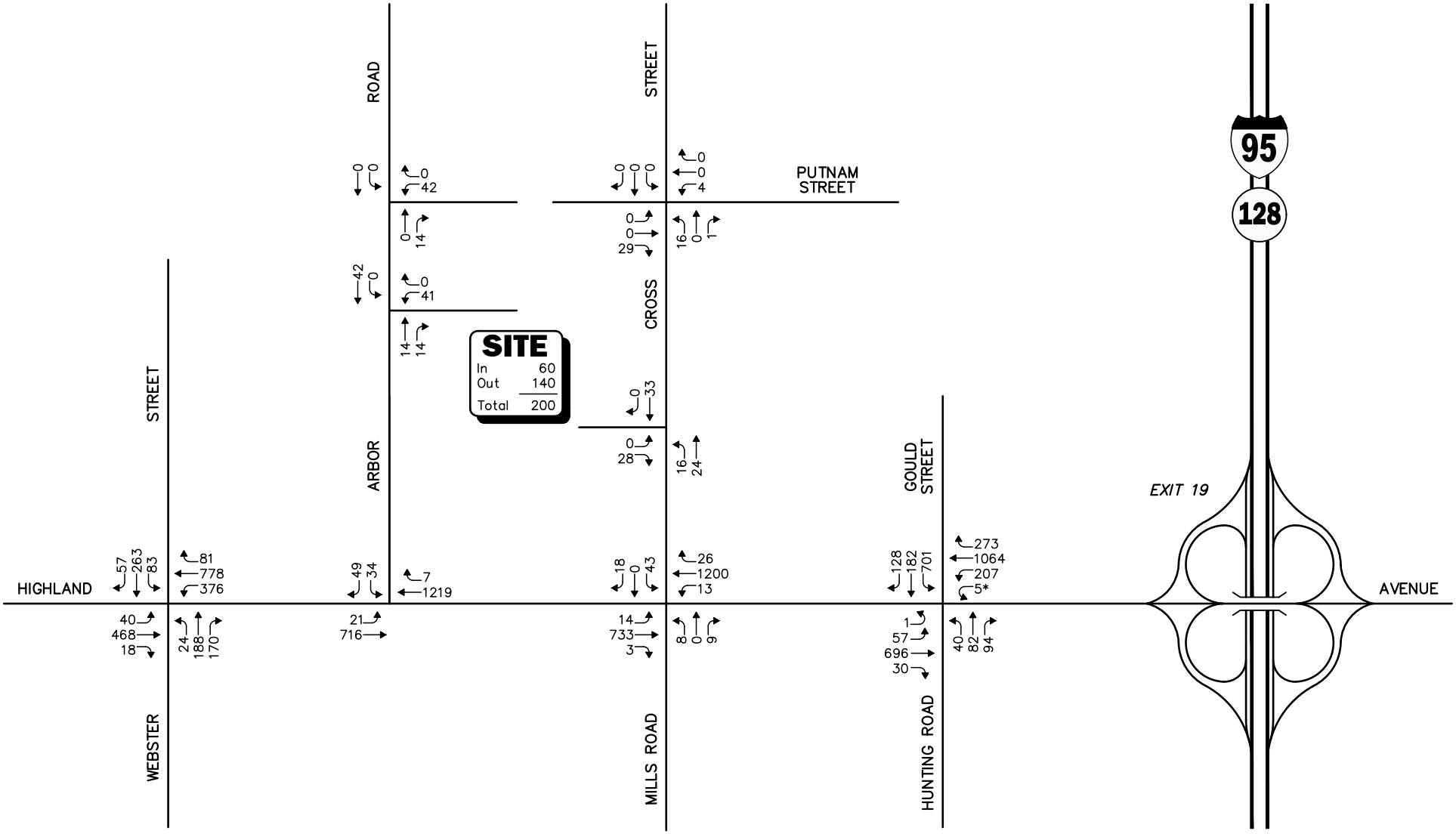
Not To Scale

Figure 10

2030 Build
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig 10, 5/29/2023 11:27:48 AM



*Illegal maneuver

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 11

2030 Build
Weekday Evening
Peak Hour Traffic Volumes

Vanasse & Associates inc

A summary of peak-hour projected traffic-volume changes outside of the study area that is the subject of this assessment is shown in Table 6. These changes are a result of the construction of the Project.

Table 7
PEAK-HOUR TRAFFIC-VOLUME INCREASES

Location/Peak-Hour	2023 Existing	2030 No-Build	2030 Build	Traffic-Volume Increase Over No-Build	Percent Increase Over No-Build
Highland Ave., west of Webster St.:					
Weekday Morning	1,142	1,310	1,335	25	1.9
Weekday Evening	1,175	1,340	1,385	45	3.4
Highland Ave., east of Gould St.:					
Weekday Morning	2,364	2,975	3,026	51	1.7
Weekday Evening	2,369	2,965	3,045	80	2.7
Webster St., north of Highland Ave.:					
Weekday Morning	622	668	672	4	0.6
Weekday Evening	656	704	712	8	1.1
Webster St., south of Highland Ave.:					
Weekday Morning	953	1,020	1,035	15	1.5
Weekday Evening	942	1,011	1,039	28	2.8
Mills Rd., south of Highland Ave.:					
Weekday Morning	25	27	27	0	0.0
Weekday Evening	31	34	33	-1	-2.9
Gould St., north of Highland Ave.:					
Weekday Morning	990	1,560	1,563	3	0.2
Weekday Evening	875	1,419	1,423	4	0.3
Hunting Rd., south of Highland Ave.:					
Weekday Morning	657	728	731	3	0.4
Weekday Evening	567	631	635	4	0.6

As shown in Table 6, Project-related traffic-volume changes outside of the study area relative to 2030 No-Build conditions are anticipated to range from a decrease of 2.9 percent to an increase of 3.4 percent during the peak periods, with vehicle changes shown to range from a decrease of one (1) vehicle to an increase of 80 vehicles. The identified decreases are a result of the removal of trips associated with the existing uses that occupy the Project site. ***When distributed over the peak-hour, the predicted traffic-volume increases would not result in a significant impact (increase) on motorist delays or vehicle queuing outside of the immediate study area that is the subject of this assessment.***

TRAFFIC OPERATIONS ANALYSIS

Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, roadway capacity and vehicle queue analyses were conducted under Existing, No-Build, and Build traffic-volume conditions. Capacity analyses provide an indication of how well the roadway facilities serve the traffic demands placed upon them, with vehicle queue analyses providing a secondary measure of the operational characteristics of an intersection or section of roadway under study.

METHODOLOGY

Levels of Service

A primary result of capacity analyses is the assignment of level of service to traffic facilities under various traffic-flow conditions.[10] The concept of level of service is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with level-of-service (LOS) A representing the best operating conditions and LOS F representing congested or constrained operating conditions.

Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year.

[10]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual, 6th Edition;* Transportation Research Board; Washington, DC; 2016.

Signalized Intersections

The six levels of service for signalized intersections may be described as follows:

- *LOS A* describes operations with very low control delay; most vehicles do not stop at all.
- *LOS B* describes operations with relatively low control delay. However, more vehicles stop than LOS A.
- *LOS C* describes operations with higher control delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
- *LOS D* describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop and individual cycle failures are noticeable.
- *LOS E* describes operations with high control delay values. Individual cycle failures are frequent occurrences.
- *LOS F* describes operations with high control delay values that often occur with oversaturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Levels of service for signalized intersections are calculated using the operational analysis methodology of the 2000 *Highway Capacity Manual*[11] and implemented as a part of the Synchro® 11 software. This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. Level-of-service designations are based on the criterion of control or signal delay per vehicle. Control or signal delay is a measure of driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. Table 7 summarizes the relationship between level of service and control delay. The tabulated control delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to entire intersections.

[11] *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2000.

Table 8
LEVEL-OF-SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS[a]

Level of Service	Control (Signal) Delay Per Vehicle (Seconds)
A	≤10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	>80.0

[a]Source: *Highway Capacity Manual*, Transportation Research Board; Washington, DC; 2000; page 16-2.

Unsignalized Intersections

The six levels of service for unsignalized intersections may be described as follows:

- *LOS A* represents a condition with little or no control delay to minor street traffic.
- *LOS B* represents a condition with short control delays to minor street traffic.
- *LOS C* represents a condition with average control delays to minor street traffic.
- *LOS D* represents a condition with long control delays to minor street traffic.
- *LOS E* represents operating conditions at or near capacity level, with very long control delays to minor street traffic.
- *LOS F* represents a condition where minor street demand volume exceeds the capacity of an approach lane, with extreme control delays resulting.

The levels of service of unsignalized intersections are determined by application of a procedure described in the *Highway Capacity Manual, 6th Edition.*[12] Level of service is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the effects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. Definitions for level of service at unsignalized intersections are also given in the *Highway Capacity Manual, 6th Edition*. Table 8 summarizes the relationship between level of service and average control delay for two-way stop controlled and all-way stop controlled intersections.

[12]*Highway Capacity Manual, 6th Edition;* Transportation Research Board; Washington, DC; 2016.

Table 9
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Level-Of-Service by Volume-to-Capacity Ratio		Average Control Delay
v/c ≤ 1.0	v/c > 1.0	(Seconds Per Vehicle)
A	F	≤10.0
B	F	10.1 to 15.0
C	F	15.1 to 25.0
D	F	25.1 to 35.0
E	F	35.1 to 50.0
F	F	>50.0

[a]Source: *Highway Capacity Manual, 6th Edition*; Transportation Research Board; Washington, DC; 2016; page 20-6.

Vehicle Queue Analysis

Vehicle queue analyses are a direct measurement of an intersection's ability to process vehicles under various traffic control and volume scenarios and lane use arrangements. The vehicle queue analysis was performed using the Synchro® intersection capacity analysis software which is based upon the methodology and procedures presented in the *Highway Capacity Manual, 6th Edition*. The Synchro® vehicle queue analysis methodology is a simulation based model which reports the number of vehicles that experience a delay of six seconds or more at an intersection. For signalized intersections, Synchro® reports both the average (50th percentile) and the 95th percentile vehicle queue. For unsignalized intersections, Synchro® reports the 95th percentile vehicle queue. Vehicle queue lengths are a function of the capacity of the movement under study and the volume of traffic being processed by the intersection during the analysis period. The 95th percentile vehicle queue is the vehicle queue length that will be exceeded only 5 percent of the time, or approximately three minutes out of sixty minutes during the peak one hour of the day (during the remaining fifty-seven minutes, the vehicle queue length will be less than the 95th percentile queue length).

ANALYSIS RESULTS

Level-of-service and vehicle queue analyses were conducted for 2023 Existing, 2030 No-Build, and 2030 Build conditions for the intersections within the study area. The results of the intersection capacity and vehicle queue analyses are summarized in Tables 10 and 11, with the detailed analysis results presented in the Appendix.

The following is a summary of the level-of-service and vehicle queue analyses for the intersections within the study area. For context, we note that an LOS of "D" or better is generally defined as "acceptable" operating conditions. Project-related impacts at the study area intersections were identified as follows:

Signalized Intersections

Project-related impacts at the signalized study area intersections are shown on Table 10 and are described as follows:

Highland Avenue at Webster Street

No change in overall level of service is predicted to occur over No-Build conditions; however, the addition of Project-related traffic was shown to result in an increase in average motorist delay (16.8 seconds) that caused a change in level of service for left-turn movements from the Highland Avenue westbound approach during the weekday evening peak-hour from LOS D to LOS E. Vehicle queues at the intersection were shown to increase by up to three (3) vehicles with the addition of Project-related traffic. Independent of the Project, it was noted that overall intersection operations are predicted to be at capacity (i.e., LOS "E") during the weekday morning peak-hour under 2030 No-Build conditions, with through/right-turn movements from the Highland Avenue eastbound approach operating at capacity under 2023 Existing conditions during the weekday morning peak-hour.

Highland Avenue at Gould Street and Hunting Road

No change in level of service is predicted to occur for any movement over No-Build conditions, with Project-related impacts defined as an increase in average motorist delay of up to 16.0 seconds (Highland Avenue westbound through/right-turn movement during the weekday morning peak-hour) and in vehicle queuing of up to six (6) vehicles. Independent of the Project, it was noted that overall intersection operations are predicted to be at capacity (i.e., LOS "E") during the weekday morning peak-hour under 2030 No-Build conditions, with one or more movements at the intersection currently operating or predicted to operate at or over capacity during both peak-hours.

Unsignalized Intersections

Project-related impacts at the unsignalized study area intersections are shown on Table 11 and are described as follows:

Highland Avenue at Arbor Street

The addition of Project-related traffic was shown to result in an increase in average motorist delay on the Arbor Street approach over No-Build conditions during the weekday evening peak-hour that resulted in a change in level of service from LOS E to LOS F, with a corresponding increase in vehicle queuing of up to two (2) vehicles. All movements along Highland Avenue were shown to operate at LOS A during both the weekday morning and evening peak-hours with negligible vehicle queuing predicted. Independent of the Project, all movements from Arbor Street are predicted to operate at capacity during the weekday evening peak-hour as a result of the relatively large volume of conflicting traffic traveling along Highland Avenue.

Highland Avenue at Cross Street and Mills Road

The addition of Project-related traffic was shown to result in the following level of service changes over No-Build conditions: *weekday morning peak-hour* - an increase in average motorist delay of 19.7 seconds on the Mills Road approach that resulted in a change in level of service from LOS C to LOS E, with a corresponding increase in vehicle queuing of up to one (1) vehicle; *weekday evening peak-hour* - an increase in average motorist delay of >50 seconds on the Cross Street

approach that resulted in a change in level of service from LOS D to LOS F, with a corresponding increase in vehicle queuing of up to four (4) vehicles (from one (1) vehicle to five (5) vehicles). All movements along Highland Avenue were shown to operate at LOS A during both the weekday morning and evening peak-hours with negligible vehicle queuing predicted. Independent of the project, it was noted that all movements from Mills Road are currently operating at capacity during the weekday morning peak-hour as a result of the relatively large volume of conflicting traffic traveling along Highland Avenue.

Cross Street at Putnam Street and the Project site driveway

No change in level of service or vehicle queuing is predicted to occur for any movement over No-Build conditions, with all movements continuing to operate at LOS A with negligible vehicle queuing.

Cross Street at the Project Site Driveway

All movements at this intersection are predicted to operate at LOS A during both the weekday morning and evening peak-hours with negligible vehicle queuing; however, actual operating conditions will be directly related to motorist delays and vehicle queuing on the Cross Street southbound approach to the Highland Avenue/Cross Street intersection.

Arbor Street at the Project Site Driveways

All movements at the Project site driveway intersections with Arbor Street are predicted to operate at LOS A during both the weekday morning and evening peak-hours with negligible vehicle queuing.

Table 10
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/ Peak-Hour/Movement	2023 Existing				2030 No-Build				2030 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
Highland Avenue at Webster Street												
Weekday Morning:												
Highland Avenue EB LT	0.18	18.2	B	1/3	0.21	19.1	B	1/3	0.21	19.1	B	1/3
Highland Avenue EB TH/RT	0.99	57.1	E	14/31	1.20	>50.0	F	21/39	1.24	>50.0	F	22/40
Highland Avenue WB LT	0.41	16.5	B	1/5	0.44	17.1	B	1/5	0.46	17.2	B	2/5
Highland Avenue WB TH/RT	0.54	12.0	B	6/17	0.60	13.7	B	7/20	0.61	13.8	B	7/20
Webster Street NB LT/TH	0.74	36.4	D	6/16	0.77	37.5	D	7/18	0.77	37.5	D	7/18
Webster Street NB RT	0.36	19.0	B	1/3	0.40	19.2	B	2/3	0.41	19.4	B	2/4
Webster Street SB LT/TH/RT	0.51	28.5	C	3/6	0.54	28.9	C	3/6	0.55	29.1	C	3/6
Overall	**--**	**31.5**	**C**	**--**	**--**	**55.8**	**E**	**--**	**--**	**60.6**	**E**	**--**
Weekday Evening:												
Highland Avenue EB LT	0.17	22.3	C	1/3	0.30	24.8	C	1/3	0.37	26.2	C	1/3
Highland Avenue EB TH/RT	0.76	33.3	C	10/22	0.83	38.7	D	11/26	0.86	41.0	D	12/27
Highland Avenue WB LT	0.74	22.4	C	4/15	0.88	44.4	D	6/18	0.96	61.2	E	7/21
Highland Avenue WB TH/RT	0.70	16.1	B	10/30	0.82	22.2	C	13/38	0.86	24.8	C	15/40
Webster Street NB LT/TH	0.56	31.1	C	5/9	0.59	32.4	C	6/10	0.59	32.5	C	6/10
Webster Street NB RT	0.12	13.6	B	0/1	0.13	14.2	B	0/1	0.14	14.3	B	0/1
Webster Street SB LT/TH/RT	0.69	34.0	C	5/9	0.73	36.3	D	5/10	0.74	36.6	D	5/10
Overall	**--**	**25.0**	**C**	**--**	**--**	**31.3**	**C**	**--**	**--**	**34.9**	**C**	**--**

See notes at end of table.

Table 10 (Continued)
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/ Peak-Hour/Movement	2023 Existing				2030 No-Build				2030 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
Highland Avenue at Gould Street and Hunting Road												
Weekday Morning:												
Highland Avenue EB LT	0.57	22.8	C	2/5	0.93	73.5	E	4/11	0.93	73.4	E	4/11
Highland Avenue EB TH/RT	0.67	26.7	C	12/17	0.57	26.2	C	9/13	0.80	32.5	C	14/19
Highland Avenue WB UT[e]/LT	0.20	17.9	B	1/2	0.15	13.5	B	1/2	0.20	16.7	B	1/2
Highland Avenue WBTH/RT	0.79	32.7	C	14/18	1.08	>50.0	F	25/30	1.13	>50.0	F	26/32
Hunting Road NB LT/TH	0.82	57.8	E	9/17	1.10	>50.0	F	11/18	1.10	>50.0	F	11/18
Hunting Road NB RT	0.61	45.1	D	4/10	0.61	36.5	D	4/6	0.64	37.6	D	4/6
Gould Street SB LT	0.59	47.7	D	5/7	0.49	42.4	D	4/5	0.49	42.3	D	4/5
Gould Street SB LT/TH/RT	0.53	45.8	D	4/7	--	--	--	--	--	--	--	--
Gould Street SB TH	--	--	--	--	0.23	40.2	D	2/3	0.23	40.2	D	2/3
Gould Street SB RT	--	--	--	--	0.03	38.6	D	0/0	0.03	38.5	D	0/0
Overall	**--**	**35.1**	**D**	**--**	**--**	**64.6**	**E**	**--**	**--**	**70.4**	**E**	**--**
Weekday Evening:												
Highland Avenue EB UT/LT	0.26	23.7	C	1/2	0.26	22.8	C	1/2	0.28	23.0	C	1/2
Highland Avenue EB TH/RT	0.56	31.7	C	9/13	0.67	31.7	C	9/11	0.72	33.1	C	10/12
Highland Avenue WB UT[e]/LT	0.51	18.0	B	4/6	0.57	18.2	B	3/5	0.61	19.7	B	3/6
Highland Avenue WBTH/RT	0.83	34.6	C	17/23	1.06	72.8	E	20/26	1.07	77.2	E	21/26
Hunting Road NB LT/TH	0.50	47.5	D	4/7	0.73	57.2	E	4/7	0.74	58.4	E	4/7
Hunting Road NB RT	0.06	43.3	D	0/0	0.07	28.1	C	0/1	0.07	28.2	C	0/1
Gould Street SB LT	0.79	50.2	D	10/17	0.85	41.3	D	10/13	0.85	41.6	D	10/13
Gould Street SB LT/TH/RT	0.75	47.1	D	10/15	--	--	--	--	--	--	--	--
Gould Street SB TH	--	--	--	--	0.40	29.5	C	5/7	0.41	29.7	C	5/7
Gould Street SB RT	--	--	--	--	0.09	26.5	C	0/1	0.09	26.6	C	0/1
Overall	**--**	**36.5**	**D**	**--**	**--**	**48.2**	**D**	**--**	**--**	**50.1**	**D**	**--**

[a]Volume-to-capacity ratio.
[b]Control (signal) delay per vehicle in seconds.
[c]Level-of-Service.
[d]Queue length in vehicles based on 25-feet per vehicle.
[e]Illegal U-turning movements observed.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.
UT = U-turning movements; LT = left-turning movements; TH = through movements; RT = right-turning movements.

Table 11
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2023 Existing				2030 No-Build				2030 Build			
Unsignalized Intersection/Peak-hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue[d] 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Highland Avenue at Arbor Street												
Weekday Morning:												
Highland Avenue EB LT/TH	1,029	0.0	A	0	1,175	0.0	A	0	1,211	1.0	A	0
Highland Avenue WB TH/RT	651	0.0	A	0	711	0.0	A	0	718	0.0	A	0
Arbor Street SB LT/RT	2	27.9	D	0	2	34.0	D	0	16	27.3	D	1
Weekday Evening:												
Highland Avenue EB LT/TH	651	0.0	A	0	712	0.0	A	0	737	0.7	A	0
Highland Avenue WB TH/RT	1,066	0.0	A	0	1,208	0.0	A	0	1,226	0.0	A	0
Arbor Street SB LT/RT	17	28.4	D	1	17	36.3	E	1	83	>50.0	F	3
Highland Avenue at Cross Street and Mills Road												
Weekday Morning:												
Highland Avenue EB LT/TH/RT	1,030	0.2	A	0	1,176	0.3	A	0	1,182	0.3	A	0
Highland Avenue WB LT/TH/RT	648	0.2	A	0	707	0.2	A	0	752	0.2	A	0
Mills Road NB LT/TH/RT	11	38.9	E	1	12	>50.0	F	1	12	>50.0	F	1
Cross Street SB LT/TH/RT	8	17.5	C	0	8	20.3	C	0	14	40.0	E	1
Weekday Evening:												
Highland Avenue EB LT/TH/RT	662	0.3	A	0	723	0.4	A	0	750	0.5	A	0
Highland Avenue WB LT/TH/RT	1,073	0.3	A	0	1,215	0.3	A	0	1,239	0.4	A	0
Mills Road NB LT/TH/RT	16	26.4	D	1	18	33.4	D	1	17	32.3	D	1
Cross Street SB LT/TH/RT	7	24.1	C	0	7	30.7	D	1	61	>50.0	F	5
Cross Street at Putnam Street and the Project Site Driveway												
Weekday Morning:												
Project site driveway EB LT/TH/RT	0	0.0	A	0	0	0.0	A	0	6	8.3	A	0
Putnam Street WB LT/TH/RT	3	8.5	A	0	3	8.5	A	0	3	9.0	A	0
Cross Street NB LT/TH/RT	1	0.0	A	0	1	0.0	A	0	28	6.4	A	0
Cross Street SB LT/TH/RT	0	0.0	A	0	0	0.0	A	0	0	0.0	A	0
Weekday Evening:												
Project site driveway EB LT/TH/RT	0	0.0	A	0	0	0.0	A	0	29	8.4	A	0
Putnam Street WB LT/TH/RT	4	8.5	A	0	4	8.5	A	0	4	8.9	A	0
Cross Street NB LT/TH/RT	1	0.0	A	0	1	0.0	A	0	17	5.9	A	0
Cross Street SB LT/TH/RT	0	0.0	A	0	0	0.0	A	0	0	0.0	A	0

See notes at end of table.

Table 11 (Continued)
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2023 Existing				2030 No-Build				2030 Build			
Unsignalized Intersection/Peak-hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue 95th[d]	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Cross Street at the Project Site Driveway												
Weekday Morning:												
Project site driveway EB LT/RT	--	--	--	--	--	--	--	--	5	8.4	A	0
Cross Street NB LT/TH	--	--	--	--	--	--	--	--	54	3.5	A	0
Cross Street SB TH/RT	--	--	--	--	--	--	--	--	9	0.0	A	0
Weekday Evening:												
Project site driveway EB LT/RT	--	--	--	--	--	--	--	--	28	8.6	A	0
Cross Street NB LT/TH	--	--	--	--	--	--	--	--	40	2.9	A	0
Cross Street SB TH/RT	--	--	--	--	--	--	--	--	33	0.0	A	0
Arbor Street at the North Project Site Driveway												
Weekday Morning:												
Project site driveway WB LT/RT	--	--	--	--	--	--	--	--	8	8.6	A	0
Arbor Street NB TH/RT	--	--	--	--	--	--	--	--	25	0.0	A	0
Arbor Street SB LT/TH	--	--	--	--	--	--	--	--	0	0.0	A	0
Weekday Evening:												
Project site driveway WB LT/RT	--	--	--	--	--	--	--	--	42	8.7	A	0
Arbor Street NB TH/RT	--	--	--	--	--	--	--	--	14	0.0	A	0
Arbor Street SB LT/TH	--	--	--	--	--	--	--	--	0	0.0	A	0
Arbor Street at the North Project Site Driveway												
Weekday Morning:												
Project site driveway WB LT/RT	--	--	--	--	--	--	--	--	8	8.8	A	0
Arbor Street NB TH/RT	--	--	--	--	--	--	--	--	49	0.0	A	0
Arbor Street SB LT/TH	--	--	--	--	--	--	--	--	8	0.0	A	0
Weekday Evening:												
Project site driveway WB LT/RT	--	--	--	--	--	--	--	--	41	9.0	A	0
Arbor Street NB TH/RT	--	--	--	--	--	--	--	--	28	0.0	A	0
Arbor Street SB LT/TH	--	--	--	--	--	--	--	--	42	0.0	A	0

[a]Demand in vehicles per hour.
[b]Average control delay per vehicle (in seconds).
[c]Level-of-Service.
[d]Queue length in vehicles.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.
LT = left-turning movements; TH = through movements; RT = right-turning movements.

SIGHT DISTANCE EVALUATION

Sight distance measurements were performed at the Project site driveway intersections with Arbor Street and Cross Street in accordance with MassDOT and American Association of State Highway and Transportation Officials (AASHTO)[13] requirements. Both stopping sight distance (SSD) and intersection sight distance (ISD) measurements were performed. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an object in its travel path. ISD or corner sight distance (CSD) is the sight distance required by a driver entering or crossing an intersecting roadway to perceive an on-coming vehicle and safely complete a turning or crossing maneuver with on-coming traffic. In accordance with AASHTO standards, if the measured ISD is at least equal to the required SSD value for the appropriate design speed, the intersection can operate in a safe manner. Table 12 presents the measured SSD and ISD at the subject intersections.

As can be seen in Table 12, with the selective trimming or removal of the existing vegetation located within the sight triangle areas of the Project site driveways along Arbor Street, the available lines of sight at the Project site driveway intersections with Arbor Street and Cross Street were found to exceed the recommended minimum sight distances for the driveways to function in a safe (SSD) manner based on the appropriate approach speed.

[13] *A Policy on Geometric Design of Highway and Streets,* 7th Edition; American Association of State Highway and Transportation Officials (AASHTO); Washington D.C.; 2018.

Table 12
SIGHT DISTANCE MEASUREMENTS[a]

Intersection/Sight Distance Measurement	Feet		
	Required Minimum (SSD)	Desirable (ISD)[b]	Measured
Arbor Street at the North Project Site Driveway			
Stopping Sight Distance:			
Arbor Street approaching from the north	185	--	227[c]
Arbor Street approaching from the south	220	--	370[d]
Intersection Sight Distance:			
Looking to the north from the Project Site Driveway	185	280	44/227[c,e]
Looking to the south from the Project Site Driveway	220	240	370[d]
Arbor Street at the South Project Site Driveway			
Stopping Sight Distance:			
Arbor Street approaching from the north	185	--	277[c]
Arbor Street approaching from the south	220	--	290[d]
Intersection Sight Distance:			
Looking to the north from the Project Site Driveway	185	280	79/277[c,e]
Looking to the south from the Project Site Driveway	220	240	290[d]
Cross Street at Putnam Street and the Project Site Driveway[f]			
Stopping Sight Distance:			
Cross Street approaching from the south	200	--	335[d]
Intersection Sight Distance:			
Looking to the south from the Project Site Driveway	200	280	335[d]
Cross Street at the Project Site Driveway			
Stopping Sight Distance:			
Cross Street approaching from the north	200	--	268[g]
Cross Street approaching from the south	80	--	80[d]
Intersection Sight Distance:			
Looking to the north from the Project Site Driveway	155	240	268[g]
Looking to the south from the Project Site Driveway	80	280	80[d]

[a]Recommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets,* 7th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2018; and based on a 30 mph approach speed along Arbor Street and Cross Street (a 15 mph approach speed was used along Cross Street northbound approaching the Project site driveway to account for the reduced speed of traffic turning from Highland Avenue onto Cross Street). An approach grade of 7% was used along Arbor Street.

[b]Values shown are the intersection sight distance for a vehicle turning right or left exiting a roadway under STOP control such that motorists approaching the intersection on the major street should not need to adjust their travel speed to less than 70 percent of their initial approach speed.

[c]Sight distance available to/from the end of Arbor Street.

[d]Sight distance available to/from Highland Avenue.

[e]With the selective trimming or removal of the vegetation located along the Project site frontage on Arbor Street.

[f]Cross Street ends approximately 15 feet north of Putnam Street/the Project site driveway.

[g]Sight distance available to/from the end of Cross Street.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

VAI has conducted a TIA in order to determine the potential impacts on the transportation infrastructure associated with the proposed redevelopment of 629-661 Highland Avenue in Needham, Massachusetts, to accommodate an medical office building. The following specific areas have been evaluated as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; under existing and future conditions, both with and without the Project. Based on this assessment, we have concluded the following with respect to the Project:

1. Using trip-generation statistics published by the ITE,[14] the Project is expected to generate approximately 1,800 vehicle trips on an average weekday (two-way volume over the operational day of the Project), with 129 vehicle trips expected during the weekday morning peak-hour and 200 vehicle trips expected during the weekday evening peak-hour;

2. In comparison to the existing uses that currently occupy the Project site, the Project is expected to generate approximately 1,166 additional vehicle trips on an average weekday, with 101 additional vehicle trips expected during the weekday morning peak-hour and 168 additional vehicle trips expected during the weekday evening peak-hour;

3. The Project will not result in a significant impact (increase) on motorist delays or vehicle queuing over Existing or anticipated future conditions without the Project (No-Build conditions); however, it was noted that one or more movements at the study intersections are currently operating at or over capacity (defined as LOS "E" or "F", respectively) independent of the Project. Project-related impacts were generally defined as an increase in average motorist delay that resulted in a corresponding increase in vehicle queuing of up to four (4) vehicles;

4. No apparent safety deficiencies were noted with respect to the motor vehicle crash history at the study area intersections; and

[14] Ibid 1.

5. Lines of sight to and from the Project site driveway intersections were found to meet or exceed or could be made to meet or exceed the recommended minimum distances for safe operation based on the appropriate approach speed.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with implementation of the recommendations that follow.

RECOMMENDATIONS

A detailed transportation improvement program has been developed that is designed to provide safe and efficient access to the Project site and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The following improvements have been recommended as a part of this evaluation and, where applicable, will be completed in conjunction with the Project subject to receipt of all necessary rights, permits, and approvals.

Project Access

Access to the Project site will be provided by way of four (4) driveways configured as follows: the existing driveway that intersects the west side of Cross Street approximately 280 feet north of Highland Avenue and opposite Putnam Street; a new driveway that will intersect the west side of Cross Street approximately 80 feet north of Highland Avenue; and two (2) new driveways that will intersect the east side of Arbor Street approximately 290 feet and 370 feet north of Highland Avenue. The following recommendations are offered with respect to the design and operation of the Project site access and internal circulation, many of which are reflected on the site plans.

- The Project site driveways and internal circulating aisles should be a minimum of 24 feet in width and designed to accommodate the turning and maneuvering requirements of the largest anticipated responding emergency vehicle as defined by the Needham Fire Department.

- Where perpendicular parking is proposed, the drive aisle behind the parking should be a minimum of 23 feet in order to facilitate parking maneuvers.

- Vehicles exiting the Project site should be placed under STOP-sign control with a marked STOP-line provided.

- All signs and pavement markings to be installed within the Project site should conform to the applicable standards of the *Manual on Uniform Traffic Control Devices* (MUTCD).[15]

- A sidewalk has been provided that links the proposed building to the sidewalk infrastructure along Highland Avenue and includes Americans with Disabilities Act (ADA)-compliant wheelchair ramps.

- Signs and landscaping to be installed as a part of the Project within the intersection sight triangle areas should be designed and maintained so as not to restrict lines of sight.

[15]Ibid 2.

- Existing vegetation located along the Project site frontage on Arbor Street should selectively trimmed or removed so that no portion of the vegetation is located within the sight triangle areas of the Project site driveways.

- Snow accumulations (windrows) within the sight triangle areas should be promptly removed where such accumulations would impede sight lines.

Off Site

Highland Avenue at Webster Street

Independent of the Project, overall operating conditions at the intersection of Highland Avenue at Webster Street were predicted to be at capacity (i.e., LOS "E") during the weekday morning peak-hour under 2030 No-Build conditions. In order to improve operating conditions at the intersection and to off-set the predicted impact of the Project, the Project proponent will design and implement an optimal traffic signal timing and phasing plan. As can be seen in Table 13, with the implementation of the recommended traffic signal timing improvements, motorist delays and vehicle queuing will be reduced such that intersection operations will be improved (over No-Build conditions) to an overall LOS D during the weekday morning peak-hour and the intersection will continue to operate at an overall LOS C during the weekday evening peak-hour. These improvements will be designed and constructed by the Project proponent prior to the issuance of a Certificate of Occupancy for the Project subject to receipt of all necessary rights, permits and approvals.

Highland Avenue at Gould Street and Hunting Road

Independent of the Project, overall operating conditions at the intersection of Highland Avenue at Gould Street and Hunting Road were predicted to be at capacity during the weekday morning peak-hour under 2030 No-Build conditions. In order to improve operating conditions at the intersection and to off-set the predicted impact of the Project, the Project proponent will design and implement an optimal traffic signal timing and phasing plan. As can be seen in Table 13, with the implementation of the recommended traffic signal timing improvements, overall motorist delays and vehicle queuing will be reduced to the extent that there will be a general improvement over No-Build conditions. These improvements will be designed and constructed by the Project proponent prior to the issuance of a Certificate of Occupancy for the Project subject to receipt of all necessary rights, permits and approvals.

Table 13
MITIGATED SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/ Peak-Hour/Movement	2030 No-Build				2030 Build				2030 Build with Mitigation			
	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
Highland Avenue at Webster Street												
Weekday Morning:												
Highland Avenue EB LT	0.21	19.1	B	1/3	0.21	19.1	B	1/3	0.18	16.9	B	1/3
Highland Avenue EB TH/RT	1.20	>50.0	F	21/39	1.24	>50.0	F	22/40	0.98	53.4	D	19/38
Highland Avenue WB LT	0.44	17.1	B	1/5	0.46	17.2	B	2/5	0.68	36.2	D	2/8
Highland Avenue WB TH/RT	0.60	13.7	B	7/20	0.61	13.8	B	7/20	0.57	14.1	B	7/20
Webster Street NB LT/TH	0.77	37.5	D	7/18	0.77	37.5	D	7/18	0.94	73.4	E	9/21
Webster Street NB RT	0.40	19.2	B	2/3	0.41	19.4	B	2/4	0.58	34.7	C	4/8
Webster Street SB LT/TH/RT	0.54	28.9	C	3/6	0.55	29.1	C	3/6	0.66	43.2	D	4/8
Overall	**--**	**55.8**	**E**	**--**	**--**	**60.6**	**E**	**--**	**--**	**41.5**	**D**	**--**
Weekday Evening:												
Highland Avenue EB LT	0.30	24.8	C	1/3	0.37	26.2	C	1/3	0.29	26.2	C	1/3
Highland Avenue EB TH/RT	0.83	38.7	D	11/26	0.86	41.0	D	12/27	0.84	41.9	D	13/28
Highland Avenue WB LT	0.88	44.4	D	6/18	0.96	61.2	E	7/21	0.85	41.8	D	7/20
Highland Avenue WB TH/RT	0.82	22.2	C	13/38	0.86	24.8	C	15/40	0.82	21.4	C	15/41
Webster Street NB LT/TH	0.59	32.4	C	6/10	0.59	32.5	C	6/10	0.67	39.7	D	6/11
Webster Street NB RT	0.13	14.2	B	0/1	0.14	14.3	B	0/1	0.15	15.1	B	0/1
Webster Street SB LT/TH/RT	0.73	36.3	D	5/10	0.74	36.6	D	5/10	0.82	45.5	D	6/11
Overall	**--**	**31.3**	**C**	**--**	**--**	**34.9**	**C**	**--**	**--**	**33.6**	**C**	**--**

See notes at end of table.

Table 13 (Continued)
MITIGATED SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/ Peak-Hour/Movement	2030 No-Build				2030 Build				2030 Build with Mitigation			
	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
Highland Avenue at Gould Street and Hunting Road												
Weekday Morning:												
Highland Avenue EB LT	0.93	73.5	E	4/11	0.93	73.4	E	4/11	1.05	>50.0	F	6/13
Highland Avenue EB TH/RT	0.57	26.2	C	9/13	0.80	32.5	C	14/19	0.73	32.8	C	17/21
Highland Avenue WB UT[e]/LT	0.15	13.5	B	1/2	0.20	16.7	B	1/2	0.19	17.8	B	1/2
Highland Avenue WBTH/RT	1.08	>50.0	F	25/30	1.13	>50.0	F	26/32	1.05	74.9	E	30/36
Hunting Road NB LT/TH	1.10	>50.0	F	11/18	1.10	>50.0	F	11/18	1.05	>50.0	F	13/20
Hunting Road NB RT	0.61	36.5	D	4/6	0.64	37.6	D	4/6	0.66	45.0	D	6/8
Gould Street SB LT	0.49	42.4	D	4/5	0.49	42.3	D	4/5	0.53	52.6	D	5/6
Gould Street SB TH	0.23	40.2	D	2/3	0.23	40.2	D	2/3	0.25	49.7	D	2/4
Gould Street SB RT	0.03	38.6	D	0/0	0.03	38.5	D	0/0	0.03	47.7	D	0/0
Overall	**--**	**64.6**	**E**	**--**	**--**	**70.4**	**E**	**--**	**--**	**63.7**	**E**	**--**
Weekday Evening:												
Highland Avenue EB UT/LT	0.26	22.8	C	1/2	0.28	23.0	C	1/2	0.31	24.3	C	1/2
Highland Avenue EB TH/RT	0.67	31.7	C	9/11	0.72	33.1	C	10/12	0.65	31.8	C	10/13
Highland Avenue WB UT[e]/LT	0.57	18.2	B	3/5	0.61	19.7	B	3/6	0.59	19.2	B	3/5
Highland Avenue WBTH/RT	1.06	72.8	E	20/26	1.07	77.2	E	21/26	0.98	52.3	D	20/27
Hunting Road NB LT/TH	0.73	57.2	E	4/7	0.74	58.4	E	4/7	0.67	55.2	E	4/7
Hunting Road NB RT	0.07	28.1	C	0/1	0.07	28.2	C	0/1	0.07	30.8	C	0/1
Gould Street SB LT	0.85	41.3	D	10/13	0.85	41.6	D	10/13	0.92	54.4	D	12/16
Gould Street SB TH	0.40	29.5	C	5/7	0.41	29.7	C	5/7	0.44	34.4	C	5/8
Gould Street SB RT	0.09	26.5	C	0/1	0.09	26.6	C	0/1	0.09	30.8	C	0/1
Overall	**--**	**48.2**	**D**	**--**	**--**	**50.1**	**D**	**--**	**--**	**44.0**	**D**	**--**

[a]Volume-to-capacity ratio.
[b]Control (signal) delay per vehicle in seconds.
[c]Level-of-Service.
[d]Queue length in vehicles based on 25-feet per vehicle.
[e]Illegal U-turning movements observed.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.
UT = U-turning movements; LT = left-turning movements; TH = through movements; RT = right-turning movements.

Transportation Demand Management

Regularly scheduled public transportation services are not currently provided in the immediate vicinity of the Project site. To the west of the Project site, the MBTA provides commuter rail service to South Station in Boston on the Needham Line by way of Needham Heights Station, which is located at 95 Avery Square in Needham (an approximate 3 minute driving distance of the Project site). In an effort to encourage the use of alternative modes of transportation to single-occupant vehicles, the following Transportation Demand Management (TDM) measures will be implemented as a part of the Project:

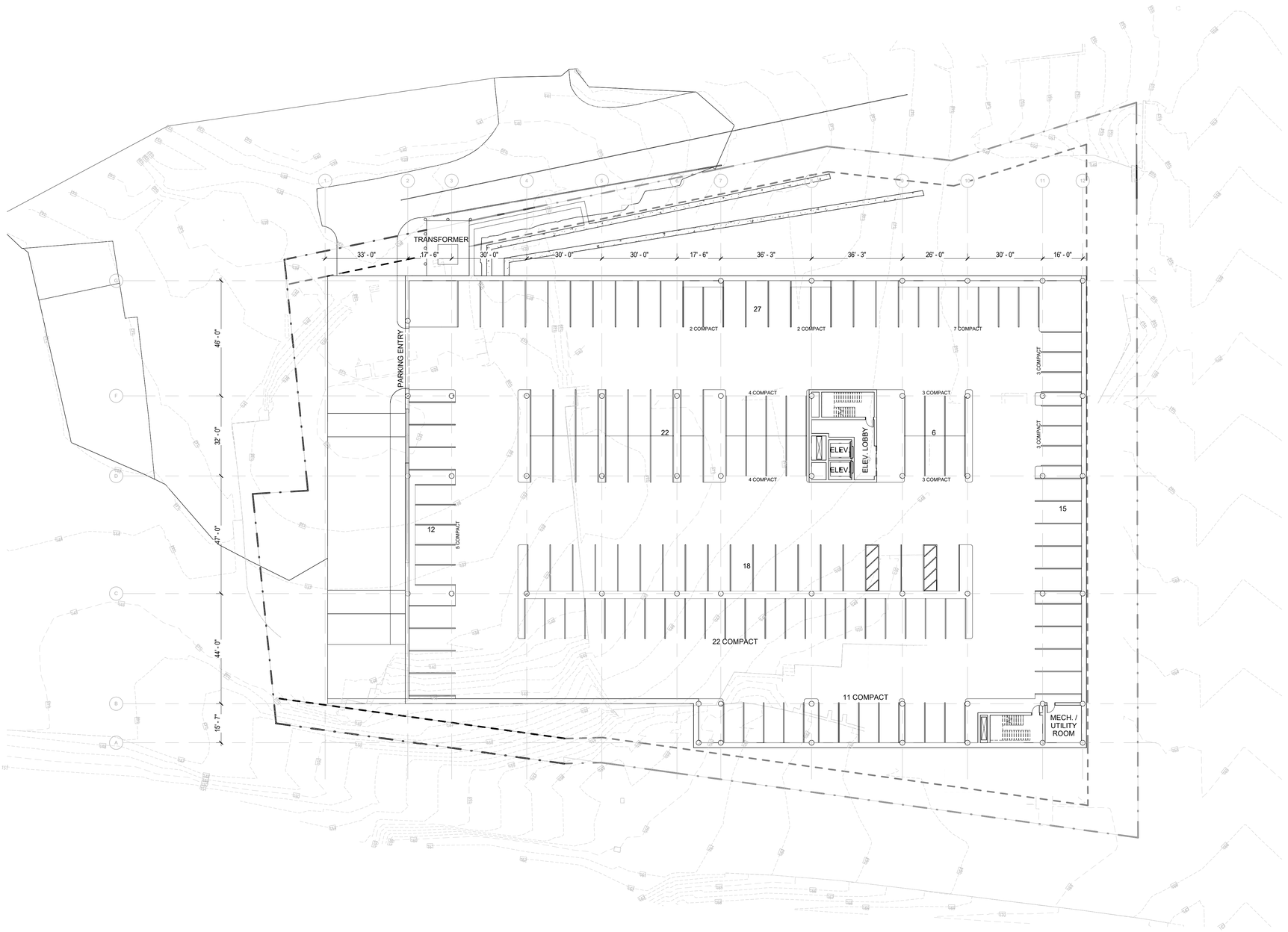
- The Project proponent will become a member of the Route 128 Business Council Transportation Management Association (TMA) who will manage and coordinate the TDM program for the Project;
- A transportation coordinator will be assigned for the Project to coordinate the TDM program and to serve as the point of contact for the TMA;
- The TMA will facilitate a rideshare matching program for employees to encourage carpooling;
- A "guaranteed-ride-home" program will be offered through the TMA to employees that use public transportation, carpool, vanpool, walk or bicycle to the Project site, and that register with the transportation coordinator and the TMA;
- A "welcome packet" will be provided to employees detailing available commuter options and will include the contact information for the transportation coordinator and information to enroll in the employee rideshare program;
- Specific amenities will be provided to discourage off-site trips which may include providing a breakroom equipped with a microwave and refrigerator; offering direct deposit of paychecks; and other such measures to reduce overall traffic volumes and travel during peak-traffic-volume periods;
- Pedestrian accommodations have been incorporated within the Project site; and
- Secure bicycle parking will be provided at an appropriate location within the Project site.

With implementation of the aforementioned recommendations, safe and efficient access will be provided to the Project site and the Project can be accommodated within the confines of the existing transportation system.

APPENDIX

PROJECT SITE PLAN
AUTOMATIC TRAFFIC RECORDER COUNT DATA
MANUAL TURNING MOVEMENT COUNT DATA
SEASONAL ADJUSTMENT DATA
VEHICLE TRAVEL SPEED DATA
TRANSIT INFORMATION
MASSDOT CRASH RATE WORKSHEETS AND HIGH CRASH LOCATION MAPPING
GENERAL BACKGROUND TRAFFIC GROWTH
BACKGROUND DEVELOPMENT TRAFFIC-VOLUME NETWORKS
PROPOSED TRIP-GENERATION CALCULATIONS
EXISTING TRIP-GENERATION CALCULATIONS
CAPACITY ANALYSIS WORKSHEETS

PROJECT SITE PLAN



1 P-1 UPPER PARKING
SCALE: 3/64" = 1'-0"

Notes:

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: 3/64" = 1'-0"

Issue:	Date:
XXXX	XXXX

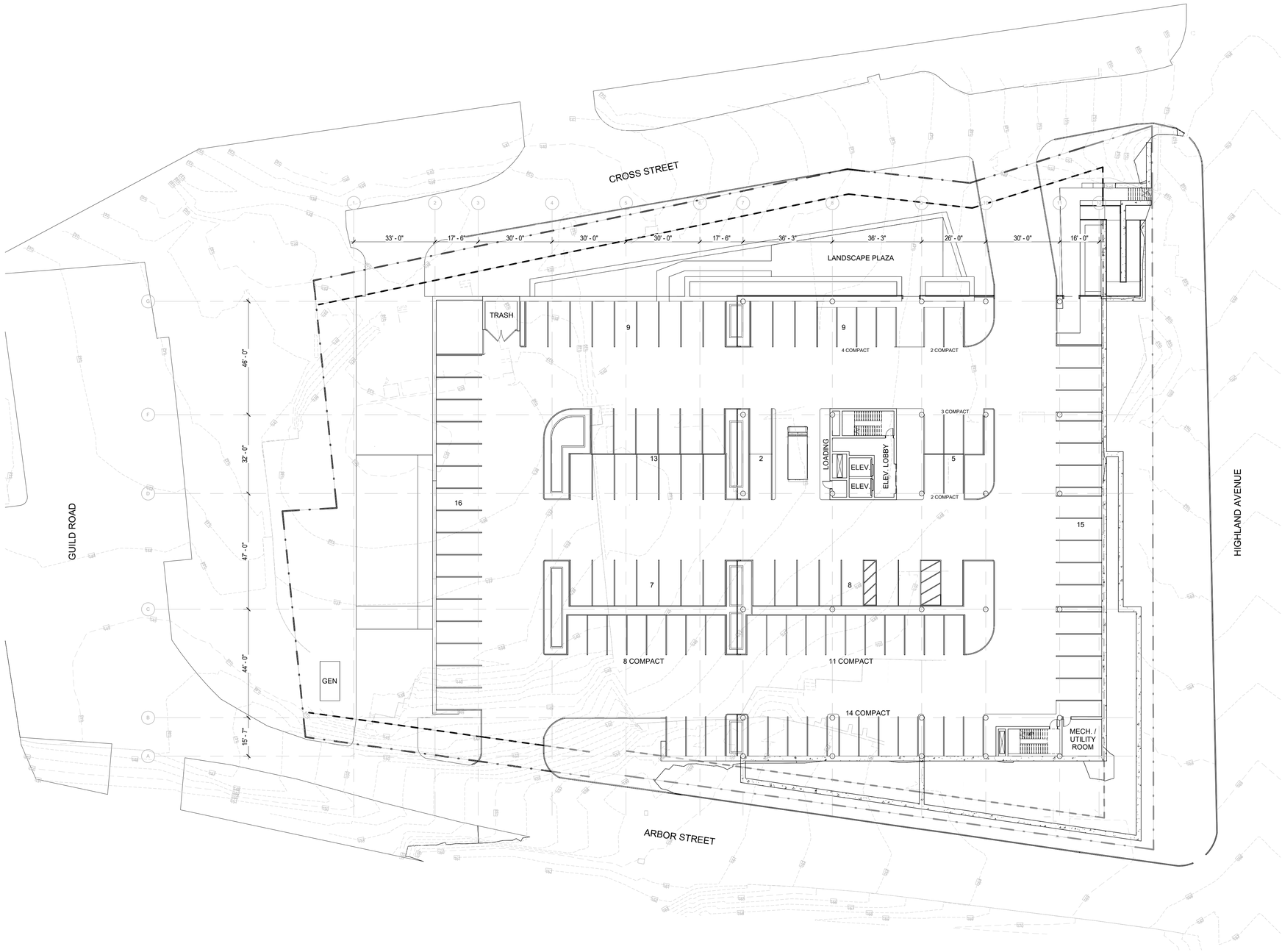
Revisions:	Date:

Drawing Title:
P-1 Parking Plan

Sheet Number:

A.101

MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM



1 FIRST FLOOR
SCALE: 3/64" = 1'-0"

Notes:

PARTITION LEGEND	
	EXISTING WALL, VERIFY CONSTRUCTION IN FIELD
	BRICK VENEER EXTERIOR WALL W/ MTL STUD BACK-UP
	BRICK VENEER EXTERIOR WALL W/ MASONRY BACK-UP
	EIFS EXTERIOR WALL
	CMU WALL
	INTERIOR PARTITION

PARTITION NOTES

1. ALL WALLS NOT KEYED IN BY WALL TYPE DESIGNATION TO BE PARTITION "P1", TYP.

DIMENSIONING NOTES

1. EXTERIOR MASONRY WALLS ARE DIMENSIONED TO THE FACE OF MASONRY
2. INTERIOR MASONRY WALLS ARE DIMENSIONED TO THE FACE OF MASONRY
3. WOOD FRAMED EXTERIOR WALLS ARE DIMENSIONED TO THE EXTERIOR FACE OF STUD.
4. INTERIOR PARTITIONS ARE DIMENSIONED TO THE CENTERLINE, UON

FIRE EXTINGUISHER	
FE-1	SURFACE MOUNT FIRE EXTINGUISHER, JL INDUSTRIES COSMIX 5X
FE-2	RECESSED FIRE EXTINGUISHER- 1-1/2" TRIM, JL INDUSTRIES COSMIX 5X, CABINET #1826G17, MILL FINISH

Key Plan:

Architect's Stamp:

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: As indicated

Issue:	Date:
XXXX	XXXX

Revisions:	Date:

Drawing Title:
First Floor Plan

Sheet Number:
A.102

MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM

AUTOMATIC TRAFFIC RECORDER COUNT DATA

Accurate Counts
978-664-2565

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315VOL1

Start	9/4/2019	EB		Hour Totals		WB		Hour Totals		Combined Totals	
Time	Wed	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00		13	152			14	156				
12:15		9	142			16	172				
12:30		7	140			6	154				
12:45		5	133	34	567	9	176	45	658	79	1225
01:00		5	124			9	176				
01:15		12	159			5	136				
01:30		8	130			7	168				
01:45		3	137	28	550	4	154	25	634	53	1184
02:00		3	129			4	158				
02:15		2	133			3	183				
02:30		2	146			1	167				
02:45		3	166	10	574	1	166	9	674	19	1248
03:00		3	178			2	142				
03:15		1	162			4	169				
03:30		2	156			5	180				
03:45		3	146	9	642	5	170	16	661	25	1303
04:00		4	136			7	220				
04:15		5	154			4	209				
04:30		9	128			8	224				
04:45		14	136	32	554	7	229	26	882	58	1436
05:00		22	132			18	208				
05:15		37	141			18	222				
05:30		35	104			36	221				
05:45		58	119	152	496	35	205	107	856	259	1352
06:00		61	112			62	214				
06:15		91	132			78	219				
06:30		104	105			94	197				
06:45		137	114	393	463	131	166	365	796	758	1259
07:00		184	105			139	179				
07:15		221	97			168	175				
07:30		198	110			148	126				
07:45		182	100	785	412	180	126	635	606	1420	1018
08:00		218	82			145	114				
08:15		230	96			141	94				
08:30		250	79			138	90				
08:45		178	68	876	325	146	66	570	364	1446	689
09:00		197	65			115	61				
09:15		176	43			125	56				
09:30		139	46			141	60				
09:45		137	49	649	203	164	50	545	227	1194	430
10:00		151	42			141	32				
10:15		120	33			158	37				
10:30		145	18			149	24				
10:45		139	20	555	113	150	36	598	129	1153	242
11:00		122	12			168	28				
11:15		146	22			135	22				
11:30		125	21			190	17				
11:45		164	8	557	63	124	15	617	82	1174	145
Total		4080	4962			3558	6569			7638	11531
Percent		45.1%	54.9%			35.1%	64.9%			39.8%	60.2%

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315VOL1

Start Time	9/5/2019 Thu	EB Morning	EB Afternoon	Hour Totals Morning	Hour Totals Afternoon	WB Morning	WB Afternoon	Hour Totals Morning	Hour Totals Afternoon	Combined Totals Morning	Combined Totals Afternoon
12:00		13	152			16	157				
12:15		10	123			7	174				
12:30		4	129			11	176				
12:45		8	133	35	537	9	162	43	669	78	1206
01:00		4	147			6	154				
01:15		5	140			6	164				
01:30		6	142			3	157				
01:45		6	152	21	581	9	160	24	635	45	1216
02:00		4	145			2	181				
02:15		0	137			3	181				
02:30		2	143			3	179				
02:45		2	151	8	576	1	171	9	712	17	1288
03:00		3	182			3	167				
03:15		4	161			1	188				
03:30		5	145			4	155				
03:45		3	155	15	643	5	185	13	695	28	1338
04:00		5	147			6	214				
04:15		9	137			12	185				
04:30		11	132			8	220				
04:45		9	118	34	534	7	223	33	842	67	1376
05:00		20	107			10	206				
05:15		22	119			27	238				
05:30		45	118			28	221				
05:45		66	95	153	439	29	221	94	886	247	1325
06:00		58	130			63	217				
06:15		67	117			66	210				
06:30		106	110			70	199				
06:45		136	111	367	468	123	185	322	811	689	1279
07:00		166	91			145	183				
07:15		198	111			167	162				
07:30		226	103			143	165				
07:45		232	119	822	424	130	132	585	642	1407	1066
08:00		215	84			150	130				
08:15		255	79			133	108				
08:30		214	83			134	85				
08:45		209	75	893	321	160	106	577	429	1470	750
09:00		165	57			152	75				
09:15		175	44			158	56				
09:30		136	51			140	65				
09:45		143	50	619	202	147	49	597	245	1216	447
10:00		150	50			149	52				
10:15		123	31			142	49				
10:30		148	29			136	40				
10:45		148	26	569	136	158	41	585	182	1154	318
11:00		134	24			165	27				
11:15		137	18			147	21				
11:30		129	13			152	15				
11:45		148	6	548	61	158	16	622	79	1170	140
Total		4084	4922			3504	6827			7588	11749
Percent		45.3%	54.7%			33.9%	66.1%			39.2%	60.8%
Grand Total		8164	9884			7062	13396			15226	23280
Percent		45.2%	54.8%			34.5%	65.5%			39.5%	60.5%

ADT ADT 19,253 AADT 19,253

Accurate Counts
978-664-2565

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315VOL1

Start	9/2/2019		Tue		Wed		Thu		Fri		Sat		Sun		Week Average	
Time	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
12:00 AM	*	*	*	*	34	45	35	43	*	*	*	*	*	*	34	44
01:00	*	*	*	*	28	25	21	24	*	*	*	*	*	*	24	24
02:00	*	*	*	*	10	9	8	9	*	*	*	*	*	*	9	9
03:00	*	*	*	*	9	16	15	13	*	*	*	*	*	*	12	14
04:00	*	*	*	*	32	26	34	33	*	*	*	*	*	*	33	30
05:00	*	*	*	*	152	107	153	94	*	*	*	*	*	*	152	100
06:00	*	*	*	*	393	365	367	322	*	*	*	*	*	*	380	344
07:00	*	*	*	*	785	**635**	822	585	*	*	*	*	*	*	804	610
08:00	*	*	*	*	**876**	570	**893**	577	*	*	*	*	*	*	**884**	574
09:00	*	*	*	*	649	545	619	597	*	*	*	*	*	*	634	571
10:00	*	*	*	*	555	598	569	585	*	*	*	*	*	*	562	592
11:00	*	*	*	*	557	617	548	**622**	*	*	*	*	*	*	552	**620**
12:00 PM	*	*	*	*	567	658	537	669	*	*	*	*	*	*	552	664
01:00	*	*	*	*	550	634	581	635	*	*	*	*	*	*	566	634
02:00	*	*	*	*	574	674	576	712	*	*	*	*	*	*	575	693
03:00	*	*	*	*	**642**	661	**643**	695	*	*	*	*	*	*	**642**	678
04:00	*	*	*	*	554	**882**	534	842	*	*	*	*	*	*	544	862
05:00	*	*	*	*	496	856	439	**886**	*	*	*	*	*	*	468	**871**
06:00	*	*	*	*	463	796	468	811	*	*	*	*	*	*	466	804
07:00	*	*	*	*	412	606	424	642	*	*	*	*	*	*	418	624
08:00	*	*	*	*	325	364	321	429	*	*	*	*	*	*	323	396
09:00	*	*	*	*	203	227	202	245	*	*	*	*	*	*	202	236
10:00	*	*	*	*	113	129	136	182	*	*	*	*	*	*	124	156
11:00	*	*	*	*	63	82	61	79	*	*	*	*	*	*	62	80
Lane	0	0	0	0	9042	10127	9006	10331	0	0	0	0	0	0	9022	10230
Day	0		0		19169		19337		0		0		0		19252	
AM Peak	-	-	-	-	08:00	07:00	08:00	11:00	-	-	-	-	-	-	08:00	11:00
Vol.	-	-	-	-	876	635	893	622	-	-	-	-	-	-	884	620
PM Peak	-	-	-	-	15:00	16:00	15:00	17:00	-	-	-	-	-	-	15:00	17:00
Vol.	-	-	-	-	642	882	643	886	-	-	-	-	-	-	642	871

Comb. Total	0	0	19169	19337	0	0	0	19252

ADT ADT 19,253 AADT 19,253

Accurate Counts

978-664-2565

Location : Highland Avenue 83150001
Location : West of Cross Street
City/State: Needham, MA

3/28/2023	EB		Hour Totals		WB		Hour Totals		Combined Totals	
Time	Morning	Afternoon	Morning	Afternon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00	4	140			8	142				
12:15	3	143			2	134				
12:30	5	126			4	149				
12:45	7	128	19	537	9	155	23	580	42	1117
1:00	0	126			5	134				
1:15	1	130			4	141				
1:30	1	135			4	133				
1:45	1	124	3	515	1	130	14	538	17	1053
2:00	2	134			3	138				
2:15	4	150			2	161				
2:30	3	150			2	167				
2:45	3	159	12	593	6	164	13	630	25	1223
3:00	3	174			6	144				
3:15	2	150			3	153				
3:30	1	152			3	165				
3:45	3	137	9	613	4	193	16	655	25	1268
4:00	2	159			6	181				
4:15	6	138			5	184				
4:30	11	138			5	192				
4:45	9	148	28	583	6	208	22	765	50	1348
5:00	17	139			12	197				
5:15	14	161			13	200				
5:30	20	127			27	180				
5:45	34	143	85	570	41	181	93	758	178	1328
6:00	44	130			35	169				
6:15	44	92			44	143				
6:30	66	113			75	128				
6:45	88	94	242	429	93	141	247	581	489	1010
7:00	102	105			96	105				
7:15	110	93			115	94				
7:30	138	77			147	93				
7:45	179	64	529	339	174	105	532	397	1061	736
8:00	187	67			125	78				
8:15	177	76			139	83				
8:30	153	52			126	74				
8:45	136	71	653	266	146	47	536	282	1189	548
9:00	147	59			142	43				
9:15	119	34			124	38				
9:30	126	43			139	56				
9:45	114	33	506	169	138	46	543	183	1049	352
10:00	107	35			112	38				
10:15	118	25			106	31				
10:30	119	24			133	30				
10:45	104	10	448	94	143	34	494	133	942	227
11:00	122	14			138	19				
11:15	127	19			130	14				
11:30	138	11			126	16				
11:45	111	7	498	51	130	5	524	54	1022	105
Total	3032	4759			3057	5556			6089	10315
Percent	38.9%	61.1%			35.5%	64.5%			37.1%	62.9%

Accurate Counts
978-664-2565

Location : Highland Avenue 83150001
Location : West of Cross Street
City/State: Needham, MA

3/29/2023	EB		Hour Totals		WB		Hour Totals		Combined Totals	
Time	Morning	Afternoon	Morning	Afternon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00	5	141			12	122				
12:15	4	135			4	157				
12:30	5	115			3	135				
12:45	6	127	20	518	9	158	28	572	48	1090
1:00	1	132			0	116				
1:15	1	155			6	139				
1:30	2	137			4	139				
1:45	2	141	6	565	5	137	15	531	21	1096
2:00	2	128			3	142				
2:15	3	161			4	143				
2:30	1	133			4	166				
2:45	1	160	7	582	1	142	12	593	19	1175
3:00	0	148			0	177				
3:15	1	177			4	163				
3:30	5	146			6	164				
3:45	3	135	9	606	9	180	19	684	28	1290
4:00	6	142			4	185				
4:15	9	137			6	182				
4:30	5	144			4	205				
4:45	13	136	33	559	6	187	20	759	53	1318
5:00	23	150			12	217				
5:15	17	138			17	201				
5:30	17	151			26	215				
5:45	37	136	94	575	47	200	102	833	196	1408
6:00	31	137			34	179				
6:15	42	145			54	188				
6:30	68	129			66	148				
6:45	85	113	226	524	107	163	261	678	487	1202
7:00	92	105			102	120				
7:15	126	69			129	114				
7:30	168	85			156	108				
7:45	173	92	559	351	144	96	531	438	1090	789
8:00	204	77			137	97				
8:15	159	71			135	93				
8:30	174	68			138	83				
8:45	151	58	688	274	109	68	519	341	1207	615
9:00	118	83			135	63				
9:15	131	42			143	68				
9:30	105	72			139	59				
9:45	127	46	481	243	140	38	557	228	1038	471
10:00	127	33			131	30				
10:15	113	38			135	32				
10:30	115	24			129	27				
10:45	117	23	472	118	119	14	514	103	986	221
11:00	115	20			134	22				
11:15	132	15			148	22				
11:30	134	8			131	19				
11:45	128	6	509	49	142	10	555	73	1064	122
Total	3104	4964			3133	5833			6237	10797
Percent	38.5%	61.5%			34.9%	65.1%			36.6%	63.4%
Grand Total	6136	9723			6190	11389			12326	21112
Percent	38.7%	61.3%			35.2%	64.8%			36.9%	63.1%
ADT		ADT: 16,719		AADT: 16,719						

Accurate Counts
978-664-2565

Location : Highland Avenue 83150001
Location : West of Cross Street
City/State: Needham, MA

3/27/2023	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Week Average	
Time	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
12:00 AM	*	*	19	23	20	28	*	*	*	*	*	*	*	*	20	26
1:00	*	*	3	14	6	15	*	*	*	*	*	*	*	*	4	14
2:00	*	*	12	13	7	12	*	*	*	*	*	*	*	*	10	12
3:00	*	*	9	16	9	19	*	*	*	*	*	*	*	*	9	18
4:00	*	*	28	22	33	20	*	*	*	*	*	*	*	*	30	21
5:00	*	*	85	93	94	102	*	*	*	*	*	*	*	*	90	98
6:00	*	*	242	247	226	261	*	*	*	*	*	*	*	*	234	254
7:00	*	*	529	532	559	531	*	*	*	*	*	*	*	*	544	532
8:00	*	*	653	536	688	519	*	*	*	*	*	*	*	*	670	528
9:00	*	*	506	543	481	557	*	*	*	*	*	*	*	*	494	550
10:00	*	*	448	494	472	514	*	*	*	*	*	*	*	*	460	504
11:00	*	*	498	524	509	555	*	*	*	*	*	*	*	*	504	540
12:00 PM	*	*	537	580	518	572	*	*	*	*	*	*	*	*	528	576
1:00	*	*	515	538	565	531	*	*	*	*	*	*	*	*	540	534
2:00	*	*	593	630	582	593	*	*	*	*	*	*	*	*	588	612
3:00	*	*	613	655	606	684	*	*	*	*	*	*	*	*	610	670
4:00	*	*	583	765	559	759	*	*	*	*	*	*	*	*	571	762
5:00	*	*	570	758	575	833	*	*	*	*	*	*	*	*	572	796
6:00	*	*	429	581	524	678	*	*	*	*	*	*	*	*	476	630
7:00	*	*	339	397	351	438	*	*	*	*	*	*	*	*	345	418
8:00	*	*	266	282	274	341	*	*	*	*	*	*	*	*	270	312
9:00	*	*	169	183	243	228	*	*	*	*	*	*	*	*	206	206
10:00	*	*	94	133	118	103	*	*	*	*	*	*	*	*	106	118
11:00	*	*	51	54	20	22	*	*	*	*	*	*	*	*	36	38
Total	0	0	7791	8613	8039	8915	0	0	0	0	0	0	0	0	7917	8769
Day	0		16404		16954		0		0		0		0		16686	
AM Peak			8:00	9:00	8:00	9:00									8:00	9:00
Volume			653	543	688	557									670	550
PM Peak			3:00	4:00	3:00	5:00									3:00	5:00
Volume			613	765	606	833									610	796
Comb Total	0		16404		16954		0		0		0		0		16686	
ADT	ADT: 16,719		AADT: 16,719													

MANUAL TURNING MOVEMENT COUNT DATA

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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	21	27	7	42	94	12	0	38	82	3	105	1	432
07:15 AM	22	59	6	55	100	17	1	42	87	7	135	4	535
07:30 AM	21	55	6	41	100	9	1	49	85	6	112	7	492
07:45 AM	17	33	6	36	112	18	3	91	86	14	117	8	541
Total	81	174	25	174	406	56	5	220	340	30	469	20	2000
08:00 AM	27	18	12	23	106	11	9	69	98	15	127	5	520
08:15 AM	24	30	10	27	123	8	7	39	83	10	165	8	534
08:30 AM	35	20	6	35	92	13	10	66	105	6	121	5	514
08:45 AM	18	16	3	28	95	15	8	59	82	10	95	4	433
Total	104	84	31	113	416	47	34	233	368	41	508	22	2001
Grand Total	185	258	56	287	822	103	39	453	708	71	977	42	4001
Apprch %	37.1	51.7	11.2	23.7	67.8	8.5	3.2	37.8	59	6.5	89.6	3.9	
Total %	4.6	6.4	1.4	7.2	20.5	2.6	1	11.3	17.7	1.8	24.4	1	
Cars	182	253	54	283	809	100	39	449	702	68	966	42	3947
% Cars	98.4	98.1	96.4	98.6	98.4	97.1	100	99.1	99.2	95.8	98.9	100	98.7
Trucks	3	5	2	4	13	3	0	4	6	3	11	0	54
% Trucks	1.6	1.9	3.6	1.4	1.6	2.9	0	0.9	0.8	4.2	1.1	0	1.3

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 2

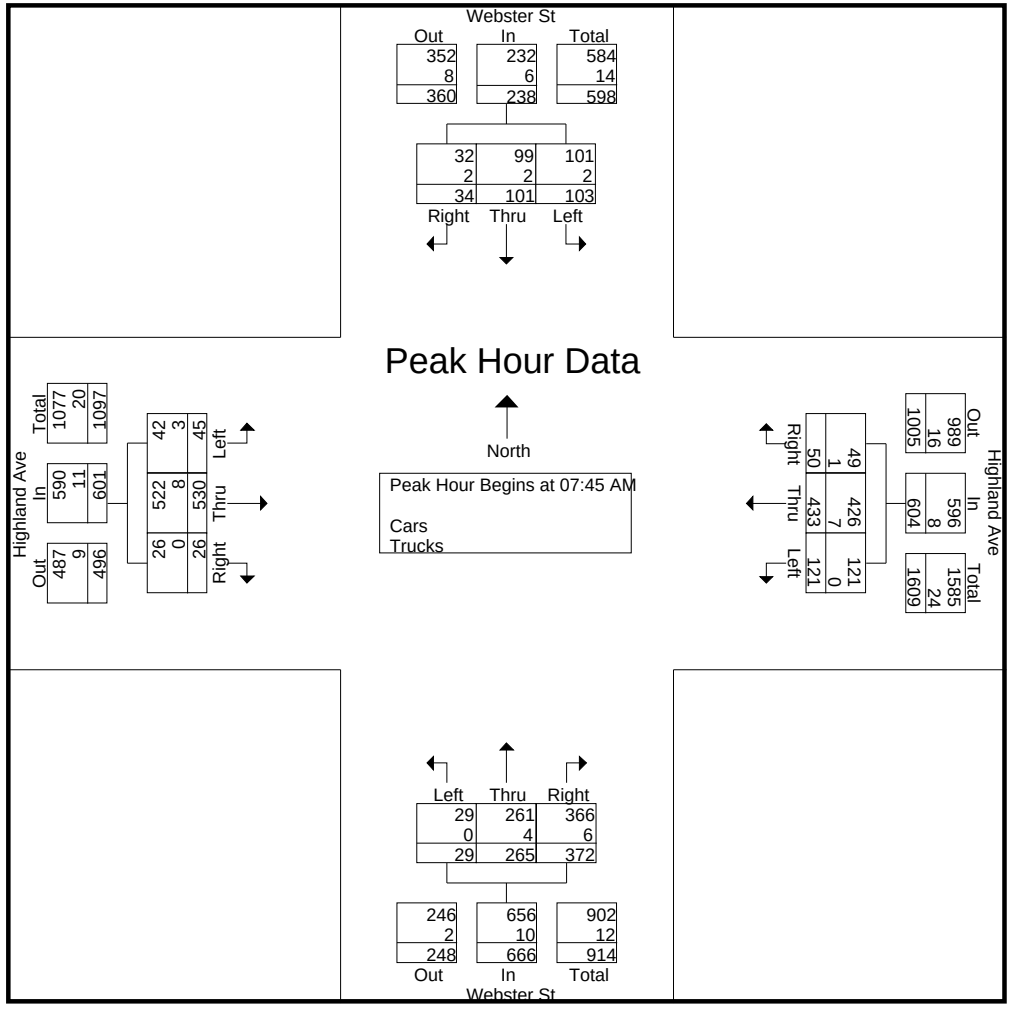
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	17	**33**	6	56	**36**	112	**18**	**166**	3	**91**	86	180	14	117	**8**	139	**541**
08:00 AM	27	18	**12**	57	23	106	11	140	9	69	98	176	**15**	127	5	147	520
08:15 AM	24	30	10	**64**	27	**123**	8	158	7	39	83	129	10	**165**	8	**183**	534
08:30 AM	**35**	20	6	61	35	92	13	140	**10**	66	**105**	**181**	6	121	5	132	514
Total Volume	103	101	34	238	121	433	50	604	29	265	372	666	45	530	26	601	2109
% App. Total	43.3	42.4	14.3		20	71.7	8.3		4.4	39.8	55.9		7.5	88.2	4.3		
PHF	.736	.765	.708	.930	.840	.880	.694	.910	.725	.728	.886	.920	.750	.803	.813	.821	.975
Cars	101	99	32	232	121	426	49	596	29	261	366	656	42	522	26	590	2074
% Cars	98.1	98.0	94.1	97.5	100	98.4	98.0	98.7	100	98.5	98.4	98.5	93.3	98.5	100	98.2	98.3
Trucks	2	2	2	6	0	7	1	8	0	4	6	10	3	8	0	11	35
% Trucks	1.9	2.0	5.9	2.5	0	1.6	2.0	1.3	0	1.5	1.6	1.5	6.7	1.5	0	1.8	1.7

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

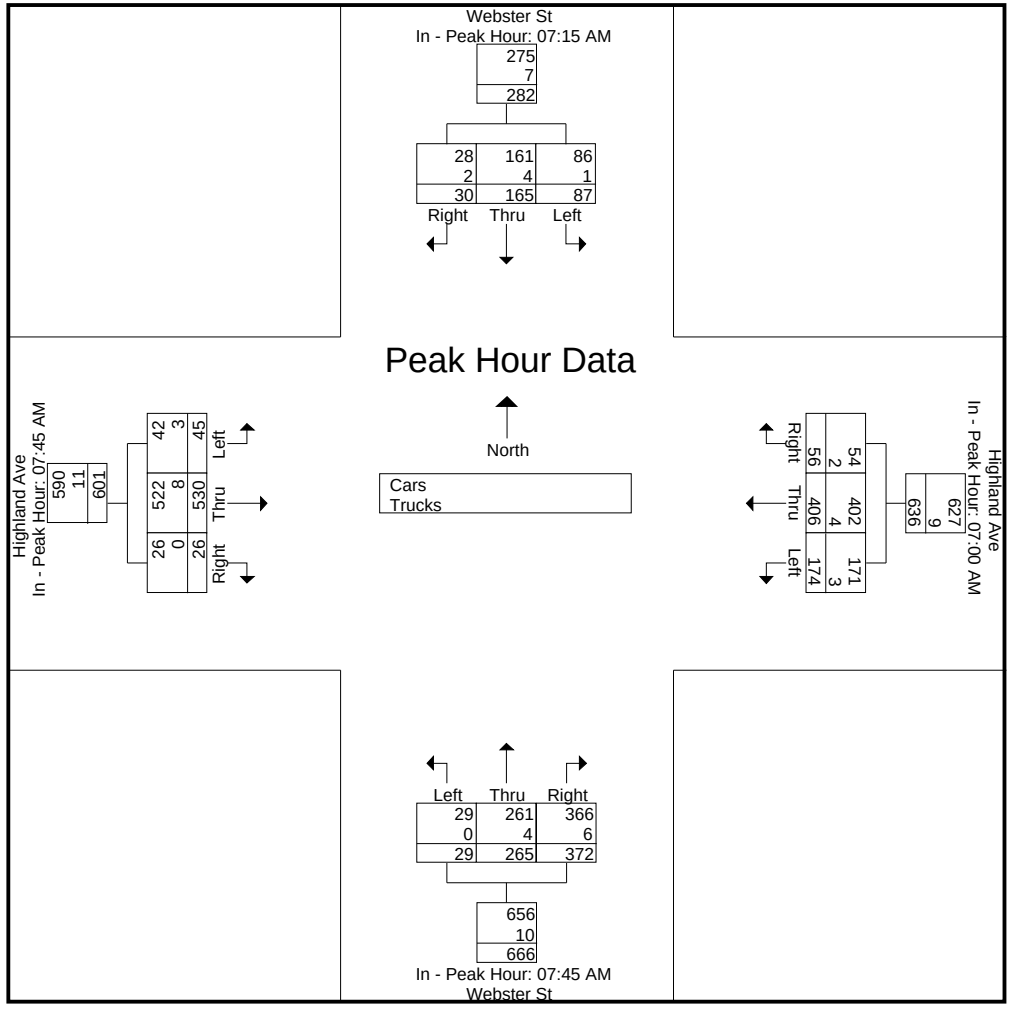
Peak Hour for Each Approach Begins at:

	07:15 AM				07:00 AM				07:45 AM				07:45 AM			
+0 mins.	22	**59**	6	**87**	42	94	12	148	3	**91**	86	180	14	117	**8**	139
+15 mins.	21	55	6	82	**55**	100	17	**172**	9	69	98	176	**15**	127	5	147
+30 mins.	17	33	6	56	41	100	9	150	7	39	83	129	10	**165**	8	**183**
+45 mins.	**27**	18	**12**	57	36	**112**	**18**	166	**10**	66	**105**	**181**	6	121	5	132
Total Volume	87	165	30	282	174	406	56	636	29	265	372	666	45	530	26	601

Accurate Counts

978-664-2565

% App. Total	30.9	58.5	10.6		27.4	63.8	8.8		4.4	39.8	55.9		7.5	88.2	4.3	
PHF	.806	.699	.625	.810	.791	.906	.778	.924	.725	.728	.886	.920	.750	.803	.813	.821
Cars	86	161	28	275	171	402	54	627	29	261	366	656	42	522	26	590
% Cars	98.9	97.6	93.3	97.5	98.3	99	96.4	98.6	100	98.5	98.4	98.5	93.3	98.5	100	98.2
Trucks	1	4	2	7	3	4	2	9	0	4	6	10	3	8	0	11
% Trucks	1.1	2.4	6.7	2.5	1.7	1	3.6	1.4	0	1.5	1.6	1.5	6.7	1.5	0	1.8



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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	21	26	7	40	92	10	0	38	82	3	104	1	424
07:15 AM	22	59	6	54	100	17	1	42	87	7	135	4	534
07:30 AM	21	53	6	41	99	9	1	49	85	6	112	7	489
07:45 AM	17	33	5	36	111	18	3	89	83	14	114	8	531
Total	81	171	24	171	402	54	5	218	337	30	465	20	1978
08:00 AM	26	16	11	23	103	10	9	68	98	13	126	5	508
08:15 AM	23	30	10	27	120	8	7	38	80	10	164	8	525
08:30 AM	35	20	6	35	92	13	10	66	105	5	118	5	510
08:45 AM	17	16	3	27	92	15	8	59	82	10	93	4	426
Total	101	82	30	112	407	46	34	231	365	38	501	22	1969
Grand Total	182	253	54	283	809	100	39	449	702	68	966	42	3947
Apprch %	37.2	51.7	11	23.7	67.9	8.4	3.3	37.7	59	6.3	89.8	3.9	
Total %	4.6	6.4	1.4	7.2	20.5	2.5	1	11.4	17.8	1.7	24.5	1.1	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 6

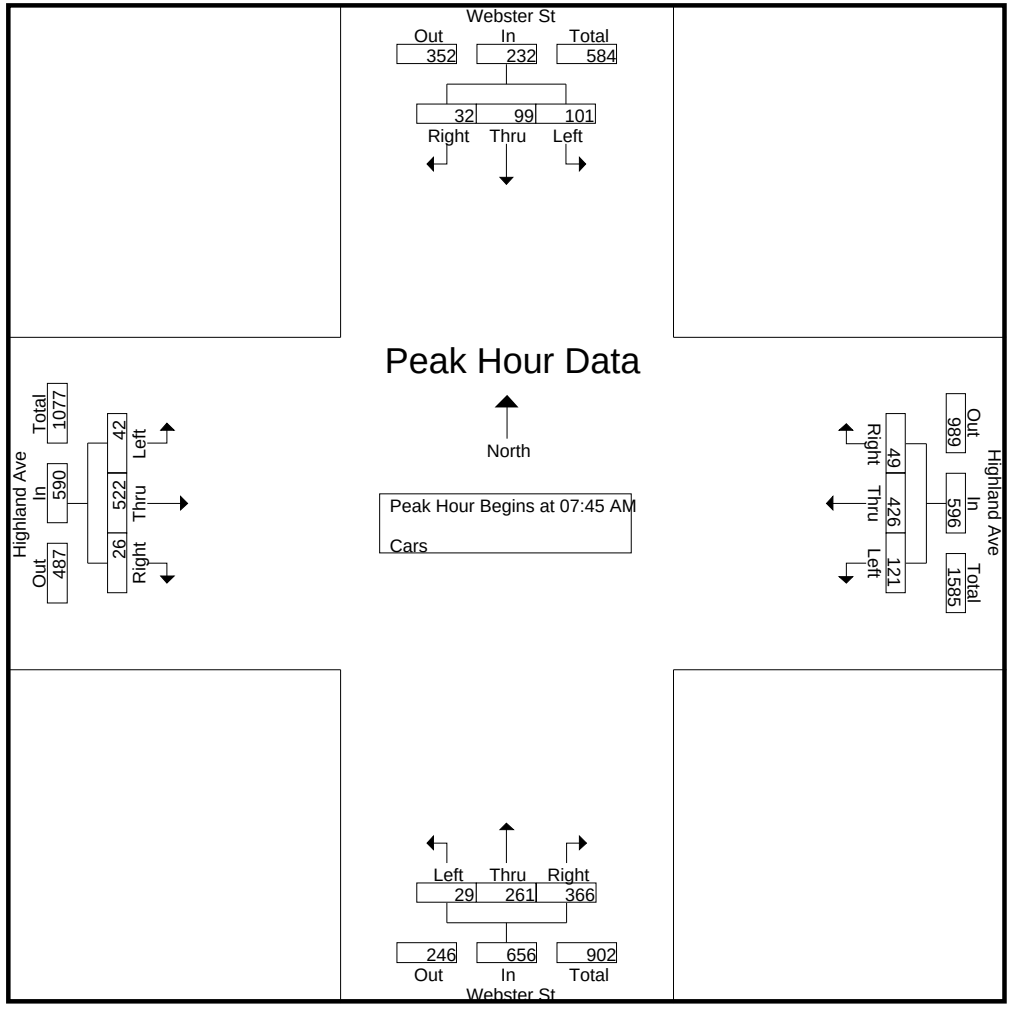
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	17	**33**	5	55	**36**	111	**18**	**165**	3	**89**	83	175	**14**	114	**8**	136	**531**
08:00 AM	26	16	**11**	53	23	103	10	136	9	68	98	175	13	126	5	144	508
08:15 AM	23	30	10	**63**	27	**120**	8	155	7	38	80	125	10	**164**	8	**182**	525
08:30 AM	**35**	20	6	61	35	92	13	140	**10**	66	**105**	**181**	5	118	5	128	510
Total Volume	101	99	32	232	121	426	49	596	29	261	366	656	42	522	26	590	2074
% App. Total	43.5	42.7	13.8		20.3	71.5	8.2		4.4	39.8	55.8		7.1	88.5	4.4		
PHF	.721	.750	.727	.921	.840	.888	.681	.903	.725	.733	.871	.906	.750	.796	.813	.810	.976

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

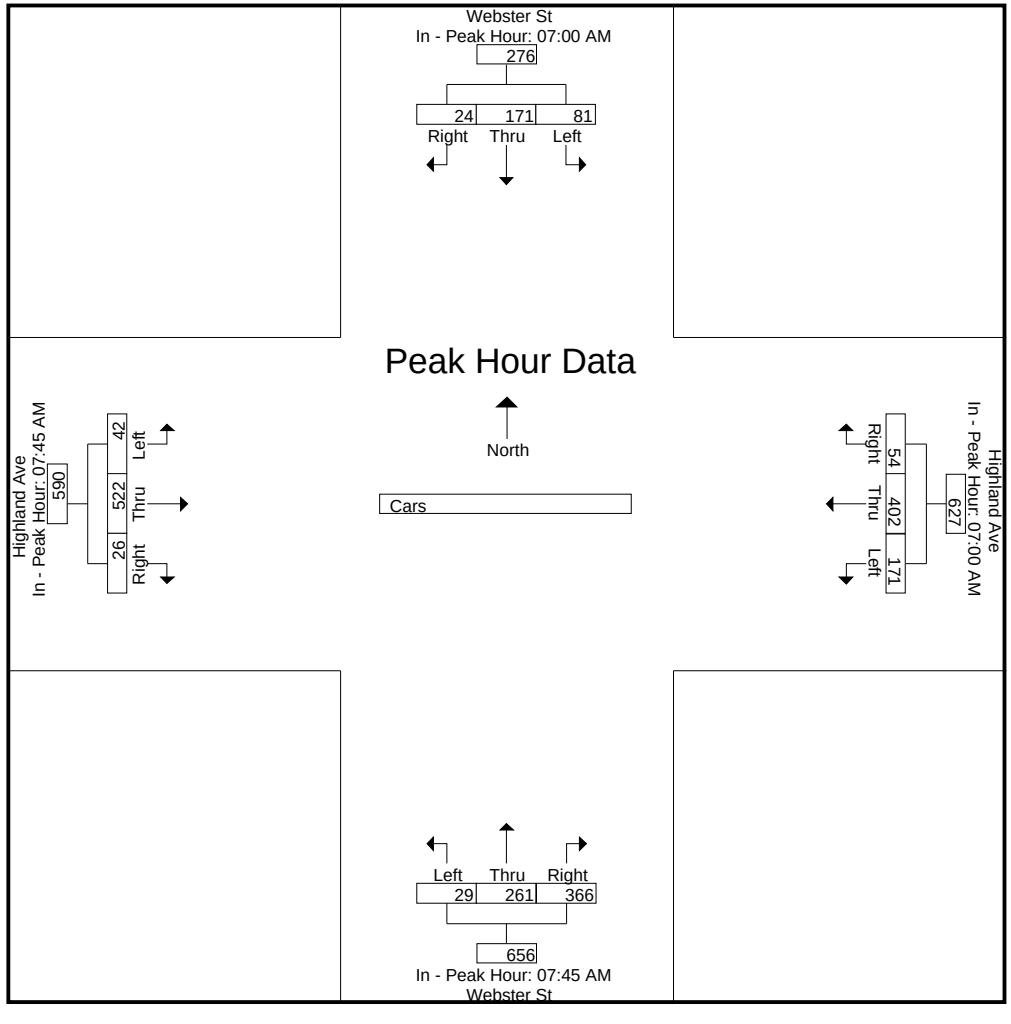
Peak Hour for Each Approach Begins at:

	07:00 AM				07:00 AM				07:45 AM				07:45 AM			
+0 mins.	21	26	**7**	54	40	92	10	142	3	**89**	83	175	**14**	114	**8**	136
+15 mins.	**22**	**59**	6	**87**	**54**	100	17	**171**	9	68	98	175	13	126	5	144
+30 mins.	21	53	6	80	41	99	9	149	7	38	80	125	10	**164**	8	**182**
+45 mins.	17	33	5	55	36	**111**	**18**	165	**10**	66	**105**	**181**	5	118	5	128
Total Volume	81	171	24	276	171	402	54	627	29	261	366	656	42	522	26	590

Accurate Counts

978-664-2565

% App. Total	29.3	62	8.7		27.3	64.1	8.6		4.4	39.8	55.8		7.1	88.5	4.4	
PHF	.920	.725	.857	.793	.792	.905	.750	.917	.725	.733	.871	.906	.750	.796	.813	.810



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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	1	0	2	2	2	0	0	0	0	1	0	8
07:15 AM	0	0	0	1	0	0	0	0	0	0	0	0	1
07:30 AM	0	2	0	0	1	0	0	0	0	0	0	0	3
07:45 AM	0	0	1	0	1	0	0	2	3	0	3	0	10
Total	0	3	1	3	4	2	0	2	3	0	4	0	22
08:00 AM	1	2	1	0	3	1	0	1	0	2	1	0	12
08:15 AM	1	0	0	0	3	0	0	1	3	0	1	0	9
08:30 AM	0	0	0	0	0	0	0	0	0	1	3	0	4
08:45 AM	1	0	0	1	3	0	0	0	0	0	2	0	7
Total	3	2	1	1	9	1	0	2	3	3	7	0	32
Grand Total	3	5	2	4	13	3	0	4	6	3	11	0	54
Apprch %	30	50	20	20	65	15	0	40	60	21.4	78.6	0	
Total %	5.6	9.3	3.7	7.4	24.1	5.6	0	7.4	11.1	5.6	20.4	0	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 10

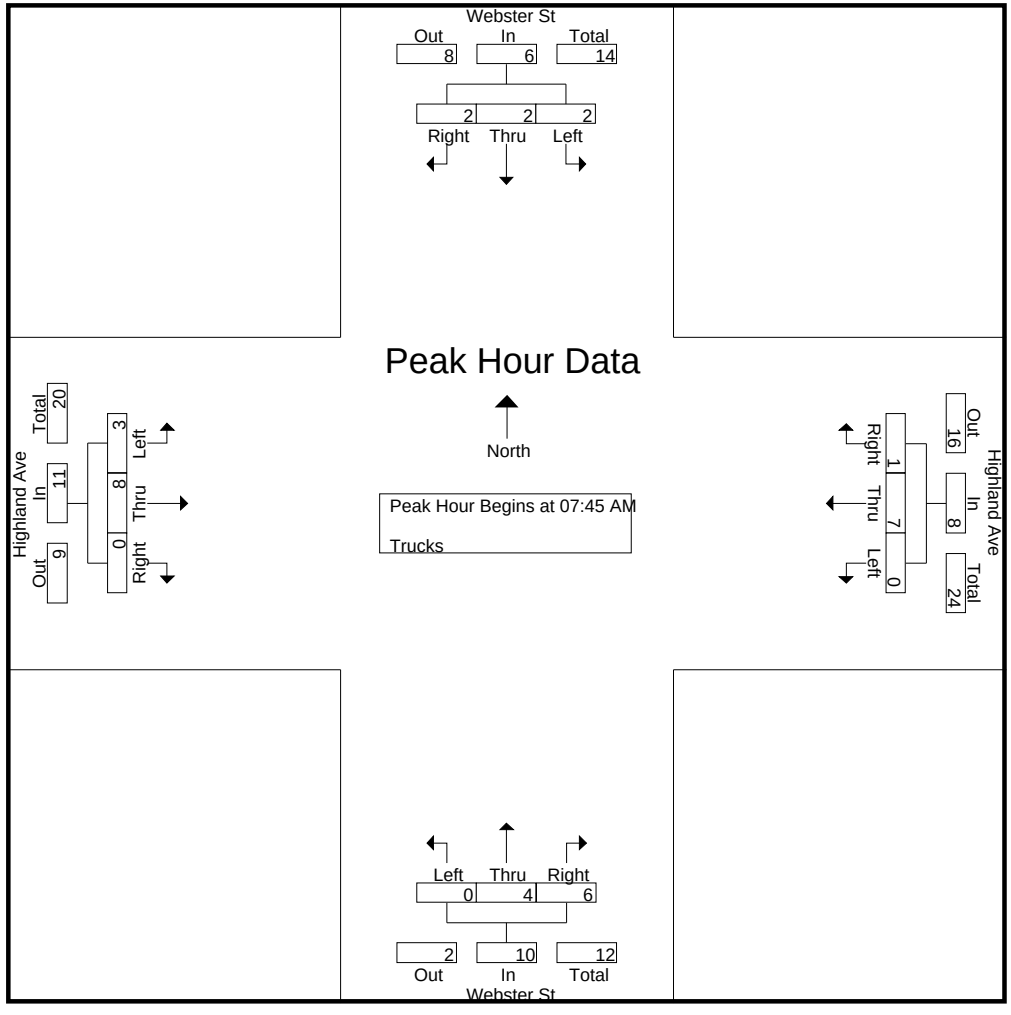
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	0	0	**1**	1	0	1	0	1	0	**2**	**3**	**5**	0	**3**	0	3	10
08:00 AM	**1**	**2**	1	**4**	0	**3**	**1**	**4**	0	1	0	1	**2**	1	0	3	**12**
08:15 AM	1	0	0	1	0	3	0	3	0	1	3	4	0	1	0	1	9
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	**4**	4
Total Volume	2	2	2	6	0	7	1	8	0	4	6	10	3	8	0	11	35
% App. Total	33.3	33.3	33.3		0	87.5	12.5		0	40	60		27.3	72.7	0		
PHF	.500	.250	.500	.375	.000	.583	.250	.500	.000	.500	.500	.500	.375	.667	.000	.688	.729

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

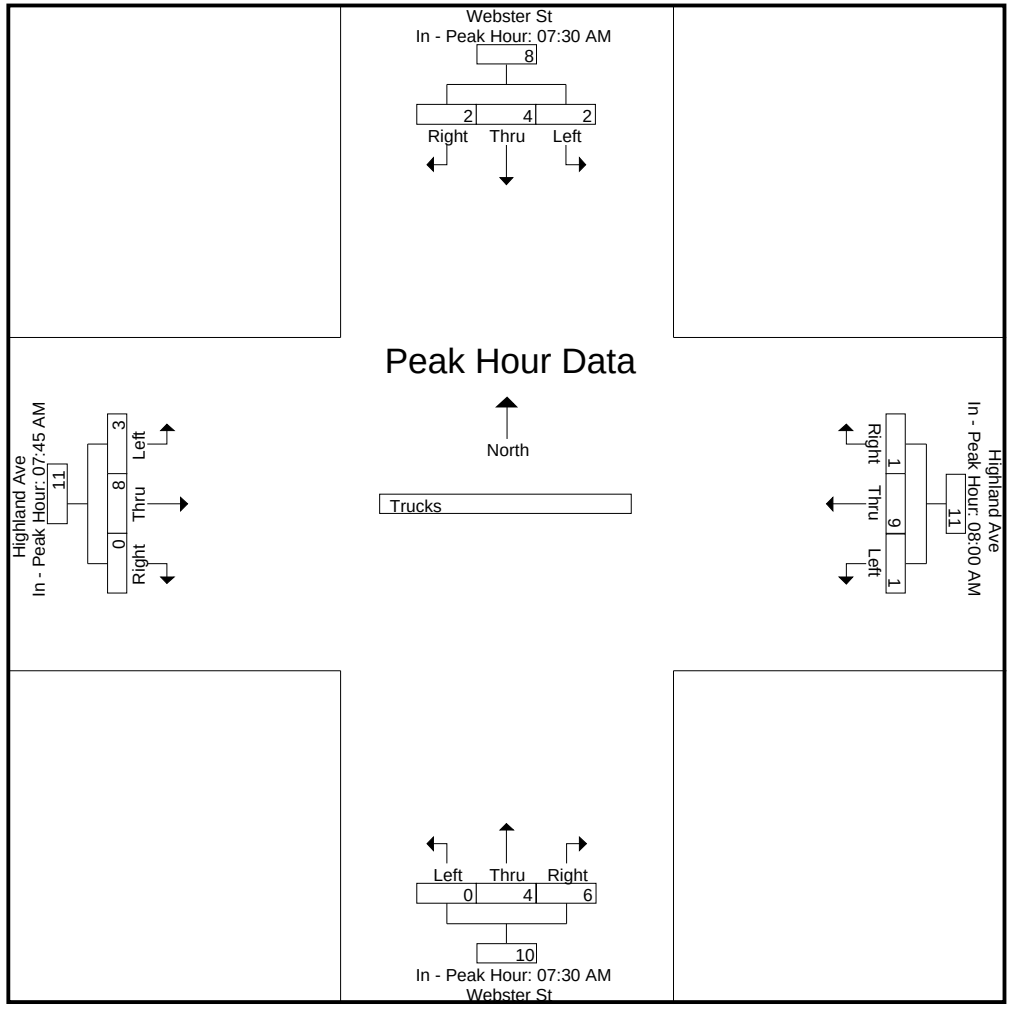
Peak Hour for Each Approach Begins at:

	07:30 AM				08:00 AM				07:30 AM				07:45 AM			
+0 mins.	0	**2**	0	2	0	**3**	**1**	**4**	0	0	0	0	0	**3**	0	3
+15 mins.	0	0	**1**	1	0	3	0	3	0	**2**	**3**	**5**	**2**	1	0	3
+30 mins.	**1**	2	1	**4**	0	0	0	0	0	1	0	1	0	1	0	1
+45 mins.	1	0	0	1	**1**	3	0	4	0	1	3	4	1	3	0	**4**
Total Volume	2	4	2	8	1	9	1	11	0	4	6	10	3	8	0	11

Accurate Counts

978-664-2565

% App. Total	25	50	25		9.1	81.8	9.1		0	40	60		27.3	72.7	0	
PHF	.500	.500	.500	.500	.250	.750	.250	.688	.000	.500	.500	.500	.375	.667	.000	.688



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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	1	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0	5	5
07:15 AM	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	1	4	1	5
07:30 AM	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	3	5
07:45 AM	0	0	0	0	0	0	0	4	0	0	1	0	0	2	0	0	4	3	7
Total	0	4	1	1	0	0	0	7	1	0	4	1	0	2	0	1	10	12	22
08:00 AM	0	1	0	0	0	0	0	3	0	2	1	0	0	0	0	1	4	4	8
08:15 AM	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	1	2	3
08:30 AM	0	0	0	1	0	0	0	2	0	0	1	1	0	0	0	0	4	1	5
08:45 AM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	3	0	3
Total	0	1	0	2	0	0	0	7	0	4	2	1	0	0	0	2	12	7	19
Grand Total	0	5	1	3	0	0	0	14	1	4	6	2	0	2	0	3	22	19	41
Apprch %	0	83.3	16.7		0	0	0		9.1	36.4	54.5		0	100	0				
Total %	0	26.3	5.3		0	0	0		5.3	21.1	31.6		0	10.5	0		53.7	46.3	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 14

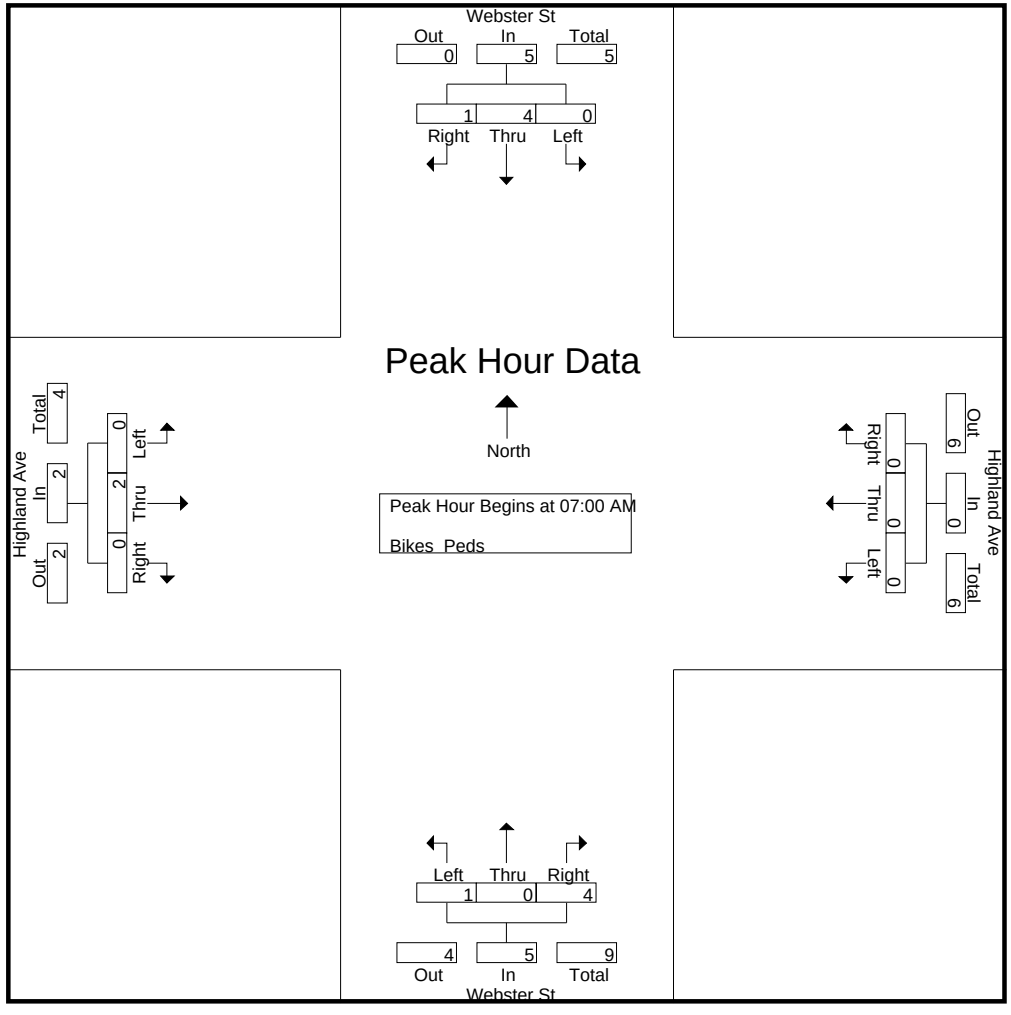
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:00 AM																	
07:00 AM	0	1	**1**	2	0	0	0	0	**1**	0	**2**	**3**	0	0	0	0	**5**
07:15 AM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
07:30 AM	0	**3**	0	**3**	0	0	0	0	0	0	0	0	0	0	0	0	3
07:45 AM	0	0	0	0	0	0	0	0	0	0	1	1	0	**2**	0	**2**	3
Total Volume	0	4	1	5	0	0	0	0	1	0	4	5	0	2	0	2	12
% App. Total	0	80	20		0	0	0		20	0	80		0	100	0		
PHF	.000	.333	.250	.417	.000	.000	.000	.000	.250	.000	.500	.417	.000	.250	.000	.250	.600

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

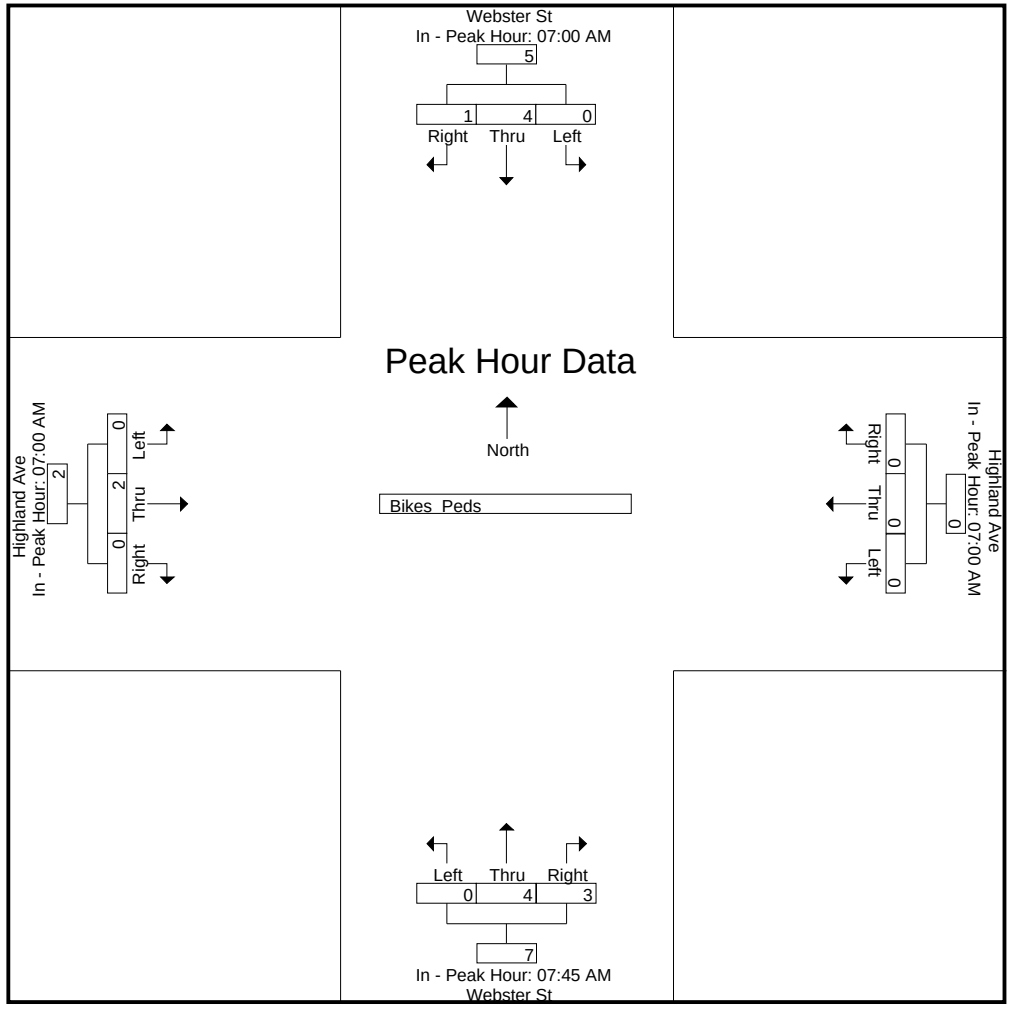
Peak Hour for Each Approach Begins at:

	07:00 AM				07:00 AM				07:45 AM				07:00 AM			
+0 mins.	0	1	**1**	2	0	0	0	0	0	0	**1**	1	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	**2**	1	**3**	0	0	0	0
+30 mins.	0	**3**	0	**3**	0	0	0	0	0	2	0	2	0	0	0	0
+45 mins.	0	0	0	0	0	0	0	0	0	0	1	1	0	**2**	0	**2**
Total Volume	0	4	1	5	0	0	0	0	0	4	3	7	0	2	0	2

Accurate Counts

978-664-2565

% App. Total	0	80	20		0	0	0		0	57.1	42.9		0	100	0	
PHF	.000	.333	.250	.417	.000	.000	.000	.000	.000	.500	.750	.583	.000	.250	.000	.250



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
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
03:00 PM	28	46	8	37	103	12	2	32	62	10	112	1	453
03:15 PM	20	26	11	52	111	12	2	22	44	6	116	5	427
03:30 PM	20	39	11	50	137	14	4	27	52	8	113	2	477
03:45 PM	15	40	6	45	115	12	1	31	44	7	97	4	417
Total	83	151	36	184	466	50	9	112	202	31	438	12	1774
04:00 PM	16	36	14	69	155	21	3	40	45	6	93	2	500
04:15 PM	11	56	11	65	114	15	7	21	56	5	117	9	487
04:30 PM	17	46	12	94	146	16	7	15	32	6	103	6	500
04:45 PM	23	54	7	84	145	17	6	41	36	4	97	3	517
Total	67	192	44	312	560	69	23	117	169	21	410	20	2004
05:00 PM	19	77	15	64	159	15	3	31	28	5	119	3	538
05:15 PM	22	61	14	86	141	17	7	29	39	14	100	7	537
05:30 PM	14	44	11	82	159	15	5	51	34	8	89	2	514
05:45 PM	18	53	11	88	152	20	6	57	43	9	86	4	547
Total	73	235	51	320	611	67	21	168	144	36	394	16	2136
Grand Total	223	578	131	816	1637	186	53	397	515	88	1242	48	5914
Apprch %	23.9	62	14.1	30.9	62	7	5.5	41.1	53.4	6.4	90.1	3.5	
Total %	3.8	9.8	2.2	13.8	27.7	3.1	0.9	6.7	8.7	1.5	21	0.8	
Cars	221	577	128	816	1626	183	53	393	513	88	1231	48	5877
% Cars	99.1	99.8	97.7	100	99.3	98.4	100	99	99.6	100	99.1	100	99.4
Trucks	2	1	3	0	11	3	0	4	2	0	11	0	37
% Trucks	0.9	0.2	2.3	0	0.7	1.6	0	1	0.4	0	0.9	0	0.6

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
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 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	19	**77**	**15**	**111**	64	**159**	15	238	3	31	28	62	5	**119**	3	**127**	538
05:15 PM	**22**	61	14	97	86	141	17	244	**7**	29	39	75	**14**	100	**7**	121	537
05:30 PM	14	44	11	69	82	159	15	256	5	51	34	90	8	89	2	99	514
05:45 PM	18	53	11	82	**88**	152	**20**	**260**	6	**57**	**43**	**106**	9	86	4	99	**547**
Total Volume	73	235	51	359	320	611	67	998	21	168	144	333	36	394	16	446	2136
% App. Total	20.3	65.5	14.2		32.1	61.2	6.7		6.3	50.5	43.2		8.1	88.3	3.6		
PHF	.830	.763	.850	.809	.909	.961	.838	.960	.750	.737	.837	.785	.643	.828	.571	.878	.976
Cars	73	235	49	357	320	608	67	995	21	168	144	333	36	392	16	444	2129
% Cars	100	100	96.1	99.4	100	99.5	100	99.7	100	100	100	100	100	99.5	100	99.6	99.7
Trucks	0	0	2	2	0	3	0	3	0	0	0	0	0	2	0	2	7
% Trucks	0	0	3.9	0.6	0	0.5	0	0.3	0	0	0	0	0	0.5	0	0.4	0.3

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 3

Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

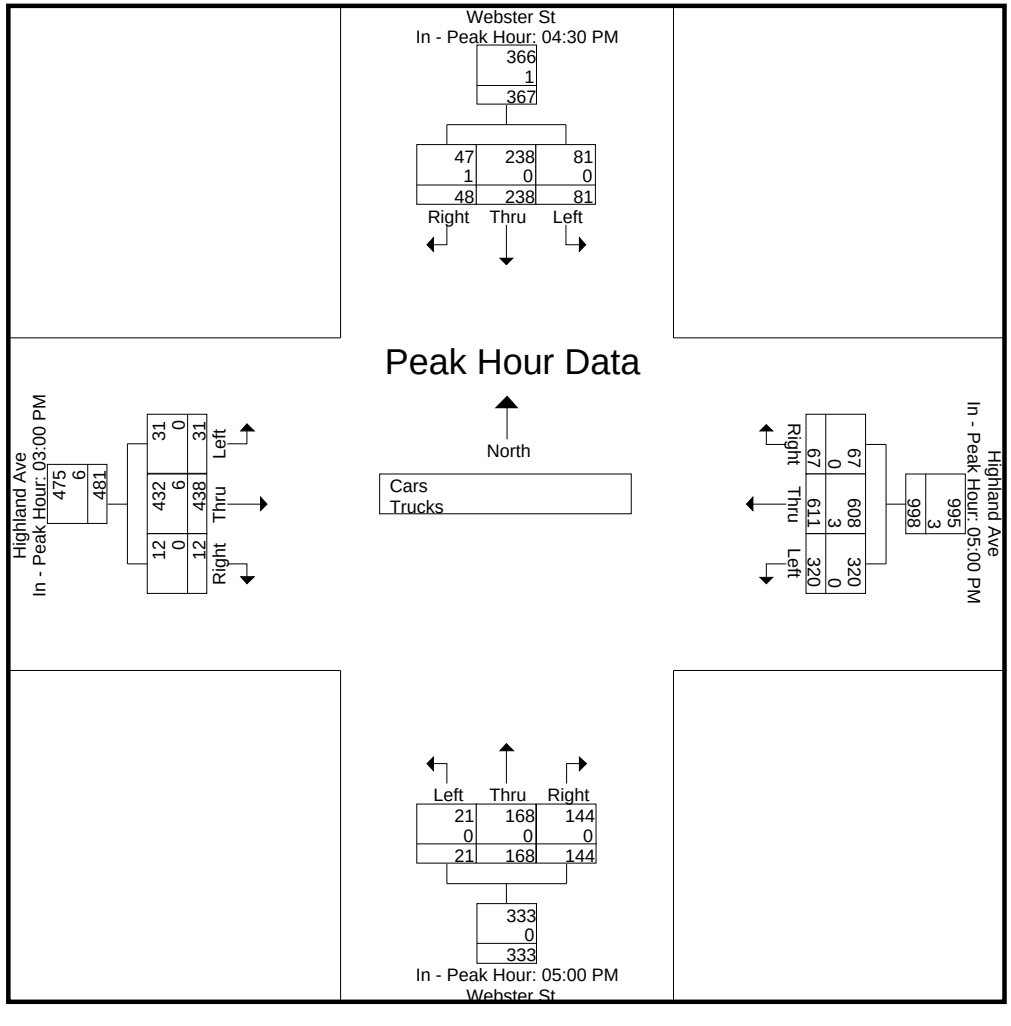
Peak Hour for Each Approach Begins at:

	04:30 PM				05:00 PM				05:00 PM				03:00 PM			
+0 mins.	17	46	12	75	64	**159**	15	238	3	31	28	62	**10**	112	1	123
+15 mins.	**23**	54	7	84	86	141	17	244	**7**	29	39	75	6	**116**	**5**	**127**
+30 mins.	19	**77**	**15**	**111**	82	159	15	256	5	51	34	90	8	113	2	123
+45 mins.	22	61	14	97	**88**	152	**20**	**260**	6	**57**	**43**	**106**	7	97	4	108
Total Volume	81	238	48	367	320	611	67	998	21	168	144	333	31	438	12	481
% App. Total	22.1	64.9	13.1		32.1	61.2	6.7		6.3	50.5	43.2		6.4	91.1	2.5	
PHF	.880	.773	.800	.827	.909	.961	.838	.960	.750	.737	.837	.785	.775	.944	.600	.947

Accurate Counts

978-664-2565

Cars	81	238	47	366	320	608	67	995	21	168	144	333	31	432	12	475
% Cars	100	100	97.9	99.7	100	99.5	100	99.7	100	100	100	100	100	98.6	100	98.8
Trucks	0	0	1	1	0	3	0	3	0	0	0	0	0	6	0	6
% Trucks	0	0	2.1	0.3	0	0.5	0	0.3	0	0	0	0	0	1.4	0	1.2



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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
03:00 PM	27	45	7	37	103	12	2	32	62	10	111	1	449
03:15 PM	20	26	11	52	110	11	2	21	43	6	112	5	419
03:30 PM	20	39	11	50	135	12	4	26	52	8	112	2	471
03:45 PM	14	40	6	45	114	12	1	30	44	7	97	4	414
Total	81	150	35	184	462	47	9	109	201	31	432	12	1753
04:00 PM	16	36	14	69	154	21	3	40	45	6	93	2	499
04:15 PM	11	56	11	65	114	15	7	20	56	5	117	9	486
04:30 PM	17	46	12	94	144	16	7	15	32	6	100	6	495
04:45 PM	23	54	7	84	144	17	6	41	35	4	97	3	515
Total	67	192	44	312	556	69	23	116	168	21	407	20	1995
05:00 PM	19	77	15	64	159	15	3	31	28	5	119	3	538
05:15 PM	22	61	13	86	141	17	7	29	39	14	100	7	536
05:30 PM	14	44	11	82	158	15	5	51	34	8	88	2	512
05:45 PM	18	53	10	88	150	20	6	57	43	9	85	4	543
Total	73	235	49	320	608	67	21	168	144	36	392	16	2129
Grand Total	221	577	128	816	1626	183	53	393	513	88	1231	48	5877
Apprch %	23.9	62.3	13.8	31.1	61.9	7	5.5	41	53.5	6.4	90.1	3.5	
Total %	3.8	9.8	2.2	13.9	27.7	3.1	0.9	6.7	8.7	1.5	20.9	0.8	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 6

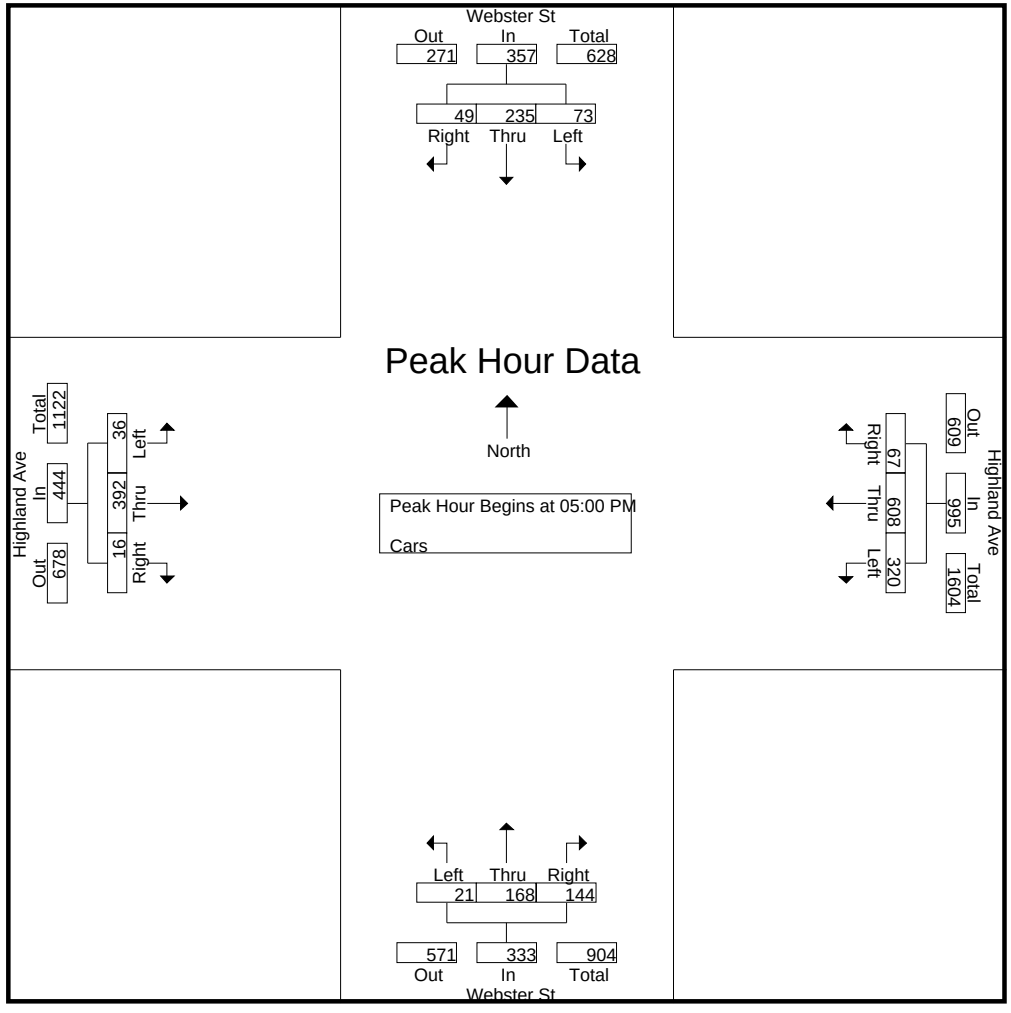
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	19	**77**	**15**	**111**	64	**159**	15	238	3	31	28	62	5	**119**	3	**127**	538
05:15 PM	**22**	61	13	96	86	141	17	244	**7**	29	39	75	**14**	100	**7**	121	536
05:30 PM	14	44	11	69	82	158	15	255	5	51	34	90	8	88	2	98	512
05:45 PM	18	53	10	81	**88**	150	**20**	**258**	6	**57**	**43**	**106**	9	85	4	98	**543**
Total Volume	73	235	49	357	320	608	67	995	21	168	144	333	36	392	16	444	2129
% App. Total	20.4	65.8	13.7		32.2	61.1	6.7		6.3	50.5	43.2		8.1	88.3	3.6		
PHF	.830	.763	.817	.804	.909	.956	.838	.964	.750	.737	.837	.785	.643	.824	.571	.874	.980

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

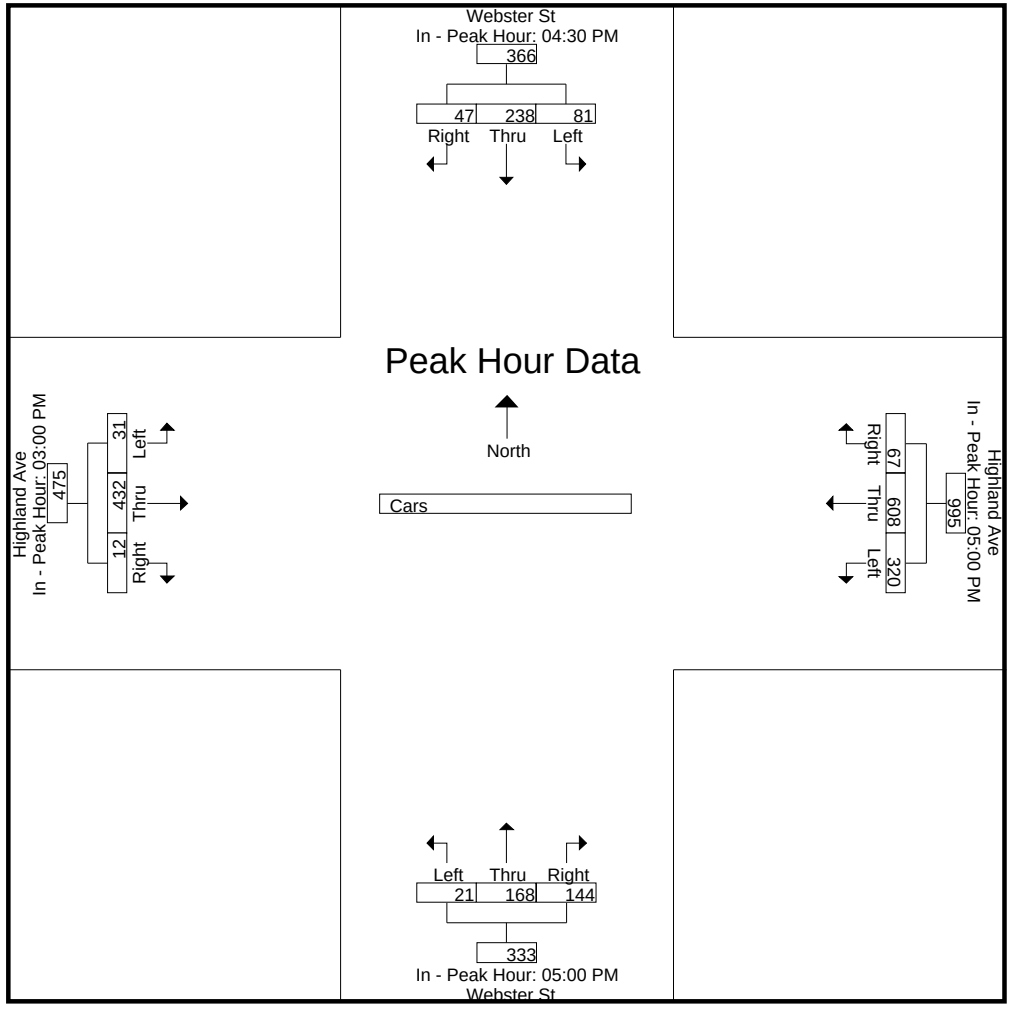
	04:30 PM				05:00 PM				05:00 PM				03:00 PM			
+0 mins.	17	46	12	75	64	**159**	15	238	3	31	28	62	**10**	111	1	122
+15 mins.	**23**	54	7	84	86	141	17	244	**7**	29	39	75	6	**112**	**5**	**123**
+30 mins.	19	**77**	**15**	**111**	82	158	15	255	5	51	34	90	8	112	2	122
+45 mins.	22	61	13	96	**88**	150	**20**	**258**	6	**57**	**43**	**106**	7	97	4	108
Total Volume	81	238	47	366	320	608	67	995	21	168	144	333	31	432	12	475
% App. Total	22.1	65	12.8		32.2	61.1	6.7		6.3	50.5	43.2		6.5	90.9	2.5	
PHF	.880	.773	.783	.824	.909	.956	.838	.964	.750	.737	.837	.785	.775	.964	.600	.965

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 8



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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
03:00 PM	1	1	1	0	0	0	0	0	0	0	1	0	4
03:15 PM	0	0	0	0	1	1	0	1	1	0	4	0	8
03:30 PM	0	0	0	0	2	2	0	1	0	0	1	0	6
03:45 PM	1	0	0	0	1	0	0	1	0	0	0	0	3
Total	2	1	1	0	4	3	0	3	1	0	6	0	21
04:00 PM	0	0	0	0	1	0	0	0	0	0	0	0	1
04:15 PM	0	0	0	0	0	0	0	1	0	0	0	0	1
04:30 PM	0	0	0	0	2	0	0	0	0	0	3	0	5
04:45 PM	0	0	0	0	1	0	0	0	1	0	0	0	2
Total	0	0	0	0	4	0	0	1	1	0	3	0	9
05:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
05:15 PM	0	0	1	0	0	0	0	0	0	0	0	0	1
05:30 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
05:45 PM	0	0	1	0	2	0	0	0	0	0	1	0	4
Total	0	0	2	0	3	0	0	0	0	0	2	0	7
Grand Total	2	1	3	0	11	3	0	4	2	0	11	0	37
Apprch %	33.3	16.7	50	0	78.6	21.4	0	66.7	33.3	0	100	0	
Total %	5.4	2.7	8.1	0	29.7	8.1	0	10.8	5.4	0	29.7	0	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 10

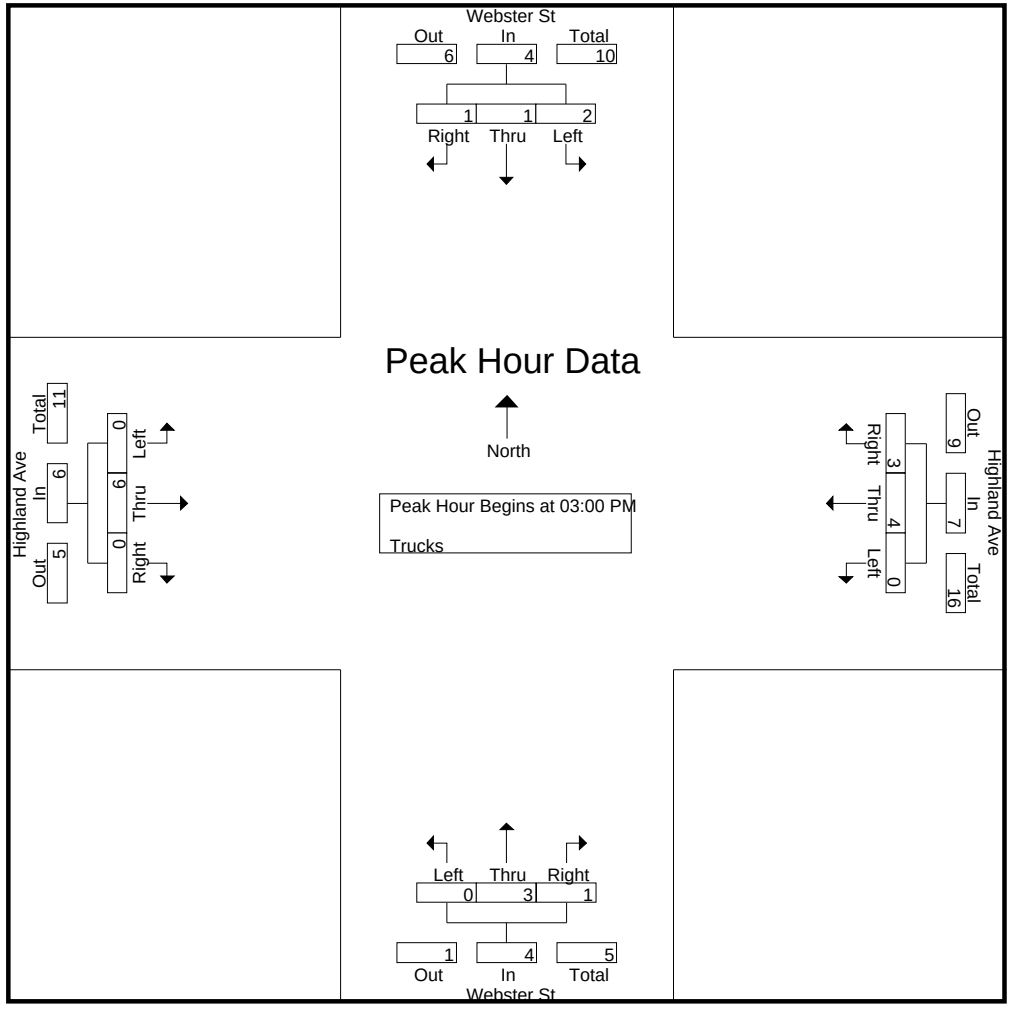
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:00 PM																	
03:00 PM	**1**	**1**	**1**	**3**	0	0	0	0	0	0	0	0	0	1	0	1	4
03:15 PM	0	0	0	0	0	1	1	2	0	**1**	**1**	**2**	0	**4**	0	**4**	**8**
03:30 PM	0	0	0	0	0	**2**	**2**	**4**	0	1	0	1	0	1	0	1	6
03:45 PM	1	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0	3
Total Volume	2	1	1	4	0	4	3	7	0	3	1	4	0	6	0	6	21
% App. Total	50	25	25		0	57.1	42.9		0	75	25		0	100	0		
PHF	.500	.250	.250	.333	.000	.500	.375	.438	.000	.750	.250	.500	.000	.375	.000	.375	.656

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

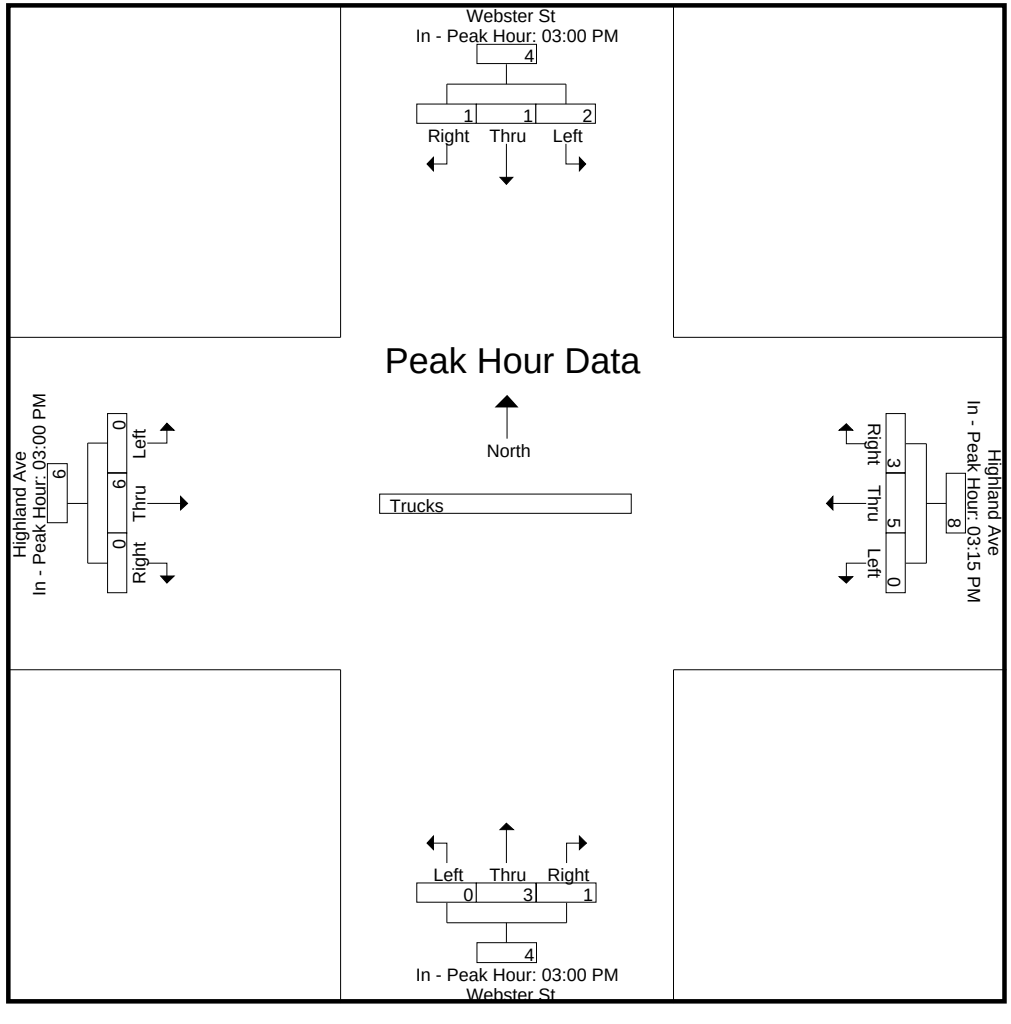
	03:00 PM				03:15 PM				03:00 PM				03:00 PM			
+0 mins.	**1**	**1**	**1**	**3**	0	1	1	2	0	0	0	0	0	1	0	1
+15 mins.	0	0	0	0	0	**2**	**2**	**4**	0	**1**	**1**	**2**	0	**4**	0	**4**
+30 mins.	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1
+45 mins.	1	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0
Total Volume	2	1	1	4	0	5	3	8	0	3	1	4	0	6	0	6
% App. Total	50	25	25		0	62.5	37.5		0	75	25		0	100	0	
PHF	.500	.250	.250	.333	.000	.625	.375	.500	.000	.750	.250	.500	.000	.375	.000	.375

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 12



Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019

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
03:00 PM	0	0	1	0	0	0	0	1	0	2	0	2	0	0	0	2	5	3	8
03:15 PM	0	0	0	1	0	0	0	3	1	0	0	3	0	1	0	0	7	2	9
03:30 PM	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	2	2	4
03:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	2
Total	0	0	1	1	0	2	0	4	1	3	0	7	0	1	0	3	15	8	23
04:00 PM	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	4	4
04:15 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
04:30 PM	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	2	0	0	0	0	0	0	0	1	0	0	0	0	3	0	3
Total	0	2	0	3	0	0	0	0	0	0	1	1	0	1	0	0	4	4	8
05:00 PM	0	1	0	0	1	1	0	2	0	1	0	1	0	1	0	0	3	5	8
05:15 PM	0	0	0	0	1	1	0	2	0	1	0	1	0	0	0	0	3	3	6
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	2	1	3
05:45 PM	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	1	3	4
Total	0	1	0	0	3	3	0	5	0	3	0	4	1	1	0	0	9	12	21
Grand Total	0	3	1	4	3	5	0	9	1	6	1	12	1	3	0	3	28	24	52
Apprch %	0	75	25		37.5	62.5	0		12.5	75	12.5		25	75	0				
Total %	0	12.5	4.2		12.5	20.8	0		4.2	25	4.2		4.2	12.5	0		53.8	46.2	

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 14

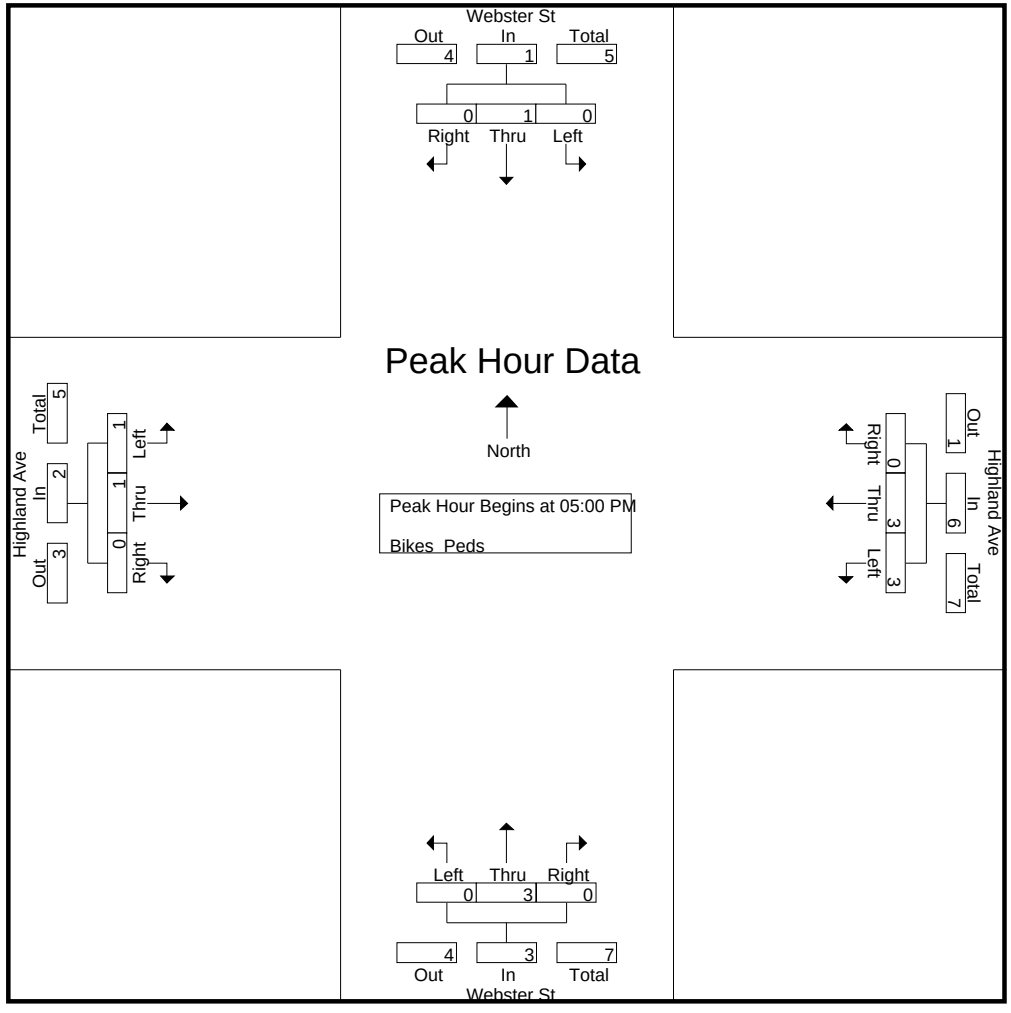
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	**1**	0	**1**	**1**	**1**	0	**2**	0	**1**	0	**1**	0	**1**	0	**1**	**5**
05:15 PM	0	0	0	0	1	1	0	2	0	1	0	1	0	0	0	0	3
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	1	1
05:45 PM	0	0	0	0	1	1	0	2	0	1	0	1	0	0	0	0	3
Total Volume	0	1	0	1	3	3	0	6	0	3	0	3	1	1	0	2	12
% App. Total	0	100	0		50	50	0		0	100	0		50	50	0		
PHF	.000	.250	.000	.250	.750	.750	.000	.750	.000	.750	.000	.750	.250	.250	.000	.500	.600

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

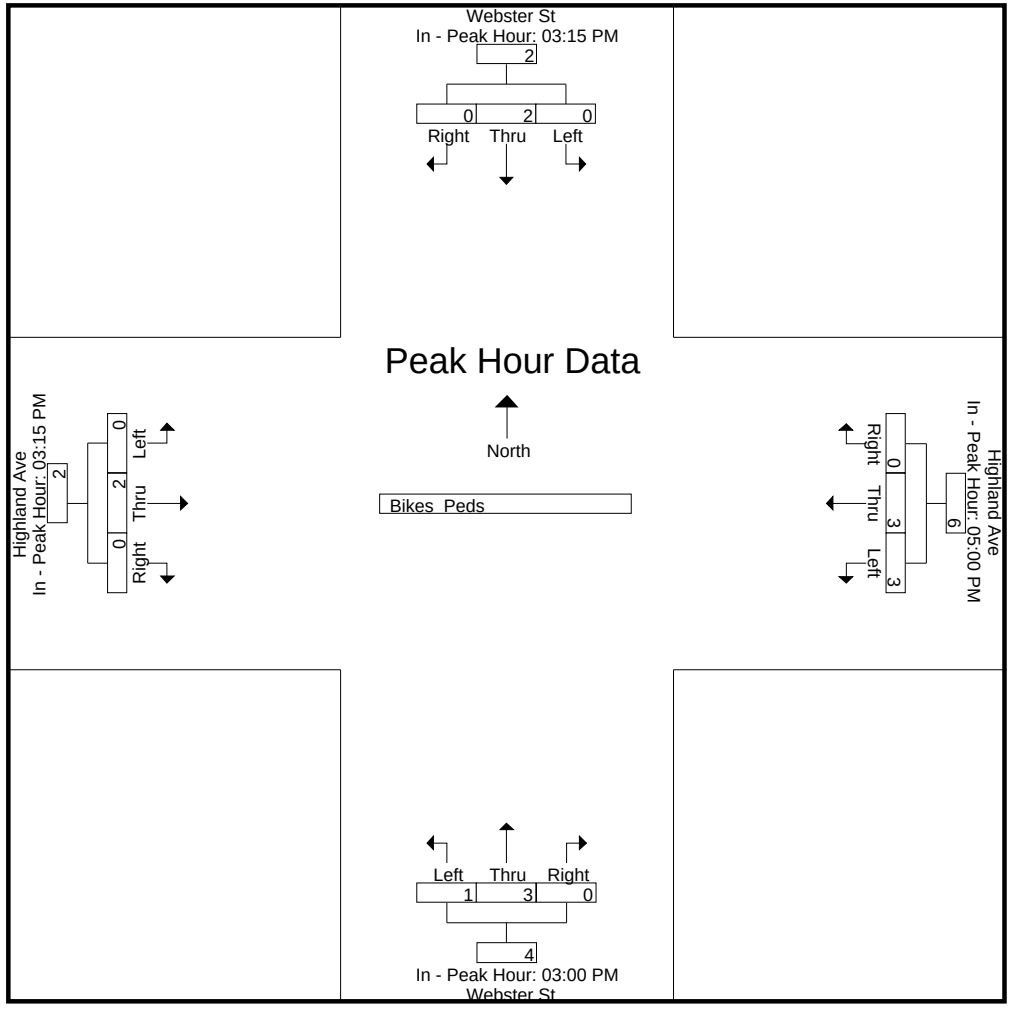
	03:15 PM				05:00 PM				03:00 PM				03:15 PM			
+0 mins.	0	0	0	0	**1**	**1**	0	**2**	0	**2**	0	**2**	0	**1**	0	**1**
+15 mins.	0	0	0	0	1	1	0	2	**1**	0	0	1	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
+45 mins.	0	**2**	0	**2**	1	1	0	2	0	0	0	0	0	1	0	1
Total Volume	0	2	0	2	3	3	0	6	1	3	0	4	0	2	0	2
% App. Total	0	100	0		50	50	0		25	75	0		0	100	0	
PHF	.000	.250	.000	.250	.750	.750	.000	.750	.250	.375	.000	.500	.000	.500	.000	.500

Accurate Counts

978-664-2565

N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 16



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Cars - Trucks

	Arbor Rd From North		Highland Ave From East		Highland Ave From West		
Start Time	Left	Right	Thru	Right	Left	Thru	Int. Total
07:00 AM	1	0	143	0	0	199	343
07:15 AM	0	2	172	0	1	243	418
07:30 AM	0	0	158	0	0	212	370
07:45 AM	0	0	175	1	0	215	391
Total	1	2	648	1	1	869	1522
08:00 AM	1	0	150	0	0	257	408
08:15 AM	0	0	156	2	1	261	420
08:30 AM	1	0	140	2	0	255	398
08:45 AM	0	0	136	3	2	196	337
Total	2	0	582	7	3	969	1563
Grand Total	3	2	1230	8	4	1838	3085
Apprch %	60	40	99.4	0.6	0.2	99.8	
Total %	0.1	0.1	39.9	0.3	0.1	59.6	
Cars	2	1	1205	8	4	1818	3038
% Cars	66.7	50	98	100	100	98.9	98.5
Trucks	1	1	25	0	0	20	47
% Trucks	33.3	50	2	0	0	1.1	1.5

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 2

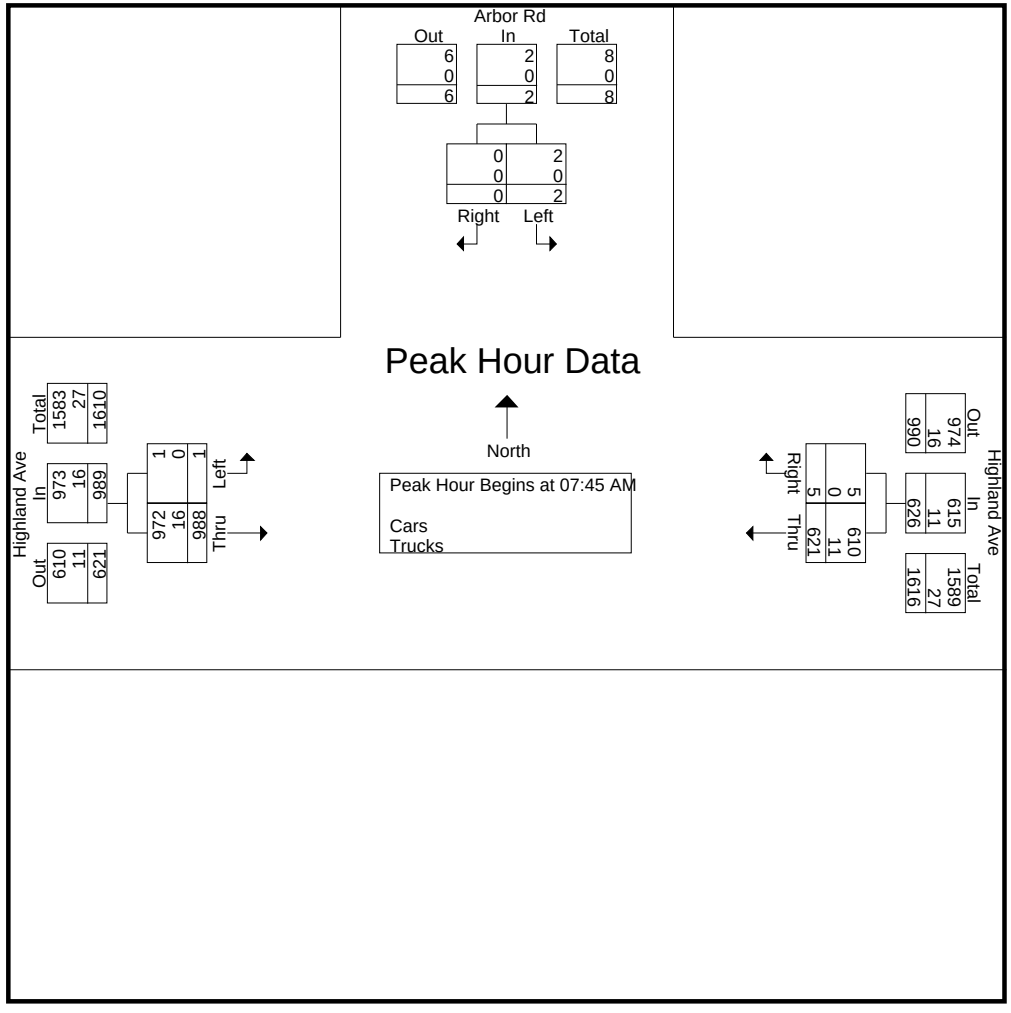
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 07:45 AM										
07:45 AM	0	0	0	**175**	1	**176**	0	215	215	391
08:00 AM	**1**	0	**1**	150	0	150	0	257	257	408
08:15 AM	0	0	0	156	**2**	158	**1**	**261**	**262**	**420**
08:30 AM	1	0	1	140	2	142	0	255	255	398
Total Volume	2	0	2	621	5	626	1	988	989	1617
% App. Total	100	0		99.2	0.8		0.1	99.9		
PHF	.500	.000	.500	.887	.625	.889	.250	.946	.944	.963
Cars	2	0	2	610	5	615	1	972	973	1590
% Cars	100	0	100	98.2	100	98.2	100	98.4	98.4	98.3
Trucks	0	0	0	11	0	11	0	16	16	27
% Trucks	0	0	0	1.8	0	1.8	0	1.6	1.6	1.7

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

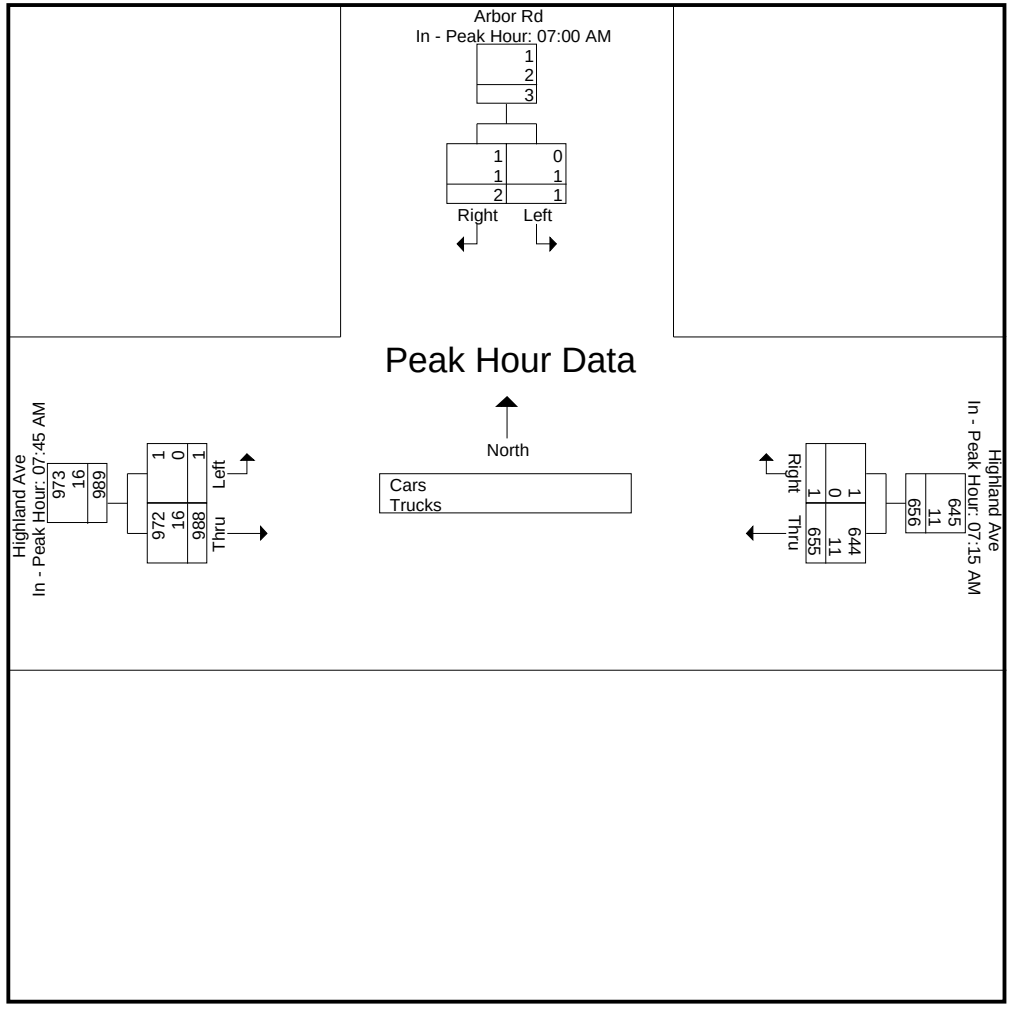
Peak Hour for Each Approach Begins at:

	07:00 AM			07:15 AM			07:45 AM		
+0 mins.	**1**	0	1	172	0	172	0	215	215
+15 mins.	0	**2**	**2**	158	0	158	0	257	257
+30 mins.	0	0	0	**175**	**1**	**176**	**1**	**261**	**262**
+45 mins.	0	0	0	150	0	150	0	255	255
Total Volume	1	2	3	655	1	656	1	988	989

Accurate Counts

978-664-2565

% App. Total	33.3	66.7		99.8	0.2		0.1	99.9	
PHF	.250	.250	.375	.936	.250	.932	.250	.946	.944
Cars	0	1	1	644	1	645	1	972	973
% Cars	0	50	33.3	98.3	100	98.3	100	98.4	98.4
Trucks	1	1	2	11	0	11	0	16	16
% Trucks	100	50	66.7	1.7	0	1.7	0	1.6	1.6



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Cars

	Arbor Rd From North		Highland Ave From East		Highland Ave From West		
Start Time	Left	Right	Thru	Right	Left	Thru	Int. Total
07:00 AM	0	0	136	0	0	198	334
07:15 AM	0	1	170	0	1	243	415
07:30 AM	0	0	157	0	0	212	369
07:45 AM	0	0	174	1	0	211	386
Total	0	1	637	1	1	864	1504
08:00 AM	1	0	143	0	0	253	397
08:15 AM	0	0	153	2	1	255	411
08:30 AM	1	0	140	2	0	253	396
08:45 AM	0	0	132	3	2	193	330
Total	2	0	568	7	3	954	1534
Grand Total	2	1	1205	8	4	1818	3038
Apprch %	66.7	33.3	99.3	0.7	0.2	99.8	
Total %	0.1	0	39.7	0.3	0.1	59.8	

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 6

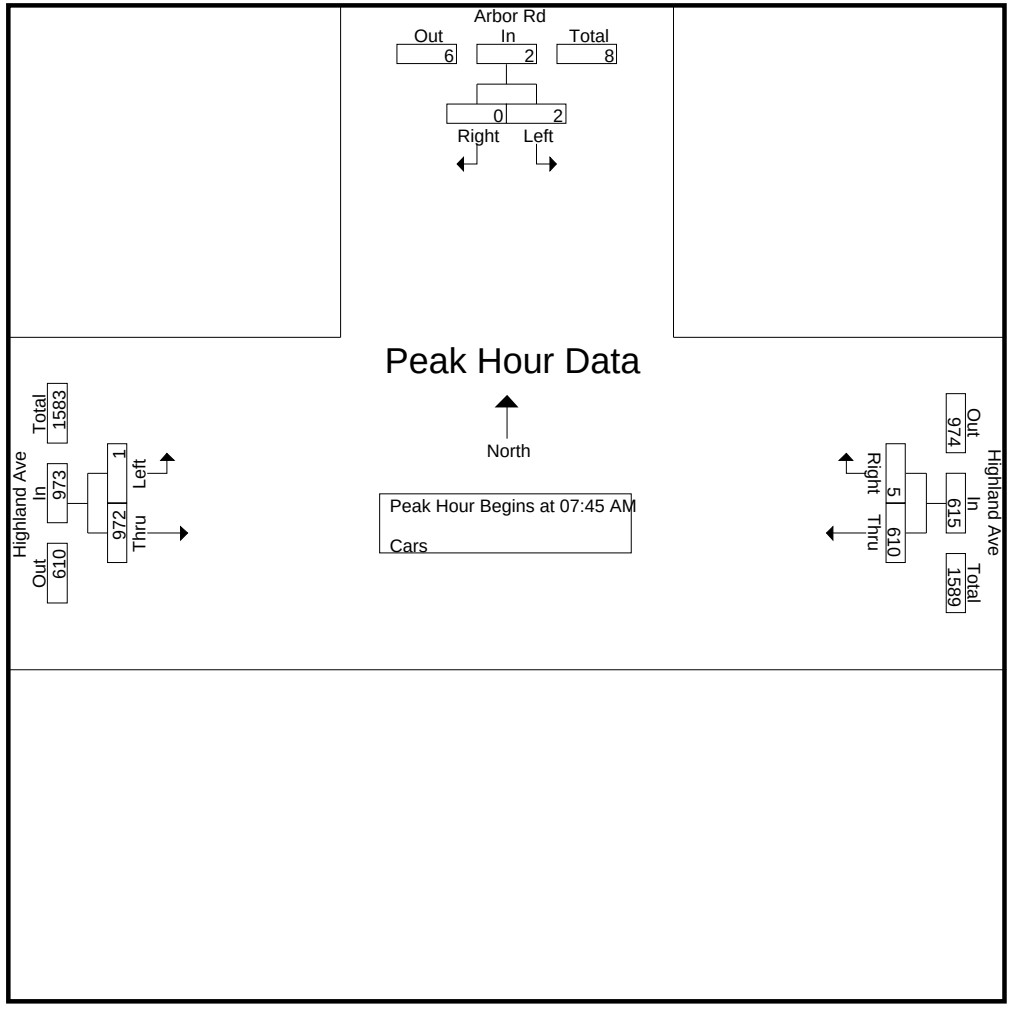
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 07:45 AM										
07:45 AM	0	0	0	**174**	1	**175**	0	211	211	386
08:00 AM	**1**	0	**1**	143	0	143	0	253	253	397
08:15 AM	0	0	0	153	**2**	155	**1**	**255**	**256**	**411**
08:30 AM	1	0	1	140	2	142	0	253	253	396
Total Volume	2	0	2	610	5	615	1	972	973	1590
% App. Total	100	0		99.2	0.8		0.1	99.9		
PHF	.500	.000	.500	.876	.625	.879	.250	.953	.950	.967

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

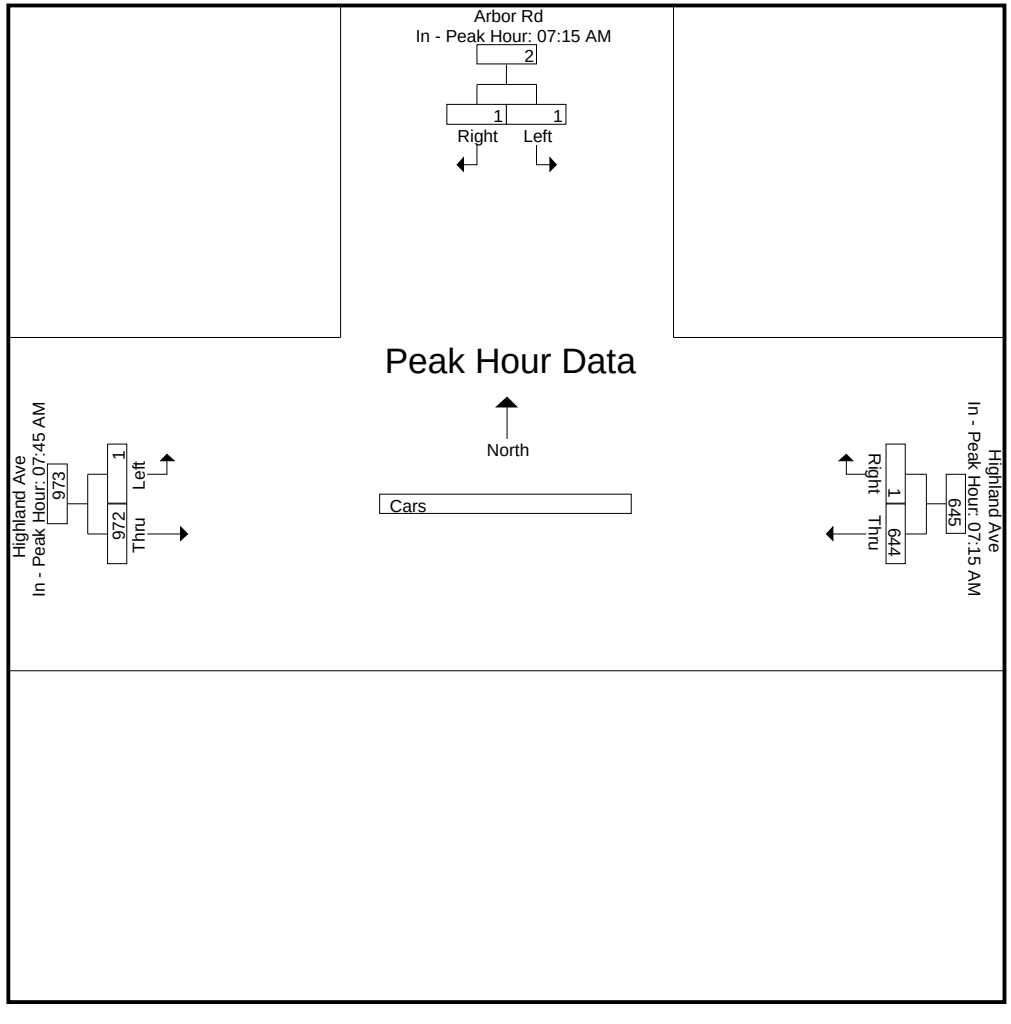
Peak Hour for Each Approach Begins at:

	07:15 AM			07:15 AM			07:45 AM		
+0 mins.	0	**1**	**1**	170	0	170	0	211	211
+15 mins.	0	0	0	157	0	157	0	253	253
+30 mins.	0	0	0	**174**	**1**	**175**	**1**	**255**	**256**
+45 mins.	**1**	0	1	143	0	143	0	253	253
Total Volume	1	1	2	644	1	645	1	972	973

Accurate Counts

978-664-2565

% App. Total	50	50		99.8	0.2		0.1	99.9	
PHF	.250	.250	.500	.925	.250	.921	.250	.953	.950



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Trucks

	Arbor Rd From North		Highland Ave From East		Highland Ave From West		
Start Time	Left	Right	Thru	Right	Left	Thru	Int. Total
07:00 AM	1	0	7	0	0	1	9
07:15 AM	0	1	2	0	0	0	3
07:30 AM	0	0	1	0	0	0	1
07:45 AM	0	0	1	0	0	4	5
Total	1	1	11	0	0	5	18
08:00 AM	0	0	7	0	0	4	11
08:15 AM	0	0	3	0	0	6	9
08:30 AM	0	0	0	0	0	2	2
08:45 AM	0	0	4	0	0	3	7
Total	0	0	14	0	0	15	29
Grand Total	1	1	25	0	0	20	47
Apprch %	50	50	100	0	0	100	
Total %	2.1	2.1	53.2	0	0	42.6	

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 10

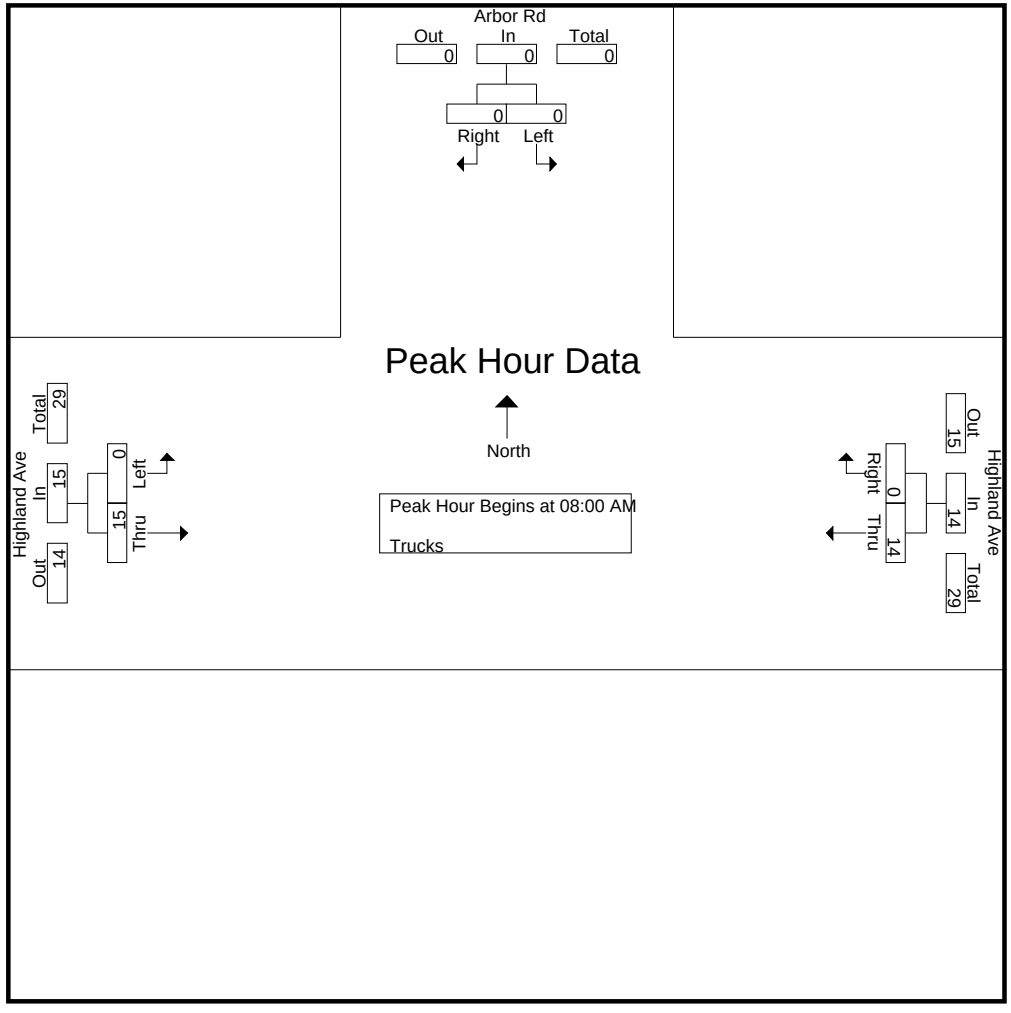
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 08:00 AM										
08:00 AM	0	0	0	**7**	0	**7**	0	4	4	**11**
08:15 AM	0	0	0	3	0	3	0	**6**	**6**	9
08:30 AM	0	0	0	0	0	0	0	2	2	2
08:45 AM	0	0	0	4	0	4	0	3	3	7
Total Volume	0	0	0	14	0	14	0	15	15	29
% App. Total	0	0		100	0		0	100		
PHF	.000	.000	.000	.500	.000	.500	.000	.625	.625	.659

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

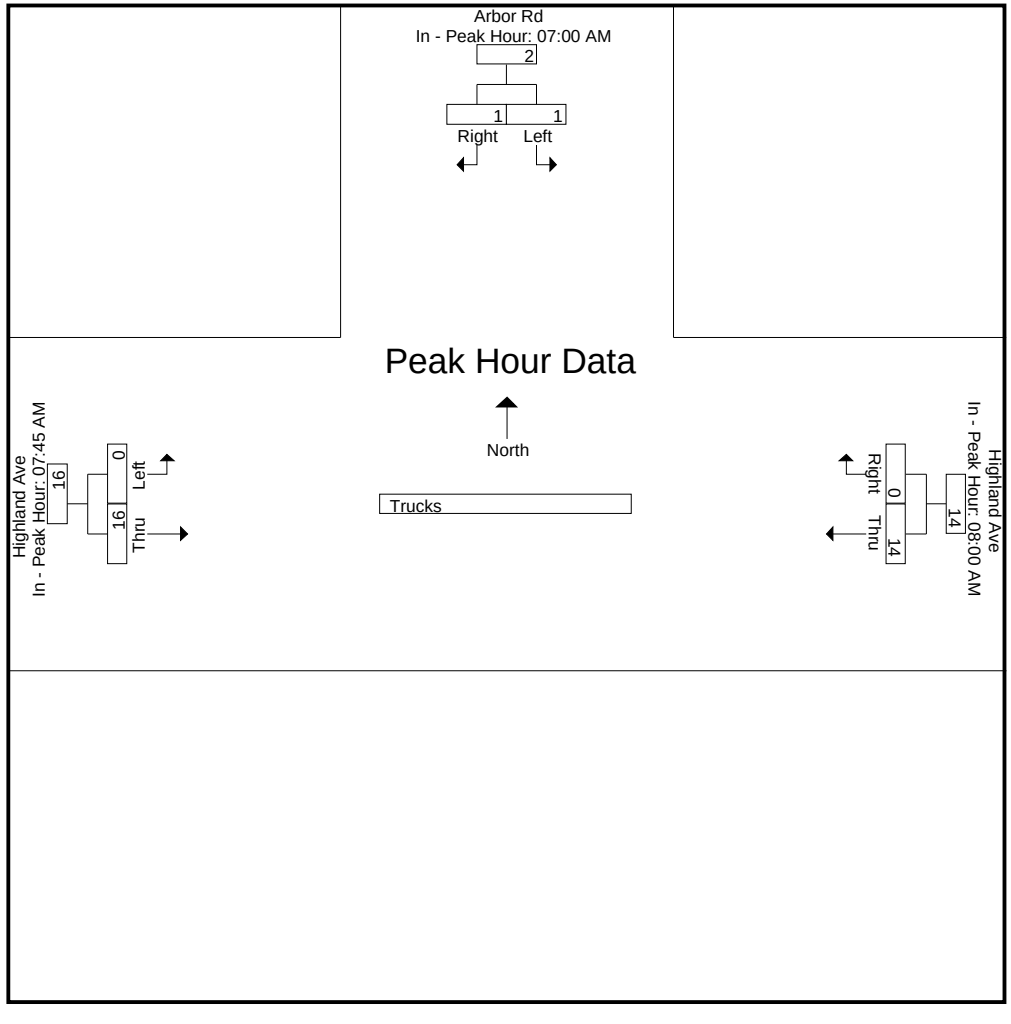
Peak Hour for Each Approach Begins at:

	07:00 AM			08:00 AM			07:45 AM		
+0 mins.	**1**	0	**1**	**7**	0	**7**	0	4	4
+15 mins.	0	**1**	1	3	0	3	0	4	4
+30 mins.	0	0	0	0	0	0	0	**6**	**6**
+45 mins.	0	0	0	4	0	4	0	2	2
Total Volume	1	1	2	14	0	14	0	16	16

Accurate Counts

978-664-2565

% App. Total	50	50		100	0		0	100	
PHF	.250	.250	.500	.500	.000	.500	.000	.667	.667



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Arbor Rd From North			Highland Ave From East			Highland Ave From West					
Start Time	Left	Right	Peds	Thru	Right	Peds	Left	Thru	Peds	Exclu. Total	Inclu. Total	Int. Total
07:00 AM	0	0	1	0	0	1	0	1	0	2	1	3
07:15 AM	0	0	1	0	0	0	0	1	0	1	1	2
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	2	0	0	2	2
Total	0	0	2	0	0	1	0	4	0	3	4	7
08:00 AM	0	0	0	0	0	0	0	2	0	0	2	2
08:15 AM	0	0	3	0	0	0	0	0	0	3	0	3
08:30 AM	0	0	0	0	0	0	0	1	0	0	1	1
08:45 AM	0	0	1	0	0	0	0	0	0	1	0	1
Total	0	0	4	0	0	0	0	3	0	4	3	7
Grand Total	0	0	6	0	0	1	0	7	0	7	7	14
Apprch %	0	0		0	0		0	100				
Total %	0	0		0	0		0	100		50	50	

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 14

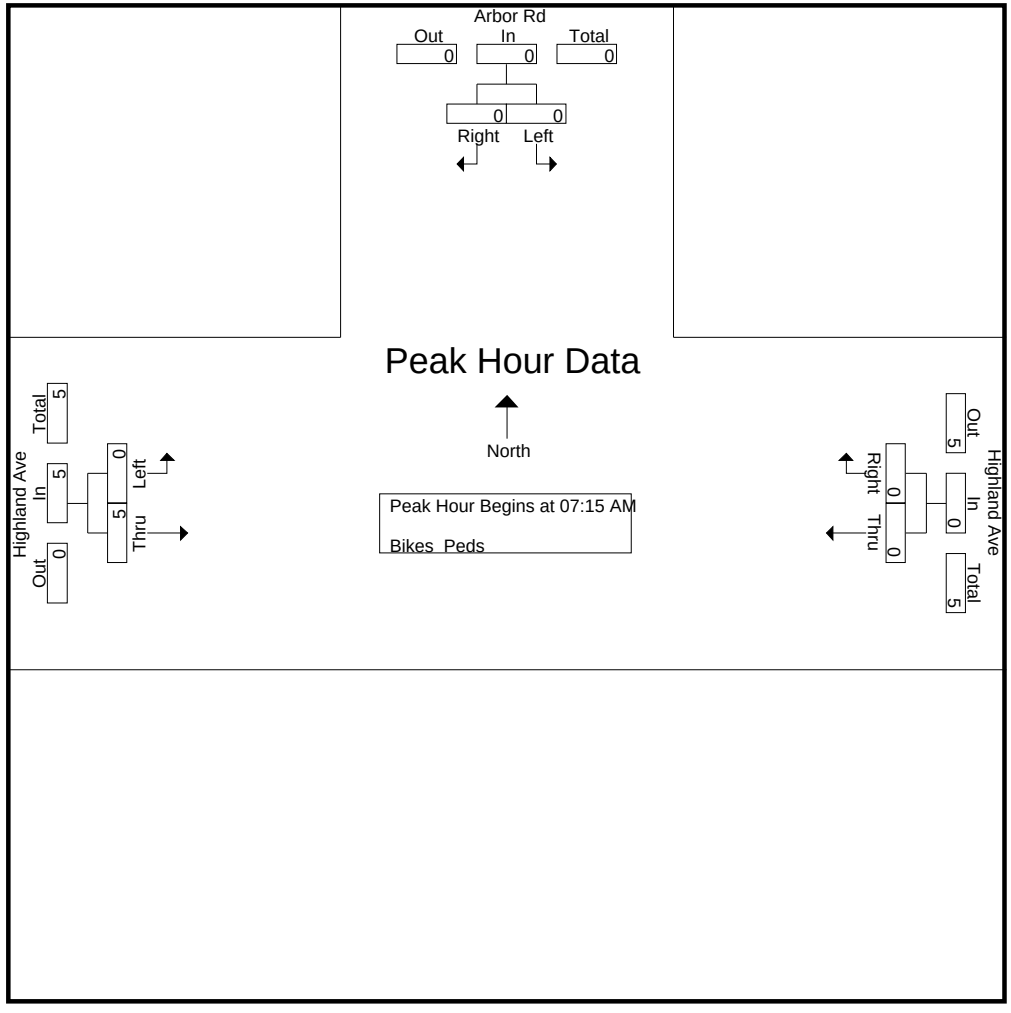
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 07:15 AM										
07:15 AM	0	0	0	0	0	0	0	1	1	1
07:30 AM	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	**2**	**2**	**2**
08:00 AM	0	0	0	0	0	0	0	2	2	2
Total Volume	0	0	0	0	0	0	0	5	5	5
% App. Total	0	0		0	0		0	100		
PHF	.000	.000	.000	.000	.000	.000	.000	.625	.625	.625

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

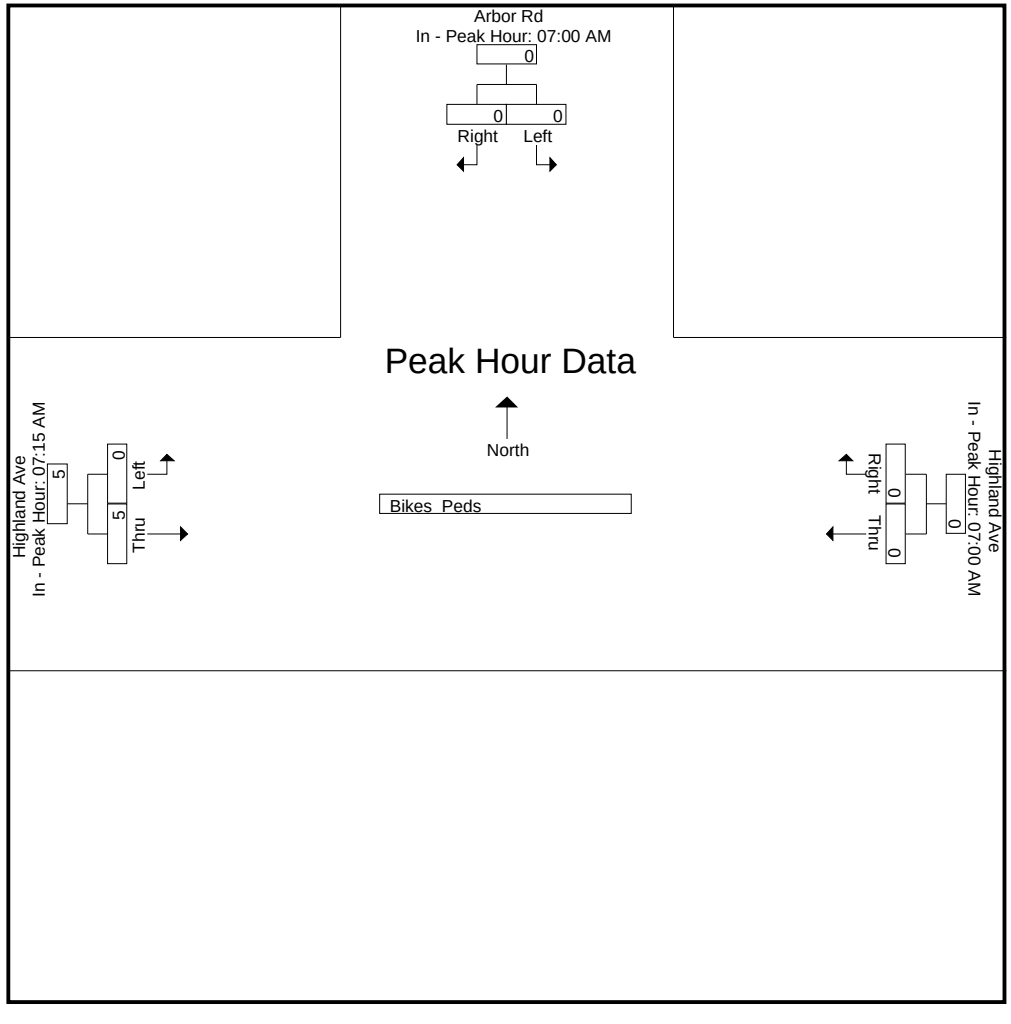
Peak Hour for Each Approach Begins at:

	07:00 AM			07:00 AM			07:15 AM		
+0 mins.	0	0	0	0	0	0	0	1	1
+15 mins.	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	**2**	**2**
+45 mins.	0	0	0	0	0	0	0	2	2
Total Volume	0	0	0	0	0	0	0	5	5

Accurate Counts

978-664-2565

% App. Total	0	0		0	0		0	100	
PHF	.000	.000	.000	.000	.000	.000	.000	.625	.625



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars - Trucks

	Arbor Rd From North		Highland Ave From East		Highland Ave From West		
Start Time	Left	Right	Thru	Right	Left	Thru	Int. Total
03:00 PM	1	3	165	2	1	204	376
03:15 PM	1	1	176	1	0	180	359
03:30 PM	0	0	205	0	0	182	387
03:45 PM	0	1	183	0	2	160	346
Total	2	5	729	3	3	726	1468
04:00 PM	0	1	250	1	2	156	410
04:15 PM	2	1	209	4	1	183	400
04:30 PM	2	1	258	2	0	150	413
04:45 PM	3	1	258	0	0	155	417
Total	7	4	975	7	3	644	1640
05:00 PM	2	3	250	0	0	158	413
05:15 PM	4	1	255	0	0	163	423
05:30 PM	0	1	270	0	0	137	408
05:45 PM	0	1	263	1	1	139	405
Total	6	6	1038	1	1	597	1649
Grand Total	15	15	2742	11	7	1967	4757
Apprch %	50	50	99.6	0.4	0.4	99.6	
Total %	0.3	0.3	57.6	0.2	0.1	41.3	
Cars	15	14	2727	11	6	1953	4726
% Cars	100	93.3	99.5	100	85.7	99.3	99.3
Trucks	0	1	15	0	1	14	31
% Trucks	0	6.7	0.5	0	14.3	0.7	0.7

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 2

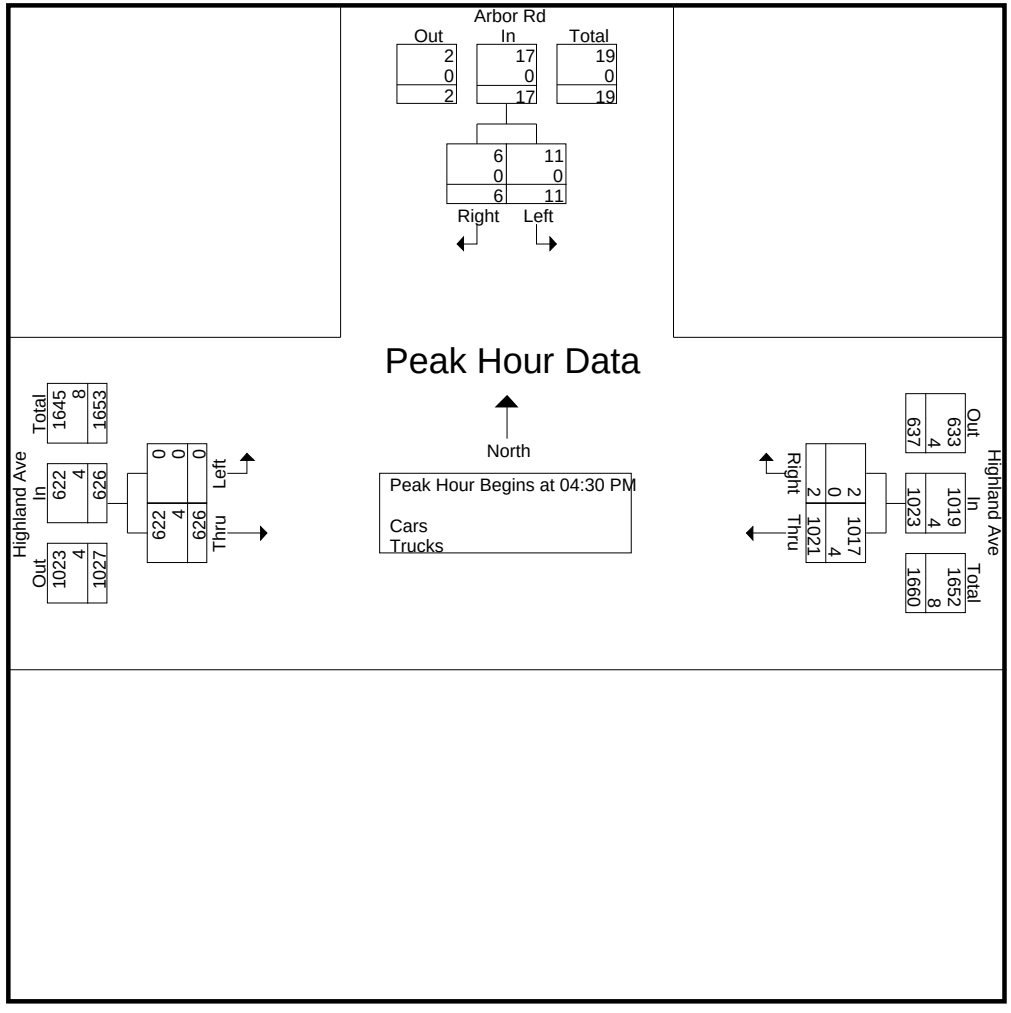
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 04:30 PM										
04:30 PM	2	1	3	**258**	**2**	**260**	0	150	150	413
04:45 PM	3	1	4	258	0	258	0	155	155	417
05:00 PM	2	**3**	**5**	250	0	250	0	158	158	413
05:15 PM	**4**	1	5	255	0	255	0	**163**	**163**	**423**
Total Volume	11	6	17	1021	2	1023	0	626	626	1666
% App. Total	64.7	35.3		99.8	0.2		0	100		
PHF	.688	.500	.850	.989	.250	.984	.000	.960	.960	.985
Cars	11	6	17	1017	2	1019	0	622	622	1658
% Cars	100	100	100	99.6	100	99.6	0	99.4	99.4	99.5
Trucks	0	0	0	4	0	4	0	4	4	8
% Trucks	0	0	0	0.4	0	0.4	0	0.6	0.6	0.5

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

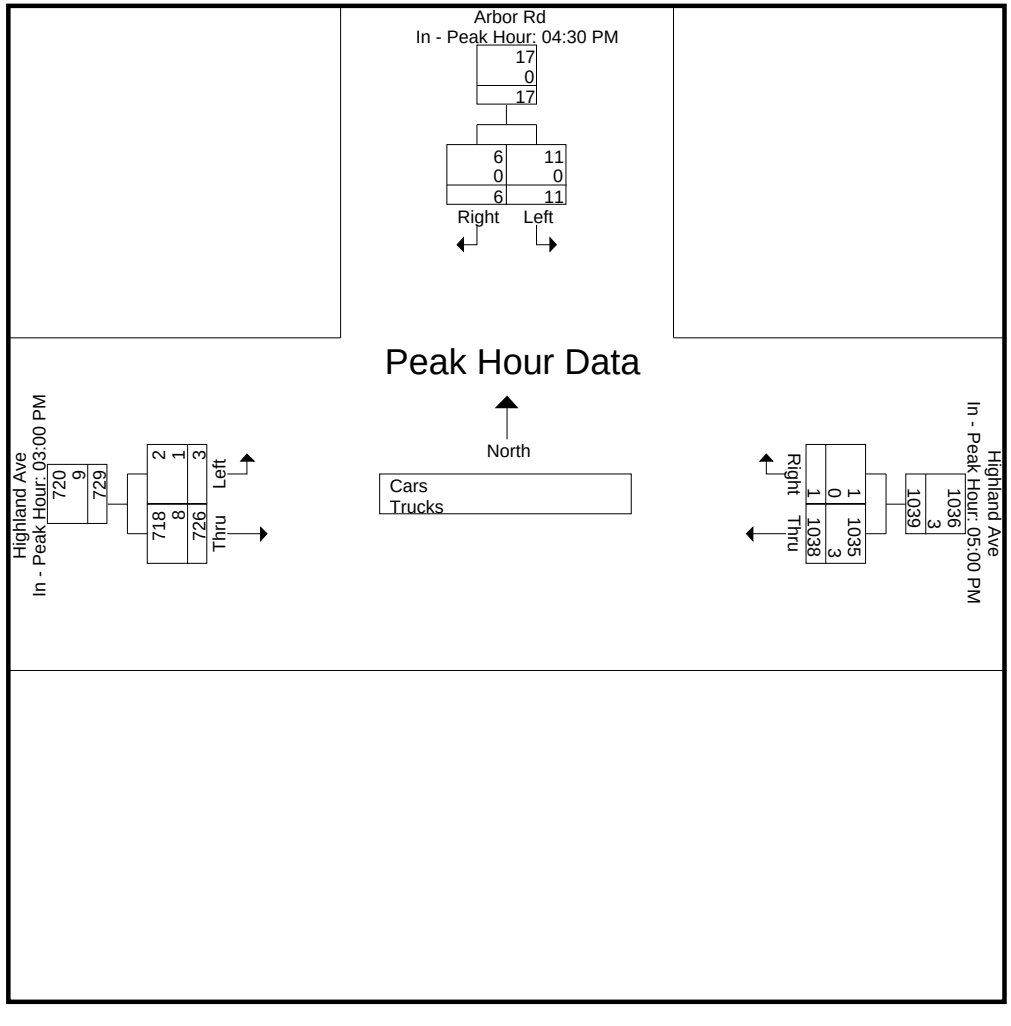
Peak Hour for Each Approach Begins at:

	04:30 PM			05:00 PM			03:00 PM		
+0 mins.	2	1	3	250	0	250	1	**204**	**205**
+15 mins.	3	1	4	255	0	255	0	180	180
+30 mins.	2	**3**	**5**	**270**	0	**270**	0	182	182
+45 mins.	**4**	1	5	263	**1**	264	**2**	160	162
Total Volume	11	6	17	1038	1	1039	3	726	729
% App. Total	64.7	35.3		99.9	0.1		0.4	99.6	
PHF	.688	.500	.850	.961	.250	.962	.375	.890	.889

Accurate Counts

978-664-2565

Cars	11	6	17	1035	1	1036	2	718	720
% Cars	100	100	100	99.7	100	99.7	66.7	98.9	98.8
Trucks	0	0	0	3	0	3	1	8	9
% Trucks	0	0	0	0.3	0	0.3	33.3	1.1	1.2



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Cars

	Arbor Rd From North		Highland Ave From East		Highland Ave From West		
Start Time	Left	Right	Thru	Right	Left	Thru	Int. Total
03:00 PM	1	3	165	2	1	202	374
03:15 PM	1	0	175	1	0	176	353
03:30 PM	0	0	202	0	0	181	383
03:45 PM	0	1	182	0	1	159	343
Total	2	4	724	3	2	718	1453
04:00 PM	0	1	247	1	2	156	407
04:15 PM	2	1	209	4	1	183	400
04:30 PM	2	1	255	2	0	147	407
04:45 PM	3	1	257	0	0	154	415
Total	7	4	968	7	3	640	1629
05:00 PM	2	3	250	0	0	158	413
05:15 PM	4	1	255	0	0	163	423
05:30 PM	0	1	269	0	0	136	406
05:45 PM	0	1	261	1	1	138	402
Total	6	6	1035	1	1	595	1644
Grand Total	15	14	2727	11	6	1953	4726
Apprch %	51.7	48.3	99.6	0.4	0.3	99.7	
Total %	0.3	0.3	57.7	0.2	0.1	41.3	

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 6

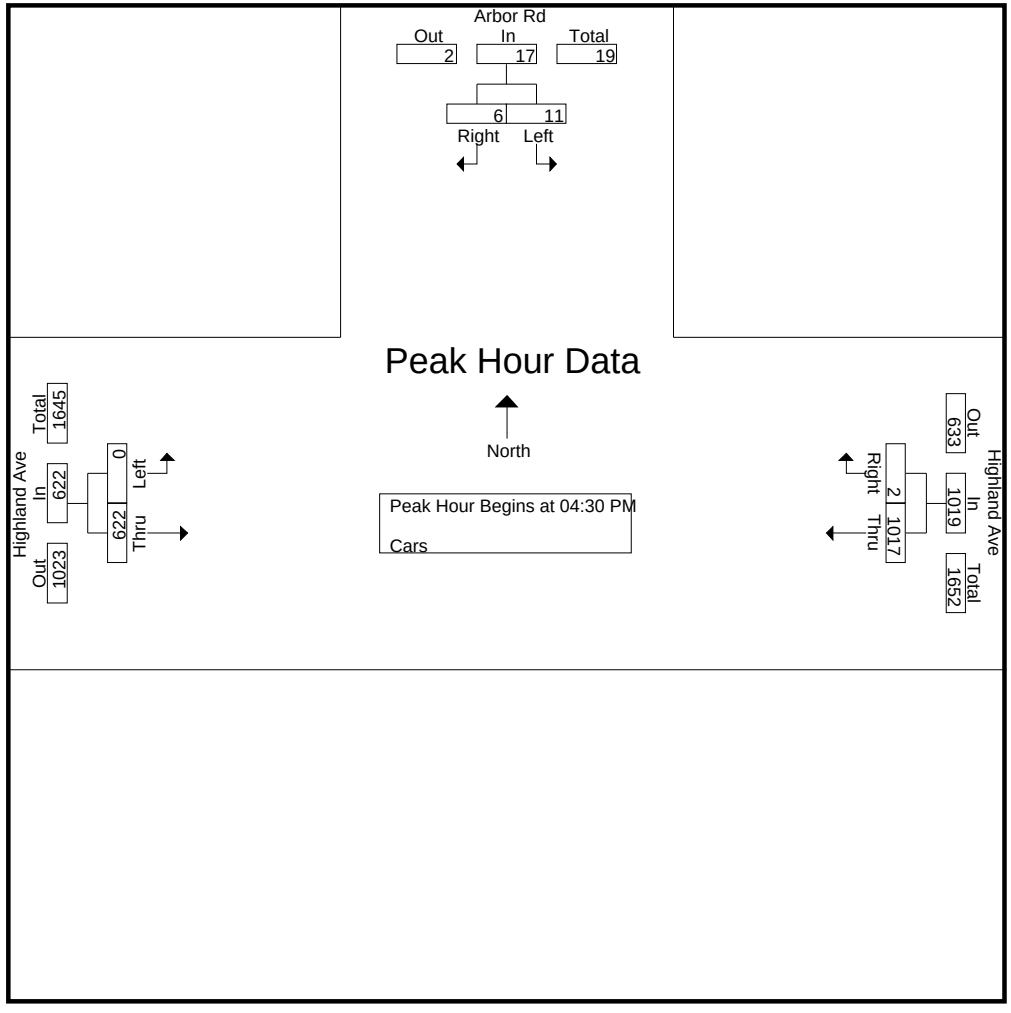
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 04:30 PM										
04:30 PM	2	1	3	255	**2**	**257**	0	147	147	407
04:45 PM	3	1	4	**257**	0	257	0	154	154	415
05:00 PM	2	**3**	**5**	250	0	250	0	158	158	413
05:15 PM	**4**	1	5	255	0	255	0	**163**	**163**	**423**
Total Volume	11	6	17	1017	2	1019	0	622	622	1658
% App. Total	64.7	35.3		99.8	0.2		0	100		
PHF	.688	.500	.850	.989	.250	.991	.000	.954	.954	.980

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

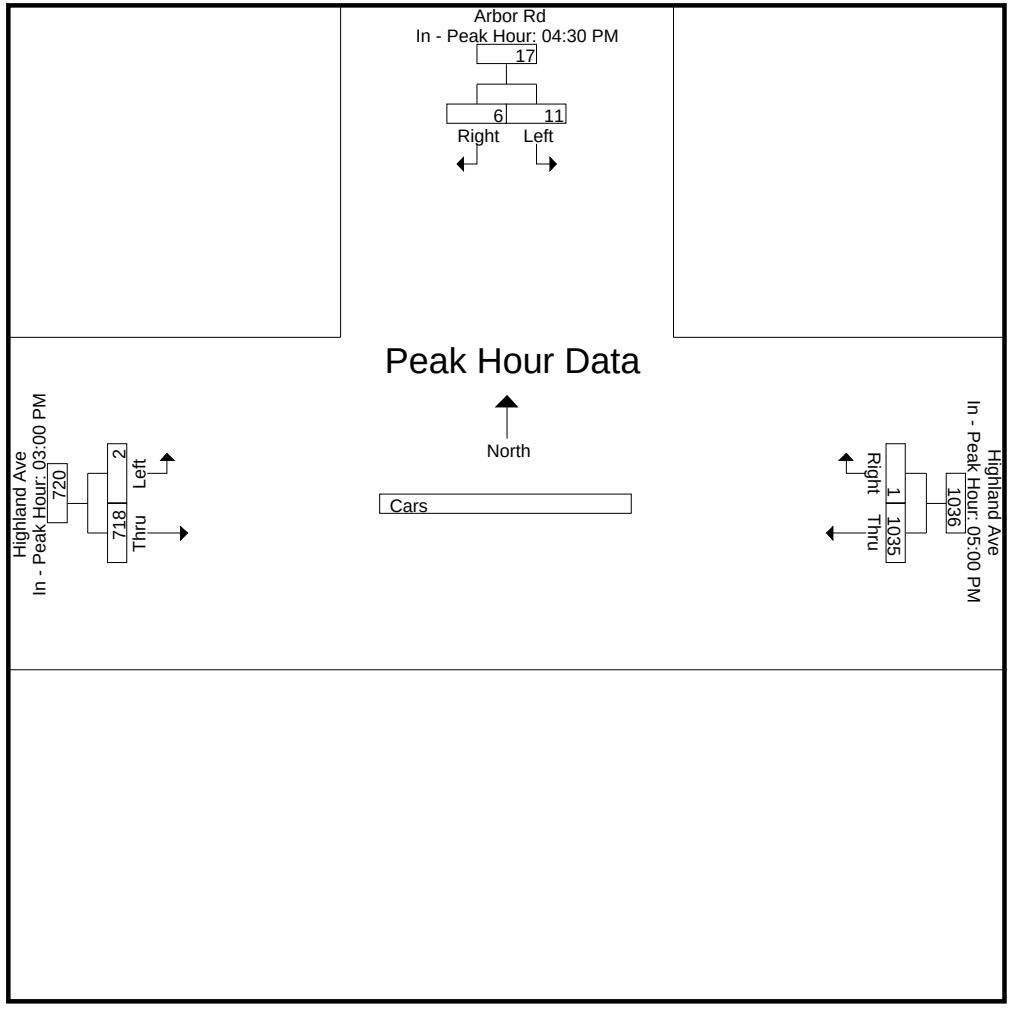
	04:30 PM			05:00 PM			03:00 PM		
+0 mins.	2	1	3	250	0	250	**1**	**202**	**203**
+15 mins.	3	1	4	255	0	255	0	176	176
+30 mins.	2	**3**	**5**	**269**	0	**269**	0	181	181
+45 mins.	**4**	1	5	261	**1**	262	1	159	160
Total Volume	11	6	17	1035	1	1036	2	718	720
% App. Total	64.7	35.3		99.9	0.1		0.3	99.7	
PHF	.688	.500	.850	.962	.250	.963	.500	.889	.887

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 8



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Trucks

	Arbor Rd From North		Highland Ave From East		Highland Ave From West		
Start Time	Left	Right	Thru	Right	Left	Thru	Int. Total
03:00 PM	0	0	0	0	0	2	2
03:15 PM	0	1	1	0	0	4	6
03:30 PM	0	0	3	0	0	1	4
03:45 PM	0	0	1	0	1	1	3
Total	0	1	5	0	1	8	15
04:00 PM	0	0	3	0	0	0	3
04:15 PM	0	0	0	0	0	0	0
04:30 PM	0	0	3	0	0	3	6
04:45 PM	0	0	1	0	0	1	2
Total	0	0	7	0	0	4	11
05:00 PM	0	0	0	0	0	0	0
05:15 PM	0	0	0	0	0	0	0
05:30 PM	0	0	1	0	0	1	2
05:45 PM	0	0	2	0	0	1	3
Total	0	0	3	0	0	2	5
Grand Total	0	1	15	0	1	14	31
Apprch %	0	100	100	0	6.7	93.3	
Total %	0	3.2	48.4	0	3.2	45.2	

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 10

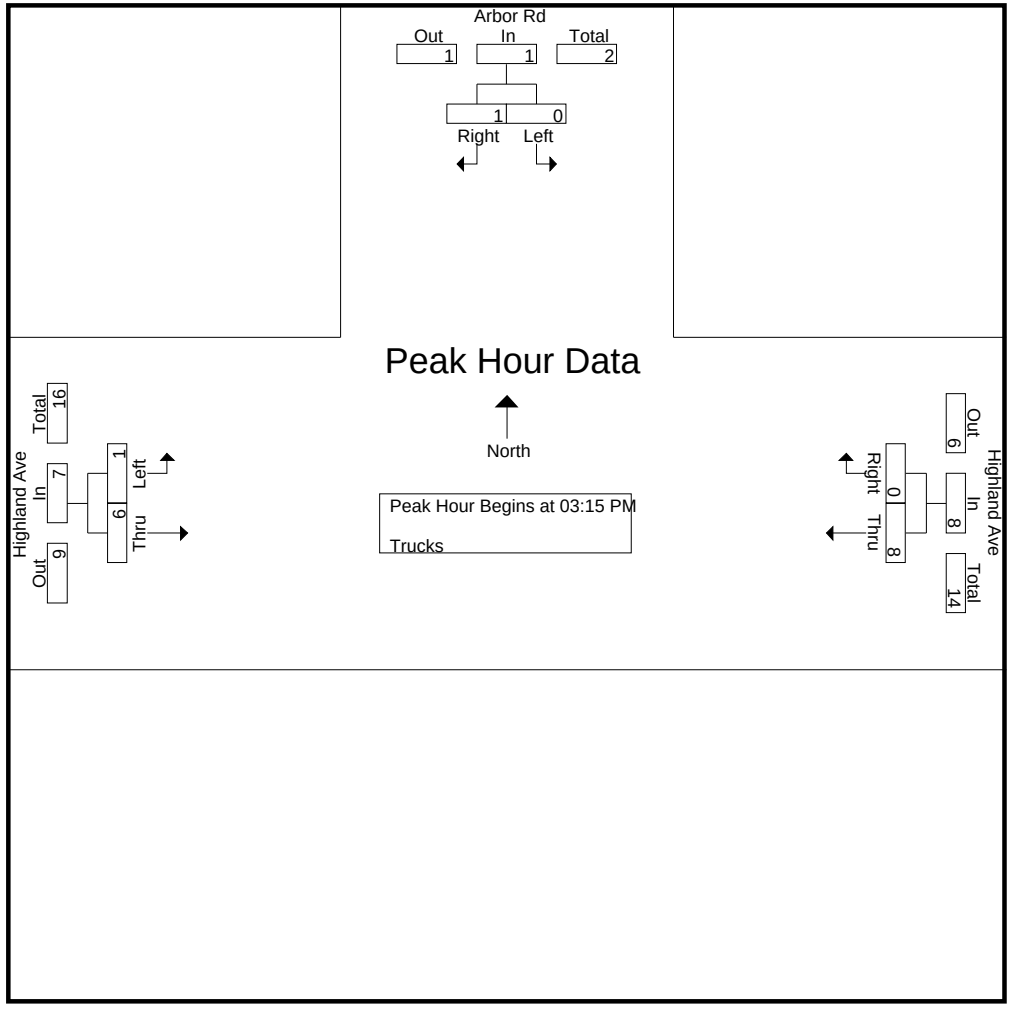
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 03:15 PM										
03:15 PM	0	**1**	**1**	1	0	1	0	**4**	**4**	**6**
03:30 PM	0	0	0	**3**	0	**3**	0	1	1	4
03:45 PM	0	0	0	1	0	1	**1**	1	2	3
04:00 PM	0	0	0	3	0	3	0	0	0	3
Total Volume	0	1	1	8	0	8	1	6	7	16
% App. Total	0	100		100	0		14.3	85.7		
PHF	.000	.250	.250	.667	.000	.667	.250	.375	.438	.667

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

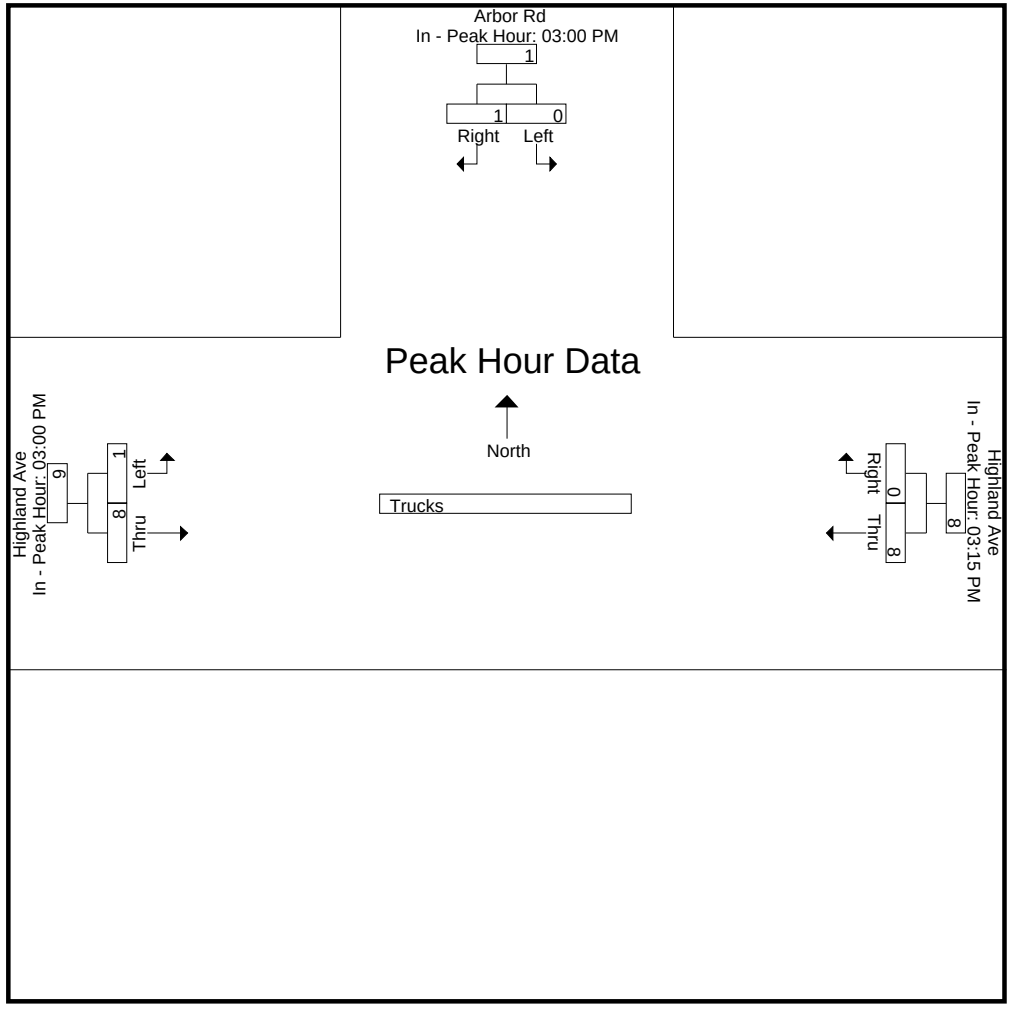
	03:00 PM			03:15 PM			03:00 PM		
+0 mins.	0	0	0	1	0	1	0	2	2
+15 mins.	0	**1**	**1**	**3**	0	**3**	0	**4**	**4**
+30 mins.	0	0	0	1	0	1	0	1	1
+45 mins.	0	0	0	3	0	3	**1**	1	2
Total Volume	0	1	1	8	0	8	1	8	9
% App. Total	0	100		100	0		11.1	88.9	
PHF	.000	.250	.250	.667	.000	.667	.250	.500	.563

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 12



Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Arbor Rd From North			Highland Ave From East			Highland Ave From West					
Start Time	Left	Right	Peds	Thru	Right	Peds	Left	Thru	Peds	Exclu. Total	Inclu. Total	Int. Total
03:00 PM	0	0	1	0	0	0	0	0	0	1	0	1
03:15 PM	0	0	5	0	0	0	0	1	0	5	1	6
03:30 PM	0	0	1	1	0	0	0	0	0	1	1	2
03:45 PM	0	0	1	1	0	0	0	1	0	1	2	3
Total	0	0	8	2	0	0	0	2	0	8	4	12
04:00 PM	0	0	0	0	0	0	0	2	0	0	2	2
04:15 PM	0	0	2	0	0	0	0	0	0	2	0	2
04:30 PM	0	0	3	0	0	0	0	0	0	3	0	3
04:45 PM	0	0	1	0	0	0	0	0	0	1	0	1
Total	0	0	6	0	0	0	0	2	0	6	2	8
05:00 PM	0	0	1	2	0	0	0	1	0	1	3	4
05:15 PM	0	0	0	2	0	0	0	0	0	0	2	2
05:30 PM	0	0	1	0	0	0	0	0	0	1	0	1
05:45 PM	0	0	0	2	0	0	0	0	0	0	2	2
Total	0	0	2	6	0	0	0	1	0	2	7	9
Grand Total	0	0	16	8	0	0	0	5	0	16	13	29
Apprch %	0	0		100	0		0	100				
Total %	0	0		61.5	0		0	38.5		55.2	44.8	

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019

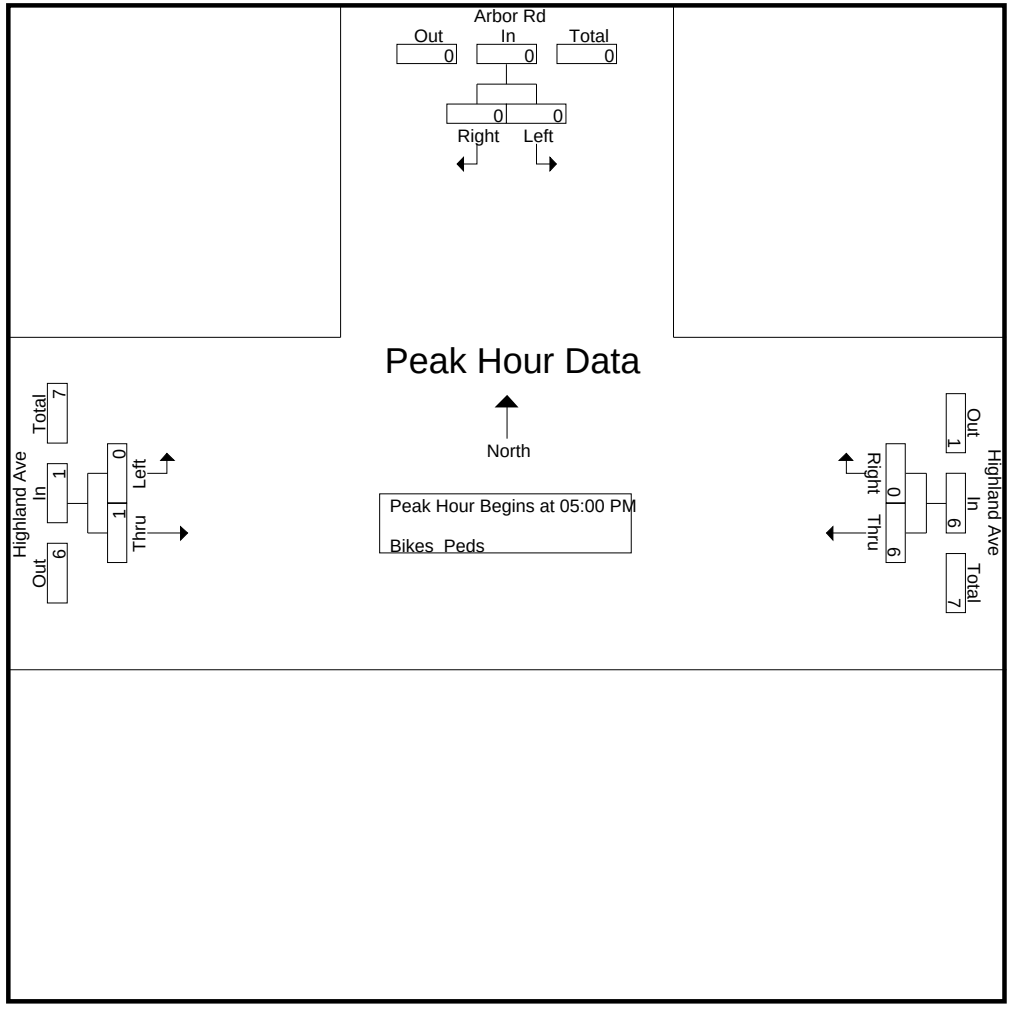
	Arbor Rd From North			Highland Ave From East			Highland Ave From West			
Start Time	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 05:00 PM										
05:00 PM	0	0	0	**2**	0	**2**	0	**1**	**1**	**3**
05:15 PM	0	0	0	2	0	2	0	0	0	2
05:30 PM	0	0	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	2	0	2	0	0	0	2
Total Volume	0	0	0	6	0	6	0	1	1	7
% App. Total	0	0		100	0		0	100		
PHF	.000	.000	.000	.750	.000	.750	.000	.250	.250	.583

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

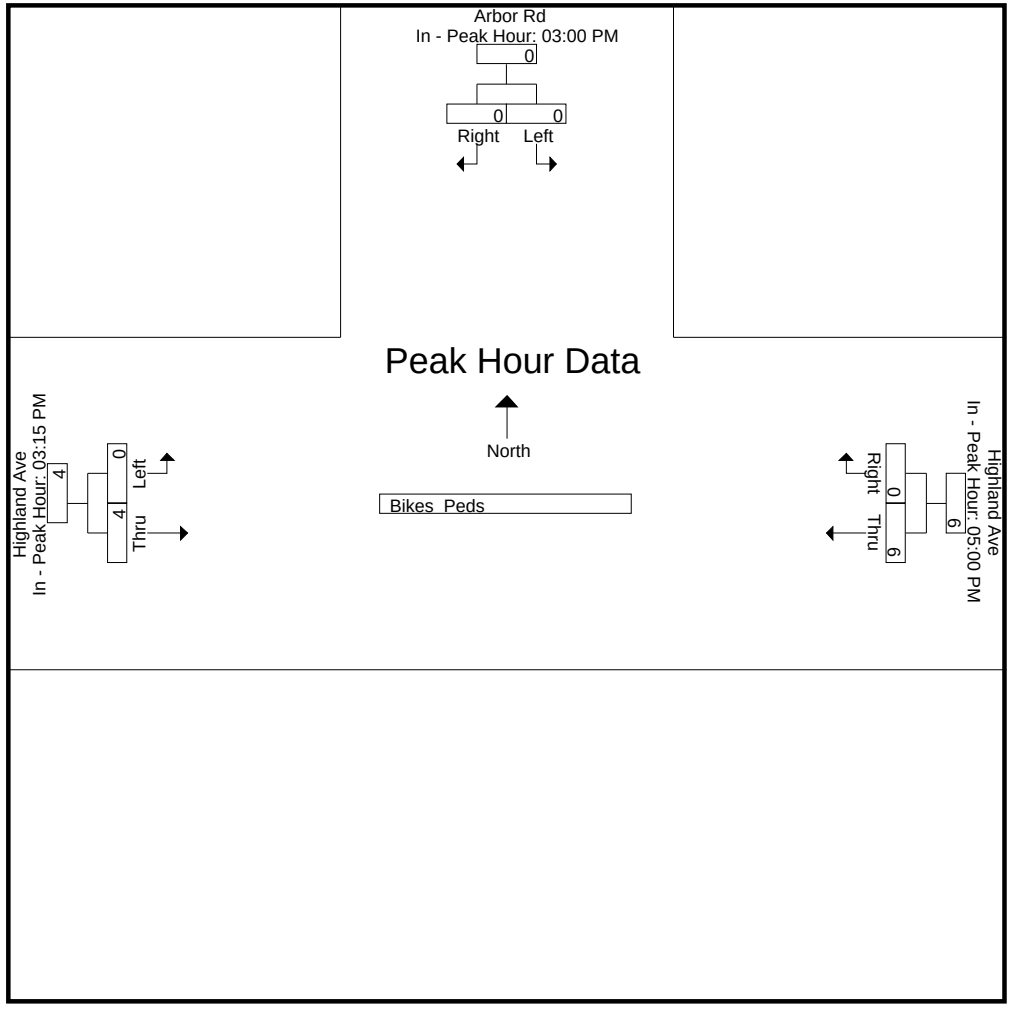
	03:00 PM			05:00 PM			03:15 PM		
+0 mins.	0	0	0	**2**	0	**2**	0	1	1
+15 mins.	0	0	0	2	0	2	0	0	0
+30 mins.	0	0	0	0	0	0	0	1	1
+45 mins.	0	0	0	2	0	2	0	**2**	**2**
Total Volume	0	0	0	6	0	6	0	4	4
% App. Total	0	0		100	0		0	100	
PHF	.000	.000	.000	.750	.000	.750	.000	.500	.500

Accurate Counts

978-664-2565

N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 16



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Cars - Trucks

	Cross St From North			Highland Ave From East			Mills Rd 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	4	0	10	0	136	1	1	0	1	0	197	0	350
07:15 AM	1	1	2	0	162	0	3	0	2	2	241	1	415
07:30 AM	0	0	1	0	155	1	3	0	1	1	203	4	369
07:45 AM	1	0	0	1	175	1	1	0	3	1	215	2	400
Total	6	1	13	1	628	3	8	0	7	4	856	7	1534
08:00 AM	1	0	2	0	141	0	4	0	1	3	255	0	407
08:15 AM	0	0	3	1	155	0	1	0	0	2	253	2	417
08:30 AM	0	0	1	3	138	4	1	0	0	5	247	5	404
08:45 AM	1	0	0	1	141	6	0	0	4	9	189	1	352
Total	2	0	6	5	575	10	6	0	5	19	944	8	1580
Grand Total	8	1	19	6	1203	13	14	0	12	23	1800	15	3114
Apprch %	28.6	3.6	67.9	0.5	98.4	1.1	53.8	0	46.2	1.3	97.9	0.8	
Total %	0.3	0	0.6	0.2	38.6	0.4	0.4	0	0.4	0.7	57.8	0.5	
Cars	8	1	19	6	1180	13	14	0	12	23	1779	14	3069
% Cars	100	100	100	100	98.1	100	100	0	100	100	98.8	93.3	98.6
Trucks	0	0	0	0	23	0	0	0	0	0	21	1	45
% Trucks	0	0	0	0	1.9	0	0	0	0	0	1.2	6.7	1.4

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 2

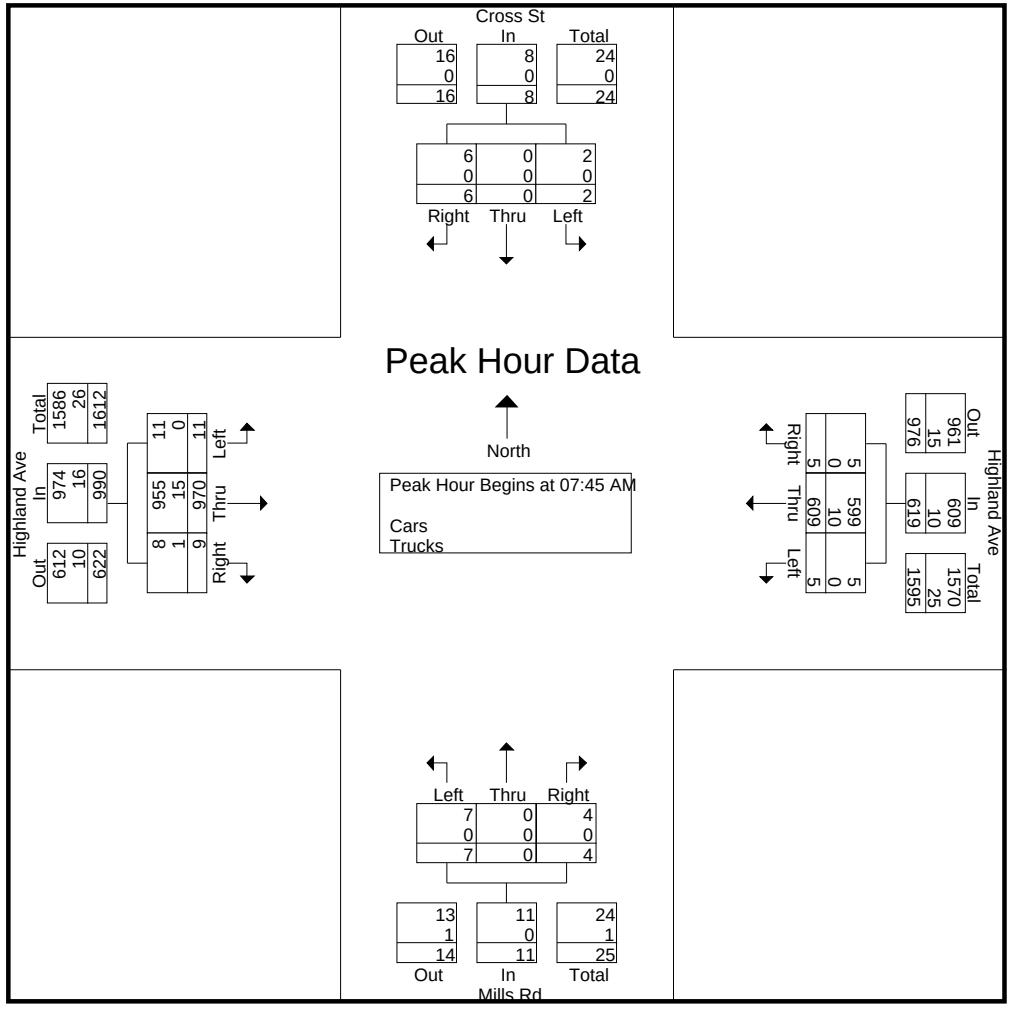
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	**1**	0	0	1	1	**175**	1	**177**	1	0	**3**	4	1	215	2	218	400
08:00 AM	1	0	2	**3**	0	141	0	141	**4**	0	1	**5**	3	**255**	0	**258**	407
08:15 AM	0	0	**3**	3	1	155	0	156	1	0	0	1	2	253	2	257	**417**
08:30 AM	0	0	1	1	**3**	138	**4**	145	1	0	0	1	**5**	247	**5**	257	404
Total Volume	2	0	6	8	5	609	5	619	7	0	4	11	11	970	9	990	1628
% App. Total	25	0	75		0.8	98.4	0.8		63.6	0	36.4		1.1	98	0.9		
PHF	.500	.000	.500	.667	.417	.870	.313	.874	.438	.000	.333	.550	.550	.951	.450	.959	.976
Cars	2	0	6	8	5	599	5	609	7	0	4	11	11	955	8	974	1602
% Cars	100	0	100	100	100	98.4	100	98.4	100	0	100	100	100	98.5	88.9	98.4	98.4
Trucks	0	0	0	0	0	10	0	10	0	0	0	0	0	15	1	16	26
% Trucks	0	0	0	0	0	1.6	0	1.6	0	0	0	0	0	1.5	11.1	1.6	1.6

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

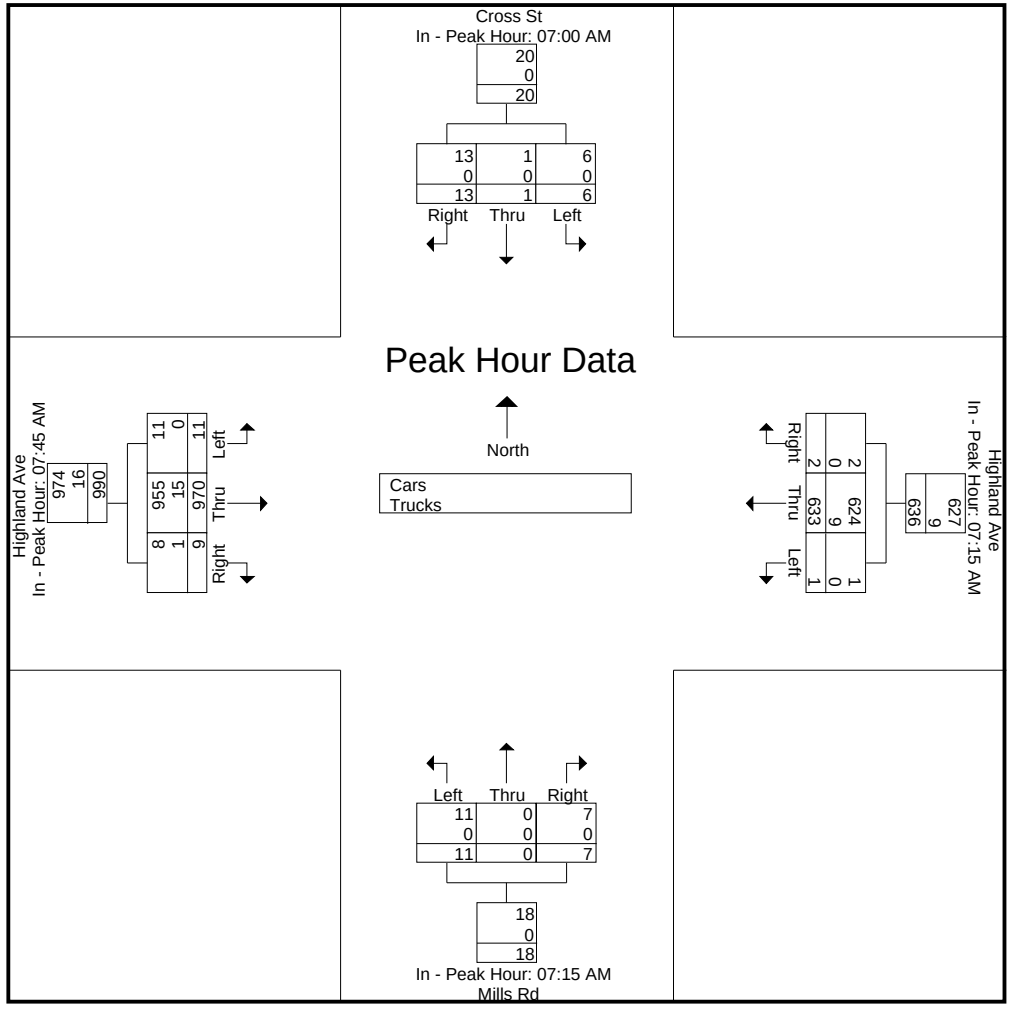
Peak Hour for Each Approach Begins at:

	07:00 AM				07:15 AM				07:15 AM				07:45 AM			
+0 mins.	**4**	0	**10**	**14**	0	162	0	162	3	0	2	**5**	1	215	2	218
+15 mins.	1	**1**	2	4	0	155	**1**	156	3	0	1	4	3	**255**	0	**258**
+30 mins.	0	0	1	1	**1**	**175**	1	**177**	1	0	**3**	4	2	253	2	257
+45 mins.	1	0	0	1	0	141	0	141	**4**	0	1	5	**5**	247	**5**	257
Total Volume	6	1	13	20	1	633	2	636	11	0	7	18	11	970	9	990

Accurate Counts

978-664-2565

% App. Total	30	5	65		0.2	99.5	0.3		61.1	0	38.9		1.1	98	0.9	
PHF	.375	.250	.325	.357	.250	.904	.500	.898	.688	.000	.583	.900	.550	.951	.450	.959
Cars	6	1	13	20	1	624	2	627	11	0	7	18	11	955	8	974
% Cars	100	100	100	100	100	98.6	100	98.6	100	0	100	100	100	98.5	88.9	98.4
Trucks	0	0	0	0	0	9	0	9	0	0	0	0	0	15	1	16
% Trucks	0	0	0	0	0	1.4	0	1.4	0	0	0	0	0	1.5	11.1	1.6



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Cars

	Cross St From North			Highland Ave From East			Mills Rd 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	4	0	10	0	129	1	1	0	1	0	195	0	341
07:15 AM	1	1	2	0	160	0	3	0	2	2	241	1	413
07:30 AM	0	0	1	0	155	1	3	0	1	1	203	4	369
07:45 AM	1	0	0	1	174	1	1	0	3	1	211	1	394
Total	6	1	13	1	618	3	8	0	7	4	850	6	1517
08:00 AM	1	0	2	0	135	0	4	0	1	3	251	0	397
08:15 AM	0	0	3	1	152	0	1	0	0	2	247	2	408
08:30 AM	0	0	1	3	138	4	1	0	0	5	246	5	403
08:45 AM	1	0	0	1	137	6	0	0	4	9	185	1	344
Total	2	0	6	5	562	10	6	0	5	19	929	8	1552
Grand Total	8	1	19	6	1180	13	14	0	12	23	1779	14	3069
Apprch %	28.6	3.6	67.9	0.5	98.4	1.1	53.8	0	46.2	1.3	98	0.8	
Total %	0.3	0	0.6	0.2	38.4	0.4	0.5	0	0.4	0.7	58	0.5	

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 6

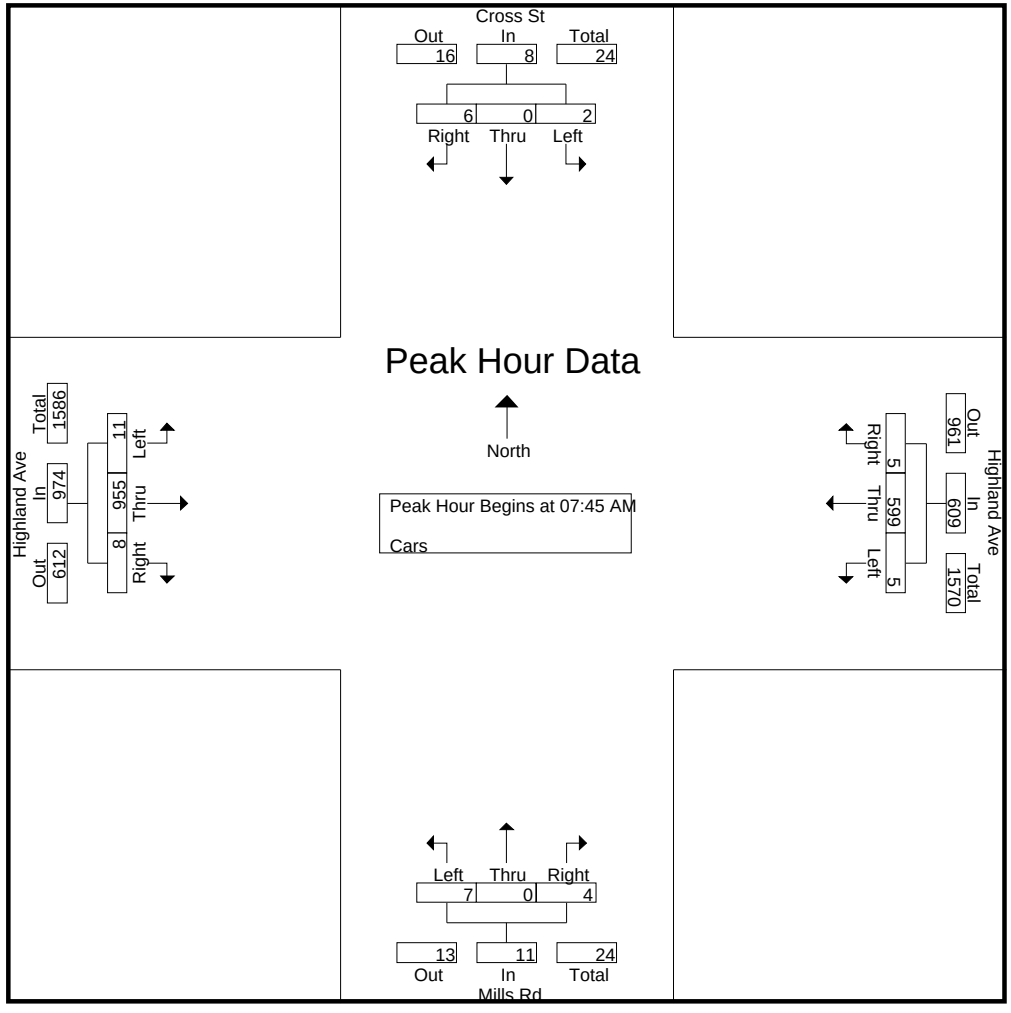
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	**1**	0	0	1	1	**174**	1	**176**	1	0	**3**	4	1	211	1	213	394
08:00 AM	1	0	2	**3**	0	135	0	135	**4**	0	1	**5**	3	**251**	0	254	397
08:15 AM	0	0	**3**	3	1	152	0	153	1	0	0	1	2	247	2	251	**408**
08:30 AM	0	0	1	1	**3**	138	**4**	145	1	0	0	1	**5**	246	**5**	**256**	403
Total Volume	2	0	6	8	5	599	5	609	7	0	4	11	11	955	8	974	1602
% App. Total	25	0	75		0.8	98.4	0.8		63.6	0	36.4		1.1	98	0.8		
PHF	.500	.000	.500	.667	.417	.861	.313	.865	.438	.000	.333	.550	.550	.951	.400	.951	.982

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

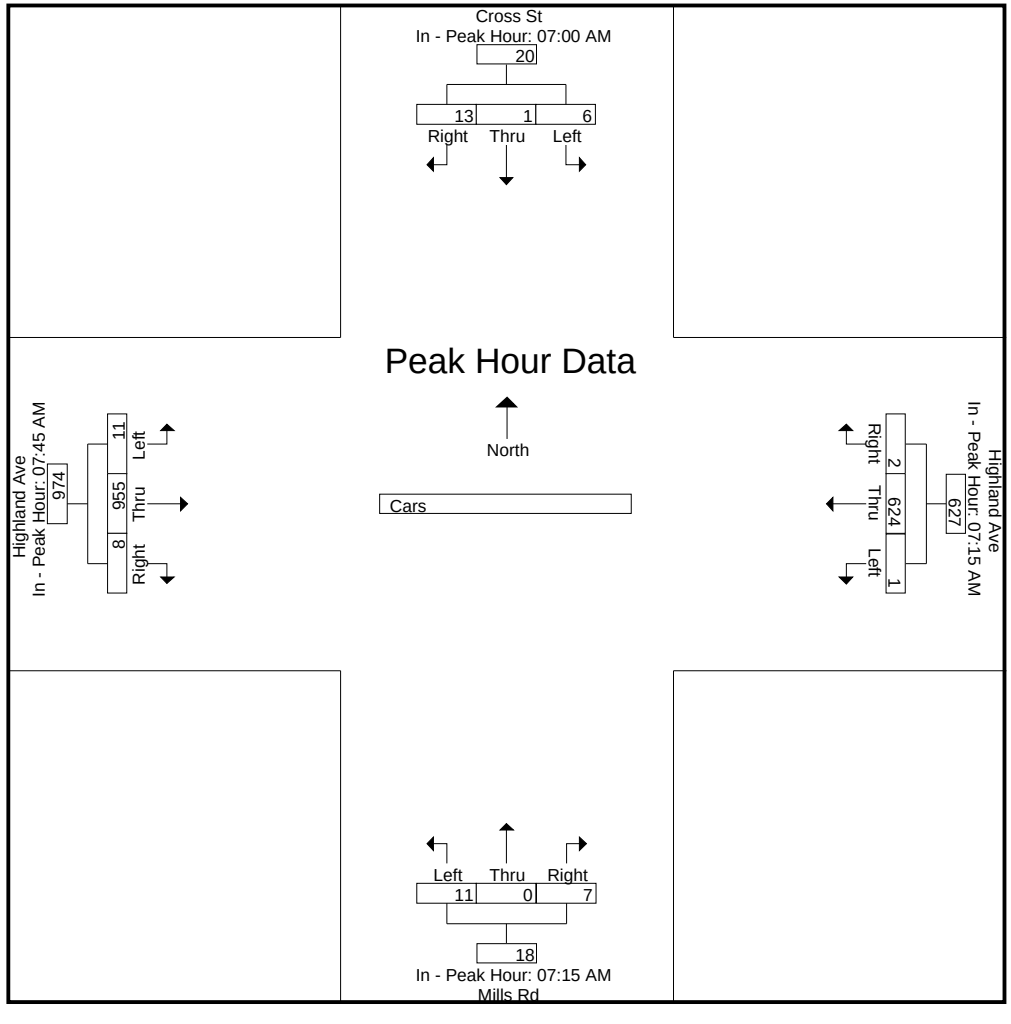
Peak Hour for Each Approach Begins at:

	07:00 AM				07:15 AM				07:15 AM				07:45 AM			
+0 mins.	**4**	0	**10**	**14**	0	160	0	160	3	0	2	**5**	1	211	1	213
+15 mins.	1	**1**	2	4	0	155	**1**	156	3	0	1	4	3	**251**	0	254
+30 mins.	0	0	1	1	**1**	**174**	1	**176**	1	0	**3**	4	2	247	2	251
+45 mins.	1	0	0	1	0	135	0	135	**4**	0	1	5	**5**	246	**5**	**256**
Total Volume	6	1	13	20	1	624	2	627	11	0	7	18	11	955	8	974

Accurate Counts

978-664-2565

% App. Total	30	5	65		0.2	99.5	0.3		61.1	0	38.9		1.1	98	0.8	
PHF	.375	.250	.325	.357	.250	.897	.500	.891	.688	.000	.583	.900	.550	.951	.400	.951



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Trucks

	Cross St From North			Highland Ave From East			Mills Rd 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	0	7	0	0	0	0	0	2	0	9
07:15 AM	0	0	0	0	2	0	0	0	0	0	0	0	2
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	1	0	0	0	0	0	4	1	6
Total	0	0	0	0	10	0	0	0	0	0	6	1	17
08:00 AM	0	0	0	0	6	0	0	0	0	0	4	0	10
08:15 AM	0	0	0	0	3	0	0	0	0	0	6	0	9
08:30 AM	0	0	0	0	0	0	0	0	0	0	1	0	1
08:45 AM	0	0	0	0	4	0	0	0	0	0	4	0	8
Total	0	0	0	0	13	0	0	0	0	0	15	0	28
Grand Total	0	0	0	0	23	0	0	0	0	0	21	1	45
Apprch %	0	0	0	0	100	0	0	0	0	0	95.5	4.5	
Total %	0	0	0	0	51.1	0	0	0	0	0	46.7	2.2	

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

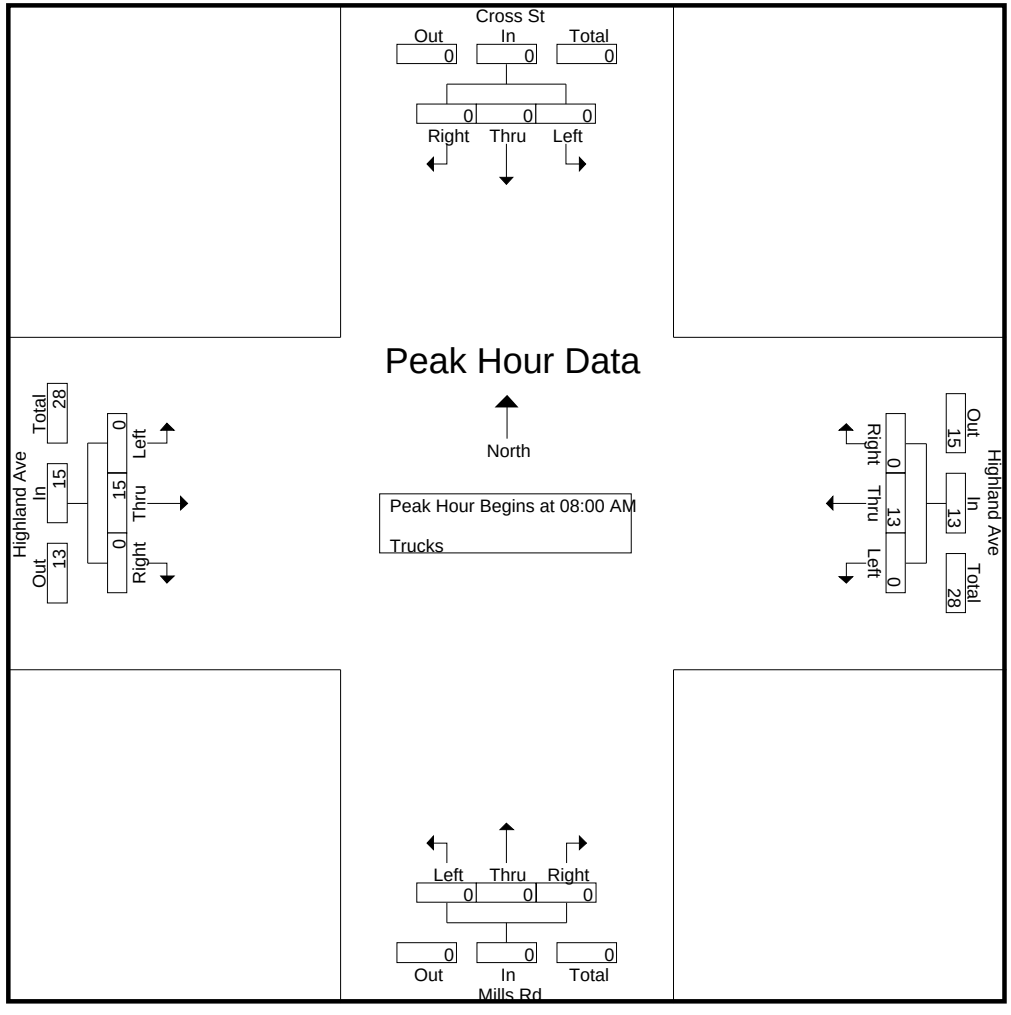
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 08:00 AM																	
08:00 AM	0	0	0	0	0	**6**	0	**6**	0	0	0	0	0	4	0	4	**10**
08:15 AM	0	0	0	0	0	3	0	3	0	0	0	0	0	**6**	0	**6**	9
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
08:45 AM	0	0	0	0	0	4	0	4	0	0	0	0	0	4	0	4	8
Total Volume	0	0	0	0	0	13	0	13	0	0	0	0	0	15	0	15	28
% App. Total	0	0	0		0	100	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.000	.542	.000	.542	.000	.000	.000	.000	.000	.625	.000	.625	.700

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

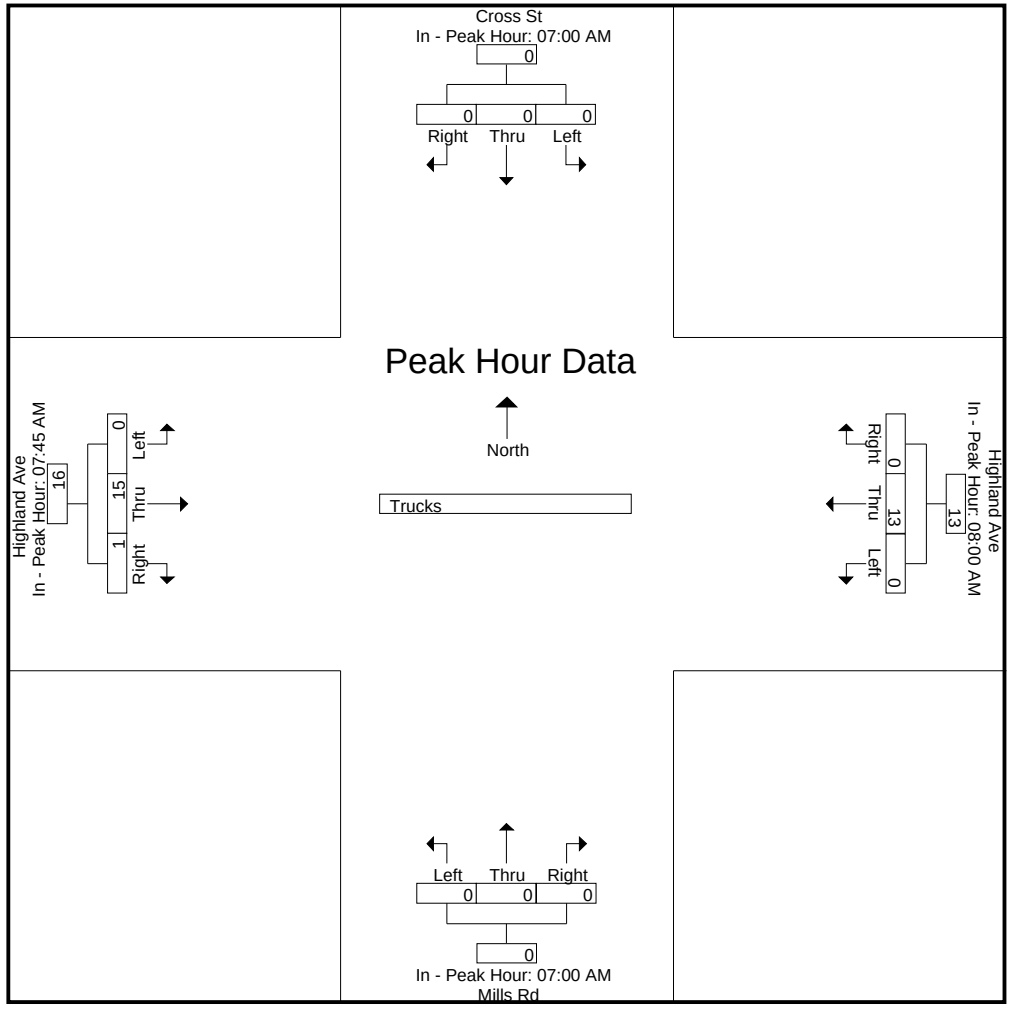
Peak Hour for Each Approach Begins at:

	07:00 AM				08:00 AM				07:00 AM				07:45 AM			
+0 mins.	0	0	0	0	0	**6**	0	**6**	0	0	0	0	0	4	**1**	5
+15 mins.	0	0	0	0	0	3	0	3	0	0	0	0	0	4	0	4
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**	0	**6**
+45 mins.	0	0	0	0	0	4	0	4	0	0	0	0	0	1	0	1
Total Volume	0	0	0	0	0	13	0	13	0	0	0	0	0	15	1	16

Accurate Counts

978-664-2565

% App. Total	0	0	0		0	100	0		0	0	0		0	93.8	6.2	
PHF	.000	.000	.000	.000	.000	.542	.000	.542	.000	.000	.000	.000	.000	.625	.250	.667



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Cross St From North				Highland Ave From East				Mills Rd 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	0	0	0	0	0	0	1	0	0	1	1	2
07:15 AM	0	0	0	1	0	0	0	0	0	0	0	2	0	1	0	0	3	1	4
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	2	0	0	0	2	2
Total	0	0	0	2	0	0	0	0	0	0	0	2	0	4	0	0	4	4	8
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
08:15 AM	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
08:30 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	2
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	4	0	0	0	0	0	0	0	0	0	3	0	0	4	3	7
Grand Total	0	0	0	6	0	0	0	0	0	0	0	2	0	7	0	0	8	7	15
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		53.3	46.7	

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 14

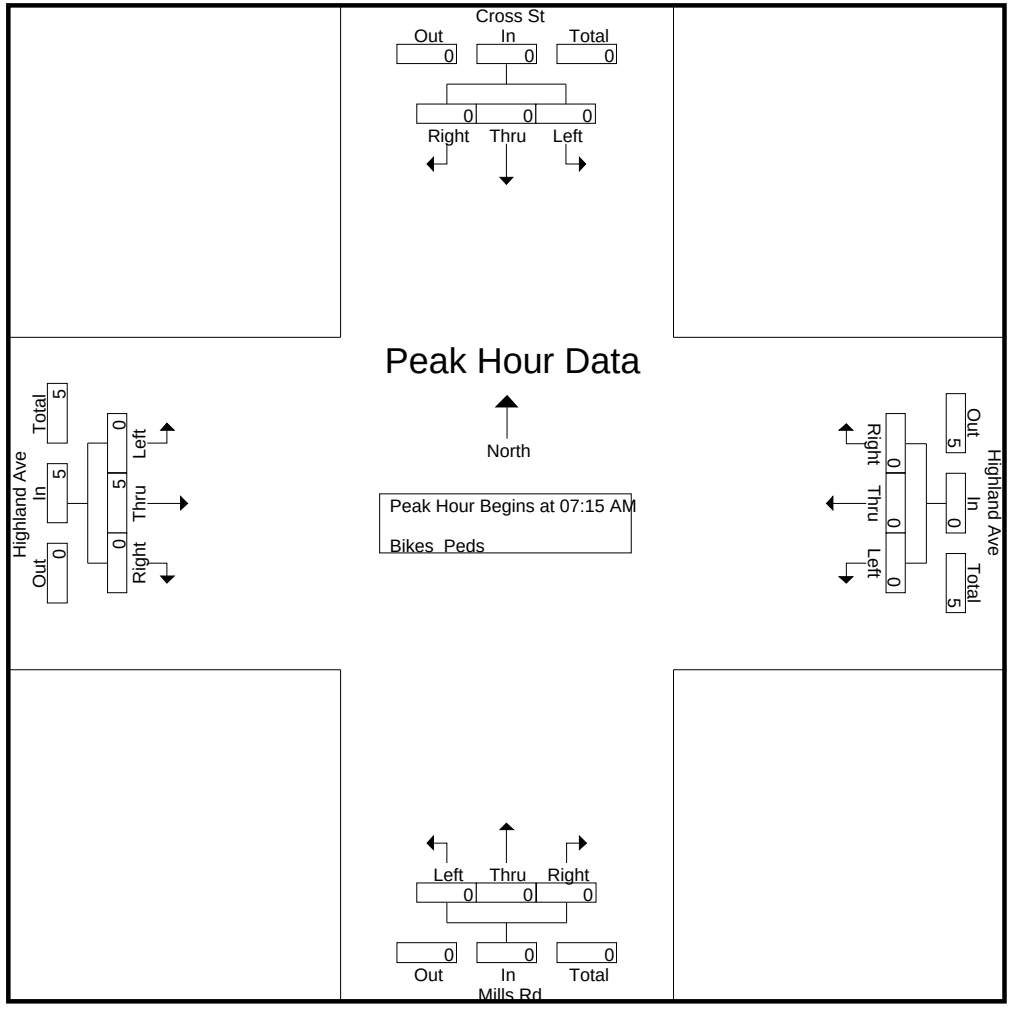
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
07:30 AM	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	**2**	0	**2**	**2**
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	5
% App. Total	0	0	0		0	0	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.625	.000	.625	.625

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

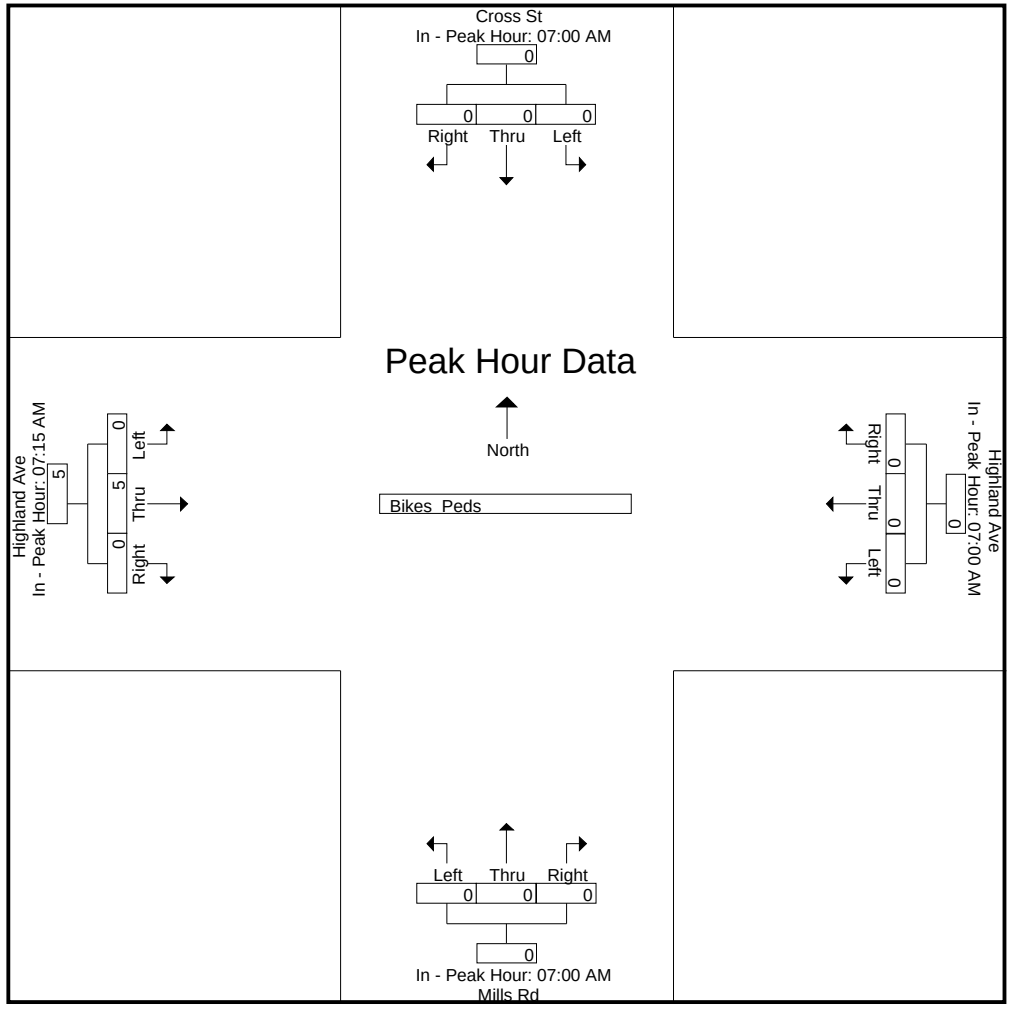
Peak Hour for Each Approach Begins at:

	07:00 AM				07:00 AM				07:00 AM				07:15 AM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	0	**2**
+45 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5

Accurate Counts

978-664-2565

% App. Total	0	0	0		0	0	0		0	0	0		0	100	0	
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.625	.000	.625



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars - Trucks

	Cross St From North			Highland Ave From East			Mills Rd From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
03:00 PM	2	0	1	3	164	0	1	0	2	2	205	1	381
03:15 PM	4	0	1	2	172	1	2	0	0	0	176	4	362
03:30 PM	1	0	1	2	195	1	1	0	2	0	177	1	381
03:45 PM	1	0	2	3	183	0	0	0	2	1	154	2	348
Total	8	0	5	10	714	2	4	0	6	3	712	8	1472
04:00 PM	2	0	2	2	251	0	0	0	0	0	152	1	410
04:15 PM	2	0	1	0	212	0	2	0	0	3	180	5	405
04:30 PM	1	0	1	4	263	1	1	0	3	0	146	3	423
04:45 PM	0	0	1	1	254	2	1	1	1	0	151	2	414
Total	5	0	5	7	980	3	4	1	4	3	629	11	1652
05:00 PM	1	0	2	2	242	2	3	0	1	2	159	3	417
05:15 PM	0	0	1	5	254	2	2	0	3	1	159	2	429
05:30 PM	2	0	4	4	257	3	1	2	1	3	129	7	413
05:45 PM	1	0	1	2	258	3	1	0	0	3	133	3	405
Total	4	0	8	13	1011	10	7	2	5	9	580	15	1664
Grand Total	17	0	18	30	2705	15	15	3	15	15	1921	34	4788
Apprch %	48.6	0	51.4	1.1	98.4	0.5	45.5	9.1	45.5	0.8	97.5	1.7	
Total %	0.4	0	0.4	0.6	56.5	0.3	0.3	0.1	0.3	0.3	40.1	0.7	
Cars	17	0	18	29	2688	15	15	3	15	15	1906	34	4755
% Cars	100	0	100	96.7	99.4	100	100	100	100	100	99.2	100	99.3
Trucks	0	0	0	1	17	0	0	0	0	0	15	0	33
% Trucks	0	0	0	3.3	0.6	0	0	0	0	0	0.8	0	0.7

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 2

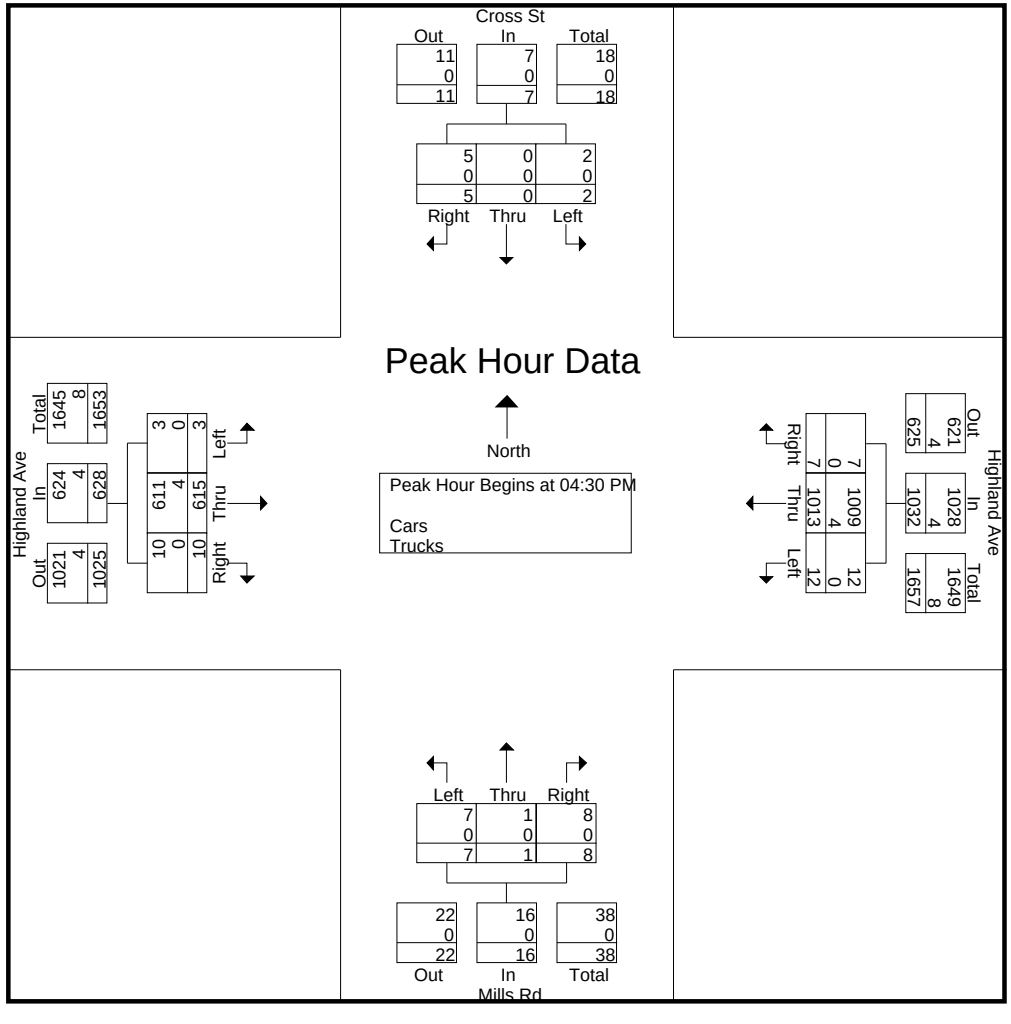
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	**1**	0	1	2	4	**263**	1	**268**	1	0	**3**	4	0	146	**3**	149	423
04:45 PM	0	0	1	1	1	254	**2**	257	1	**1**	1	3	0	151	2	153	414
05:00 PM	1	0	**2**	**3**	2	242	2	246	**3**	0	1	4	**2**	**159**	3	**164**	417
05:15 PM	0	0	1	1	**5**	254	2	261	2	0	3	**5**	1	159	2	162	**429**
Total Volume	2	0	5	7	12	1013	7	1032	7	1	8	16	3	615	10	628	1683
% App. Total	28.6	0	71.4		1.2	98.2	0.7		43.8	6.2	50		0.5	97.9	1.6		
PHF	.500	.000	.625	.583	.600	.963	.875	.963	.583	.250	.667	.800	.375	.967	.833	.957	.981
Cars	2	0	5	7	12	1009	7	1028	7	1	8	16	3	611	10	624	1675
% Cars	100	0	100	100	100	99.6	100	99.6	100	100	100	100	100	99.3	100	99.4	99.5
Trucks	0	0	0	0	0	4	0	4	0	0	0	0	0	4	0	4	8
% Trucks	0	0	0	0	0	0.4	0	0.4	0	0	0	0	0	0.7	0	0.6	0.5

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

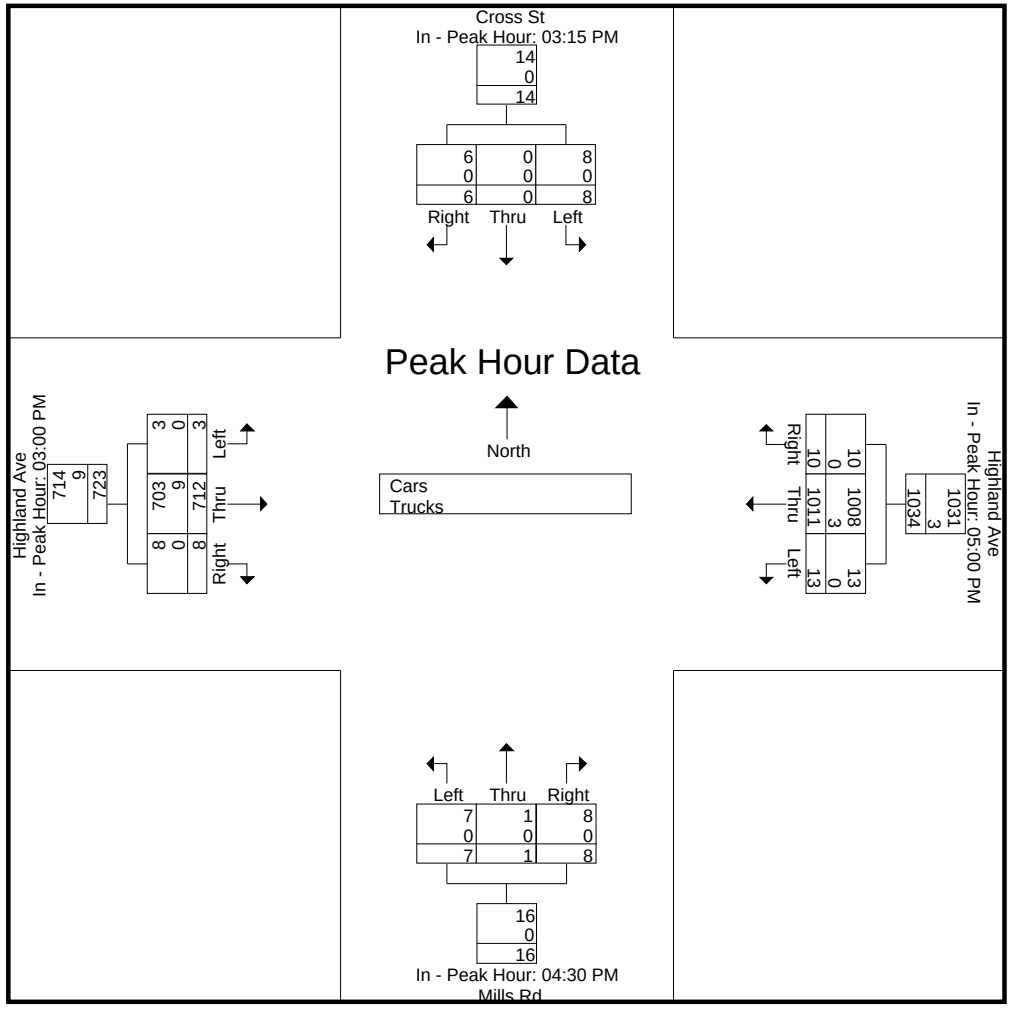
Peak Hour for Each Approach Begins at:

	03:15 PM				05:00 PM				04:30 PM				03:00 PM			
+0 mins.	**4**	0	1	**5**	2	242	2	246	1	0	**3**	4	**2**	**205**	1	**208**
+15 mins.	1	0	1	2	**5**	254	2	261	1	**1**	1	3	0	176	**4**	180
+30 mins.	1	0	**2**	3	4	257	**3**	**264**	**3**	0	1	4	0	177	1	178
+45 mins.	2	0	2	4	2	**258**	3	263	2	0	3	**5**	1	154	2	157
Total Volume	8	0	6	14	13	1011	10	1034	7	1	8	16	3	712	8	723
% App. Total	57.1	0	42.9		1.3	97.8	1		43.8	6.2	50		0.4	98.5	1.1	
PHF	.500	.000	.750	.700	.650	.980	.833	.979	.583	.250	.667	.800	.375	.868	.500	.869

Accurate Counts

978-664-2565

Cars	8	0	6	14	13	1008	10	1031	7	1	8	16	3	703	8	714
% Cars	100	0	100	100	100	99.7	100	99.7	100	100	100	100	100	98.7	100	98.8
Trucks	0	0	0	0	0	3	0	3	0	0	0	0	0	9	0	9
% Trucks	0	0	0	0	0	0.3	0	0.3	0	0	0	0	0	1.3	0	1.2



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Cars

	Cross St From North			Highland Ave From East			Mills Rd From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
03:00 PM	2	0	1	3	164	0	1	0	2	2	203	1	379
03:15 PM	4	0	1	1	169	1	2	0	0	0	171	4	353
03:30 PM	1	0	1	2	192	1	1	0	2	0	176	1	377
03:45 PM	1	0	2	3	182	0	0	0	2	1	153	2	346
Total	8	0	5	9	707	2	4	0	6	3	703	8	1455
04:00 PM	2	0	2	2	248	0	0	0	0	0	152	1	407
04:15 PM	2	0	1	0	212	0	2	0	0	3	180	5	405
04:30 PM	1	0	1	4	260	1	1	0	3	0	143	3	417
04:45 PM	0	0	1	1	253	2	1	1	1	0	150	2	412
Total	5	0	5	7	973	3	4	1	4	3	625	11	1641
05:00 PM	1	0	2	2	242	2	3	0	1	2	159	3	417
05:15 PM	0	0	1	5	254	2	2	0	3	1	159	2	429
05:30 PM	2	0	4	4	256	3	1	2	1	3	128	7	411
05:45 PM	1	0	1	2	256	3	1	0	0	3	132	3	402
Total	4	0	8	13	1008	10	7	2	5	9	578	15	1659
Grand Total	17	0	18	29	2688	15	15	3	15	15	1906	34	4755
Apprch %	48.6	0	51.4	1.1	98.4	0.5	45.5	9.1	45.5	0.8	97.5	1.7	
Total %	0.4	0	0.4	0.6	56.5	0.3	0.3	0.1	0.3	0.3	40.1	0.7	

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 6

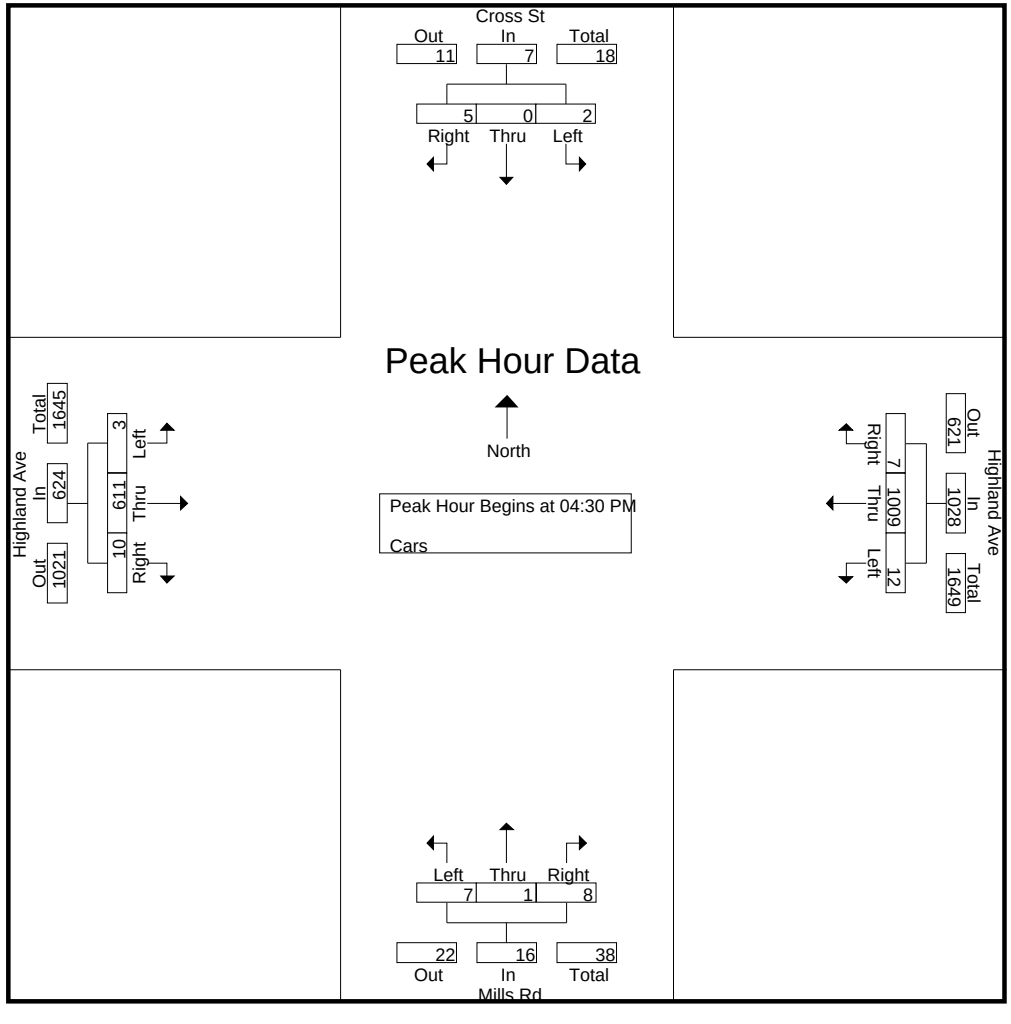
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	**1**	0	1	2	4	**260**	1	**265**	1	0	**3**	4	0	143	**3**	146	417
04:45 PM	0	0	1	1	1	253	**2**	256	1	**1**	1	3	0	150	2	152	412
05:00 PM	1	0	**2**	**3**	2	242	2	246	**3**	0	1	4	**2**	**159**	3	**164**	417
05:15 PM	0	0	1	1	**5**	254	2	261	2	0	3	**5**	1	159	2	162	**429**
Total Volume	2	0	5	7	12	1009	7	1028	7	1	8	16	3	611	10	624	1675
% App. Total	28.6	0	71.4		1.2	98.2	0.7		43.8	6.2	50		0.5	97.9	1.6		
PHF	.500	.000	.625	.583	.600	.970	.875	.970	.583	.250	.667	.800	.375	.961	.833	.951	.976

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

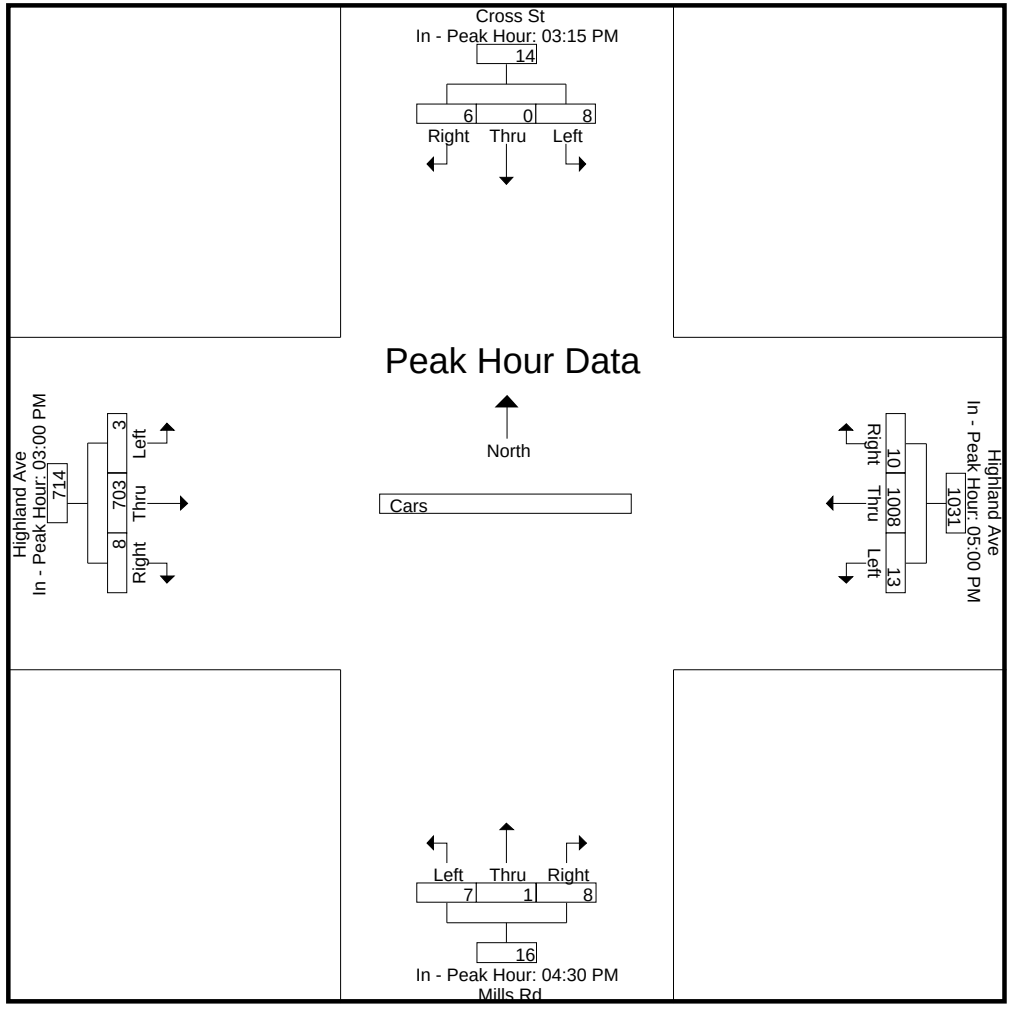
	03:15 PM				05:00 PM				04:30 PM				03:00 PM			
+0 mins.	**4**	0	1	**5**	2	242	2	246	1	0	**3**	4	**2**	**203**	1	**206**
+15 mins.	1	0	1	2	**5**	254	2	261	1	**1**	1	3	0	171	**4**	175
+30 mins.	1	0	**2**	3	4	**256**	**3**	**263**	**3**	0	1	4	0	176	1	177
+45 mins.	2	0	2	4	2	256	3	261	2	0	3	**5**	1	153	2	156
Total Volume	8	0	6	14	13	1008	10	1031	7	1	8	16	3	703	8	714
% App. Total	57.1	0	42.9		1.3	97.8	1		43.8	6.2	50		0.4	98.5	1.1	
PHF	.500	.000	.750	.700	.650	.984	.833	.980	.583	.250	.667	.800	.375	.866	.500	.867

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 8



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Trucks

	Cross St From North			Highland Ave From East			Mills Rd From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
03:00 PM	0	0	0	0	0	0	0	0	0	0	2	0	2
03:15 PM	0	0	0	1	3	0	0	0	0	0	5	0	9
03:30 PM	0	0	0	0	3	0	0	0	0	0	1	0	4
03:45 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
Total	0	0	0	1	7	0	0	0	0	0	9	0	17
04:00 PM	0	0	0	0	3	0	0	0	0	0	0	0	3
04:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
04:30 PM	0	0	0	0	3	0	0	0	0	0	3	0	6
04:45 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
Total	0	0	0	0	7	0	0	0	0	0	4	0	11
05:00 PM	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
05:30 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
05:45 PM	0	0	0	0	2	0	0	0	0	0	1	0	3
Total	0	0	0	0	3	0	0	0	0	0	2	0	5
Grand Total	0	0	0	1	17	0	0	0	0	0	15	0	33
Apprch %	0	0	0	5.6	94.4	0	0	0	0	0	100	0	
Total %	0	0	0	3	51.5	0	0	0	0	0	45.5	0	

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 10

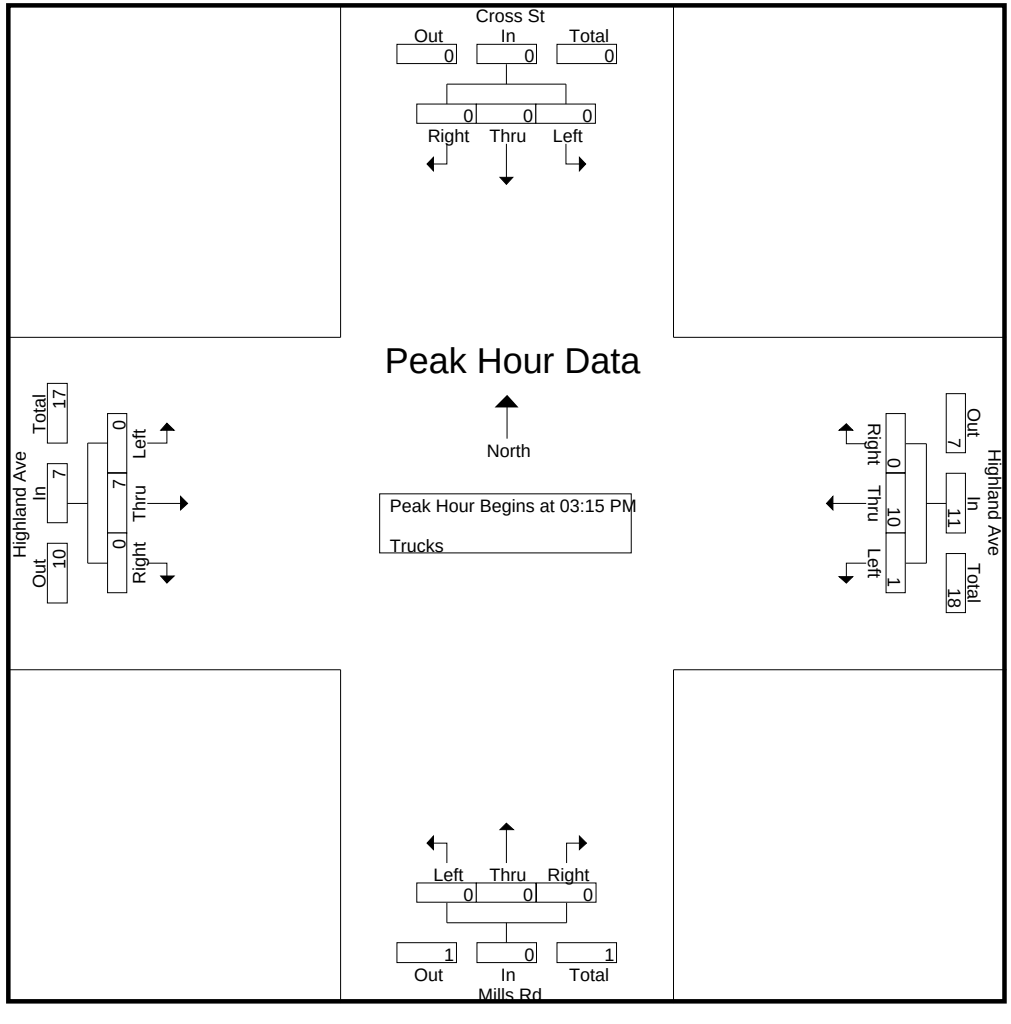
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:15 PM																	
03:15 PM	0	0	0	0	**1**	**3**	0	**4**	0	0	0	0	0	**5**	0	**5**	**9**
03:30 PM	0	0	0	0	0	3	0	3	0	0	0	0	0	1	0	1	4
03:45 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	2
04:00 PM	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	3
Total Volume	0	0	0	0	1	10	0	11	0	0	0	0	0	7	0	7	18
% App. Total	0	0	0		9.1	90.9	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.250	.833	.000	.688	.000	.000	.000	.000	.000	.350	.000	.350	.500

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

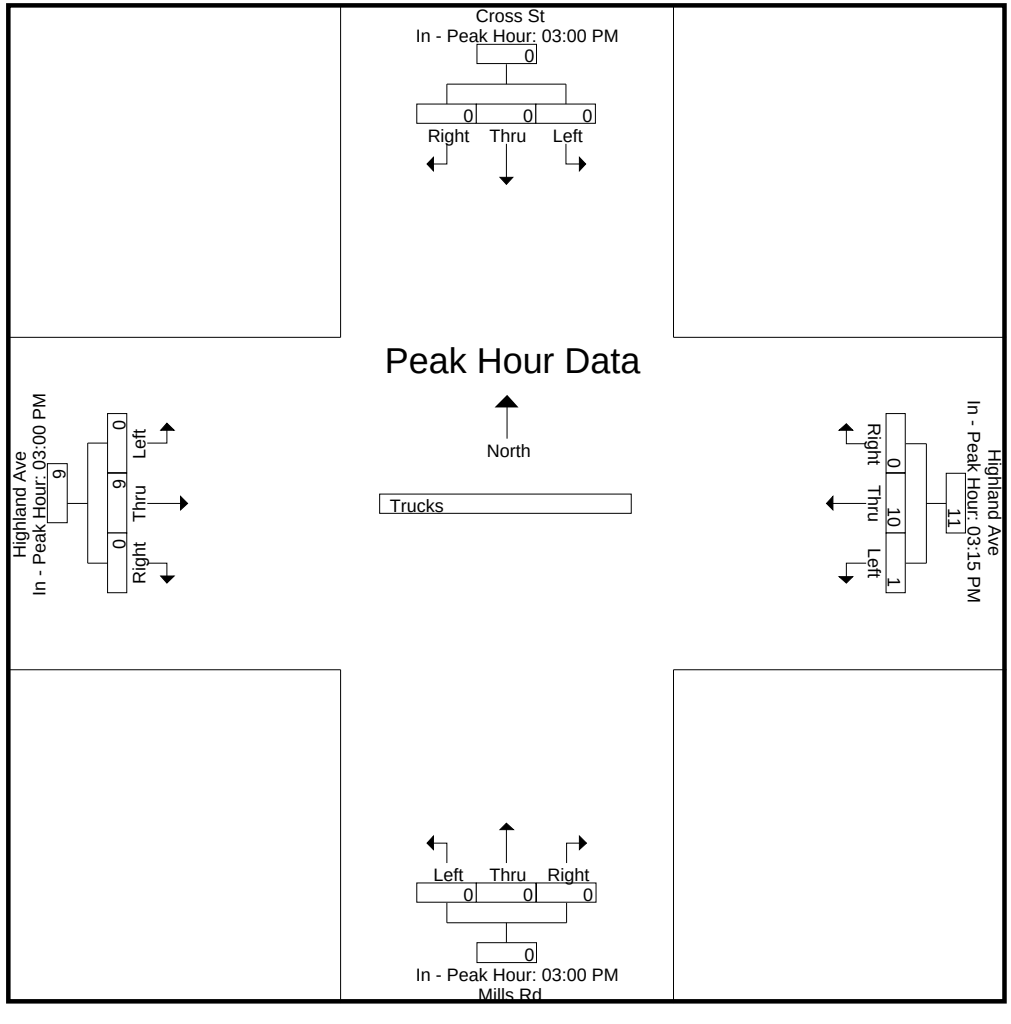
	03:00 PM				03:15 PM				03:00 PM				03:00 PM			
+0 mins.	0	0	0	0	**1**	**3**	0	**4**	0	0	0	0	0	2	0	2
+15 mins.	0	0	0	0	0	3	0	3	0	0	0	0	0	**5**	0	**5**
+30 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1
+45 mins.	0	0	0	0	0	3	0	3	0	0	0	0	0	1	0	1
Total Volume	0	0	0	0	1	10	0	11	0	0	0	0	0	9	0	9
% App. Total	0	0	0		9.1	90.9	0		0	0	0		0	100	0	
PHF	.000	.000	.000	.000	.250	.833	.000	.688	.000	.000	.000	.000	.000	.450	.000	.450

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 12



Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Cross St From North				Highland Ave From East				Mills Rd 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
03:00 PM	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	0	2
03:15 PM	0	0	0	5	0	0	0	0	0	0	0	0	0	1	0	0	5	1	6
03:30 PM	0	0	0	3	0	1	0	0	0	0	0	2	0	0	0	0	5	1	6
03:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	2	2
Total	0	0	0	9	0	1	0	0	1	0	0	3	0	2	0	0	12	4	16
04:00 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1	2	3
04:15 PM	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	2	1	3
04:30 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	2
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	3	0	1	0	1	0	0	0	0	0	3	0	0	4	4	8
05:00 PM	0	0	0	1	0	2	0	0	0	0	0	1	0	2	0	0	2	4	6
05:15 PM	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	2	2	4
05:30 PM	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	0	2
05:45 PM	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2
Total	0	0	0	2	0	6	0	0	0	0	0	2	0	2	0	2	6	8	14
Grand Total	0	0	0	14	0	8	0	1	1	0	0	5	0	7	0	2	22	16	38
Apprch %	0	0	0		0	100	0		100	0	0		0	100	0				
Total %	0	0	0		0	50	0		6.2	0	0		0	43.8	0		57.9	42.1	

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 14

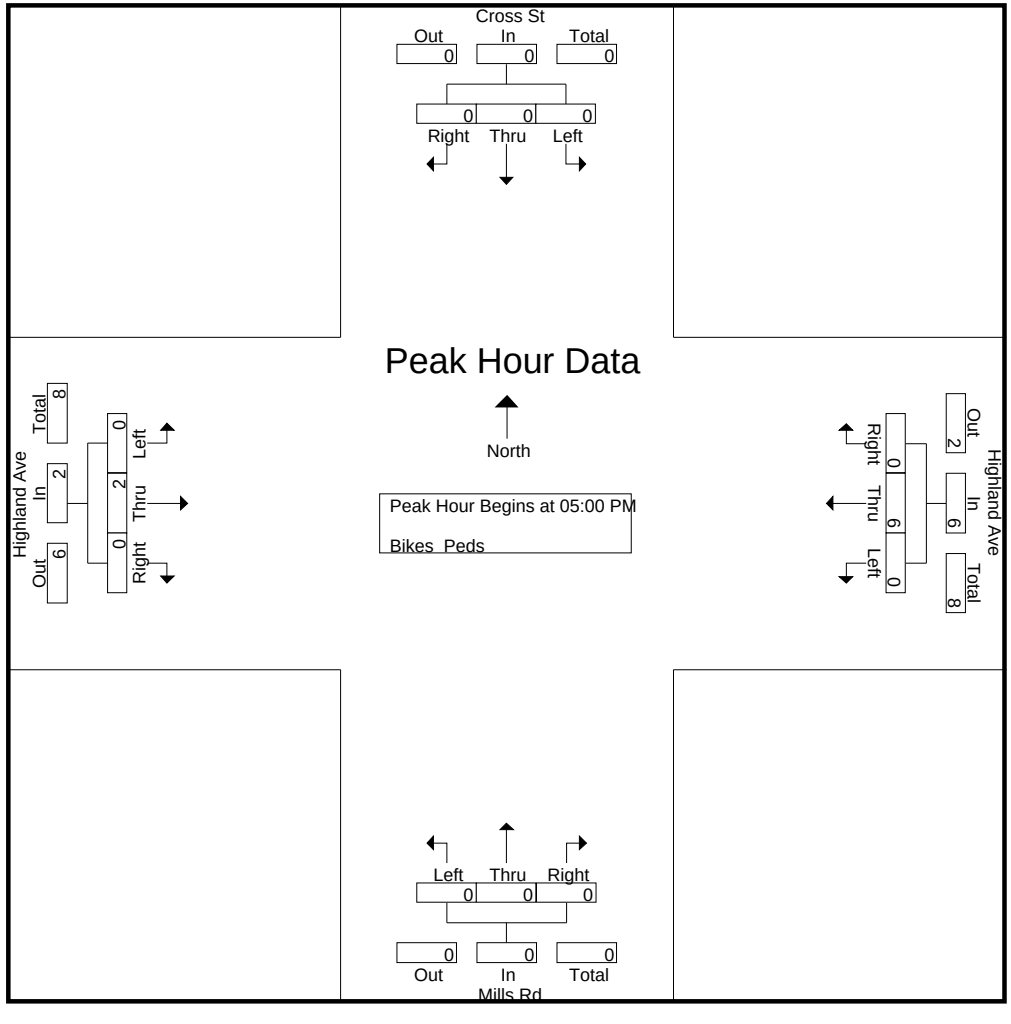
	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	0	0	0	0	**2**	0	**2**	0	0	0	0	0	**2**	0	**2**	**4**
05:15 PM	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	2
05:30 PM	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	2	0	2	0	0	0	0	0	0	0	0	2
Total Volume	0	0	0	0	0	6	0	6	0	0	0	0	0	2	0	2	8
% App. Total	0	0	0		0	100	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.000	.750	.000	.750	.000	.000	.000	.000	.000	.250	.000	.250	.500

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

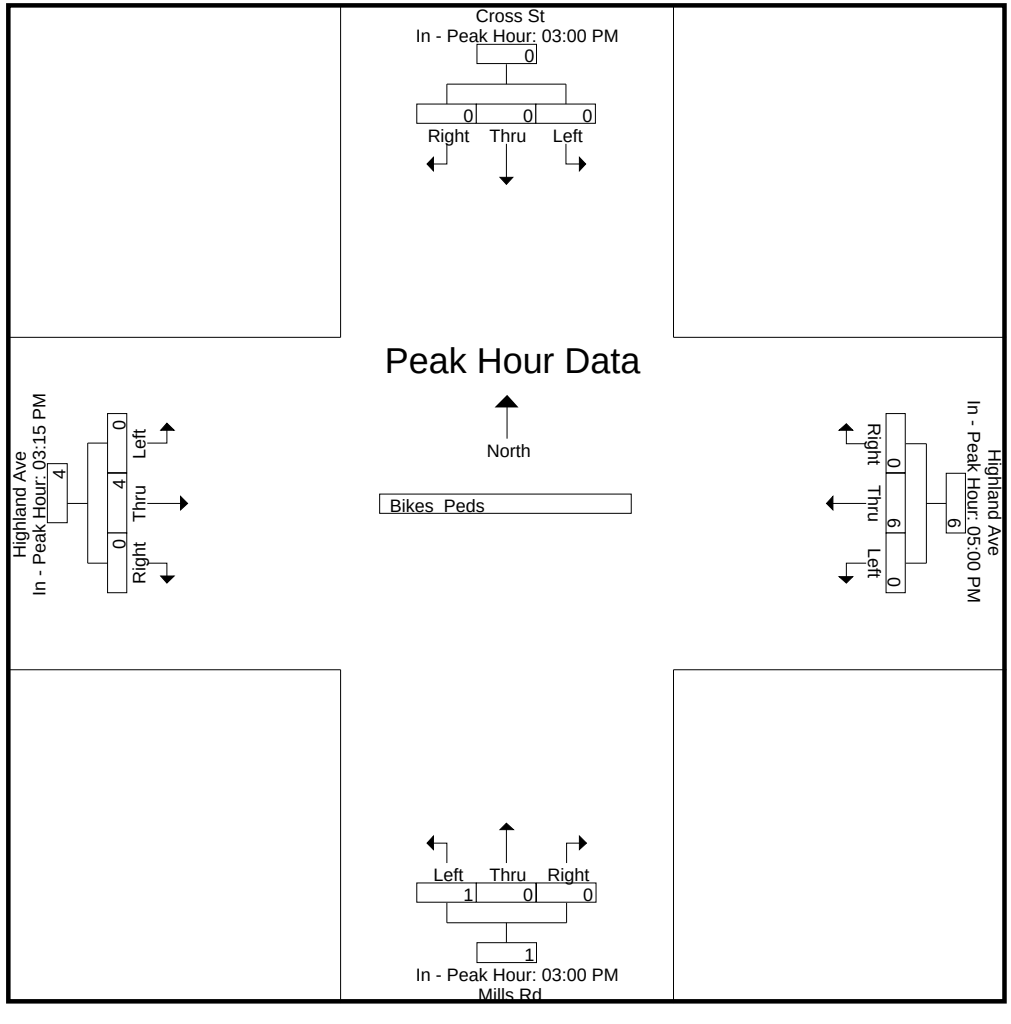
	03:00 PM				05:00 PM				03:00 PM				03:15 PM			
+0 mins.	0	0	0	0	0	**2**	0	**2**	0	0	0	0	0	1	0	1
+15 mins.	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
+45 mins.	0	0	0	0	0	2	0	2	**1**	0	0	**1**	0	**2**	0	**2**
Total Volume	0	0	0	0	0	6	0	6	1	0	0	1	0	4	0	4
% App. Total	0	0	0		0	100	0		100	0	0		0	100	0	
PHF	.000	.000	.000	.000	.000	.750	.000	.750	.250	.000	.000	.250	.000	.500	.000	.500

Accurate Counts

978-664-2565

N/S Street : Cross Street / Mills Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 16



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

Groups Printed- Cars - Trucks

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
07:00 AM	39	7	9	16	130	75	0	15	20	41	9	185	1	0	547
07:15 AM	27	8	5	15	145	58	0	8	22	58	13	222	2	0	583
07:30 AM	44	12	11	7	139	59	1	8	30	61	20	183	3	0	578
07:45 AM	34	10	7	7	154	120	1	9	46	46	33	176	7	0	650
Total	144	37	32	45	568	312	2	40	118	206	75	766	13	0	2358
08:00 AM	44	17	5	11	128	72	0	12	59	80	18	222	2	0	670
08:15 AM	31	10	12	8	142	95	0	4	47	69	28	243	1	0	690
08:30 AM	49	14	9	13	136	98	1	7	59	86	34	204	7	0	717
08:45 AM	38	13	9	16	126	121	3	10	54	44	36	156	2	0	628
Total	162	54	35	48	532	386	4	33	219	279	116	825	12	0	2705
Grand Total	306	91	67	93	1100	698	6	73	337	485	191	1591	25	0	5063
Apprch %	65.9	19.6	14.4	4.9	58	36.8	0.3	8.2	37.7	54.2	10.6	88	1.4	0	
Total %	6	1.8	1.3	1.8	21.7	13.8	0.1	1.4	6.7	9.6	3.8	31.4	0.5	0	
Cars	302	91	67	93	1085	690	6	72	334	484	189	1578	25	0	5016
% Cars	98.7	100	100	100	98.6	98.9	100	98.6	99.1	99.8	99	99.2	100	0	99.1
Trucks	4	0	0	0	15	8	0	1	3	1	2	13	0	0	47
% Trucks	1.3	0	0	0	1.4	1.1	0	1.4	0.9	0.2	1	0.8	0	0	0.9

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 2

	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	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	34	10	7	51	7	**154**	**120**	**1**	**282**	9	46	46	101	33	176	**7**	0	216	650
08:00 AM	44	**17**	5	66	11	128	72	0	211	**12**	**59**	80	151	18	222	2	0	242	670
08:15 AM	31	10	**12**	53	8	142	95	0	245	4	47	69	120	28	**243**	1	0	**272**	690
08:30 AM	**49**	14	9	**72**	**13**	136	98	1	248	7	59	**86**	**152**	**34**	204	7	0	245	**717**
Total Volume	158	51	33	242	39	560	385	2	986	32	211	281	524	113	845	17	0	975	2727
% App. Total	65.3	21.1	13.6		4	56.8	39	0.2		6.1	40.3	53.6		11.6	86.7	1.7	0		
PHF	.806	.750	.688	.840	.750	.909	.802	.500	.874	.667	.894	.817	.862	.831	.869	.607	.000	.896	.951
Cars	154	51	33	238	39	554	380	2	975	32	209	281	522	112	838	17	0	967	2702
% Cars	97.5	100	100	98.3	100	98.9	98.7	100	98.9	100	99.1	100	99.6	99.1	99.2	100	0	99.2	99.1
Trucks	4	0	0	4	0	6	5	0	11	0	2	0	2	1	7	0	0	8	25
% Trucks	2.5	0	0	1.7	0	1.1	1.3	0	1.1	0	0.9	0	0.4	0.9	0.8	0	0	0.8	0.9

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3

Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

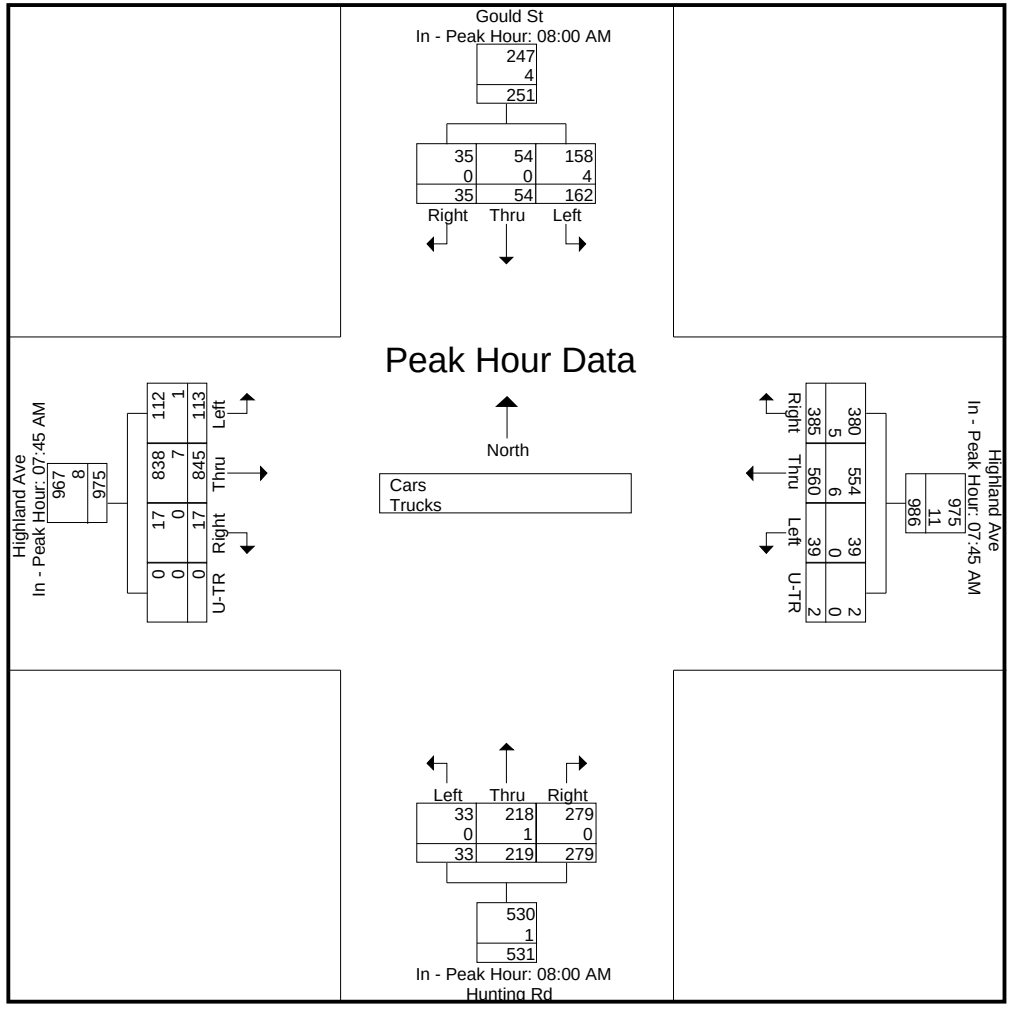
Peak Hour for Each Approach Begins at:

	08:00 AM				07:45 AM					08:00 AM				07:45 AM				
+0 mins.	44	**17**	5	66	7	**154**	**120**	**1**	**282**	**12**	**59**	80	151	33	176	**7**	0	216
+15 mins.	31	10	**12**	53	11	128	72	0	211	4	47	69	120	18	222	2	0	242
+30 mins.	**49**	14	9	**72**	8	142	95	0	245	7	59	**86**	**152**	28	**243**	1	0	**272**
+45 mins.	38	13	9	60	**13**	136	98	1	248	10	54	44	108	**34**	204	7	0	245
Total Volume	162	54	35	251	39	560	385	2	986	33	219	279	531	113	845	17	0	975

Accurate Counts

978-664-2565

% App. Total	64.5	21.5	13.9		4	56.8	39	0.2		6.2	41.2	52.5		11.6	86.7	1.7	0	
PHF	.827	.794	.729	.872	.750	.909	.802	.500	.874	.688	.928	.811	.873	.831	.869	.607	.000	.896
Cars	158	54	35	247	39	554	380	2	975	33	218	279	530	112	838	17	0	967
% Cars	97.5	100	100	98.4	100	98.9	98.7	100	98.9	100	99.5	100	99.8	99.1	99.2	100	0	99.2
Trucks	4	0	0	4	0	6	5	0	11	0	1	0	1	1	7	0	0	8
% Trucks	2.5	0	0	1.6	0	1.1	1.3	0	1.1	0	0.5	0	0.2	0.9	0.8	0	0	0.8



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
07:00 AM	39	7	9	16	125	74	0	14	20	41	9	183	1	0	538
07:15 AM	27	8	5	15	144	56	0	8	22	58	13	221	2	0	579
07:30 AM	44	12	11	7	138	59	1	8	29	60	20	182	3	0	574
07:45 AM	34	10	7	7	153	117	1	9	45	46	33	173	7	0	642
Total	144	37	32	45	560	306	2	39	116	205	75	759	13	0	2333
08:00 AM	44	17	5	11	125	71	0	12	58	80	17	221	2	0	663
08:15 AM	30	10	12	8	140	94	0	4	47	69	28	241	1	0	684
08:30 AM	46	14	9	13	136	98	1	7	59	86	34	203	7	0	713
08:45 AM	38	13	9	16	124	121	3	10	54	44	35	154	2	0	623
Total	158	54	35	48	525	384	4	33	218	279	114	819	12	0	2683
Grand Total	302	91	67	93	1085	690	6	72	334	484	189	1578	25	0	5016
Apprch %	65.7	19.8	14.6	5	57.9	36.8	0.3	8.1	37.5	54.4	10.5	88.1	1.4	0	
Total %	6	1.8	1.3	1.9	21.6	13.8	0.1	1.4	6.7	9.6	3.8	31.5	0.5	0	

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

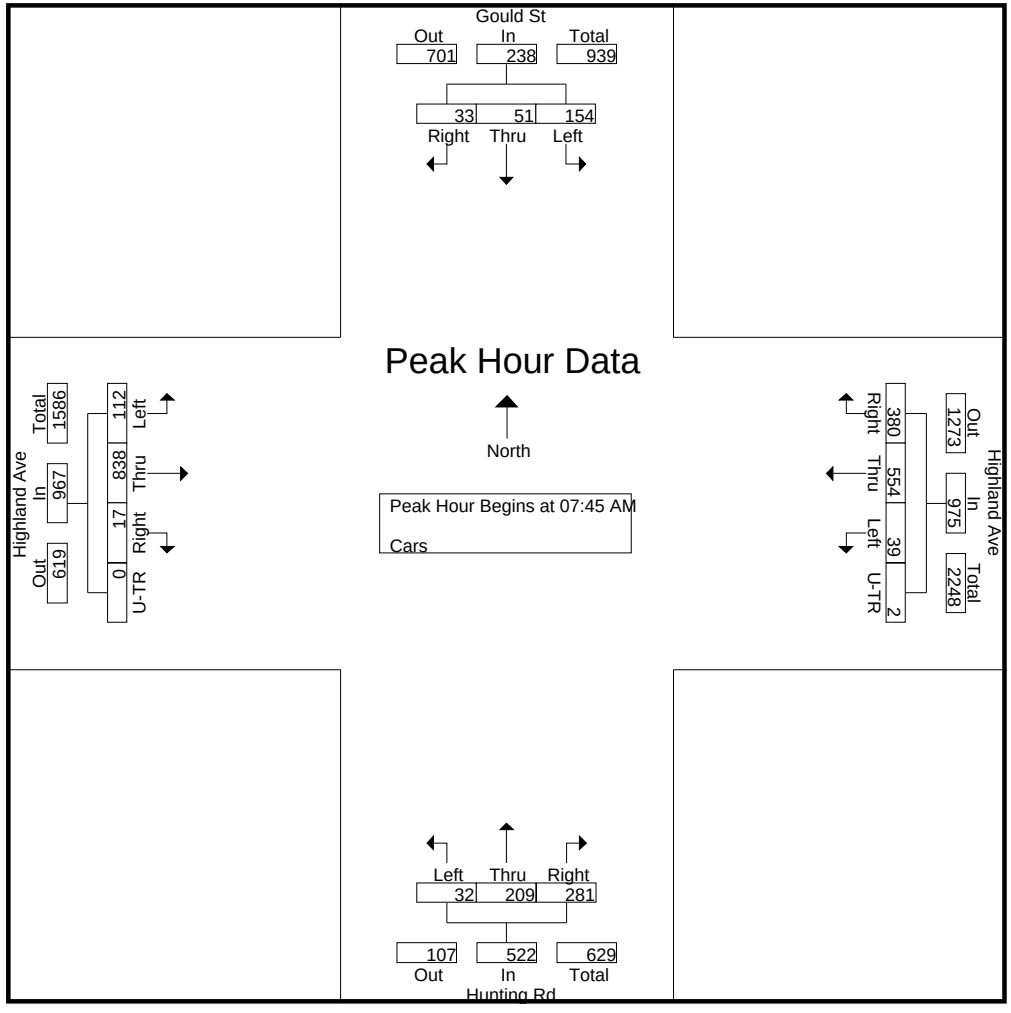
	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 07:45 AM																			
07:45 AM	34	10	7	51	7	**153**	**117**	**1**	**278**	9	45	46	100	33	173	**7**	0	213	642
08:00 AM	44	**17**	5	66	11	125	71	0	207	**12**	58	80	150	17	221	2	0	240	663
08:15 AM	30	10	**12**	52	8	140	94	0	242	4	47	69	120	28	**241**	1	0	**270**	684
08:30 AM	**46**	14	9	**69**	**13**	136	98	1	248	7	**59**	**86**	**152**	**34**	203	7	0	244	**713**
Total Volume	154	51	33	238	39	554	380	2	975	32	209	281	522	112	838	17	0	967	2702
% App. Total	64.7	21.4	13.9		4	56.8	39	0.2		6.1	40	53.8		11.6	86.7	1.8	0		
PHF	.837	.750	.688	.862	.750	.905	.812	.500	.877	.667	.886	.817	.859	.824	.869	.607	.000	.895	.947

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

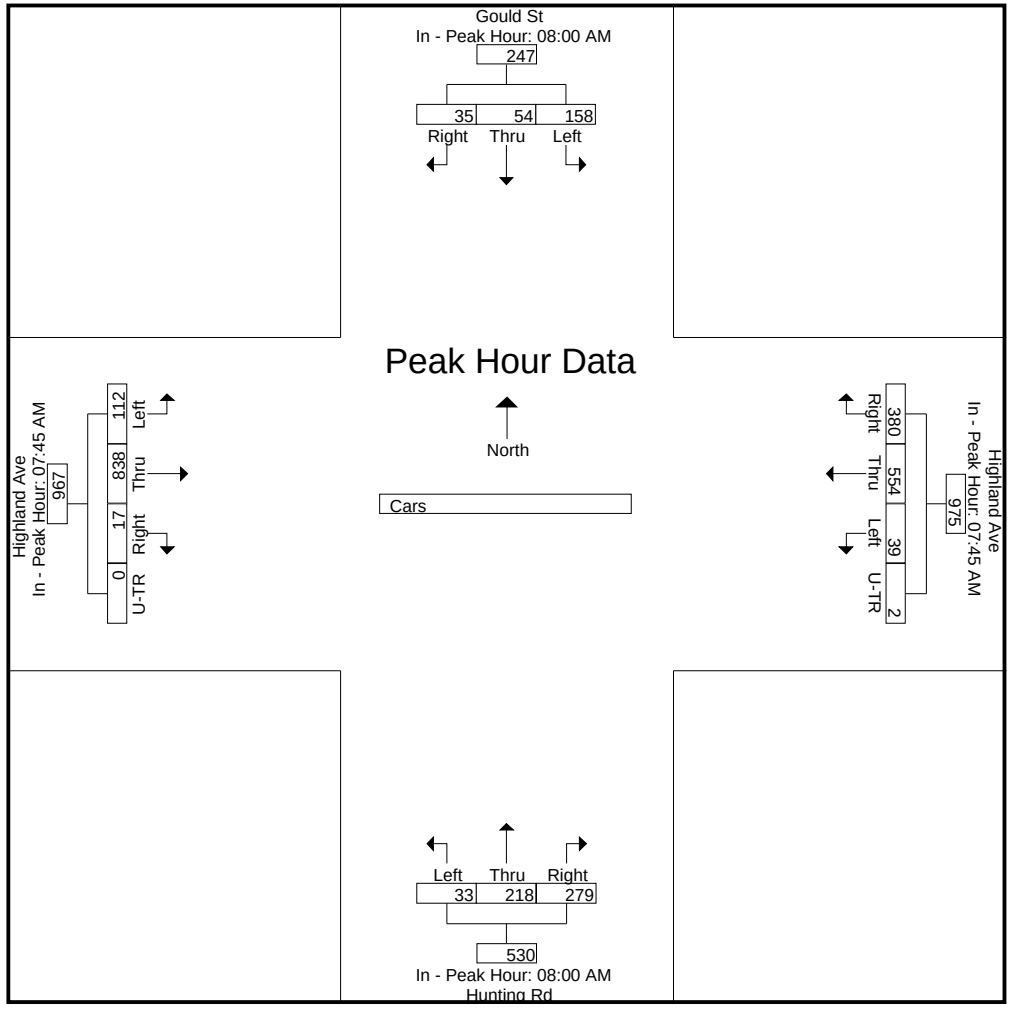
Peak Hour for Each Approach Begins at:

	08:00 AM				07:45 AM					08:00 AM				07:45 AM				
+0 mins.	44	**17**	5	66	7	**153**	**117**	**1**	**278**	**12**	58	80	150	33	173	**7**	0	213
+15 mins.	30	10	**12**	52	11	125	71	0	207	4	47	69	120	17	221	2	0	240
+30 mins.	**46**	14	9	**69**	8	140	94	0	242	7	**59**	**86**	**152**	28	**241**	1	0	**270**
+45 mins.	38	13	9	60	**13**	136	98	1	248	10	54	44	108	**34**	203	7	0	244
Total Volume	158	54	35	247	39	554	380	2	975	33	218	279	530	112	838	17	0	967

Accurate Counts

978-664-2565

% App. Total	64	21.9	14.2		4	56.8	39	0.2		6.2	41.1	52.6		11.6	86.7	1.8	0	
PHF	.859	.794	.729	.895	.750	.905	.812	.500	.877	.688	.924	.811	.872	.824	.869	.607	.000	.895



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

Groups Printed- Trucks

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
07:00 AM	0	0	0	0	5	1	0	1	0	0	0	2	0	0	9
07:15 AM	0	0	0	0	1	2	0	0	0	0	0	1	0	0	4
07:30 AM	0	0	0	0	1	0	0	0	1	1	0	1	0	0	4
07:45 AM	0	0	0	0	1	3	0	0	1	0	0	3	0	0	8
Total	0	0	0	0	8	6	0	1	2	1	0	7	0	0	25
08:00 AM	0	0	0	0	3	1	0	0	1	0	1	1	0	0	7
08:15 AM	1	0	0	0	2	1	0	0	0	0	0	2	0	0	6
08:30 AM	3	0	0	0	0	0	0	0	0	0	0	1	0	0	4
08:45 AM	0	0	0	0	2	0	0	0	0	0	1	2	0	0	5
Total	4	0	0	0	7	2	0	0	1	0	2	6	0	0	22
Grand Total	4	0	0	0	15	8	0	1	3	1	2	13	0	0	47
Apprch %	100	0	0	0	65.2	34.8	0	20	60	20	13.3	86.7	0	0	
Total %	8.5	0	0	0	31.9	17	0	2.1	6.4	2.1	4.3	27.7	0	0	

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

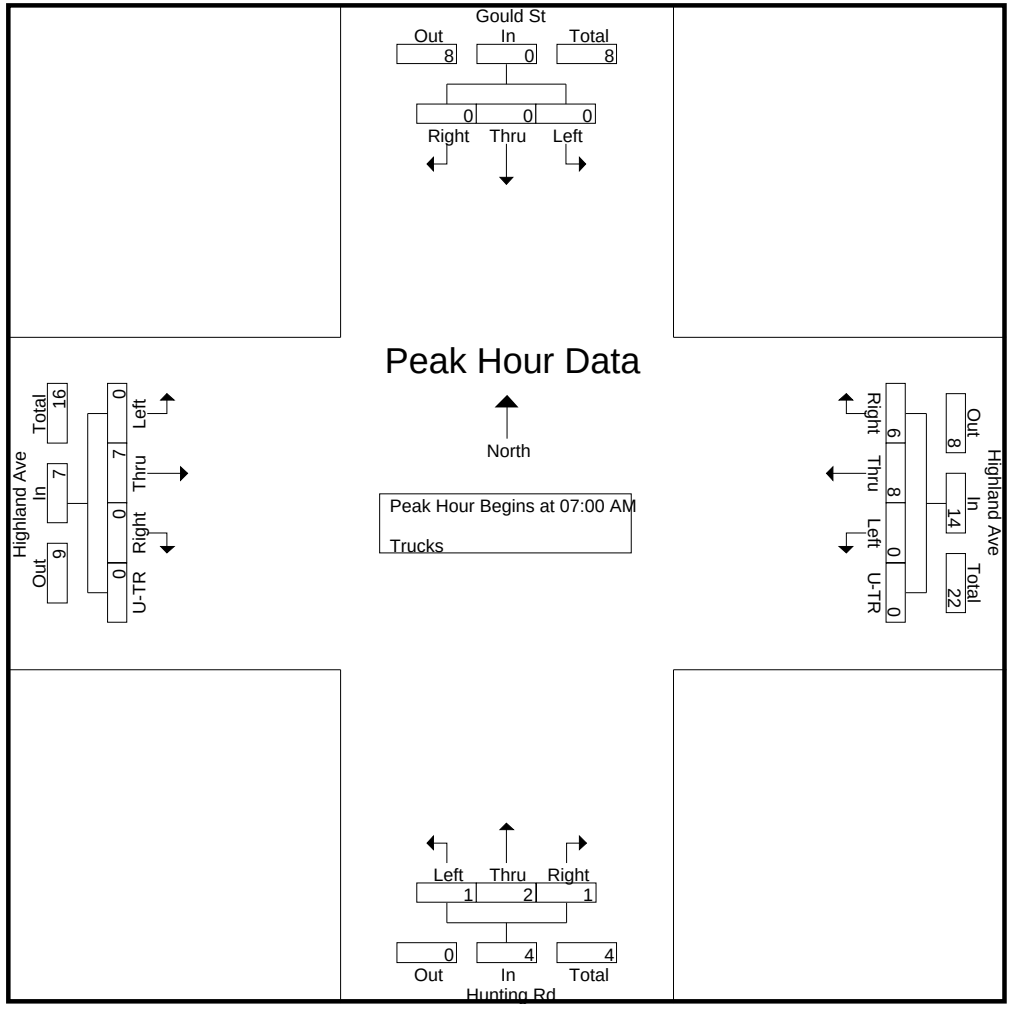
	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 07:00 AM																			
07:00 AM	0	0	0	0	0	**5**	1	0	**6**	**1**	0	0	1	0	2	0	0	2	**9**
07:15 AM	0	0	0	0	0	1	2	0	3	0	0	0	0	0	1	0	0	1	4
07:30 AM	0	0	0	0	0	1	0	0	1	0	**1**	**1**	**2**	0	1	0	0	1	4
07:45 AM	0	0	0	0	0	1	**3**	0	4	0	1	0	1	0	**3**	0	0	**3**	8
Total Volume	0	0	0	0	0	8	6	0	14	1	2	1	4	0	7	0	0	7	25
% App. Total	0	0	0		0	57.1	42.9	0		25	50	25		0	100	0	0		
PHF	.000	.000	.000	.000	.000	.400	.500	.000	.583	.250	.500	.250	.500	.000	.583	.000	.000	.583	.694

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

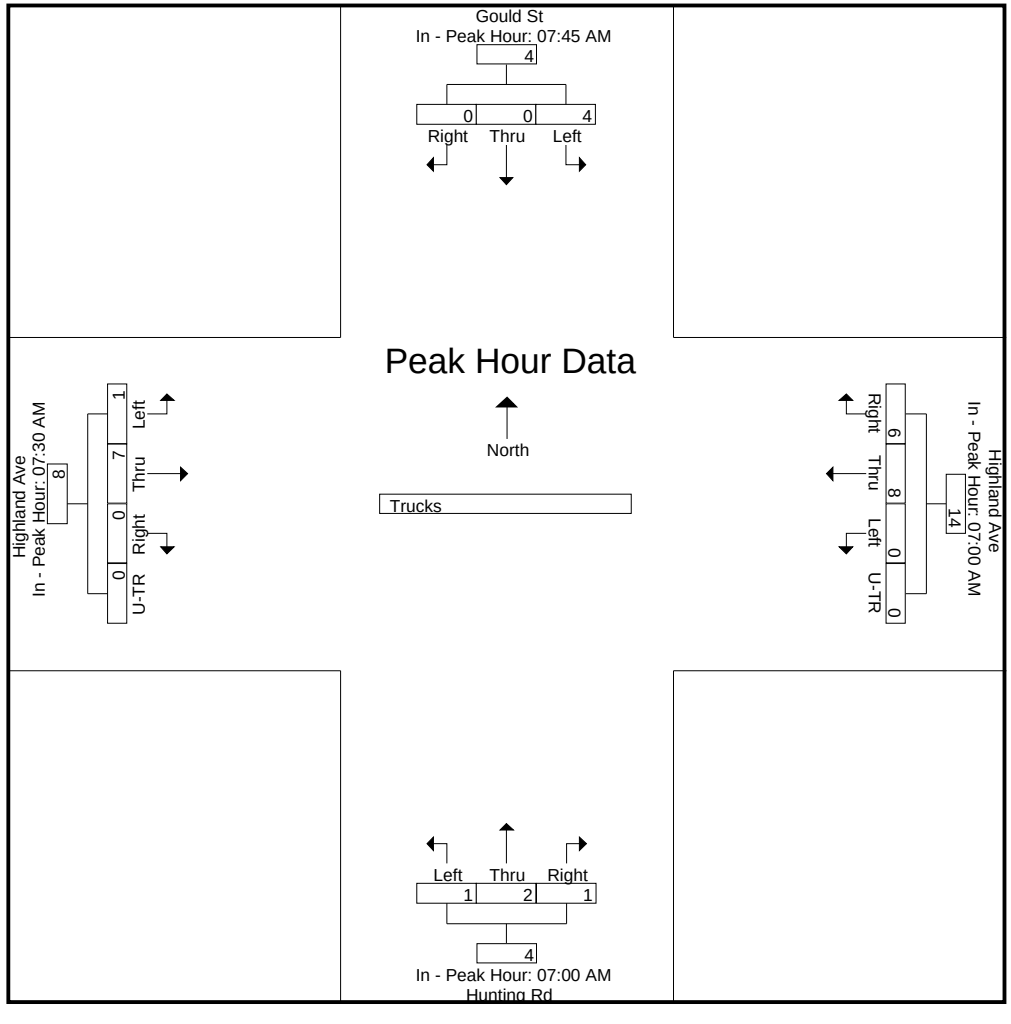
Peak Hour for Each Approach Begins at:

	07:45 AM				07:00 AM					07:00 AM				07:30 AM				
+0 mins.	0	0	0	0	0	**5**	1	0	**6**	**1**	0	0	1	0	1	0	0	1
+15 mins.	0	0	0	0	0	1	2	0	3	0	0	0	0	0	**3**	0	0	**3**
+30 mins.	1	0	0	1	0	1	0	0	1	0	**1**	**1**	**2**	**1**	1	0	0	2
+45 mins.	**3**	0	0	**3**	0	1	**3**	0	4	0	1	0	1	0	2	0	0	2
Total Volume	4	0	0	4	0	8	6	0	14	1	2	1	4	1	7	0	0	8

Accurate Counts

978-664-2565

% App. Total	100	0	0		0	57.1	42.9	0		25	50	25		12.5	87.5	0	0	
PHF	.333	.000	.000	.333	.000	.400	.500	.000	.583	.250	.500	.250	.500	.250	.583	.000	.000	.667



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Gould St From North				Highland Ave From East				Hunting Rd 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	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	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	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	3
Total	0	1	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	5	5
08:00 AM	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	3	3
08:15 AM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	2
08:45 AM	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	2
Total	1	0	0	0	0	0	1	0	0	2	0	0	0	3	0	1	1	7	8
Grand Total	1	1	0	0	0	0	1	0	0	2	0	0	0	6	1	1	1	12	13
Apprch %	50	50	0		0	0	100		0	100	0		0	85.7	14.3				
Total %	8.3	8.3	0		0	0	8.3		0	16.7	0		0	50	8.3		7.7	92.3	

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 2

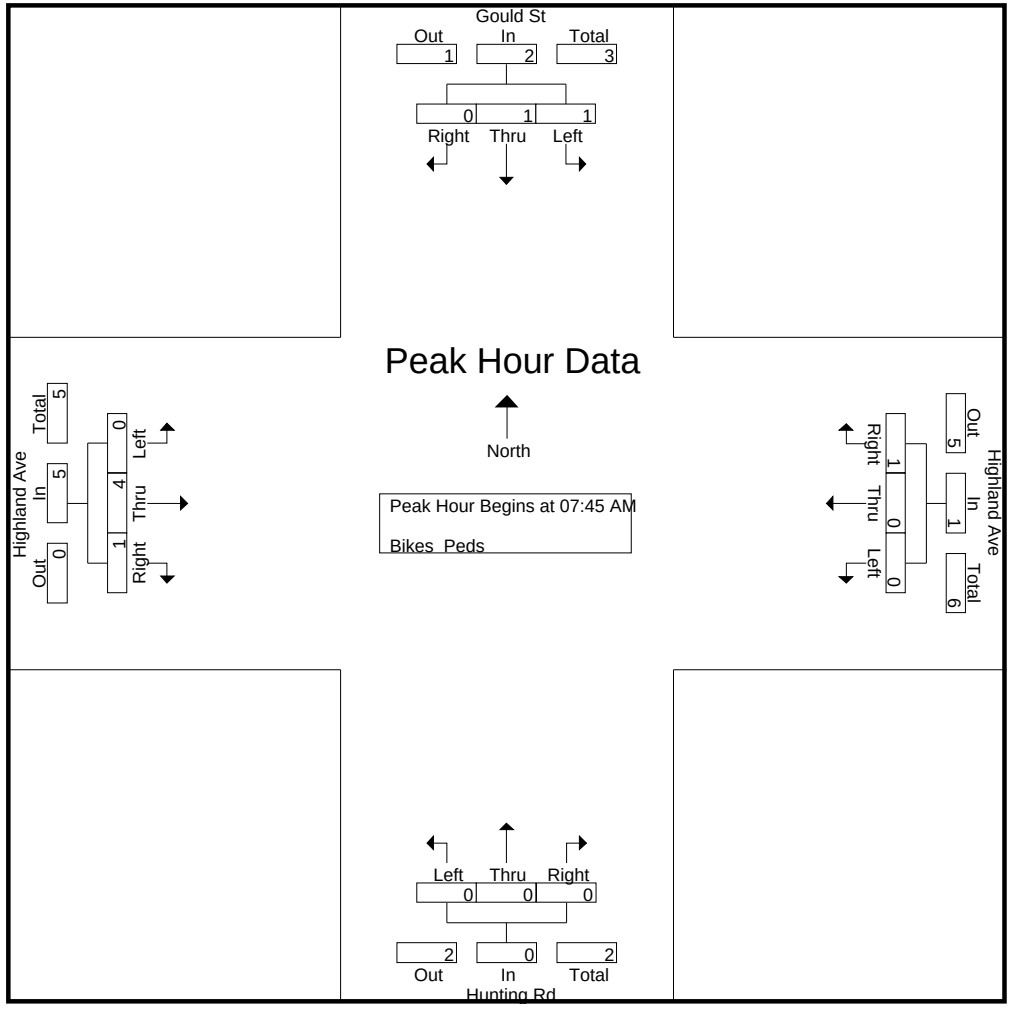
	Gould St From North				Highland Ave From East				Hunting Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	0	**1**	0	**1**	0	0	0	0	0	0	0	0	0	1	**1**	**2**	**3**
08:00 AM	0	0	0	0	0	0	**1**	**1**	0	0	0	0	0	**2**	0	2	3
08:15 AM	**1**	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Total Volume	1	1	0	2	0	0	1	1	0	0	0	0	0	4	1	5	8
% App. Total	50	50	0		0	0	100		0	0	0		0	80	20		
PHF	.250	.250	.000	.500	.000	.000	.250	.250	.000	.000	.000	.000	.000	.500	.250	.625	.667

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

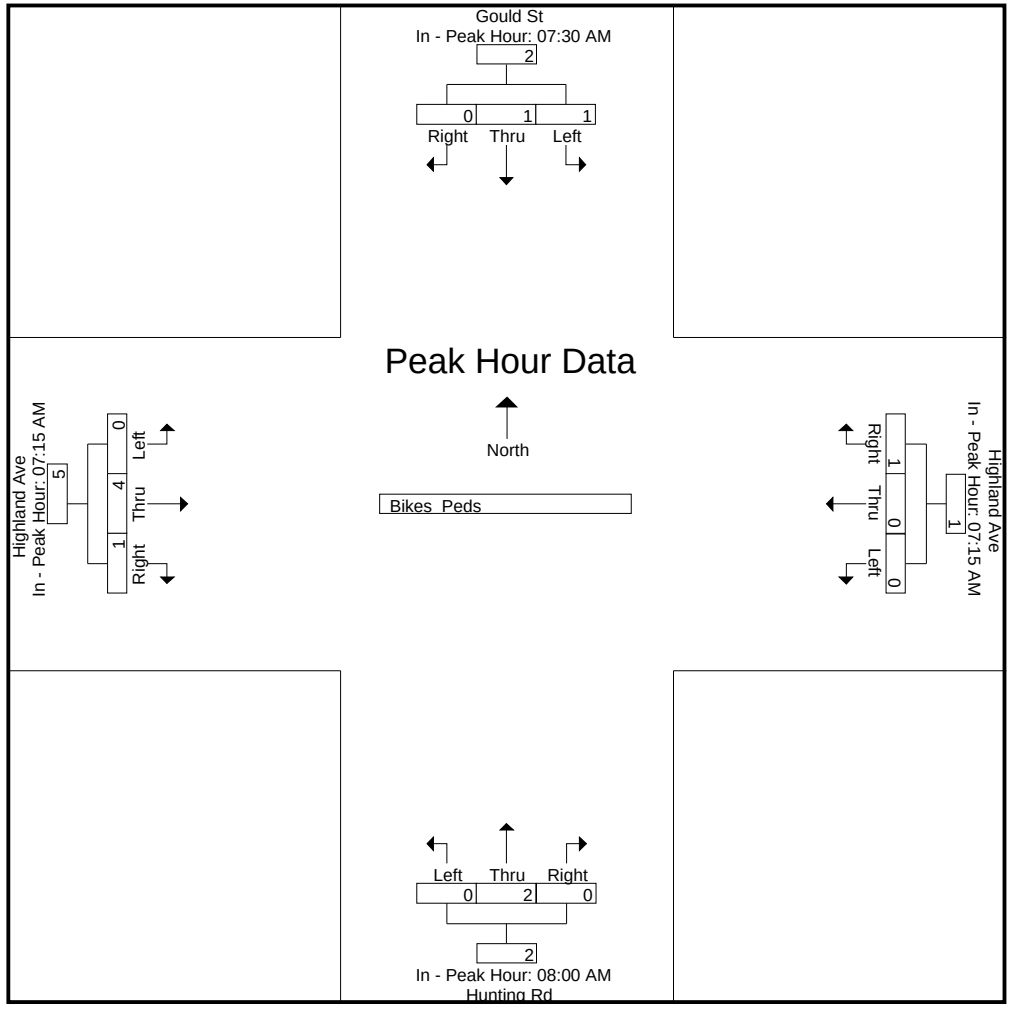
Peak Hour for Each Approach Begins at:

	07:30 AM				07:15 AM				08:00 AM				07:15 AM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
+15 mins.	0	**1**	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**	**2**
+45 mins.	**1**	0	0	1	0	0	**1**	**1**	0	**2**	0	**2**	0	**2**	0	2
Total Volume	1	1	0	2	0	0	1	1	0	2	0	2	0	4	1	5

Accurate Counts

978-664-2565

% App. Total	50	50	0		0	0	100		0	100	0		0	80	20	
PHF	.250	.250	.000	.500	.000	.000	.250	.250	.000	.250	.000	.250	.000	.500	.250	.625



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars - Trucks

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
03:00 PM	71	32	10	20	156	56	0	4	9	23	16	188	7	0	592
03:15 PM	54	24	15	20	151	50	0	4	13	24	13	159	2	0	529
03:30 PM	82	29	14	26	199	51	0	4	10	23	9	183	3	0	633
03:45 PM	55	30	17	26	170	47	3	6	23	23	14	137	5	0	556
Total	262	115	56	92	676	204	3	18	55	93	52	667	17	0	2310
04:00 PM	80	29	18	35	216	29	5	6	12	22	4	154	6	0	616
04:15 PM	49	27	10	37	208	36	2	2	13	32	6	169	7	0	598
04:30 PM	70	44	22	48	224	42	1	8	15	19	10	135	8	0	646
04:45 PM	82	31	19	41	240	47	2	11	16	18	5	139	5	0	656
Total	281	131	69	161	888	154	10	27	56	91	25	597	26	0	2516
05:00 PM	105	35	15	47	232	49	2	10	15	26	11	152	5	0	704
05:15 PM	70	36	16	49	222	47	0	6	24	22	14	141	6	1	654
05:30 PM	85	36	21	28	254	52	1	10	10	11	4	120	5	2	639
05:45 PM	66	26	11	32	240	42	1	8	18	18	8	131	5	0	606
Total	326	133	63	156	948	190	4	34	67	77	37	544	21	3	2603
Grand Total	869	379	188	409	2512	548	17	79	178	261	114	1808	64	3	7429
Apprch %	60.5	26.4	13.1	11.7	72.1	15.7	0.5	15.3	34.4	50.4	5.7	90.9	3.2	0.2	
Total %	11.7	5.1	2.5	5.5	33.8	7.4	0.2	1.1	2.4	3.5	1.5	24.3	0.9	0	
Cars	866	378	187	408	2503	547	17	79	176	257	112	1797	64	3	7394
% Cars	99.7	99.7	99.5	99.8	99.6	99.8	100	100	98.9	98.5	98.2	99.4	100	100	99.5
Trucks	3	1	1	1	9	1	0	0	2	4	2	11	0	0	35
% Trucks	0.3	0.3	0.5	0.2	0.4	0.2	0	0	1.1	1.5	1.8	0.6	0	0	0.5

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

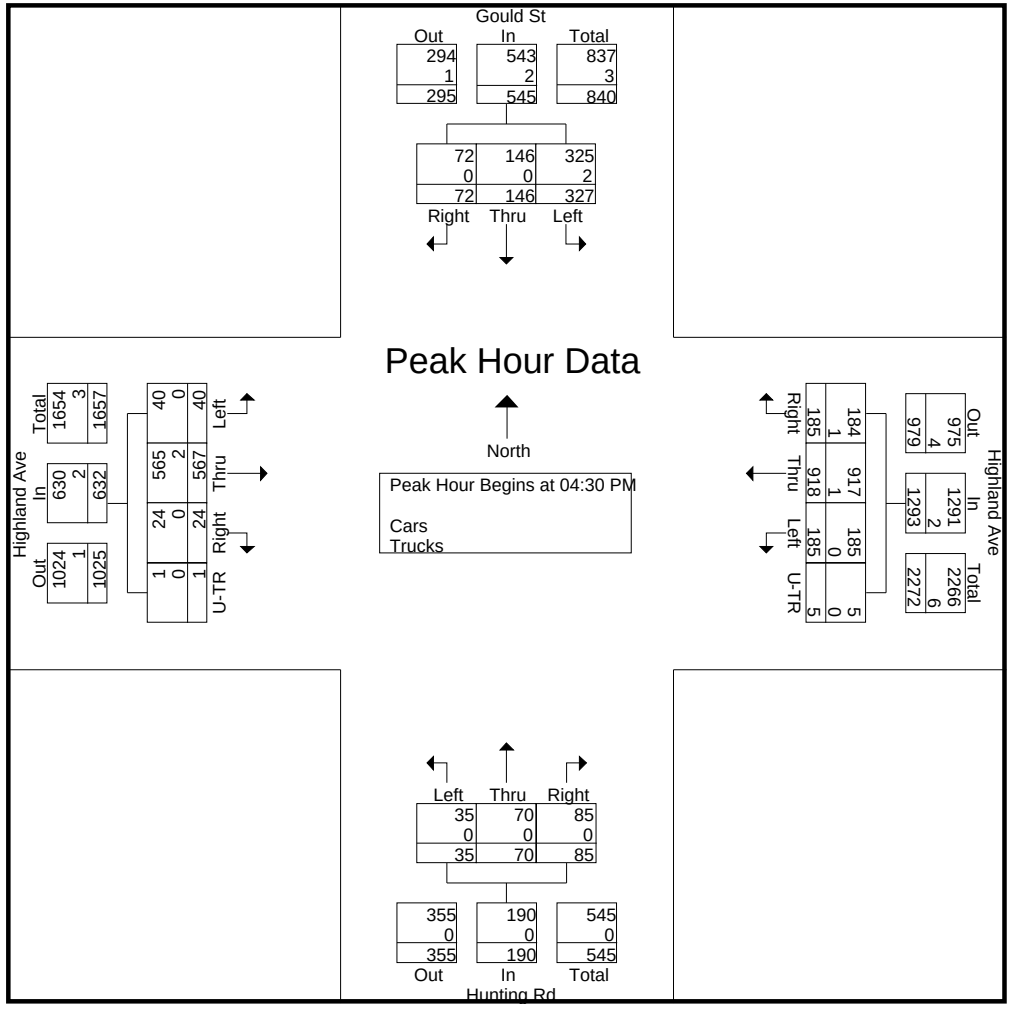
	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 04:30 PM																			
04:30 PM	70	**44**	**22**	136	48	224	42	1	315	8	15	19	42	10	135	**8**	0	153	646
04:45 PM	82	31	19	132	41	**240**	47	**2**	**330**	**11**	16	18	45	5	139	5	0	149	656
05:00 PM	**105**	35	15	**155**	47	232	**49**	2	330	10	15	**26**	51	11	**152**	5	0	**168**	**704**
05:15 PM	70	36	16	122	**49**	222	47	0	318	6	**24**	22	**52**	**14**	141	6	**1**	162	654
Total Volume	327	146	72	545	185	918	185	5	1293	35	70	85	190	40	567	24	1	632	2660
% App. Total	60	26.8	13.2		14.3	71	14.3	0.4		18.4	36.8	44.7		6.3	89.7	3.8	0.2		
PHF	.779	.830	.818	.879	.944	.956	.944	.625	.980	.795	.729	.817	.913	.714	.933	.750	.250	.940	.945
Cars	325	146	72	543	185	917	184	5	1291	35	70	85	190	40	565	24	1	630	2654
% Cars	99.4	100	100	99.6	100	99.9	99.5	100	99.8	100	100	100	100	100	99.6	100	100	99.7	99.8
Trucks	2	0	0	2	0	1	1	0	2	0	0	0	0	0	2	0	0	2	6
% Trucks	0.6	0	0	0.4	0	0.1	0.5	0	0.2	0	0	0	0	0	0.4	0	0	0.3	0.2

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

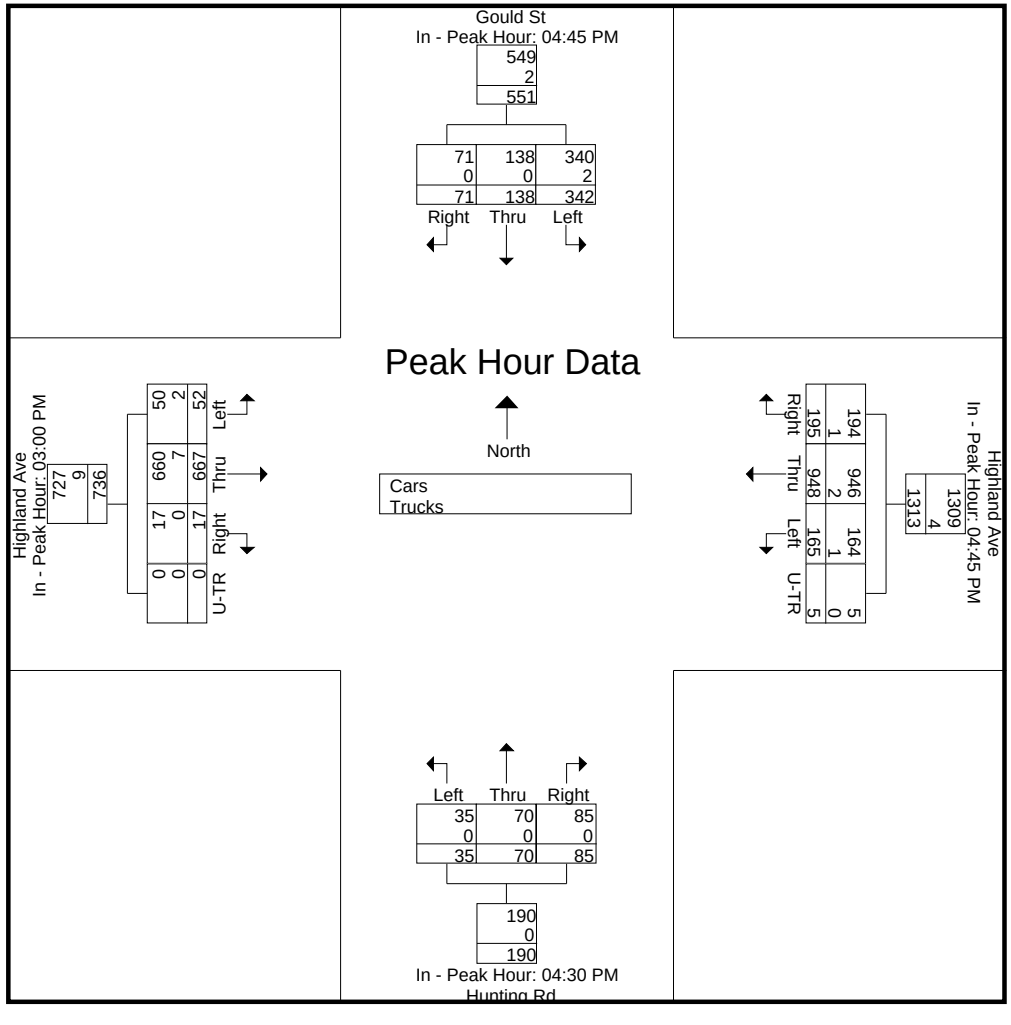
Peak Hour for Each Approach Begins at:

	04:45 PM				04:45 PM					04:30 PM				03:00 PM				
+0 mins.	82	31	19	132	41	240	47	**2**	330	8	15	19	42	**16**	**188**	**7**	0	**211**
+15 mins.	**105**	35	15	**155**	47	232	49	2	330	**11**	16	18	45	13	159	2	0	174
+30 mins.	70	**36**	16	122	**49**	222	47	0	318	10	15	**26**	51	9	183	3	0	195
+45 mins.	85	36	**21**	142	28	**254**	**52**	1	**335**	6	**24**	22	**52**	14	137	5	0	156
Total Volume	342	138	71	551	165	948	195	5	1313	35	70	85	190	52	667	17	0	736
% App. Total	62.1	25	12.9		12.6	72.2	14.9	0.4		18.4	36.8	44.7		7.1	90.6	2.3	0	
PHF	.814	.958	.845	.889	.842	.933	.938	.625	.980	.795	.729	.817	.913	.813	.887	.607	.000	.872

Accurate Counts

978-664-2565

Cars	340	138	71	549	164	946	194	5	1309	35	70	85	190	50	660	17	0	727
% Cars	99.4	100	100	99.6	99.4	99.8	99.5	100	99.7	100	100	100	100	96.2	99	100	0	98.8
Trucks	2	0	0	2	1	2	1	0	4	0	0	0	0	2	7	0	0	9
% Trucks	0.6	0	0	0.4	0.6	0.2	0.5	0	0.3	0	0	0	0	3.8	1	0	0	1.2



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

Groups Printed- Cars

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
03:00 PM	71	32	10	20	156	56	0	4	8	21	14	187	7	0	586
03:15 PM	53	24	14	20	150	50	0	4	12	22	13	155	2	0	519
03:30 PM	82	28	14	26	197	51	0	4	10	23	9	182	3	0	629
03:45 PM	55	30	17	26	170	47	3	6	23	23	14	136	5	0	555
Total	261	114	55	92	673	204	3	18	53	89	50	660	17	0	2289
04:00 PM	80	29	18	35	213	29	5	6	12	22	4	154	6	0	613
04:15 PM	49	27	10	37	207	36	2	2	13	32	6	169	7	0	597
04:30 PM	70	44	22	48	224	42	1	8	15	19	10	133	8	0	644
04:45 PM	81	31	19	41	239	47	2	11	16	18	5	139	5	0	654
Total	280	131	69	161	883	154	10	27	56	91	25	595	26	0	2508
05:00 PM	104	35	15	47	232	49	2	10	15	26	11	152	5	0	703
05:15 PM	70	36	16	49	222	46	0	6	24	22	14	141	6	1	653
05:30 PM	85	36	21	27	253	52	1	10	10	11	4	119	5	2	636
05:45 PM	66	26	11	32	240	42	1	8	18	18	8	130	5	0	605
Total	325	133	63	155	947	189	4	34	67	77	37	542	21	3	2597
Grand Total	866	378	187	408	2503	547	17	79	176	257	112	1797	64	3	7394
Apprch %	60.5	26.4	13.1	11.7	72	15.7	0.5	15.4	34.4	50.2	5.7	90.9	3.2	0.2	
Total %	11.7	5.1	2.5	5.5	33.9	7.4	0.2	1.1	2.4	3.5	1.5	24.3	0.9	0	

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 2

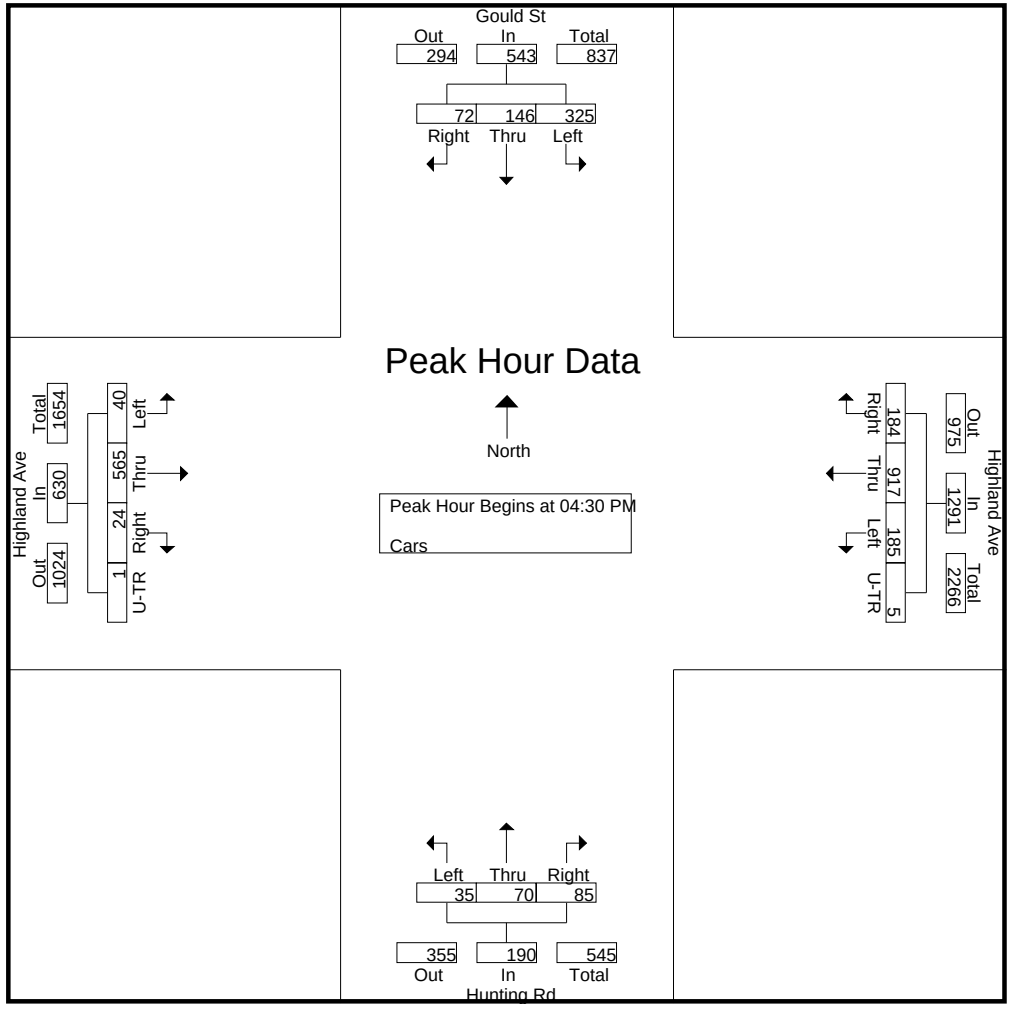
	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 04:30 PM																			
04:30 PM	70	**44**	**22**	136	48	224	42	1	315	8	15	19	42	10	133	**8**	0	151	644
04:45 PM	81	31	19	131	41	**239**	47	**2**	329	**11**	16	18	45	5	139	5	0	149	654
05:00 PM	**104**	35	15	**154**	47	232	**49**	2	**330**	10	15	**26**	51	11	**152**	5	0	**168**	**703**
05:15 PM	70	36	16	122	**49**	222	46	0	317	6	**24**	22	**52**	**14**	141	6	**1**	162	653
Total Volume	325	146	72	543	185	917	184	5	1291	35	70	85	190	40	565	24	1	630	2654
% App. Total	59.9	26.9	13.3		14.3	71	14.3	0.4		18.4	36.8	44.7		6.3	89.7	3.8	0.2		
PHF	.781	.830	.818	.881	.944	.959	.939	.625	.978	.795	.729	.817	.913	.714	.929	.750	.250	.938	.944

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

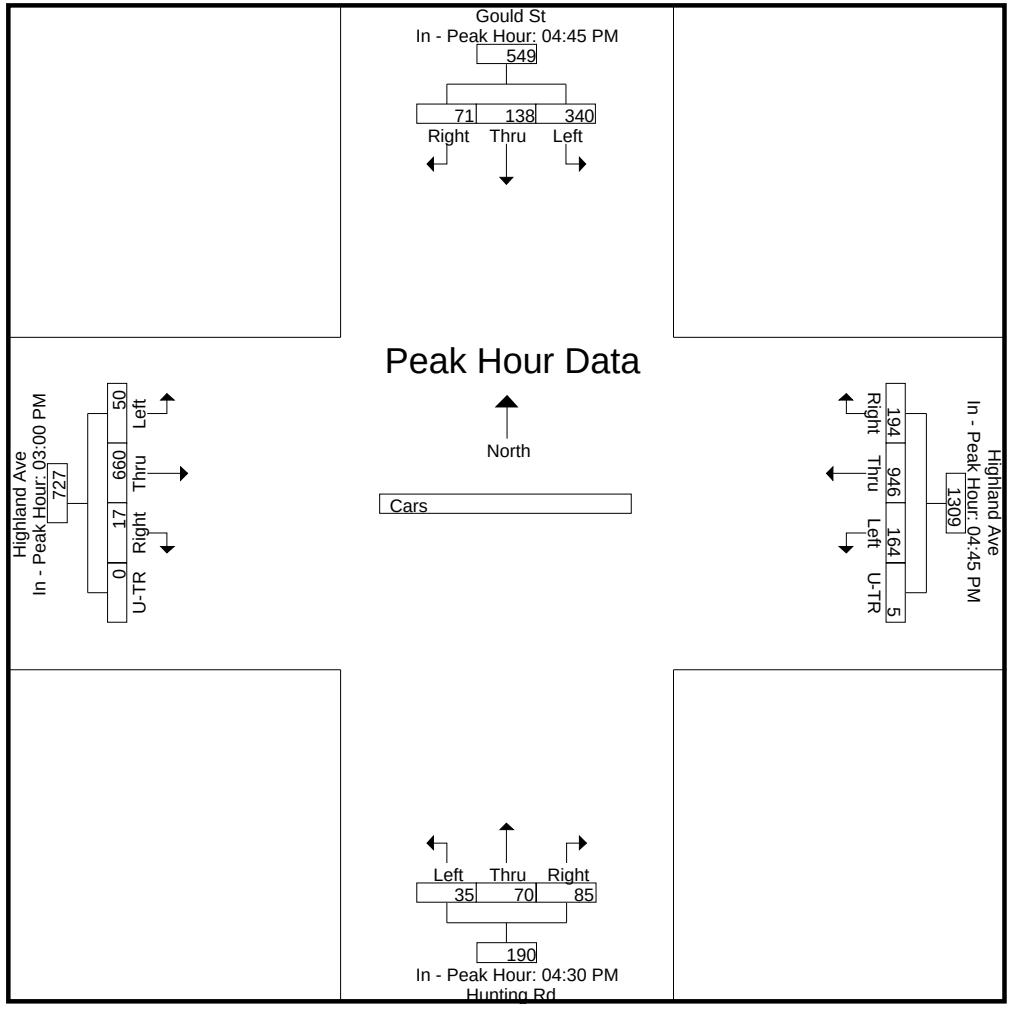
	04:45 PM				04:45 PM					04:30 PM				03:00 PM				
+0 mins.	81	31	19	131	41	239	47	**2**	329	8	15	19	42	**14**	**187**	**7**	0	**208**
+15 mins.	**104**	35	15	**154**	47	232	49	2	330	**11**	16	18	45	13	155	2	0	170
+30 mins.	70	**36**	16	122	**49**	222	46	0	317	10	15	**26**	51	9	182	3	0	194
+45 mins.	85	36	**21**	142	27	**253**	**52**	1	**333**	6	**24**	22	**52**	14	136	5	0	155
Total Volume	340	138	71	549	164	946	194	5	1309	35	70	85	190	50	660	17	0	727
% App. Total	61.9	25.1	12.9		12.5	72.3	14.8	0.4		18.4	36.8	44.7		6.9	90.8	2.3	0	
PHF	.817	.958	.845	.891	.837	.935	.933	.625	.983	.795	.729	.817	.913	.893	.882	.607	.000	.874

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 4



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

Groups Printed- Trucks

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
03:00 PM	0	0	0	0	0	0	0	0	1	2	2	1	0	0	6
03:15 PM	1	0	1	0	1	0	0	0	1	2	0	4	0	0	10
03:30 PM	0	1	0	0	2	0	0	0	0	0	0	1	0	0	4
03:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total	1	1	1	0	3	0	0	0	2	4	2	7	0	0	21
04:00 PM	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
04:15 PM	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
04:45 PM	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Total	1	0	0	0	5	0	0	0	0	0	0	2	0	0	8
05:00 PM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05:15 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
05:30 PM	0	0	0	1	1	0	0	0	0	0	0	1	0	0	3
05:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total	1	0	0	1	1	1	0	0	0	0	0	2	0	0	6
Grand Total	3	1	1	1	9	1	0	0	2	4	2	11	0	0	35
Apprch %	60	20	20	9.1	81.8	9.1	0	0	33.3	66.7	15.4	84.6	0	0	
Total %	8.6	2.9	2.9	2.9	25.7	2.9	0	0	5.7	11.4	5.7	31.4	0	0	

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

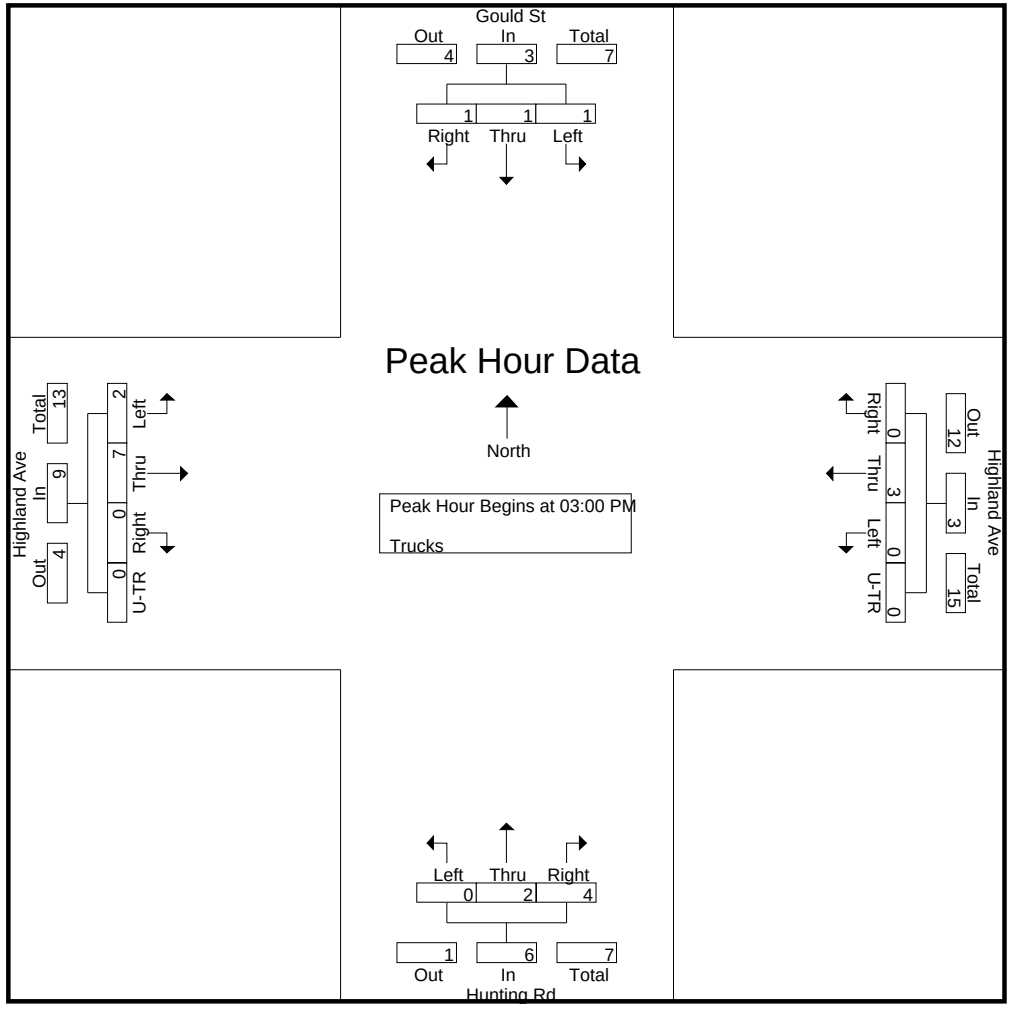
	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 03:00 PM																			
03:00 PM	0	0	0	0	0	0	0	0	0	0	**1**	**2**	**3**	**2**	1	0	0	3	6
03:15 PM	**1**	0	**1**	**2**	0	1	0	0	1	0	1	2	3	0	**4**	0	0	**4**	**10**
03:30 PM	0	**1**	0	1	0	**2**	0	0	**2**	0	0	0	0	0	1	0	0	1	4
03:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Total Volume	1	1	1	3	0	3	0	0	3	0	2	4	6	2	7	0	0	9	21
% App. Total	33.3	33.3	33.3		0	100	0	0		0	33.3	66.7		22.2	77.8	0	0		
PHF	.250	.250	.250	.375	.000	.375	.000	.000	.375	.000	.500	.500	.500	.250	.438	.000	.000	.563	.525

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

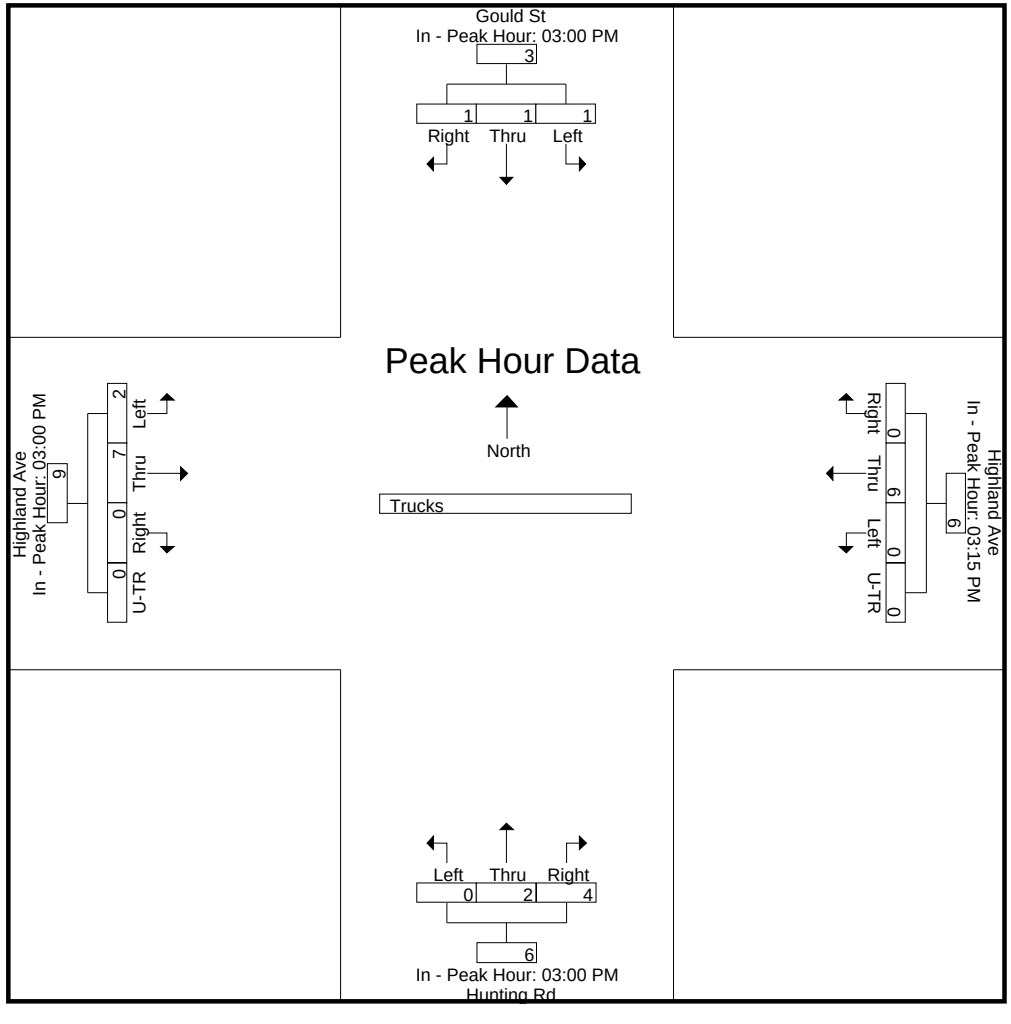
	03:00 PM				03:15 PM					03:00 PM				03:00 PM				
+0 mins.	0	0	0	0	0	1	0	0	1	0	**1**	**2**	**3**	**2**	1	0	0	3
+15 mins.	**1**	0	**1**	**2**	0	2	0	0	2	0	1	2	3	0	**4**	0	0	**4**
+30 mins.	0	**1**	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
+45 mins.	0	0	0	0	0	**3**	0	0	**3**	0	0	0	0	0	1	0	0	1
Total Volume	1	1	1	3	0	6	0	0	6	0	2	4	6	2	7	0	0	9
% App. Total	33.3	33.3	33.3		0	100	0	0		0	33.3	66.7		22.2	77.8	0	0	
PHF	.250	.250	.250	.375	.000	.500	.000	.000	.500	.000	.500	.500	.500	.250	.438	.000	.000	.563

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 4



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Gould St From North				Highland Ave From East				Hunting Rd 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
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
03:15 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	2	3
03:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:45 PM	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	1	0	0	0	0	0	0	0	0	2	2	2	3	5
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
04:15 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1	3	4
05:00 PM	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	1	2	3
05:15 PM	0	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	6
05:30 PM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
05:45 PM	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2
Total	0	4	0	1	0	5	0	0	0	0	0	1	0	1	0	0	2	10	12
Grand Total	0	5	0	2	0	6	0	0	0	0	0	1	0	3	2	2	5	16	21
Apprch %	0	100	0		0	100	0		0	0	0		0	60	40				
Total %	0	31.2	0		0	37.5	0		0	0	0		0	18.8	12.5		23.8	76.2	

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019

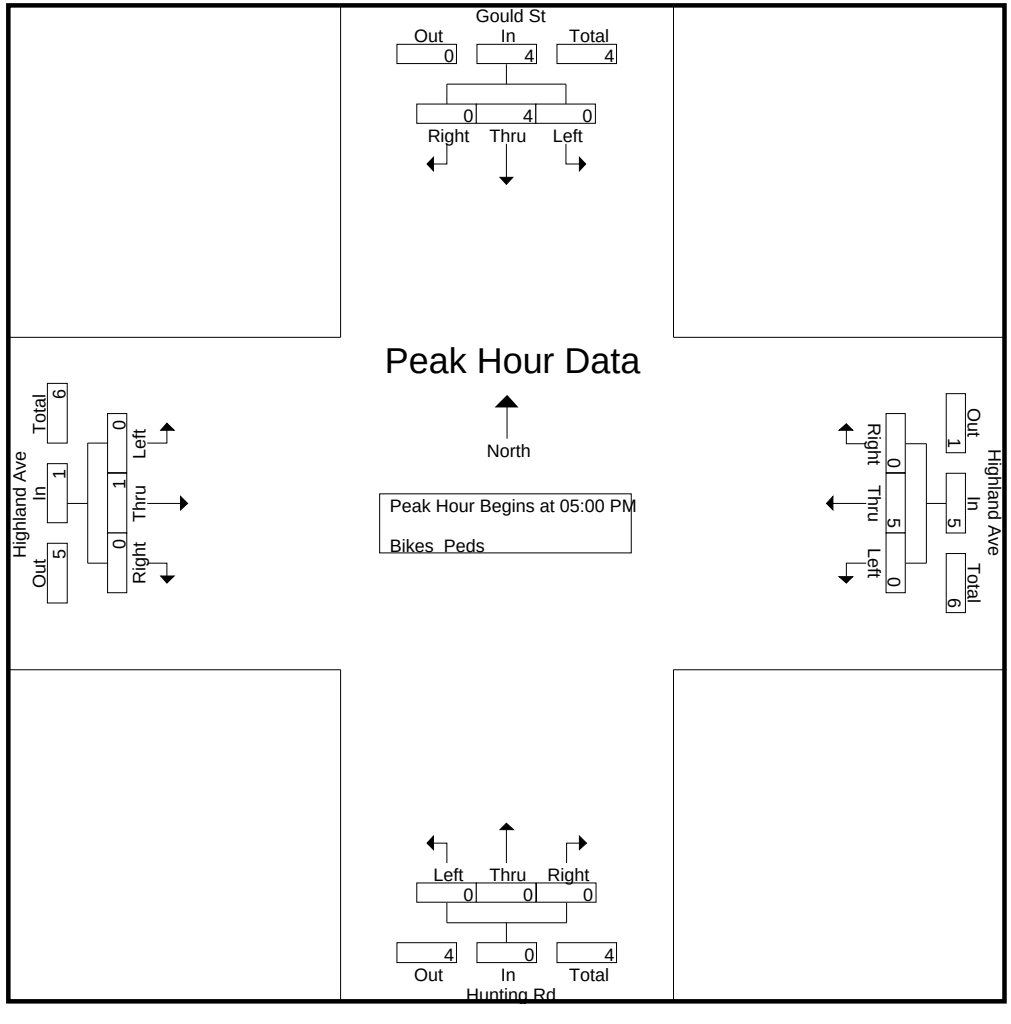
	Gould St From North				Highland Ave From East				Hunting Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	**1**	0	**1**	2
05:15 PM	0	**4**	0	**4**	0	**2**	0	**2**	0	0	0	0	0	0	0	0	**6**
05:30 PM	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	2	0	2	0	0	0	0	0	0	0	0	2
Total Volume	0	4	0	4	0	5	0	5	0	0	0	0	0	1	0	1	10
% App. Total	0	100	0		0	100	0		0	0	0		0	100	0		
PHF	.000	.250	.000	.250	.000	.625	.000	.625	.000	.000	.000	.000	.000	.250	.000	.250	.417

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

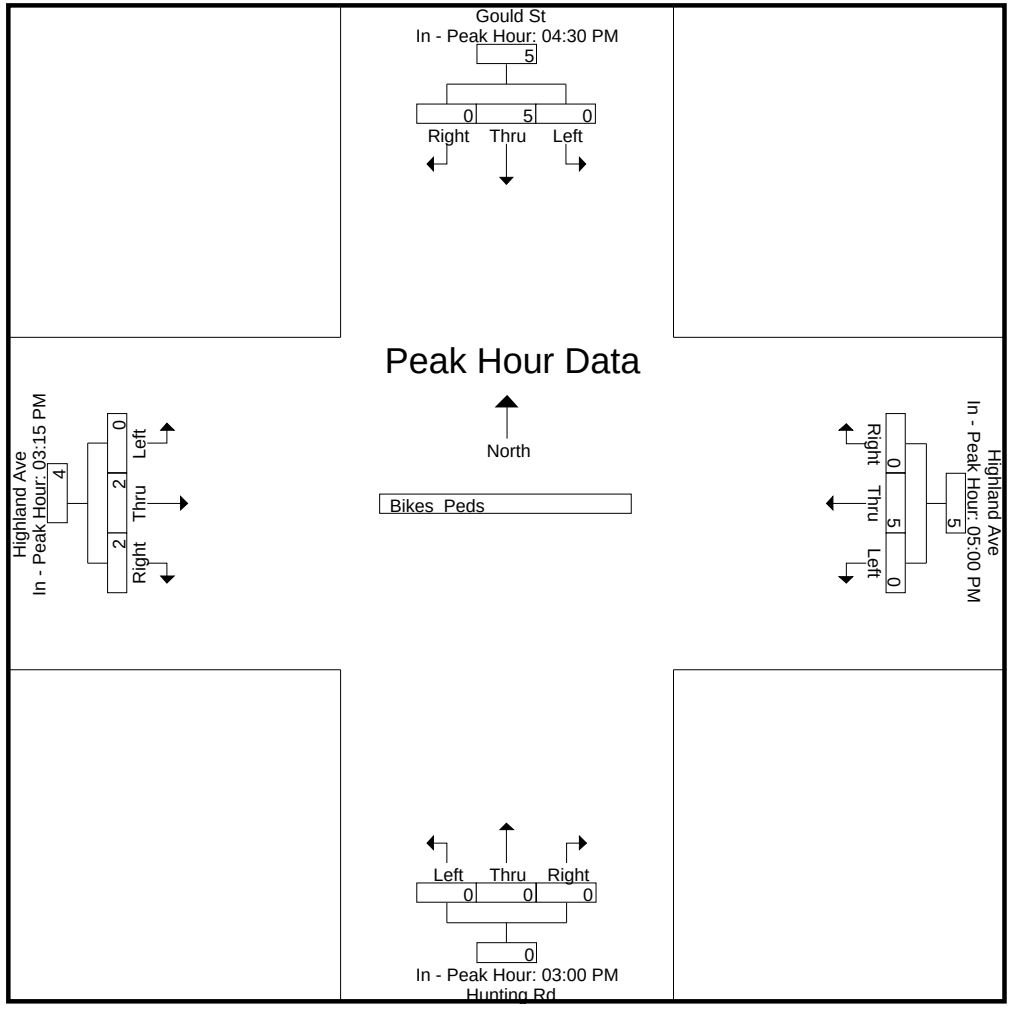
	04:30 PM				05:00 PM				03:00 PM				03:15 PM			
+0 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	0	**1**	1
+15 mins.	0	1	0	1	0	**2**	0	**2**	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
+45 mins.	0	**4**	0	**4**	0	2	0	2	0	0	0	0	0	**2**	0	**2**
Total Volume	0	5	0	5	0	5	0	5	0	0	0	0	0	2	2	4
% App. Total	0	100	0		0	100	0		0	0	0		0	50	50	
PHF	.000	.313	.000	.313	.000	.625	.000	.625	.000	.000	.000	.000	.000	.250	.500	.500

Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 4



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Cars - Trucks

	Dwy From North			Putnam St From East			Cross St From South			Putnam St From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	2	0	0	0	0	0	0	0	0	2
07:30 AM	0	0	0	0	0	0	0	0	1	0	0	0	1
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	2	0	0	0	0	1	0	0	0	3
08:00 AM	0	0	0	1	0	0	0	0	0	0	0	0	1
08:15 AM	0	0	0	1	0	0	0	0	0	0	0	0	1
08:30 AM	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
Total	0	0	0	2	0	0	0	0	0	0	0	0	2
Grand Total	0	0	0	4	0	0	0	0	1	0	0	0	5
Apprch %	0	0	0	100	0	0	0	0	100	0	0	0	
Total %	0	0	0	80	0	0	0	0	20	0	0	0	
Cars	0	0	0	4	0	0	0	0	1	0	0	0	5
% Cars	0	0	0	100	0	0	0	0	100	0	0	0	100
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

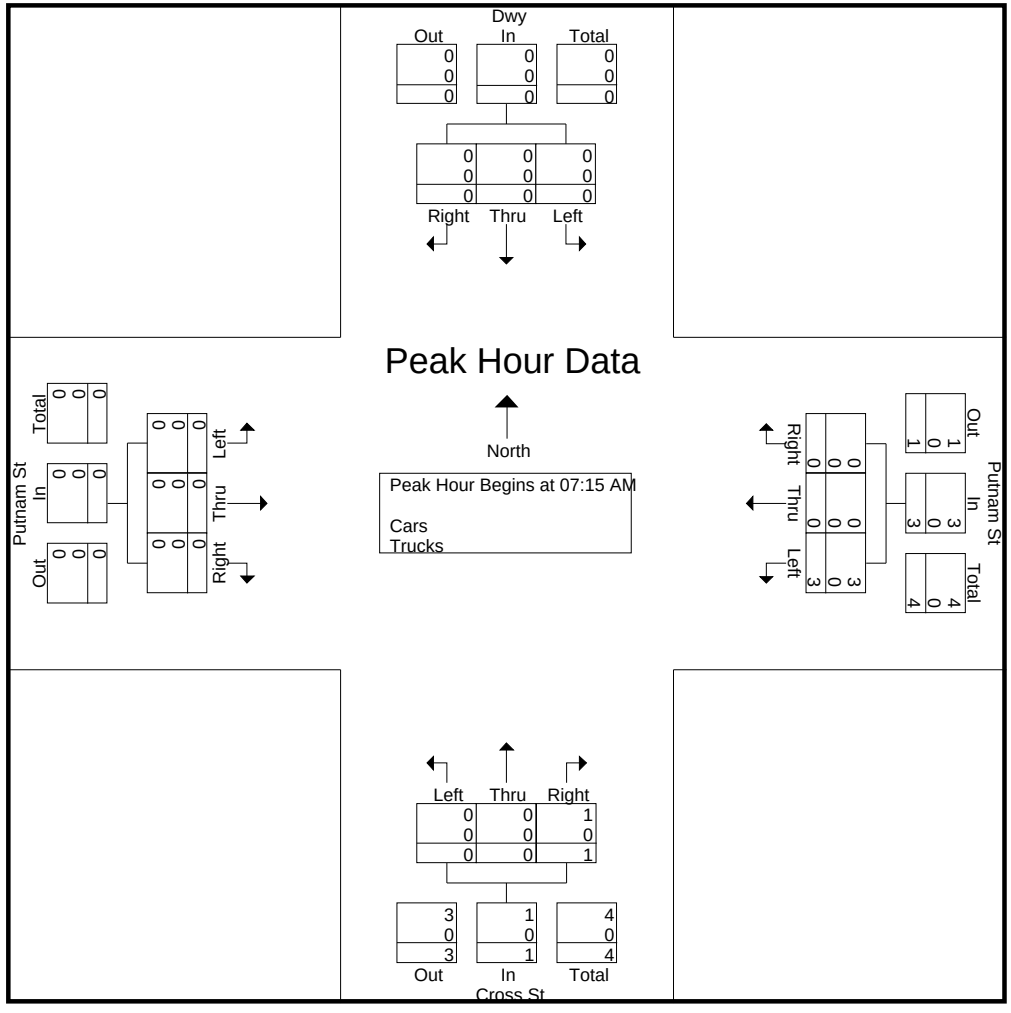
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	0	0	**2**	0	0	**2**	0	0	0	0	0	0	0	0	**2**
07:30 AM	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0	1
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0	4
% App. Total	0	0	0		100	0	0		0	0	100		0	0	0		
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000	.500
Cars	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0	4
% Cars	0	0	0	0	100	0	0	100	0	0	100	100	0	0	0	0	100
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

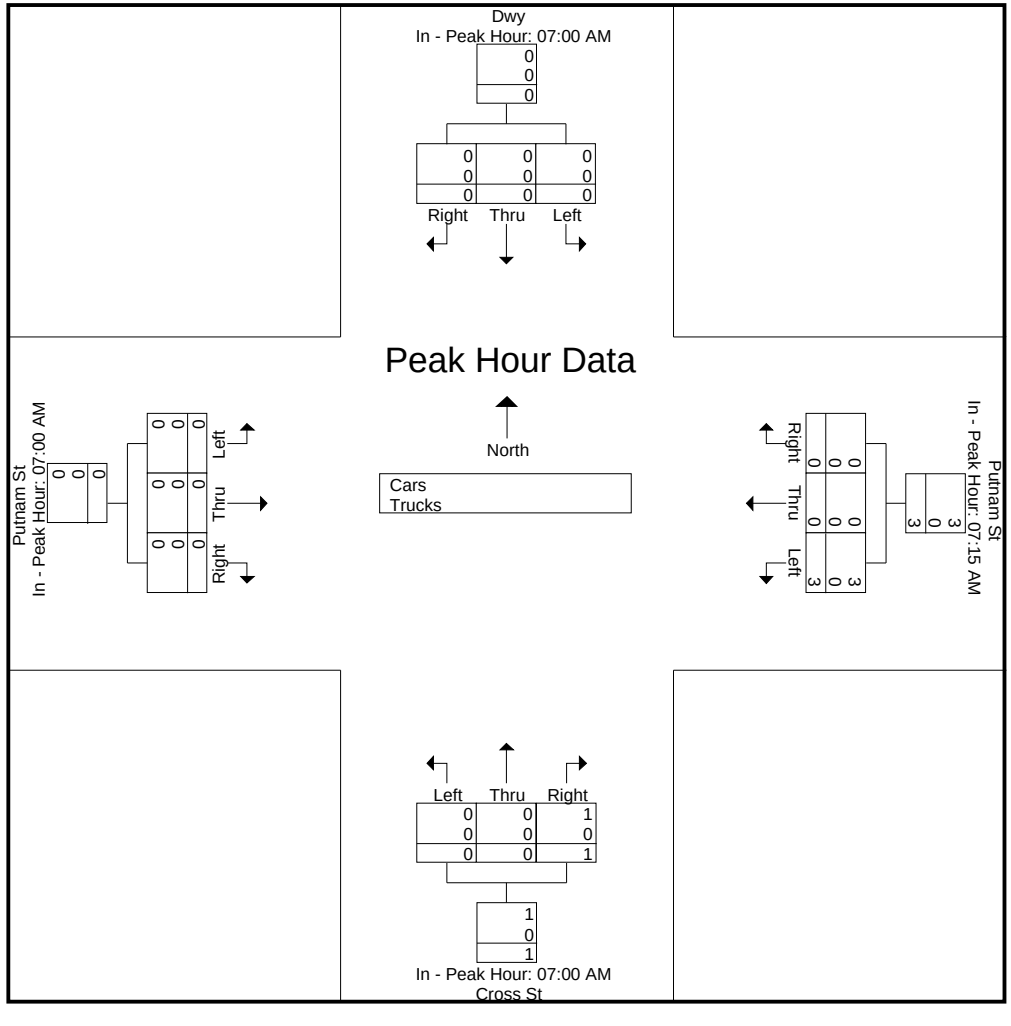
Peak Hour for Each Approach Begins at:

	07:00 AM				07:15 AM				07:00 AM				07:00 AM			
+0 mins.	0	0	0	0	**2**	0	0	**2**	0	0	0	0	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0
+45 mins.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0

Accurate Counts

978-664-2565

% App. Total	0	0	0		100	0	0		0	0	100		0	0	0	
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000
Cars	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0
% Cars	0	0	0	0	100	0	0	100	0	0	100	100	0	0	0	0
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Cars

	Dwy From North			Putnam St From East			Cross St From South			Putnam St From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	2	0	0	0	0	0	0	0	0	2
07:30 AM	0	0	0	0	0	0	0	0	1	0	0	0	1
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	2	0	0	0	0	1	0	0	0	3
08:00 AM	0	0	0	1	0	0	0	0	0	0	0	0	1
08:15 AM	0	0	0	1	0	0	0	0	0	0	0	0	1
08:30 AM	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
Total	0	0	0	2	0	0	0	0	0	0	0	0	2
Grand Total	0	0	0	4	0	0	0	0	1	0	0	0	5
Apprch %	0	0	0	100	0	0	0	0	100	0	0	0	
Total %	0	0	0	80	0	0	0	0	20	0	0	0	

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

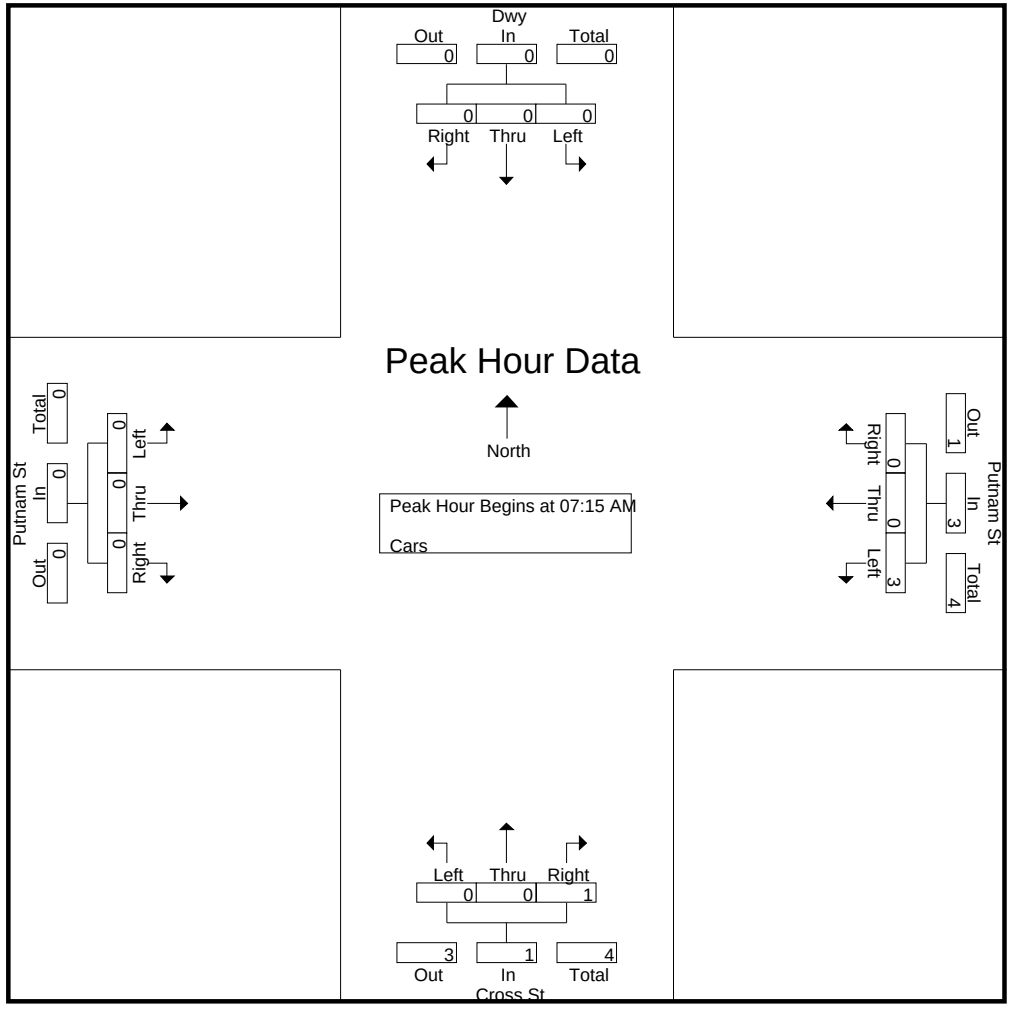
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	0	0	**2**	0	0	**2**	0	0	0	0	0	0	0	0	**2**
07:30 AM	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0	1
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0	4
% App. Total	0	0	0		100	0	0		0	0	100		0	0	0		
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000	.500

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

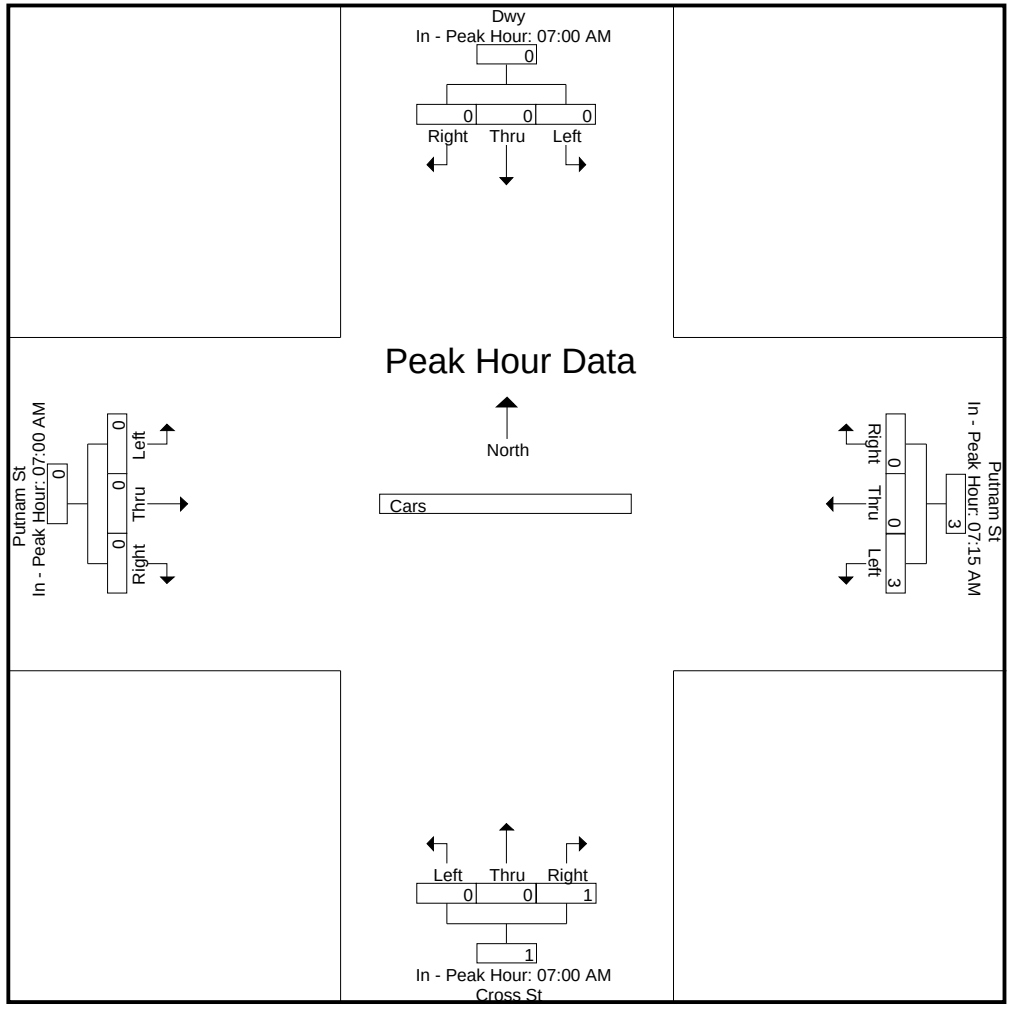
Peak Hour for Each Approach Begins at:

	07:00 AM				07:15 AM				07:00 AM				07:00 AM			
+0 mins.	0	0	0	0	**2**	0	0	**2**	0	0	0	0	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	0	0	0
+45 mins.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0

Accurate Counts

978-664-2565

% App. Total	0	0	0		100	0	0		0	0	100		0	0	0			
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000		



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Trucks

	Dwy From North			Putnam St From East			Cross St From South			Putnam St From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	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
07:30 AM	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
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	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
08:30 AM	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
Total	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
Apprch %	0	0	0	0	0	0	0	0	0	0	0	0	
Total %													

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

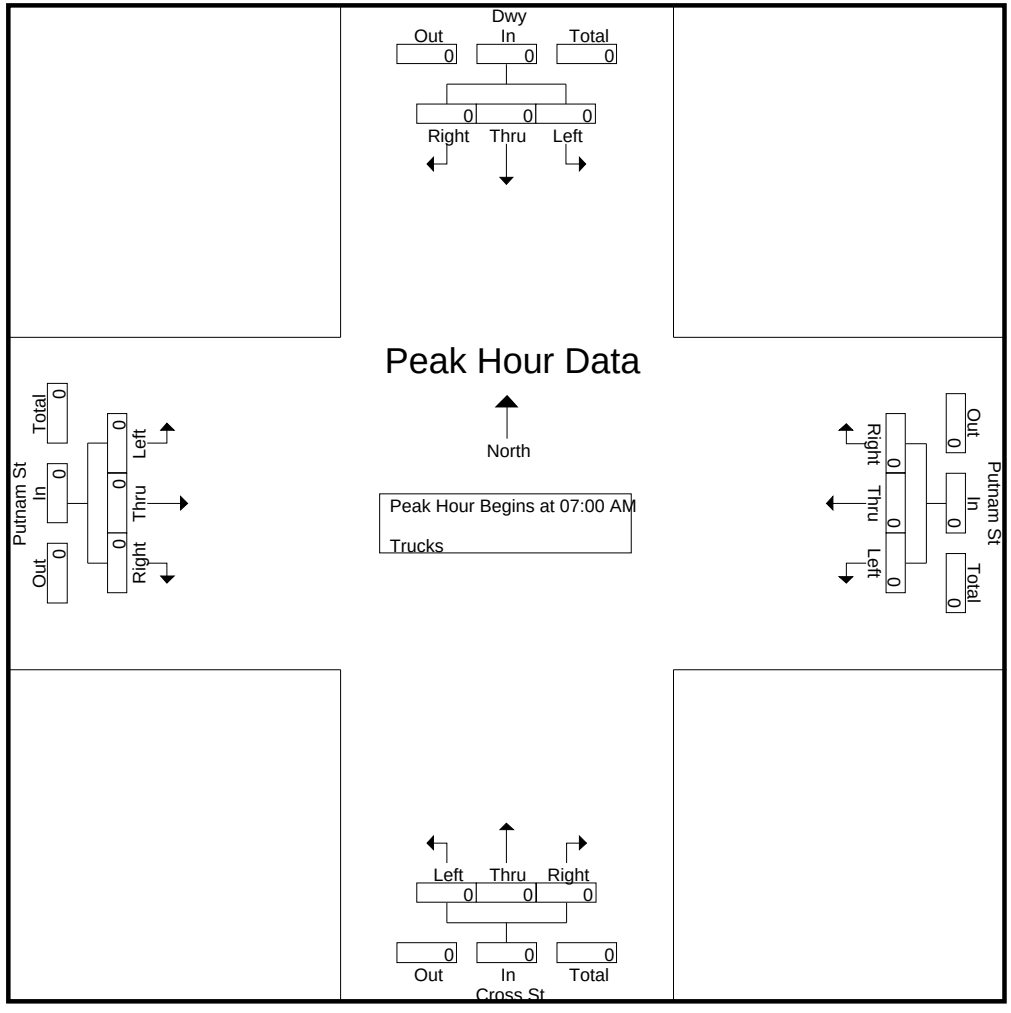
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:00 AM																	
07:00 AM	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
07:30 AM	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	0	0
Total Volume	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		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

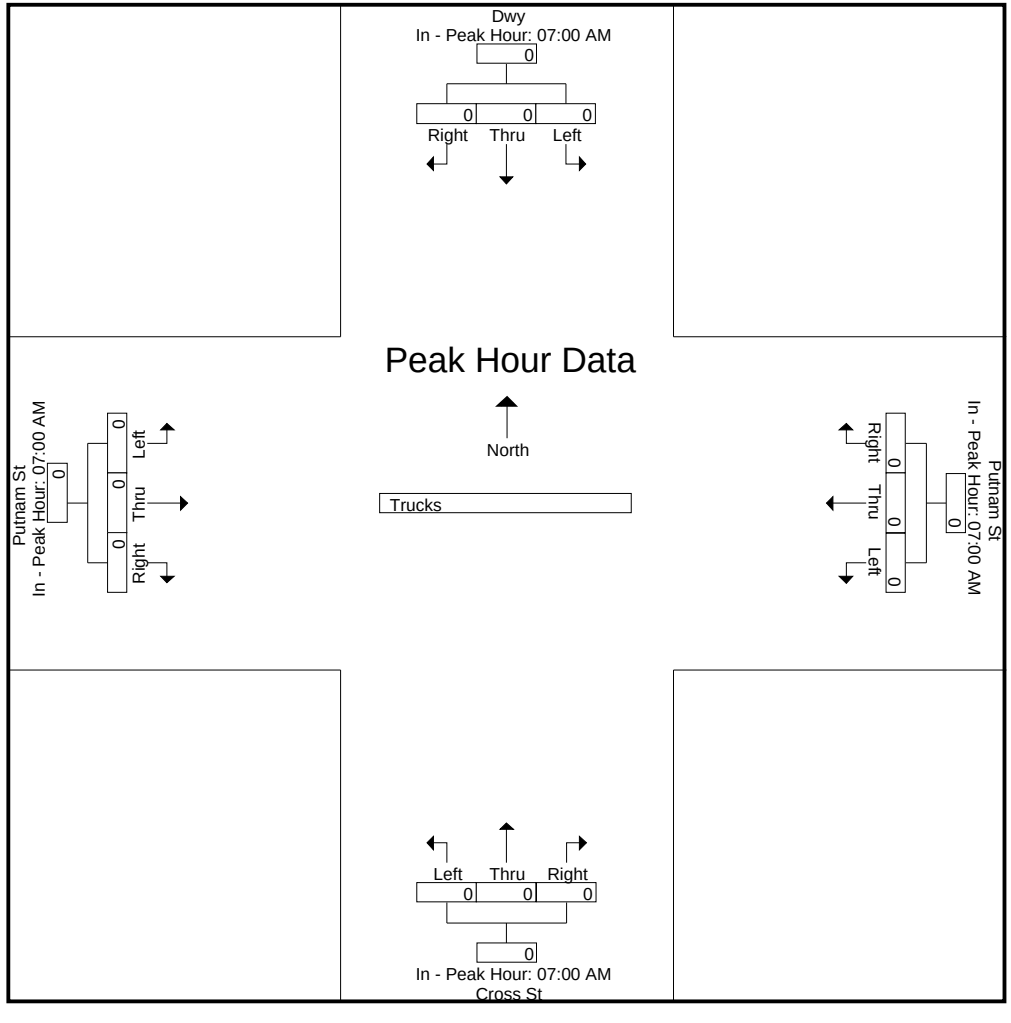
Peak Hour for Each Approach Begins at:

	07:00 AM				07:00 AM				07:00 AM				07:00 AM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+45 mins.	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

Accurate Counts

978-664-2565

% App. Total	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



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Dwy From North				Putnam St From East				Cross St From South				Putnam St 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	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
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	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	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
08:30 AM	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
Total	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
Apprch %	0	0	0		0	0	0		0	0	0		0	0	0				
Total %																	0	0	

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

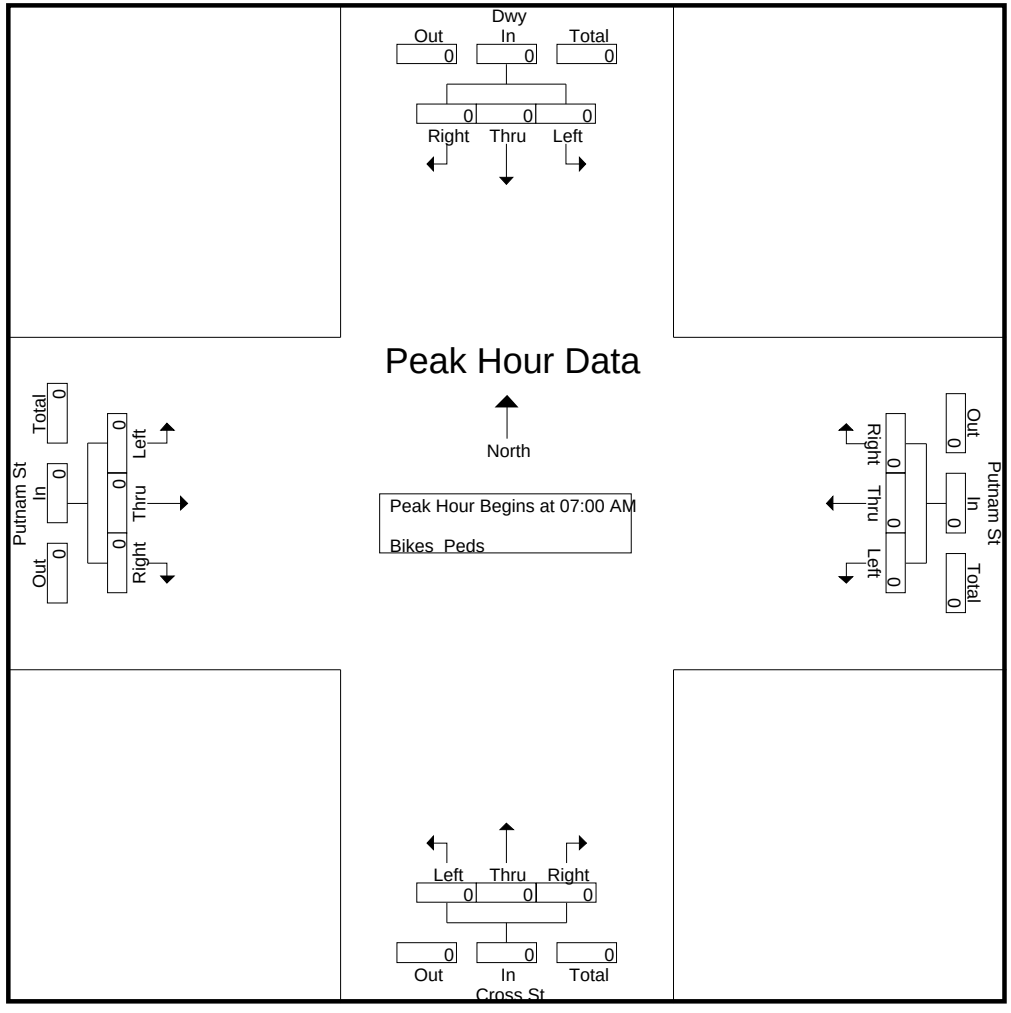
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:00 AM																	
07:00 AM	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
07:30 AM	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	0	0
Total Volume	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		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

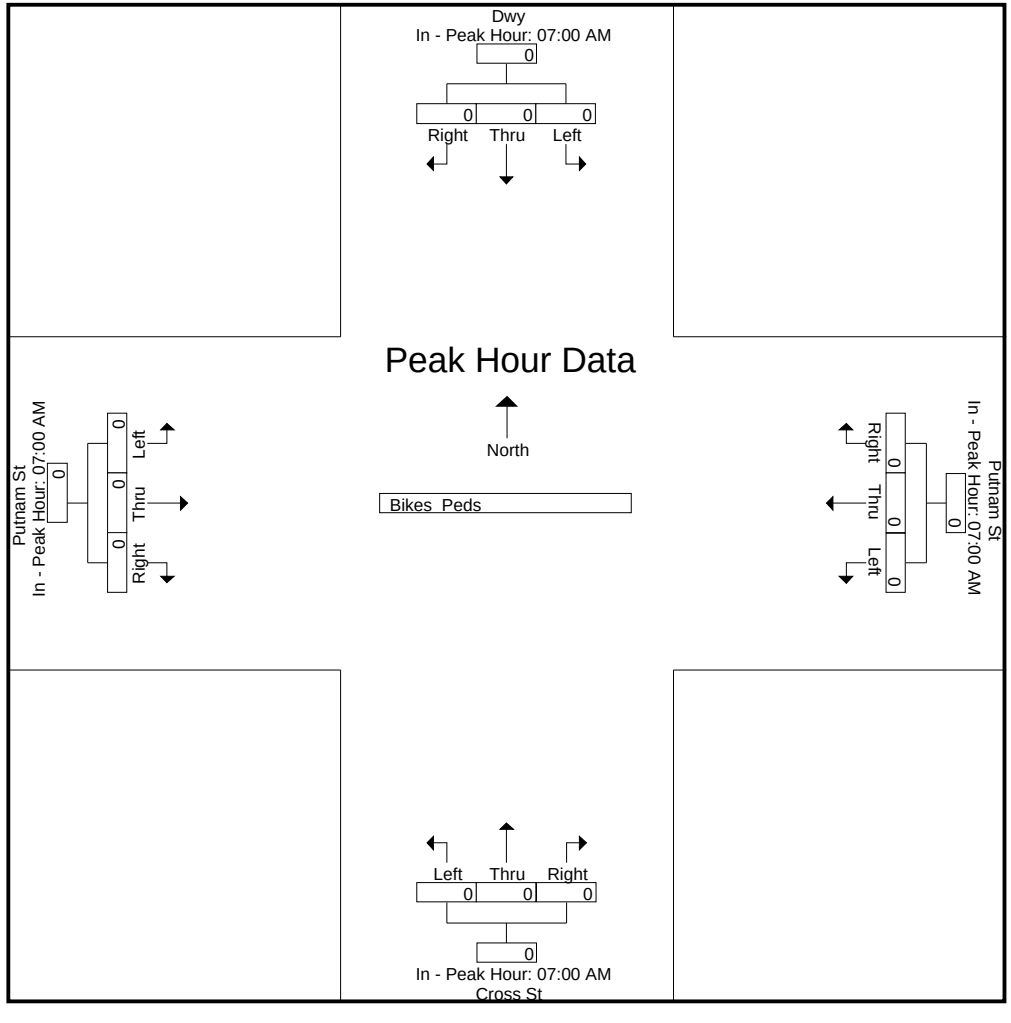
Peak Hour for Each Approach Begins at:

	07:00 AM				07:00 AM				07:00 AM				07:00 AM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+45 mins.	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

Accurate Counts

978-664-2565

% App. Total	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



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Cars - Trucks

	Dwy From North			Putnam St From East			Cross St From South			Putnam St From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
03:00 PM	0	0	0	1	0	0	0	0	1	0	0	0	2
03:15 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
03:30 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
03:45 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
Total	0	0	0	4	0	0	0	0	1	0	0	0	5
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	0	0	1	0	0	0	1
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	1
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	1	0	0	1	2
05:00 PM	0	0	0	1	0	0	0	0	1	0	0	0	2
05:15 PM	0	0	0	0	0	0	0	0	1	0	0	0	1
05:30 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
05:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	1
Total	0	0	0	2	0	0	0	0	3	0	0	0	5
Grand Total	0	0	0	6	0	0	0	0	5	0	0	1	12
Apprch %	0	0	0	100	0	0	0	0	100	0	0	100	
Total %	0	0	0	50	0	0	0	0	41.7	0	0	8.3	
Cars	0	0	0	6	0	0	0	0	5	0	0	1	12
% Cars	0	0	0	100	0	0	0	0	100	0	0	100	100
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

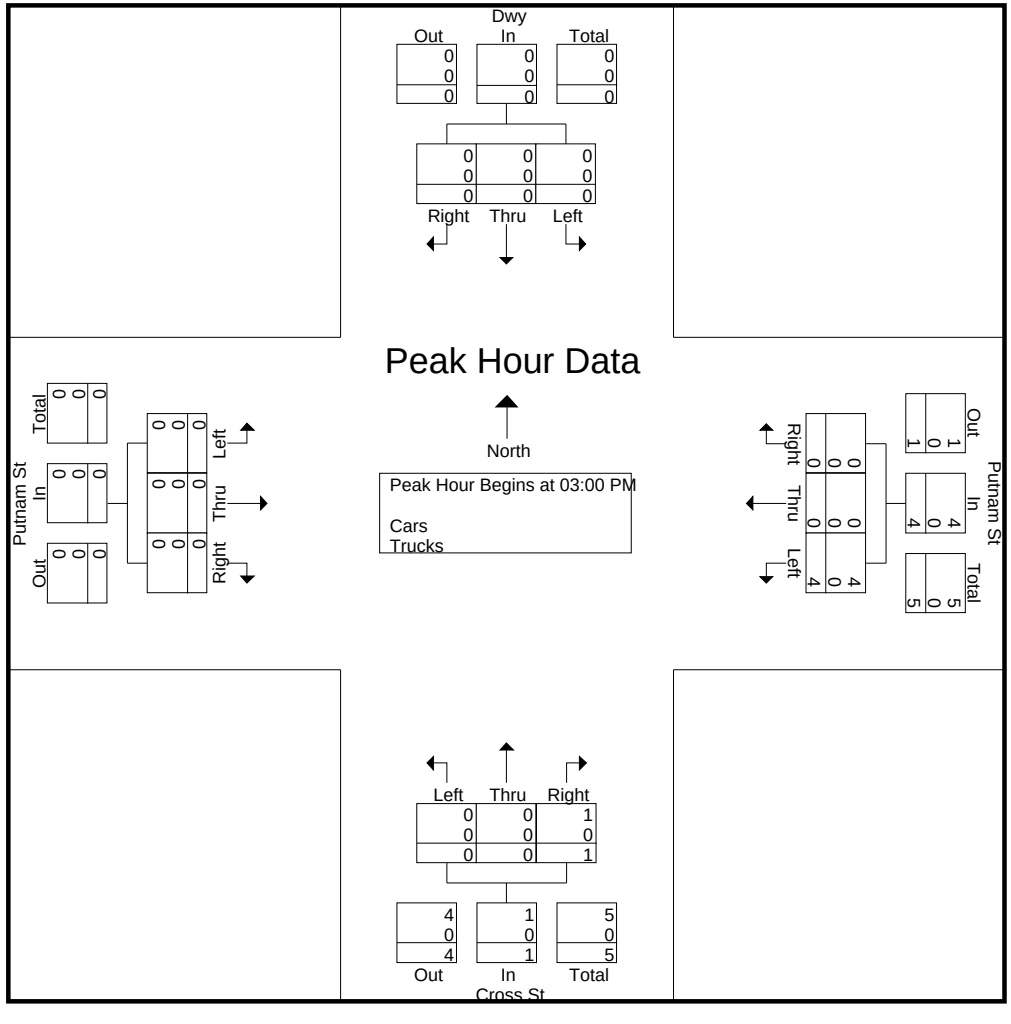
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:00 PM																	
03:00 PM	0	0	0	0	**1**	0	0	**1**	0	0	**1**	**1**	0	0	0	0	**2**
03:15 PM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
03:30 PM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
03:45 PM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	4	0	0	4	0	0	1	1	0	0	0	0	5
% App. Total	0	0	0		100	0	0		0	0	100		0	0	0		
PHF	.000	.000	.000	.000	1.00	.000	.000	1.00	.000	.000	.250	.250	.000	.000	.000	.000	.625
Cars	0	0	0	0	4	0	0	4	0	0	1	1	0	0	0	0	5
% Cars	0	0	0	0	100	0	0	100	0	0	100	100	0	0	0	0	100
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 3



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

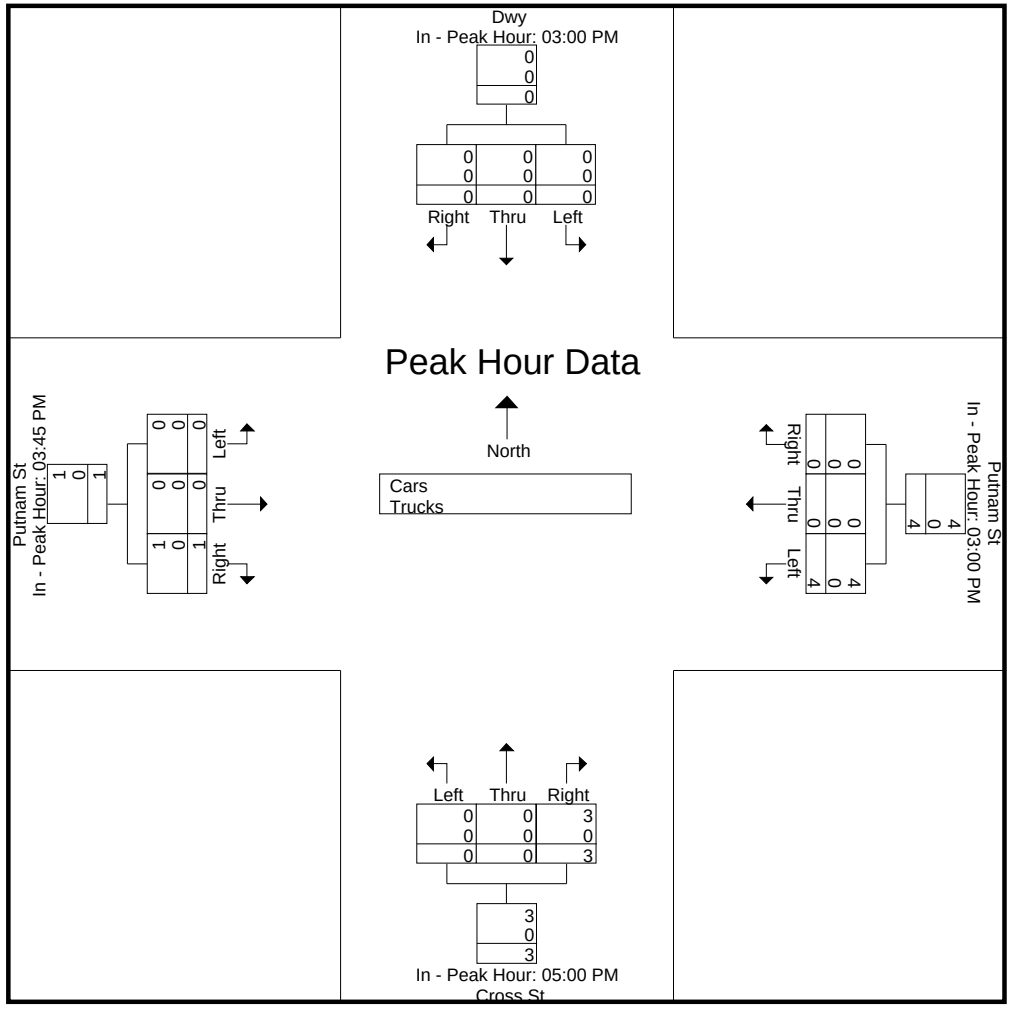
Peak Hour for Each Approach Begins at:

	03:00 PM				03:00 PM				05:00 PM				03:45 PM			
+0 mins.	0	0	0	0	**1**	0	0	**1**	0	0	**1**	**1**	0	0	0	0
+15 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
+30 mins.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
+45 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	**1**	**1**
Total Volume	0	0	0	0	4	0	0	4	0	0	3	3	0	0	1	1
% App. Total	0	0	0		100	0	0		0	0	100		0	0	100	
PHF	.000	.000	.000	.000	1.000	.000	.000	1.000	.000	.000	.750	.750	.000	.000	.250	.250

Accurate Counts

978-664-2565

Cars	0	0	0	0	4	0	0	4	0	0	3	3	0	0	1	1
% Cars	0	0	0	0	100	0	0	100	0	0	100	100	0	0	100	100
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Cars

	Dwy From North			Putnam St From East			Cross St From South			Putnam St From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
03:00 PM	0	0	0	1	0	0	0	0	1	0	0	0	2
03:15 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
03:30 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
03:45 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
Total	0	0	0	4	0	0	0	0	1	0	0	0	5
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	0	0	1	0	0	0	1
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	1
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	1	0	0	1	2
05:00 PM	0	0	0	1	0	0	0	0	1	0	0	0	2
05:15 PM	0	0	0	0	0	0	0	0	1	0	0	0	1
05:30 PM	0	0	0	1	0	0	0	0	0	0	0	0	1
05:45 PM	0	0	0	0	0	0	0	0	1	0	0	0	1
Total	0	0	0	2	0	0	0	0	3	0	0	0	5
Grand Total	0	0	0	6	0	0	0	0	5	0	0	1	12
Apprch %	0	0	0	100	0	0	0	0	100	0	0	100	
Total %	0	0	0	50	0	0	0	0	41.7	0	0	8.3	

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 6

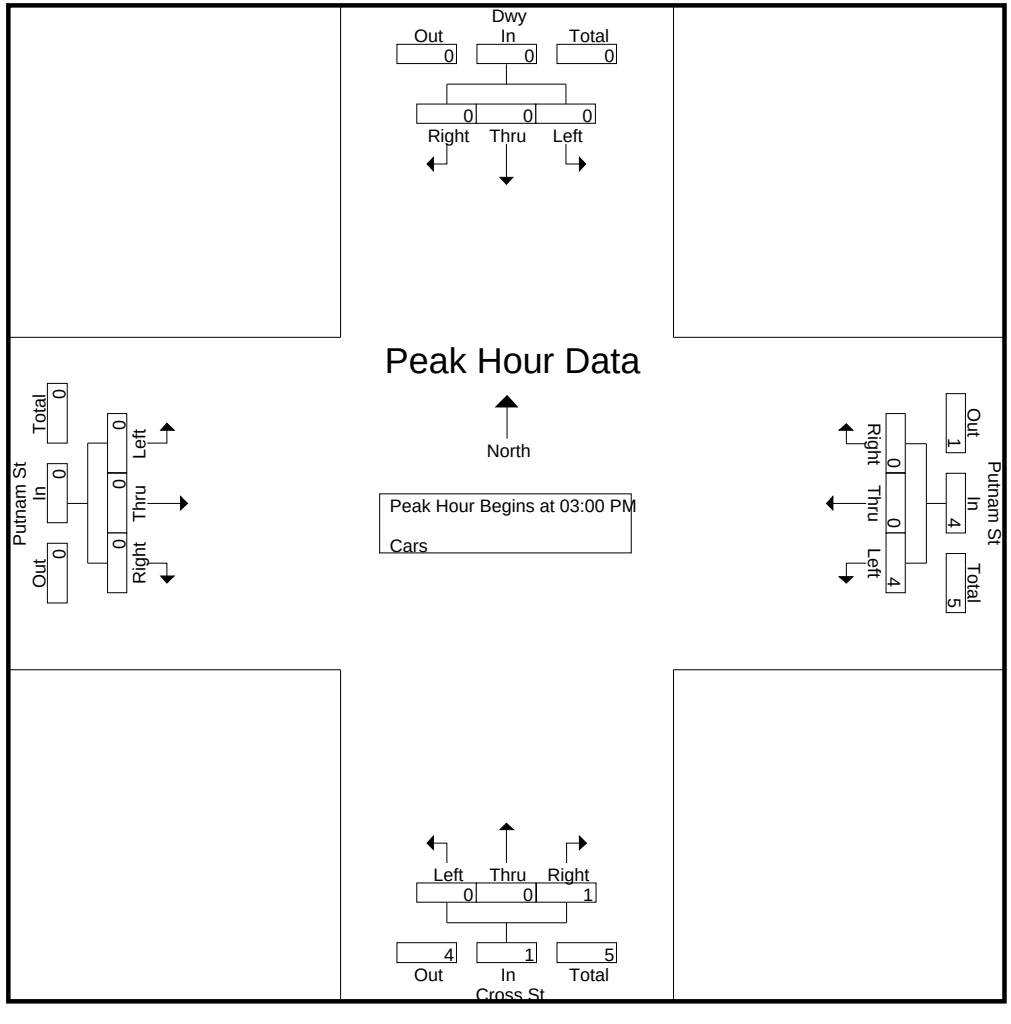
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:00 PM																	
03:00 PM	0	0	0	0	**1**	0	0	**1**	0	0	**1**	**1**	0	0	0	0	**2**
03:15 PM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
03:30 PM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
03:45 PM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	4	0	0	4	0	0	1	1	0	0	0	0	5
% App. Total	0	0	0		100	0	0		0	0	100		0	0	0		
PHF	.000	.000	.000	.000	1.00	.000	.000	1.00	.000	.000	.250	.250	.000	.000	.000	.000	.625

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 7



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

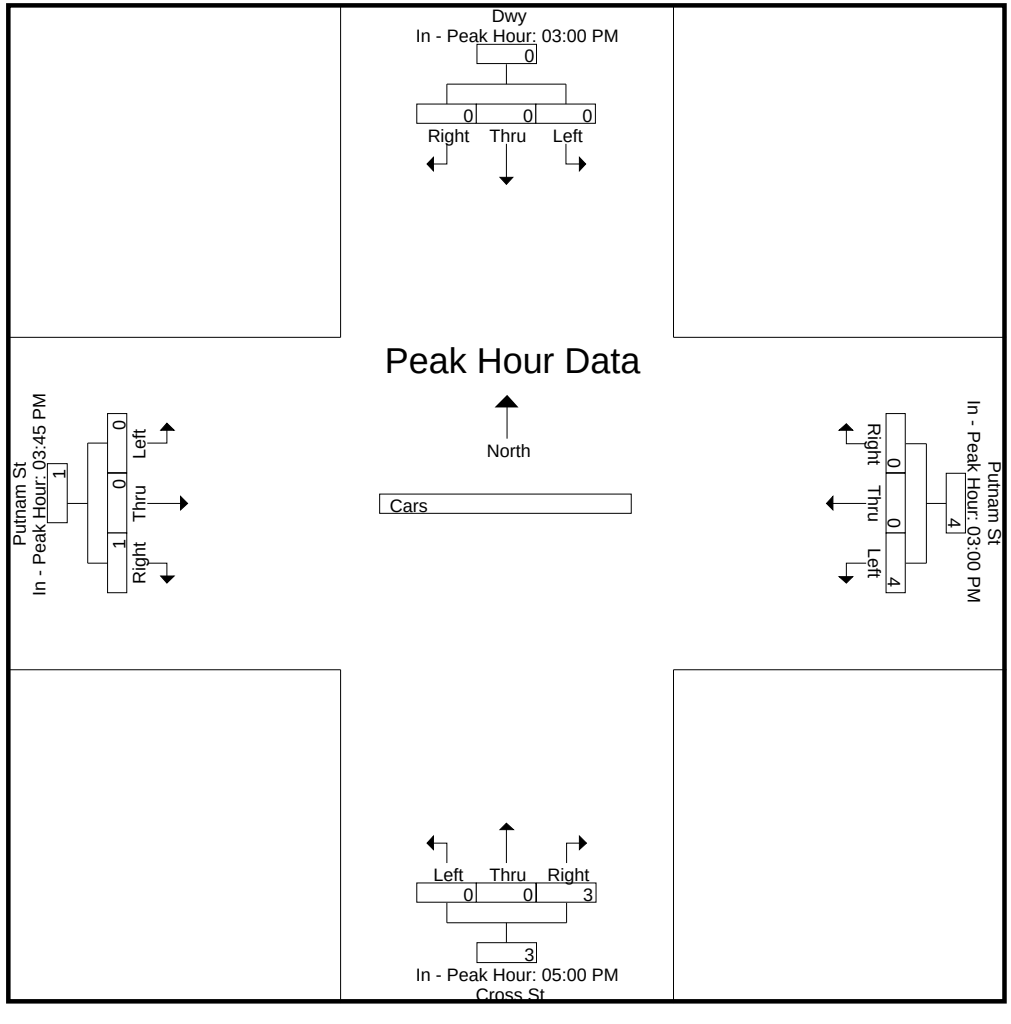
	03:00 PM				03:00 PM				05:00 PM				03:45 PM			
+0 mins.	0	0	0	0	**1**	0	0	**1**	0	0	**1**	**1**	0	0	0	0
+15 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
+30 mins.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
+45 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	**1**	**1**
Total Volume	0	0	0	0	4	0	0	4	0	0	3	3	0	0	1	1
% App. Total	0	0	0		100	0	0		0	0	100		0	0	100	
PHF	.000	.000	.000	.000	1.000	.000	.000	1.000	.000	.000	.750	.750	.000	.000	.250	.250

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 8



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Trucks

	Dwy From North			Putnam St From East			Cross St From South			Putnam St From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
03:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
03:45 PM	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
04:00 PM	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
04:30 PM	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
Total	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
05:15 PM	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
05:45 PM	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
Grand Total	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	
Total %													

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 10

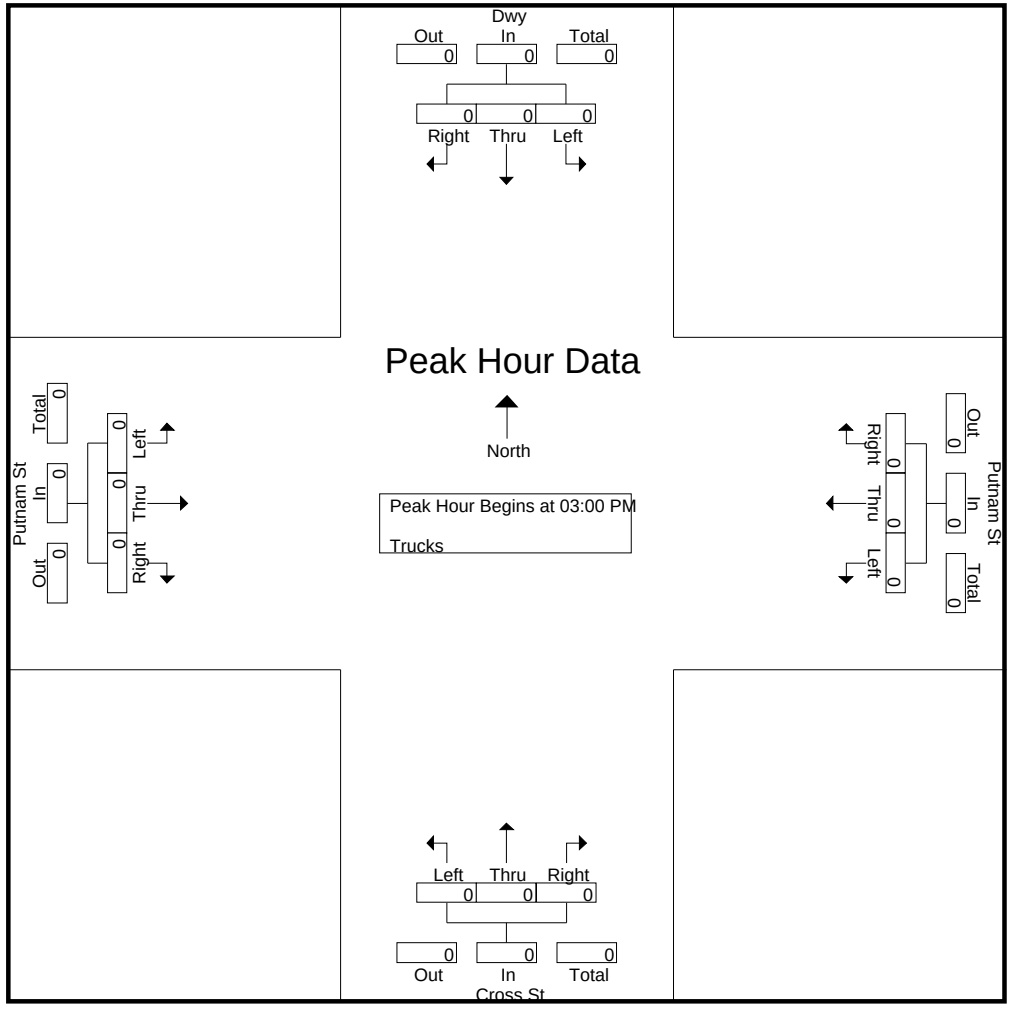
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:00 PM																	
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:45 PM	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
% App. Total	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

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 11



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

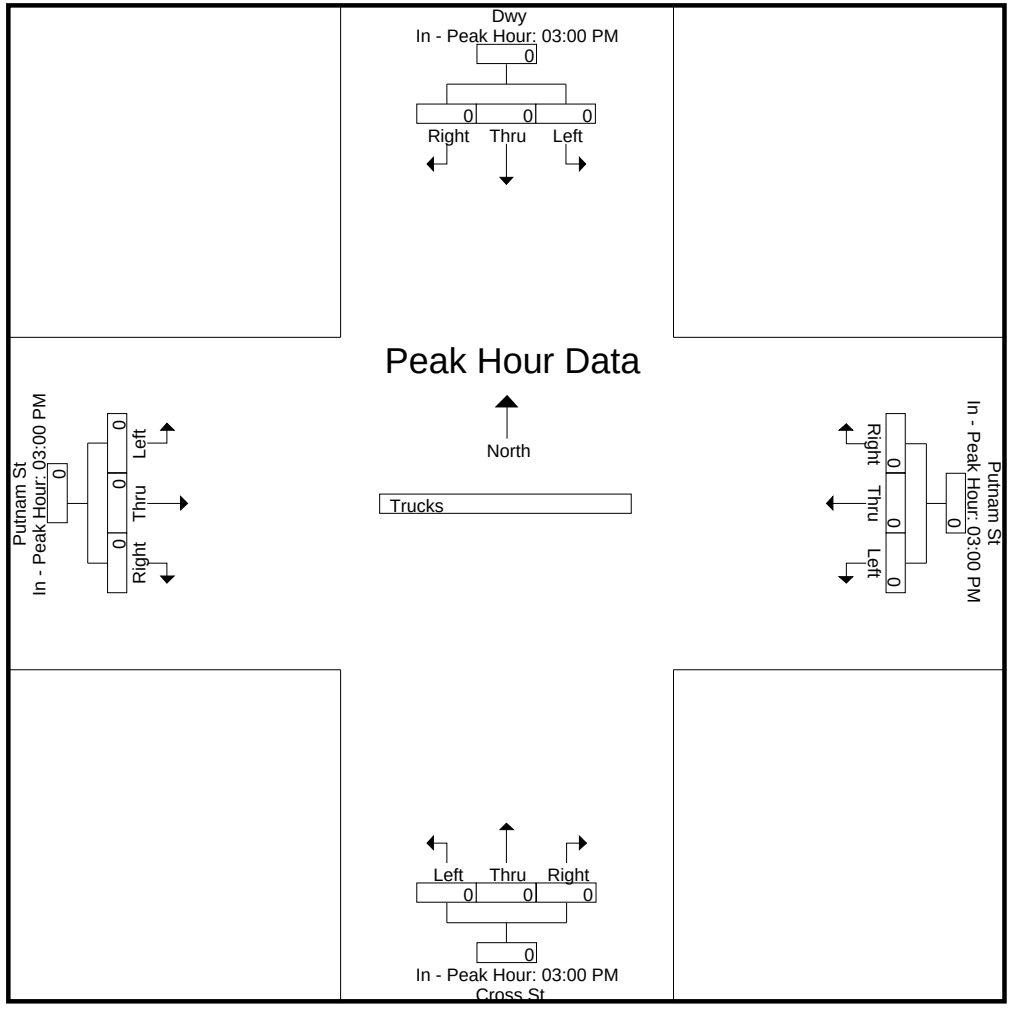
	03:00 PM				03:00 PM				03:00 PM				03:00 PM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+45 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% App. Total	0	0	0		0	0	0		0	0	0		0	0	0	
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 12



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

Groups Printed- Bikes Peds

	Dwy From North				Putnam St From East				Cross St From South				Putnam St 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
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
03:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:45 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	0	2	0	0	0	0	2	0	2
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	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
04:45 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	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
05:15 PM	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
05:45 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	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	0	0	2	0	2
Apprch %	0	0	0		0	0	0		0	0	0		0	0	0				
Total %																	100	0	

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019

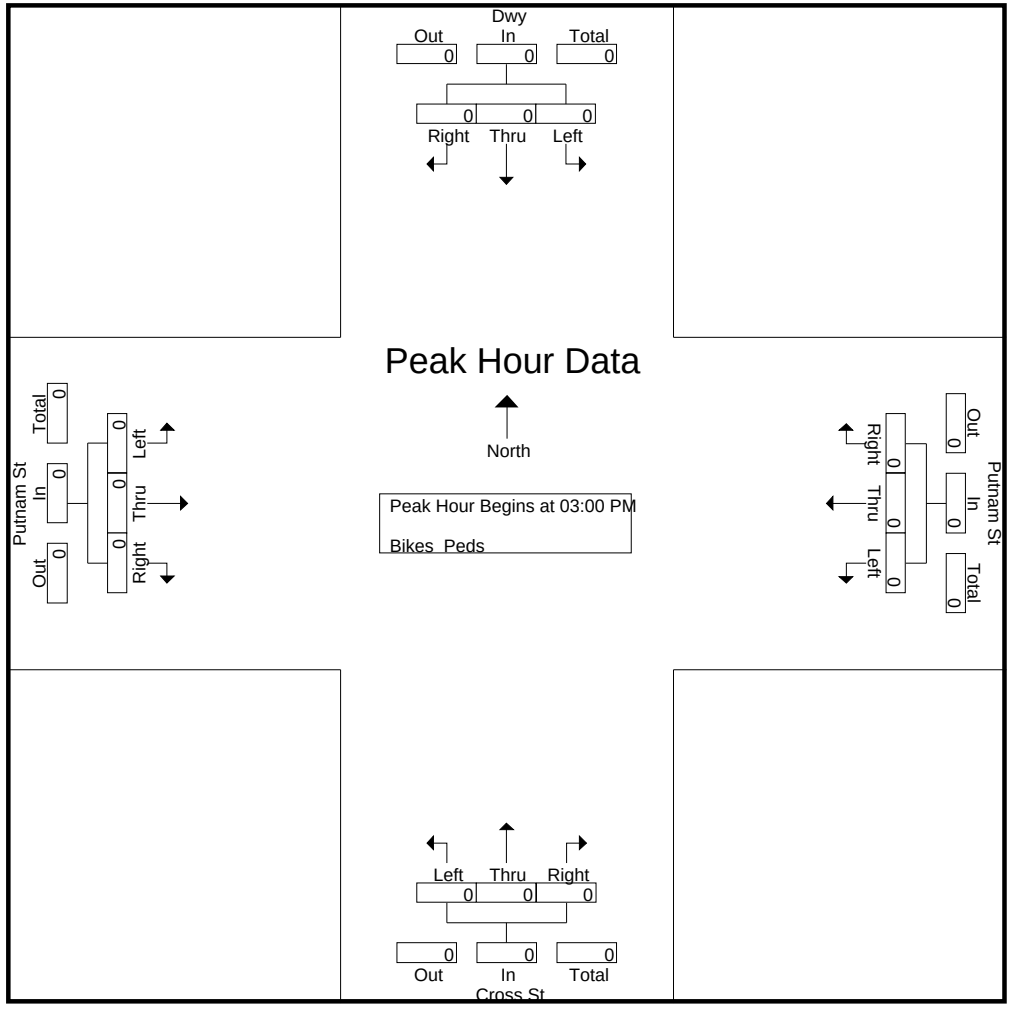
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:00 PM																	
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:45 PM	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
% App. Total	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

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 15



Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

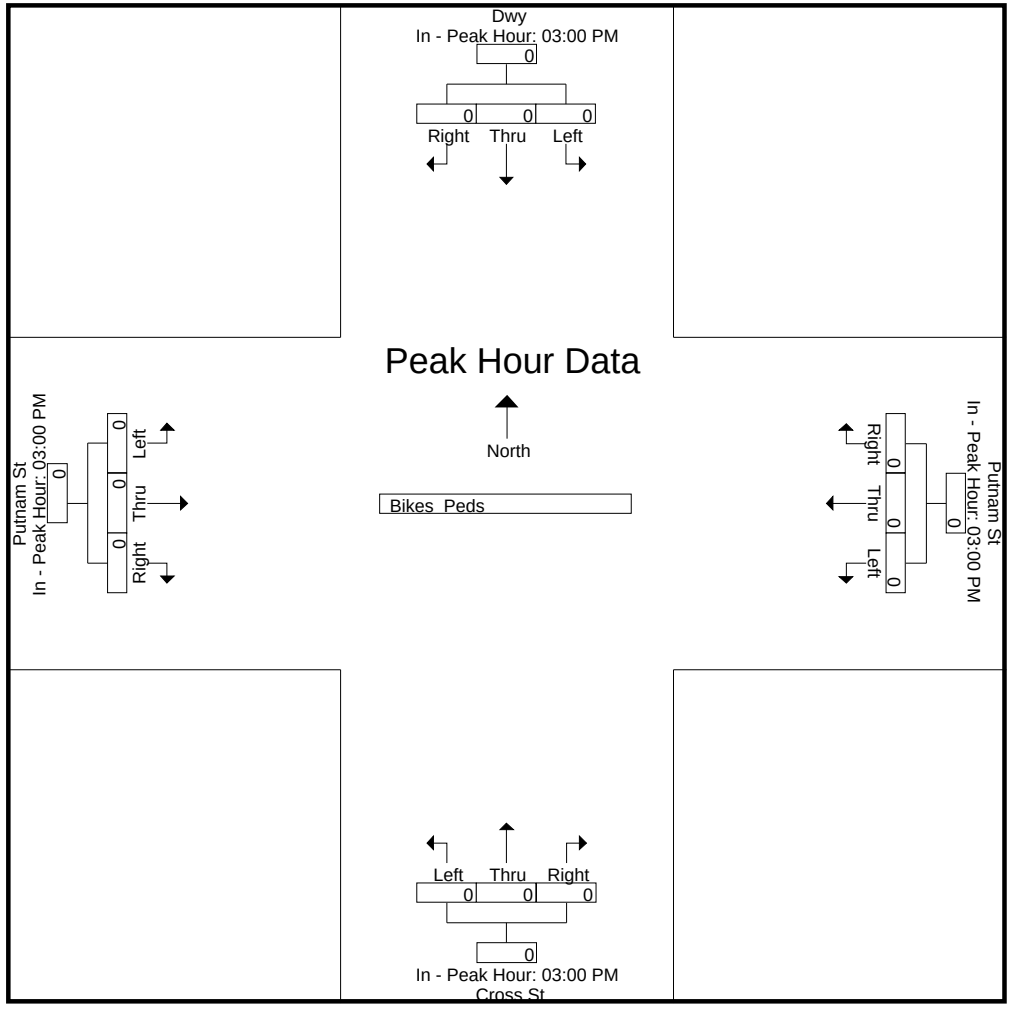
	03:00 PM				03:00 PM				03:00 PM				03:00 PM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+45 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% App. Total	0	0	0		0	0	0		0	0	0		0	0	0	
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 16



SEASONAL ADJUSTMENT DATA

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.

9/7/2021

VEHICLE TRAVEL SPEED DATA

Accurate Counts
978-664-2565

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315SPD1

EB

Start Time	1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	37 39	40 999	Total
09/04/19	0	0	0	0	0	0	0	3	3	4	6	8	8	2	34
01:00	0	0	0	0	0	0	0	1	3	4	5	10	5	0	28
02:00	0	0	0	0	0	0	0	0	1	3	1	0	5	0	10
03:00	0	0	0	0	0	0	0	0	0	3	3	0	2	1	9
04:00	0	0	0	0	0	0	0	0	0	1	8	14	2	7	32
05:00	0	0	0	0	0	1	2	7	14	19	41	32	23	13	152
06:00	0	0	0	1	0	6	5	10	16	67	115	106	43	24	393
07:00	0	0	0	0	4	4	9	48	145	238	220	84	24	9	785
08:00	0	0	1	1	4	15	31	155	182	237	173	63	12	2	876
09:00	0	0	0	0	1	2	13	43	116	198	173	84	16	3	649
10:00	0	0	0	1	0	5	9	37	99	167	141	71	20	5	555
11:00	0	0	0	0	0	1	15	43	108	171	134	54	27	4	557
12 PM	0	0	0	0	0	1	18	55	130	171	120	57	12	3	567
13:00	0	0	0	0	0	5	11	53	106	173	131	50	19	2	550
14:00	0	0	0	2	0	8	23	57	121	169	118	56	14	6	574
15:00	0	0	0	0	0	5	38	77	143	192	116	49	17	5	642
16:00	0	0	0	0	0	3	12	47	101	173	121	75	15	7	554
17:00	0	0	0	0	3	7	21	68	140	126	81	36	11	3	496
18:00	0	0	0	0	0	2	15	47	88	143	106	45	14	3	463
19:00	0	0	0	0	0	2	6	49	97	125	84	41	5	3	412
20:00	0	0	0	0	1	2	3	20	57	102	100	30	8	2	325
21:00	0	0	0	1	0	0	4	14	33	68	48	28	7	0	203
22:00	0	0	0	0	0	0	2	4	14	27	45	12	8	1	113
23:00	0	0	0	0	0	1	0	2	9	10	21	11	3	6	63
Total	0	0	1	6	13	70	237	840	1726	2591	2111	1016	320	111	9042

Daily

15th Percentile :	24 MPH
50th Percentile :	28 MPH
85th Percentile :	32 MPH
95th Percentile :	35 MPH
Mean Speed(Average) :	29 MPH
10 MPH Pace Speed :	25-34 MPH
Number in Pace :	6767
Percent in Pace :	74.8%
Number of Vehicles > 30 MPH :	3558
Percent of Vehicles > 30 MPH :	39.3%

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315SPD1

EB

Start Time	1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	37 39	40 999	Total
09/05/19	0	0	0	0	0	0	0	2	1	5	15	9	2	1	35
01:00	0	0	0	0	0	0	0	0	2	7	6	2	3	1	21
02:00	0	0	0	0	0	0	0	0	1	2	2	2	1	0	8
03:00	0	0	0	0	0	0	0	0	1	0	5	5	1	3	15
04:00	0	0	0	0	1	0	0	0	1	3	9	10	8	2	34
05:00	0	0	0	0	0	0	0	10	13	17	43	32	29	9	153
06:00	0	0	0	0	0	0	2	7	15	55	132	96	41	19	367
07:00	0	0	0	2	8	9	26	88	189	233	178	62	21	6	822
08:00	0	0	1	4	11	28	43	129	224	249	138	45	17	4	893
09:00	0	0	0	0	3	7	14	59	118	207	117	72	17	5	619
10:00	0	0	0	0	0	4	21	75	162	170	89	34	12	2	569
11:00	0	0	0	0	0	6	14	45	122	167	118	59	14	3	548
12 PM	0	0	0	0	0	7	9	40	122	187	122	41	7	2	537
13:00	0	0	1	0	1	2	11	50	138	168	128	54	24	4	581
14:00	0	0	0	1	0	2	20	40	118	170	137	71	14	3	576
15:00	0	0	0	1	6	18	44	91	166	183	100	27	4	3	643
16:00	0	0	0	1	5	12	24	79	118	157	92	35	10	1	534
17:00	0	0	0	0	2	4	21	45	119	111	95	26	12	4	439
18:00	0	0	0	1	1	2	13	49	76	122	120	68	14	2	468
19:00	0	0	0	0	0	2	20	42	101	131	89	29	9	1	424
20:00	0	0	0	0	1	1	12	54	71	100	48	26	7	1	321
21:00	0	0	0	0	0	0	3	9	36	56	51	33	10	4	202
22:00	0	0	0	0	0	0	2	8	20	38	33	23	9	3	136
23:00	0	0	0	0	0	0	0	4	7	20	18	4	3	5	61
Total	0	0	2	10	39	104	299	926	1941	2558	1885	865	289	88	9006

Daily

15th Percentile :	23 MPH
50th Percentile :	28 MPH
85th Percentile :	32 MPH
95th Percentile :	35 MPH
Mean Speed(Average) :	29 MPH
10 MPH Pace Speed :	24-33 MPH
Number in Pace :	6693
Percent in Pace :	74.3%
Number of Vehicles > 30 MPH :	3127
Percent of Vehicles > 30 MPH :	34.7%

Grand Total	0	0	3	16	52	174	536	1766	3667	5149	3996	1881	609	199	18048

Overall

15th Percentile :	24 MPH
50th Percentile :	28 MPH
85th Percentile :	32 MPH
95th Percentile :	35 MPH
Mean Speed(Average) :	29 MPH
10 MPH Pace Speed :	25-34 MPH
Number in Pace :	13439
Percent in Pace :	74.5%
Number of Vehicles > 30 MPH :	6685
Percent of Vehicles > 30 MPH :	37.0%

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315SPD1

WB

Start Time	1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	37 39	40 999	Total
09/04/19	0	0	0	0	0	0	2	0	2	5	17	10	7	2	45
01:00	0	0	0	0	0	0	2	0	2	7	6	5	2	1	25
02:00	0	0	0	0	0	0	0	0	2	1	1	2	2	1	9
03:00	0	0	0	0	1	1	3	2	2	1	2	2	2	0	16
04:00	0	0	0	0	0	0	0	1	3	5	5	9	3	0	26
05:00	0	0	0	0	0	0	3	4	10	18	28	23	9	12	107
06:00	0	0	0	0	2	1	6	24	55	74	80	75	25	23	365
07:00	0	0	0	3	8	22	67	93	132	133	97	50	22	8	635
08:00	0	0	0	5	13	28	61	120	125	112	62	31	9	4	570
09:00	0	0	0	1	6	13	43	80	119	133	89	41	15	5	545
10:00	0	0	0	2	4	19	62	95	137	137	87	36	12	7	598
11:00	0	0	0	10	17	31	71	91	141	109	88	36	16	7	617
12 PM	0	0	0	12	30	48	74	110	130	127	76	39	6	6	658
13:00	0	0	0	10	30	33	71	117	129	111	76	39	13	5	634
14:00	0	0	0	17	45	82	118	126	103	79	64	27	10	3	674
15:00	0	0	1	18	51	55	79	129	143	102	46	34	3	0	661
16:00	0	0	2	52	136	135	131	124	108	88	65	26	10	5	882
17:00	0	0	2	127	257	187	114	73	47	23	16	5	4	1	856
18:00	0	0	1	48	86	92	134	120	114	112	53	26	6	4	796
19:00	0	0	0	9	43	40	78	121	136	98	60	15	4	2	606
20:00	0	0	0	3	5	10	29	39	62	78	79	38	14	7	364
21:00	0	0	0	0	0	1	2	14	44	76	59	19	10	2	227
22:00	0	0	0	0	0	0	1	7	8	38	35	27	9	4	129
23:00	0	0	0	0	0	1	3	3	9	18	23	10	11	4	82
Total	0	0	6	317	734	799	1154	1493	1763	1685	1214	625	224	113	10127

Daily

15th Percentile :	16 MPH
50th Percentile :	24 MPH
85th Percentile :	31 MPH
95th Percentile :	34 MPH
Mean Speed(Average) :	25 MPH
10 MPH Pace Speed :	22-31 MPH
Number in Pace :	5346
Percent in Pace :	52.8%
Number of Vehicles > 30 MPH :	2176
Percent of Vehicles > 30 MPH :	21.5%

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315SPD1

WB

Start Time	1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	37 39	40 999	Total
09/05/19	0	0	0	0	0	0	0	1	4	4	19	10	5	0	43
01:00	0	0	0	0	0	0	1	1	3	6	3	5	3	2	24
02:00	0	0	0	0	0	0	0	1	1	2	1	3	0	1	9
03:00	0	0	0	0	0	1	0	0	3	0	2	2	1	4	13
04:00	0	0	0	0	0	2	3	4	1	2	6	7	7	1	33
05:00	0	0	0	0	0	0	2	3	6	15	21	19	15	13	94
06:00	0	0	0	0	0	3	6	18	22	54	101	67	36	15	322
07:00	0	0	0	3	23	37	71	81	105	111	86	41	22	5	585
08:00	0	0	0	11	27	37	67	115	117	100	55	37	7	4	577
09:00	0	0	0	3	26	48	77	105	124	104	65	27	13	5	597
10:00	0	0	1	16	41	43	64	77	120	109	66	32	13	3	585
11:00	0	0	1	9	44	52	81	111	109	113	53	42	6	1	622
12 PM	0	0	0	19	27	56	83	115	125	120	77	36	7	4	669
13:00	0	0	0	11	17	41	84	104	115	136	75	35	15	2	635
14:00	0	0	0	14	38	68	102	149	144	95	69	24	7	2	712
15:00	0	0	0	107	165	119	104	52	51	53	26	14	4	0	695
16:00	0	0	5	127	199	164	120	92	68	46	11	10	0	0	842
17:00	0	0	4	139	253	221	131	73	38	17	7	2	1	0	886
18:00	0	0	0	50	81	129	107	145	121	95	50	18	12	3	811
19:00	0	0	1	16	33	62	68	104	129	126	56	28	14	5	642
20:00	0	0	0	3	2	19	43	68	88	101	66	28	8	3	429
21:00	0	0	0	0	0	2	5	20	48	64	64	28	10	4	245
22:00	0	0	0	0	0	1	1	9	23	38	61	30	15	4	182
23:00	0	0	0	0	0	0	1	10	11	17	20	9	7	4	79
Total	0	0	12	528	976	1105	1221	1458	1576	1528	1060	554	228	85	10331

Daily

15th Percentile :	15 MPH
50th Percentile :	23 MPH
85th Percentile :	30 MPH
95th Percentile :	34 MPH
Mean Speed(Average) :	24 MPH
10 MPH Pace Speed :	21-30 MPH
Number in Pace :	4969
Percent in Pace :	48.1%
Number of Vehicles > 30 MPH :	1927
Percent of Vehicles > 30 MPH :	18.7%

Grand Total	0	0	18	845	1710	1904	2375	2951	3339	3213	2274	1179	452	198	20458

Overall

15th Percentile :	15 MPH
50th Percentile :	24 MPH
85th Percentile :	31 MPH
95th Percentile :	34 MPH
Mean Speed(Average) :	24 MPH
10 MPH Pace Speed :	21-30 MPH
Number in Pace :	10295
Percent in Pace :	50.3%
Number of Vehicles > 30 MPH :	4103
Percent of Vehicles > 30 MPH :	20.1%

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315SPD1

EB, WB

Start Time	1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	37 39	40 999	Total
09/04/19	0	0	0	0	0	0	2	3	5	9	23	18	15	4	79
01:00	0	0	0	0	0	0	2	1	5	11	11	15	7	1	53
02:00	0	0	0	0	0	0	0	0	3	4	2	2	7	1	19
03:00	0	0	0	0	1	1	3	2	2	4	5	2	4	1	25
04:00	0	0	0	0	0	0	0	1	3	6	13	23	5	7	58
05:00	0	0	0	0	0	1	5	11	24	37	69	55	32	25	259
06:00	0	0	0	1	2	7	11	34	71	141	195	181	68	47	758
07:00	0	0	0	3	12	26	76	141	277	371	317	134	46	17	1420
08:00	0	0	1	6	17	43	92	275	307	349	235	94	21	6	1446
09:00	0	0	0	1	7	15	56	123	235	331	262	125	31	8	1194
10:00	0	0	0	3	4	24	71	132	236	304	228	107	32	12	1153
11:00	0	0	0	10	17	32	86	134	249	280	222	90	43	11	1174
12 PM	0	0	0	12	30	49	92	165	260	298	196	96	18	9	1225
13:00	0	0	0	10	30	38	82	170	235	284	207	89	32	7	1184
14:00	0	0	0	19	45	90	141	183	224	248	182	83	24	9	1248
15:00	0	0	1	18	51	60	117	206	286	294	162	83	20	5	1303
16:00	0	0	2	52	136	138	143	171	209	261	186	101	25	12	1436
17:00	0	0	2	127	260	194	135	141	187	149	97	41	15	4	1352
18:00	0	0	1	48	86	94	149	167	202	255	159	71	20	7	1259
19:00	0	0	0	9	43	42	84	170	233	223	144	56	9	5	1018
20:00	0	0	0	3	6	12	32	59	119	180	179	68	22	9	689
21:00	0	0	0	1	0	1	6	28	77	144	107	47	17	2	430
22:00	0	0	0	0	0	0	3	11	22	65	80	39	17	5	242
23:00	0	0	0	0	0	2	3	5	18	28	44	21	14	10	145
Total	0	0	7	323	747	869	1391	2333	3489	4276	3325	1641	544	224	19169

Daily

15th Percentile :	19 MPH
50th Percentile :	27 MPH
85th Percentile :	32 MPH
95th Percentile :	35 MPH
Mean Speed(Average) :	27 MPH
10 MPH Pace Speed :	24-33 MPH
Number in Pace :	11868
Percent in Pace :	61.9%
Number of Vehicles > 30 MPH :	5734
Percent of Vehicles > 30 MPH :	29.9%

Location : Highland Avenue
Location : West of Cross Street
City/State: Needham, MA

8315SPD1

EB, WB

Start Time	1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	37 39	40 999	Total
09/05/19	0	0	0	0	0	0	0	3	5	9	34	19	7	1	78
01:00	0	0	0	0	0	0	1	1	5	13	9	7	6	3	45
02:00	0	0	0	0	0	0	0	1	2	4	3	5	1	1	17
03:00	0	0	0	0	0	1	0	0	4	0	7	7	2	7	28
04:00	0	0	0	0	1	2	3	4	2	5	15	17	15	3	67
05:00	0	0	0	0	0	0	2	13	19	32	64	51	44	22	247
06:00	0	0	0	0	0	3	8	25	37	109	233	163	77	34	689
07:00	0	0	0	5	31	46	97	169	294	344	264	103	43	11	1407
08:00	0	0	1	15	38	65	110	244	341	349	193	82	24	8	1470
09:00	0	0	0	3	29	55	91	164	242	311	182	99	30	10	1216
10:00	0	0	1	16	41	47	85	152	282	279	155	66	25	5	1154
11:00	0	0	1	9	44	58	95	156	231	280	171	101	20	4	1170
12 PM	0	0	0	19	27	63	92	155	247	307	199	77	14	6	1206
13:00	0	0	1	11	18	43	95	154	253	304	203	89	39	6	1216
14:00	0	0	0	15	38	70	122	189	262	265	206	95	21	5	1288
15:00	0	0	0	108	171	137	148	143	217	236	126	41	8	3	1338
16:00	0	0	5	128	204	176	144	171	186	203	103	45	10	1	1376
17:00	0	0	4	139	255	225	152	118	157	128	102	28	13	4	1325
18:00	0	0	0	51	82	131	120	194	197	217	170	86	26	5	1279
19:00	0	0	1	16	33	64	88	146	230	257	145	57	23	6	1066
20:00	0	0	0	3	3	20	55	122	159	201	114	54	15	4	750
21:00	0	0	0	0	0	2	8	29	84	120	115	61	20	8	447
22:00	0	0	0	0	0	1	3	17	43	76	94	53	24	7	318
23:00	0	0	0	0	0	0	1	14	18	37	38	13	10	9	140
Total	0	0	14	538	1015	1209	1520	2384	3517	4086	2945	1419	517	173	19337

Daily

15th Percentile :	18 MPH
50th Percentile :	26 MPH
85th Percentile :	32 MPH
95th Percentile :	35 MPH
Mean Speed(Average) :	26 MPH
10 MPH Pace Speed :	24-33 MPH
Number in Pace :	11343
Percent in Pace :	58.7%
Number of Vehicles > 30 MPH :	5054
Percent of Vehicles > 30 MPH :	26.1%

Grand Total	0	0	21	861	1762	2078	2911	4717	7006	8362	6270	3060	1061	397	38506

Overall

15th Percentile :	19 MPH
50th Percentile :	26 MPH
85th Percentile :	32 MPH
95th Percentile :	35 MPH
Mean Speed(Average) :	26 MPH
10 MPH Pace Speed :	24-33 MPH
Number in Pace :	23210
Percent in Pace :	60.3%
Number of Vehicles > 30 MPH :	10788
Percent of Vehicles > 30 MPH :	28.0%

TRANSIT INFORMATION

NEEDHAM LINE SPRING/SUMMER SCHEDULE
Effective May 22, 2023

Monday to Friday

Inbound to Boston

ZONE	STATION	TRAIN #	AM							PM								
	Bikes Allowed		600	602	604	606	608	610	612	614	616	618	620	622	624	626	628	630
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

Outbound from Boston

ZONE	STATION	TRAIN #	AM						PM										
	Bikes Allowed		603	605	607	609	611	613	615	617	619	621	623	625	627	629	631	Providence 839	633
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	
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	Board Providence Train 839 and change trains at Forest Hills for a Needham connection
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

Inbound to Boston

ZONE	STATION	SATURDAY TRAIN # / SUNDAY TRAIN #	AM			PM				
	Bikes Allowed		1600 / 2600	1602 / 2602	1604 / 2604	1606 / 2606	1608 / 2608	1610 / 2610	1612 / 2612	1614 / 2614
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

Outbound from Boston

ZONE	STATION	SATURDAY TRAIN # / SUNDAY TRAIN #	AM			PM				
	Bikes Allowed		1601 / 2601	1603 / 2603	1605 / 2605	1607 / 2607	1609 / 2609	1611 / 2611	1613 / 2613	1615 / 2615
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.

Keep in Mind:

This schedule will be effective from May 22, 2023 and will replace the schedule of October 17, 2022.

Holiday Service

On Monday, May 29th (Memorial Day), Tuesday, July 4th (Independence Day) and Monday, September 4th (Labor Day), all lines will operate on a weekend schedule.

On Monday, June 19th (Juneteenth), Monday, July 3rd (Day before Independence Day), and Monday, October 9th (Columbus Day), all lines will operate on a regular weekday schedule.

For all holiday schedules, please check MBTA.com/holidays or call 617-222-3200.

MASSDOT CRASH RATE WORKSHEETS AND HIGH CRASH LOCATION MAPPING

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham COUNT DATE :

DISTRICT : 6 UNSIGNALIZED : SIGNALIZED : X

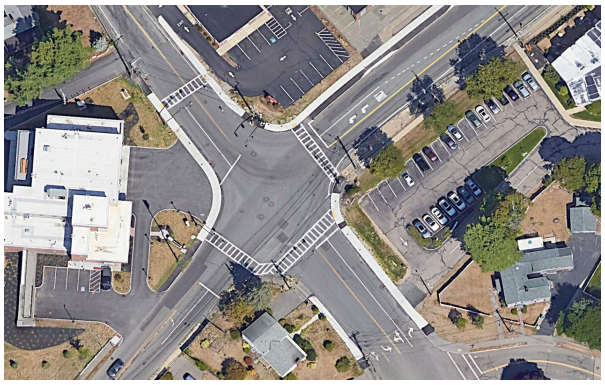
~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Webster Street

INTERSECTION DIAGRAM (Label Approaches)

↑ *North*



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	NB	SB	EB	WB		
PEAK HOURLY VOLUMES (PM) :	347	374	464	1,039		**2,224**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **24,711**

TOTAL # OF CRASHES : 10 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **2.00**

CRASH RATE CALCULATION : **0.22** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Below Statewide (0.78) and District (0.71) Crash Rates

Project Title & Date: Proposed Medical Office Building

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham COUNT DATE :

DISTRICT : 6 UNSIGNALIZED : X SIGNALIZED :

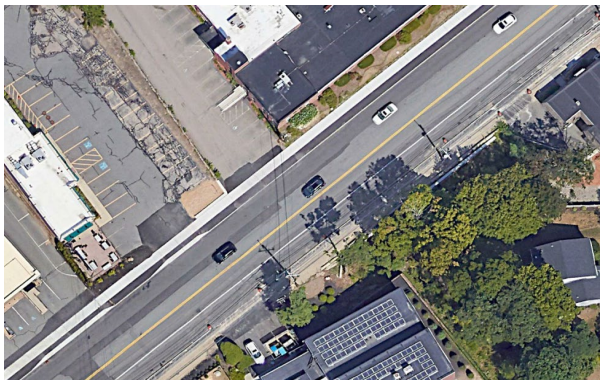
~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Arbor Street

INTERSECTION DIAGRAM (Label Approaches)

↑ *North*



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	SB	EB	WB			
PEAK HOURLY VOLUMES (PM) :	17	651	1,066			**1,734**

" K " FACTOR : **0.090**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **19,267**

TOTAL # OF CRASHES : 1

OF YEARS : 5

AVERAGE # OF CRASHES PER YEAR (**A**) : **0.20**

CRASH RATE CALCULATION : **0.03**

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Below Statewide (0.57) and District (0.52) Crash Rates

Project Title & Date: Proposed Medical Office Building

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham COUNT DATE :

DISTRICT : 6 UNSIGNALIZED : X SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Cross Street

Mills Road

INTERSECTION DIAGRAM (Label Approaches)

↑ *North*

PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	NB	SB	EB	WB		
PEAK HOURLY VOLUMES (PM) :	16	7	662	1,073		**1,758**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **19,533**

TOTAL # OF CRASHES : 3 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **0.60**

CRASH RATE CALCULATION : **0.08** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Below Statewide (0.57) and District (0.52) Crash Rates

Project Title & Date: Proposed Medical Office Building

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham COUNT DATE :

DISTRICT : 6 UNSIGNALIZED : SIGNALIZED : X

~ INTERSECTION DATA ~

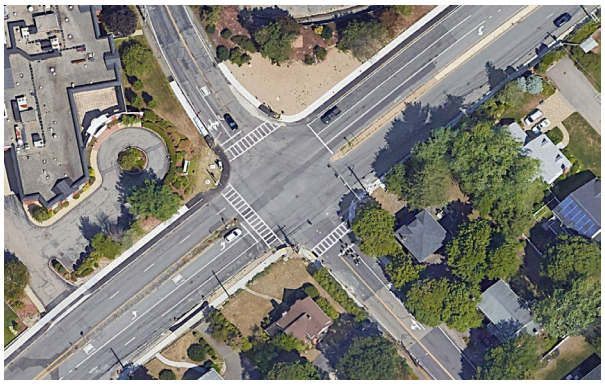
MAJOR STREET : Highland Avenue

MINOR STREET(S) : Gould Street

Hunting Road

INTERSECTION DIAGRAM (Label Approaches)

↑ *North*



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	NB	SB	EB	WB		
PEAK HOURLY VOLUMES (PM) :	347	374	464	1,039		**2,224**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **24,711**

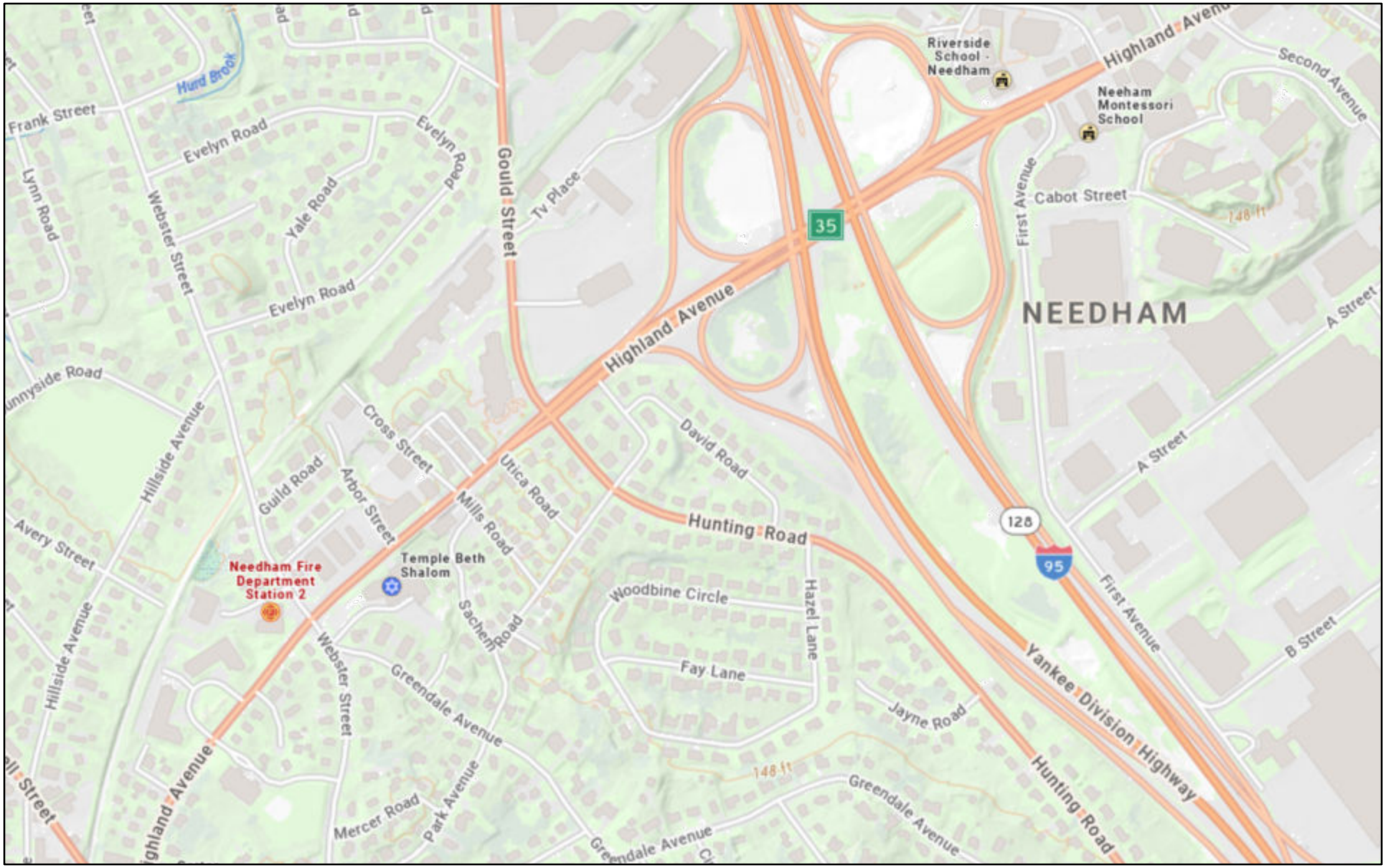
TOTAL # OF CRASHES : 19 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **3.80**

CRASH RATE CALCULATION : **0.42** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : Below Statewide (0.78) and District (0.71) Crash Rates

Project Title & Date: Proposed Medical Office Building

MassDOT Top Crash Locations



5/30/2023, 12:20:34 PM

1:9,028

0 0.05 0.1 0.2 mi

0 0.07 0.15 0.3 km

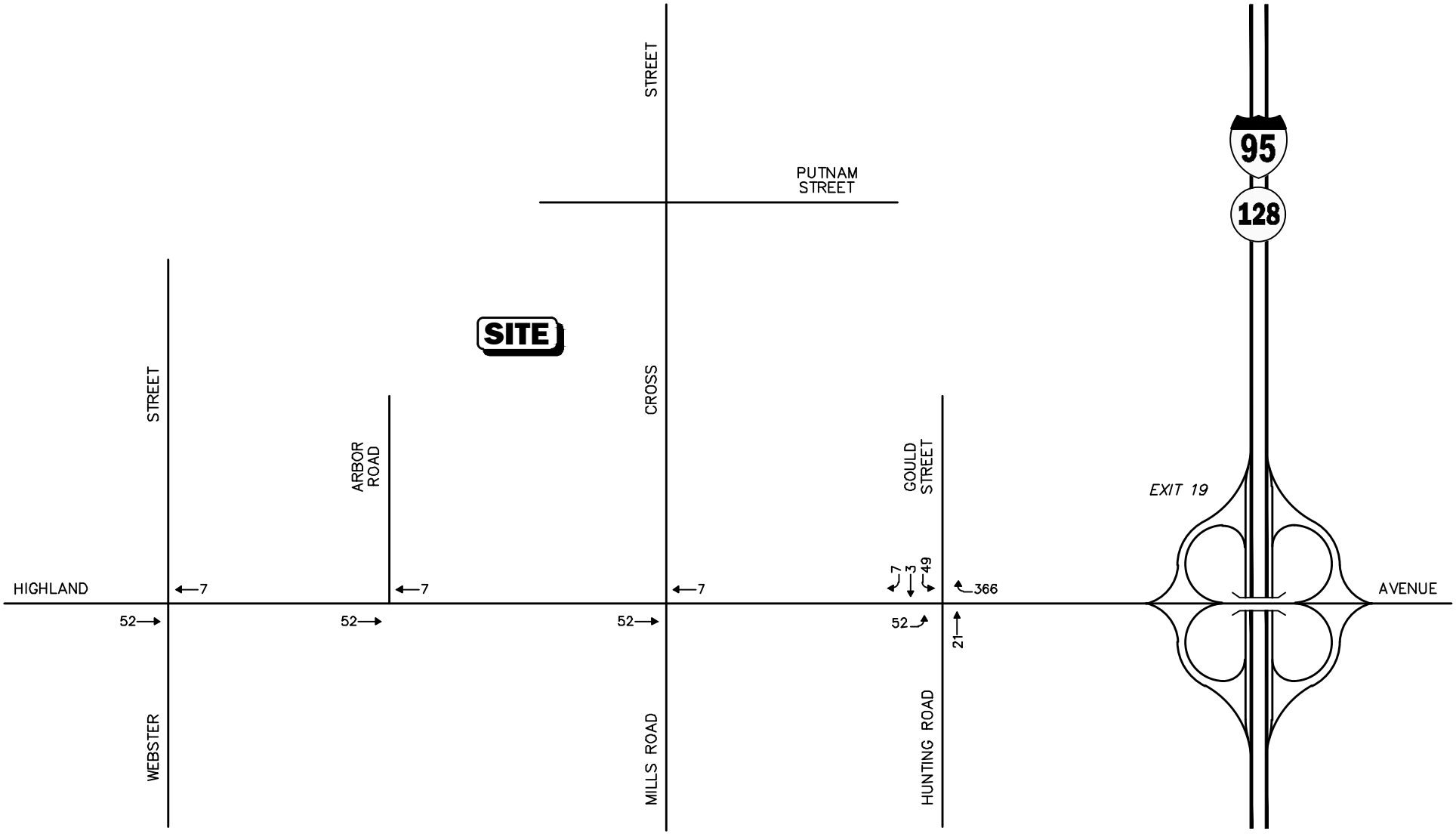
MassDOT

GENERAL BACKGROUND TRAFFIC GROWTH

General Background Traffic Growth - Daily Traffic Volumes

CITY/TOWN	ROUTE/STREET	LOCATION	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Annual Growth Rate
Needham	Yankee Division Highway	South of Ramp-Rt 9 EB to Rt 95 SB		142,000					165,986	178,933	178,396	183,119	184,218	**2.71%**
Needham	Highland Avenue	West of Gould Street	19,125	19,335	19,458	19,039	19,541	18,819	19,026	19,273	19,518	19,791	19,870	**0.29%**
Needham	Highland Avenue	West of Rosemary Street	18,129	18,328	14,399	14,221	14,418	17,439	17,631	17,860	14,785	14,992	15,052	**-0.93%**
Needham	Chapel Street	North of Great Plain Avenue	8,662	8,900	8,931	9,675	9,798	10,337	9,465	9,588	9,693	8,877	8,913	**0.34%**
														0.60%

BACKGROUND DEVELOPMENT TRAFFIC-VOLUME NETWORKS

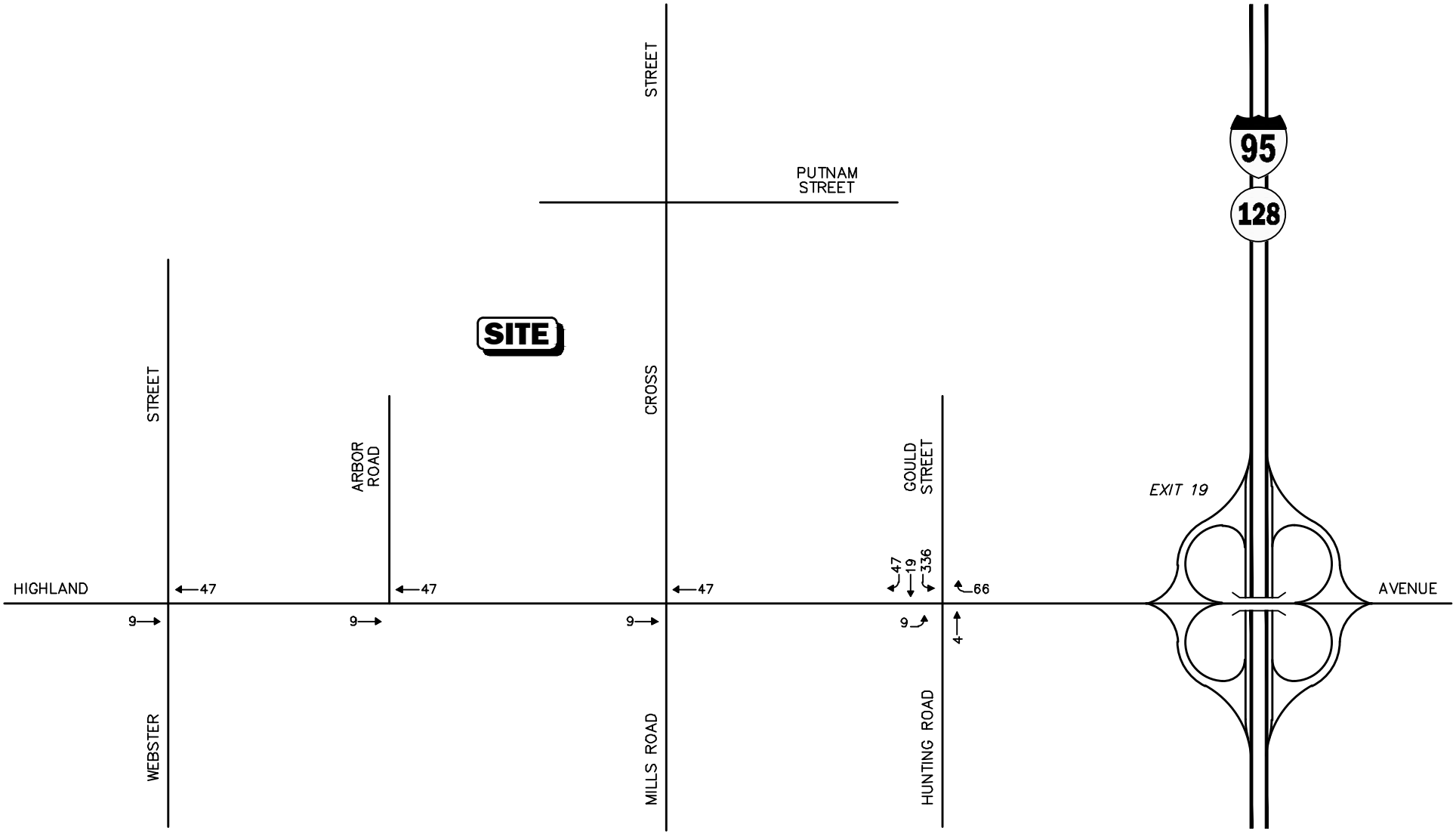


Not To Scale

Figure A-1

Highland Science Center
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc

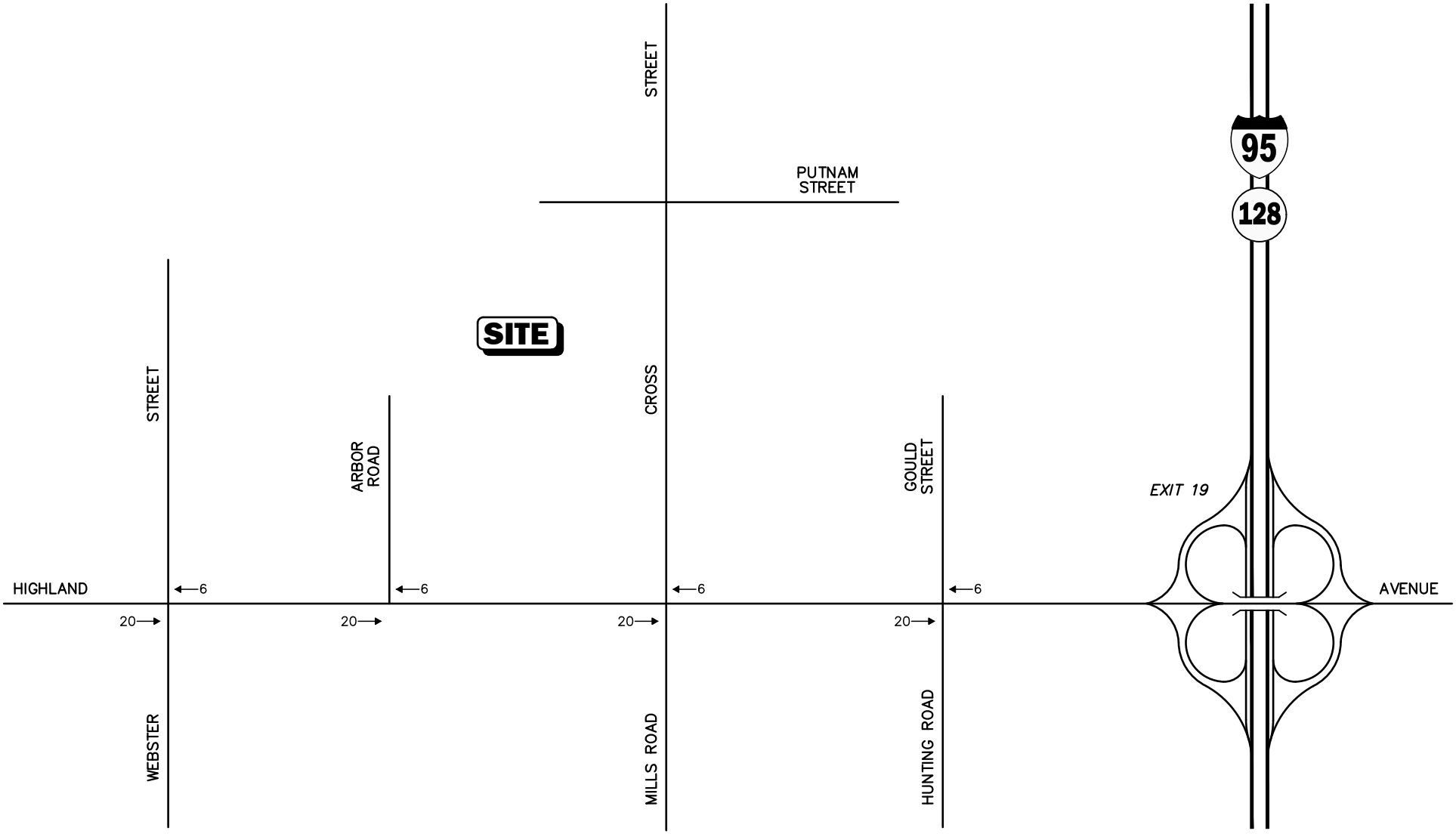


Not To Scale

Figure A-2

Highland Science Center
Weekday Evening
Peak Hour Traffic Volumes

Vanasse & Associates inc



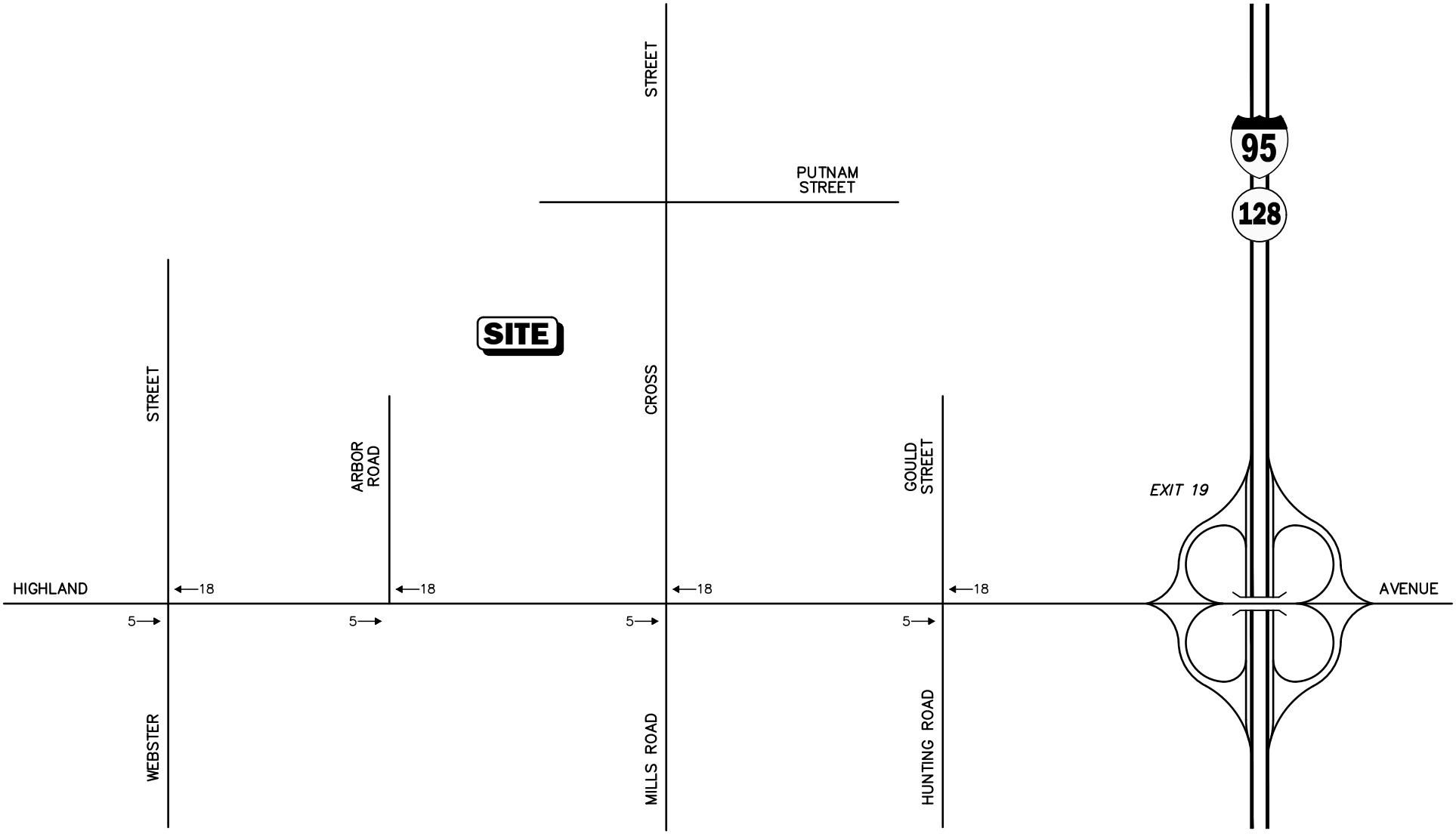
Not To Scale

Figure A-1

Boston Children's Hospital Development Weekday Morning

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig A-3, 5/28/2023 12:22:16 PM



Not To Scale

Figure A-4

Boston Children's Hospital Development
Weekday Evening Peak Hour Traffic Volumes

Vanasse & Associates inc

PROPOSED TRIP-GENERATION CALCULATIONS

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE:
Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE:
720

LAND USE GROUP:
(700-799) Office

LAND USE :
720 - Medical-Dental Office Building

LAND USE SUBCATEGORY:
Stand-Alone

SETTING/LOCATION:
General Urban/Suburban

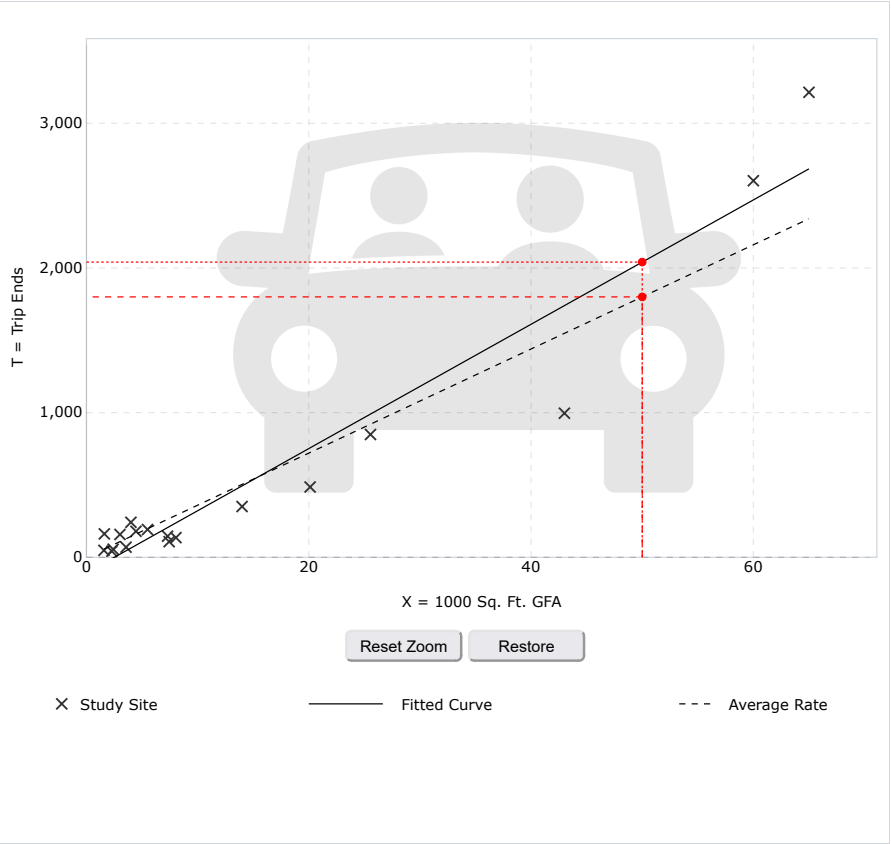
INDEPENDENT VARIABLE (IV):
1000 Sq. Ft. GFA

TIME PERIOD:
Weekday

TRIP TYPE:
Vehicle

ENTER IV VALUE TO CALCULATE TRIPS:
50.00 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Medical-Dental Office Building - Stand-Alone (720)
Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
18

Avg. 1000 Sq. Ft. GFA:
15

Average Rate:
36.00

Range of Rates:
14.52 - 100.75

Standard Deviation:
13.38

Fitted Curve Equation:
T = 42.97(X) - 108.01

R^2:
0.92

Directional Distribution:
50% entering, 50% exiting

Calculated Trip Ends:
Average Rate: 1800 (Total), 900 (Entry), 900 (Exit)
Fitted Curve: 2040 (Total), 1020 (Entry), 1020 (Exit)

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE: Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE: 720

LAND USE GROUP: (700-799) Office

LAND USE : 720 - Medical-Dental Office Building

LAND USE SUBCATEGORY: Stand-Alone

SETTING/LOCATION: General Urban/Suburban

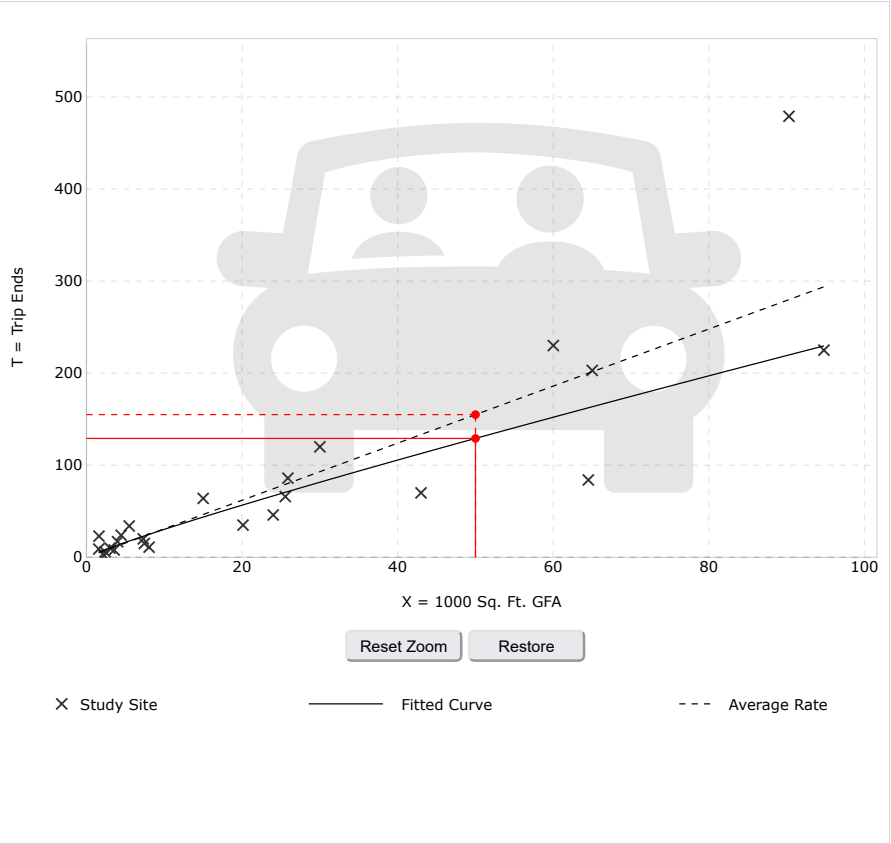
INDEPENDENT VARIABLE (IV): 1000 Sq. Ft. GFA

TIME PERIOD: Weekday, Peak Hour of Adjacent Street Traffic, I

TRIP TYPE: Vehicle

ENTER IV VALUE TO CALCULATE TRIPS: 50.00 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Medical-Dental Office Building - Stand-Alone (720)
Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday
Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
24

Avg. 1000 Sq. Ft. GFA:
25

Average Rate:
3.10

Range of Rates:
0.87 - 14.30

Standard Deviation:
1.49

Fitted Curve Equation:
Ln(T) = 0.90 Ln(X) + 1.34

R^2:
0.80

Directional Distribution:
79% entering, 21% exiting

Calculated Trip Ends:
Average Rate: 155 (Total), 122 (Entry), 33 (Exit)
Fitted Curve: 129 (Total), 102 (Entry), 27 (Exit)

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE: Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE: 720

LAND USE GROUP: (700-799) Office

LAND USE : 720 - Medical-Dental Office Building

LAND USE SUBCATEGORY: Stand-Alone

SETTING/LOCATION: General Urban/Suburban

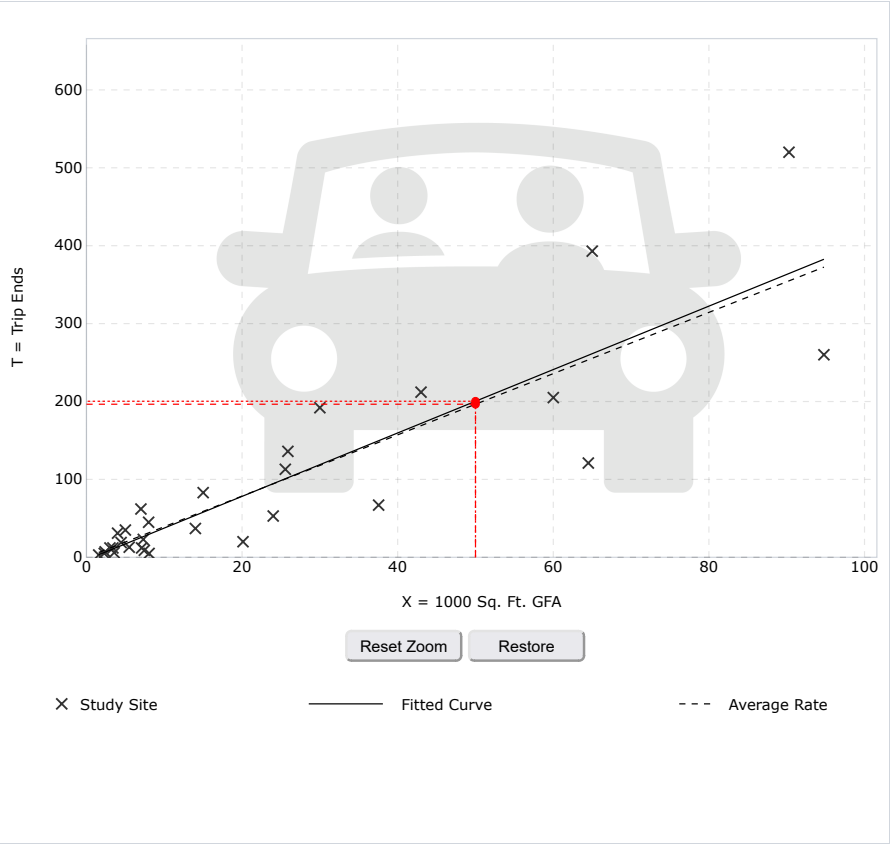
INDEPENDENT VARIABLE (IV): 1000 Sq. Ft. GFA

TIME PERIOD: Weekday, Peak Hour of Adjacent Street Traffic, I

TRIP TYPE: Vehicle

ENTER IV VALUE TO CALCULATE TRIPS: 50.00 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Medical-Dental Office Building - Stand-Alone (720)
Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday
Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
30

Avg. 1000 Sq. Ft. GFA:
23

Average Rate:
3.93

Range of Rates:
0.62 - 8.86

Standard Deviation:
1.86

Fitted Curve Equation:
T = 4.07(X) - 3.17

R^2:
0.77

Directional Distribution:
30% entering, 70% exiting

Calculated Trip Ends:
Average Rate: 197 (Total), 59 (Entry), 138 (Exit)
Fitted Curve: 200 (Total), 60 (Entry), 140 (Exit)

EXISTING TRIP-GENERATION CALCULATIONS

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE: Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE: 110

LAND USE GROUP: (100-199) Industrial

LAND USE : 110 - General Light Industrial

LAND USE SUBCATEGORY: All Sites

SETTING/LOCATION: General Urban/Suburban

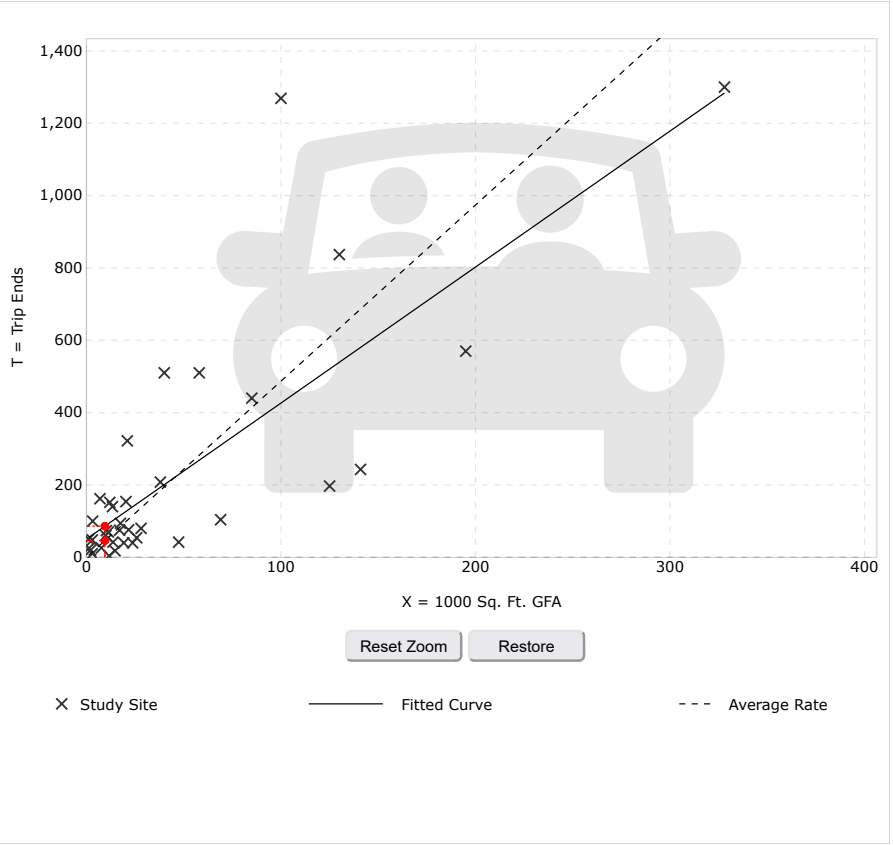
INDEPENDENT VARIABLE (IV): 1000 Sq. Ft. GFA

TIME PERIOD: Weekday

TRIP TYPE: Vehicle

ENTER IV VALUE TO CALCULATE TRIPS: 9.48 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
General Light Industrial (110) Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
37

Avg. 1000 Sq. Ft. GFA:
45

Average Rate:
4.87

Range of Rates:
0.34 - 43.86

Standard Deviation:
4.08

Fitted Curve Equation:
T = 3.76(X) + 50.47

R^2:
0.61

Directional Distribution:
50% entering, 50% exiting

Calculated Trip Ends:
Average Rate: 46 (Total), 23 (Entry), 23 (Exit)
Fitted Curve: 86 (Total), 43 (Entry), 43 (Exit)

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use *ITETripGen*
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE: Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE: 150

LAND USE GROUP: (100-199) Industrial

LAND USE : 150 - Warehousing

LAND USE SUBCATEGORY: All Sites

SETTING/LOCATION: General Urban/Suburban

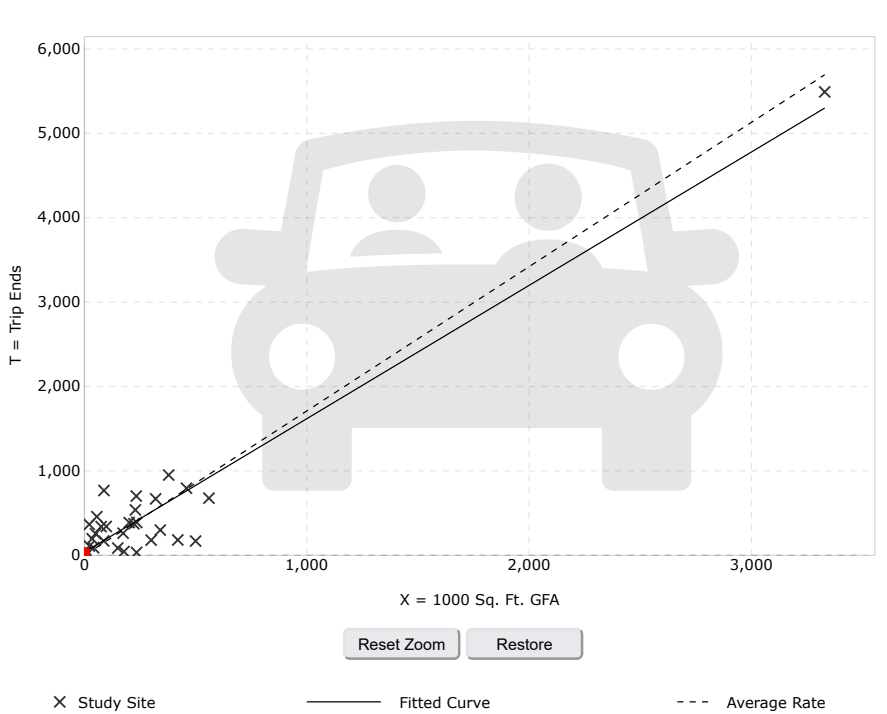
INDEPENDENT VARIABLE (IV): 1000 Sq. Ft. GFA

TIME PERIOD: Weekday

TRIP TYPE: Vehicle

ENTER IV VALUE TO CALCULATE TRIPS: 5.03 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Warehousing (150) Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
31

Avg. 1000 Sq. Ft. GFA:
292

Average Rate:
1.71

Range of Rates:
0.15 - 16.93

Standard Deviation:
1.48

Fitted Curve Equation:
T = 1.58(X) + 38.29

R^2:
0.92

Directional Distribution:
50% entering, 50% exiting

Calculated Trip Ends:
Average Rate: 9 (Total), 4 (Entry), 5 (Exit)
Fitted Curve: 46 (Total), 23 (Entry), 23 (Exit)

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use *ITETripGen*
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE: Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE: 495

LAND USE GROUP: (400-499) Recreational

LAND USE : 495 - Recreational Community Center

LAND USE SUBCATEGORY: All Sites

SETTING/LOCATION: General Urban/Suburban

INDEPENDENT VARIABLE (IV): 1000 Sq. Ft. GFA

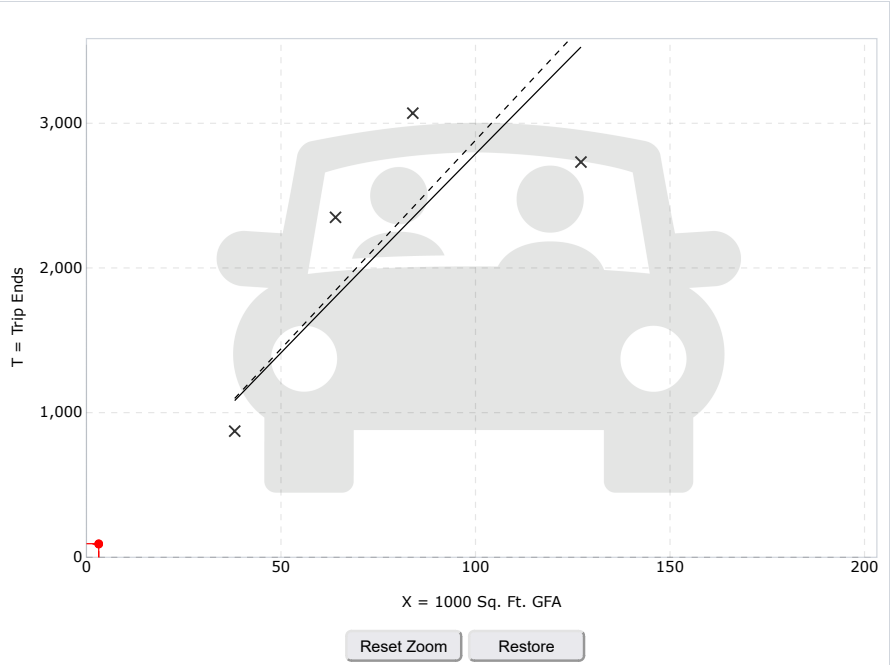
TIME PERIOD: Weekday

TRIP TYPE: Vehicle

ENTER IV VALUE TO CALCULATE TRIPS: 3.15 Calculate

Data Plot and Equation

Caution – Small Sample Size



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Recreational Community Center (495) Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
4

Avg. 1000 Sq. Ft. GFA:
78

Average Rate:
28.82

Range of Rates:
21.49 - 36.71

Standard Deviation:
8.56

Fitted Curve Equation:
Ln(T) = 0.98 Ln(X) + 3.42

R^2:
0.74

Directional Distribution:
50% entering, 50% exiting

Calculated Trip Ends:
Average Rate: 91 (Total), 45 (Entry), 46 (Exit)
Fitted Curve: 94 (Total), 47 (Entry), 47 (Exit)

Graph Look Up

Graph Look Up
How to Use ITETripGen
TGM Desk Reference
TGM Appendices
Support Documents
Add Users
Comments

Add-ons to do more
Try OTISS Pro

Query | Filter

DATA SOURCE:
Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE:
710

LAND USE GROUP:
(700-799) Office

LAND USE :
710 - General Office Building

LAND USE SUBCATEGORY:
All Sites

SETTING/LOCATION:
General Urban/Suburban

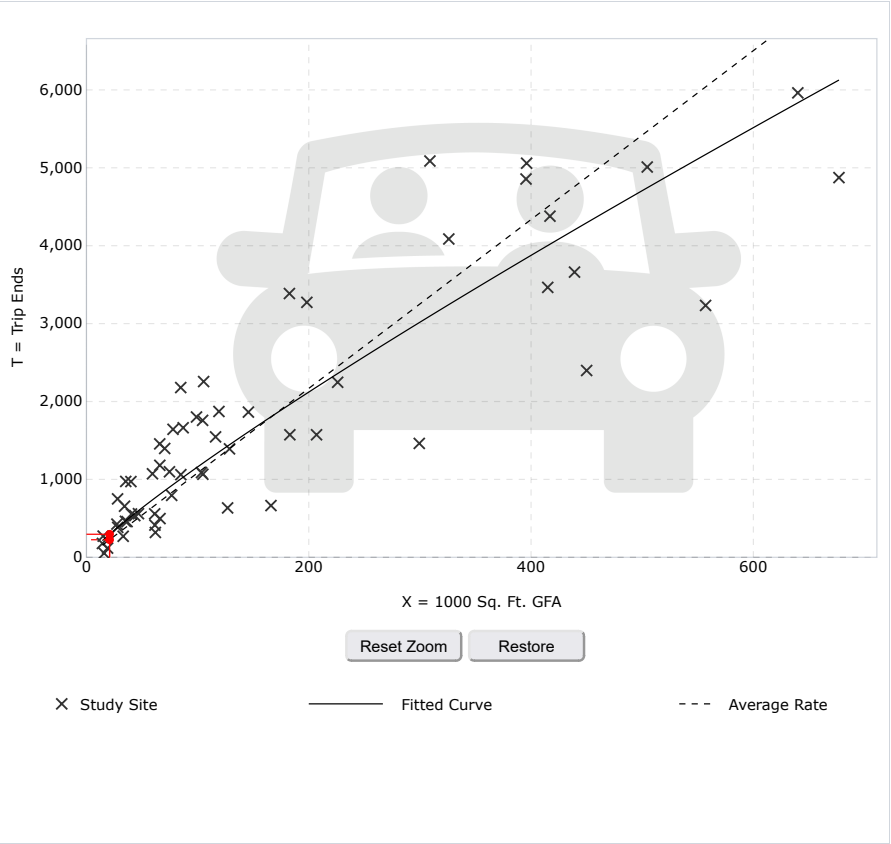
INDEPENDENT VARIABLE (IV):
1000 Sq. Ft. GFA

TIME PERIOD:
Weekday

TRIP TYPE:
Vehicle

ENTER IV VALUE TO CALCULATE TRIPS:
20.80 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
General Office Building (710) Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
59

Avg. 1000 Sq. Ft. GFA:
163

Average Rate:
10.84

Range of Rates:
3.27 - 27.56

Standard Deviation:
4.76

Fitted Curve Equation:
Ln(T) = 0.87 Ln(X) + 3.05

R^2:
0.78

Directional Distribution:
50% entering, 50% exiting

Calculated Trip Ends:
Average Rate: 225 (Total), 113 (Entry), 112 (Exit)
Fitted Curve: 296 (Total), 148 (Entry), 148 (Exit)

Graph Look Up

ITETripGen Web-based App

- Graph Look Up
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

Add-ons to do more

Try OTISS Pro

Query | Filter

DATA SOURCE:
Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE:
720

LAND USE GROUP:
(700-799) Office

LAND USE :
720 - Medical-Dental Office Building

LAND USE SUBCATEGORY:
Stand-Alone

SETTING/LOCATION:
General Urban/Suburban

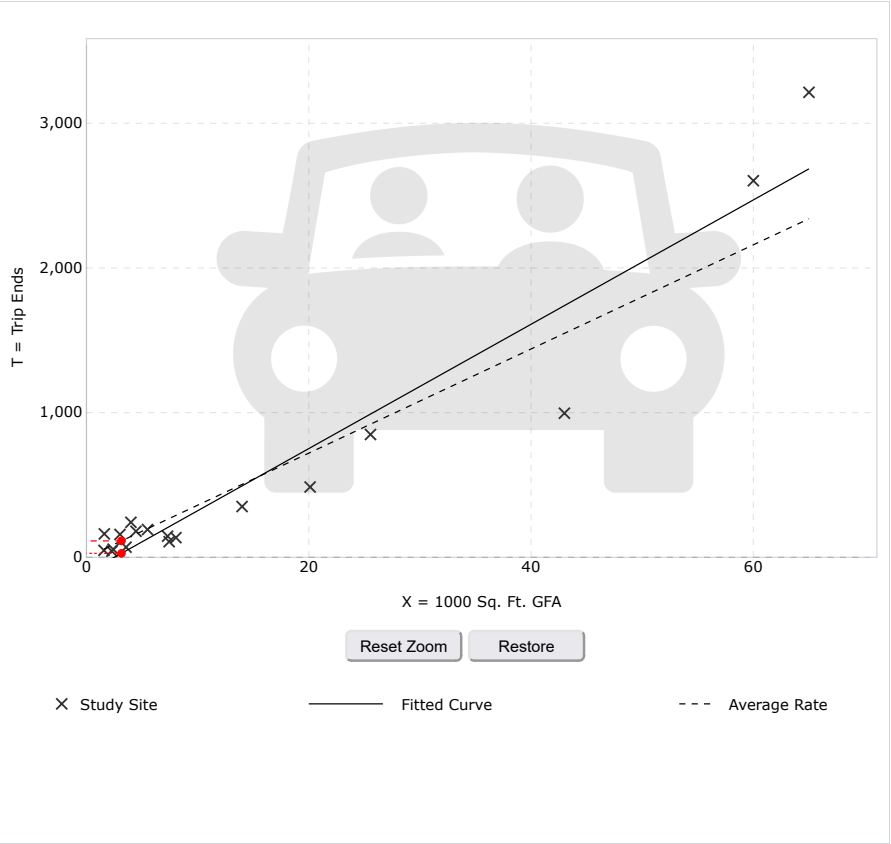
INDEPENDENT VARIABLE (IV):
1000 Sq. Ft. GFA

TIME PERIOD:
Weekday

TRIP TYPE:
Vehicle

ENTER IV VALUE TO CALCULATE TRIPS:
3.15 Calculate

Data Plot and Equation



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Medical-Dental Office Building - Stand-Alone (720)
Click for Description and Data Plots

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
18

Avg. 1000 Sq. Ft. GFA:
15

Average Rate:
36.00

Range of Rates:
14.52 - 100.75

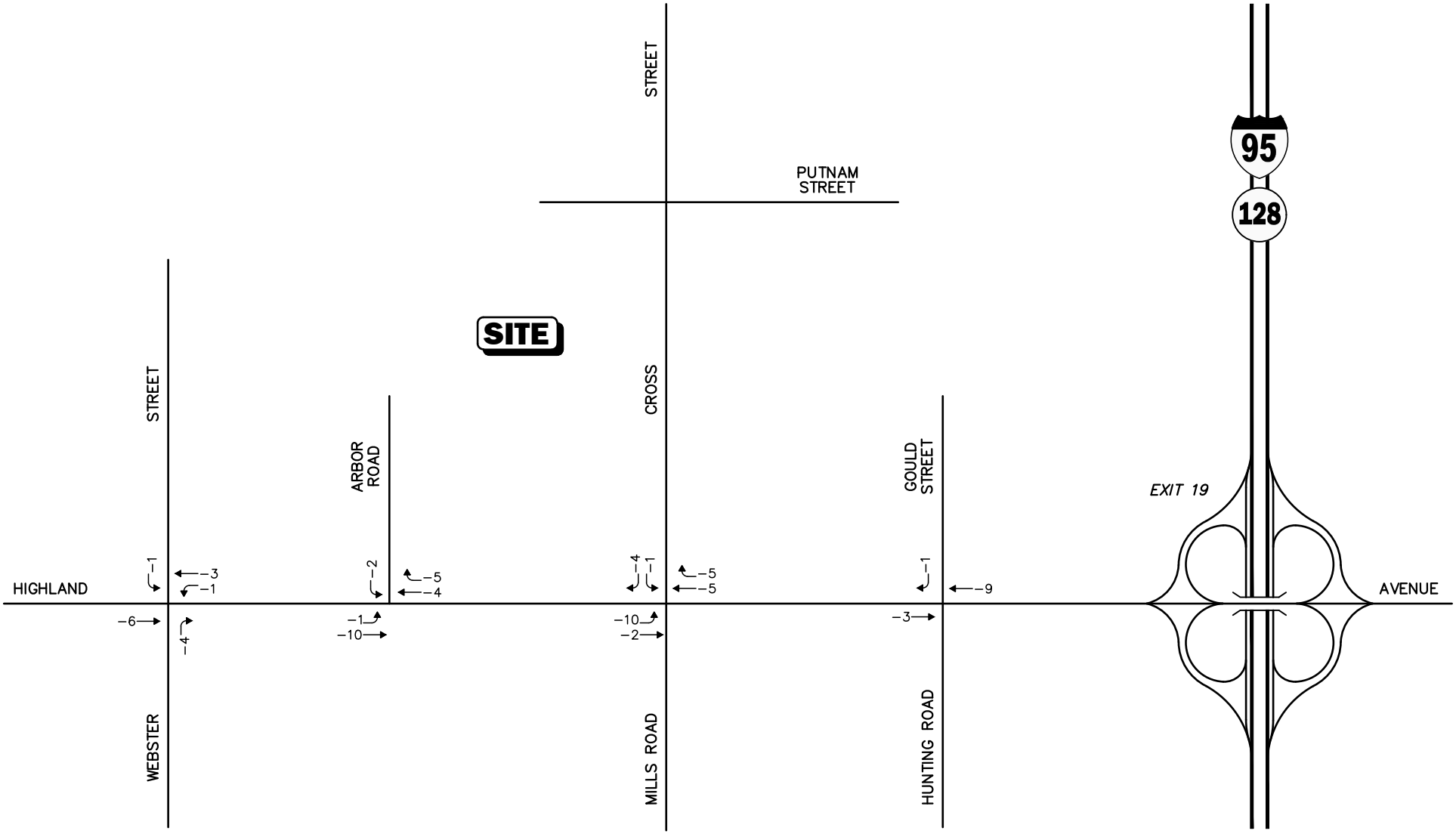
Standard Deviation:
13.38

Fitted Curve Equation:
T = 42.97(X) - 108.01

R^2:
0.92

Directional Distribution:
50% entering, 50% exiting

Calculated Trip Ends:
Average Rate: 113 (Total), 57 (Entry), 56 (Exit)
Fitted Curve: 27 (Total), 14 (Entry), 13 (Exit)



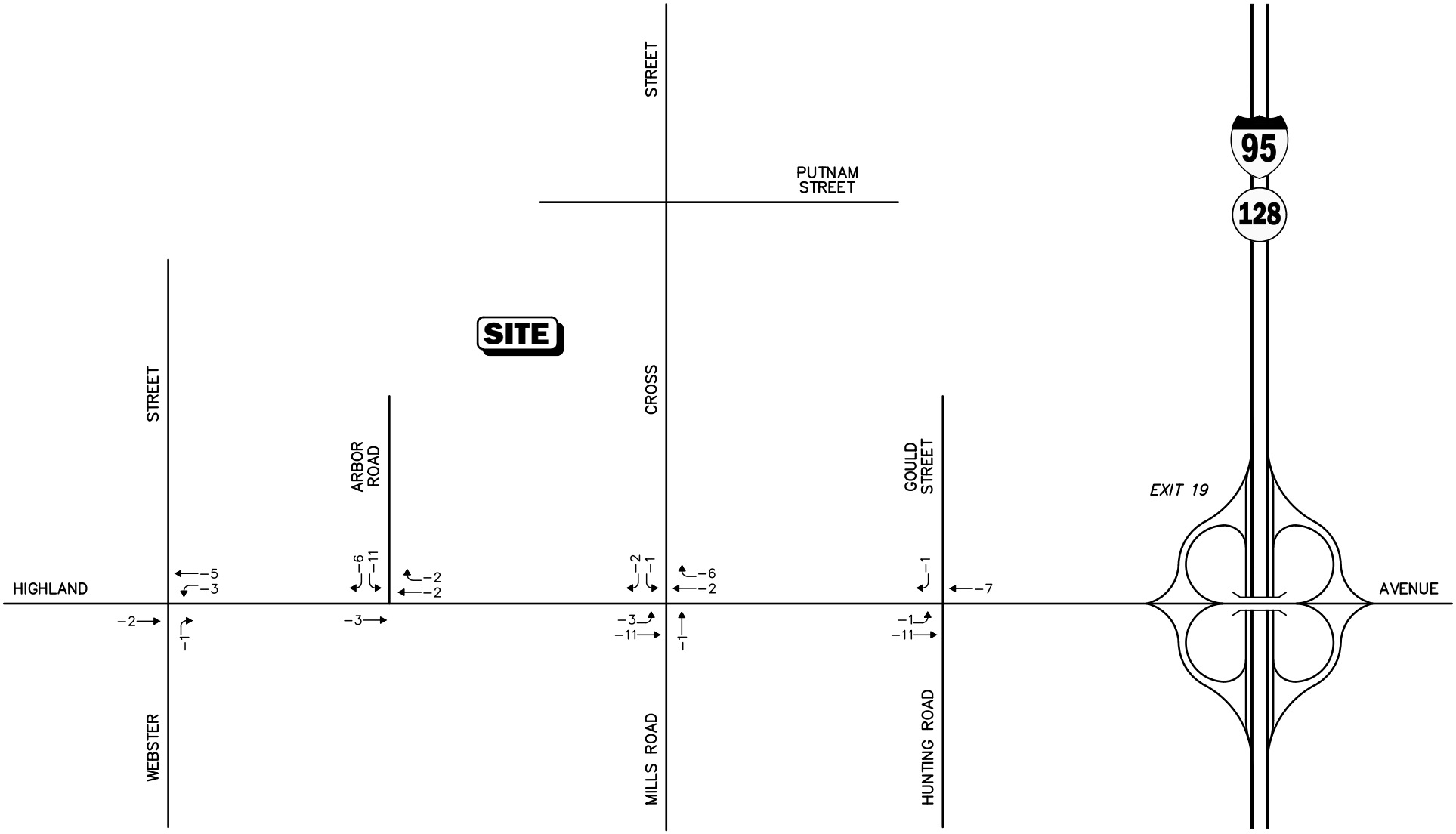
Not To Scale

Figure A-5

Site Trips Removed
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig A-5, 5/28/2023 12:15:14 PM



Not To Scale

Figure A-6

Site Trips Removed
Weekday Evening
Peak Hour Traffic Volumes

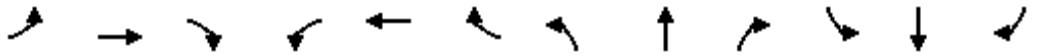
Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig A-6, 5/28/2023 12:14:14 PM

CAPACITY ANALYSIS WORKSHEETS

2023 Existing Weekday Morning Peak-Hour
2023 Existing Weekday Evening Peak-Hour
2030 No-Build Weekday Morning Peak-Hour
2030 No-Build Weekday Evening Peak-Hour
2030 Build Weekday Morning Peak-Hour
2030 Build Weekday Evening Peak-Hour
2030 Mitigated Weekday Morning Peak-Hour
2030 Mitigated Weekday Evening Peak-Hour

2023 Existing Weekday Morning Peak-Hour



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	47	552	27	126	451	52	30	276	387	107	105	35
Future Volume (vph)	47	552	27	126	451	52	30	276	387	107	105	35
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.993			0.985				0.850		0.979	
Flt Protected	0.950			0.950				0.995			0.979	
Satd. Flow (prot)	1687	1851	0	1745	1774	0	0	1795	1531	0	3261	0
Flt Permitted	0.457			0.105				0.942			0.572	
Satd. Flow (perm)	811	1851	0	193	1774	0	0	1700	1531	0	1905	0
Satd. Flow (RTOR)		2			7				338		15	
Adj. Flow (vph)	57	673	33	138	496	57	33	300	421	115	113	38
Lane Group Flow (vph)	57	706	0	138	553	0	0	333	421	0	266	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	37.5	37.5		17.5	55.0		28.5	28.5	17.5	28.5	28.5	
Total Split (%)	33.6%	33.6%		15.7%	49.3%		25.6%	25.6%	15.7%	25.6%	25.6%	
Maximum Green (s)	30.0	30.0		10.0	47.5		22.0	22.0	10.0	22.0	22.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-2.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.18	0.97		0.40	0.53			0.73	0.49		0.51	
Control Delay	23.5	56.3		15.6	15.4			41.5	5.2		31.2	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	23.5	56.3		15.6	15.4			41.5	5.2		31.2	
Queue Length 50th (ft)	19	348		28	146			153	22		56	
Queue Length 95th (ft)	60	#757		106	429			#399	63		132	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	317	726		358	1061			487	878		556	
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	0.97		0.39	0.52			0.68	0.48		0.48	

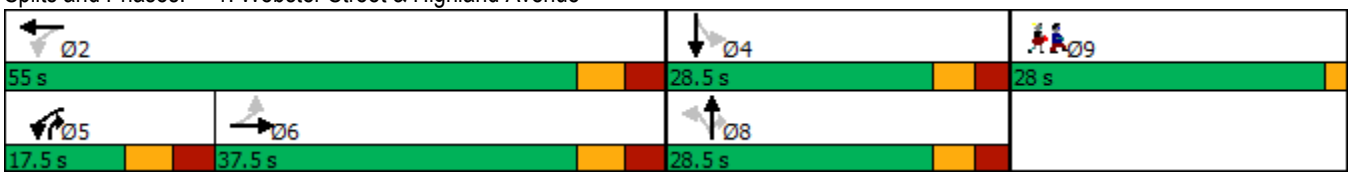
Intersection Summary
Cycle Length: 111.5

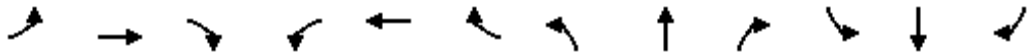
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	25%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	13
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 87
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	47	552	27	126	451	52	30	276	387	107	105	35
Future Volume (vph)	47	552	27	126	451	52	30	276	387	107	105	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		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)	1687	1851		1745	1773			1795	1531		3259	
Flt Permitted	0.46	1.00		0.10	1.00			0.94	1.00		0.57	
Satd. Flow (perm)	812	1851		193	1773			1700	1531		1904	
Peak-hour factor, PHF	0.82	0.82	0.82	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93
Adj. Flow (vph)	57	673	33	138	496	57	33	300	421	115	113	38
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	203	0	11	0
Lane Group Flow (vph)	57	705	0	138	550	0	0	333	218	0	255	0
Heavy Vehicles (%)	7%	2%	0%	0%	2%	2%	0%	2%	2%	2%	2%	6%
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			20.8	30.2		20.8	
Effective Green, g (s)	34.1	34.1		51.0	51.0			23.3	35.2		23.3	
Actuated g/C Ratio	0.39	0.39		0.58	0.58			0.26	0.40		0.26	
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)	313	714		337	1022			448	609		501	
v/s Ratio Prot		c0.38		0.06	c0.31				0.05			
v/s Ratio Perm	0.07			0.18				c0.20	0.09		0.13	
v/c Ratio	0.18	0.99		0.41	0.54			0.74	0.36		0.51	
Uniform Delay, d1	17.9	26.9		15.7	11.5			29.8	18.7		27.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.3	30.1		0.8	0.5			6.6	0.4		0.8	
Delay (s)	18.2	57.1		16.5	12.0			36.4	19.0		28.5	
Level of Service	B	E		B	B			D	B		C	
Approach Delay (s)		54.2			12.9			26.7			28.5	
Approach LOS		D			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	31.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	88.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	1	1028	646	5	2	0
Future Vol, veh/h	1	1028	646	5	2	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	89	89	50	50
Heavy Vehicles, %	0	2	2	0	0	0
Mvmt Flow	1	1094	726	6	4	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	732	0	-	0	1278	366
Stage 1	-	-	-	-	729	-
Stage 2	-	-	-	-	549	-
Critical Hdwy	4.1	-	-	-	6.8	6.9
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	882	-	-	-	161	637
Stage 1	-	-	-	-	444	-
Stage 2	-	-	-	-	548	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	882	-	-	-	161	637
Mov Cap-2 Maneuver	-	-	-	-	161	-
Stage 1	-	-	-	-	443	-
Stage 2	-	-	-	-	548	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	27.9
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	882	-	-	-	161
HCM Lane V/C Ratio	0.001	-	-	-	0.025
HCM Control Delay (s)	9.1	0	-	-	27.9
HCM Lane LOS	A	A	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	11	1010	9	5	638	5	7	0	4	2	0	6
Future Vol, veh/h	11	1010	9	5	638	5	7	0	4	2	0	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	96	96	96	87	87	87	55	55	55	67	67	67
Heavy Vehicles, %	0	2	11	0	2	0	0	0	0	0	0	0
Mvmt Flow	11	1052	9	6	733	6	13	0	7	3	0	9

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	739	0	0	1061	0	0	1458	1830	531	1296	1831	370
Stage 1	-	-	-	-	-	-	1079	1079	-	748	748	-
Stage 2	-	-	-	-	-	-	379	751	-	548	1083	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.5	6.5	6.9	7.5	6.5	6.9
Critical Hdwy Stg 1	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	876	-	-	664	-	-	92	77	498	122	77	633
Stage 1	-	-	-	-	-	-	237	297	-	375	423	-
Stage 2	-	-	-	-	-	-	620	421	-	493	296	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	876	-	-	664	-	-	88	73	498	116	73	633
Mov Cap-2 Maneuver	-	-	-	-	-	-	88	73	-	116	73	-
Stage 1	-	-	-	-	-	-	230	288	-	363	417	-
Stage 2	-	-	-	-	-	-	602	415	-	471	287	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0.2	38.9	17.5
HCM LOS			E	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	126	876	-	-	664	-	-	299
HCM Lane V/C Ratio	0.159	0.013	-	-	0.009	-	-	0.04
HCM Control Delay (s)	38.9	9.2	0.1	-	10.5	0.1	-	17.5
HCM Lane LOS	E	A	A	-	B	A	-	C
HCM 95th %tile Q(veh)	0.5	0	-	-	0	-	-	0.1

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	118	879	18	2	41	583	401	33	220	292	164	53
Future Volume (vph)	118	879	18	2	41	583	401	33	220	292	164	53
Lane Util. Factor	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.95	0.95
Frt		0.997				0.939				0.850		0.959
Flt Protected	0.950				0.950				0.994		0.950	0.985
Satd. Flow (prot)	1668	3445	0	0	1685	3244	0	0	1810	1561	1609	1633
Flt Permitted	0.088				0.170				0.994		0.950	0.985
Satd. Flow (perm)	155	3445	0	0	301	3244	0	0	1810	1561	1609	1633
Satd. Flow (RTOR)		2				163				189		13
Adj. Flow (vph)	131	977	20	2	47	670	461	38	256	340	195	63
Lane Group Flow (vph)	131	997	0	0	49	1131	0	0	294	340	150	148
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	Prot	Split	NA
Protected Phases	1	6			5	2		3	3	3	4	4
Permitted Phases	6			5 2	2							
Detector Phase	1	6		5 2	5	2		3	3	3	4	4
Switch Phase												
Minimum Initial (s)	6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0	6.0
Minimum Split (s)	12.0	21.0			12.0	21.0		12.0	12.0	12.0	30.0	30.0
Total Split (s)	16.0	50.0			26.0	60.0		26.0	26.0	26.0	30.0	30.0
Total Split (%)	12.1%	37.9%			19.7%	45.5%		19.7%	19.7%	19.7%	22.7%	22.7%
Maximum Green (s)	10.0	45.0			20.0	55.0		20.0	20.0	20.0	24.0	24.0
Yellow Time (s)	3.0	4.0			3.0	4.0		3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	3.0	1.0			3.0	1.0		2.5	2.5	2.5	2.5	2.5
Lost Time Adjust (s)	-2.0	-1.0			-2.0	-1.0			-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	None	Min			None	Min		None	None	None	None	None
Walk Time (s)		4.0				4.0					4.0	4.0
Flash Dont Walk (s)		12.0				12.0					20.0	20.0
Pedestrian Calls (#/hr)		1				0					0	0
v/c Ratio	0.57	0.66			0.19	0.82			0.81	0.73	0.58	0.54
Control Delay	29.2	28.6			15.1	31.6			64.3	30.8	54.9	48.8
Queue Delay	0.0	0.0			0.0	0.0			0.0	0.0	0.0	0.0
Total Delay	29.2	28.6			15.1	31.6			64.3	30.8	54.9	48.8
Queue Length 50th (ft)	46	303			16	331			209	105	108	96
Queue Length 95th (ft)	116	430			38	437			#406	#246	180	167
Internal Link Dist (ft)		411				548			225			114
Turn Bay Length (ft)	115				190					100	80	
Base Capacity (vph)	245	1562			436	1730			361	463	379	395
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	0.53	0.64			0.11	0.65			0.81	0.73	0.40	0.37

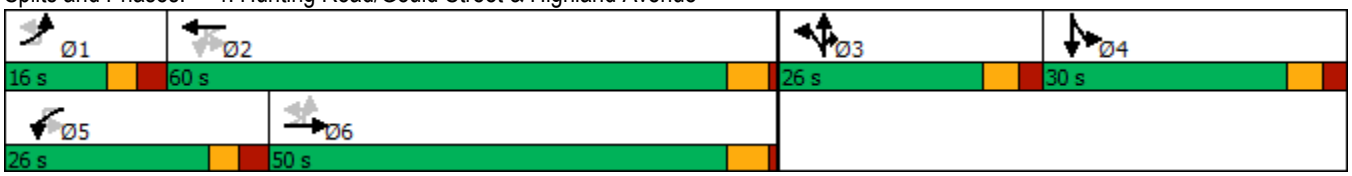
Intersection Summary
Cycle Length: 132

Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	34
Future Volume (vph)	34
Lane Util. Factor	1.00
Frt	
Flt Protected	
Satd. Flow (prot)	0
Flt Permitted	
Satd. Flow (perm)	0
Satd. Flow (RTOR)	
Adj. Flow (vph)	40
Lane Group Flow (vph)	0
Turn Type	
Protected Phases	
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	
Minimum Split (s)	
Total Split (s)	
Total Split (%)	
Maximum Green (s)	
Yellow Time (s)	
All-Red Time (s)	
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	
Recall Mode	
Walk Time (s)	
Flash Dont Walk (s)	
Pedestrian Calls (#/hr)	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 112.3
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue



Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	118	879	18	2	41	583	401	33	220	292	164	53
Future Volume (vph)	118	879	18	2	41	583	401	33	220	292	164	53
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	11	10	10	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			1.00	0.95			1.00	1.00	0.95	0.95
Frt	1.00	1.00			1.00	0.94			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)	1668	3445			1685	3244			1809	1561	1609	1634
Flt Permitted	0.09	1.00			0.17	1.00			0.99	1.00	0.95	0.99
Satd. Flow (perm)	154	3445			302	3244			1809	1561	1609	1634
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.84	0.84
Adj. Flow (vph)	131	977	20	2	47	670	461	38	256	340	195	63
RTOR Reduction (vph)	0	1	0	0	0	97	0	0	0	152	0	11
Lane Group Flow (vph)	131	996	0	0	49	1034	0	0	294	188	150	137
Heavy Vehicles (%)	1%	1%	0%	0%	0%	1%	1%	0%	1%	0%	3%	0%
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	Prot	Split	NA
Protected Phases	1	6			5	2		3	3	3	4	4
Permitted Phases	6			5 2	2							
Actuated Green, G (s)	57.3	48.2			50.7	44.9			20.4	20.4	16.0	16.0
Effective Green, g (s)	61.3	49.2			54.7	45.9			22.4	22.4	18.0	18.0
Actuated g/C Ratio	0.54	0.43			0.48	0.40			0.20	0.20	0.16	0.16
Clearance Time (s)	6.0	5.0			6.0	5.0			6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	231	1494			240	1313			357	308	255	259
v/s Ratio Prot	c0.06	0.29			0.01	c0.32			c0.16	0.12	c0.09	0.08
v/s Ratio Perm	0.25				0.08							
v/c Ratio	0.57	0.67			0.20	0.79			0.82	0.61	0.59	0.53
Uniform Delay, d1	19.7	25.6			17.4	29.5			43.6	41.5	44.3	43.8
Progression Factor	1.00	1.00			1.00	1.00			1.00	1.00	1.00	1.00
Incremental Delay, d2	3.2	1.1			0.4	3.2			14.2	3.6	3.4	2.0
Delay (s)	22.8	26.7			17.9	32.7			57.8	45.1	47.7	45.8
Level of Service	C	C			B	C			E	D	D	D
Approach Delay (s)		26.3				32.1			51.0			46.7
Approach LOS		C				C			D			D

Intersection Summary			
HCM 2000 Control Delay	35.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	113.4	Sum of lost time (s)	18.0
Intersection Capacity Utilization	69.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	34
Future Volume (vph)	34
Ideal Flow (vphpl)	1900
Lane Width	11
Total Lost time (s)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.84
Adj. Flow (vph)	40
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Heavy Vehicles (%)	0%
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	
Intersection Summary	

Intersection	
Int Delay, s/veh	5.2

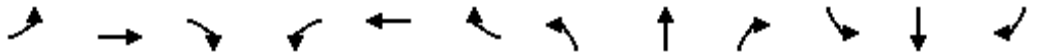
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	0	0	3	0	0	0	0	1	0	0	0
Future Vol, veh/h	0	0	0	3	0	0	0	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	38	38	38	25	25	25	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	0	0	8	0	0	0	0	4	0	0	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	3	5	1	3	3	2	1	0	0	4	0	0
Stage 1	1	1	-	2	2	-	-	-	-	-	-	-
Stage 2	2	4	-	1	1	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Mov Cap-2 Maneuver	1024	894	-	1024	897	-	-	-	-	-	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	8.5	0	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1635	-	-	-	1024	1631	-	-
HCM Lane V/C Ratio	-	-	-	-	0.008	-	-	-
HCM Control Delay (s)	0	-	-	0	8.5	0	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	0	0	-	-

2023 Existing Weekday Evening Peak-Hour



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	37	410	17	333	636	70	22	175	150	76	245	53
Future Volume (vph)	37	410	17	333	636	70	22	175	150	76	245	53
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.994			0.985				0.850		0.979	
Flt Protected	0.950			0.950				0.994			0.990	
Satd. Flow (prot)	1805	1871	0	1745	1809	0	0	1826	1561	0	3363	0
Flt Permitted	0.378			0.175				0.912			0.710	
Satd. Flow (perm)	718	1871	0	321	1809	0	0	1675	1561	0	2412	0
Satd. Flow (RTOR)		2			6				192		14	
Adj. Flow (vph)	42	466	19	347	663	73	28	224	192	94	302	65
Lane Group Flow (vph)	42	485	0	347	736	0	0	252	192	0	461	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	37.5	37.5		22.5	60.0		31.5	31.5	22.5	31.5	31.5	
Total Split (%)	31.4%	31.4%		18.8%	50.2%		26.4%	26.4%	18.8%	26.4%	26.4%	
Maximum Green (s)	30.0	30.0		15.0	52.5		25.0	25.0	15.0	25.0	25.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-3.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.17	0.76		0.73	0.69			0.55	0.21		0.68	
Control Delay	27.5	37.7		26.2	20.1			36.2	2.3		36.9	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	27.5	37.7		26.2	20.1			36.2	2.3		36.9	
Queue Length 50th (ft)	16	235		97	251			120	0		116	
Queue Length 95th (ft)	56	#545		#366	#733			226	14		207	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	264	689		478	1113			505	898		737	
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	0.16	0.70		0.73	0.66			0.50	0.21		0.63	

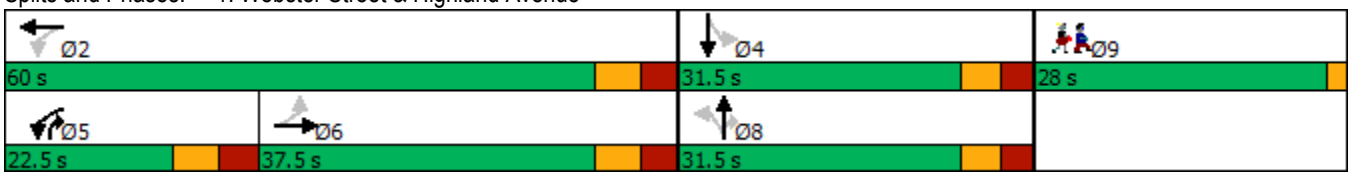
Intersection Summary
Cycle Length: 119.5

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	23%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	9
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 93.1
Natural Cycle: 110
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	37	410	17	333	636	70	22	175	150	76	245	53
Future Volume (vph)	37	410	17	333	636	70	22	175	150	76	245	53
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		1.00	0.99			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)	1805	1871		1745	1809			1827	1561		3362	
Flt Permitted	0.38	1.00		0.18	1.00			0.91	1.00		0.71	
Satd. Flow (perm)	718	1871		322	1809			1675	1561		2411	
Peak-hour factor, PHF	0.88	0.88	0.88	0.96	0.96	0.96	0.78	0.78	0.78	0.81	0.81	0.81
Adj. Flow (vph)	42	466	19	347	662	73	28	224	192	94	302	65
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	100	0	10	0
Lane Group Flow (vph)	42	484	0	347	733	0	0	252	92	0	451	0
Heavy Vehicles (%)	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%
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)	28.5	28.5		51.3	51.3			23.1	38.4		23.1	
Effective Green, g (s)	32.0	32.0		54.8	54.8			25.6	45.4		25.6	
Actuated g/C Ratio	0.34	0.34		0.58	0.58			0.27	0.48		0.27	
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)	243	633		469	1049			453	749		653	
v/s Ratio Prot		0.26		0.15	c0.41				0.02			
v/s Ratio Perm	0.06			c0.28				0.15	0.03		c0.19	
v/c Ratio	0.17	0.76		0.74	0.70			0.56	0.12		0.69	
Uniform Delay, d1	22.0	27.9		16.4	14.0			29.6	13.6		30.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.3	5.5		6.0	2.1			1.5	0.1		3.1	
Delay (s)	22.3	33.3		22.4	16.1			31.1	13.6		34.0	
Level of Service	C	C		C	B			C	B		C	
Approach Delay (s)		32.5			18.1			23.5			34.0	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	25.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	94.5	Sum of lost time (s)	14.0
Intersection Capacity Utilization	80.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	651	1064	2	11	6
Future Vol, veh/h	0	651	1064	2	11	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	96	96	98	98	85	85
Heavy Vehicles, %	0	1	0	0	0	0
Mvmt Flow	0	678	1086	2	13	7

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1088	0	-	0	1426	544
Stage 1	-	-	-	-	1087	-
Stage 2	-	-	-	-	339	-
Critical Hdwy	4.1	-	-	-	6.8	6.9
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	649	-	-	-	129	488
Stage 1	-	-	-	-	289	-
Stage 2	-	-	-	-	699	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	649	-	-	-	129	488
Mov Cap-2 Maneuver	-	-	-	-	129	-
Stage 1	-	-	-	-	289	-
Stage 2	-	-	-	-	699	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	28.4
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	649	-	-	-	174
HCM Lane V/C Ratio	-	-	-	-	0.115
HCM Control Delay (s)	0	-	-	-	28.4
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.4

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	649	3	12	1054	7	7	1	8	2	0	5
Future Vol, veh/h	10	649	3	12	1054	7	7	1	8	2	0	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	96	96	96	96	96	96	80	80	80	58	58	58
Heavy Vehicles, %	0	1	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	10	676	3	13	1098	7	9	1	10	3	0	9

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1105	0	0	679	0	0	1273	1829	340	1487	1827	553
Stage 1	-	-	-	-	-	-	698	698	-	1128	1128	-
Stage 2	-	-	-	-	-	-	575	1131	-	359	699	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.5	6.5	6.9	7.5	6.5	6.9
Critical Hdwy Stg 1	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	639	-	-	923	-	-	126	77	662	88	78	482
Stage 1	-	-	-	-	-	-	402	445	-	221	282	-
Stage 2	-	-	-	-	-	-	475	281	-	637	445	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	639	-	-	923	-	-	118	72	662	82	73	482
Mov Cap-2 Maneuver	-	-	-	-	-	-	118	72	-	82	73	-
Stage 1	-	-	-	-	-	-	392	434	-	215	272	-
Stage 2	-	-	-	-	-	-	449	271	-	610	434	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0.3	26.4	24.1
HCM LOS			D	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	188	639	-	-	923	-	-	201
HCM Lane V/C Ratio	0.106	0.016	-	-	0.014	-	-	0.06
HCM Control Delay (s)	26.4	10.7	0.1	-	9	0.2	-	24.1
HCM Lane LOS	D	B	A	-	A	A	-	C
HCM 95th %tile Q(veh)	0.4	0.1	-	-	0	-	-	0.2

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	42	590	25	5	193	955	193	36	73	88	340
Future Volume (vph)	1	42	590	25	5	193	955	193	36	73	88	340
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.95
Frt			0.994				0.975				0.850	
Flt Protected		0.950				0.950				0.984		0.950
Satd. Flow (prot)	0	1685	3469	0	0	1685	3397	0	0	1807	1561	1641
Flt Permitted		0.103				0.236				0.984		0.950
Satd. Flow (perm)	0	183	3469	0	0	419	3397	0	0	1807	1561	1641
Satd. Flow (RTOR)			3				21				164	
Adj. Flow (vph)	1	45	628	27	5	197	974	197	40	80	97	386
Lane Group Flow (vph)	0	46	655	0	0	202	1171	0	0	120	97	324
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	Prot	Split
Protected Phases		1	6			5	2		3	3	3	4
Permitted Phases	1 6	6			5 2	2						
Detector Phase	1 6	1	6		5 2	5	2		3	3	3	4
Switch Phase												
Minimum Initial (s)		6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0
Minimum Split (s)		12.0	21.0			12.0	21.0		12.0	12.0	12.0	30.0
Total Split (s)		16.0	45.0			26.0	55.0		26.0	26.0	26.0	36.0
Total Split (%)		12.0%	33.8%			19.5%	41.4%		19.5%	19.5%	19.5%	27.1%
Maximum Green (s)		10.0	40.0			20.0	50.0		20.0	20.0	20.0	30.0
Yellow Time (s)		3.0	4.0			3.0	4.0		3.5	3.5	3.5	3.5
All-Red Time (s)		3.0	1.0			3.0	1.0		2.5	2.5	2.5	2.5
Lost Time Adjust (s)		-2.0	-1.0			-2.0	-1.0			-2.0	-2.0	-2.0
Total Lost Time (s)		4.0	4.0			4.0	4.0			4.0	4.0	4.0
Lead/Lag		Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag
Lead-Lag Optimize?		Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes
Vehicle Extension (s)		3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0
Recall Mode		None	Min			None	Min		None	None	None	None
Walk Time (s)			4.0				4.0					4.0
Flash Dont Walk (s)			12.0				12.0					20.0
Pedestrian Calls (#/hr)			0				0					1
v/c Ratio		0.23	0.58			0.52	0.83			0.49	0.27	0.78
Control Delay		19.4	35.0			21.8	37.0			56.4	1.9	56.4
Queue Delay		0.0	0.0			0.0	0.0			0.0	0.0	0.0
Total Delay		19.4	35.0			21.8	37.0			56.4	1.9	56.4
Queue Length 50th (ft)		18	214			85	426			91	0	252
Queue Length 95th (ft)		41	314			145	576			156	0	#413
Internal Link Dist (ft)			411				548			225		
Turn Bay Length (ft)		115				190					100	80
Base Capacity (vph)		245	1343			466	1608			366	447	483
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		0.19	0.49			0.43	0.73			0.33	0.22	0.67

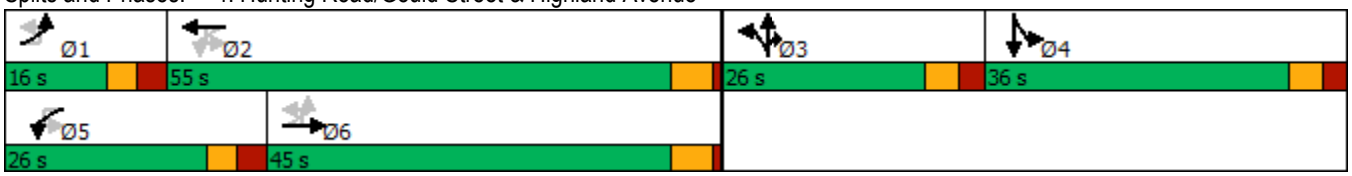
Intersection Summary
Cycle Length: 133

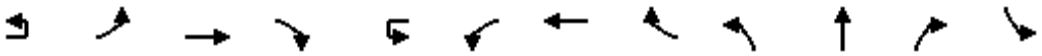
Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	152	75
Future Volume (vph)	152	75
Lane Util. Factor	0.95	1.00
Frt	0.960	
Flt Protected	0.990	
Satd. Flow (prot)	1655	0
Flt Permitted	0.990	
Satd. Flow (perm)	1655	0
Satd. Flow (RTOR)	13	
Adj. Flow (vph)	173	85
Lane Group Flow (vph)	320	0
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Detector Phase	4	
Switch Phase		
Minimum Initial (s)	6.0	
Minimum Split (s)	30.0	
Total Split (s)	36.0	
Total Split (%)	27.1%	
Maximum Green (s)	30.0	
Yellow Time (s)	3.5	
All-Red Time (s)	2.5	
Lost Time Adjust (s)	-2.0	
Total Lost Time (s)	4.0	
Lead/Lag	Lag	
Lead-Lag Optimize?	Yes	
Vehicle Extension (s)	3.0	
Recall Mode	None	
Walk Time (s)	4.0	
Flash Dont Walk (s)	20.0	
Pedestrian Calls (#/hr)	1	
v/c Ratio	0.75	
Control Delay	52.0	
Queue Delay	0.0	
Total Delay	52.0	
Queue Length 50th (ft)	237	
Queue Length 95th (ft)	#373	
Internal Link Dist (ft)	114	
Turn Bay Length (ft)		
Base Capacity (vph)	497	
Starvation Cap Reductn	0	
Spillback Cap Reductn	0	
Storage Cap Reductn	0	
Reduced v/c Ratio	0.64	

Intersection Summary

Actuated Cycle Length: 113.5
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue





Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	42	590	25	5	193	955	193	36	73	88	340
Future Volume (vph)	1	42	590	25	5	193	955	193	36	73	88	340
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	10	11	11	10	10	11	11	11	11	11	11
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			1.00	0.95			1.00	1.00	0.95
Frt		1.00	0.99			1.00	0.97			1.00	0.85	1.00
Flt Protected		0.95	1.00			0.95	1.00			0.98	1.00	0.95
Satd. Flow (prot)		1685	3468			1685	3396			1807	1561	1641
Flt Permitted		0.10	1.00			0.24	1.00			0.98	1.00	0.95
Satd. Flow (perm)		182	3468			418	3396			1807	1561	1641
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.98	0.98	0.98	0.98	0.91	0.91	0.91	0.88
Adj. Flow (vph)	1	45	628	27	5	197	974	197	40	80	97	386
RTOR Reduction (vph)	0	0	2	0	0	0	12	0	0	0	84	0
Lane Group Flow (vph)	0	46	653	0	0	202	1159	0	0	120	13	324
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	Prot	Split
Protected Phases		1	6			5	2		3	3	3	4
Permitted Phases	1 6	6			5 2	2						
Actuated Green, G (s)		42.9	37.3			57.4	45.8			13.3	13.3	26.5
Effective Green, g (s)		46.9	38.3			59.4	46.8			15.3	15.3	28.5
Actuated g/C Ratio		0.41	0.34			0.52	0.41			0.13	0.13	0.25
Clearance Time (s)		6.0	5.0			6.0	5.0			6.0	6.0	6.0
Vehicle Extension (s)		3.0	3.0			3.0	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)		174	1163			396	1391			242	209	409
v/s Ratio Prot		0.02	0.19			c0.07	c0.34			c0.07	0.01	c0.20
v/s Ratio Perm		0.09				0.19						
v/c Ratio		0.26	0.56			0.51	0.83			0.50	0.06	0.79
Uniform Delay, d1		22.9	31.1			16.9	30.2			45.9	43.2	40.1
Progression Factor		1.00	1.00			1.00	1.00			1.00	1.00	1.00
Incremental Delay, d2		0.8	0.6			1.1	4.4			1.6	0.1	10.1
Delay (s)		23.7	31.7			18.0	34.6			47.5	43.3	50.2
Level of Service		C	C			B	C			D	D	D
Approach Delay (s)			31.2				32.2			45.6		
Approach LOS			C				C			D		

Intersection Summary			
HCM 2000 Control Delay	36.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	114.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	72.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	152	75
Future Volume (vph)	152	75
Ideal Flow (vphpl)	1900	1900
Lane Width	11	11
Total Lost time (s)	4.0	
Lane Util. Factor	0.95	
Frt	0.96	
Flt Protected	0.99	
Satd. Flow (prot)	1656	
Flt Permitted	0.99	
Satd. Flow (perm)	1656	
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	173	85
RTOR Reduction (vph)	10	0
Lane Group Flow (vph)	310	0
Heavy Vehicles (%)	0%	0%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	26.5	
Effective Green, g (s)	28.5	
Actuated g/C Ratio	0.25	
Clearance Time (s)	6.0	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	413	
v/s Ratio Prot	0.19	
v/s Ratio Perm		
v/c Ratio	0.75	
Uniform Delay, d1	39.6	
Progression Factor	1.00	
Incremental Delay, d2	7.5	
Delay (s)	47.1	
Level of Service	D	
Approach Delay (s)	48.6	
Approach LOS	D	

Intersection Summary

Intersection	
Int Delay, s/veh	3.7

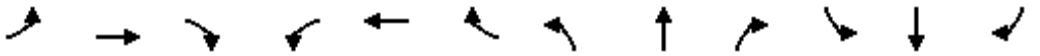
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	0	0	4	0	0	0	0	1	0	0	0
Future Vol, veh/h	0	0	0	4	0	0	0	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	100	100	100	25	25	25	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	0	0	4	0	0	0	0	4	0	0	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	3	5	1	3	3	2	1	0	0	4	0	0
Stage 1	1	1	-	2	2	-	-	-	-	-	-	-
Stage 2	2	4	-	1	1	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Mov Cap-2 Maneuver	1024	894	-	1024	897	-	-	-	-	-	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	8.5	0	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1635	-	-	-	1024	1631	-	-
HCM Lane V/C Ratio	-	-	-	-	0.004	-	-	-
HCM Control Delay (s)	0	-	-	0	8.5	0	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	0	0	-	-

2030 No-Build Weekday Morning Peak-Hour



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	664	29	135	497	56	32	296	415	115	113	38
Future Volume (vph)	50	664	29	135	497	56	32	296	415	115	113	38
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.994			0.985				0.850		0.979	
Flt Protected	0.950			0.950				0.995			0.979	
Satd. Flow (prot)	1687	1853	0	1745	1774	0	0	1795	1531	0	3261	0
Flt Permitted	0.435			0.105				0.940			0.559	
Satd. Flow (perm)	772	1853	0	193	1774	0	0	1696	1531	0	1862	0
Satd. Flow (RTOR)		2			7				337		15	
Adj. Flow (vph)	61	810	35	148	546	62	35	322	451	124	122	41
Lane Group Flow (vph)	61	845	0	148	608	0	0	357	451	0	287	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	37.5	37.5		17.5	55.0		28.5	28.5	17.5	28.5	28.5	
Total Split (%)	33.6%	33.6%		15.7%	49.3%		25.6%	25.6%	15.7%	25.6%	25.6%	
Maximum Green (s)	30.0	30.0		10.0	47.5		22.0	22.0	10.0	22.0	22.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-2.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.21	1.18		0.44	0.59			0.76	0.51		0.54	
Control Delay	24.1	123.6		16.7	17.0			42.7	6.1		32.1	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	24.1	123.6		16.7	17.0			42.7	6.1		32.1	
Queue Length 50th (ft)	20	~524		30	168			167	31		62	
Queue Length 95th (ft)	64	#960		116	492			#440	80		145	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	297	715		352	1043			477	885		535	
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	1.18		0.42	0.58			0.75	0.51		0.54	

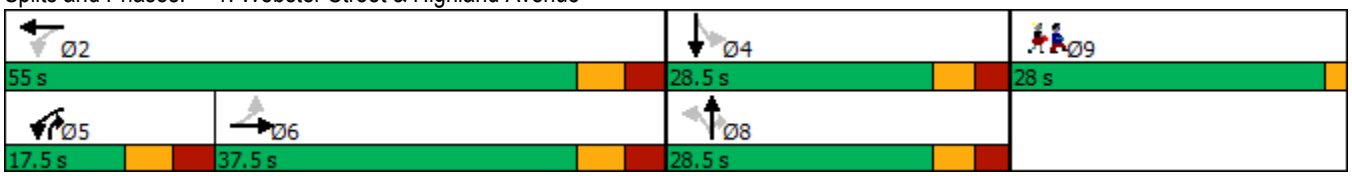
Intersection Summary
Cycle Length: 111.5

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	25%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	13
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 88.2
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	664	29	135	497	56	32	296	415	115	113	38
Future Volume (vph)	50	664	29	135	497	56	32	296	415	115	113	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		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)	1687	1853		1745	1773			1795	1531		3259	
Flt Permitted	0.43	1.00		0.11	1.00			0.94	1.00		0.56	
Satd. Flow (perm)	772	1853		193	1773			1695	1531		1862	
Peak-hour factor, PHF	0.82	0.82	0.82	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93
Adj. Flow (vph)	61	810	35	148	546	62	35	322	451	124	122	41
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	199	0	11	0
Lane Group Flow (vph)	61	844	0	148	605	0	0	357	252	0	276	0
Heavy Vehicles (%)	7%	2%	0%	0%	2%	2%	0%	2%	2%	2%	2%	6%
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)	30.5	30.5		47.5	47.5			22.1	31.6		22.1	
Effective Green, g (s)	34.0	34.0		51.0	51.0			24.6	36.6		24.6	
Actuated g/C Ratio	0.38	0.38		0.57	0.57			0.27	0.41		0.27	
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)	292	702		334	1008			464	624		510	
v/s Ratio Prot		c0.46		0.06	c0.34				0.05			
v/s Ratio Perm	0.08			0.19				c0.21	0.11		0.15	
v/c Ratio	0.21	1.20		0.44	0.60			0.77	0.40		0.54	
Uniform Delay, d1	18.8	27.9		16.1	12.7			29.9	18.8		27.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.4	104.2		0.9	1.0			7.5	0.4		1.2	
Delay (s)	19.1	132.0		17.1	13.7			37.5	19.2		28.9	
Level of Service	B	F		B	B			D	B		C	
Approach Delay (s)		124.4			14.3			27.3			28.9	
Approach LOS		F			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	55.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	89.7	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	1	1174	706	5	2	0
Future Vol, veh/h	1	1174	706	5	2	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	89	89	50	50
Heavy Vehicles, %	0	2	2	0	0	0
Mvmt Flow	1	1249	793	6	4	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	799	0	-	0	1423	400
Stage 1	-	-	-	-	796	-
Stage 2	-	-	-	-	627	-
Critical Hdwy	4.1	-	-	-	6.8	6.9
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	833	-	-	-	129	605
Stage 1	-	-	-	-	410	-
Stage 2	-	-	-	-	500	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	833	-	-	-	128	605
Mov Cap-2 Maneuver	-	-	-	-	128	-
Stage 1	-	-	-	-	408	-
Stage 2	-	-	-	-	500	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	34
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	833	-	-	-	128
HCM Lane V/C Ratio	0.001	-	-	-	0.031
HCM Control Delay (s)	9.3	0	-	-	34
HCM Lane LOS	A	A	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	11	1155	10	5	697	5	8	0	4	2	0	6
Future Vol, veh/h	11	1155	10	5	697	5	8	0	4	2	0	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	96	96	96	87	87	87	55	55	55	67	67	67
Heavy Vehicles, %	0	2	11	0	2	0	0	0	0	0	0	0
Mvmt Flow	11	1203	10	6	801	6	15	0	7	3	0	9

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	807	0	0	1213	0	0	1643	2049	607	1440	2051	404
Stage 1	-	-	-	-	-	-	1230	1230	-	816	816	-
Stage 2	-	-	-	-	-	-	413	819	-	624	1235	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.5	6.5	6.9	7.5	6.5	6.9
Critical Hdwy Stg 1	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	827	-	-	582	-	-	67	56	444	95	56	602
Stage 1	-	-	-	-	-	-	191	252	-	341	393	-
Stage 2	-	-	-	-	-	-	592	392	-	445	251	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	827	-	-	582	-	-	63	53	444	89	53	602
Mov Cap-2 Maneuver	-	-	-	-	-	-	63	53	-	89	53	-
Stage 1	-	-	-	-	-	-	183	242	-	327	386	-
Stage 2	-	-	-	-	-	-	572	385	-	420	241	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0.2	58.9	20.3
HCM LOS			F	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	88	827	-	-	582	-	-	247
HCM Lane V/C Ratio	0.248	0.014	-	-	0.01	-	-	0.048
HCM Control Delay (s)	58.9	9.4	0.2	-	11.2	0.1	-	20.3
HCM Lane LOS	F	A	A	-	B	A	-	C
HCM 95th %tile Q(veh)	0.9	0	-	-	0	-	-	0.2

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	179	692	19	2	44	631	796	35	257	313	225	60
Future Volume (vph)	179	692	19	2	44	631	796	35	257	313	225	60
Lane Util. Factor	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.97	1.00
Frt		0.996				0.916				0.850		
Flt Protected	0.950				0.950				0.994		0.950	
Satd. Flow (prot)	1668	3442	0	0	1685	3165	0	0	1810	1561	3286	1837
Flt Permitted	0.088				0.217				0.994		0.950	
Satd. Flow (perm)	155	3442	0	0	385	3165	0	0	1810	1561	3286	1837
Satd. Flow (RTOR)		3				311				132		
Adj. Flow (vph)	199	769	21	2	51	725	915	41	299	364	268	71
Lane Group Flow (vph)	199	790	0	0	53	1640	0	0	340	364	268	71
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split	NA
Protected Phases	1	6			5	2		3	3	5!	4	4
Permitted Phases	6			5 2!	2					3		
Detector Phase	1	6		5 2	5	2		3	3	5	4	4
Switch Phase												
Minimum Initial (s)	6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0	6.0
Minimum Split (s)	14.0	23.0			14.0	23.0		14.0	14.0	14.0	32.0	32.0
Total Split (s)	14.0	48.0			17.0	51.0		23.0	23.0	17.0	32.0	32.0
Total Split (%)	11.7%	40.0%			14.2%	42.5%		19.2%	19.2%	14.2%	26.7%	26.7%
Maximum Green (s)	6.0	41.0			9.0	44.0		15.0	15.0	9.0	24.0	24.0
Yellow Time (s)	6.0	5.0			6.0	5.0		6.0	6.0	6.0	6.0	6.0
All-Red Time (s)	2.0	2.0			2.0	2.0		2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-4.0	-3.0			-4.0	-3.0			-4.0	-4.0	-4.0	-4.0
Total Lost Time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	None	Min			None	Min		None	None	None	None	None
Walk Time (s)		4.0				4.0					4.0	4.0
Flash Dont Walk (s)		12.0				12.0					20.0	20.0
Pedestrian Calls (#/hr)		1				0					0	0
v/c Ratio	0.93	0.57			0.15	1.08			1.09	0.67	0.49	0.23
Control Delay	75.9	28.1			13.4	72.8			122.5	19.0	44.6	41.4
Queue Delay	0.0	0.0			0.0	0.0			0.0	0.0	0.0	0.0
Total Delay	75.9	28.1			13.4	72.8			122.5	19.0	44.6	41.4
Queue Length 50th (ft)	94	224			16	~610			~272	89	89	44
Queue Length 95th (ft)	#256	309			37	#751			#447	143	121	79
Internal Link Dist (ft)		411				548			225			114
Turn Bay Length (ft)	115				190					100	80	
Base Capacity (vph)	213	1384			361	1524			311	545	831	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	0.93	0.57			0.15	1.08			1.09	0.67	0.32	0.15

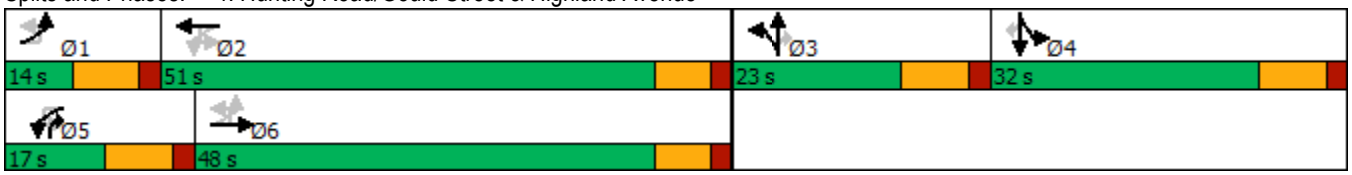
Intersection Summary
Cycle Length: 120

Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	43
Future Volume (vph)	43
Lane Util. Factor	1.00
Frt	0.850
Flt Protected	
Satd. Flow (prot)	1561
Flt Permitted	
Satd. Flow (perm)	1561
Satd. Flow (RTOR)	182
Adj. Flow (vph)	51
Lane Group Flow (vph)	51
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Detector Phase	4
Switch Phase	
Minimum Initial (s)	6.0
Minimum Split (s)	32.0
Total Split (s)	32.0
Total Split (%)	26.7%
Maximum Green (s)	24.0
Yellow Time (s)	6.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	-4.0
Total Lost Time (s)	4.0
Lead/Lag	Lag
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	4.0
Flash Dont Walk (s)	20.0
Pedestrian Calls (#/hr)	0
v/c Ratio	0.12
Control Delay	0.6
Queue Delay	0.0
Total Delay	0.6
Queue Length 50th (ft)	0
Queue Length 95th (ft)	0
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	531
Starvation Cap Reductn	0
Spillback Cap Reductn	0
Storage Cap Reductn	0
Reduced v/c Ratio	0.10

Intersection Summary

Actuated Cycle Length: 110.7
Natural Cycle: 145
Control Type: Actuated-Uncoordinated
~ 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.
! Phase conflict between lane groups.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue



Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	179	692	19	2	44	631	796	35	257	313	225	60
Future Volume (vph)	179	692	19	2	44	631	796	35	257	313	225	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	11	10	10	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			1.00	0.95			1.00	1.00	0.97	1.00
Frt	1.00	1.00			1.00	0.92			1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00			0.95	1.00			0.99	1.00	0.95	1.00
Satd. Flow (prot)	1668	3442			1685	3166			1810	1561	3286	1837
Flt Permitted	0.09	1.00			0.22	1.00			0.99	1.00	0.95	1.00
Satd. Flow (perm)	154	3442			385	3166			1810	1561	3286	1837
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.84	0.84
Adj. Flow (vph)	199	769	21	2	51	725	915	41	299	364	268	71
RTOR Reduction (vph)	0	2	0	0	0	179	0	0	0	94	0	0
Lane Group Flow (vph)	199	788	0	0	53	1461	0	0	340	270	268	71
Heavy Vehicles (%)	1%	1%	0%	0%	0%	1%	1%	0%	1%	0%	3%	0%
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split	NA
Protected Phases	1	6			5	2		3	3	5!	4	4
Permitted Phases	6			5 2!	2					3		
Actuated Green, G (s)	47.5	41.5			52.7	44.1			15.0	23.6	14.6	14.6
Effective Green, g (s)	55.5	44.5			60.7	47.1			19.0	31.6	18.6	18.6
Actuated g/C Ratio	0.50	0.40			0.55	0.43			0.17	0.29	0.17	0.17
Clearance Time (s)	8.0	7.0			8.0	7.0			8.0	8.0	8.0	8.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	213	1383			359	1347			310	445	552	308
v/s Ratio Prot	c0.08	0.23			c0.02	c0.46			c0.19	0.07	c0.08	0.04
v/s Ratio Perm	0.38				0.06					0.10		
v/c Ratio	0.93	0.57			0.15	1.08			1.10	0.61	0.49	0.23
Uniform Delay, d1	30.2	25.7			13.3	31.8			45.9	34.2	41.7	39.9
Progression Factor	1.00	1.00			1.00	1.00			1.00	1.00	1.00	1.00
Incremental Delay, d2	43.3	0.5			0.2	51.0			79.6	2.3	0.7	0.4
Delay (s)	73.5	26.2			13.5	82.8			125.4	36.5	42.4	40.2
Level of Service	E	C			B	F			F	D	D	D
Approach Delay (s)		35.7				80.6			79.4			41.5
Approach LOS		D				F			E			D

Intersection Summary			
HCM 2000 Control Delay	64.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	110.7	Sum of lost time (s)	20.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	43
Future Volume (vph)	43
Ideal Flow (vphpl)	1900
Lane Width	11
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1561
Flt Permitted	1.00
Satd. Flow (perm)	1561
Peak-hour factor, PHF	0.84
Adj. Flow (vph)	51
RTOR Reduction (vph)	42
Lane Group Flow (vph)	9
Heavy Vehicles (%)	0%
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	14.6
Effective Green, g (s)	18.6
Actuated g/C Ratio	0.17
Clearance Time (s)	8.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	262
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.03
Uniform Delay, d1	38.5
Progression Factor	1.00
Incremental Delay, d2	0.1
Delay (s)	38.6
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Intersection	
Int Delay, s/veh	5.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	0	0	3	0	0	0	0	1	0	0	0
Future Vol, veh/h	0	0	0	3	0	0	0	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	38	38	38	25	25	25	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	0	0	8	0	0	0	0	4	0	0	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	3	5	1	3	3	2	1	0	0	4	0	0
Stage 1	1	1	-	2	2	-	-	-	-	-	-	-
Stage 2	2	4	-	1	1	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Mov Cap-2 Maneuver	1024	894	-	1024	897	-	-	-	-	-	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	8.5	0	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1635	-	-	-	1024	1631	-	-
HCM Lane V/C Ratio	-	-	-	-	0.008	-	-	-
HCM Control Delay (s)	0	-	-	0	8.5	0	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	0	0	-	-

2030 No-Build Weekday Evening Peak-Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	454	18	357	747	75	24	188	161	81	263	57
Future Volume (vph)	40	454	18	357	747	75	24	188	161	81	263	57
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.994			0.986				0.850		0.979	
Flt Protected	0.950			0.950				0.994			0.990	
Satd. Flow (prot)	1805	1871	0	1745	1811	0	0	1826	1561	0	3363	0
Flt Permitted	0.229			0.128				0.893			0.690	
Satd. Flow (perm)	435	1871	0	235	1811	0	0	1640	1561	0	2344	0
Satd. Flow (RTOR)		2			6				206		14	
Adj. Flow (vph)	45	516	20	372	778	78	31	241	206	100	325	70
Lane Group Flow (vph)	45	536	0	372	856	0	0	272	206	0	495	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	37.5	37.5		22.5	60.0		31.5	31.5	22.5	31.5	31.5	
Total Split (%)	31.4%	31.4%		18.8%	50.2%		26.4%	26.4%	18.8%	26.4%	26.4%	
Maximum Green (s)	30.0	30.0		15.0	52.5		25.0	25.0	15.0	25.0	25.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-3.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.30	0.82		0.87	0.81			0.58	0.23		0.73	
Control Delay	33.3	42.0		44.2	25.4			37.5	2.3		39.0	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	33.3	42.0		44.2	25.4			37.5	2.3		39.0	
Queue Length 50th (ft)	18	270		142	330			131	0		128	
Queue Length 95th (ft)	66	#633		#455	#936			245	14		#239	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	151	654		428	1058			469	902		681	
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	0.30	0.82		0.87	0.81			0.58	0.23		0.73	

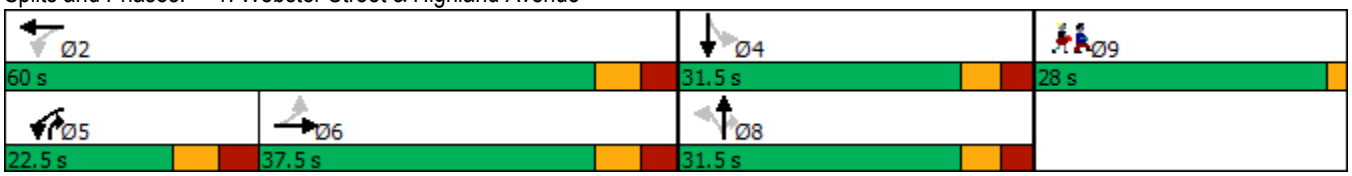
Intersection Summary
Cycle Length: 119.5

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	23%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	9
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 97.1
Natural Cycle: 140
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	454	18	357	747	75	24	188	161	81	263	57
Future Volume (vph)	40	454	18	357	747	75	24	188	161	81	263	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		1.00	0.99			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)	1805	1871		1745	1812			1826	1561		3362	
Flt Permitted	0.23	1.00		0.13	1.00			0.89	1.00		0.69	
Satd. Flow (perm)	435	1871		236	1812			1640	1561		2344	
Peak-hour factor, PHF	0.88	0.88	0.88	0.96	0.96	0.96	0.78	0.78	0.78	0.81	0.81	0.81
Adj. Flow (vph)	45	516	20	372	778	78	31	241	206	100	325	70
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	107	0	10	0
Lane Group Flow (vph)	45	535	0	372	853	0	0	272	99	0	485	0
Heavy Vehicles (%)	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%
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)	30.4	30.4		53.1	53.1			25.3	40.5		25.3	
Effective Green, g (s)	33.9	33.9		56.6	56.6			27.8	47.5		27.8	
Actuated g/C Ratio	0.34	0.34		0.57	0.57			0.28	0.48		0.28	
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)	149	643		421	1040			462	752		660	
v/s Ratio Prot		0.29		c0.17	0.47				0.03			
v/s Ratio Perm	0.10			c0.34				0.17	0.04		c0.21	
v/c Ratio	0.30	0.83		0.88	0.82			0.59	0.13		0.73	
Uniform Delay, d1	23.7	29.7		25.2	16.9			30.5	14.1		32.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	1.1	9.0		19.2	5.3			1.9	0.1		4.2	
Delay (s)	24.8	38.7		44.4	22.2			32.4	14.2		36.3	
Level of Service	C	D		D	C			C	B		D	
Approach Delay (s)		37.6			28.9			24.6			36.3	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	98.6	Sum of lost time (s)	14.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	712	1206	2	11	6
Future Vol, veh/h	0	712	1206	2	11	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	96	96	98	98	85	85
Heavy Vehicles, %	0	1	0	0	0	0
Mvmt Flow	0	742	1231	2	13	7

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1233	0	-	0	1603	617
Stage 1	-	-	-	-	1232	-
Stage 2	-	-	-	-	371	-
Critical Hdwy	4.1	-	-	-	6.8	6.9
Critical Hdwy Stg 1	-	-	-	-	5.8	-
Critical Hdwy Stg 2	-	-	-	-	5.8	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	572	-	-	-	98	438
Stage 1	-	-	-	-	242	-
Stage 2	-	-	-	-	674	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	572	-	-	-	98	438
Mov Cap-2 Maneuver	-	-	-	-	98	-
Stage 1	-	-	-	-	242	-
Stage 2	-	-	-	-	674	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	36.3
HCM LOS			E

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	572	-	-	-	135
HCM Lane V/C Ratio	-	-	-	-	0.148
HCM Control Delay (s)	0	-	-	-	36.3
HCM Lane LOS	A	-	-	-	E
HCM 95th %tile Q(veh)	0	-	-	-	0.5

Intersection	
Int Delay, s/veh	0.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	710	3	13	1195	7	8	1	9	2	0	5
Future Vol, veh/h	10	710	3	13	1195	7	8	1	9	2	0	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	96	96	96	96	96	96	80	80	80	58	58	58
Heavy Vehicles, %	0	1	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	10	740	3	14	1245	7	10	1	11	3	0	9

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1252	0	0	743	0	0	1413	2042	372	1668	2040	626
Stage 1	-	-	-	-	-	-	762	762	-	1277	1277	-
Stage 2	-	-	-	-	-	-	651	1280	-	391	763	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.5	6.5	6.9	7.5	6.5	6.9
Critical Hdwy Stg 1	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.5	5.5	-	6.5	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	563	-	-	873	-	-	100	57	631	64	57	432
Stage 1	-	-	-	-	-	-	368	416	-	179	239	-
Stage 2	-	-	-	-	-	-	429	239	-	610	416	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	563	-	-	873	-	-	92	52	631	58	52	432
Mov Cap-2 Maneuver	-	-	-	-	-	-	92	52	-	58	52	-
Stage 1	-	-	-	-	-	-	357	404	-	174	226	-
Stage 2	-	-	-	-	-	-	398	226	-	579	404	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.4	0.3	33.4	30.7
HCM LOS			D	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	149	563	-	-	873	-	-	152
HCM Lane V/C Ratio	0.151	0.019	-	-	0.016	-	-	0.079
HCM Control Delay (s)	33.4	11.5	0.2	-	9.2	0.2	-	30.7
HCM Lane LOS	D	B	A	-	A	A	-	D
HCM 95th %tile Q(veh)	0.5	0.1	-	-	0	-	-	0.3

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	54	638	27	5	207	1042	273	39	82	94	701
Future Volume (vph)	1	54	638	27	5	207	1042	273	39	82	94	701
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.97
Frt			0.994				0.969				0.850	
Flt Protected		0.950				0.950				0.984		0.950
Satd. Flow (prot)	0	1685	3469	0	0	1685	3374	0	0	1807	1561	3351
Flt Permitted		0.128				0.187				0.984		0.950
Satd. Flow (perm)	0	227	3469	0	0	332	3374	0	0	1807	1561	3351
Satd. Flow (RTOR)			4				37				131	
Adj. Flow (vph)	1	57	679	29	5	211	1063	279	43	90	103	797
Lane Group Flow (vph)	0	58	708	0	0	216	1342	0	0	133	103	797
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split
Protected Phases		1	6			5	2		3	3	5!	4
Permitted Phases	1 6	6			5 2!	2					3	
Detector Phase	1 6	1	6		5 2	5	2		3	3	5	4
Switch Phase												
Minimum Initial (s)		6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0
Minimum Split (s)		14.0	23.0			14.0	23.0		14.0	14.0	14.0	32.0
Total Split (s)		14.0	34.0			20.0	40.0		14.0	14.0	20.0	32.0
Total Split (%)		14.0%	34.0%			20.0%	40.0%		14.0%	14.0%	20.0%	32.0%
Maximum Green (s)		6.0	27.0			12.0	33.0		6.0	6.0	12.0	24.0
Yellow Time (s)		6.0	5.0			6.0	5.0		6.0	6.0	6.0	6.0
All-Red Time (s)		2.0	2.0			2.0	2.0		2.0	2.0	2.0	2.0
Lost Time Adjust (s)		-4.0	-3.0			-4.0	-3.0			-4.0	-4.0	-4.0
Total Lost Time (s)		4.0	4.0			4.0	4.0			4.0	4.0	4.0
Lead/Lag		Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag
Lead-Lag Optimize?		Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes
Vehicle Extension (s)		3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0
Recall Mode		None	Min			None	Min		None	None	None	None
Walk Time (s)			4.0				4.0					4.0
Flash Dont Walk (s)			12.0				12.0					20.0
Pedestrian Calls (#/hr)			0				0					1
v/c Ratio		0.24	0.70			0.58	1.04			0.72	0.21	0.84
Control Delay		16.4	34.8			21.2	66.1			65.7	2.4	42.4
Queue Delay		0.0	0.0			0.0	0.0			0.0	0.0	0.0
Total Delay		16.4	34.8			21.2	66.1			65.7	2.4	42.4
Queue Length 50th (ft)		18	206			76	~500			84	0	247
Queue Length 95th (ft)		39	272			123	#637			#176	12	#316
Internal Link Dist (ft)			411				548			225		
Turn Bay Length (ft)		115				190					100	80
Base Capacity (vph)		239	1081			385	1294			186	513	967
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		0.24	0.65			0.56	1.04			0.72	0.20	0.82

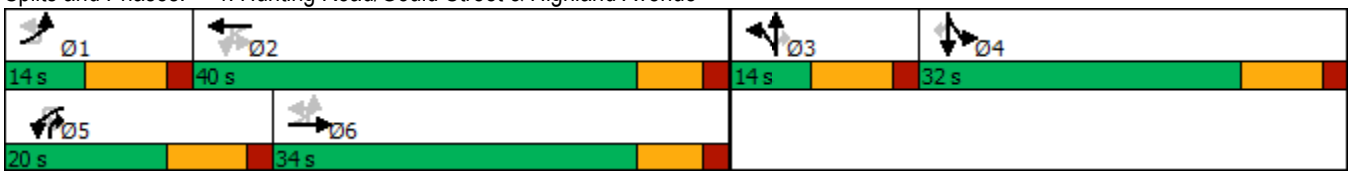
Intersection Summary
Cycle Length: 100

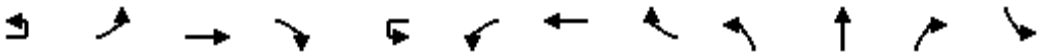
Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	182	127
Future Volume (vph)	182	127
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected		
Satd. Flow (prot)	1837	1561
Flt Permitted		
Satd. Flow (perm)	1837	1561
Satd. Flow (RTOR)		218
Adj. Flow (vph)	207	144
Lane Group Flow (vph)	207	144
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	6.0	6.0
Minimum Split (s)	32.0	32.0
Total Split (s)	32.0	32.0
Total Split (%)	32.0%	32.0%
Maximum Green (s)	24.0	24.0
Yellow Time (s)	6.0	6.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	-4.0	-4.0
Total Lost Time (s)	4.0	4.0
Lead/Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes
Vehicle Extension (s)	3.0	3.0
Recall Mode	None	None
Walk Time (s)	4.0	4.0
Flash Dont Walk (s)	20.0	20.0
Pedestrian Calls (#/hr)	1	1
v/c Ratio	0.40	0.24
Control Delay	31.6	1.6
Queue Delay	0.0	0.0
Total Delay	31.6	1.6
Queue Length 50th (ft)	107	0
Queue Length 95th (ft)	169	6
Internal Link Dist (ft)	114	
Turn Bay Length (ft)		
Base Capacity (vph)	530	605
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.39	0.24

Intersection Summary

Actuated Cycle Length: 97.3
Natural Cycle: 95
Control Type: Actuated-Uncoordinated
~ 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.
! Phase conflict between lane groups.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue





Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	54	638	27	5	207	1042	273	39	82	94	701
Future Volume (vph)	1	54	638	27	5	207	1042	273	39	82	94	701
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	10	11	11	10	10	11	11	11	11	11	11
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			1.00	0.95			1.00	1.00	0.97
Frt		1.00	0.99			1.00	0.97			1.00	0.85	1.00
Flt Protected		0.95	1.00			0.95	1.00			0.98	1.00	0.95
Satd. Flow (prot)		1685	3468			1685	3374			1807	1561	3351
Flt Permitted		0.13	1.00			0.19	1.00			0.98	1.00	0.95
Satd. Flow (perm)		227	3468			332	3374			1807	1561	3351
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.98	0.98	0.98	0.98	0.91	0.91	0.91	0.88
Adj. Flow (vph)	1	57	679	29	5	211	1063	279	43	90	103	797
RTOR Reduction (vph)	0	0	3	0	0	0	23	0	0	0	77	0
Lane Group Flow (vph)	0	58	705	0	0	216	1319	0	0	133	26	797
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split
Protected Phases		1	6			5	2		3	3	5!	4
Permitted Phases	1 6	6			5 2!	2					3	
Actuated Green, G (s)		31.9	27.2			44.9	33.7			6.0	17.2	23.7
Effective Green, g (s)		39.9	30.2			50.4	36.7			10.0	25.2	27.7
Actuated g/C Ratio		0.40	0.30			0.51	0.37			0.10	0.25	0.28
Clearance Time (s)		8.0	7.0			8.0	7.0			8.0	8.0	8.0
Vehicle Extension (s)		3.0	3.0			3.0	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)		219	1056			376	1249			182	396	936
v/s Ratio Prot		0.02	0.20			c0.09	c0.39			c0.07	0.01	c0.24
v/s Ratio Perm		0.08				0.20					0.01	
v/c Ratio		0.26	0.67			0.57	1.06			0.73	0.07	0.85
Uniform Delay, d1		22.2	30.1			16.1	31.2			43.2	28.0	33.8
Progression Factor		1.00	1.00			1.00	1.00			1.00	1.00	1.00
Incremental Delay, d2		0.7	1.6			2.1	41.6			14.0	0.1	7.5
Delay (s)		22.8	31.7			18.2	72.8			57.2	28.1	41.3
Level of Service		C	C			B	E			E	C	D
Approach Delay (s)			31.0				65.2			44.5		
Approach LOS			C				E			D		

Intersection Summary			
HCM 2000 Control Delay	48.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	99.1	Sum of lost time (s)	20.0
Intersection Capacity Utilization	82.3%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	182	127
Future Volume (vph)	182	127
Ideal Flow (vphpl)	1900	1900
Lane Width	11	11
Total Lost time (s)	4.0	4.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.85
Flt Protected	1.00	1.00
Satd. Flow (prot)	1837	1561
Flt Permitted	1.00	1.00
Satd. Flow (perm)	1837	1561
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	207	144
RTOR Reduction (vph)	0	104
Lane Group Flow (vph)	207	40
Heavy Vehicles (%)	0%	0%
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Actuated Green, G (s)	23.7	23.7
Effective Green, g (s)	27.7	27.7
Actuated g/C Ratio	0.28	0.28
Clearance Time (s)	8.0	8.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	513	436
v/s Ratio Prot	0.11	
v/s Ratio Perm		0.03
v/c Ratio	0.40	0.09
Uniform Delay, d1	29.0	26.4
Progression Factor	1.00	1.00
Incremental Delay, d2	0.5	0.1
Delay (s)	29.5	26.5
Level of Service	C	C
Approach Delay (s)	37.3	
Approach LOS	D	

Intersection Summary

Intersection	
Int Delay, s/veh	3.7

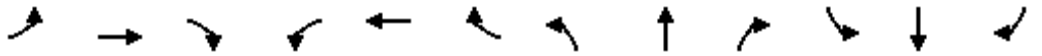
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	0	0	4	0	0	0	0	1	0	0	0
Future Vol, veh/h	0	0	0	4	0	0	0	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	100	100	100	25	25	25	92	92	92
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	0	0	0	4	0	0	0	0	4	0	0	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	3	5	1	3	3	2	1	0	0	4	0	0
Stage 1	1	1	-	2	2	-	-	-	-	-	-	-
Stage 2	2	4	-	1	1	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	1024	894	1090	1024	897	1088	1635	-	-	1631	-	-
Mov Cap-2 Maneuver	1024	894	-	1024	897	-	-	-	-	-	-	-
Stage 1	1027	899	-	1026	898	-	-	-	-	-	-	-
Stage 2	1026	897	-	1027	899	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	8.5	0	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1635	-	-	-	1024	1631	-	-
HCM Lane V/C Ratio	-	-	-	-	0.004	-	-	-
HCM Control Delay (s)	0	-	-	0	8.5	0	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	0	0	-	-

2030 Build Weekday Morning Peak-Hour



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Future Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.994			0.985				0.850		0.979	
Flt Protected	0.950			0.950				0.995			0.979	
Satd. Flow (prot)	1687	1853	0	1745	1774	0	0	1795	1531	0	3261	0
Flt Permitted	0.432			0.105				0.939			0.558	
Satd. Flow (perm)	767	1853	0	193	1774	0	0	1694	1531	0	1859	0
Satd. Flow (RTOR)		2			7				347		15	
Adj. Flow (vph)	61	835	35	152	551	63	35	322	464	127	122	41
Lane Group Flow (vph)	61	870	0	152	614	0	0	357	464	0	290	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	37.5	37.5		17.5	55.0		28.5	28.5	17.5	28.5	28.5	
Total Split (%)	33.6%	33.6%		15.7%	49.3%		25.6%	25.6%	15.7%	25.6%	25.6%	
Maximum Green (s)	30.0	30.0		10.0	47.5		22.0	22.0	10.0	22.0	22.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-2.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.21	1.22		0.45	0.60			0.76	0.53		0.55	
Control Delay	24.2	138.0		17.1	17.1			42.8	6.1		32.3	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	24.2	138.0		17.1	17.1			42.8	6.1		32.3	
Queue Length 50th (ft)	20	~553		31	171			167	32		62	
Queue Length 95th (ft)	64	#997		120	499			#441	81		146	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	295	714		352	1043			477	891		534	
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	1.22		0.43	0.59			0.75	0.52		0.54	

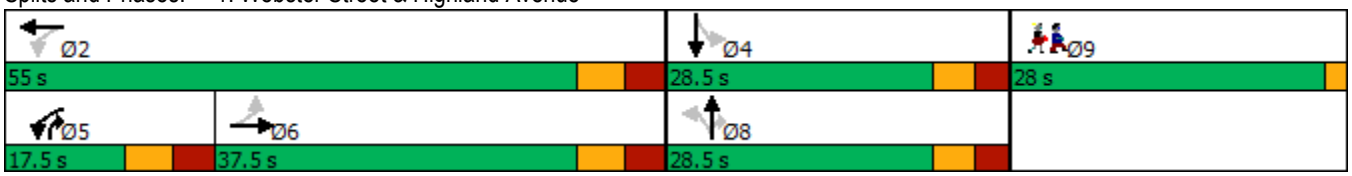
Intersection Summary
Cycle Length: 111.5

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	25%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	13
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 88.3
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Future Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		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)	1687	1853		1745	1773			1795	1531		3259	
Flt Permitted	0.43	1.00		0.10	1.00			0.94	1.00		0.56	
Satd. Flow (perm)	767	1853		193	1773			1695	1531		1859	
Peak-hour factor, PHF	0.82	0.82	0.82	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93
Adj. Flow (vph)	61	835	35	152	551	63	35	322	464	127	122	41
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	206	0	11	0
Lane Group Flow (vph)	61	869	0	152	611	0	0	357	258	0	279	0
Heavy Vehicles (%)	7%	2%	0%	0%	2%	2%	0%	2%	2%	2%	2%	6%
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		47.6	47.6			22.1	31.6		22.1	
Effective Green, g (s)	34.1	34.1		51.1	51.1			24.6	36.6		24.6	
Actuated g/C Ratio	0.38	0.38		0.57	0.57			0.27	0.41		0.27	
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)	291	703		334	1008			464	623		509	
v/s Ratio Prot		c0.47		0.07	c0.34				0.06			
v/s Ratio Perm	0.08			0.19				c0.21	0.11		0.15	
v/c Ratio	0.21	1.24		0.46	0.61			0.77	0.41		0.55	
Uniform Delay, d1	18.8	27.8		16.2	12.7			30.0	19.0		27.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.4	118.2		1.0	1.0			7.5	0.4		1.2	
Delay (s)	19.1	146.0		17.2	13.8			37.5	19.4		29.1	
Level of Service	B	F		B	B			D	B		C	
Approach Delay (s)		137.7			14.4			27.3			29.1	
Approach LOS		F			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	60.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	89.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	83.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	36	1175	705	13	7	9
Future Vol, veh/h	36	1175	705	13	7	9
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	94	89	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	39	1250	792	14	8	10

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	806	0	-	0	1502	403
Stage 1	-	-	-	-	799	-
Stage 2	-	-	-	-	703	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	814	-	-	-	112	597
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	452	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	814	-	-	-	94	597
Mov Cap-2 Maneuver	-	-	-	-	94	-
Stage 1	-	-	-	-	340	-
Stage 2	-	-	-	-	452	-

Approach	EB	WB	SB
HCM Control Delay, s	1	0	27.3
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	814	-	-	-	179
HCM Lane V/C Ratio	0.048	-	-	-	0.097
HCM Control Delay (s)	9.6	0.7	-	-	27.3
HCM Lane LOS	A	A	-	-	D
HCM 95th %tile Q(veh)	0.2	-	-	-	0.3

Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	12	1160	10	5	705	42	8	0	4	9	0	5
Future Vol, veh/h	12	1160	10	5	705	42	8	0	4	9	0	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	96	96	87	87	92	55	92	55	92	92	92
Heavy Vehicles, %	2	2	11	0	2	2	0	2	0	2	2	2
Mvmt Flow	13	1208	10	6	810	46	15	0	7	10	0	5

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	856	0	0	1218	0	0	1656	2107	609	1475	2089	428
Stage 1	-	-	-	-	-	-	1239	1239	-	845	845	-
Stage 2	-	-	-	-	-	-	417	868	-	630	1244	-
Critical Hdwy	4.14	-	-	4.1	-	-	7.5	6.54	6.9	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.5	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.5	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.2	-	-	3.5	4.02	3.3	3.52	4.02	3.32
Pot Cap-1 Maneuver	780	-	-	580	-	-	66	51	443	88	52	575
Stage 1	-	-	-	-	-	-	189	246	-	324	377	-
Stage 2	-	-	-	-	-	-	589	368	-	436	244	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	780	-	-	580	-	-	62	47	443	82	48	575
Mov Cap-2 Maneuver	-	-	-	-	-	-	62	47	-	82	48	-
Stage 1	-	-	-	-	-	-	179	233	-	307	369	-
Stage 2	-	-	-	-	-	-	572	361	-	407	231	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0.2	59.7	40
HCM LOS			F	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	87	780	-	-	580	-	-	118
HCM Lane V/C Ratio	0.251	0.017	-	-	0.01	-	-	0.129
HCM Control Delay (s)	59.7	9.7	0.2	-	11.3	0.1	-	40
HCM Lane LOS	F	A	A	-	B	A	-	E
HCM 95th %tile Q(veh)	0.9	0.1	-	-	0	-	-	0.4

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Future Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Lane Util. Factor	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.97	1.00
Frt		0.997				0.919				0.850		
Flt Protected	0.950				0.950				0.994		0.950	
Satd. Flow (prot)	1668	3445	0	0	1685	3175	0	0	1810	1561	3286	1837
Flt Permitted	0.088				0.096				0.994		0.950	
Satd. Flow (perm)	155	3445	0	0	170	3175	0	0	1810	1561	3286	1837
Satd. Flow (RTOR)		2				293				109		
Adj. Flow (vph)	200	1080	22	2	51	772	915	43	299	364	268	71
Lane Group Flow (vph)	200	1102	0	0	53	1687	0	0	342	364	268	71
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split	NA
Protected Phases	1	6			5	2		3	3	5!	4	4
Permitted Phases	6			5 2!	2					3		
Detector Phase	1	6		5 2	5	2		3	3	5	4	4
Switch Phase												
Minimum Initial (s)	6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0	6.0
Minimum Split (s)	14.0	23.0			14.0	23.0		14.0	14.0	14.0	32.0	32.0
Total Split (s)	14.0	48.0			17.0	51.0		23.0	23.0	17.0	32.0	32.0
Total Split (%)	11.7%	40.0%			14.2%	42.5%		19.2%	19.2%	14.2%	26.7%	26.7%
Maximum Green (s)	6.0	41.0			9.0	44.0		15.0	15.0	9.0	24.0	24.0
Yellow Time (s)	6.0	5.0			6.0	5.0		6.0	6.0	6.0	6.0	6.0
All-Red Time (s)	2.0	2.0			2.0	2.0		2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-4.0	-3.0			-4.0	-3.0			-4.0	-4.0	-4.0	-4.0
Total Lost Time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	None	Min			None	Min		None	None	None	None	None
Walk Time (s)		4.0				4.0					4.0	4.0
Flash Dont Walk (s)		12.0				12.0					20.0	20.0
Pedestrian Calls (#/hr)		1				0					0	0
v/c Ratio	0.94	0.80			0.20	1.11			1.10	0.69	0.49	0.23
Control Delay	77.0	35.0			14.2	86.5			124.5	21.2	44.6	41.4
Queue Delay	0.0	0.0			0.0	0.0			0.0	0.0	0.0	0.0
Total Delay	77.0	35.0			14.2	86.5			124.5	21.2	44.6	41.4
Queue Length 50th (ft)	95	355			16	~653			~274	100	89	44
Queue Length 95th (ft)	#257	478			37	#797			#450	155	121	79
Internal Link Dist (ft)		411				548			225			114
Turn Bay Length (ft)	115				190					100	80	
Base Capacity (vph)	213	1381			270	1517			311	529	831	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	0.94	0.80			0.20	1.11			1.10	0.69	0.32	0.15

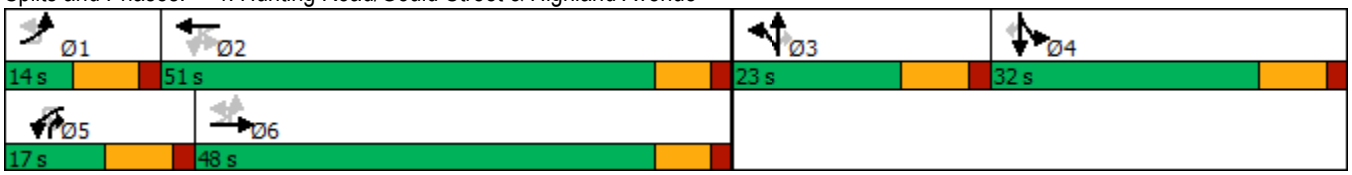
Intersection Summary
Cycle Length: 120

Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	45
Future Volume (vph)	45
Lane Util. Factor	1.00
Frt	0.850
Flt Protected	
Satd. Flow (prot)	1561
Flt Permitted	
Satd. Flow (perm)	1561
Satd. Flow (RTOR)	182
Adj. Flow (vph)	54
Lane Group Flow (vph)	54
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Detector Phase	4
Switch Phase	
Minimum Initial (s)	6.0
Minimum Split (s)	32.0
Total Split (s)	32.0
Total Split (%)	26.7%
Maximum Green (s)	24.0
Yellow Time (s)	6.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	-4.0
Total Lost Time (s)	4.0
Lead/Lag	Lag
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	4.0
Flash Dont Walk (s)	20.0
Pedestrian Calls (#/hr)	0
v/c Ratio	0.13
Control Delay	0.6
Queue Delay	0.0
Total Delay	0.6
Queue Length 50th (ft)	0
Queue Length 95th (ft)	0
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	531
Starvation Cap Reductn	0
Spillback Cap Reductn	0
Storage Cap Reductn	0
Reduced v/c Ratio	0.10

Intersection Summary

Actuated Cycle Length: 110.7
Natural Cycle: 145
Control Type: Actuated-Uncoordinated
~ 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.
! Phase conflict between lane groups.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue



Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Future Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	11	10	10	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			1.00	0.95			1.00	1.00	0.97	1.00
Frt	1.00	1.00			1.00	0.92			1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00			0.95	1.00			0.99	1.00	0.95	1.00
Satd. Flow (prot)	1668	3445			1685	3174			1809	1561	3286	1837
Flt Permitted	0.09	1.00			0.10	1.00			0.99	1.00	0.95	1.00
Satd. Flow (perm)	155	3445			170	3174			1809	1561	3286	1837
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.84	0.84
Adj. Flow (vph)	200	1080	22	2	51	772	915	43	299	364	268	71
RTOR Reduction (vph)	0	1	0	0	0	168	0	0	0	78	0	0
Lane Group Flow (vph)	200	1101	0	0	53	1519	0	0	342	286	268	71
Heavy Vehicles (%)	1%	1%	0%	0%	0%	1%	1%	0%	1%	0%	3%	0%
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split	NA
Protected Phases	1	6			5	2		3	3	5!	4	4
Permitted Phases	6			5 2!	2					3		
Actuated Green, G (s)	47.3	41.3			52.7	44.0			15.0	23.7	14.6	14.6
Effective Green, g (s)	55.3	44.3			60.7	47.0			19.0	31.7	18.6	18.6
Actuated g/C Ratio	0.50	0.40			0.55	0.42			0.17	0.29	0.17	0.17
Clearance Time (s)	8.0	7.0			8.0	7.0			8.0	8.0	8.0	8.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	214	1379			267	1348			310	447	552	308
v/s Ratio Prot	c0.08	0.32			c0.02	c0.48			c0.19	0.07	c0.08	0.04
v/s Ratio Perm	0.38				0.09					0.11		
v/c Ratio	0.93	0.80			0.20	1.13			1.10	0.64	0.49	0.23
Uniform Delay, d1	30.2	29.2			16.3	31.8			45.8	34.5	41.7	39.8
Progression Factor	1.00	1.00			1.00	1.00			1.00	1.00	1.00	1.00
Incremental Delay, d2	43.2	3.3			0.4	67.0			81.7	3.1	0.7	0.4
Delay (s)	73.4	32.5			16.7	98.8			127.5	37.6	42.3	40.2
Level of Service	E	C			B	F			F	D	D	D
Approach Delay (s)		38.8				96.3			81.2			41.4
Approach LOS		D				F			F			D

Intersection Summary			
HCM 2000 Control Delay	70.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	110.6	Sum of lost time (s)	20.0
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	45
Future Volume (vph)	45
Ideal Flow (vphpl)	1900
Lane Width	11
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1561
Flt Permitted	1.00
Satd. Flow (perm)	1561
Peak-hour factor, PHF	0.84
Adj. Flow (vph)	54
RTOR Reduction (vph)	45
Lane Group Flow (vph)	9
Heavy Vehicles (%)	0%
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	14.6
Effective Green, g (s)	18.6
Actuated g/C Ratio	0.17
Clearance Time (s)	8.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	262
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.03
Uniform Delay, d1	38.5
Progression Factor	1.00
Incremental Delay, d2	0.1
Delay (s)	38.5
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

Intersection	
Int Delay, s/veh	6.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	0	6	3	0	0	27	0	1	0	0	0
Future Vol, veh/h	0	0	6	3	0	0	27	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	38	92	38	92	25	25	92	92	92
Heavy Vehicles, %	2	2	2	0	2	0	2	0	0	0	0	2
Mvmt Flow	0	0	7	8	0	0	29	0	4	0	0	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	61	63	1	65	61	2	1	0	0	4	0	0
Stage 1	1	1	-	60	60	-	-	-	-	-	-	-
Stage 2	60	62	-	5	1	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.1	6.52	6.2	4.12	-	-	4.1	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.1	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.1	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.5	4.018	3.3	2.218	-	-	2.2	-	-
Pot Cap-1 Maneuver	934	828	1084	934	830	1088	1622	-	-	1631	-	-
Stage 1	1022	895	-	957	845	-	-	-	-	-	-	-
Stage 2	951	843	-	1022	895	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	921	813	1084	915	815	1088	1622	-	-	1631	-	-
Mov Cap-2 Maneuver	921	813	-	915	815	-	-	-	-	-	-	-
Stage 1	1004	895	-	940	830	-	-	-	-	-	-	-
Stage 2	934	828	-	1016	895	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	8.3	9	6.4	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1622	-	-	1084	915	1631	-	-
HCM Lane V/C Ratio	0.018	-	-	0.006	0.009	-	-	-
HCM Control Delay (s)	7.3	0	-	8.3	9	0	-	-
HCM Lane LOS	A	A	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0	0	0	-	-

Intersection	
Int Delay, s/veh	3.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	0	5	26	28	9	0
Future Vol, veh/h	0	5	26	28	9	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	5	28	30	10	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	96	10	10	0	-	0
Stage 1	10	-	-	-	-	-
Stage 2	86	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	903	1071	1610	-	-	-
Stage 1	1013	-	-	-	-	-
Stage 2	937	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	887	1071	1610	-	-	-
Mov Cap-2 Maneuver	887	-	-	-	-	-
Stage 1	995	-	-	-	-	-
Stage 2	937	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	8.4	3.5	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1610	-	1071	-	-
HCM Lane V/C Ratio	0.018	-	0.005	-	-
HCM Control Delay (s)	7.3	0	8.4	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0.1	-	0	-	-

Intersection	
Int Delay, s/veh	2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	8	0	0	25	0	0
Future Vol, veh/h	8	0	0	25	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	9	0	0	27	0	0

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	15	14	0	0	27	0
Stage 1	14	-	-	-	-	-
Stage 2	1	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	1004	1066	-	-	1587	-
Stage 1	1009	-	-	-	-	-
Stage 2	1022	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	1004	1066	-	-	1587	-
Mov Cap-2 Maneuver	1004	-	-	-	-	-
Stage 1	1009	-	-	-	-	-
Stage 2	1022	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.6	0	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	1004	1587	-
HCM Lane V/C Ratio	-	-	0.009	-	-
HCM Control Delay (s)	-	-	8.6	0	-
HCM Lane LOS	-	-	A	A	-
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	8	0	25	24	0	8
Future Vol, veh/h	8	0	25	24	0	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	9	0	27	26	0	9

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	49	40	0	0	53	0
Stage 1	40	-	-	-	-	-
Stage 2	9	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	960	1031	-	-	1553	-
Stage 1	982	-	-	-	-	-
Stage 2	1014	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	960	1031	-	-	1553	-
Mov Cap-2 Maneuver	960	-	-	-	-	-
Stage 1	982	-	-	-	-	-
Stage 2	1014	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.8	0	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	960	1553	-
HCM Lane V/C Ratio	-	-	0.009	-	-
HCM Control Delay (s)	-	-	8.8	0	-
HCM Lane LOS	-	-	A	A	-
HCM 95th %tile Q(veh)	-	-	0	0	-

2030 Build Weekday Evening Peak-Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Future Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.995			0.986				0.850		0.979	
Flt Protected	0.950			0.950				0.994			0.990	
Satd. Flow (prot)	1805	1872	0	1745	1811	0	0	1826	1561	0	3363	0
Flt Permitted	0.188			0.112				0.891			0.687	
Satd. Flow (perm)	357	1872	0	206	1811	0	0	1636	1561	0	2334	0
Satd. Flow (RTOR)		2			6				218		14	
Adj. Flow (vph)	45	532	20	392	810	84	31	241	218	102	325	70
Lane Group Flow (vph)	45	552	0	392	894	0	0	272	218	0	497	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	37.5	37.5		22.5	60.0		31.5	31.5	22.5	31.5	31.5	
Total Split (%)	31.4%	31.4%		18.8%	50.2%		26.4%	26.4%	18.8%	26.4%	26.4%	
Maximum Green (s)	30.0	30.0		15.0	52.5		25.0	25.0	15.0	25.0	25.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-3.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.36	0.84		0.94	0.84			0.58	0.24		0.73	
Control Delay	37.8	43.9		58.2	27.6			37.5	2.3		39.3	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	37.8	43.9		58.2	27.6			37.5	2.3		39.3	
Queue Length 50th (ft)	19	282		166	359			131	0		130	
Queue Length 95th (ft)	70	#659		#508	#1001			245	14		#241	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	124	654		416	1058			468	908		678	
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	0.36	0.84		0.94	0.84			0.58	0.24		0.73	

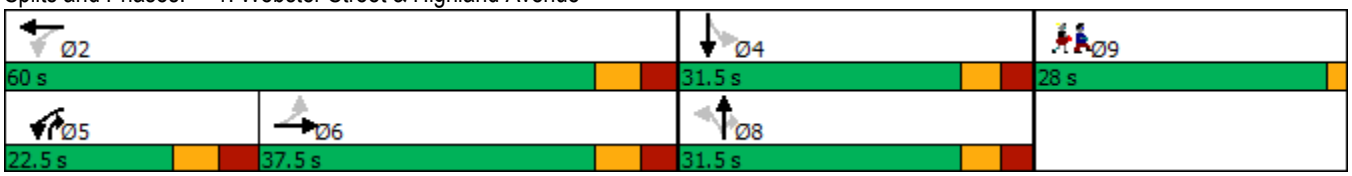
Intersection Summary
Cycle Length: 119.5

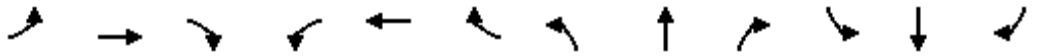
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	23%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	9
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 97.1
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Future Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		1.00	0.99			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)	1805	1872		1745	1811			1826	1561		3362	
Flt Permitted	0.19	1.00		0.11	1.00			0.89	1.00		0.69	
Satd. Flow (perm)	357	1872		206	1811			1636	1561		2333	
Peak-hour factor, PHF	0.88	0.88	0.88	0.96	0.96	0.96	0.78	0.78	0.78	0.81	0.81	0.81
Adj. Flow (vph)	45	532	20	392	810	84	31	241	218	102	325	70
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	113	0	10	0
Lane Group Flow (vph)	45	551	0	392	891	0	0	272	105	0	487	0
Heavy Vehicles (%)	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%
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)	30.4	30.4		53.1	53.1			25.3	40.5		25.3	
Effective Green, g (s)	33.9	33.9		56.6	56.6			27.8	47.5		27.8	
Actuated g/C Ratio	0.34	0.34		0.57	0.57			0.28	0.48		0.28	
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)	122	643		410	1039			461	752		657	
v/s Ratio Prot		0.29		c0.18	0.49				0.03			
v/s Ratio Perm	0.13			c0.37				0.17	0.04		c0.21	
v/c Ratio	0.37	0.86		0.96	0.86			0.59	0.14		0.74	
Uniform Delay, d1	24.3	30.1		28.2	17.6			30.5	14.2		32.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	1.9	10.9		33.0	7.2			2.0	0.1		4.5	
Delay (s)	26.2	41.0		61.2	24.8			32.5	14.3		36.6	
Level of Service	C	D		E	C			C	B		D	
Approach Delay (s)		39.8			35.9			24.4			36.6	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM 2000 Control Delay	34.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	98.6	Sum of lost time (s)	14.0
Intersection Capacity Utilization	90.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	2.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	21	716	1219	7	34	49
Future Vol, veh/h	21	716	1219	7	34	49
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	96	98	92	92	92
Heavy Vehicles, %	2	1	0	2	2	2
Mvmt Flow	23	746	1244	8	37	53

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1252	0	-	0	1667	626
Stage 1	-	-	-	-	1248	-
Stage 2	-	-	-	-	419	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	552	-	-	-	87	427
Stage 1	-	-	-	-	234	-
Stage 2	-	-	-	-	632	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	552	-	-	-	81	427
Mov Cap-2 Maneuver	-	-	-	-	81	-
Stage 1	-	-	-	-	217	-
Stage 2	-	-	-	-	632	-

Approach	EB	WB	SB
HCM Control Delay, s	0.7	0	56.4
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	552	-	-	-	155
HCM Lane V/C Ratio	0.041	-	-	-	0.582
HCM Control Delay (s)	11.8	0.4	-	-	56.4
HCM Lane LOS	B	A	-	-	F
HCM 95th %tile Q(veh)	0.1	-	-	-	3

Intersection	
Int Delay, s/veh	6.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	14	733	3	13	1200	26	8	0	9	43	0	18
Future Vol, veh/h	14	733	3	13	1200	26	8	0	9	43	0	18
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	96	96	96	96	92	80	92	80	92	92	92
Heavy Vehicles, %	2	1	0	0	0	2	0	2	0	2	2	2
Mvmt Flow	15	764	3	14	1250	28	10	0	11	47	0	20

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1278	0	0	767	0	0	1449	2102	384	1704	2089	639
Stage 1	-	-	-	-	-	-	796	796	-	1292	1292	-
Stage 2	-	-	-	-	-	-	653	1306	-	412	797	-
Critical Hdwy	4.14	-	-	4.1	-	-	7.5	6.54	6.9	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.5	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.5	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.2	-	-	3.5	4.02	3.3	3.52	4.02	3.32
Pot Cap-1 Maneuver	539	-	-	856	-	-	94	51	620	59	52	419
Stage 1	-	-	-	-	-	-	351	397	-	172	232	-
Stage 2	-	-	-	-	-	-	427	228	-	588	397	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	539	-	-	856	-	-	83	46	620	53	47	419
Mov Cap-2 Maneuver	-	-	-	-	-	-	83	46	-	53	47	-
Stage 1	-	-	-	-	-	-	334	378	-	164	219	-
Stage 2	-	-	-	-	-	-	384	215	-	549	378	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.5	0.4	32.3	187.6
HCM LOS			D	F

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	153	539	-	-	856	-	-	71
HCM Lane V/C Ratio	0.139	0.028	-	-	0.016	-	-	0.934
HCM Control Delay (s)	32.3	11.9	0.3	-	9.3	0.3	-	187.6
HCM Lane LOS	D	B	A	-	A	A	-	F
HCM 95th %tile Q(veh)	0.5	0.1	-	-	0	-	-	4.7

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Future Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.97
Frt			0.994				0.969				0.850	
Flt Protected		0.950				0.950				0.984		0.950
Satd. Flow (prot)	0	1685	3469	0	0	1685	3375	0	0	1807	1561	3351
Flt Permitted		0.127				0.156				0.984		0.950
Satd. Flow (perm)	0	225	3469	0	0	277	3375	0	0	1807	1561	3351
Satd. Flow (RTOR)			4				36				131	
Adj. Flow (vph)	1	61	740	32	5	211	1086	279	44	90	103	797
Lane Group Flow (vph)	0	62	772	0	0	216	1365	0	0	134	103	797
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split
Protected Phases		1	6			5	2		3	3	5!	4
Permitted Phases	1 6	6			5 2!	2					3	
Detector Phase	1 6	1	6		5 2	5	2		3	3	5	4
Switch Phase												
Minimum Initial (s)		6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0
Minimum Split (s)		14.0	23.0			14.0	23.0		14.0	14.0	14.0	32.0
Total Split (s)		14.0	34.0			20.0	40.0		14.0	14.0	20.0	32.0
Total Split (%)		14.0%	34.0%			20.0%	40.0%		14.0%	14.0%	20.0%	32.0%
Maximum Green (s)		6.0	27.0			12.0	33.0		6.0	6.0	12.0	24.0
Yellow Time (s)		6.0	5.0			6.0	5.0		6.0	6.0	6.0	6.0
All-Red Time (s)		2.0	2.0			2.0	2.0		2.0	2.0	2.0	2.0
Lost Time Adjust (s)		-4.0	-3.0			-4.0	-3.0			-4.0	-4.0	-4.0
Total Lost Time (s)		4.0	4.0			4.0	4.0			4.0	4.0	4.0
Lead/Lag		Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag
Lead-Lag Optimize?		Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes
Vehicle Extension (s)		3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0
Recall Mode		None	Min			None	Min		None	None	None	None
Walk Time (s)			4.0				4.0					4.0
Flash Dont Walk (s)			12.0				12.0					20.0
Pedestrian Calls (#/hr)			0				0					1
v/c Ratio		0.26	0.76			0.61	1.05			0.72	0.21	0.84
Control Delay		16.7	36.7			23.6	70.2			66.7	2.4	42.7
Queue Delay		0.0	0.0			0.0	0.0			0.0	0.0	0.0
Total Delay		16.7	36.7			23.6	70.2			66.7	2.4	42.7
Queue Length 50th (ft)		20	231			76	~517			84	0	247
Queue Length 95th (ft)		42	301			137	#654			#177	12	#316
Internal Link Dist (ft)			411				548			225		
Turn Bay Length (ft)		115				190					100	80
Base Capacity (vph)		239	1075			366	1300			185	511	962
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		0.26	0.72			0.59	1.05			0.72	0.20	0.83

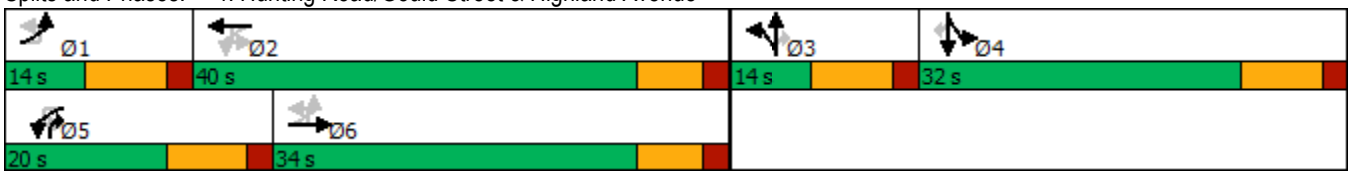
Intersection Summary
Cycle Length: 100

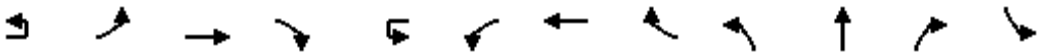
Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	182	128
Future Volume (vph)	182	128
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected		
Satd. Flow (prot)	1837	1561
Flt Permitted		
Satd. Flow (perm)	1837	1561
Satd. Flow (RTOR)		218
Adj. Flow (vph)	207	145
Lane Group Flow (vph)	207	145
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	6.0	6.0
Minimum Split (s)	32.0	32.0
Total Split (s)	32.0	32.0
Total Split (%)	32.0%	32.0%
Maximum Green (s)	24.0	24.0
Yellow Time (s)	6.0	6.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	-4.0	-4.0
Total Lost Time (s)	4.0	4.0
Lead/Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes
Vehicle Extension (s)	3.0	3.0
Recall Mode	None	None
Walk Time (s)	4.0	4.0
Flash Dont Walk (s)	20.0	20.0
Pedestrian Calls (#/hr)	1	1
v/c Ratio	0.40	0.24
Control Delay	31.6	1.7
Queue Delay	0.0	0.0
Total Delay	31.6	1.7
Queue Length 50th (ft)	107	0
Queue Length 95th (ft)	169	7
Internal Link Dist (ft)	114	
Turn Bay Length (ft)		
Base Capacity (vph)	527	603
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.39	0.24

Intersection Summary

Actuated Cycle Length: 97.8
Natural Cycle: 95
Control Type: Actuated-Uncoordinated
~ 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.
! Phase conflict between lane groups.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue





Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Future Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	10	11	11	10	10	11	11	11	11	11	11
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			1.00	0.95			1.00	1.00	0.97
Frt		1.00	0.99			1.00	0.97			1.00	0.85	1.00
Flt Protected		0.95	1.00			0.95	1.00			0.98	1.00	0.95
Satd. Flow (prot)		1685	3468			1685	3376			1807	1561	3351
Flt Permitted		0.13	1.00			0.16	1.00			0.98	1.00	0.95
Satd. Flow (perm)		225	3468			277	3376			1807	1561	3351
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.98	0.98	0.98	0.98	0.91	0.91	0.91	0.88
Adj. Flow (vph)	1	61	740	32	5	211	1086	279	44	90	103	797
RTOR Reduction (vph)	0	0	3	0	0	0	23	0	0	0	77	0
Lane Group Flow (vph)	0	62	769	0	0	216	1342	0	0	134	26	797
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split
Protected Phases		1	6			5	2		3	3	5!	4
Permitted Phases	1 6	6			5 2!	2					3	
Actuated Green, G (s)		32.2	27.5			45.2	34.0			6.0	17.2	23.7
Effective Green, g (s)		40.2	30.5			50.7	37.0			10.0	25.2	27.7
Actuated g/C Ratio		0.40	0.31			0.51	0.37			0.10	0.25	0.28
Clearance Time (s)		8.0	7.0			8.0	7.0			8.0	8.0	8.0
Vehicle Extension (s)		3.0	3.0			3.0	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)		218	1064			356	1256			181	395	933
v/s Ratio Prot		0.02	0.22			c0.09	c0.40			c0.07	0.01	c0.24
v/s Ratio Perm		0.09				0.22					0.01	
v/c Ratio		0.28	0.72			0.61	1.07			0.74	0.07	0.85
Uniform Delay, d1		22.2	30.7			16.8	31.2			43.4	28.2	33.9
Progression Factor		1.00	1.00			1.00	1.00			1.00	1.00	1.00
Incremental Delay, d2		0.7	2.5			2.9	46.0			15.0	0.1	7.7
Delay (s)		23.0	33.1			19.7	77.2			58.4	28.2	41.6
Level of Service		C	C			B	E			E	C	D
Approach Delay (s)			32.4				69.3			45.3		
Approach LOS			C				E			D		

Intersection Summary			
HCM 2000 Control Delay	50.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	99.4	Sum of lost time (s)	20.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	182	128
Future Volume (vph)	182	128
Ideal Flow (vphpl)	1900	1900
Lane Width	11	11
Total Lost time (s)	4.0	4.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.85
Flt Protected	1.00	1.00
Satd. Flow (prot)	1837	1561
Flt Permitted	1.00	1.00
Satd. Flow (perm)	1837	1561
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	207	145
RTOR Reduction (vph)	0	105
Lane Group Flow (vph)	207	40
Heavy Vehicles (%)	0%	0%
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Actuated Green, G (s)	23.7	23.7
Effective Green, g (s)	27.7	27.7
Actuated g/C Ratio	0.28	0.28
Clearance Time (s)	8.0	8.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	511	435
v/s Ratio Prot	0.11	
v/s Ratio Perm		0.03
v/c Ratio	0.41	0.09
Uniform Delay, d1	29.2	26.5
Progression Factor	1.00	1.00
Incremental Delay, d2	0.5	0.1
Delay (s)	29.7	26.6
Level of Service	C	C
Approach Delay (s)	37.6	
Approach LOS	D	

Intersection Summary

Intersection	
Int Delay, s/veh	7.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	0	29	4	0	0	16	0	1	0	0	0
Future Vol, veh/h	0	0	29	4	0	0	16	0	1	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	100	100	100	92	25	25	92	92	92
Heavy Vehicles, %	2	2	2	0	2	0	2	0	0	0	0	2
Mvmt Flow	0	0	32	4	0	0	17	0	4	0	0	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	37	39	1	53	37	2	1	0	0	4	0	0
Stage 1	1	1	-	36	36	-	-	-	-	-	-	-
Stage 2	36	38	-	17	1	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.1	6.52	6.2	4.12	-	-	4.1	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.1	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.1	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.5	4.018	3.3	2.218	-	-	2.2	-	-
Pot Cap-1 Maneuver	968	853	1084	951	855	1088	1622	-	-	1631	-	-
Stage 1	1022	895	-	985	865	-	-	-	-	-	-	-
Stage 2	980	863	-	1008	895	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	960	844	1084	916	846	1088	1622	-	-	1631	-	-
Mov Cap-2 Maneuver	960	844	-	916	846	-	-	-	-	-	-	-
Stage 1	1011	895	-	974	855	-	-	-	-	-	-	-
Stage 2	969	854	-	979	895	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	8.4	8.9	5.9	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1622	-	-	1084	916	1631	-	-
HCM Lane V/C Ratio	0.011	-	-	0.029	0.004	-	-	-
HCM Control Delay (s)	7.2	0	-	8.4	8.9	0	-	-
HCM Lane LOS	A	A	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0	0	-	-

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	0	28	16	24	33	0
Future Vol, veh/h	0	28	16	24	33	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	30	17	26	36	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	96	36	36	0	-	0
Stage 1	36	-	-	-	-	-
Stage 2	60	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	903	1037	1575	-	-	-
Stage 1	986	-	-	-	-	-
Stage 2	963	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	893	1037	1575	-	-	-
Mov Cap-2 Maneuver	893	-	-	-	-	-
Stage 1	975	-	-	-	-	-
Stage 2	963	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	8.6	2.9	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1575	-	1037	-	-
HCM Lane V/C Ratio	0.011	-	0.029	-	-
HCM Control Delay (s)	7.3	0	8.6	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-

Intersection	
Int Delay, s/veh	6.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	42	0	0	14	0	0
Future Vol, veh/h	42	0	0	14	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	46	0	0	15	0	0

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	9	8	0	0	15	0
Stage 1	8	-	-	-	-	-
Stage 2	1	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	1011	1074	-	-	1603	-
Stage 1	1015	-	-	-	-	-
Stage 2	1022	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	1011	1074	-	-	1603	-
Mov Cap-2 Maneuver	1011	-	-	-	-	-
Stage 1	1015	-	-	-	-	-
Stage 2	1022	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.7	0	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	1011	1603	-
HCM Lane V/C Ratio	-	-	0.045	-	-
HCM Control Delay (s)	-	-	8.7	0	-
HCM Lane LOS	-	-	A	A	-
HCM 95th %tile Q(veh)	-	-	0.1	0	-

Intersection	
Int Delay, s/veh	3.3

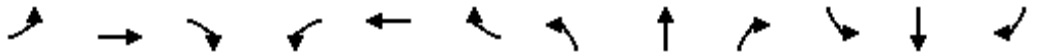
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	41	0	14	14	0	42
Future Vol, veh/h	41	0	14	14	0	42
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	45	0	15	15	0	46

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	69	23	0	0	30	0
Stage 1	23	-	-	-	-	-
Stage 2	46	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	936	1054	-	-	1583	-
Stage 1	1000	-	-	-	-	-
Stage 2	976	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	936	1054	-	-	1583	-
Mov Cap-2 Maneuver	936	-	-	-	-	-
Stage 1	1000	-	-	-	-	-
Stage 2	976	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	9	0	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	936	1583	-
HCM Lane V/C Ratio	-	-	0.048	-	-
HCM Control Delay (s)	-	-	9	0	-
HCM Lane LOS	-	-	A	A	-
HCM 95th %tile Q(veh)	-	-	0.1	0	-

2030 Mitigated Weekday Morning Peak-Hour



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Future Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.994			0.985				0.850		0.979	
Flt Protected	0.950			0.950				0.995			0.979	
Satd. Flow (prot)	1687	1853	0	1745	1774	0	0	1795	1531	0	3261	0
Flt Permitted	0.393			0.069				0.936			*0.566	
Satd. Flow (perm)	698	1853	0	127	1774	0	0	1689	1531	0	1885	0
Satd. Flow (RTOR)		2			7				276		13	
Adj. Flow (vph)	61	835	35	152	551	63	35	322	464	127	122	41
Lane Group Flow (vph)	61	870	0	152	614	0	0	357	464	0	290	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	57.0	57.0		14.0	71.0		29.0	29.0	14.0	29.0	29.0	
Total Split (%)	44.5%	44.5%		10.9%	55.5%		22.7%	22.7%	10.9%	22.7%	22.7%	
Maximum Green (s)	49.5	49.5		6.5	63.5		22.5	22.5	6.5	22.5	22.5	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-2.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.18	0.97		0.68	0.57			0.93	0.67		0.66	
Control Delay	22.3	53.8		38.1	17.9			75.0	15.5		47.7	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	22.3	53.8		38.1	17.9			75.0	15.5		47.7	
Queue Length 50th (ft)	19	466		42	174			217	89		82	
Queue Length 95th (ft)	60	#933		#188	488			#526	197		#182	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	337	897		224	1086			385	691		440	
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	0.97		0.68	0.57			0.93	0.67		0.66	

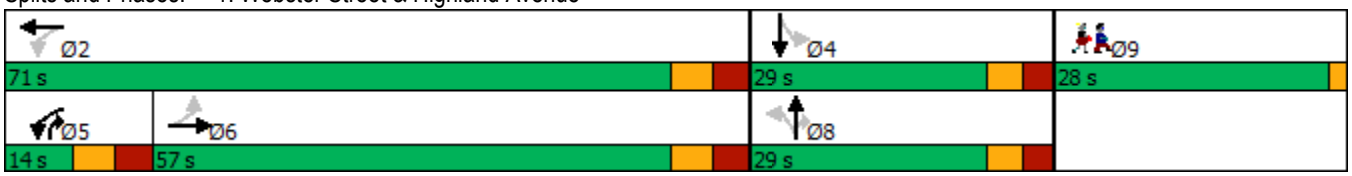
Intersection Summary
Cycle Length: 128

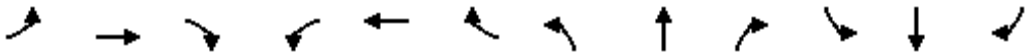
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	22%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	13
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 111.2
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
* User Entered Value
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Future Volume (vph)	50	685	29	138	501	57	32	296	427	118	113	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	5.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		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)	1687	1853		1745	1773			1795	1531		3259	
Flt Permitted	0.39	1.00		0.07	1.00			0.94	1.00		0.57	
Satd. Flow (perm)	698	1853		127	1773			1689	1531		1885	
Peak-hour factor, PHF	0.82	0.82	0.82	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93
Adj. Flow (vph)	61	835	35	152	551	63	35	322	464	127	122	41
RTOR Reduction (vph)	0	1	0	0	3	0	0	0	191	0	10	0
Lane Group Flow (vph)	61	869	0	152	611	0	0	357	273	0	280	0
Heavy Vehicles (%)	7%	2%	0%	0%	2%	2%	0%	2%	2%	2%	2%	6%
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)	50.3	50.3		64.4	64.4			22.8	29.4		22.8	
Effective Green, g (s)	53.8	53.8		67.9	67.9			25.3	34.4		25.3	
Actuated g/C Ratio	0.48	0.48		0.61	0.61			0.23	0.31		0.23	
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)	334	888		222	1072			380	469		425	
v/s Ratio Prot		c0.47		c0.06	0.34				0.05			
v/s Ratio Perm	0.09			0.35				c0.21	0.13		0.15	
v/c Ratio	0.18	0.98		0.68	0.57			0.94	0.58		0.66	
Uniform Delay, d1	16.7	28.6		27.7	13.4			42.7	32.8		39.5	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.3	24.7		8.4	0.7			30.7	1.8		3.7	
Delay (s)	16.9	53.4		36.2	14.1			73.4	34.7		43.2	
Level of Service	B	D		D	B			E	C		D	
Approach Delay (s)		51.0			18.5			51.5			43.2	
Approach LOS		D			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	41.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	112.2	Sum of lost time (s)	15.0
Intersection Capacity Utilization	83.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Future Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Lane Util. Factor	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.97	1.00
Frt		0.997				0.919				0.850		
Flt Protected	0.950				0.950				0.994		0.950	
Satd. Flow (prot)	1668	3445	0	0	1685	3175	0	0	1810	1561	3286	1837
Flt Permitted	0.068				0.114				0.994		0.950	
Satd. Flow (perm)	119	3445	0	0	202	3175	0	0	1810	1561	3286	1837
Satd. Flow (RTOR)		2				271				94		
Adj. Flow (vph)	200	1080	22	2	51	772	915	43	299	364	268	71
Lane Group Flow (vph)	200	1102	0	0	53	1687	0	0	342	364	268	71
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split	NA
Protected Phases	1	6			5	2		3	3	5!	4	4
Permitted Phases	6			5 2!	2					3		
Detector Phase	1	6		5 2	5	2		3	3	5	4	4
Switch Phase												
Minimum Initial (s)	6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0	6.0
Minimum Split (s)	14.0	23.0			14.0	23.0		14.0	14.0	14.0	32.0	32.0
Total Split (s)	15.0	61.0			19.0	65.0		28.0	28.0	19.0	32.0	32.0
Total Split (%)	10.7%	43.6%			13.6%	46.4%		20.0%	20.0%	13.6%	22.9%	22.9%
Maximum Green (s)	7.0	54.0			11.0	58.0		20.0	20.0	11.0	24.0	24.0
Yellow Time (s)	6.0	5.0			6.0	5.0		6.0	6.0	6.0	6.0	6.0
All-Red Time (s)	2.0	2.0			2.0	2.0		2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-4.0	-3.0			-4.0	-3.0			-4.0	-4.0	-4.0	-4.0
Total Lost Time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	None	Min			None	Min		None	None	None	None	None
Walk Time (s)		4.0				4.0					4.0	4.0
Flash Dont Walk (s)		12.0				12.0					20.0	20.0
Pedestrian Calls (#/hr)		1				0					0	0
v/c Ratio	1.05	0.73			0.19	1.05			1.04	0.70	0.53	0.25
Control Delay	114.7	35.1			15.0	66.1			113.6	25.9	55.5	51.3
Queue Delay	0.0	0.0			0.0	0.0			0.0	0.0	0.0	0.0
Total Delay	114.7	35.1			15.0	66.1			113.6	25.9	55.5	51.3
Queue Length 50th (ft)	~140	407			19	~754			~316	139	110	54
Queue Length 95th (ft)	#319	530			41	#894			#502	200	144	94
Internal Link Dist (ft)		411				548			225			114
Turn Bay Length (ft)	115				190					100	80	
Base Capacity (vph)	190	1505			283	1609			328	526	695	388
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	1.05	0.73			0.19	1.05			1.04	0.69	0.39	0.18

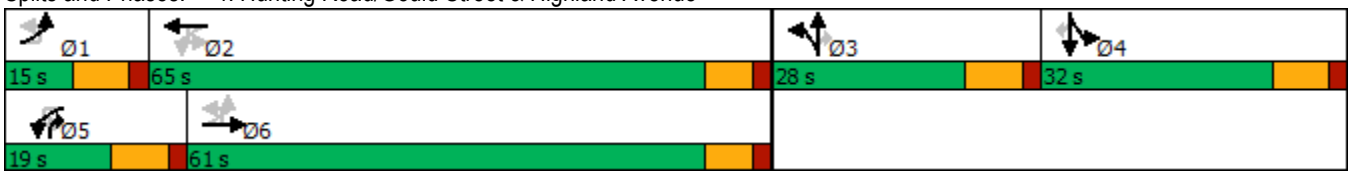
Intersection Summary
Cycle Length: 140

Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	45
Future Volume (vph)	45
Lane Util. Factor	1.00
Frt	0.850
Flt Protected	
Satd. Flow (prot)	1561
Flt Permitted	
Satd. Flow (perm)	1561
Satd. Flow (RTOR)	156
Adj. Flow (vph)	54
Lane Group Flow (vph)	54
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Detector Phase	4
Switch Phase	
Minimum Initial (s)	6.0
Minimum Split (s)	32.0
Total Split (s)	32.0
Total Split (%)	22.9%
Maximum Green (s)	24.0
Yellow Time (s)	6.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	-4.0
Total Lost Time (s)	4.0
Lead/Lag	Lag
Lead-Lag Optimize?	Yes
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	4.0
Flash Dont Walk (s)	20.0
Pedestrian Calls (#/hr)	0
v/c Ratio	0.15
Control Delay	0.8
Queue Delay	0.0
Total Delay	0.8
Queue Length 50th (ft)	0
Queue Length 95th (ft)	0
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	453
Starvation Cap Reductn	0
Spillback Cap Reductn	0
Storage Cap Reductn	0
Reduced v/c Ratio	0.12

Intersection Summary

Actuated Cycle Length: 132.5
Natural Cycle: 145
Control Type: Actuated-Uncoordinated
~ 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.
! Phase conflict between lane groups.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue



Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Future Volume (vph)	180	972	20	2	44	672	796	37	257	313	225	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	11	10	10	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95			1.00	0.95			1.00	1.00	0.97	1.00
Frt	1.00	1.00			1.00	0.92			1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00			0.95	1.00			0.99	1.00	0.95	1.00
Satd. Flow (prot)	1668	3445			1685	3174			1809	1561	3286	1837
Flt Permitted	0.07	1.00			0.11	1.00			0.99	1.00	0.95	1.00
Satd. Flow (perm)	119	3445			202	3174			1809	1561	3286	1837
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.87	0.86	0.86	0.86	0.84	0.84
Adj. Flow (vph)	200	1080	22	2	51	772	915	43	299	364	268	71
RTOR Reduction (vph)	0	1	0	0	0	146	0	0	0	67	0	0
Lane Group Flow (vph)	200	1101	0	0	53	1541	0	0	342	297	268	71
Heavy Vehicles (%)	1%	1%	0%	0%	0%	1%	1%	0%	1%	0%	3%	0%
Turn Type	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split	NA
Protected Phases	1	6			5	2		3	3	5!	4	4
Permitted Phases	6			5 2!	2					3		
Actuated Green, G (s)	61.8	54.8			68.2	58.0			20.0	30.2	16.4	16.4
Effective Green, g (s)	69.8	57.8			76.2	61.0			24.0	38.2	20.4	20.4
Actuated g/C Ratio	0.53	0.44			0.58	0.46			0.18	0.29	0.15	0.15
Clearance Time (s)	8.0	7.0			8.0	7.0			8.0	8.0	8.0	8.0
Vehicle Extension (s)	3.0	3.0			3.0	3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	191	1503			275	1462			327	450	506	283
v/s Ratio Prot	c0.09	0.32			0.02	c0.49			c0.19	0.07	c0.08	0.04
v/s Ratio Perm	0.46				0.09					0.12		
v/c Ratio	1.05	0.73			0.19	1.05			1.05	0.66	0.53	0.25
Uniform Delay, d1	41.2	30.9			17.4	35.7			54.2	41.4	51.6	49.3
Progression Factor	1.00	1.00			1.00	1.00			1.00	1.00	1.00	1.00
Incremental Delay, d2	78.1	1.9			0.3	39.2			62.3	3.6	1.0	0.5
Delay (s)	119.3	32.8			17.8	74.9			116.5	45.0	52.6	49.7
Level of Service	F	C			B	E			F	D	D	D
Approach Delay (s)		46.1				73.1			79.6			51.4
Approach LOS		D				E			E			D

Intersection Summary			
HCM 2000 Control Delay	63.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	132.4	Sum of lost time (s)	20.0
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		

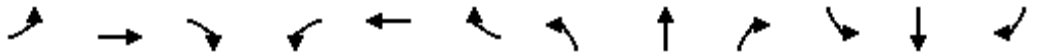
! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBR
Lane Configurations	
Traffic Volume (vph)	45
Future Volume (vph)	45
Ideal Flow (vphpl)	1900
Lane Width	11
Total Lost time (s)	4.0
Lane Util. Factor	1.00
Frt	0.85
Flt Protected	1.00
Satd. Flow (prot)	1561
Flt Permitted	1.00
Satd. Flow (perm)	1561
Peak-hour factor, PHF	0.84
Adj. Flow (vph)	54
RTOR Reduction (vph)	46
Lane Group Flow (vph)	8
Heavy Vehicles (%)	0%
Turn Type	Perm
Protected Phases	
Permitted Phases	4
Actuated Green, G (s)	16.4
Effective Green, g (s)	20.4
Actuated g/C Ratio	0.15
Clearance Time (s)	8.0
Vehicle Extension (s)	3.0
Lane Grp Cap (vph)	240
v/s Ratio Prot	
v/s Ratio Perm	0.01
v/c Ratio	0.03
Uniform Delay, d1	47.6
Progression Factor	1.00
Incremental Delay, d2	0.1
Delay (s)	47.7
Level of Service	D
Approach Delay (s)	
Approach LOS	

Intersection Summary

2030 Mitigated Weekday Evening Peak-Hour



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Future Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95
Frt		0.995			0.986				0.850		0.979	
Flt Protected	0.950			0.950				0.994			0.990	
Satd. Flow (prot)	1805	1872	0	1745	1811	0	0	1826	1561	0	3363	0
Flt Permitted	0.237			0.117				0.838			0.668	
Satd. Flow (perm)	450	1872	0	215	1811	0	0	1539	1561	0	2269	0
Satd. Flow (RTOR)		1			6				210		13	
Adj. Flow (vph)	45	532	20	392	810	84	31	241	218	102	325	70
Lane Group Flow (vph)	45	552	0	392	894	0	0	272	218	0	497	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		
Detector Phase	6	6		5	2		8	8	5	4	4	
Switch Phase												
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0	6.0	6.0	6.0	
Minimum Split (s)	17.5	17.5		13.5	17.5		12.5	12.5	13.5	12.5	12.5	
Total Split (s)	41.0	41.0		27.0	68.0		32.0	32.0	27.0	32.0	32.0	
Total Split (%)	32.0%	32.0%		21.1%	53.1%		25.0%	25.0%	21.1%	25.0%	25.0%	
Maximum Green (s)	33.5	33.5		19.5	60.5		25.5	25.5	19.5	25.5	25.5	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	3.5	4.0	3.5	3.5	
All-Red Time (s)	3.5	3.5		3.5	3.5		3.0	3.0	3.5	3.0	3.0	
Lost Time Adjust (s)	-3.5	-3.5		-3.5	-3.5			-2.5	-3.5		-2.5	
Total Lost Time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lead/Lag	Lag	Lag		Lead					Lead			
Lead-Lag Optimize?	Yes	Yes		Yes					Yes			
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Recall Mode	Min	Min		None	Min		None	None	None	None	None	
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.28	0.83		0.84	0.81			0.66	0.24		0.81	
Control Delay	34.1	44.9		41.9	24.6			45.0	2.5		47.6	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	
Total Delay	34.1	44.9		41.9	24.6			45.0	2.5		47.6	
Queue Length 50th (ft)	20	309		170	365			151	2		148	
Queue Length 95th (ft)	68	#683		#490	#1010			268	17		#274	
Internal Link Dist (ft)		308			362			135			245	
Turn Bay Length (ft)	60								115			
Base Capacity (vph)	159	663		468	1110			411	912		616	
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	0.28	0.83		0.84	0.81			0.66	0.24		0.81	

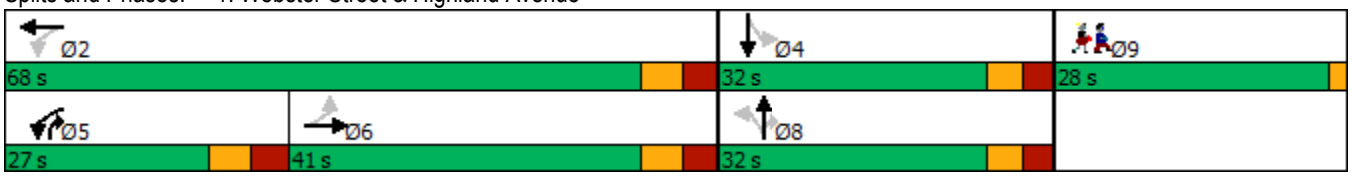
Intersection Summary
Cycle Length: 128

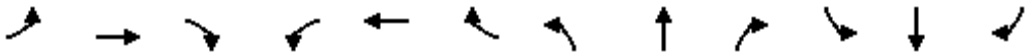
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	28.0
Total Split (s)	28.0
Total Split (%)	22%
Maximum Green (s)	26.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	19.0
Pedestrian Calls (#/hr)	9
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 105.6
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Webster Street & Highland Avenue





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Future Volume (vph)	40	468	18	376	778	81	24	188	170	83	263	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0	4.0		4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		0.95	
Frt	1.00	0.99		1.00	0.99			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)	1805	1872		1745	1811			1826	1561		3362	
Flt Permitted	0.24	1.00		0.12	1.00			0.84	1.00		0.67	
Satd. Flow (perm)	451	1872		215	1811			1539	1561		2270	
Peak-hour factor, PHF	0.88	0.88	0.88	0.96	0.96	0.96	0.78	0.78	0.78	0.81	0.81	0.81
Adj. Flow (vph)	45	532	20	392	810	84	31	241	218	102	325	70
RTOR Reduction (vph)	0	1	0	0	2	0	0	0	107	0	10	0
Lane Group Flow (vph)	45	551	0	392	892	0	0	272	111	0	487	0
Heavy Vehicles (%)	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%
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)	33.9	33.9		61.1	61.1			25.7	45.4		25.7	
Effective Green, g (s)	37.4	37.4		64.6	64.6			28.2	52.4		28.2	
Actuated g/C Ratio	0.35	0.35		0.60	0.60			0.26	0.49		0.26	
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)	157	653		461	1092			405	763		597	
v/s Ratio Prot		0.29		0.18	c0.49				0.03			
v/s Ratio Perm	0.10			c0.33				0.18	0.04		c0.21	
v/c Ratio	0.29	0.84		0.85	0.82			0.67	0.15		0.82	
Uniform Delay, d1	25.2	32.2		27.8	16.6			35.3	15.0		37.0	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	1.0	9.8		14.0	4.8			4.3	0.1		8.5	
Delay (s)	26.2	41.9		41.8	21.4			39.7	15.1		45.5	
Level of Service	C	D		D	C			D	B		D	
Approach Delay (s)		40.7			27.6			28.7			45.5	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	33.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	107.1	Sum of lost time (s)	14.0
Intersection Capacity Utilization	90.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Future Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Lane Util. Factor	0.95	1.00	0.95	0.95	0.95	1.00	0.95	0.95	1.00	1.00	1.00	0.97
Frt			0.994				0.969				0.850	
Flt Protected		0.950				0.950				0.984		0.950
Satd. Flow (prot)	0	1685	3469	0	0	1685	3375	0	0	1807	1561	3351
Flt Permitted		0.105				0.180				0.984		0.950
Satd. Flow (perm)	0	186	3469	0	0	319	3375	0	0	1807	1561	3351
Satd. Flow (RTOR)			4				35				119	
Adj. Flow (vph)	1	61	740	32	5	211	1086	279	44	90	103	797
Lane Group Flow (vph)	0	62	772	0	0	216	1365	0	0	134	103	797
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split
Protected Phases		1	6			5	2		3	3	5!	4
Permitted Phases	1 6	6			5 2!	2					3	
Detector Phase	1 6	1	6		5 2	5	2		3	3	5	4
Switch Phase												
Minimum Initial (s)		6.0	10.0			6.0	10.0		6.0	6.0	6.0	6.0
Minimum Split (s)		14.0	23.0			14.0	23.0		14.0	14.0	14.0	32.0
Total Split (s)		14.0	41.0			21.0	48.0		16.0	16.0	21.0	32.0
Total Split (%)		12.7%	37.3%			19.1%	43.6%		14.5%	14.5%	19.1%	29.1%
Maximum Green (s)		6.0	34.0			13.0	41.0		8.0	8.0	13.0	24.0
Yellow Time (s)		6.0	5.0			6.0	5.0		6.0	6.0	6.0	6.0
All-Red Time (s)		2.0	2.0			2.0	2.0		2.0	2.0	2.0	2.0
Lost Time Adjust (s)		-4.0	-3.0			-4.0	-3.0			-4.0	-4.0	-4.0
Total Lost Time (s)		4.0	4.0			4.0	4.0			4.0	4.0	4.0
Lead/Lag		Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag
Lead-Lag Optimize?		Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes
Vehicle Extension (s)		3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0
Recall Mode		None	Min			None	Min		None	None	None	None
Walk Time (s)			4.0				4.0					4.0
Flash Dont Walk (s)			12.0				12.0					20.0
Pedestrian Calls (#/hr)			0				0					1
v/c Ratio		0.28	0.68			0.59	0.97			0.66	0.21	0.91
Control Delay		17.3	34.4			21.6	48.8			63.3	3.2	54.5
Queue Delay		0.0	0.0			0.0	0.0			0.0	0.0	0.0
Total Delay		17.3	34.4			21.6	48.8			63.3	3.2	54.5
Queue Length 50th (ft)		21	241			79	488			92	0	284
Queue Length 95th (ft)		42	310			126	#657			#177	17	#386
Internal Link Dist (ft)			411				548			225		
Turn Bay Length (ft)		115				190					100	80
Base Capacity (vph)		218	1213			381	1410			203	510	877
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		0.28	0.64			0.57	0.97			0.66	0.20	0.91

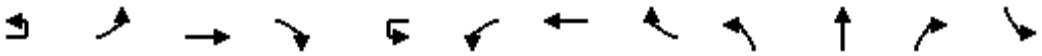
Intersection Summary
Cycle Length: 110

Lane Group	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	182	128
Future Volume (vph)	182	128
Lane Util. Factor	1.00	1.00
Frt		0.850
Flt Protected		
Satd. Flow (prot)	1837	1561
Flt Permitted		
Satd. Flow (perm)	1837	1561
Satd. Flow (RTOR)		198
Adj. Flow (vph)	207	145
Lane Group Flow (vph)	207	145
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Detector Phase	4	4
Switch Phase		
Minimum Initial (s)	6.0	6.0
Minimum Split (s)	32.0	32.0
Total Split (s)	32.0	32.0
Total Split (%)	29.1%	29.1%
Maximum Green (s)	24.0	24.0
Yellow Time (s)	6.0	6.0
All-Red Time (s)	2.0	2.0
Lost Time Adjust (s)	-4.0	-4.0
Total Lost Time (s)	4.0	4.0
Lead/Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes
Vehicle Extension (s)	3.0	3.0
Recall Mode	None	None
Walk Time (s)	4.0	4.0
Flash Dont Walk (s)	20.0	20.0
Pedestrian Calls (#/hr)	1	1
v/c Ratio	0.43	0.26
Control Delay	37.2	2.7
Queue Delay	0.0	0.0
Total Delay	37.2	2.7
Queue Length 50th (ft)	123	0
Queue Length 95th (ft)	190	16
Internal Link Dist (ft)	114	
Turn Bay Length (ft)		
Base Capacity (vph)	481	554
Starvation Cap Reductn	0	0
Spillback Cap Reductn	0	0
Storage Cap Reductn	0	0
Reduced v/c Ratio	0.43	0.26

Intersection Summary

Actuated Cycle Length: 107.2
Natural Cycle: 95
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
! Phase conflict between lane groups.

Splits and Phases: 4: Hunting Road/Gould Street & Highland Avenue



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Future Volume (vph)	1	57	696	30	5	207	1064	273	40	82	94	701
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	10	11	11	10	10	11	11	11	11	11	11
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			1.00	0.95			1.00	1.00	0.97
Frt		1.00	0.99			1.00	0.97			1.00	0.85	1.00
Flt Protected		0.95	1.00			0.95	1.00			0.98	1.00	0.95
Satd. Flow (prot)		1685	3468			1685	3376			1807	1561	3351
Flt Permitted		0.11	1.00			0.18	1.00			0.98	1.00	0.95
Satd. Flow (perm)		187	3468			319	3376			1807	1561	3351
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.98	0.98	0.98	0.98	0.91	0.91	0.91	0.88
Adj. Flow (vph)	1	61	740	32	5	211	1086	279	44	90	103	797
RTOR Reduction (vph)	0	0	3	0	0	0	21	0	0	0	77	0
Lane Group Flow (vph)	0	62	769	0	0	216	1344	0	0	134	26	797
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
Turn Type	custom	pm+pt	NA		custom	pm+pt	NA		Split	NA	pm+ov	Split
Protected Phases		1	6			5	2		3	3	5!	4
Permitted Phases	1 6	6			5 2!	2					3	
Actuated Green, G (s)		38.7	34.0			52.9	41.1			8.0	19.8	24.1
Effective Green, g (s)		46.7	37.0			57.8	44.1			12.0	27.8	28.1
Actuated g/C Ratio		0.43	0.34			0.53	0.40			0.11	0.26	0.26
Clearance Time (s)		8.0	7.0			8.0	7.0			8.0	8.0	8.0
Vehicle Extension (s)		3.0	3.0			3.0	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)		199	1178			367	1367			199	398	864
v/s Ratio Prot		0.02	0.22			c0.09	c0.40			c0.07	0.01	c0.24
v/s Ratio Perm		0.11				0.23					0.01	
v/c Ratio		0.31	0.65			0.59	0.98			0.67	0.07	0.92
Uniform Delay, d1		23.4	30.5			16.8	32.0			46.6	30.7	39.3
Progression Factor		1.00	1.00			1.00	1.00			1.00	1.00	1.00
Incremental Delay, d2		0.9	1.3			2.4	20.3			8.7	0.1	15.1
Delay (s)		24.3	31.8			19.2	52.3			55.2	30.8	54.4
Level of Service		C	C			B	D			E	C	D
Approach Delay (s)			31.3				47.8			44.6		
Approach LOS			C				D			D		

Intersection Summary			
HCM 2000 Control Delay	44.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	108.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	182	128
Future Volume (vph)	182	128
Ideal Flow (vphpl)	1900	1900
Lane Width	11	11
Total Lost time (s)	4.0	4.0
Lane Util. Factor	1.00	1.00
Frt	1.00	0.85
Flt Protected	1.00	1.00
Satd. Flow (prot)	1837	1561
Flt Permitted	1.00	1.00
Satd. Flow (perm)	1837	1561
Peak-hour factor, PHF	0.88	0.88
Adj. Flow (vph)	207	145
RTOR Reduction (vph)	0	108
Lane Group Flow (vph)	207	37
Heavy Vehicles (%)	0%	0%
Turn Type	NA	Perm
Protected Phases	4	
Permitted Phases		4
Actuated Green, G (s)	24.1	24.1
Effective Green, g (s)	28.1	28.1
Actuated g/C Ratio	0.26	0.26
Clearance Time (s)	8.0	8.0
Vehicle Extension (s)	3.0	3.0
Lane Grp Cap (vph)	474	402
v/s Ratio Prot	0.11	
v/s Ratio Perm		0.02
v/c Ratio	0.44	0.09
Uniform Delay, d1	33.8	30.7
Progression Factor	1.00	1.00
Incremental Delay, d2	0.6	0.1
Delay (s)	34.4	30.8
Level of Service	C	C
Approach Delay (s)	47.8	
Approach LOS	D	

Intersection Summary

STORMWATER REPORT

Medical Office Building

629-661 Highland Avenue
Needham, MA

PREPARED FOR

Boston Development Group, LLC
93 Union St, Suite 135
Newton Centre, MA, 02459
617.332.6400

PREPARED BY

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

ISSUE

August 4, 2023

Table of Contents

List of Tables

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Town of Needham's Stormwater Bylaw (the Bylaw) and associated regulations for stormwater design and management. Although the project is not subject to the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00), this Stormwater Report documents compliance with the MA Stormwater Management Standards per the requirements of the Bylaw.

Project Description

The Applicant, Boston Development Group, LLC, is proposing to construct a new medical office building with related site improvements (The Project) at the existing 629-661 Highland Avenue addresses in Needham, MA. The Project consists of a two story, 50,000 square foot building constructed over a new partially underground parking structure. Associated site improvements include an outdoor amenity space, 250 parking spaces, utilities improvements to support the proposed use, and ancillary landscape improvements.

The stormwater management design has been developed to ensure that proposed conditions do not impact any onsite or neighboring areas. While onsite impervious areas will decrease slightly, the redevelopment will result in a minor, overall increase in impervious area of approximately 13,700 SF due to widening of adjacent private roadways and driveways to accommodate two-way travel. A new, comprehensive stormwater management system focusing on water quality treatment and infiltration has been proposed for the Project. Due to anticipated vehicle volumes above 1,000 vehicle trips per day, the Project is considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) and as such, the Project has been designed to provide associated pretreatment prior to infiltration.

Site Description

The Project Site is located at 629-661 Highland Ave on approximately 1.9 acres of land in Needham, Massachusetts (see Figure 1). The Site lies within the surface watershed of the Charles River. The Site is bounded by Cross Street to the northeast, Arbor Street to the southwest, Highland Avenue to the southeast, and a commercial use property (40 Arbor Street) and private road to the northwest. See Figure 1, Site Locus Map.

Existing conditions at the Site consist primarily of four buildings and a garage structure, associated paved parking areas, and small areas of landscaping scattered throughout the Site. There is a larger area of grass and vegetation located at the northwest portion of the Site

between two terraced parking areas nearest to Arbor Street. Following the preparation of the Existing Conditions Plan of Land (Site Survey), one of the buildings and the garage have been razed.

Topography at the Site varies significantly and generally slopes from the south corner of the Site, near the intersection of Arbor Street and Highland Avenue, to the north corner of the Site, where the pavement in Cross Street terminates. Highland Avenue forms the highest topography on the Site and the road generally slopes from west (El. 166-feet±) to east (El. 156-feet±). Directly adjacent to Highland Avenue, the Site forms an upper terrace parking area with three buildings and ranges in elevations from El. 150-feet± to El. 140-feet±. The upper terrace covers approximately 70% of the overall Site. The Site then steps down to a lower terrace parking and grass/vegetated area where the demolished building and garage structure are located. The flat parking area portions of the lower terrace range in elevation from El. 138-feet± to El. 135-feet±. The lower terrace grass and vegetated area at the west end of the Site slopes up to Arbor Street and ranges in elevations from El. 158-feet± (at the street) to El. 138-feet± (at the flat parking area). The lower terrace covers approximately 30% of the overall Site.

Under existing conditions, surface runoff is captured and routed to two stormwater management systems at the Site. One is located in the upper terrace parking area and one is located in the lower terrace parking area. Both the upper and lower terrace stormwater system consist of a single water quality proprietary unit with grate inlet located at the low point of the parking area that directs stormwater to a subsurface infiltration system. The lower terrace stormwater system also collected and infiltrated roof runoff from the now demolished building. For the upper terrace area, overflows from larger storm events that exceed the capacity of the existing subsurface system are directed over the retaining wall of the parking area to the lower terrace area and collected within that system. For the lower terrace area, overflows from larger storm events pond in the parking area, would flood the recently demolished building, and spill towards Cross Street at approximate El. 138.4-feet± (3.7-feet± higher than the inlet elevation of the lower terrace stormwater system).

Soils Information

According to the Natural Resources Conservation Service (NRCS), surface soils on the Site consist of urban land in the upper terrace area, with no Hydrologic Soil Group (HSG) classification identified, and Merrimac-urban land complex in the lower terrace area, with an HSG 'A' classification. These classifications are consistent with the geotechnical investigations performed on the Site. Additional soil testing will be necessary during construction to confirm the design infiltration rates at each subsurface infiltration system location. While the infiltration rates are anticipated to vary at different infiltration system locations based on in-situ testing, for the purposes of design, the systems at the Site are assumed to have an infiltration rate of 1.02 in/hr., which was determined based on a subsurface infiltration program conducted by McPhail Associates to establish the anticipated hydraulic conductivity for each subsurface infiltration system. Where a soil texture (USDA) analysis was performed, the Rawls Rate was established using Table 2.3.3 of the MA Stormwater Management Standards. On-site soils are classified as Hydrologic Soil Groups (HSG) "A". Based on the soil evaluation included in Appendix C, the soils

at the elevations of proposed infiltration are 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 and predominately impervious with generally terraced topography. As shown, the project is divided into two onsite drainage subcatchments and four offsite drainage subcatchments that discharge to two existing design points. Figure 2 illustrates the existing drainage patterns on the Site. Under existing conditions, the following Design Points and contributing subcatchments have been identified:

Design Points

DP-1, Offsite to North: Surface discharge point to an existing pervious channel at the end of Cross Street.

DP-2, Highland Avenue: The existing Highland Avenue conventional stormwater drainage system owned by MassDOT.

Existing Subcatchment Areas

EX-1, Lower Lot and Buildings: This subcatchment area consists of the lower terrace parking and grass/vegetated area where the demolished building and garage structure are located. Overland runoff flows to the low point in the parking area where an existing grate inlet and single water quality proprietary unit capture and treat the runoff. Runoff is routed to an existing subsurface infiltration system, P-1. For modeling purposes, the roof runoff of the now demolished building is assumed to have been routed directly to the subsurface infiltration system, as the demolition of the building occurred recently in preparation for the Project. As previously indicated, overflows from larger storm events that exceed the capacity of the existing subsurface system are directed to DP-1.

EX-2, Upper Lot, Buildings, and Upstream Area: This subcatchment area consists of the upper terrace parking area with three buildings. Overland runoff flows to the low point in the parking area where an existing grate inlet and single water quality proprietary unit capture and treat the runoff. Runoff is routed to an existing subsurface infiltration system, P-2. As previously indicated, overflows from larger storm events that exceed the capacity of the existing subsurface system are directed to P-1.

EX-A, 40 Arbor Street and Upstream Area: This subcatchment area consists of the tributary areas from developed residential and commercial properties north and west of the Project Site. Runoff flows overland north of the Project Site in this subcatchment through the 40 Arbor Street property and discharges directly to DP-1.

EX-B, 673 Highland Avenue and Upstream Area: This subcatchment area consists of the tributary areas from developed commercial properties along Highland Avenue that are located west/southwest of the Project Site. There is an existing leaching catch basin meant to serve this entire area; however, the existing basin is completely plugged and buried under existing conditions. Onsite evidence of runoff is apparent to Arbor Street, and this flow travels east across Arbor Street and overflows into the Project Site. The runoff traverses the upper terrace area, is combined with the subcatchment EX-2, and is managed in P-2.

EX-C, Cross Street: This subcatchment area consists of the tributary areas from Cross Street and a portion of the existing lot located at the east edge of the Site. Runoff flows north overland in Cross Street and discharges directly to DP-1.

EX-D, Overland to Highland Avenue: This subcatchment area consists of the tributary areas from the minimal pervious area at the frontage of the Site and a small portion of Highland Avenue within the vicinity of the Project Area. Runoff flows south to combine with Highland Avenue runoff and is routed east in Highland Avenue (DP-2).

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)
EX-1	Infiltration; Overflow to DP-1	DP-1	0.6	73	5.0
EX-2	Infiltration; Overflow to EX-1	DP-1	1.1	73	5.0
EX-A	Overland flow direct to DP-1	DP-1	2.0	68	5.0
EX-B	Overland through site to P-2	DP-1	0.6	98	5.0
EX-C	Overland flow direct to DP-1	DP-1	0.8	73	5.0
EX-D	Overland flow direct to DP-2	DP-2	0.3	89	5.0

Proposed Drainage Conditions

Figure 3 illustrates the proposed "post construction" drainage conditions for the project. As shown, the project is divided into three drainage subcatchments located on-site and four drainage subcatchments located off-site that discharge treated stormwater to the two existing Design Points. The drainage areas are described below, and Table 2 provides a summary of the proposed conditions hydrologic data.

Proposed Subcatchment Areas

PR-1, On-site driveway and a portion of Arbor St.: This subcatchment area consists of the proposed driveway and adjacent vegetated areas at the north end of the Project Site and portions of Arbor Street. Runoff flows east in the proposed driveway and north in Arbor Street. New deep sump catch basins are proposed in paved areas and area drains are proposed in vegetated areas to collect surface runoff. Runoff is then directed toward structural water quality devices and ultimately discharged into P-1, an infiltration system constructed of plastic chambers surrounded by a bed of crushed stone. Storms up to and including the 25-year peak storm event will be contained below grade, with larger storms overflowing at the intersection of the new driveway and Cross Street and discharging to DP-1.

PR-2, Proposed building and exposed parking areas and portions of on-site vegetated areas adjacent to Highland Avenue, Cross Street, and Arbor Street: This subcatchment area consists of the building, exposed parking areas, and a majority of the on-site vegetated areas adjacent to Highland Avenue, Cross Street, and Arbor Street. New deep sump catch basins are proposed in paved areas and area drains are proposed in vegetated areas to collect surface runoff. A roof collection system will collect roof runoff. Runoff from the various stormwater collection systems is then directed toward structural water quality devices proposed outside of the building and garage structure footprint. Following treatment, runoff will be discharged into P-2, an infiltration system constructed of concrete chambers placed on a bed of crushed stone located under the garage structure footprint. Storms up to and including the 25-year peak storm event will be contained below grade. Larger storms will overflow out of a proposed overflow structure located outside of the structure footprint, near the intersection of the new driveway and Cross Street, and will discharge to DP-1.

PR-3, Permeable patio: This subcatchment area consists of the permeable patio amenity space proposed on the east side of the building. Rainfall that falls on the patio area will be infiltrated in place within the designed base/subbase of the patio. Overflow structure(s) within the patio area will route runoff from storm events greater than the 100-year to the infiltration system under the garage footprint, P-2.

EX-A, 40 Arbor Street and Upstream Area: This subcatchment area consists of the tributary areas from developed residential and commercial properties north and west of the Project Site. Runoff flows overland north of the Project Site in this subcatchment and discharges directly to DP-1.

EX-B, 673 Highland Avenue and Upstream Area: This subcatchment area consists of the tributary areas from developed commercial properties along Highland Avenue that are located west of the Project Site. In coordination with this project, the 673 Highland Avenue stormwater system has been upgraded to include a new subsurface infiltration system that captures and infiltrates runoff from the subject property's parking area and building. Storms up to and including the 25-year peak storm event will be contained below grade. Larger storms will overflow toward a new wall constructed on the south side of Arbor Street. Overland flows will flow behind the wall and will combine with the surface runoff of EX-A. The peak runoff and volume of the combined EX-A and EX-B subcatchments will not exceed pre-development conditions for storm events up to and including the 100-year peak storm event.

PR-C, Cross Street: This subcatchment area consists of the tributary areas from Cross Street and a small portion of the vegetated areas located adjacent to the road. This subcatchment area was reduced by approximately 17,400 square feet or 49% when compared to the existing conditions. This reduction comes as a result of a majority of the subcatchment's drainage from the Project Site is no longer directed to Cross Street and is instead managed in stormwater systems located within the Project Site. Runoff continues to flow north overland in Cross Street in this subcathment and discharges directly to DP-1 when compared to the existing conditions.

EX-D, Overland to Highland Avenue: This subcatchment area continues to maintain similar land cover and drainage patterns when compared to the existing conditions. Similar to the existing conditions, runoff from the subcatchment flows south to the Highland Avenue drainage system and is routed east in Highland Avenue (DP-2).

Table 2 Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
PR-1	Infiltration; Overflow to DP-1	DP-1	0.5	76	5.0
PR-2	Infiltration; Overflow to DP-1	DP-1	1.5	84	5.0
PR-3	Infiltration; Overflow to P-2.1	DP-1	0.1	98	5.0
EX-A	Overland flow direct to DP-1	DP-1	2.0	66	5.0
EX-B	Overland flow direct to DP-1	DP-1	0.6	98	5.0
PR-C	Overland flow direct to DP-1	DP-1	0.4	77	5.0
EX-D	Overland flow direct to DP-2	DP-2	0.3	95	5.0

The site design integrates a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook and Town of Needham requirements. Because the Project is considered a LUHPPL , the proposed stormwater management system has been designed to treat the one inch Water Quality Volume and provide 44% Total Suspended Solids (TSS) pretreatment prior to infiltration.

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 promoting water quality, pollutant reduction, and rate/volume mitigation through the installation of several high-capacity infiltration areas and a permeable patio amenity space. Additional information regarding volume mitigation and water quality treatment can be found in Appendices B and C, corresponding to MassDEP Stormwater Standards 3 and 4.

This page intentionally left blank.

Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated below, the proposed Project will comply with all ten of 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. The Project does not propose any new stormwater outlets and is not adjacent to any wetland resource areas.

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 4 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 A.

Table 4 Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	25-year	100-year
DP-1: Existing Outfall				
Existing	3.6	8.4	11.7	16.8
Proposed	2.0	5.8	8.5	12.9
DP-2: Existing Highland Avenue Drainage System				
Existing	0.9	1.6	2.0	2.7
Proposed	0.9	1.5	1.9	2.5

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3.

The Project is a redevelopment of an existing Site. On the project site itself, there will be a small decrease in impervious area. With the overall project area, including widening of adjacent roads and driveways, the Project proposes a slight increase in impervious area of approximately 13,600 SF, which results in a required recharge volume for HSG A soils of 680 CF. Additionally, there is an existing recharge capacity of approximately 7,270 cubic feet in the existing systems. Together, these are assumed to be the minimum required recharge volume totaling 7,950 CF.

Due to the Site's low-lying topography and lack of a piped drainage system outlet, the proposed infiltration systems are designed to manage stormwater flows from large-depth storm events. As such, the recharge volumes provided significantly exceed required volumes, since there are no low-flow outlets to the systems. Only at-grade overflows accommodations are provided. A total proposed volume of 22,890 cubic feet will be provided in the future condition, well exceeding the required volume by a factor of almost three.

Recharge of stormwater has been provided through the use of multiple subsurface systems designed to infiltrate the majority of stormwater tributary to the Site. The infiltration system on the exterior site will be plastic chambers surrounded by a bed of crushed stone (Stormtech units) and the infiltration system constructed below the parking structure will be concrete chambers placed on a bed of crushed stone (StormTrap units). Both systems have been sized using the Static Method, and each infiltration BMP has been designed to drain completely within 72 hours.

Table 5 below provides a summary of the proposed infiltration BMPs utilized for the Project.

Table 5 Summary of Recharge Calculations

Infiltration BMP	Provided Recharge Volume (cubic feet)
P-1.1: Stormtech 740	4,571
P-2.1: StormTrap	16,855
P-3.1: Permeable Patio	1,464
Total Provided Recharge	**22,890**
Total Required Recharge	

Whereas the stormwater infiltration improvements at the adjacent 673 Highland Avenue site are being undertaken under a separate project, the provided recharge volumes above do not account for that proposed system (Infiltration System "P-B" in the HydroCAD model). The offsite system has only been used to model project hydrology under Standard 2.

Soil information (including Geotechnical Report), computations, and a mounding analysis are included in Appendix B. The mounding analysis confirms that the system will drain completely within 72-hours of a storm event despite its proposed elevation being within four feet of the estimated seasonal high groundwater elevation.

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, as well as 44% pretreatment prior to infiltration BMPs. A majority of the treatment trains for the Project consist of deep-sump and hooded catch basins, structural water quality devices, and storage capacities infiltrating storms well exceeding the one-inch runoff event. The exception is the permeable patio that infiltrates rainfall over the footprint of the patio in-place. The base/subbase of the patio reservoir is proposed to be 2-feet deep to detain the volume of runoff of a peak 100-year storm event from the patio area.

Furthermore, given the emphasis on infiltration to achieve water quality treatment, Total Phosphorus loads from the Site will be reduce by close to 100% for onsite areas. A phosphorous removal calculation showing 99% TP removal has been included. The anticipated TP removal resulting from the Project's heavy emphasis on infiltration exceeds local and state requirements.

Whereas the stormwater infiltration improvements at the adjacent 673 Highland Avenue site are being undertaken under a separate project, the provided water quality volumes and phosphorus removals above do not account for that proposed system (Infiltration System "P-B" in the HydroCAD model). The offsite system has only been used to model project hydrology under Standard 2.

Computations and supporting information, including water quality treatment calculations, are included in Appendix C. The Long-Term Pollution Prevention Plan is included as part of the Operations and Maintenance Plan provided in Appendix E.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

Based on the Transportation Impact Assessment, the Project is expected to generate 1,800 vehicle trips on an average weekday. Assuming the upper, exposed parking lot will likely be utilized more frequently than the lower parking garage floor due to its proximity to the building, it is conservatively assumed that the Project will experience above 1,000 vehicle trips per day. As a result, the Project would be considered a LUHPPL and, therefore, has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and provide the pretreatment requirement of 44% TSS removal prior to infiltration. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix E.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff from LUHPPLs, see Appendix C.

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 is a redevelopment of an existing Site; however, the proposed stormwater management system 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 greater than an acre of land and is therefore required to obtain coverage under the Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under the CGP, 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 D.

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 E in combination with the Long-Term Pollution Prevention Plan.

Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures which were part of the previous development on this site will be removed during the site redevelopment. The design plans submitted with this report have been designed in full compliance with current standards. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.

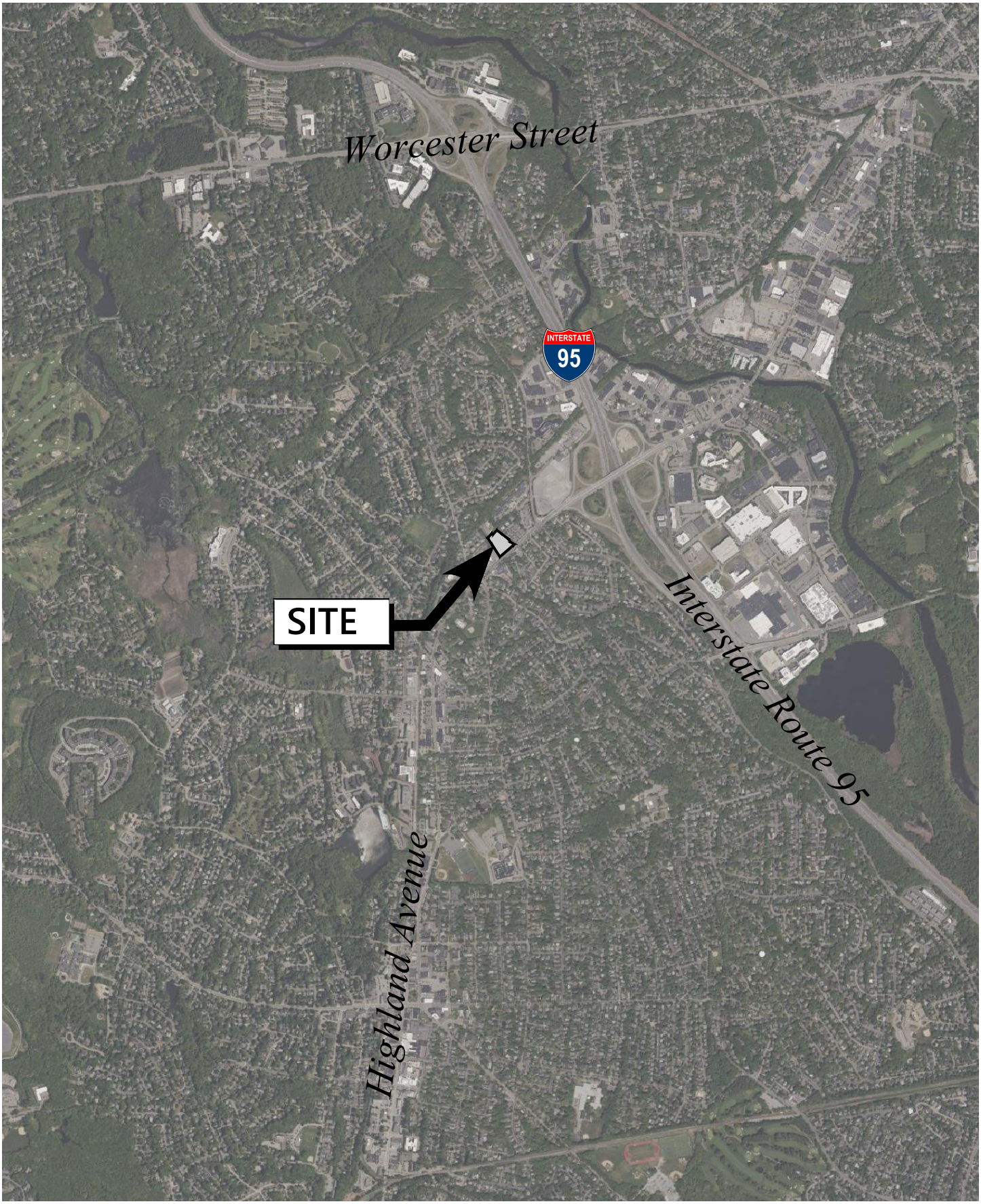
Town of Needham Stormwater Bylaw and Regulations

In accordance with the Town of Needham Stormwater Bylaw, the Project has been designed in accordance with the Town's regulations for stormwater management. In addition to meeting the MassDEP Stormwater Management Standards (as outlined previously herein), the following highlights are included in the analysis and associated design:

- The stormwater management system has been designed to reduce stormwater volumes and peak discharge rates for the 2-year, 10-year, 25-year, and 100-year design storms when comparing the post-development conditions to the pre-development conditions and pollutant loading was reduced through the use of stormwater infiltration mechanisms.
- A combined volumetric capacity is provided to recharge more than one-inch of rainfall depth over the total proposed impervious area of the property.
- The hydrologic analysis uses Needham-provided inputs for storm depths and runoff coefficients/land uses.
- The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide 80% TSS removal for stormwater runoff from all proposed impervious surfaces, as well as 44% pretreatment prior to infiltration BMPs. Although the local regulation allows stormwater runoff collected from building rooftops to be directly recharged into the ground without pretreatment, the proposed system routes rooftop stormwater through pretreatment devices to protect the functionality of the infiltration systems.
- The redevelopment project is designed to remove greater than 50% TP and pathogens.
- The proposed closed-drainage systems onsite are designed to accommodate a 25-year peak storm event.

As outlined through information included within this Stormwater Report and the attached appendices, the Project is expected to comply fully with the Town of Needham's requirements for stormwater management.

\\Vhb\gbl\proj\Wat-LD\14781.00 BDG Highland Ave Needham\cad\ld\Eng\Stormwater\14781.00 Locus.dwg



0 1000 2000 Feet

Locus Figure

629 Highland Ave
Needham, MA

Figure 1

August 4, 2023

\\vhb.com\gbl\proj\Wat-LD\14781.00 BDG Highland Ave Needham\cad\ld\Eng\Stormwater\14781.00-Drainage-EX Figure.dwg

DP-1
DP-2
P-1
P-2
EX-1
EX-2
EX-A
EX-B
EX-C
EX-D
GUILD (PRIVATE - 40' WIDE) ROAD
GUILD (PRIVATE - 30' WIDE) ROAD
PUTNAM (PRIVATE - 30' WIDE) STREET
CROSS (VARIABLE WIDTH) STREET
HIGHLAND PUBLIC - VARIABLE WIDTH AVENUE
ARBOR (VARIABLE WIDTH) STREET

Legend

SYMBOLS

X — **DESIGN POINT**

X — **DRAINAGE AREA DESIGNATION**

X — **POND**

LINETYPES

DRAINAGE AREA BOUNDARY

0 40 80 Feet

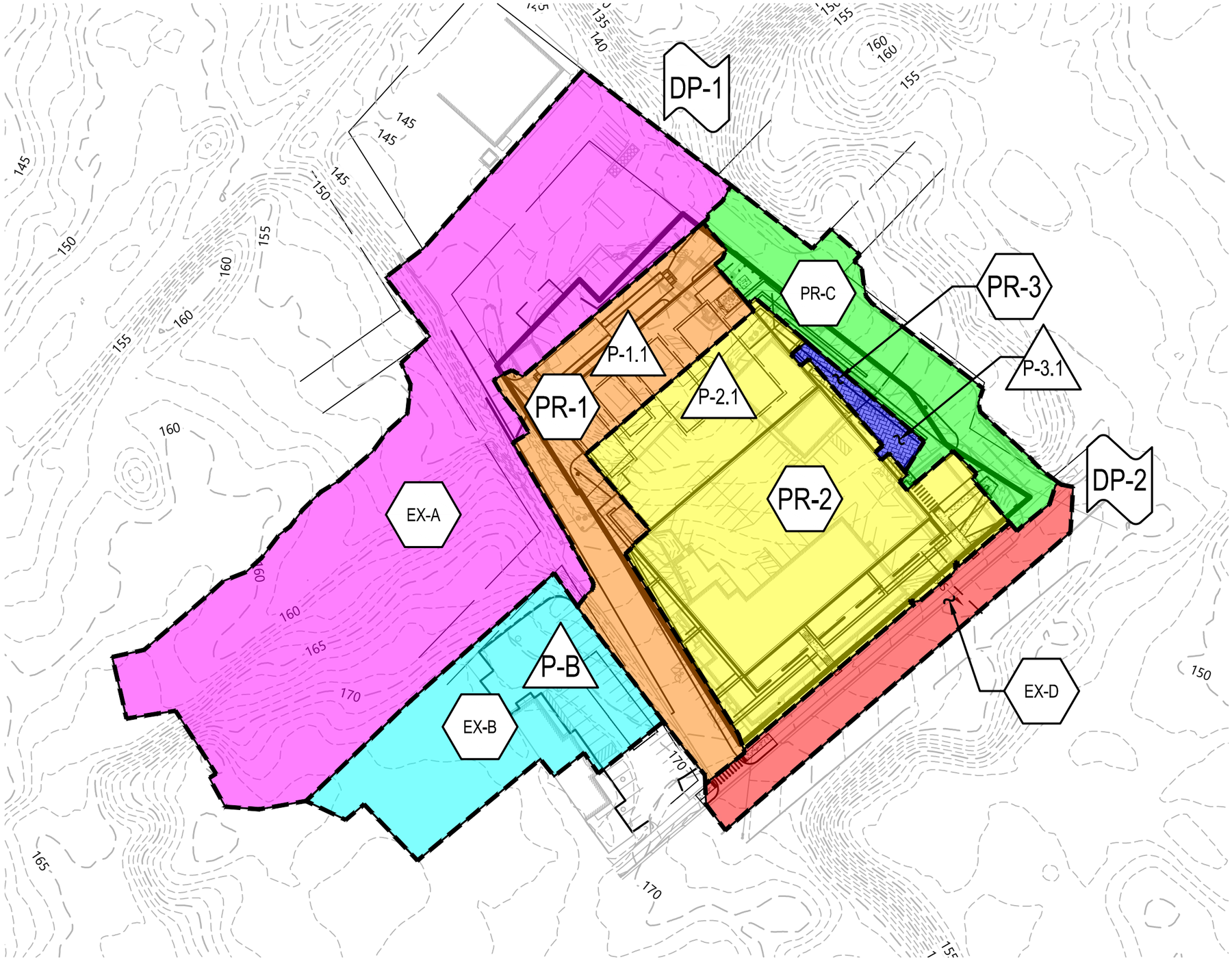
vhb

Existing Drainage Conditions

Figure 2

Highland Ave MOB
Needham, MA

08/04/2023



Legend

SYMBOLS

- DESIGN POINT
- DRAINAGE AREA DESIGNATION
- POND

LINETYPES

- DRAINAGE AREA BOUNDARY

0 50 100 Feet

vhb

Proposed Drainage Conditions

Figure 3

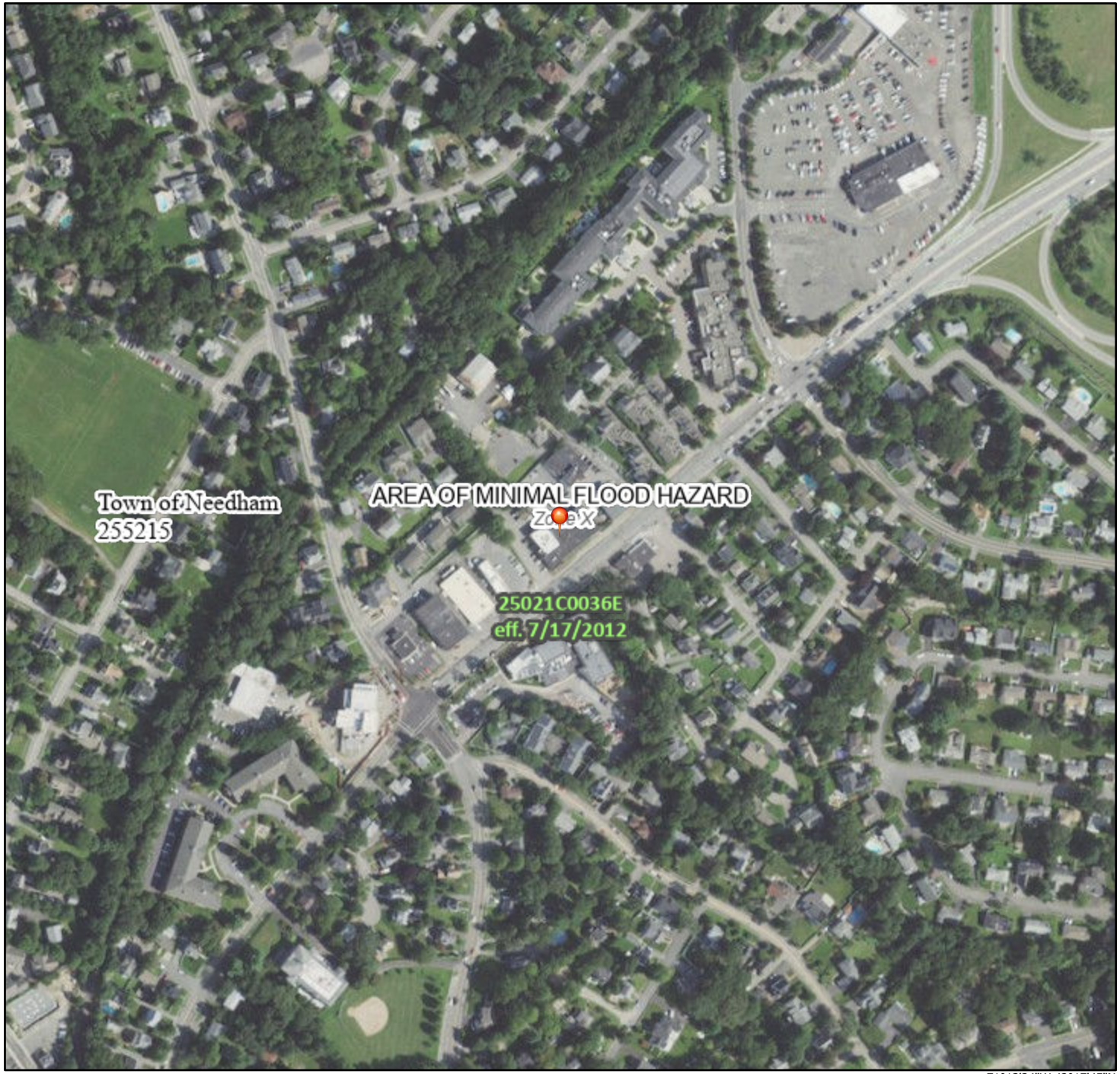
Highland Ave MOB
Needham, MA

08/04/2023

National Flood Hazard Layer FIRMette

FEMA

71°14'12"W 42°18'11"N



71°13'34"W 42°17'45"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

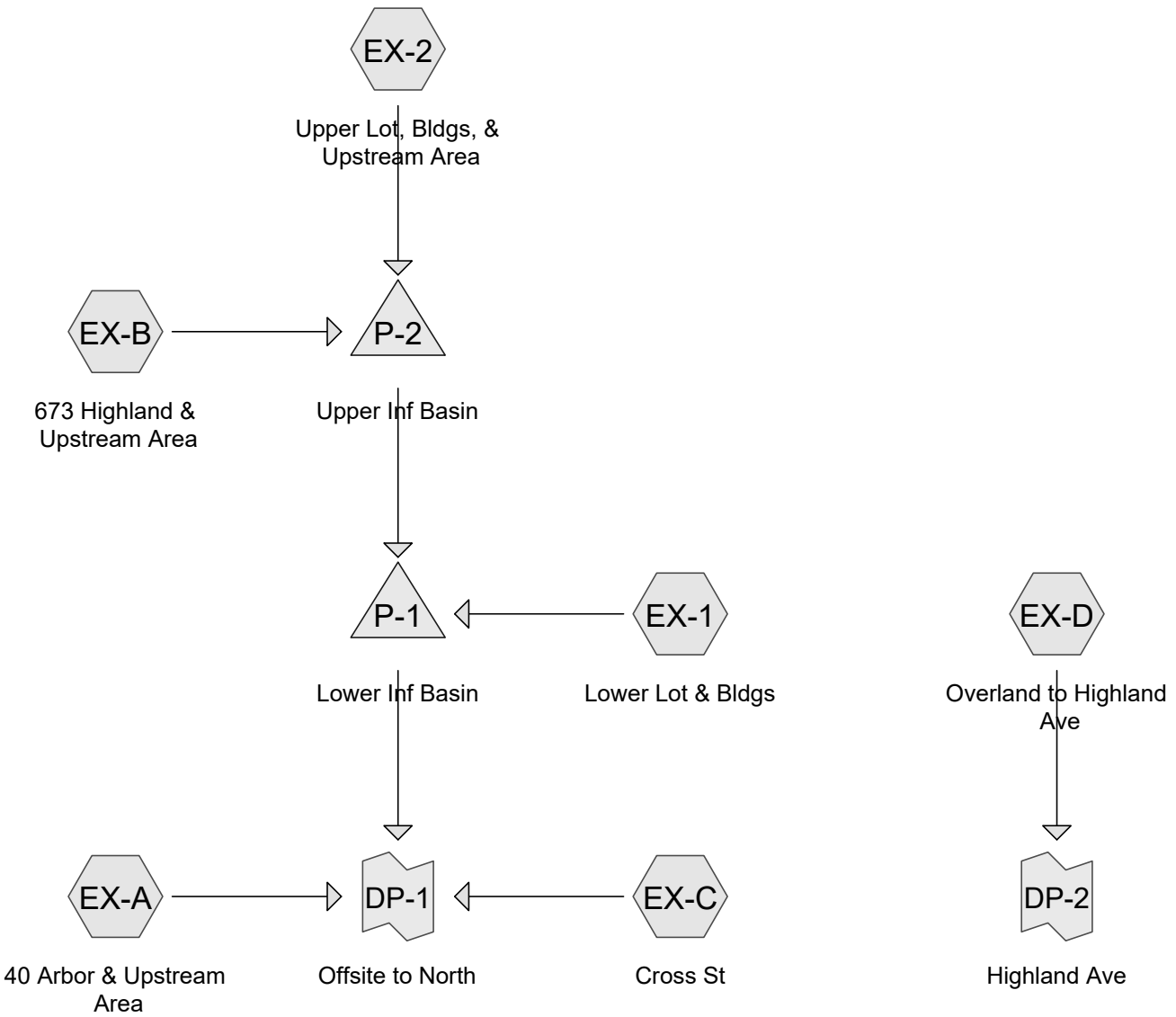
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/1/2023 at 9:19 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix A: 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 Town of Needham's designated rainfall depths, which correspond to the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm and NOAA Atlas 14 Point Precipitation Frequency Estimates for Needham as 3.3, 5.2, 6.4, and 8.2 inches, respectively. Runoff coefficients for the pre- and post-development conditions, as previously shown in Tables 2 and 3 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



Subcat Reach Pond Link

Routing Diagram for 14781.00-EX
Prepared by VHB, Printed 8/1/2023

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
67,902	39	>75% Grass cover, Good, HSG A (EX-1, EX-2, EX-A, EX-C, EX-D)
122,297	98	Paved parking, HSG A (EX-1, EX-2, EX-A, EX-B, EX-C, EX-D)
43,721	98	Roofs, HSG A (EX-1, EX-2, EX-A, EX-B, EX-C)
233,920	**81**	**TOTAL AREA**

2-Year Storm Event – Existing

Summary for Subcatchment EX-1: Lower Lot & Bldgs

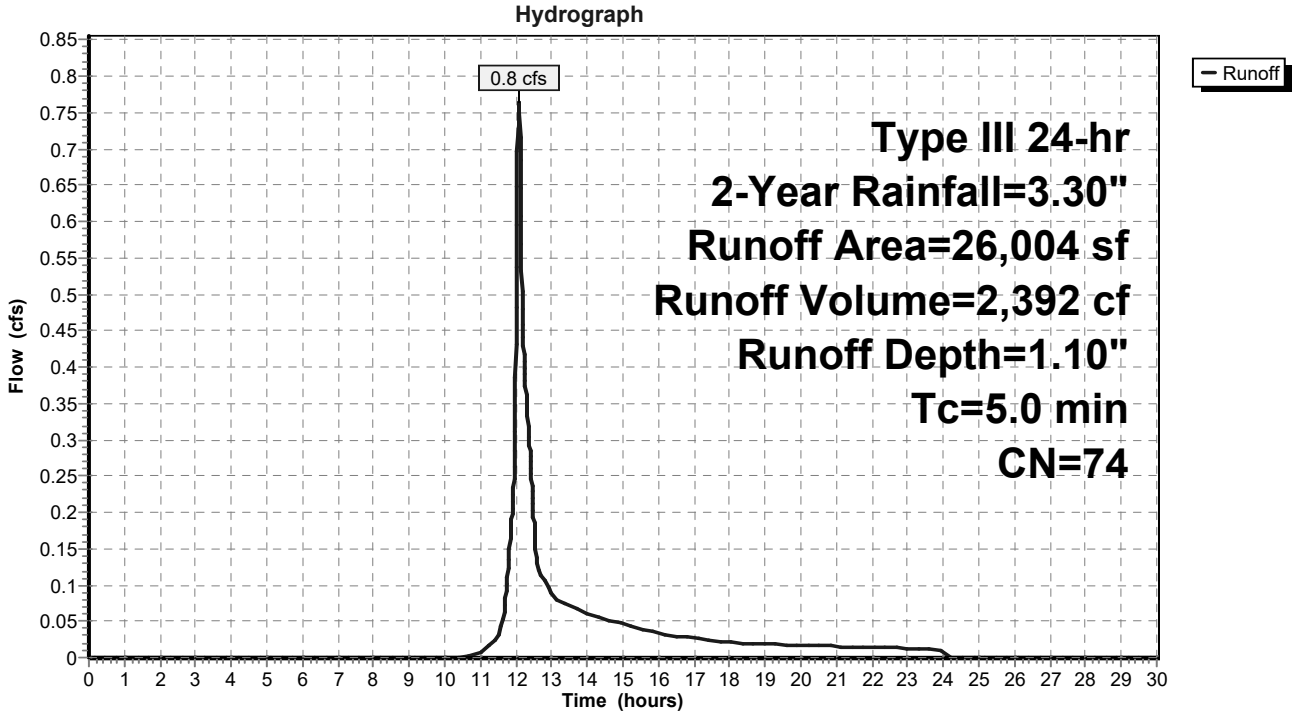
Runoff = 0.8 cfs @ 12.08 hrs, Volume= 2,392 cf, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
10,797	39	>75% Grass cover, Good, HSG A
13,290	98	Paved parking, HSG A
1,916	98	Roofs, HSG A
26,004	74	Weighted Average
10,797		41.52% Pervious Area
15,207		58.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-1: Lower Lot & Bldgs



Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

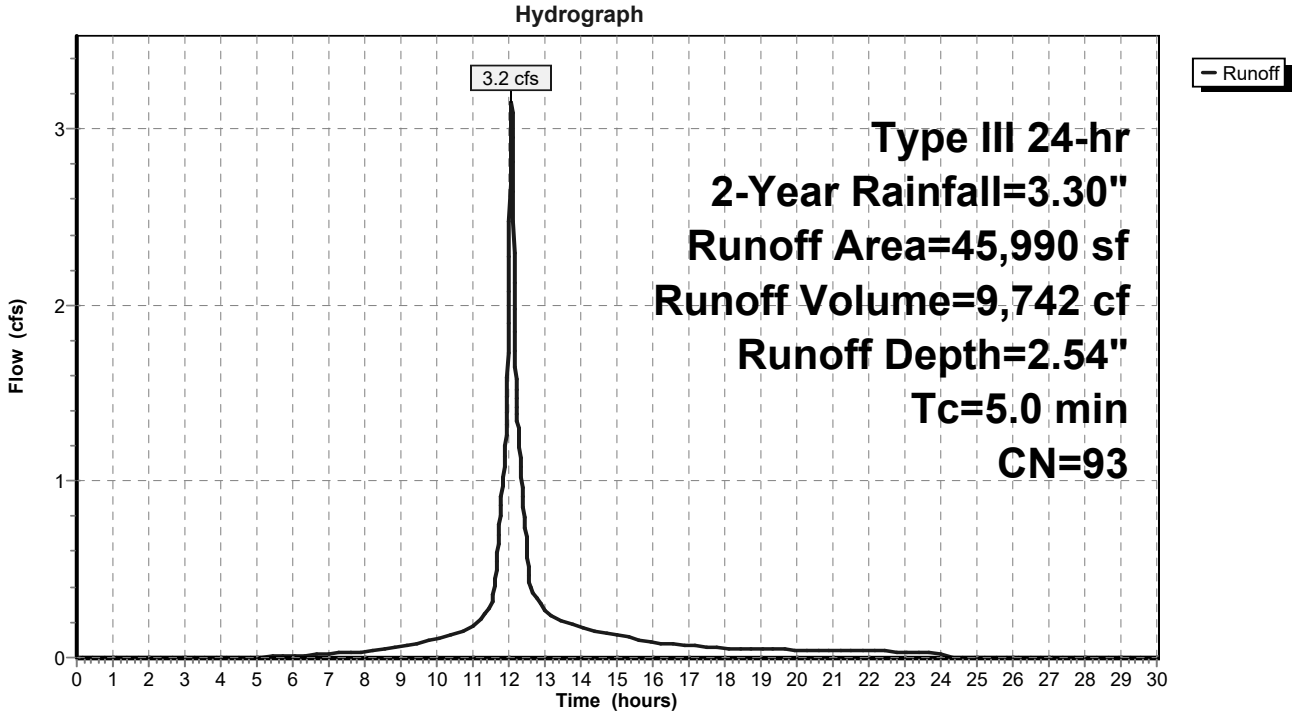
Runoff = 3.2 cfs @ 12.07 hrs, Volume= 9,742 cf, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
3,922	39	>75% Grass cover, Good, HSG A
26,311	98	Paved parking, HSG A
15,757	98	Roofs, HSG A
45,990	93	Weighted Average
3,922		8.53% Pervious Area
42,068		91.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area



Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

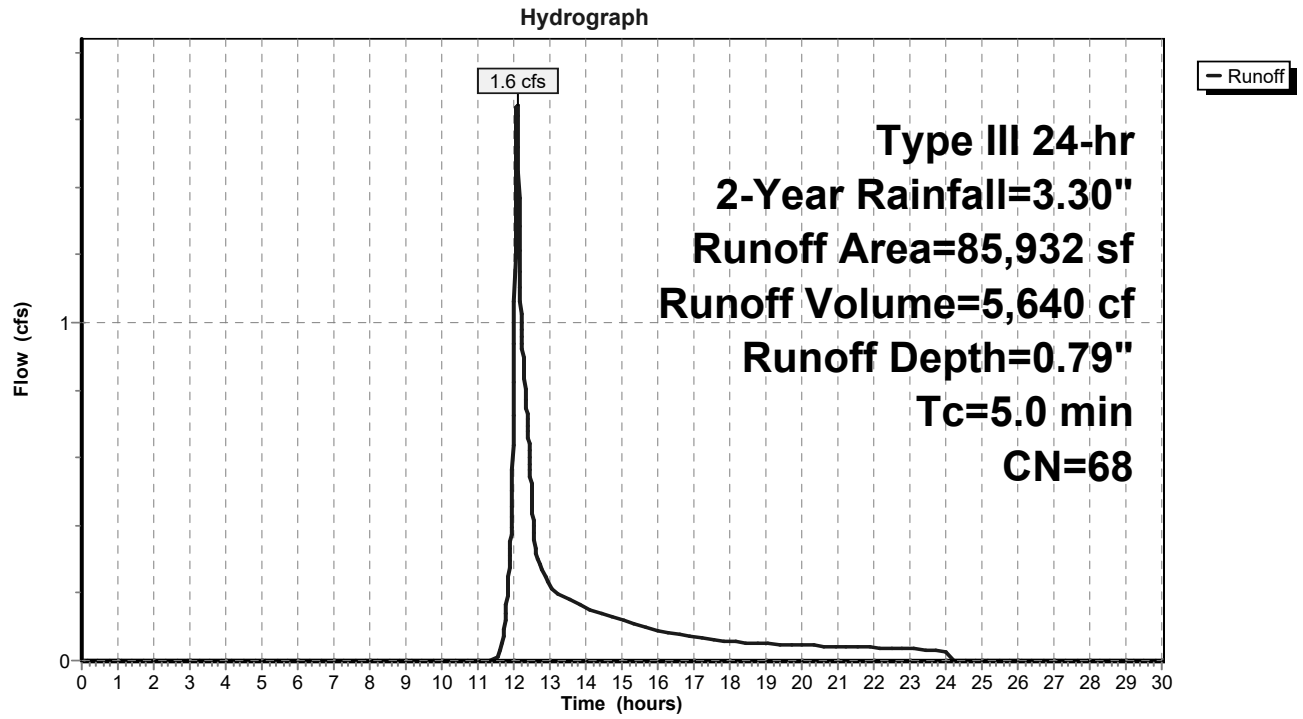
Runoff = 1.6 cfs @ 12.09 hrs, Volume= 5,640 cf, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
44,266	39	>75% Grass cover, Good, HSG A
28,825	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
85,932	68	Weighted Average
44,266		51.51% Pervious Area
41,666		48.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

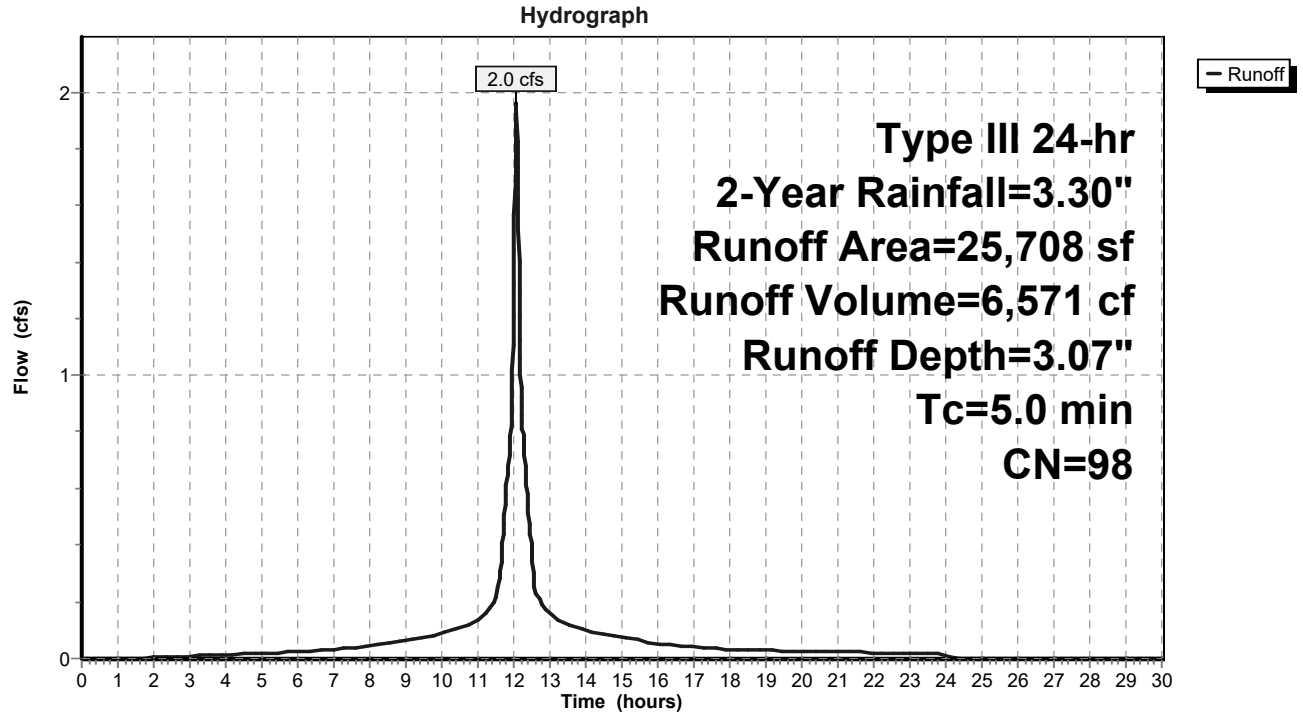
Runoff = 2.0 cfs @ 12.07 hrs, Volume= 6,571 cf, Depth= 3.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-C: Cross St

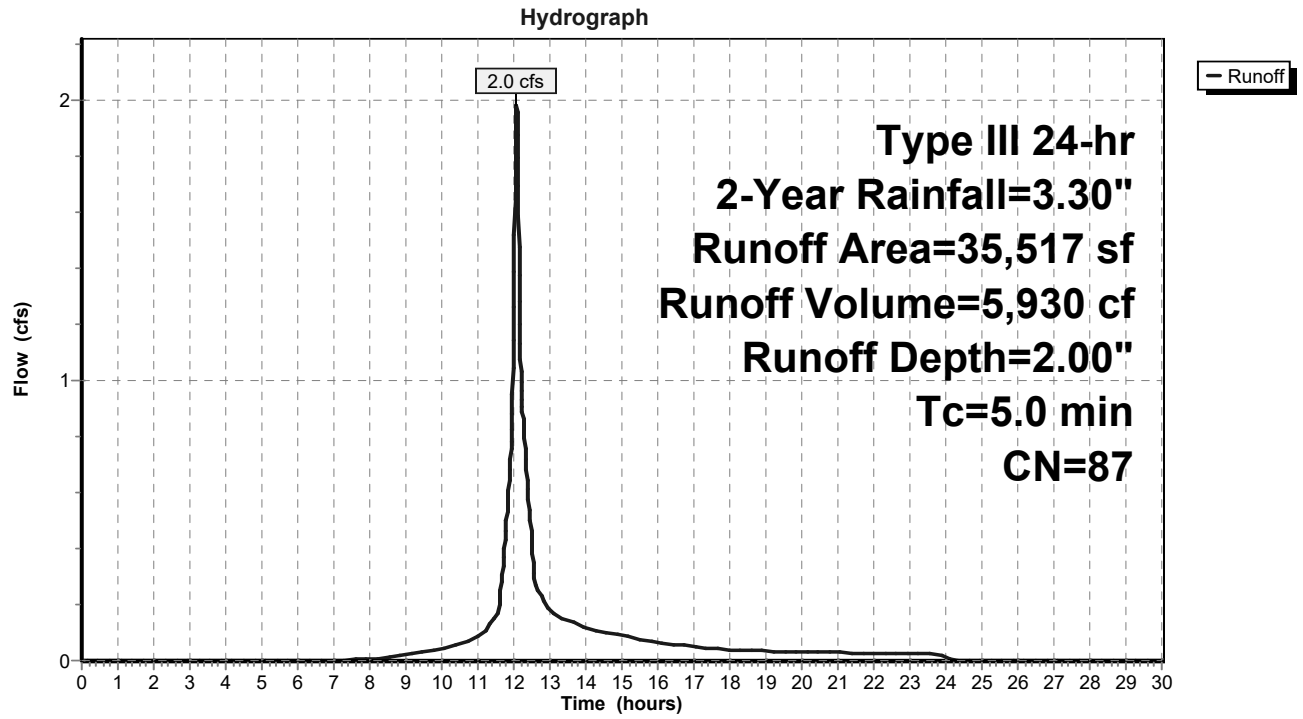
Runoff = 2.0 cfs @ 12.07 hrs, Volume= 5,930 cf, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
6,618	39	>75% Grass cover, Good, HSG A
22,132	98	Paved parking, HSG A
6,767	98	Roofs, HSG A
35,517	87	Weighted Average
6,618		18.63% Pervious Area
28,898		81.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-C: Cross St



Summary for Subcatchment EX-D: Overland to Highland Ave

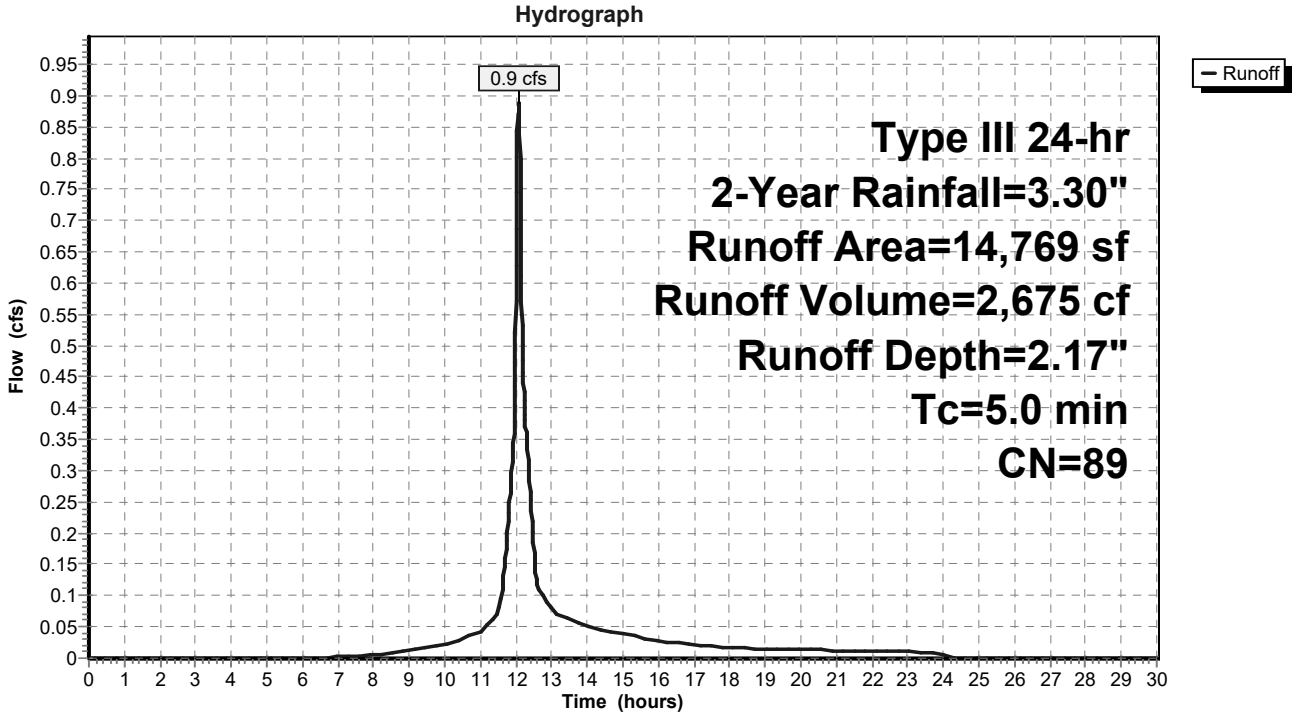
Runoff = 0.9 cfs @ 12.07 hrs, Volume= 2,675 cf, Depth= 2.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
2,298	39	>75% Grass cover, Good, HSG A
12,471	98	Paved parking, HSG A
14,769	89	Weighted Average
2,298		15.56% Pervious Area
12,471		84.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Pond P-1: Lower Inf Basin

Inflow Area = 97,702 sf, 84.93% Impervious, Inflow Depth = 1.46" for 2-Year event
Inflow = 5.8 cfs @ 12.07 hrs, Volume= 11,869 cf
Outflow = 0.1 cfs @ 11.86 hrs, Volume= 7,554 cf, Atten= 98%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.86 hrs, Volume= 7,554 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 136.06' @ 16.15 hrs Surf.Area= 2,050 sf Storage= 8,860 cf

Plug-Flow detention time= 519.4 min calculated for 7,554 cf (64% of inflow)
Center-of-Mass det. time= 451.3 min (1,249.9 - 798.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	130.03'	1,831 cf	**44.25'W x 46.34'L x 3.50'H Stone Bed for StormTech** 7,176 cf Overall - 2,481 cf Embedded = 4,696 cf x 39.0% Voids
#2A	130.53'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 9 Rows
#3	133.53'	4 cf	**2.00'D x 1.15'H Structure with Grate Inlet** Impervious
#4	134.68'	41,949 cf	**Parking Lot Surface Storage-Lower Terrace (Prismatic)** Listed below (Recal
		46,264 cf	Total Available Storage

Storage Group A created with Chamber Wizard

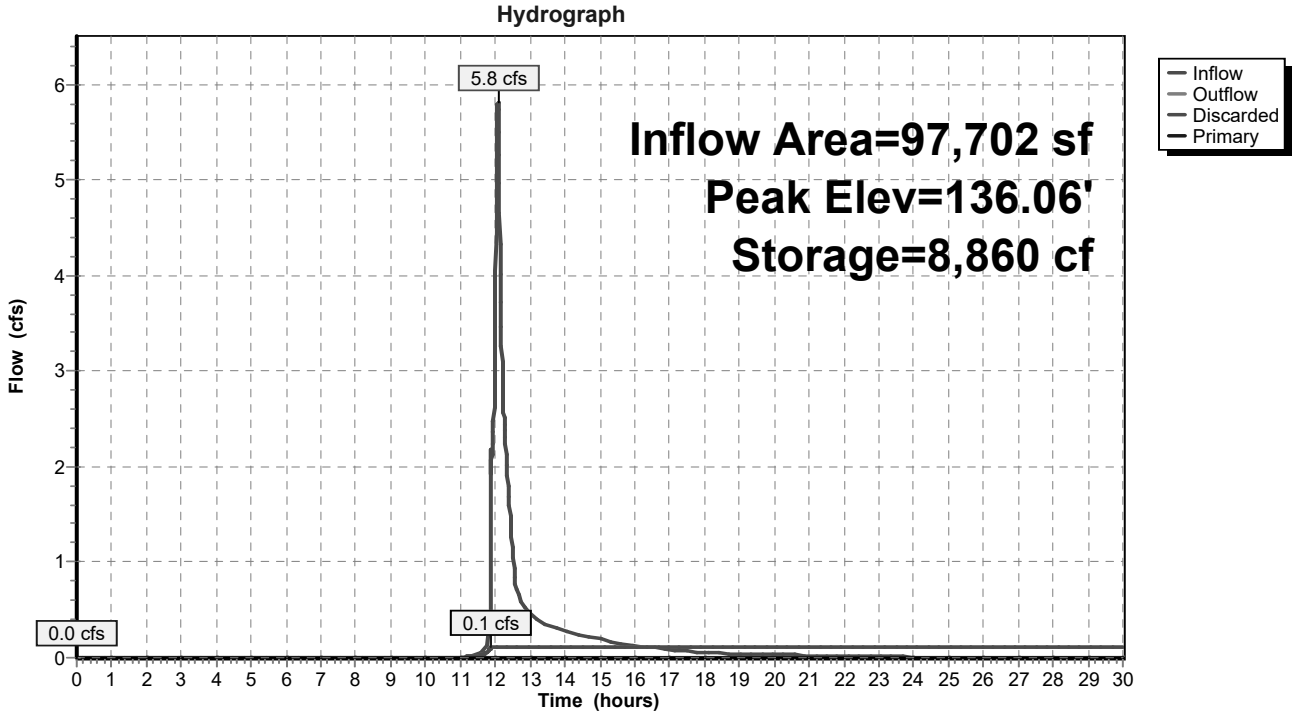
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
134.68	0	0	0
134.70	4	0	0
135.00	1,483	223	223
136.00	6,384	3,934	4,157
137.00	10,744	8,564	12,721
138.00	14,921	12,833	25,553
139.00	17,870	16,396	41,949

Device	Routing	Invert	Outlet Devices
#1	Discarded	130.03'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	138.26'	**20.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.1 cfs @ 11.86 hrs HW=130.12' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=130.03' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond P-1: Lower Inf Basin



Summary for Pond P-2: Upper Inf Basin

Inflow Area = 71,698 sf, 94.53% Impervious, Inflow Depth = 2.73" for 2-Year event
Inflow = 5.1 cfs @ 12.07 hrs, Volume= 16,313 cf
Outflow = 5.1 cfs @ 12.07 hrs, Volume= 14,271 cf, Atten= 0%, Lag= 0.2 min
Discarded = 0.1 cfs @ 7.22 hrs, Volume= 4,795 cf
Primary = 5.1 cfs @ 12.07 hrs, Volume= 9,477 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 144.04' @ 12.07 hrs Surf.Area= 963 sf Storage= 3,254 cf

Plug-Flow detention time= 155.0 min calculated for 14,271 cf (87% of inflow)
Center-of-Mass det. time= 97.8 min (874.0 - 776.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	133.73'	1,823 cf	**30.00'W x 32.10'L x 6.00'H Stone Bed for StormTech** 5,777 cf Overall - 1,103 cf Embedded = 4,675 cf x 39.0% Voids
#2A	134.23'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 6 Rows
#3	139.73'	12 cf	**2.00'D x 3.74'H Structure with Grate Inlet** Impervious
#4	143.46'	2,684 cf	**Parking Lot Surface Storage-Upper Terrace (Prismatic)** Listed below (Recal
		5,621 cf	Total Available Storage

Storage Group A created with Chamber Wizard

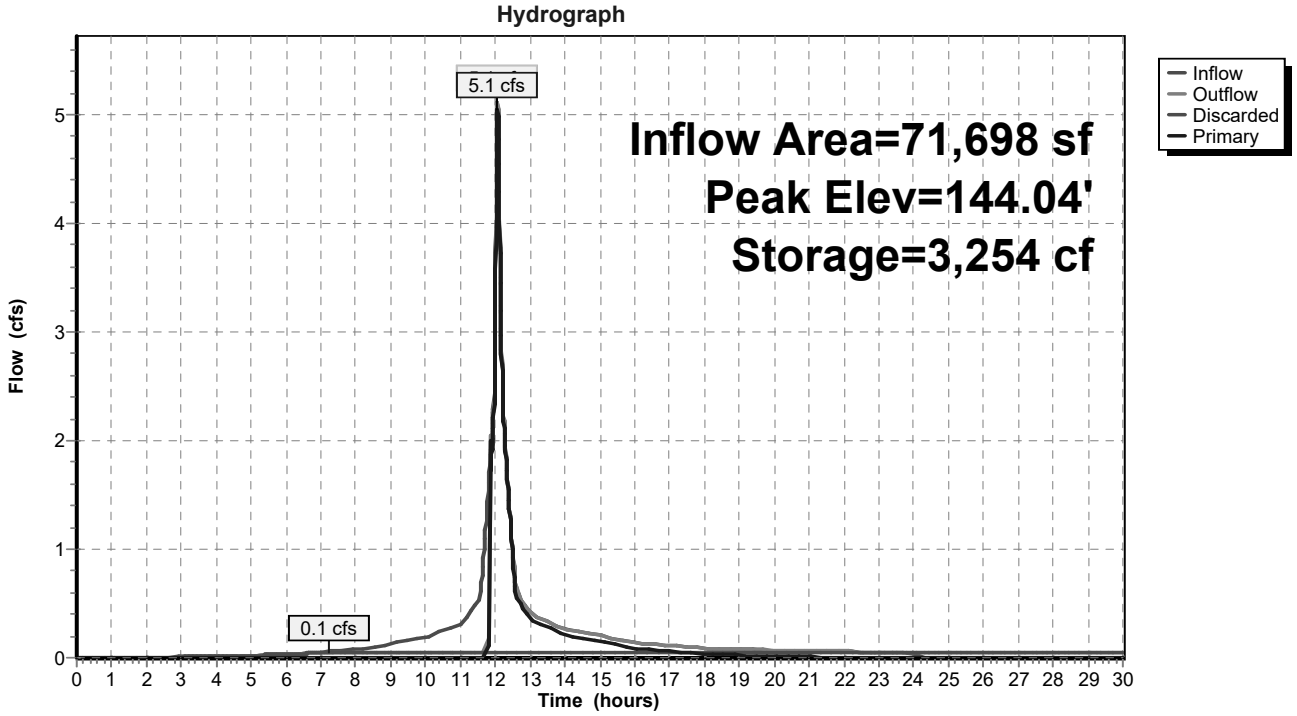
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
143.46	0	0	0
143.50	4	0	0
144.00	1,080	271	271
145.00	3,745	2,413	2,684

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.73'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	144.00'	**151.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.1 cfs @ 7.22 hrs HW=133.84' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=3.2 cfs @ 12.07 hrs HW=144.04' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 3.2 cfs @ 0.54 fps)

Pond P-2: Upper Inf Basin

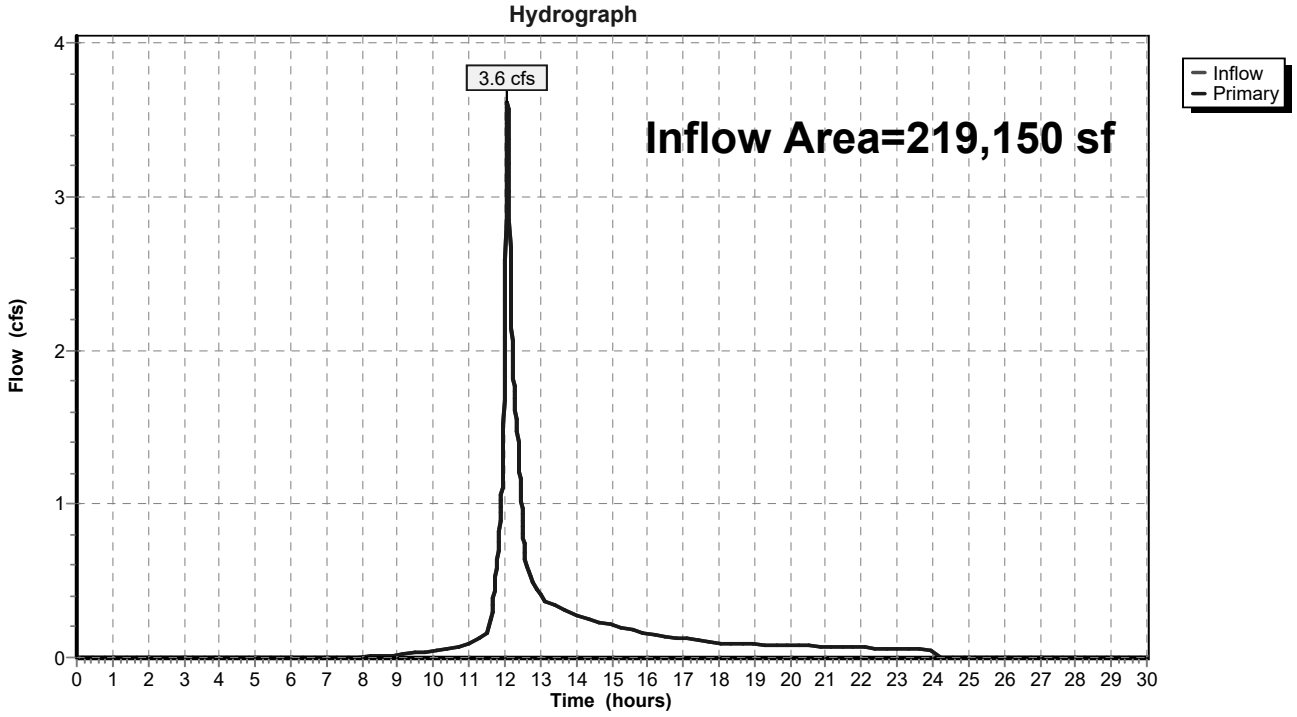


Summary for Link DP-1: Offsite to North

Inflow Area = 219,150 sf, 70.06% Impervious, Inflow Depth = 0.63" for 2-Year event
Inflow = 3.6 cfs @ 12.08 hrs, Volume= 11,570 cf
Primary = 3.6 cfs @ 12.08 hrs, Volume= 11,570 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

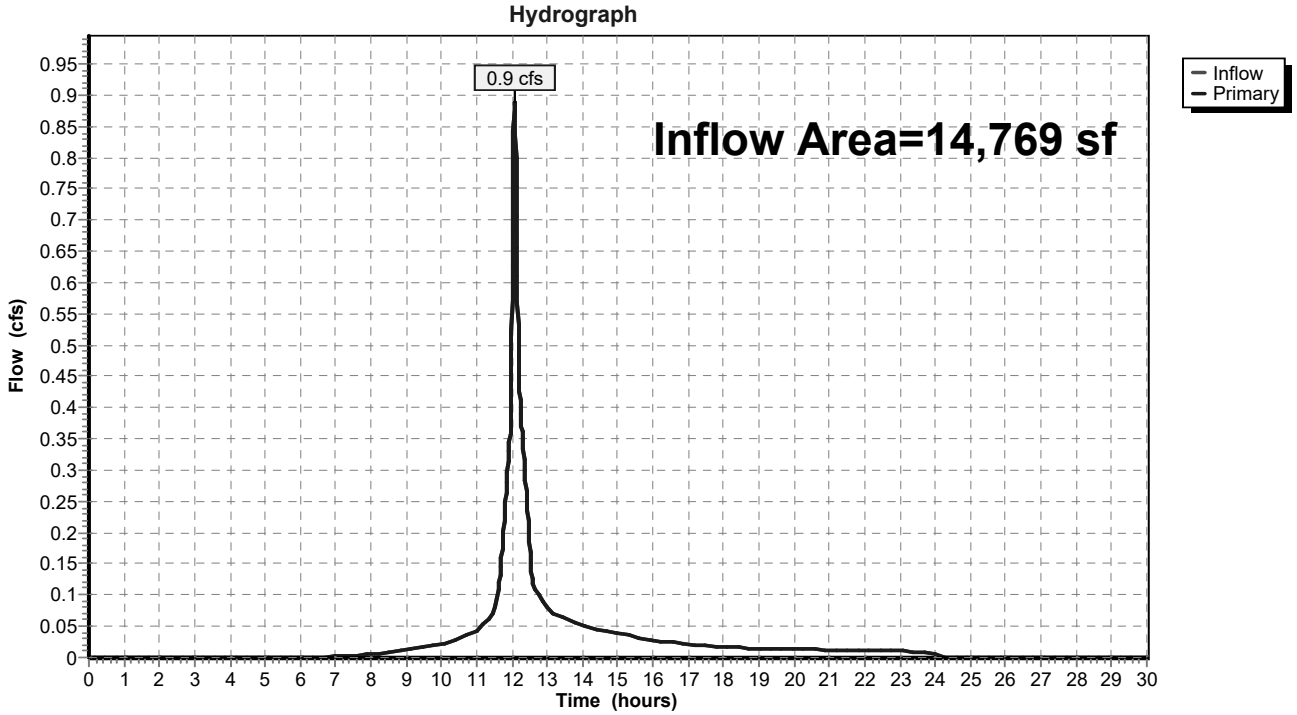


Summary for Link DP-2: Highland Ave

Inflow Area = 14,769 sf, 84.44% Impervious, Inflow Depth = 2.17" for 2-Year event
Inflow = 0.9 cfs @ 12.07 hrs, Volume= 2,675 cf
Primary = 0.9 cfs @ 12.07 hrs, Volume= 2,675 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



10-Year Storm Event – Existing

Summary for Subcatchment EX-1: Lower Lot & Bldgs

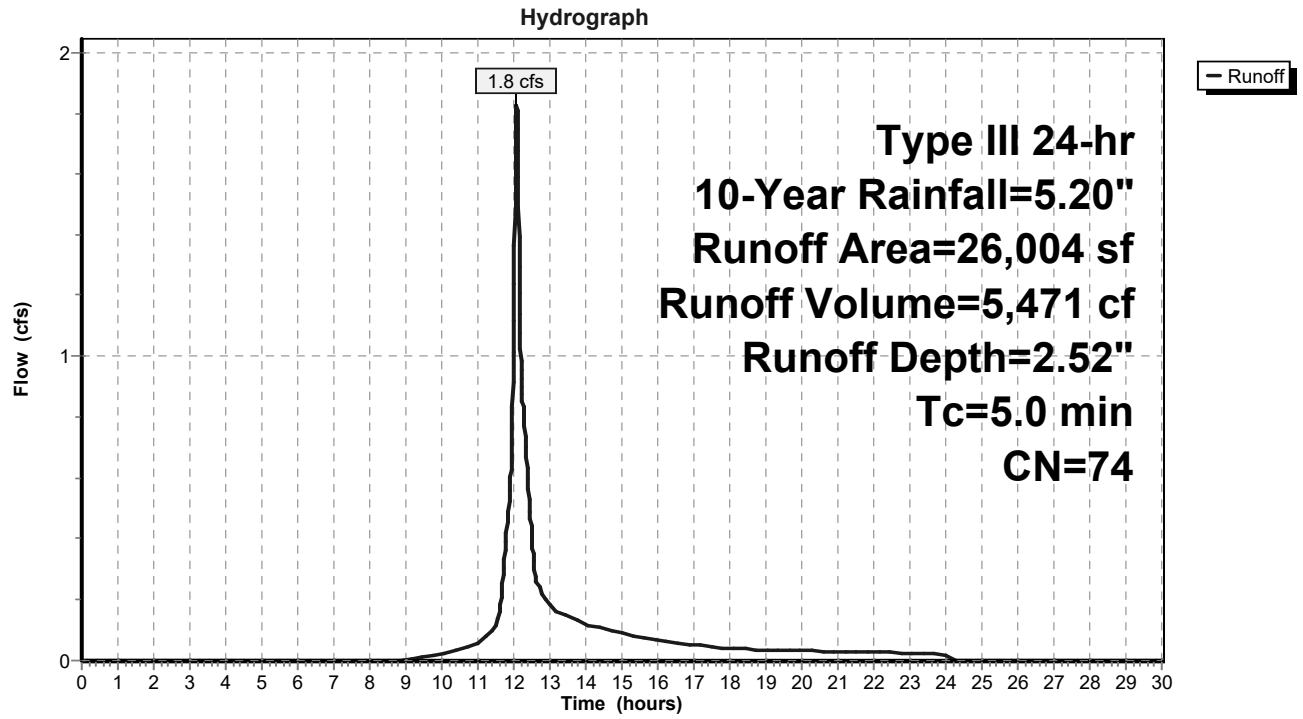
Runoff = 1.8 cfs @ 12.08 hrs, Volume= 5,471 cf, Depth= 2.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
10,797	39	>75% Grass cover, Good, HSG A
13,290	98	Paved parking, HSG A
1,916	98	Roofs, HSG A
26,004	74	Weighted Average
10,797		41.52% Pervious Area
15,207		58.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-1: Lower Lot & Bldgs



Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

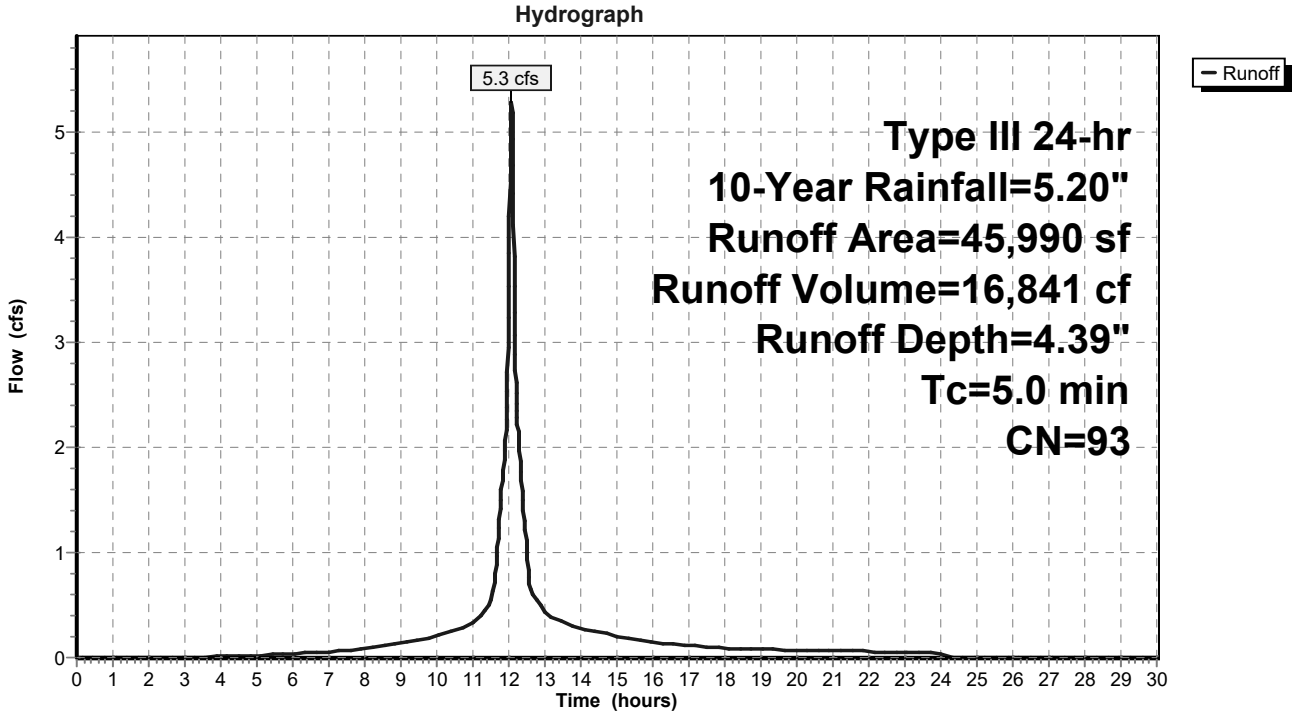
Runoff = 5.3 cfs @ 12.07 hrs, Volume= 16,841 cf, Depth= 4.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
3,922	39	>75% Grass cover, Good, HSG A
26,311	98	Paved parking, HSG A
15,757	98	Roofs, HSG A
45,990	93	Weighted Average
3,922		8.53% Pervious Area
42,068		91.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area



Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

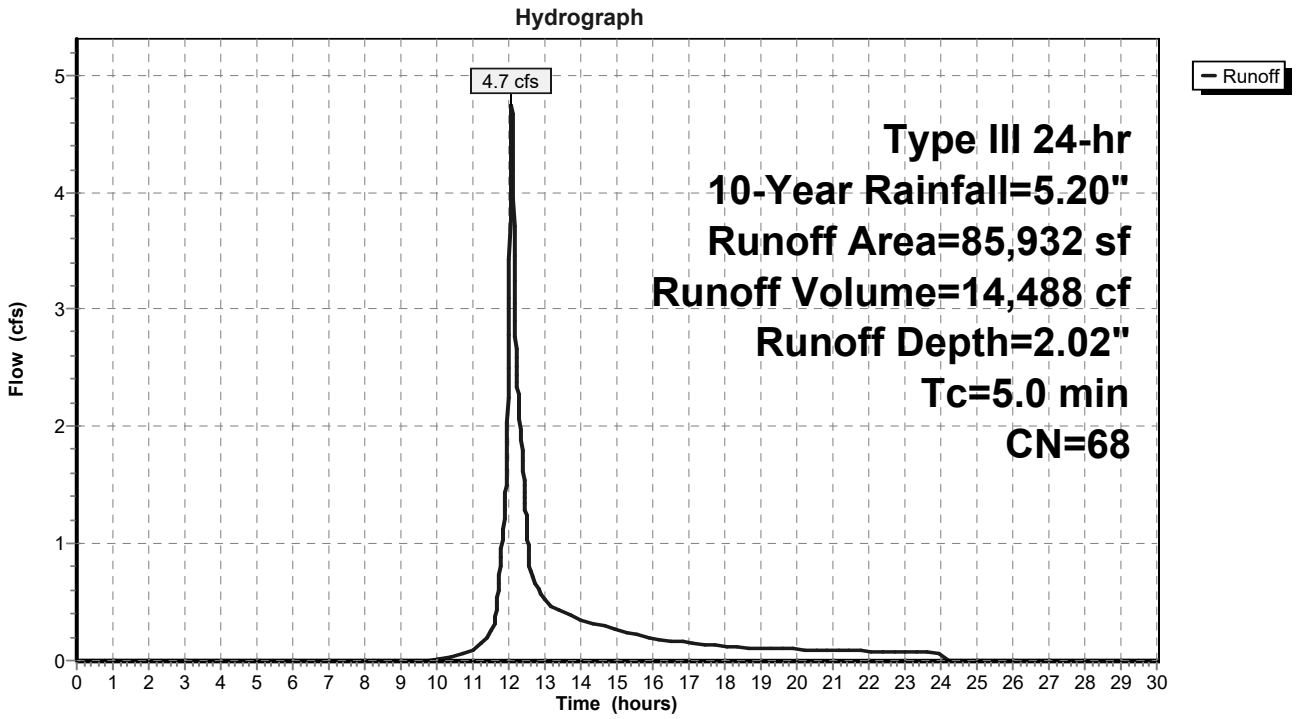
Runoff = 4.7 cfs @ 12.08 hrs, Volume= 14,488 cf, Depth= 2.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
44,266	39	>75% Grass cover, Good, HSG A
28,825	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
85,932	68	Weighted Average
44,266		51.51% Pervious Area
41,666		48.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

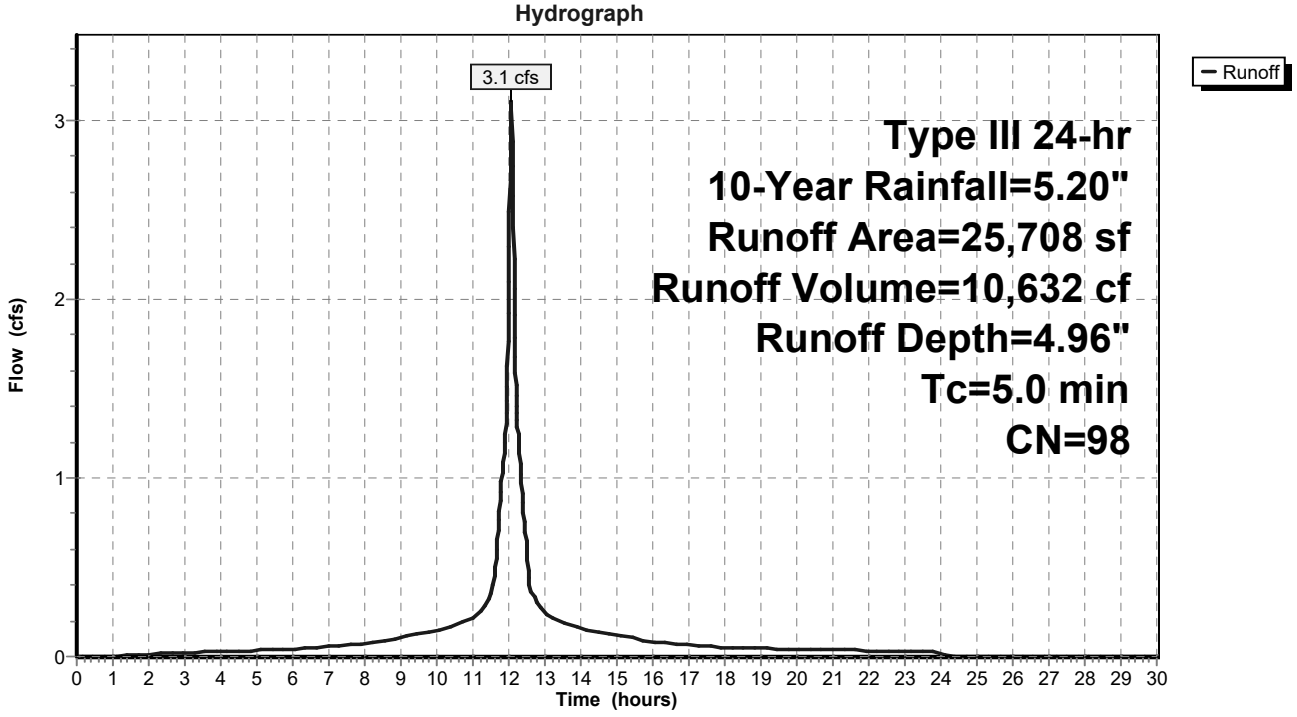
Runoff = 3.1 cfs @ 12.07 hrs, Volume= 10,632 cf, Depth= 4.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-C: Cross St

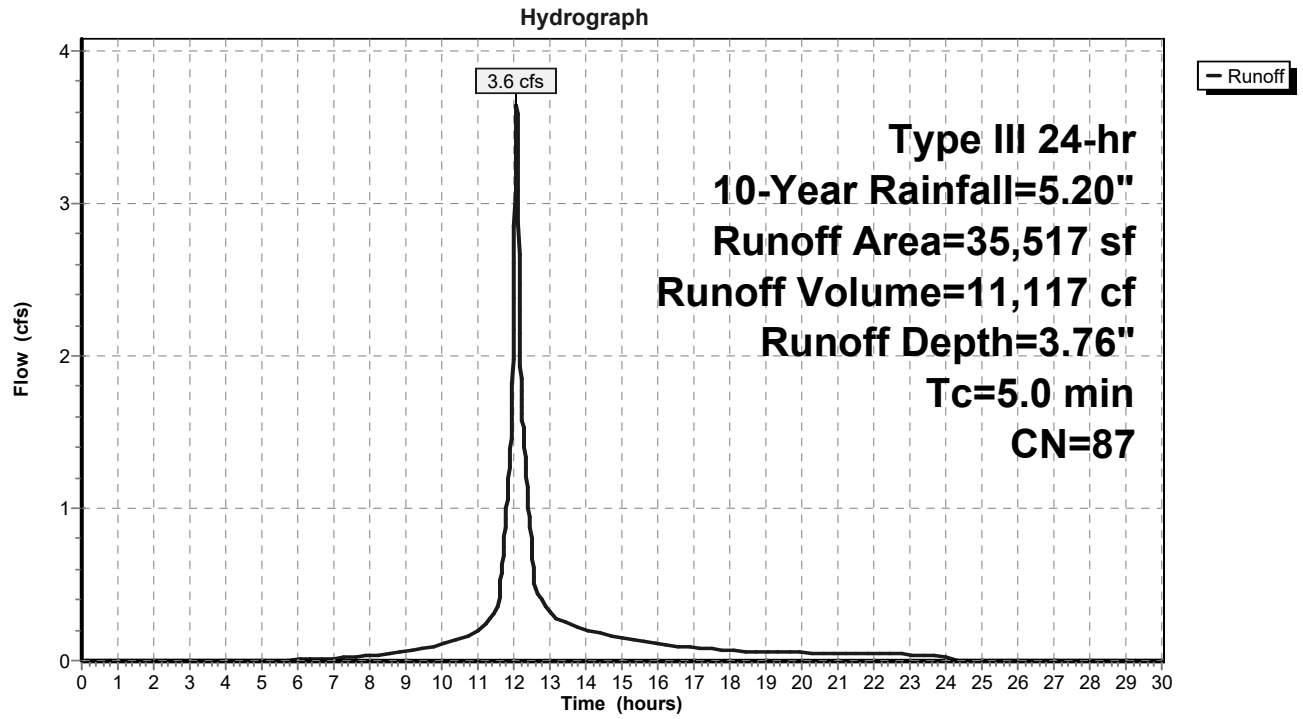
Runoff = 3.6 cfs @ 12.07 hrs, Volume= 11,117 cf, Depth= 3.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
6,618	39	>75% Grass cover, Good, HSG A
22,132	98	Paved parking, HSG A
6,767	98	Roofs, HSG A
35,517	87	Weighted Average
6,618		18.63% Pervious Area
28,898		81.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-C: Cross St



Summary for Subcatchment EX-D: Overland to Highland Ave

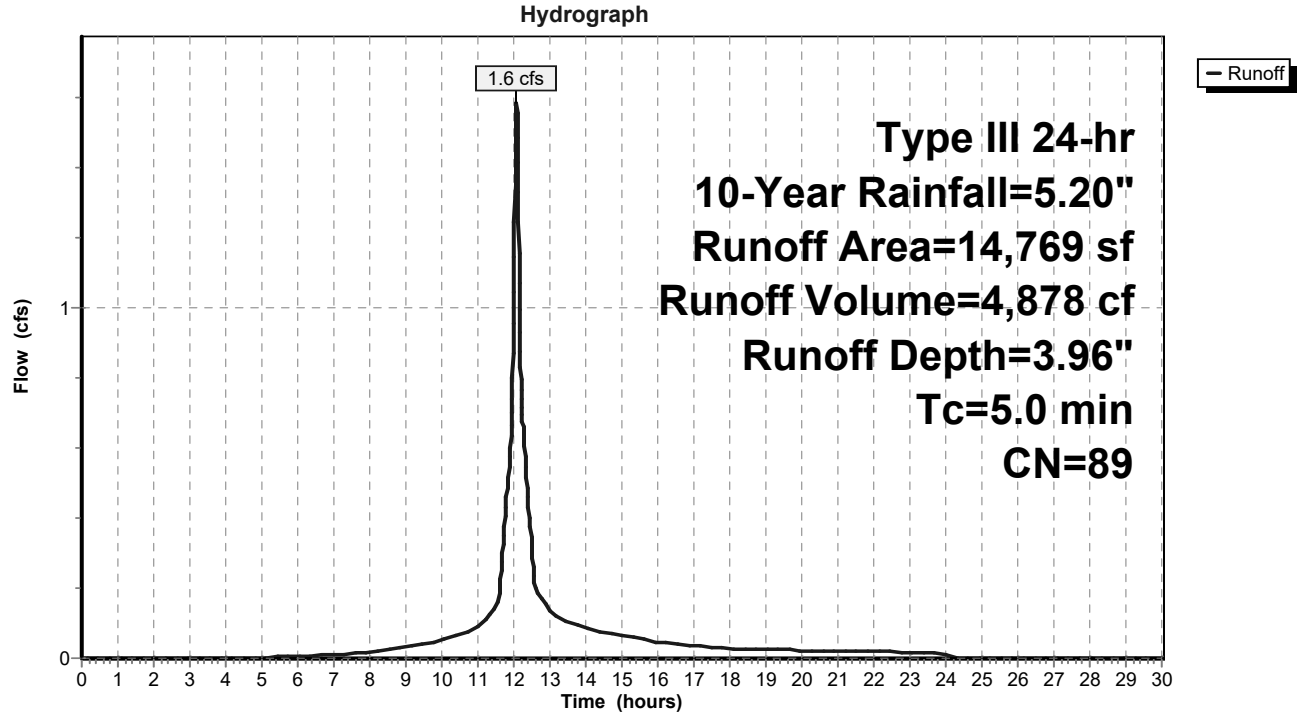
Runoff = 1.6 cfs @ 12.07 hrs, Volume= 4,878 cf, Depth= 3.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
2,298	39	>75% Grass cover, Good, HSG A
12,471	98	Paved parking, HSG A
14,769	89	Weighted Average
2,298		15.56% Pervious Area
12,471		84.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Pond P-1: Lower Inf Basin

Inflow Area = 97,702 sf, 84.93% Impervious, Inflow Depth = 3.16" for 10-Year event
Inflow = 10.2 cfs @ 12.07 hrs, Volume= 25,712 cf
Outflow = 0.1 cfs @ 10.96 hrs, Volume= 7,980 cf, Atten= 99%, Lag= 0.0 min
Discarded = 0.1 cfs @ 10.96 hrs, Volume= 7,980 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 137.34' @ 18.55 hrs Surf.Area= 2,050 sf Storage= 20,951 cf

Plug-Flow detention time= 514.6 min calculated for 7,980 cf (31% of inflow)
Center-of-Mass det. time= 421.5 min (1,218.5 - 797.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	130.03'	1,831 cf	**44.25'W x 46.34'L x 3.50'H Stone Bed for StormTech** 7,176 cf Overall - 2,481 cf Embedded = 4,696 cf x 39.0% Voids
#2A	130.53'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 9 Rows
#3	133.53'	4 cf	**2.00'D x 1.15'H Structure with Grate Inlet** Impervious
#4	134.68'	41,949 cf	**Parking Lot Surface Storage-Lower Terrace (Prismatic)** Listed below (Recal
		46,264 cf	Total Available Storage

Storage Group A created with Chamber Wizard

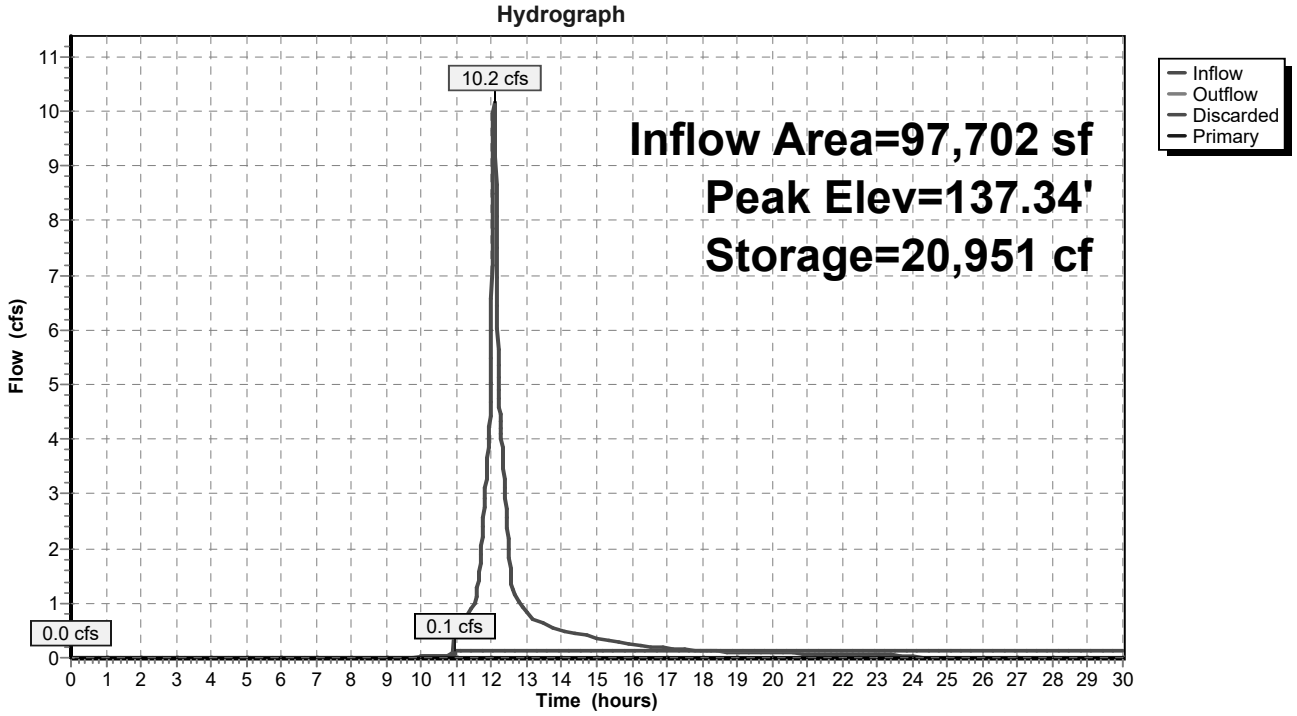
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
134.68	0	0	0
134.70	4	0	0
135.00	1,483	223	223
136.00	6,384	3,934	4,157
137.00	10,744	8,564	12,721
138.00	14,921	12,833	25,553
139.00	17,870	16,396	41,949

Device	Routing	Invert	Outlet Devices
#1	Discarded	130.03'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	138.26'	**20.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.1 cfs @ 10.96 hrs HW=130.13' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=130.03' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond P-1: Lower Inf Basin



Summary for Pond P-2: Upper Inf Basin

Inflow Area = 71,698 sf, 94.53% Impervious, Inflow Depth = 4.60" for 10-Year event
Inflow = 8.4 cfs @ 12.07 hrs, Volume= 27,474 cf
Outflow = 8.4 cfs @ 12.07 hrs, Volume= 25,409 cf, Atten= 0%, Lag= 0.2 min
Discarded = 0.1 cfs @ 4.98 hrs, Volume= 5,168 cf
Primary = 8.3 cfs @ 12.07 hrs, Volume= 20,241 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 144.07' @ 12.07 hrs Surf.Area= 963 sf Storage= 3,285 cf

Plug-Flow detention time= 104.9 min calculated for 25,409 cf (92% of inflow)
Center-of-Mass det. time= 64.9 min (829.6 - 764.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	133.73'	1,823 cf	**30.00'W x 32.10'L x 6.00'H Stone Bed for StormTech** 5,777 cf Overall - 1,103 cf Embedded = 4,675 cf x 39.0% Voids
#2A	134.23'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 6 Rows
#3	139.73'	12 cf	**2.00'D x 3.74'H Structure with Grate Inlet** Impervious
#4	143.46'	2,684 cf	**Parking Lot Surface Storage-Upper Terrace (Prismatic)** Listed below (Recal
		5,621 cf	Total Available Storage

Storage Group A created with Chamber Wizard

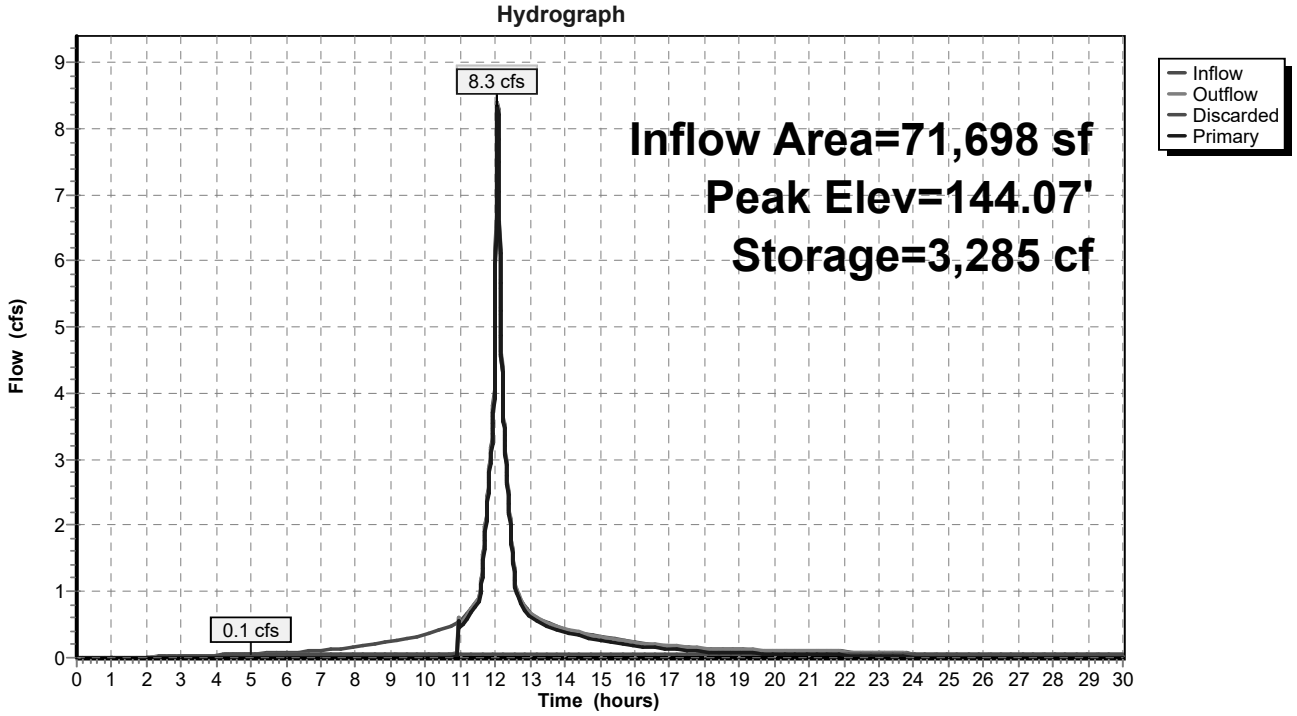
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
143.46	0	0	0
143.50	4	0	0
144.00	1,080	271	271
145.00	3,745	2,413	2,684

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.73'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	144.00'	**151.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.1 cfs @ 4.98 hrs HW=133.84' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=6.8 cfs @ 12.07 hrs HW=144.07' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 6.8 cfs @ 0.69 fps)

Pond P-2: Upper Inf Basin

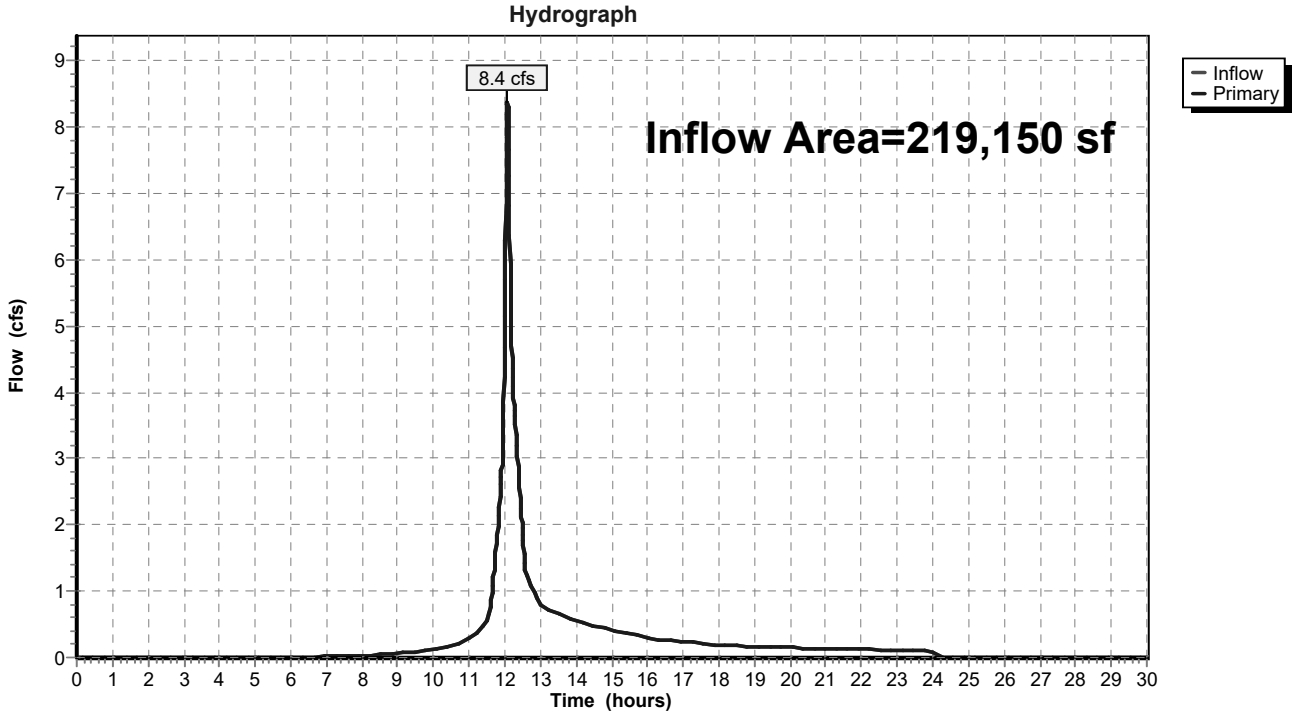


Summary for Link DP-1: Offsite to North

Inflow Area = 219,150 sf, 70.06% Impervious, Inflow Depth = 1.40" for 10-Year event
Inflow = 8.4 cfs @ 12.08 hrs, Volume= 25,605 cf
Primary = 8.4 cfs @ 12.08 hrs, Volume= 25,605 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

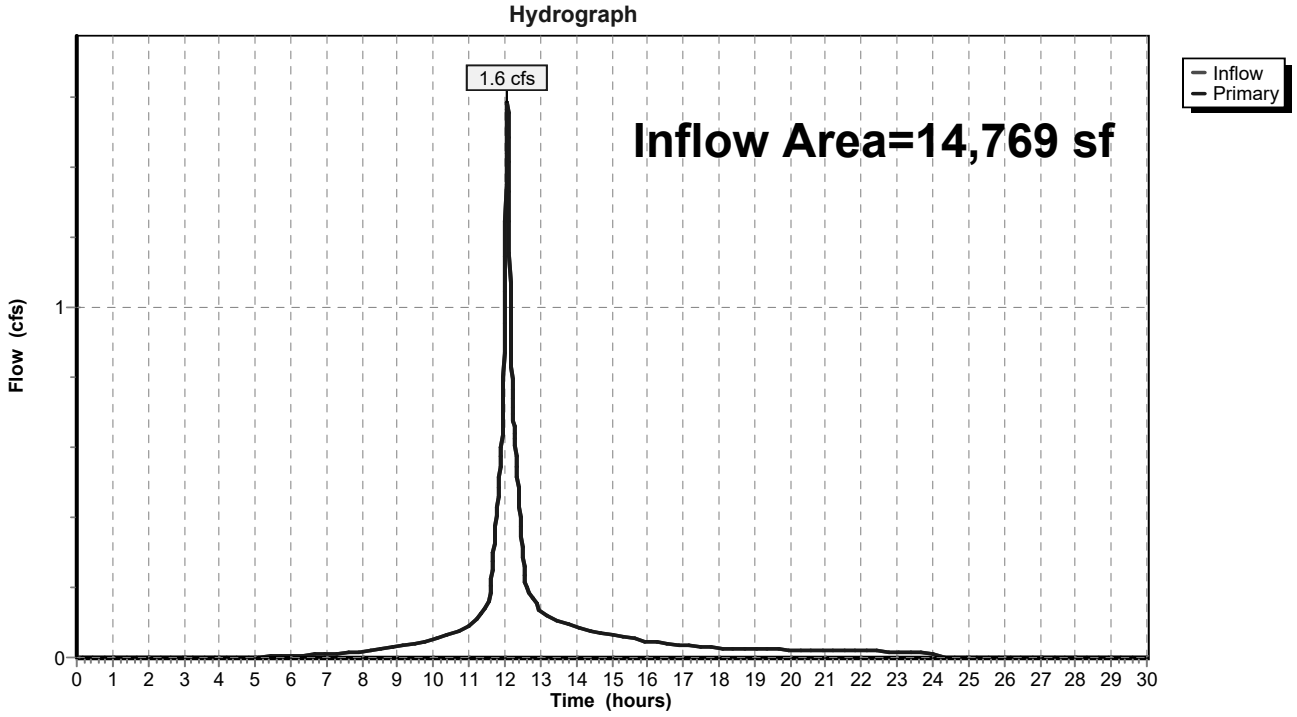


Summary for Link DP-2: Highland Ave

Inflow Area = 14,769 sf, 84.44% Impervious, Inflow Depth = 3.96" for 10-Year event
Inflow = 1.6 cfs @ 12.07 hrs, Volume= 4,878 cf
Primary = 1.6 cfs @ 12.07 hrs, Volume= 4,878 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



25-Year Storm Event – Existing

Summary for Subcatchment EX-1: Lower Lot & Bldgs

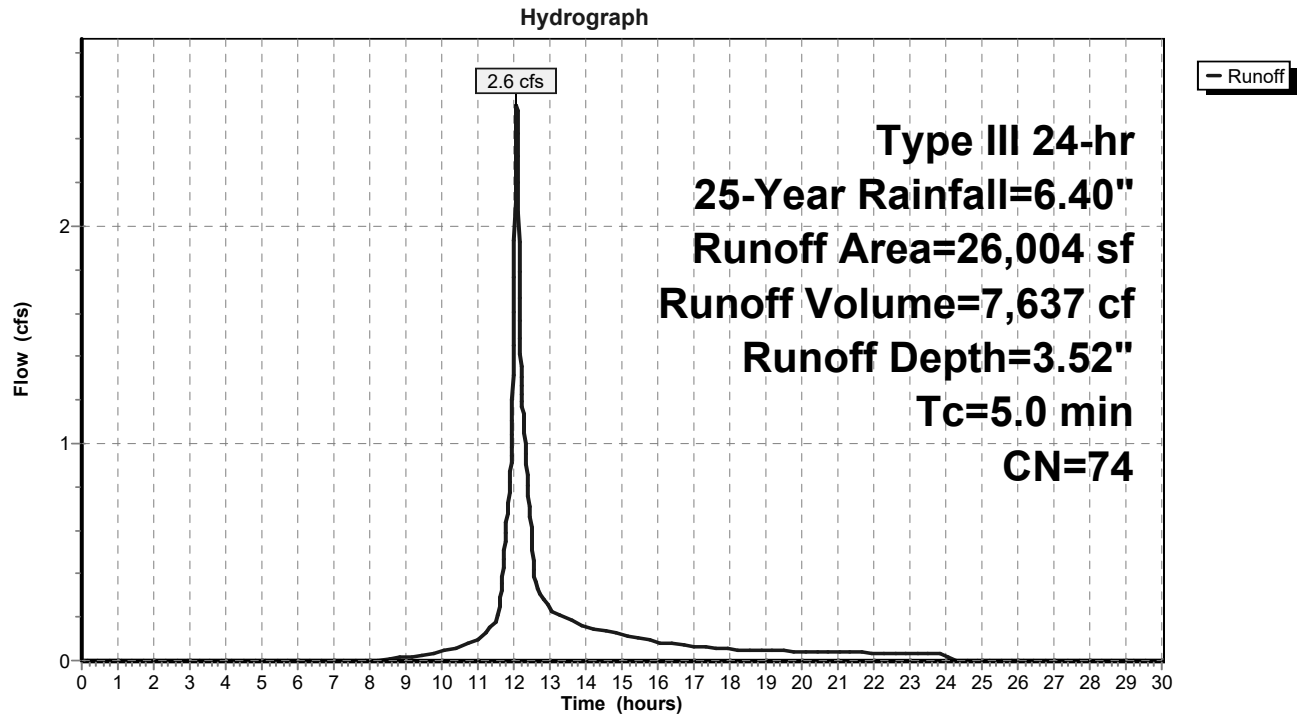
Runoff = 2.6 cfs @ 12.07 hrs, Volume= 7,637 cf, Depth= 3.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

Area (sf)	CN	Description
10,797	39	>75% Grass cover, Good, HSG A
13,290	98	Paved parking, HSG A
1,916	98	Roofs, HSG A
26,004	74	Weighted Average
10,797		41.52% Pervious Area
15,207		58.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-1: Lower Lot & Bldgs



Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

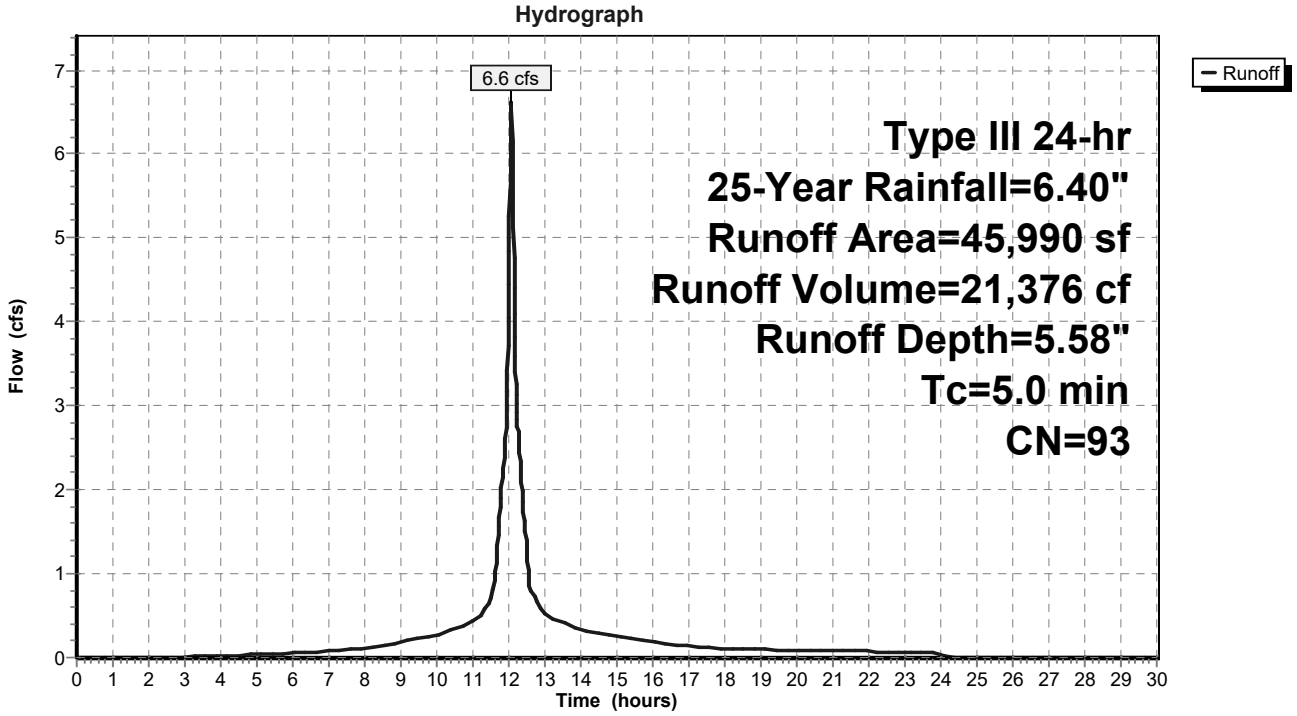
Runoff = 6.6 cfs @ 12.07 hrs, Volume= 21,376 cf, Depth= 5.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

Area (sf)	CN	Description
3,922	39	>75% Grass cover, Good, HSG A
26,311	98	Paved parking, HSG A
15,757	98	Roofs, HSG A
45,990	93	Weighted Average
3,922		8.53% Pervious Area
42,068		91.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area



Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

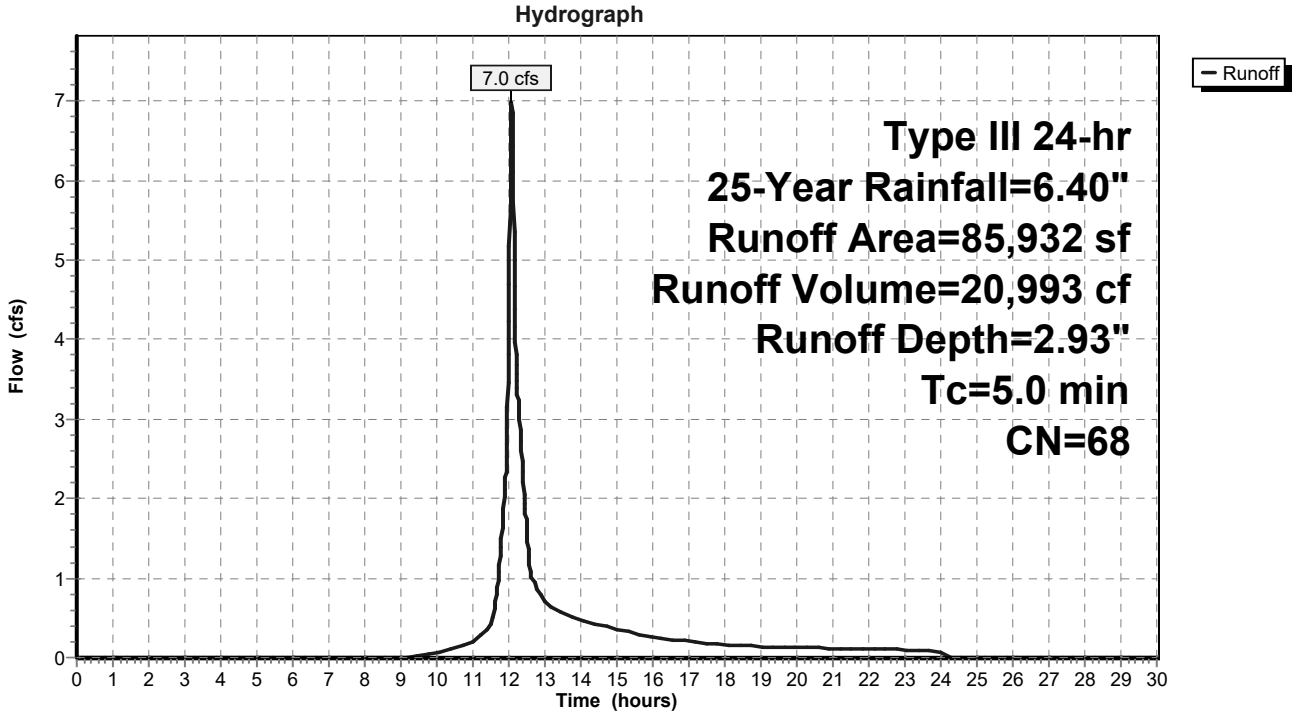
Runoff = 7.0 cfs @ 12.08 hrs, Volume= 20,993 cf, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

Area (sf)	CN	Description
44,266	39	>75% Grass cover, Good, HSG A
28,825	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
85,932	68	Weighted Average
44,266		51.51% Pervious Area
41,666		48.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

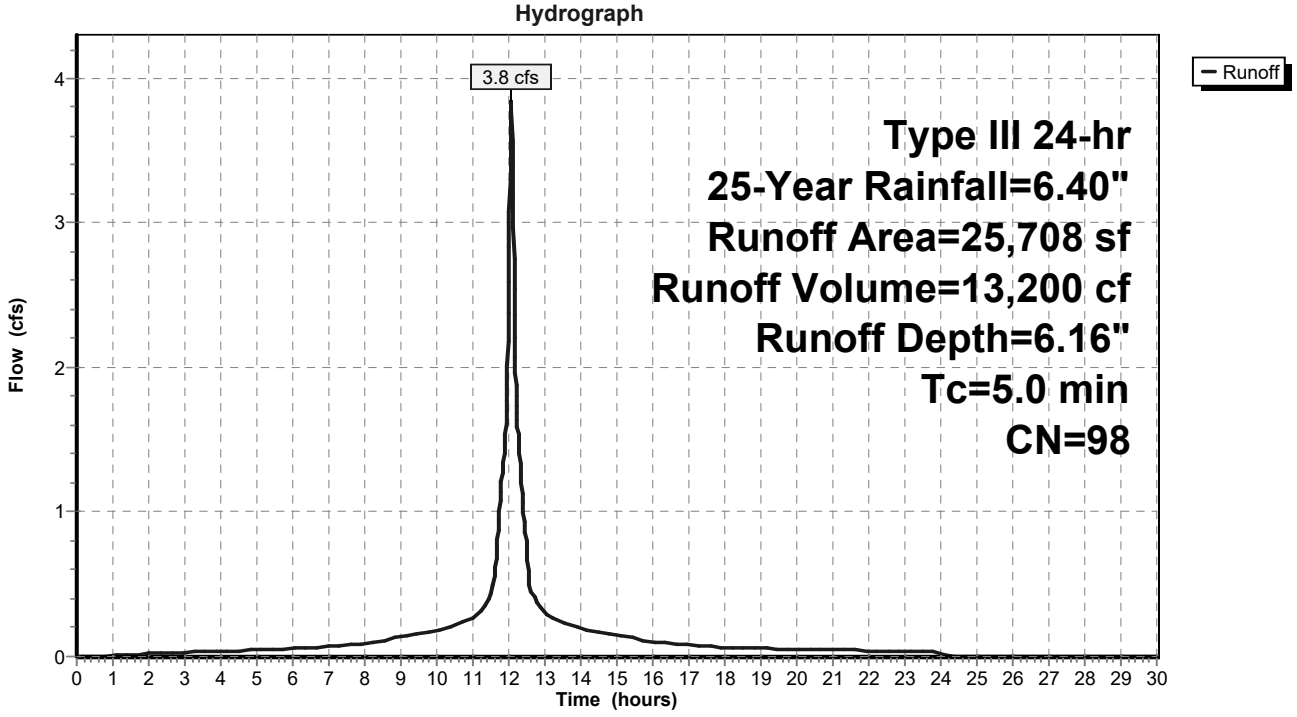
Runoff = 3.8 cfs @ 12.07 hrs, Volume= 13,200 cf, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-C: Cross St

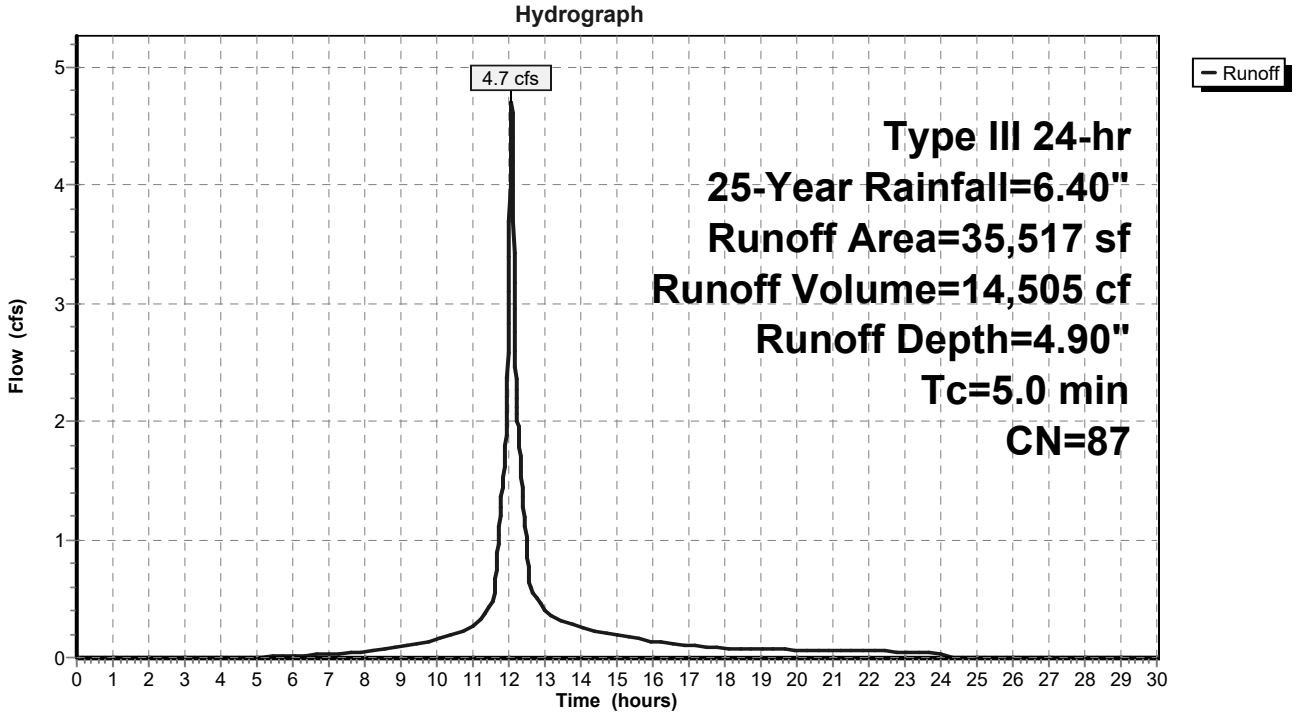
Runoff = 4.7 cfs @ 12.07 hrs, Volume= 14,505 cf, Depth= 4.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

Area (sf)	CN	Description
6,618	39	>75% Grass cover, Good, HSG A
22,132	98	Paved parking, HSG A
6,767	98	Roofs, HSG A
35,517	87	Weighted Average
6,618		18.63% Pervious Area
28,898		81.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-C: Cross St



Summary for Subcatchment EX-D: Overland to Highland Ave

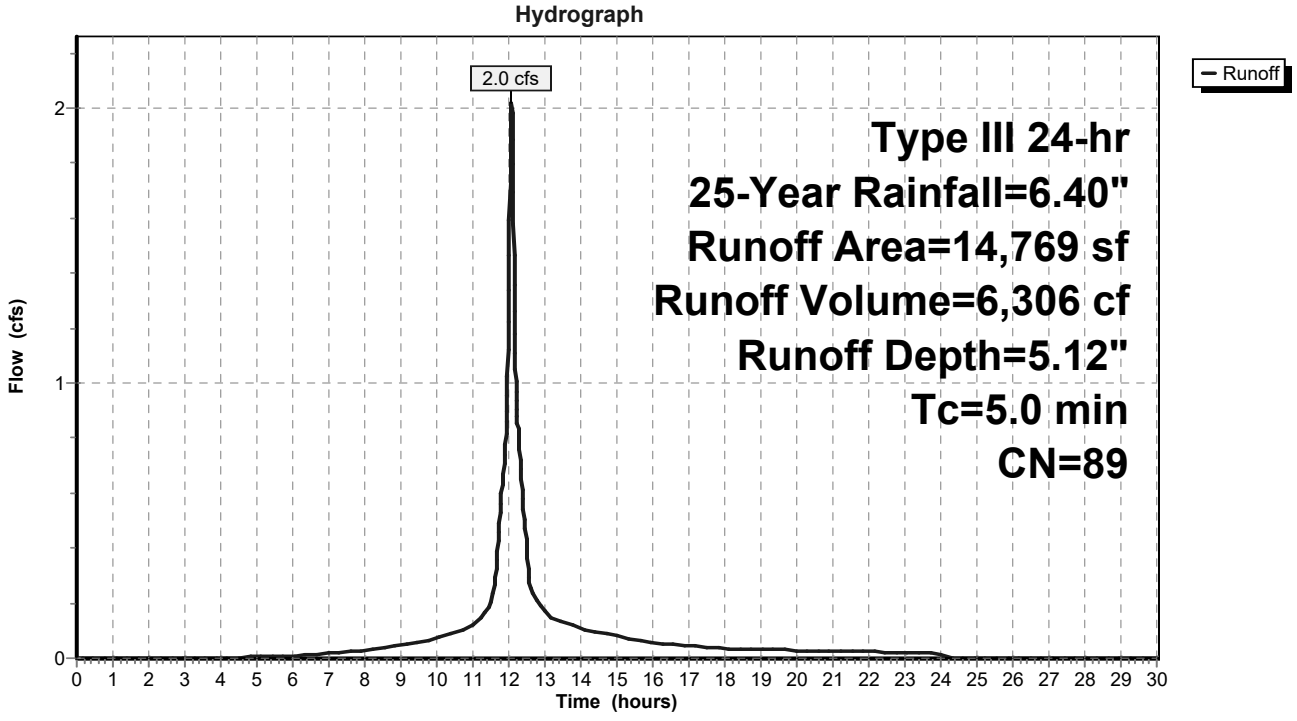
Runoff = 2.0 cfs @ 12.07 hrs, Volume= 6,306 cf, Depth= 5.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

Area (sf)	CN	Description
2,298	39	>75% Grass cover, Good, HSG A
12,471	98	Paved parking, HSG A
14,769	89	Weighted Average
2,298		15.56% Pervious Area
12,471		84.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Pond P-1: Lower Inf Basin

Inflow Area = 97,702 sf, 84.93% Impervious, Inflow Depth = 4.28" for 25-Year event
Inflow = 12.9 cfs @ 12.07 hrs, Volume= 34,842 cf
Outflow = 0.1 cfs @ 10.22 hrs, Volume= 8,288 cf, Atten= 99%, Lag= 0.0 min
Discarded = 0.1 cfs @ 10.22 hrs, Volume= 8,288 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 137.96' @ 20.81 hrs Surf.Area= 2,050 sf Storage= 29,292 cf

Plug-Flow detention time= 513.3 min calculated for 8,288 cf (24% of inflow)
Center-of-Mass det. time= 402.9 min (1,196.0 - 793.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	130.03'	1,831 cf	**44.25'W x 46.34'L x 3.50'H Stone Bed for StormTech** 7,176 cf Overall - 2,481 cf Embedded = 4,696 cf x 39.0% Voids
#2A	130.53'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 9 Rows
#3	133.53'	4 cf	**2.00'D x 1.15'H Structure with Grate Inlet** Impervious
#4	134.68'	41,949 cf	**Parking Lot Surface Storage-Lower Terrace (Prismatic)** Listed below (Recal
		46,264 cf	Total Available Storage

Storage Group A created with Chamber Wizard

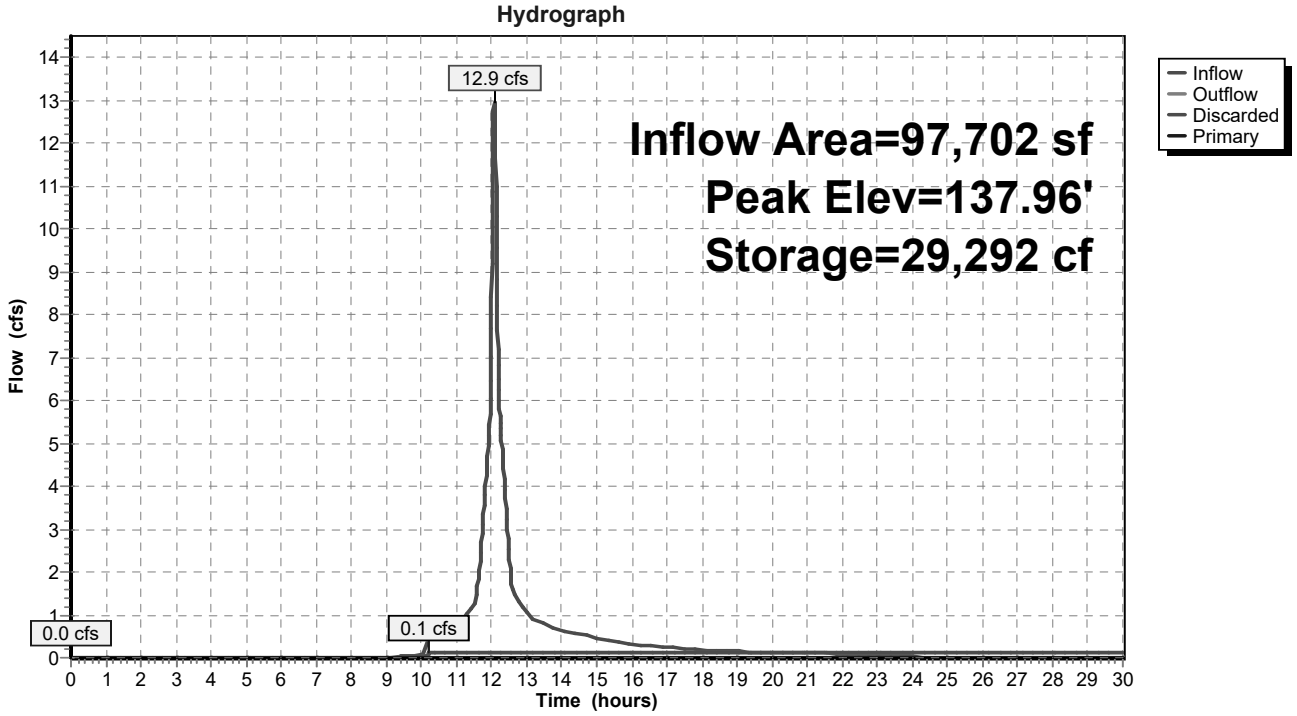
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
134.68	0	0	0
134.70	4	0	0
135.00	1,483	223	223
136.00	6,384	3,934	4,157
137.00	10,744	8,564	12,721
138.00	14,921	12,833	25,553
139.00	17,870	16,396	41,949

Device	Routing	Invert	Outlet Devices
#1	Discarded	130.03'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	138.26'	**20.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.1 cfs @ 10.22 hrs HW=130.13' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=130.03' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond P-1: Lower Inf Basin



Summary for Pond P-2: Upper Inf Basin

Inflow Area = 71,698 sf, 94.53% Impervious, Inflow Depth = 5.79" for 25-Year event
Inflow = 10.5 cfs @ 12.07 hrs, Volume= 34,576 cf
Outflow = 10.4 cfs @ 12.07 hrs, Volume= 32,510 cf, Atten= 0%, Lag= 0.2 min
Discarded = 0.1 cfs @ 3.94 hrs, Volume= 5,305 cf
Primary = 10.4 cfs @ 12.07 hrs, Volume= 27,205 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 144.08' @ 12.07 hrs Surf.Area= 963 sf Storage= 3,306 cf

Plug-Flow detention time= 88.9 min calculated for 32,499 cf (94% of inflow)
Center-of-Mass det. time= 55.6 min (815.6 - 760.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	133.73'	1,823 cf	**30.00'W x 32.10'L x 6.00'H Stone Bed for StormTech** 5,777 cf Overall - 1,103 cf Embedded = 4,675 cf x 39.0% Voids
#2A	134.23'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 6 Rows
#3	139.73'	12 cf	**2.00'D x 3.74'H Structure with Grate Inlet** Impervious
#4	143.46'	2,684 cf	**Parking Lot Surface Storage-Upper Terrace (Prismatic)** Listed below (Recal
		5,621 cf	Total Available Storage

Storage Group A created with Chamber Wizard

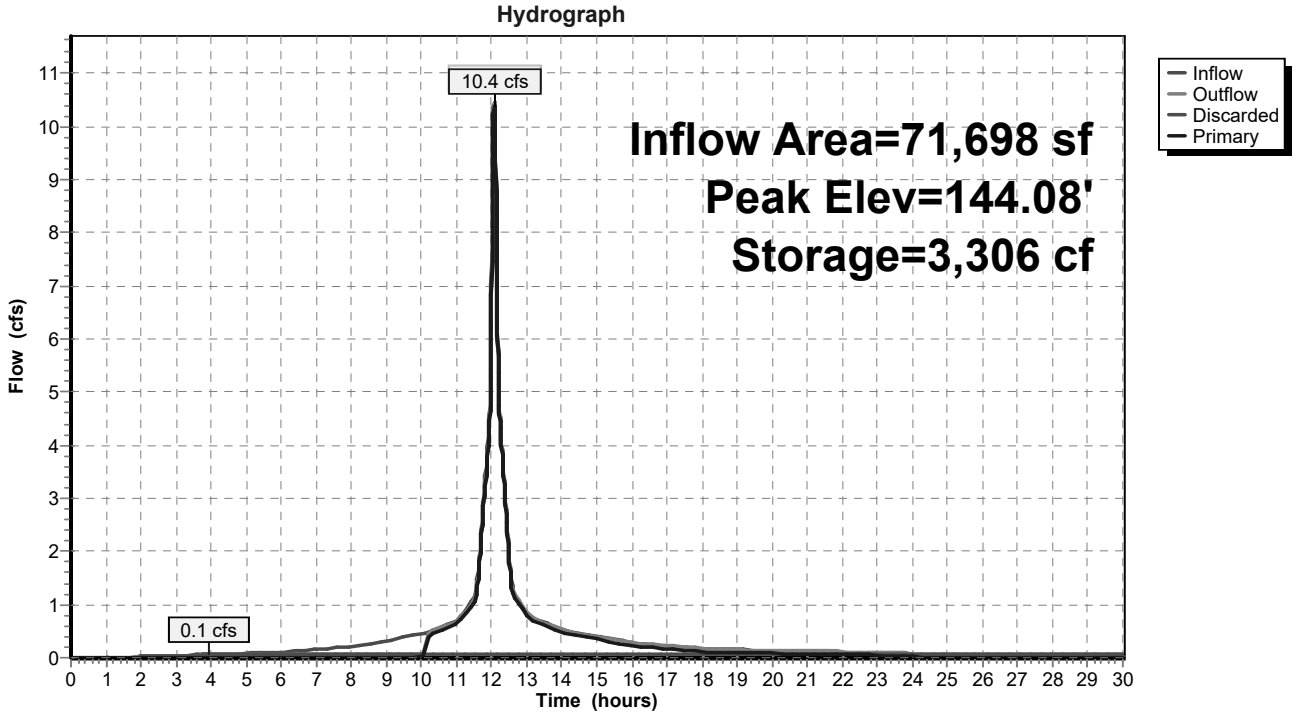
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
143.46	0	0	0
143.50	4	0	0
144.00	1,080	271	271
145.00	3,745	2,413	2,684

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.73'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	144.00'	**151.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.1 cfs @ 3.94 hrs HW=133.84' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=9.4 cfs @ 12.07 hrs HW=144.08' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 9.4 cfs @ 0.77 fps)

Pond P-2: Upper Inf Basin

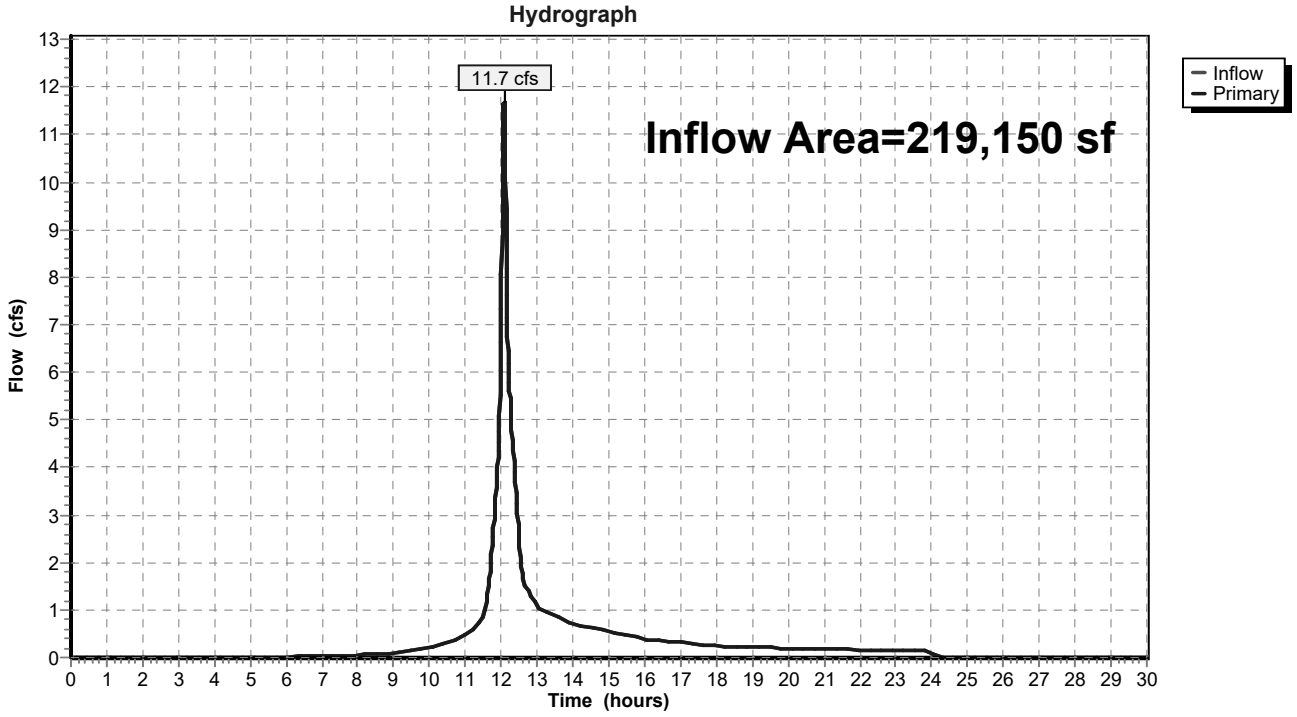


Summary for Link DP-1: Offsite to North

Inflow Area = 219,150 sf, 70.06% Impervious, Inflow Depth = 1.94" for 25-Year event
Inflow = 11.7 cfs @ 12.07 hrs, Volume= 35,498 cf
Primary = 11.7 cfs @ 12.07 hrs, Volume= 35,498 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

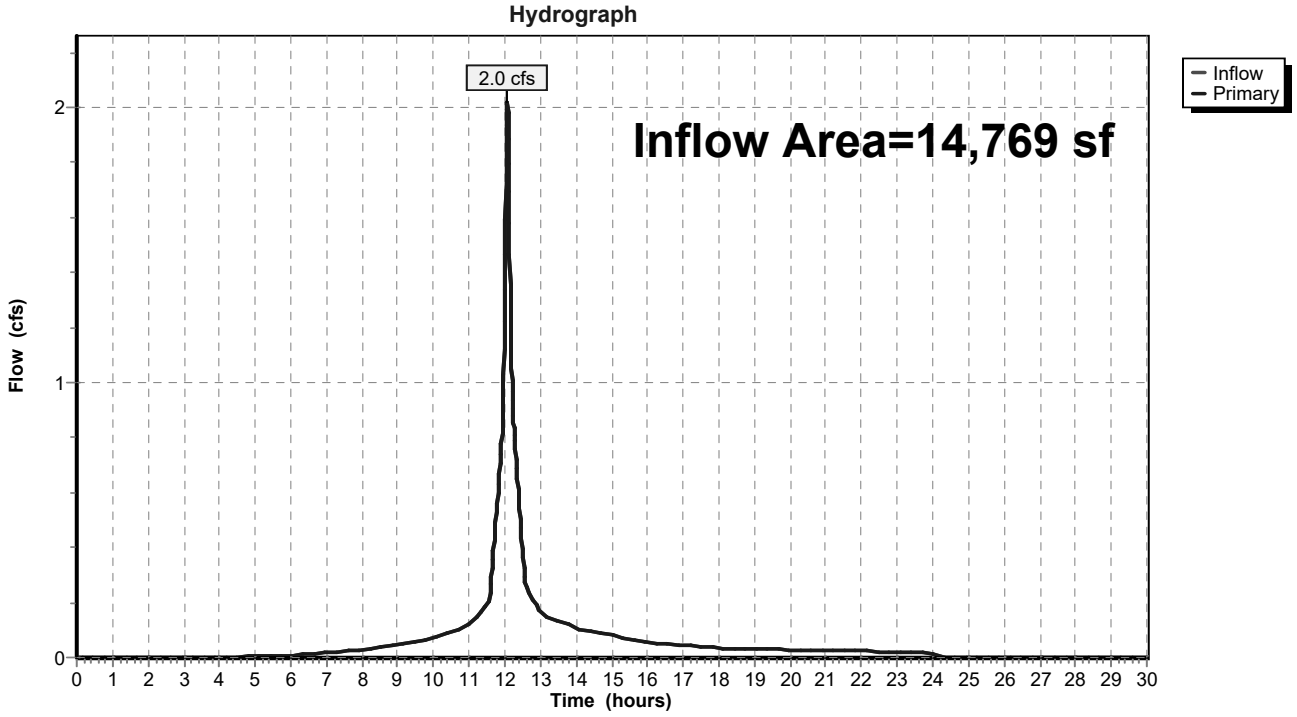


Summary for Link DP-2: Highland Ave

Inflow Area = 14,769 sf, 84.44% Impervious, Inflow Depth = 5.12" for 25-Year event
Inflow = 2.0 cfs @ 12.07 hrs, Volume= 6,306 cf
Primary = 2.0 cfs @ 12.07 hrs, Volume= 6,306 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



100-Year Storm Event – Existing

Summary for Subcatchment EX-1: Lower Lot & Bldgs

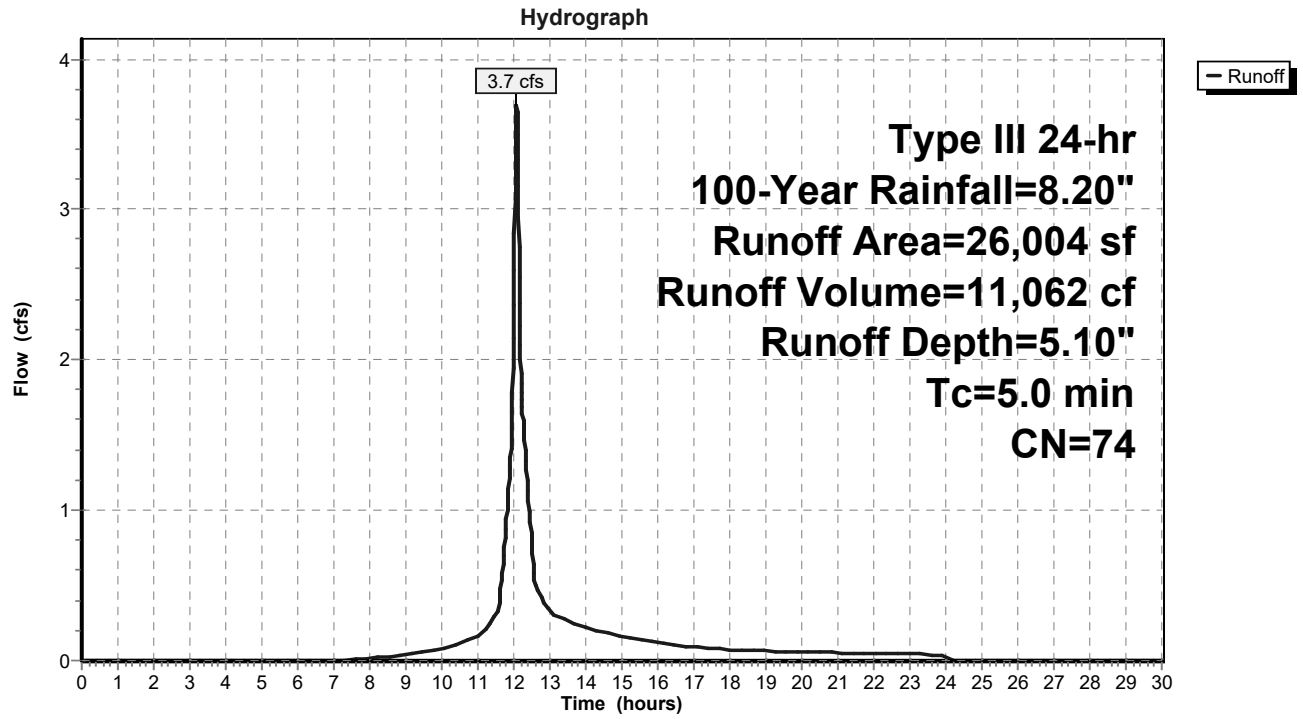
Runoff = 3.7 cfs @ 12.07 hrs, Volume= 11,062 cf, Depth= 5.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

Area (sf)	CN	Description
10,797	39	>75% Grass cover, Good, HSG A
13,290	98	Paved parking, HSG A
1,916	98	Roofs, HSG A
26,004	74	Weighted Average
10,797		41.52% Pervious Area
15,207		58.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-1: Lower Lot & Bldgs



Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

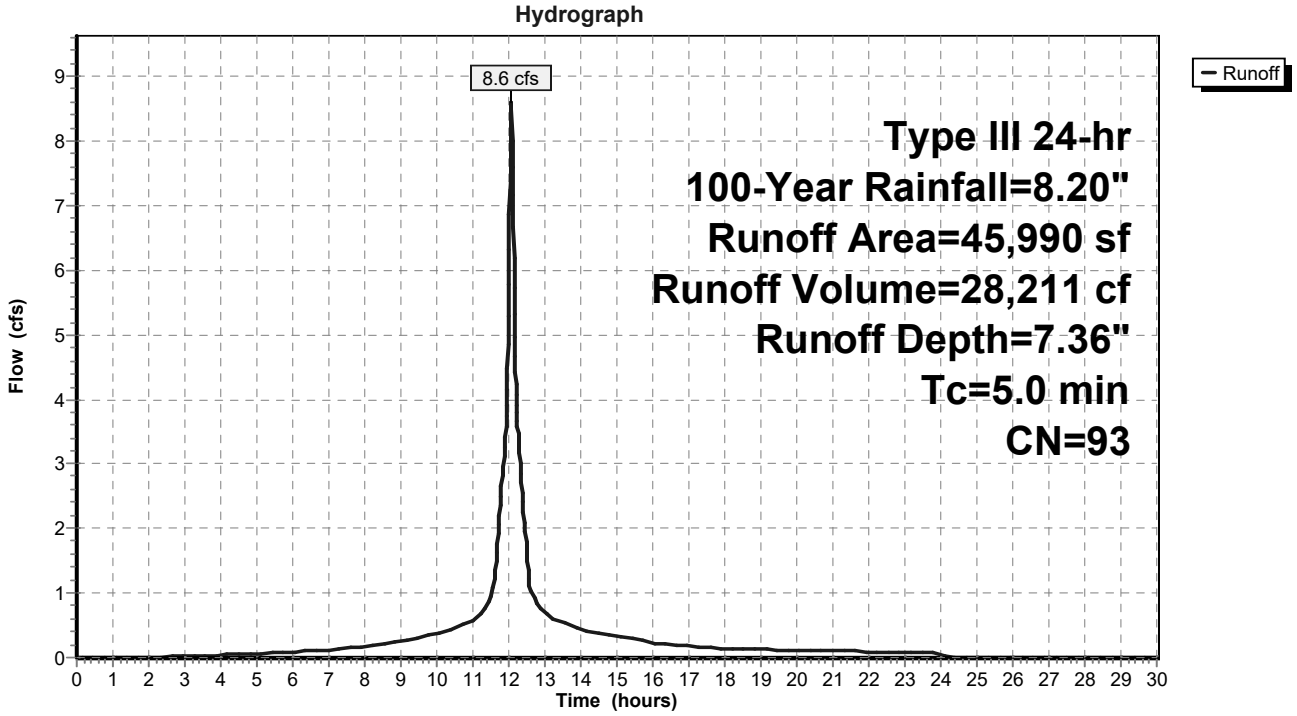
Runoff = 8.6 cfs @ 12.07 hrs, Volume= 28,211 cf, Depth= 7.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

Area (sf)	CN	Description
3,922	39	>75% Grass cover, Good, HSG A
26,311	98	Paved parking, HSG A
15,757	98	Roofs, HSG A
45,990	93	Weighted Average
3,922		8.53% Pervious Area
42,068		91.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area



Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

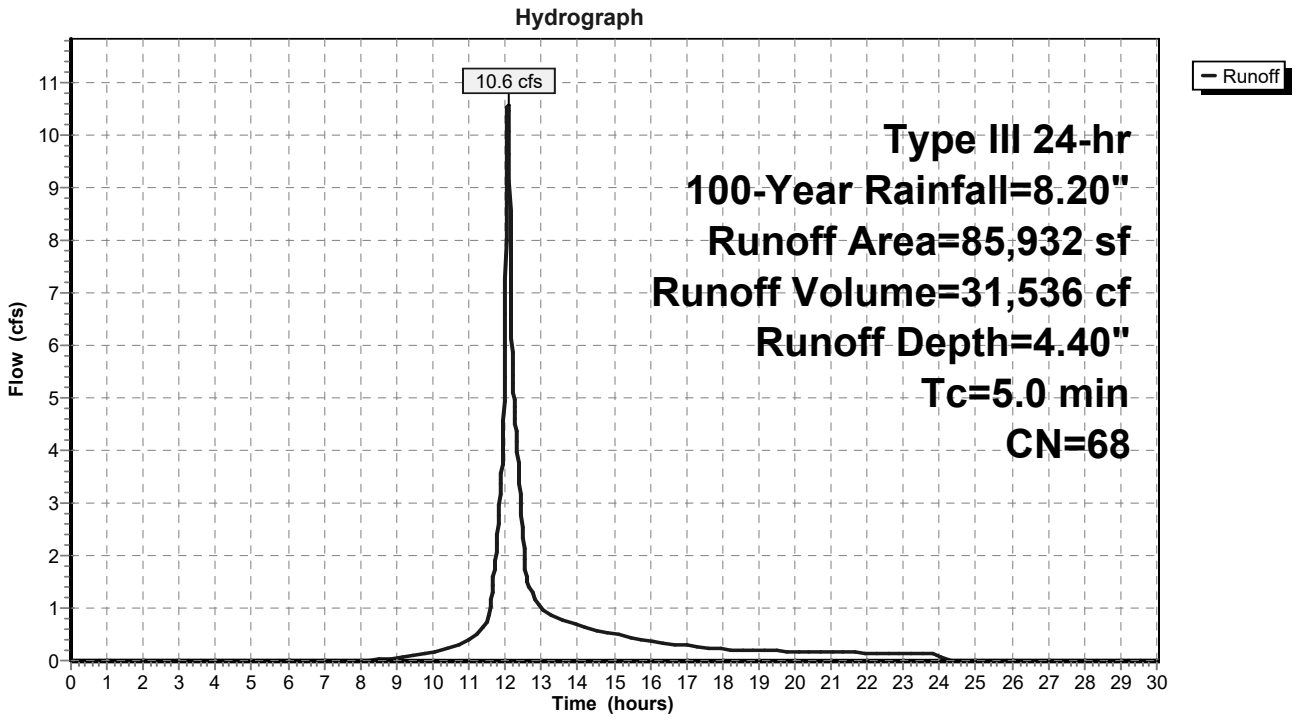
Runoff = 10.6 cfs @ 12.08 hrs, Volume= 31,536 cf, Depth= 4.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

Area (sf)	CN	Description
44,266	39	>75% Grass cover, Good, HSG A
28,825	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
85,932	68	Weighted Average
44,266		51.51% Pervious Area
41,666		48.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

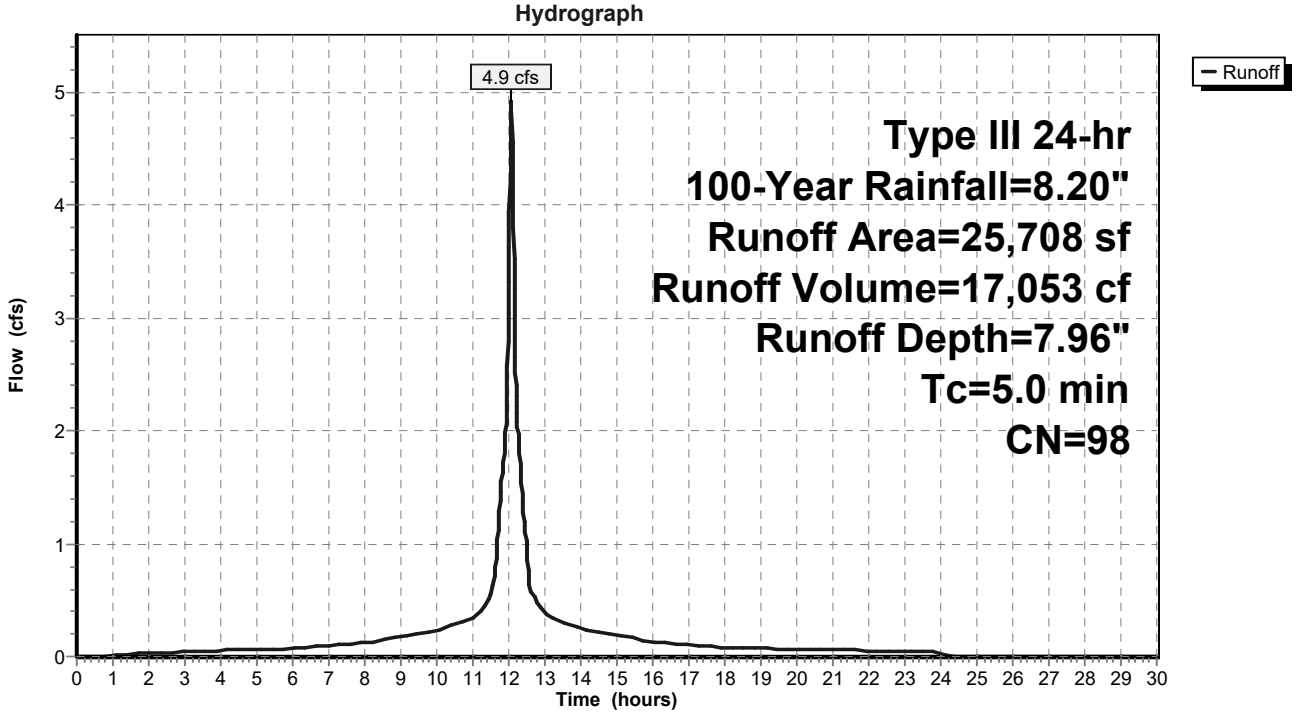
Runoff = 4.9 cfs @ 12.07 hrs, Volume= 17,053 cf, Depth= 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-C: Cross St

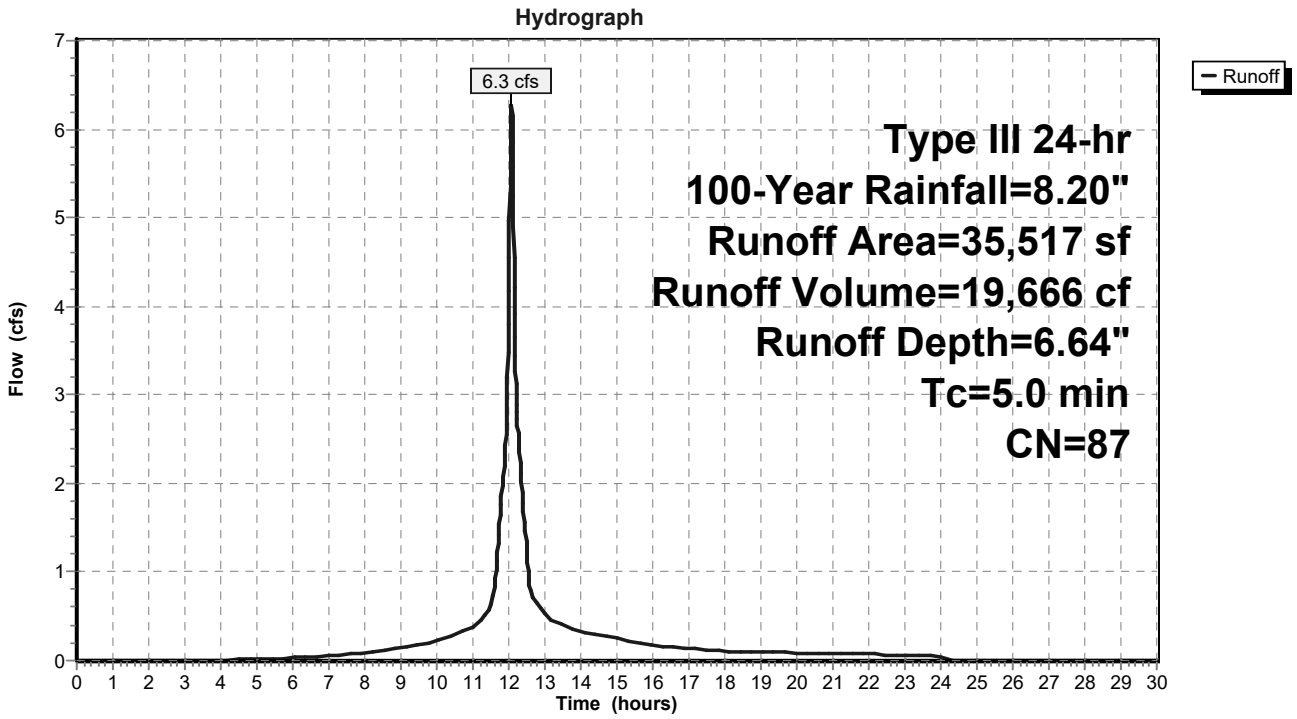
Runoff = 6.3 cfs @ 12.07 hrs, Volume= 19,666 cf, Depth= 6.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

Area (sf)	CN	Description
6,618	39	>75% Grass cover, Good, HSG A
22,132	98	Paved parking, HSG A
6,767	98	Roofs, HSG A
35,517	87	Weighted Average
6,618		18.63% Pervious Area
28,898		81.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-C: Cross St



Summary for Subcatchment EX-D: Overland to Highland Ave

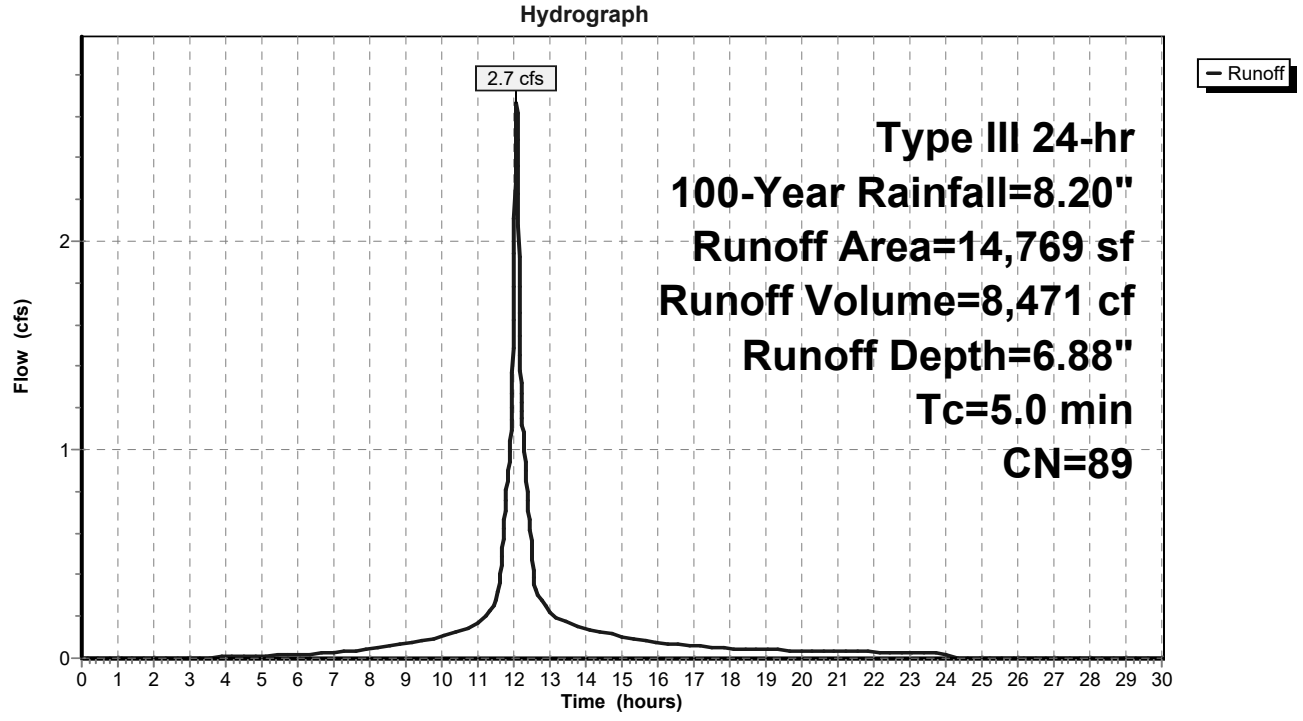
Runoff = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

Area (sf)	CN	Description
2,298	39	>75% Grass cover, Good, HSG A
12,471	98	Paved parking, HSG A
14,769	89	Weighted Average
2,298		15.56% Pervious Area
12,471		84.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Pond P-1: Lower Inf Basin

Inflow Area = 97,702 sf, 84.93% Impervious, Inflow Depth = 6.00" for 100-Year event
Inflow = 17.1 cfs @ 12.07 hrs, Volume= 48,822 cf
Outflow = 0.9 cfs @ 13.90 hrs, Volume= 17,427 cf, Atten= 95%, Lag= 109.8 min
Discarded = 0.1 cfs @ 9.23 hrs, Volume= 8,689 cf
Primary = 0.8 cfs @ 13.90 hrs, Volume= 8,737 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 138.32' @ 13.90 hrs Surf.Area= 2,050 sf Storage= 34,750 cf

Plug-Flow detention time= 379.4 min calculated for 17,421 cf (36% of inflow)
Center-of-Mass det. time= 272.3 min (1,059.4 - 787.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	130.03'	1,831 cf	**44.25'W x 46.34'L x 3.50'H Stone Bed for StormTech** 7,176 cf Overall - 2,481 cf Embedded = 4,696 cf x 39.0% Voids
#2A	130.53'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 9 Rows
#3	133.53'	4 cf	**2.00'D x 1.15'H Structure with Grate Inlet** Impervious
#4	134.68'	41,949 cf	**Parking Lot Surface Storage-Lower Terrace (Prismatic)** Listed below (Recal
		46,264 cf	Total Available Storage

Storage Group A created with Chamber Wizard

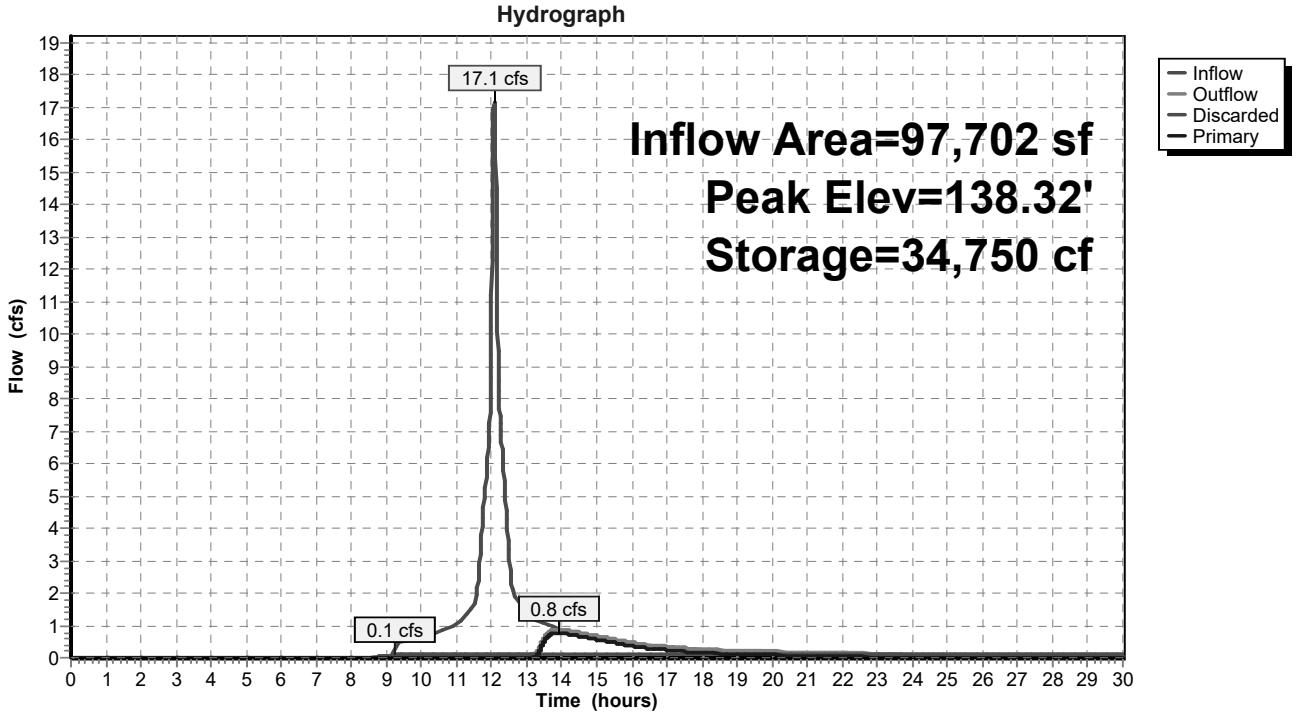
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
134.68	0	0	0
134.70	4	0	0
135.00	1,483	223	223
136.00	6,384	3,934	4,157
137.00	10,744	8,564	12,721
138.00	14,921	12,833	25,553
139.00	17,870	16,396	41,949

Device	Routing	Invert	Outlet Devices
#1	Discarded	130.03'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	138.26'	**20.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.1 cfs @ 9.23 hrs HW=130.12' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.6 cfs @ 13.90 hrs HW=138.32' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.6 cfs @ 0.56 fps)

Pond P-1: Lower Inf Basin



Summary for Pond P-2: Upper Inf Basin

Inflow Area = 71,698 sf, 94.53% Impervious, Inflow Depth = 7.58" for 100-Year event
Inflow = 13.5 cfs @ 12.07 hrs, Volume= 45,265 cf
Outflow = 13.5 cfs @ 12.07 hrs, Volume= 43,197 cf, Atten= 0%, Lag= 0.1 min
Discarded = 0.1 cfs @ 2.95 hrs, Volume= 5,437 cf
Primary = 13.5 cfs @ 12.07 hrs, Volume= 37,759 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 144.10' @ 12.07 hrs Surf.Area= 963 sf Storage= 3,333 cf

Plug-Flow detention time= 73.5 min calculated for 43,197 cf (95% of inflow)
Center-of-Mass det. time= 46.6 min (801.4 - 754.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	133.73'	1,823 cf	**30.00'W x 32.10'L x 6.00'H Stone Bed for StormTech** 5,777 cf Overall - 1,103 cf Embedded = 4,675 cf x 39.0% Voids
#2A	134.23'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 6 Rows
#3	139.73'	12 cf	**2.00'D x 3.74'H Structure with Grate Inlet** Impervious
#4	143.46'	2,684 cf	**Parking Lot Surface Storage-Upper Terrace (Prismatic)** Listed below (Recal
		5,621 cf	Total Available Storage

Storage Group A created with Chamber Wizard

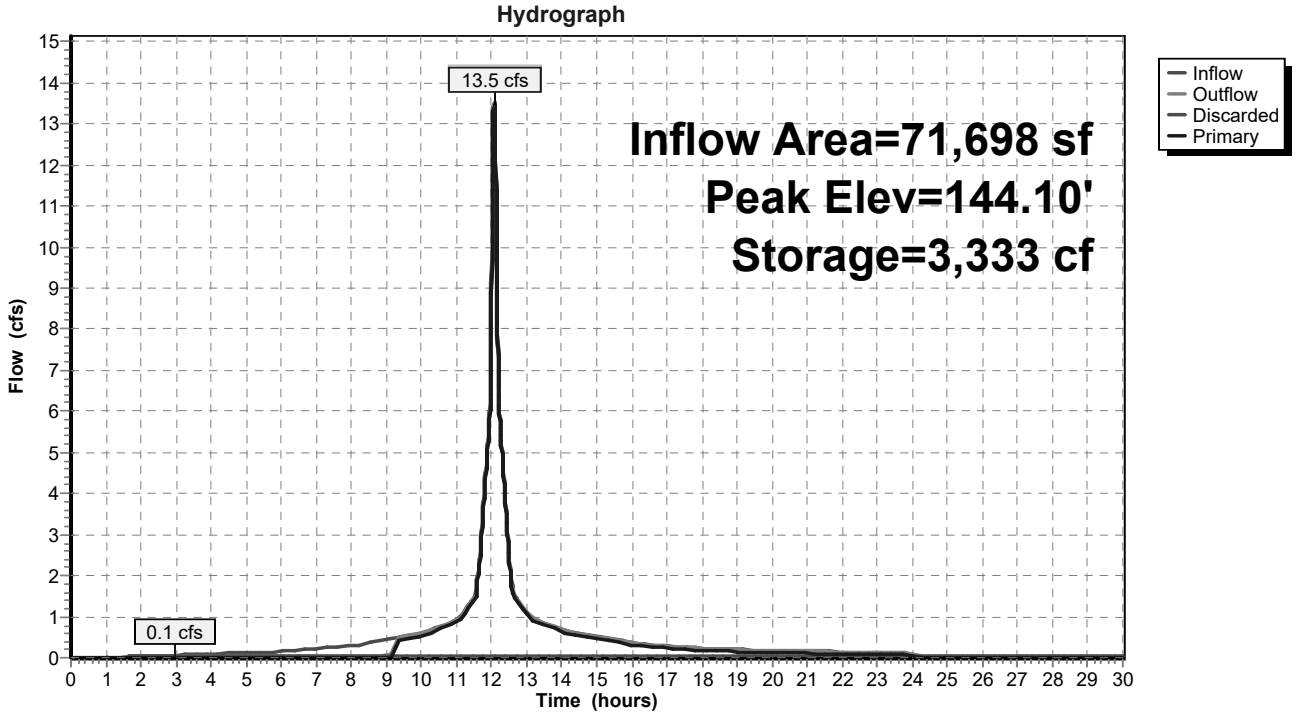
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
143.46	0	0	0
143.50	4	0	0
144.00	1,080	271	271
145.00	3,745	2,413	2,684

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.73'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	144.00'	**151.0' long x 1.0' 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 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.1 cfs @ 2.95 hrs HW=133.84' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=13.3 cfs @ 12.07 hrs HW=144.10' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 13.3 cfs @ 0.86 fps)

Pond P-2: Upper Inf Basin

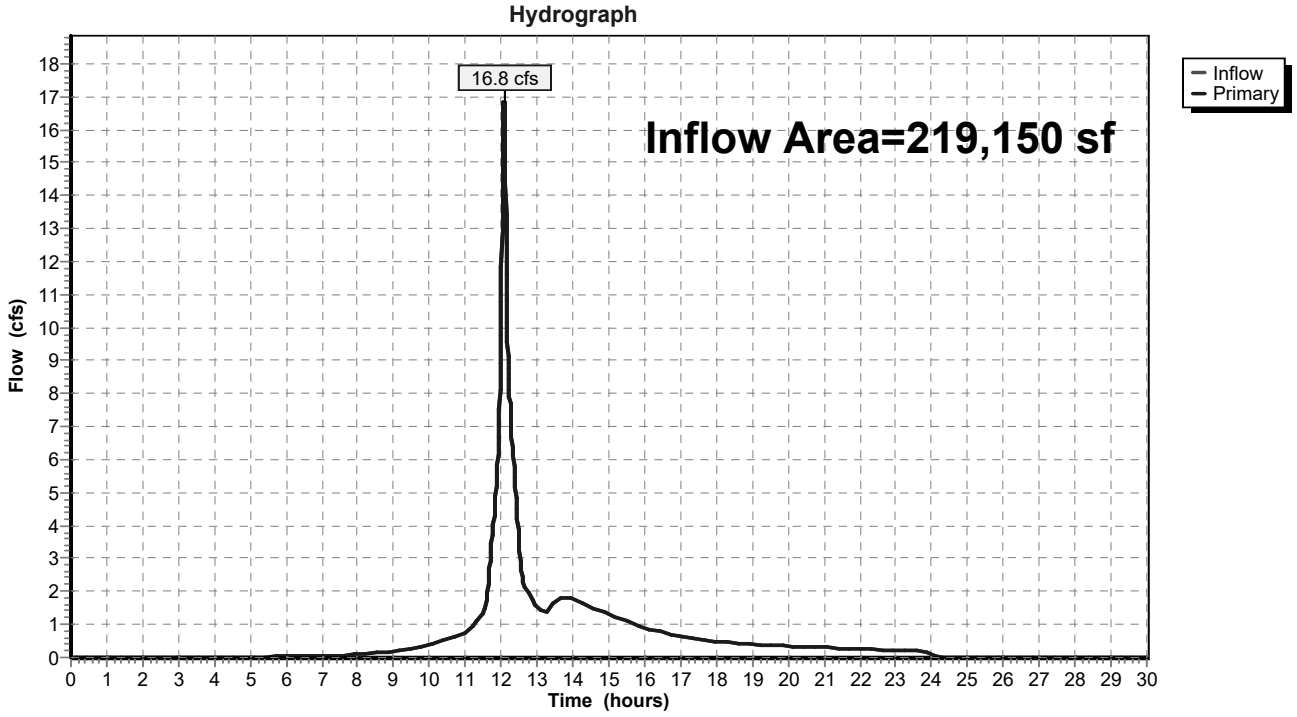


Summary for Link DP-1: Offsite to North

Inflow Area = 219,150 sf, 70.06% Impervious, Inflow Depth = 3.28" for 100-Year event
Inflow = 16.8 cfs @ 12.07 hrs, Volume= 59,939 cf
Primary = 16.8 cfs @ 12.07 hrs, Volume= 59,939 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

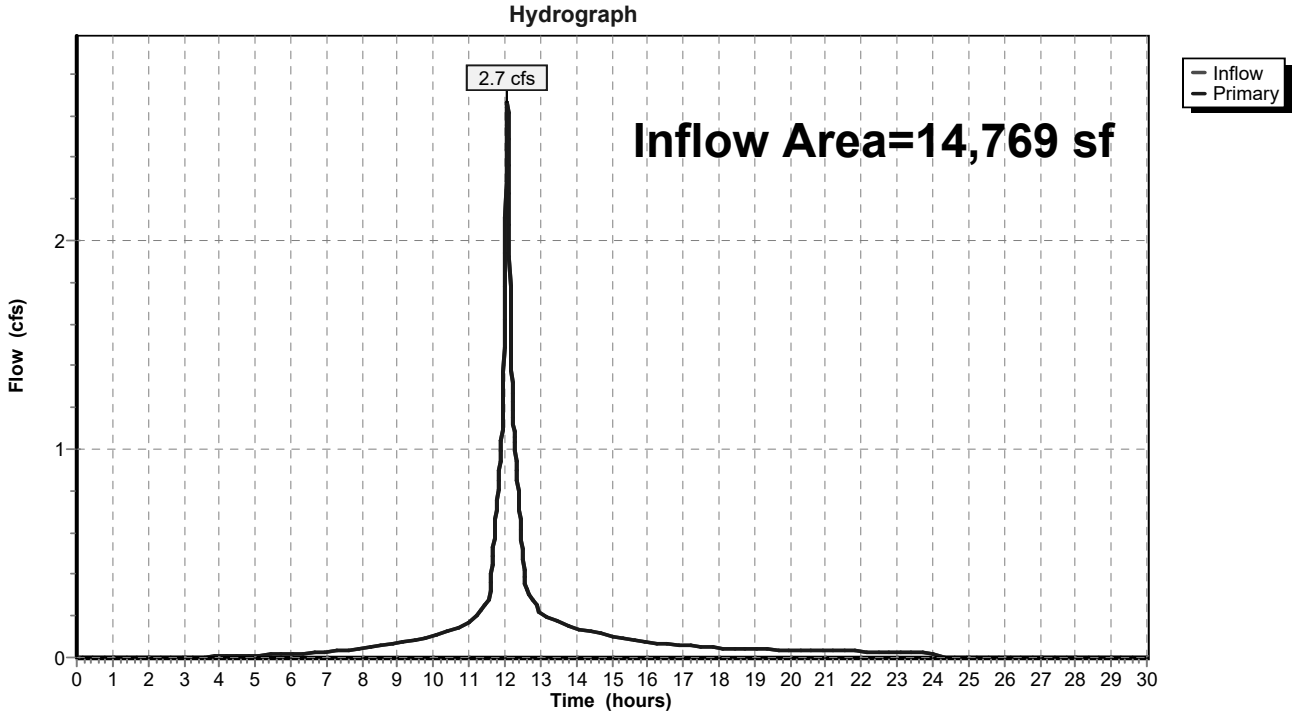


Summary for Link DP-2: Highland Ave

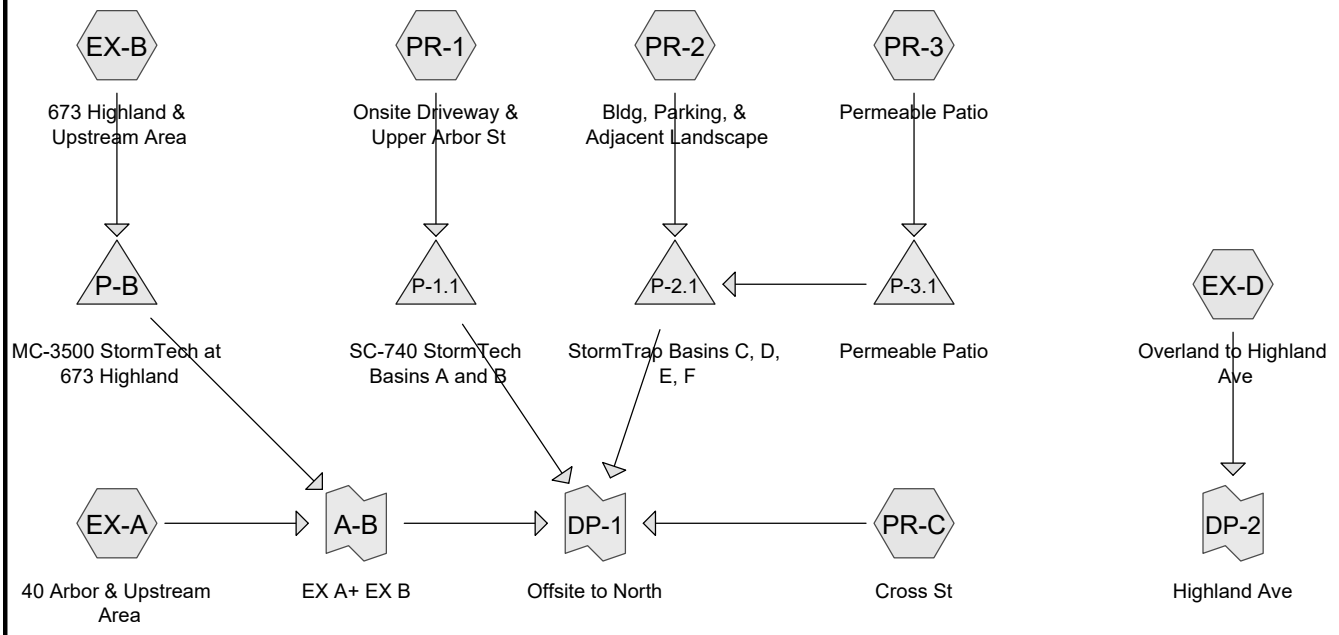
Inflow Area = 14,769 sf, 84.44% Impervious, Inflow Depth = 6.88" for 100-Year event
Inflow = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf
Primary = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf, Atten= 0%, Lag= 0.0 min

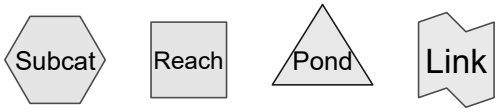
Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



HydroCAD Analysis: Proposed Conditions





Routing Diagram for 1478100-PR
Prepared by VHB, Printed 8/1/2023

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
77,853	39	>75% Grass cover, Good, HSG A (EX-A, EX-D, PR-1, PR-2, PR-C)
111,638	98	Paved parking, HSG A (EX-A, EX-B, EX-D, PR-1, PR-2, PR-3, PR-C)
44,429	98	Roofs, HSG A (EX-A, EX-B, PR-2, PR-3)
233,920	**78**	**TOTAL AREA**

2-Year Storm Event – Proposed

Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

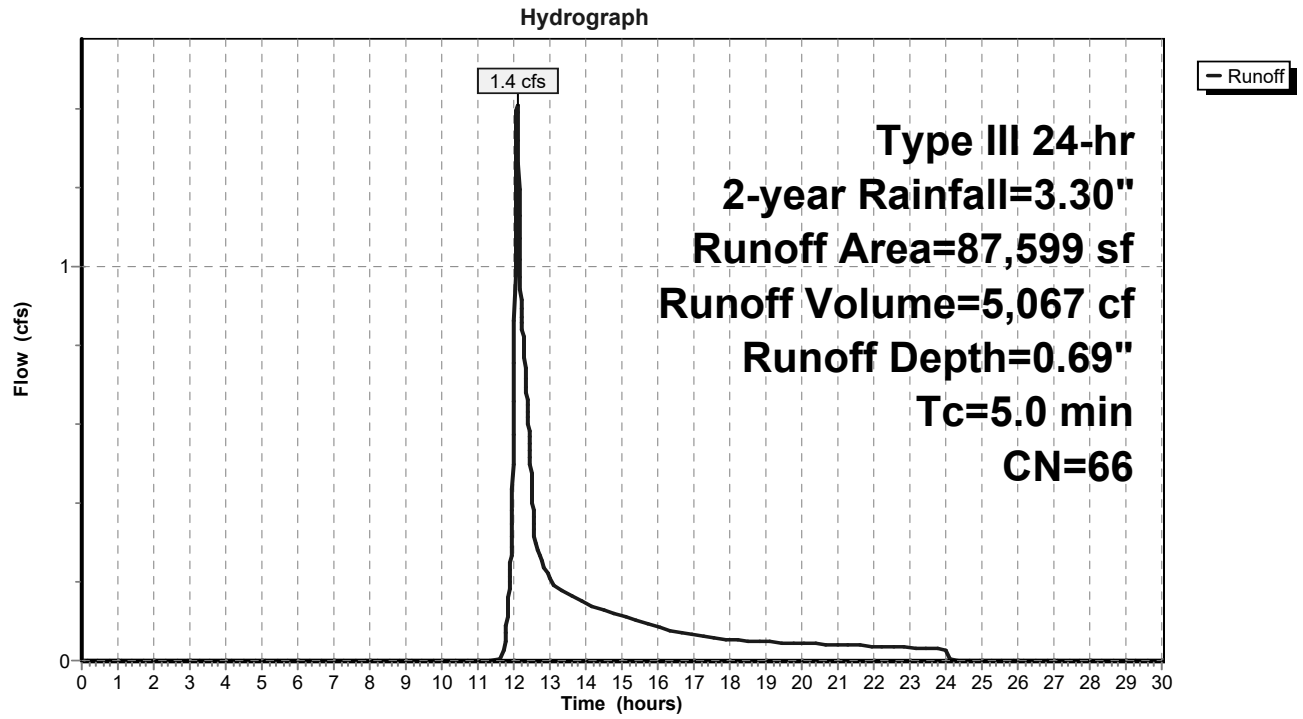
Runoff = 1.4 cfs @ 12.09 hrs, Volume= 5,067 cf, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
47,249	39	>75% Grass cover, Good, HSG A
27,508	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
87,599	66	Weighted Average
47,249		53.94% Pervious Area
40,349		46.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

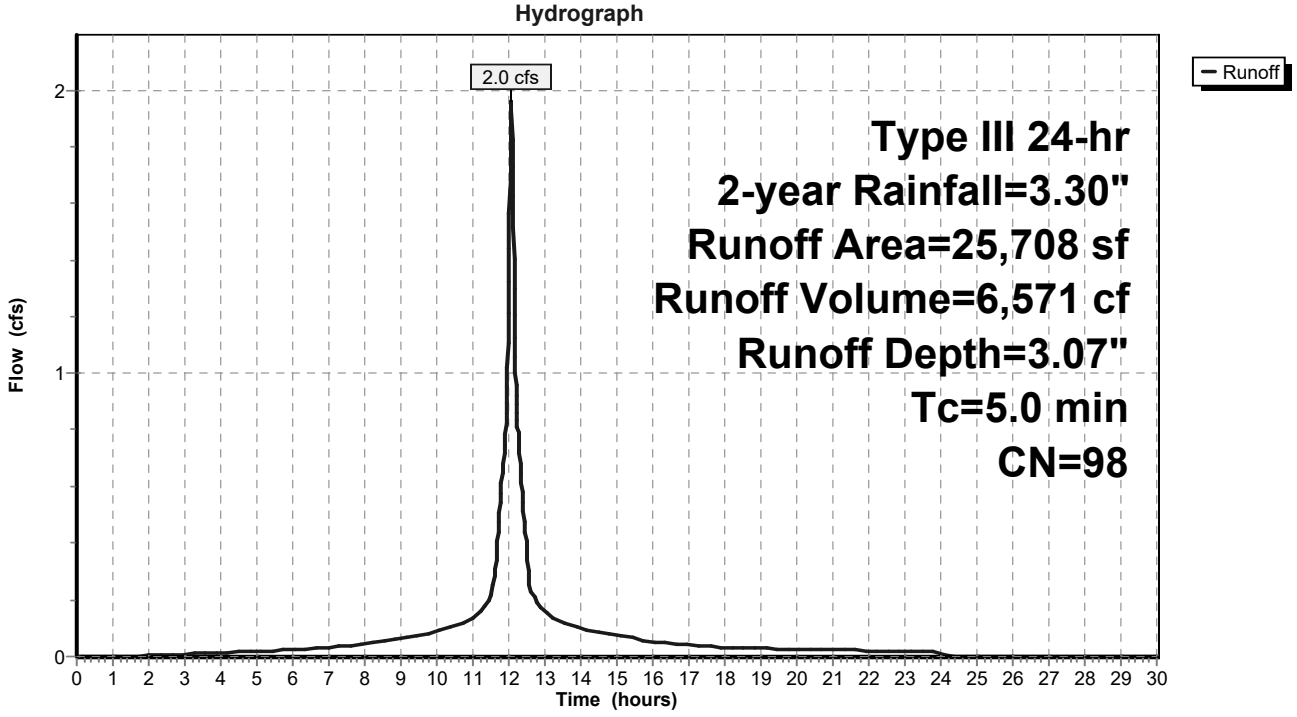
Runoff = 2.0 cfs @ 12.07 hrs, Volume= 6,571 cf, Depth= 3.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-D: Overland to Highland Ave

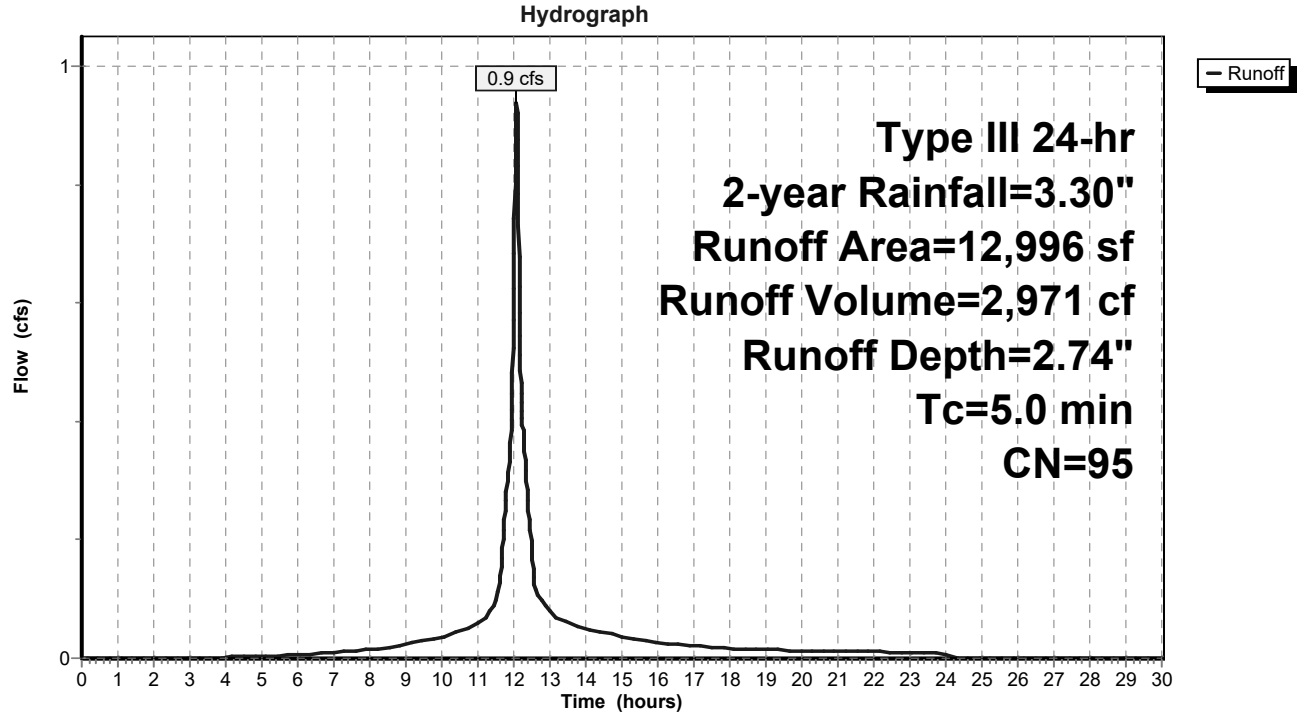
Runoff = 0.9 cfs @ 12.07 hrs, Volume= 2,971 cf, Depth= 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
632	39	>75% Grass cover, Good, HSG A
12,364	98	Paved parking, HSG A
12,996	95	Weighted Average
632		4.86% Pervious Area
12,364		95.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

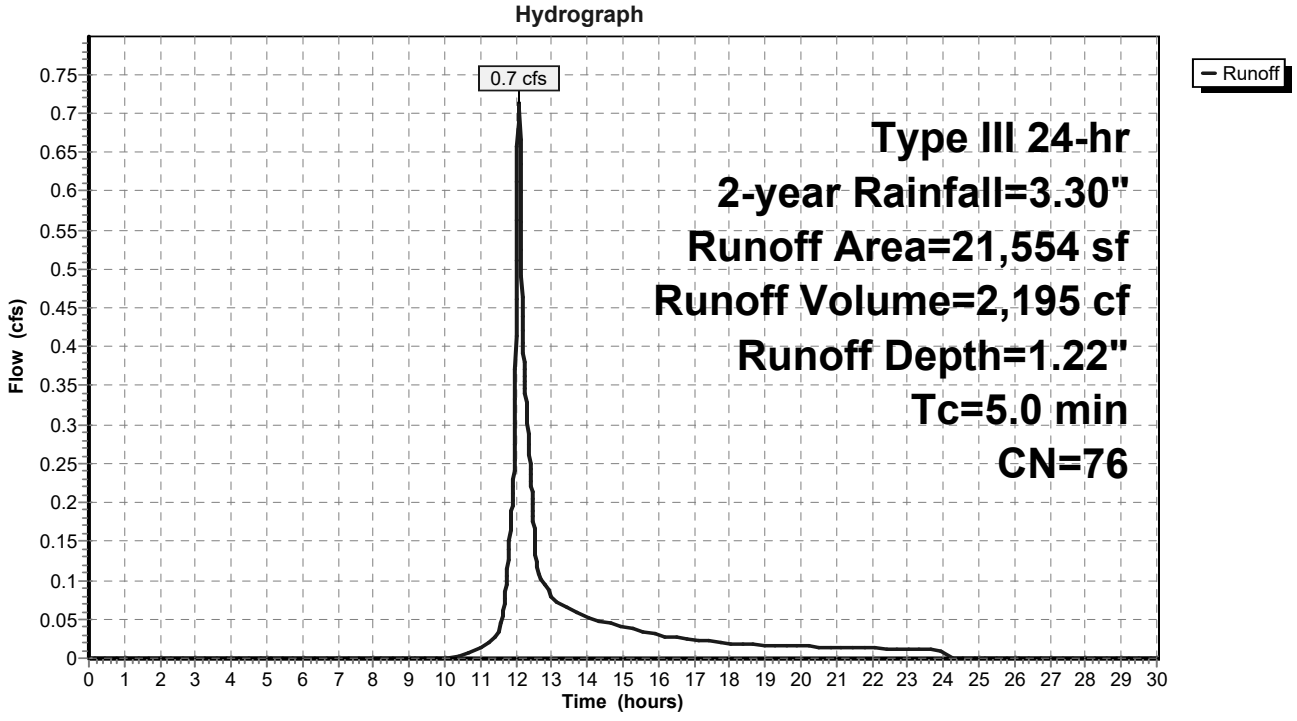
Runoff = 0.7 cfs @ 12.08 hrs, Volume= 2,195 cf, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
7,873	39	>75% Grass cover, Good, HSG A
13,680	98	Paved parking, HSG A
21,554	76	Weighted Average
7,873		36.53% Pervious Area
13,680		63.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-1: Onsite Driveway & Upper Arbor St



Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

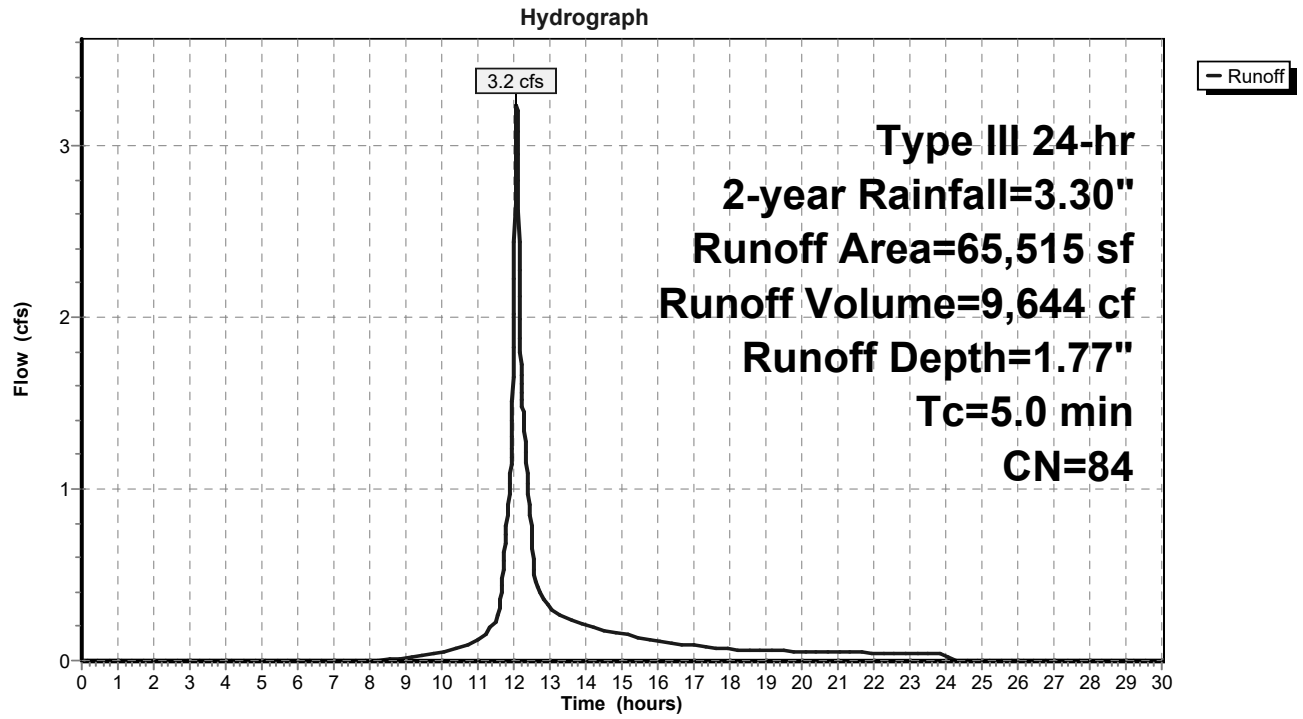
Runoff = 3.2 cfs @ 12.08 hrs, Volume= 9,644 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
15,673	39	>75% Grass cover, Good, HSG A
24,695	98	Paved parking, HSG A
25,148	98	Roofs, HSG A
65,515	84	Weighted Average
15,673		23.92% Pervious Area
49,843		76.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape



Summary for Subcatchment PR-3: Permeable Patio

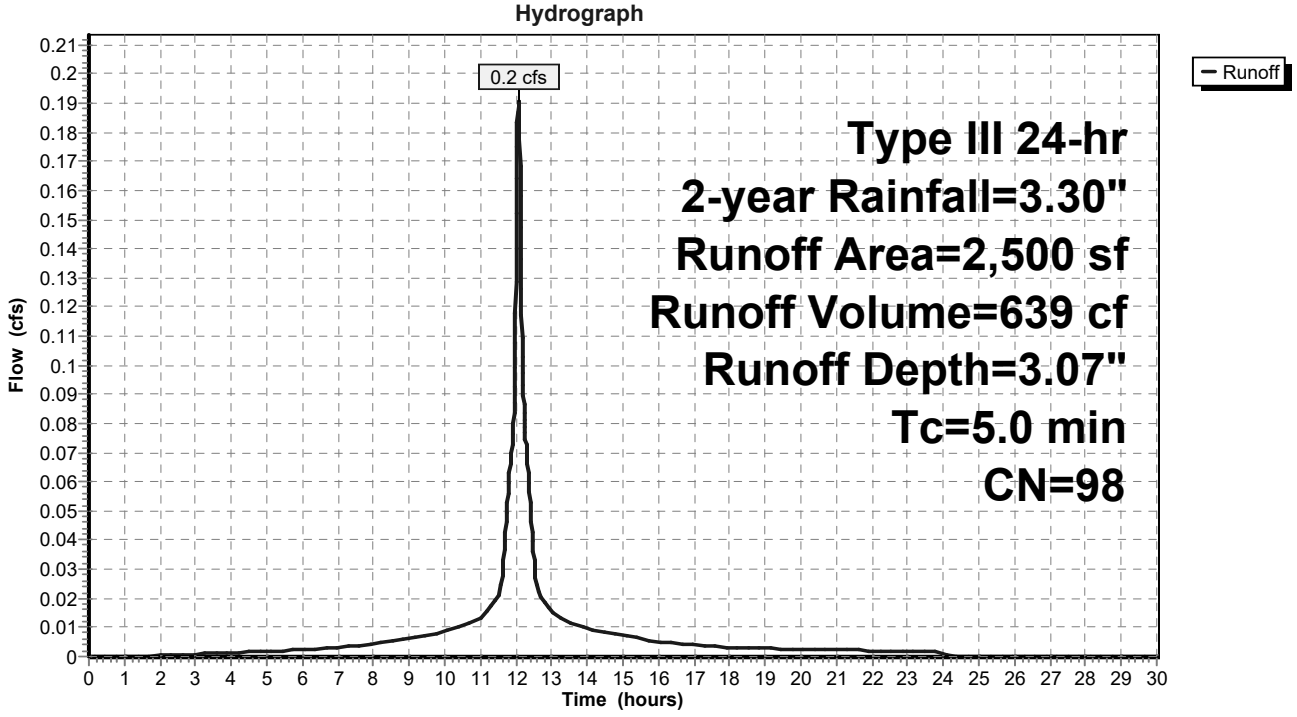
Runoff = 0.2 cfs @ 12.07 hrs, Volume= 639 cf, Depth= 3.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
2,500	98	Paved parking, HSG A
0	98	Roofs, HSG A
2,500	98	Weighted Average
2,500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-3: Permeable Patio



Summary for Subcatchment PR-C: Cross St

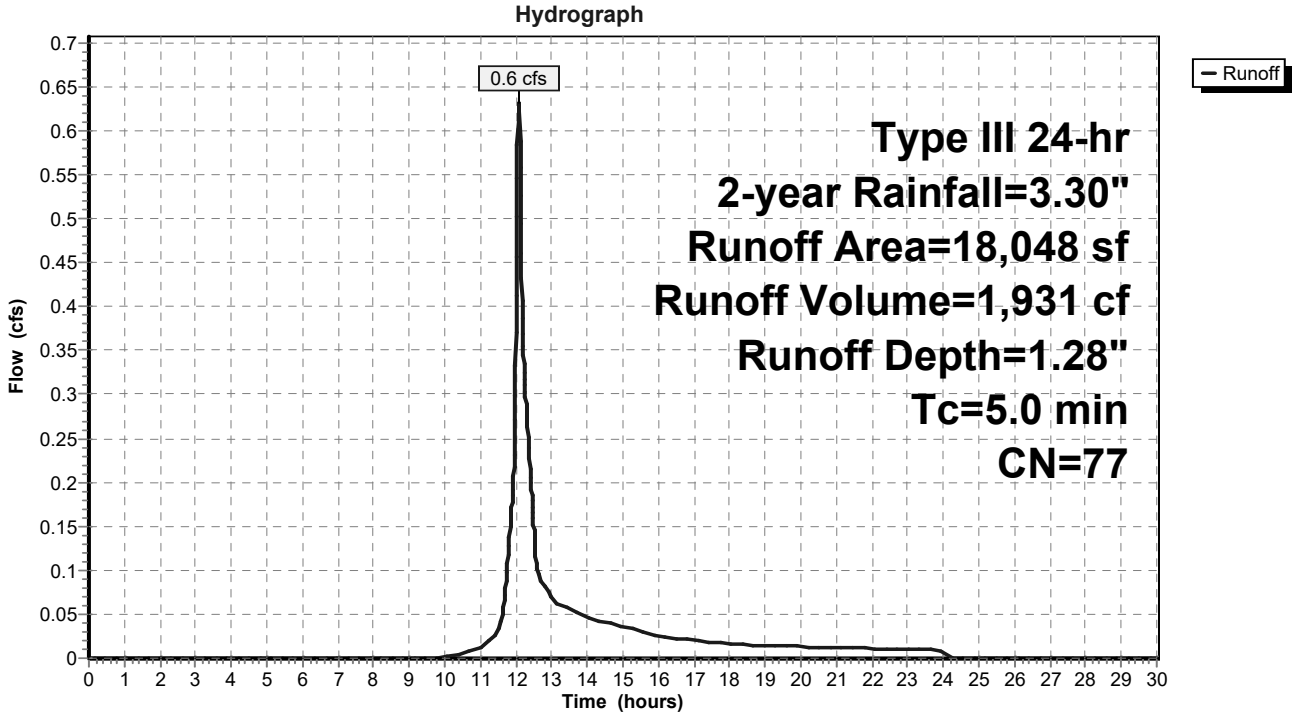
Runoff = 0.6 cfs @ 12.08 hrs, Volume= 1,931 cf, Depth= 1.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

Area (sf)	CN	Description
6,426	39	>75% Grass cover, Good, HSG A
11,623	98	Paved parking, HSG A
18,048	77	Weighted Average
6,426		35.60% Pervious Area
11,623		64.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-C: Cross St



Summary for Pond P-1.1: SC-740 StormTech Basins A and B

Inflow Area = 21,554 sf, 63.47% Impervious, Inflow Depth = 1.22" for 2-year event
Inflow = 0.7 cfs @ 12.08 hrs, Volume= 2,195 cf
Outflow = 0.1 cfs @ 11.77 hrs, Volume= 2,195 cf, Atten= 93%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.77 hrs, Volume= 2,195 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 133.80' @ 14.04 hrs Surf.Area= 2,196 sf Storage= 949 cf

Plug-Flow detention time= 186.4 min calculated for 2,194 cf (100% of inflow)
Center-of-Mass det. time= 186.3 min (1,039.2 - 852.9)

Volume	Invert	Avail.Storage	Storage Description
#1J	133.00'	1,122 cf	**20.50'W x 60.58'L x 3.50'H Stone Bed For StormTech - A** 4,346 cf Overall - 1,470 cf Embedded = 2,876 cf x 39.0% Voids
#2J	133.50'	1,470 cf	**ADS_StormTech SC-740 +Cap** x 32 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 32 Chambers in 4 Rows
#3K	133.00'	872 cf	**15.75'W x 60.58'L x 3.50'H Stone Bed For StormTech - B** 3,339 cf Overall - 1,103 cf Embedded = 2,237 cf x 39.0% Voids
#4K	133.50'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 3 Rows
#5	136.50'	5 cf	**2.00'D x 1.50'H Structure with Grate Inlet** Impervious
		4,571 cf	Total Available Storage

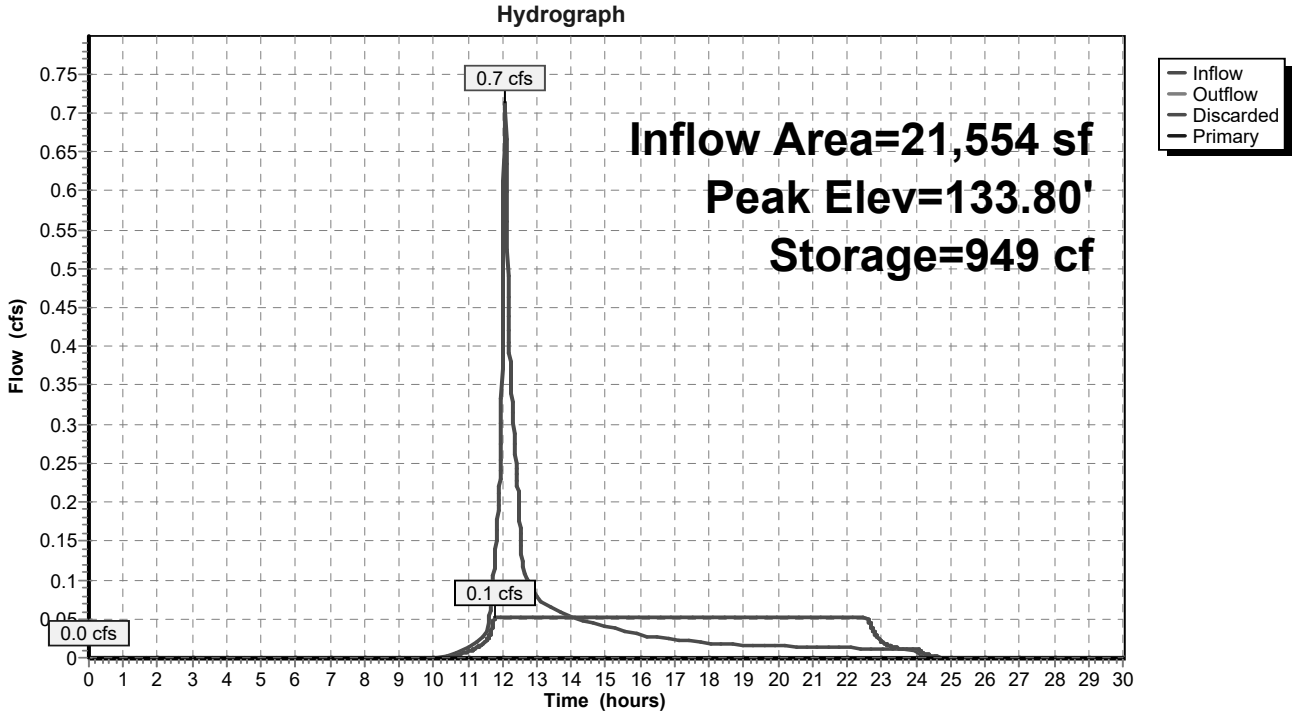
Storage Group J created with Chamber Wizard
Storage Group K created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	138.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.77 hrs HW=133.06' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)
↑**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-1.1: SC-740 StormTech Basins A and B



Summary for Pond P-2.1: StormTrap Basins C, D, E, F

Inflow Area = 68,015 sf, 76.96% Impervious, Inflow Depth = 1.70" for 2-year event
Inflow = 3.2 cfs @ 12.08 hrs, Volume= 9,644 cf
Outflow = 0.2 cfs @ 11.55 hrs, Volume= 9,644 cf, Atten= 95%, Lag= 0.0 min
Discarded = 0.2 cfs @ 11.55 hrs, Volume= 9,644 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 134.58' @ 14.63 hrs Surf.Area= 7,258 sf Storage= 4,746 cf

Plug-Flow detention time= 278.6 min calculated for 9,641 cf (100% of inflow)
Center-of-Mass det. time= 278.6 min (1,105.8 - 827.2)

Volume	Invert	Avail.Storage	Storage Description
#1G	133.00'	1,599 cf	**30.27'W x 90.29'L x 4.00'H Stone Bed For StormTrap - C** 10,933 cf Overall - 6,833 cf Embedded = 4,100 cf x 39.0% Voids
#2G	134.50'	4,758 cf	**StormTrap ST2 SingleTrap 2-0** x 10 Inside #1 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 10 Chambers in 2 Rows 16.96' x 76.98' Core + 6.66' Border = 30.27' x 90.29' System
#3H	133.00'	1,326 cf	**30.27'W x 74.90'L x 4.00'H Stone Bed For StormTrap - D** 9,069 cf Overall - 5,668 cf Embedded = 3,401 cf x 39.0% Voids
#4H	134.50'	3,944 cf	**StormTrap ST2 SingleTrap 2-0** x 8 Inside #3 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8 Chambers in 2 Rows 16.96' x 61.58' Core + 6.66' Border = 30.27' x 74.90' System
#5E	133.00'	562 cf	**21.79'W x 44.10'L x 4.00'H Stone Bed For StormTrap - E** 3,844 cf Overall - 2,403 cf Embedded = 1,442 cf x 39.0% Voids
#6E	134.50'	1,660 cf	**StormTrap ST2 SingleTrap 2-0** x 2 Inside #5 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 30.79' Core + 6.66' Border = 21.79' x 44.10' System
#7I	133.00'	759 cf	**21.79'W x 59.50'L x 4.00'H Stone Bed For StormTrap - F** 5,186 cf Overall - 3,242 cf Embedded = 1,945 cf x 39.0% Voids
#8I	134.50'	2,242 cf	**StormTrap ST2 SingleTrap 2-0** x 3 Inside #7 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 46.19' Core + 6.66' Border = 21.79' x 59.50' System
#9	136.90'	6 cf	**2.00'D x 2.00'H Structure with Grate Inlet** Impervious
		16,856 cf	Total Available Storage

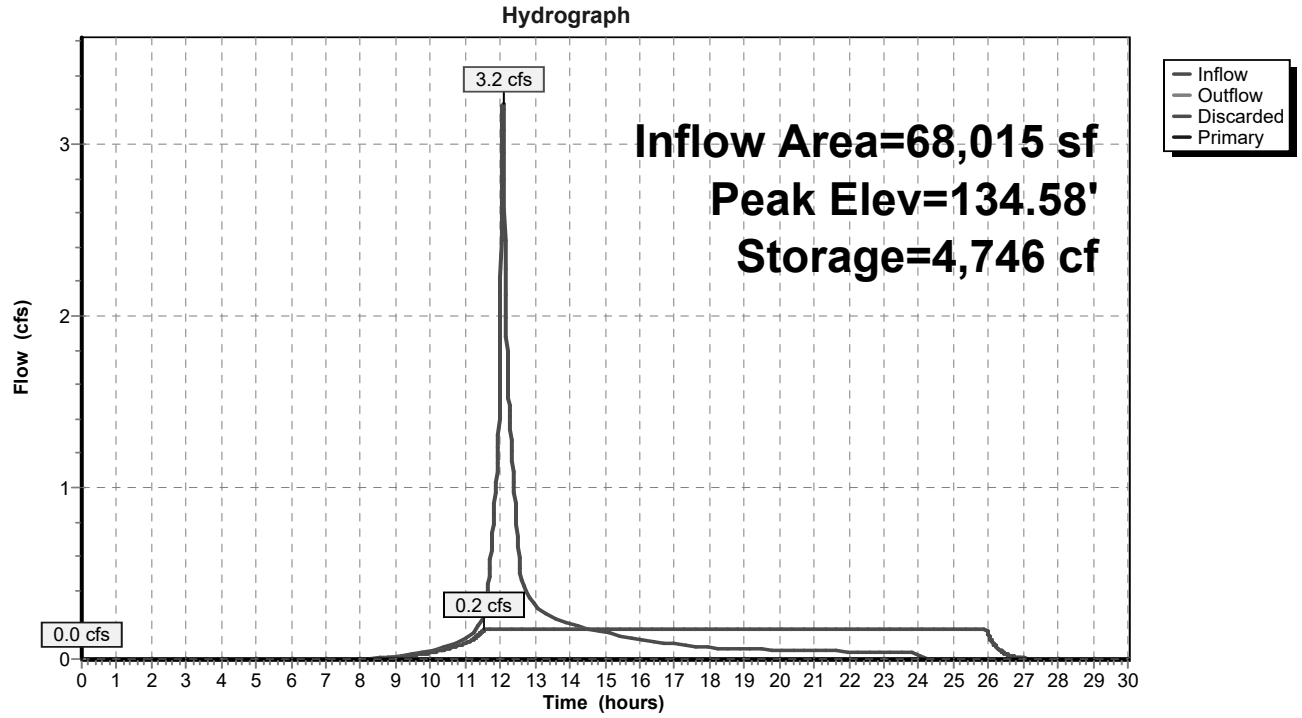
Storage Group G created with Chamber Wizard
Storage Group H created with Chamber Wizard
Storage Group E created with Chamber Wizard
Storage Group I created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	139.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.2 cfs @ 11.55 hrs HW=133.07' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)
↑**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-2.1: StormTrap Basins C, D, E, F



Summary for Pond P-3.1: Permeable Patio

Inflow Area = 2,500 sf,100.00% Impervious, Inflow Depth = 3.07" for 2-year event
Inflow = 0.2 cfs @ 12.07 hrs, Volume= 639 cf
Outflow = 0.1 cfs @ 11.97 hrs, Volume= 639 cf, Atten= 69%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.97 hrs, Volume= 639 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 149.62' @ 12.36 hrs Surf.Area= 2,500 sf Storage= 121 cf

Plug-Flow detention time= 16.2 min calculated for 639 cf (100% of inflow)
Center-of-Mass det. time= 16.1 min (771.0 - 754.8)

Volume	Invert	Avail.Storage	Storage Description
#1	149.50'	1,463 cf	**Porous Pavement Stone (Prismatic)** Listed below (Recalc) 3,750 cf Overall x 39.0% Voids
#2	151.00'	1 cf	**Patio Drain (Prismatic)** Listed below (Recalc) -Impervious
#3	152.00'	2,500 cf	**Patio Surface Storage (Prismatic)** Listed below (Recalc) -Impervious
		3,964 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
149.50	2,500	0	0
150.50	2,500	2,500	2,500
151.00	2,500	1,250	3,750

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	1	0	0
152.00	1	1	1

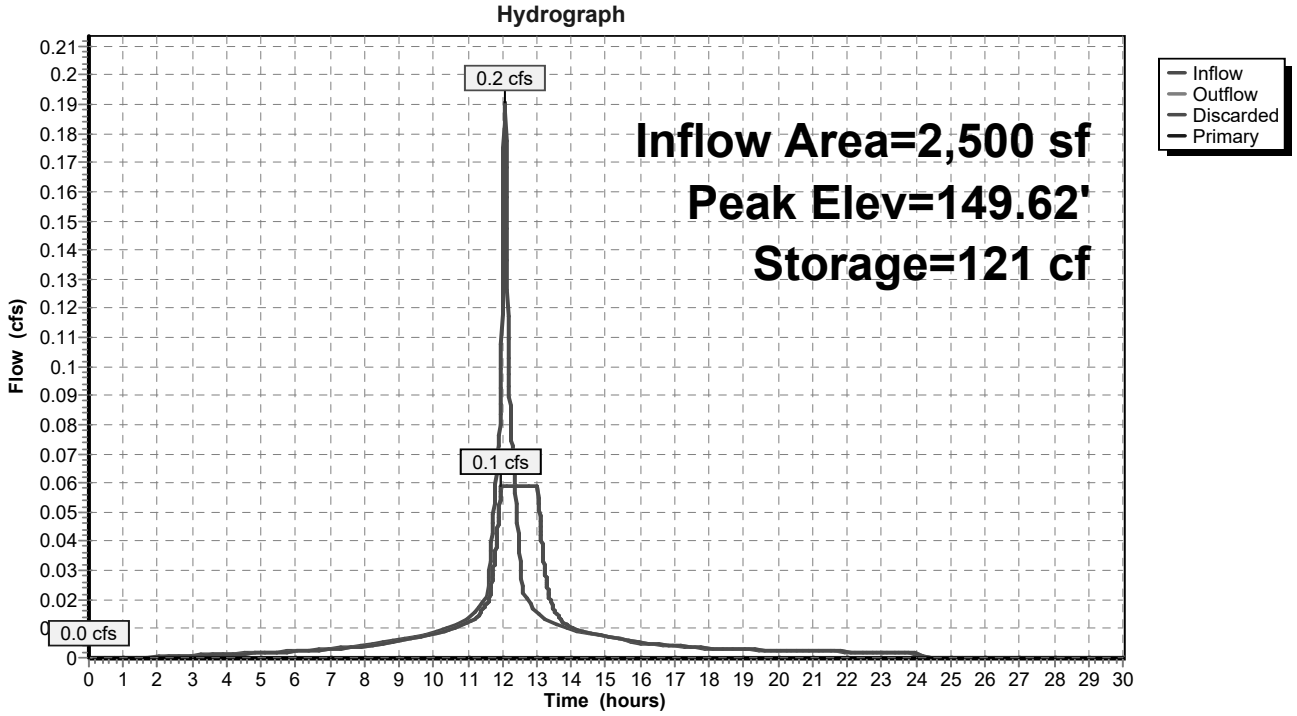
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	2,500	0	0
153.00	2,500	2,500	2,500

Device	Routing	Invert	Outlet Devices
#1	Discarded	149.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.50'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.97 hrs HW=149.54' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=149.50' (Free Discharge)
↑—**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-3.1: Permeable Patio



Summary for Pond P-B: MC-3500 StormTech at 673 Highland

Inflow Area = 25,708 sf,100.00% Impervious, Inflow Depth = 3.07" for 2-year event
Inflow = 2.0 cfs @ 12.07 hrs, Volume= 6,571 cf
Outflow = 0.3 cfs @ 11.69 hrs, Volume= 6,571 cf, Atten= 83%, Lag= 0.0 min
Discarded = 0.3 cfs @ 11.69 hrs, Volume= 6,571 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 163.04' @ 12.52 hrs Surf.Area= 1,761 sf Storage= 1,670 cf

Plug-Flow detention time= 27.3 min calculated for 6,571 cf (100% of inflow)
Center-of-Mass det. time= 27.3 min (782.1 - 754.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	161.50'	2,456 cf	**22.75'W x 77.40'L x 5.50'H Stone Bed for StormTech-673** 9,685 cf Overall - 3,388 cf Embedded = 6,297 cf x 39.0% Voids
#2A	162.25'	3,388 cf	**ADS_StormTech MC-3500 d +Cap** x 30 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 30 Chambers in 3 Rows Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
#3	167.00'	3 cf	**2.00'D x 1.00'H Structure with Grate Inlet** -Impervious
#4	167.67'	3,741 cf	**Parking Lot Surface Storage (Prismatic)** Listed below (Recalc) -Impervious
		9,588 cf	Total Available Storage

Storage Group A created with Chamber Wizard

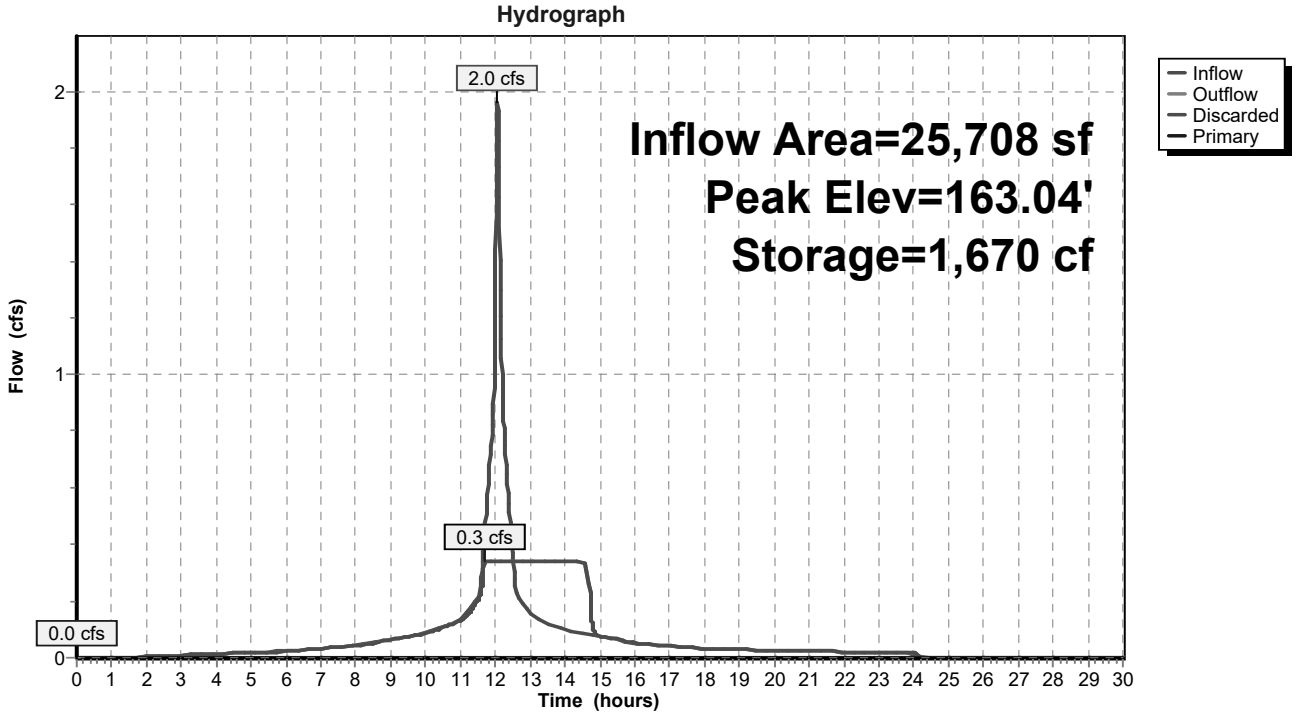
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.67	0	0	0
167.70	16	0	0
168.00	155	26	26
169.00	1,500	828	853
170.00	4,275	2,888	3,741

Device	Routing	Invert	Outlet Devices
#1	Discarded	161.50'	**8.270 in/hr Exfiltration over Surface area**
#2	Primary	168.50'	**12.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.3 cfs @ 11.69 hrs HW=161.59' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=161.50' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond P-B: MC-3500 StormTech at 673 Highland

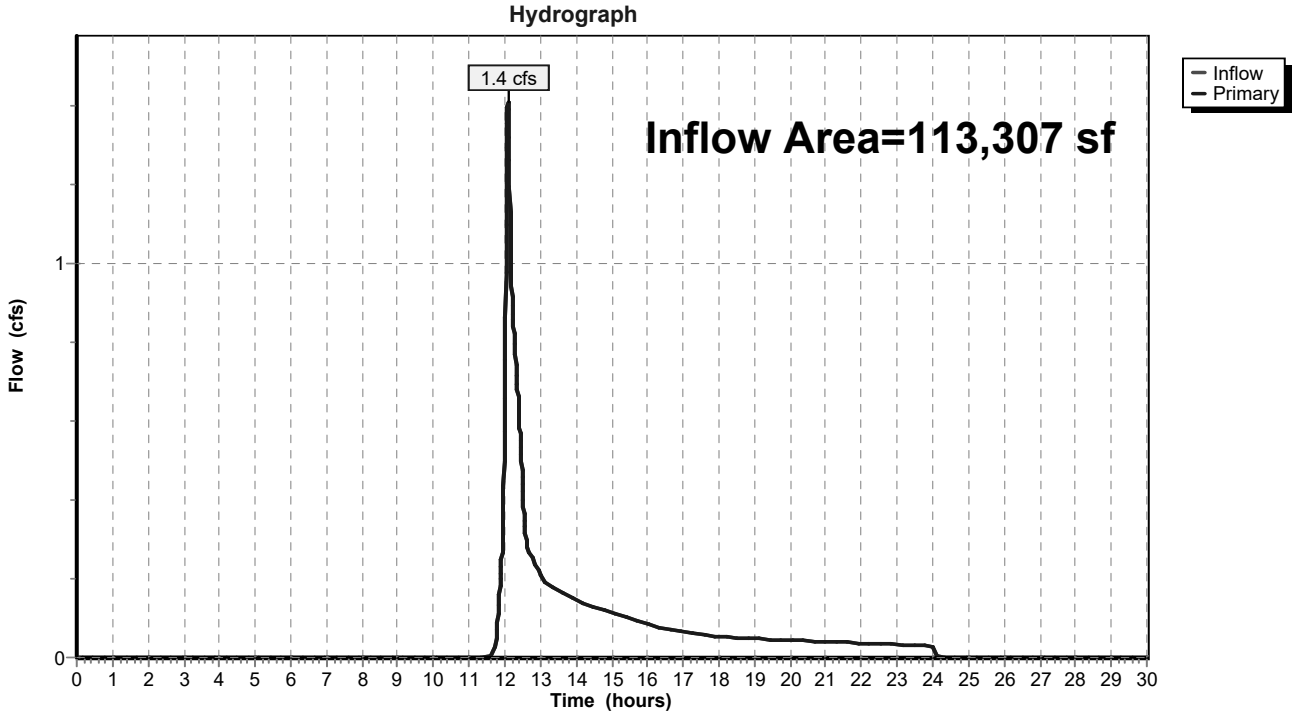


Summary for Link A-B: EX A+ EX B

Inflow Area = 113,307 sf, 58.30% Impervious, Inflow Depth = 0.54" for 2-year event
Inflow = 1.4 cfs @ 12.09 hrs, Volume= 5,067 cf
Primary = 1.4 cfs @ 12.09 hrs, Volume= 5,067 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link A-B: EX A+ EX B

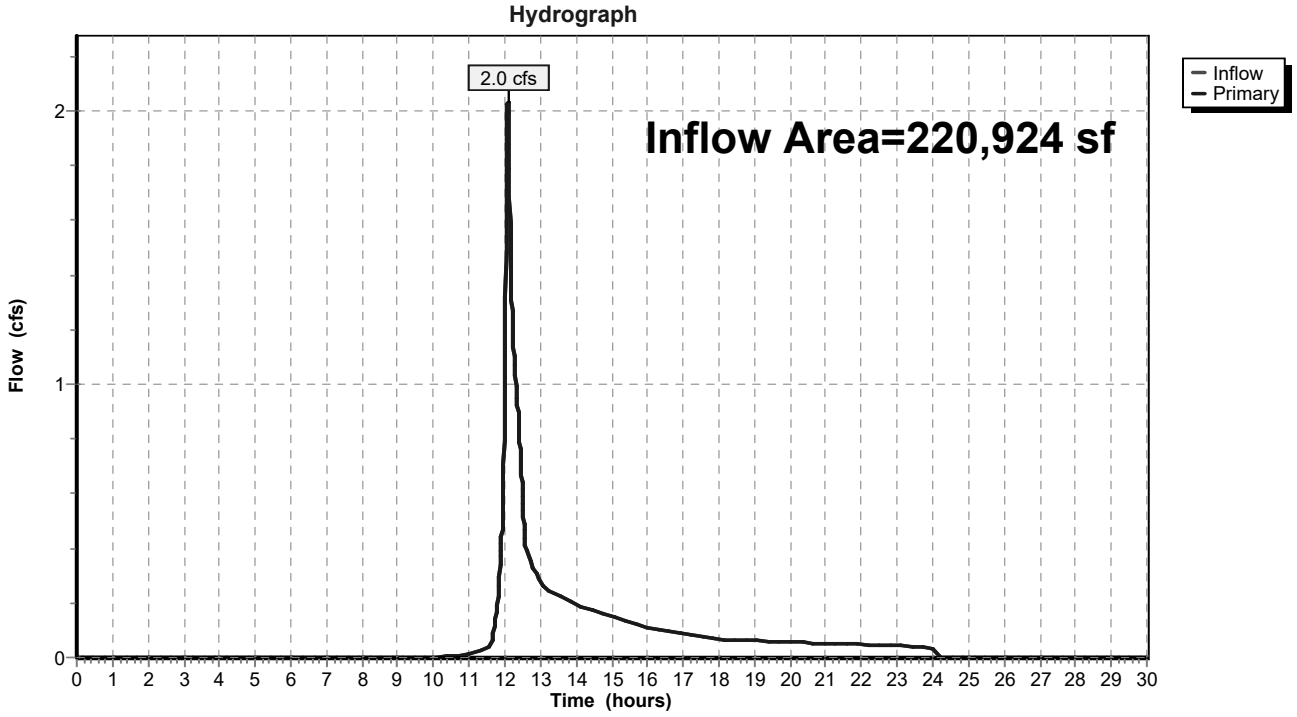


Summary for Link DP-1: Offsite to North

Inflow Area = 220,924 sf, 65.05% Impervious, Inflow Depth = 0.38" for 2-year event
Inflow = 2.0 cfs @ 12.09 hrs, Volume= 6,998 cf
Primary = 2.0 cfs @ 12.09 hrs, Volume= 6,998 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

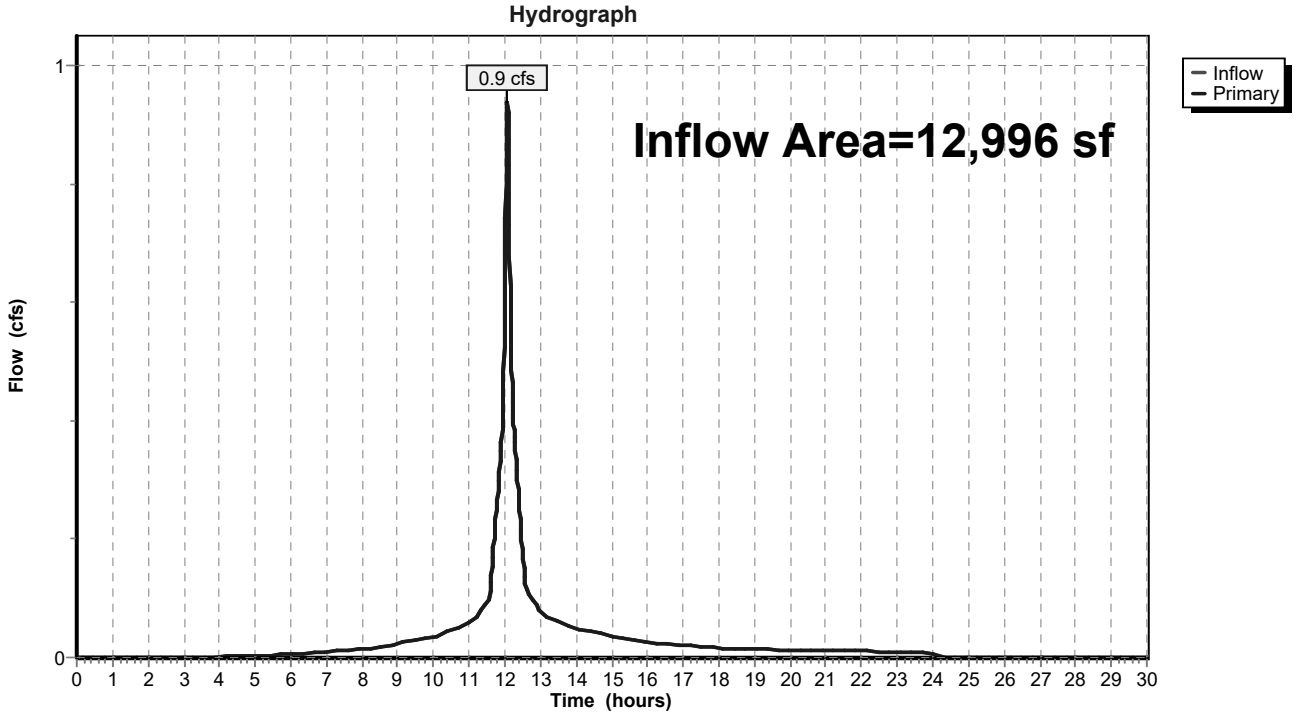


Summary for Link DP-2: Highland Ave

Inflow Area = 12,996 sf, 95.14% Impervious, Inflow Depth = 2.74" for 2-year event
Inflow = 0.9 cfs @ 12.07 hrs, Volume= 2,971 cf
Primary = 0.9 cfs @ 12.07 hrs, Volume= 2,971 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



10-Year Storm Event – Proposed

Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

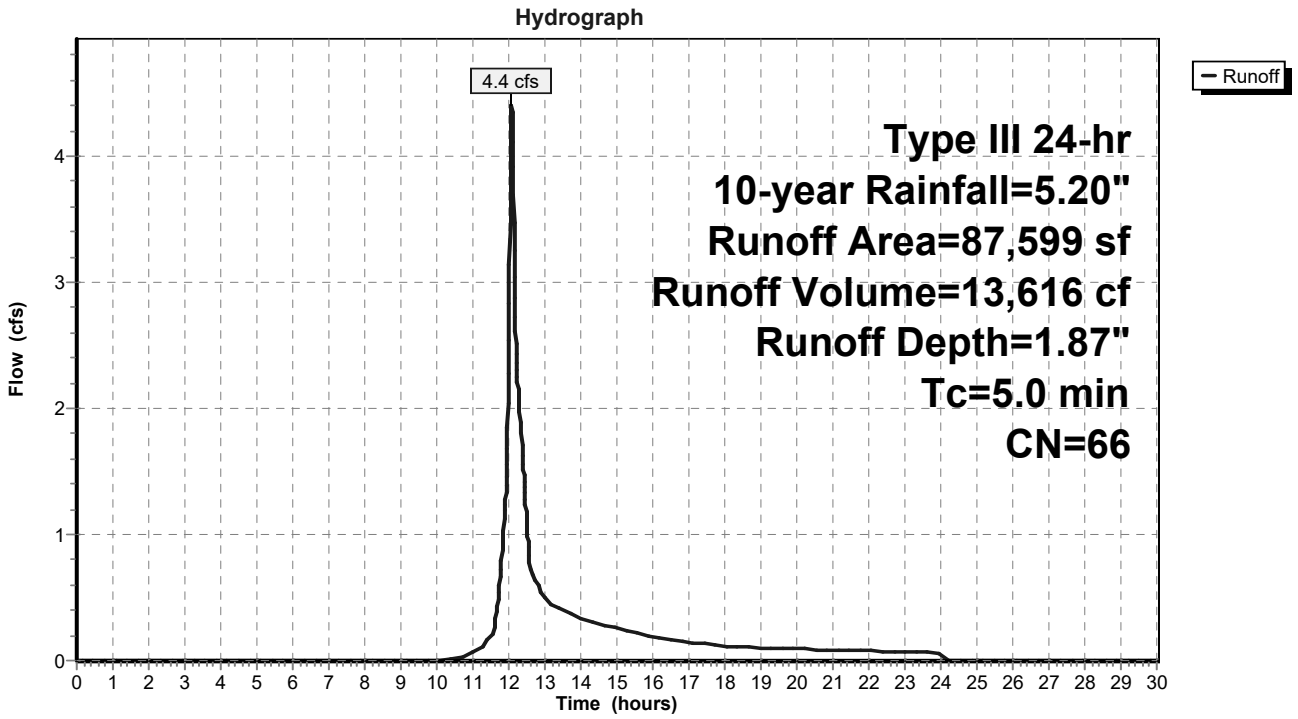
Runoff = 4.4 cfs @ 12.08 hrs, Volume= 13,616 cf, Depth= 1.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
47,249	39	>75% Grass cover, Good, HSG A
27,508	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
87,599	66	Weighted Average
47,249		53.94% Pervious Area
40,349		46.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

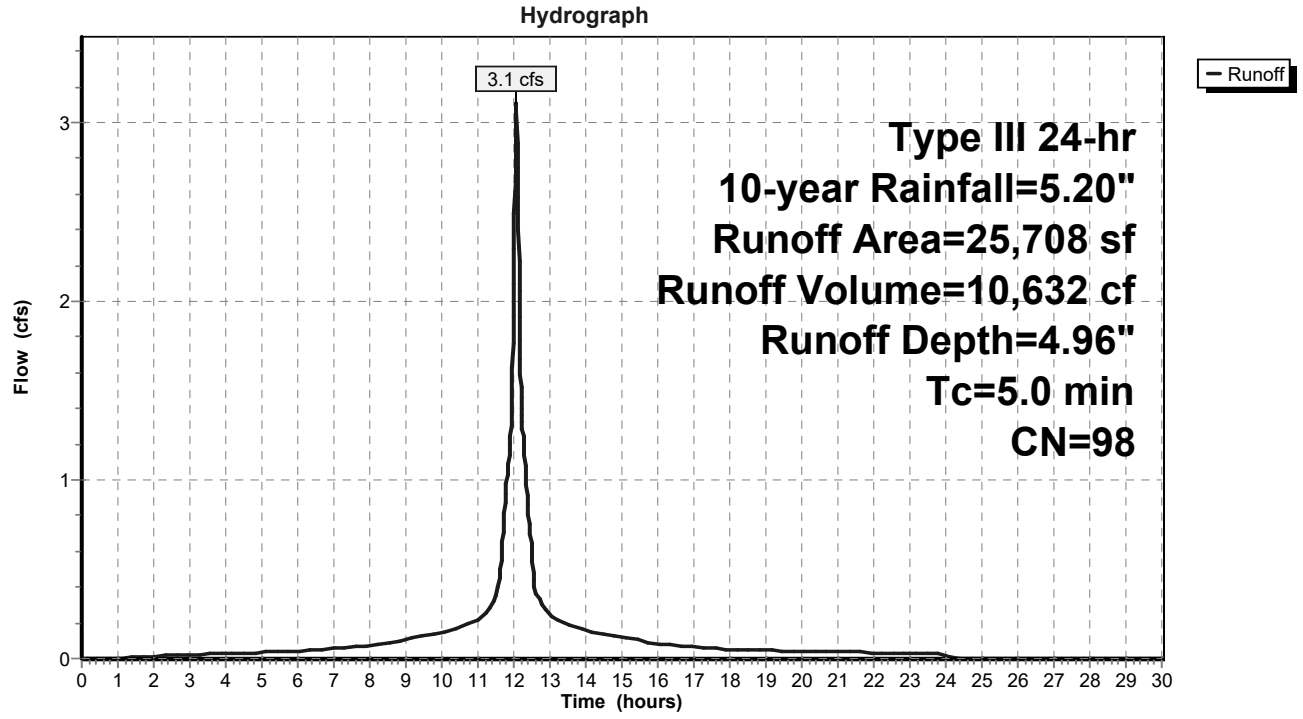
Runoff = 3.1 cfs @ 12.07 hrs, Volume= 10,632 cf, Depth= 4.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-D: Overland to Highland Ave

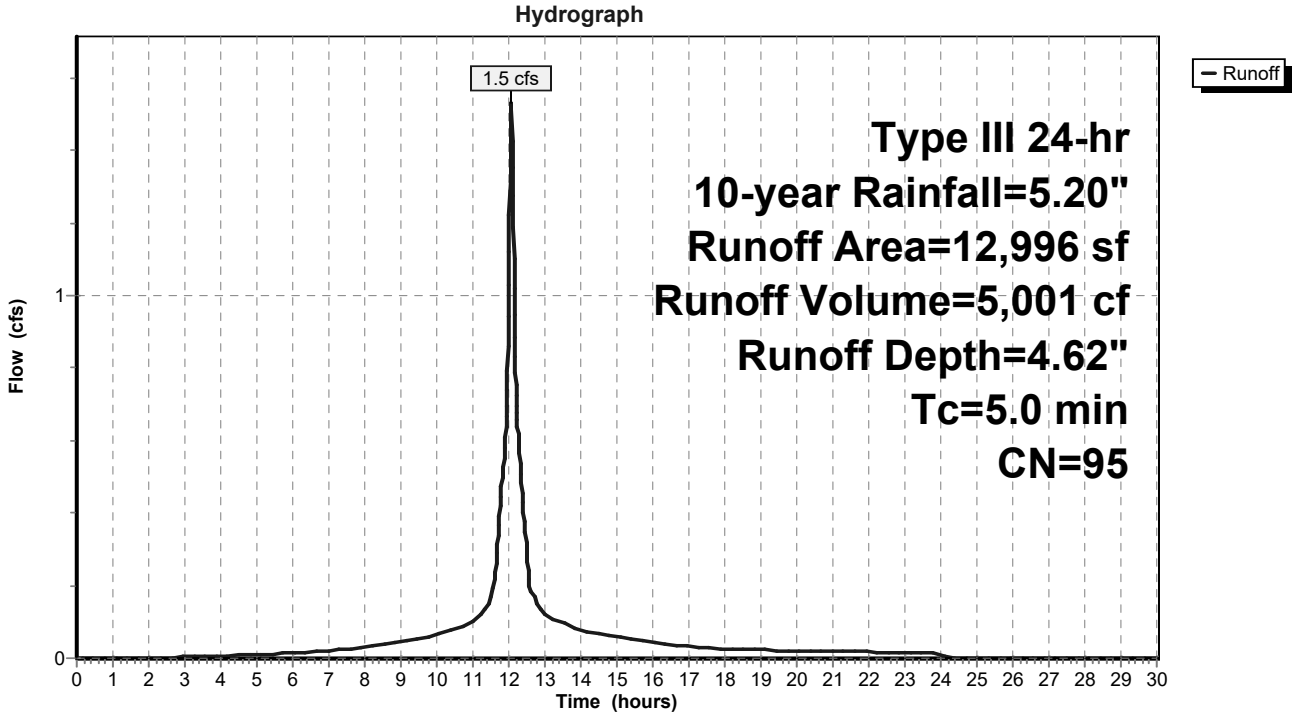
Runoff = 1.5 cfs @ 12.07 hrs, Volume= 5,001 cf, Depth= 4.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
632	39	>75% Grass cover, Good, HSG A
12,364	98	Paved parking, HSG A
12,996	95	Weighted Average
632		4.86% Pervious Area
12,364		95.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

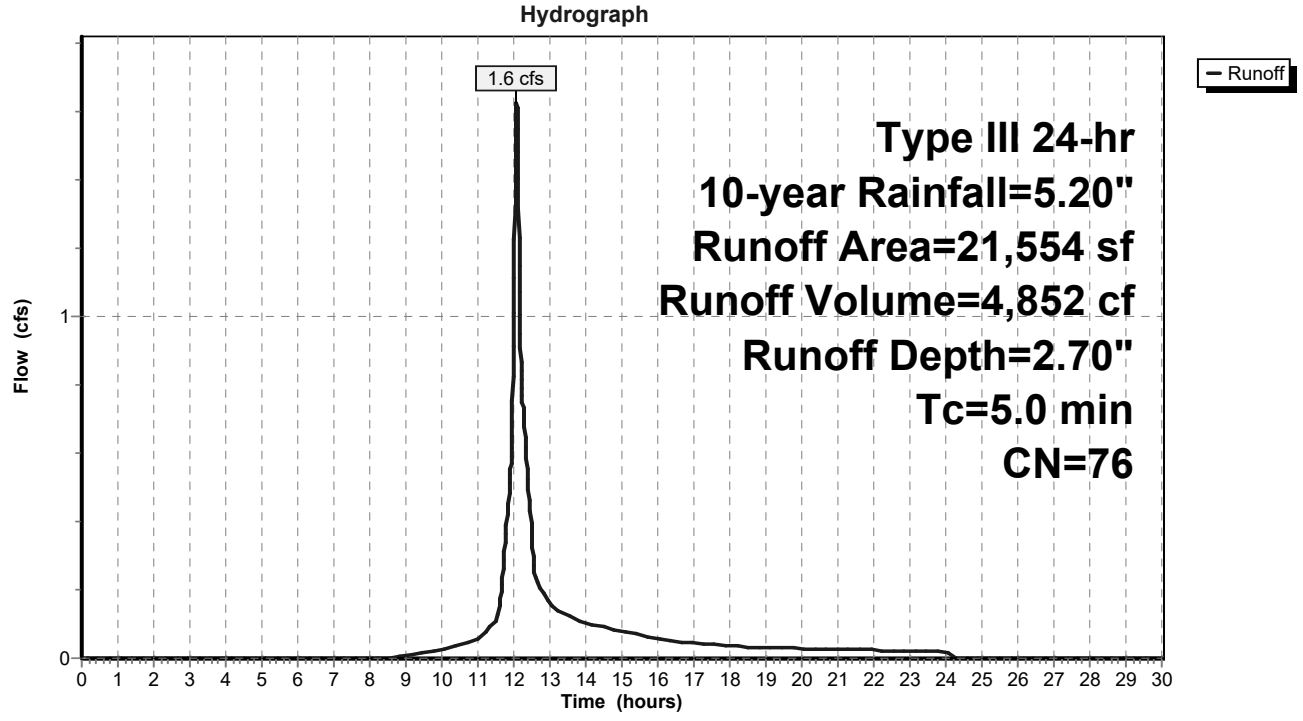
Runoff = 1.6 cfs @ 12.08 hrs, Volume= 4,852 cf, Depth= 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
7,873	39	>75% Grass cover, Good, HSG A
13,680	98	Paved parking, HSG A
21,554	76	Weighted Average
7,873		36.53% Pervious Area
13,680		63.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-1: Onsite Driveway & Upper Arbor St



Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

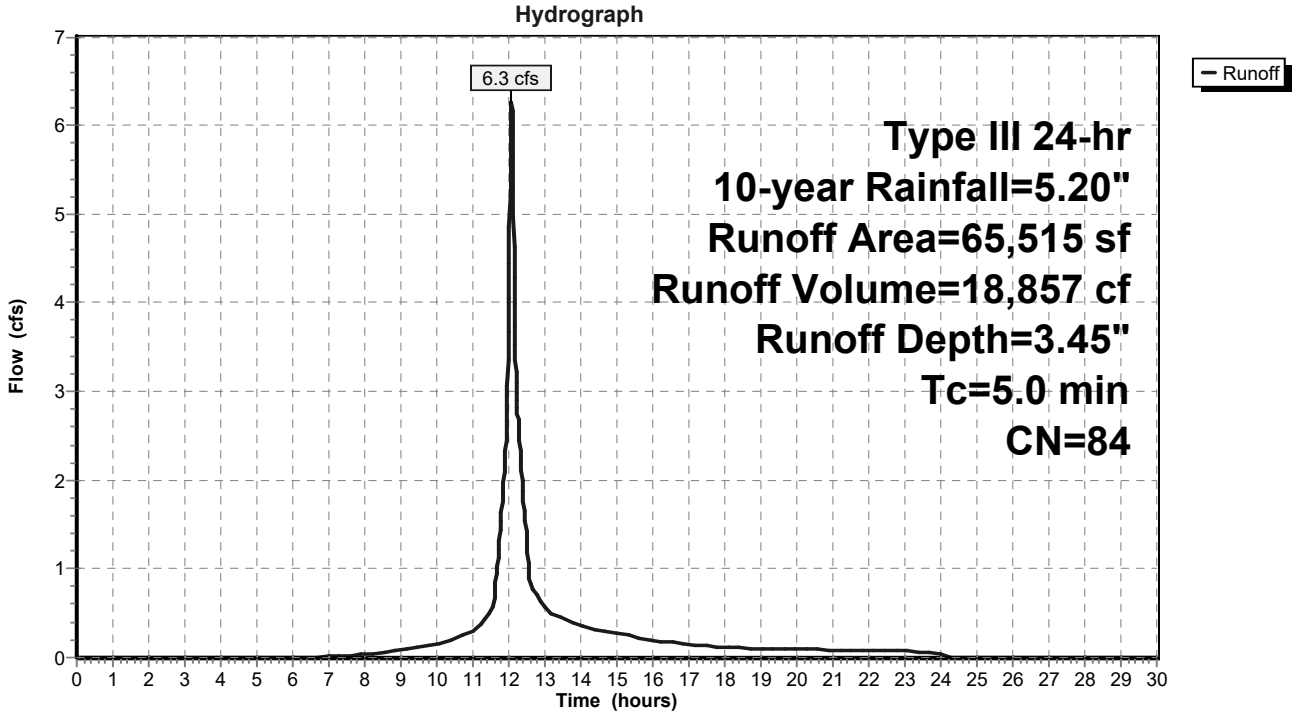
Runoff = 6.3 cfs @ 12.07 hrs, Volume= 18,857 cf, Depth= 3.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
15,673	39	>75% Grass cover, Good, HSG A
24,695	98	Paved parking, HSG A
25,148	98	Roofs, HSG A
65,515	84	Weighted Average
15,673		23.92% Pervious Area
49,843		76.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape



Summary for Subcatchment PR-3: Permeable Patio

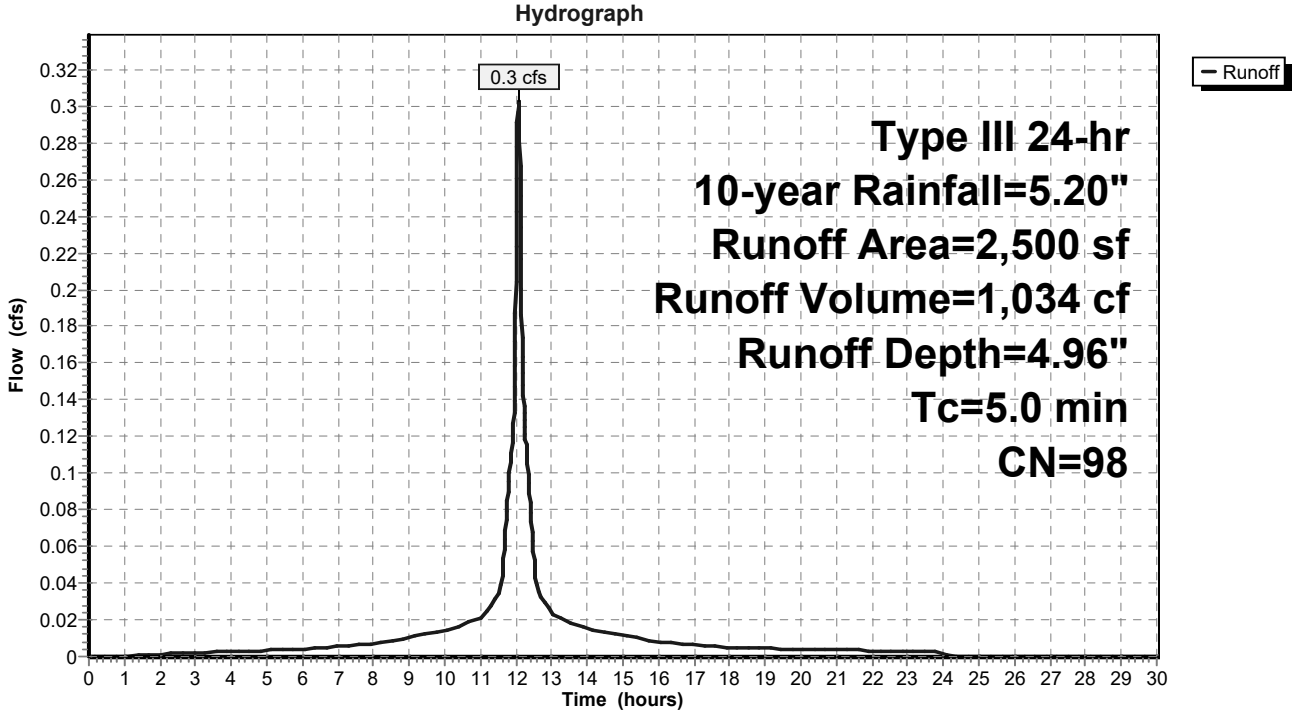
Runoff = 0.3 cfs @ 12.07 hrs, Volume= 1,034 cf, Depth= 4.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
2,500	98	Paved parking, HSG A
0	98	Roofs, HSG A
2,500	98	Weighted Average
2,500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-3: Permeable Patio



Summary for Subcatchment PR-C: Cross St

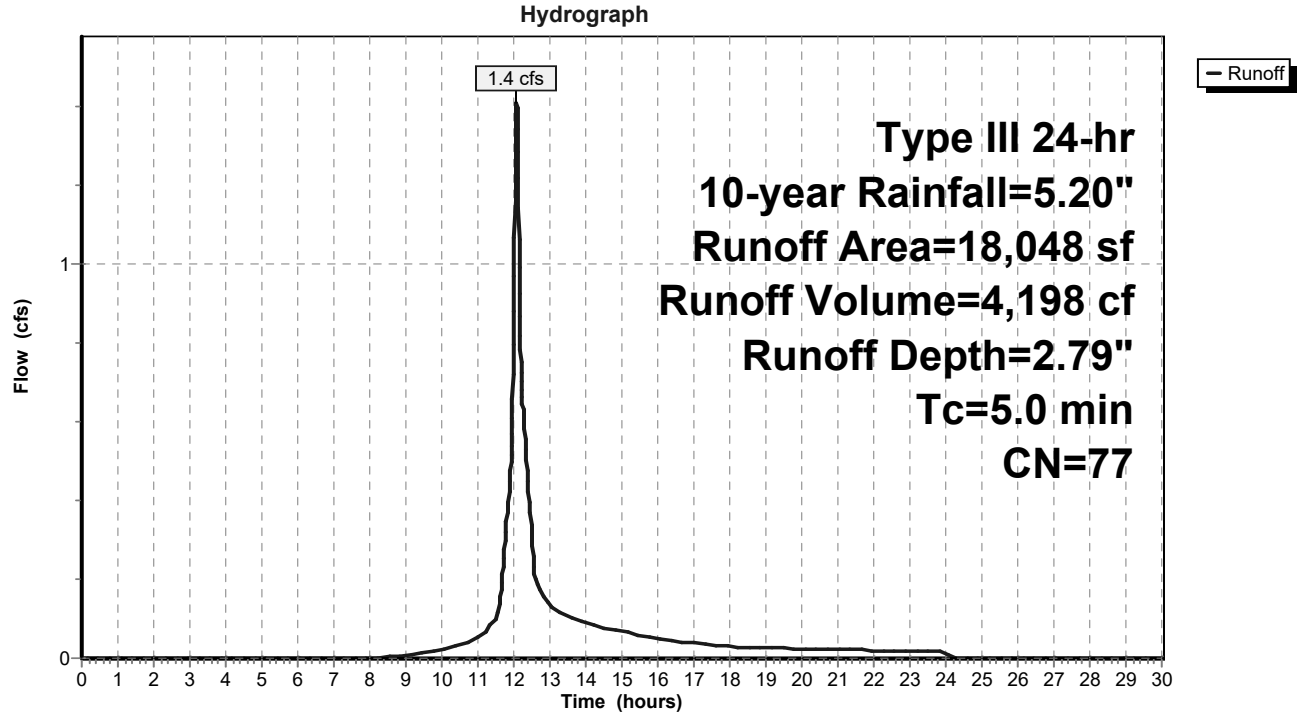
Runoff = 1.4 cfs @ 12.08 hrs, Volume= 4,198 cf, Depth= 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

Area (sf)	CN	Description
6,426	39	>75% Grass cover, Good, HSG A
11,623	98	Paved parking, HSG A
18,048	77	Weighted Average
6,426		35.60% Pervious Area
11,623		64.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-C: Cross St



Summary for Pond P-1.1: SC-740 StormTech Basins A and B

Inflow Area = 21,554 sf, 63.47% Impervious, Inflow Depth = 2.70" for 10-year event
Inflow = 1.6 cfs @ 12.08 hrs, Volume= 4,852 cf
Outflow = 0.1 cfs @ 11.14 hrs, Volume= 3,694 cf, Atten= 97%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.14 hrs, Volume= 3,694 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 134.98' @ 16.32 hrs Surf.Area= 2,196 sf Storage= 2,887 cf

Plug-Flow detention time= 462.9 min calculated for 3,694 cf (76% of inflow)
Center-of-Mass det. time= 376.3 min (1,205.9 - 829.6)

Volume	Invert	Avail.Storage	Storage Description
#1J	133.00'	1,122 cf	**20.50'W x 60.58'L x 3.50'H Stone Bed For StormTech - A** 4,346 cf Overall - 1,470 cf Embedded = 2,876 cf x 39.0% Voids
#2J	133.50'	1,470 cf	**ADS_StormTech SC-740 +Cap** x 32 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 32 Chambers in 4 Rows
#3K	133.00'	872 cf	**15.75'W x 60.58'L x 3.50'H Stone Bed For StormTech - B** 3,339 cf Overall - 1,103 cf Embedded = 2,237 cf x 39.0% Voids
#4K	133.50'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 3 Rows
#5	136.50'	5 cf	**2.00'D x 1.50'H Structure with Grate Inlet** Impervious
		4,571 cf	Total Available Storage

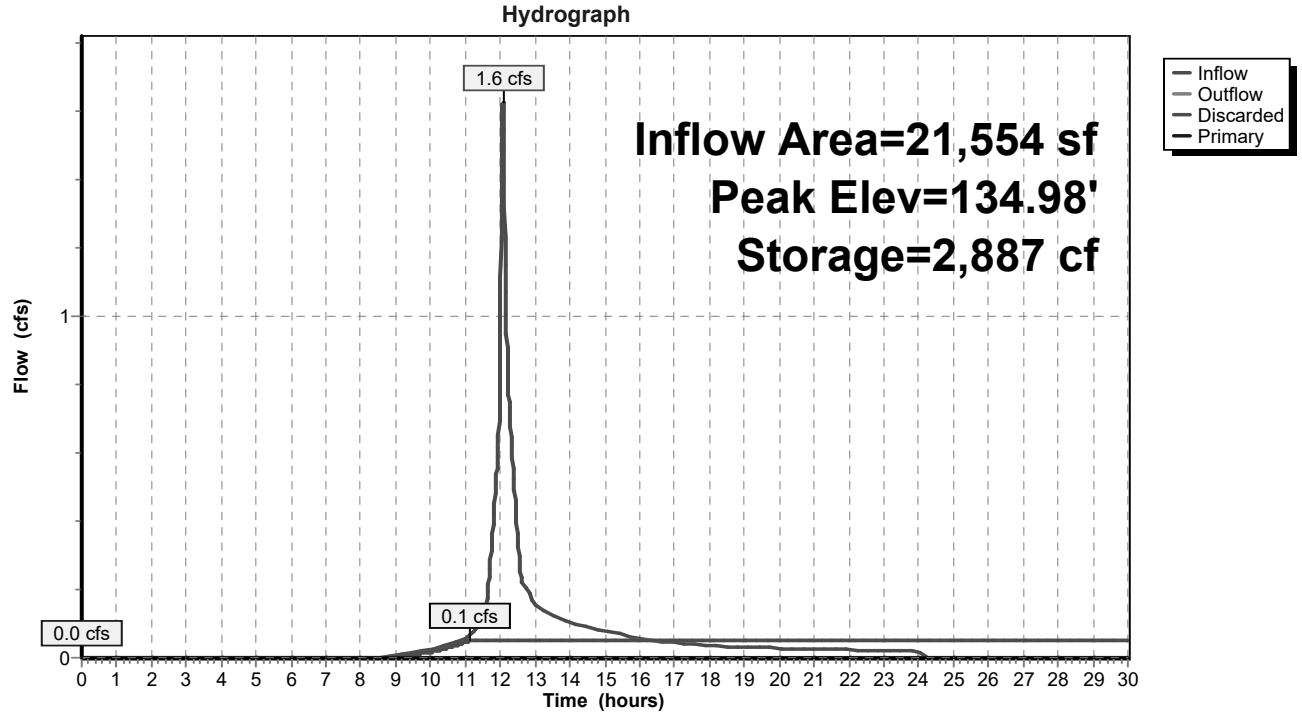
Storage Group J created with Chamber Wizard
Storage Group K created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	138.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.14 hrs HW=133.06' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)
↑**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-1.1: SC-740 StormTech Basins A and B



Summary for Pond P-2.1: StormTrap Basins C, D, E, F

Inflow Area = 68,015 sf, 76.96% Impervious, Inflow Depth = 3.33" for 10-year event
Inflow = 6.3 cfs @ 12.07 hrs, Volume= 18,857 cf
Outflow = 0.2 cfs @ 10.42 hrs, Volume= 12,902 cf, Atten= 97%, Lag= 0.0 min
Discarded = 0.2 cfs @ 10.42 hrs, Volume= 12,902 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 135.67' @ 16.48 hrs Surf.Area= 7,258 sf Storage= 11,606 cf

Plug-Flow detention time= 459.2 min calculated for 12,902 cf (68% of inflow)
Center-of-Mass det. time= 363.3 min (1,171.4 - 808.1)

Volume	Invert	Avail.Storage	Storage Description
#1G	133.00'	1,599 cf	**30.27'W x 90.29'L x 4.00'H Stone Bed For StormTrap - C** 10,933 cf Overall - 6,833 cf Embedded = 4,100 cf x 39.0% Voids
#2G	134.50'	4,758 cf	**StormTrap ST2 SingleTrap 2-0** x 10 Inside #1 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 10 Chambers in 2 Rows 16.96' x 76.98' Core + 6.66' Border = 30.27' x 90.29' System
#3H	133.00'	1,326 cf	**30.27'W x 74.90'L x 4.00'H Stone Bed For StormTrap - D** 9,069 cf Overall - 5,668 cf Embedded = 3,401 cf x 39.0% Voids
#4H	134.50'	3,944 cf	**StormTrap ST2 SingleTrap 2-0** x 8 Inside #3 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8 Chambers in 2 Rows 16.96' x 61.58' Core + 6.66' Border = 30.27' x 74.90' System
#5E	133.00'	562 cf	**21.79'W x 44.10'L x 4.00'H Stone Bed For StormTrap - E** 3,844 cf Overall - 2,403 cf Embedded = 1,442 cf x 39.0% Voids
#6E	134.50'	1,660 cf	**StormTrap ST2 SingleTrap 2-0** x 2 Inside #5 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 30.79' Core + 6.66' Border = 21.79' x 44.10' System
#7I	133.00'	759 cf	**21.79'W x 59.50'L x 4.00'H Stone Bed For StormTrap - F** 5,186 cf Overall - 3,242 cf Embedded = 1,945 cf x 39.0% Voids
#8I	134.50'	2,242 cf	**StormTrap ST2 SingleTrap 2-0** x 3 Inside #7 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 46.19' Core + 6.66' Border = 21.79' x 59.50' System
#9	136.90'	6 cf	**2.00'D x 2.00'H Structure with Grate Inlet** Impervious
		16,856 cf	Total Available Storage

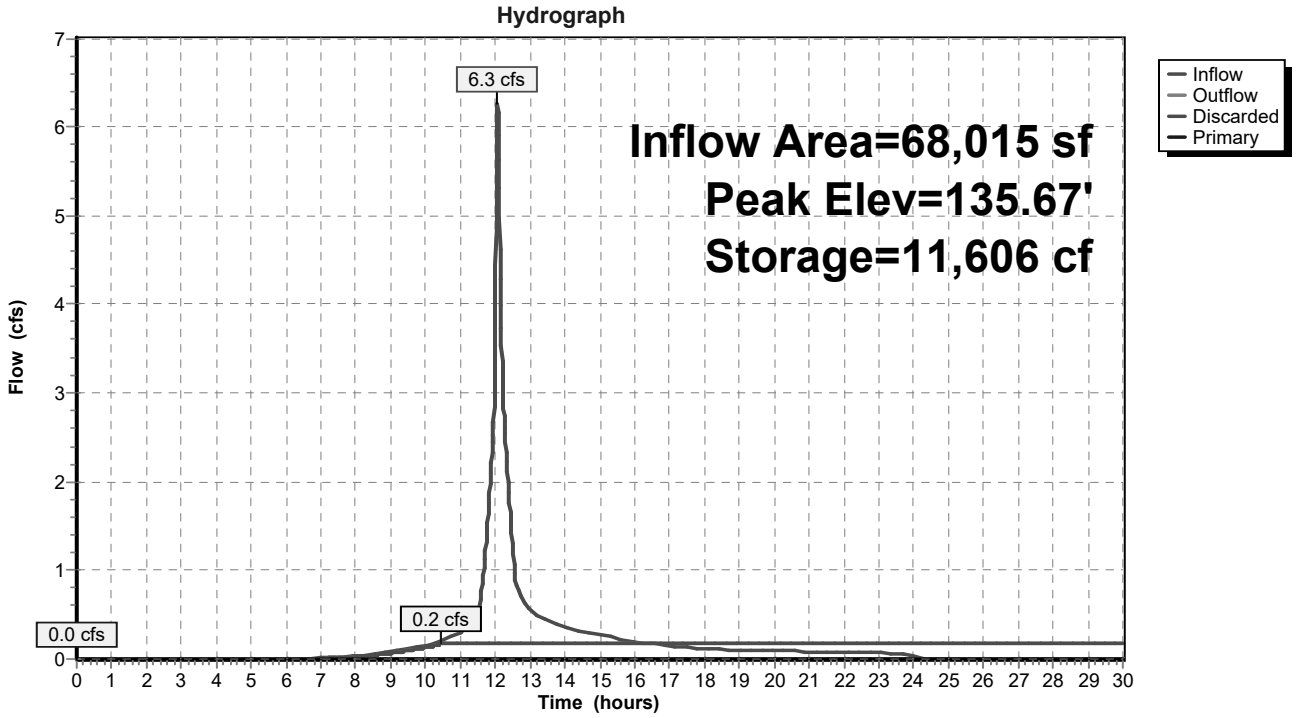
Storage Group G created with Chamber Wizard
Storage Group H created with Chamber Wizard
Storage Group E created with Chamber Wizard
Storage Group I created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	139.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.2 cfs @ 10.42 hrs HW=133.07' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)
↑**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-2.1: StormTrap Basins C, D, E, F



Summary for Pond P-3.1: Permeable Patio

Inflow Area = 2,500 sf,100.00% Impervious, Inflow Depth = 4.96" for 10-year event
Inflow = 0.3 cfs @ 12.07 hrs, Volume= 1,034 cf
Outflow = 0.1 cfs @ 11.81 hrs, Volume= 1,034 cf, Atten= 80%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.81 hrs, Volume= 1,034 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 149.77' @ 12.49 hrs Surf.Area= 2,500 sf Storage= 259 cf

Plug-Flow detention time= 28.2 min calculated for 1,034 cf (100% of inflow)
Center-of-Mass det. time= 28.2 min (774.6 - 746.4)

Volume	Invert	Avail.Storage	Storage Description
#1	149.50'	1,463 cf	**Porous Pavement Stone (Prismatic)** Listed below (Recalc) 3,750 cf Overall x 39.0% Voids
#2	151.00'	1 cf	**Patio Drain (Prismatic)** Listed below (Recalc) -Impervious
#3	152.00'	2,500 cf	**Patio Surface Storage (Prismatic)** Listed below (Recalc) -Impervious
		3,964 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
149.50	2,500	0	0
150.50	2,500	2,500	2,500
151.00	2,500	1,250	3,750

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	1	0	0
152.00	1	1	1

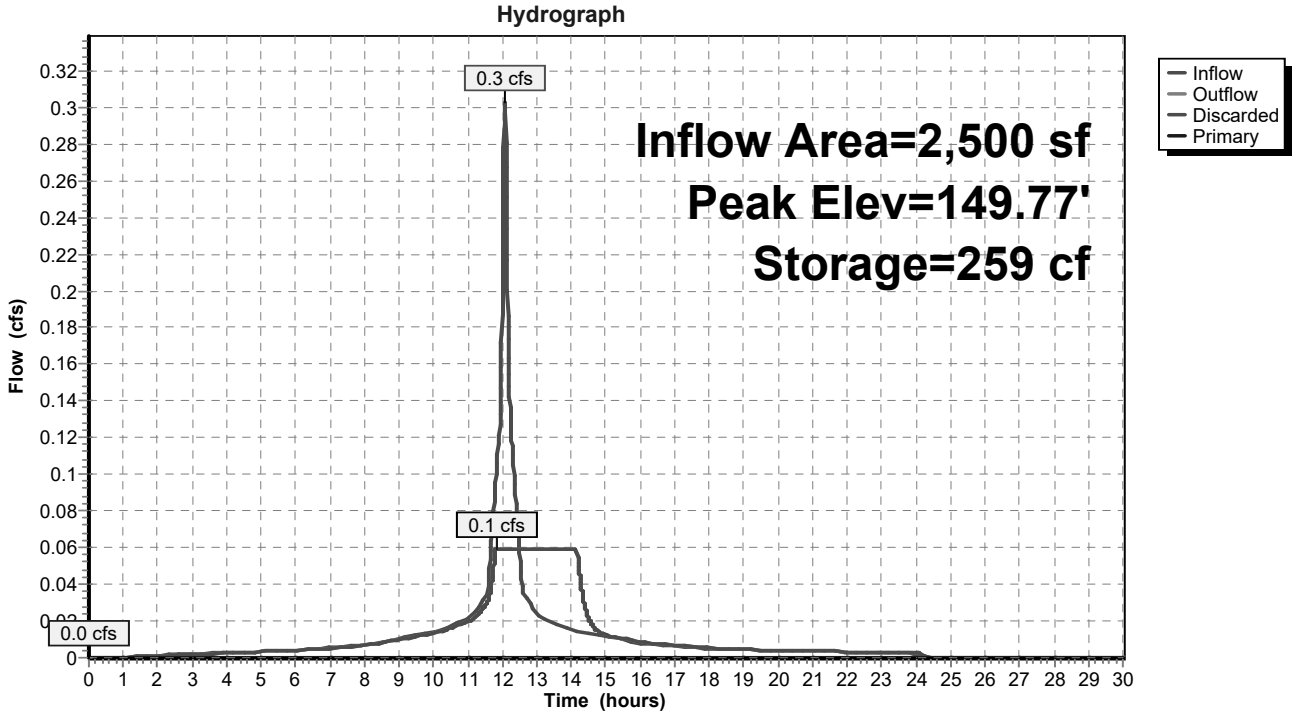
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	2,500	0	0
153.00	2,500	2,500	2,500

Device	Routing	Invert	Outlet Devices
#1	Discarded	149.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.50'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.81 hrs HW=149.54' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=149.50' (Free Discharge)
↑—**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-3.1: Permeable Patio



Summary for Pond P-B: MC-3500 StormTech at 673 Highland

Inflow Area = 25,708 sf,100.00% Impervious, Inflow Depth = 4.96" for 10-year event
Inflow = 3.1 cfs @ 12.07 hrs, Volume= 10,632 cf
Outflow = 0.3 cfs @ 11.54 hrs, Volume= 10,632 cf, Atten= 89%, Lag= 0.0 min
Discarded = 0.3 cfs @ 11.54 hrs, Volume= 10,632 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 164.25' @ 12.69 hrs Surf.Area= 1,761 sf Storage= 3,324 cf

Plug-Flow detention time= 62.6 min calculated for 10,629 cf (100% of inflow)
Center-of-Mass det. time= 62.6 min (809.0 - 746.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	161.50'	2,456 cf	**22.75'W x 77.40'L x 5.50'H Stone Bed for StormTech-673** 9,685 cf Overall - 3,388 cf Embedded = 6,297 cf x 39.0% Voids
#2A	162.25'	3,388 cf	**ADS_StormTech MC-3500 d +Cap** x 30 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 30 Chambers in 3 Rows Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
#3	167.00'	3 cf	**2.00'D x 1.00'H Structure with Grate Inlet** -Impervious
#4	167.67'	3,741 cf	**Parking Lot Surface Storage (Prismatic)** -Listed below (Recalc) -Impervious
		9,588 cf	Total Available Storage

Storage Group A created with Chamber Wizard

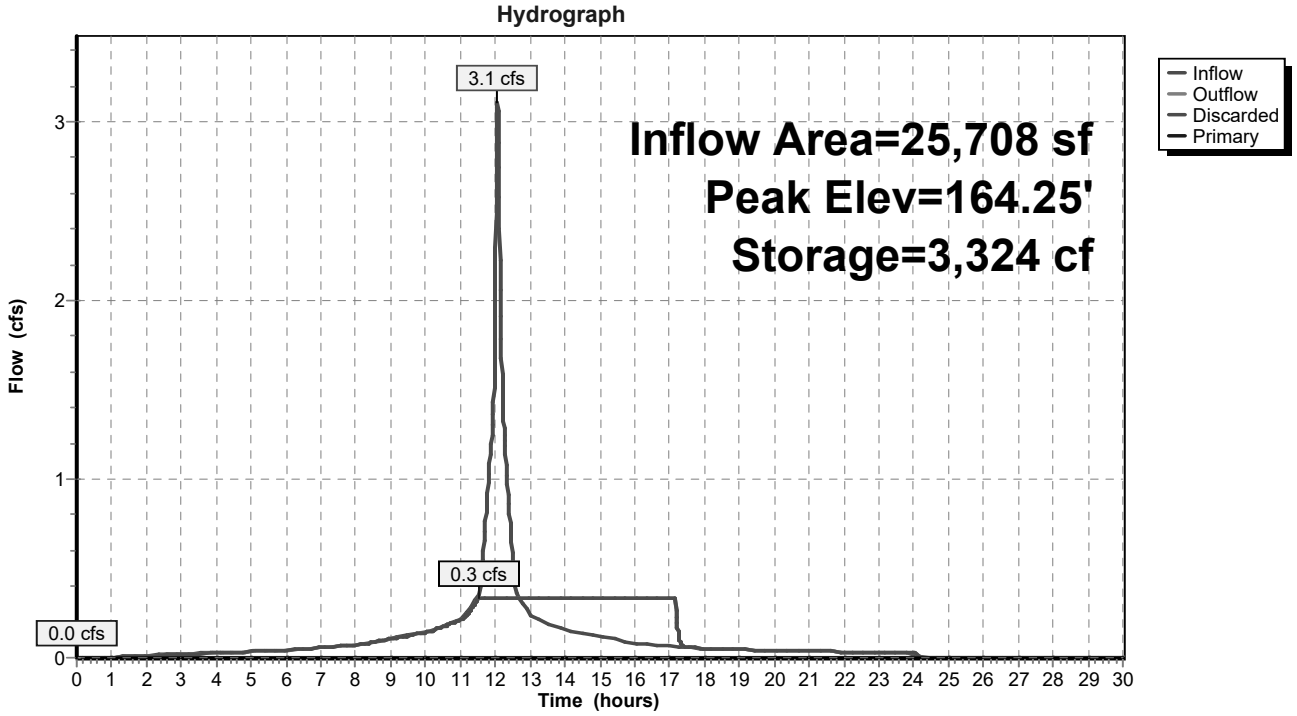
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.67	0	0	0
167.70	16	0	0
168.00	155	26	26
169.00	1,500	828	853
170.00	4,275	2,888	3,741

Device	Routing	Invert	Outlet Devices
#1	Discarded	161.50'	**8.270 in/hr Exfiltration over Surface area**
#2	Primary	168.50'	**12.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.3 cfs @ 11.54 hrs HW=161.59' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=161.50' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond P-B: MC-3500 StormTech at 673 Highland

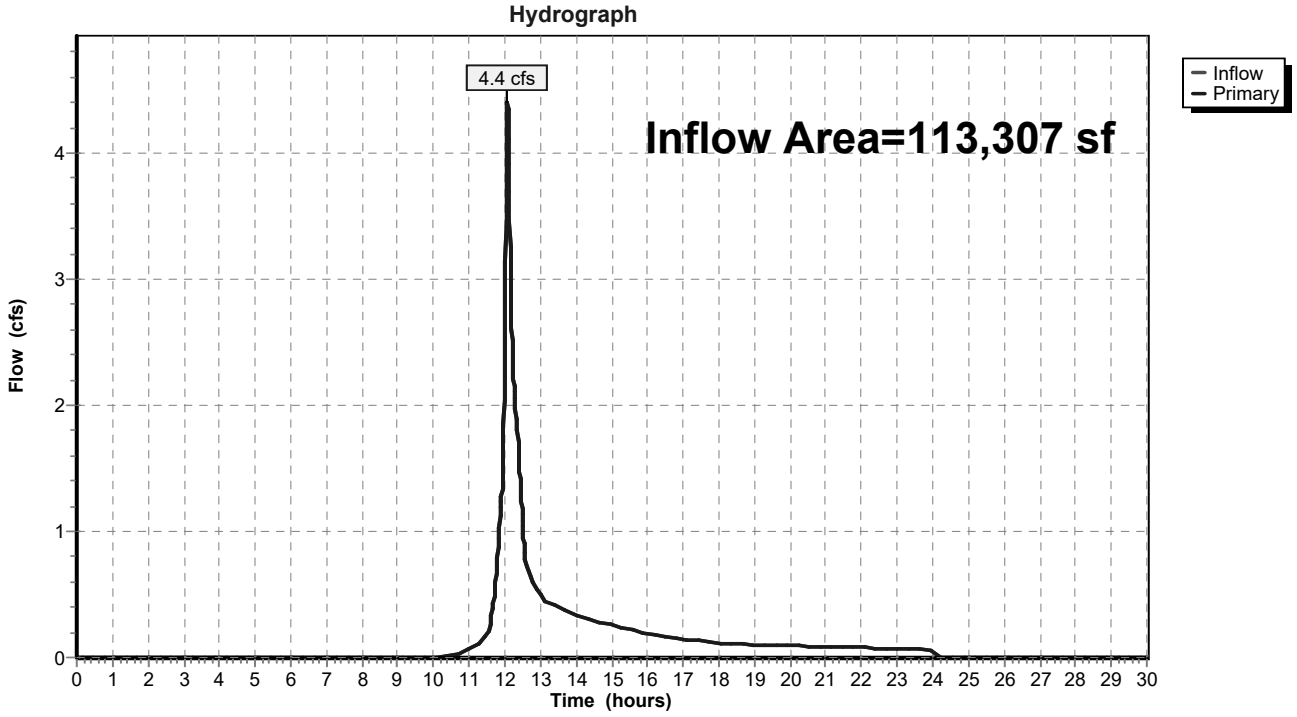


Summary for Link A-B: EX A+ EX B

Inflow Area = 113,307 sf, 58.30% Impervious, Inflow Depth = 1.44" for 10-year event
Inflow = 4.4 cfs @ 12.08 hrs, Volume= 13,616 cf
Primary = 4.4 cfs @ 12.08 hrs, Volume= 13,616 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link A-B: EX A+ EX B

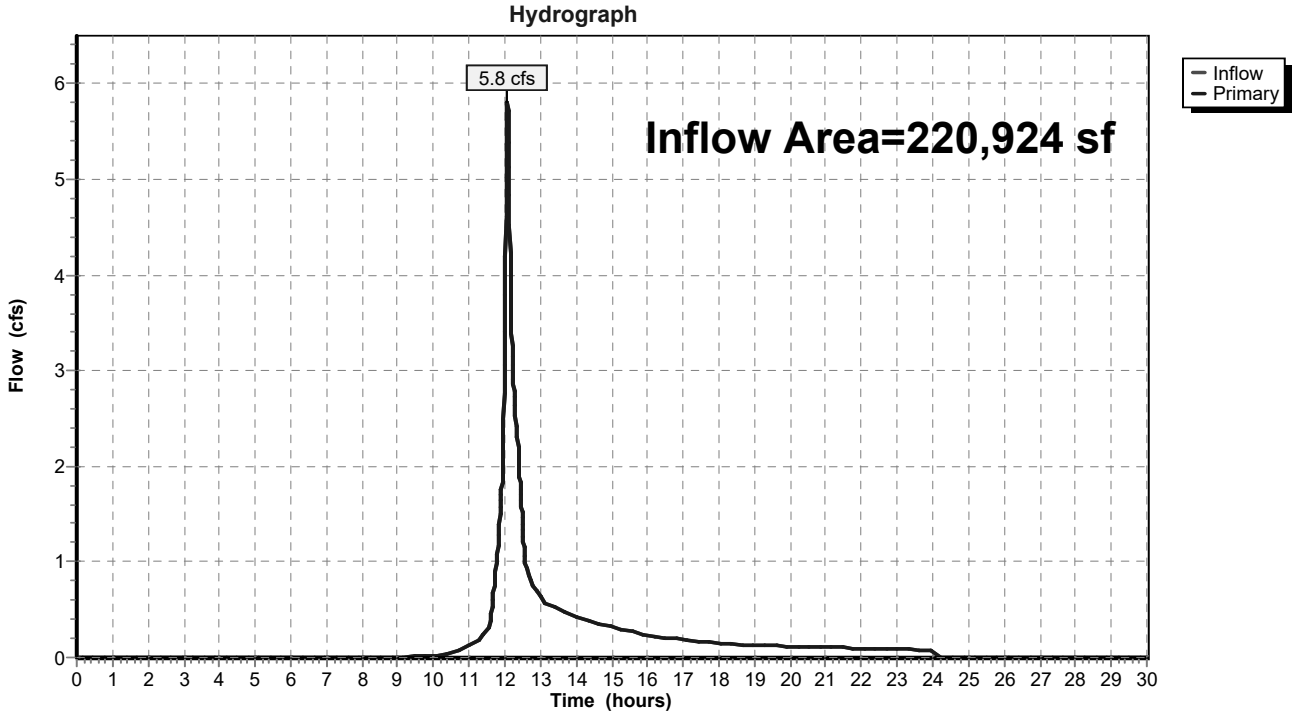


Summary for Link DP-1: Offsite to North

Inflow Area = 220,924 sf, 65.05% Impervious, Inflow Depth = 0.97" for 10-year event
Inflow = 5.8 cfs @ 12.08 hrs, Volume= 17,814 cf
Primary = 5.8 cfs @ 12.08 hrs, Volume= 17,814 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

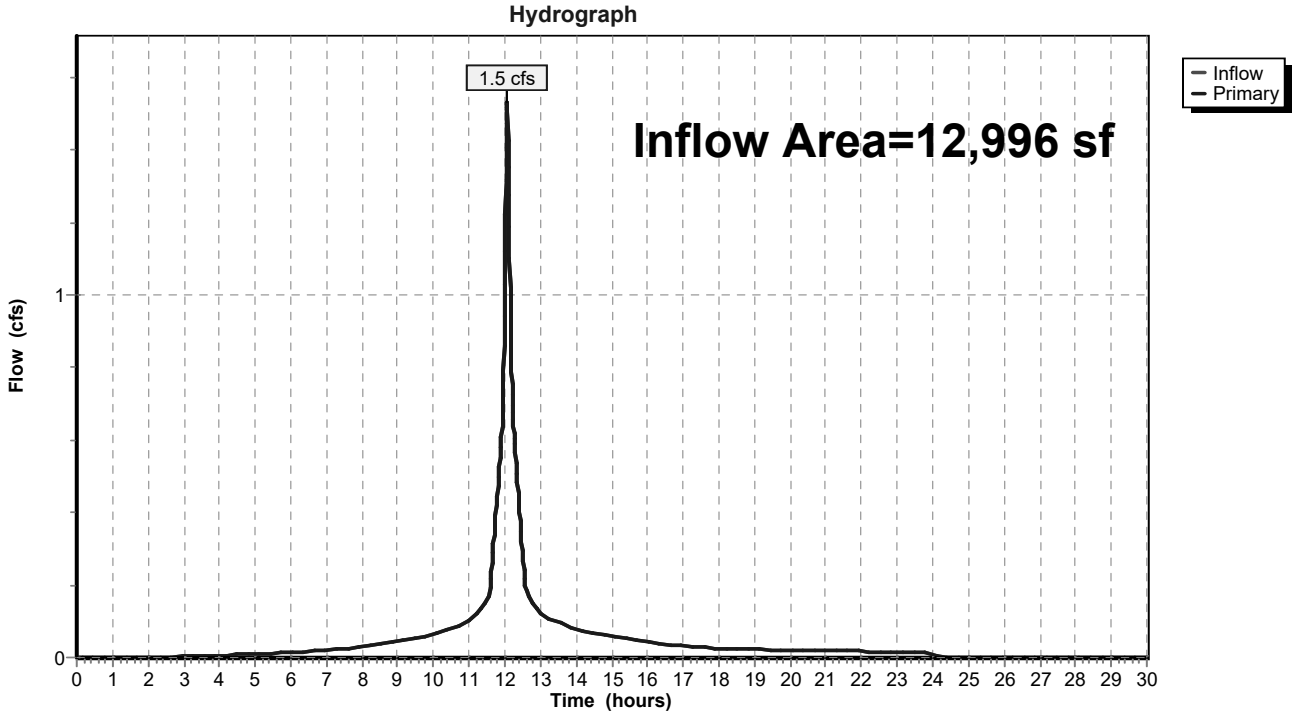


Summary for Link DP-2: Highland Ave

Inflow Area = 12,996 sf, 95.14% Impervious, Inflow Depth = 4.62" for 10-year event
Inflow = 1.5 cfs @ 12.07 hrs, Volume= 5,001 cf
Primary = 1.5 cfs @ 12.07 hrs, Volume= 5,001 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



25-Year Storm Event – Proposed

Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

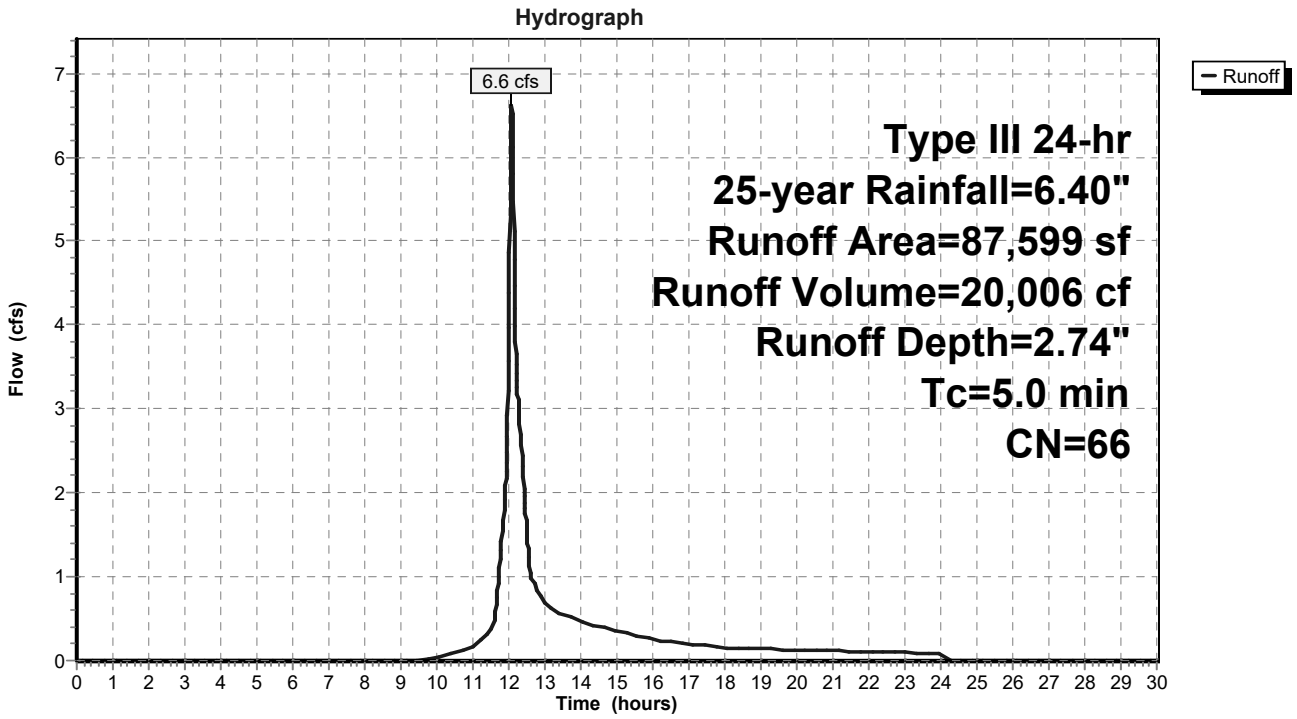
Runoff = 6.6 cfs @ 12.08 hrs, Volume= 20,006 cf, Depth= 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
47,249	39	>75% Grass cover, Good, HSG A
27,508	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
87,599	66	Weighted Average
47,249		53.94% Pervious Area
40,349		46.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

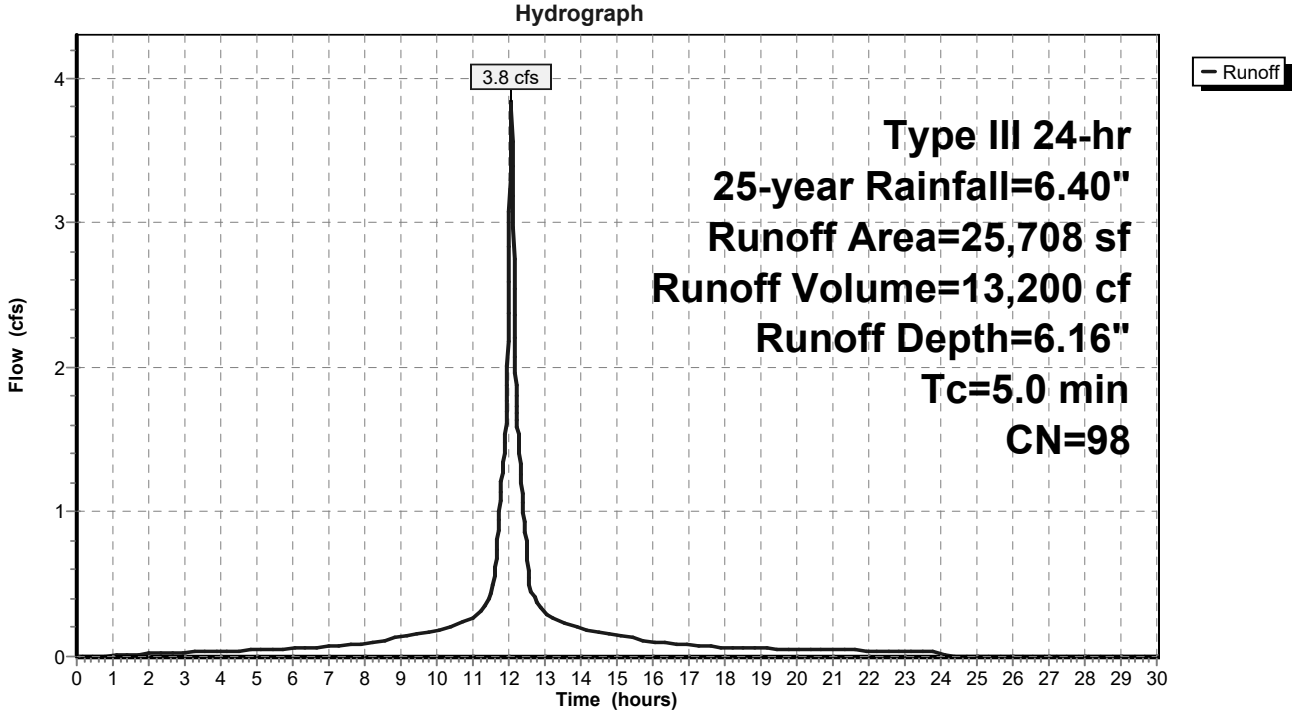
Runoff = 3.8 cfs @ 12.07 hrs, Volume= 13,200 cf, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-D: Overland to Highland Ave

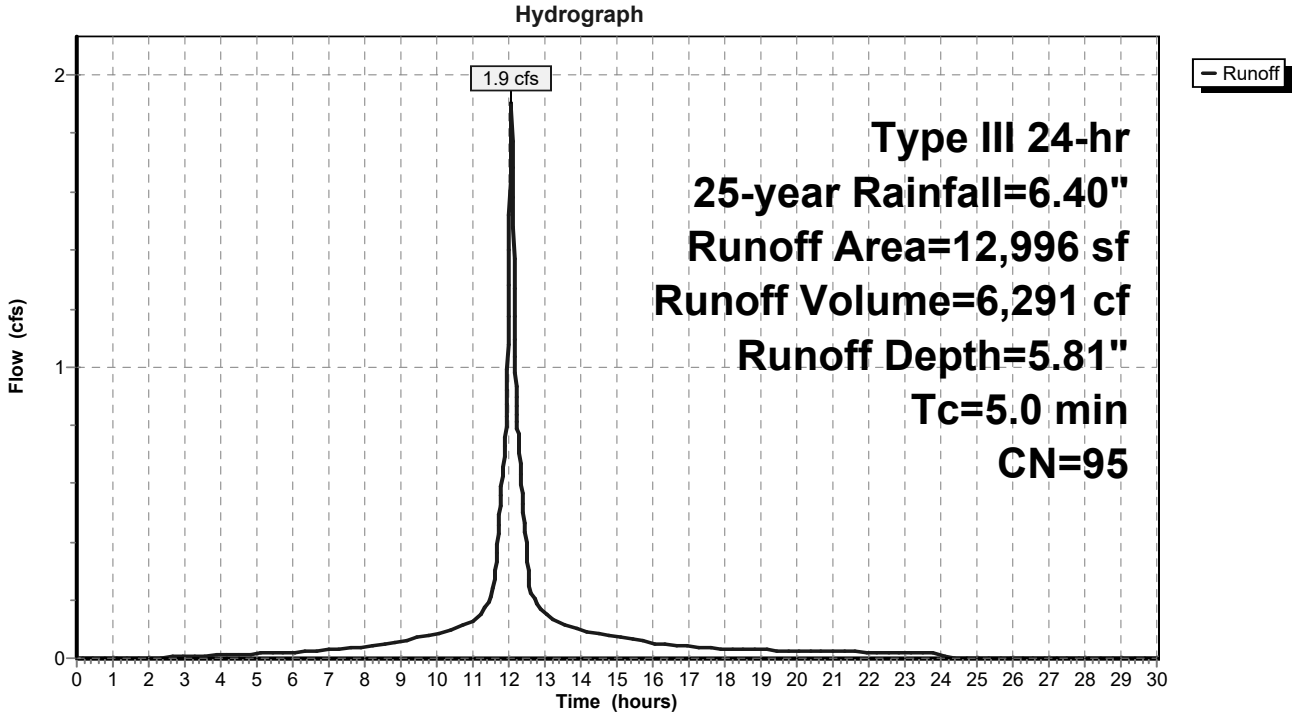
Runoff = 1.9 cfs @ 12.07 hrs, Volume= 6,291 cf, Depth= 5.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
632	39	>75% Grass cover, Good, HSG A
12,364	98	Paved parking, HSG A
12,996	95	Weighted Average
632		4.86% Pervious Area
12,364		95.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

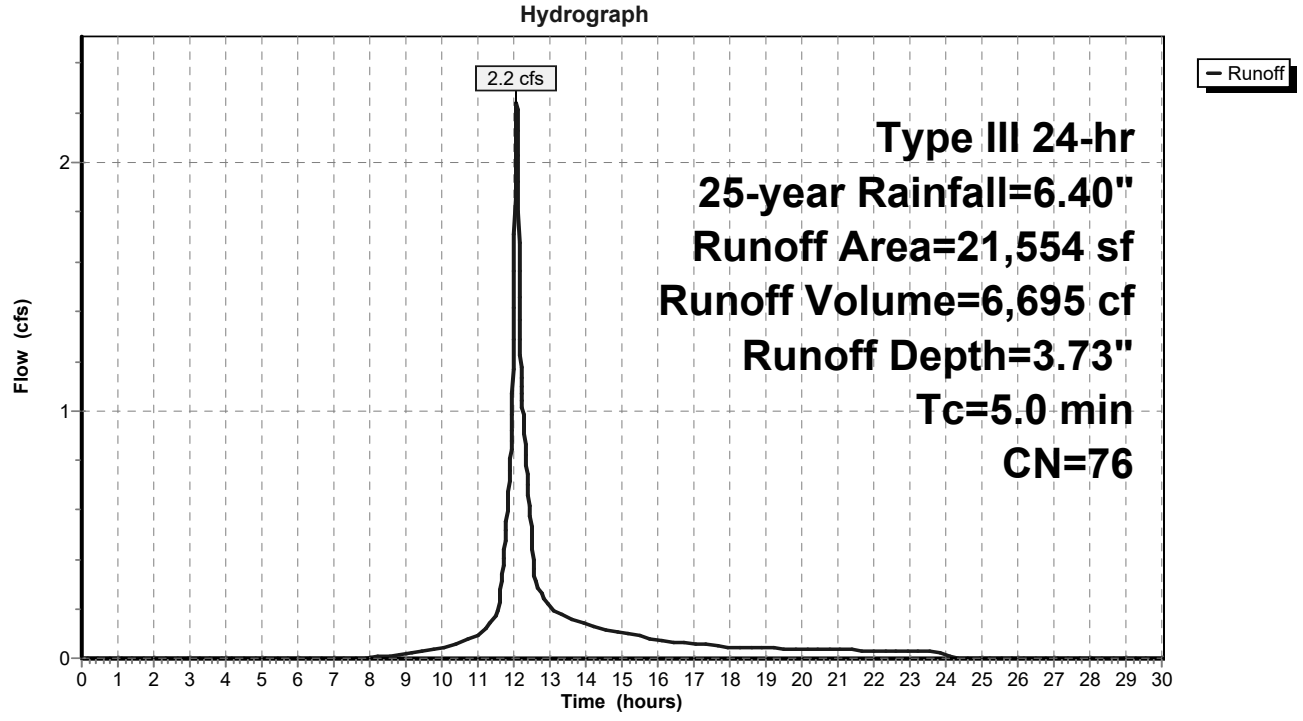
Runoff = 2.2 cfs @ 12.07 hrs, Volume= 6,695 cf, Depth= 3.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
7,873	39	>75% Grass cover, Good, HSG A
13,680	98	Paved parking, HSG A
21,554	76	Weighted Average
7,873		36.53% Pervious Area
13,680		63.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-1: Onsite Driveway & Upper Arbor St



Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

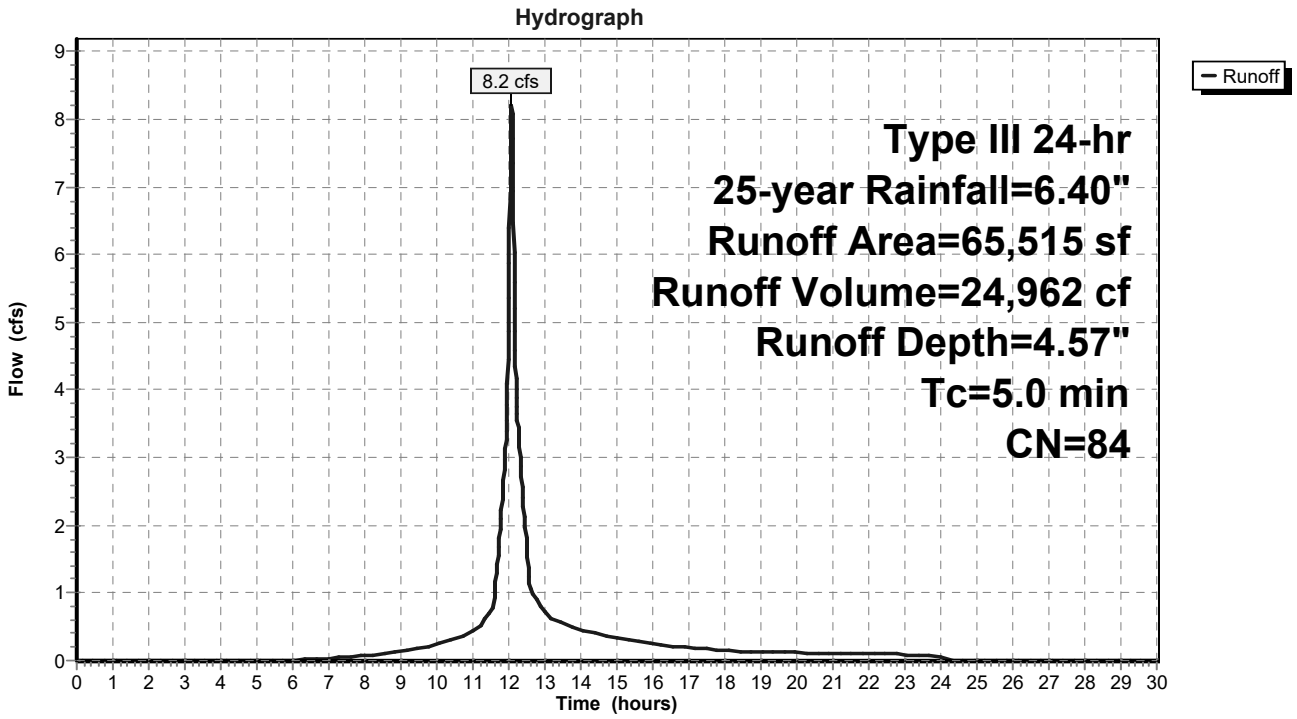
Runoff = 8.2 cfs @ 12.07 hrs, Volume= 24,962 cf, Depth= 4.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
15,673	39	>75% Grass cover, Good, HSG A
24,695	98	Paved parking, HSG A
25,148	98	Roofs, HSG A
65,515	84	Weighted Average
15,673		23.92% Pervious Area
49,843		76.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape



Summary for Subcatchment PR-3: Permeable Patio

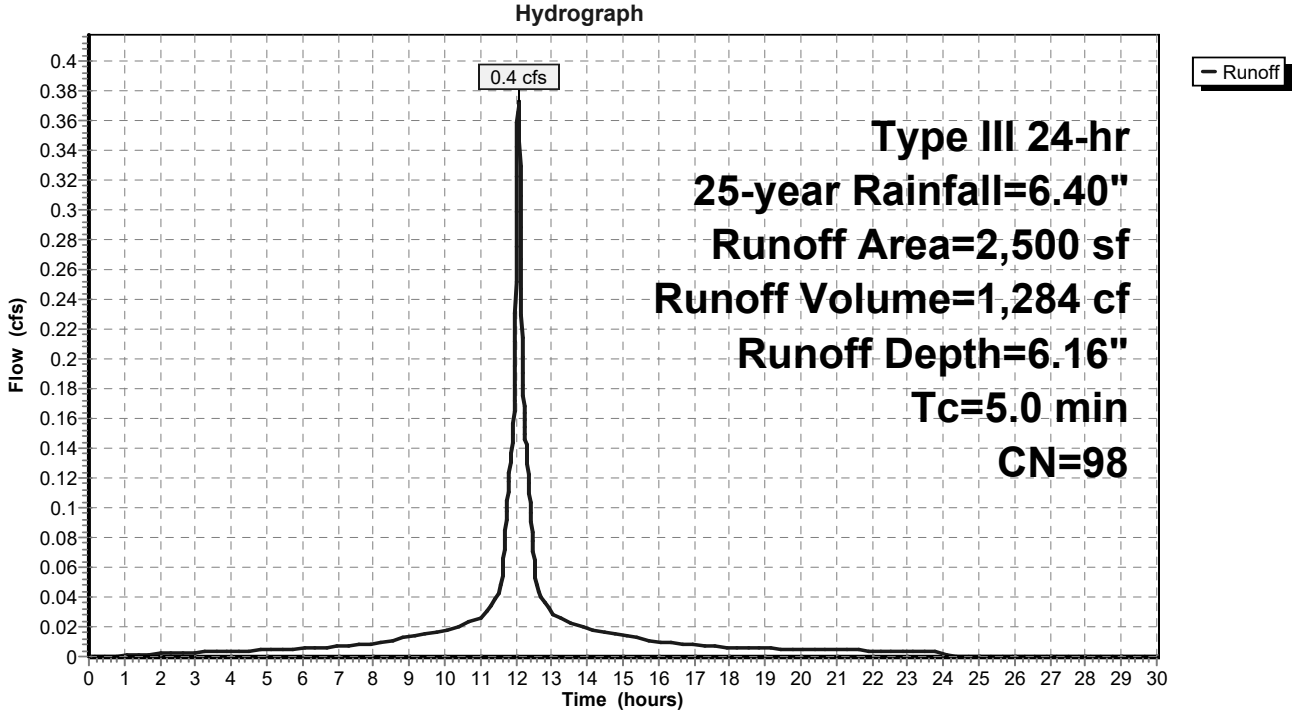
Runoff = 0.4 cfs @ 12.07 hrs, Volume= 1,284 cf, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
2,500	98	Paved parking, HSG A
0	98	Roofs, HSG A
2,500	98	Weighted Average
2,500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-3: Permeable Patio



Summary for Subcatchment PR-C: Cross St

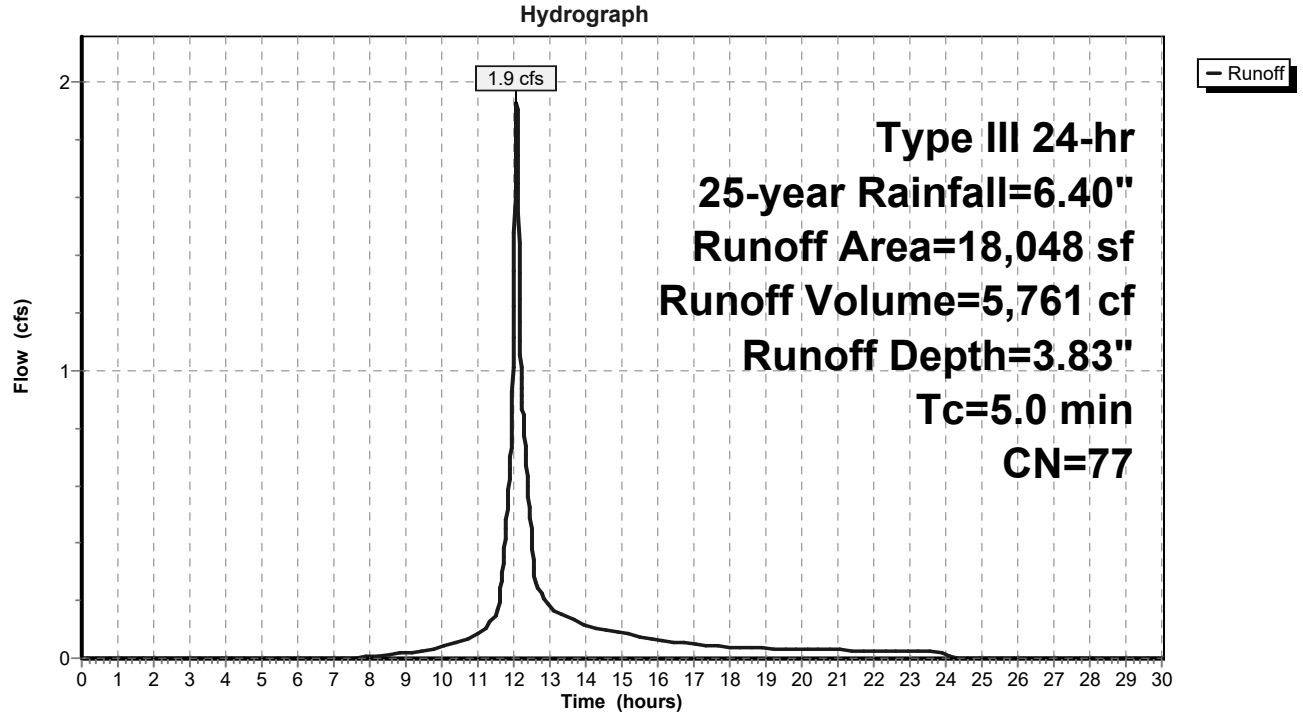
Runoff = 1.9 cfs @ 12.07 hrs, Volume= 5,761 cf, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
6,426	39	>75% Grass cover, Good, HSG A
11,623	98	Paved parking, HSG A
18,048	77	Weighted Average
6,426		35.60% Pervious Area
11,623		64.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-C: Cross St



Summary for Pond P-1.1: SC-740 StormTech Basins A and B

Inflow Area = 21,554 sf, 63.47% Impervious, Inflow Depth = 3.73" for 25-year event
Inflow = 2.2 cfs @ 12.07 hrs, Volume= 6,695 cf
Outflow = 0.1 cfs @ 10.50 hrs, Volume= 3,832 cf, Atten= 98%, Lag= 0.0 min
Discarded = 0.1 cfs @ 10.50 hrs, Volume= 3,832 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 136.28' @ 17.50 hrs Surf.Area= 2,196 sf Storage= 4,380 cf

Plug-Flow detention time= 472.8 min calculated for 3,832 cf (57% of inflow)
Center-of-Mass det. time= 363.3 min (1,183.6 - 820.3)

Volume	Invert	Avail.Storage	Storage Description
#1J	133.00'	1,122 cf	**20.50'W x 60.58'L x 3.50'H Stone Bed For StormTech - A** 4,346 cf Overall - 1,470 cf Embedded = 2,876 cf x 39.0% Voids
#2J	133.50'	1,470 cf	**ADS_StormTech SC-740 +Cap** x 32 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 32 Chambers in 4 Rows
#3K	133.00'	872 cf	**15.75'W x 60.58'L x 3.50'H Stone Bed For StormTech - B** 3,339 cf Overall - 1,103 cf Embedded = 2,237 cf x 39.0% Voids
#4K	133.50'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 3 Rows
#5	136.50'	5 cf	**2.00'D x 1.50'H Structure with Grate Inlet** Impervious
		4,571 cf	Total Available Storage

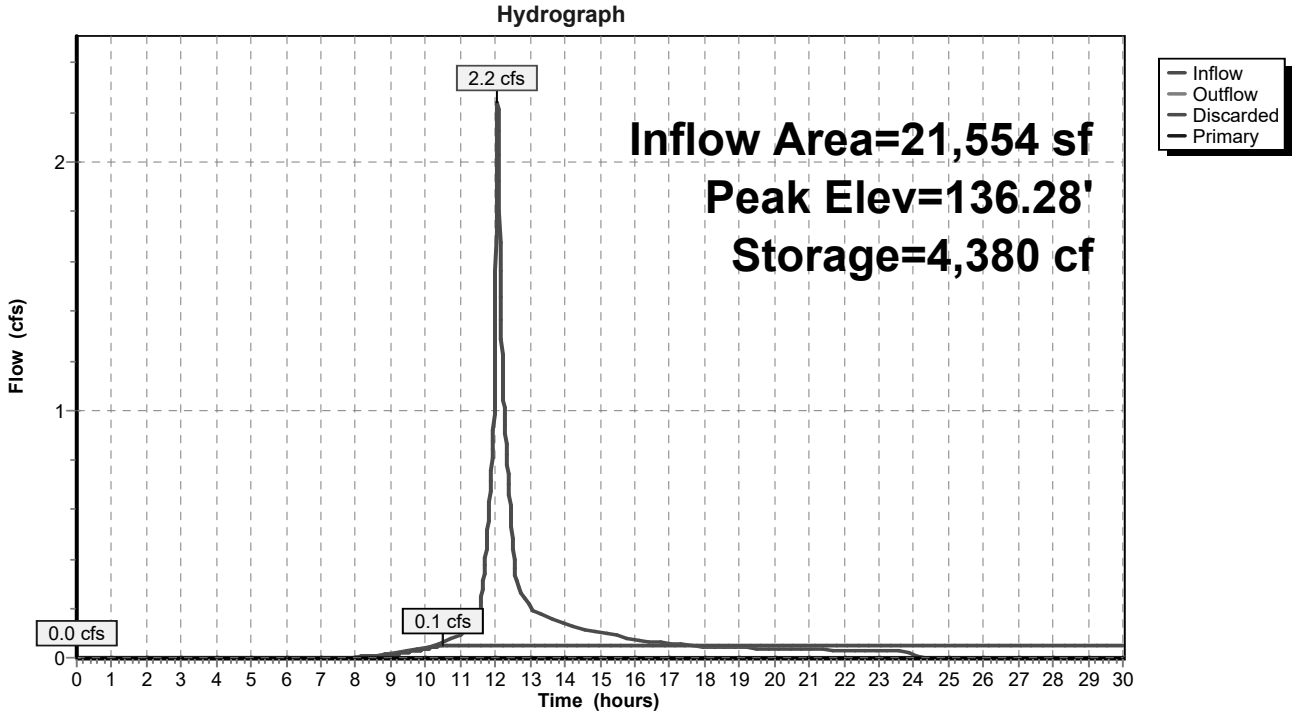
Storage Group J created with Chamber Wizard
Storage Group K created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	138.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 10.50 hrs HW=133.06' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)
↑**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-1.1: SC-740 StormTech Basins A and B



Summary for Pond P-2.1: StormTrap Basins C, D, E, F

Inflow Area = 68,015 sf, 76.96% Impervious, Inflow Depth = 4.40" for 25-year event
Inflow = 8.2 cfs @ 12.07 hrs, Volume= 24,962 cf
Outflow = 0.2 cfs @ 9.68 hrs, Volume= 13,393 cf, Atten= 98%, Lag= 0.0 min
Discarded = 0.2 cfs @ 9.68 hrs, Volume= 13,393 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 136.46' @ 17.50 hrs Surf.Area= 7,258 sf Storage= 16,594 cf

Plug-Flow detention time= 456.6 min calculated for 13,393 cf (54% of inflow)
Center-of-Mass det. time= 347.3 min (1,147.4 - 800.1)

Volume	Invert	Avail.Storage	Storage Description
#1G	133.00'	1,599 cf	**30.27'W x 90.29'L x 4.00'H Stone Bed For StormTrap - C** 10,933 cf Overall - 6,833 cf Embedded = 4,100 cf x 39.0% Voids
#2G	134.50'	4,758 cf	**StormTrap ST2 SingleTrap 2-0** x 10 Inside #1 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 10 Chambers in 2 Rows 16.96' x 76.98' Core + 6.66' Border = 30.27' x 90.29' System
#3H	133.00'	1,326 cf	**30.27'W x 74.90'L x 4.00'H Stone Bed For StormTrap - D** 9,069 cf Overall - 5,668 cf Embedded = 3,401 cf x 39.0% Voids
#4H	134.50'	3,944 cf	**StormTrap ST2 SingleTrap 2-0** x 8 Inside #3 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8 Chambers in 2 Rows 16.96' x 61.58' Core + 6.66' Border = 30.27' x 74.90' System
#5E	133.00'	562 cf	**21.79'W x 44.10'L x 4.00'H Stone Bed For StormTrap - E** 3,844 cf Overall - 2,403 cf Embedded = 1,442 cf x 39.0% Voids
#6E	134.50'	1,660 cf	**StormTrap ST2 SingleTrap 2-0** x 2 Inside #5 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 30.79' Core + 6.66' Border = 21.79' x 44.10' System
#7I	133.00'	759 cf	**21.79'W x 59.50'L x 4.00'H Stone Bed For StormTrap - F** 5,186 cf Overall - 3,242 cf Embedded = 1,945 cf x 39.0% Voids
#8I	134.50'	2,242 cf	**StormTrap ST2 SingleTrap 2-0** x 3 Inside #7 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 46.19' Core + 6.66' Border = 21.79' x 59.50' System
#9	136.90'	6 cf	**2.00'D x 2.00'H Structure with Grate Inlet** Impervious
		16,856 cf	Total Available Storage

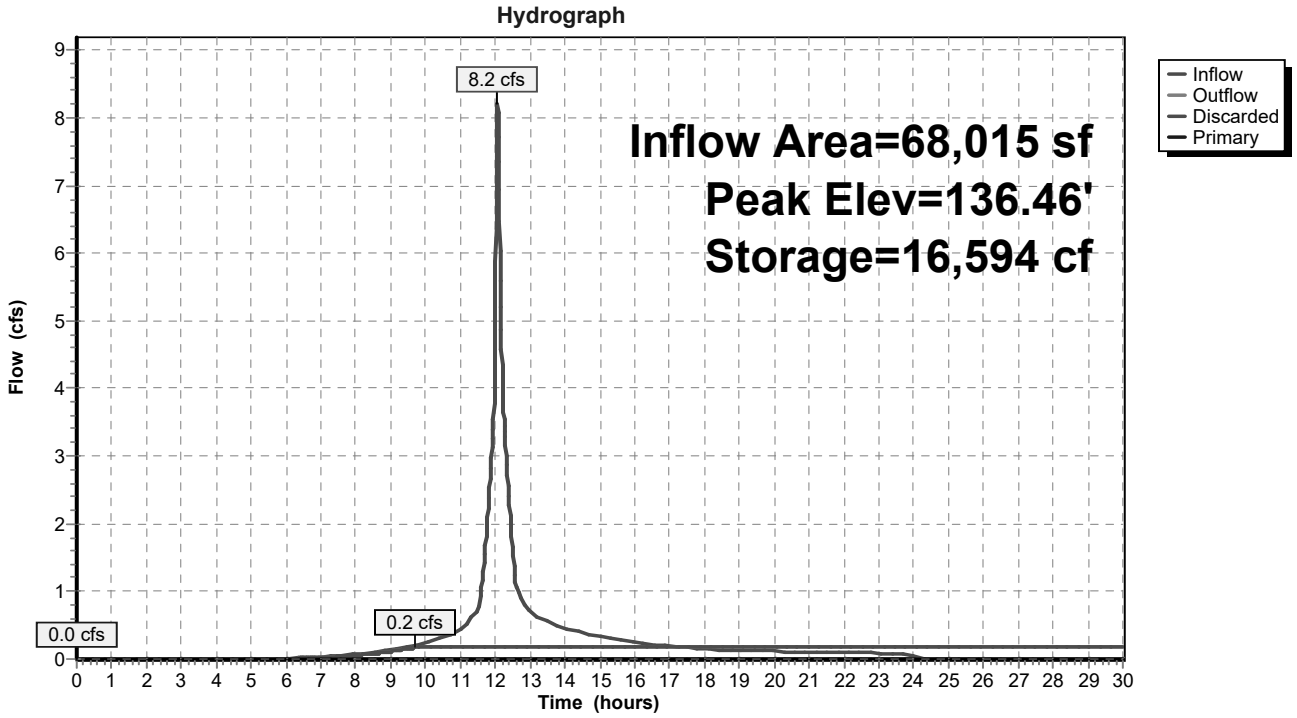
Storage Group G created with Chamber Wizard
Storage Group H created with Chamber Wizard
Storage Group E created with Chamber Wizard
Storage Group I created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	139.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.2 cfs @ 9.68 hrs HW=133.07' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)
↑**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-2.1: StormTrap Basins C, D, E, F



Summary for Pond P-3.1: Permeable Patio

Inflow Area = 2,500 sf,100.00% Impervious, Inflow Depth = 6.16" for 25-year event
Inflow = 0.4 cfs @ 12.07 hrs, Volume= 1,284 cf
Outflow = 0.1 cfs @ 11.74 hrs, Volume= 1,284 cf, Atten= 84%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.74 hrs, Volume= 1,284 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 149.87' @ 12.53 hrs Surf.Area= 2,500 sf Storage= 356 cf

Plug-Flow detention time= 38.3 min calculated for 1,284 cf (100% of inflow)
Center-of-Mass det. time= 38.3 min (781.6 - 743.3)

Volume	Invert	Avail.Storage	Storage Description
#1	149.50'	1,463 cf	**Porous Pavement Stone (Prismatic)** Listed below (Recalc) 3,750 cf Overall x 39.0% Voids
#2	151.00'	1 cf	**Patio Drain (Prismatic)** Listed below (Recalc) -Impervious
#3	152.00'	2,500 cf	**Patio Surface Storage (Prismatic)** Listed below (Recalc) -Impervious
		3,964 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
149.50	2,500	0	0
150.50	2,500	2,500	2,500
151.00	2,500	1,250	3,750

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	1	0	0
152.00	1	1	1

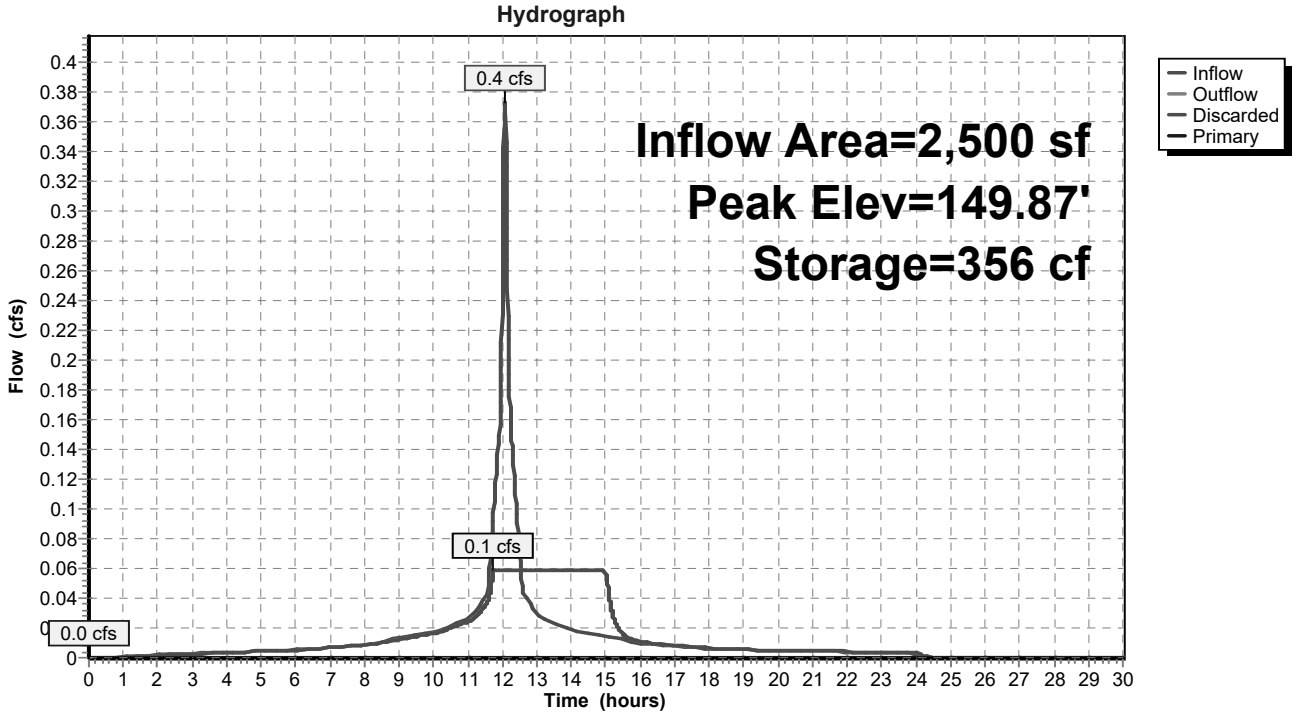
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	2,500	0	0
153.00	2,500	2,500	2,500

Device	Routing	Invert	Outlet Devices
#1	Discarded	149.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.50'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.74 hrs HW=149.54' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=149.50' (Free Discharge)
↑—**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-3.1: Permeable Patio



Summary for Pond P-B: MC-3500 StormTech at 673 Highland

Inflow Area = 25,708 sf,100.00% Impervious, Inflow Depth = 6.16" for 25-year event
Inflow = 3.8 cfs @ 12.07 hrs, Volume= 13,200 cf
Outflow = 0.3 cfs @ 11.31 hrs, Volume= 13,200 cf, Atten= 91%, Lag= 0.0 min
Discarded = 0.3 cfs @ 11.31 hrs, Volume= 13,200 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 165.23' @ 12.91 hrs Surf.Area= 1,761 sf Storage= 4,490 cf

Plug-Flow detention time= 90.3 min calculated for 13,196 cf (100% of inflow)
Center-of-Mass det. time= 90.3 min (833.5 - 743.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	161.50'	2,456 cf	**22.75'W x 77.40'L x 5.50'H Stone Bed for StormTech-673** 9,685 cf Overall - 3,388 cf Embedded = 6,297 cf x 39.0% Voids
#2A	162.25'	3,388 cf	**ADS_StormTech MC-3500 d +Cap** x 30 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 30 Chambers in 3 Rows Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
#3	167.00'	3 cf	**2.00'D x 1.00'H Structure with Grate Inlet** -Impervious
#4	167.67'	3,741 cf	**Parking Lot Surface Storage (Prismatic)** Listed below (Recalc) -Impervious
		9,588 cf	Total Available Storage

Storage Group A created with Chamber Wizard

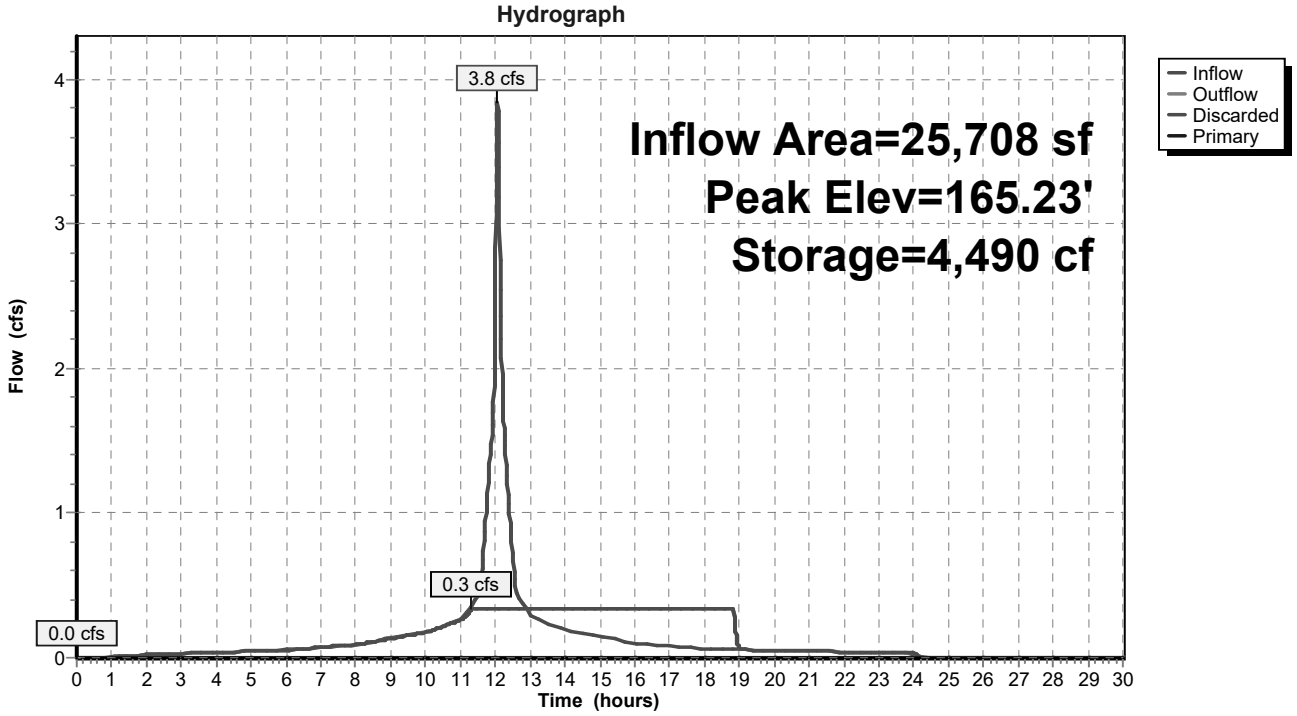
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.67	0	0	0
167.70	16	0	0
168.00	155	26	26
169.00	1,500	828	853
170.00	4,275	2,888	3,741

Device	Routing	Invert	Outlet Devices
#1	Discarded	161.50'	**8.270 in/hr Exfiltration over Surface area**
#2	Primary	168.50'	**12.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.3 cfs @ 11.31 hrs HW=161.59' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=161.50' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond P-B: MC-3500 StormTech at 673 Highland

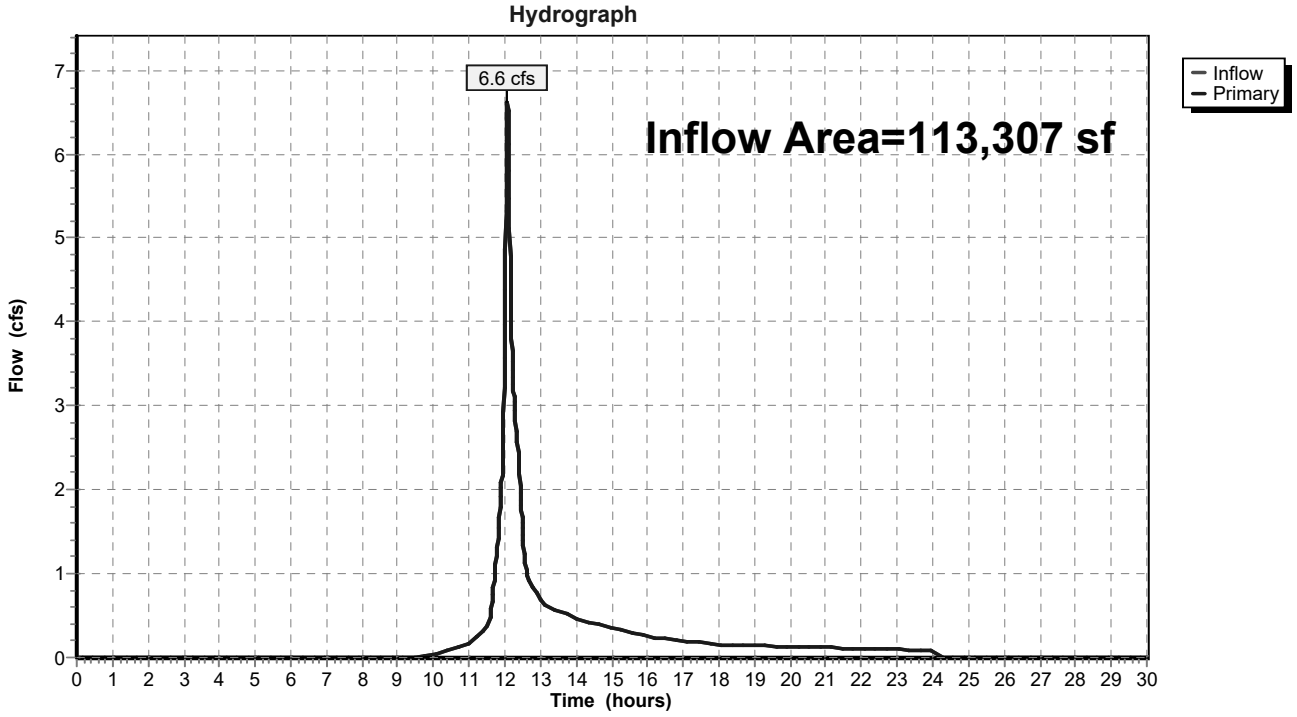


Summary for Link A-B: EX A+ EX B

Inflow Area = 113,307 sf, 58.30% Impervious, Inflow Depth = 2.12" for 25-year event
Inflow = 6.6 cfs @ 12.08 hrs, Volume= 20,006 cf
Primary = 6.6 cfs @ 12.08 hrs, Volume= 20,006 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link A-B: EX A+ EX B

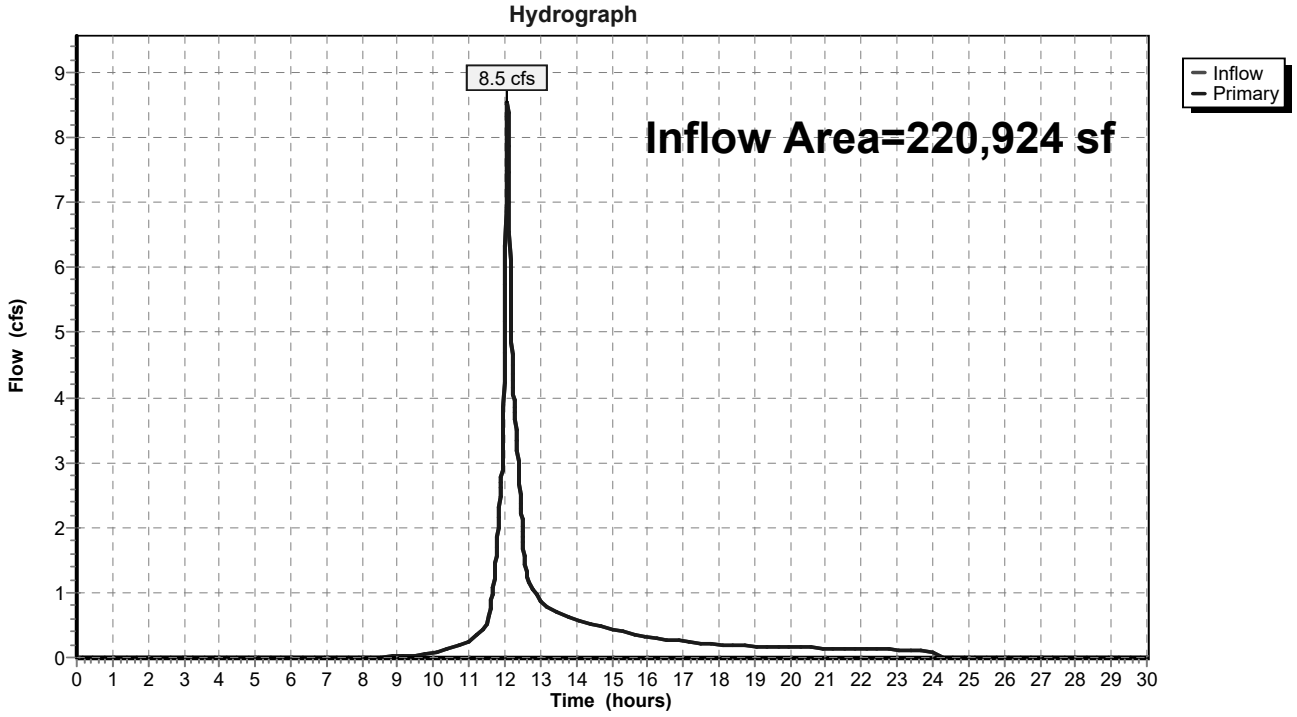


Summary for Link DP-1: Offsite to North

Inflow Area = 220,924 sf, 65.05% Impervious, Inflow Depth = 1.40" for 25-year event
Inflow = 8.5 cfs @ 12.08 hrs, Volume= 25,767 cf
Primary = 8.5 cfs @ 12.08 hrs, Volume= 25,767 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

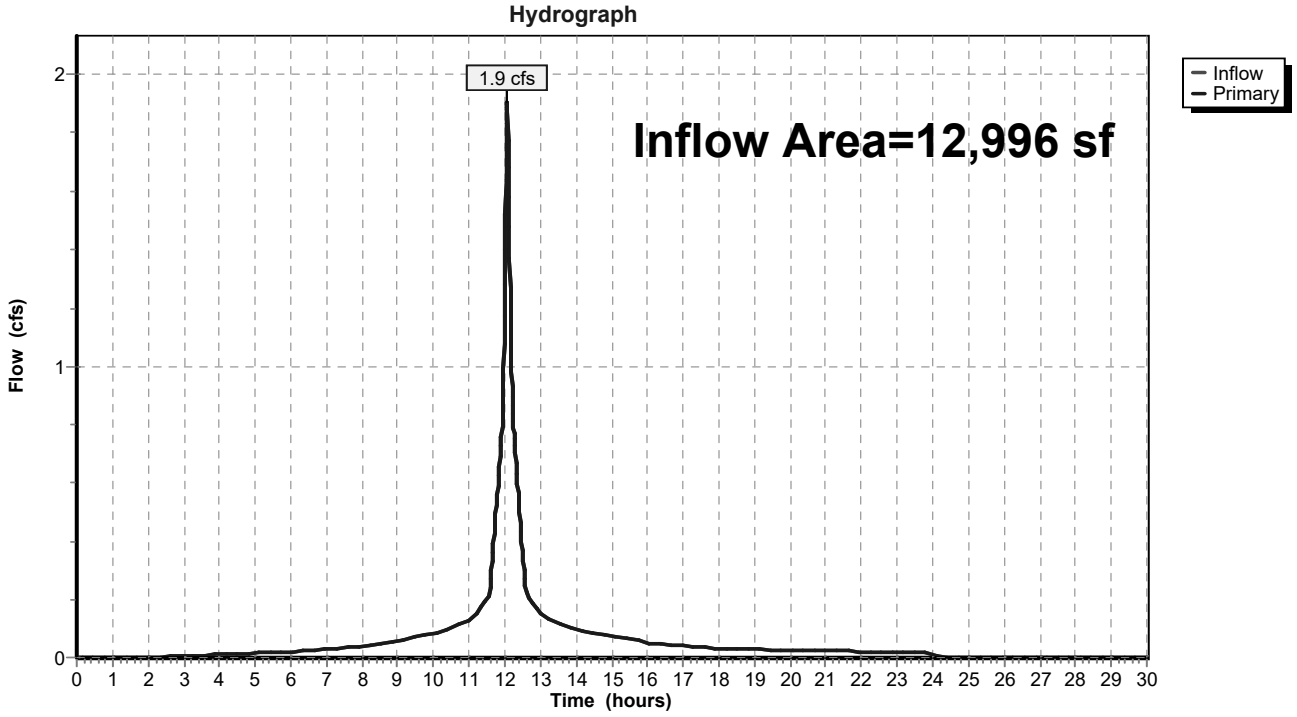


Summary for Link DP-2: Highland Ave

Inflow Area = 12,996 sf, 95.14% Impervious, Inflow Depth = 5.81" for 25-year event
Inflow = 1.9 cfs @ 12.07 hrs, Volume= 6,291 cf
Primary = 1.9 cfs @ 12.07 hrs, Volume= 6,291 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



100-Year Storm Event – Proposed

Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

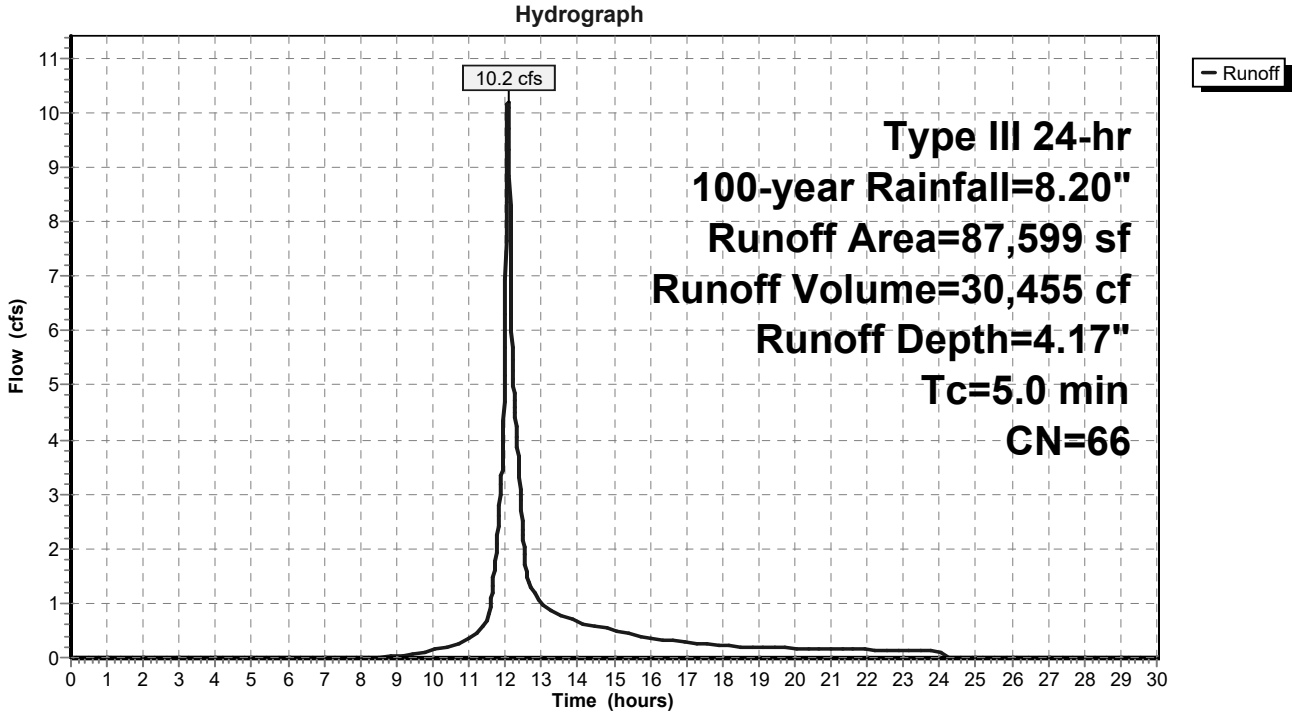
Runoff = 10.2 cfs @ 12.08 hrs, Volume= 30,455 cf, Depth= 4.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
47,249	39	>75% Grass cover, Good, HSG A
27,508	98	Paved parking, HSG A
12,841	98	Roofs, HSG A
87,599	66	Weighted Average
47,249		53.94% Pervious Area
40,349		46.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-A: 40 Arbor & Upstream Area



Summary for Subcatchment EX-B: 673 Highland & Upstream Area

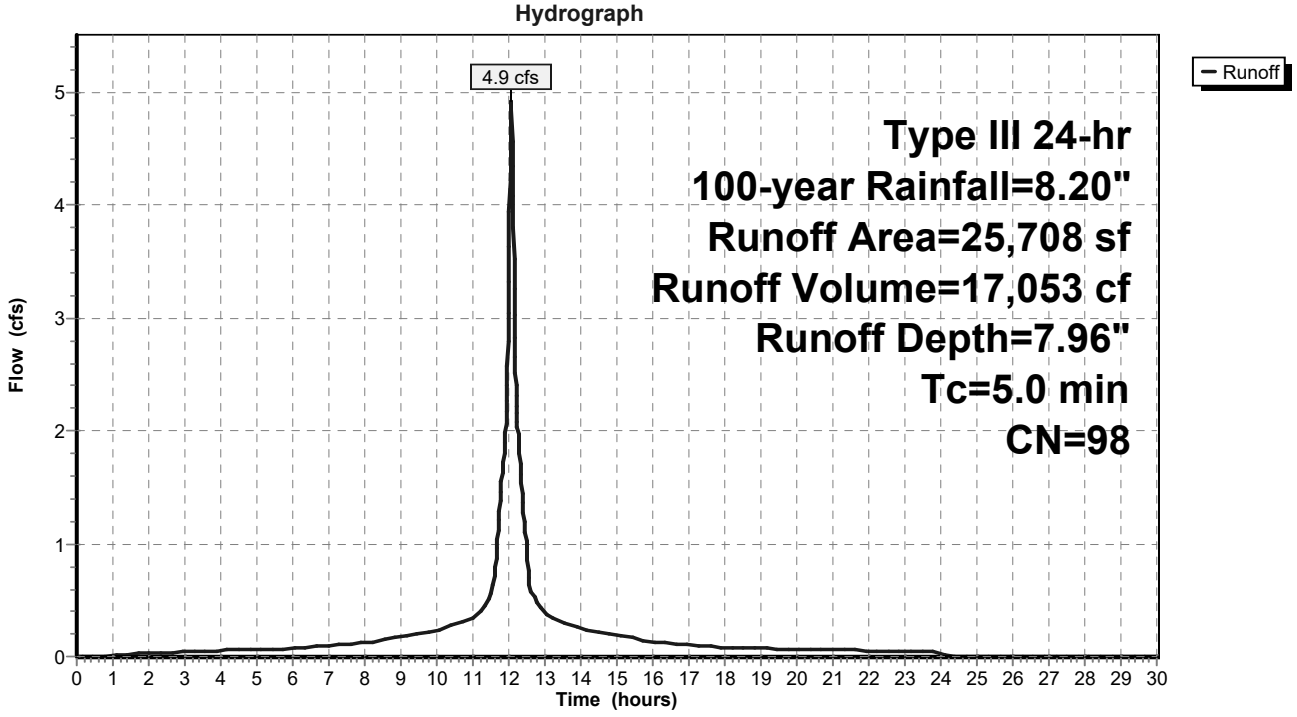
Runoff = 4.9 cfs @ 12.07 hrs, Volume= 17,053 cf, Depth= 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
19,268	98	Paved parking, HSG A
6,440	98	Roofs, HSG A
25,708	98	Weighted Average
25,708		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-B: 673 Highland & Upstream Area



Summary for Subcatchment EX-D: Overland to Highland Ave

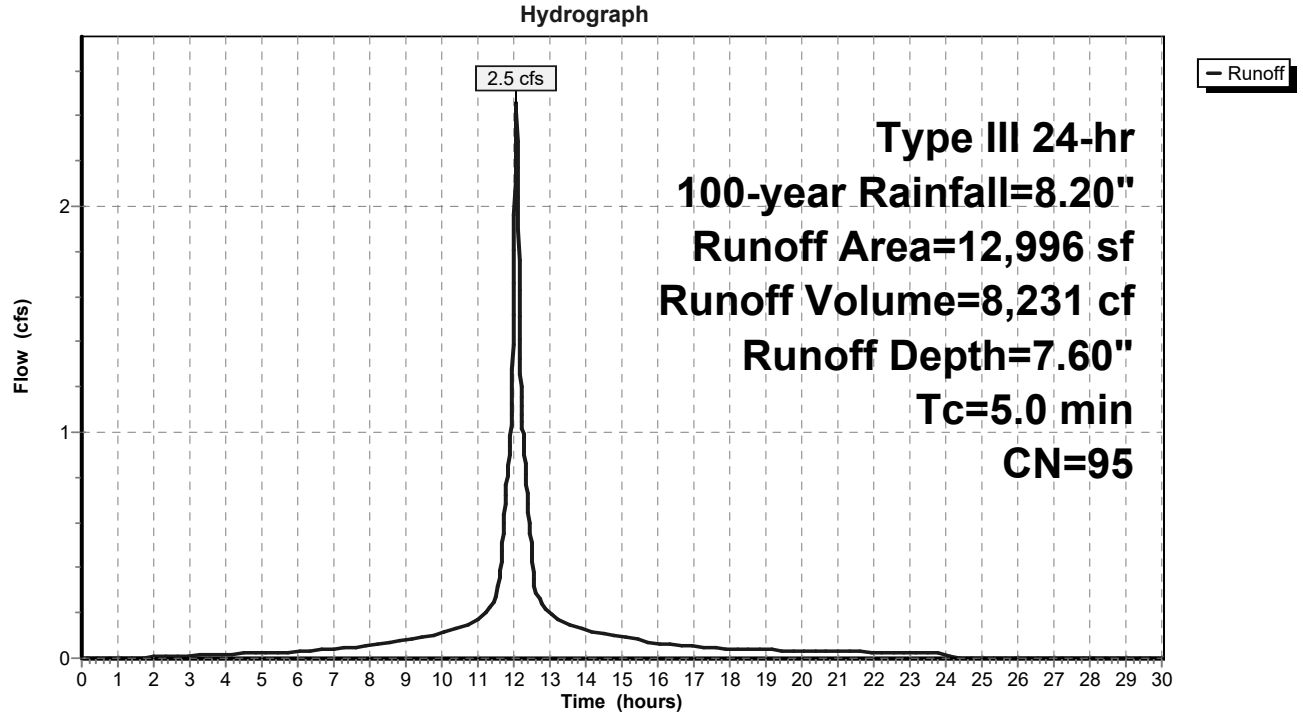
Runoff = 2.5 cfs @ 12.07 hrs, Volume= 8,231 cf, Depth= 7.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
632	39	>75% Grass cover, Good, HSG A
12,364	98	Paved parking, HSG A
12,996	95	Weighted Average
632		4.86% Pervious Area
12,364		95.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX-D: Overland to Highland Ave



Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

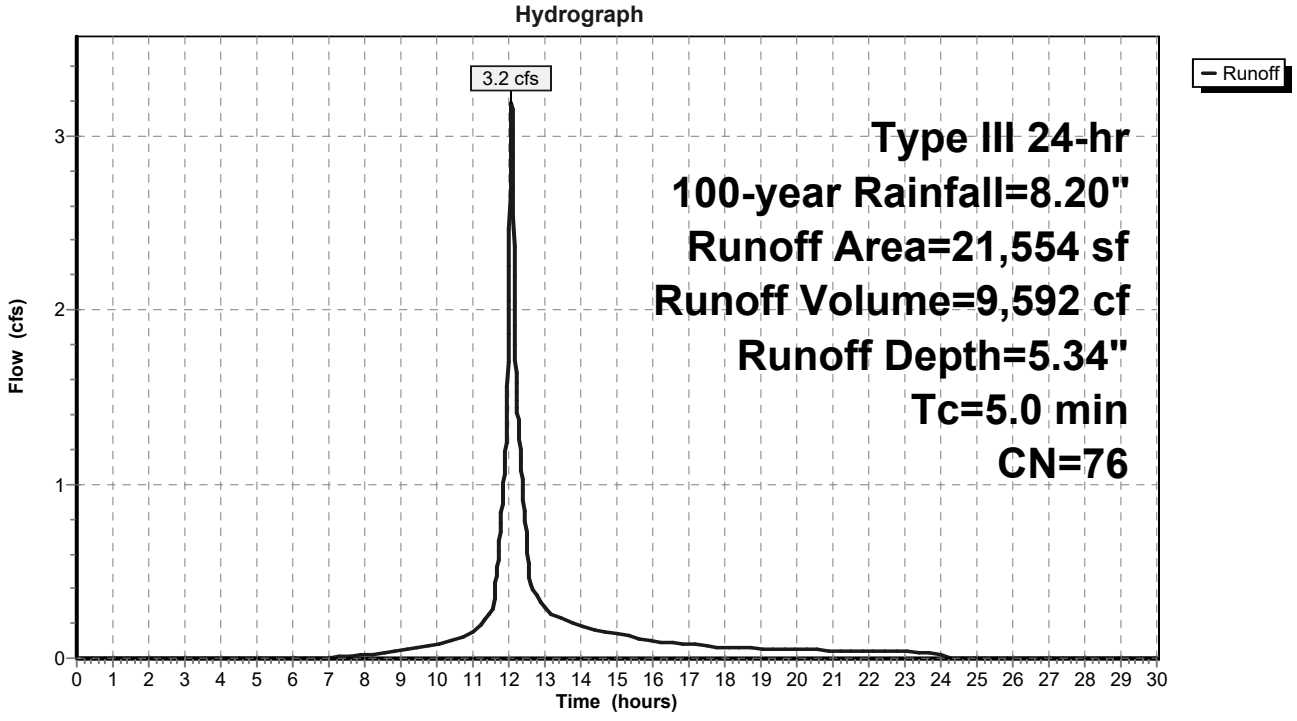
Runoff = 3.2 cfs @ 12.07 hrs, Volume= 9,592 cf, Depth= 5.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
7,873	39	>75% Grass cover, Good, HSG A
13,680	98	Paved parking, HSG A
21,554	76	Weighted Average
7,873		36.53% Pervious Area
13,680		63.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-1: Onsite Driveway & Upper Arbor St



Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

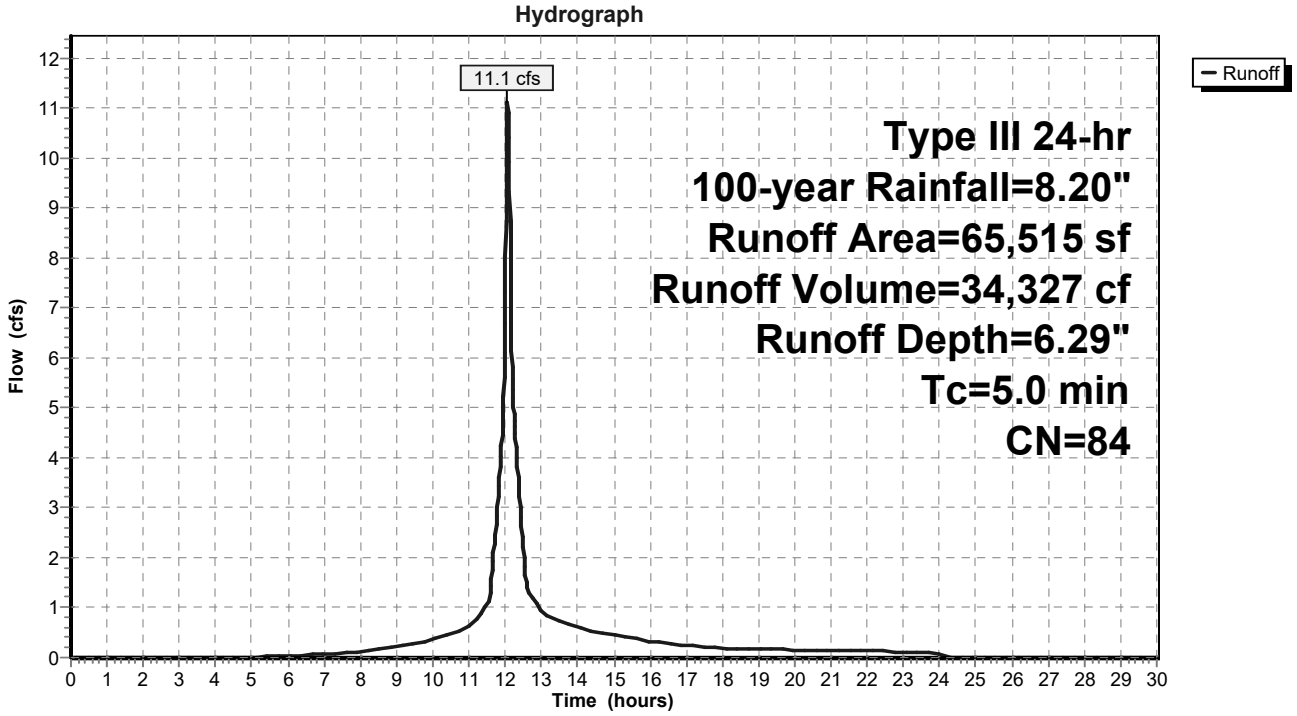
Runoff = 11.1 cfs @ 12.07 hrs, Volume= 34,327 cf, Depth= 6.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
15,673	39	>75% Grass cover, Good, HSG A
24,695	98	Paved parking, HSG A
25,148	98	Roofs, HSG A
65,515	84	Weighted Average
15,673		23.92% Pervious Area
49,843		76.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape



Summary for Subcatchment PR-3: Permeable Patio

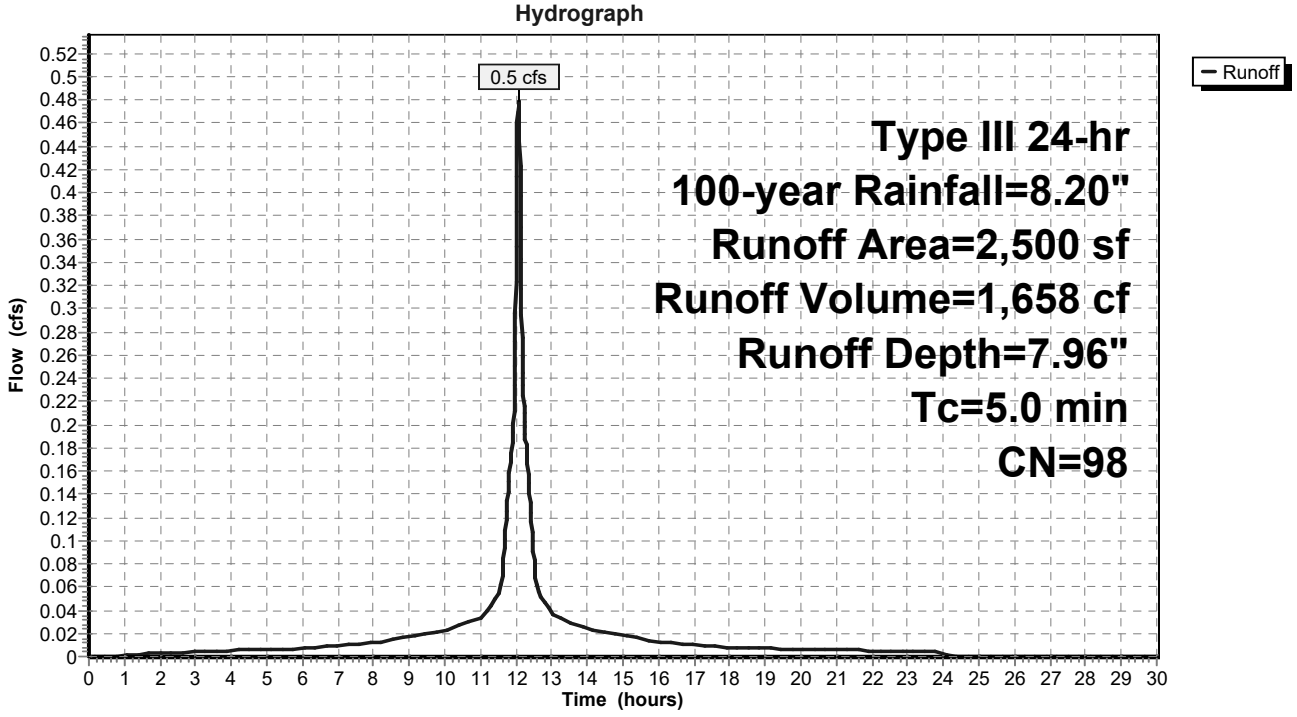
Runoff = 0.5 cfs @ 12.07 hrs, Volume= 1,658 cf, Depth= 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
2,500	98	Paved parking, HSG A
0	98	Roofs, HSG A
2,500	98	Weighted Average
2,500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-3: Permeable Patio



Summary for Subcatchment PR-C: Cross St

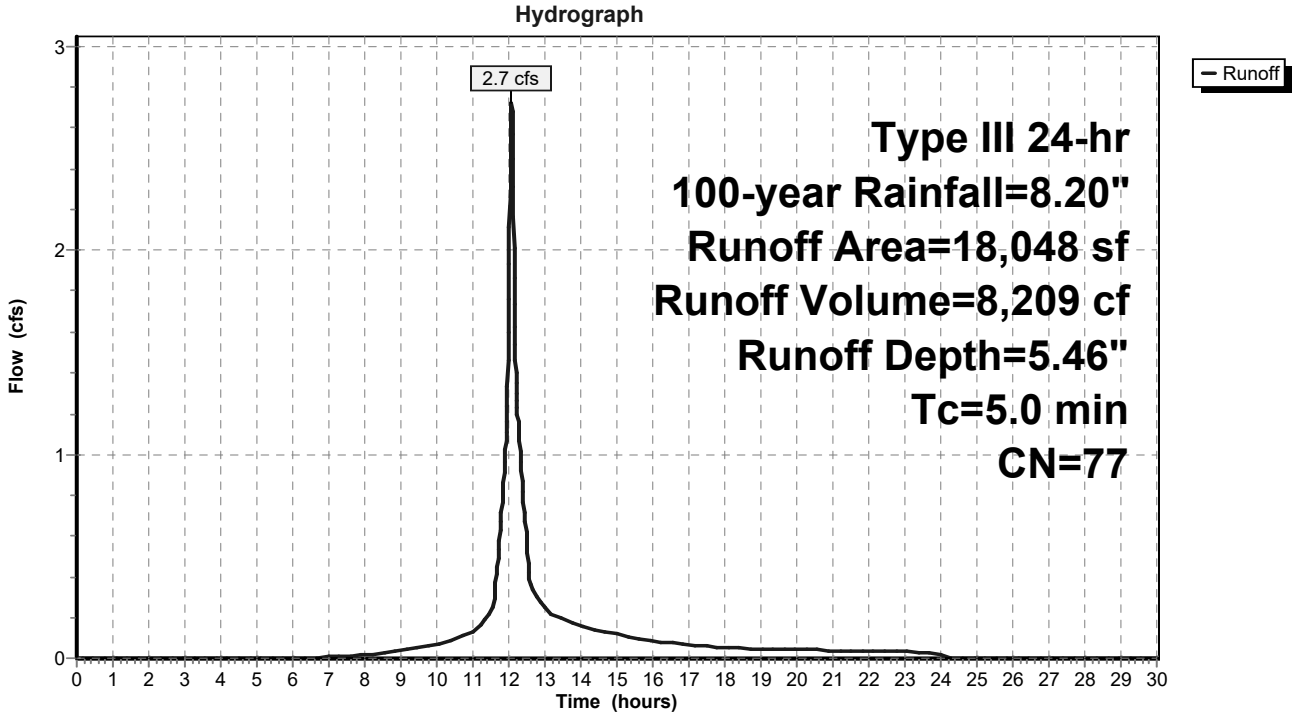
Runoff = 2.7 cfs @ 12.07 hrs, Volume= 8,209 cf, Depth= 5.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

Area (sf)	CN	Description
6,426	39	>75% Grass cover, Good, HSG A
11,623	98	Paved parking, HSG A
18,048	77	Weighted Average
6,426		35.60% Pervious Area
11,623		64.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment PR-C: Cross St



Summary for Pond P-1.1: SC-740 StormTech Basins A and B

Inflow Area = 21,554 sf, 63.47% Impervious, Inflow Depth = 5.34" for 100-year event
Inflow = 3.2 cfs @ 12.07 hrs, Volume= 9,592 cf
Outflow = 1.7 cfs @ 12.43 hrs, Volume= 6,282 cf, Atten= 48%, Lag= 21.4 min
Discarded = 0.1 cfs @ 9.61 hrs, Volume= 4,008 cf
Primary = 1.6 cfs @ 12.43 hrs, Volume= 2,274 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 138.08' @ 12.43 hrs Surf.Area= 2,196 sf Storage= 4,571 cf

Plug-Flow detention time= 327.9 min calculated for 6,280 cf (65% of inflow)
Center-of-Mass det. time= 228.5 min (1,038.6 - 810.0)

Volume	Invert	Avail.Storage	Storage Description
#1J	133.00'	1,122 cf	**20.50'W x 60.58'L x 3.50'H Stone Bed For StormTech - A** 4,346 cf Overall - 1,470 cf Embedded = 2,876 cf x 39.0% Voids
#2J	133.50'	1,470 cf	**ADS_StormTech SC-740 +Cap** x 32 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 32 Chambers in 4 Rows
#3K	133.00'	872 cf	**15.75'W x 60.58'L x 3.50'H Stone Bed For StormTech - B** 3,339 cf Overall - 1,103 cf Embedded = 2,237 cf x 39.0% Voids
#4K	133.50'	1,103 cf	**ADS_StormTech SC-740 +Cap** x 24 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 24 Chambers in 3 Rows
#5	136.50'	5 cf	**2.00'D x 1.50'H Structure with Grate Inlet** Impervious
		4,571 cf	Total Available Storage

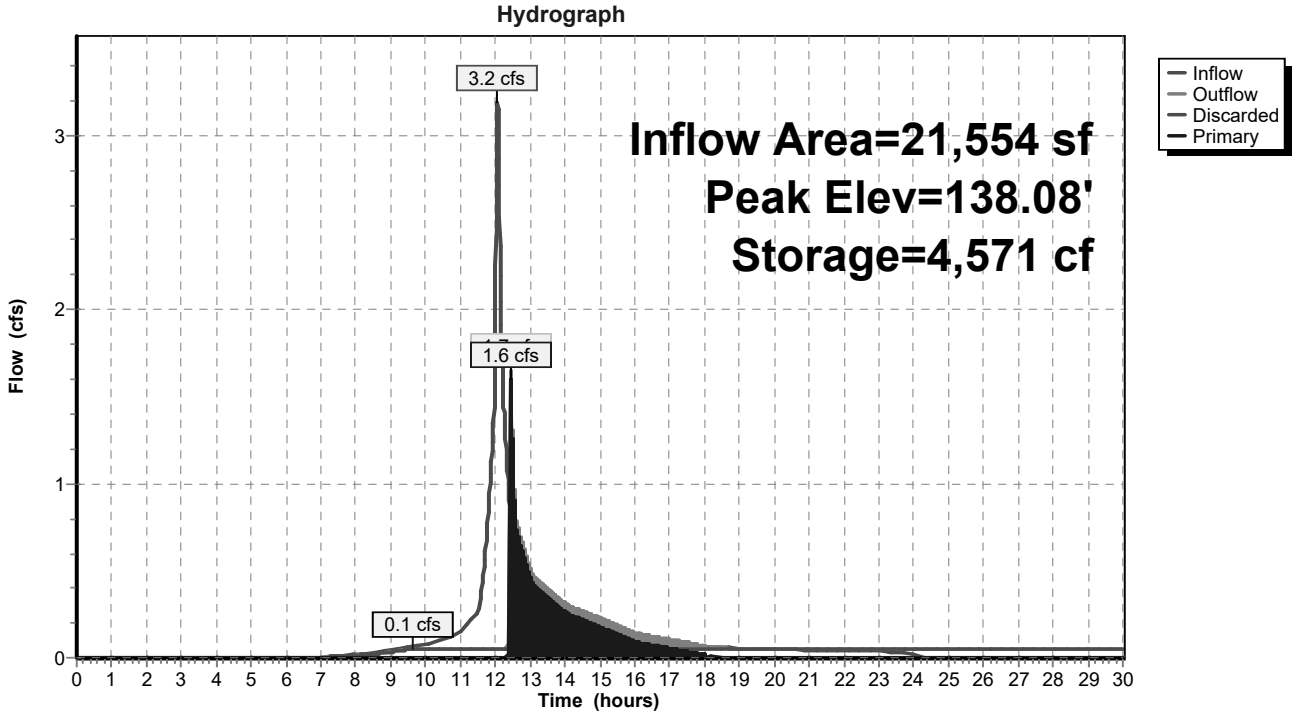
Storage Group J created with Chamber Wizard
Storage Group K created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	138.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 9.61 hrs HW=133.06' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=1.6 cfs @ 12.43 hrs HW=138.08' (Free Discharge)
↑**2=Special & User-Defined** (Custom Controls 1.6 cfs)

Pond P-1.1: SC-740 StormTech Basins A and B



Summary for Pond P-2.1: StormTrap Basins C, D, E, F

Inflow Area = 68,015 sf, 76.96% Impervious, Inflow Depth = 6.06" for 100-year event
Inflow = 11.1 cfs @ 12.07 hrs, Volume= 34,327 cf
Outflow = 3.5 cfs @ 12.40 hrs, Volume= 21,732 cf, Atten= 69%, Lag= 19.7 min
Discarded = 0.2 cfs @ 8.81 hrs, Volume= 13,995 cf
Primary = 3.3 cfs @ 12.40 hrs, Volume= 7,737 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 139.16' @ 12.40 hrs Surf.Area= 7,258 sf Storage= 16,856 cf

Plug-Flow detention time= 322.5 min calculated for 21,725 cf (63% of inflow)
Center-of-Mass det. time= 222.9 min (1,014.2 - 791.3)

Volume	Invert	Avail.Storage	Storage Description
#1G	133.00'	1,599 cf	**30.27'W x 90.29'L x 4.00'H Stone Bed For StormTrap - C** 10,933 cf Overall - 6,833 cf Embedded = 4,100 cf x 39.0% Voids
#2G	134.50'	4,758 cf	**StormTrap ST2 SingleTrap 2-0** x 10 Inside #1 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 10 Chambers in 2 Rows 16.96' x 76.98' Core + 6.66' Border = 30.27' x 90.29' System
#3H	133.00'	1,326 cf	**30.27'W x 74.90'L x 4.00'H Stone Bed For StormTrap - D** 9,069 cf Overall - 5,668 cf Embedded = 3,401 cf x 39.0% Voids
#4H	134.50'	3,944 cf	**StormTrap ST2 SingleTrap 2-0** x 8 Inside #3 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8 Chambers in 2 Rows 16.96' x 61.58' Core + 6.66' Border = 30.27' x 74.90' System
#5E	133.00'	562 cf	**21.79'W x 44.10'L x 4.00'H Stone Bed For StormTrap - E** 3,844 cf Overall - 2,403 cf Embedded = 1,442 cf x 39.0% Voids
#6E	134.50'	1,660 cf	**StormTrap ST2 SingleTrap 2-0** x 2 Inside #5 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 30.79' Core + 6.66' Border = 21.79' x 44.10' System
#7I	133.00'	759 cf	**21.79'W x 59.50'L x 4.00'H Stone Bed For StormTrap - F** 5,186 cf Overall - 3,242 cf Embedded = 1,945 cf x 39.0% Voids
#8I	134.50'	2,242 cf	**StormTrap ST2 SingleTrap 2-0** x 3 Inside #7 Inside= 101.7"W x 24.0"H => 15.05 sf x 15.40'L = 231.7 cf Outside= 101.7"W x 30.0"H => 21.20 sf x 15.40'L = 326.4 cf 8.48' x 46.19' Core + 6.66' Border = 21.79' x 59.50' System
#9	136.90'	6 cf	**2.00'D x 2.00'H Structure with Grate Inlet** Impervious
		16,856 cf	Total Available Storage

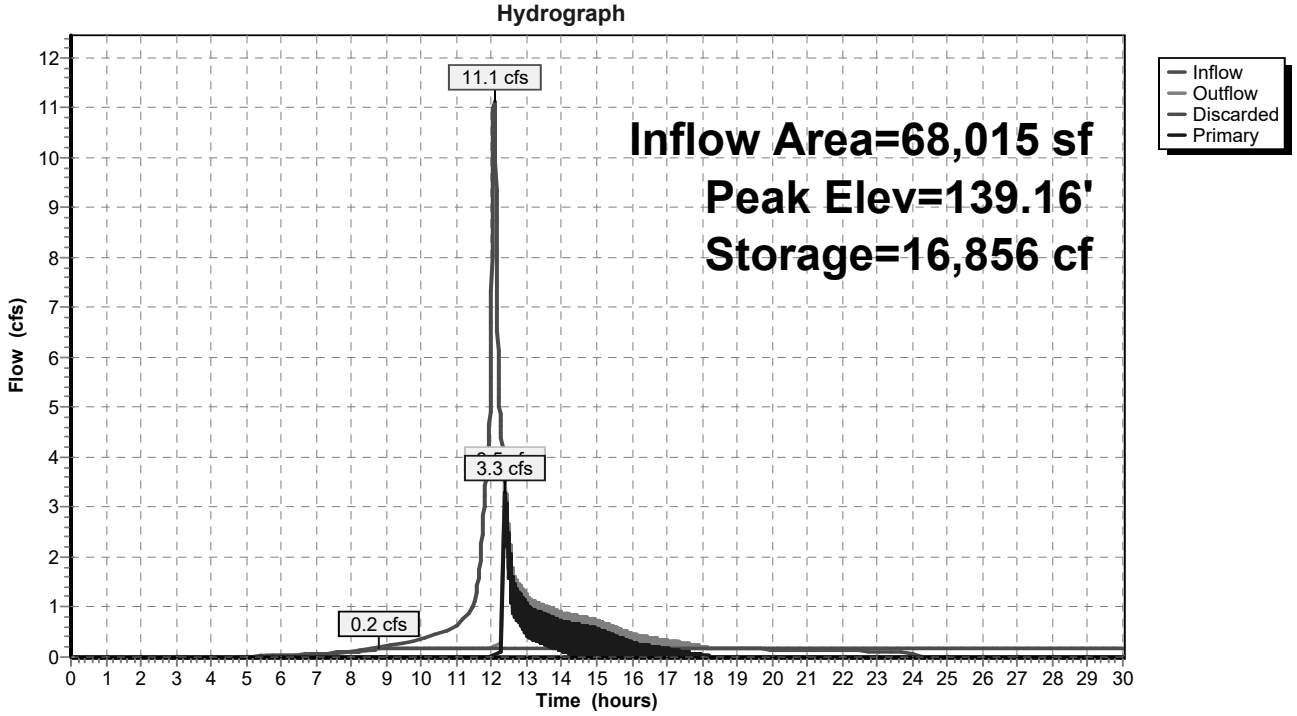
Storage Group G created with Chamber Wizard
Storage Group H created with Chamber Wizard
Storage Group E created with Chamber Wizard
Storage Group I created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	139.00'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.2 cfs @ 8.81 hrs HW=133.07' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=3.2 cfs @ 12.40 hrs HW=139.16' (Free Discharge)
↑**2=Special & User-Defined** (Custom Controls 3.2 cfs)

Pond P-2.1: StormTrap Basins C, D, E, F



Summary for Pond P-3.1: Permeable Patio

Inflow Area = 2,500 sf,100.00% Impervious, Inflow Depth = 7.96" for 100-year event
Inflow = 0.5 cfs @ 12.07 hrs, Volume= 1,658 cf
Outflow = 0.1 cfs @ 11.67 hrs, Volume= 1,658 cf, Atten= 88%, Lag= 0.0 min
Discarded = 0.1 cfs @ 11.67 hrs, Volume= 1,658 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 150.02' @ 12.59 hrs Surf.Area= 2,500 sf Storage= 509 cf

Plug-Flow detention time= 56.4 min calculated for 1,658 cf (100% of inflow)
Center-of-Mass det. time= 56.4 min (796.4 - 740.0)

Volume	Invert	Avail.Storage	Storage Description
#1	149.50'	1,463 cf	**Porous Pavement Stone (Prismatic)** Listed below (Recalc) 3,750 cf Overall x 39.0% Voids
#2	151.00'	1 cf	**Patio Drain (Prismatic)** Listed below (Recalc) -Impervious
#3	152.00'	2,500 cf	**Patio Surface Storage (Prismatic)** Listed below (Recalc) -Impervious
		3,964 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
149.50	2,500	0	0
150.50	2,500	2,500	2,500
151.00	2,500	1,250	3,750

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	1	0	0
152.00	1	1	1

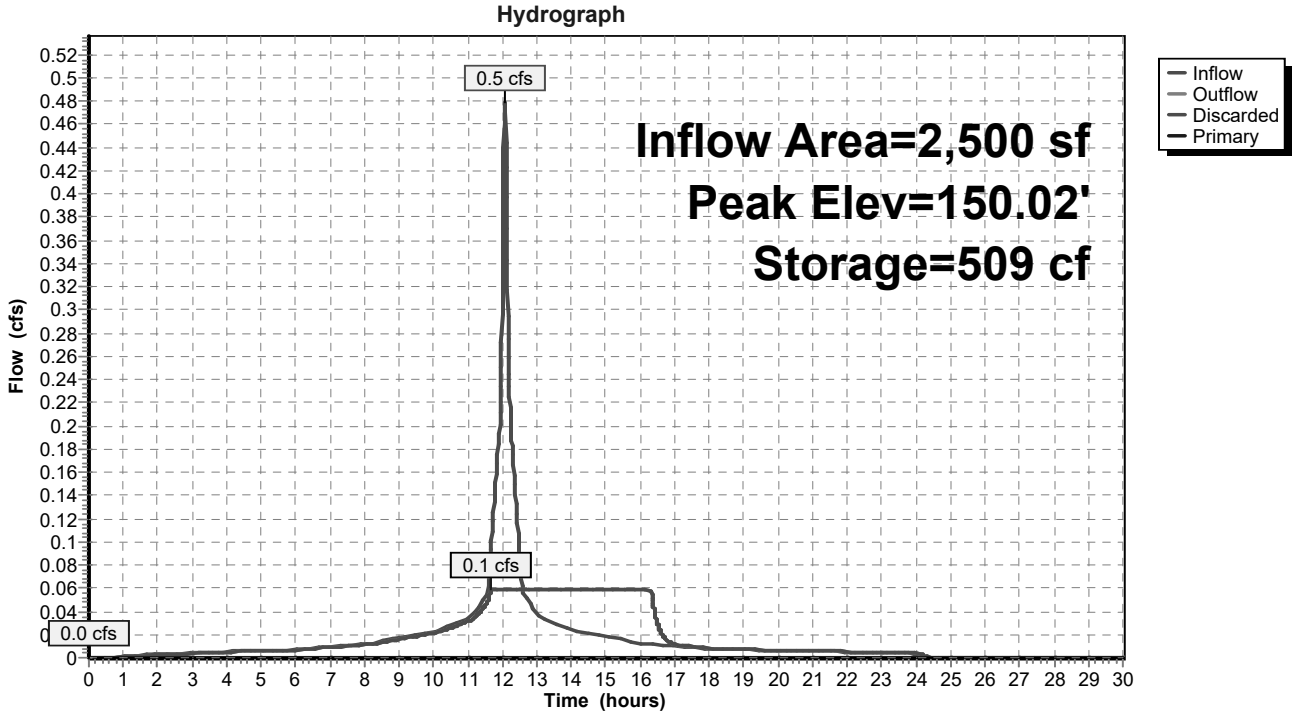
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	2,500	0	0
153.00	2,500	2,500	2,500

Device	Routing	Invert	Outlet Devices
#1	Discarded	149.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.50'	**Special & User-Defined** Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.67 hrs HW=149.54' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=149.50' (Free Discharge)
↑—**2=Special & User-Defined** (Controls 0.0 cfs)

Pond P-3.1: Permeable Patio



Summary for Pond P-B: MC-3500 StormTech at 673 Highland

Inflow Area = 25,708 sf,100.00% Impervious, Inflow Depth = 7.96" for 100-year event
Inflow = 4.9 cfs @ 12.07 hrs, Volume= 17,053 cf
Outflow = 0.6 cfs @ 12.63 hrs, Volume= 17,053 cf, Atten= 88%, Lag= 33.6 min
Discarded = 0.3 cfs @ 10.99 hrs, Volume= 16,775 cf
Primary = 0.2 cfs @ 12.63 hrs, Volume= 279 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 168.54' @ 12.63 hrs Surf.Area= 1,761 sf Storage= 6,148 cf

Plug-Flow detention time= 130.0 min calculated for 17,048 cf (100% of inflow)
Center-of-Mass det. time= 129.9 min (869.9 - 740.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	161.50'	2,456 cf	**22.75'W x 77.40'L x 5.50'H Stone Bed for StormTech-673** 9,685 cf Overall - 3,388 cf Embedded = 6,297 cf x 39.0% Voids
#2A	162.25'	3,388 cf	**ADS_StormTech MC-3500 d +Cap** x 30 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 30 Chambers in 3 Rows Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
#3	167.00'	3 cf	**2.00'D x 1.00'H Structure with Grate Inlet** -Impervious
#4	167.67'	3,741 cf	**Parking Lot Surface Storage (Prismatic)** -Listed below (Recalc) -Impervious
		9,588 cf	Total Available Storage

Storage Group A created with Chamber Wizard

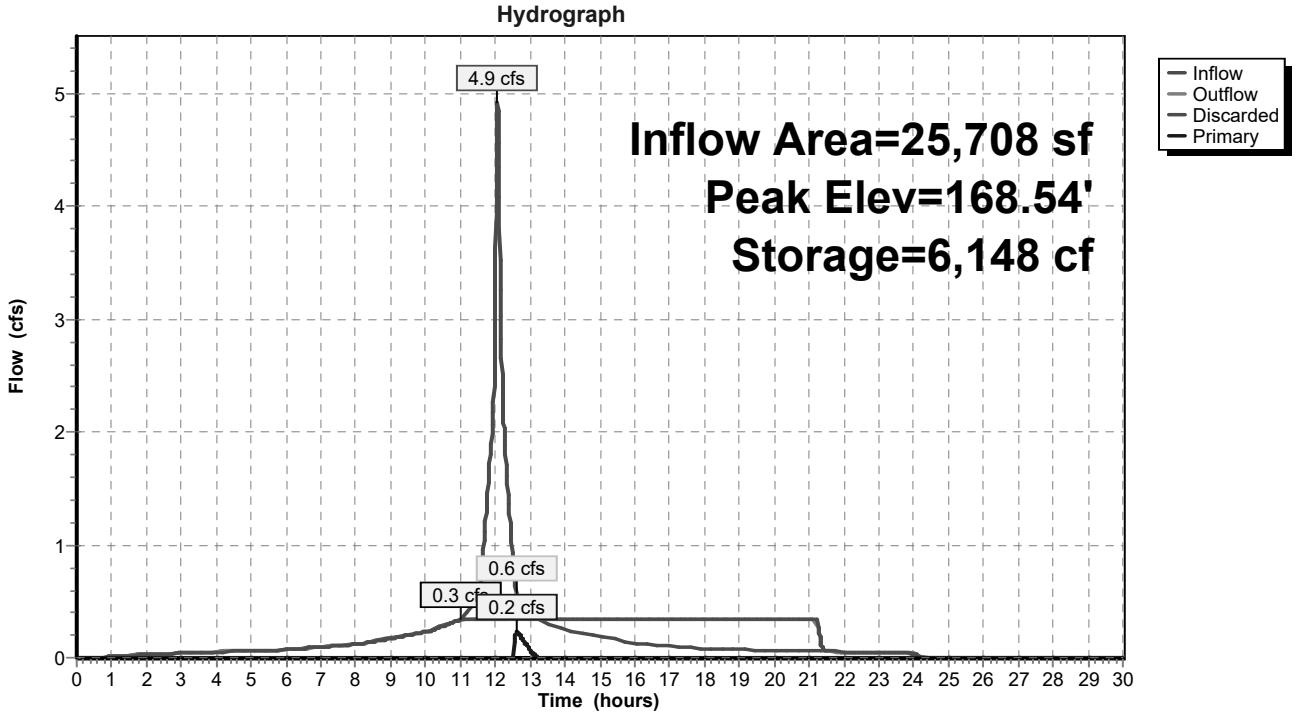
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.67	0	0	0
167.70	16	0	0
168.00	155	26	26
169.00	1,500	828	853
170.00	4,275	2,888	3,741

Device	Routing	Invert	Outlet Devices
#1	Discarded	161.50'	**8.270 in/hr Exfiltration over Surface area**
#2	Primary	168.50'	**12.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.3 cfs @ 10.99 hrs HW=161.59' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=0.2 cfs @ 12.63 hrs HW=168.54' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.2 cfs @ 0.44 fps)

Pond P-B: MC-3500 StormTech at 673 Highland

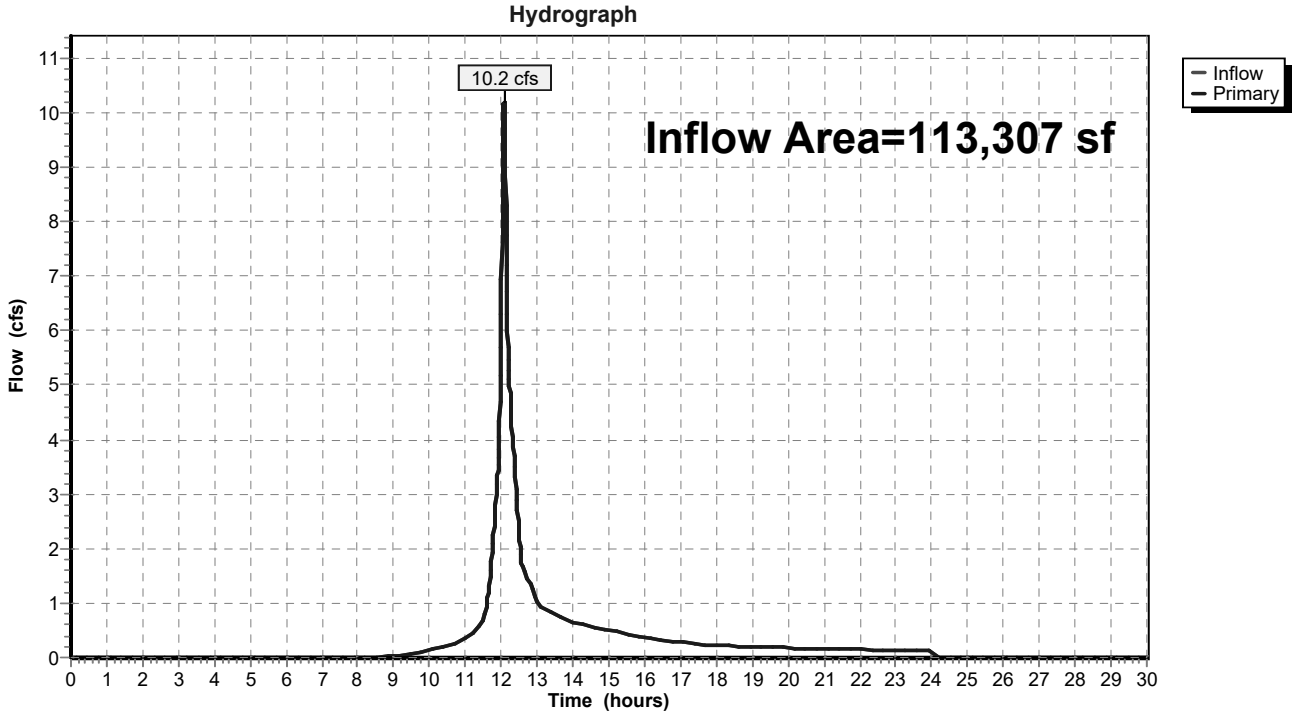


Summary for Link A-B: EX A+ EX B

Inflow Area = 113,307 sf, 58.30% Impervious, Inflow Depth = 3.25" for 100-year event
Inflow = 10.2 cfs @ 12.08 hrs, Volume= 30,734 cf
Primary = 10.2 cfs @ 12.08 hrs, Volume= 30,734 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link A-B: EX A+ EX B

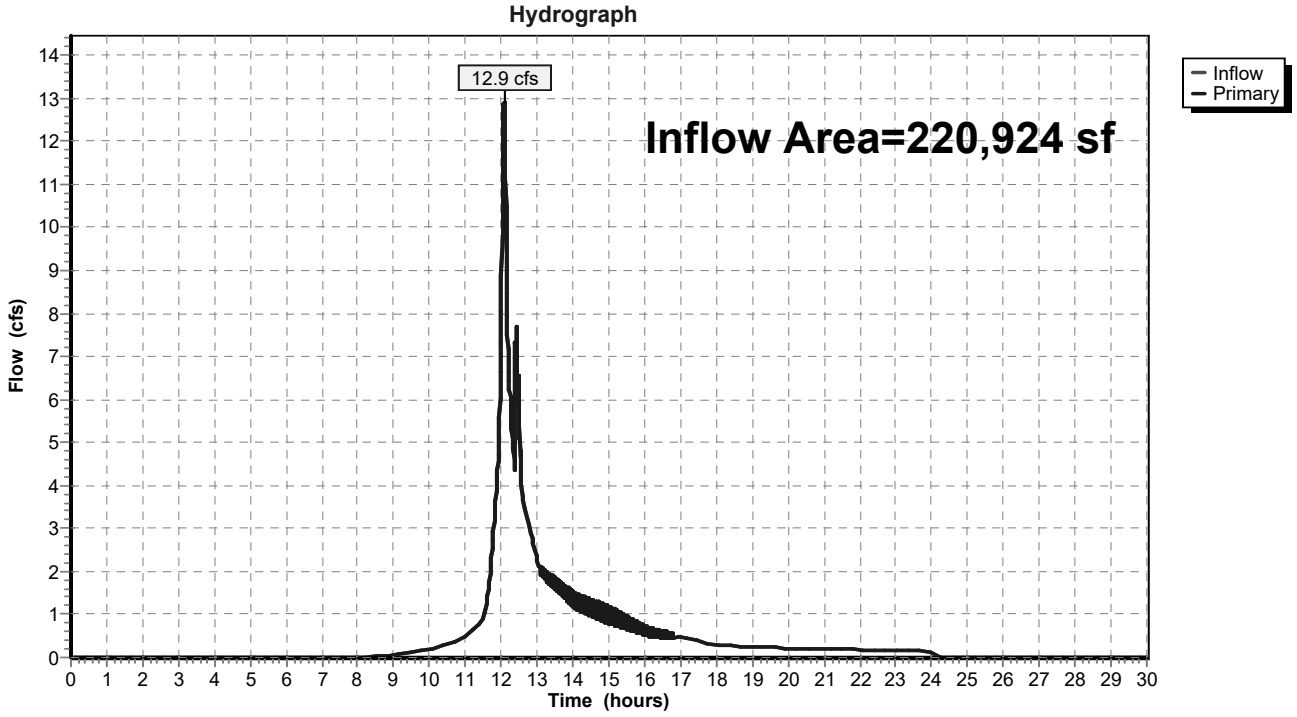


Summary for Link DP-1: Offsite to North

Inflow Area = 220,924 sf, 65.05% Impervious, Inflow Depth = 2.66" for 100-year event
Inflow = 12.9 cfs @ 12.08 hrs, Volume= 48,954 cf
Primary = 12.9 cfs @ 12.08 hrs, Volume= 48,954 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-1: Offsite to North

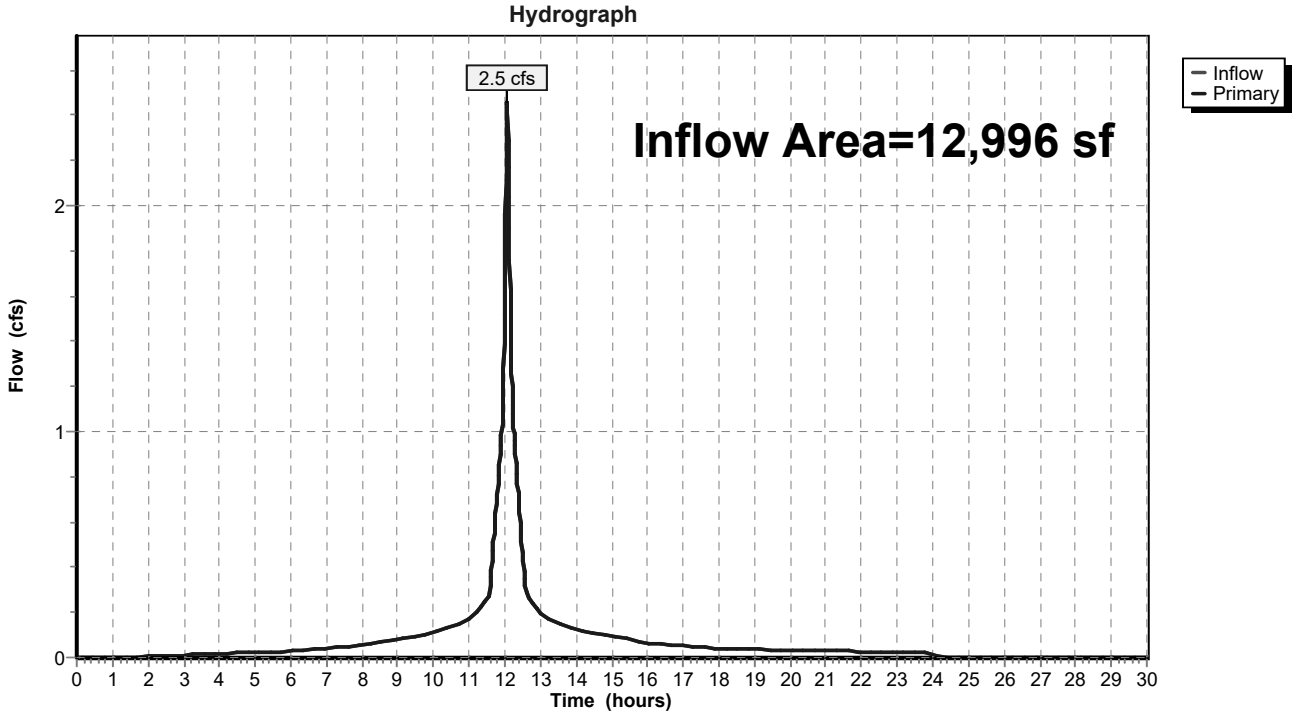


Summary for Link DP-2: Highland Ave

Inflow Area = 12,996 sf, 95.14% Impervious, Inflow Depth = 7.60" for 100-year event
Inflow = 2.5 cfs @ 12.07 hrs, Volume= 8,231 cf
Primary = 2.5 cfs @ 12.07 hrs, Volume= 8,231 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



Appendix B: Standard 3 Computations and Supporting Documentation

- Soil Information provided in accordance with Volume 3, Chapter 1 of the Handbook
- Recharge volume calculations with 72-hour drawdown analysis
- Mounding analysis

Soils Information

- NRCS Soils Map
- Boring and Test Pit Logs

Hydrologic Soil Group—Norfolk and Suffolk Counties, Massachusetts
(HSGs)

Map Scale: 1:2,110 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 18, Sep 9, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
602	Urban land, 0 to 15 percent slopes		4.8	21.5%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	17.4	78.5%
Totals for Area of Interest			**22.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

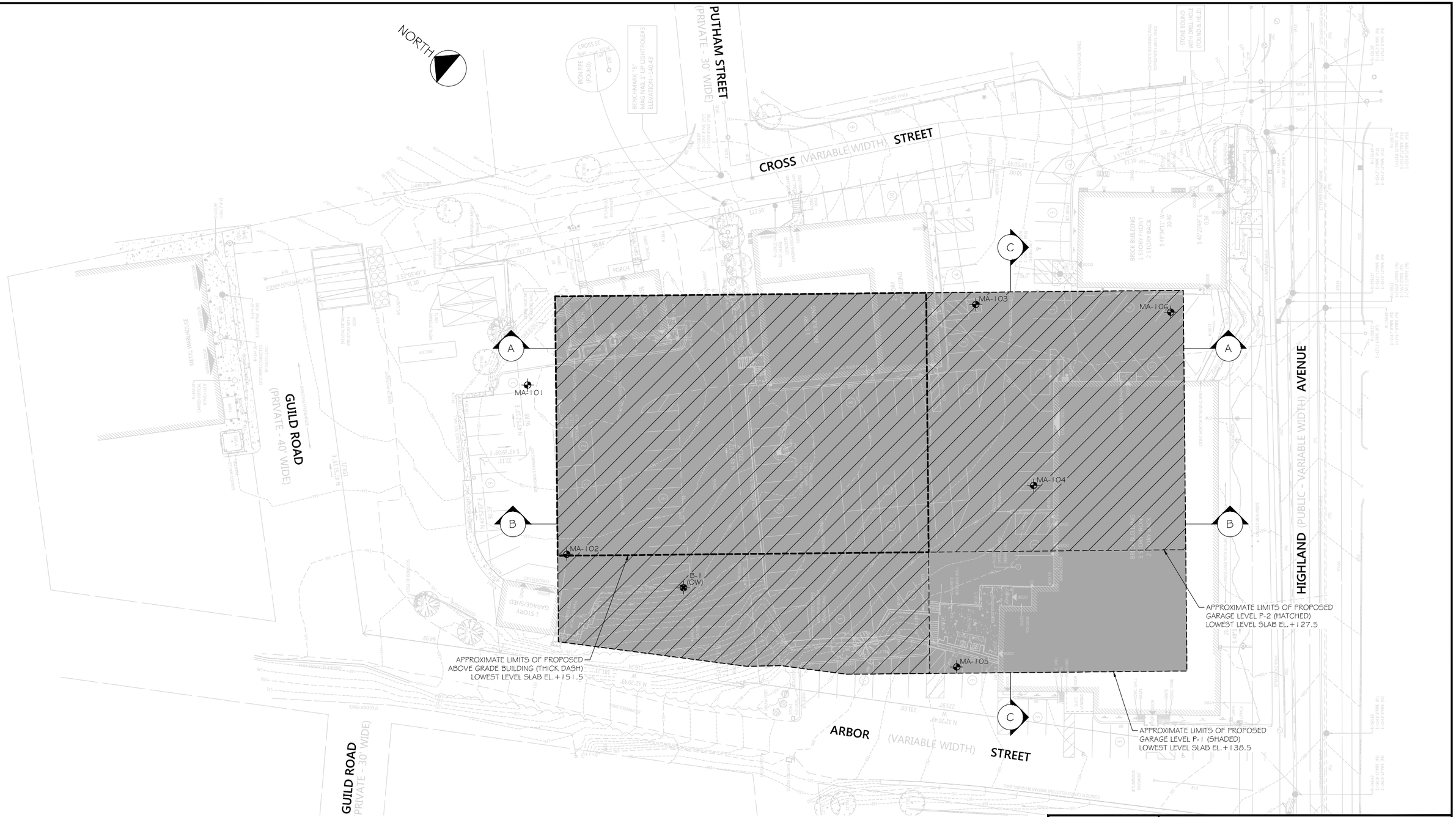
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



LEGEND

— APPROXIMATE LOCATION OF BORING PERFORMED BY SEABOARD DRILLING FROM DECEMBER 10 TO 15, 2020 FOR McPHAIL ASSOCIATES, LLC

— APPROXIMATE LOCATION OF BORING PERFORMED BY OTHERS ON NOVEMBER 21, 2019

REFERENCE: THIS PLAN WAS PREPARED FROM A 20-SCALE DRAWING ENTITLED, "EXISTING CONDITIONS PLAN OF LAND" DATED NOVEMBER 16, 2020 PREPARED BY VHB

GRAPHIC SCALE

20 0 20 40 80

McPHAIL ASSOCIATES, LLC
Geotechnical and
Geoenvironmental Engineers
2269 Massachusetts Avenue
Cambridge, MA 02140
617/868-1420
617/868-1423 (Fax)
www.mcphailgeo.com

629 - 661 HIGHLAND AVENUE

NEEDHAM MASSACHUSETTS

SUBSURFACE EXPLORATION PLAN

FOR

BOSTON DEVELOPMENT GROUP

BY

McPHAIL ASSOCIATES, LLC

Date: FEBRUARY 2021	Dwn: M.B.S.	Chkd: J.A.E.	Scale: 1" = 20'
Project No: 7076			FIGURE 2

FILE NAME: N:\Acad\JOBS\7076\7076-FO2rev2.dwg

Project:	661 Highland Ave	**Job #:**	7076
Location:	Needham MA	**Date Started:**	12-11-20
City/State:	Needham Ma	**Date Finished:**	12-11-20

Boring No.

MA-101

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 135.0

Casing Type/Depth (ft): HW TO 10'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
			0.3 / 134.7	ASPHALT						
1	134									
2	133				15	S1	24/10	1.0-3.0	15 5 10 67	Compact, brown to dark brown, SILTY SAND, trace gravel w/ comcrete. (Fill)
3	132									
4	131			FILL						
5	130									
6	129				4	S2	24/4	5.0-7.0	2 2 2 1	Very loose to loose, brown, SILTY SAND, trace gravel, w/ wood fragments. (Fill) Note: Started casing
7	128									
8	127		8.0 / 127.0							
9	126									
10	125									
11	124			GLACIAL OUTWASH	59	S3	24/10	10.0-12.0	18 29 30 25	Very dense, brown to white, SILTY SAND and GRAVEL. (Glacial Outwash)
12	123									
13	122									
14	121		14.0 / 121.0							
15	120			WEATHERED BEDROCK	147	S4	9/10	15.0-15.8	47 100/3	Very dense, white to gray to light brown, WEATHERED BEDROCK and SILTY SAND. (Weathered Bedrock)
16	119		16.0 / 119.0	Bottom of borehole 16' BGS						Note: Solid bedrock at 16' BGS
17	118									
18	117									
19	116									
20	115									
21	114									
22	113									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project:	661 Highland Ave	**Job #:**	7076
Location:	Needham MA	**Date Started:**	12-11-20
City/State:	Needham Ma	**Date Finished:**	12-11-20

Boring No.

MA-102

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 138.0

Casing Type/Depth (ft): HW TO 20'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
			0.5 / 137.5	ASPHALT						
1	137			FILL	47	S1	24/14	1.0-3.0	20 24 23 21	Dense,, brown to light brown, SILTY SAND, some gravel. (Fill) Note: Attempted to start casing after sampling, too many obstructions and could not get it down, had to auger to softer material before using casing.
2	136									
3	135		3.0 / 135.0							
4	134			GLACIAL OUTWASH						
5	133				76	S2	24/10	5.0-7.0	49 29 47 44	Very dense, brown to light brown, SAND and GRAVEL, trace silt. (Glacial Outwash) Note: Started casing
6	132									
7	131									
8	130									
9	129									
10	128				56	S3	24/12	10.0-12.0	48 30 26 24	Very dense, brown to pink, SAND and GRAVEl, some silt. (Glacial Outwash)
11	127									
12	126									
13	125									
14	124									
15	123				45	S4	24/4	15.0-17.0	20 20 25 18	Dense, brown to gray, SILTY SAND and GRAVEL. (Glacial Outwash)
16	122									
17	121		17.0 / 121.0							
18	120			GLACIAL TILL						
19	119									
20	118				142	S5	16/8	20.0-21.3	47 42 100/4	Very dense, brown to light brown, SILT and SAND w/ weathered bedrock. (Glacial Till)
21	117		21.5 / 116.5							
22	116			WEATHERED BEDROCK						

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project:	661 Highland Ave	**Job #:**	7076
Location:	Needham MA	**Date Started:**	12-11-20
City/State:	Needham Ma	**Date Finished:**	12-11-20

Boring No.

MA-102

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 138.0

Casing Type/Depth (ft): HW TO 20'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
24	114			WEATHERED BEDROCK						
25	113									
26	112		26.0 / 112.0							
27	111			BEDROCK	3	RC1	60/54	26.0-31.0	RQD: 26/60	Medium hard, moderately weathered, severely fractured, some horizontal drilling fractures, green to gray, medium grained, no cavitites observed.
28	110				5				RQD: 43%	
29	109				3					
30	108				2					
31	107		31.0 / 107.0		8					
32	106			Bottom of borehole 31' BGS						
33	105									
34	104									
35	103									
36	102									
37	101									
38	100									
39	99									
40	98									
41	97									
42	96									
43	95									
44	94									
45	93									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project: 661 Highland Ave
Location: Needham MA
City/State: Needham Ma

Job #: 7076
Date Started: 12-15-20
Date Finished: 12-15-20

Boring No. MA-103

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 146.0

Casing Type/Depth (ft): HW TO 20'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
			0.3 / 145.7	ASPHALT						
1	145								8	Compact, brown to dark brown, SILTY SAND and GRAVEL. (Fill)
2	144				15	S1	24/10	1.0-3.0	8	
3	143			FILL					7	
4	142								7	
5	141		5.0 / 141.0							
6	140				55	S2	24/14	5.0-7.0	13	Very dense, brown, SAND and GRAVEL, some silt. (Glacial Outwash)
7	139								24	
8	138			GLACIAL OUTWASH					31	
9	137								32	
10	136				120	S3	12/8	10.0-11.0	20	Very dense, brown to gray, SAND and GRAVEL, some silt. (Glacial Outwash)
11	135		11.0 / 135.0						100/4	Note: Started casing
12	134									
13	133									
14	132			GLACIAL TILL						
15	131									
16	130				57	S5	24/12	15.0-17.0	19	Very dense, gray, SILTY SAND, trace gravel, w/ weathered bedrock. (Glacial Till)
17	129		17.0 / 129.0						27	
18	128		18.0 / 128.0	WEATHERED BEDROCK					30	
19	127								19	
20	126									
21	125			BEDROCK					RQD: 33/60	Medium hard, gray, fine grained, slight weathering, moderately fractured, high angular fractures, trace horizontal drilling fractures, no cavities visible.
22	124								RQD: 55%	
					5	RC1	60/56	20.0-25.0		

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project: 661 Highland Ave
Location: Needham MA
City/State: Needham Ma

Job #: 7076
Date Started: 12-15-20
Date Finished: 12-15-20

Boring No.

MA-103

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 146.0

Casing Type/Depth (ft): HW TO 20'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
24	122			BEDROCK	9 15 7 6					
25	121		25.0 / 121.0	Bottom of borehole 25' BGS						
26	120									
27	119									
28	118									
29	117									
30	116									
31	115									
32	114									
33	113									
34	112									
35	111									
36	110									
37	109									
38	108									
39	107									
40	106									
41	105									
42	104									
43	103									
44	102									
45	101									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project:	661 Highland Ave	**Job #:**	7076
Location:	Needham MA	**Date Started:**	12-15-20
City/State:	Needham Ma	**Date Finished:**	12-15-20

Boring No.

MA-104

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 146.0

Casing Type/Depth (ft): HSA
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
			0.3 / 145.7	ASPHALT						
1	145								7	Compact, brown to dark brown, SAND and GRAVEL, some silt. (Fill)
2	144			FILL	23	S1	24/10	1.0-3.0	15	
3	143		3.0 / 143.0						8 43	
4	142									
5	141								36	Very dense, brown to light brown, SAND and GRAVEL, trace silt. (Glacial Outwash)
6	140				136	S2	24/10	5.0-7.0	100/4	
7	139									
8	138			GLACIAL OUTWASH						
9	137									
10	136								17	Very dense, brown to light brown, SAND and GRAVEL, trace silt. (Glacial Outwash)
11	135				104	S3	24/18	10.0-12.0	50 54	
12	134								49	
13	133		13.0 / 133.0							
			13.3 / 132.7	BEDROCK	100	S4	3/0	13.0-13.3	100/3	NO SAMPLE RECOVERED
14	132			Bottom of borehole 13.3' BGS						
15	131									
16	130									
17	129									
18	128									
19	127									
20	126									
21	125									
22	124									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project:	661 Highland Ave	**Job #:**	7076
Location:	Needham MA	**Date Started:**	12-10-20
City/State:	Needham Ma	**Date Finished:**	12-10-20

Boring No.

MA-105

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 162.0

Casing Type/Depth (ft): HW To 30'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
			0.5 / 161.5	ASPHALT						
1	161									
2	160				3	S1	24/6	1.0-3.0	6 2 1 3	Very loose, brown, SILTY SAND, trace gravel w/ trace ash & cinders, brick and asphalt. (Fill) Note: Started casing after sample
3	159									
4	158									
5	157			FILL						
6	156				14	S2	24/4	5.0-7.0	8 5 9 9	Compact, brown, SILTY SAND, trace to some gravel. (Fill)
7	155									
8	154									
9	153									
10	152		10.0 / 152.0							
11	151				43	S3	24/10	10.0-12.0	20 22 21 20	Dense, brown w/ green tint, SAND, trace silt and gravel. (Glacial Outwash)
12	150									
13	149									
14	148									
15	147			GLACIAL OUTWASH						
16	146				43	S4	24/10	15.0-17.0	60 29 14 14	Dense, brown, SAND and GRAVEL, trace silt. (Glacial Outwash)
17	145									
18	144									
19	143									
20	142		20.0 / 142.0							
21	141			GLACIAL TILL	127	S5	15/3	20.0-21.3	14 27 100/3	Very dense, brown, SILTY SAND, trace gravel. (Glacial Outwash) Note: Water coming up from casing smells of petroleum
22	140		22.0 / 140.0							
			23.0 / 139.0	BOULDER						

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project:	661 Highland Ave	**Job #:**	7076
Location:	Needham MA	**Date Started:**	12-10-20
City/State:	Needham Ma	**Date Finished:**	12-10-20

Boring No.

MA-105

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 162.0

Casing Type/Depth (ft): HW To 30'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
24	138									
25	137			GLACIAL TILL						
26	136				66	S6	24/10	25.0-27.0	25 52 14 13	Very dense, gray, SAND, trace gravel and silt w/ petroleum odor. (Glacial Till) Note: Layer of dense course sand between 27' and 30' ("Running sand seam") kept getting stuck in pipes, had to put more casing down.
27	135		27.0 / 135.0							
28	134			RUNNING SAND SEAM						
29	133									
30	132		30.0 / 132.0							
31	131				65	S7	24/14	30.0-32.0	31 38 27 38	Very dense, orange to light brown, SILT and fine SAND. (Glacial Till)
32	130			GLACIAL TILL						
33	129									
34	128									
35	127									
36	126				100	S8	9/3	35.0-35.8	13 100/3	Very dense, light brown, SILTY SAND, w/ trace weathered bedrock. (Glacial Till)
37	125		37.0 / 125.0							
38	124								RQD: 51/60 RQD: 85%	Gray w/ green tint, dark gray visible grains, fine to medium grained, trace quartz visible, trace horizontal drilling fractures, some high angular fractures, mild weathering, very hard.
39	123			BEDROCK	6 6 6 6 10	RC1	60/56	37.0-42.0		
40	122									
41	121									
42	120		42.0 / 120.0							
43	119			Bottom of borehole 42' BGS						
44	118									
45	117									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project: 661 Highland Ave
Location: Needham MA
City/State: Needham Ma

Job #: 7076
Date Started: 12-14-20
Date Finished: 12-14-20

Boring No. MA-106

Contractor: Seaboard
Driller/Helper: Dale/Mike
Logged By/Reviewed By: M. White
Surface Elevation (ft): 148.0

Casing Type/Depth (ft): HW TO 15'
Casing Hammer (lbs)/Drop (in): 300/24
Sampler Size/Type: 2' Split Spoon
Sampler Hammer (lbs)/Drop (in): 140/30

Groundwater Observations

Date	Depth	Elev.	Notes

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows Per 6"	Sample Description and Boring Notes
			0.3 / 147.7	ASPHALT						
1	147									
2	146				100	S1	24/2	1.0-3.0	100/5	Very dense, brown, SILTY SAND, some gravel. (Fill) Note: Large piece of gravel stuck in tip of spoon
3	145									
4	144			FILL						
5	143									
6	142				17	S2	24/10	5.0-7.0	2 9 8 9	Compact, brown to light brown, SILTY SAND. (Fill) Note: Started casing. Also hit boulder around 8' bgs, roller bit 2' into it decided to core.
7	141									
8	140		8.0 / 140.0							
9	139									
10	138			BOULDER						
11	137				2 3	RC1	18/4	10.0-11.5	RQD: 4/18 RQD: 22%	Hard, pink/brown, course grained, no weathering, no fractures, no cavities.
12	136				6					
13	135		13.0 / 135.0							
14	134									
15	133			GLACIAL TILL						
16	132				102	S3	24/12	15.0-17.0	38 43 59 76	Very dense, gray to light brown, SILTY SAND, trace gravel w/ weathered bedrock. (Glacial Till)
17	131		17.0 / 131.0							
18	130		18.0 / 130.0	WEATHERED ROCK						
19	129									
20	128			BEDROCK						
21	127				4 6	RC2	24/24	20.0-22.0	RQD: 14/24 RQD: 58%	Medium hard to hard, gray and blue, fine grained, trace horizontal drilling fractures, some angular fractures, no weathering, no cavities visible. Note: Due to a large fracture in the rock too much water was lost and was only able to core 2 feet of rock.
22	126		22.0 / 126.0							
				Bottom of borehole 22' BGS						

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:
Truck rig with auto hammer.

Weather:

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

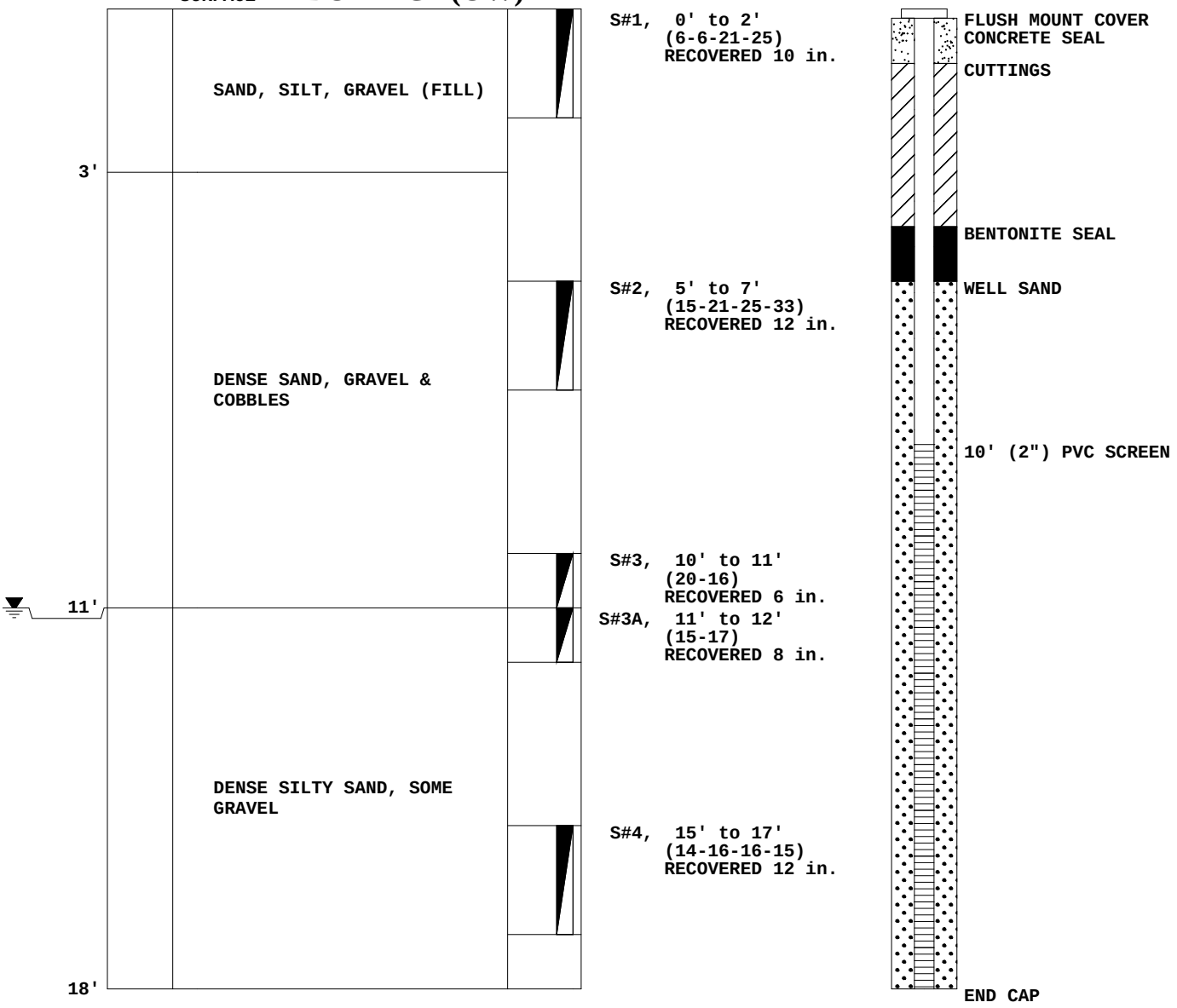
CARR-DEE CORP.

37 LINDEN STREET MEDFORD, MA 02155-0001 Telephone (781) 391-4500

To: BOSTON DEVELOPMENT GROUP, 93 UNION ST., NEWTON Date: 11-21-2019 Job No.: 2019-241

Location: 629-661 HIGHLAND AVENUE, NEEDHAM, MA Scale: 1 in.= 3 ft.

BORING 1(OW)



WATER LEVEL 11'
SIZE OF AUGERS: 3-3/4" I.D., LENGTH: 18'0"
DRILLER: S. DESIMONE, JR., INSPECTOR: D. MEEGAN
DATE STARTED & COMPLETED: 11-20-2019

All samples have been visually classified by . Unless otherwise specified, water levels noted were observed at completion of borings, and do not necessarily represent permanent ground water levels. Figures in parenthesis indicate the number of blows required to drive Two-inch Split Sampler 6 inches using 140 lb. weight falling 30 inches(±). Figures in column to left (if noted) indicate number of blows to drive casing one foot, using 300 lb. weight falling 24 inches (±).

NORTH

PUTHAM STREET
(PRIVATE - 30' WIDE)

CROSS (VARIABLE WIDTH) STREET

APPROXIMATE LIMITS OF SUBJECT PROPERTY

CROSS ST.

IRON PIPE (FOUND)

BENCHMARK "B"
MAG NAIL IT UP LIGHTPOLE#3
ELEVATION=140.43'

STONE BOUND WITH DRILL HOLE (FOUND & HELD)

B-404

B-403

B-401

B-402A

B-202B

TP-1

TP-2

TP-3

TP-4

GUILD ROAD
(PRIVATE - 40' WIDE)

GUILD ROAD
PRIVATE - 30' WIDE

ARBOR (VARIABLE WIDTH) STREET

HIGHLAND (PUBLIC - VARIABLE WIDTH) AVENUE

METAL WAREHOUSE

1 STORY BRICK BUILDING

2 STORY BRICK BUILDING

1-1/2 STORY WOOD HOUSE

ENCLOSED PORCH

PORCH

BRICK BUILDING
1 STORY FRONT
2 STORY BACK

1 STORY GARAGE/SHED

LEGEND

— APPROXIMATE LOCATION OF BORING PERFORMED BY CARR-DEE CORP. DURING THE PERIOD OF MARCH 31 THROUGH APRIL 3, 2023 FOR McPHAIL ASSOCIATES, LLC

— APPROXIMATE LOCATION OF TEST PIT PERFORMED BY GUARINO SITE AND UTILITY CONTRACTING LLC ON APRIL 7, 2023 FOR McPHAIL ASSOCIATES, LLC

REFERENCE: THIS PLAN WAS PREPARED FROM A 20-SCALE DRAWING ENTITLED, "EXISTING CONDITIONS PLAN OF LAND" DATED NOVEMBER 16, 2020 PREPARED BY VHB

GRAPHIC SCALE
20 0 20 40 80

McPHAIL ASSOCIATES, LLC
Geotechnical and Geoenvironmental Engineers
2269 Massachusetts Avenue
Cambridge, MA 02140
617/868-1420
617/868-1423 (Fax)
www.mcphailgeo.com

629 - 661 HIGHLAND AVENUE

NEEDHAM MASSACHUSETTS

SUBSURFACE EXPLORATION PLAN

FOR

BOSTON DEVELOPMENT GROUP

BY

McPHAIL ASSOCIATES, LLC

Date: APRIL 2023	Dwn: F.G.P.	Chkd: J.A.E.	Scale: 1" = 20'
Project No: 7076			FIGURE 2

FILE NAME: N:\Acad\JOBS\7076\7076-FG2rev3.dwg

Project: 629-661 Highland Avenue
Location:
City/State: Needham, MA

Job #: 7076
Date Started: 4-3-23
Date Finished: 4-3-23

Boring No. B-401

Contractor: Carr-Dee
Driller/Helper: Steve D./Frank L.
Logged By/Reviewed By: L. Espindola
Surface Elevation (ft): 136.3

Casing Type: 2.25" HSA
Casing Hammer (lbs)/Drop (in): 300lbs/24"
Sampler Size/Type: 1 3/8 ID Splitspoon
Sampler Hammer (lbs)/Drop (in): 140lbs/30"

Groundwater Observations

Date	Depth	Elev.	Notes
4-3-23	N.E.		

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value / RQD	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows/6" / Min/ft	Sample Description and Boring Notes
	136		0.3 / 136.0	ASPHALT						
1	135			FILL	8	S-1	24/10	1.0-3.0	6 4 4 7	Loose, dark brown, gravelly SAND and SILT, with brick and asphalt. (FILL)
2	134									
3	133				10	S-2	24/10	3.0-5.0	4 5 5 8	Loose to compact, brown, silty SAND, some gravel. (FILL)
4	132		5.0 / 131.3							
5	131			GLACIAL OUTWASH	73	S-3	24/12	5.0-7.0	22 32 41 64	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)
6	130									
7	129				191/11"	S-4	11/	7.0-7.9	91 100/5"	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)
8	128		8.3 / 128.0							
9	127			Bottom of borehole extends 8.3 feet below ground surface.						
10	126									
11	125									
12	124									
13	123									
14	122									
15	121									
16	120									
17	119									
18	118									
19	117									
20	116									
21	115									
22	114									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:

Weather: Clear

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project:	629-661 Highland Avenue	**Job #:**	7076
Location:		**Date Started:**	3-31-23
City/State:	Needham, MA	**Date Finished:**	3-31-23

Boring No.

B-402/B-402a

Contractor: Carr-Dee
Driller/Helper: Steve D./Frank L.
Logged By/Reviewed By: L. Espindola
Surface Elevation (ft): 145.4

Casing Type: 2.25" HSA/ 3" NW Casing
Casing Hammer (lbs)/Drop (in): 300lbs/24"
Sampler Size/Type: 1 3/8 ID Splitspoon
Sampler Hammer (lbs)/Drop (in): 140lbs/30"

Groundwater Observations

Date	Depth	Elev.	Notes
3-31-23	12.5	132.9	

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value / RQD	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows/6" / Min/ft	Sample Description and Boring Notes
	145		0.3 / 145.1	ASPHALT						
1	144				13	S-1	18/8	0.5-2.0	4 5 8	Compact, brown, SILT, SAND and GRAVEL. (FILL)
2	143				54	S-2	24/10	2.0-4.0	25 31 23 19	Very dense, gray-brown, SAND and GRAVEL, trace silt. (FILL)
3	142			FILL						
4	141				33	S-3	12/6	4.0-5.0	14 19	Dense, light gray, SAND and GRAVEL, trace silt. (FILL) NOTE: Pulverized gravel/cobbles throughout sample.
5	140				110	S-4	24/15	5.0-7.0	56 61 49 44	Very dense, light gray, GRAVEL, some sand, trace silt. (FILL) NOTE: Pulverized gravel/cobbles throughout sample.
6	139		7.0 / 138.4							
7	138				142/10"	S-5	10/7	7.0-7.8	42 100/4"	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH) NOTE: Rock in splitspoon tip. Splitspoon refusal at 7.8' and Auger refusal at 8.5'. Offset hole 6' to the northeast and augered to 9' without sampling.
8	137									
9	136			GLACIAL OUTWASH						
10	135				83	S-6	24/16	9.0-11.0	31 45 38 53	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)
11	134		11.0 / 134.4							
12	133				46	S-7	24/18	11.0-13.0	18 22 24 22	Dense, gray-brown, SILT, SAND and GRAVEL. (GLACIAL TILL) NOTE: Constant head infiltration test at 11'.
13	132			GLACIAL TILL						
14	131				31	S-8	24/14	13.0-15.0	16 15 16 14	Dense, gray-brown, SILT, SAND and GRAVEL. (GLACIAL TILL)
15	130		15.0 / 130.4							
16	129			Bottom of borehole extends 15 feet below ground surface.						
17	128									
18	127									
19	126									
20	125									
21	124									
22	123									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:

Weather: Clear

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project: 629-661 Highland Avenue
Location:
City/State: Needham, MA

Job #: 7076
Date Started: 3-31-23
Date Finished: 3-31-23

Boring No. B-403

Contractor: Carr-Dee
Driller/Helper: Steve D./Frank L.
Logged By/Reviewed By: L. Espindola
Surface Elevation (ft): 147.1

Casing Type: 2.25" HSA/ 3" NW Casing
Casing Hammer (lbs)/Drop (in): 300lbs/24"
Sampler Size/Type: 1 3/8 ID Splitspoon
Sampler Hammer (lbs)/Drop (in): 140lbs/30"

Groundwater Observations

Date	Depth	Elev.	Notes
3-31-23	12	135.1	

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value / RQD	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows/6" / Min/ft	Sample Description and Boring Notes
			0.3 / 146.8	ASPHALT						
1	146				10	S-1	24/6	1.0-3.0	7 5 5 4	Loose to compact, dark brown, silty SAND and GRAVEL, with asphalt. (FILL)
2	145			FILL						
3	144				6	S-2	24/4	3.0-5.0	4 3 3 3	Loose, dark brown, SAND and GRAVEL, some silt. (FILL)
4	143									
5	142		5.0 / 142.1		36	S-3	24/10	5.0-7.0	8 16 20 35	Dense, gray-brown, silty SAND and GRAVEL. (GLACIAL OUTWASH)
6	141									
7	140				152/10"	S-4	10/8	7.0-7.8	52 100/4"	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)
8	139									
9	138				114	S-5	18/13	8.5-10.0	10 32 82	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)
10	137			GLACIAL OUTWASH						
11	136				42	S-6	24/11	10.0-12.0	17 22 20 15	Dense, gray-brown, SAND and GRAVEL, trace to some silt. (GLACIAL OUWASH) NOTE: Constant head infiltration test at 10'.
12	135									
13	134				25	S-7	24/10	12.0-14.0	7 11 14 12	Dense, gray-brown, SAND and GRAVEL, trace to some silt. (GLACIAL OUWASH)
14	133		14.0 / 133.1							
				Bottom of borehole extends 14 feet below ground surface.						
15	132									
16	131									
17	130									
18	129									
19	128									
20	127									
21	126									
22	125									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:

Weather: Clear

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

Project: 629-661 Highland Avenue
Location:
City/State: Needham, MA

Job #: 7076
Date Started: 4-3-23
Date Finished: 4-3-23

Boring No. B-404

Contractor: Carr-Dee
Driller/Helper: Steve D./Frank L.
Logged By/Reviewed By: L. Espindola
Surface Elevation (ft): 146.3

Casing Type: 2.25" HSA/ 3" NW Casing
Casing Hammer (lbs)/Drop (in): 300lbs/24"
Sampler Size/Type: 1 3/8 ID Splitspoon
Sampler Hammer (lbs)/Drop (in): 140lbs/30"

Groundwater Observations

Date	Depth	Elev.	Notes
4-3-23	12	134.3	

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample N-Value / RQD	Sample No.	Sample Pen./Rec. (in)	Sample Depth (ft)	Sample Blows/6" / Min/ft	Sample Description and Boring Notes
0	146		0.3 / 146.0	ASPHALT						
1	145			FILL	16	S-1	24/5	1.0-3.0	16 9 7 23	Compact, dark brown, sandy SILT, some gravel, with brick and asphalt. (FILL)
2	144									
3	143				25	S-2	24/11	3.0-5.0	15 14 11 21	Compact, brown, medium to coarse SAND and GRAVEL, trace silt. (FILL)
4	142									
5	141		5.0 / 141.3	GLACIAL OUTWASH	127/8"	S-3	20/8	5.0-6.7	14 23 27 100/2"	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)
6	140									
7	139									
8	138				86	S-4	24/16	8.0-10.0	25 34 52 61	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH) NOTE: Constant head infiltration test at 8'
9	137									
10	136				100/4"	S-5	4/4	10.0-10.3	100/4"	Very dense, gray-brown, sandy GRAVEL, trace to some silt. (GLACIAL OUTWASH) NOTE: Constant head infiltration test at 10'. Infiltration test potentially influenced by obstruction encountered at 10'.
11	135		12.0 / 134.3							
12	134			GLACIAL TILL	77	S-6	21/16	12.0-13.8	57 41 36 100/3"	Very dense, gray-brown, silty SAND and GRAVEL (GLACIAL TILL)
13	133		13.8 / 132.5							
14	132			Bottom of borehole extends 13.8 feet below ground surface.						
15	131									
16	130									
17	129									
18	128									
19	127									
20	126									
21	125									
22	124									

GRANULAR SOILS	
BLOWS/FT.	DENSITY
0-4	V.LOOSE
4-10	LOOSE
10-30	COMPACT
30-50	DENSE
>50	V.DENSE

COHESIVE SOILS	
BLOWS/FT.	CONSISTENCY
<2	V.SOFT
2-4	SOFT
4-8	FIRM
8-15	STIFF
15-30	V.STIFF
>30	HARD

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Notes:

Weather: Clear

McPHAIL ASSOCIATES, LLC
2269 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02140
TEL: 617-868-1420
FAX: 617-868-1423

TEST PIT LOG

JOB NO. 7076
DATE APRIL 7, 2023

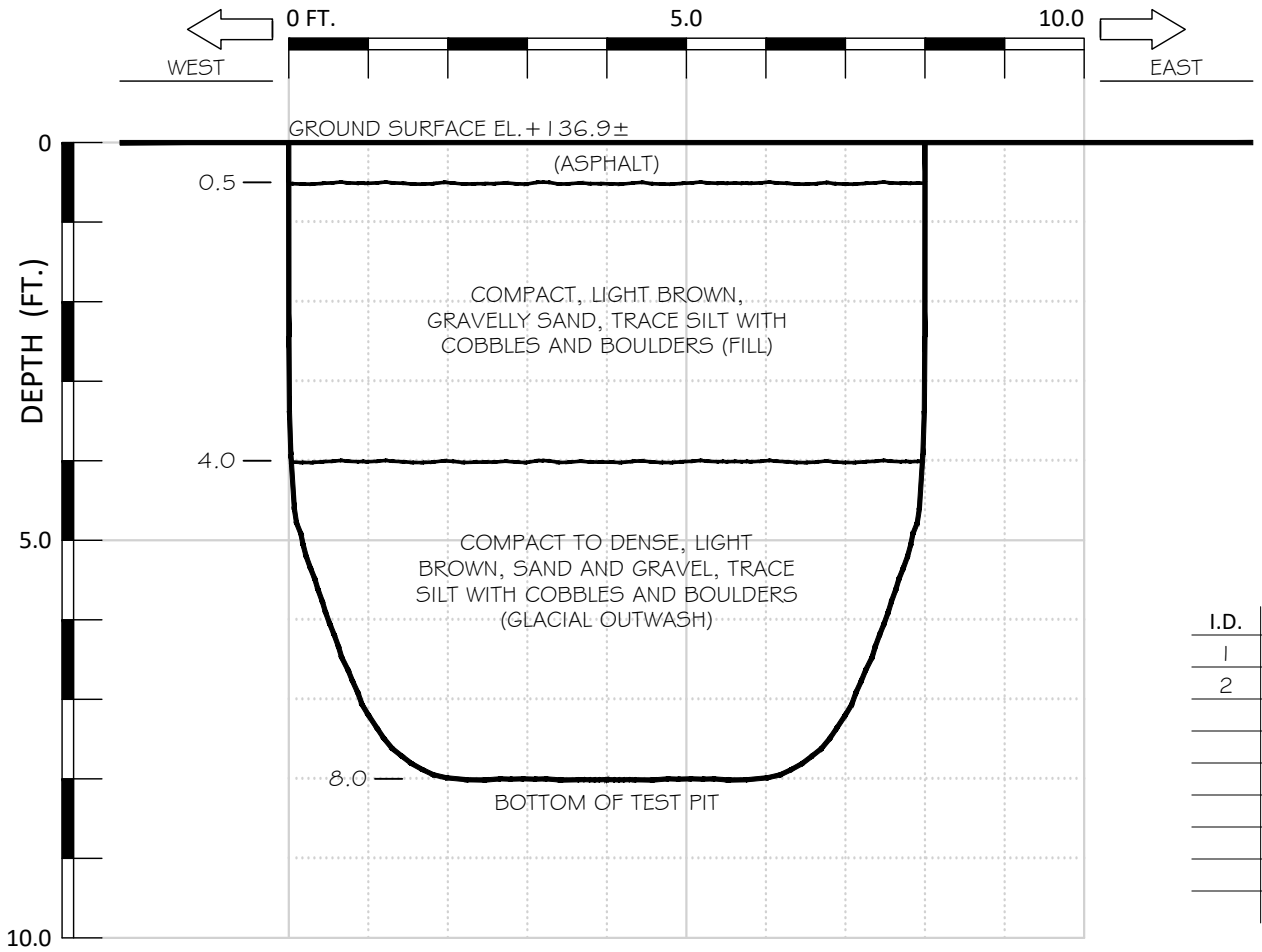
TEST PIT NO. 1

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

EXCAVATOR MAKE: CAT
EXCAVATOR MODEL: 304E

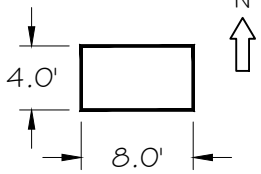
DEPTH TO GROUNDWATER: N.E.
FLOW: ☐ STANDING WATER ☐ TRICKLING ☐ HIGH FLOW



SAMPLES OBTAINED

I.D.	STRATA	DEPTH (FT)	PID (ppm)
1	FILL	0.5-4.0	
2	GLACIAL OUTWASH	4.0-8.0	

TEST PIT PLAN



COBBLES/BOULDERS — INDICATE COUNT OR % BY VOLUME (i.e. 10-20%)

STRATA	FILL	GLACIAL OUTWASH
COBBLES (2"-8")	35-40%	15-20%
SMALL BOULDER (8"-24")	5-10%	5-10%
LARGE BOULDER (>24")	5-10%	0-5%

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

TEST PIT LOG

JOB NO. 7076
DATE APRIL 7, 2023

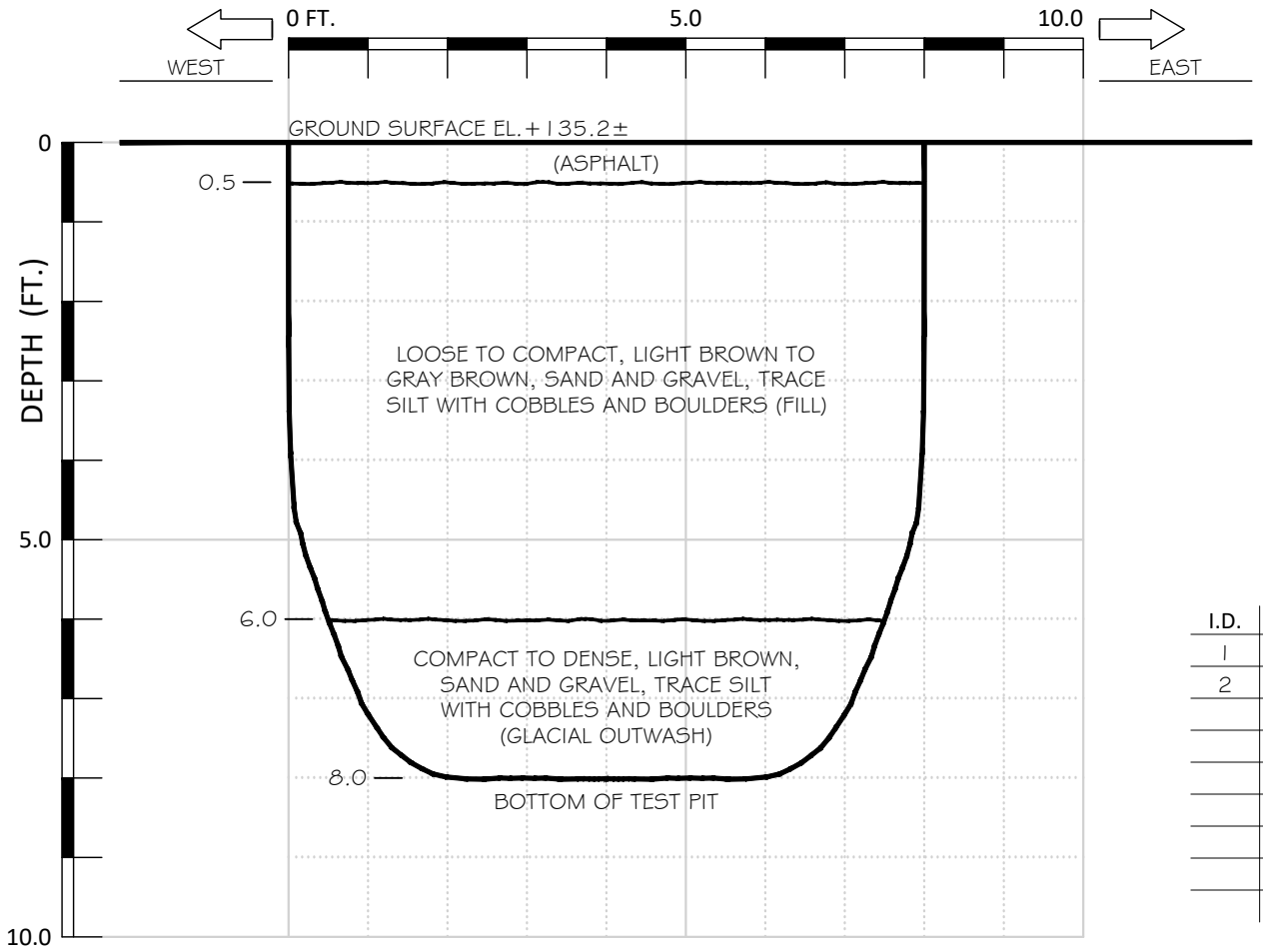
TEST PIT NO. 2

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

EXCAVATOR MAKE: CAT
EXCAVATOR MODEL: 304E

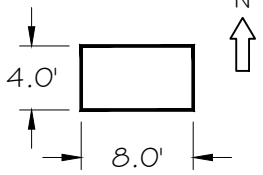
DEPTH TO GROUNDWATER: 7.0'
FLOW: ☐ STANDING WATER ☐ TRICKLING ☒ HIGH FLOW



SAMPLES OBTAINED

I.D.	STRATA	DEPTH (FT)	PID (ppm)
1	FILL	0.5-6.0	
2	GLACIAL OUTWASH	6.0-8.0	

TEST PIT PLAN



COBBLES/BOULDERS — INDICATE COUNT OR % BY VOLUME (i.e. 10-20%)

STRATA	FILL	GLACIAL OUTWASH
COBBLES (2"-8")	35-40%	15-20%
SMALL BOULDER (8"-24")	0-5%	5-10%
LARGE BOULDER (>24")	0-5%	0-5%

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

TEST PIT LOG

JOB NO. 7076
DATE APRIL 7, 2023

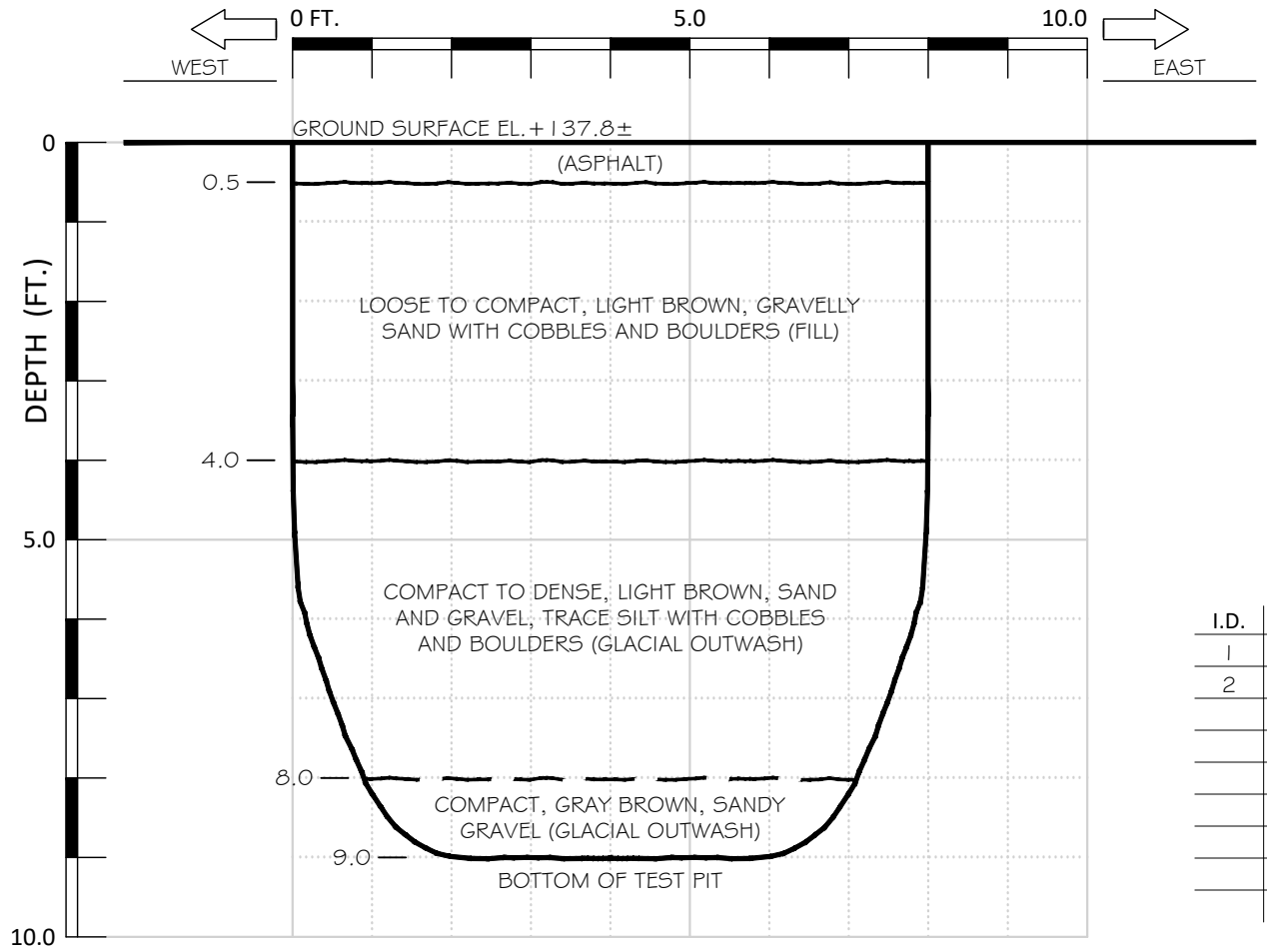
TEST PIT NO. 3

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

EXCAVATOR MAKE: CAT
EXCAVATOR MODEL: 304E

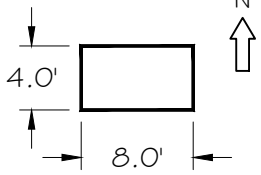
DEPTH TO GROUNDWATER: 9.0'
FLOW: ☐ STANDING WATER ☒ TRICKLING ☐ HIGH FLOW



SAMPLES OBTAINED

I.D.	STRATA	DEPTH (FT)	PID (ppm)
1	FILL	0.5-4.0	
2	GLACIAL OUTWASH	4.0-9.0	

TEST PIT PLAN



COBBLES/BOULDERS — INDICATE COUNT OR % BY VOLUME (i.e. 10-20%)

STRATA	FILL	GLACIAL OUTWASH
COBBLES (2"-8")	25-30%	20-25%
SMALL BOULDER (8"-24")	10-15%	10-15%
LARGE BOULDER (>24")	5-10%	5-10%

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

TEST PIT LOG

JOB NO. 7076
DATE APRIL 7, 2023

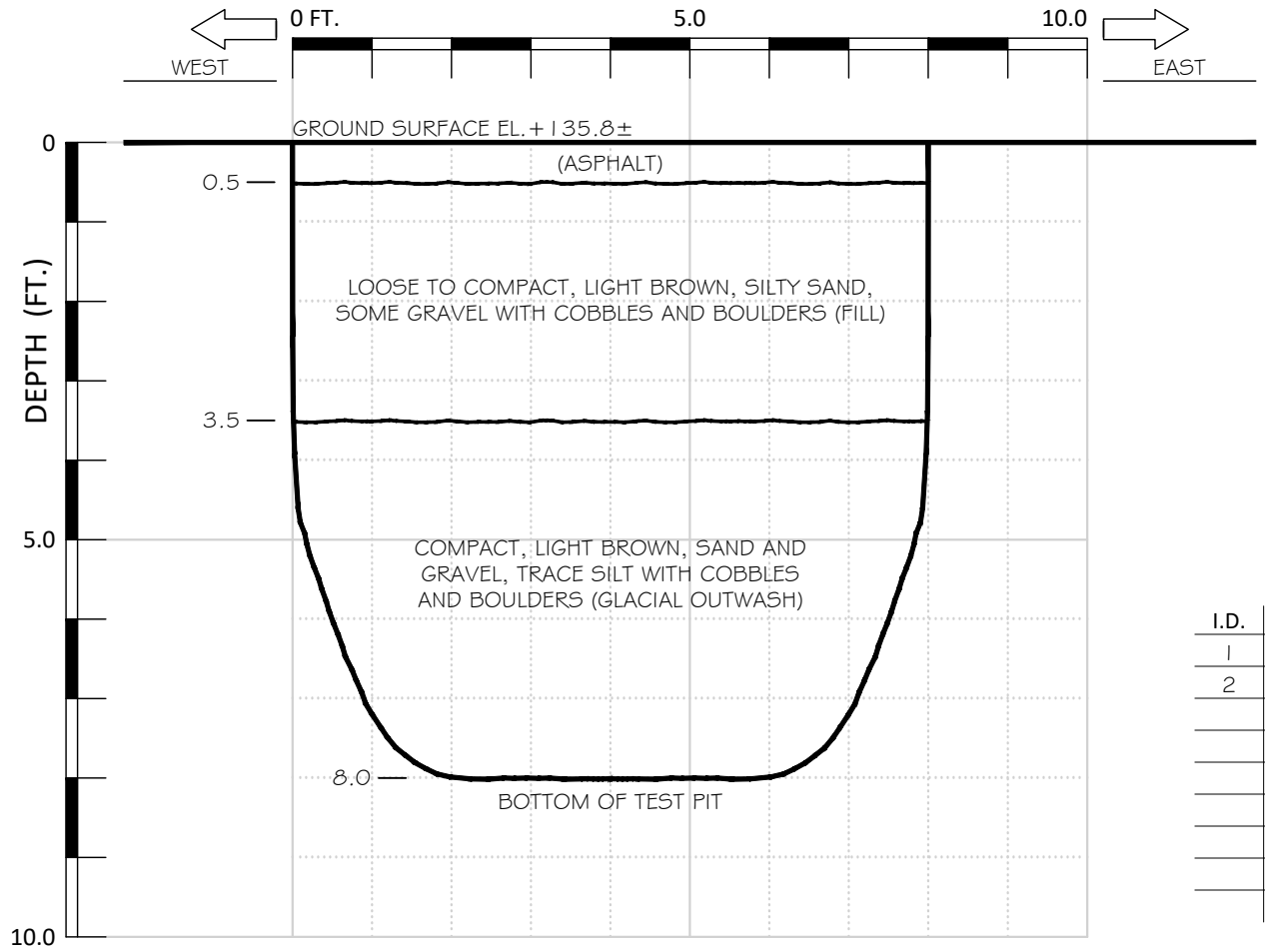
TEST PIT NO. 4

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

EXCAVATOR MAKE: CAT
EXCAVATOR MODEL: 304E

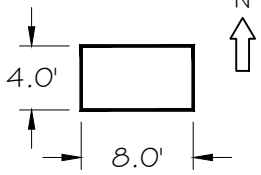
DEPTH TO GROUNDWATER: 8.0'
FLOW: ☐ STANDING WATER ☒ TRICKLING ☐ HIGH FLOW



SAMPLES OBTAINED

I.D.	STRATA	DEPTH (FT)	PID (ppm)
1	FILL	0.5-3.5	
2	GLACIAL OUTWASH	3.5-8.0	

TEST PIT PLAN



COBBLES/BOULDERS — INDICATE COUNT OR % BY VOLUME (i.e. 10-20%)

STRATA	FILL	GLACIAL OUTWASH
COBBLES (2"-8")	10-15%	30-40%
SMALL BOULDER (8"-24")	0-5%	5-10%
LARGE BOULDER (>24")	0-5%	0-5%

SOIL COMPONENT

DESCRIPTIVE TERM	PROPORTION OF TOTAL
"TRACE"	0-10%
"SOME"	10-20%
"ADJECTIVE" (eg SANDY, SILTY)	20-35%
"AND"	35-50%

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

Required and Provided Recharge Volumes

Recharge Calculations

Project	Highland Ave MOB	**Project #**	14781.00
Calculated by	SRK	**Date**	August 2023
Checked by	JWM	**Date**	August 2023

REQUIRED RECHARGE VOLUME

Hydrologic Soil Group (HSG)	Net Increase (ft^2)	Inches of Runoff (in)	Volume (ft^3)
A	13,600	0.60	680
B	0	0.35	0
C	0	0.25	0
D	0	0.10	0
TOTAL			**680**
	Existing Onsite Recharge Volume (ft^3):		7,270
	Total Required Recharge Volume:		**7,950**

PROVIDED RECHARGE VOLUME

BASIN P-1.1:

Stormtech SC-740

No outlet proposed. Volume provided below surface elevation of 138.0.

Provided Volume:		**Bottom Area (ft^2)**	**Volume (ft^3)**
		2,196	**4,571**

Drawdown:	$(V_{Infiltration}/A_{Bottom})$/Recharge Rate		
	Recharge Rate:	1.02	(in/hr)
	Drawdown Time:	**24**	(hours)

BASIN P-2.1:

StormTrap ST-2

No outlet proposed. Volume provided below surface elevation of 138.5.

Provided Volume:		**Bottom Area (ft^2)**	**Volume (ft^3)**
		7,258	**16,855**

Drawdown:	$(V_{Infiltration}/A_{Bottom})$/Rawl's Rate		
	Rawls Recharge Rate:	1.02	(in/hr)
	Drawdown Time:	**27**	(hours)

Recharge Calculations

Project	Highland Ave MOB	**Project #**	14781.00
Calculated by	SRK	**Date**	August 2023
Checked by	JWM	**Date**	August 2023

BASIN P-3.1

Permeable Pavers at Patio

No outlet proposed. Volume provided below surface elevation of 152.0

Provided Volume:	**Bottom Area (ft^2)**	**Volume (ft^3)**
	2,500	**1,464**

Drawdown: $(V_{Infiltration}/A_{Bottom})$/Rawl's Rate

Rawls Recharge Rate:	1.02	(in/hr)
Drawdown Time:	7	(hours)

RECHARGE VOLUME SUMMARY

Total Required Recharge Volume:	**7,950**	**(ft^3)**
Total Recharge Volume Provided:	**22,890**	**(ft^3)**

Mounding Analysis

The following analyses demonstrate that the “mound” of water formed by the proposed infiltration systems above the estimated seasonal high groundwater (ESHGW) will adequately disperse within 72 hours of a storm event to a point that detained stormwater will no longer remain within the footprints of the systems. The analysis was performed using the Hantush Method adopted by the U.S. Geological Survey and were modeled using AQTESOLV aquifer analysis software.

101 Walnut Street
Watertown, MA 02472
P 617.924.1770

Mounding Analysis - Infiltration Basin 1.1: Stormtech

Project:	Highland Ave MOB Needham, MA	**Project #:**	14781.00
Calculated by:	PTM	**Date:**	August 2023
Checked by:		**Date:**	

In accordance with MassDEP Stormwater Management Standards, mounding analysis is required for the proposed stormwater infiltration system 1.1, Stormtech, as the bottom of the system, 133.0, is within 4 feet of estimated seasonal high groundwater (ESHGW), 130.6, and the system is used to attenuate the peak discharge rates for the 10-year and larger storms. The mounding analysis was performed using the Hantush method and calculation of the equation variables is included below.

Horizontal Hydraulic Conductivity (K)

Assumed to be 10x greater than the horizontal hydraulic conductivity (Rawl's Rate).

Rawl's	1.02	IN/HR
K	10.2	IN/HR
	20.4	**FT/DAY**

Specific Yield (ε)

From Table 4.2 Values of Specific Yield for Various Geologic Materials, Physical and Chemical Hydrogeology by Patrick A. Domerico and Franklin W. Schwartz. Sand, medium.

Sy	**28**	**%**

Initial Saturated Thickness (h_i)

Estimated seasonal high groundwater (ESHGW) is 130.6 in the vicinity of the infiltration system 1.1. Bottom of Test Pit TP-2 is 127.2, which is assumed to be the bottom of the aquifer.

ESHGW	ESHGW	130.6	FT
Bottom of Aquifer		127.2	FT
hi	ESHGW - Elevation at Bottom of Aquifer		FT
hi		**3.4**	**FT**

Recharge Area Dimensions (A/B)

The stormwater recharge area consists of 50 StormTech SC-740 subsurface infiltration chambers. The system footprint is modeled as 139.43 feet long by 15.75 feet wide.

A	**139.43**	**FT**
B	**15.75**	**FT**

Recharge Rate (w)

The recharge rate is the runoff volume over the recharge bottom area. For this calculation, the runoff volume for the 10-year, 24-hour storm event was used.

Volume	4,852	CF/DAY
Area	2,196	SF
w	Volume/Area	FT/DAY
w	**2.21**	**FT/DAY**

Time (t)

Per MassDEP Stormwater Management Standards, infiltration system must be fully dewatered (the maximum height of the mound below the bottom of system) within 72 hours (3 days).

t	3	**DAYS**

Below, the inputs for the mounding analysis are shown for the software using the Hantush method, provided by AQTSOLV. The results are included on the following page. As shown, the maximum height of the mound at 72 hours is 1.2 feet above ESHGW, or elevation 131.8. This is below the bottom of the infiltration system at 133.0.

```
Transient Water-Table Rise Beneath a Rectangular Recharge Area
Groundwater Mounding Solution by Hantush (1967)

Aquifer Properties:
        Hydraulic conductivity, K = 20.4 ft/day
        Specific yield, Sy = 0.28
        Initial saturated thickness, h(0) = 3.4 ft

Recharge Area Properties:
        Recharge rate, w = 2.21 ft/day
        Simulation time, t = 3 day
        Time when recharge stops, t(0) = 1 day
        X coordinate at center of recharge area, X = 69.71 ft
        Y coordinate at center of recharge area, Y = 7.88 ft
        Length in x direction, l = 139.43 ft
        Length in y direction, a = 15.75 ft

Water-Table Rise at Center of Recharge Area:
        t (day) h (ft)
        ------- ------
        0.3     1.52227
        0.6     2.32044
        0.9     2.90216
        1.2     2.40159
        1.5     1.97885
        1.8     1.7291
        2.1     1.55134
        2.4     1.4137
        2.7     1.30201
        3       1.20864
        Note: recovery begins after 1 day.

----------
Report generated by AQTESOLV v4.50.002 (www.aqtesolv.com) on 08/02/23 at 08:06:34.
AQTESOLV for Windows (c) 1996-2007 HydroSOLVE, Inc.  All Rights Reserved.
```

101 Walnut Street
Watertown, MA 02472
P 617.924.1770

Mounding Analysis - Infiltration System 2.1: StormTrap

Project:	Highland Ave MOB Needham, MA	**Project #:**	14781.00
Calculated by:	PTM	**Date:**	August 2023
Checked by:		**Date:**	

In accordance with MassDEP Stormwater Management Standards, mounding analysis is required for the proposed stormwater infiltration system 2.1, StromTrap, as the bottom of the system, 133.0, is within 4 feet of estimated seasonal high groundwater (ESHGW), 130.6, and the system is used to attenuate the peak discharge rates for the 10-year and larger storms. The mounding analysis was performed using the Hantush method and calculation of the equation variables is included below.

Horizontal Hydraulic Conductivity (K)

Assumed to be 10x greater than the horizontal hydraulic conductivity (Rawl's Rate).

Rawl's	1.02	IN/HR
K	10.2	IN/HR
	20.4	**FT/DAY**

Specific Yield (ε)

From Table 4.2 Values of Specific Yield for Various Geologic Materials, Physical and Chemical Hydrogeology by Patrick A. Domerico and Franklin W. Schwartz. Sand, medium.

Sy	**28**	**%**

Initial Saturated Thickness (h_i)

Estimated seasonal high groundwater (ESHGW) is 130.6 in the vicinity of the infiltration system C-F. Bottom of Test Pit, TP-4, is 127.8, which is assumed to be the bottom of the aquifer.

ESHGW	ESHGW	130.6	FT
Bottom of Aquifer		127.8	FT
hi	ESHGW - Elevation at Bottom of Aquifer		FT
hi		**2.8**	**FT**

Recharge Area Dimensions (A/B)

The stormwater recharge area consists of 4 connected Stormtrap ST2 Single Trap subsurface infiltration systems that were modeled as one single system. The system footprint is modeled as 333.09 feet long by 21.79 feet wide.

A	**333.09**	**FT**
B	**21.79**	**FT**

Recharge Rate (w)

The recharge rate is the runoff volume over the recharge bottom area. For this calculation, the runoff volume for the 10-year, 24-hour storm event was used.

Volume	18,857	CF/DAY
Area	7,258	SF
w	Volume/Area	FT/DAY
w	**2.60**	**FT/DAY**

Time (t)

Per MassDEP Stormwater Management Standards, infiltration system must be fully dewatered (the maximum height of the mound below the bottom of system) within 72 hours (3 days).

t	3	**DAYS**

Below, the inputs for the mounding analysis are shown for the software using the Hantush method, provided by AQTSOLV. The results are included on the following page. As shown, the maximum height of the mound at 72 hours is 2.1 feet above ESHGW, or elevation 132.7. This is below the bottom of the infiltration system at 133.0.

```
Transient Water-Table Rise Beneath a Rectangular Recharge Area
Groundwater Mounding Solution by Hantush (1967)

Aquifer Properties:
        Hydraulic conductivity, K = 20.4 ft/day
        Specific yield, Sy = 0.28
        Initial saturated thickness, h(0) = 2.8 ft

Recharge Area Properties:
        Recharge rate, w = 2.6 ft/day
        Simulation time, t = 3 day
        Time when recharge stops, t(0) = 1 day
        X coordinate at center of recharge area, X = 166.54 ft
        Y coordinate at center of recharge area, Y = 10.9 ft
        Length in x direction, l = 333.09 ft
        Length in y direction, a = 21.79 ft

Water-Table Rise at Center of Recharge Area:
        t (day) h (ft)
        ------- ------
        0.3     2.18677
        0.6     3.43957
        0.9     4.34036
        1.2     3.78153
        1.5     3.18871
        1.8     2.83604
        2.1     2.58931
        2.4     2.40238
        2.7     2.25369
        3       2.13136
        Note: recovery begins after 1 day.

----------
Report generated by AQTESOLV v4.50.002 (www.aqtesolv.com) on 08/02/23 at 09:50:46.
AQTESOLV for Windows (c) 1996-2007 HydroSOLVE, Inc.  All Rights Reserved.
```

Appendix C: Standard 4 Computations and Supporting Information

- Water Quality Volume Calculations
- TSS Removal Worksheets
- Total Phosphorus Removal Worksheet

Note: Long-Term Pollution Prevention Plan included in Appendix E

Water Quality Volume Calculations

Water Quality Volume Calculations

Project Name: Highland Ave MOB **Proj. No.:** 14781.00

Date: August 2023

Project Location: Needham, MA **Calculated by:** SRK

Subcatchment PR-1: Stormtech System P-1.1 Impervious Area= 13,680 s.f.

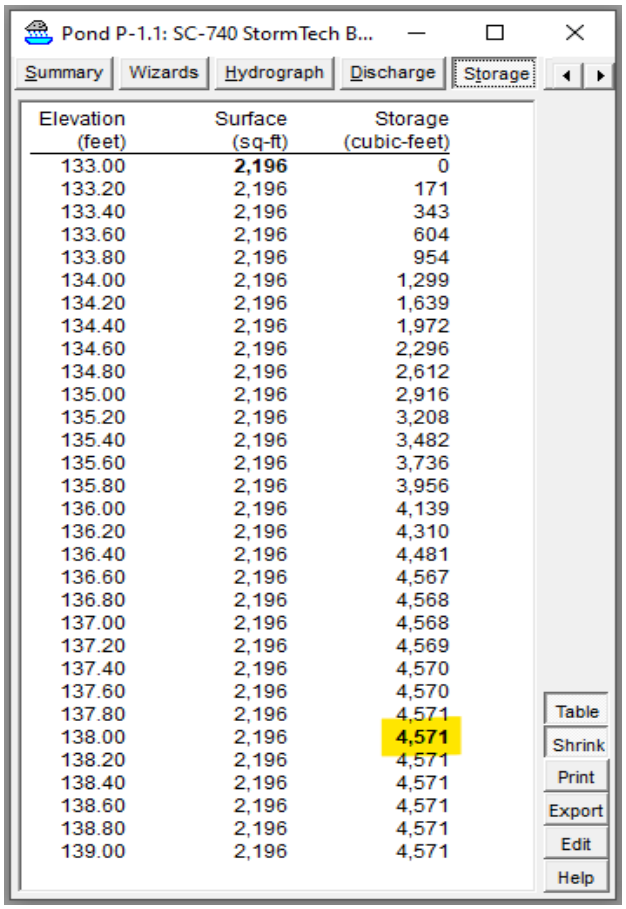
Required:

	Runoff Depth to be Treated (in.)	Required Volume
Water Quality Volume:	1.0	**1,140 cf**

Provided:

Chamber Storage **4,571 cf** No outlet provided. Volume indicates storage below surface.

Volume Calculations



Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
133.00	**2,196**	0
133.20	2,196	171
133.40	2,196	343
133.60	2,196	604
133.80	2,196	954
134.00	2,196	1,299
134.20	2,196	1,639
134.40	2,196	1,972
134.60	2,196	2,296
134.80	2,196	2,612
135.00	2,196	2,916
135.20	2,196	3,208
135.40	2,196	3,482
135.60	2,196	3,736
135.80	2,196	3,956
136.00	2,196	4,139
136.20	2,196	4,310
136.40	2,196	4,481
136.60	2,196	4,567
136.80	2,196	4,568
137.00	2,196	4,568
137.20	2,196	4,569
137.40	2,196	4,570
137.60	2,196	4,570
137.80	2,196	4,571
138.00	2,196	**4,571**
138.20	2,196	4,571
138.40	2,196	4,571
138.60	2,196	4,571
138.80	2,196	4,571
139.00	2,196	4,571

Water Quality Volume Calculations

Project Name: Highland Ave MOB **Proj. No.:** 14781.00

Date: August 2023

Project Location: Needham, MA **Calculated by:** SRK

Subcatchment PR-2 - StormTrap System P-2.1 Impervious Area= 49,843 s.f.

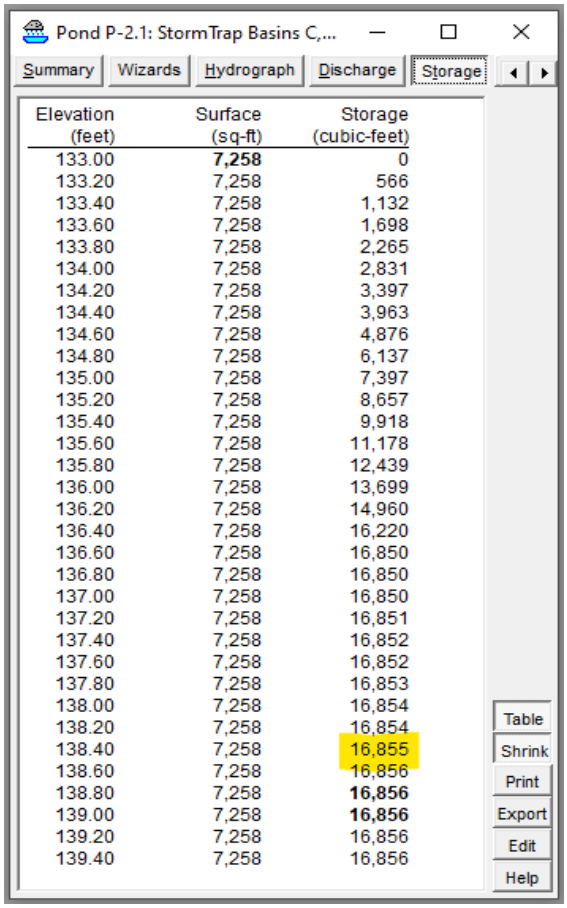
Required:

	Runoff Depth to be Treated (in.)	Required Volume
Water Quality Volume:	1.0	**4,154 cf**

Provided:

Chamber Storage **16,855 cf** No outlet provided. Volume indicates storage below surface.

Volume Calculations



Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
133.00	**7,258**	0
133.20	7,258	566
133.40	7,258	1,132
133.60	7,258	1,698
133.80	7,258	2,265
134.00	7,258	2,831
134.20	7,258	3,397
134.40	7,258	3,963
134.60	7,258	4,876
134.80	7,258	6,137
135.00	7,258	7,397
135.20	7,258	8,657
135.40	7,258	9,918
135.60	7,258	11,178
135.80	7,258	12,439
136.00	7,258	13,699
136.20	7,258	14,960
136.40	7,258	16,220
136.60	7,258	16,850
136.80	7,258	16,850
137.00	7,258	16,850
137.20	7,258	16,851
137.40	7,258	16,852
137.60	7,258	16,852
137.80	7,258	16,853
138.00	7,258	16,854
138.20	7,258	16,854
138.40	7,258	16,855
138.60	7,258	16,856
138.80	7,258	**16,856**
139.00	7,258	**16,856**
139.20	7,258	16,856
139.40	7,258	16,856

Water Quality Volume Calculations

Project Name: Highland Ave MOB **Proj. No.:** 14781.00

Date: August 2023

Project Location: Needham, MA **Calculated by:** SRK

Subcatchment PR-2B - Permeable Patio Impervious Area= 2,500 s.f.

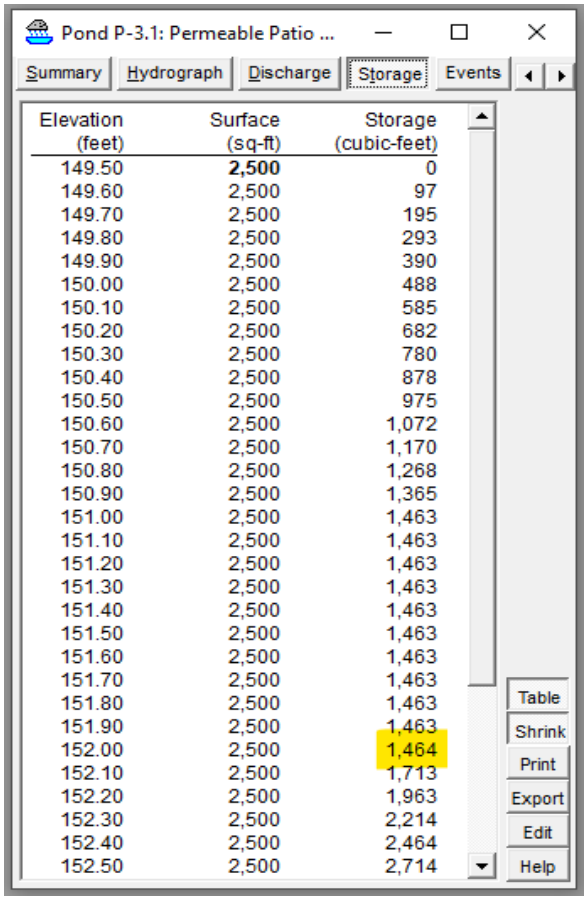
Required:

	Runoff Depth to be Treated (in.)	Required Volume
Water Quality Volume:	1.0	**208 cf**

Provided:

Chamber Storage **1,464 cf** No outlet provided. Volume indicates storage below surface.

Volume Calculations



Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
149.50	**2,500**	0
149.60	2,500	97
149.70	2,500	195
149.80	2,500	293
149.90	2,500	390
150.00	2,500	488
150.10	2,500	585
150.20	2,500	682
150.30	2,500	780
150.40	2,500	878
150.50	2,500	975
150.60	2,500	1,072
150.70	2,500	1,170
150.80	2,500	1,268
150.90	2,500	1,365
151.00	2,500	1,463
151.10	2,500	1,463
151.20	2,500	1,463
151.30	2,500	1,463
151.40	2,500	1,463
151.50	2,500	1,463
151.60	2,500	1,463
151.70	2,500	1,463
151.80	2,500	1,463
151.90	2,500	1,463
152.00	2,500	1,464
152.10	2,500	1,713
152.20	2,500	1,963
152.30	2,500	2,214
152.40	2,500	2,464
152.50	2,500	2,714

TSS Removal Worksheets

TSS Removal Calculation Worksheet

101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**Medical Office Building**	Sheet:	**1 of 3**
Project Number:	**14781.00**	Date:	
Location:	**629-659 Highland Ave, Needl**	Computed by:	**CJM**
Discharge Point:	**DP-1**	Checked by:	**SRK**
Drainage Area(s):	**PR-1**		

1. Pre-Treatment prior to Infiltration

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Water Quality Unit	**50%**	**100%**	**50%**	**50%**
Isolator Row	**80%**	**50%**	**40%**	**10%**

Pre-Treatment TSS Removal = **90%**

2. Total TSS Removal including Pretreatment 1.

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Water Quality Unit	**50%**	**100%**	**50%**	**50%**
Isolator Row	**80%**	**50%**	**40%**	**10%**
Infiltration Basin	**80%**	**10%**	**8%**	**2%**

* 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)

Treatment Train TSS Removal = **98%**

TSS Removal Calculation Worksheet

101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**Medical Office Building**	Sheet:	**2 of 3**
Project Number:	**14781.00**	Date:	
Location:	**629-659 Highland Ave, Needl**	Computed by:	**CJM**
Discharge Point:	**DP-1**	Checked by:	**SRK**
Drainage Area(s):	**PR-2**		

1. Pre-Treatment prior to Infiltration

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Water Quality Unit	**50%**	**100%**	**50%**	**50%**
			Pre-Treatment TSS Removal =	**50%**

2. Total TSS Removal including Pretreatment 1.

BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Water Quality Unit	**50%**	**100%**	**50%**	**50%**
Infiltration Basin	**80%**	**50%**	**40%**	**10%**

* 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)

Treatment Train TSS Removal = **90%**

TSS Removal Calculation Worksheet

VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**Medical Office Building**	Sheet:	**3 of 3**
Project Number:	**14781.00**	Date:	
Location:	**629 Highland Ave, Needham,**	Computed by:	**CJM**
Discharge Point:	**P-2.1**	Checked by:	**SRK**
Drainage Area(s):	**PR-3**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D E)
Porous Pavement	**80%**	**1.00**	**0.80**	**0.20**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.

** Equals remaining load from previous BMP (E)

Treatment Train TSS Removal = **80%**

Total Phosphorus Removal Worksheet

101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Phosphorus Removal Calculation Worksheet

Project Name: **Highland Ave MOB**
Project Number: **14781.00**
Location: **Needham, MA**

Sheet: **1 of 1**
Date: **August 2023**
Computed by: **JWM**

Proposed Total Phosphorus (TP) Annual Load - Onsite (Areas PR-1, PR-2, & PR-3)			
Land Use	**Area (ac)**	**TP Load Export Rate (lb/acre/year) [1]**	**TP Annual Load (lbs/year)**
Impervious - Com/Ind	1.52	1.78	2.70
Pervious - Dev. Land	0.54	0.21	0.11
Total:	**2.06**		**2.81**

Removal Percentage Calculation					
Catchment Delineation	**Total Area (ac)**	**Static Volume Below Lowest Outlet (cf)**	**Effective Rainfall Depth (volume/area)**	**Infiltration Rate (in/hr)**	**TP Load Reduction Rate**
Infiltration Basin P-1.1	0.49	4,571	2.54	1.02	99% (2)
Infiltration Basin P-2.1	1.50	16,855	3.09	1.02	99% (2)
Infiltration Basin P-3.1	0.06	1,464	7.03	1.02	99% (2)

Proposed Total Phosphorus (TP) Annual Load Reduction				
Catchment	**Area (ac)**	**TP Load Export Rate (lb/acre/year)[1]**	**BMP Cumulative TP Load Reduction Rate**	**TP Load Reduction (lb/acre/year)**
PR-1 - Impervious (to INF P-1.1)	0.31	1.78	99%	0.55
PR-1 - Pervious (to INF P-1.1)	0.18	0.21	99%	0.04
PR-2.1 - Impervious (to INF P-2.1)	1.14	1.78	99%	2.02
PR-2.1 - Pervious (to INF P-2.1)	0.36	0.21	99%	0.07
PR-3.1 - Impervious (to INF P-3.1)	0.06	1.78	99%	0.10
PR-3.1 - Pervious (to INF P-3.1)	0.00	0.21	99%	0.00
Total:	**2.06**			**2.78**

TP Annual Load Reduction from Proposed Condition (removal/load):	**99.0%**

References

[1] MS4 General Permit - Appendix F, Table 2-1 (Page 2, Attachment 2)

[2] MS4 General Permit - Appendix F, Table 3-9 (Page 44, Attachment 3) - Infiltration Trench BMP (IR=1.02 in/hr)
> 2" effective depth = 100% removal of TP

Table 3- 9: Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table

Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table: Long-Term Phosphorus & Nitrogen Load Reduction								
BMP Capacity: Depth of Runoff from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	26.3%	44.6%	68.2%	81.0%	88.0%	92.1%	96.5%	98.3%
Cumulative Phosphorus Load Reduction	27%	47%	73%	86%	92%	96%	99%	100%
Cumulative Nitrogen Load Reduction	61%	78%	92%	97%	98%	99%	100%	100%

Figure 3- 4: BMP Performance Curve: Infiltration Trench (infiltration rate = 1.02 in/hr)

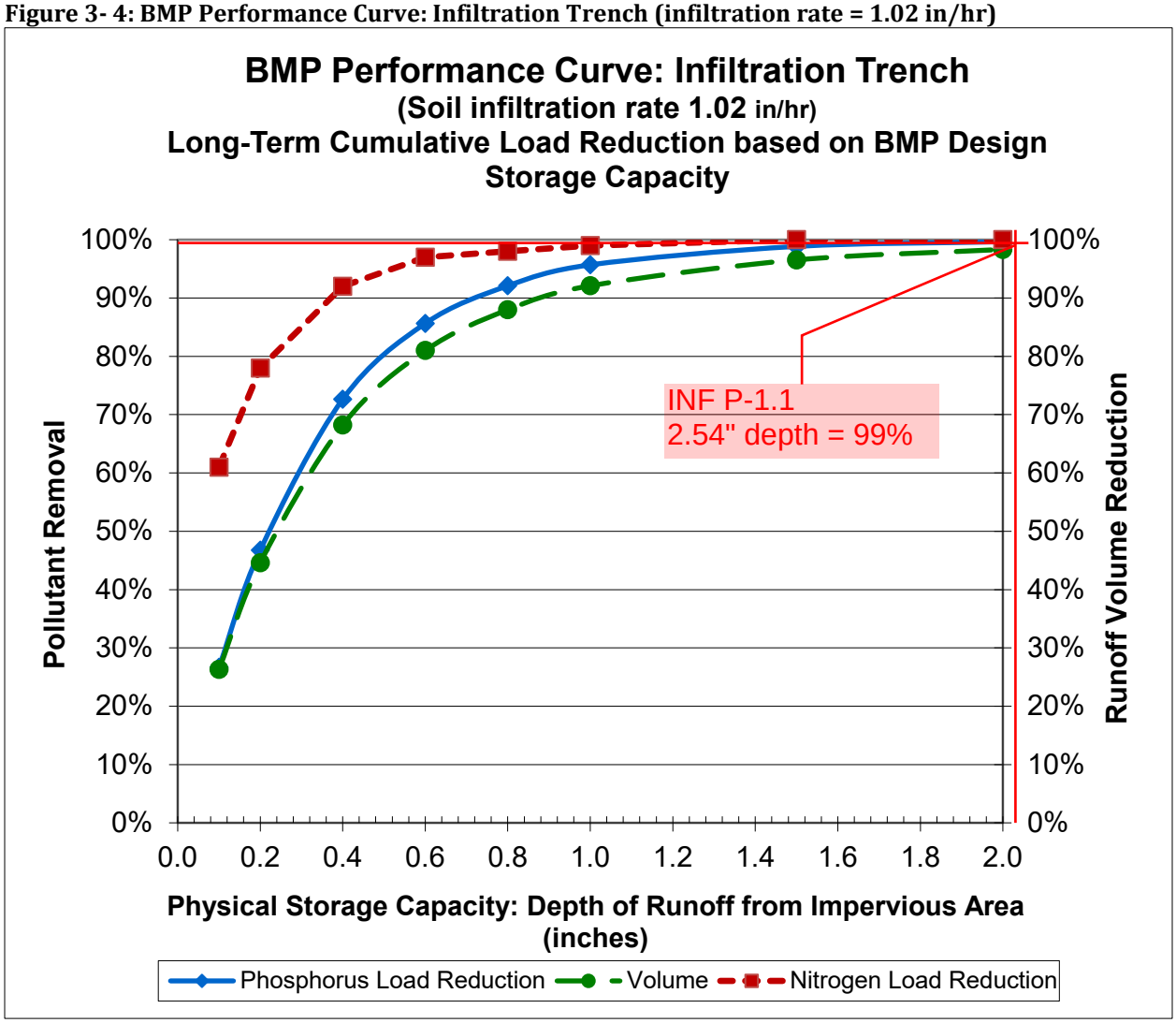


Table 3- 10: Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table

Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	34%	55%	78%	88%	93%	96%	99%	100%
Cumulative Phosphorus Load Reduction	33%	55%	81%	91%	96%	98%	100%	100%
Cumulative Nitrogen Load Reduction	65%	83%	95%	98%	99%	100%	100%	100%

Figure 3- 5: BMP Performance Curve: Infiltration Trench (infiltration rate = 2.41 in/hr)

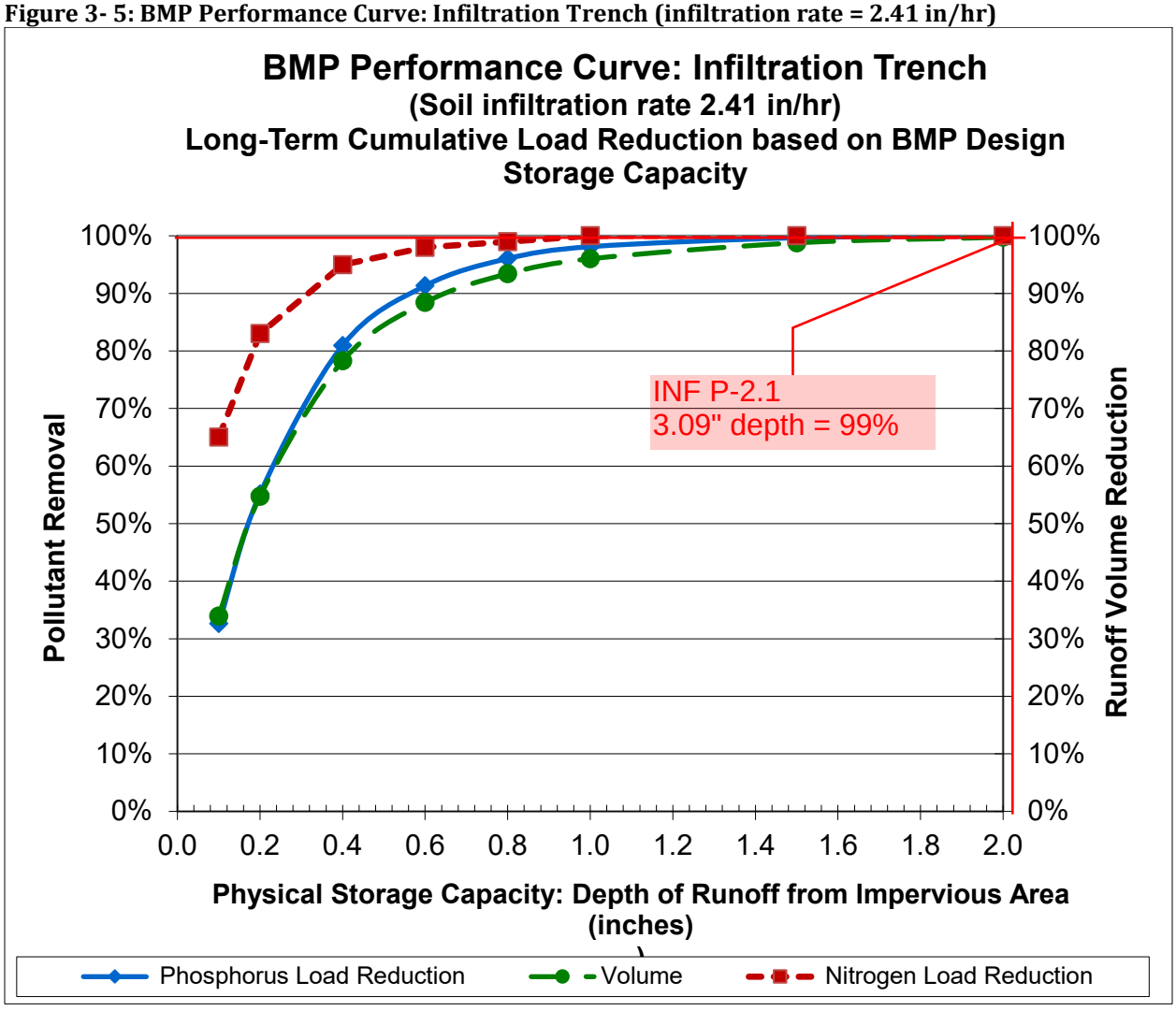
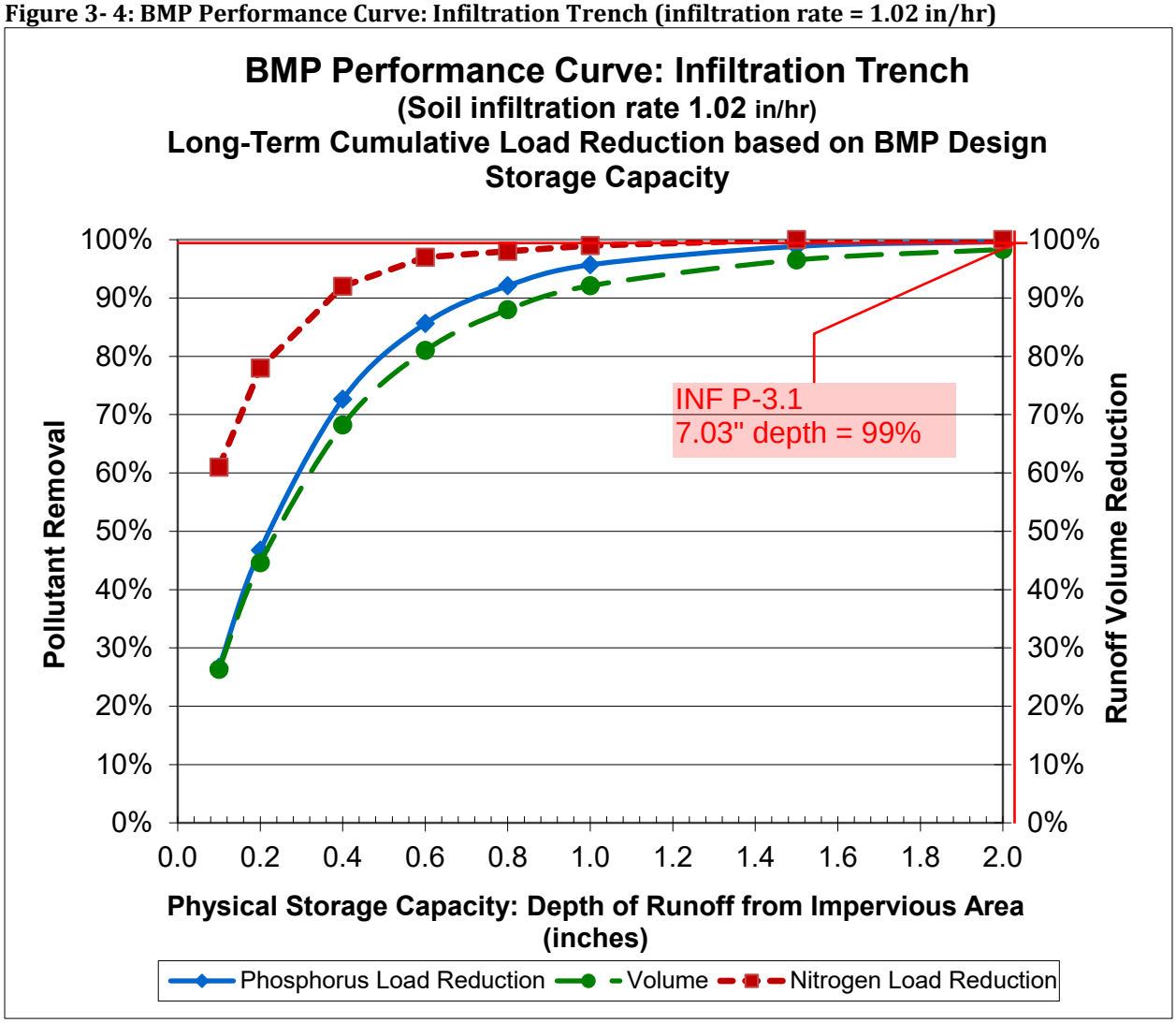


Table 3- 9: Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table

Infiltration Trench (IR = 1.02 in/hr) BMP Performance Table: Long-Term Phosphorus & Nitrogen Load Reduction								
BMP Capacity: Depth of Runoff from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	26.3%	44.6%	68.2%	81.0%	88.0%	92.1%	96.5%	98.3%
Cumulative Phosphorus Load Reduction	27%	47%	73%	86%	92%	96%	99%	100%
Cumulative Nitrogen Load Reduction	61%	78%	92%	97%	98%	99%	100%	100%

Figure 3- 4: BMP Performance Curve: Infiltration Trench (infiltration rate = 1.02 in/hr)



Appendix D: Standard 8 Supporting Information

- List of recommended Construction Period BMPs
- Recommended construction period maintenance checklist

Recommended Construction Period BMPs

Recommended Construction Period 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 and Compost Socks

Straw bale barriers and/or compost socks 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. Compost socks will be installed tight against the ground and overlapped horizontally at least two feet at joints.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, hay 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 hay 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 regraded and stabilized as necessary.

Construction BMP Checklist

Construction Best Management Practices – Maintenance/Evaluation Checklist

Medical Office Building, Highland Avenue – Needham, Massachusetts

Best Management Practice	Inspection Frequency	Date Inspected	Inspector Initials	Minimum Maintenance and Key Items to Check	Cleaning or Repair Needed ☐Yes/No (List Items)	Date of Cleaning or Repair	Performed by:
Silt Barrier, Silt Fencing, Compost Socks	In accordance with the NPDES CGP			Inspect for deterioration or failure. Remove sediment when buildup exceeds half the bale or sock height.			
Crushed-Stone Construction Exit	In accordance with the NPDES CGP			Inspect for breakdown of crushed-stone. Reapply stone if necessary to depths specified in construction documents			
Catch Basin Inlet Protection	In accordance with the NPDES CGP			Inspect for proper operation of catch basin. If clogged, dispose of sediment.			
Diversion Channels	In accordance with the NPDES CGP			Inspect for proper function. Correct if necessary.			
Temporary Sedimentation Basins	In accordance with the NPDES CGP			Inspect for proper function. Correct if necessary.			
Vegetated Slope Stabilization	In accordance with the NPDES CGP			Inspect for erosion. Correct if necessary.			

Appendix E: Operations and Maintenance Plan

Operation & Maintenance Plan
629-661 Highland Avenue, Needham, MA

Project Information

Site

Project Name:	Highland Ave Medical Office Building
Address or Locus:	629-661 Highland Avenue
City, State:	Needham, Massachusetts

Owner

Owner Name:	Boston Development Group, LLC
Owner Address:	93 Union St, Suite 135
Owner City, State, Zip:	Newton Centre, MA 02459
Owner Phone Number:	617-332-6400

Site Supervisor

Site Manager Name:	
Site Manager Address:	
Site Manager City, State, Zip:	
Site Manager Phone Number:	

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Asphalt Pavement and Concrete Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Sweep or vacuum pavement areas with a commercial cleaning unit when sediment buildup is visible on pavement surfaces. At a minimum, pavement shall be vacuum swept once annually in the spring following last expected snowfall. Dispose of removed material.
- Check loading and dumpster areas regularly for spillage and/or pavement staining and clean as necessary.
- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Maintenance of Vegetated Areas

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. Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean 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.
- Cut grass vegetation 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
- Require site users to pick up after pets. Do not allow pet waste to remain in vegetated areas and wash into the onsite drainage system.

Maintenance of Pervious Pavers

The primary maintenance requirement for pervious pavers is to clean the surface drainage voids. Fine debris and dirt accumulate in the drainage openings and reduce the paver's flow capacity. Even though some irreplaceable loss in permeability should be expected over the paver's lifetime, you can increase the longevity of the system by following the maintenance schedule for vacuum sweeping and high-pressure washing, limiting the use of de-icing chemicals and sand, and implementing a stringent sediment control plan. Practices that should be followed under the regular maintenance of the pervious pavers include:

Preventing Clogging of Pervious Paver Surface Area

- Patio areas and/or other areas with pervious pavers shall be cleaned annually with vacuums or washed with high pressure washers.
- Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface.
- Maintain vegetated areas adjacent to areas with pervious pavers to prevent washout of soil onto surface.
- Do not apply any type of sealant to pervious pavers.

Inspecting the System

- Inspect areas paved with pervious pavers monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect areas paved with pervious pavers annually after initial three-month period. Annual inspections should take place after large storms, when puddles will make any clogging obvious.

Repairing Damages

- Do not apply any type of sealant to pervious pavers.
- If necessary, add additional aggregate fill material made up of clean sand or gravel.
- Damaged interlocking paving blocks should be replaced.

Management of Snow and Ice

Storage and Disposal – Within the Exposed Parking Structure Footprint

Snow shall be hauled from the site for legal disposal. Snow shall not be stockpiled within the exposed parking structure footprint.

Storage and Disposal – Outside the Exposed Parking Structure Footprint

- 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 infiltration capacity of the system and causing localized flooding.
- Sand and debris deposited on vegetated or paved areas shall be cleared 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.
- No sand or grit shall be used on porous pavement systems and other deicers are to be used only to the extent necessary to protect public safety. Operators shall be instructed to monitor deicer application rates, as porous pavement systems tend to require less deicer due to their operational characteristics.
- Shovel snow off pervious pavers as necessary and avoid plowing areas with pervious pavers.
- Removal of sediments tracked onto porous pavement surfaces is a high-priority maintenance item and will protect the pavement from premature clogging.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site-specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials.

Stormwater BMP Maintenance

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Onsite stormwater best management practices (BMPs) should be inspected by a facilities supervisor or other designated, qualified personnel. When cleaning is necessary, the site supervisor shall determine whether the required work can be performed by onsite personnel or contracted through a third party (e.g. catch basin cleaning).

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.

- 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, 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.

Roof Drain Leaders

- Perform roof inspections at least twice per year, in spring and fall.
- Keep roofs clean and free of debris.
- Keep roof drainage systems clear.
- Clean inlets draining to the subsurface bed twice per year or as necessary.
- Keep roof access limited to authorized personnel.

Onsite Structural Water Quality Units (ADS Barracuda)

- Inspect devices monthly for the first three months after construction.
- Inspect devices at least twice per year, in spring and fall, and clean in accordance with manufacturer's recommendations regarding sediment depth. At a minimum, clean water quality units annually.
- Follow manufacturer instructions for inspection and cleaning and contact manufacturer if system is malfunctioning.

Garage Oil/Gas Separators

- Inspect oil/gas separators from parking garage drainage at least twice per year, in spring and fall, and clean in accordance with manufacturer's recommendations regarding sediment depth. At a minimum, clean annually.
- Follow manufacturer instructions for inspection and cleaning and contact manufacturer if system is malfunctioning.

Subsurface Infiltration Systems

- The subsurface infiltration systems will be inspected at least once each year by removing the manhole/access port covers and determining the thickness of sediment that has accumulated in the sediment removal row for StormTechs. If sediment is more than six inches deep, it must be suspended via flushing with clean water and removed using a vactor truck. Follow manufacturer's specifications and instructions for cleaning the sediment removal row.
- For StromTraps, inspect system twice per year, in spring and fall, for proper function. Remove sediment buildup at inlets, if present.
- Within the first year of operation, observe after rainfalls greater than 0.5" to confirm proper function.

Documentation of Stormwater Maintenance

Inspections and maintenance for the stormwater management system shall be accurately documented and kept on site. Documentation shall include a summary of work completed in the previous 12-months and any recommendations for repairs, capital upgrades and follow-up actions. Documentation shall be made available to the Needham Planning Board and or Department of Public Works upon request.

Attached to this plan are a Stormwater Operation & Maintenance Checklist and a Stormwater BMP Location Plan for use during the long-term operation and maintenance of the stormwater management system.

Spill Prevention and Response Plan

Spill prevention equipment and training will be provided by the property management company.

Initial Notification

In the event of a spill the facility manager or supervisor will be notified immediately.

Name: _____

Phone: _____

Email: _____

The supervisor will first contact the Fire Department and then notify the Police Department, and the Board of Health. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts 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: _____

E-mail: _____

ALTERNATE CONTACT:

Name: _____ Phone: _____

E-mail: _____

2. FIRE DEPARTMENT Emergency: 911

Business: (781) 455-7580

POLICE DEPARTMENT Emergency: 911

Business: (781) 455-7570

3. CLEANUP CONTRACTOR

Address: _____ Phone: _____

4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION Emergency: 1-888-304-1133

Northeast Regional Office: 978-694-3200

5. NATIONAL RESPONSE CENTER Phone: (800) 424-8802

6. BOARD OF HEALTH

Contact: Director of Health and Human Services Phone: (781) 455-7940

Hazardous Waste Spill Report

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: _____

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.

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)

Stormwater BMP Operation & Maintenance Checklist

Roof Runoff Drain Leaders:

Inspect roofs twice per year (spring and fall). Remove debris and clean inlets draining to the stormwater management system twice per year or as necessary.

Building #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Leaf litter, etc.)
				/ /	

Catch Basins / Trench Drains / Area Drains:

Inspect quarterly, clean annually and when sediment depth >6 inches

Inlet #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Sediment, etc.)
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	
				/ /	

Structural Water Quality Unit:

Inspect twice per year, clean as needed (once per year minimum) or per manufacturer's recommendations.

Unit #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Sediment, Trash, Washout, Blockage, etc.)
WQU #___				/ /	
WQU #___				/ /	
WQU #___				/ /	
WQU #___				/ /	

Garage Roof Oil/Grit Separator:

Inspect twice per year, clean as needed (once per year minimum) per manufacturer's recommendations.

Unit #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Sediment, Trash, Washout, Blockage, etc.)
				/ /	
				/ /	
				/ /	
				/ /	

Subsurface Infiltration Basins

Inspect outlets twice per year, clean if blockages are noted.

Basin #	Inspected (Y/N)	Standing Water?	Cleaning needed? (Y/N)	Date Cleaned	Comments (Sediment, Trash, Washout, Blockage, etc.)
SIB #1.1 - StormTech				/ /	
SIB #2.1 - StormTrap				/ /	

Street Sweeping:

Inspect pavement and parking areas quarterly (minimum). Remove debris and vacuum sweep once annually in the spring following the last expected snowfall (at a minimum) or as necessary.

Area #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Sediment, Leaf litter, etc.)
				/ /	
				/ /	
				/ /	
				/ /	

Pervious Patio:

Inspect patio areas annualy (minimum). Remove debris and vacuum sweep or pressure wash once annually (at a minimum) or as necessary.

Area #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Sediment, Leaf litter, etc.)
				/ /	

CROSS STREET

GUILD ROAD

HIGHLAND AVENUE

ARBOR STREET

MEDICAL OFFICE BUILDING
WITH PARKING BELOW

N/F
ARBOR STREET REALTY TRUST

LEGEND

CB	Catch Basin	SIB	Subsurface Infiltration Basin
WQU	Water Quality Unit	AD	Area Drain

0 20 40 Feet

Stormwater BMP Location Plan

Figure E-1

629 Highland Ave
Needham, MA

August 4, 2023

TOWN OF NEEDHAM
TOWN HALL
1471 Highland Avenue
Needham, MA 02492-2669

Design Review Board

August 8, 2023
Memo: Site Plan Review, 629 Highland Avenue

The proposal is a new 50,000 square foot medical office building with associated parking.

The site has a large change in elevation from Highland Avenue to the rear of the property. The proposed building sits above a portion of 2 levels of parking. The parking areas encompass a large portion of the site. The lowest level is at the elevation of the rear of the property. The upper parking level is accessed from the adjacent side streets. The building sits at the front of the site, but is well set back approximately 60 feet, the area will be well landscaped. Due to the parking garage ceiling height, which is designed for emergency and delivery vehicle access, the first floor of the building is above the grade at Highland Avenue. The design incorporates the use of terraced landscaping on both the front and the sides. Low retaining walls create a variety of planting beds. The plan is to also create a small outdoor plaza. The applicant noted the new design significantly increases the landscaped area and reduces the impervious surface area compared to the existing site development. The Board believes the site development is very well done. The design deals very well with the potentially difficult topographic changes.

The landscaping is very well done. The plant selections include many native plants. There is not a large amount of grass area, which will help conserve water use. They propose red oak trees for the street tree. These trees will be dropping acorns, which is not great in areas with sidewalks or the plaza, they may want to consider an alternative. There was some discussion of the root system for the trees but the landscape areas seem large enough to support the trees proposed. One of the ground cover vines, *Euonymus fortunei* 'Coloratus' can turn into a climbing vine if used in beds near trees. The Board noted there are existing power poles. The applicant hopes to remove them.

Site lighting is limited to meet required levels. The fixtures are dark sky compliant and there is no off-site spillover.

The building has 2 stories with a mechanical roof screen which is set back from the roof edges. It is clad in white metal panels. There is a shade screen above the second-floor windows. Window openings are aluminum frame system with glazing and black spandrel panels. The louvered mechanical screen will hide the mechanical equipment well and complements the material and color choices for the building walls. The Board approves of the exterior materials and overall building design.

The Board believes the site and building design are well designed and deal well with complicated topography.
End of notes.

From: John Schlittler
To: Alexandra Clee
Subject: RE: Request for comment - 629-661 Highland Ave
Date: Tuesday, August 15, 2023 3:16:00 PM

Alex,
I am concerned with the additional 1,166 vehicle trips per day and its impact to the area. I think consideration should be made of the potential transportation impact of the future Muzi project development (The Muzi location was not mentioned in the Specific Development by Others section in Transportation Impact Assessment.)

I question whether the Transportation Management Association encouragement of carpooling and other measures to discourage commuting and off-site trips will provide impactful relief from vehicle congestion.

With its proximity to Route 95 one would assume that most traffic exiting the location would turn left towards 95. This vehicle movement would require a vehicle to cross a sidewalk, bike lane and two vehicular travel lanes that are heading into Needham. Exiting vehicles would have successfully navigate those issues to enter the two outbound lanes and then later be able to merge onto the Highway.

What steps are being taken to restrict vehicular traffic off Putnam St as a cut through to Highland Ave.

Chief John Schlittler

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments

by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661 Highland_Neehigh LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.

2. Letter from Attorney Evans Huber, dated August 4, 2023.

3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.

4. Letter from Attorney Evans Huber, dated August 7, 2023.

5. Plan entitled "Highland Ave Medical Office Building," prepared by Maugel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled "Existing Conditions Plan of Land," dated August 4, 2023; Sheet 5, Sheet C1.01, entitled "Legend and General Notes," dated August 4, 2023; Sheet 6, Sheet C2.01, entitled "Site Preparation Plan," dated August 4, 2023; Sheet 7, Sheet C3.01, entitled "Layout and Materials Plan," dated August 4, 2023; Sheet 8, Sheet C4.01, entitled "Grading and Drainage Plan," dated August 4, 2023; Sheet 9, Sheet C5.01, entitled "Utilities Plan," dated August 4, 2023; Sheet 10, Sheet C6.01, entitled "Site Details 1," dated August 4, 2023; Sheet 11, Sheet C6.02, entitled "Site Details ," dated August 4, 2023; Sheet 12, Sheet C6.03, entitled "Site Details 3," dated August 4, 2023; Sheet 13, Sheet L102, entitled "Rendered Material plan," dated August 4, 2023; Sheet 14, Sheet L103, entitled "Grading Plan," dated August 4, 2023; Sheet 15, Sheet L104, entitled "Planting Plan," dated August 4, 2023; Sheet 16, Sheet L501, entitled "Details," dated August 4, 2023; Sheet 17, Sheet L520, entitled "Planting Details," dated August 4, 2023; Sheet 18, Sheet L521, entitled "Planting Details," dated August 4, 2023; Sheet 19, entitled "Site Lighting Photometric Plan," dated July 14, 2023; Sheet 20, Sheet A.101, entitled "F-1 Lower Parking plan," dated August 4, 2023; Sheet 21, Sheet A.102, entitled "F-2 Upper parking Plan," dated August 4, 2023; Sheet 22, Sheet A.103, entitled "First Floor Plan," dated August 4, 2023; Sheet 23, Sheet A.104, entitled "Second Floor Plan," dated August 4, 2023; Sheet 24, Sheet A.105, entitled "Roof Plan," dated August 4, 2023; Sheet 25, Sheet A.201, entitled "Elevations," dated August 4, 2023; Sheet 26, Sheet A.301, entitled "Building Sections," dated August 4, 2023; Sheet 27, entitled "P-1 Lower Below Grade Parking," dated July 14, 2023; Sheet 28, entitled" P-2 Upper Parking," dated July 14, 2023; Sheet 29, entitled "First Floor Plan," dated July 14, 2023; Sheet 30, entitled "Second Floor Plan," dated July 14, 2023; Sheet 31, entitled "Roof Plan," dated July 14, 2023; Sheet 32, entitled "Materials of Major Architectural Elements," dated July 14, 2023; Sheet 33, entitled "Concept Renderings, View at Highland Ave & Cross Street" dated July 14, 2023; Sheet 34, entitled "Concept Renderings, View at P-2 parking Level (South)" dated July 14, 2023; Sheet

35, entitled “Concept Renderings, View at P-2 Parking Level (West)” dated July 14, 2023; Sheet 36, entitled “Concept Renderings, View along highland Ave (North)” dated July 14, 2023; Sheet 37, entitled “Concept Renderings, View at Cross Street Below Grade Garage Entrance” dated July 14, 2023; Sheet 38, entitled “Concept Renderings, View at Arbor Street Above Grade Parking Entrance” dated July 14, 2023; Sheet 39, entitled “Concept Renderings, View at Landscape Plaza” dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.

7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

From:	Tara Gurge
To:	Alexandra Clee
Cc:	Lee Newman
Subject:	RE: Request for comment - 629-661 Highland Ave
Date:	Wednesday, August 30, 2023 1:34:13 PM
Attachments:	image002.png image003.png

Hello Alex –

Here are the Public Health Divisions comments for the proposed Planning Board project up for discussion located at **629-661 Highland Avenue**. See below:

- If any retail/food establishments are proposed in the new Medical Office Building to be located on this property there would need to be 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 Plan Review permit application - https://needhamma.viewpointcloud.com/categories/1073/record-types/1006516 .
- Please keep in mind, if a retail 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, along with waste oil/grease containment (if applicable.) These dumpsters must be placed in an easily accessible area outside of the new facility. An exterior grease interceptor may also need to be installed.
- Prior to demolition of the five structures on site, the owner must apply for the Demolition reviews online, via our online permit application system. See direct link to this permit review application --https://needhamma.viewpointcloud.com/categories/1073/record-types/1006508. This form will need to be completed for each separate structure to be demolished, along with the uploading of the required supplemental report documents for our review and approval (as noted on the form.) **PLEASE NOTE**: Pest control reports, along with the asbestos sampling reports, etc., must be uploaded to our online system for review for each structure to be demolished, prior to the issuance of the Demolition permits by the Building Department.
- On-going pest control must be conducted during demolition of the structures AND on-going pest control must be conducted throughout construction of the new office building.

Please let us know if you have any follow-up questions or if you need any additional information from us 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

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661 Highland_Neehigh LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.

2. Letter from Attorney Evans Huber, dated August 4, 2023.

3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.

4. Letter from Attorney Evans Huber, dated August 7, 2023.

5. Plan entitled “Highland Ave Medical Office Building,” prepared by Maugel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled “Existing Conditions Plan of Land,” dated August 4, 2023; Sheet 5, Sheet C1.01, entitled “Legend and General Notes,” dated August 4, 2023; Sheet 6, Sheet C2.01, entitled “Site Preparation Plan,” dated August 4, 2023; Sheet 7, Sheet C3.01, entitled “Layout and Materials Plan,” dated August 4, 2023; Sheet 8, Sheet C4.01, entitled “Grading and Drainage Plan,” dated August 4, 2023; Sheet 9, Sheet C5.01, entitled “Utilities Plan,” dated August 4, 2023; Sheet 10, Sheet C6.01, entitled “Site Details 1,” dated August 4, 2023; Sheet 11, Sheet C6.02, entitled “Site Details ,” dated August 4, 2023; Sheet 12, Sheet C6.03, entitled “Site Details 3,” dated August 4, 2023; Sheet 13, Sheet L102, entitled “Rendered Material plan,” dated August 4, 2023; Sheet 14, Sheet L103, entitled “Grading Plan,” dated August 4, 2023; Sheet 15, Sheet L104, entitled “Planting Plan,” dated August 4, 2023; Sheet 16, Sheet L501, entitled “Details,” dated August 4, 2023; Sheet 17, Sheet L520, entitled “Planting Details,” dated August 4, 2023; Sheet 18, Sheet L521, entitled “Planting Details,” dated August 4, 2023; Sheet 19, entitled “Site Lighting Photometric Plan,” dated July 14, 2023; Sheet 20, Sheet A.101, entitled “F-1 Lower Parking plan,” dated August 4, 2023; Sheet 21, Sheet A.102, entitled “F-2 Upper parking Plan,” dated August 4, 2023; Sheet 22, Sheet A.103, entitled “First Floor Plan,” dated August 4, 2023; Sheet 23, Sheet A.104, entitled “Second Floor Plan,” dated August 4, 2023; Sheet 24, Sheet A.105, entitled “Roof Plan,” dated August 4, 2023; Sheet 25, Sheet A.201, entitled “Elevations,” dated August 4, 2023; Sheet 26, Sheet A.301, entitled “Building Sections,” dated August 4, 2023; Sheet 27, entitled “P-1 Lower Below Grade Parking,” dated July 14, 2023; Sheet 28, entitled” P-2 Upper Parking,” dated July 14, 2023; Sheet 29, entitled “First Floor Plan,” dated July 14, 2023; Sheet 30, entitled “Second Floor Plan,” dated July 14, 2023; Sheet 31, entitled “Roof Plan,” dated July 14, 2023; Sheet 32, entitled “Materials of Major Architectural Elements,” dated July 14, 2023; Sheet 33, entitled “Concept Renderings, View at Highland Ave & Cross Street” dated July 14, 2023; Sheet 34, entitled “Concept Renderings, View at P-2 parking Level (South)” dated July 14, 2023; Sheet 35, entitled “Concept Renderings, View at P-2 Parking Level (West)” dated July 14, 2023; Sheet 36, entitled “Concept Renderings, View along highland Ave (North)” dated July 14, 2023; Sheet 37, entitled “Concept Renderings, View at Cross Street Below Grade Garage Entrance” dated July 14, 2023; Sheet 38, entitled “Concept Renderings, View at Arbor Street Above Grade Parking Entrance” dated July 14, 2023; Sheet 39, entitled “Concept Renderings,

View at Landscape Plaza" dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.

7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

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

August 30, 2023

Needham Planning Board
Needham Public Safety Administration Building
Needham, MA 02492

RE: Major Project Special Permit No. 2023-03
629-661Highland Ave- Neehigh, LLC

Dear Members of the Board,

The Department of Public Works has completed its review of the above referenced application for the proposed work at 629-661 Highland Ave. The project includes the redevelopment of the site for a new two-story medical office building and 250 car, two-story parking garage. The project also includes the demolition of five existing buildings, new utility upgrades and the addition of storm water management system.

The documents submitted for review are as follows:

- Cover Letter Prepared by Frieze Cramer Rosen & Hubber llp dated 8/4/23.
- Cover Letter Prepared by Frieze Cramer Rosen & Hubber llp dated 8/7/23.
- Application for Special Permit dated No.2023-03
- Letter of Authorization Neehigh LLC dated 8/3/23.
- Plan set entitled "Highland Ave Medical Office Building," prepared by Maugel DeStefano Architects, Inc. dated 8/4/23 consisting of 39 Sheets.
- Transportation Impact Assessment, prepared by Vanasse & Associates, dated July 2023.
- Stormwater Report, prepared by Vanesse Hangen Brustlin, dated 8/4/23.

Our comments and recommendations are as follows:

- The Engineering Division has met with the applicant's Engineers and will provide additional information on the utilities and work with them to investigate if gravity sewer connections are possible through the Putnam Street sewer system.

- The Water and Sewer Division will have comments as the project design progresses and may have additional Water and Sewer permit requirements prior to construction. Which may include possible looping of the water main and upgrading the existing 6" water main on Cross Street to accommodate the new domestic water and fire protection services.

- The Transportation Impact Assessment incorporates potential future transportation mitigation that is proposed for the 557 Highland Avenue project. The Engineering Division concurs with the Police Department's comments and suggests a peer review from assess the traffic mitigation proposal with this project.

- For the new facility, two times the 3,750 GPD expected generated in wastewater flow equates to a total of 7,500 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.

- A separate MassDOT approval is required for any work for this section of Highland Ave right of way.

- 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.

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

Truly yours,

Thomas A Ryder
Town Engineer

Town of Needham
Building Department
500 Dedham Ave.
Needham, MA 02492

Tel.781-455-7550 x 308

August 31, 2022

Town of Needham Planning Board
Lee Newman / Town Planner
500 Dedham Ave.
Needham, MA. 024902

Re: 629-661 Highland Ave./ Medical Office Building/ Major Project

Dear Planning Board Members,

Please be advised that I have reviewed the proposed plan for the new medical office building proposed by Neehigh LLC at 629-661 Highland Ave. have the following comments:

The proposal shows a new medical office building. The grade of the site slopes down, approximately 20' from Highland Ave. to Guild St. The 2 uppermost levels will contain 50,000 square feet of medical office space and the two lower levels contain 250 parking spaces. Because the lowest level is mostly below grade, the building is considered only 3 stories. The plans, at this point show a "shell" building. Presumably, various suites will be designed for each tenant as they are acquired.

The building itself, based on the plans submitted, does appear to be compliant with all relevant sections of the Zoning Bylaw.

There appears to be a discrepancy/error in the table on page P3 (Site Diagram) of the plans, which indicates the setback from Highland to be 57.75'/62.25'. This conflicts with the site plan on page C3.01 which shows a uniform setback of 38' from Highland.

Also, there is no access shown for persons with disabilities at the front entry, facing Highland Ave. There is only a set of stairs shown here but no access ramp. The Mass Architectural Access Code, 521CMR requires ALL entrances to be fully accessible.

Sincerely,

Joe Prondak
Needham Building Commissioner

From:	Tom Conroy
To:	Alexandra Clee
Cc:	Donald Anastasi; Jay Steeves; Ronnie Gavel
Subject:	RE: Request for comment - 629-661 Highland Ave
Date:	Wednesday, August 30, 2023 9:17:51 AM
Attachments:	image002.png

Hi Alex,

Sorry for the late response. Would it be possible to get more detail on the hydrant location and the fire department sprinkler intake connection?

Thank you.

Thomas M. Conroy
Fire Chief - Needham Fire Department
tconroy@needhamma.gov
Ph (781) 455-7580

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Tuesday, August 29, 2023 5:23 PM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi there,

Sending a reminder to please send your comments by tomorrow.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov/planning

From: Alexandra Clee
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John

Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661 Highland_Neehigh LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.

2. Letter from Attorney Evans Huber, dated August 4, 2023.

3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.

4. Letter from Attorney Evans Huber, dated August 7, 2023.

5. Plan entitled “Highland Ave Medical Office Building,” prepared by Maugel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled “Existing Conditions Plan of Land,” dated August 4, 2023; Sheet 5, Sheet C1.01, entitled “Legend and General Notes,” dated August 4, 2023; Sheet 6, Sheet C2.01, entitled “Site Preparation Plan,” dated August 4, 2023; Sheet 7, Sheet C3.01, entitled “Layout and Materials Plan,” dated August 4, 2023; Sheet 8, Sheet C4.01, entitled “Grading and Drainage Plan,” dated August 4, 2023; Sheet 9, Sheet C5.01, entitled “Utilities Plan,” dated August 4, 2023; Sheet 10, Sheet C6.01, entitled “Site Details 1,” dated August 4, 2023; Sheet 11, Sheet C6.02, entitled “Site Details ,” dated August 4, 2023; Sheet 12, Sheet C6.03, entitled “Site Details 3,” dated August 4, 2023; Sheet 13, Sheet L102, entitled “Rendered

Material plan," dated August 4, 2023; Sheet 14, Sheet L103, entitled "Grading Plan," dated August 4, 2023; Sheet 15, Sheet L104, entitled "Planting Plan," dated August 4, 2023; Sheet 16, Sheet L501, entitled "Details," dated August 4, 2023; Sheet 17, Sheet L520, entitled "Planting Details," dated August 4, 2023; Sheet 18, Sheet L521, entitled "Planting Details," dated August 4, 2023; Sheet 19, entitled "Site Lighting Photometric Plan," dated July 14, 2023; Sheet 20, Sheet A.101, entitled "F-1 Lower Parking plan," dated August 4, 2023; Sheet 21, Sheet A.102, entitled "F-2 Upper parking Plan," dated August 4, 2023; Sheet 22, Sheet A.103, entitled "First Floor Plan," dated August 4, 2023; Sheet 23, Sheet A.104, entitled "Second Floor Plan," dated August 4, 2023; Sheet 24, Sheet A.105, entitled "Roof Plan," dated August 4, 2023; Sheet 25, Sheet A.201, entitled "Elevations," dated August 4, 2023; Sheet 26, Sheet A.301, entitled "Building Sections," dated August 4, 2023; Sheet 27, entitled "P-1 Lower Below Grade Parking," dated July 14, 2023; Sheet 28, entitled" P-2 Upper Parking," dated July 14, 2023; Sheet 29, entitled "First Floor Plan," dated July 14, 2023; Sheet 30, entitled "Second Floor Plan," dated July 14, 2023; Sheet 31, entitled "Roof Plan," dated July 14, 2023; Sheet 32, entitled "Materials of Major Architectural Elements," dated July 14, 2023; Sheet 33, entitled "Concept Renderings, View at Highland Ave & Cross Street" dated July 14, 2023; Sheet 34, entitled "Concept Renderings, View at P-2 parking Level (South)" dated July 14, 2023; Sheet 35, entitled "Concept Renderings, View at P-2 Parking Level (West)" dated July 14, 2023; Sheet 36, entitled "Concept Renderings, View along highland Ave (North)" dated July 14, 2023; Sheet 37, entitled "Concept Renderings, View at Cross Street Below Grade Garage Entrance" dated July 14, 2023; Sheet 38, entitled "Concept Renderings, View at Arbor Street Above Grade Parking Entrance" dated July 14, 2023; Sheet 39, entitled "Concept Renderings, View at Landscape Plaza" dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.

7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

From:	Justin Mosca
To:	Tom Conroy
Cc:	Donald Anastasi; Jay Steeves; Ronnie Gavel; Alexandra Clee; Lee Newman; Evans Huber
Subject:	RE: Request for comment - 629-661 Highland Ave
Date:	Wednesday, August 30, 2023 2:51:29 PM
Attachments:	image001.png Highland MOB-Fire Truck Routing.pdf

Chief Conroy,

VHB was forwarded your request below regarding additional information on hydrant locations and fire dept. connections for the proposed MOB on Highland Avenue. Please find attached a figure which shows our anticipated hydrant coverage and fire truck routing around the site using Needham's aerial tower truck. One of the hydrants (along Highland Ave) is existing to remain. The other two are new proposed hydrants to provide no more than 250' between a hydrant and building points.

With regards to the fire department connection, the location is flexible and I think we'd be interested to hear your opinion on where you'd like it to be located, since you'll know where you'd like to set up with the pumper truck. It should be within 100' of a hydrant to meet code requirements, but other than that, I believe it can be on whichever face of the building you'd prefer. We're also curious if you have a preferred style of connection (Siamese or Storz).

Please let us know your thoughts. Feel free to give me a call to talk it through if easier.

Thank you,

Justin Mosca, PE
Project Manager
Licensed in MA

P 617.607.2727

www.vhb.com

From: Tom Conroy <TConroy@needhamma.gov>
Sent: Wednesday, August 30, 2023 9:17:48 AM
To: Alexandra Clee <aclee@needhamma.gov>
Cc: Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi Alex,

Sorry for the late response. Would it be possible to get more detail on the hydrant location and the fire department sprinkler intake connection?

Thank you.

Thomas M. Conroy
Fire Chief - Needham Fire Department
tconroy@needhamma.gov
Ph (781) 455-7580

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Tuesday, August 29, 2023 5:23 PM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi there,

Sending a reminder to please send your comments by tomorrow.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov/planning

From: Alexandra Clee
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story

50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661 Highland_Neehigh LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.

2. Letter from Attorney Evans Huber, dated August 4, 2023.

3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.

4. Letter from Attorney Evans Huber, dated August 7, 2023.

5. Plan entitled "Highland Ave Medical Office Building," prepared by Maugel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled "Existing Conditions Plan of Land," dated August 4, 2023; Sheet 5, Sheet C1.01, entitled "Legend and General Notes," dated August 4, 2023; Sheet 6, Sheet C2.01, entitled "Site Preparation Plan," dated August 4, 2023; Sheet 7, Sheet C3.01, entitled "Layout and Materials Plan," dated August 4, 2023; Sheet 8, Sheet C4.01, entitled "Grading and Drainage Plan," dated August 4, 2023; Sheet 9, Sheet C5.01, entitled "Utilities Plan," dated August 4, 2023; Sheet 10, Sheet C6.01, entitled "Site Details 1," dated August 4, 2023; Sheet 11, Sheet C6.02, entitled "Site Details ," dated August 4, 2023; Sheet 12, Sheet C6.03, entitled "Site Details 3," dated August 4, 2023; Sheet 13, Sheet L102, entitled "Rendered Material plan," dated August 4, 2023; Sheet 14, Sheet L103, entitled "Grading Plan," dated August 4, 2023; Sheet 15, Sheet L104, entitled "Planting Plan," dated August 4, 2023; Sheet 16, Sheet L501, entitled "Details," dated August 4, 2023; Sheet 17, Sheet L520, entitled "Planting Details," dated August 4, 2023; Sheet 18, Sheet L521, entitled "Planting Details," dated August 4, 2023; Sheet 19, entitled "Site Lighting Photometric Plan," dated July 14, 2023; Sheet 20, Sheet A.101, entitled "F-1 Lower Parking plan," dated August 4, 2023; Sheet 21, Sheet A.102, entitled "F-2 Upper parking Plan," dated August 4, 2023; Sheet 22, Sheet A.103, entitled "First Floor Plan," dated August 4, 2023; Sheet 23, Sheet A.104, entitled "Second Floor Plan," dated August 4, 2023; Sheet 24, Sheet A.105, entitled "Roof Plan," dated August 4, 2023; Sheet 25, Sheet A.201, entitled "Elevations," dated August 4, 2023; Sheet 26, Sheet A.301, entitled "Building Sections," dated August 4, 2023; Sheet 27, entitled "P-1 Lower Below Grade Parking," dated July 14, 2023; Sheet 28, entitled" P-2 Upper Parking," dated July 14,

2023; Sheet 29, entitled “First Floor Plan,” dated July 14, 2023; Sheet 30, entitled “Second Floor Plan,” dated July 14, 2023; Sheet 31, entitled “Roof Plan,” dated July 14, 2023; Sheet 32, entitled “Materials of Major Architectural Elements,” dated July 14, 2023; Sheet 33, entitled “Concept Renderings, View at Highland Ave & Cross Street” dated July 14, 2023; Sheet 34, entitled “Concept Renderings, View at P-2 parking Level (South)” dated July 14, 2023; Sheet 35, entitled “Concept Renderings, View at P-2 Parking Level (West)” dated July 14, 2023; Sheet 36, entitled “Concept Renderings, View along highland Ave (North)” dated July 14, 2023; Sheet 37, entitled “Concept Renderings, View at Cross Street Below Grade Garage Entrance” dated July 14, 2023; Sheet 38, entitled “Concept Renderings, View at Arbor Street Above Grade Parking Entrance” dated July 14, 2023; Sheet 39, entitled “Concept Renderings, View at Landscape Plaza” dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.

7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

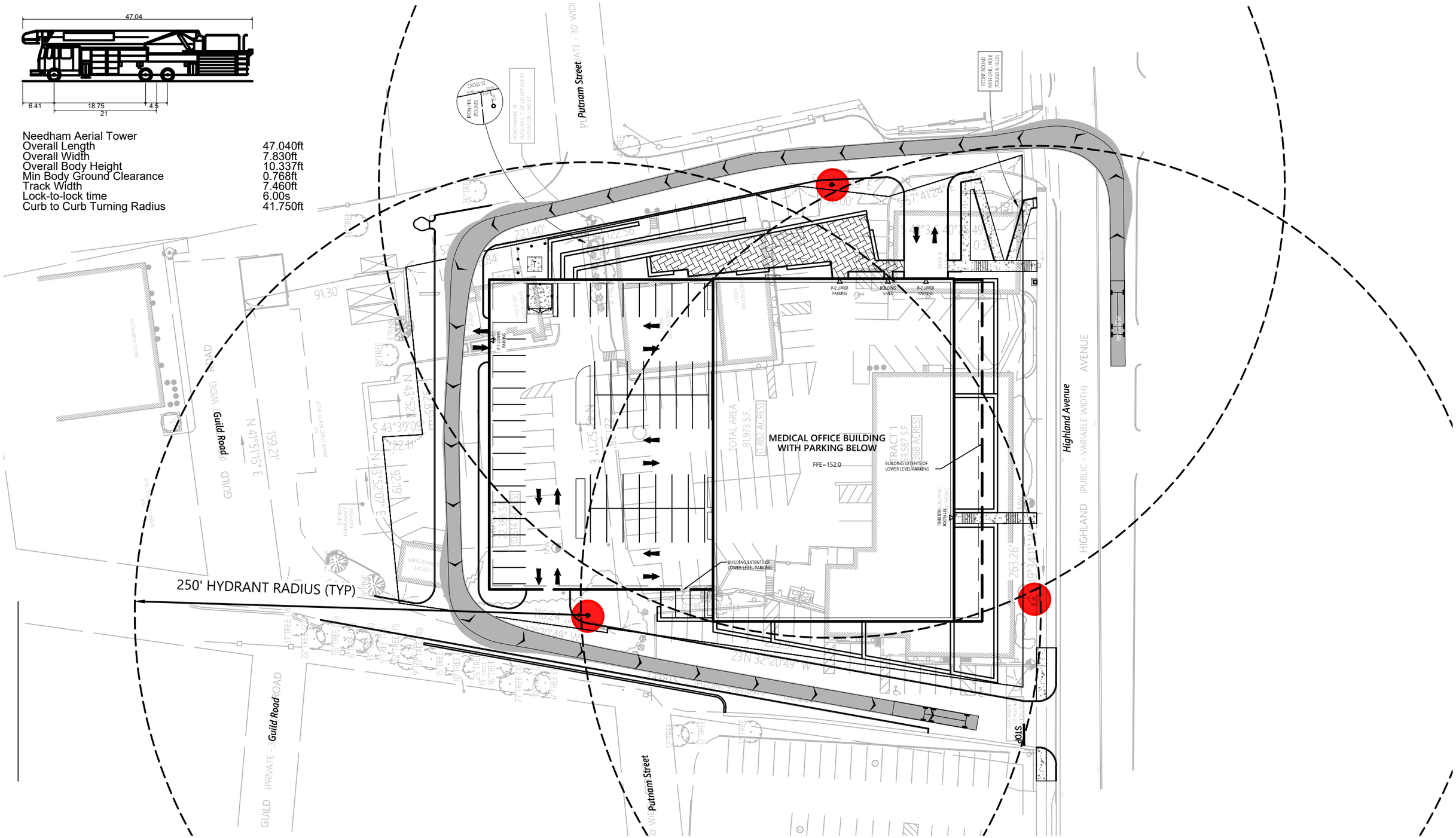
I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

\\vhb\gbl\proj\Wat-LD\14781.00 BDG Highland Ave Needham\cad\ld\Planmisc\Truck Turns\14781.00-TT.dwg

Needham Aerial Tower	
Overall Length	47.040ft
Overall Width	7.830ft
Overall Body Height	10.337ft
Min Body Ground Clearance	0.768ft
Track Width	7.460ft
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	41.750ft



0 25 50 100 Feet

Fire Access Plan

Needham Medical Office
Highland Ave, Needham, MA

Figure FT-1

August 4, 2023

MAUGEL DESTEFANO
ARCHITECTS

31 August 2023

Town of Needham Planning Board
Lee Newman/ Town Planner
500 Dedham Ave.
Needham, MA 02492

RE: 629-661 Highland Ave./ Proposed Medical Office Building/ Building Commissioner Letter

Dear Ms. Newman and Planning Board Members,

Thank you for forwarding the Building Commissioner's letter dated August 31, 2023. Before meeting with the Board next Tuesday evening, we wanted to provide the following clarifications regarding two of Mr. Prondak's comments.

Discrepancy/error in the table on Page P3 (Site Diagram)
The Site Diagram distances listed under "Setback from Highland" refer to the space between the face of the building(s) and the pavement edge along Highland Avenue. This information differs from the zoning setback relative to the property line. The zoning setback is accurately indicated on the civil plans---38' from the property line to the face of the medical office building, and 22.5' to the concealed underground parking structure. We apologize for any confusion with our use of the term "setback" on Page P3.

No access for persons with disabilities at the front entry, facing Highland Ave.
The door facing Highland Avenue is being provided for emergency building egress only, and it will be outfitted with hardware and signed accordingly. The building's entrance is located beneath the building and is designed to be fully accessible. It is served by adjacent accessible parking spaces, accessible drop-off areas, and an accessible pedestrian route from the corner of Cross Street and Highland Avenue.

We trust that this information is helpful, and please do not hesitate to reach out should you have any further questions. We look forward to meeting with the Board next week and, in the future, working with the Building Department to review and coordinate code compliance for the project.

Sincerely,

Daniel Barton AIA
Principal

978 273-3291
dbarton@maugel.com

Vanasse & Associates inc
Transportation Engineers & Planners

35 New England Business Center Drive
Suite 140
Andover, MA 01810

Ref: 8315

August 31, 2023

Ms. Alexandra Clee
Assistant Town Planner
Town of Needham
Planning and Community Development Department
Public Services Administration Building
500 Dedham Avenue
Needham, MA 02492

Re: Response to Police Department Comments
Proposed Medical Office Building – 629-661 Highland Avenue
Needham, Massachusetts

Dear Alex:

Vanasse & Associates, Inc. (VAI) is providing responses to the initial comments that were offered by Chief John Schlittler of the Needham Police Department concerning his review of the July 2023 *Transportation Impact Assessment* (the "July 2023 TIA") prepared by VAI in support of the proposed medical office building to be located at 629-661 Highland Avenue in Needham, Massachusetts (hereafter referred to as the "Project"). Listed below are the comments that were offered by Chief Schlitter in his August 15, 2023 email followed by our response on behalf of the Applicant:

Comment 1: *I am concerned with the additional 1,166 vehicle trips per day and its impact to the area. I think consideration should be made of the potential transportation impact of the future Muzi project development (The Muzi location was not mentioned in the Specific Development by Others section in Transportation Impact Assessment.)*

Response: The impacts associated with the redevelopment of the former Muzi Ford site were considered in the July 2023 TIA and the cumulative impact of both the Project and the redevelopment of the Muzi Ford site (a.k.a. Highland Science Center) were assessed (see page 15 of the July 2023 TIA and the "Background Development Traffic-Volume Networks" section of the accompanying Technical Appendix). Based on this evaluation and with consideration of the improvements that will be advanced as a part of the Highland Science Center and those proposed as a part of the Project (traffic signal timing improvements at the Highland Avenue/Webster Street and Highland Avenue/Gould Street/Hunting Road intersections), overall motorist delays and vehicle queuing will be reduced to the extent that there will be a general improvement over No-Build conditions (see Table 13 on page 35 of the July 2023 TIA. The column in Table 13 titled: "2030 Build with Mitigation" details the improved conditions along Highland Avenue, which include a general reduction in motorist delay over No-Build conditions of up to 14.3 seconds).

Comment 2: *I question whether the Transportation Management Association encouragement of carpooling and other measures to discourage commuting and off-site trips will provide impactful relief from vehicle congestion.*

Response: The elements of the Transportation Demand Management (TDM) program include proven measures that have been successful at reducing employee related automobile trips. An effectively marketed TDM program can achieve trip reductions of 10 percent or more over baseline (no TDM program) conditions. Any reduction in trips that may result from the TDM program will be beneficial to reducing the impact of the Project on the transportation infrastructure.

Comment 3: *With its proximity to Route 95 one would assume that most traffic exiting the location would turn left towards 95. This vehicle movement would require a vehicle to cross a sidewalk, bike lane and two vehicular travel lanes that are heading into Needham. Exiting vehicles would have successfully navigate those issues to enter the two outbound lanes and then later be able to merge onto the Highway.*

Response: It is anticipated that 54 percent of the trips associated with the Project will be oriented to and from the east of the Project site and toward Interstate 95. The analyses presented in the July 2023 TIA reflect the increased time required for a motorist to complete a left-turn movement exiting from the Project site to Highland Avenue. Based on this analysis, motorists exiting the Project site will experience delays due to the volume of traffic on Highland Avenue; however, the residual vehicle queuing was found to range from one (1) to five (5) vehicles (see Table 11 on page 28 of the July 2023 TIA), and can be contained along Arbor Street and Cross Street without impeding the movement of vehicles, pedestrians or bicyclists along Highland Avenue. It is important to note that the traffic signals along Highland Avenue on either side of the Project at Hunting Road/Gould Street and at Webster Street create gaps in the flow of traffic along Highland Avenue that will allow motorists to exit the Project site with less delay than predicted by the analysis model. Further, when there is extended vehicle queuing along Arbor Street or Cross Street, the residual queue will extend into the Project site and not necessarily along these roadways.

Further and most importantly, the sight distance measurements for a motorist exiting from the Project site also considers these conditions and the need for an exiting motorist to observe a pedestrian in the sidewalk and a bicyclist in the bicycle lane before entering the traveled-way to complete a left or right-turn movement. The available lines of sight to and from Arbor Street and Cross Street along Highland Avenue will allow for these intersections to continue to function in a safe manner (see pages 30 and 31 of the July 2023 TIA).

Comment 4: *What steps are being taken to restrict vehicular traffic off Putnam St as a cut through to Highland Ave.?*

Response: The Applicant has agreed to implement specific measures to reduce the potential for the use of Putnam Street by Project-related traffic. These measures may include the following:

- Installation of "No Thru Traffic" signs on both Cross Street and Highland Avenue at Putnam Street; and/or

- Installation of turn restriction signs on Cross Street at Putnam Avenue ("No Left Turn" for traffic exiting from Putnam Street to Cross Street and for traffic on Cross Street approaching Putnam Lane).

The specific measures would be designed and constructed by the Applicant subject to receipt of all necessary rights, permits and approvals.

We trust that this information is responsive to the initial comments that were offered by Chief Schlittler concerning his review of the July 2023 TIA. If you should have any questions regarding this information, please feel free to contact me.

Sincerely,

VANASSE & ASSOCIATES, INC.

Jeffrey Dirk

Jeffrey S. Dirk, P.E., PTOE, FITE
Managing Partner

Professional Engineer in CT, MA, ME, NH, RI, and VA

JSD/jsd

From:	Joseph Prondak
To:	Alexandra Clee
Cc:	Lee Newman
Subject:	RE: Highland MOB - PB Response to Bldg. Commissioner"s Letter
Date:	Tuesday, September 5, 2023 8:37:16 AM

Thanks, Alex,

I am good w/ that response.

Joe P.

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Friday, September 1, 2023 5:40 PM
To: Joseph Prondak <jprondak@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>
Subject: FW: Highland MOB - PB Response to Bldg. Commissioner's Letter

Hi Joe,

Please find letter attached replying to your comments on this project.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

From: Evans Huber <eh@128law.com>
Sent: Friday, September 1, 2023 1:59 PM
To: Alexandra Clee <aclee@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>
Subject: FW: Highland MOB - PB Response to Bldg. Commissioner's Letter

Alex and Lee: please see the attached response from our architectural team regrading a couple of issues raised by the building commissioner. Please forward this to him as well as to members of the Board.

Thanks, Evans

Evans Huber
Frieze Cramer Rosen & Huber, LLP
62 Walnut Street, Suite 6
Wellesley, MA 02481
781-943-4000 (main)

781-943-4043 (direct)
781-799-9272 (cell)
eh@128law.com
www.128law.com

The following materials are being newly distributed in this October 17, 2023 Planning Board meeting packet

From:	Justin Mosca
To:	Tom Conroy
Cc:	Donald Anastasi; Jay Steeves; Ronnie Gavel; Alexandra Clee; Lee Newman; Evans Huber
Subject:	RE: Request for comment - 629-661 Highland Ave
Date:	Friday, September 8, 2023 10:31:29 AM
Attachments:	image001.png Highland MOB - Fire Access Figure [2023-09-08].pdf

Chief Conroy,

It has come to our attention that there is an existing hydrant at the far end of Cross Street that was in the middle of the pavement (with a couple bollards around it). We had missed this on the plan, so we're now showing that hydrant to be relocated to the northeast edge of pavement, which will provide four hydrants in the vicinity of the Project rather than the three shown previously. Please see attached for an updated figure with the hydrant coverages.

If you have any comments on hydrant locations or preferences for the FDC serving the building, please let us know.

Thank you,

Justin

Justin Mosca, PE
Project Manager
Licensed in MA

P 617.607.2727

www.vhb.com

From: Justin Mosca
Sent: Wednesday, August 30, 2023 2:51 PM
To: TConroy@needhamma.gov
Cc: DAnastasi@needhamma.gov; steevesj@needhamma.gov; rgavel@needhamma.gov; Alexandra Clee (aclee@needhamma.gov) <aclee@needhamma.gov>; LNewman@needhamma.gov; Evans Huber <eh@128law.com>
Subject: RE: Request for comment - 629-661 Highland Ave

Chief Conroy,

VHB was forwarded your request below regarding additional information on hydrant locations and fire dept. connections for the proposed MOB on Highland Avenue. Please find attached a figure which shows our anticipated hydrant coverage and fire truck routing around the site using Needham's aerial tower truck. One of the hydrants (along Highland Ave) is existing to remain. The other two are new proposed hydrants to provide no more than 250' between a hydrant and building points.

With regards to the fire department connection, the location is flexible and I think we'd be interested to hear your opinion on where you'd like it to be located, since you'll know where you'd like to set up with the pumper truck. It should be within 100' of a hydrant to meet code requirements, but other than that, I believe it can be on whichever face of the building you'd prefer. We're also curious if you have a preferred style of connection (Siamese or Storz).

Please let us know your thoughts. Feel free to give me a call to talk it through if easier.

Thank you,

Justin Mosca, PE
Project Manager
Licensed in MA
P 617.607.2727
www.vhb.com

From: Tom Conroy <TConroy@needhamma.gov>
Sent: Wednesday, August 30, 2023 9:17:48 AM
To: Alexandra Clee <aclee@needhamma.gov>
Cc: Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi Alex,

Sorry for the late response. Would it be possible to get more detail on the hydrant location and the fire department sprinkler intake connection?

Thank you.

Thomas M. Conroy
Fire Chief - Needham Fire Department
tconroy@needhamma.gov
Ph (781) 455-7580

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Tuesday, August 29, 2023 5:23 PM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi there,

Sending a reminder to please send your comments by tomorrow.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov/planning

From: Alexandra Clee
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661 Highland_Neehigh LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.

2. Letter from Attorney Evans Huber, dated August 4, 2023.

3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.

4. Letter from Attorney Evans Huber, dated August 7, 2023.

5. Plan entitled “Highland Ave Medical Office Building,” prepared by Maugel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut

Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled "Existing Conditions Plan of Land," dated August 4, 2023; Sheet 5, Sheet C1.01, entitled "Legend and General Notes," dated August 4, 2023; Sheet 6, Sheet C2.01, entitled "Site Preparation Plan," dated August 4, 2023; Sheet 7, Sheet C3.01, entitled "Layout and Materials Plan," dated August 4, 2023; Sheet 8, Sheet C4.01, entitled "Grading and Drainage Plan," dated August 4, 2023; Sheet 9, Sheet C5.01, entitled "Utilities Plan," dated August 4, 2023; Sheet 10, Sheet C6.01, entitled "Site Details 1," dated August 4, 2023; Sheet 11, Sheet C6.02, entitled "Site Details ," dated August 4, 2023; Sheet 12, Sheet C6.03, entitled "Site Details 3," dated August 4, 2023; Sheet 13, Sheet L102, entitled "Rendered Material plan," dated August 4, 2023; Sheet 14, Sheet L103, entitled "Grading Plan," dated August 4, 2023; Sheet 15, Sheet L104, entitled "Planting Plan," dated August 4, 2023; Sheet 16, Sheet L501, entitled "Details," dated August 4, 2023; Sheet 17, Sheet L520, entitled "Planting Details," dated August 4, 2023; Sheet 18, Sheet L521, entitled "Planting Details," dated August 4, 2023; Sheet 19, entitled "Site Lighting Photometric Plan," dated July 14, 2023; Sheet 20, Sheet A.101, entitled "F-1 Lower Parking plan," dated August 4, 2023; Sheet 21, Sheet A.102, entitled "F-2 Upper parking Plan," dated August 4, 2023; Sheet 22, Sheet A.103, entitled "First Floor Plan," dated August 4, 2023; Sheet 23, Sheet A.104, entitled "Second Floor Plan," dated August 4, 2023; Sheet 24, Sheet A.105, entitled "Roof Plan," dated August 4, 2023; Sheet 25, Sheet A.201, entitled "Elevations," dated August 4, 2023; Sheet 26, Sheet A.301, entitled "Building Sections," dated August 4, 2023; Sheet 27, entitled "P-1 Lower Below Grade Parking," dated July 14, 2023; Sheet 28, entitled" P-2 Upper Parking," dated July 14, 2023; Sheet 29, entitled "First Floor Plan," dated July 14, 2023; Sheet 30, entitled "Second Floor Plan," dated July 14, 2023; Sheet 31, entitled "Roof Plan," dated July 14, 2023; Sheet 32, entitled "Materials of Major Architectural Elements," dated July 14, 2023; Sheet 33, entitled "Concept Renderings, View at Highland Ave & Cross Street" dated July 14, 2023; Sheet 34, entitled "Concept Renderings, View at P-2 parking Level (South)" dated July 14, 2023; Sheet 35, entitled "Concept Renderings, View at P-2 Parking Level (West)" dated July 14, 2023; Sheet 36, entitled "Concept Renderings, View along highland Ave (North)" dated July 14, 2023; Sheet 37, entitled "Concept Renderings, View at Cross Street Below Grade Garage Entrance" dated July 14, 2023; Sheet 38, entitled "Concept Renderings, View at Arbor Street Above Grade Parking Entrance" dated July 14, 2023; Sheet 39, entitled "Concept Renderings, View at Landscape Plaza" dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.

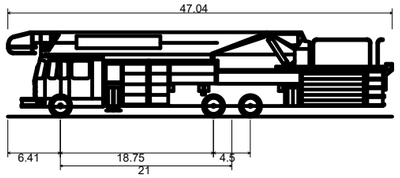
7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

\\Vhb\gbl\proj\Wat-LD\14781.00 BDG Highland Ave Needham\cad\ld\Planmisc\Truck Turns\14781.00-TT.dwg



Needham Aerial Tower	
Overall Length	47.040ft
Overall Width	7.830ft
Overall Body Height	10.337ft
Min Body Ground Clearance	0.768ft
Track Width	7.460ft
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	41.750ft

Fire Access Plan

Needham Medical Office
Highland Ave, Needham, MA

Figure FT-1

9/8/2023

From: Jay Steeves
To: Alexandra Clee
Cc: Tom Conroy; Lee Newman; Donald Anastasi; Ronnie Gavel
Subject: Re: Request for comment - 629-661 Highland Ave
Date: Tuesday, September 26, 2023 12:25:27 PM
Attachments: image001.png

Hi Alex,

Chief Conroy asked me to respond to your email. The Fire Departments initial question regarding hydrant and fire department connection location, was answered by the applicant and we have no further questions.

Thanks, Jay

Sent from my iPhone

> On Sep 26, 2023, at 10:54, Alexandra Clee <aclee@needhamma.gov> wrote:
>
> Hi Chief,
>
> Would you be able to send a revised comment after having received the feedback from the Applicant? I would love your comments by Thursday morning ideally, but certainly before the hearing Tuesday night.
>
> Thanks, alex.
>
> Alexandra Clee
> Assistant Town Planner
> Needham, MA
> 781-455-7550 ext. 271
> www.needhamma.gov/planning
>
> ---
>
> **From:** Justin Mosca <JMosca@VHB.com>
> **Sent:** Friday, September 8, 2023 10:31 AM
> **To:** Tom Conroy <TConroy@needhamma.gov>
> **Cc:** Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Evans Huber <eh@128law.com>
> **Subject:** RE: Request for comment - 629-661 Highland Ave
>
> Chief Conroy,
>
> It has come to our attention that there is an existing hydrant at the far end of Cross Street that

was in the middle of the pavement (with a couple bollards around it). We had missed this on the plan, so we're now showing that hydrant to be relocated to the northeast edge of pavement, which will provide four hydrants in the vicinity of the Project rather than the three shown previously. Please see attached for an updated figure with the hydrant coverages.

If you have any comments on hydrant locations or preferences for the FDC serving the building, please let us know.

Thank you,

Justin

Justin Mosca, PE
Project Manager
Licensed in MA

P 617.607.2727

www.vhb.com

From: Justin Mosca
Sent: Wednesday, August 30, 2023 2:51 PM
To: TConroy@needhamma.gov
Cc: DAnastasi@needhamma.gov; steevesj@needhamma.gov; rgavel@needhamma.gov; Alexandra Clee (aclee@needhamma.gov) <aclee@needhamma.gov>; LNewman@needhamma.gov; Evans Huber <eh@128law.com>
Subject: RE: Request for comment - 629-661 Highland Ave

Chief Conroy,

VHB was forwarded your request below regarding additional information on hydrant locations and fire dept. connections for the proposed MOB on Highland Avenue. Please find attached a figure which shows our anticipated hydrant coverage and fire truck routing around the site using Needham's aerial tower truck. One of the hydrants (along Highland Ave) is existing to remain. The other two are new proposed hydrants to provide no more than 250' between a hydrant and building points.

With regards to the fire department connection, the location is flexible and I think we'd be interested to hear your opinion on where you'd like it to be located, since you'll know where you'd like to set up with the pumper truck. It should be within 100' of a hydrant to meet code requirements, but other than that, I believe it can be on whichever face of the building you'd prefer. We're also curious if you have a preferred style of connection (Siamese or Storz).

Please let us know your thoughts. Feel free to give me a call to talk it through if easier.

Thank you,

Justin Mosca, PE
Project Manager
Licensed in MA

P 617.607.2727

www.vhb.com

From: Tom Conroy <TConroy@needhamma.gov>
Sent: Wednesday, August 30, 2023 9:17:48 AM
To: Alexandra Clee <aclee@needhamma.gov>
Cc: Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi Alex,

Sorry for the late response. Would it be possible to get more detail on the hydrant location and the fire department sprinkler intake connection?

Thank you.

<image001.png>

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Tuesday, August 29, 2023 5:23 PM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi there,

Sending a reminder to please send your comments by tomorrow.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov/planning

From: Alexandra Clee

Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661 Highland_Neehigh LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.

2. Letter from Attorney Evans Huber, dated August 4, 2023.

3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.

4. Letter from Attorney Evans Huber, dated August 7, 2023.

5. Plan entitled “Highland Ave Medical Office Building,” prepared by Maugel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled “Existing Conditions Plan of Land,” dated August 4, 2023; Sheet 5, Sheet C1.01, entitled “Legend and General Notes,” dated August 4, 2023; Sheet 6, Sheet C2.01, entitled “Site Preparation Plan,” dated August 4, 2023; Sheet 7,

Sheet C3.01, entitled “Layout and Materials Plan,” dated August 4, 2023; Sheet 8, Sheet C4.01, entitled “Grading and Drainage Plan,” dated August 4, 2023; Sheet 9, Sheet C5.01, entitled “Utilities Plan,” dated August 4, 2023; Sheet 10, Sheet C6.01, entitled “Site Details 1,” dated August 4, 2023; Sheet 11, Sheet C6.02, entitled “Site Details ,” dated August 4, 2023; Sheet 12, Sheet C6.03, entitled “Site Details 3,” dated August 4, 2023; Sheet 13, Sheet L102, entitled “Rendered Material plan,” dated August 4, 2023; Sheet 14, Sheet L103, entitled “Grading Plan,” dated August 4, 2023; Sheet 15, Sheet L104, entitled “Planting Plan,” dated August 4, 2023; Sheet 16, Sheet L501, entitled “Details,” dated August 4, 2023; Sheet 17, Sheet L520, entitled “Planting Details,” dated August 4, 2023; Sheet 18, Sheet L521, entitled “Planting Details,” dated August 4, 2023; Sheet 19, entitled “Site Lighting Photometric Plan,” dated July 14, 2023; Sheet 20, Sheet A.101, entitled “F-1 Lower Parking plan,” dated August 4, 2023; Sheet 21, Sheet A.102, entitled “F-2 Upper parking Plan,” dated August 4, 2023; Sheet 22, Sheet A.103, entitled “First Floor Plan,” dated August 4, 2023; Sheet 23, Sheet A.104, entitled “Second Floor Plan,” dated August 4, 2023; Sheet 24, Sheet A.105, entitled “Roof Plan,” dated August 4, 2023; Sheet 25, Sheet A.201, entitled “Elevations,” dated August 4, 2023; Sheet 26, Sheet A.301, entitled “Building Sections,” dated August 4, 2023; Sheet 27, entitled “P-1 Lower Below Grade Parking,” dated July 14, 2023; Sheet 28, entitled” P-2 Upper Parking,” dated July 14, 2023; Sheet 29, entitled “First Floor Plan,” dated July 14, 2023; Sheet 30, entitled “Second Floor Plan,” dated July 14, 2023; Sheet 31, entitled “Roof Plan,” dated July 14, 2023; Sheet 32, entitled “Materials of Major Architectural Elements,” dated July 14, 2023; Sheet 33, entitled “Concept Renderings, View at Highland Ave & Cross Street” dated July 14, 2023; Sheet 34, entitled “Concept Renderings, View at P-2 parking Level (South)” dated July 14, 2023; Sheet 35, entitled “Concept Renderings, View at P-2 Parking Level (West)” dated July 14, 2023; Sheet 36, entitled “Concept Renderings, View along highland Ave (North)” dated July 14, 2023; Sheet 37, entitled “Concept Renderings, View at Cross Street Below Grade Garage Entrance” dated July 14, 2023; Sheet 38, entitled “Concept Renderings, View at Arbor Street Above Grade Parking Entrance” dated July 14, 2023; Sheet 39, entitled “Concept Renderings, View at Landscape Plaza” dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.

7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

<Highland MOB - Fire Access Figure [2023-09-08].pdf>

September 20, 2023

REF: NEX-2200392.00

Ms. Lee Newman
Director of Planning and Community Development
500 Dedham Avenue
Needham, MA 02492

SUBJECT: Proposed Medical Office Building, 629-661 Highland Avenue, 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 (TIAS) prepared by Vanasse & Associates, Inc. (VAI) for review by the Town of Needham for the proposed Medical Office Building in Needham, Massachusetts. The site is located at 629-661 Highland Avenue and is bounded by Arbor Street to the west, Cross Street to the east, and a commercial property to the north. The site currently contains four (4) commercial buildings that will be removed to accommodate the Project. The Project will consist of a 50,000 square foot (sf) medical office building with 250 parking spaces. GPI has reviewed the TIAS and supporting traffic analysis 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. A review of the MassDOT State Highway Layouts Map indicates that the Project directly abuts the State Highway Layout (SHLO) on Highland Avenue and therefore, the Project will require a Vehicular Access Permit from MassDOT. As the Project is anticipated to generate more than 1,000 vehicles per day (vpd) and construction of more than 150 parking spaces, the project will require review by the Massachusetts Environmental Policy Act (MEPA) office in the form of an Environmental Notification Form (ENF).

Study Area

2. The TIAS includes an evaluation of the impact to traffic operations associated with the project at a total of five (5) intersections. 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 development.

Existing Conditions

3. 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.

4. The Existing Conditions Vehicle Volumes were derived from traffic counts obtained in September 2019, prior to the COVID-19 pandemic, however, MassDOT Engineering Directive E-22-003 released on July 28, 2022 requires that traffic data be less than 2 years old. The Applicant collected ATRs along Highland Avenue in March 2023 to compare 2019 volumes to current 2023 counts and concluded that traffic volumes in 2019 are significantly higher and therefore should be used as a baseline and grown by 1% per year to establish the 2023 Existing Conditions. While GPI agrees that this methodology will result in the most conservative (worst case) estimate of the project's impacts on traffic operations through the

study area, it does not establish a true existing conditions assessment and does not comply to current standards. In addition to changes in traffic patterns due to COVID-19, the Muzi Ford dealership, located at 557 Highland Avenue, closed in November 2021 and has since been demolished, which would have also contributed to changes in traffic patterns in the area. **GPI suggests that the Applicant collect new weekday peak hour turning movement counts for the study area intersections to account for changes in travel patterns post-COVID 19.**

5. MassDOT's Weekday Seasonal Factors data for 2019 indicates that traffic volumes during the month of September represents above-average conditions for Group Factors U3-U7. Therefore, no seasonal adjustment would be required for any of the study area intersections. The TIAS states that the traffic volumes for January were reviewed, however, the counts were collected in September. The typo should be corrected.

6. The Applicant should include a comparison table to show the difference between the 2019 and the 2023 ATR volumes along Highland Avenue and show the percent difference between them.

7. Figure 1 shows a purple "T" icon to the northeast of the site (behind 235 Gould Street) however, there is no Commuter Rail Station at that location. The map should be corrected.

8. The TIAS states that the only public transportation in the vicinity of the Project site is the Needham Line of the MBTA Commuter Rail with a stop at the Needham Heights Station, approximately 3-minute driving distance from the Project Site. GPI reviewed nearby transit available in the area and found that there is also MBTA bus service provided via Route 59 with a stop at the Webster Street / Hillside Avenue intersection, less than a 10-minute walk from the Project Site. Route 59 provides service between Needham Junction Station and Watertown Square, with 35-40 minute headways during the peak hour. The MBTA's Bus Network Redesign is proposing to reduce peak hour headways along this route to 25-minutes. Additionally, a private shuttle service is provided by the Route 128 Business Council and connects the Newton Highlands Green Line station to the Needham Crossing Area.

Collision History

9. The crash rate workbook for Highland Avenue at Gould Street and Hunting Street shows incorrect volumes. Please correct the volumes and update the calculated crash rate.

10. Although the intersection of Highland Avenue at Gould Street and Hunting Road 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 and the nearby Highland Science Center is proposing additional improvements. Therefore, preparation of a collision diagram for this location is not required.

2030 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 the other proposed or approved developments in the surrounding area. GPI concurs with this methodology.

12. The Highland Innovation Center TIAS (approved by the town in December 2022) included the 100 West Street Project, Newton Northland Development, and the 589 Highland Avenue projects as project-specific growth in their Future No-Build volumes. For consistency, the Applicant should consider if these projects will add background volumes to the Project's study area.

Trip Generation

13. The TIAS states that the existing daily site-generated trips were estimated using ITE Trip Generation Manual, 11th Edition. The TIAS should include existing size of each land use and should describe why each land use code was selected. It is unclear why the existing medical office use described in page 18 is broken into 20.8KSF general office (LUC 710) and 3.15KSF of medical-dental office building (LUC 720).

14. The morning and evening existing site-generated trips were estimated based on empirical traffic counts collected on September 4, 2019. While GPI concurs with this methodology, the Applicant should clarify if existing trips from the Landscaping/Crane business adjacent to the Project site were excluded from the existing counts since their access is also through Arbor Road. Additionally, GPI was not able to verify if the existing site-generated volumes on Table 6 were correct and requests that the Applicant clarify which intersections/movements were added to establish the existing site-generated trips.

15. Although the Applicant has proposed a 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.

16. The Project Generated figures (Figures 9 and 10) provided in the TIAS reflect the trip assignment for the new project generated trips (129 in the morning and 200 in the evening) and not the net-new project generated trips (101 in the morning and 168 in the evening). The Applicant should clarify if the analysis was conducted for the net-new traffic volumes or the total new volumes.

17. Table 7 on page 19 shows the traffic volume increase using the net-new project generated volumes. The Applicant should clarify if the new or net-new volumes were used in the analysis. If the analysis was conducted using the new vehicle trips (not net-new), the table should be updated to show percent increases compared to new trips or should explain why only net-new trips were used.

Traffic Operations Analysis

18. The TIAS did not provide any V/C ratios for the overall intersection, GPI requests that these be included in Table 10.

19. According to Table 11, the Cross Street southbound approach to Highland Avenue will operate with delays of approximately 185 seconds during the evening peak hour. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.

20. Additionally, the queues from the Highland Avenue eastbound approach at the Highland Avenue at Gould Street and Hunting Road intersection extend past Cross Street and will impact vehicles turning left from Cross Street to Highland Avenue. The Applicant should investigate measures, like "Do Not Block the Box" markings on Highland Avenue to ensure that site-generated traffic is able to exit the site and not produce extensive queues to Putnam Street or the Site Driveway.

21. Similarly, the Arbor Street southbound approach to Highland Avenue will operate with delays of approximately 55 seconds during the evening peak hour. The Applicant should investigate measures to reduce delay and improve operations at this location.

22. The Applicant should clarify why operations improve between the No-Build and Build conditions for the intersection of Highland Avenue at Arbor Street during the morning peak hour.

23. The Peak Hour Factor (PHF) for the future conditions has not been adjusted to 0.92, as required by MassDOT. GPI requests that the PHF be updated for the 2030 No-Build, 2030 Build, and 2030 Build with Mitigation analyses.

24. Some intersections reviewed by GPI have discrepancies in the percent heavy vehicle when comparing the same time periods between the No-Build and Build Conditions. GPI requests that the Applicant review these factors and correct any discrepancies.

Transportation Demand Management (TDM) Measures

25. The Applicant has proposed the following TDM measures:
    - Become a member of the Route 128 Business Council Transportation Management Association (TMA),
    - Hire a transportation coordinator,
    - Rideshare matching,
    - Guaranteed ride home,
    - Promotional efforts,
    - Amenities to discourage off-site trips,
    - Pedestrian accommodations,
    - Secure bike parking.

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.

26. As part of their approval, the Highland Science Center has committed to providing a shuttle to the commuter rail at Needham Heights and the Green Line D Branch at Newton Highlands during the hours of 7:00AM – 9:00AM and 4:00PM and 6:00PM Monday through Friday. GPI requests that the applicant coordinate with the Proponent of the Highland Science Center to assess the feasibility of participating in the shuttle service.

27. GPI requests that the Applicant explore additional TDM measures including providing a 50 percent transit pass subsidy to its employees and displaying real-time transit related information in the Main Lobby for tenants and visitors (i.e., Transit Screen)

Bicycle Accommodations

28. The TIAS states that secure bicycle parking will be provided within the Project site. The Applicant does not indicate how many bike parking spaces will be provided and how many of those spaces will be indoors and how many will be outdoors. Section 5.1.3(n) in the Town of Needham's Zoning Bylaws states that bicycle parking shall be provided at a rate of one bicycle parking per forty parking spaces required therefore it is expected that at least six (6) bike parking spaces will be provided on-site. However, with the recent bicycle improvements in the area, GPI requests that the Applicant consider providing more bicycle parking than the minimum required to support cycling to/from the Site.

29. The TIAS 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. 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.

Site Access, Circulation, and Site Plan

30. The Site Plan provided in the TIAS (Sheet A.102) has a different building elevator core location from the Planning Board Submission package. Please show the correct site plan in the TIAS.

31. The site plan in the TIAS should depict the location of vehicular access, loading, trash, pedestrian entrances, bicycle entrances, long-term and short-term bike racks, and any other proposed transportation related infrastructure.

32. A loading area is shown in the P-2 Upper Parking Plan; however, it is unclear if it is sized properly for the anticipated use. GPI requests that the applicant provide the anticipated size and quantity of truck using the loading area to ensure that one loading zone is sufficient.

33. A small trash room is shown in the P-2 level. The Applicant should confirm if the size is appropriate for the medical office use and ensure that medical waste is properly stored and disposed of.

34. GPI requests that the stall dimensions for regular, compact, and handicapped parking be provided in the site plan. The applicant should confirm that the stall dimensions comply with the Town of Needham Zoning Bylaw related to off-street parking.

35. Currently no handicapped parking is shown in the Site Plan. GPI requests that the number and location of handicapped parking be provided.

36. 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. For Cross Street, the Applicant should provide the roadway grade and ensure that trucks and vehicles can safely exit Cross Street onto Highland Avenue.

37. Table 11 of the TIAS indicates that queues of nearly 125 feet (five vehicles) could occur at the Cross Street approach of the intersection of Highland Street at Cross Street and Millis Road. It appears that only about 50 feet of stacking distance is provided before reaching the proposed driveway to the P-2 upper parking deck. Therefore, the queues exiting the P-2 parking will regularly back up and may impact operations within the garage. Also, vehicles trying to turn left from Cross Street to the garage driveway might encounter a vehicle blocking the driveway and could cause spillback onto Highland Avenue. The Applicant should consider modifications to the site plan to provide additional vehicle stacking exiting Cross Street.

38. The Applicant should identify where patient drop-off/pick up will occur within the Project site as to not interfere with operations along Highland Avenue.

39. The Applicant should commit to providing appropriate Wayfinding signs to indicate where patients, employees, and service vehicles should enter the site.

40. Sheet C3.01 depicts a pedestrian crosswalk across Arbor Street at the Highland Avenue intersection. This approach should also include a bike crosswalk and ramp to accommodate the sidewalk level bike lane.

Other Typos and Corrections

41. The posted street name sign on Arbor Street referrers to the roadway as “Arbor Road”. Please confirm if the roadway is “Arbor Road” or “Arbor Street”.

42. The No-Build Traffic volumes section in page 17 indicates that the No-Build conditions is for the year 2029. The typo should be corrected.

43. At multiple locations throughout the TIAS, the development is referred to "an medical office building". The typo should be corrected to say "a medical office building."

Should you have any questions regarding these comments, please contact me directly at 617-207-8740 or asantiago@gpinet.com, or John Diaz at 978-570-2953, or jdiaz@gpient.com.

Sincerely,

GREENMAN-PEDERSEN, INC.

Adriana Santiago, P.E.
Project Engineer

cc: J. Diaz, GPI via email

From:	Colby Cavanagh
To:	Lee Newman; Alexandra Clee
Cc:	Jodie Zussman; Robert Doherty; Daniel Barton; Jeffrey Dirk; Justin Mosca; Jonathan Cocker; Evans Huber
Subject:	RE: 629-661 Highland
Date:	Tuesday, October 10, 2023 3:26:59 PM
Attachments:	image001.png 629-661 Highland Ave RTC 10_23.pdf Figure FT-1 - Fire Truck.pdf Figure TT-1 - SU-30 Delivery.pdf Figure TT-2 - Garbage Collection.pdf Highland Ave MOB_A.101&A.102_20231006.pdf MDA Letter to Needham PB 10-10-2023.pdf

---

Good Afternoon Lee & Alex,

Please see the attached PDFs in response to the GPI peer review report. They include the following:

- VAI Letter addressing GPI Traffic comments
- MDA Letter addressing GPI Site Access, Circulation & Site Plan comments
- Fire Truck turning movement figure (previously sent to the Fire Department)
- Delivery & Garbage Collection turning movement figures
- Revised Upper and Lower Parking plans for further clarification to GPI Comments

Feel free to let me know if you have any trouble opening / accessing these documents. Thank you for your continued assistance.

Best,
Colby

MAUGEL DESTEFANO ARCHITECTS

Colby Ann Cavanagh, AIA
978 456 2860

200 Ayer Road, Suite 200, Harvard, MA 01451
22 Ladd Street, Portsmouth, NH 03801

MAUGEL.COM / **Celebrating 30 Years of Shaping the Exceptional**

From: Evans Huber <eh@128law.com>
Sent: Tuesday, October 10, 2023 10:29 AM
To: Lee Newman <LNewman@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>
Cc: Colby Cavanagh <ccavanagh@maugel.com>; Jodie Zussman <jzussman@bdg1.com>; Robert Doherty <rdoherty@bdg1.com>; Daniel Barton <dbarton@maugel.com>; Jeffrey Dirk <jdirk@rdva.com>; Justin Mosca <JMosca@VHB.com>
Subject: 629-661 Highland

Lee and Alex:

We will be submitting our response to the GPI peer review report this afternoon. In addition to the traffic-related issues that VAI will be responding to, some of the issues raised by GPI are being responded to by other members of our team (architects, civil engineers). Accordingly, Colby Cavanaugh from our architectural firm, Maugel Destefano, will be compiling the responses and sending them to you directly. Please be sure to reach out to her directly (and to me) if you have any difficulty opening any of the documents she sends.

Thanks, Evans

Evans Huber
Frieze Cramer Rosen & Huber, LLP
62 Walnut Street, Suite 6
Wellesley, MA 02481
781-943-4000 (main)
781-943-4043 (direct)
781-799-9272 (cell)
eh@128law.com
www.128law.com

Vanasse & Associates inc
Transportation Engineers & Planners

35 New England Business Center Drive
Suite 140
Andover, MA 01810

Ref: 8315

October 10, 2023

Ms. Lee Newman
Director of Planning and Community Development
500 Dedham Avenue
Needham, MA 02492

Re: Response to Traffic Peer Review
Proposed Medical Office Building - 629-661 Highland Avenue
Needham, Massachusetts

Dear Lee:

Vanasse & Associates, Inc. (VAI) is providing responses to the comments that were raised in the September 20, 2023 *Traffic Peer Review* letter prepared by Greenman-Pedersen Inc. (GPI) concerning their review of the July 2023 *Transportation Impact Assessment* (the "July 2023 TIA") that was prepared by VAI in support of the proposed medical office building to be located at 629-661 Highland Avenue in Needham, Massachusetts (hereafter referred to as the "Project"). Listed below are the comments that were identified by GPI in the subject letter followed by our response on behalf of the Project proponent. Responses to the comments pertaining to "Site Access, Circulation, and Site Plan" (comments 30 through 40) will be provided by others under separate cover.

General Comments

GPI Comment 1: *A review of the MassDOT State Highway Layouts Map indicates that the Project directly abuts the State Highway Layout (SHLO) on Highland Avenue and therefore, the Project will require a Vehicular Access Permit from MassDOT. As the Project is anticipated to generate more than 1,000 vehicles per day (vpd) and construction of more than 150 parking spaces, the project will require review by the Massachusetts Environmental Policy Act (MEPA) office in the form of an Environmental Notification Form (ENF).*

Response: While the Project will require a State Highway Access Permit from MassDOT and is expected to generate >1,000 new vehicle trips on an average weekday (1,166 new vehicle trips are predicted), the net increase in parking will be less than 150 new parking spaces (130 new parking spaces are proposed) and, as such, the Project does not exceed the Transportation thresholds established under MEPA that would require the filing of an ENF.

Study Area

GPI Comment 2: *The TIAS includes an evaluation of the impact to traffic operations associated with the project at a total of five (5) intersections. 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 development.*

Response: No response required.

Existing Conditions

GPI Comment 3: *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.*

Response: No response required.

GPI Comment 4: *The Existing Conditions Vehicle Volumes were derived from traffic counts obtained in September 2019, prior to the COVID-19 pandemic, however, MassDOT Engineering Directive E-22-003 released on July 28, 2022 requires that traffic data be less than 2 years old. The Applicant collected ATRs along Highland Avenue in March 2023 to compare 2019 volumes to current 2023 counts and concluded that traffic volumes in 2019 are significantly higher and therefore should be used as a baseline and grown by 1% per year to establish the 2023 Existing Conditions. While GPI agrees that this methodology will result in the most conservative (worst case) estimate of the project's impacts on traffic operations through the study area, it does not establish a true existing conditions assessment and does not comply to current standards. In addition to changes in traffic patterns due to COVID-19, the Muzi Ford dealership, located at 557 Highland Avenue, closed in November 2021 and has since been demolished, which would have also contributed to changes in traffic patterns in the area.* ***GPI suggests that the Applicant collect new weekday peak hour turning movement counts for the study area intersections to account for changes in travel patterns post-COVID 19.***

Response: New weekday peak-hour turning movement counts (TMCs) have been scheduled for the study area intersections and will be completed on Tuesday, October 10, 2023.

GPI Comment 5: *MassDOT's Weekday Seasonal Factors data for 2019 indicates that traffic volumes during the month of September represents above-average conditions for Group Factors U3-U7. Therefore, no seasonal adjustment would be required for any of the study area intersections. The TIAS states that the traffic volumes for January were reviewed, however, the counts were collected in September. The typo should be corrected.*

Response: The typo is noted and does not affect the underlying conclusion that the September traffic counts represent above average conditions. The seasonal adjustment data will be updated and the identified correction will be addressed in the October 2023 Update to the July 2023 TIA.

GPI Comment 6: *The Applicant should include a comparison table to show the difference between the 2019 and the 2023 ATR volumes along Highland Avenue and show the percent difference between them.*

Response: Table 2A provides a comparison of the 2019 and 2023 ATR volumes along Highland Avenue and includes the percentage difference.

Table 2A
HIGHLAND AVENUE TRAFFIC VOLUME COMPARISON[a]

Time Period	2023	2019	Difference	% Difference
Average Weekday Traffic	16,385	17,715	-1,330	-7.5%
Weekday Morning Peak-Hour	1,247	1,547	-300	-19.4%
Weekday Evening Peak-Hour	1,355	1,590	-235	-14.8%

[a]Traffic volumes adjusted to average-month conditions.

GPI Comment 7: *Figure 1 shows a purple "T" icon to the northeast of the site (behind 235 Gould Street) however, there is no Commuter Rail Station at that location. The map should be corrected.*

Response: The purple "T" icon shown on Figure 1 is intended to indicate the location of the Commuter Rail tracks and not a Commuter Rail Station, which would have been indicated by including the name of the station. The map is correct as presented; however, the intent will be clarified in the October 2023 Update to the July 2023 TIA.

GPI Comment 8: *The TIAS states that the only public transportation in the vicinity of the Project site is the Needham Line of the MBTA Commuter Rail with a stop at the Needham Heights Station, approximately 3-minute driving distance from the Project Site. GPI reviewed nearby transit available in the area and found that there is also MBTA bus service provided via Route 59 with a stop at the Webster Street/ Hillside Avenue intersection, less than a 10-minute walk from the Project Site. Route 59 provides service between Needham Junction Station and Watertown Square, with 35-40 minute headways during the peak hour. The MBTA's Bus Network Redesign is proposing to reduce peak hour headways along this route to 25-minutes. Additionally, a private shuttle service is provided by the Route 128 Business Council and connects the Newton Highlands Green Line station to the Needham Crossing Area.*

Response: Comment noted. No response required.

Collision History

GPI Comment 9: *The crash rate workbook for Highland Avenue at Gould Street and Hunting Street shows incorrect volumes. Please correct the volumes and update the calculated crash rate.*

Response: The motor vehicle crash analysis and crash rate calculations will be updated as a part of the October 2023 Update to the July 2023 TIA.

GPI Comment 10: *Although the intersection of Highland Avenue at Gould Street and Hunting Road 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 and the nearby Highland Science Center is proposing additional improvements. Therefore, preparation of a collision diagram for this location is not required.*

Response: No response required.

2030 No-Build Conditions

GPI Comment 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 the other proposed or approved developments in the surrounding area. GPI concurs with this methodology.*

Response: No response required.

GPI Comment 12: *The Highland Innovation Center TIAS (approved by the town in December 2022) included the 100 West Street Project, Newton Northland Development, and the 589 Highland Avenue projects as project specific growth in their Future No-Build volumes. For consistency, the Applicant should consider if these projects will add background volumes to the Project's study area.*

Response: A review of traffic volumes associated with the following specific development projects by others was undertaken:

Senior Living Residential Redevelopment, 100 West Street, Needham, Massachusetts. There is currently no pending application before the Town for a project at this location. The prior development proposal that was withdrawn was to entail the construction of a senior housing community consisting of 100 units of senior adult housing and a 96 bed memory care facility.

Northland Newton Development, Needham Street, Newton, Massachusetts. This project entails the redevelopment of existing commercial space into a mixed-use development consisting of a 822 unit multifamily residential development, 180,000 square feet (sf) of office space and 237,000 sf of retail space to be located off Needham Street, east of the Project site.

Senior Adult Housing, 589 Highland Avenue, Needham, Massachusetts. This project entails the conversion of an existing 142-bed skilled nursing facility to a 72 unit senior adult housing community. The materials that were submitted in support of this project indicated that the proposed uses would result in less traffic than the previous use(s) that occupied the property.

Based on this review, it was determined that the additional traffic associated with these projects (if any) within the study area that was assessed in the July 2023 TIA would be minor and reflected in the general background traffic growth rate.

Trip Generation

GPI Comment 13: *The TIAS states that the existing daily site-generated trips were estimated using ITE Trip Generation Manual, 11th Edition. The TIAS should include existing size of each land use and should describe why each land use code was selected. It is unclear why the existing medical office use described in page 18 is broken into 20.8 KSF general office (LUC 710) and 3.15 KSF of medical-dental office building (LUC 720).*

Response: Traffic volumes associated with the existing/former uses that operated from within the Project site were developed based on the occupancy of the buildings at the time that the data collection was performed (tenant list and building areas attached). At the time of the data collection, one tenant, Kennedy Brothers physical therapy (NEE-633100), was classified as a medical office use and encompassed approximately 3,150 sf. The rest of the uses included 20,800± sf of office space; 9,480± sf of light industrial space; 5,030± sf of warehousing; and a 3,150± sf yoga studio.

GPI Comment 14: *The morning and evening existing site-generated trips were estimated based on empirical traffic counts collected on September 4, 2019. While GPI concurs with this methodology, the Applicant should clarify if existing trips from the Landscaping/Crane business adjacent to the Project site were excluded from the existing counts since their access is also through Arbor Road. Additionally, GPI was not able to verify if the existing site-generated volumes on Table 6 were correct and requests that the Applicant clarify which intersections/movements were added to establish the existing site-generated trips.*

Response: The traffic volumes generated by the landscaping business were assumed to be negligible during the weekday morning and evening peak-hours. The existing site trips are graphically depicted in the July 2023 TIA Technical Appendix as Figures A-5 and A-6 for the weekday morning and weekday evening peak-hours, respectively (copies attached). In brief, all volumes entering and exiting Arbor Road and all vehicles entering and exiting Cross Street, excluding those entering and exiting Putnam Street, were assumed to be related to the existing land uses located in the Project site at the time that the traffic counts were performed.

GPI Comment 15: *Although the Applicant has proposed a 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.

Response: The Project includes a commitment to implement a comprehensive Transportation Demand Management (TDM) program that includes proven measures that have been successful at reducing employee related automobile trips, including: providing a rideshare matching program; offering a "guaranteed-ride-home" program; providing on-site amenities such as a breakroom with refrigerator and microwave, and direct deposit of paychecks; and providing secure, weather protected bicycle parking. An effectively marketed TDM program can achieve trip reductions of 10 percent or more over baseline (no TDM program) conditions. The 10 percent trip reduction goal will be used as a benchmark for the Traffic Monitoring Program that will be included as a part of the Project. Any reduction in trips that may result from the TDM program will be beneficial to reducing the impact of the Project on the transportation infrastructure.

GPI Comment 16: *The Project Generated figures (Figures 9 and 10) provided in the TIAS reflect the trip assignment for the new project generated trips (129 in the morning and 200 in the evening) and not the net-new project generated trips (101 in the morning and 168 in the evening). The Applicant should clarify if the analysis was conducted for the net-new traffic volumes or the total new volumes.*

Response: Trip associated with the existing uses were removed from the 2030 No-Build condition traffic volumes and the new volumes associated with the Project were then added to develop the 2030 Build condition traffic volumes. Traffic volume networks documenting the removal of the existing site trips were provided in the July 2023 TIA Technical Appendix (also attached).

GPI Comment 17: *Table 7 on page 19 shows the traffic volume increase using the net-new project generated volumes. The Applicant should clarify if the new or net-new volumes were used in the analysis. If the analysis was conducted using the new vehicle trips (not net-new), the table should be updated to show percent increases compared to new trips or should explain why only net-new trips were used.*

Response: The intent of Table 7 is to document the increase in trips on the roadway network as a result of the construction of the Project and correctly presented the net increase in traffic over No-Build conditions.

Traffic Operations Analysis

GPI Comment 18: *The TIAS did not provide any V/C ratios for the overall intersection, GPI requests that these be included in Table 10.*

Response: V/C rations for the overall intersection will be included in Table 10 of the October 2023 Update to the July 2023 TIA.

GPI Comment 19: *According to Table 11, the Cross Street southbound approach to Highland Avenue will operate with delays of approximately 185 seconds during the evening peak hour. The Applicant has not proposed any measures to mitigate this impact. The Applicant should investigate measures to mitigate this significant impact to operations.*

Response: Cross Street approaching Highland Avenue was recently improved within the current layout as a part of MassDOT's Highland Avenue Improvement Project. Recognizing that the installation of a traffic control signal is not warranted, improvement options would include widening Cross Street to provide a two (2) lane approach to Highland Avenue, or restricting exiting movements to right-turn only. The two-lane exit would serve to reduce vehicle queuing, but cannot be accommodated within the existing roadway layout and would not materially reduce motorist delays. Restricting exiting movements to right-turn only operation would shift more traffic to Arbor Road and increase motorist delays and vehicle queueing, and could also result in motorists using side streets or driveways to reverse direction to travel east on Highland Avenue. Accordingly, the parking garage has been designed to provide a rear (north) driveway to allow vehicles to use either Cross Street or Arbor Road, and wayfinding signs will be provided to disperse exiting traffic between Cross Street and Arbor Road to better manage motorist delays and the associated residual vehicle queuing.

GPI Comment 20: *Additionally, the queues from the Highland Avenue eastbound approach at the Highland Avenue at Gould Street and Hunting Road intersection extend past Cross Street and will impact vehicles turning left from Cross Street to Highland Avenue. The Applicant should investigate measures, like "Do Not Block the Box" markings on Highland Avenue to ensure that site-generated traffic is able to exit the site and not produce extensive queues to Putnam Street or the Site Driveway.*

Response: To the extent approved by MassDOT, the Project proponent will design and install "Do Not Block" signs and pavement markings on Highland Avenue at the Cross Street/Mills Road intersection.

GPI Comment 21: *Similarly, the Arbor Street southbound approach to Highland Avenue will operate with delays of approximately 55 seconds during the evening peak hour. The Applicant should investigate measures to reduce delay and improve operations at this location.*

Response: While there are delays on the Arbor Road approach with the construction of the Project, similar to other unsignalized side streets and driveways along the Highland Avenue corridor, the residual vehicle queue is between one (1) and three (3) vehicles, which can be contained along Arbor Road without impeding access to Arbor Road or the movement of vehicles, pedestrians or bicyclists along Highland Avenue.

In order to reduce delays on Arbor Road and recognizing that the installation of a traffic control signal is not warranted, improvement options would include widening Arbor Road to provide separate left and right-turn lanes, or restricting exiting movements to right-turn only. The two-lane exit would serve to reduce vehicle queuing, but would not materially reduce motorist delays. Restricting

exiting movements to right-turn only operation would shift more traffic to Cross Street and increase motorist delays and vehicle queueing, and could also result in motorists using side streets or driveways to reverse direction to travel east on Highland Avenue. As such and recognizing the limited vehicle queuing along Arbor Road, no improvements appear warranted.

GPI Comment 22: *The Applicant should clarify why operations improve between the No-Build and Build conditions for the intersection of Highland Avenue at Arbor Street during the morning peak hour.*

Response: The reduction in average motorist delay for the Arbor Road approach to Highland Avenue during the weekday morning peak-hour between No-Build and Build conditions is a result of the increase in the number of right-turn movements with the construction of the Project, a movement that operates with less delay than left-turn movements. As the number of right-turn movements increases, the average delay will be reduced.

GPI Comment 23: *The Peak Hour Factor (PHF) for the future conditions has not been adjusted to 0.92, as required by MassDOT. GPI requests that the PHF be updated for the 2030 No-Build, 2030 Build, and 2030 Build with Mitigation analyses.*

Response: The PHF for all future analysis conditions (2030 No-Build, 2030 Build, and 2030 Build with Mitigation) will be adjusted to 0.92 as a part of the updated analyses that will be presented in the October 2023 Update to the July 2023 TIA.

GPI Comment 24: *Some intersections reviewed by GPI have discrepancies in the percent heavy vehicle when comparing the same time periods between the No-Build and Build Conditions. GPI requests that the Applicant review these factors and correct any discrepancies.*

Response: The heavy vehicle percentages will be updated as a part of the analyses that will be presented in the October 2023 Update to the July 2023 TIA.

Transportation Demand Management (TDM) Measures

GPI Comment 25: *The Applicant has proposed the following TDM measures:*

- *Become a member of the Route 128 Business Council Transportation Management*
- *Association (TMA),*
- *Hire a transportation coordinator,*
- *Rideshare matching,*
- *Guaranteed ride home,*
- *Promotional efforts,*
- *Amenities to discourage off-site trips,*
- *Pedestrian accommodations,*
- *Secure bike parking.*

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

Response: As a part of the TDM program, the Applicant will become a member of the Route 128 Business Council, who will coordinate the carpool matching program and emergency ride home program. These services are provided as a part of the membership fee that will be assessed to the Project.

GPI Comment 26: *As part of their approval, the Highland Science Center has committed to providing a shuttle to the commuter rail at Needham Heights and the Green Line D Branch at Newton Highlands during the hours of 7:00 AM – 9:00 AM and 4:00 PM and 6:00 PM Monday through Friday. GPI requests that the applicant coordinate with the Proponent of the Highland Science Center to assess the feasibility of participating in the shuttle service.*

Response: The Applicant will participate with the Town and the proponent of the Highland Science Center project to assess the feasibility of participating in the shuttle service program that will be operated as a part of the Highland Science Center project.

GPI Comment 27: *GPI requests that the Applicant explore additional TDM measures including providing a 50 percent transit pass subsidy to its employees and displaying real-time transit related information in the Main Lobby for tenants and visitors (i.e., Transit Screen)*

Response: The Applicant will encourage their tenant to offer a 50 percent transit pass subsidy based on the amount of an MBTA Monthly LinkPass (currently $90) to employees that commute to the Project site using public transportation at least three (3) days per week and that register with the Transportation Coordinator. In addition, a transit screen or equivalent display will be provided in the building lobby to display real-time traffic and bus location information (similar to https://transitscreen.com/).

Bicycle Accommodations

GPI Comment 28: *The TIAS states that secure bicycle parking will be provided within the Project site. The Applicant does not indicate how many bike parking spaces will be provided and how many of those spaces will be indoors and how many will be outdoors. Section 5.1.3(n) in the Town of Needham's Zoning Bylaws states that bicycle parking shall be provided at a rate of one bicycle parking per forty parking spaces required therefore it is expected that at least six (6) bike parking spaces will be provided on-site. However, with the recent bicycle improvements in the area, GPI requests that the Applicant consider providing more bicycle parking than the minimum required to support cycling to/from the Site.*

Response: The Project will include a minimum of 13 bicycle spaces consisting of secure, weather protected bicycle parking spaces in the parking garage and/or exterior bicycle parking for bicycles. The location of the bicycle parking will be added to the revised Site Plans (provided under separate cover).

GPI Comment 29: *The TIAS 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. 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.*

Response: Based on a review of the U.S. Census American Community Survey 5-year Estimates Data Profile for the Census Tract that contains the Project site (Census Tract 4035.01), approximately 6 percent of residents walk to work with no (0 percent) residents reporting that bicycling was their primary mode of transportation to work. Assuming that 6 percent of the employees of the Project may choose to walk and/or bicycle to work and an estimated maximum of 105 employees are on-site on a typical day, this would equate to a maximum bicycle parking demand of 6 bicycles if all 6 percent of the employees arrived by bicycle.

Other Typos and Corrections

GPI Comment 41: *The posted street name sign on Arbor Street refers to the roadway as "Arbor Road". Please confirm if the roadway is "Arbor Road" or "Arbor Street".*

Response: The reference should be Arbor Road and will be corrected in the October 2023 Update to the July 2023 TIA.

GPI Comment 42: *The No-Build Traffic volumes section in page 17 indicates that the No-Build conditions is for the year 2029. The typo should be corrected.*

Response: This will be corrected in the October 2023 Update to the July 2023 TIA.

GPI Comment 43: *At multiple locations throughout the TIAS the development is referred to "an medical office building". The typo should be corrected to say "a medical office building".*

Response: This will be corrected in the October 2023 Update to the July 2023 TIA.

We trust that this information is responsive to the comments that were identified in the September 20, 2023 letter prepared by GPI concerning their review of the Project. If you should have any questions or would like to discuss our responses in more detail, please feel free to contact me.

Sincerely,

VANASSE & ASSOCIATES, INC.

Jeffrey Dirk

Jeffrey S. Dirk, P.E., PTOE, FITE
Managing Partner

Professional Engineer in CT, MA, ME, NH, RI, and VA

JSD/jsd

Attachments

ATTACHMENTS

SEPTEMBER 2019 RENT ROLL
EXISTING SITE TRIP FIGURES

SEPTEMBER 2019 RENT ROLL

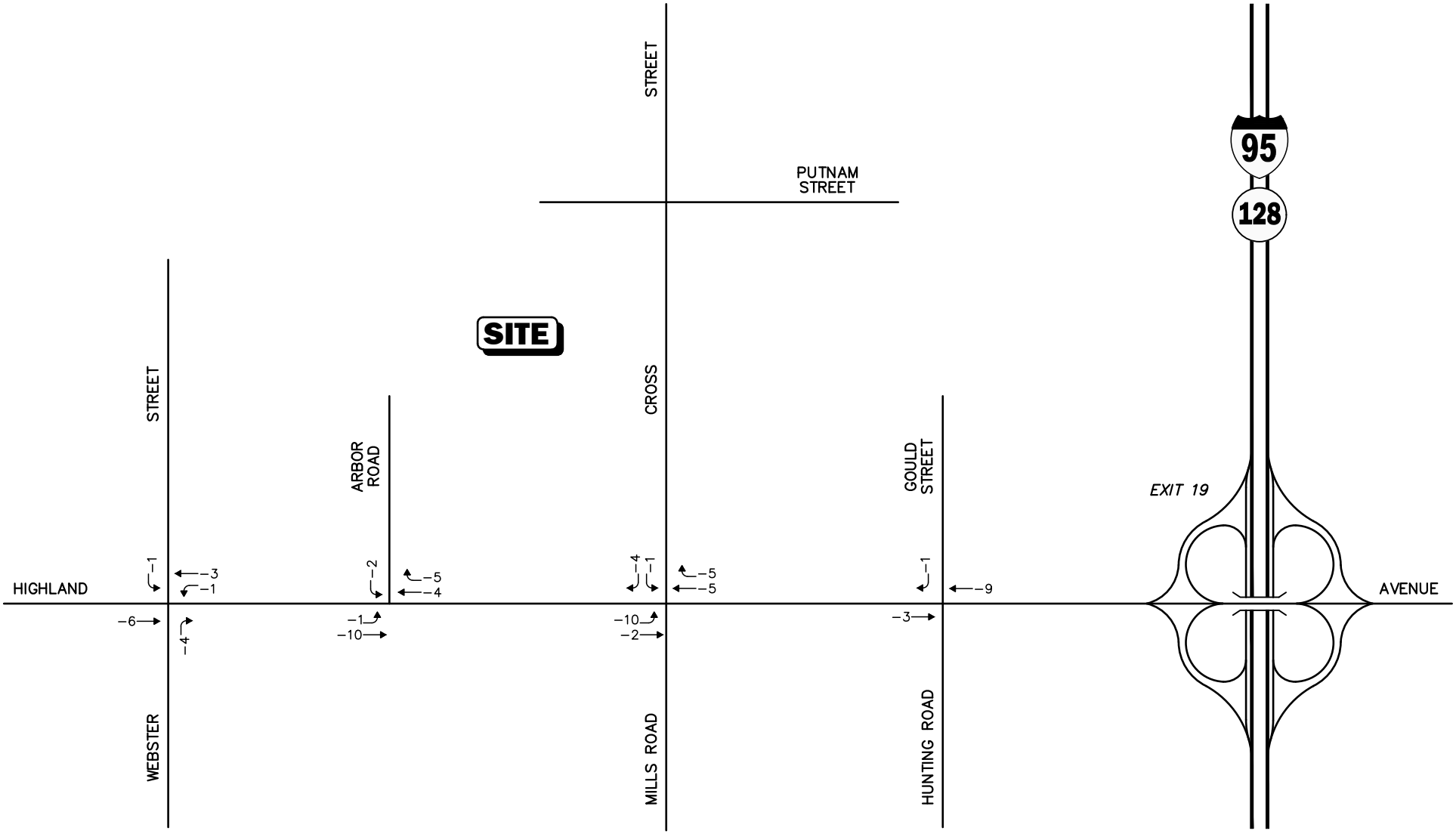
NEEDHAM RENT ROLL FOR PARKING

Unit Number	Tenant Name	Square Feet	Use Type	Parking Requirement	Number of Employees
NEE-661103	MULTI TENANTS	4,501	Office	15.00	single office
NEE-65910	DCAM METROLOGY	5,679	Industrial	1.00	1 employee
NEE-65920	HOPE & COMFORT	5,028	Warehouse	5.92	1 per 850 SF
NEE-629100	MOLDOFF, SCOTT L.	1,400	Office	4.67	
NEE-629101	SPEEDPRO IMAGING	3,800	Industrial	4.47	3 employees
NEE-629102	MED-EQUIP	621	Office	2.07	
NEE-629200	CHEMASSIST	1,951	Office	6.50	
NEE-629201	VACANT	1,184	Office	3.95	
NEE-633100	KENNEDY BROTHERS	3,150	P/T	15.75	Medical 1 per 200 SF
NEE-633200	ADJAK PRODUCTIONS	3,150	Yoga Studio	21.00	Athletic 1 per 150 SF
NEE-661100	ARMADALE, LLC	1,023	Office	3.41	
NEE-661101	GOLDBERG, DONALD	1,880	Office	6.27	
NEE-661102	CONNELLY CPA, INC.	1,325	Office	4.42	2 employees
NEE-661104	KRISPIN, HANNAH	1,400	Office	4.67	
NEE-661107	STEPHEN MCCOURT	950	Office	3.17	
NEE-661109	GANZ LAW	1,151	Office	3.84	
NEE-661200	BEST HOME HEALTH	932	Office	3.11	
NEE-661210	VACANT	2,657	Office	8.86	
		41,782		118.05	

Per 1,000	USE
150	ATHLETIC
300	OFFICE
200	PT/MEDICAL
850	WAREHOUSE

Athletic
Industrial
Medical

EXISTING SITE TRIP FIGURES



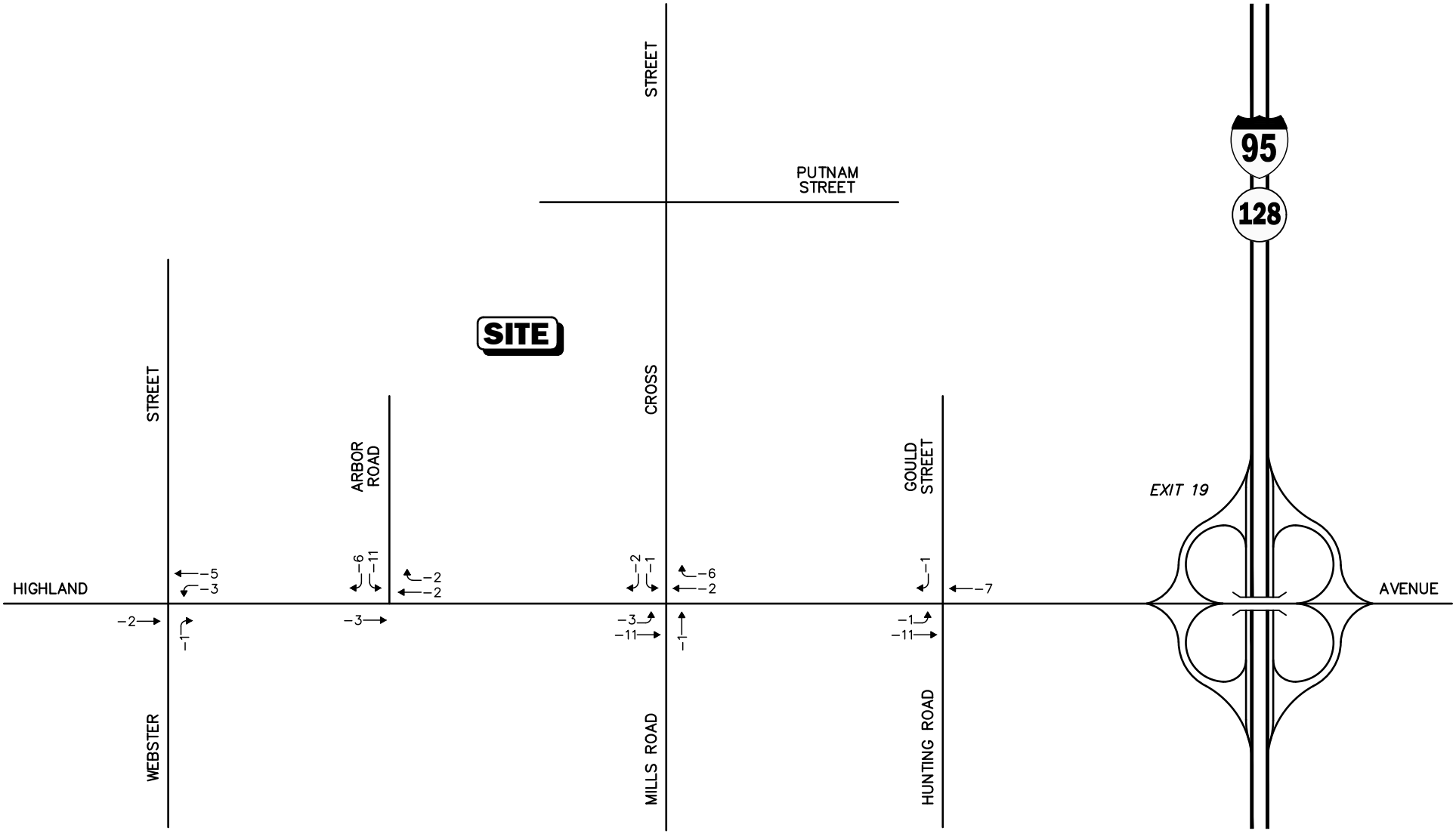
Not To Scale

Figure A-5

Site Trips Removed
Weekday Morning
Peak Hour Traffic Volumes

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig A-5, 5/28/2023 12:15:14 PM



Not To Scale

Figure A-6

Site Trips Removed
Weekday Evening
Peak Hour Traffic Volumes

Vanasse & Associates inc

R:\8315\8315NT2.dwg, Fig A-6, 5/28/2023 12:14:14 PM

MAUGEL DESTEFANO
ARCHITECTS

10 October 2023

Town of Needham Planning Board
Lee Newman/ Town Planner
500 Dedham Ave.
Needham, MA 02492

RE: 629-661 Highland Ave./ Proposed Medical Office Building/ Peer Review

Dear Ms. Newman and Planning Board Members,

Thank you for providing GPI's Traffic Peer Review comments regarding 629-661 Highland Avenue, dated September 20, 2023. This letter provides our responses to GPI's comments on the proposed building design and those from our team's Civil Engineer related to vehicle maneuvering and roadways. Our Traffic Engineer will respond to related comments under a separate cover.

As an overall point of clarification, please note that the Transportation Impact and Traffic Study (TIAS) prepared by Vanasse & Associates was undertaken in conjunction with our development of the proposed building design. As such, the TIAS included preliminary architectural information for reference purposes, which, while not finalized, was sufficient for the traffic study. Subsequent project submission to the Planning Board included refined architectural and site plan (Civil) information.

We are pleased to provide the following responses to GPI's comments. The numbers below correspond with GPI's letter.

30. *The Site Plan provided in the TIAS (Sheet A.102) has a different building elevator core location from the Planning Board Submission package. Please show the correct site plan in the TIAS.*

    RESPONSE: The architectural plans submitted to the Planning Board show the correct elevator core location. Vanasse & Associates has been provided with updated architectural information, which will be corrected in the October 2023 update to the July 2023 TIA.

31. *The site plan in the TIAS should depict the location of vehicular access, loading, trash, pedestrian entrances, bicycle entrances, long-term and short-term bike racks, and any other proposed transportation-related infrastructure.*

    RESPONSE: The site plans submitted to the Planning Board depict the locations of these elements. The October 2023 update to the July 2023 TIA will be corrected accordingly.

32. *A loading area is shown in the P-2 Upper Parking Plan; however, it is unclear if it is sized properly for the anticipated use. GPI requests that the applicant provide the anticipated size and quantity of trucks using the loading area to ensure that one loading zone is sufficient.*

    RESPONSE: The loading area is designed to accommodate a 30-foot box truck and smaller delivery vehicles that typically serve medical office buildings (i.e., FedEx/UPS trucks, linen delivery, office equipment delivery, etc.). We believe one dedicated loading area is sufficient based on our experience with medical office buildings.

33. *A small trash room is shown in the P-2 level. The Applicant should confirm if the size is appropriate for the medical office use and ensure that medical waste is properly stored and disposed of.*

    RESPONSE: The space designated for trash on parking level P-2 is an outdoor enclosure to accommodate an appropriately sized general trash dumpster. Medical waste will be collected and stored within tenant space(s) and disposed of properly by outside vendors.

34. *GPI requests that the stall dimensions for regular, compact, and handicapped parking be provided in the site plan. The applicant should confirm that the stall dimensions comply with the Town of Needham Zoning Bylaw related to off-street parking.*

    RESPONSE: All parking stall dimensions are designed to meet or exceed the town's requirements. Please refer to the attached updated copy of the parking level plans (A.101 and A.102) showing typical stall dimensions.

35. *Currently, no handicapped parking is shown on the Site Plan. GPI requests that the number and location of handicapped parking be provided.*

    RESPONSE: Accessible parking spaces are shown on the colored plans submitted to the Planning Board. Please refer to the attached updated copy of the parking level plans (A.101 and A.102) showing accessible parking spaces.

36. *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. For Cross Street, the Applicant should provide the roadway grade and ensure that trucks and vehicles can safely exit Cross Street onto Highland Avenue.*

    RESPONSE: Vehicle turning analyses have been performed for the Project, including turning movements for fire trucks, delivery vehicles, and garbage disposal. A fire truck access figure with hydrant coverage depictions was provided to and reviewed by the Needham Fire Department and included here for reference. Figures showing adequate turning space for SU-30 box truck deliveries and garbage collection are also attached.

    Cross Street is an existing, shared private way. No changes to the topography at the Cross Street intersection at Highland Avenue are proposed. Existing loading and vehicle access will remain as they are currently operating.

37. *Table 11 of the TIAS indicates that queues of nearly 125 feet (five vehicles) could occur at the Cross Street approach of the intersection of Highland Street at Cross Street and Millis Road. It appears that only about 50 feet of stacking distance is provided before reaching the proposed driveway to the P-2 upper parking deck. Therefore, the queues exiting the P-2 parking will regularly back up and may impact operations within the garage. Also, vehicles trying to turn left from Cross Street to the garage driveway might encounter a vehicle blocking the driveway and could cause spillback onto Highland Avenue. The Applicant should consider modifications to the site plan to provide additional vehicle stacking exiting Cross Street.*

RESPONSE: The location of the proposed upper parking driveway connection to Cross Street is fixed by the existing Cross Street grades, which slope away from Highland Avenue. To provide uninterrupted access to the upper parking driveway during queuing events, the site plans will be modified to provide "Do Not Block" striping.

38. *The Applicant should identify where patient drop-off/pick-up will occur within the project site so as to not interfere with the operations along Highland Avenue.*

    RESPONSE: Patient drop-off and pick-up will occur along the sides of the elevator lobby at both parking levels beneath the building. Please refer to the attached updated copy of the parking level plans (A.101 and A.102) showing patient drop-off/pick-up areas.

    As noted in our August 31, 2023 letter, there is no building entrance on Highland Avenue but rather a single emergency egress door. No patient drop-off/pick-up activities will interfere with Highland Avenue operations.

39. *The Applicant should commit to providing appropriate wayfinding signs to indicate where patients, employees, and service vehicles should enter the site.*

    RESPONSE: The applicant agrees to provide appropriate wayfinding signage.

40. *Sheet C3.01 depicts a pedestrian crosswalk across Arbor Street at the Highland Avenue intersection. This approach should also include a bike crosswalk and ramp to accommodate the sidewalk level bike lane.*

    RESPONSE: Noted; the crosswalk at Arbor Street will be updated to show the bicycle crossing consistent with the pavement markings recently installed by MassDOT at the Cross Street intersection as part of the Highland Avenue improvements project.

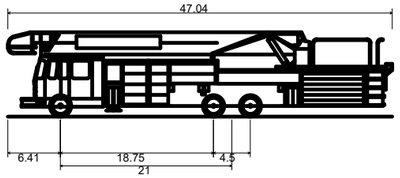
We trust that this information is helpful. Please do not hesitate to reach out with any further questions regarding these items. We look forward to continuing the project review with the Planning Board at its meeting on October 17.

Sincerely,

Daniel Barton AIA
Principal

978 273-3291
dbarton@maugel.com

\\Vhb\gbl\proj\Wat-LD\14781.00 BDG Highland Ave Needham\cad\ld\Planmisc\Truck Turns\14781.00-TT.dwg



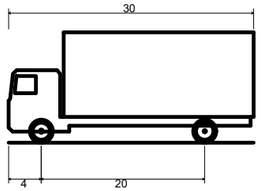
Needham Aerial Tower	
Overall Length	47.040ft
Overall Width	7.830ft
Overall Body Height	10.337ft
Min Body Ground Clearance	0.768ft
Track Width	7.460ft
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	41.750ft

Fire Access Plan

Needham Medical Office
Highland Ave, Needham, MA

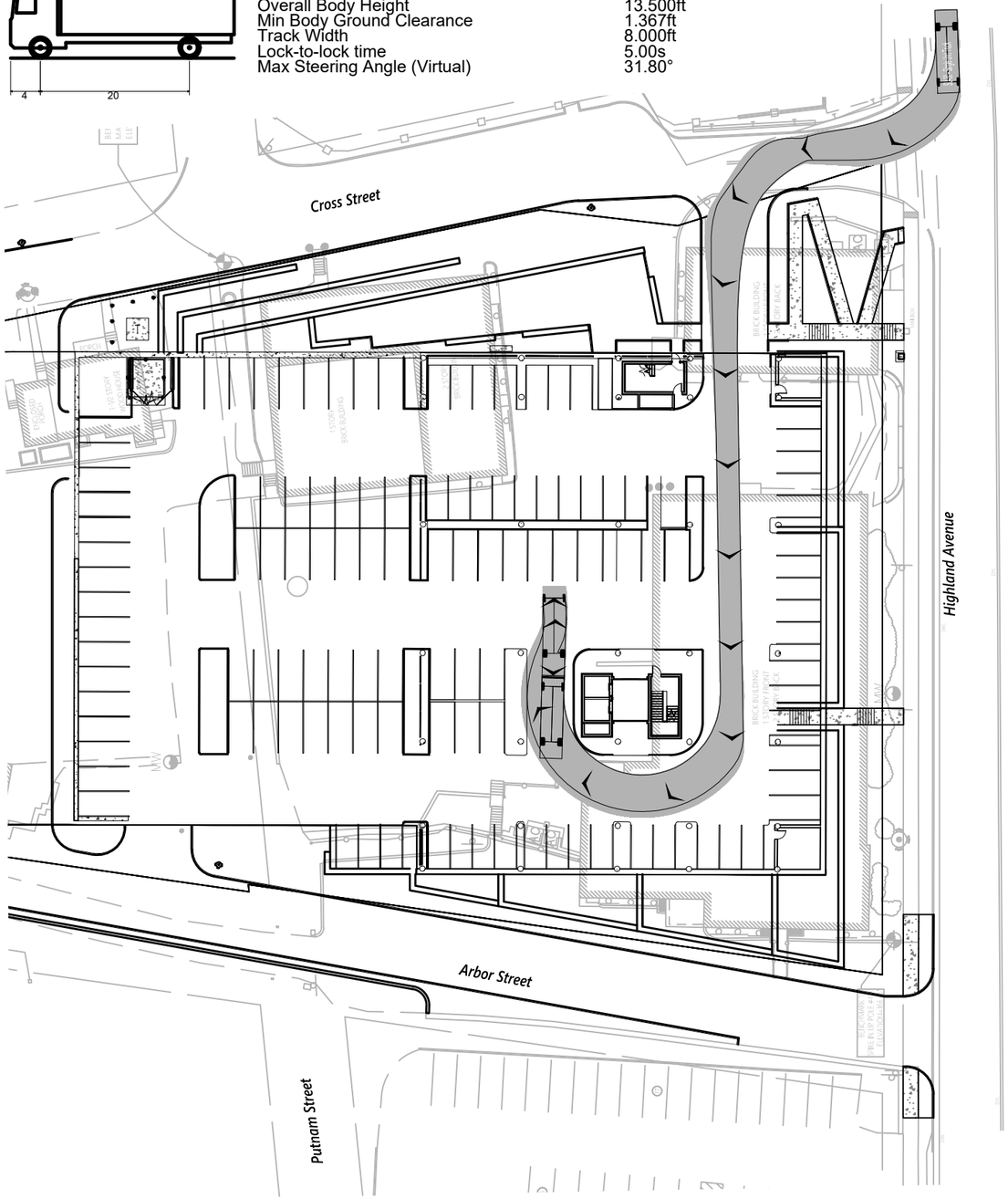
Figure FT-1

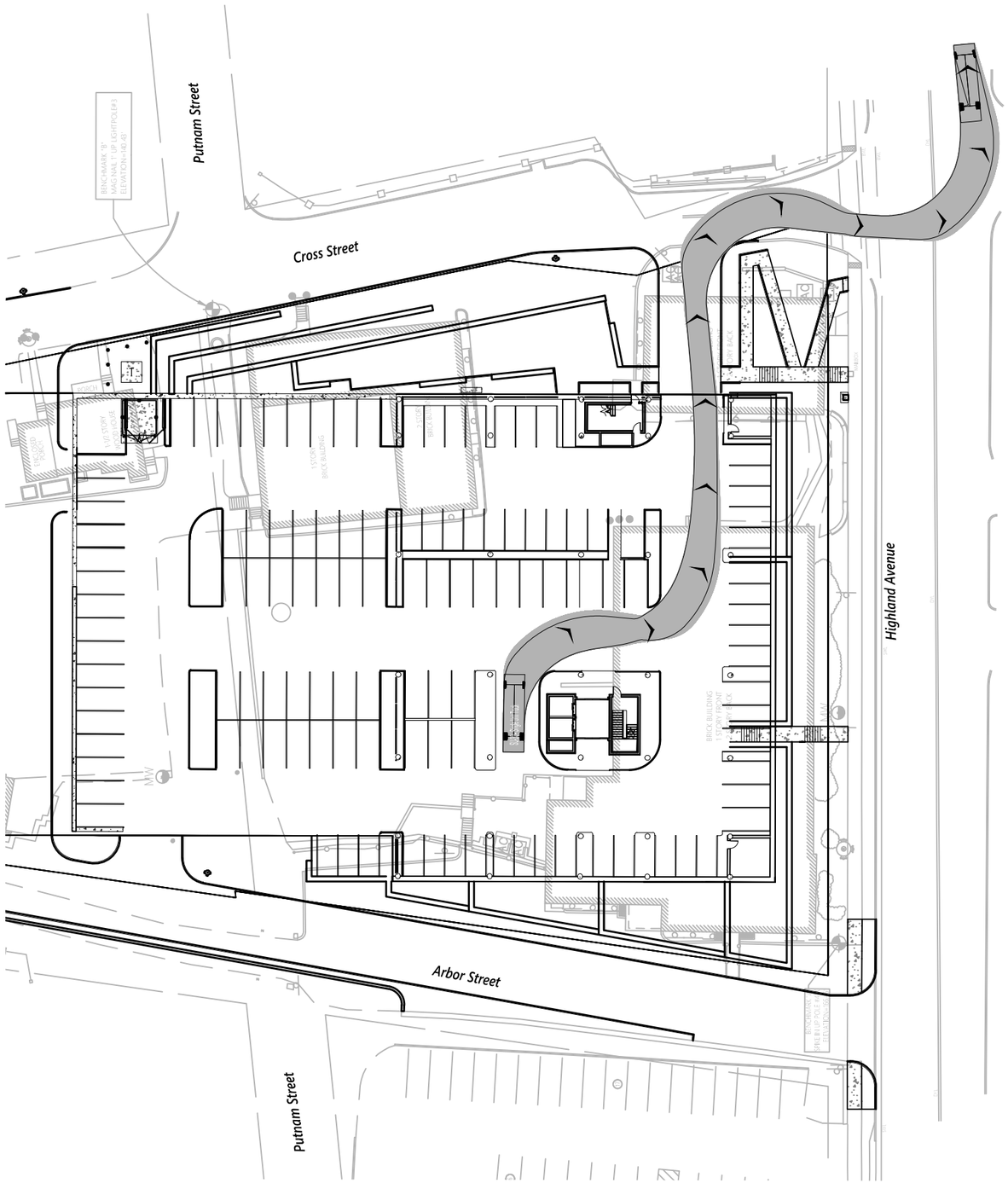
9/8/2023



SU-30 - Single Unit Truck

Overall Length	30.000ft
Overall Width	8.000ft
Overall Body Height	13.500ft
Min Body Ground Clearance	1.367ft
Track Width	8.000ft
Lock-to-lock time	5.00s
Max Steering Angle (Virtual)	31.80°



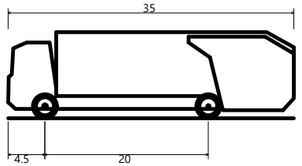


0 25 50 100 Feet

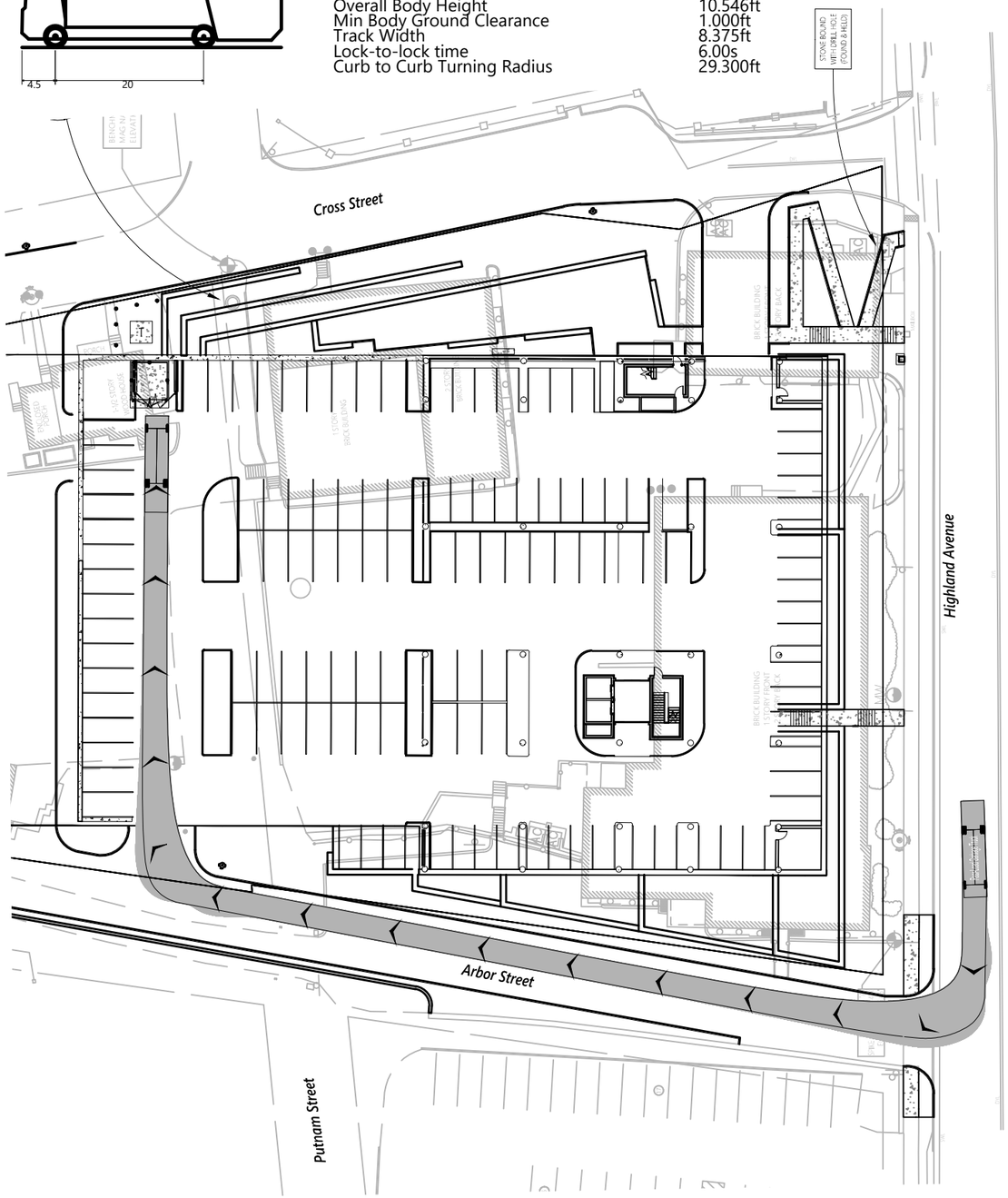
SU-30 Truck
Turning Movements
Needham Medical Office
Highland Ave, Needham, MA

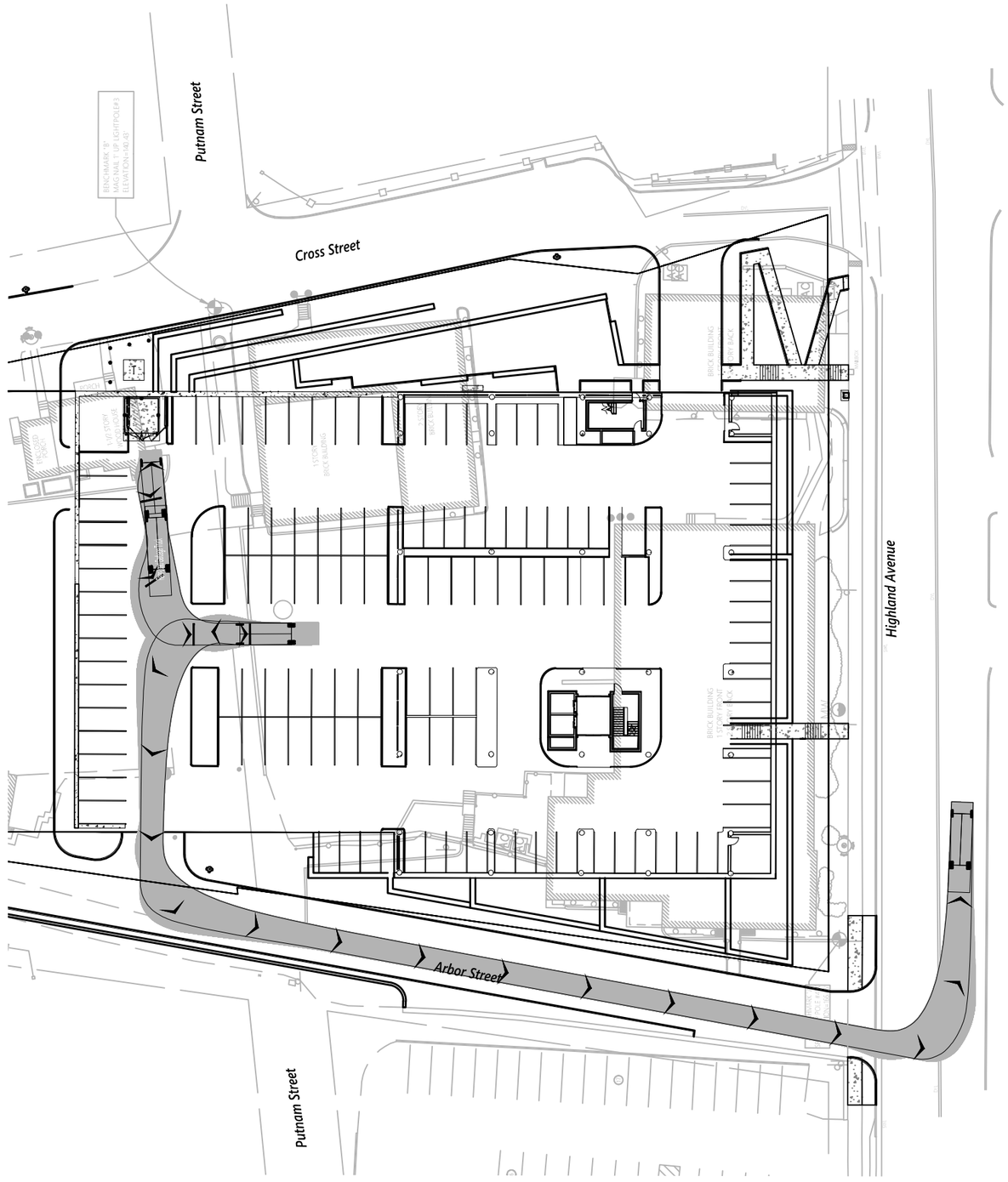
Figure TT-1

October 2023



Garbage Truck	
Overall Length	35.000ft
Overall Width	8.375ft
Overall Body Height	10.546ft
Min Body Ground Clearance	1.000ft
Track Width	8.375ft
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	29.300ft





0 25 50 100 Feet

Garbage Truck
Turning Movements
Needham Medical Office
Highland Ave, Needham, MA

Figure TT-2

October 2023

PROPOSED PARKING CHART			
	STANDARD 9' X 18.5'	COMPACT 8' X 16'	TOTAL
P-1 LOWER PARKING LEVEL	51	81	132
P-2 UPPER PARKING LEVEL	75	43	118
TOTAL	126	124	250

1 P-1 LOWER PARKING
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: As indicated

Issue:	**Date:**
PLANNING BOARD SUBMISSION	08/04/2023

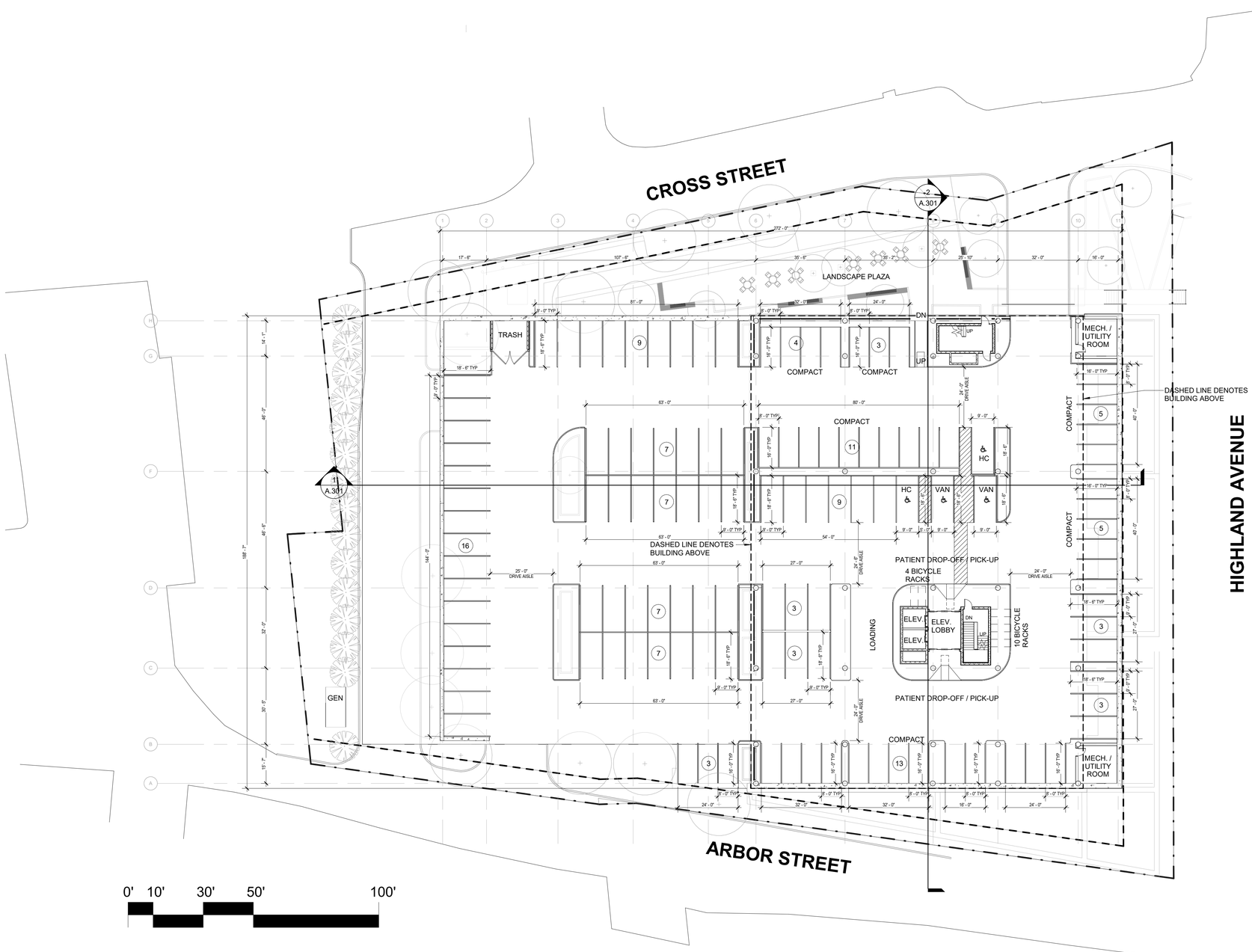
Revisions:	**Date:**

Drawing Title:
P-1 Lower Parking Plan

Sheet Number:
A.101

MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456 2800
MAUGEL.COM

PROPOSED PARKING CHART			
	STANDARD 9' X 18.5'	COMPACT 8' X 16'	TOTAL
P-1 LOWER PARKING LEVEL	51	81	132
P-2 UPPER PARKING LEVEL	75	43	118
TOTAL	126	124	250



1 P-2 UPPER PARKING
SCALE: 3/64" = 1'-0"

Notes:

TRUE NORTH

Key Plan:

Architect's Stamp:

Project:
Highland Ave
Medical Office Building
629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135, Newton Centre, MA 02459

Project #: 22090

Scale: As indicated

Issue:	Date:
PLANNING BOARD SUBMISSION	08/04/2023

Revisions:	Date:

Drawing Title:
P-2 Upper Parking Plan

Sheet Number:
A.102

MAUGEL ARCHITECTS
200 AYER ROAD I SUITE 200
HARVARD, MA 01451
978 456.2800
MAUGEL.COM

\\vhb.com\gbl\proj\Wat-LD\14781.00 BDG Highland Ave Needham\cad\ld\Planmisc\Locus Figure\14781.00_Locus Figure.dwg

Locus Figure

Highland Ave MOB
Needham, MA

Source: **VHB**
Prepared for: **Needham Planning Board**
Date: **09/21/2023**

0 60 120 240 Feet

vhb

From: Joanie Freidman
To: Planning
Subject: Please pass onto to Adam Block
Date: Friday, September 8, 2023 11:07:47 AM

Attention: Adam Block - Planning Board Chair

Hi Adam,

It was so nice to see you at the planning board meeting the other evening!

Both Alan and myself have a few comments and concerns that we are hoping you can pass along to the entire planning board on behalf of Gateway condos for the next meeting in October for the Highland Ave project. We have lived here for 27 years and we see 3 major projects that will be in the works and need to be sure we protect our small neighborhood which will sit in the middle of all of this construction and future traffic. Right now because Muzzi, Wingate and Cross Street have no businesses and are empty, the traffic is down but we still have a very difficult time getting access into our Putnam Street entrance from Highland Ave.

Please see below for concerns:

- **Trash** - On the site plan it is now shown on the Cross street lower parking lot. Can this be put onto the Arbor street side where there are no residents on that side. Gateway unit owners use to hear the trash trucks come at 4:30am in the past. You would be awoken by the dumpster truck backing up and would hear the beep beep sound that was very loud and the sound of the dumpsters being emptied. Very unnecessary to do again knowing this happens and can be placed on the Arbor Street parking area having the trash trucks use that road. (They come at crazy hours)
- **Rats** - With all of the digging up we could see Rats again like we did with the construction from Highland Ave. What do they plan to do to protect our properties so we do not have rats again.
- **Power washing** - With all of the construction and inconveniences this will add to all unit owners, we would like to see them power wash our units and windows a couple of times during the construction.
- **Cross Street** - All unit owners know that the top of Cross Street is at an angle and hard to come out onto Highland especially when taking a left turn especially during peak times. This will add back up on Cross Street especially if there are 2-3 plus cars coming out of building's entrance. **On the Plans, it shows that The top of Cross Street is almost level to Highland ave.** The town board needs to know this is not how the grade level is as pictured and is very difficult to get onto Highland ave. (Perhaps they should all try it) This will cause traffic. It's hard enough when it is just one car trying to turn onto Highland Ave. What happens to the parking spaces in back of the condos along Cross Street? Nothing was mentioned about that in the plans. In the past, there were cars parking there at all times even with signs saying no parking. All businesses would get letters about this and it still did not matter, people parked there. We do not have parking on Putnam street and these spaces are for our guests and unit owners to use. During business hours they were always filled. Trucks is another big issue, because Cross street is difficult at the pitch to turn onto Highland have, trucks would find this difficult and would back up and cut through Putnam street always! These trucks would do damage to our front lawns as we have no sidewalks and they would damage shrubs

on the corners with the trucks turning.

- **<u>Putnam Street Units, 62/64, 70/72, 78/80</u>** (They are not part of the 12 Gateway condos on the other part of Putnam street) -They can only use Cross Street to access their homes to those 6 units. They do not access their units from our Putnam Street entrance. What will they plan to make access to their units easy.
- **<u>Electronic Gate</u>** -We brought this up at the first meeting with the developer. They said they would look into this. It was not mentioned at the planning board meeting when we spoke about the issue with people cutting through. This may be the only thing that will prevent cars to use Putnam.
- **<u>Deliveries</u>** - Can all deliveries to this medical building be directed to Arbor? This way there are no trucks coming down Cross Street.

We would like to know what the planning boards thoughts are on these issues and how the planning board plans to help work with us on these very important issues.

We look forward to hearing back from you,
Joanie and Alan Freidman
71 Putnam Street

Joanie Freidman
Strategic Planning & Event Coordinator
781.910.4733
Jlmfconsulting@gmail.com

Photo taken by Jeanne McKnight on October 13, 2023

Photo taken by Jeanne McKnight on October 13, 2023

Photo taken by Jeanne McKnight on October 13, 2023

TOWN OF NEEDHAM
MASSACHUSETTS

RECEIVED TOWN CLERK
NEEDHAM, MA 02492

2023 OCT 10 PM 12:25

PLANNING BOARD

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

APPLICATION FOR ENDORSEMENT OF PLAN
BELIEVED NOT TO REQUIRE APPROVAL

Submit three (3) copies. One copy to be filed with the Planning Board and one with the Town Clerk as required by Section 81-P, Chapter 41 of the General Laws. This application must be accompanied by the **Original Tracing** and **three (3) copies of the plan.**

To the Planning Board:

The undersigned, believing that the accompanying plan of land in the Town of Needham does not constitute a subdivision within the meaning of the Subdivision Control Law, for the reasons outlined below, herewith submits said plan for a determination and endorsement that Planning Board approval under the Subdivision Control Law is not required.

1. Name of Applicant 969 South St. LLC

   Address 910 Boston Post Road East, Suite 310, Marlborough, MA 01752

2. Name of Engineer or Surveyor Hancock Associates

   Address 121 East Berkeley Street, Boston, MA 02118

3. Deed of property recorded in _____ Registry,
   Book _____, Page _____
   Land Court Case 2417-Q; Land Court Certificate #119671

4. Location and description of property
   969 South Street - a 6.631 acre parcel located on the north side just east of Burr Drive.

5. Reasons approval is not required (check as applicable):

   a) ☒ Every lot shown has the area and frontage required by the Zoning By-Law on a way, as defined by Section 81-L, Chapter 41 of the General Laws.

   b) ☐ Land designated _____ shall not be used as separate building lot(s) but only together with adjacent lots having the required area and frontage.

   c) ☐ Lot(s) having less than required frontage or area resulted from a taking for public purpose or have been recorded prior to 3/26/1925, no land is available to make up the deficiency and the frontage and land area of such lots are not being reduced by the plan.

   d) _____

(If the applicant is not the owner, written authorization to act as agent must be attached)

Signature of Applicant _____

Address 910 Boston Post Rd Marlborough MA 01752

By Richard D Stein (agent)

Application accepted this 6 *day of* Oct. 20 23
as duly submitted under the rules and regulations of the Planning Board.

By _____

SURVEY TRAVERSE DATA

PRECISION: 1: 52,403
LINEAR ERROR OF CLOSURE: 0.04'
DIRECTIONAL ERROR OF CLOSURE: N 86°56'17" W
ALL SURVEY DISTANCES WERE MEASURED BY ELECTRONIC DISTANCE MEASURING EQUIPMENT (ACCURACY = ±(5 MM + 3 PPM –D)

Traverse Line Table		
Line #	Length	Direction
L1	33.46'	S53°00'19"W
L2	45.86'	N27°55'17"E
L3	43.88'	N04°11'11"W
L4	97.40'	N40°39'27"E
L5	102.83'	N45°44'28"E
L6	37.87'	S04°42'04"E
L7	102.08'	S36°40'09"W
L8	36.90'	S67°22'19"W

LOT BUILD FACTOR (SEC. 4.2.5)

LBF = LOT PERIMETER SQUARED/LOT AREA
MAX LBF = 30

LOT 31 = 28.0
LOT 32 = 29.9
LOT 33 = 20.9
LOT 34 = 26.7

APPROVAL UNDER THE SUBDIVISION CONTROL LAW NOT REQUIRED.
NEEDHAM PLANNING BOARD

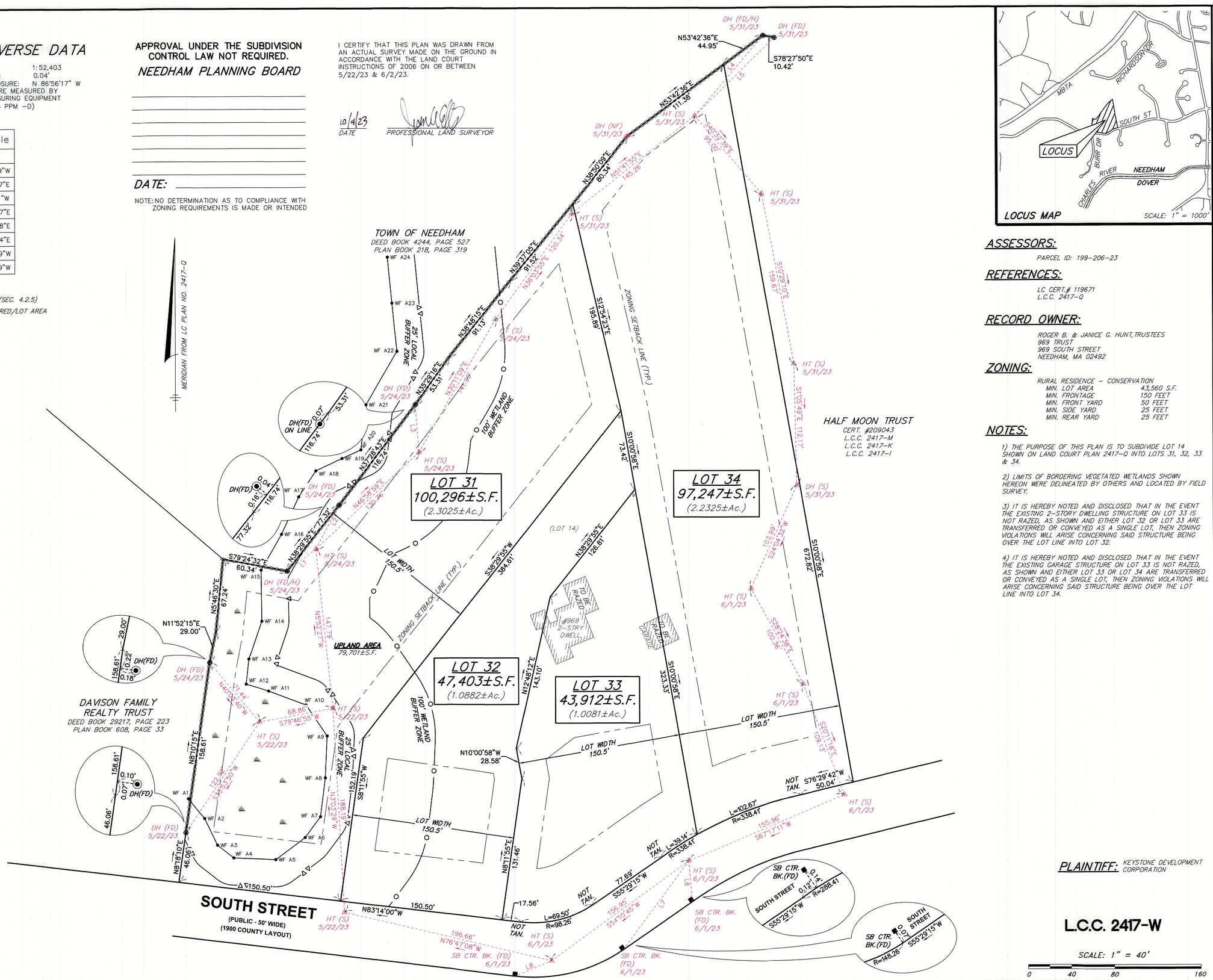
DATE: _____

NOTE: NO DETERMINATION AS TO COMPLIANCE WITH ZONING REQUIREMENTS IS MADE OR INTENDED

I CERTIFY THAT THIS PLAN WAS DRAWN FROM AN ACTUAL SURVEY MADE ON THE GROUND IN ACCORDANCE WITH THE LAND COURT INSTRUCTIONS OF 2006 ON OR BETWEEN 5/22/23 & 6/2/23.

10/4/23
DATE

PROFESSIONAL LAND SURVEYOR



LEGEND

SB	⊡	STONE BOUND
I.ROD	○	IRON ROD
DH	◉	DRILL HOLE
MAG		MAGNETIC NAIL
HT		HUB & TACK
CTR. BK.		CENTER BACK
(R)		RECORD
(S)		SET
(C)		CALCULATED
(H)		HELD
(FD)		FOUND
(NF)		NOT FOUND

LOCUS MAP SCALE: 1" = 1000'

ASSESSORS:

PARCEL ID: 199-206-23

REFERENCES:

LC CERT.# 119671
L.C.C. 2417-Q

RECORD OWNER:

ROGER B. & JANICE G. HUNT, TRUSTEES
969 TRUST
969 SOUTH STREET
NEEDHAM, MA 02492

ZONING:

RURAL RESIDENCE – CONSERVATION

MIN. LOT AREA	43,560 S.F.
MIN. FRONTAGE	150 FEET
MIN. FRONT YARD	50 FEET
MIN. SIDE YARD	25 FEET
MIN. REAR YARD	25 FEET

NOTES:

1) THE PURPOSE OF THIS PLAN IS TO SUBDIVIDE LOT 14 SHOWN ON LAND COURT PLAN 2417-Q INTO LOTS 31, 32, 33 & 34.

2) LIMITS OF BORDERING VEGETATED WETLANDS SHOWN HEREON WERE DELINEATED BY OTHERS AND LOCATED BY FIELD SURVEY.

3) IT IS HEREBY NOTED AND DISCLOSED THAT IN THE EVENT THE EXISTING 2-STORY DWELLING STRUCTURE ON LOT 33 IS NOT RAZED, AS SHOWN AND EITHER LOT 32 OR LOT 33 ARE TRANSFERRED OR CONVEYED AS A SINGLE LOT, THEN ZONING VIOLATIONS WILL ARISE CONCERNING SAID STRUCTURE BEING OVER THE LOT LINE INTO LOT 32.

4) IT IS HEREBY NOTED AND DISCLOSED THAT IN THE EVENT THE EXISTING GARAGE STRUCTURE ON LOT 33 IS NOT RAZED, AS SHOWN AND EITHER LOT 33 OR LOT 34 ARE TRANSFERRED OR CONVEYED AS A SINGLE LOT, THEN ZONING VIOLATIONS WILL ARISE CONCERNING SAID STRUCTURE BEING OVER THE LOT LINE INTO LOT 34.

PLAINTIFF: KEYSTONE DEVELOPMENT CORPORATION

L.C.C. 2417-W

SCALE: 1" = 40'

0 40 80 160

#969 SOUTH STREET

Needham, Massachusetts 02492

PREPARED FOR:

KEYSTONE DEVELOPMENT CORP.

910 Boston Post Road, Suite 310
Marlborough, Massachusetts 01752

HANCOCK ASSOCIATES

Civil Engineers

Land Surveyors

Wetland Scientists

121 EAST BERKELEY STREET, BOSTON, MA 02118
VOICE (617) 357-8145, FAX (617) 357-9495
WWW.HANCOCKASSOCIATES.COM

COMMONWEALTH OF MASSACHUSETTS JASON L ELLIS No. 49092 PROFESSIONAL LAND SURVEYOR

NO.	BY	APP	DATE	ISSUE/REVISION DESCRIPTION

DATE: 9/26/2023 DRAWN BY: JML
SCALE: 1" = 40' CHECK BY: JAE

PLAN OF LAND IN NEEDHAM, MA

BEING A SUBDIVISION OF LOT 14 ***SHOWN ON LAND COURT*** PLAN #2417-Q, ***CREATING*** 4 LOTS.

PLOT DATE: Oct 03, 2023 11:03 am
PATH: D:\Civil 3D Projects\26995 – Keystone – Needham\Surv\DWG\

DWG: 26995sv.dwg
LAYOUT: ANR
SHEET: 1 OF 1

PROJECT NO.: 26995

GEORGE GIUNTA, JR.
ATTORNEY AT LAW*
281 CHESTNUT STREET
NEEDHAM, MASSACHUSETTS 02492
*Also admitted in Maryland
TELEPHONE (781) 449-4520 FAX (781) 465-6095

September 29, 2023

Lee Newman, Planning Director
Town of Needham
1471 Highland Avenue
Needham, MA 02492

Re: 920 South Street
Definitive Subdivision Application
Extension of Submittal Period

Dear Lee,

In connection with and pursuant to paragraph 42 of the Definitive Subdivision Decision, dated April 25, 2023 concerning the property at 920 South Street, Needham, MA 02492, (the "Decision), please accept this letter as a formal request to extend the period for presentation of the Plan through and including November 15, 2023.

Please let me know if you have any questions or require anything in connection with this request. As always, your courtesy and assistance are appreciated.

Sincerely,

George Giunta, Jr.

Housing Needham (HONE) Advisory Group Meeting

Town of Needham, Massachusetts

October 5, 2023

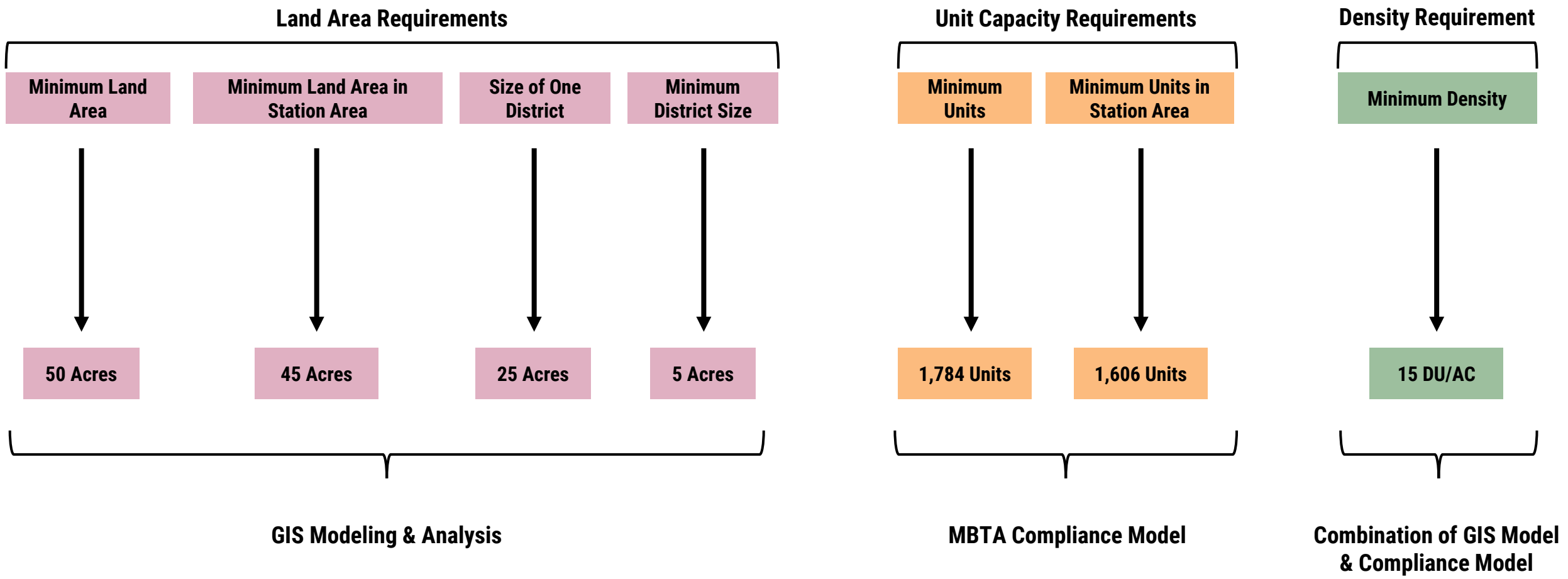
HOUSING NEEDHAM (HONE)

TOWN VISIONING FOR MULTI-FAMILY HOUSING

Content

Scenario Overview

Recap of Minimum Requirements



Scenarios for Modeling

Existing Zoning Districts

Question to Answer – What would happen if we modeled existing zoning districts and zoning parameters and had to make some changes zoning to allow multifamily housing as of right?

Housing Plan Proposal

Question to Answer – What would happen if we modeled the Housing Plan Proposal rezoning some parcels of land and making slight modifications to zoning parameters?

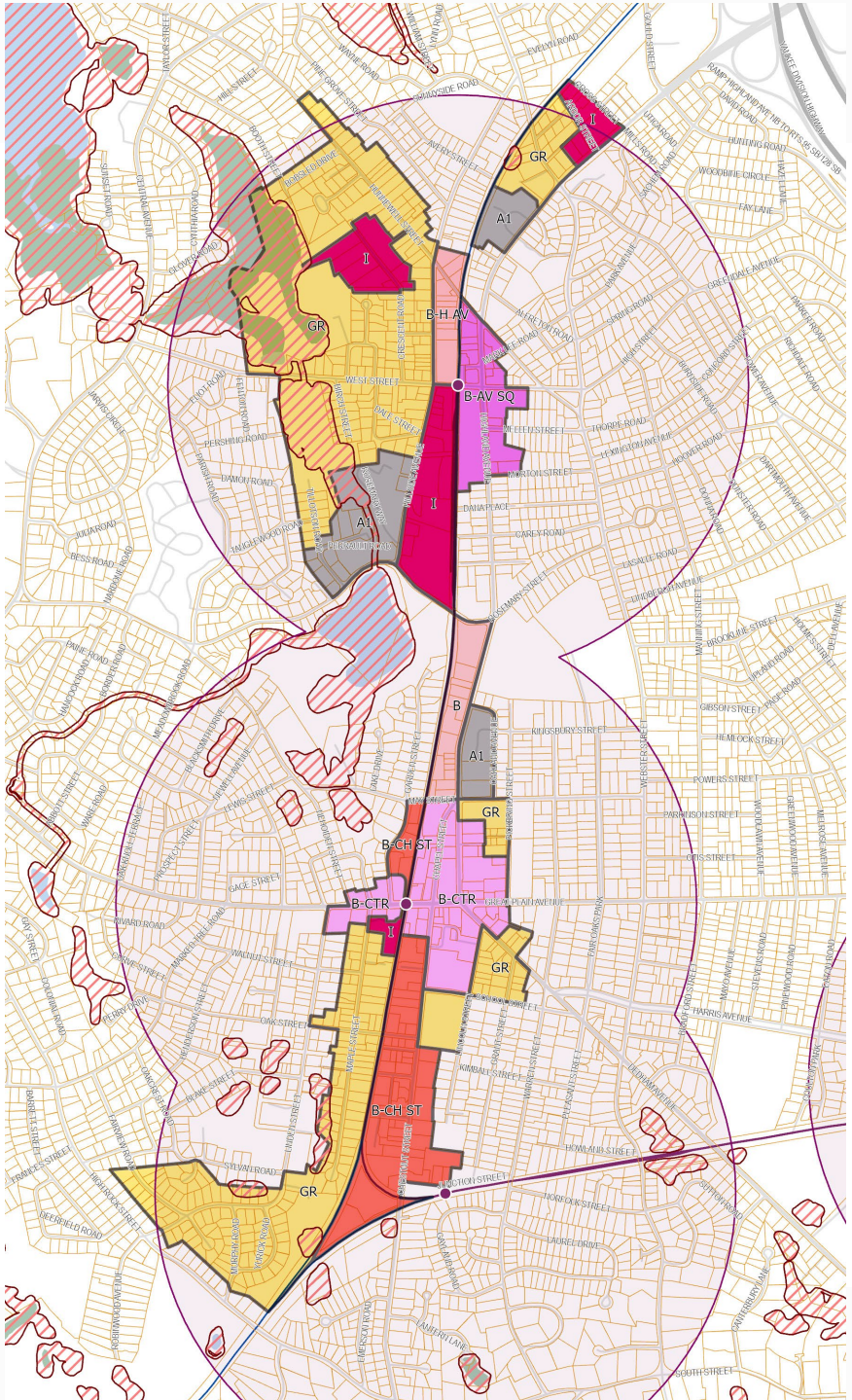
Scenarios for Modeling

Existing Zoning Scenario

Map of the Zoning Districts and Overall MBTA District

Key District Statistics

- *Gross Acreage – 307 acres*
- *Net Acreage – 273 acres*
- *Acres in Transit Area – 98% (300 AC)*



- GR – General Residence
- A1 – Apartment 1
- B H AV – Avery Square Business
- I – Industrial
- B CH ST – Chestnut Street Business
- B CTR – Center Business
- B – Business

Scenarios for Modeling

Existing Zoning Scenario

Zoning Parameters Applied in the Model

	District Name						
Zoning Metrics	Apartment 1	Business	Avery Square Business	Chestnut Street Business	Hillside Ave Business	General Resi	Industrial
Minimum Lot Size	20,000	10,000	10,000	10,000	10,000	10,000	10,000
Height (Stories)	3.0	3.0	2.5	2.5	2.5	2.5	3.0
FAR	0.50		0.70	0.70	0.70		
Max Lot Coverage		25%				30%	25%
FY Setback	25	10	10	20	20	20	20
Rear Setback	20					20	
Side Setback	20					14	
Parking per Unit	1.50		1.50	1.50	1.50	1.50	1.50
Maximum Dwelling Units per Acre	18		18	18	18	2	

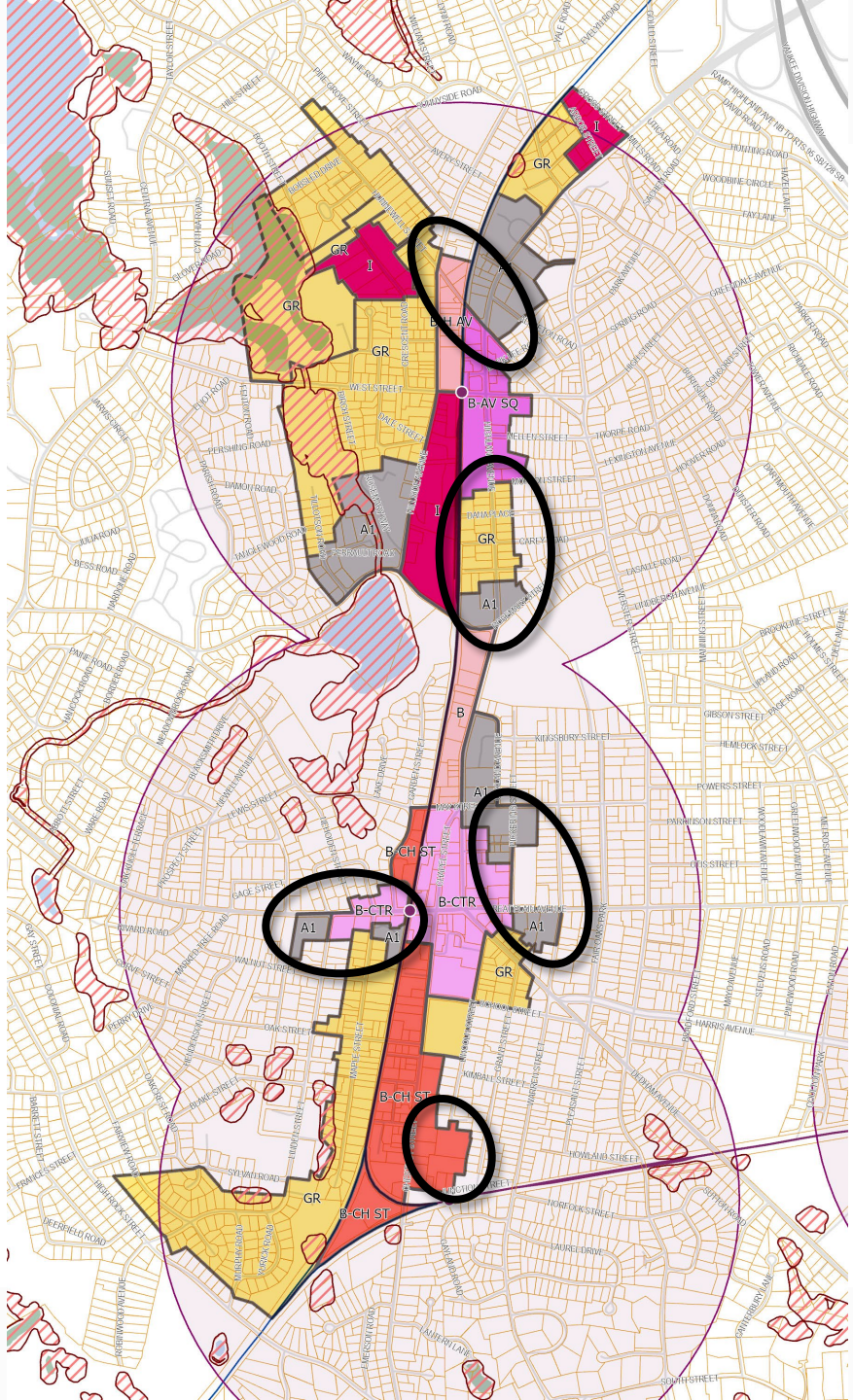
Scenarios for Modeling

Housing Plan Scenario

Map of the Zoning Districts and Overall MBTA District

Key District Statistics

- *Gross Acreage – 341 acres*
- *Net Acreage – 307 acres*
- *Acres in Transit Area – 99.8% (340 AC)*



- GR – General Residence
- A1 – Apartment 1
- B H AV – Avery Square Business
- I – Industrial
- B CH ST – Chestnut Street Business
- B CTR – Center Business
- B – Business

Scenarios for Modeling

Housing Plan Scenario

Zoning Parameters Applied in the Model

	District Name						
Zoning Metrics	Apartment 1	Business	Avery Square Business	Chestnut Street Business	Hillside Ave Business	General Resi	Industrial
Minimum Lot Size	20,000	10,000	10,000	10,000	10,000	10,000	10,000
Height (Stories)	3.0	3.0	2.5	3.0	3.0	2.5	3.0
FAR	0.50		0.70	0.50	0.50		0.50
Max Lot Coverage		25%				30%	
FY Setback	25	10	10	25	25	20	25
Rear Setback	20			20	20	20	20
Side Setback	20			20	20	14	20
Parking per Unit	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Maximum Dwelling Units per Acre	18						

Indicates a change from existing zoning.

Modeling Results

Scenarios for Modeling

Existing Zoning Scenario

Model Outputs	Apartment 1	Business	Avery Square Business	Chestnut Street Business	Hillside Ave Business	General Resi	Industrial	Total
Gross Acreage	28.18	9.79	16.13	34.87	7.10	178.57	32.92	**307.56**
DDD Acreage	25.84	9.79	16.13	34.87	7.10	146.70	32.84	**273.27**
Unit Capacity	359	210	176	375	46	45	838	**2,049**
DU/AC	13.9	21.5	10.9	10.8	6.5	0.3	25.5	**7.5**

- Exceeds district size requirements
- Exceeds unit capacity
- Falls short of DU/AC requirement of 15 DU/AC
- Removing GR subdistrict appears to create compliance boosting DU/AC to 15.8.

Scenarios for Modeling

Housing Plan Scenario

- Rezoned some SRB and GR to A-1.
- Rezoned small portion of SRB to GR.
- Allow multifamily housing as of right in all zoning subdistricts.

Model Outputs	Apartment 1	Business	Avery Square Business	Chestnut Street Business	Hillside Ave Business	General Resi	Industrial	Total
Gross Acreage	81.81	9.79	16.13	36.74	7.10	158.45	31.23	**341.25**
DDD Acreage	62.19	9.79	16.13	36.74	7.10	143.88	31.14	**306.97**
Unit Capacity	701	210	307	491	56	2,890	528	**5,183**
DU/AC	11.3	21.4	19.0	13.4	7.9	20.1	17.0	**16.9**

- Exceeds district size requirements
- Exceeds unit capacity
- Exceeds DU/AC requirement of 15 DU/AC

Pathways to Compliance

Pathways

1. Use existing zoning
   - Choice - drop districts to lower unit capacity and acreage to increase density.
   - Choice – keep district as it is, increase density through more intensive zoning.
   - Choice – combination of the two.

2. Use housing plan
   - Choice - keep everything as it is.
   - Choice - drop districts to lower unit count and size of district.
   - Choice – modify zoning to decrease unit capacity and lower density.

Scenario Summary Table

Model Outputs	Existing Zoning	Housing Plan
Gross Acreage	**307.56**	**341.25**
DDD Acreage	**273.27**	**306.97**
Unit Capacity	**2,049**	**5,183**
DU/AC	**7.5**	**16.9**

ZONING INPUTS - DISTRICT 1 — A1

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	20,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	3
Maximum Lot Coverage %	0%
Floor Area Ratio	0.50

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	18.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 2 — B

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	10,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	3
Maximum Lot Coverage %	25%
Floor Area Ratio	0.00

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	0.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 3 — B-AV SQ

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	10,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	2.5
Maximum Lot Coverage %	0%
Floor Area Ratio	0.70

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	18.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 4 — B-CH ST

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	10,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	2.5
Maximum Lot Coverage %	0%
Floor Area Ratio	0.70

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	18.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 5 — B-H AV

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	10,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	2.5
Maximum Lot Coverage %	0%
Floor Area Ratio	0.70

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	18.00
Cap on Maximum Dwelling Units per District	0.00

INFO: All information on this sheet comes from the Checklist Parameters tab and provides the model user with a summary of zoning inputs for each district being tested. You DO NOT need to enter any information in this tab.

Unit Capacity per District Table

Data Metric	District 1	District 2	District 3	District 4	District 5	Totals
District Name	A1	B	B-AV SQ	B-CH ST	B-H AV	
Modeled Unit Capacity	810	263	336	712	87	**2,208**
Dwelling Units per Acre Limit	433		208	453	94	**1,189**
District Unit Cap Limit						**0**
Max Lot Coverage Limit		267				**267**
Lot Area per Dwelling Unit Limit						**0**
Max Units per Lot Limit	810	263	336	712	87	**2,208**
FAR Limit	524		353	767	160	**1,804**
Final Unit Capacity per District	**359**	**210**	**176**	**375**	**46**	**1,166**

Summary Table

Data Metric	District 1	District 2	District 3	District 4	District 5	Totals
District Name	A1	B	B-AV SQ	B-CH ST	B-H AV	
District Acreage *(see note)*	28.2	9.8	16.1	34.9	7.1	**96.1**
District Density Denominator *(see note)*	25.8	9.8	16.1	34.9	7.1	**93.7**
Final Unit Capacity per District	**359**	**210**	**176**	**375**	**46**	**1,166**
DU/AC	**13.9**	**21.5**	**10.9**	**10.8**	**6.5**	**12.4**
Parcel Acreage	24.1	8.2	11.6	25.2	5.2	**74.2**
Total Built Square Feet	815,080	267,283	340,563	728,909	89,394	**2,241,229**
Total Units in Station Area	359	210	176	375	46	**1,166**
Non-Conforming Parcels	10	5	9	22	6	**52**
Total Excluded Land (sf)	146,650	46,462	15,087	48,340	74,021	**330,561**
Total Open Space (sf)	265,295	108,482	112,855	257,865	104,042	**848,539**
Total Parking Area (sf)	407,540	133,641	204,338	437,345	53,636	**1,236,501**
Units Forgone due to Unit Cap in Zoning	0.00	0.00	0.00	0.00	0.00	**0**

Comparison Table of Requirements and Modeled Results

Category	Guideline Requirements	Modeled Results
Community:	Needham	Needham
Community Category:	Commuter Rail	Commuter Rail
2020 Housing Units (Census PL-94):	11,891	11,891
Minimum Multi-family Unit Capacity:	1,784	1,166
Minimum Land Area:	50	96.1
Developable station area:	1,223.21	1,223.21
% Unit Capacity within Transit Station Areas:	90%	73%
% Land Area Located in Transit Station Areas:	90%	213%

ZONING INPUTS - DISTRICT 1 GR

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	10,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	2.5
Maximum Lot Coverage %	30%
Floor Area Ratio	0.00

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	8.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 2 I

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	10,000
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	1.50
Building Height	3
Maximum Lot Coverage %	25%
Floor Area Ratio	0.00

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	0.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 4 0

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	0
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	0.00
Building Height	0
Maximum Lot Coverage %	0%
Floor Area Ratio	0.00

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	0.00
Cap on Maximum Dwelling Units per District	0.00

ZONING INPUTS - DISTRICT 5 0

Model Inputs for Calculating Unit Yield	Input
Minimum Lot Size	0
Additional Lot Square Feet per Dwelling Unit	0
Open Space %	0%
Excluded Land Counted Toward Open Space	Y
Parking Spaces per Dwelling Unit	0.00
Building Height	0
Maximum Lot Coverage %	0%
Floor Area Ratio	0.00

Zoning Restrictions that Cap Unit Counts	Input
Lot Area per Dwelling Unit	0
Maximum Dwelling Units per Acre	0.00
Cap on Maximum Dwelling Units per District	0.00

Unit Capacity per District Table

Data Metric	District 1	District 2	District 3	District 4	District 5	Totals
District Name	GR	I				
Modeled Unit Capacity	2,915	1,055	0	0	0	**3,970**
Dwelling Units per Acre Limit	1,220					**1,220**
District Unit Cap Limit						**0**
Max Lot Coverage Limit	4,983	858				**5,841**
Lot Area per Dwelling Unit Limit						**0**
Max Units per Lot Limit	2,915	1,055	0	0	0	**3,970**
FAR Limit						**0**
Final Unit Capacity per District	**444**	**838**	**0**	**0**	**0**	**1,282**

Summary Table

Data Metric	District 1	District 2	District 3	District 4	District 5	Totals
District Name	GR	I				
District Acreage *(see note)*	178.6	32.9	0.0	0.0	0.0	**211.5**
District Density Denominator *(see note)*	146.7	32.8	0.0	0.0	0.0	**179.5**
Final Unit Capacity per District	**444**	**838**	**0**	**0**	**0**	**1,282**
DU/AC	**3.0**	**25.5**	**0.0**	**0.0**	**0.0**	**7.1**
Parcel Acreage	152.5	26.3	0.0	0.0	0.0	**178.8**
Total Built Square Feet	3,014,906	1,069,222	0	0	0	**4,084,128**
Total Units in Station Area	441	817	0	0	0	**1,258**
Non-Conforming Parcels	133	5	0	0	0	**138**
Total Excluded Land (sf)	1,975,175	8,780	0	0	0	**1,983,954**
Total Open Space (sf)	2,807,837	228,823	0	0	0	**3,036,661**
Total Parking Area (sf)	1,808,943	534,611	0	0	0	**2,343,555**
Units Forgone due to Unit Cap in Zoning	0.00	0.00	0.00	0.00	0.00	**0**

Comparison Table of Requirements and Modeled Results

Category	Guideline Requirements	Modeled Results
Community:	Needham	Needham
Community Category:	Commuter Rail	Commuter Rail
2020 Housing Units (Census PL-94):	11,891	11,891
Minimum Multi-family Unit Capacity:	1,784	1,282
Minimum Land Area:	50	211.5
Developable station area:	1,223.21	1,223.21
% Unit Capacity within Transit Station Areas:	90%	78%
% Land Area Located in Transit Station Areas:	90%	454%

NEEDHAM PLANNING BOARD MINUTES

September 5, 2023

The Needham Planning Board meeting, held in the Charles River Room of the Public Services Administration Building and virtually using Zoom, was called to order by Adam Block, Chairman, on Tuesday, September 5, 2023, at 7:00 p.m. with Messrs. Crocker and Alpert and Mmes. McKnight and Espada, Planner~~r~~ing Director, Ms. Newman and Assistant Planner, Ms. Clee.

Mr. Block took a roll call attendance of the Board members and staff. He noted this is an open meeting that is being held in a hybrid manner in public and remotely per state guidelines. He reviewed the rules of conduct for all meetings. This meeting does include one public hearing and public comment will be 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.

ANR Plan – Arthur Fine Homes, LLC, Petitioner, (Property located at 248 Harris Avenue and 96 Bradford Road, Needham, MA).

Mr. Block called out that on the site plan it says 284 and not 248. He asked why this is subdividing 63 square feet. Ms. Newman noted a neighbor wants to acquire that strip of land. A conveyance is the only issue being proposed here. She will clean up the transposed numbers on the mylar.

Upon a motion made by Ms. McKnight, and seconded by Mr. Crocker, it was by a vote of the five members present unanimously:
VOTED: with those corrections, to endorse the plan subdivision approval not required.

Jim Reulbach explained why the transfer is being done.

Public Hearing:

7:00 p.m. – Major Project Site Plan Special Permit No. 2023-03: Neehigh LLC, 93 Union Street, Suite 315, Newton Center, Petitioner (Property located at 629-661 Highland Avenue, Needham, Massachusetts). Regarding request to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces.

Upon a motion made by Mr. Alpert, and seconded by Ms. McKnight, it was by a vote of the five members present unanimously:
VOTED: to waive the reading of the public hearing notice.

Mr. Alpert stated he want~~s~~ed to be on record that Temple Beth Shalom is directly across the street from this project. He is General Counsel for the Temple and an Ex officio~~ant~~ member of the Board of Trustees. He checked with Temple Beth Shalom and the Temple was served with notice and ~~are~~is considered an abutter of this property. He checked with the management at the Temple, and they have no position on this matter. He checked with Town Counsel and has filed paperwork with the Town Clerk. He wanted to be up front with the applicant in case they had an issue with him sitting on this matter. Attorney Evans Huber, representative for the applicant, stated he has no issue with Mr. Alpert participating in the hearing~~s~~.

Mr. Huber stated the applicant is seeking site plan review. There are 5 existing buildings that will be demolished and replaced with one building. The new building will be a medical office building of 50,000 square feet and 2 stories. The 250 planned parking spaces meet the requirement for medical office. There will be one level of parking underground and one at grade level within the building. The applicant is not asking for any zoning relief as ~~it~~the use is allowed by law and meets all dimensional requirements. The applicant met with the abutters. The applicant~~s~~ is ~~are~~ aware of their concerns and

has~~ve~~ taken them into account. Jonathan Cocker, of Maugel Destefano Architects, showed the existing site plan and discussed what was proposed. He noted there is presently very limited green space and a lot of pervious surface. There is parking on Cross Street and Arbor Street. The buildings are right along Highland Avenue. All the buildings will be torn down and one building will be built near the center of the site. There is a 350 square foot reduction [in gross floor area?] and a 13,000 square foot reduction in paved area. There will be an increase of approximately 12,000 square feet of green space between the building and the streets.

Formatted: Highlight

Mr. Cocker noted 25% of~~f~~ the parking is surface parking. The rest is below grade concealed within the slope of the site. He showed the grading on site. A sidewalk and green space are being created. There will be a 2-story office building with a level of parking, then another parking story below that. There will be an accessible sidewalk from the corner to get into the building. Entering the building will be through an elevator lobby. Ms. Espada asked if that will be the main entrance and was informed it will be~~was~~ the main entrance to the building. Deliveries will be going in through that entry. Trucks and ambulances can access here also. There will be green space in a patio area. An access drive has been created at the end of Cross Street to Arbor Street and it will be softened with landscaping. There will be landscaping all along Arbor Street. Added features include a retaining wall and screening to prevent head-lights from shining on adjacent residents. There will be 3 drive aisles. All else is screened. He noted the lower level of the parking garage can be accessed from Arbor Street or Cross Street.

Mr. Cocker noted some roof top equipment will be screened and located toward the rear of the site. A lot of landscaping is being added along Highland Avenue as the building is pushed back from the road. The materials include sleek modern glass and white aluminum composite panels. There will be screening at the top and down at the parking level. Sunshades go as an eyebrow across the second story of the building. He noted the lowest level of parking has entry from Cross Street and Arbor Street. The upper level has one access off Cross Street with accessible parking in the middle with a lobby and loading zone. There is also access out to Arbor Street at the rear. A pad for the transformer is at the rear of the site and will be screened. All traffic will be 2-way and will be disbursed in both directions.

Mr. Block stated he was concerned that pedestrians have to cross 3 lanes of traffic to get to the lobby. He feels it should be flipped so the lobby is near the entrance. Mr. Cocker noted the reason for doing that is the need to have the egress directly to the outside of the building. The location of the lobby in the center allows better disbursement of occupants and tenants from the site. Colbi Cavanaugh, of Maugel Destefano Architects, stated it has been flipped a couple of times and this is the best outcome. Mr. Cocker noted the site will be lit for safety. Lighting is being kept to a minimum with downward facing light compliant light fixtures. There will be zero light spillage to neighboring properties. Against the building are W1 wall mount fixtures and G12 within the garage. Lights are being provided for parking and walkways via handrail lights. Mr. Block asked what time the lights will go off. Mr. Cocker noted lighting for security is needed but the hours will be compliant with the Town requirements.

Jeffrey Dirk, managing partner at Vanasse & Associates, Inc., prepared a Transportation Impact Assessment using the ~~t~~Town standards and Mass DOT standards. He worked with ~~t~~Town departments ~~within the town~~ to understand the roadway structure current and future. The Muzi site was taken into account. The critical thing was disbursing traffic and traffic moving on Arbor Street and Cross Street. About 55% of traffic goes to I-95 so they have looked at left turn queueing. Arbor Street and Cross Street will have 1 to 5 cars queuing during peak time. He looked at how the garages were designed and saw no safety deficiencies. The sight~~e~~ line exceeds the recommended sight~~e~~ lines. He noted some traffic will be on Hunting Road and Gould Street but the majority will go to I-95. He showed the existing conditions. Bike lanes have recently been added. He wanted to design the project so people could bike and walk safely. He noted there will be 20,000 cars per day over a 24-hour period with 1,700 cars at peak hours [this seems high – does he mean coming and going from the site or on Highland Avenue or other nearby streets?].

Formatted: Highlight

Ms. Espada asked why the entrance is on Cross Street where there are residences and not on Arbor Street where it is commercial. Mr. Dirk noted, from a traffic standpoint, either one would work. For disbursal, Cross Street is better. He noted people will likely use the first street~~one~~ they come to. Signs can be provided to encourage people to use one street over the other. Mr. Cocker noted people could access Arbor Street or Cross Street from the garage. Mr. Dirk showed vehicle trips. There will be 1,800 daily in 24 hours. There are 634 existing and there will be 1,166 for medical office. There will be 101 in the morning peak and 168 in the evening peak. Mr. Alpert asked the hours of operation. Mr. Huber assumes the hours will be 7:00 a.m. to 7:00 p.m.

Mr. Dirk showed the trip disbursal and noted it was designed using both streets. Mr. Block asked what the maximum capacity for queueing is before disruption. Mr. Dirk stated it could go to 10 cars on both streets before disruption. That is substantially more than what they are predicting. He noted the following recommendations: traffic signal retiming and phasing plans on either side of the project site at Highland and Webster, and Highland and Gould and Hunting, and install signs for No Through Traffic on Cross and Highland at Putnam[,unclear – Cross is off Highland; Putnam intersects with Cross]. Mr. Alpert asked if the timing could be done so there is a break in traffic at the same time so cars can get out. Mr. Dirk stated that could be done.

Justin Mosca, Civil Engineer, reviewed the stormwater management and topography plan. The site has a comprehensive storm water management system design in compliance with the Needham Stormwater By-Law and associated standards. It does not connect to the ~~t~~Town system. Highland Avenue is the high side and there is no useful connection. They rely heavily on infiltration. Enough infiltration volume is being provided for a fully managed 25-year storm and a mostly managed 100-year storm with some overflow but less than what is there today. Catch basins are set up all along Arbor Street along the frontage and [at? along?] Highland Avenue. All water from the building and parking area are going to the infiltration system. Inside the building are concrete chambers and outside is the infiltration system.

Mr. Mosca noted most of the connections for the general utilities are off Cross Street such as electric and gas. Sanitary sewer is out to Highland Avenue. There is a water line on Arbor Street for a new hydrant. He showed where the generator will be located. He noted the applicant is funding stormwater improvements on the ~~3~~Three Squares Restaurant property as the system was not working. Ms. Cavanaugh noted the green space is increased by ½ acre of open space overall. There is a 40-foot setback of green space along Highland Avenue and green space along all the sides. Retaining walls are all under 4 feet in height and have been planted. There will be significant screening along Cross Street with additional plantings at the neighbor~~'~~s' property across from Arbor. The property will be irrigated. There will be a 2,500 square foot plaza for patients and workers which will be screened. It will be flexible open space and screened with arborvitae. There will be a terrace and plantings within the parking area. Additional trees are being planted along Arbor and ornamental trees and grasses along the terrace. There will be 4 different grasses along the front, then a wall with more plantings above. The plantings will all be low maintenance.

Ms. McKnight noted a good locus plan is missing from the packet. The plan does not identify all the streets that go from Gould Street to Webster Street. Mr. Block noted the following correspondence for the record: a memo from the Design Review Board, dated 8/8/23, with comments regarding red oaks, approving the building design and materials; an email from Police Chief John Schlittler, dated 8/15/23, regarding traffic impact; a response to Chief Schlittler from Jeffrey Dirk, dated 8/31/23; an email from Assistant Public Health Director Tara Gurge, dated 8/30/23, with the usual comments; a letter from Town Engineer Thomas Ryder, dated 8/30/23, with comments; a letter from Building Commissioner Joe Prondak, dated 8/31/23, with comments; a letter in response [to Mr. Prondak?] from Daniel Burton, dated 8/31/23; an email from Fire Chief Tom Conroy, dated 8/30/23, with comments; a response to Mr. Conroy from Justin Mosca, dated 8/30/23 and an email from Town Meeting member Glenn Mulno, dated 8/31/23, with comments.

Mr. Block opened the hearing up for public comment. Attorney Howard Freedman, representative for Gateway Townhouse Condominiums at 605-607 Highland Avenue, noted the units were built in 1996. There are 12 units, with children, and there is a concern with traffic. The road [,what road? Cross Street? Putnam Street?] is congested but well maintained. There is a concern with traffic on Putnam Street. This project will be adding 1,100 new cars daily. There is concern with signage and enforcement. He feels the issues will be ongoing. Cross Street and Arbor Street are private ways so people who abut the roads need to maintain them. He would like to know the developer's contributions. Mr. Block suggested Mr. Freedman email a list of comments to the Planning Board.

Jennifer Yogel, of 612 Highland Avenue, lives directly across the street, between Mills and Utica. It is very densely populated with a lot of children who play in the streets. She is very concerned with the safety of the kids. Cut throughs will happen. It is done all the time at high speeds. She asked why there is not another access route out of the neighborhood onto Webster or Gould. She asked how medical waste is leaving these places. It is a very sticky situation with storage outside. Flooding has impacted this area of town like she's never seen before, and she is concerned with pests that get into trash, water, waste removal and traffic. She appreciates the traffic counts, but they have never tried to get in or out of their

Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight

driveways onto Highland Avenue. The project needs more work on the road systems and access. People should enter and exit different ways.

Walter Tin, Trustee of Townhouse Condominium~~mmunity~~, backed up the comments that were made. The biggest problem is the width of the streets. There are no sidewalks and kids are a real issue. These are private ways, and the community pays for all expenses. Dr Wendy Herman, of 613 Highland Avenue, Gateway Condos, has 2 small kids. The bus stop is at Cross and Highland. Her first grader is allowed to be picked up and dropped off independently. She would like to keep that available as a bus stop and ensure safety. Mr. Alpert asked how safety at the bus stop would be impacted during construction. Mr. Huber stated he would respond at the next meeting.

Rob Dengel, of 28 Hewitt Circle, feels badly for the condo owners with Muzi, Wingate, and now this. It is sandwiched from all sides. The size of the project needs to be taken into consideration. The narrow streets will not be able to handle traffic and he heard nothing about solar. Is there anything regarding LEED Certified for the building? It seems like a ~~non descript~~non-descript building and ~~does~~would not contribute to the character of Needham. He does not feel the focus was on aesthetics and traffic impacts. He wants the Board to think about the neighbors.

Mr. Alpert noted this is a project with a use that is as of right and meets all requirements. He wants to ask Town Counsel if, on a site plan review, can the Board raise these issues such as solar. He would like an answer from Town Counsel. Mr. Block stated he spoke with Town Counsel specifically on solar. It is clear under site plan authority the Board does not have authority to require solar or carbon technology. The Board does not have the discretion to require the developer to reduce the building size. The developer needs to mitigate the impacts and leave it not in a worse state post construction and there are certain standards to meet traffic mitigations. Mr. Dengel stated if the developer is not required by law to address these issues, the zoning should be looked at so the Town can have more power. Mr. Alpert noted there is a plan to identify specific By-Law changes for solar and solar technology.

David Hruska, of 21 Rosemary Street, stated it is a nice development. He is concerned with parking, particularly the cost to park there. He assumes parking will be free but there will be a lot of extended costs on the public. He wants to encourage planning for the future and reduce dependence on vehicles. They should reduce the parking and charge the market rate for parking. Nancy Greenwald, of 615 Highland Avenue and Trustee of Townhouse Condominium~~s~~, reiterated what the others have said. She would like "no access to Highland" signs on Putnam Street. 250 cars parking on this site~~there~~ are too many. She has problems getting out of her driveway in the morning as traffic backs up to her driveway. She does not feel 7:00 a.m. to 7:00 p.m. are appropriate hours. There are homes in the area. She feels 4:30 p.m. should be the last appointment.

Emily Pick, of 12 Mills Road, stated her biggest concern is traffic. She hopes the Planning Board hears the concerns. She would like to see this pushed back off Highland Avenue, more traffic disbursement and more water management. The hours of operation should be addressed. Curtailing the hours would minimize traffic. Mills Road is a cut through. She would like some mitigations put in and would like to see some method of enforcement on Highland Avenue. People speed on Highland Avenue. She would like the hours of construction minimized and is concerned with the scale of the project.

Kevin Pichetti, of 194 Webster Street, asked how many more cars there would be. Mr. Cocker noted there would be roughly 60 more vehicles in and out for 120 more vehicle trips. Mr. Pichetti asked, with the elevation change to Arbor Street, how is that going to work. Mr. Cocker stated Arbor is already a little higher than Cross Street. There will be a connecting driveway between the 2 roads. Mr. Pichetti stated there are 6 oaks on Arbor Street. Mr. Cocker noted there is a plan to remove one that is not healthy.

Ben Daniels, of 5 Sachem Road, lives across from the Muzi site. With the traffic, where does this all end?~~.~~ This is 1,100 more cars per day and there will be more with the Muzi property. He noted it is frustrating that it is just a little bit at a time. There is no ~~long range~~long-range plan. There has to be a plan, not who gets there first. They need someone to keep an eye that Needham does not turn into Somerville. The developer could put up solar or geothermal as a matter of good will.

Alan Freidman, of 71 Putnam Street, noted signs can be put up but they will not matter. There are a lot of kids. The impact with this development, Wingate and the Muzi site is awful. The Planning Board represents the residents and should not just ok all this. Mr. Block stated there could be a peer review on traffic impact analysis. Ms. McKnight stated they usually require it. Mr. Crocker noted traffic is the main focal point. He feels it would be wise to do the peer review. Ms. Espada

agreed. Mr. Alpert is in favor of a peer review. Vanasse does good work but represents the developer; ~~. A~~another set of eyes would be good. Ms. Newman stated GPI could do the peer review.

A motion was made to ask the Planning Director to reach out to GPI as they are available and request a traffic study peer review and engage a consultant. Ms. Newman noted she would work with GPI to get a proposal, cost and timeline. This would be needed for the 10/3/23 meeting. Mr. Alpert feels it should be stressed that the major concern is with traffic on small side streets and how to mitigate it.

Upon a motion made by Mr. Alpert, and seconded by Mr. Crocker, it was by a vote of the five members present unanimously:
VOTED: to ask the Planning Director to reach out to GPI and request a traffic study peer review and engage a consultant.

Upon a motion made by Mr. Alpert, and seconded by Ms. McKnight, it was by a vote of the five members present unanimously:
VOTED: to continue the hearing to 10/3/23 at 7:05 p.m.

Board of Appeals – September 21, 2023.

1458 Great Plain Avenue – Tobin Beaudet Schools, Inc.

Upon a motion made by Mr. Alpert, and seconded by Ms. McKnight, it was by a vote of the five members present unanimously:
VOTED: "No comment."

Minutes

The minutes will be discussed at the next meeting.

Report from Planning Director and Board members.

Ms. Newman noted there will be a kickoff meeting for the Housing Needham (HO~~M~~NE) ~~C~~committee this Thursday at 7:00 p.m. RKP Consultants have been hired and the paperwork has been signed. She feels the Planning Board members should review the tape of the meeting to be up to date. There will be a presentation on the MBTA Communities Act and what is expected. There will be a discussion about the public process.

Ms. Espada noted she did not see regulations for the streetscape along the Highland Avenue area they just looked at. Ms. Newman stated ~~it is~~ such regulations are not provided in the Industrial District. She tried to rezone it shortly after she arrived in 1993 and it was unsuccessful. Ms. McKnight stated, in the Town's 2022 ~~h~~Housing ~~p~~Plan, proposals for rezoning in compliance with the MBTA law ~~it~~ went to Webster Green Apartments and stopped because, beyond Webster Street, it is not transit oriented. The standard is ½ mile or a 15-minute walk to transit. Mr. Alpert noted they are dealing with an Industrial zone in the middle of a residentially-zoned area. Ms. Espada just wants members to be mindful of different lots with different setbacks. Mr. Alpert noted they are talking about the Highland Avenue corridor. He likes that this project is not directly on Highland Avenue ~~and~~but has a 40-foot landscape buffer along Highland Avenue. It is not all asphalt like on Gould Street and from Webster to Gould. This will add some class to this section of town.

Ms. Espada noted she and Ms. McKnight plan ~~a~~ once a ~~month~~ meetings for the HO~~M~~NE committee, with ~~committee~~community meetings in October, January and March. Ms. Newman stated the first community meeting will be 11/9/23. Mr. Block noted there are 3 candidates for the Economic Development Director position. He was on the search committee. The Assistant Town Manager Katie King will hold a second round. He will keep members posted of any vacancies for CEA members. He noted the Single Parcel Historical Commission will do reports to the Planning Board.

Correspondence

Mr. Block noted the following correspondence for the record: an email from Anika Law, dated 8/17/23, regarding a By-Law change for regulating gun shops; an email from Stanley Keller, dated 8/28/23, relating to 1688 Central Avenue; an email from Norman MacLeod, dated 8/29/23, regarding 1688 Central Avenue; an email from Gregg Darish, dated 8/29/23, regarding 1688 Central Avenue; an email from Lois Sockol, dated 8/29/23, regarding 1688 Central Avenue; an email from Robert and Joan Onofrey, dated 8/30/23, regarding 1688 Central Avenue and a public notice from Wellesley regarding Large House Construction.

The Board took a 5-minute recess.

Zoning Regulation of Solar Energy Systems: Material Review, Zoning Priorities and Policy Considerations.

Mr. Block stated, for the May Town Meeting, he wants to define the scope, identify action items and a schedule to move forward. The Climate Action Plan Committee (CAPC) is focused on 3 areas – solar canopies over parking lots and structures; commercial roof top solar; and small and medium sized ground–based solar. The first element in the By-Law is the purpose in any section. He will follow the same structure as other By-Laws. The framework will be around the 3 items above, but they need to identify what the process will be. Should canopies over parking lots and structures be by right or by special permit? Some advocate breaking up by size. Some recommend solar canopies by size and smaller canopies would be by right. Large, like the Boston Properties Special Permit, he would prefer by site plan review. He needs to see what the standard is. He does not know what the potential adverse effects would be and appropriate mitigation. The 888 Great Plain Avenue size would be like a small installation. He feels it could go through without site plan review. They need to know what the standard is by size.

Mr. Alpert hears the discussion as if the developer comes to the Board and wants to put solar in. He thought they were talking about where the Board can require solar. Mr. Block does not feel it needs to be a special permit process, just site plan review. Ms. Newman commented if there is already a special permit for the building, some canopies have been done as deminimus changes to the special permit. Ms. Espada stated she was at a CAPC meeting with Justin Savignano, and Steven Frail and 2 experts were brought in – Andrea Love and Jacob Knolls. They were part of the group that created the Stretch Code. This group came up with recommendations for different items already sent to the Planning Board. She read what was sent. A framework was already put together. She feels they could start with that. Mr. Block noted they could take that and focus on the solar elements.

Ms. Espada feels one thing is reviewing permitting online. Mr. Block stated they can identify what the permitting process is and add an application for solar canopies. They need information from Mr. Savignano as to the size that will tell what can be done by right. A discussion ensued regarding solar canopies. Mr. Block asked Ms. Newman to bring up the size of the Olin project and the Boston Properties parking garage for the next meeting. Ms. Newman clarified they could identify the size of what can be built over a structure by right and by special permit. Mr. Block recommends that, if it is a by–right structure it would be a by–right process. If a certain size it would be by right but with site plan review. Ms. Newman noted the same rules should be in all districts. Mr. Block was thinking not of different regulations by district but by size.

Ms. McKnight feels it is primary use versus accessory uses. There are tables of what is allowed as primary and accessory uses. They could have a footnote. She feels they should go district by district to see where this use should be allowed. Mr. Block reiterated he feels the standard is the size. Mr. Alpert noted the difference is that the size that would be allowed in Needham Center is smaller than the size that would be allowed in the Industrial District. A discussion ensued. Mr. Block noted there is no structured parking in downtown where this would be applicable. All buildings in downtown are small buildings. It would factor it in by size. It would need a definitional change throughout the By-Law to define what solar canopies should be. Ms. McKnight stated the Board needs to set what the criteria would be. Mr. Crocker stated a solar canopy is a structure. They may not need to have any regulaton~~thing~~ other than compliance with the existing setback. The Board needs to determine is it fair, practical and right. Mr. Block stated that is not relevant. The structure is not a solar canopy. The structure is the parking structure. Solar on roofs could be anywhere in town. The Board discussed the need to identify sites, understand how much is realistic for what buildings, look at the setback and see what other towns have done. Mr. Alpert noted the information provided by Steven Frail has By-Laws from other towns. Ms. Newman intends to look through and put together the information with a chart with all the elements.

Formatted: Underline

Formatted: Underline

Mr. Block summarized the discussion. The high-level items are commercial roof top solar, solar canopies over parking lot structures and small and medium ground based solar. The height and setback restrictions need to be separated out. Solar and other carbon reduction technology should be allowed and mechanicals not to exceed 15 feet on the horizontal plane and 25% of rooftop criteria. They need to look at structure setback and screening requirements. The process should be considered, identity definitions and what is being mitigated~~ding~~ for. The Dover Amendment is a protected use under Chapter 40A, Section 3. He feels they need to bring Town Counsel in at the early end. Ms. Espada stated Mr. Savignano and the new Building Commissioner should be at the next meeting. She noted the Stretch Code needs to be abided by. The Board needs to be aware of that and take it into account.

Upon a motion made by Mr. Alpert, and seconded by Ms. Espada, it was by a vote of the five members present unanimously:
VOTED: to adjourn the meeting at 10:35 p.m.

Respectfully submitted,
Donna J. Kalinowski, Notetaker

Jeanne S. McKnight, Vice-Chairman and Clerk (JSM is not Vice-Chair and we have no "Clerk" position, do we?)

Formatted: Highlight

From:	Joe Abruzese
To:	Planning; Selectboard
Cc:	Lee Newman; Alexandra Clee
Subject:	Request to publish meeting minutes and recording for executive session held on 9/11/2023
Date:	Thursday, September 28, 2023 7:45:55 AM

To the Needham Planning Board and Needham Select Board,

I am writing to request that the meeting minutes and recording for the Select Board/Planning Board Special Joint Meeting Executive Session held on September 11, 2023 be published.

On September 11, the Select Board and Planning Board held a special joint meeting. During the meeting, participants met in Executive Session to discuss litigation relative to 1688 Central Avenue. To my knowledge, the Planning Board decided to not take any further action on this matter and there are no remaining topics to be discussed. As such, I'm requesting that the minutes and recording from the session be published.

Please let me know when they are published and the online location where I can find them.

Regards,
Joe

Joe Abruzese
Town Meeting Member, Precinct D
617-429-3964
jabruzese02492@gmail.com

Christopher H. Heep
T: 617.804.2422
cheep@miyares-harrington.com

October 5, 2023

BY EMAIL (jabruzese02492@gmail.com)
Joe Abruzese
30 Bridle Trail Road
Needham, MA 021492

Re: Request for Executive Session Minutes

Dear Mr. Abruzese:

In an email dated September 28, 2023, you requested the meeting minutes and recording for the September 11, 2023 joint executive session of the Needham Planning Board and Select Board. This executive session was held to discuss strategy with respect to litigation, namely Needham Enterprises, LLC v. Needham Planning Board, Land Court Miscellaneous Case No. 22 MISC 000158, where the Chairs declared that doing so in open session would have a detrimental impact on the Planning Board's litigating position.

The Land Court has issued a judgment in this case, but several appeals are currently in process at the Appeals Court. In particular, Needham Enterprises, LLC v. Needham Planning Board, Appeals Court Case No. 2023-P-0838 remains active on the Appeals Court's docket. In addition, proposed intervenors filed a Notice of Appeal with the Land Court on September 27, 2023; this appeal has not been docketed by the Appeals Court yet.

Given that there are two appeals from Needham Enterprises, LLC v. Needham Planning Board, Land Court Miscellaneous Case No. 22 MISC 000158 pending with the Appeals Court, release of the minutes at this time would defeat the lawful purpose of the September 11, 2023 executive session. The Planning Board and Select Board will monitor the status of the pending appeals, and will release the minutes when disclosure will no longer defeat the purpose of the September 11, 2023 executive session.

Sincerely,

Christopher H. Heep

cc: Kate Fitzpatrick, Town Manager
Select Board
Lee Newman, Director of Planning and Community Development
Planning Board

From:	Heather Finnegan
To:	Planning
Subject:	Construction issues
Date:	Monday, September 18, 2023 7:45:03 PM

Hi there!
I'm another neighbor behind the Hunewell house project. My address is 15 Mellen St. I am aware my neighbor already let you know about the water problem at her house but I wanted to add the issue at my house since the entire back yard backs up to my entire back yard.
Ever since their patio went in there is a grade problem directed down into my yard. I have never had water issues before but the water is flooding my back yard.
I really can't believe that the town would allow a builder to be able to ruin other properties in town without care. I've been told there's nothing that we can do but it's really disappointing and disheartening to live in a town where we aren't heard and supported.
I'm all for construction- I did it myself. But I don't think ruining someone else's property should be allowed.

Heather Finnegan
15 Mellen St.

Sent from my (allegedly) Smart phone. Please excuse misspellings, creative grammar, brevity, and completely unrecognizable text thanks to rogue autocorrect.

From:	Board Chairman
To:	Lee Newman; Alexandra Clee
Subject:	Seniors stuck in state's pricey housing market - The Boston Globe
Date:	Saturday, September 30, 2023 12:26:43 PM
Attachments:	2023-9-9 -- Seniors stuck in state's pricey housing market - The Boston Globe.pdf

Hi Lee, Alex:

Here's a recent, relevant Boston Globe article. It provides additional context for the Linden/Chambers Redevelopment Project that Planning Board members might find interesting.

Best,

Reg

==========
Reginald C. Foster, Chair
Needham Housing Authority
Board of Commissioners
21 Highland Circle
Needham, MA 02494
Cell: (339) 222-6187
Office: (781) 444-3011
Fax: (781) 444-1089
www.needhamhousing.org
==========

Seniors stuck in state's pricey housing market

Finding an affordable living option can take 'sheer, blind, ridiculous luck'

Mary McPeak, 73, moved into 2Life Community's Brookline location after a year of couch surfing and renting a single room.

By Matt Stout, Globe Staff

Nearing 70 years old, Mary McPeak had long had a stable home in Greater Boston. But after a breakup four years ago, she suddenly found herself unmoored, couch-surfing at friends' homes or renting a room while she faced years-long wait lists for affordable senior housing.

Then a break: McPeak "won the lottery," figuratively and quite literally, when she was selected in 2020 by lottery for a new senior housing complex, the Brown Family House in Brookline run by 2Life Communities.

"It was sheer, blind, ridiculous luck," said McPeak, now 73. The retired secretary has lived in her subsidized one-bedroom apartment for nearly three years now. "It was so lucky, it was

enough to believe in God."

Such is the state of affordable housing for seniors in Massachusetts, where it seemingly takes divine intervention to find a home. In an inventory-starved market, the graying population faces some of the steepest hurdles in the country to secure an affordable place. So dire is the situation, some argue, seniors should be prioritized in the state's response to the wider-ranging housing crisis.

The dilemma has many faces. There are home-owning seniors who want to downsize but are otherwise stuck because the smaller homes they want are scarce and cost as much, if not more, than their current ones. With fixed incomes, some retirees can't keep up with rising property taxes. Others are slowly being priced out of rentals they've lived in for years, if not decades.

And when they begin looking, they find few good options: independent living complexes with price tags that are out of reach for many, or subsidized housing with wait lists that stretch three years, five years, or longer.

For single seniors and couples who rent, Massachusetts is already the most expensive state in which to live independently, according to a study by the Gerontology Institute at the University of Massachusetts Boston. Those high costs help fuel another dire reality: Older adults living alone here are more likely to be unable to afford basic needs than those in any other state.

As baby boomers age into retirement, that cohort and its needs keep expanding. In Massachusetts, roughly 1.2 million people were 65 and older in 2020, a jump of more than one-third from a decade earlier.

"That need is absolutely growing," said Elissa Sherman, president of the trade group LeadingAge Massachusetts. "Developing senior housing is not cheap. We need public investment in order to do that."

It may also be the place to start, some lawmakers and senior advocates argue. Incentivizing construction of senior housing will not only help prevent elderly homelessness, supporters contend, it could help push more single-family homes onto the market by allowing seniors to move into smaller homes they can afford. About 70 percent of people 65 and older in Massachusetts are homeowners, according to the Urban Institute.

That, in theory, could help boost badly needed supply for younger families looking to buy a

home, which in turn then frees up rentals for young professionals. Massachusetts policy makers can create “a lot more ripples when we address senior housing,” said state Representative Susannah Whipps.

“We start with the top and work down,” said Whipps, an independent from Athol, who argued that in swaths of Central and Western Massachusetts, where school enrollment is declining and communities are hungry for a younger workforce, building more housing for seniors could help address a variety of needs.

Seniors “don’t want to leave their communities,” she said. “They want to age in place. But how do we do it in an affordable way?”

That’s not the only question facing policy makers. The housing crunch touches all corners, with one state report estimating the state needs 200,000 additional housing units by 2030 to help satisfy demand among all ages, including those locked out of home ownership by steep prices and higher interest rates.

Building senior housing is a critical part of the response, said Ed Augustus, the housing secretary under Governor Maura Healey. But there’s also no “silver bullet,” he said.

“I wouldn’t say there is consensus that if you do this one thing, it unlocks all sorts of housing,” he said, before turning to a baseball analogy. “It’s a lot of singles, doubles, triples that collectively help expedite production.”

Choosing what type of housing to incentivize also requires balance. Local officials and residents across Greater Boston have regularly fretted that new development overtaxes their towns with more children in their schools, more cars on their roads, and more demand on fire or police services.

That’s made senior housing an easier sell to local voters. It tends to be less dense than family housing — so fewer people move in — and, residents argue, local schools (or taxpayers) are less likely to absorb additional students, according to a 2022 Boston Foundation report examining housing in Greater Boston. And yes, there is a need for more of it, but building age-restricted subsidized housing while limiting other types of affordable housing “can cause a mismatch” between what’s available and who may need it most, the report warned.

It pointed to an imbalance in communities such as Winchester, where almost all of the subsidized housing at that point — more than 80 percent — was restricted to senior citizens.

“That’s a town sending this signal: They have these world-class schools, but . . . you as a community are creating schools that are only for people above a certain income level,” said Katherine Levine Einstein, a professor of political science at Boston University and coauthor of the report.

The argument that simply building more senior housing can create a trickle-down effect also risks being exclusionary in practice, Einstein said. “It does end up feeling like this zero-sum game,” she said. “If you have a limited amount of funding, what is the population you’re going to prioritize?”

How exactly the state should approach helping seniors also isn’t cut and dried. The focus, said state Senator Lydia Edwards, should be on low-income seniors and renters, many of whom don’t have the financial flexibility to keep up with rising costs, and helping keep them in their homes.

She pointed to pursuing tax relief measures or creating incentives for landlords to rent to seniors.

“I know the stereotype is we live in a very rich senior market. That has not been my lived experience,” said Edwards, an East Boston Democrat and cochair of the Legislature’s housing committee. There is not enough housing generally, she said, but seniors are especially vulnerable because many are on fixed incomes. “The scariest case is when a senior has no options.”

Seniors who rent often face a heavy financial strain. Generally, people who pay more than 30 percent of their income on housing are considered “cost-burdened.” Among renters 80 and older in the Boston metropolitan area, three out of five pay more than that, said Jennifer Molinsky, project director of the Housing an Aging Society Program at Harvard University’s Joint Center for Housing Studies. One of five pays more than half, she said.

“Much of the assisted living [that’s available], and many of the retirement communities are for higher income people,” Molinsky said. “People in the middle really have very little choice if they want to move to a [new] place.”

That can also include people who may have been solidly in the middle class during their working years but then fall into poverty as they age, said Lizbeth Heyer, interim chief executive of 2Life Communities, the Brighton-based senior housing developer.

“In terms of a moral imperative, it’s despicable to think we can’t do better,” she said. “We’re

not looking ahead where the demographics are going . . . and heading off a looming crisis of elder homelessness. It's despicable."

Even at 2Life Communities, which broke ground on a new 68 apartment-building in Waltham just last month, demand far outstrips what it can build. Company officials estimate they have more than 7,600 applicants for its properties, with wait lists starting at three years for a studio at its Brighton campus; the wait for a two-bedroom could be 10 years.

Across the Greater Boston region, wait lists as long as five years can be commonplace, advocates and seniors say.

"It's almost pointless at that stage. Let's face it, who knows where we're going to be in five years," said Catherine, a senior who lives in Waltham with her sister, Mary, and asked to be identified by only her first name.

They've lived in their current two-floor apartment for 38 years, but they need single-level living as they age and the rising rent isn't helping. They're even willing to move into a one-bedroom place, if it means finding a home they can afford.

"Because we have to move," she said.

Matt Stout can be reached at matt.stout@globe.com. Follow him @mattpstout.

From:	Board Chairman
To:	Alexandra Clee
Cc:	Lee Newman
Subject:	The Boston suburbs' cynical ploy to keep poor families out: Use seniors as a shield - Boston Globe Editorial
Date:	Monday, October 2, 2023 1:07:41 PM
Attachments:	2023-10-1 - The Boston suburbs' cynical ploy to keep poor families out Use seniors as a shield - The Boston Globe.pdf

Hi Alex, Lee:

Attached is another relevant editorial from yesterday's Sunday Globe. You may want to provide the Planning Board...I don't want anyone blindsiding board members with questions derived from this editorial.

FYI, I don't think Needham qualifies as one of the "cynical suburbs" alleged in the editorial. Needham's and NHA's track record has been and is quite good over the past 15 years:

- The documented shortage of affordable housing is great for all three categories: families, the disabled and seniors.
- For the last 15 years NHA and the Preservation & Redevelopment Initiative (PRI) have focused on the need in all three categories.
    - In 2008-2009, NHA completed the High Rock Home LLC project which produced 40 affordable units of housing suitable for families, a net addition of 20 units.
    - Announced mid-2021, the PRI is a 10 year plan to overhaul all 336 of NHA's affordable housing units, producing ~200 net new units in the process. The PRI already does focus on family units, as well as senior/disabled units.
    - Yes we're starting with affordable senior/disabled housing at Linden/Chambers during this first PRI phase, and also renovating/modernizing 46 senior/disabled units at Seabeds. But we're also renovating/modernizing the 30 affordable family units at the Capt. Robert Cook development in this PRI phase as well.
    - The next PRI phase targets the redevelopment of our 60 worn out family bungalows on ~20 acres in the High Rock neighborhood, with a production goal of ~120 affordable replacement family units.
- Funding sources have been identified for the High Rock Redevelopment project, and NHA could possibly the start the predevelopment phase as soon as 2025-2026.

Best,

Reg

==========
Reginald C. Foster, Chair
Needham Housing Authority
Board of Commissioners

21 Highland Circle
Needham, MA 02494
Cell: (339) 222-6187
Office: (781) 444-3011
Fax: (781) 444-1089
www.needhamhousing.org
==========

On Oct 2, 2023, at 9:22 AM, Alexandra Clee <aclee@needhamma.gov> wrote:

Thanks, I'll share it with them.

Alexandra Clee

Assistant Town Planner

Needham, MA

781-455-7550 ext. 271

www.needhamma.gov

From: Board Chairman <chair@needhamhousing.org>
Sent: Saturday, September 30, 2023 12:26:20 PM
To: Lee Newman <LNewman@needhamma.gov>; Alexandra Clee <aclee@needhamma.gov>
Subject: Seniors stuck in state's pricey housing market - The Boston Globe

Hi Lee, Alex:

Here's a recent, relevant Boston Globe article. It provides additional context for the Linden/Chambers Redevelopment Project that Planning Board members might find interesting.

Best,

Reg

==========
Reginald C. Foster, Chair
Needham Housing Authority
Board of Commissioners
21 Highland Circle
Needham, MA 02494
Cell: (339) 222-6187
Office: (781) 444-3011
Fax: (781) 444-1089
www.needhamhousing.org
==========

EDITORIAL

The Boston suburbs' cynical ploy to keep poor families out: Use seniors as a shield

Leafy communities have steered subsidized housing away from parents with kids and toward elders for decades. It's time for a rebalancing.

By The Editorial Board Updated October 1, 2023, 4:00 a.m.

Melissa Gomes watched her 6-year-old daughter, Melyahni, bounce on the trampoline outside her home in Malden. Many suburbs have erected barriers to the kind of income-restricted, multibedroom housing that families with kids need. NATHAN KLIMA FOR THE BOSTON GLOBE

The police were serving a warrant on a troubled neighbor. A crowd was gathering outside.

And then, in an instant, a sort of manic brawl broke out.

Or, at least, that's what it sounded like to Savara Willis, huddled inside her apartment with her children as the combatants' bodies slammed against her heaving front door.

All the violence and dysfunction of her slice of Dorchester seemed to be closing in on Willis and her screaming kids. And the mantra that had been building in her head was peaking: "I gotta get them out. I gotta get them out."

When she first spoke with the Globe editorial board this spring, Willis, a 43-year-old mental health case manager, was already months into a search for a new place in the suburbs.

But like so many low-income parents who have tried to escape to the band of leafy, opportunity-rich towns that bend around Boston, she was struggling to find an apartment.

Part of the problem, no doubt, was the scarcity of apartment buildings in suburbia.

Over the last century, many suburbs have all but banned them, effectively preventing construction of the kind of places that might serve as today's reasonably priced rentals. Those zoning codes, though typically justified in terms of protecting the environment or the rural character of communities, have often been thinly veiled efforts to keep out poor people.

Exclusionary zoning, though, is not the only culprit.

The suburbs have created another, less appreciated impediment targeted specifically at families like Willis's.

In the civil rights era, the federal and state governments ratcheted up efforts to crack open wealthy communities — subsidizing, and in some cases forcing communities to accept, construction of units set aside for low-income people. But in a cynical move, many suburbs have steered those apartments away from poor parents with kids and toward a demographic they've deemed more acceptable: seniors on fixed incomes.

Low-income elders need and deserve affordable housing, of course. Like every vulnerable population in the region, they don't have nearly enough of it.

But when age-restricted housing is used as a shield against poor children, it's a problem. A moral failing, even.

And the suburbs have been quite explicit about their exclusionary aims.

Just after Congress passed the Fair Housing Act in 1969, the town of Duxbury published a plan recommending that multifamily housing be allowed "only if it can be legally restricted to elder persons." And 33 years later, Lynnfield's master plan made a cold appeal to the

bottom line, arguing that senior housing developments "have a positive fiscal impact because they do not produce any school-age children."

This preference for elders has been codified with age-restricted zoning in big swaths of suburbia.

And at the public meetings that can make or break projects, residents have spoken in coded — and not-so-coded — language about what kind of low-income neighbors they'll tolerate and what kind they won't; the state's senior population skews white, while poor families with kids are more likely to be Black and brown.

Whatever the motivation, the effects are real.

The National Low Income Housing Coalition analyzed census data for the Globe editorial board and found that 29 percent of low-income renters in a census region that covers a large swath of eastern Massachusetts and a portion of southern New Hampshire are seniors. But the share of income-restricted housing set aside for seniors appears to be higher — possibly much higher.

Determining exactly how many income-restricted units are age-restricted is a challenge. The state doesn't maintain a detailed, centralized affordable housing database as it should. But in 2016, the Globe reported on data showing that more than half of income-restricted units in Greater Boston's suburbs were set aside for seniors.

That same data showed the suburbs offered up precious few of the income-restricted, three-bedroom-or-larger apartments that are most suitable to families.

Other studies have come to similar conclusions. And the consequences of this lopsided geography of opportunity have never been clearer.

Research by Harvard University economists Raj Chetty and Nathaniel Hendren, plumbing millions of census and tax records, has demonstrated that low-income children who grow up in better-off places fare substantially better as they grow older than their peers in poor neighborhoods. They are less likely to have teenage births. They are more likely to go to college. And they earn significantly more money as adults.

A move to a high-opportunity neighborhood may, in fact, be the most powerful tool for upward mobility in America. And yet, in a state that claims to care about inequality, policy makers have too often let municipalities stand in the way.

For low-income families, 'I have no sympathy'

You don't have to venture far from the Willis family's apartment to find the sort of serenity and opportunity that Savara Willis craves.

Just a couple of miles south, across the Boston border, the town of Milton offers up safe streets and gracious parks. And the relatively small number of low-income children who have grown up there in recent decades have taken full advantage.

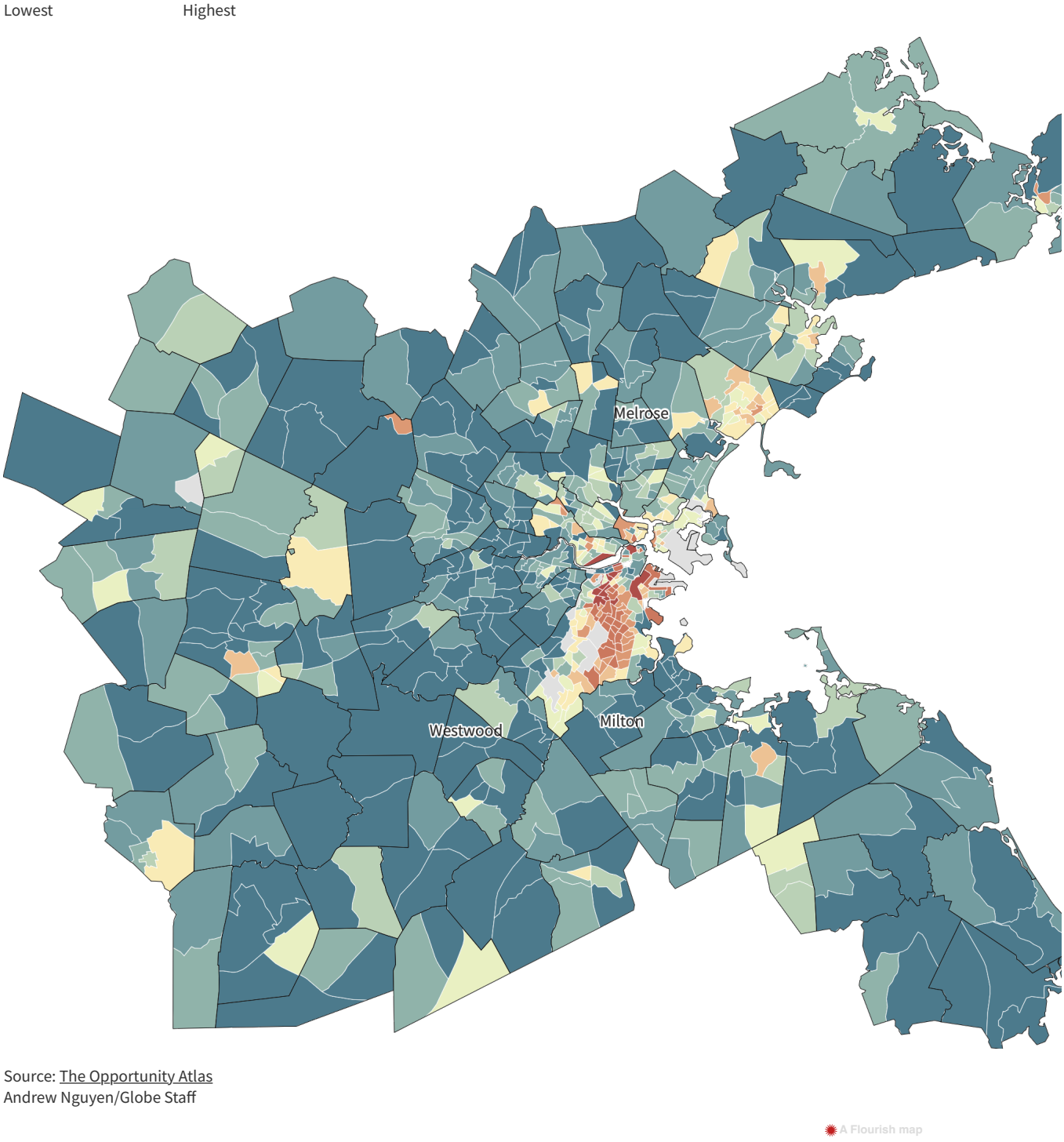
In one study, Chetty and several collaborators traced the economic trajectory of nearly every American born between 1978 and 1983 — over 20 million people — from childhood to age 35. And they were able to demonstrate that where people grow up — down to the specific neighborhood — has a profound influence on how their lives turn out.

Milton, like most of the suburbs in the region, proved a powerful engine of upward mobility.

Three of the town's five census tracts ranked in the 99th percentile, nationally, on a measure of lifting poor kids to higher adult household incomes. The town's other two tracts landed in the 83rd and 86th percentiles, respectively.

The childhood roots of social mobility

Harvard economist Raj Chetty's research has shown that Americans' life trajectories are profoundly influenced by where they gro
That holds in Greater Boston. Poor children raised in the blue-shaded census tracts had higher household incomes, as adults, tha
kids raised in the red-shaded tracts.



Source: The Opportunity Atlas
Andrew Nguyen/Globe Staff

Milton, then, can change a poor child's life. But it remains off limits for too many.

On the northern edge of the town, not far from Boston's Mattapan Square, you'll find a tall, L-shaped subsidized housing development with an American flag and rosebush out front.

But every one of its 139 studio and one-bedroom units is reserved for seniors.

Unquity House is a product of good intentions. An interfaith group pitched it in the late 1960s as a way to keep Milton seniors in town as they aged. And advocates weathered early opposition.

Then in 1969, they got a boost when the state Legislature approved a landmark anti-snob zoning law designed to plant more affordable housing in better-off places.

Suddenly, this seniors-only project looked like a chance to meet some of Milton's affordable housing obligations without attracting an undesirable element. As The Patriot Ledger put it at the time, town leaders believed approval would allow them to "head off any early moves by a private group or governmental agency to construct low income housing projects."

The vote, in the end, was overwhelming: 180 to 21. And the group behind Unquity House went on to build another all-seniors development — the 160-unit Winter Valley Residences — in 1979.

But Milton's seniors-first approach got its most dramatic airing a few years later when the relatively new Milton Housing Authority proposed a 48-unit development — 40 units for seniors and eight for families — on an old estate near Cunningham Park.

Neighbors were staunchly opposed. "If I have to step in front of a bulldozer, this isn't going to go in here," one resident said at a packed public meeting. But if it had to be built, neighbors made clear, one element had to go.

"I don't mind the elderly," one neighbor said at another community meeting. "But for the low-income [families], I have no sympathy, because I was brought up in the slums. I worked my way here." He didn't want "anybody on welfare." He didn't want "to subsidize anyone's rent." And the kids that would come with the family units, he warned, could "tear the whole damn place apart."

The town's board of appeals got the message. It approved the 40 senior apartments — with those units, board chair Charles Barrett explained, "we can limit it to our own people" — but rejected the eight family units and the out-of-towners they might attract.

A state official later described the decision as "the most blatant case of exclusionary action by a community I've seen recently." And when the state threatened to withdraw a $2.28 million grant for the project, town officials agreed to a compromise: They'd keep the project seniors-only but build or purchase eight units of scattered-site family housing elsewhere in town.

The town eventually followed through on those eight units — in the face of some neighborhood grumbling. But Milton's subsidized family housing stock hasn't grown much since.

Housing Navigator Massachusetts, a nonprofit that has spent years compiling scattered records and creating a user-friendly website with extensive listings for income-restricted housing, provided the editorial board with building-by-building data in Milton and several other towns in eastern Massachusetts.

The board checked that information with town officials and nonprofit groups and identified several units that did not appear in the original database.

In the end, the Milton analysis turned up just 12 income-restricted family rentals — or 3 percent of the rentals with income limits in town. The other 338 units, or 97 percent, are reserved for seniors.

(The analysis, focused on rentals that are broadly available to low-income people, excluded some affordable properties — a small number of units in group homes operated by the state's Department of Mental Health and Department of Developmental Services; a small number of affordable ownership units for families; and a larger number of affordable ownership units for seniors. The dataset also

excludes a small number of affordable senior rentals at a development called Fuller Village; the number of affordable units there varies over time.)

The balance could shift in the coming years. Several proposed market-rate apartment complexes in Milton, if they get built, would set aside some affordable units for tenants of all ages. But even with those additional apartments, Milton's income-restricted housing stock would still be heavily tilted toward seniors.

Analyses of several other towns in the region — using Housing Navigator data, supplemented by editorial board research, and with the kinds of exceptions described in the Milton case — show similar disparities.

In Westwood, for instance, 70 percent of income-restricted rentals are restricted to seniors. And in Melrose, it's 84 percent. Just 2 percent of Melrose's income-restricted units are three bedrooms or larger.

What to do

Policy makers have long been aware of this imbalance. And they've made periodic efforts to address it.

In the 1980s, Governor Michael Dukakis and his secretary of communities and development, Amy Anthony, made a notable push for suburban communities to build units for poor families alongside the senior apartments they preferred.

And more recently, state lawmakers passed the MBTA Communities law, which presses cities and towns served by the T to zone for multifamily housing — and mandates that the new housing "be suitable for families with children."

The law is a laudable step toward increasing housing density in the suburbs.

But there are no affordability requirements built into the measure. And the law's compliance guidelines don't stipulate that a certain number of three-bedroom units be built; they simply forbid municipalities from capping the number of bedrooms. That means developers, while free to build three- or four-bedroom units, could still cleave to the studios, one-bedrooms, and two-bedrooms they typically favor.

There is, to be sure, some value in the law's light touch; the state, in the throes of a housing shortage, can't afford to burden developers with too much regulation. But as policy makers take a once-in-a-generation swing at opening up the suburbs to development, they should require at least a modicum of affordability for low-income families with kids.

And while policy makers are strengthening the MBTA Communities law, they should also expand its scope — pressing for better zoning not just in T communities but in cities and towns served by transportation agencies in other parts of the state.

Municipalities have an obligation to pare back building restrictions on their own, too.

Right now, all sorts of height, setback, and parking restrictions curb the production of multifamily buildings in better-off communities. And there are plenty of requirements that lock out families with kids, in particular.

Housing researcher Amy Dain surveyed 100 cities and towns in Greater Boston for a 2019 report on obstacles to multifamily housing and found that more than half of the municipalities had zoning for age-restricted housing (usually ages 55 and up) in certain places. More than a quarter capped the number of bedrooms that could be included in at least some multifamily housing — requiring, for instance, as one town does, that mixed-use developments only include studios, one-bedroom, and two-bedroom apartments.

It's about more than zoning, though.

The state also has to change the way it finances affordable housing, starting with its allocation of tax credits, which are the lifeblood of subsidized housing development these days.

Developers who apply for the credits are awarded a certain number of points for proposing family housing in better-off communities. It's a useful incentive, but if the state really wants to move the needle, it should substantially increase the points allotted.

And as the state ramps up the incentives for building income-restricted housing, it should make it easier to apply for that housing. At the moment, low-income people have to pull together a dizzying array of documents for every apartment they seek. A common pre-application, with some basic information relevant to any landlord, could make the process substantially easier.

Another intriguing option is to provide low-income families with Section 8 housing vouchers they can use to rent not just income-restricted but also market-rate apartments in better-off places.

That's the strategy employed by a small state-sponsored program called Supporting Neighborhood Opportunity in Massachusetts. And the program has shown promising early results.

But even if the Legislature expands SNO Mass — and it should — vouchers aren't a panacea.

One SNO Mass participant the editorial board interviewed — Melissa Gomes, a 41-year-old medical assistant who lives with her daughters, Kamani, 14, and Melyahni, 6, and who signed up for the program through a nonprofit called Metro Housing Boston — has been looking for a new place in a well-off suburb for over a year; competition for market-rate apartments is fierce and Gomes says she's run into landlords who won't accept her Section 8, even though that kind of discrimination is against the law in Massachusetts.

Given the difficulty in securing market-rate units, permanent, subsidized housing in suburbia is a must. Without it, thousands of children will be deprived of the opportunity to build the best possible lives for themselves.

Children like Kamani and Melyahni.

Gomes, deep into a frustrating search, said she tries to assure her daughters that they'll land in a better place some day. But she can sense her kids' impatience. "Mom," her youngest keeps asking, "when are we going to go to my new house?"

Editorials represent the views of the Boston Globe Editorial Board. Follow us @GlobeOpinion.

NEEDHAM PLANNING BOARD
2024 MEETING SCHEDULE

MEETING DATE	LOCATION
January 2, 2024	Charles River Room & Hybrid
January 16, 2024	Charles River Room & Hybrid
February 6, 2024	Charles River Room & Hybrid
February 27, 2024	Charles River Room & Hybrid
March 5, 2024	Charles River Room & Hybrid
March 19, 2024	Charles River Room & Hybrid
April 2, 2024	Charles River Room & Hybrid
WEDNESDAY, April 24, 2024	Charles River Room & Hybrid
Early May – Town Meeting	
May 14, 2024	Charles River Room & Hybrid
June 4, 2024	Charles River Room & Hybrid
June 18, 2024	Charles River Room & Hybrid
TBD	Charles River Room & Hybrid
TBD	Charles River Room & Hybrid
September 3, 2024	Charles River Room & Hybrid
September 17, 2024	Charles River Room & Hybrid
October 8, 2024	Charles River Room & Hybrid
October 22, 2024	Charles River Room & Hybrid
WEDNESDAY, November 6, 2024 11/5 is Election Day	Charles River Room & Hybrid
November 19, 2024	Charles River Room & Hybrid
December 3, 2024	Charles River Room & Hybrid
December 17, 2024	Charles River Room & Hybrid

All Planning Board meetings begin at 7:00 p.m. unless otherwise noted.

10/10/2023