

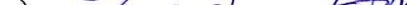
PLANNING BOARD

Project Determination: (circle one) Major Project Minor Project

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

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

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

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

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Withdrawn _____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

C O U N S E L L O R S A T L A W

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."

Needham Planning Board Members
Lee Newman
August 4, 2023
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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.

Needham Planning Board Members
Lee Newman
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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 Mangel 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.

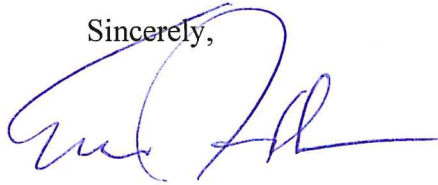
Pursuant to the Board's Covid-19 procedures, these documents are being submitted electronically; additionally three (3) hard copies of the application (with original signatures) and all supporting materials, including wet-stamped plans, are being hand delivered to the Planning Department along with the 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.

Needham Planning Board Members
Lee Newman
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Page 4

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,

A handwritten signature in blue ink, appearing to read 'Evans Huber', is written over the word 'Sincerely,'.

Evans Huber

EH:sfc

FRIEZE CRAMER ROSEN & HUBER LLP
C O U N S E L L O R S A T L A W

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 it 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:

Needham Planning Board
August 7, 2023
Page 2

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

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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.

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(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

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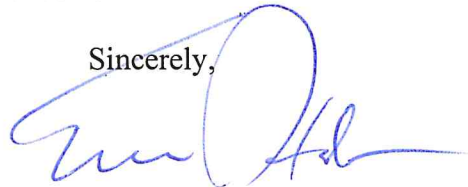
Review process, the site plans will be submitted to the Fire Department for review of the proposed fire truck access and hydrant coverage.

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,

A handwritten signature in blue ink, appearing to read 'Evans Huber', is written over the word '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				



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

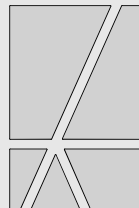
LIST OF DRAWINGS

- P1: COVER SHEET
P2: EXISTING SITE PHOTOGRAPHS
P3: SITE DIAGRAM
P4: SURVEY - SV1.00 EXISTING CONDITIONS PLAN OF LAND
P5: CIVIL - C1.01 LEGEND AND GENERAL NOTES
P6: CIVIL - C2.01 SITE PREPARATION PLAN
P7: CIVIL - C3.01 LAYOUT AND MATERIALS PLAN
P8: CIVIL - C4.01 GRADING AND DRAINAGE PLAN
P9: CIVIL - C5.01 UTILITIES PLAN
P10: CIVIL - C6.01 SITE DETAILS 1
P11: CIVIL - C6.01 SITE DETAILS 2
P12: CIVIL - C6.01 SITE DETAILS 3
P13: LANDSCAPE - L102 RENDERED MATERIAL PLAN
P14: LANDSCAPE - L103 GRADING PLAN
P15: LANDSCAPE - L104 PLANTING PLAN
P16: LANDSCAPE - L501 DETAILS
P17: LANDSCAPE - L520 PLANTING DETAILS
P18: LANDSCAPE - L521 PLANTING DETAILS
P19: SITE LIGHTING PHOTOMETRIC PLAN
P20: ARCH - A.101 P-1 LOWER PARKING PLAN
P21: ARCH - A.102 P-2 UPPER PARKING PLAN
P22: ARCH - A.103 FIRST FLOOR PLAN
P23: ARCH - A.104 SECOND FLOOR PLAN
P24: ARCH - A.105 ROOF PLAN
P25: ARCH - A.201 ELEVATIONS
P26: ARCH - A.301 BUILDING SECTIONS
P27: ARCH - RENDERED P-1 LOWER PARKING PLAN
P28: ARCH - RENDERED P-2 UPPER PARKING PLAN
P29: ARCH - RENDERED FIRST FLOOR PLAN
P30: ARCH - RENDERED SECOND FLOOR PLAN
P31: ARCH - RENDERED ROOF PLAN
P32: MATERIALS OF MAJOR ARCHITECTURAL ELEMENTS
P33: CONCEPT RENDERINGS
P34: CONCEPT RENDERINGS
P35: CONCEPT RENDERINGS
P36: CONCEPT RENDERINGS
P37: CONCEPT RENDERINGS
P38: CONCEPT RENDERINGS
P39: CONCEPT RENDERINGS

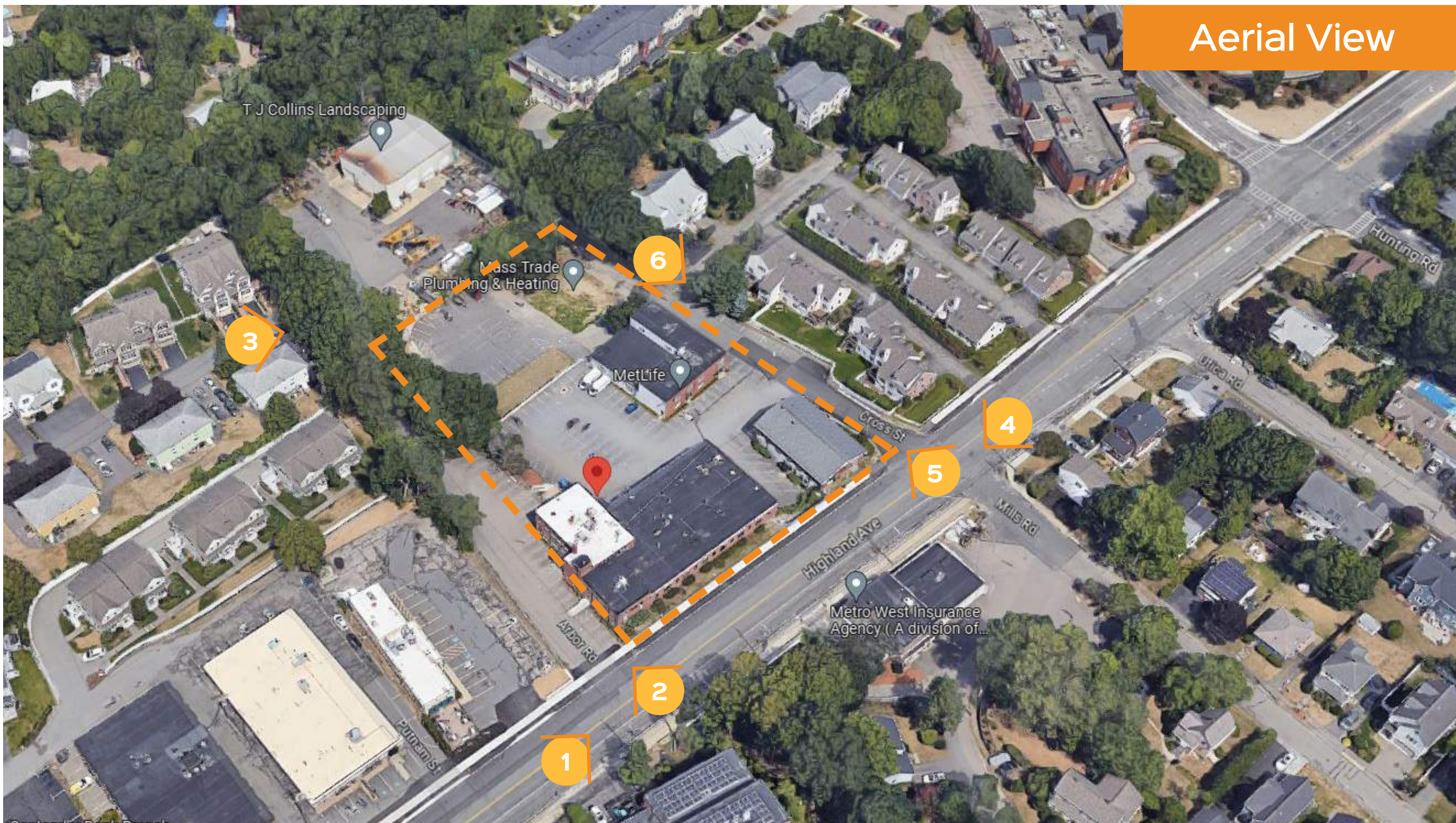


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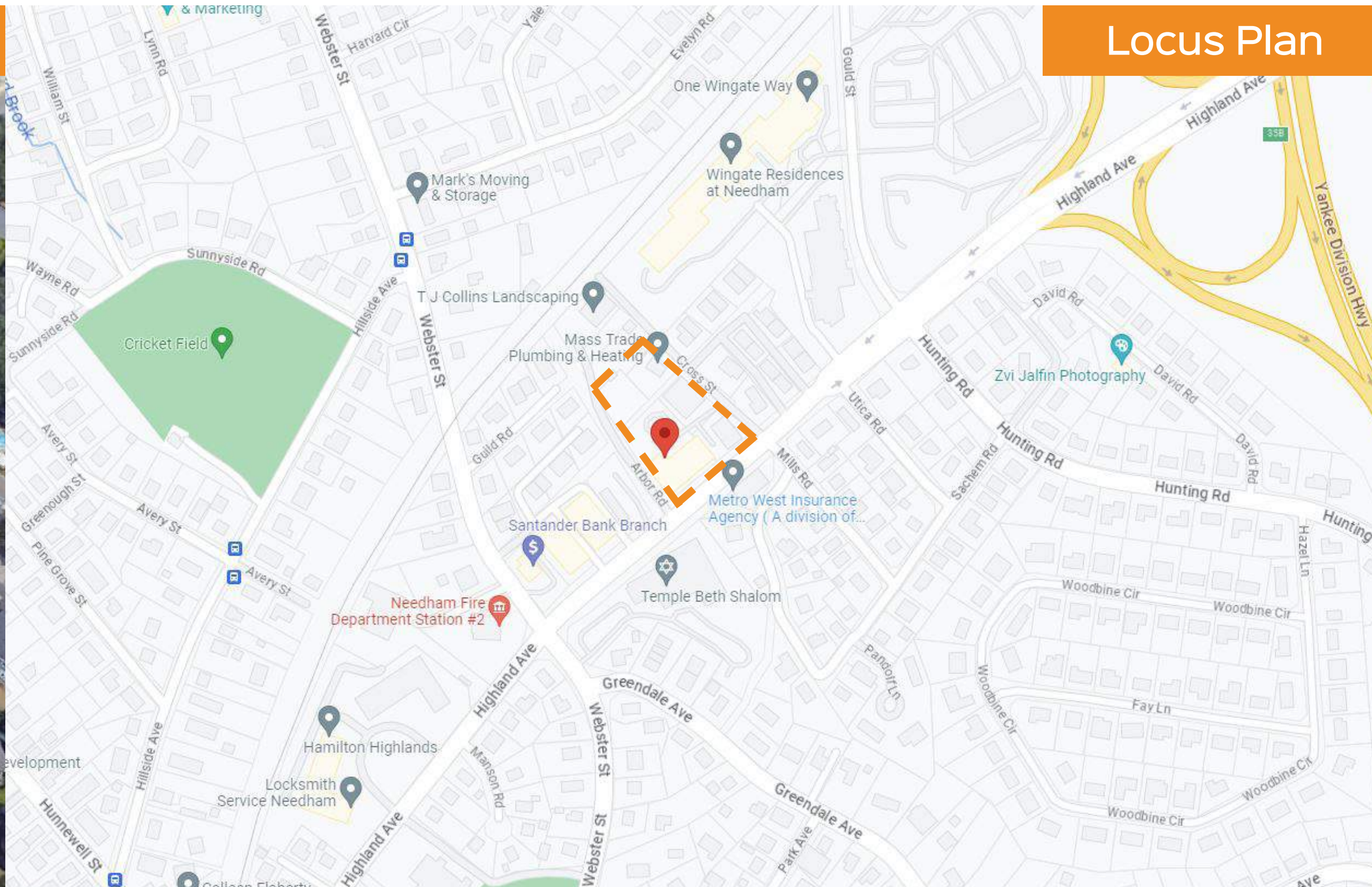
PLANNING BOARD SUBMISSION



**MAUGEL DESTEFANO
ARCHITECTS**
200 AYER ROAD | 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)

Highland Ave MOB / Existing Site Photographs / 14 July 2023

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

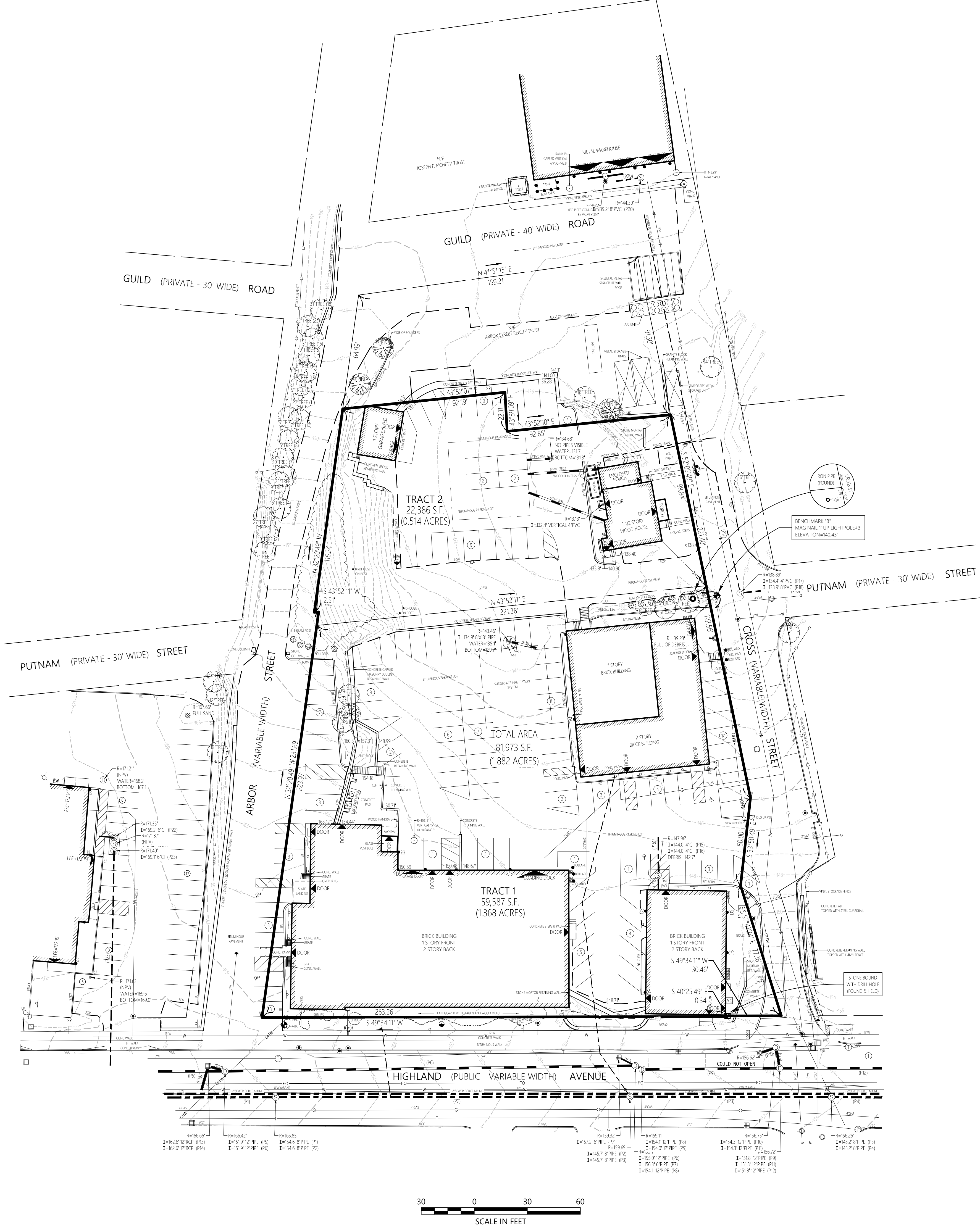
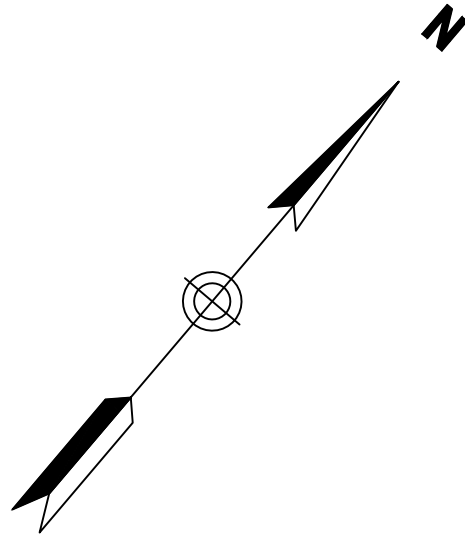
	Bldg. Setback from Highland Ave. <i>Min. / Max Feet</i>	Bldg. Length at Street <i>Feet</i>	Bldg. Footprint <i>Square Feet</i>	Paved Area <i>Square Feet</i>	Pervious / Green Space <i>Square Feet</i>
Existing	22 / 30.1	203'-9"	25,308	40,271	14,597
Proposed	57.75 / 62.25	188'-7"	24,988	27,676	26,561
IMPROVEMENT	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**
- ① DRAIN MANHOLE
 - CATCH BASIN
 - ⑤ 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
 - VSG — VERTICAL GRANITE CURB
 - SGE — SLOPED GRANITE EDGE
 - BB — BITUMINOUS BERM
 - BG — BITUMINOUS CURB
 - + + — METAL GUARDRAIL
 - + + — WOOD GUARDRAIL
 - + + — WOOD FENCE
 - + + — CHAIN LINK FENCE
 - — — DRAINAGE LINE
 - — — SEWER LINE
 - — — OVERHEAD WIRE
 - — — UNDERGROUND ELECTRIC
 - — — TELEPHONE LINE
 - — — GAS LINE
 - — — 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

- 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.
 - 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.
 - 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.
 - HORIZONTAL DATUM IS BASED ON MASS. GRID SYSTEM, NAD 1983. ELEVATIONS SHOWN ON THIS PLAN REFER TO NAVD OF 1988.
 - THE TREE SYMBOL OUTLINE SHOWN ON THIS PLAN DOES NOT REPRESENT THE ACTUAL TREE CANOPY.
 - THIS SURVEY WAS PREPARED WITHOUT THE BENEFIT OF A CURRENT TITLE REPORT AND MAY BE SUBJECT TO ADDITIONAL INFORMATION DISCLOSED IN SUCH.
 - 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 2502SC0038J, EFFECTIVE DATE MARCH 16, 2016.
 - 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. 55589
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: 08/04/2023
Planning Board Submission

Revisions:	Date:

Drawing Title:
Existing Conditions
Plan of Land

Sheet Number:
SV1.00

Legend

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

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**
- CONTRACTOR SHALL NOTIFY "DIG-SAFE" (1-888-344-7233) AT LEAST 72 HOURS BEFORE EXCAVATING.
 - CONTRACTOR SHALL BE RESPONSIBLE FOR SITE SECURITY AND JOB SAFETY. CONSTRUCTION ACTIVITIES SHALL BE IN ACCORDANCE WITH OSHA STANDARDS AND LOCAL REQUIREMENTS.
 - 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).
 - AREAS DISTURBED DURING CONSTRUCTION AND NOT RESTORED WITH IMPERVIOUS SURFACES (BUILDINGS, PAVEMENTS, WALKS, ETC) SHALL RECEIVE SIX INCHES (6") LOAM AND SEED.
 - WITHIN THE LIMITS OF THE BUILDING FOOTPRINT, THE SITE CONTRACTOR SHALL PERFORM EARTHWORK OPERATIONS REQUIRED UP TO SUBGRADE ELEVATIONS.
 - 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.
 - 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.
 - TRAFFIC SIGNAGE AND PAVEMENT MARKINGS SHALL CONFORM TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.
 - 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.
 - 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.
 - CONTRACTOR SHALL PREVENT DUST, SEDIMENT, AND DEBRIS FROM EXITING THE SITE AND SHALL BE RESPONSIBLE FOR CLEANUP, REPAIRS AND CORRECTIVE ACTION IF SUCH OCCURS.
 - DAMAGE RESULTING FROM CONSTRUCTION LOADS SHALL BE REPAIRED BY THE CONTRACTOR AT NO ADDITIONAL COST TO OWNER.
 - 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.
 - 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.
 - THE PLANS INCLUDED HEREIN ASSUME THAT TRACT 1 AND TRACT 2 ON THE FOLLOWING PLANS WILL BE CONSOLIDATED INTO A SINGLE LOT.
- Layout and Materials**
- DIMENSIONS ARE FROM THE FACE OF CURB, FACE OF BUILDING, FACE OF WALL, AND CENTER LINE OF PAVEMENT MARKINGS, UNLESS OTHERWISE NOTED.
 - CURB RADII ARE THREE FEET (3') UNLESS OTHERWISE NOTED.
 - CURBING SHALL BE VERTICAL GRANITE CURB (VGC) WITHIN THE SITE UNLESS OTHERWISE INDICATED ON THE PLANS.
 - 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.
 - PROPOSED BOUNDS AND ANY EXISTING PROPERTY LINE MONUMENTATION DISTURBED DURING CONSTRUCTION SHALL BE SET OR RESET BY A PROFESSIONAL LAND SURVEYOR.
 - 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**
- 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.
 - 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.
 - CONTRACTOR SHALL DISPOSE OF DEMOLITION DEBRIS IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS, ORDINANCES AND STATUTES.
 - 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 LATEST SITE CONDITIONS RELATED TO ANY CONDITIONS DISCOVERED DURING EXECUTION OF THE WORK.
 - UNLESS OTHERWISE SPECIFICALLY PROVIDED ON THE PLANS OR IN THE SPECIFICATIONS, THE ENGINEER HAS NO 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**
- 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.
 - 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.
 - 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.
 - 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.
 - 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.

Utilities

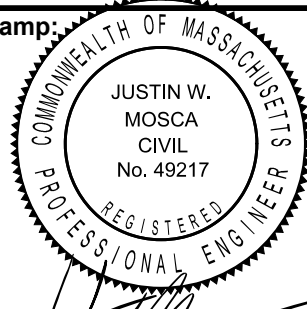
- THE LOCATIONS, SIZES, AND TYPES OF EXISTING UTILITIES ARE SHOWN AS AN APPROXIMATE REPRESENTATION ONLY. THE OWNER OR ITS REPRESENTATIVES HAVE NOT INDEPENDENTLY VERIFIED THIS INFORMATION AS SHOWN ON THE PLANS. THE UTILITY INFORMATION SHOWN DOES NOT GUARANTEE THE ACTUAL EXISTENCE, SERVICEABILITY, OR OTHER 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.
- 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.
- SET CATCH BASIN RIMS, AND INVERTS OF SEWERS, DRAINS, AND DITCHES IN ACCORDANCE WITH ELEVATIONS ON THE GRADING AND UTILITY PLANS.
- 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:
 - PAVEMENTS AND CONCRETE SURFACES: FLUSH
 - ALL SURFACES ALONG ACCESSIBLE ROUTES: FLUSH
 - LANDSCAPE, LOAM AND SEED, AND OTHER EARTH SURFACE AREAS: ONE INCH ABOVE SURROUNDING AREA AND TAPER EARTH TO THE RIM ELEVATION.
- 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.
- 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.
- UTILITY PIPE MATERIALS SHALL BE AS FOLLOWS, UNLESS OTHERWISE NOTED ON THE PLAN:
 - WATER PIPES SHALL BE THICKNESS CLASS 52 DUCTILE IRON (DI) PIPE.
 - SANITARY SEWER PIPES SHALL BE SDR 35 POLYVINYL CHLORIDE (PVC) SEWER PIPE.
 - STORM DRAINAGE PIPES SHALL BE DOUBLE-WALL, TYPE S, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.
 - PIPE INSTALLATION AND MATERIALS SHALL COMPLY WITH THE STATE PLUMBING CODE WHERE APPLICABLE. CONTRACTOR SHALL COORDINATE WITH LOCAL PLUMBING INSPECTOR PRIOR TO BEGINNING WORK.
- CONTRACTOR SHALL COORDINATE WITH ELECTRICAL CONTRACTOR AND SHALL FURNISH EXCAVATION, INSTALLATION, AND BACKFILL OF ELECTRICAL FURNISHED SITEMORK RELATED ITEMS SUCH AS PULL BOXES, CONDUITS, DUCT BANKS, LIGHT POLE BASES, AND CONCRETE PADS. SITE CONTRACTOR SHALL FURNISH CONCRETE ENCASMENT OF DUCT BANKS IF REQUIRED BY THE UTILITY COMPANY AND AS INDICATED ON THE DRAWINGS.
- CONTRACTOR SHALL EXCAVATE AND BACKFILL TRENCHES FOR GAS IN ACCORDANCE WITH GAS COMPANY'S REQUIREMENTS.
- 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.

Civil Sheet Index

No.	Drawing Title	Latest Issue
C1.01	Legend and General Notes	August 4, 2023
C2.01	Site Preparation Plan	August 4, 2023
C3.01	Layout and Materials Plan	August 4, 2023
C4.01	Grading and Drainage Plan	August 4, 2023
C5.01	Utilities Plan	August 4, 2023
C6.01	Site Details 1	August 4, 2023
C6.02	Site Details 2	August 4, 2023
C6.03	Site Details 3	August 4, 2023

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:

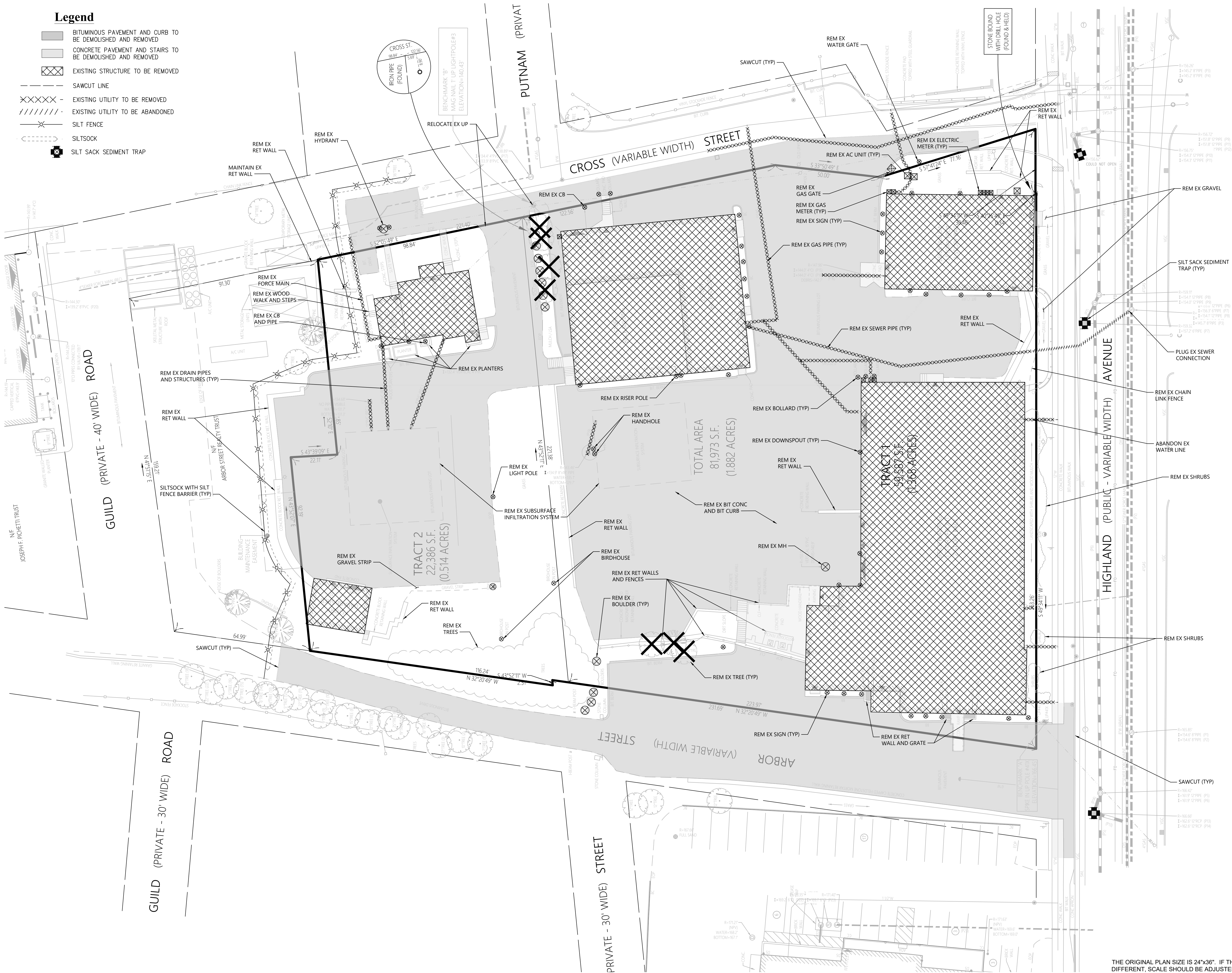
Drawing Title:
Legend and General Notes

Sheet Number:

C1.01

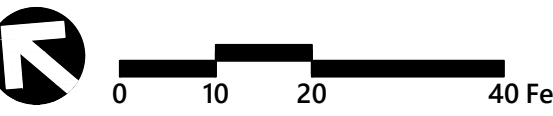
Legend

- 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
- SILT SOCK
- SILT SACK SEDIMENT TRAP

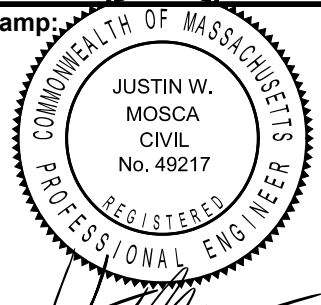


Notes:

- ELEVATIONS SHOWN REFER TO NAVD '88 VERTICAL DATUM
- 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.
- PROVIDE SILT SACKS AT EXISTING AND PROPOSED STORMWATER INLETS UNTIL UPSTREAM AREA HAS BEEN STABILIZED.
- CONTRACTOR SHALL LOCATE AND MAINTAIN CONSTRUCTION EXIT(S) AND WHEEL WASHES TO CONTROL SEDIMENT TRACKING ONTO ADJACENT RIGHTS-OF-WAY.



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: 1" = 20'

Issue:

PLANNING BOARD
SUBMISSION

Date:

08/04/2023

Revisions:

Date:

Drawing Title:

Site Preparation
Plan

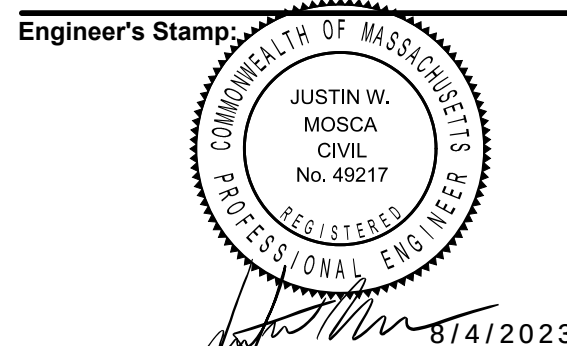
Sheet Number:

C2.01

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

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

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.



629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

Revisions:	Date:

Sheet Number:

C3.01



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

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




 JUSTIN W.
 MOSCA
 CIVIL
 No. 49217
 REGISTERED
 PROFESSIONAL ENGINEER STATE OF TENNESSEE
 8/14/2023

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Newton Centre, MA 02459

Scale: 1" = 20'

PLANNING BOARD | 08/04/2023

[illegible]

Sheet Number:

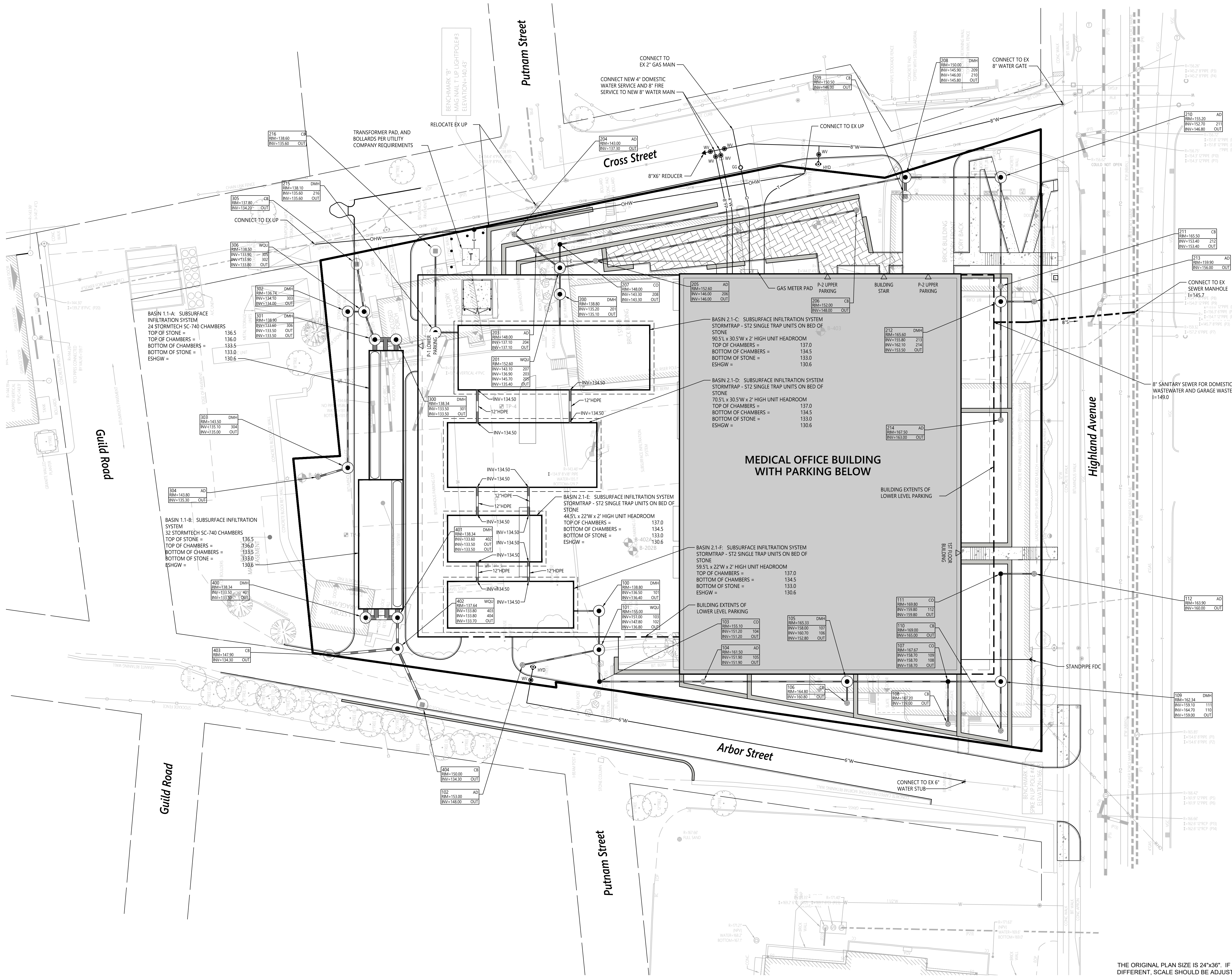


vhb

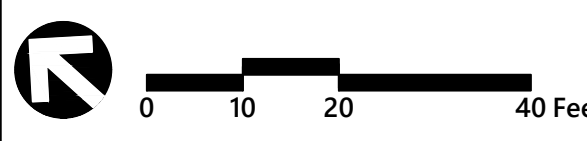
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- Notes:**
- ELEVATIONS SHOWN REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988.
 - ELECTRICAL, TELECOMMUNICATIONS, LIGHTING, AND NATURAL GAS UTILITIES AND EQUIPMENT SHOWN FOR REFERENCE ONLY. DESIGN BY OTHERS.
 - REFER TO LANDSCAPE PLANS FOR IRRIGATION REQUIREMENTS. PROVIDE SLEEVES FOR IRRIGATION WHERE IRRIGATION LINES CROSS PAVED AREAS.
 - INFILTRATION SYSTEM INSTALLATION TO BE WITNESSED BY THE PROJECT GEOTECHNICAL ENGINEER. CONTRACTOR TO COORDINATE INSTALLATION WITH AT LEAST 30 DAYS NOTICE PER PROJECT APPROVALS.
 - SEE ELECTRICAL PLANS FOR ELECTRIC DUCT BANK SIZE AND NUMBER OF CONDUITS.
 - SEE PLUMBING PLANS FOR SANITARY SEWER PIPE DIAMETERS. VERIFY SANITARY SEWER PIPE INVERT ELEVATIONS AT ALL BUILDING SEWER EXIT LOCATIONS WITH PLUMBING PLANS PRIOR TO CONSTRUCTION.



Engineer's Stamp:

Project: Highland Ave MOB

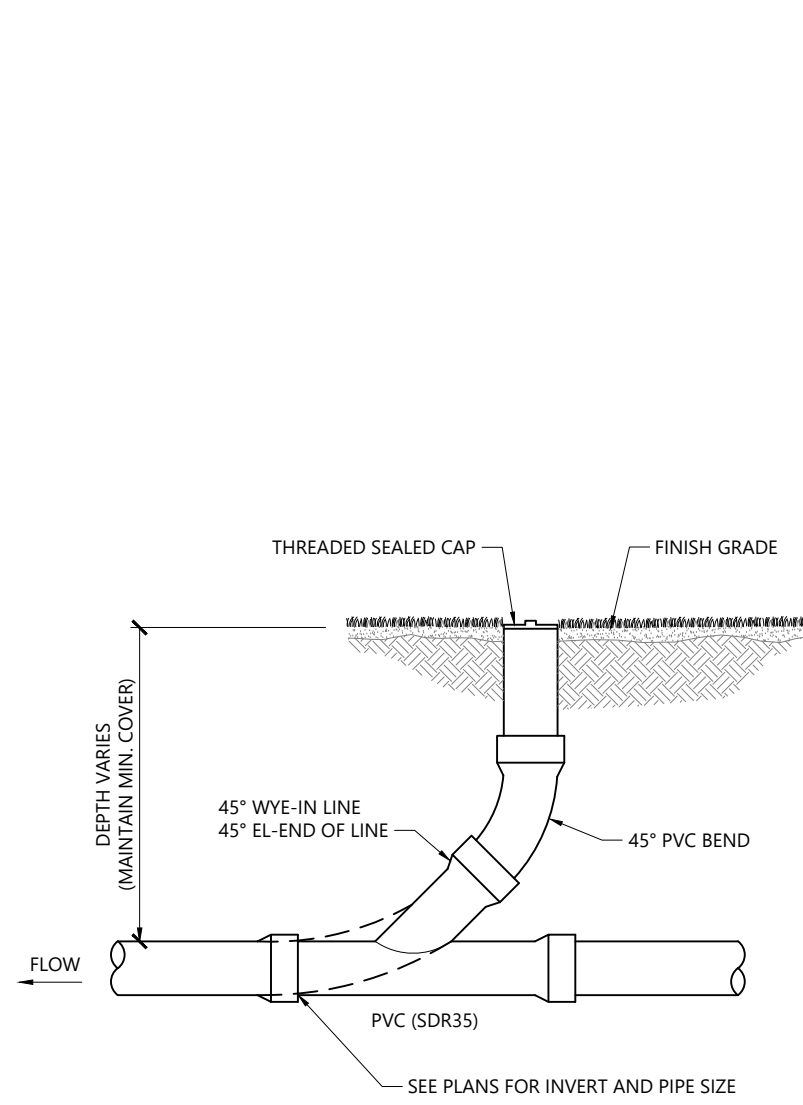
629-661 Highland Ave
Needham, MA 02494
Client: Boston Development Group
93 Union St, Suite 135
Newton Centre, MA 02459
Project #: 14781.00
Scale: 1" = 20'
Issue: PLANNING BOARD SUBMISSION
Date: 08/04/2023

Revisions:	Date:

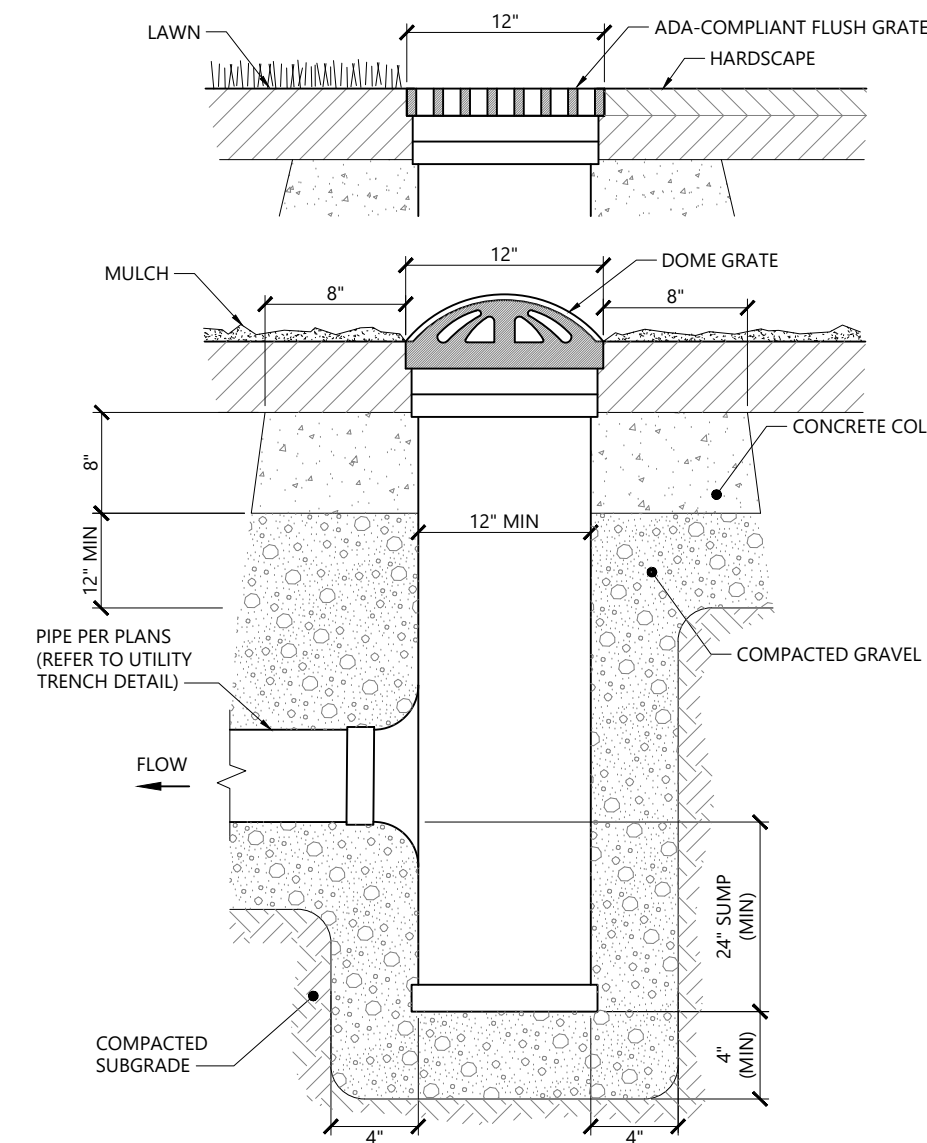
Drawing Title:
Utilities Plan

Sheet Number:
C5.01

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

**Cleanout (CO) - Landscape Area**

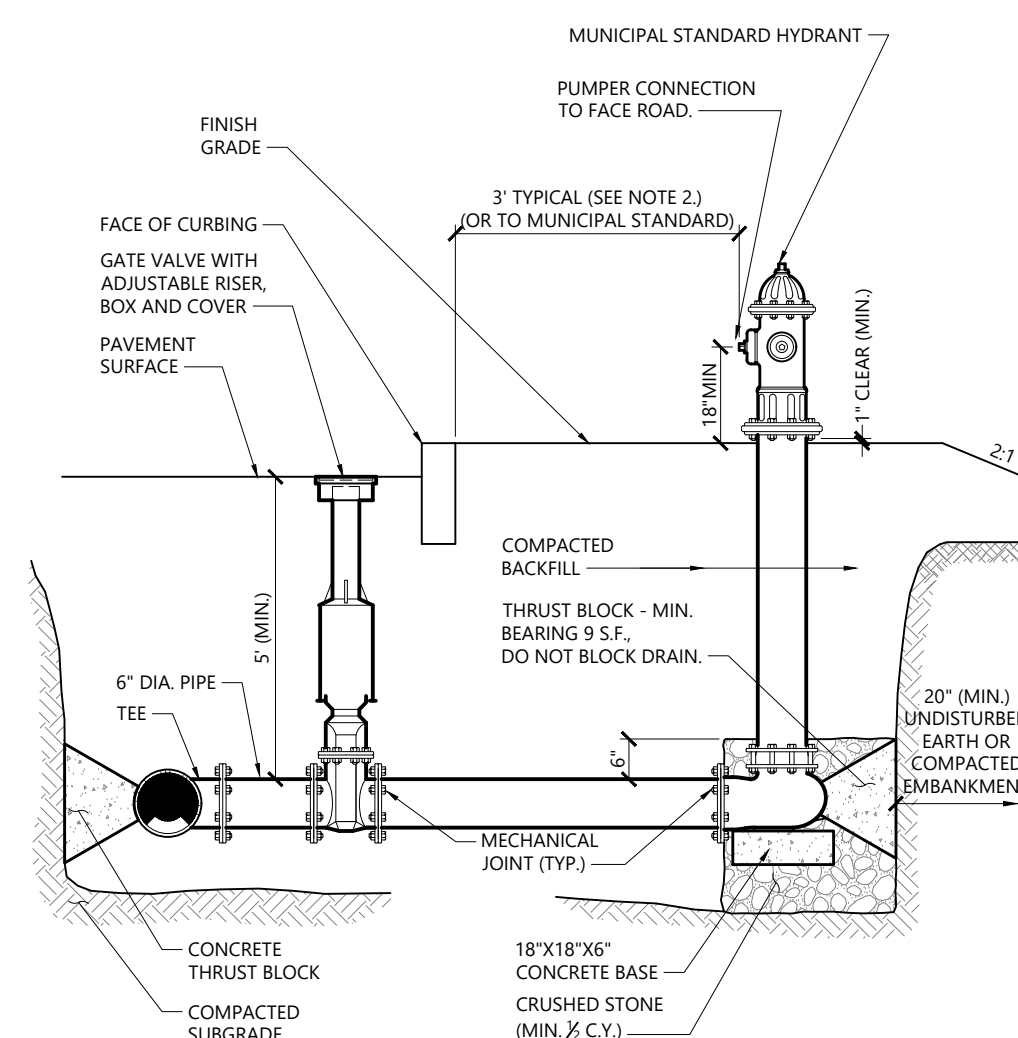
N.T.S. Source: VHB 11/19 LD_302

**NOTES:**

- AREA DRAINS SHALL BE NYLOPLAST 12" DIAMETER DRAIN BASIN, OR APPROVED EQUAL.
- GRATES SHALL BE NYLOPLAST 12" PEDESTRIAN MODEL 1299CGP OR 12" DOME GRATE MODEL 1299CGD (OR APPROVED EQUAL).

Area Drain (AD) Type 1

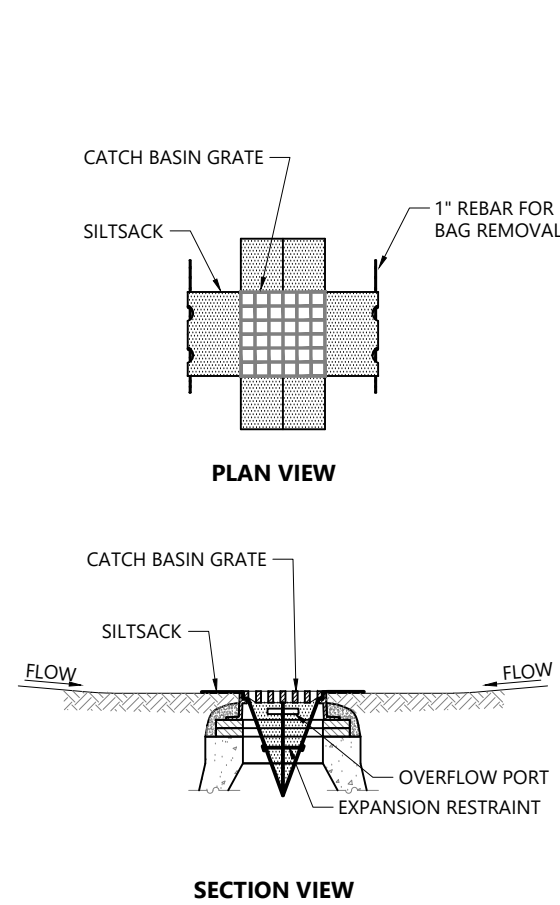
N.T.S. Source: VHB 12/19 LD_193

**NOTES**

- 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.
- HYDRANT IN SIDEWALK AREAS TO BE LOCATED TO PROVIDE MINIMUM CLEAR SIDEWALK PASSAGE WIDTH OF 3 FEET AT HYDRANT.
- A 36-INCH CLEAR SPACE SHALL BE MAINTAINED AROUND THE CIRCUMFERENCE OF THE HYDRANT UNLESS OTHERWISE APPROVED BY AUTHORITY HAVING JURISDICTION.

Hydrant Construction

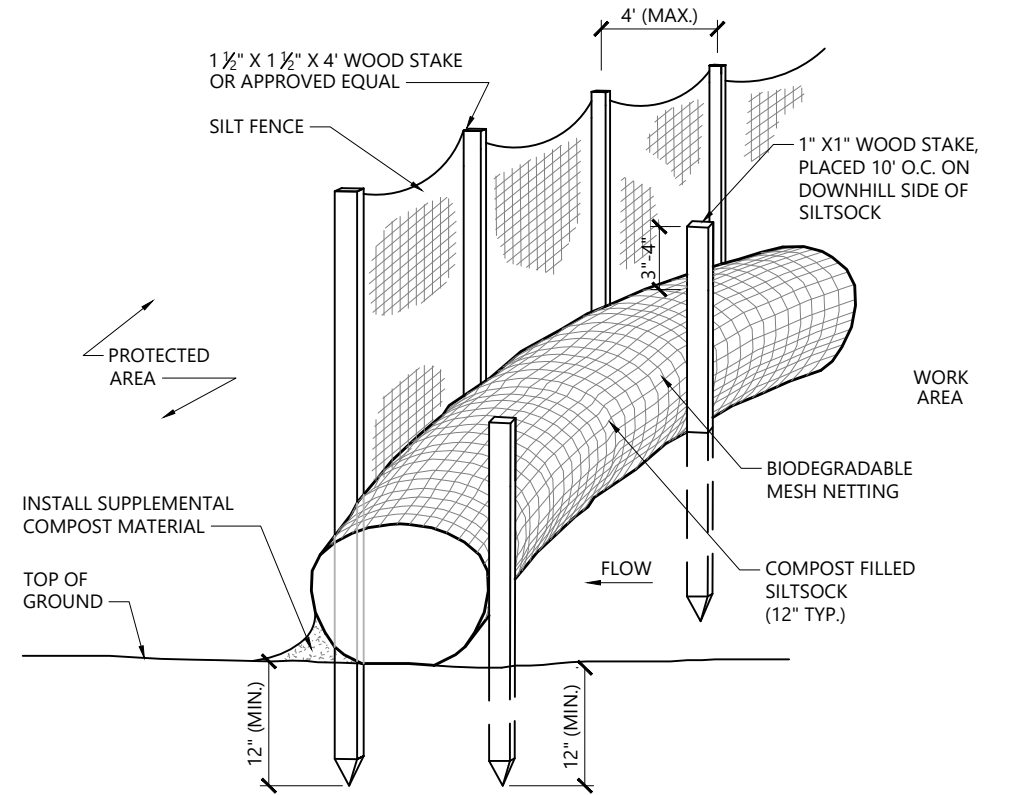
N.T.S. Source: VHB 12/19 LD_250

**NOTES**

- INSTALL SILTSAK 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.
- GRATE TO BE PLACED OVER SILTSAK.
- SILTSAK 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.

Siltsock Sediment Trap

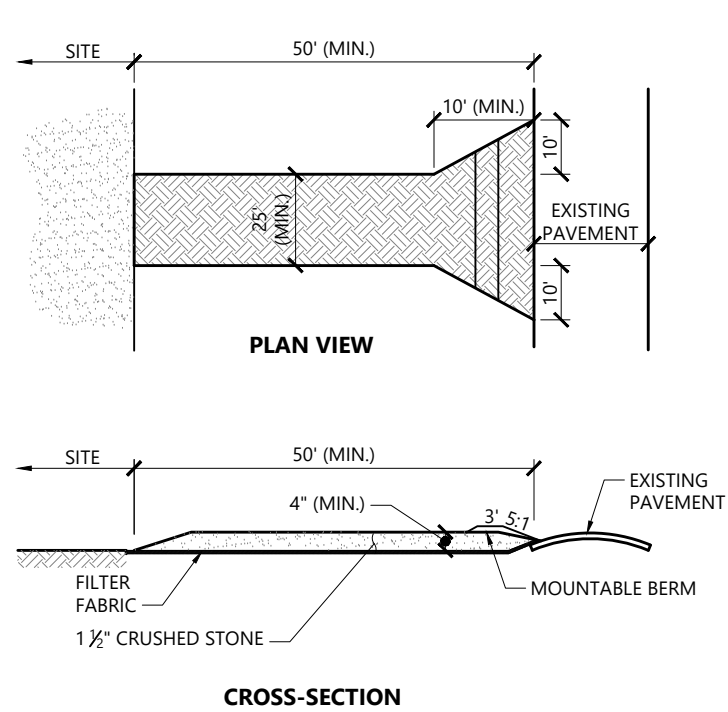
N.T.S. Source: VHB 1/20 LD_674

**NOTES**

- SILTSAK SHALL BE FILTREXX SILTSAK, OR APPROVED EQUAL.
- SILTSAKS SHALL OVERLAP A MINIMUM OF 12 INCHES.
- SILTSAK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS, AND REPAIR OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED.
- UPON SITE STABILIZATION, COMPOST MATERIAL SHALL BE DISPERSED ON SITE, AS DETERMINED BY THE ENGINEER.
- IF NON BIODEGRADABLE NETTING IS USED THE NETTING SHALL BE COLLECTED AND DISPOSED OF OFFSITE.

Siltsock / Silt Fence Barrier

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

**NOTES**

- EXIT WIDTH SHALL BE A TWENTY-FIVE (25) FOOT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
- 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.
- STABILIZED CONSTRUCTION EXIT SHALL BE REMOVED PRIOR TO FINAL FINISH MATERIALS BEING INSTALLED.

Stabilized Construction Exit

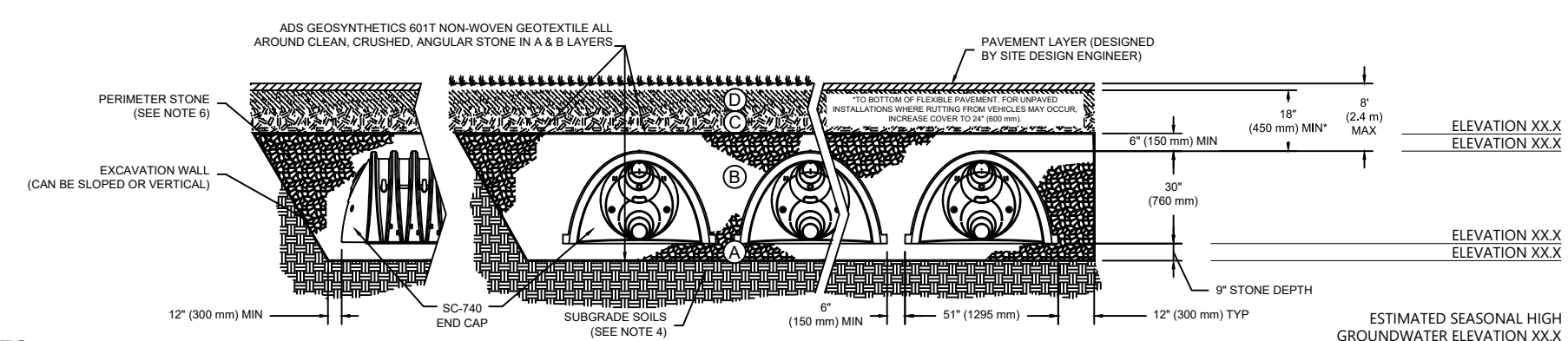
N.T.S. Source: VHB 1/16 LD_682

StormTech SC-740 Isolator Row Profile

N.T.S. Source: StormTech 10/20 LD_182-740I

ACCEPTABLE FILL MATERIALS: STORMTECH SC-740 CHAMBER SYSTEMS			
MATERIAL LOCATION	DESCRIPTION	ASHTO 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 FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER.	ANY SOIL/MATERIALS, NATIVE SOILS, OR PER ENGINEER'S DISCRETION. PER PAVEMENT SUBGRADE REQUIREMENTS.	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	INITIAL FILL FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDEDMENT STONE (18" MIN. THICK) TO THE BOTTOM OF THE 'D' LAYER.	GRANULAR WELL-DRAINED SOIL/AGGREGATE MATERIALS, $< 100\%$ FINES OR PROCEDED AGGREGATE.	BEGIN COMPACTIONS AFTER 12" MIN. OF MATERIAL HAS BEEN PLACED. CHAMBERS SHOULD BE COMPACTED TO A MIN. 96% PROCTOR DENSITY (SEE NOTE 1). MATERIAL NOT TO BE COMPACTED AGAIN.
B	EMBODIMENT STONE: FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE (A LAYER) TO THE 'C' LAYER ABOVE.	MOIST PAVEMENT SUBGRADE MATERIALS CAN BE USED (IN LAY) ON THIS LAYER.	LEFTS TO BE PROCEDED AGGREGATE - 100% FINES OR PROCEDED AGGREGATE. MATERIAL NOT TO EXCEED 12,000 PSI ON 4" DYNAMIC LOADS. NO COMPACTION REQUIRED.
A	FOUNDATION STONE: FILL BELOW CHAMBERS FROM THE SUBGRADE (UP TO THE FOOT) BOTTOM OF THE CHAMBERS.	CLEAN, CRUSHED, ANGULAR STONE.	NO COMPACTION REQUIRED.
B	EMBODIMENT STONE: FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE (A LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE.	PLATE COMPACT OR SURFACE TO ACHIEVE A FLAT SURFACE.

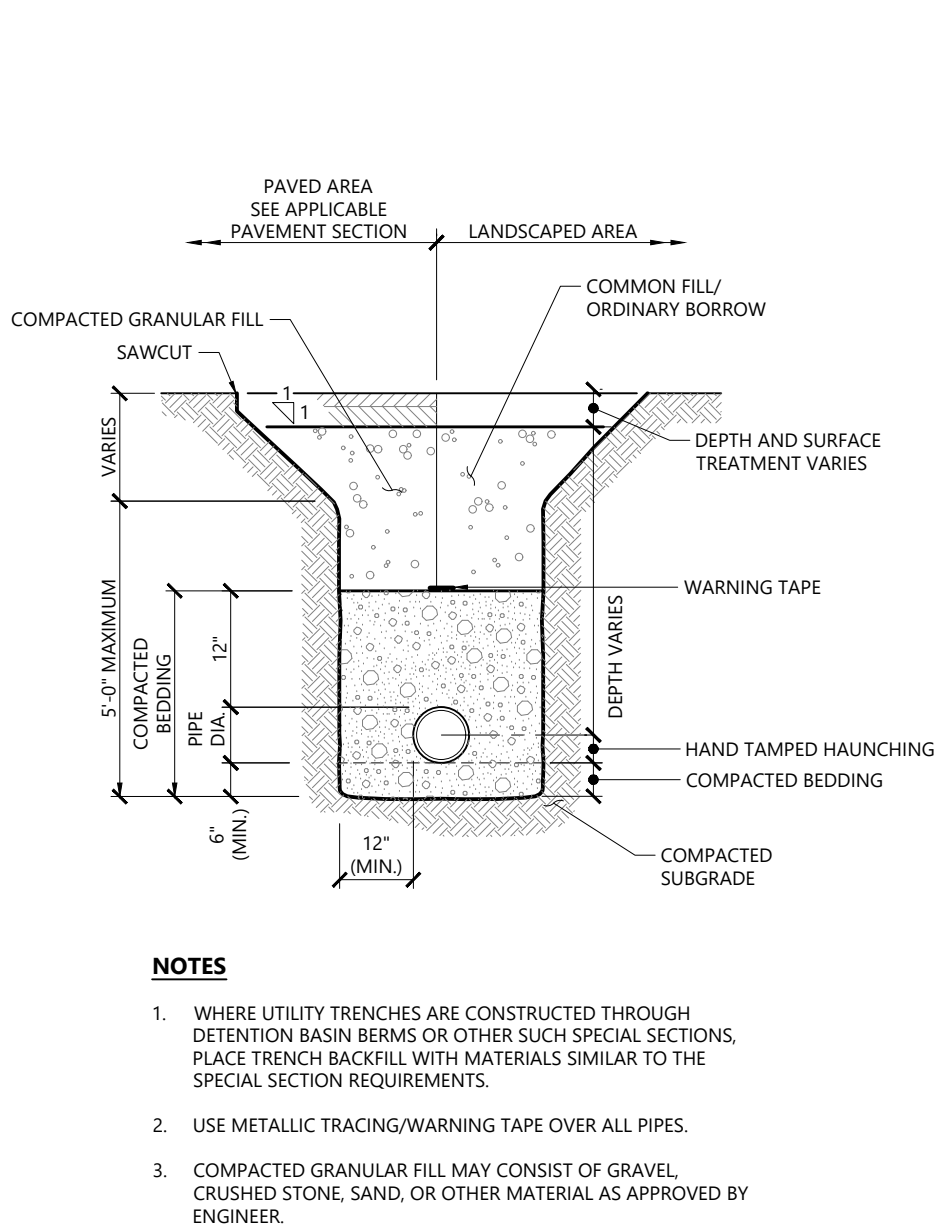
PLEASE NOTE:
1. THE LISTED ASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (ASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR A LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 1\"/>

**NOTES:**

- SC-740 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2414 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" OR ASTM F2522 "STANDARD SPECIFICATION FOR POLYETHYLENE (PE) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
- SC-740 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
- "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDEDMENT, AND FILL MATERIALS.
- 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.
- PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
- ONCE LAYER 'C' IS PLACED, ANY SOLID MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE OF THE MATERIAL REQUIREMENTS OF LAYER 'C' OR AT THE SITE DESIGN ENGINEER'S DISCRETION.

Subsurface Detention/Infiltration System (StormTech SC-740)

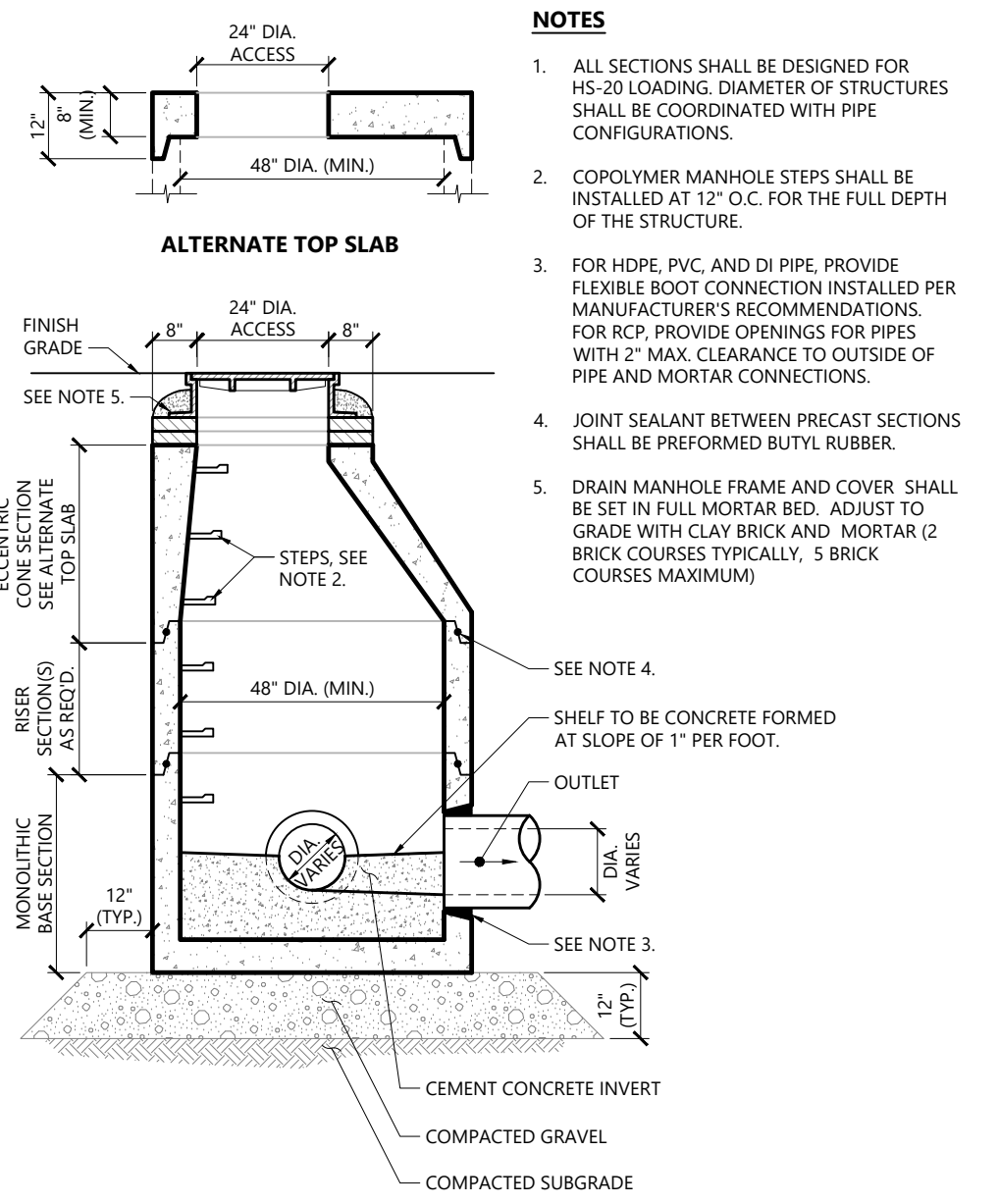
N.T.S. Source: StormTech 10/20 LD_740

**NOTES**

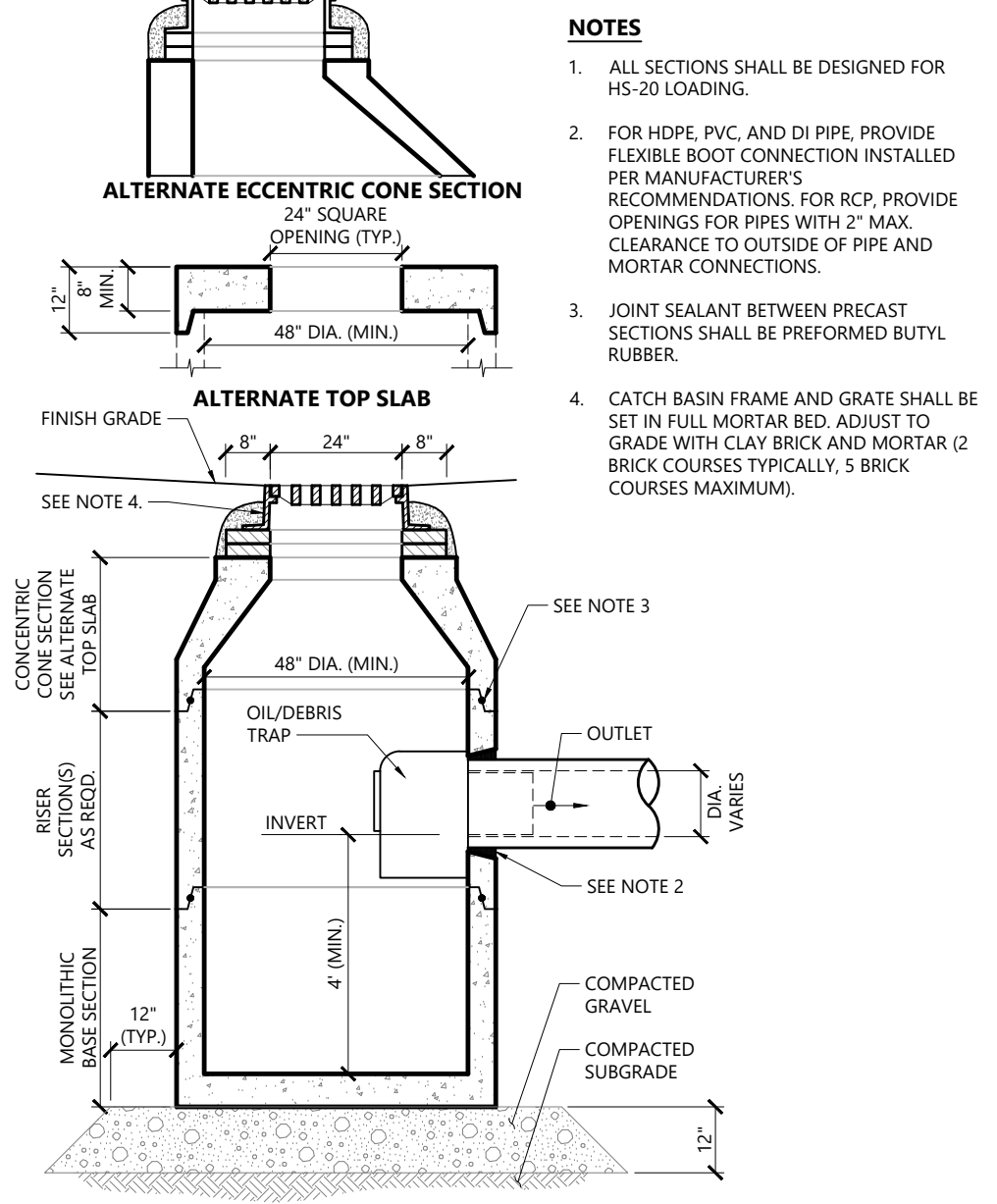
- WHERE UTILITY TRENCHES ARE CONSTRUCTED THROUGH DETENTION BASIN BERMS OR OTHER SUCH SPECIAL SECTIONS, PLACE TRENCH BACKFILL WITH MATERIALS SIMILAR TO THE SPECIAL SECTION REQUIREMENTS.
- USE METALLIC TRACING/WARNING TAPE OVER ALL PIPES.
- COMPACTED GRANULAR FILL MAY CONSIST OF GRAVEL, CRUSHED STONE, SAND, OR OTHER MATERIAL AS APPROVED BY ENGINEER.

Utility Trench

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

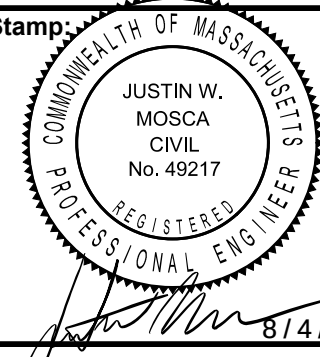
**Drain Manhole (DMH)**

N.T.S. Source: VHB 11/19 LD_115

**Catch Basin (CB) with Oil/Debris Trap**

N.T.S. Source: VHB 3/21 LD_101

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

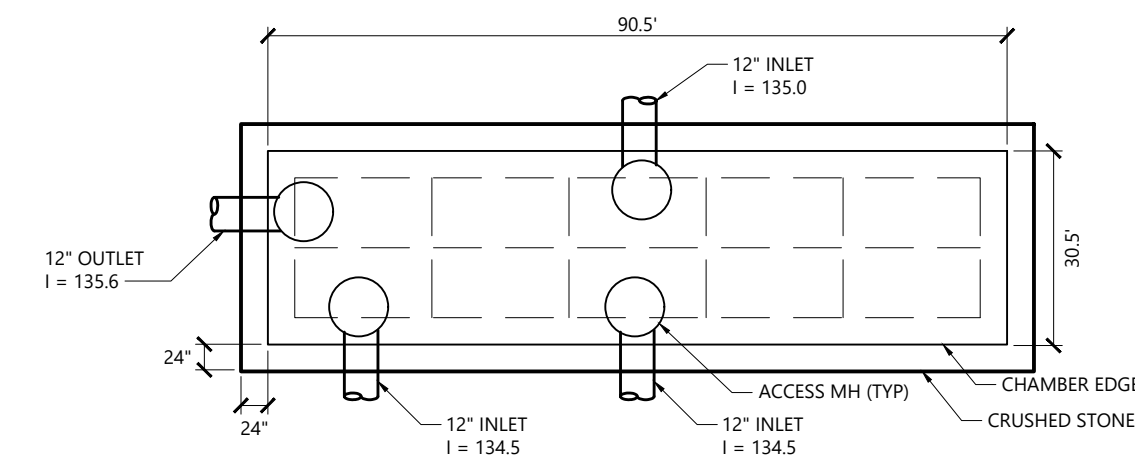
Issue: Planning Board Submission

Date: 08/04/2023

Revisions: Date:

Drawing Title: Site Details 2

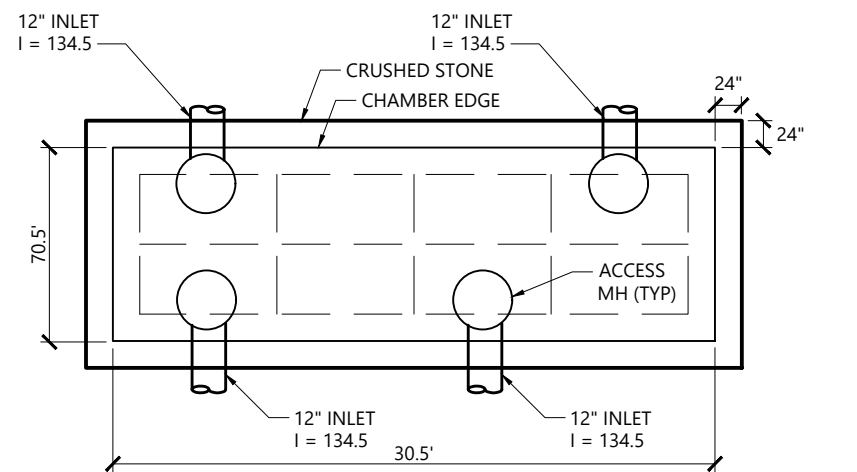
Sheet Number: C6.02



BASIN 2.1-C LAYOUT

BASIN 2.1-C SYSTEM ELEVATIONS

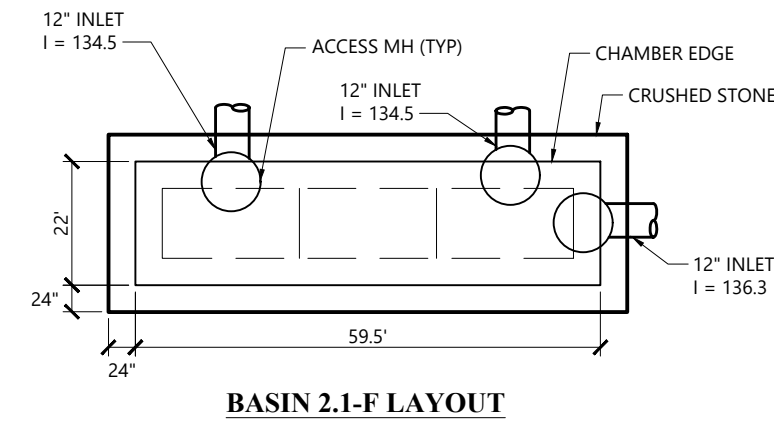
StormTrap Infiltration System - Basins 2.1-C
N.T.S. Source: VHB



BASIN 2.1-D LAYOUT

BASIN 2.1-D SYSTEM ELEVATIONS

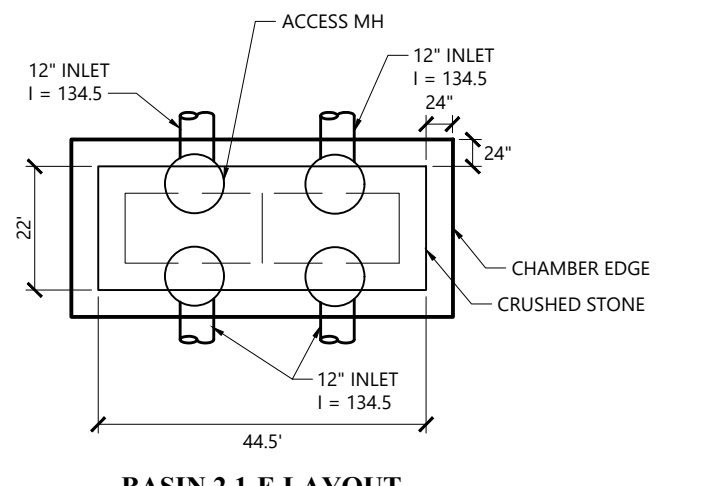
StormTrap Infiltration System - Basins 2.1-D
N.T.S. Source: VHB



BASIN 2.1-F LAYOUT

BASIN 2.1-F SYSTEM ELEVATIONS

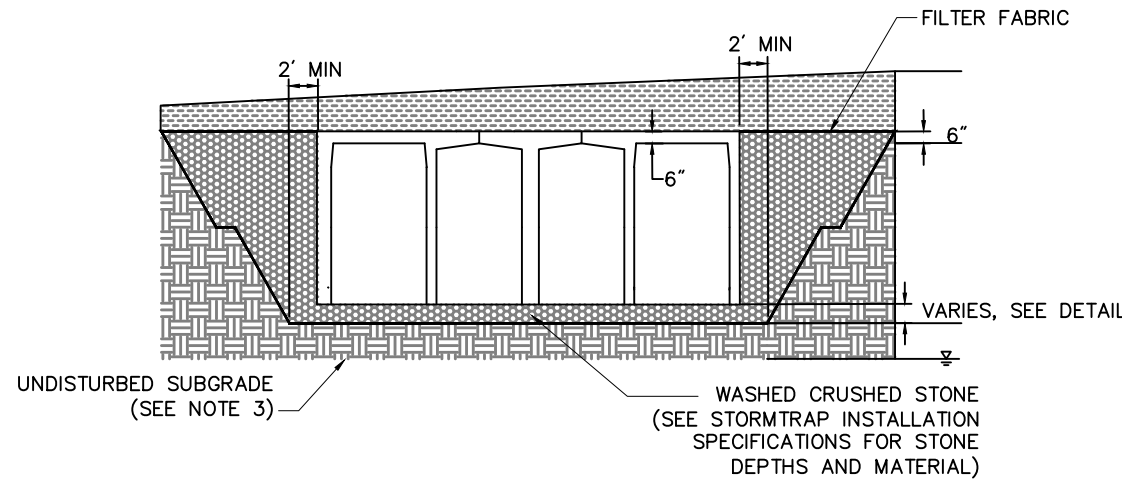
StormTrap Infiltration System - Basins 2.1-F
N.T.S. Source: VHB



BASIN 2.1-E LAYOUT

BASIN 2.1-E SYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-E
N.T.S. Source: VHB

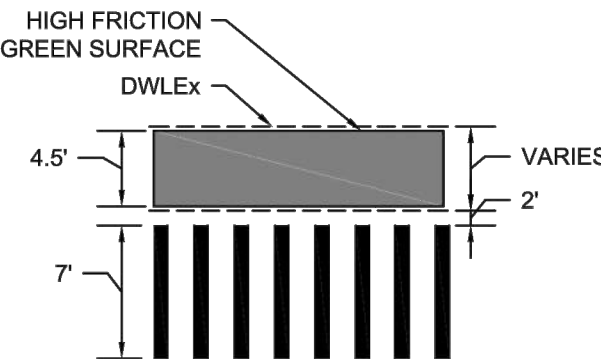


SINGLE TRAP (NO SLAB) - TYPICAL DETAIL

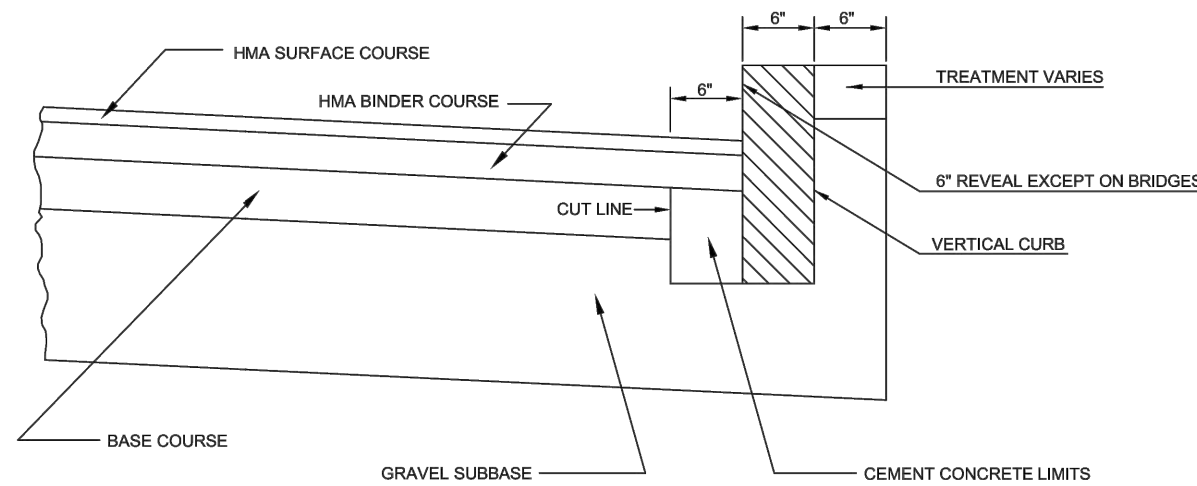
NOTES:

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



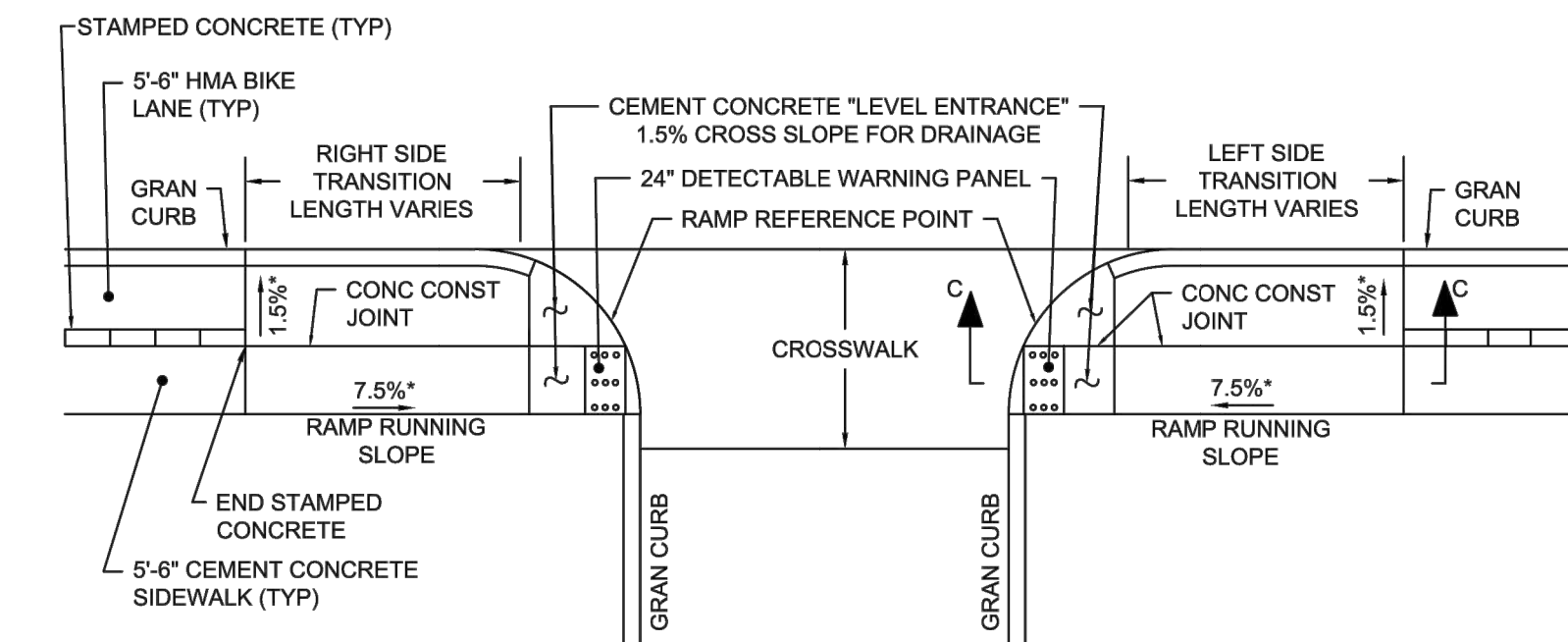
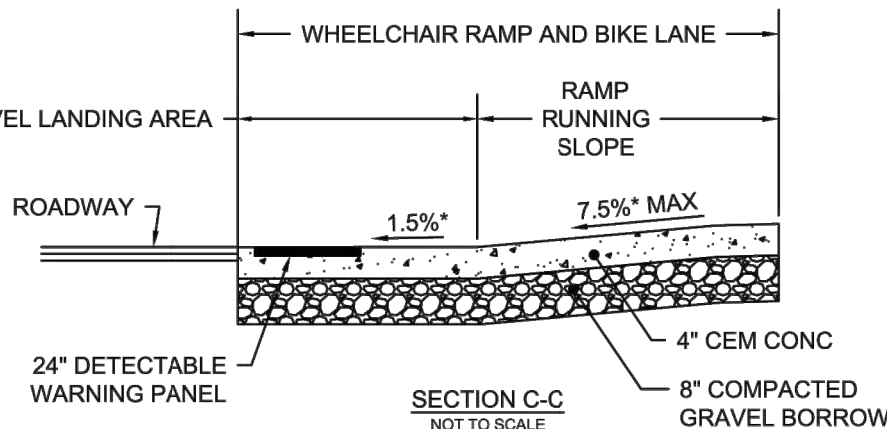
Crosswalk and Bike Lane Crossing
N.T.S. Source: MassDOT



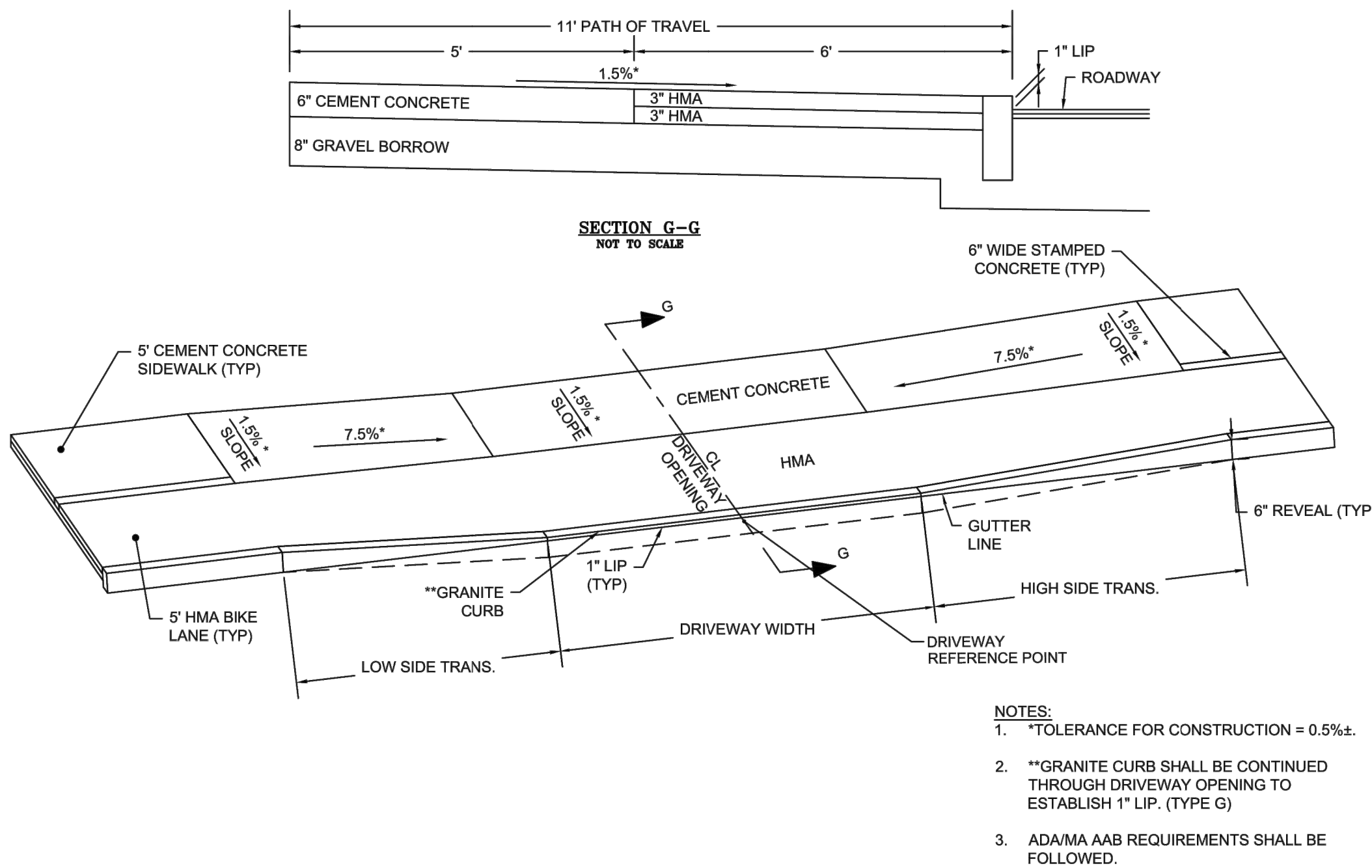
NOTES:

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 NEXT 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 BE USED AS A SUBSTITUTE.

Method of Setting Vertical Curb
N.T.S. Source: MassDOT



Wheelchair Ramp Type C
N.T.S. Source: MassDOT

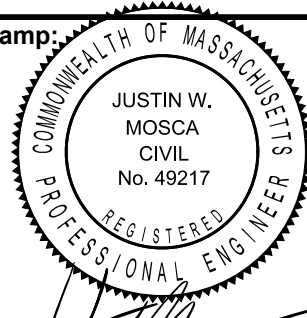


NOTES:

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 Transitions - Type G
N.T.S. Source: MassDOT

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 08/04/2023
SUBMISSION

Revisions:

Date:

Drawing Title:
Site Details 3

Sheet Number:

C6.03



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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: 08/04/2023
PLANNING BOARD
SUBMISSION

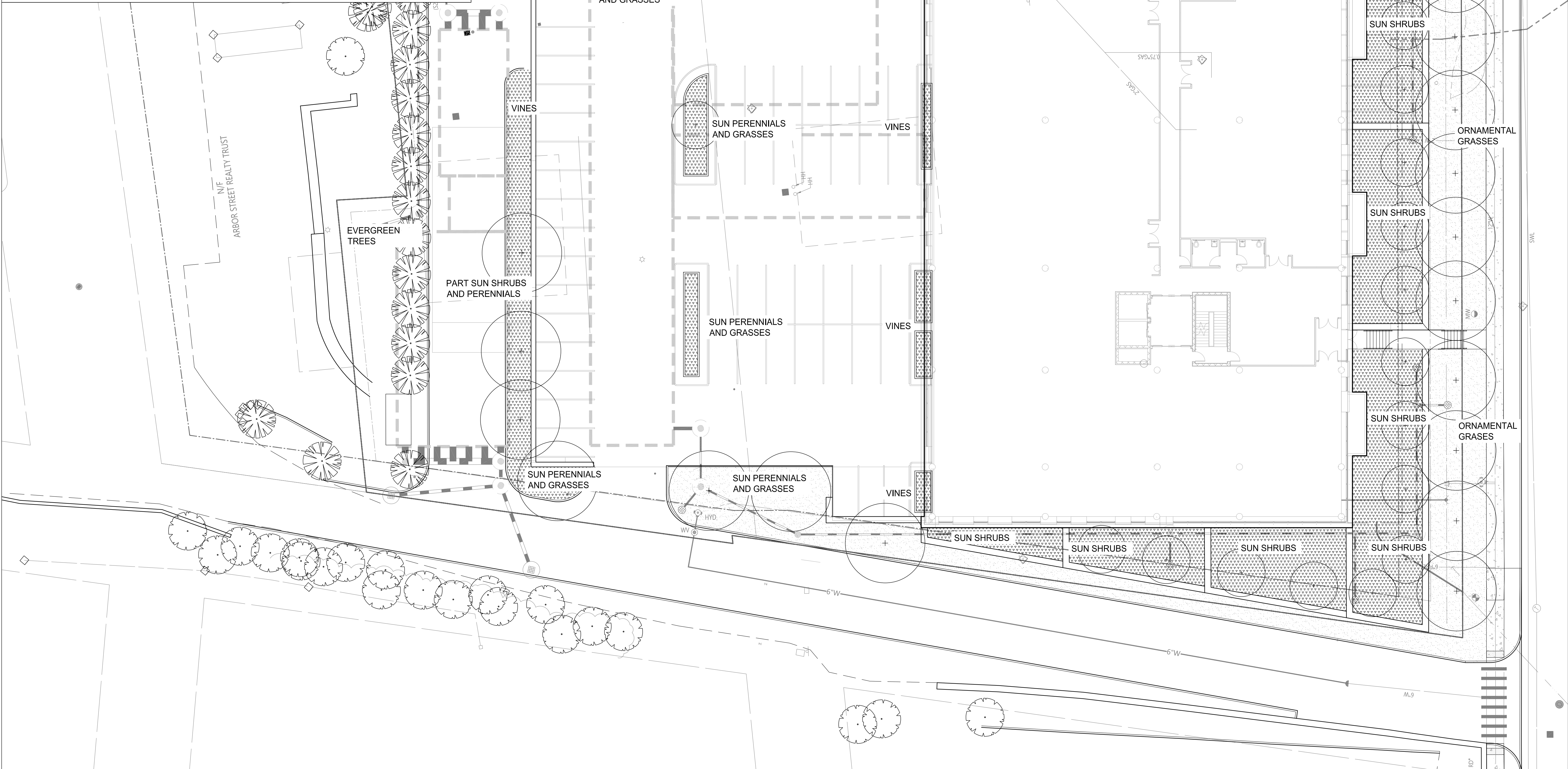
Revisions: Date:

Drawing Title:
RENDERED MATERIAL PLAN

Sheet Number:
L102

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		Comptelma 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
dc		Dennstaedtia punctilobula	Hay scented fern	1 gal	Cont.	18"	Y	Sun/ Shade
dc		Deschampsia cespitosa	Tufted Hairgrass	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		Nepeta 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

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MA 02459

Project #: 22090

Scale:

Issue: 08/04/2023
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Revisions: Date:

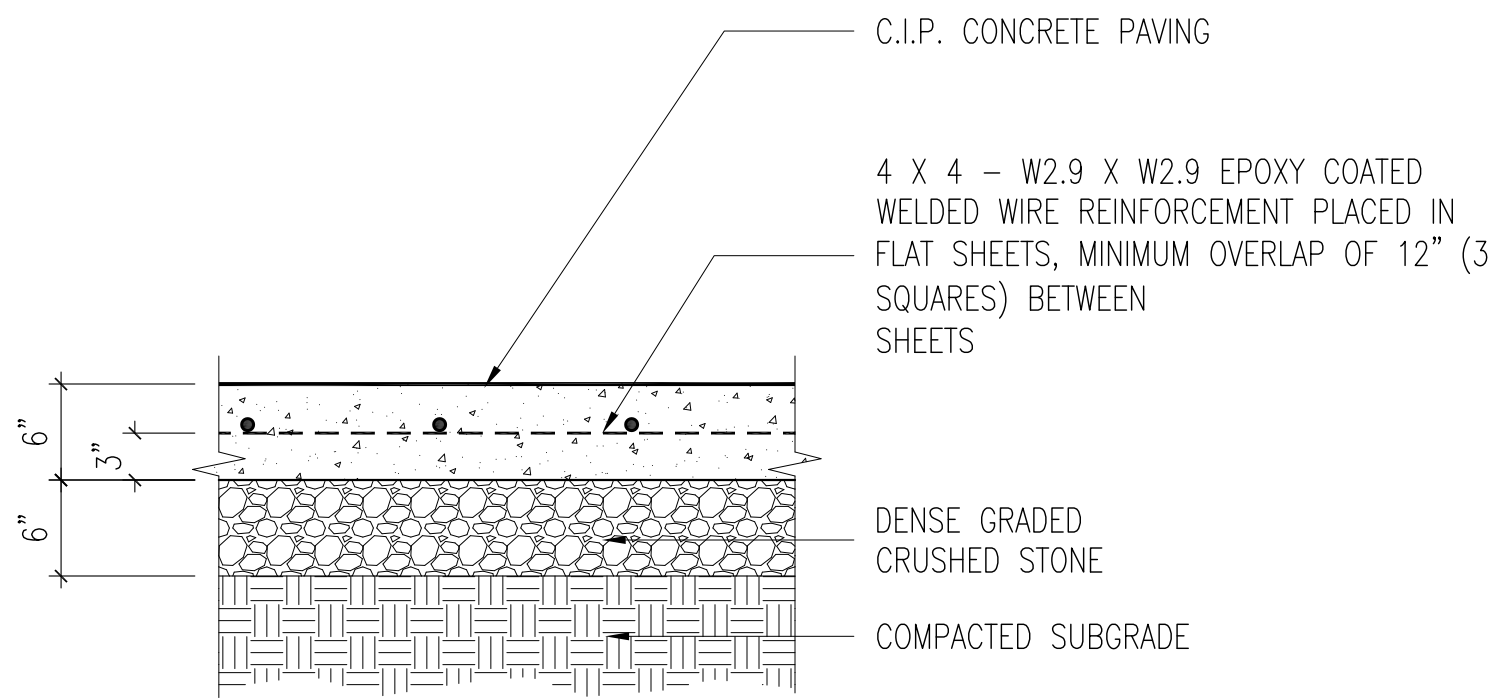
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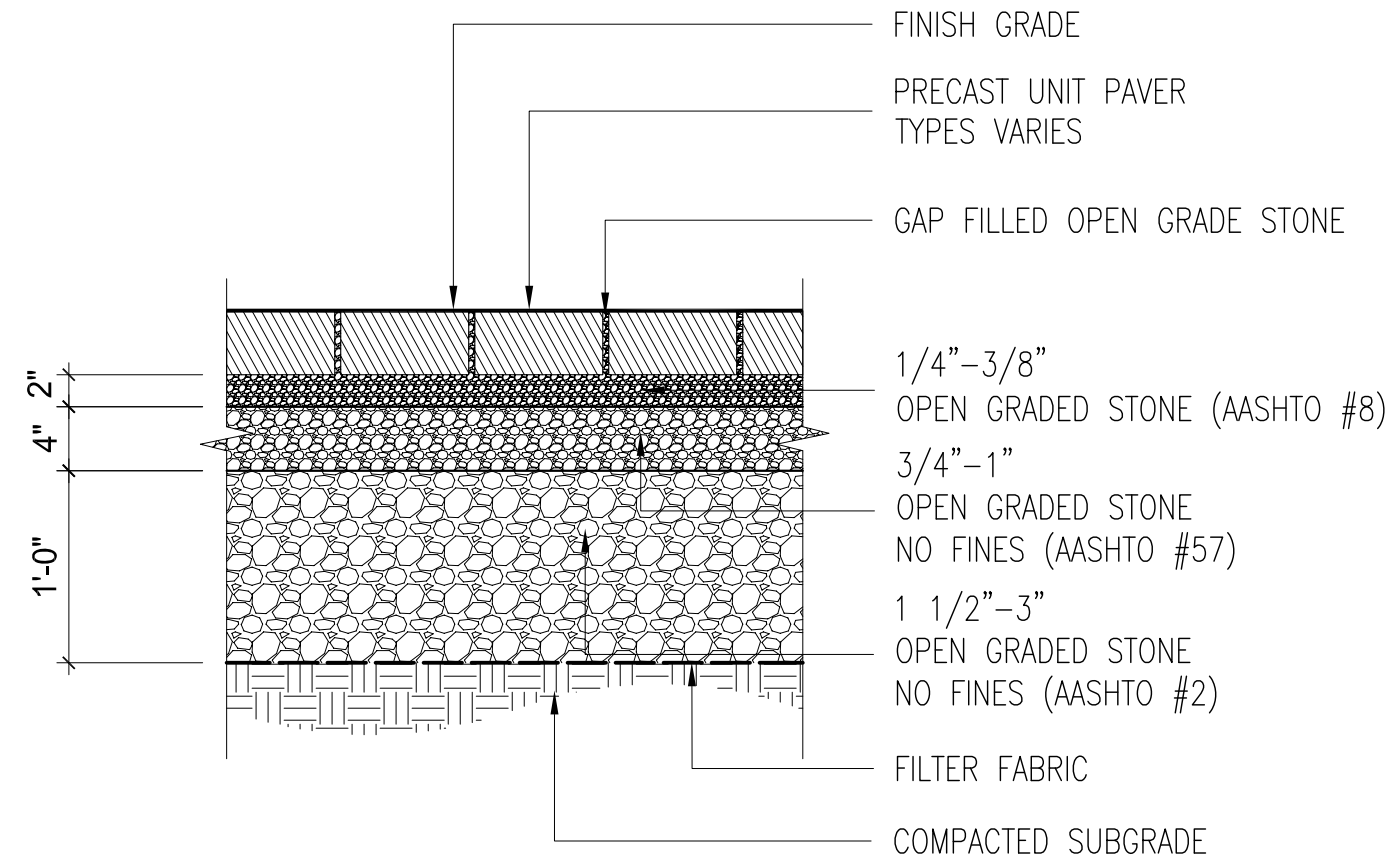
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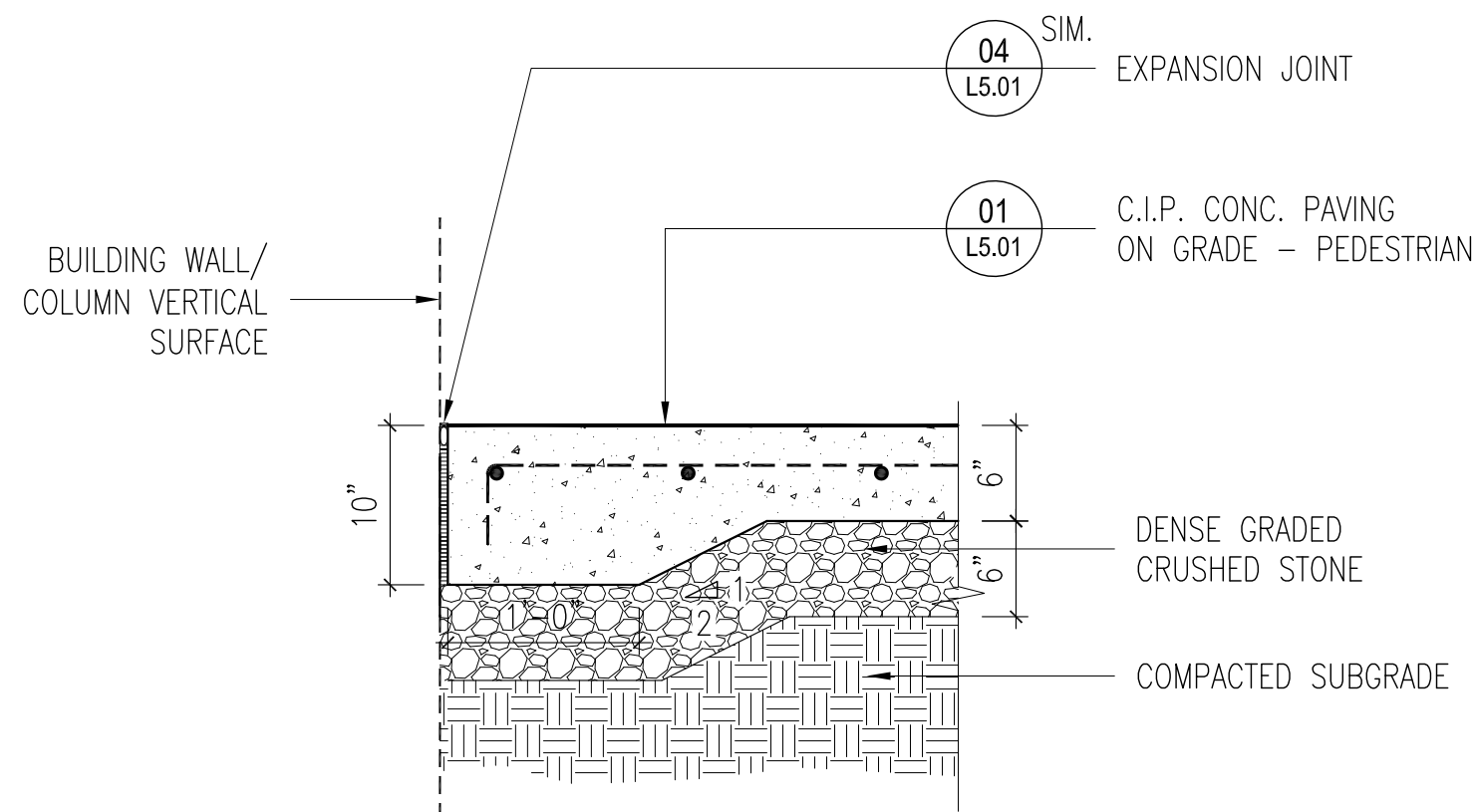
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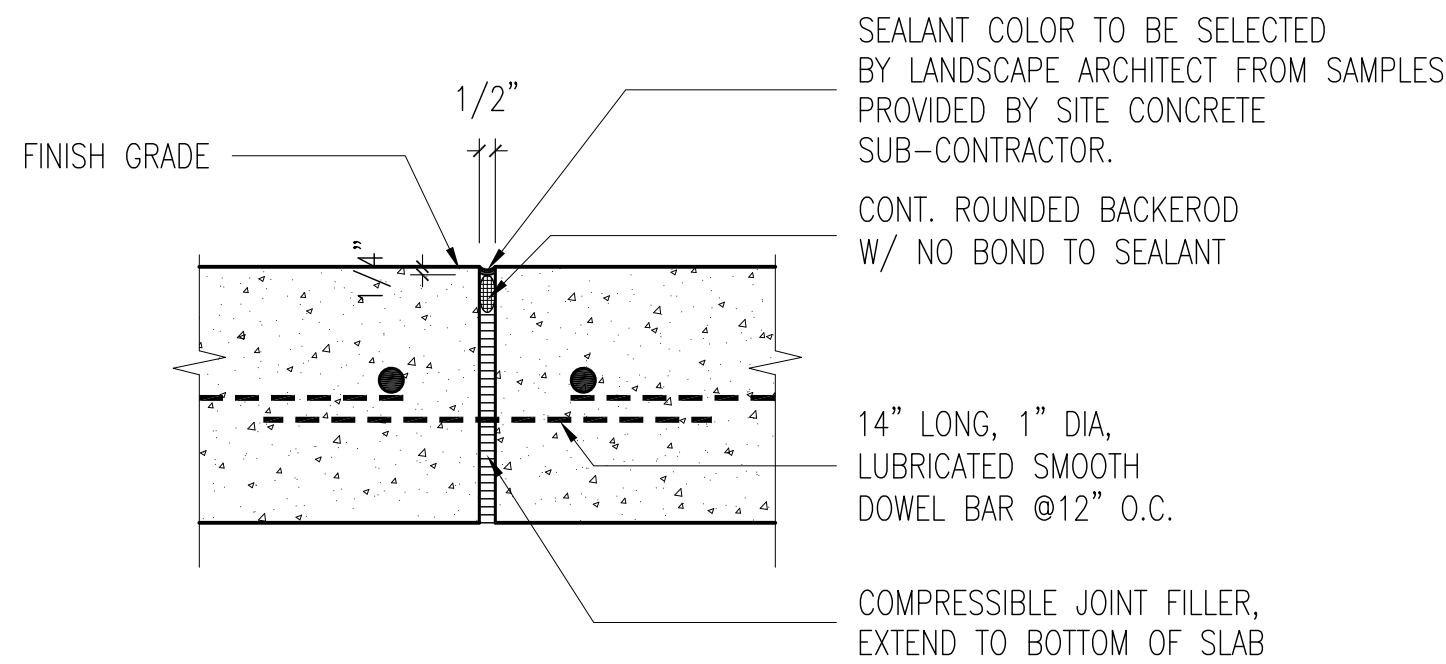
01 C.I.P. CONC. PAVING - PEDESTRIAN
SCALE: 1" = 1'-0"



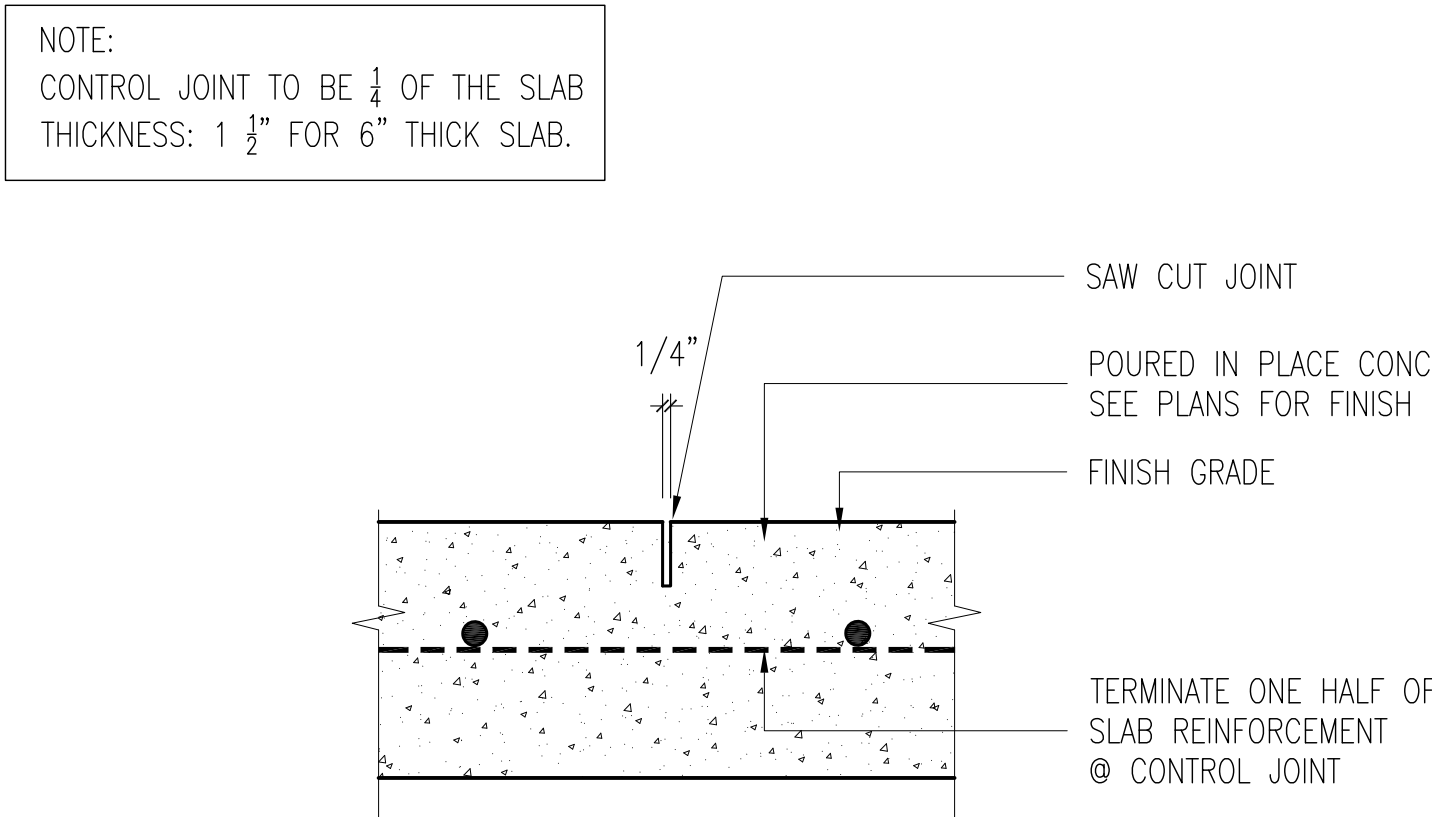
02 PERMEABLE PAVER ON CONCRETE SLAB
SCALE: 1" = 1'-0"



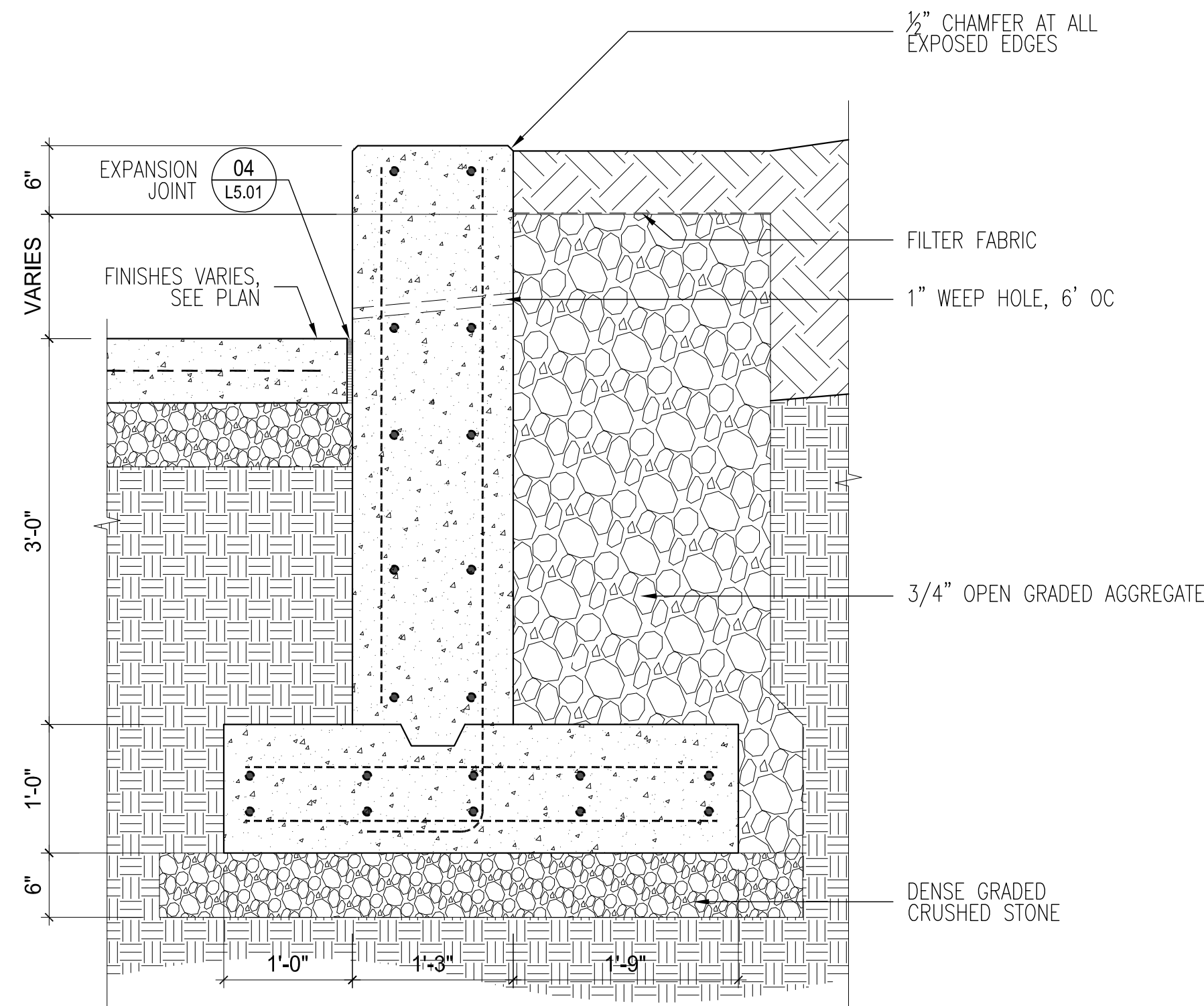
03 C.I.P. CONCRETE EDGE CONDITION
SCALE: 1" = 1'-0"



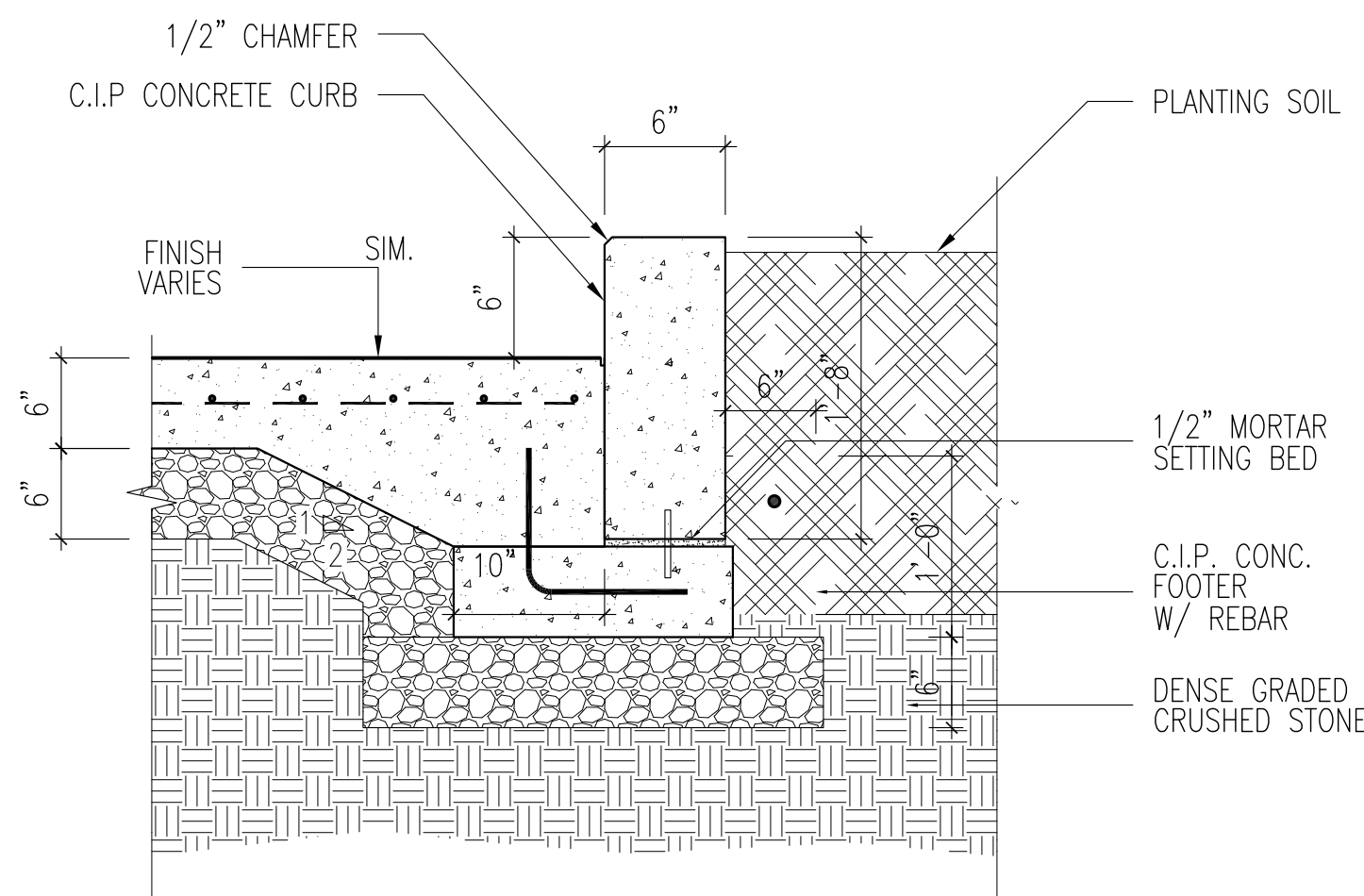
04 EXPANSION JOINT
SCALE: 2" = 1'-0"



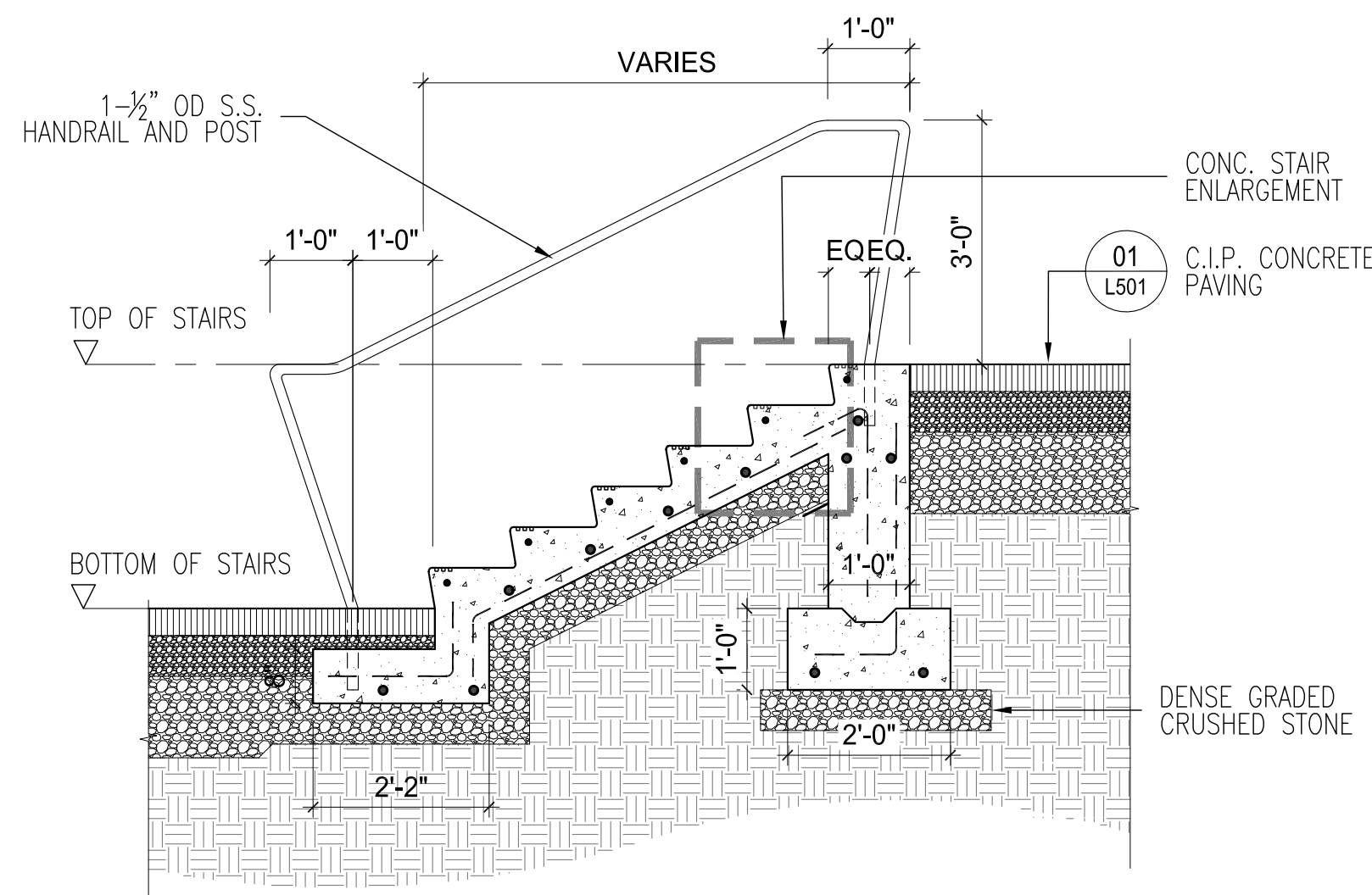
05 CONTROL JOINT
SCALE: 2" = 1'-0"



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:



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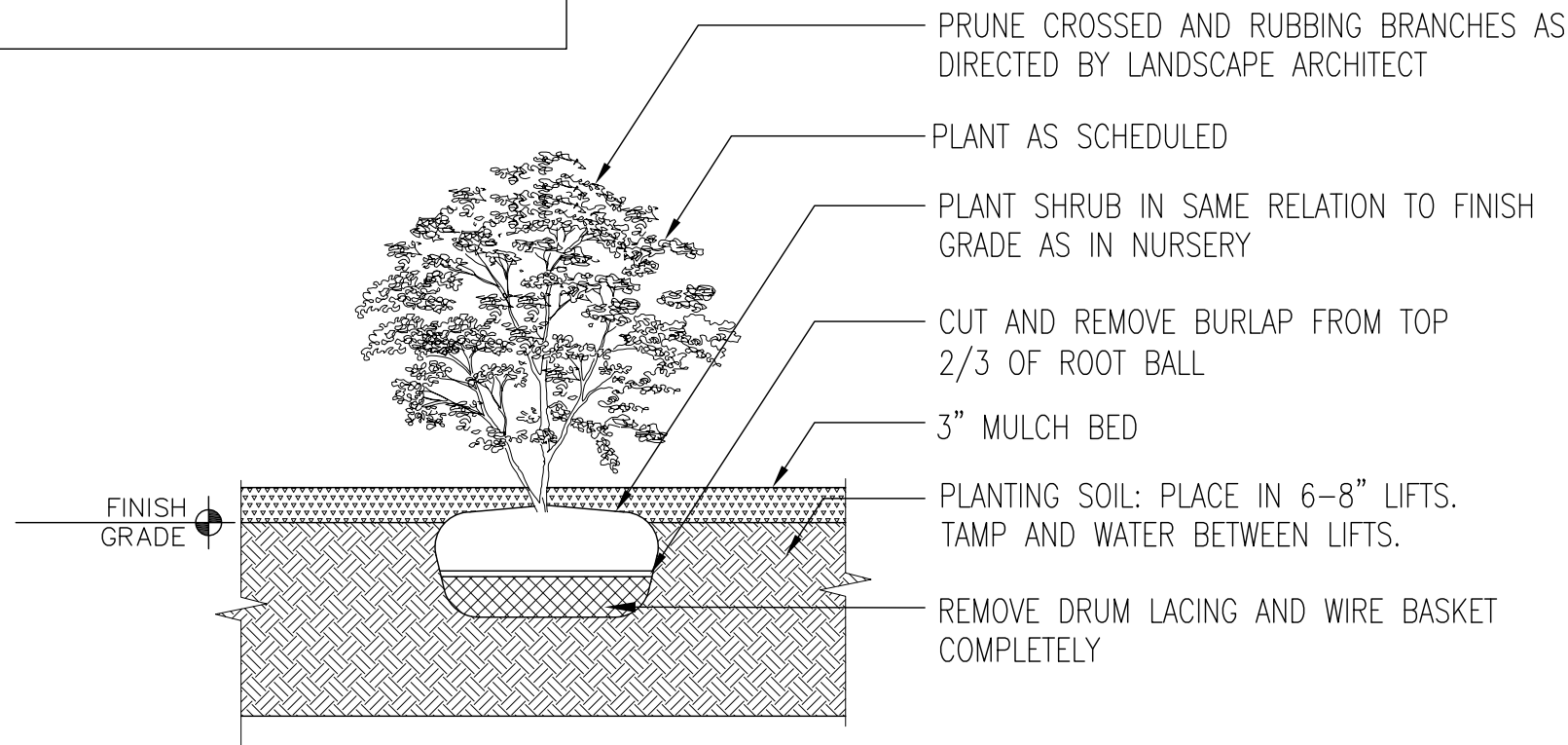
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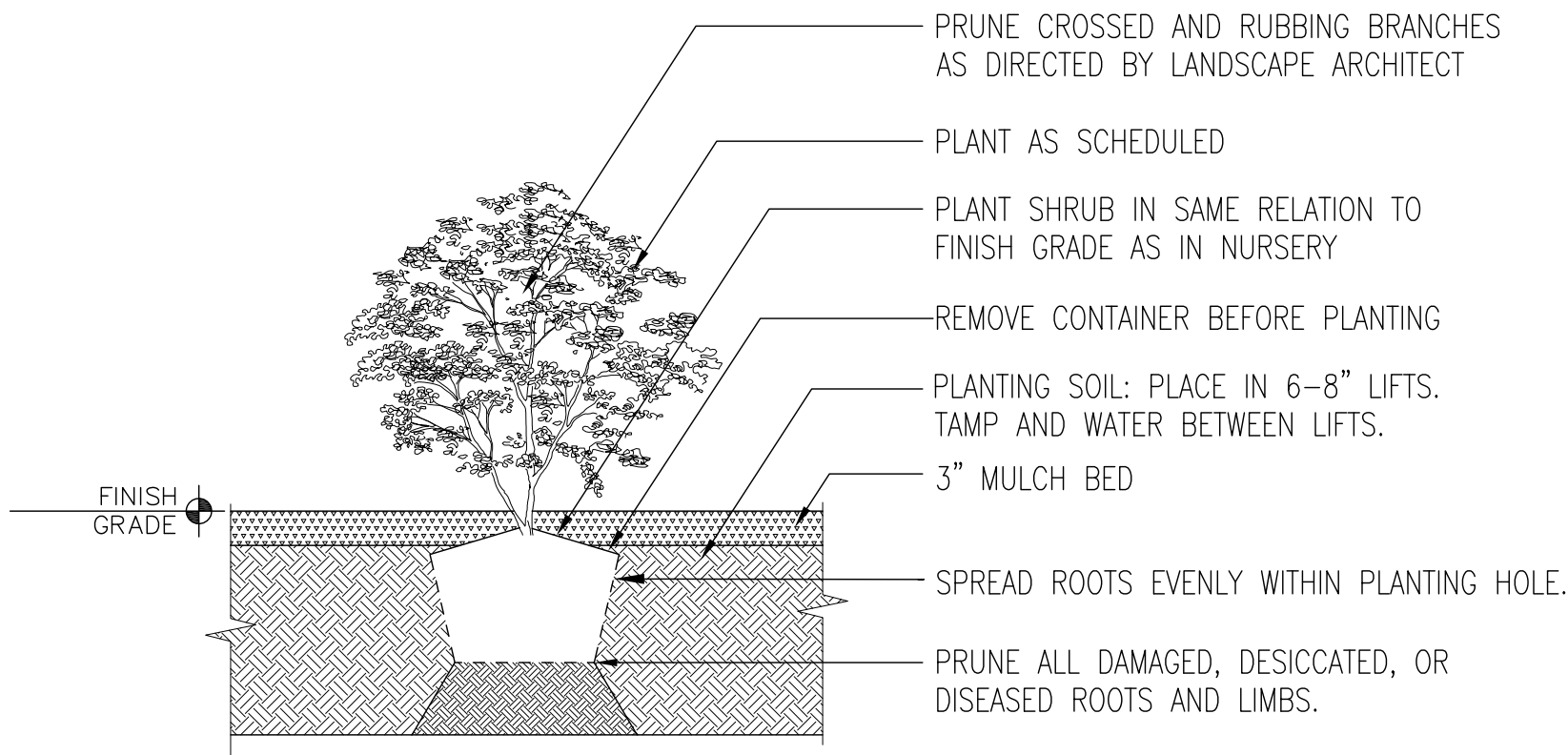
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NOTES:
- CLEANLY PRUNE ALL ROOT ENDS.
- DO NOT ALLOW ROOTS TO DRY OUT DURING THE INSTALLATION PROCESS.
- SOAK ROOTS OVERNIGHT BEFORE PLANTING.
- INSTALL BALLED AND BURLAPPED SHRUBS SIMULTANEOUSLY W/ INSTALLATION OF PLANTING SOIL



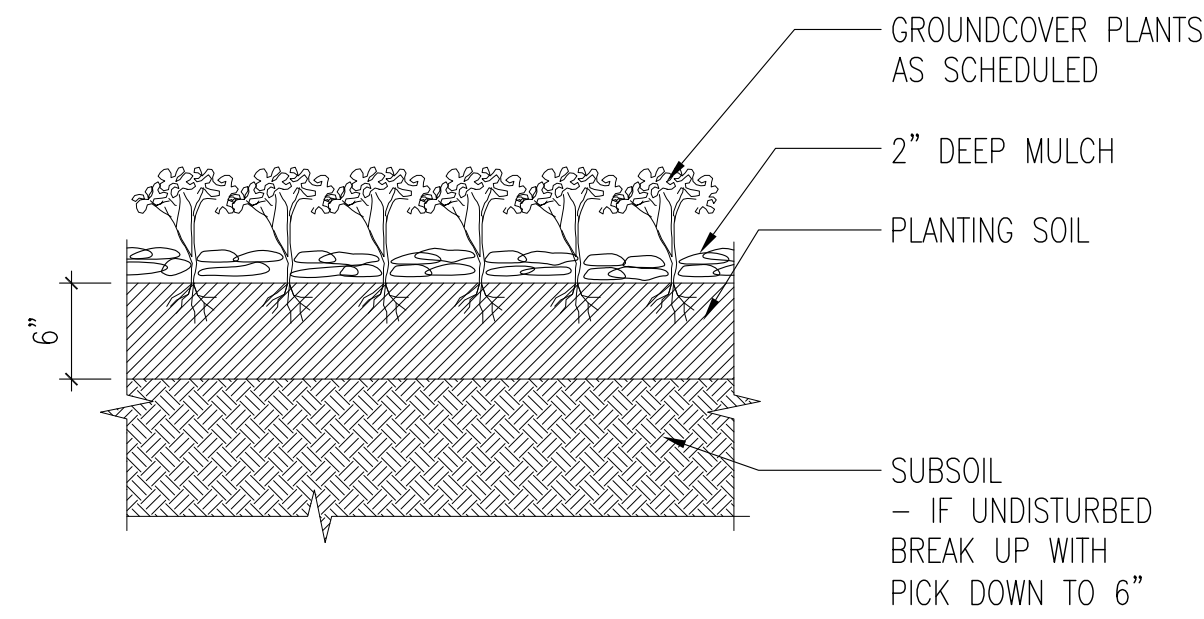
01 SHRUB PLANTING - B&B
SCALE: 3/4" = 1'-0"

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

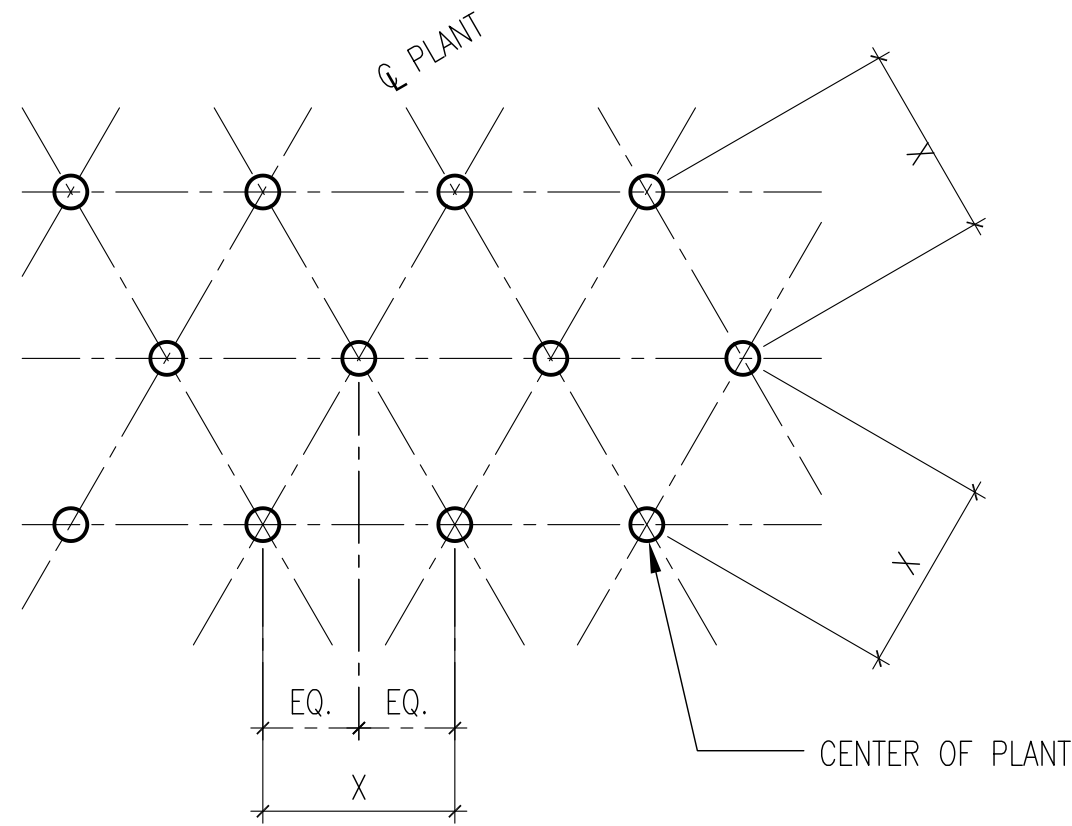


02 SHRUB/PERENNIAL - CONTAINER
SCALE: 3/4" = 1'-0"

NOTE:
SEE PLANT SPACING DIAGRAM FOR GROUNDCOVER SPACING



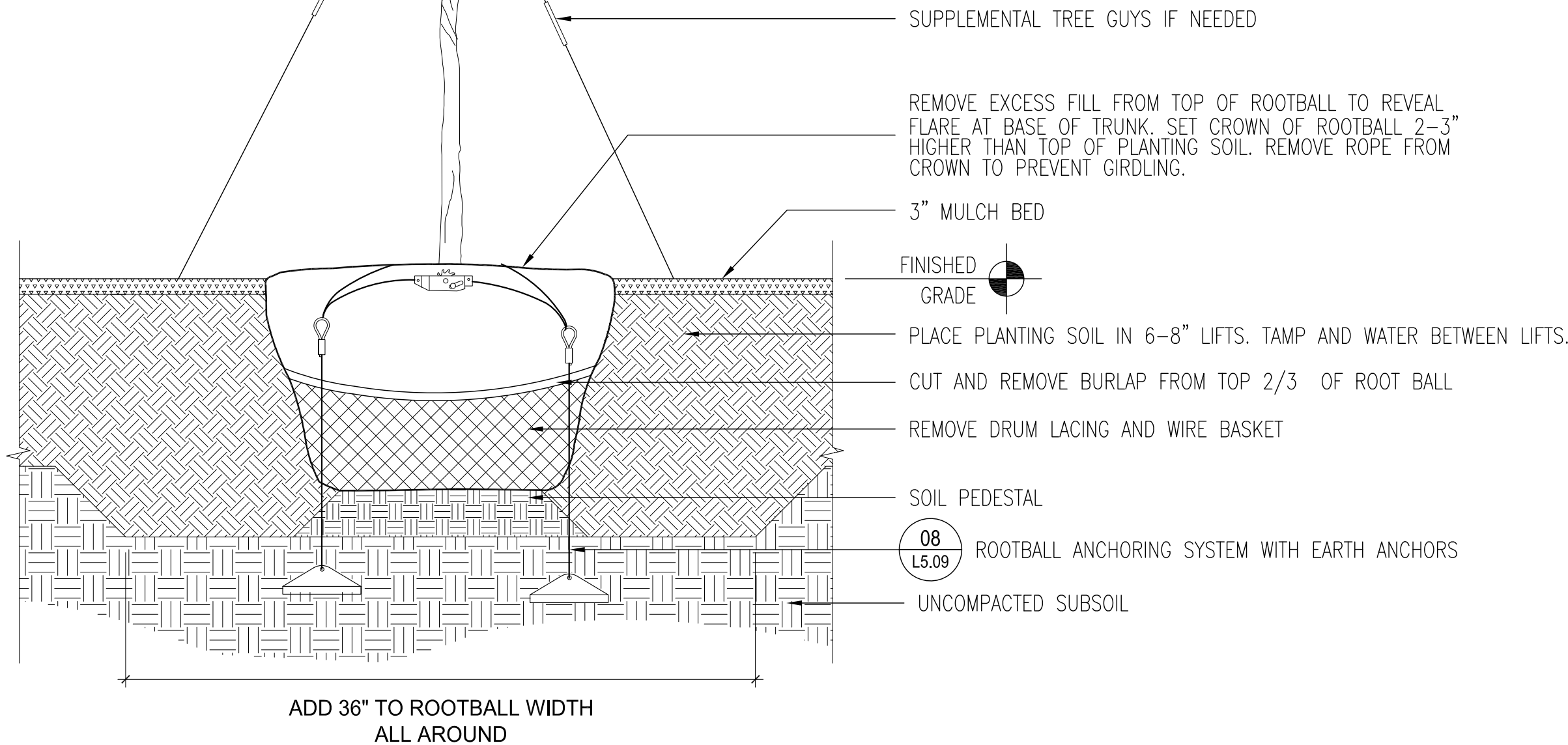
03 GROUNDCOVER PLANTING
SCALE: 1" = 1'-0"



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:

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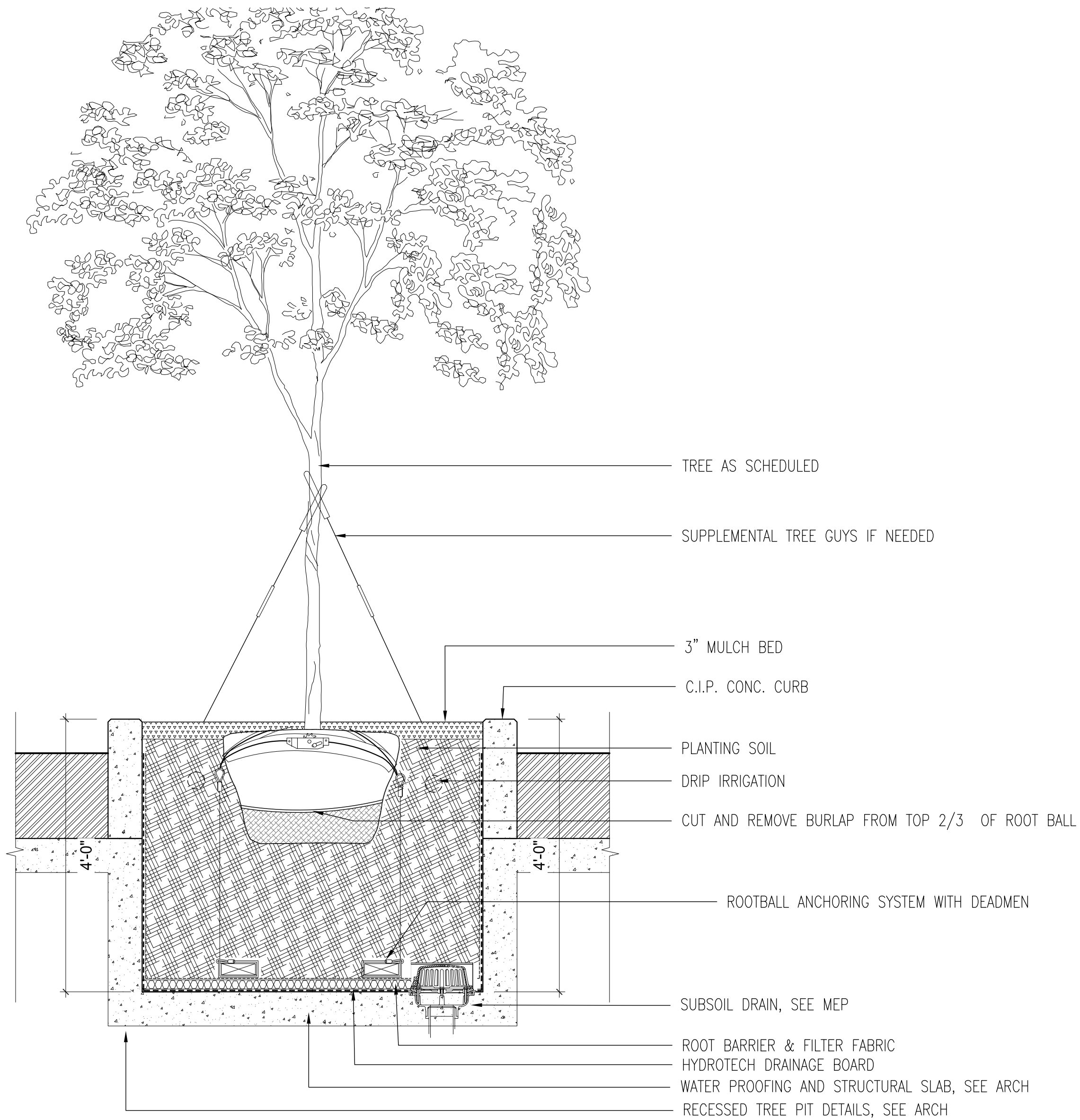
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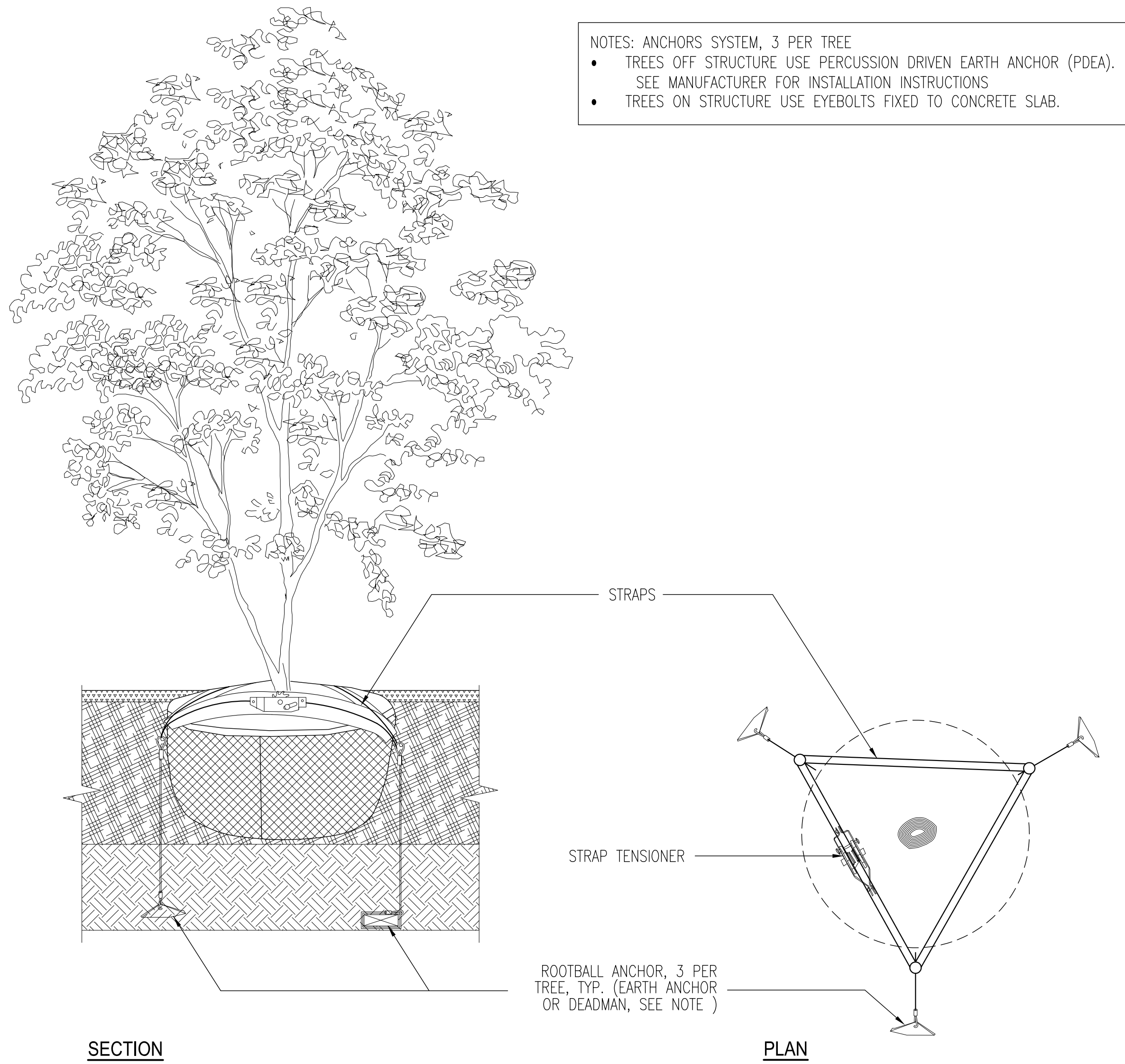
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01 TREE PLANTING AT PRECAST PAVER - ON STRUCTURE

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



02 TREE ANCHORING SYSTEM

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

Notes:

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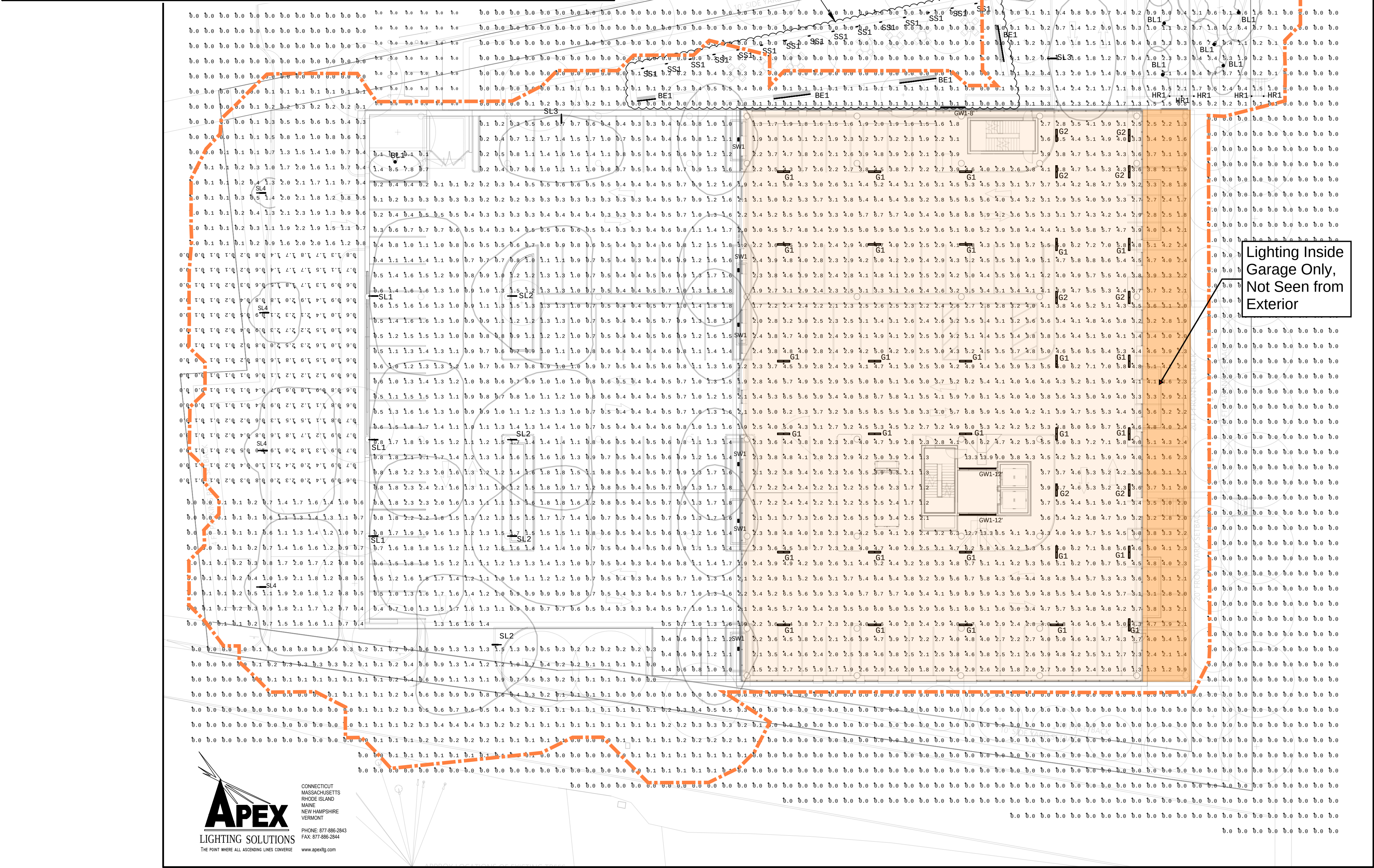
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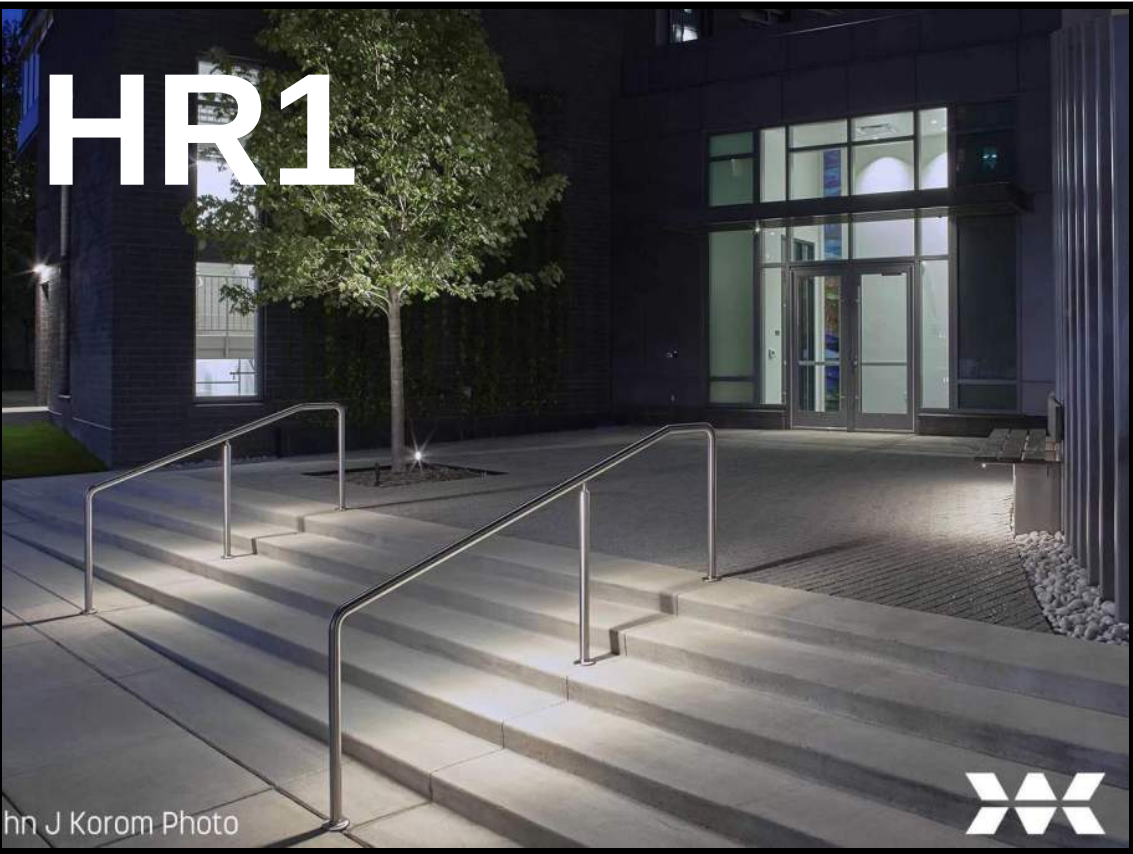
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JOB NAME: HIGHLAND M.O.B. DATE: 02/2023 APEX LIGHTING SOLUTIONS REFLECTANCES: PARKING SURFACE & WALLS=20%; CEILING IN COVERED PARKING=60% WORKPLANE: @ GROUND				
Luminaire Schedule				
Qty	Label	Wattage	Luminaire Lumens	LF/F Description
3	SL1	36	2379	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 AFS
4	SL2	24	2362	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 AFS
2	SL3	24	1612	0.700 SELUX ACL-R3-S1-SG1530-30-FINISH-UNV-DM-HS Mounted to A-A40-250-16-FINISH-HC1-BC on 4ft Tall Concrete Pedestal w/Optical Center @ ~12 AFS
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 @ ~14A AFS
6	SW1	30.2	1467	0.900 GARUDA HS-AS-435-TAM-UNV-CL-4-FINISH Mounted to Structure @ ~12H AFS
20	G1	40.4	3462	0.900 SELUX L225-2020-30-CW-F-54-FINISH-UNV-DM-Surface Mounted to Ceiling @ ~14H AFS
8	G2	20.4	1504	0.900 SELUX L225-1820-30-CW-F-54-FINISH-UNV-DM-Surface Mounted to Ceiling @ ~14H AFS
8	BL1	34.1	798	0.900 SELUX BL-3-S-2020M3-30-FINISH-UNV-LP
1	GW1-8"	38.6	3848	0.900 SELUX L60-1220-30-M-W-LENGTH-FINISH-UNV-DM-CL Mounted to Wall @ 9H AFS
2	GW1-12"	57.9	5772	0.900 SELUX L60-1220-30-M-W-LENGTH-FINISH-UNV-DM-CL Mounted to Wall @ 9H AFS
42	HR1	107	10768	0.010 Q TRAX BOKA-SW-RPS-LP-30-HC-ENG-TFL-XX-XX-CL-CL-LENGTH Mounted Beneath Benches
9	HR1	2.89	100	0.900 WAGNER LUXURIOUS-3K Mounted in Handrail 36H AFS
Luminaire Summary				
Label	Grid Height	Avg - FC	Max - FC	Min - FC
RAMP TO UNDERGROUND PARKING		1.32	2.7	0.0
OPEN AIR PARKING - DRIVE AISLES & PARKING AREAS		0.99	2.4	0.1
COVERED PARKING - VEHICULAR ENTRY #4		2.75	6.7	2.1
COVERED PARKING - VEHICULAR ENTRY #3		2.83	6.7	2.3
COVERED PARKING - VEHICULAR ENTRY #2		3.72	6.7	2.3
COVERED PARKING - VEHICULAR ENTRY #1		4.29	7.2	2.5
COVERED PARKING - DEDICATED CORNERS, DRIVE AISLES, PARKING AREAS		3.80	7.2	1.2



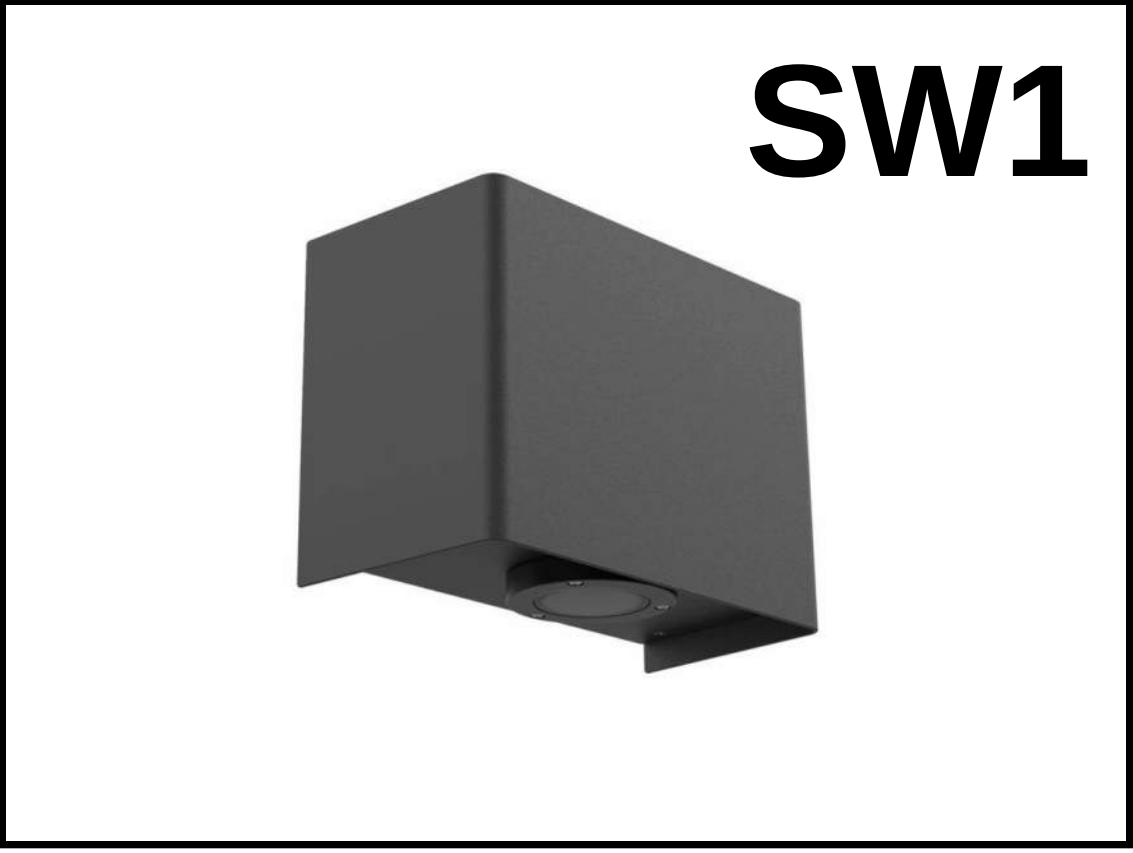
BL1 Accessible Route Lighting and Landscaped Corner at Upper Parking



HR1 Stair Lighting Concealed beneath Handrails



SL1-4 Parking & Drive Pole-Mounted Downlights



SW1 Parking Downlights Mounted below Shelf on Building

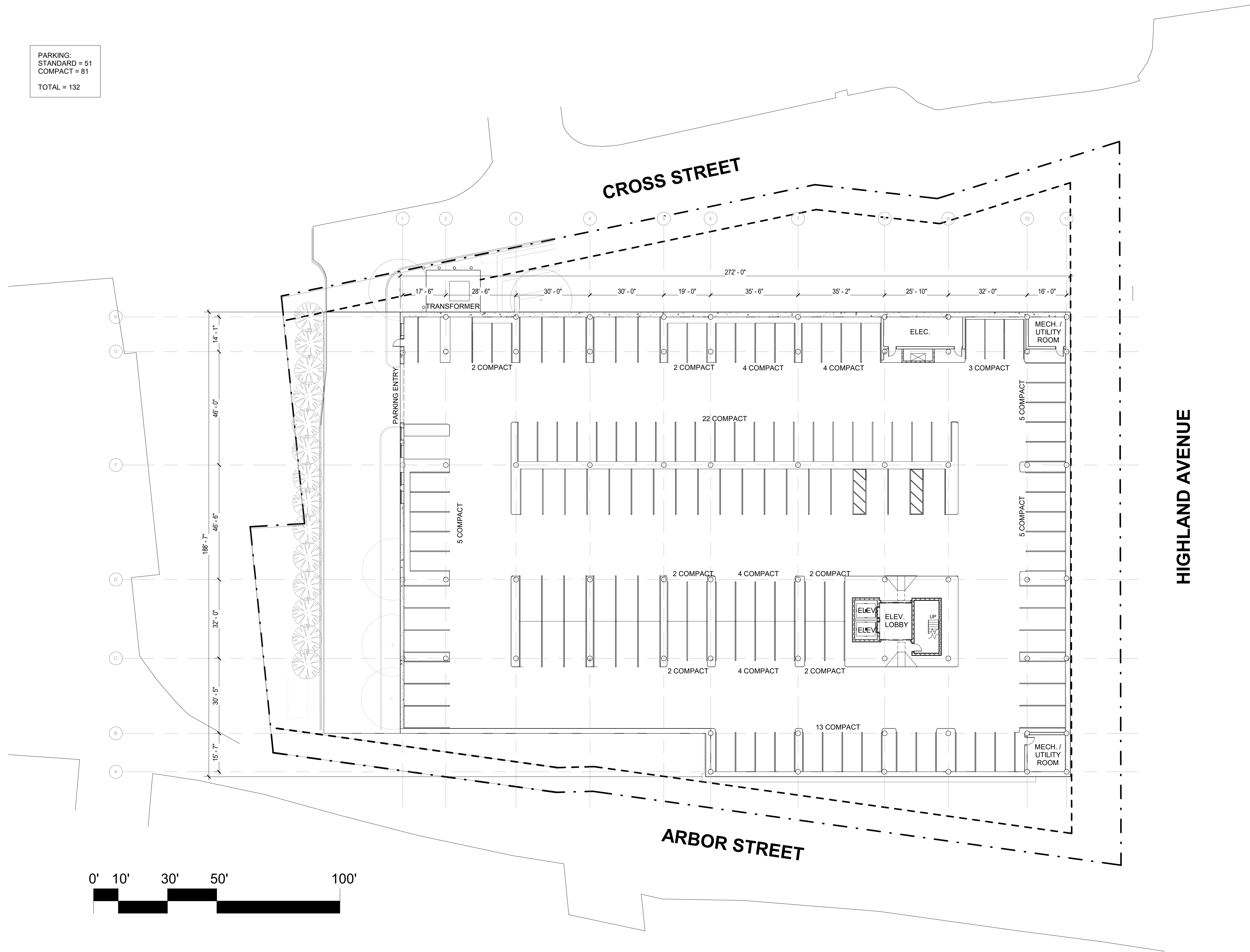


BE1 Plaza Lighting Concealed beneath Benches



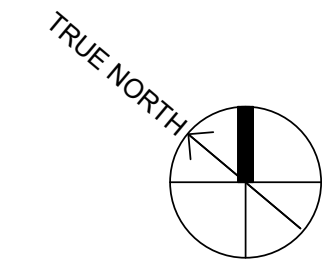
SW1 Parking Downlights Mounted below Shelf on Building

PARKING:
STANDARD = 51
COMPACT = 81
TOTAL = 132



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

Notes:



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: 3/64" = 1'-0"

Issue:

PLANNING BOARD
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Date:

08/04/2023

Revisions:

Date:

Drawing Title:

P-1 Lower Parking Plan

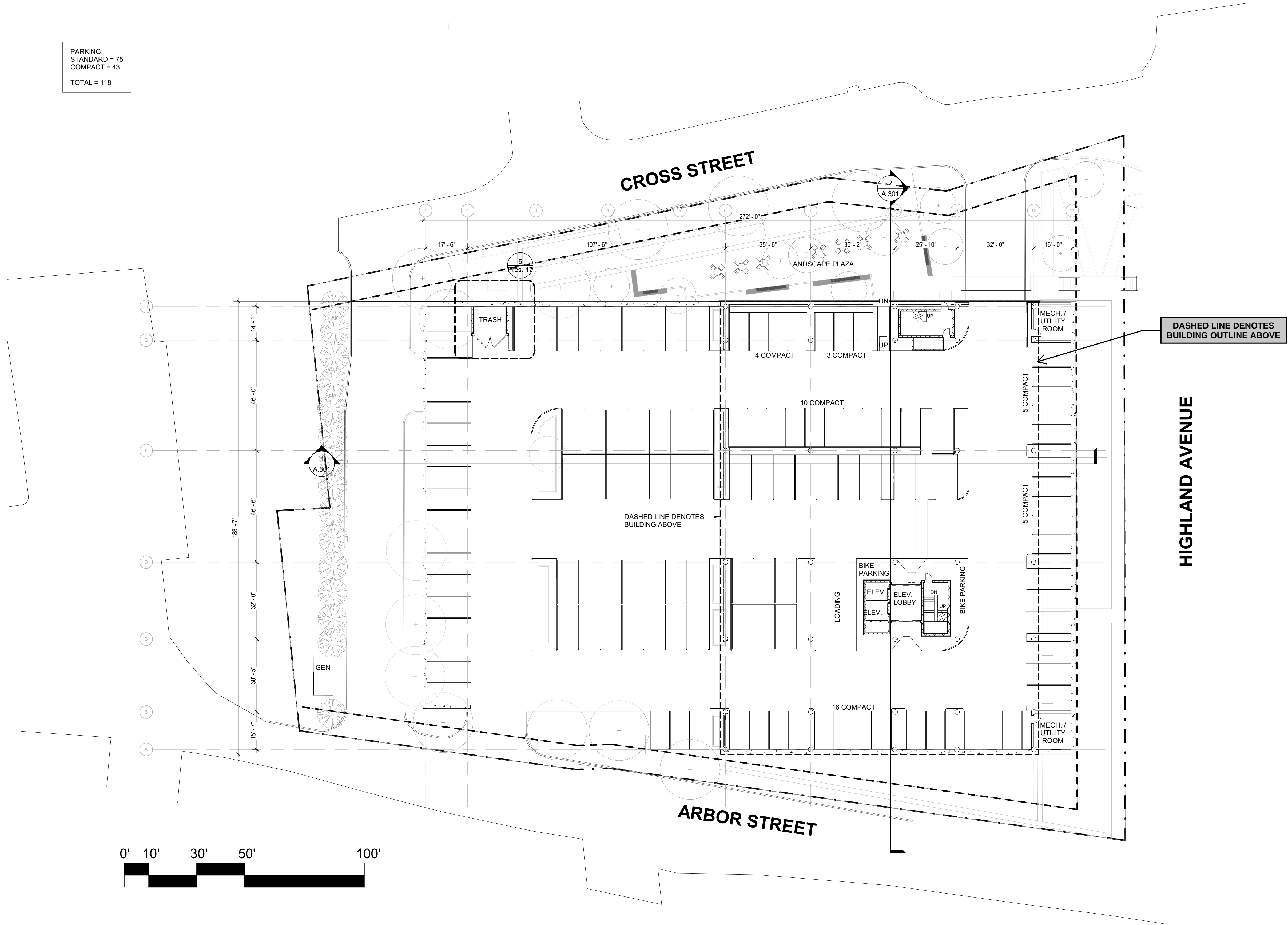
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PARKING:
STANDARD = 75
COMPACT = 43
TOTAL = 118



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

Notes:

Key Plan:

Architect's Stamp:



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Medical Office Building
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Needham, MA 02494

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Boston Development Group

93 Union St, Suite 135, Newton Centre,
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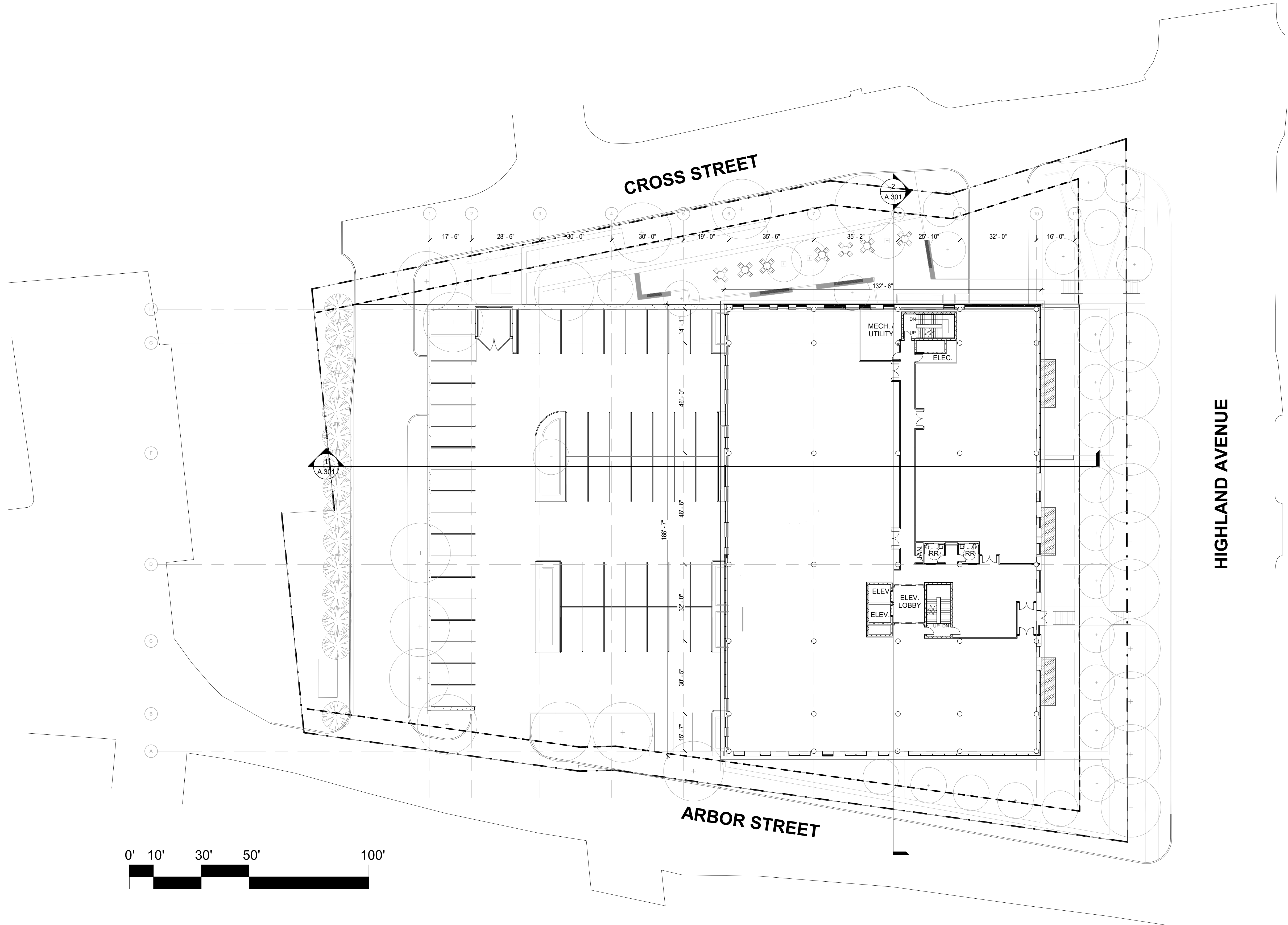
P-2 Upper Parking Plan

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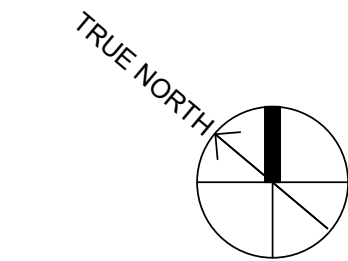
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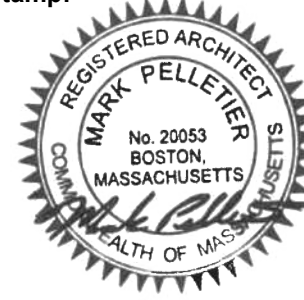


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Project #: 22090

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

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Date:
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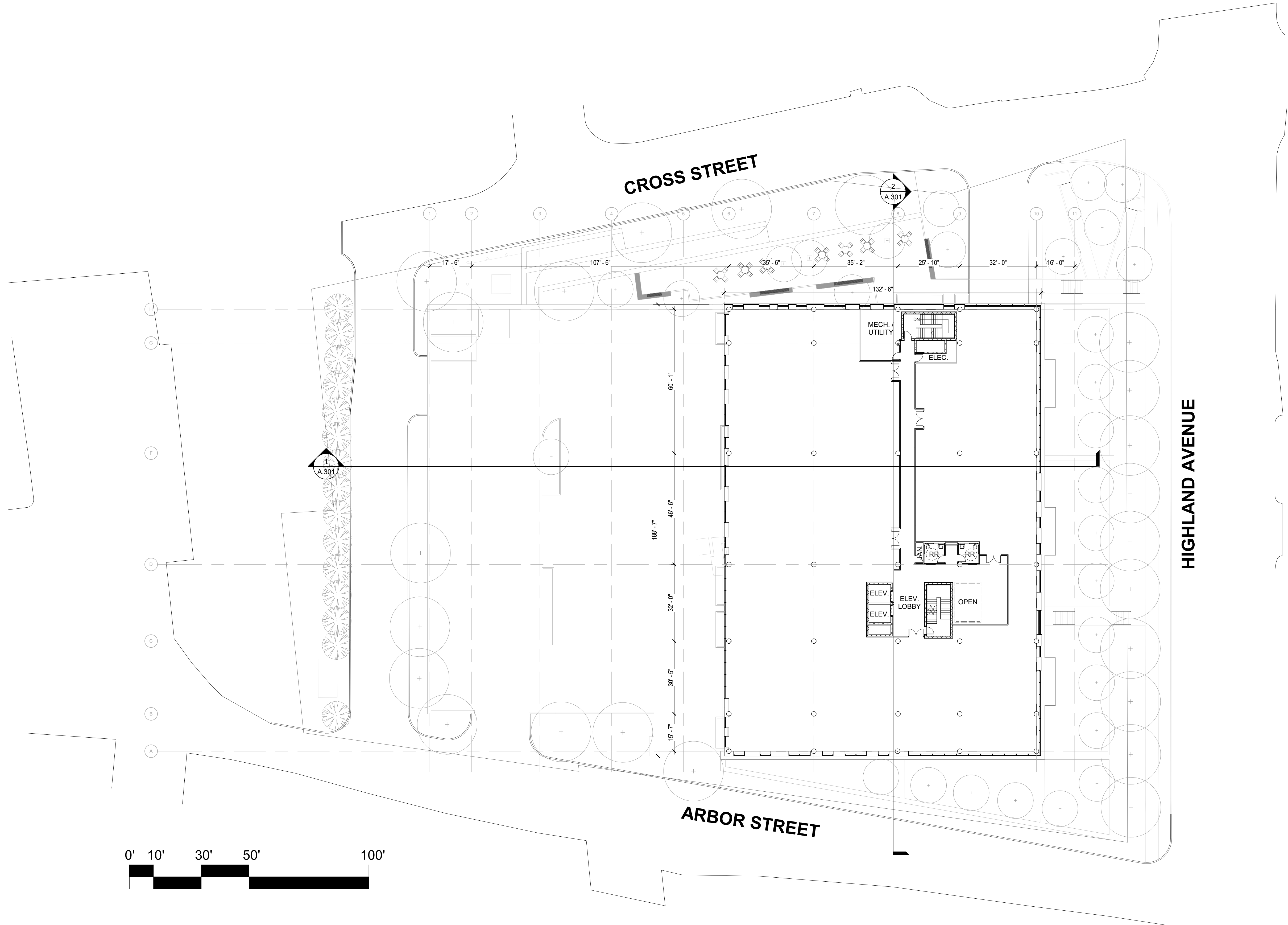
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First Floor Plan

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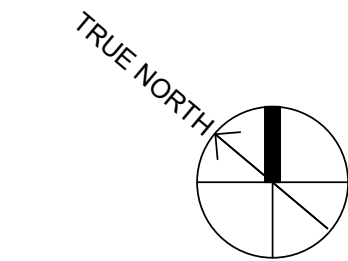
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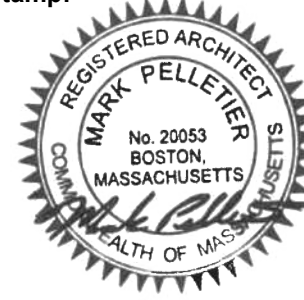


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Date: 08/04/2023

Revisions:	Date:

Drawing Title:
Second Floor Plan

Sheet Number:

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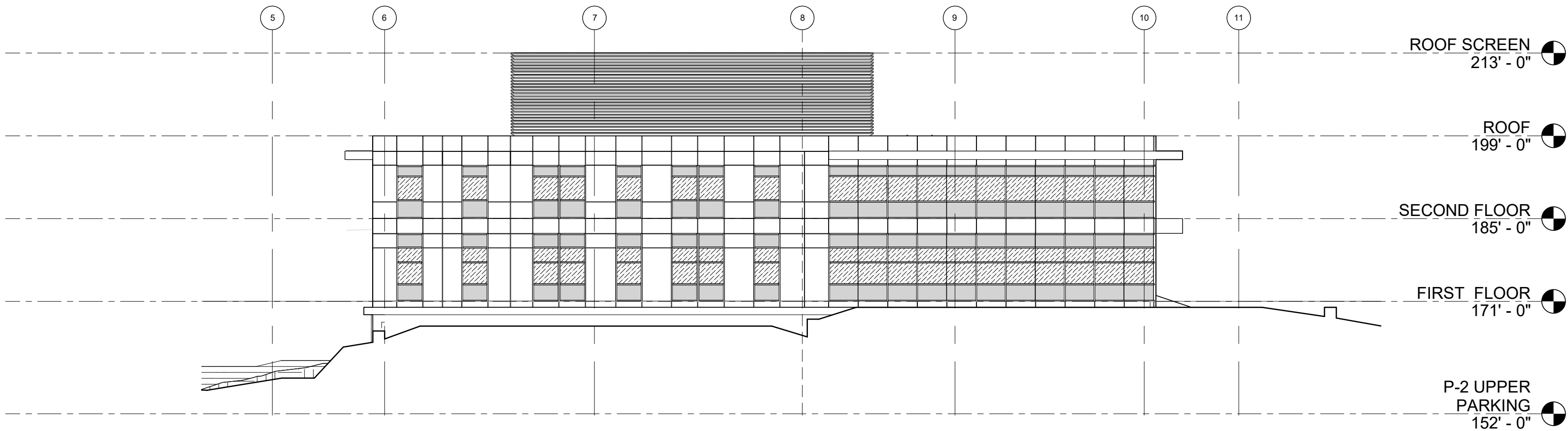


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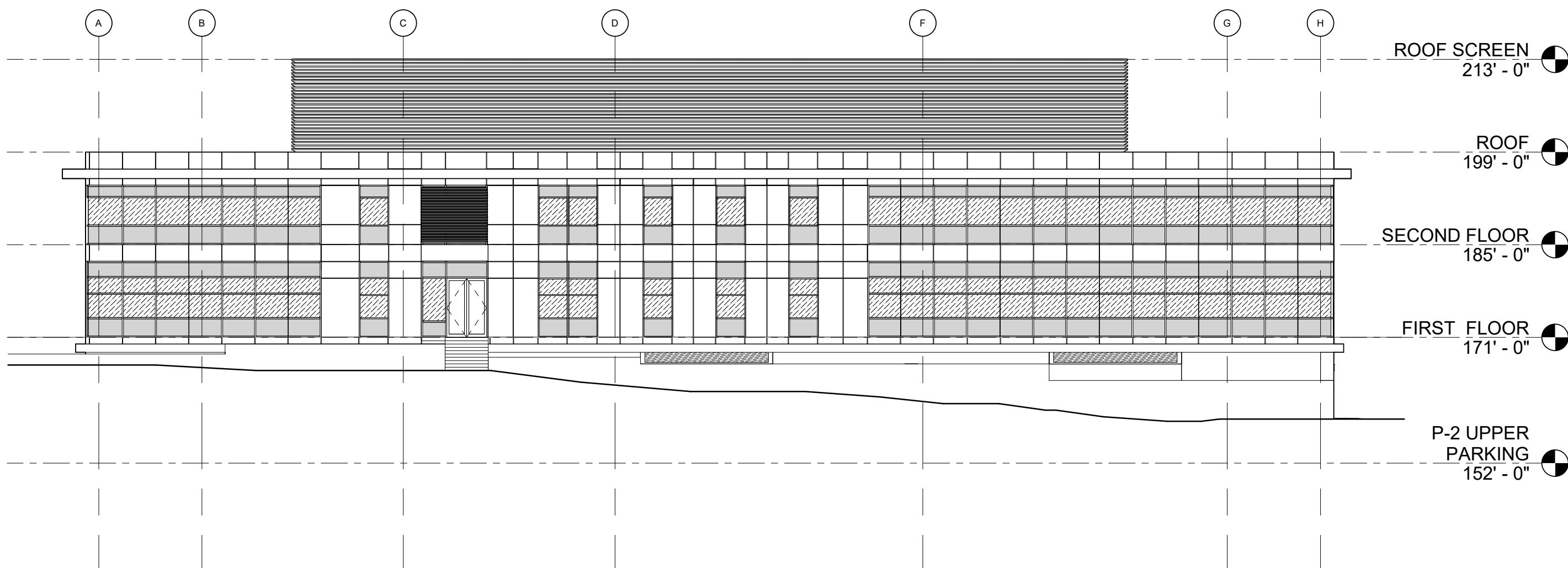
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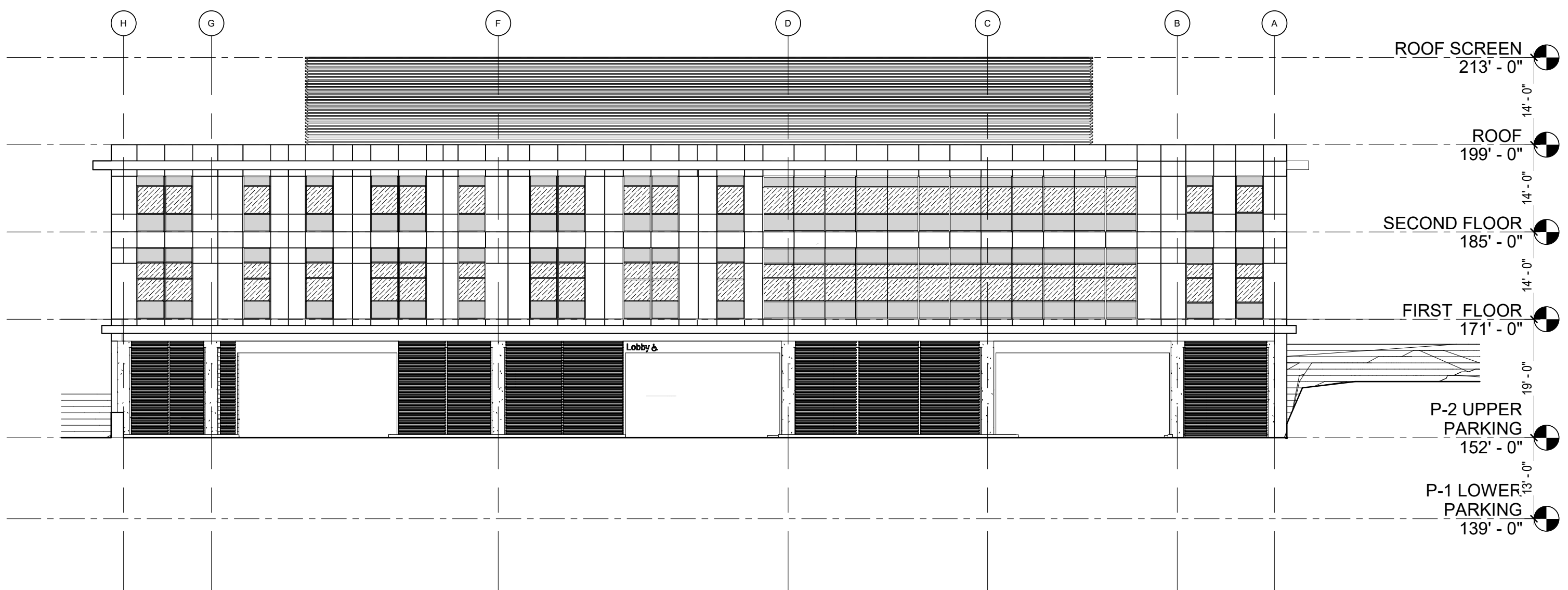
4 ARBOR STREET (SOUTH WEST) ELEVATION
SCALE: 1/16" = 1'-0"



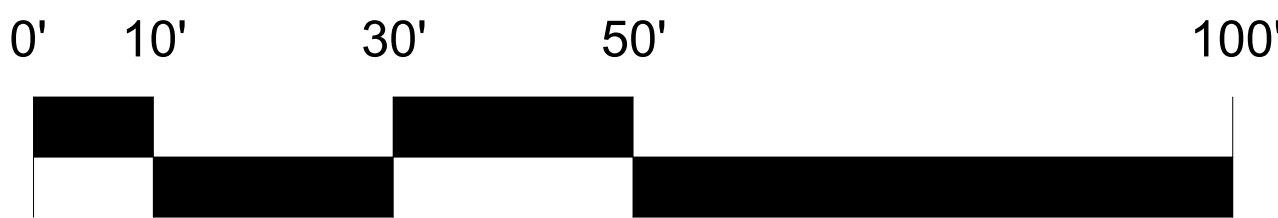
3 HIGHLAND AVE (SOUTH EAST) ELEVATION
SCALE: 1/16" = 1'-0"



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



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



Notes:

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Date: 08/04/2023

Revisions:	Date:

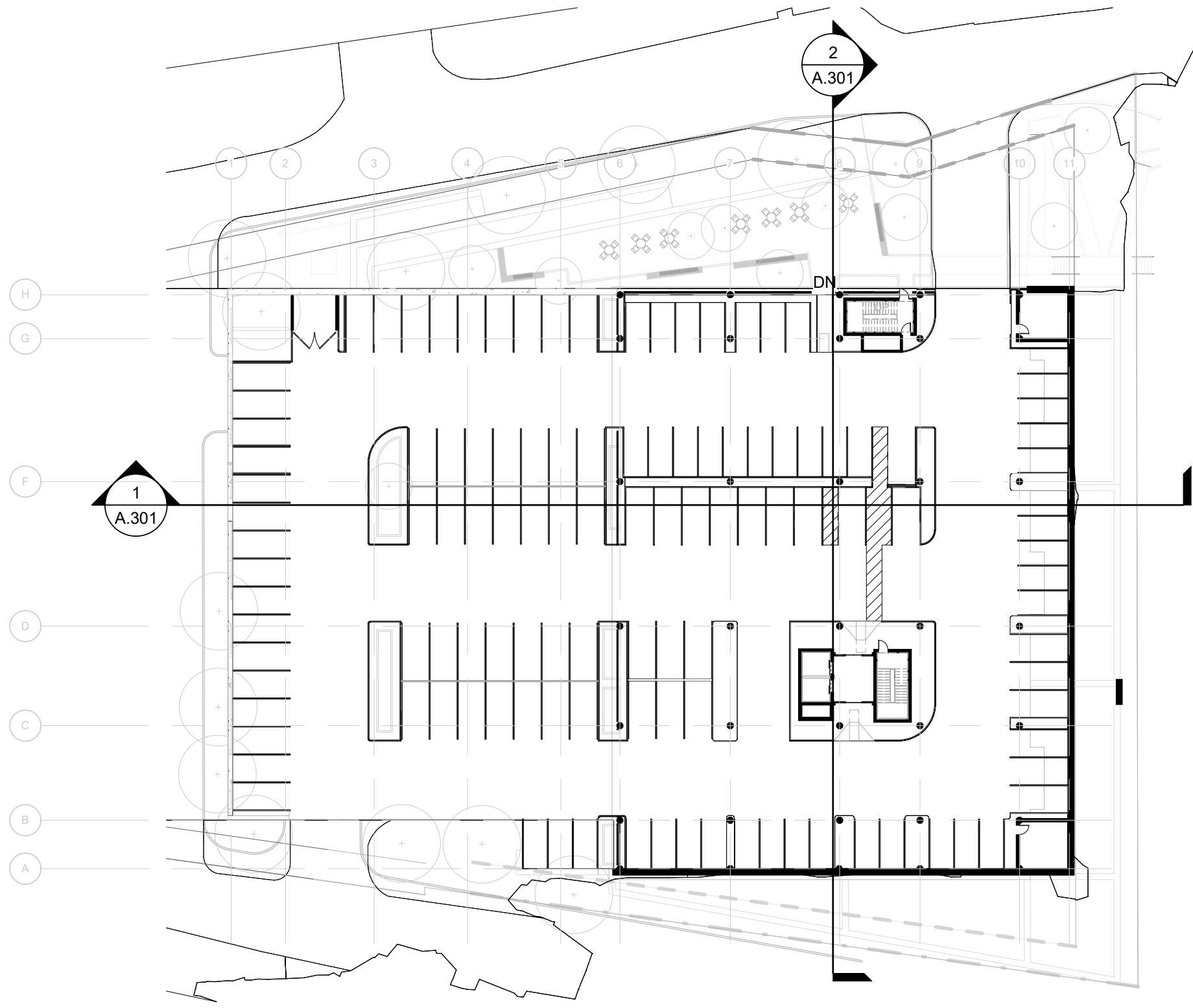
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Elevations

Sheet Number:

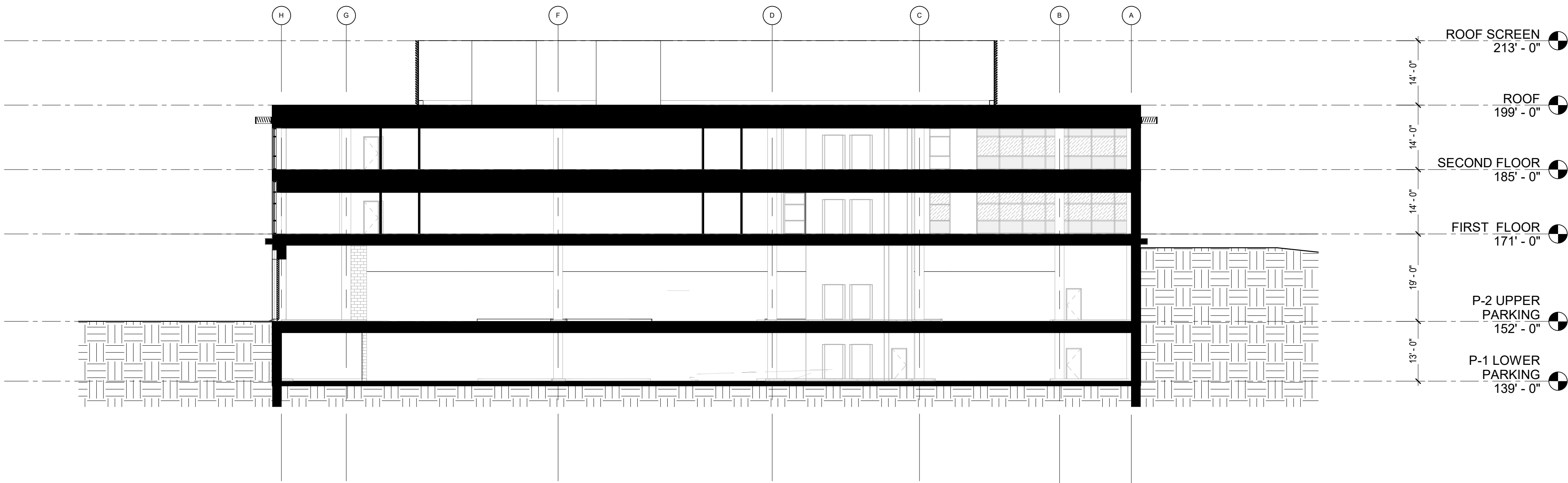
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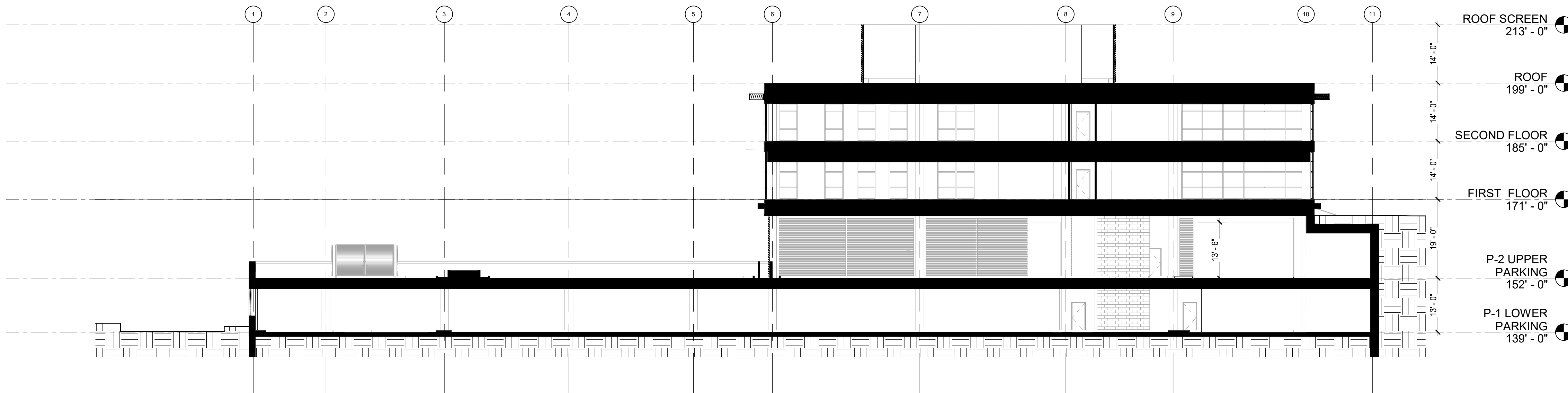
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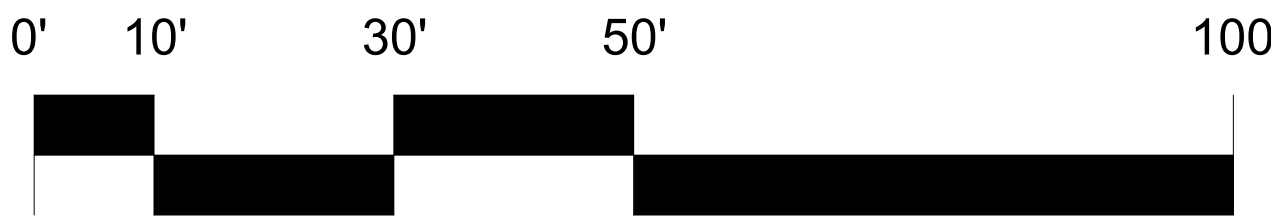
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SCALE: 1" = 40'-0"



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



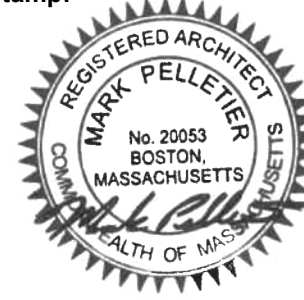
1 BUILDING SECTION 1
SCALE: 1/16" = 1'-0"



Notes:

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: PLANNING BOARD SUBMISSION
Date: 08/04/2023

Revisions: Date:

Drawing Title:
Building Sections

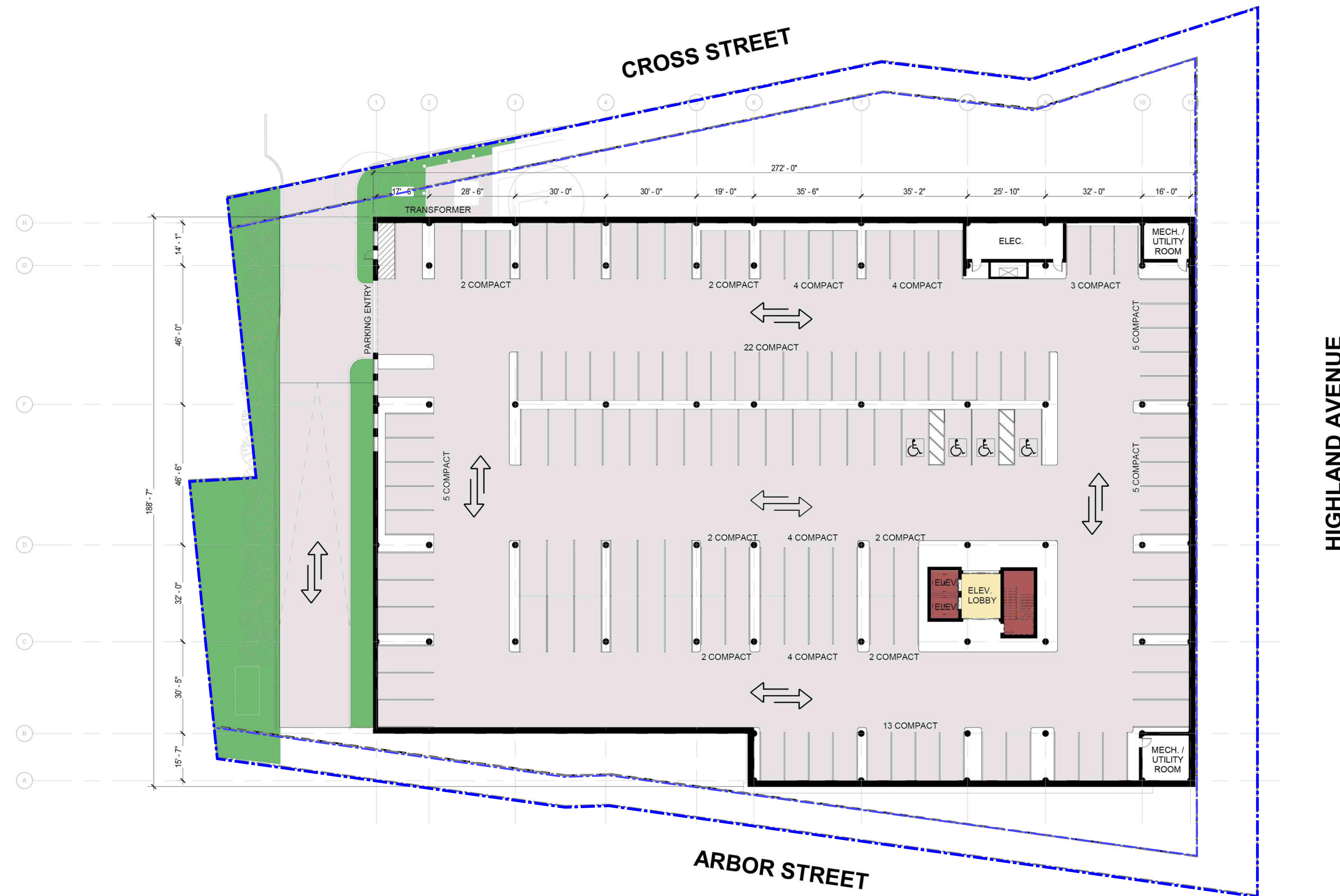
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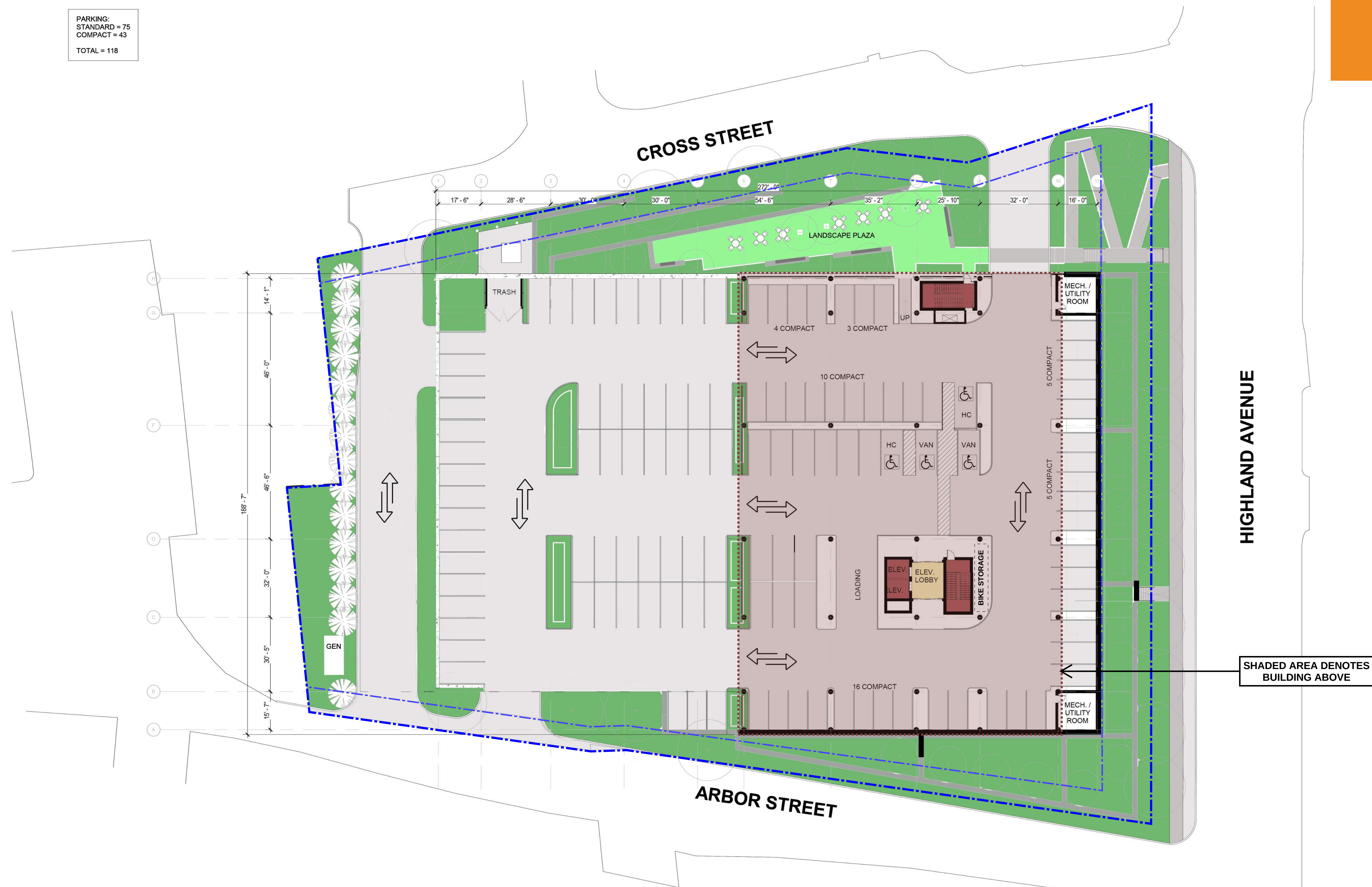
Medical Office Building
50,000 SF
250 Parking Spaces



Highland Ave MOB / P-1 Lower Below Grade Parking / 14 July 2023

Medical Office Building
50,000 SF
250 Parking Spaces

PARKING:
STANDARD = 75
COMPACT = 43
TOTAL = 118



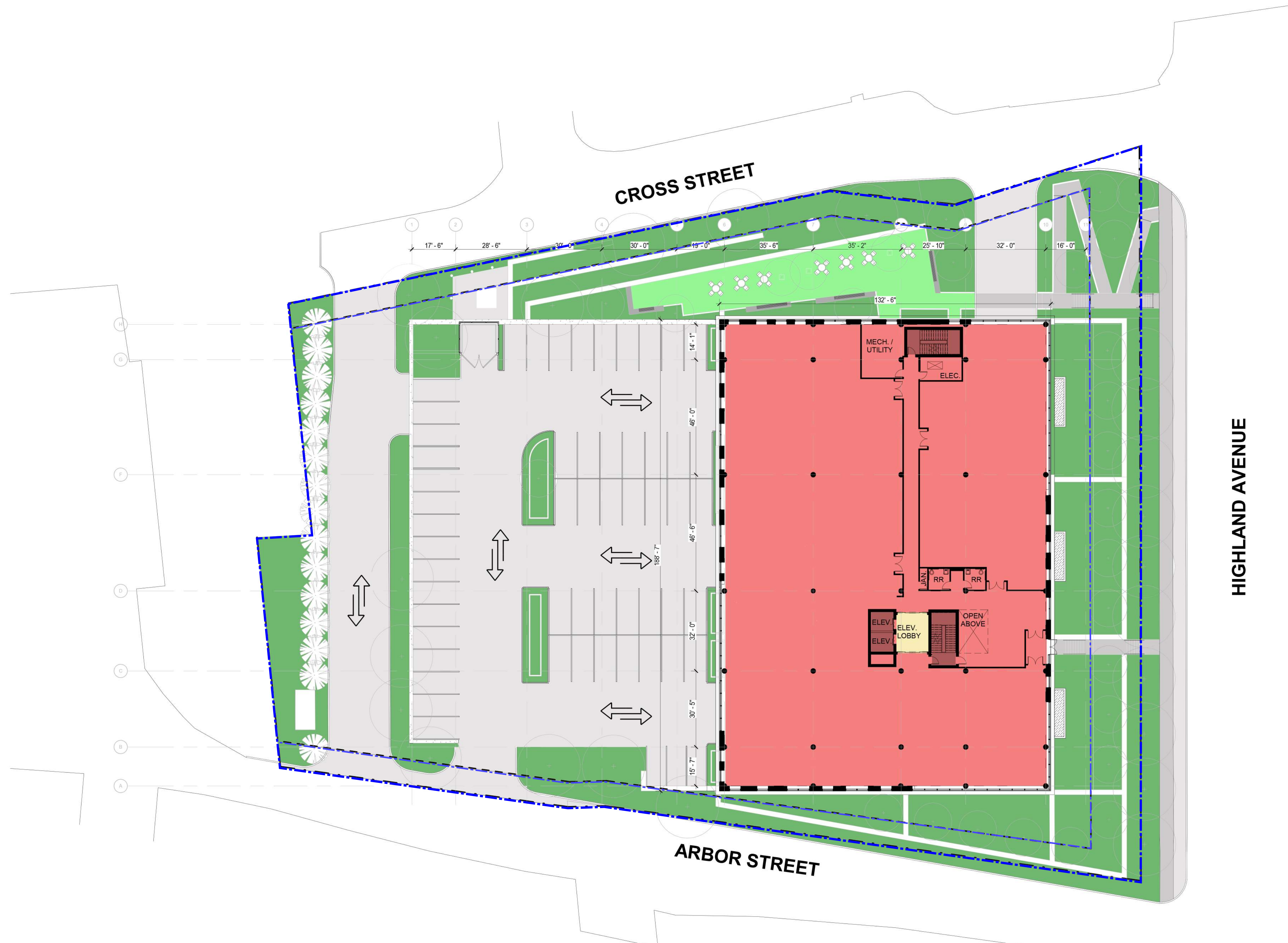
Highland Ave MOB / P-2 Upper Parking / 14 July 2023



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Medical Office Building
50,000 SF
250 Parking Spaces



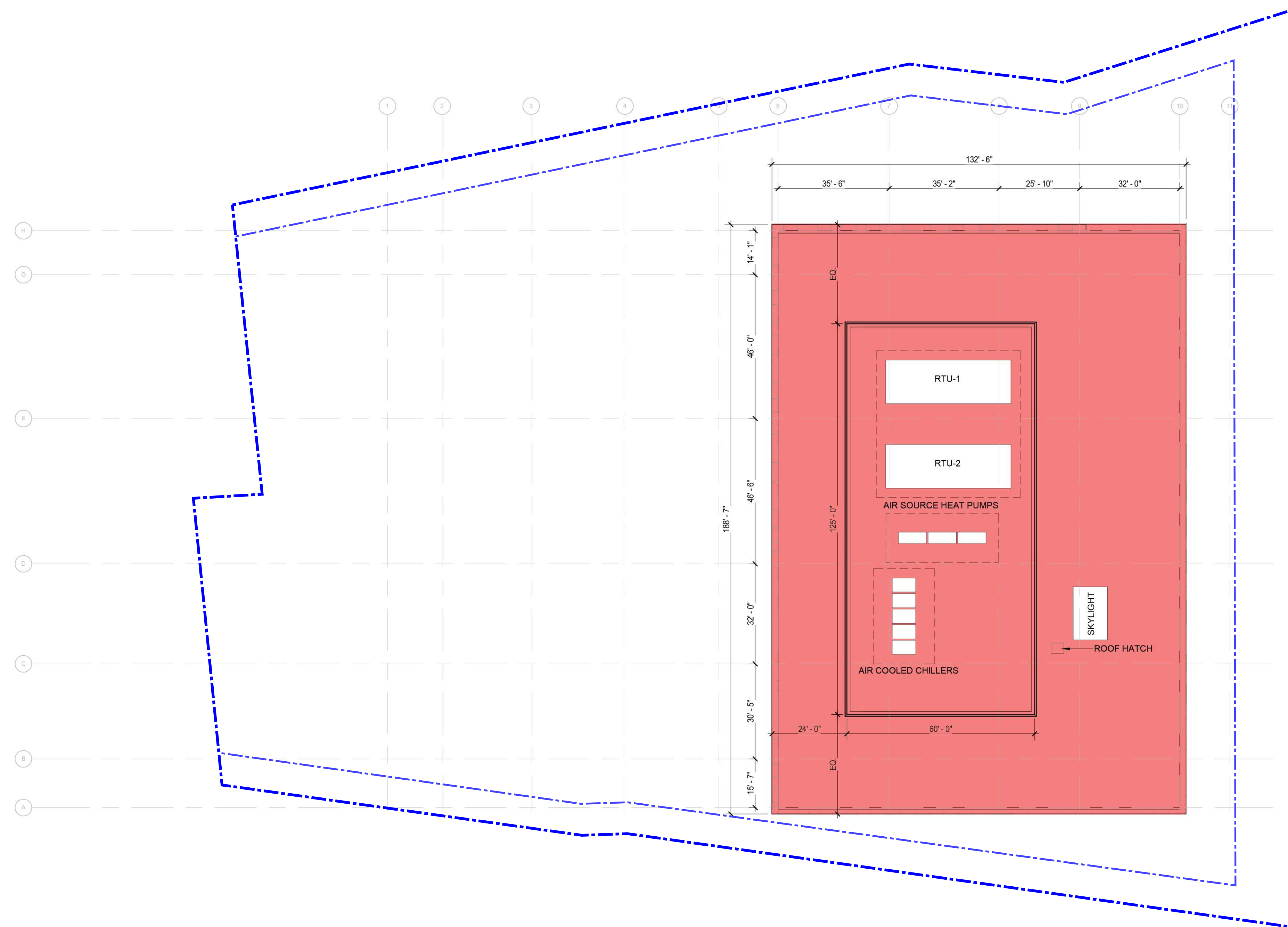
Highland Ave MOB / First Floor Plan / 14 July 2023

Medical Office Building
50,000 SF
250 Parking Spaces

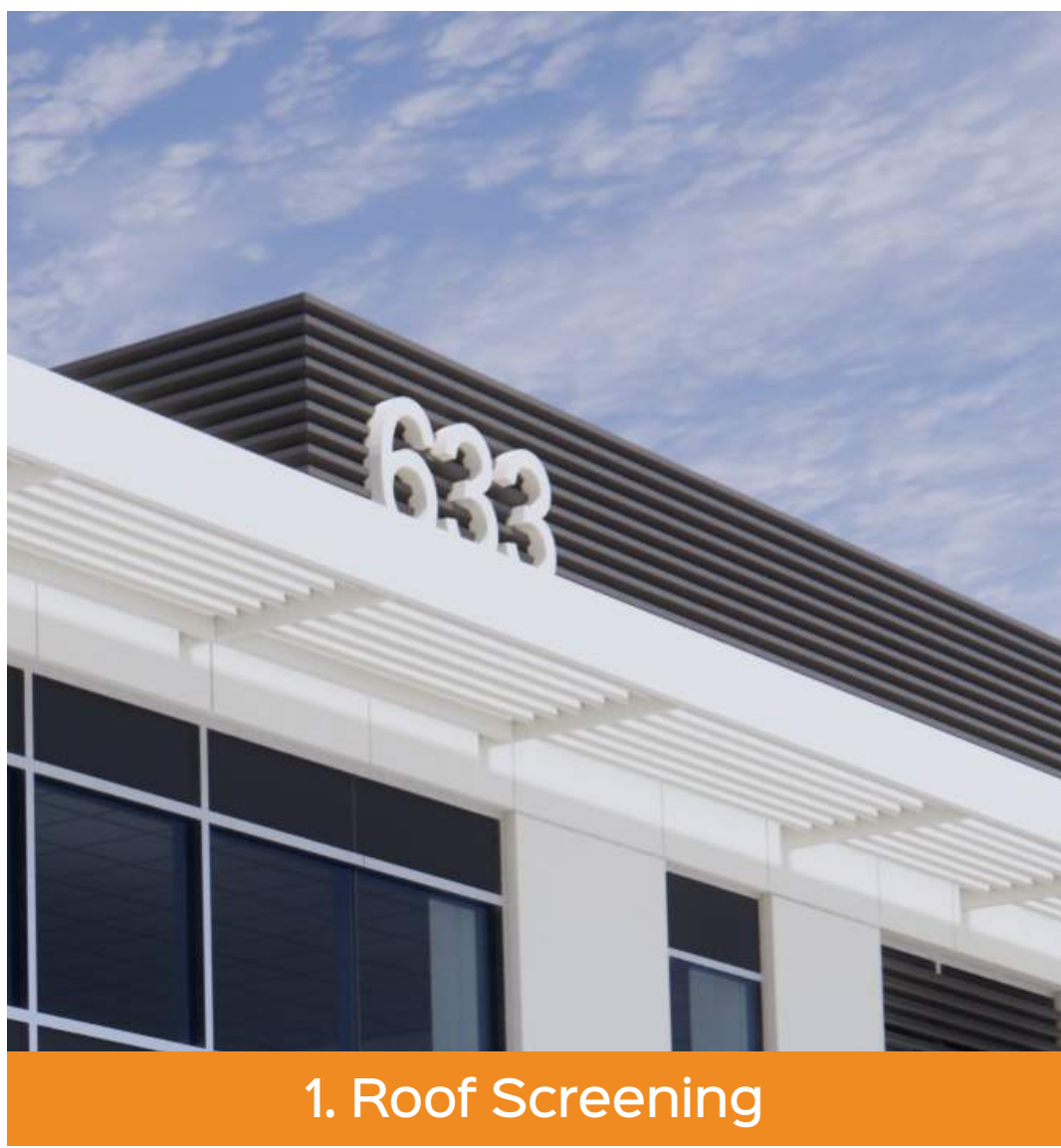


Highland Ave MOB / Second Floor Plan / 14 July 2023

Medical Office Building
50,000 SF
250 Parking Spaces



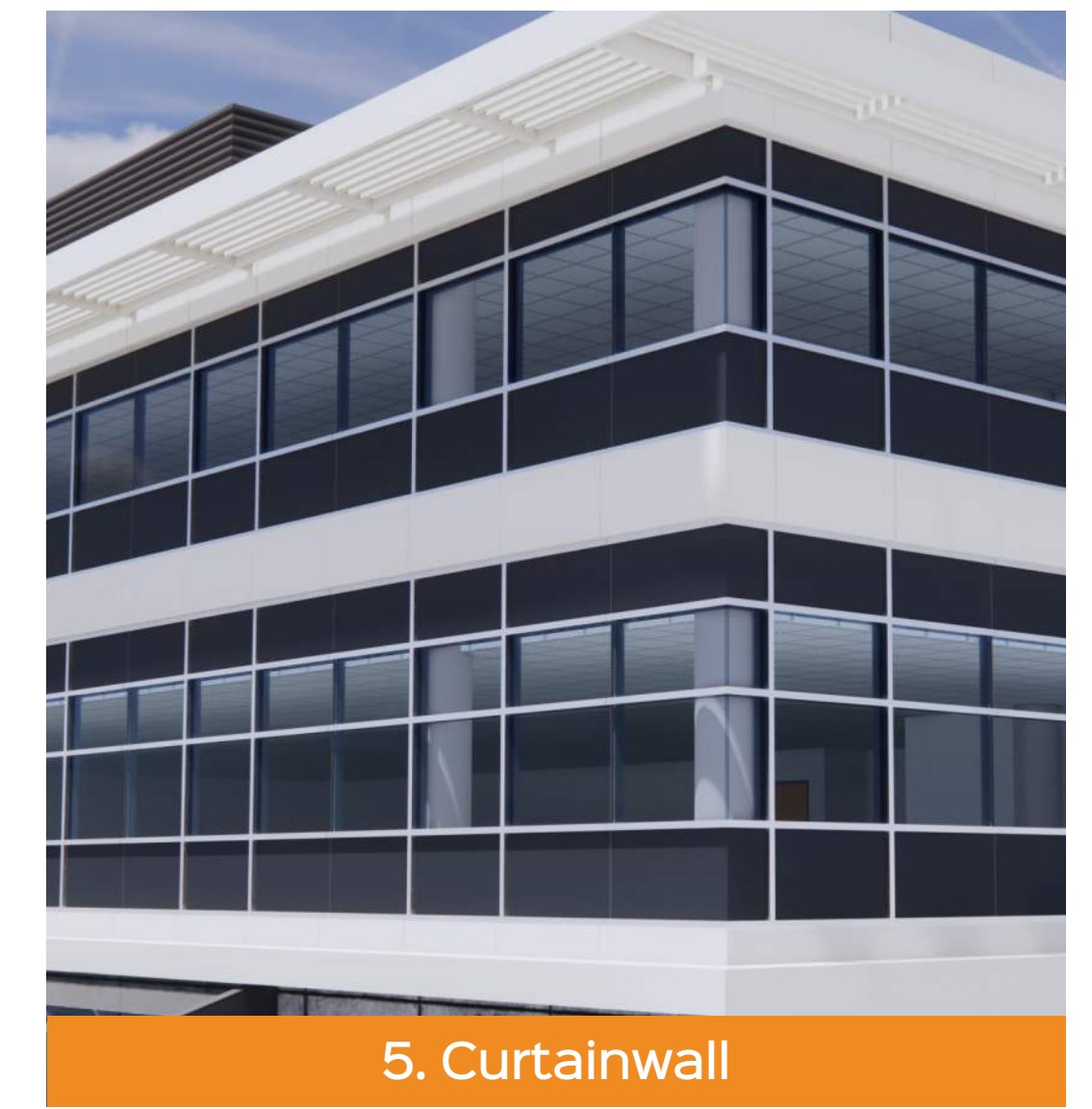
1 ROOF PLAN - PRESENTATION
SCALE: 3/64" = 1'-0"



1. Roof Screening



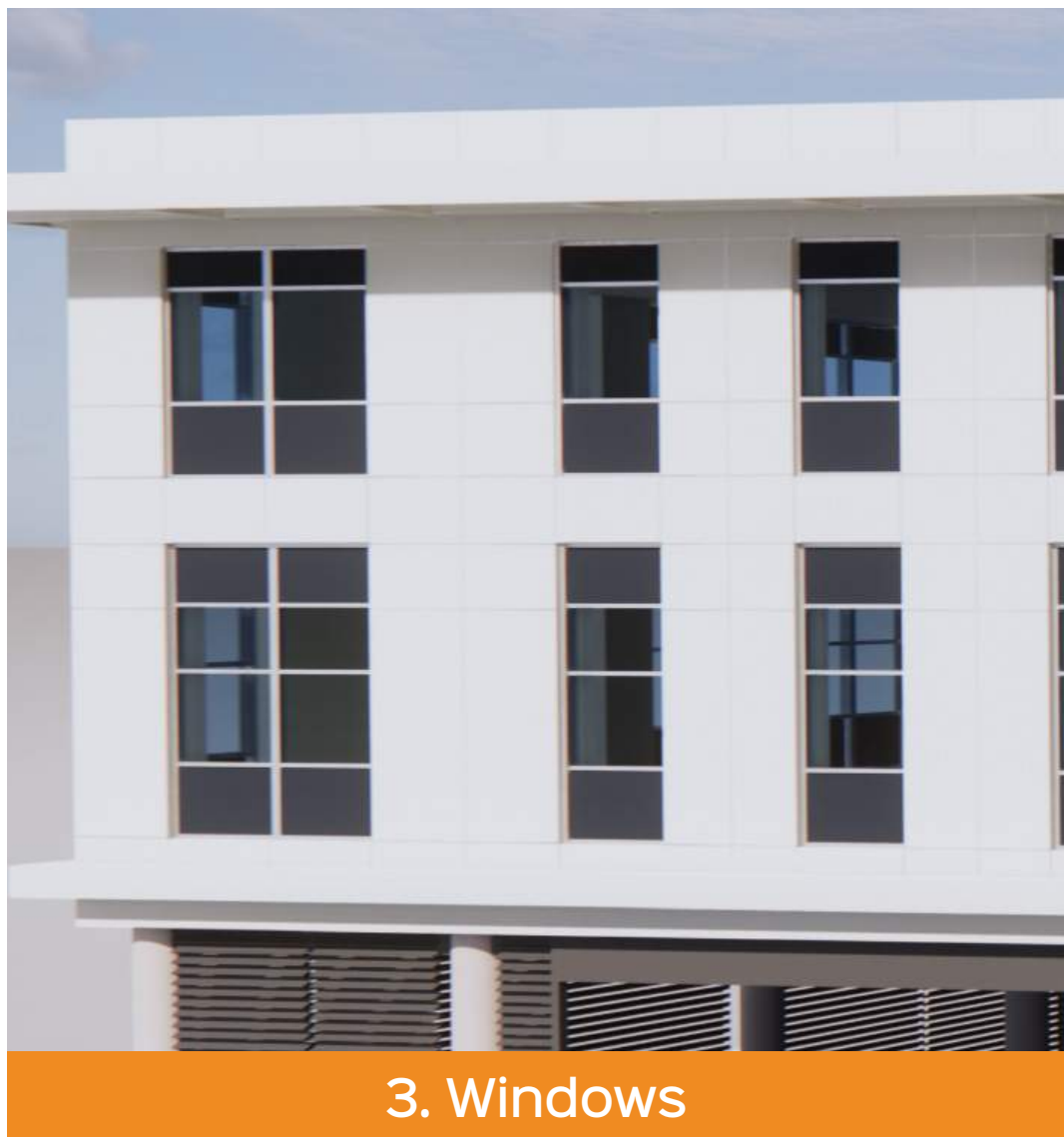
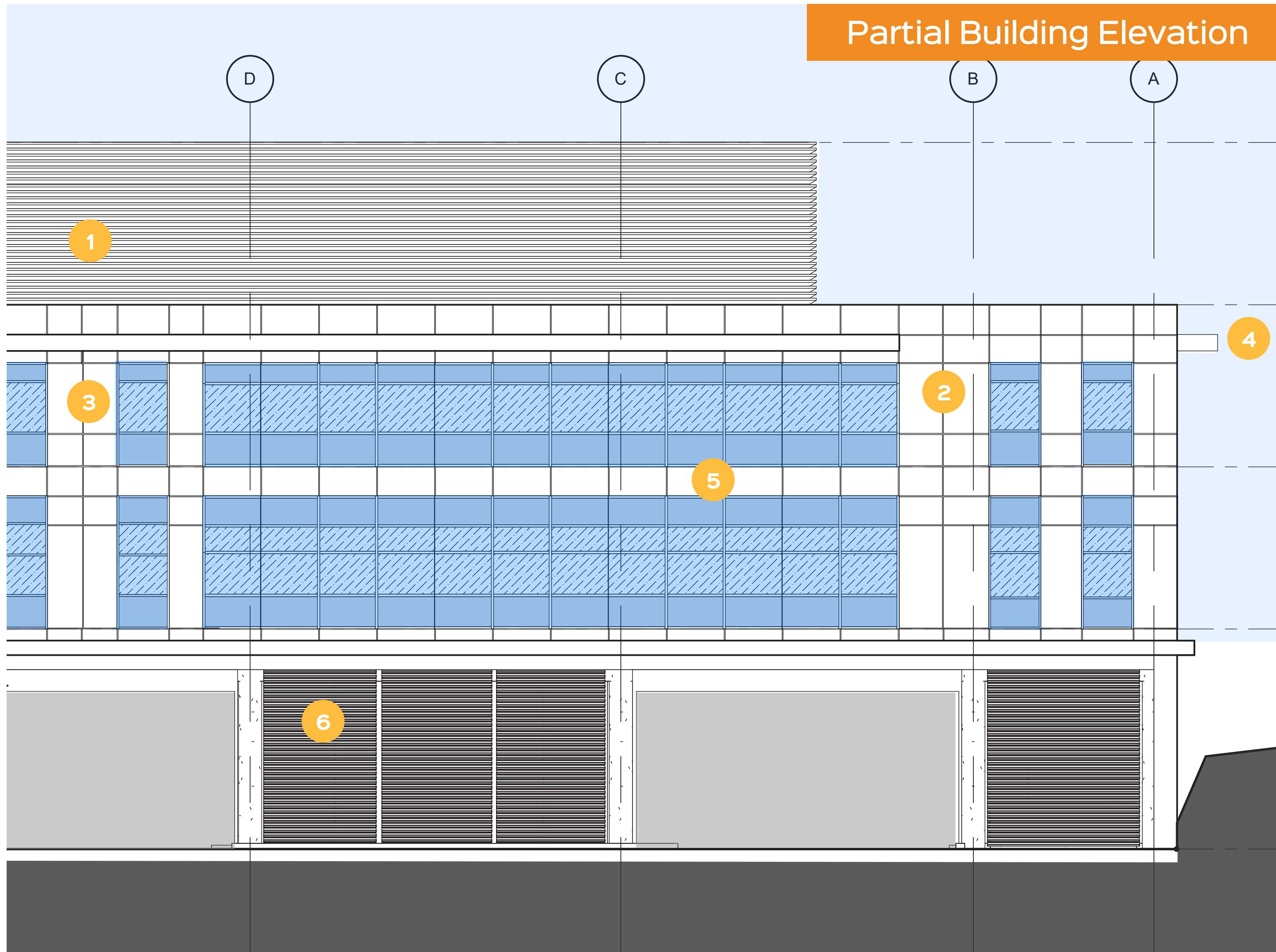
4. Sunscreen



5. Curtainwall



2. Metal Panel



3. Windows



6. Architectural Screening









View at Cross Street Below Grade Garage Entrance



Highland Ave MOB / Concept Renderings / 14 July 2023



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Transportation Impact Assessment

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

Prepared for:



Newton Center, Massachusetts

July 2023

Prepared by:



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, P.E., PTOE, FITE
Managing Partner

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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

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

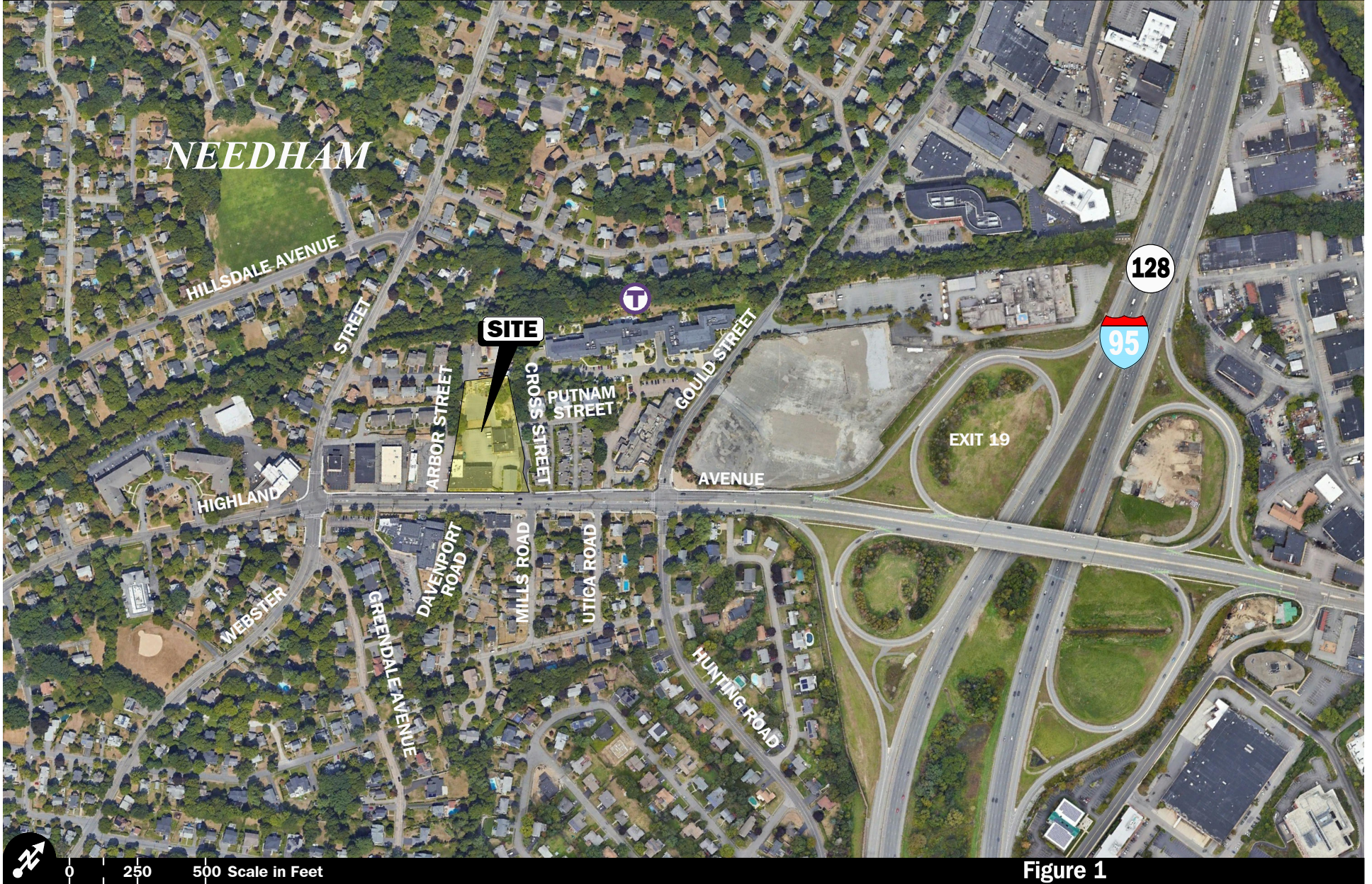


Figure 1

Site Location Map

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.

⁴The 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

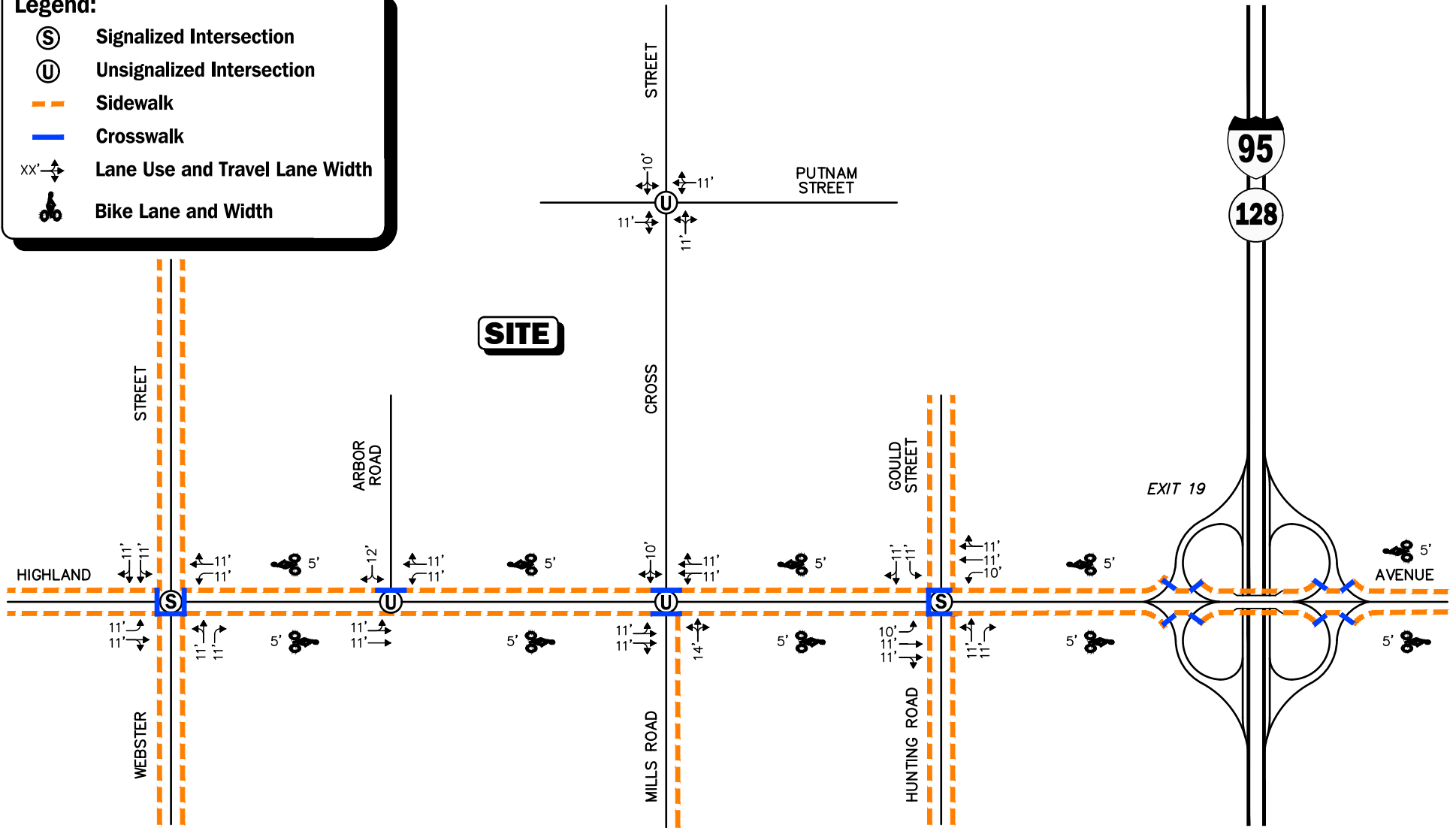
Intersection	Traffic Control Type^a	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
Highland Ave./ Webster St.	TS	1 left-turn lane and 1 through/right-turn lane on Highland Ave.; 1 left-turn/through 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

^aTS = traffic signal control; S = STOP control.

^bCombined shoulder and travel lane width equal to or exceed 14 feet.

Legend:

- Ⓢ Signalized Intersection
- Ⓤ Unsignalized Intersection
- Sidewalk
- Crosswalk
- xx' Lane Use and Travel Lane Width
- 🚲 Bike Lane and Width



Not To Scale

VA Vanasse & Associates inc

Figure 2

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

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.

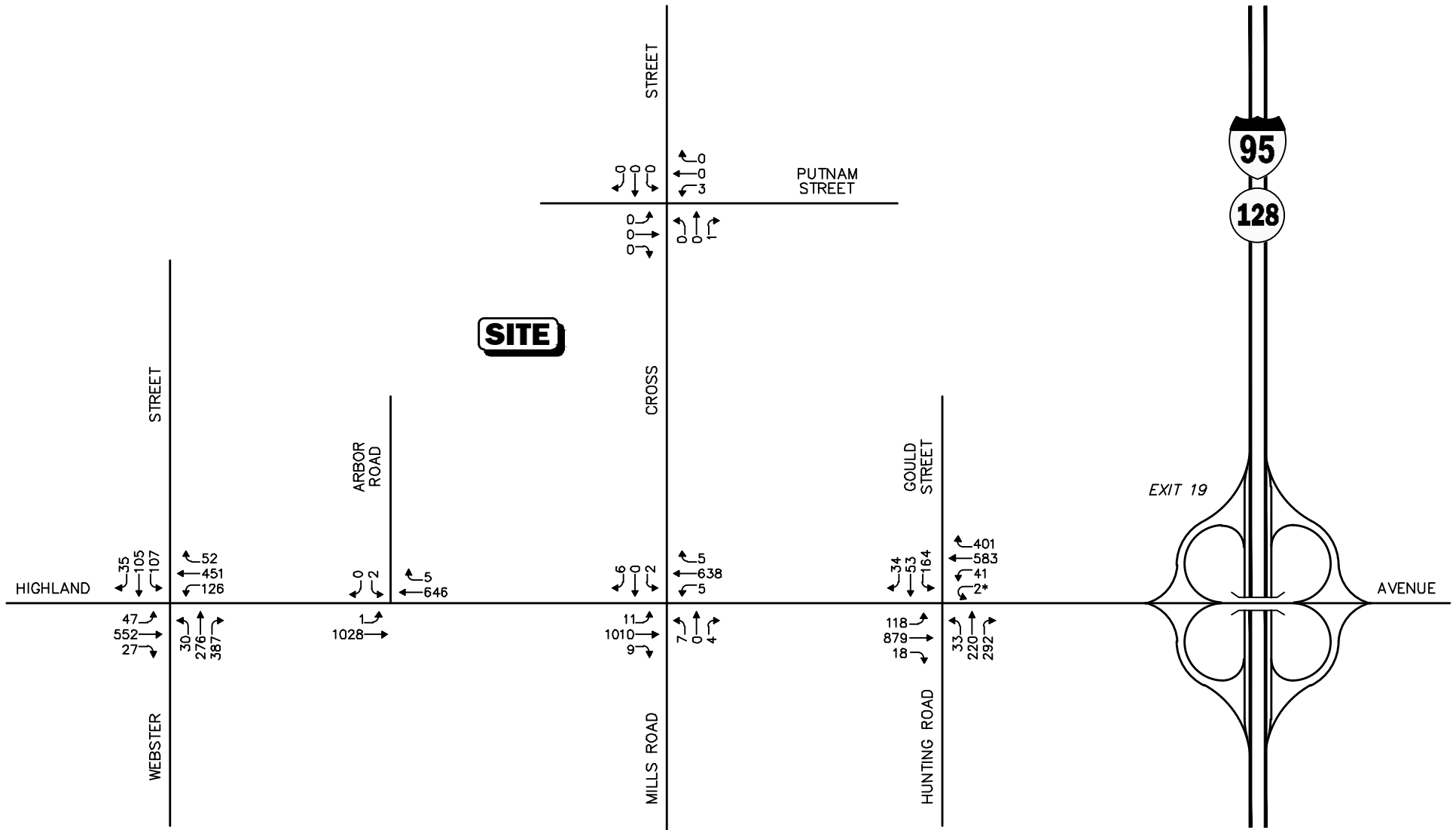
Traffic-Volume Adjustments

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.

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



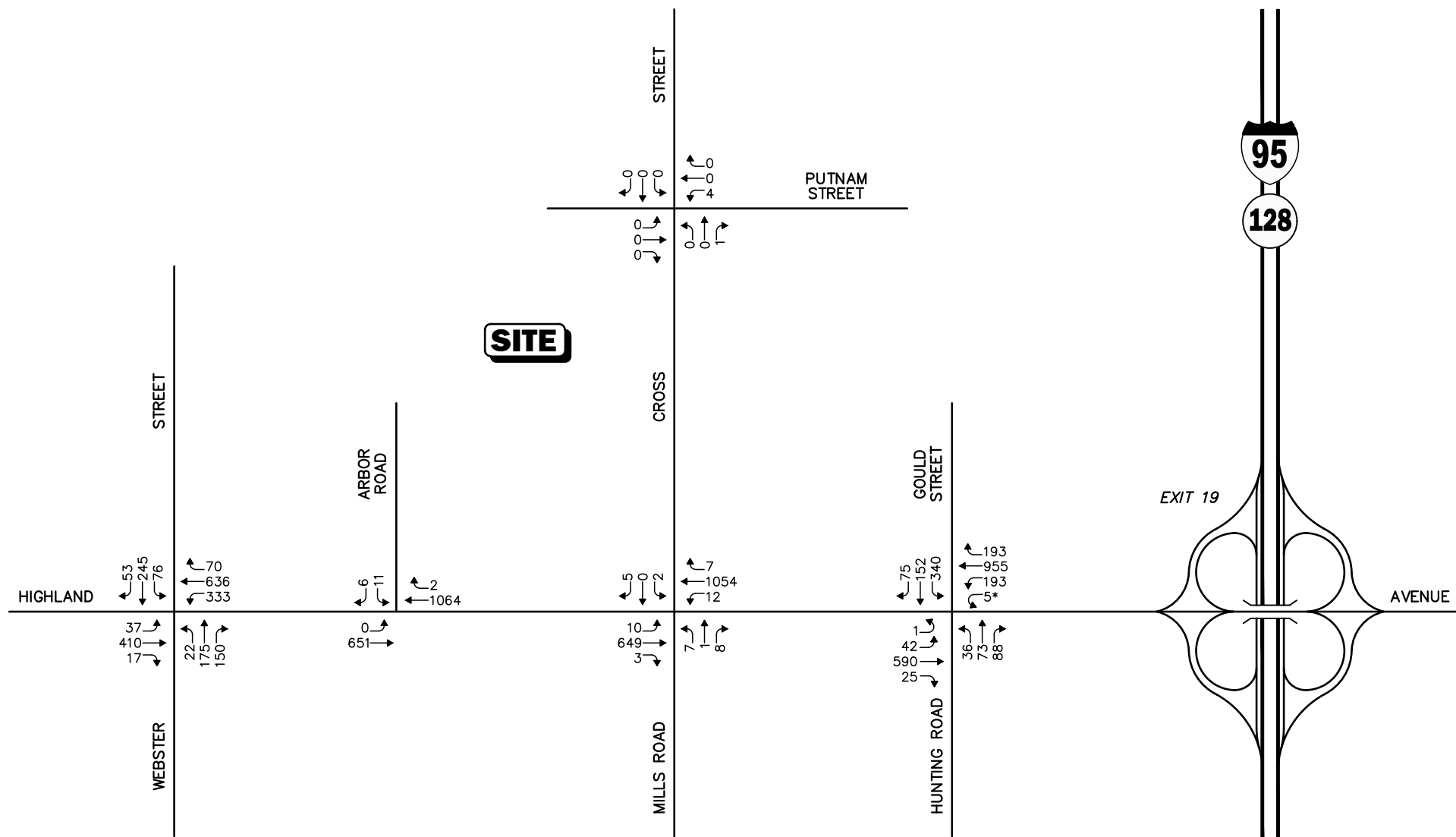
*Illegal maneuver

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



*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



Table 2
2023 EXISTING TRAFFIC VOLUMES

Location/Peak-Hour	AWT ^a	VPH ^b	K Factor ^c	Directional Distribution ^d
<i>Highland Avenue, west of Cross Street</i>	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

^aAverage weekday traffic in vehicles per day.

^bVehicles per hour.

^cPercent of daily traffic occurring during the peak-hour.

^dPercent 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

⁶A 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
85 th 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
<i>Year:</i>					
2016	3	0	1	5	0
2017	0	1	1	3	0
2018	2	0	0	4	0
2019	2	0	1	5	0
<u>2020</u>	<u>3</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>
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
<i>Type:</i>					
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
<u>Unknown/Other</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	10	1	3	19	0
<i>Conditions:</i>					
Clear	6	1	1	14	0
Cloudy	1	0	2	1	0
Rain	3	0	0	4	0
<u>Snow/Ice</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	10	1	3	19	0
<i>Lighting:</i>					
Daylight	8	1	3	12	0
Dawn/Dusk	1	0	0	1	0
Dark (Road Lit)	1	0	0	6	0
<u>Dark (Road Unlit)</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	10	1	3	19	0
<i>Day of Week:</i>					
Monday through Friday	6	1	3	16	0
Saturday	3	0	0	3	0
<u>Sunday</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	10	1	3	19	0
<i>Severity:</i>					
Property Damage Only	7	1	3	13	0
Personal Injury	3	0	0	4	0
Fatality	0	0	0	0	0
<u>Unknown</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>
Total	10	1	3	19	0

^aSource: MassDOT Safety Management/Traffic Operations Unit records, 2016 through 2020.

^bTraffic Control Type: TS = traffic signal control; S = stop control.

^cCrash rate per million vehicles entering the intersection.

^dStatewide/District crash rate.

^eThe 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.

⁷Ibid 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 ITE⁹ 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

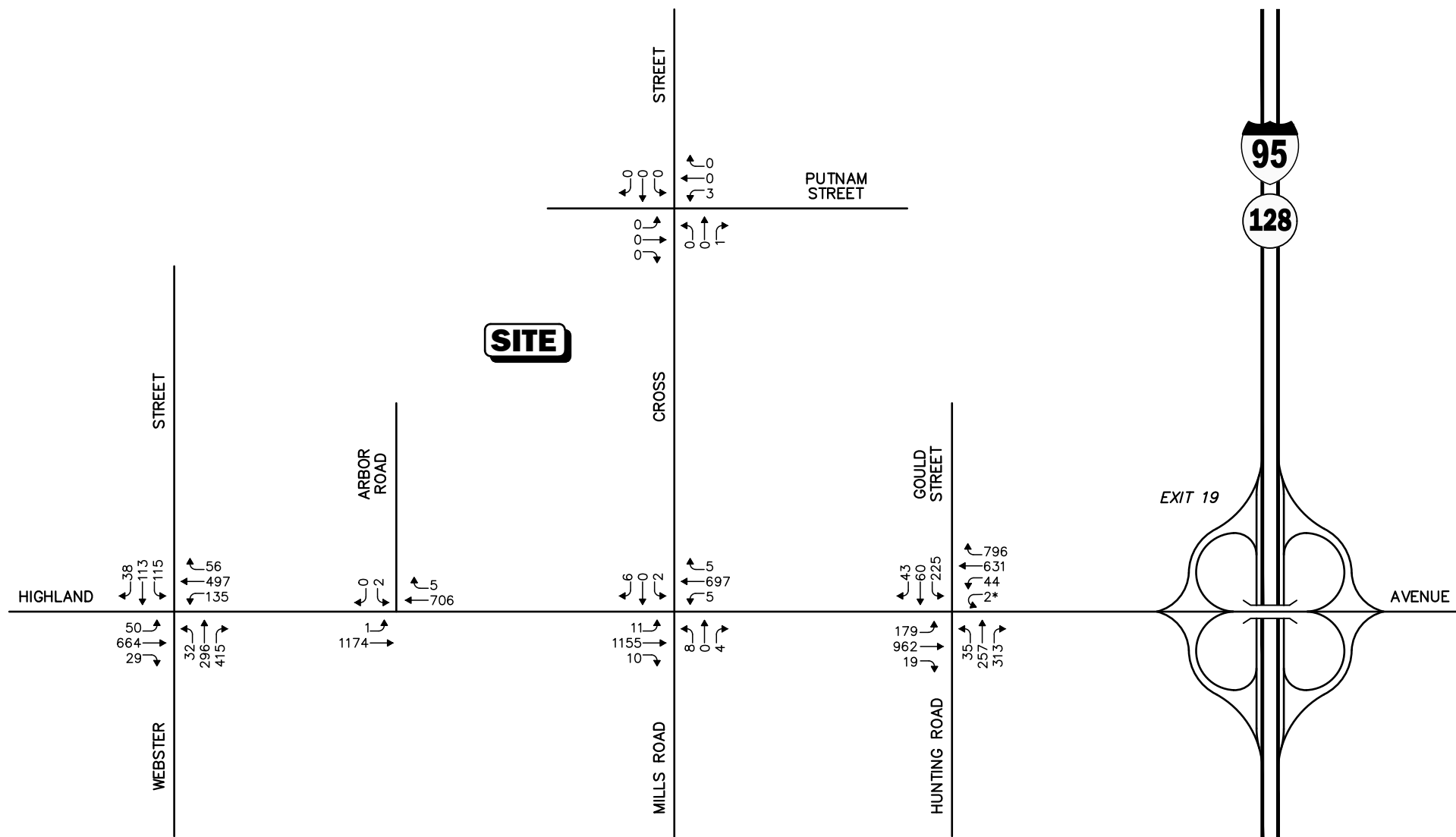
Time Period	Vehicle Trips ^a		
	Entering	Exiting	Total
<i>Average Weekday:</i>	900	900	1,800
<i>Weekday Morning Peak-Hour:</i>	102	27	129
<i>Weekday Evening Peak-Hour:</i>	60	140	200

^aBased 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.

⁹Ibid 1.



*Illegal maneuver

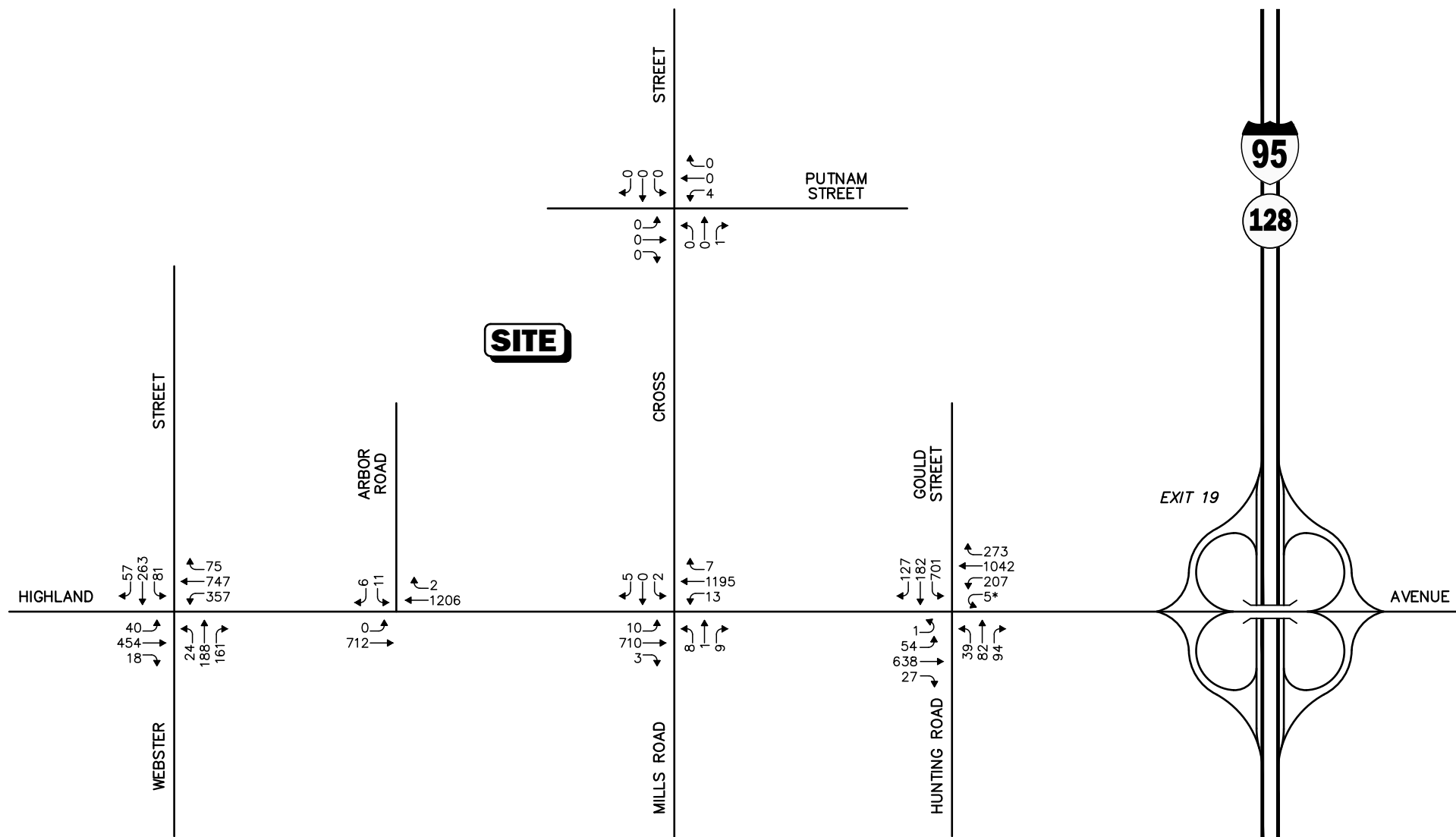
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 5

2030 No-Build
Weekday Morning
Peak Hour Traffic Volumes





*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



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

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

^aSee Table 5.

^bBased on ITE LUCs 110, *General Light Industrial*; 150, *Warehouse*; 495, *Recreational Community Center*; 710, *General Office Building*; and 720, *Medical-Dental Office Building*.

^cAs 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.

Legend:

XX Entering Trips
(XX) Exiting Trips

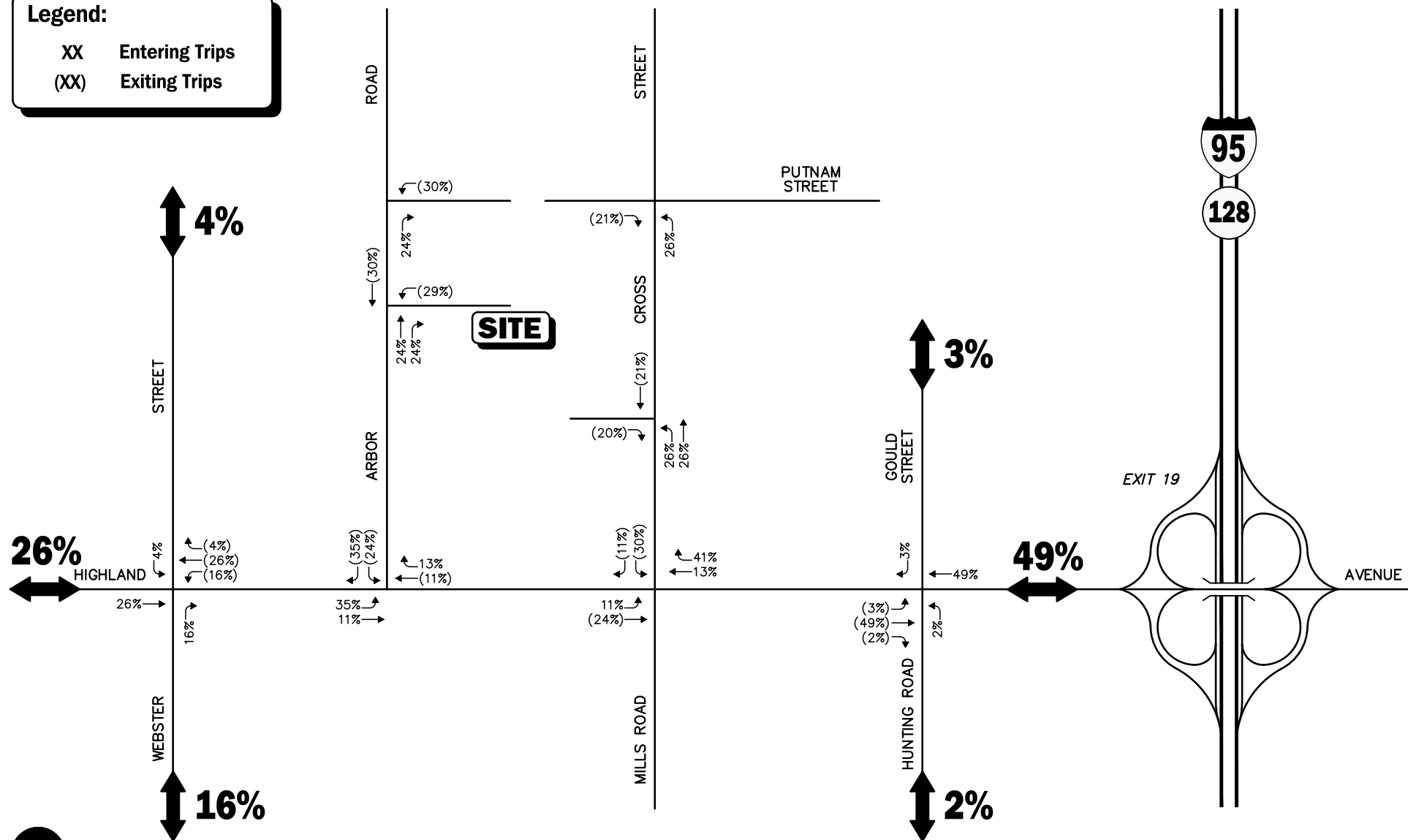
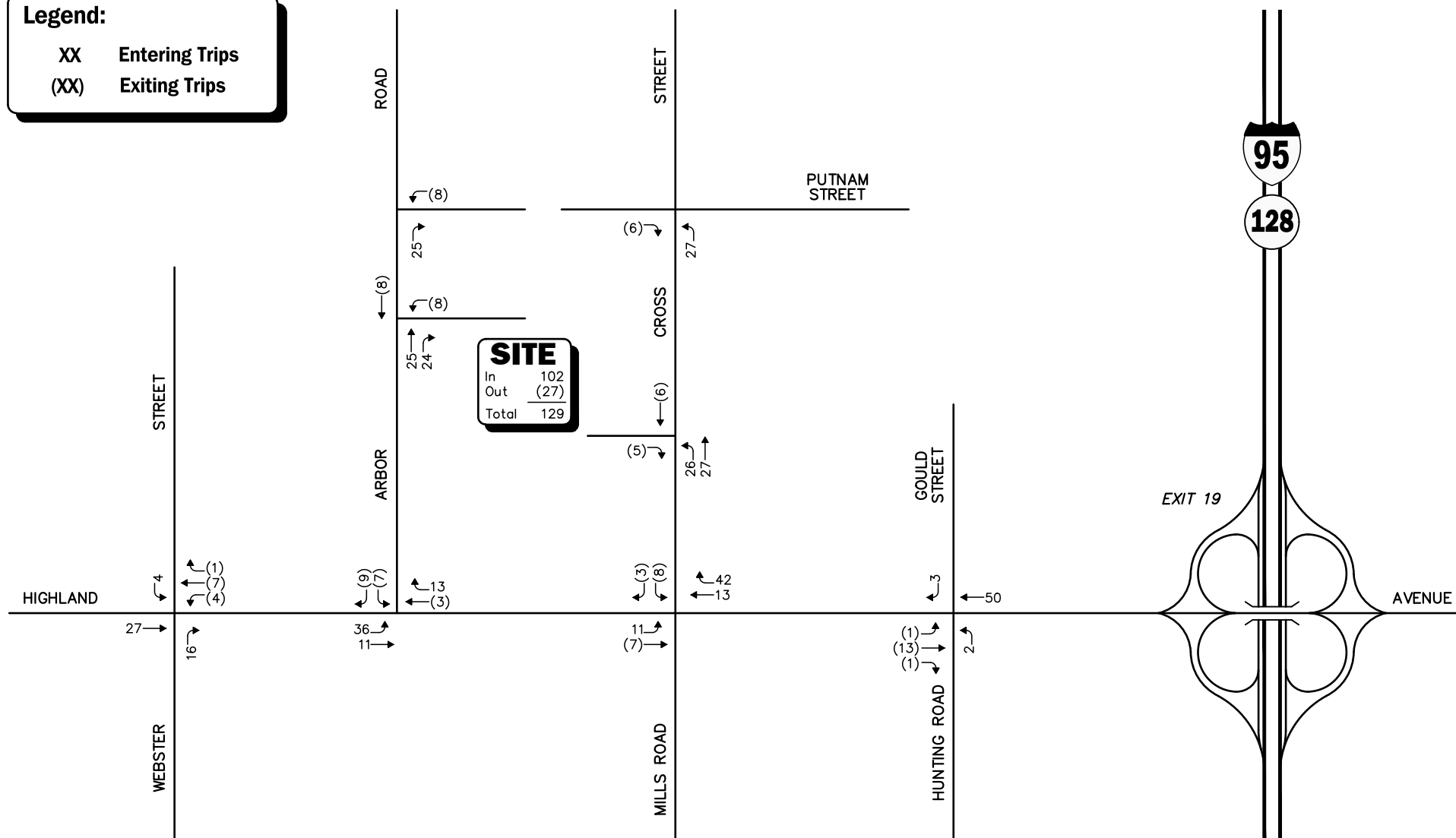


Figure 7

Trip Distribution Map

Legend:

XX Entering Trips
(XX) Exiting Trips



Not To Scale

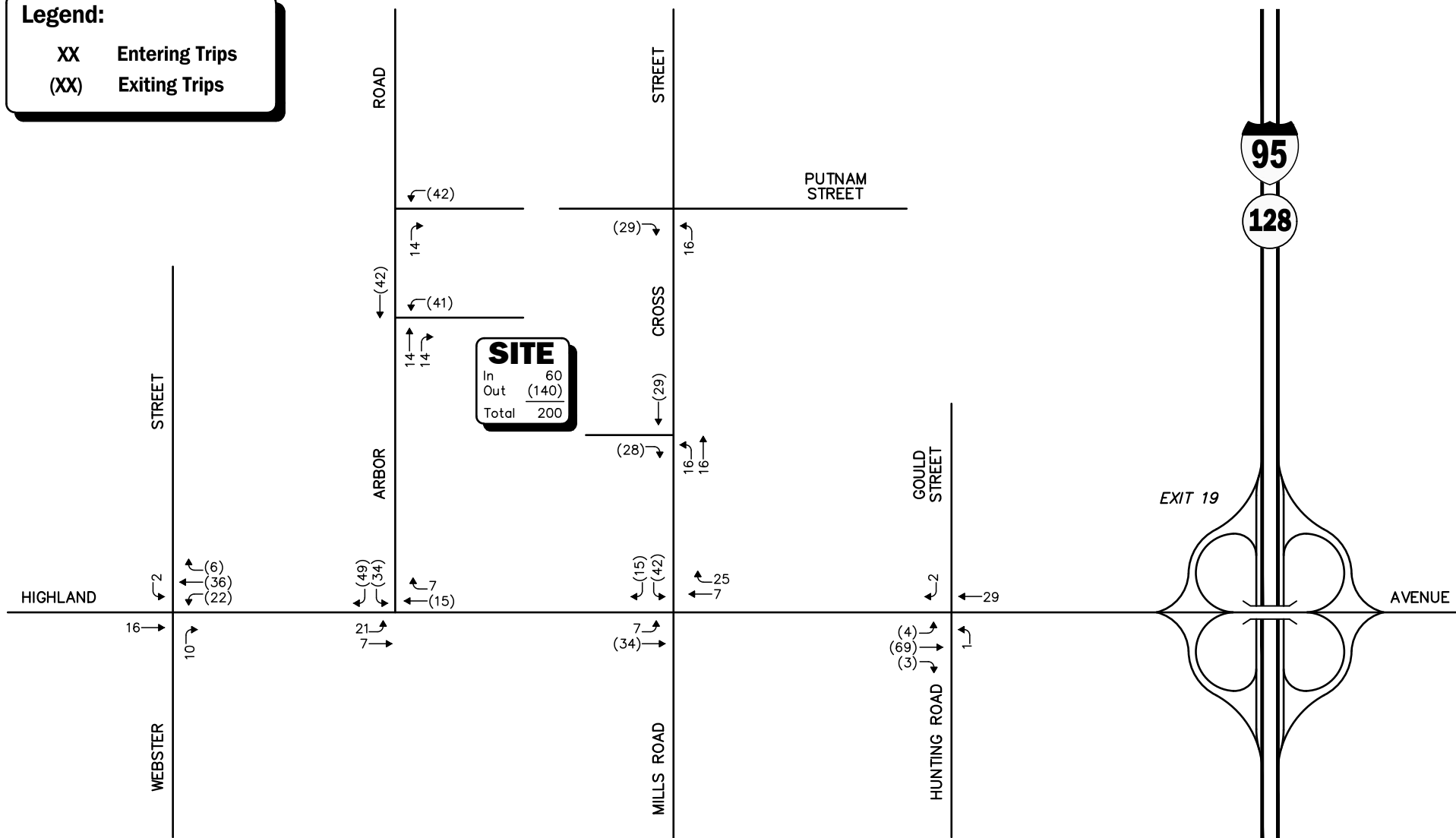
VA Vanasse & Associates inc

Figure 8

**Project Generated
Weekday Morning
Peak Hour Traffic Volumes**

Legend:

XX Entering Trips
(XX) Exiting Trips



Not To Scale

VAI Vanasse & Associates inc

Figure 9

**Project Generated
Weekday Evening
Peak Hour Traffic Volumes**

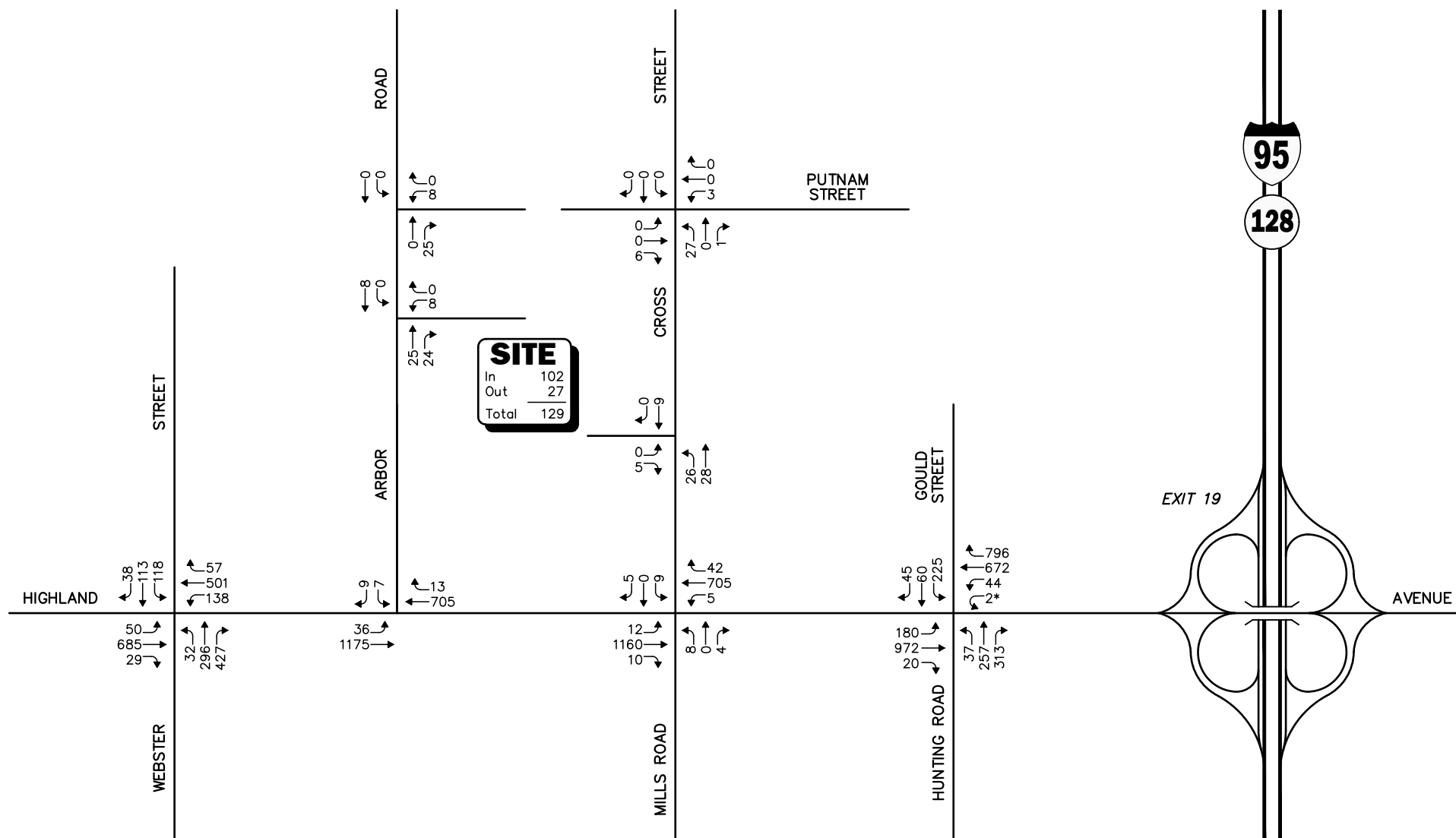


Figure 10

2030 Build
Weekday Morning
Peak Hour Traffic Volumes

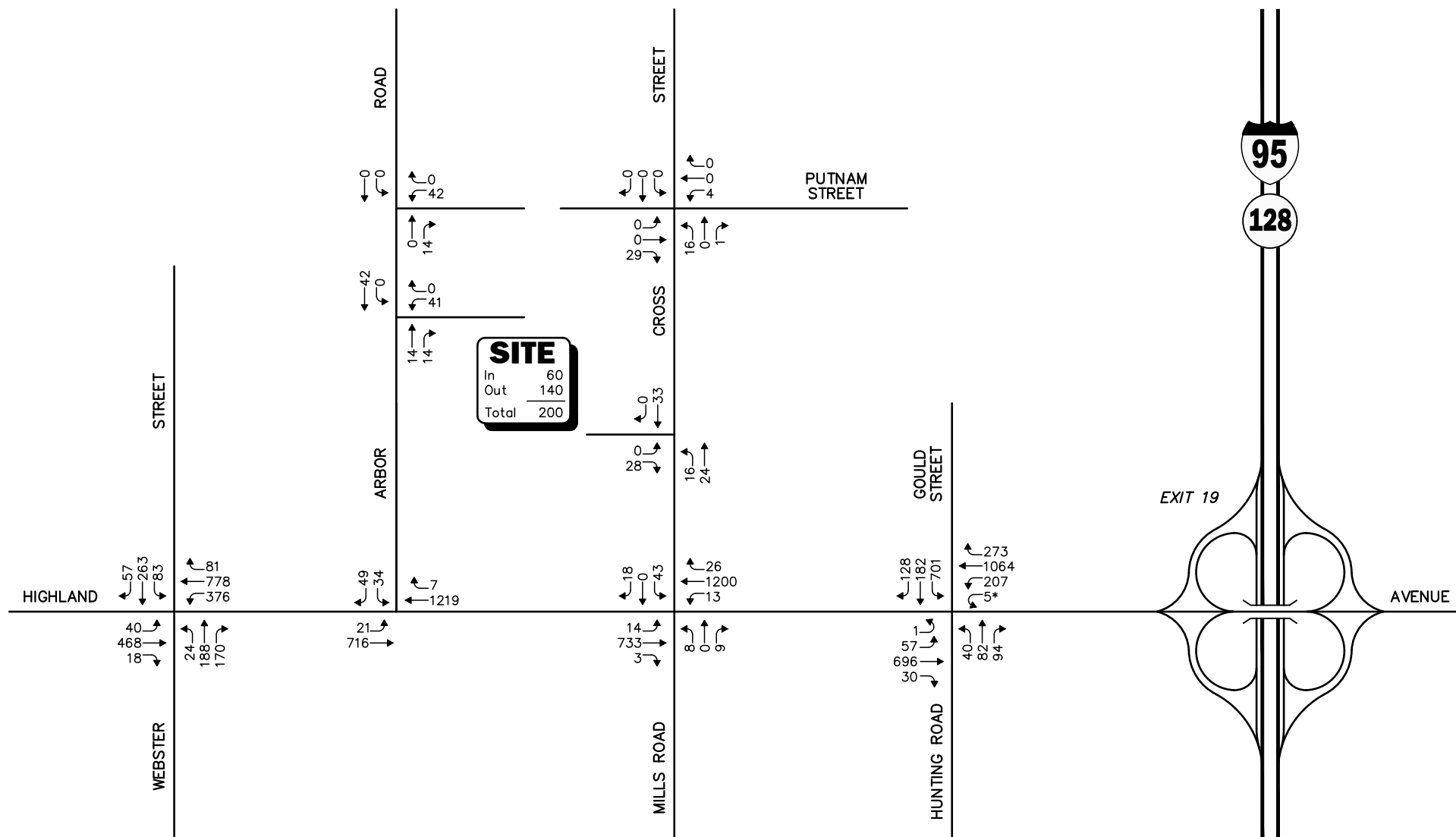


Figure 11

2030 Build
Weekday Evening
Peak Hour Traffic Volumes

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
<i>Highland Ave., west of Webster St.:</i>					
Weekday Morning	1,142	1,310	1,335	25	1.9
Weekday Evening	1,175	1,340	1,385	45	3.4
<i>Highland Ave., east of Gould St.:</i>					
Weekday Morning	2,364	2,975	3,026	51	1.7
Weekday Evening	2,369	2,965	3,045	80	2.7
<i>Webster St., north of Highland Ave.:</i>					
Weekday Morning	622	668	672	4	0.6
Weekday Evening	656	704	712	8	1.1
<i>Webster St., south of Highland Ave.:</i>					
Weekday Morning	953	1,020	1,035	15	1.5
Weekday Evening	942	1,011	1,039	28	2.8
<i>Mills Rd., south of Highland Ave.:</i>					
Weekday Morning	25	27	27	0	0.0
Weekday Evening	31	34	33	-1	-2.9
<i>Gould St., north of Highland Ave.:</i>					
Weekday Morning	990	1,560	1,563	3	0.2
Weekday Evening	875	1,419	1,423	4	0.3
<i>Hunting Rd., south of Highland Ave.:</i>					
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.

¹⁰The 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

^aSource: *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 (Seconds Per Vehicle)
$v/c \leq 1.0$	$v/c > 1.0$	
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

^aSource: *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 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
Highland Avenue at Webster Street												
<i>Weekday Morning:</i>												
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	--
<i>Weekday Evening:</i>												
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 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
Highland Avenue at Gould Street and Hunting Road												
<i>Weekday Morning:</i>												
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	--
<i>Weekday Evening:</i>												
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	--

^aVolume-to-capacity ratio.

^bControl (signal) delay per vehicle in seconds.

^cLevel-of-SERVICE.

^dQueue length in vehicles based on 25-feet per vehicle.

^eIllegal 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

Unsignalized Intersection/Peak-hour/Movement	2023 Existing				2030 No-Build				2030 Build			
	Demand ^a	Delay ^b	LOS ^c	Queue ^d 95 th	Demand	Delay	LOS	Queue 95 th	Demand	Delay	LOS	Queue 95 th
Highland Avenue at Arbor Street												
<i>Weekday Morning:</i>												
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
<i>Weekday Evening:</i>												
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												
<i>Weekday Morning:</i>												
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
<i>Weekday Evening:</i>												
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												
<i>Weekday Morning:</i>												
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
<i>Weekday Evening:</i>												
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

Unsignalized Intersection/Peak-hour/Movement	2023 Existing				2030 No-Build				2030 Build			
	Demand ^a	Delay ^b	LOS ^c	Queue ^d 95 th	Demand	Delay	LOS	Queue 95 th	Demand	Delay	LOS	Queue 95 th
<i>Cross Street at the Project Site Driveway</i>												
<i>Weekday Morning:</i>												
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
<i>Weekday Evening:</i>												
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
<i>Arbor Street at the North Project Site Driveway</i>												
<i>Weekday Morning:</i>												
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
<i>Weekday Evening:</i>												
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
<i>Arbor Street at the North Project Site Driveway</i>												
<i>Weekday Morning:</i>												
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
<i>Weekday Evening:</i>												
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

^aDemand in vehicles per hour.

^bAverage control delay per vehicle (in seconds).

^cLevel-of-Service.

^dQueue 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
<i>Arbor Street at the North Project Site Driveway</i>			
<i>Stopping Sight Distance:</i>			
Arbor Street approaching from the north	185	--	227 ^c
Arbor Street approaching from the south	220	--	370 ^d
<i>Intersection Sight Distance:</i>			
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
<i>Arbor Street at the South Project Site Driveway</i>			
<i>Stopping Sight Distance:</i>			
Arbor Street approaching from the north	185	--	277 ^c
Arbor Street approaching from the south	220	--	290 ^d
<i>Intersection Sight Distance:</i>			
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
<i>Cross Street at Putnam Street and the Project Site Driveway^f</i>			
<i>Stopping Sight Distance:</i>			
Cross Street approaching from the south	200	--	335 ^d
<i>Intersection Sight Distance:</i>			
Looking to the south from the Project Site Driveway	200	280	335 ^d
<i>Cross Street at the Project Site Driveway</i>			
<i>Stopping Sight Distance:</i>			
Cross Street approaching from the north	200	--	268 ^g
Cross Street approaching from the south	80	--	80 ^d
<i>Intersection Sight Distance:</i>			
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

^aRecommended 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.

^bValues 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.

^cSight distance available to/from the end of Arbor Street.

^dSight distance available to/from Highland Avenue.

^eWith the selective trimming or removal of the vegetation located along the Project site frontage on Arbor Street.

^fCross Street ends approximately 15 feet north of Putnam Street/the Project site driveway.

^gSight 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

¹⁴Ibid 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.

¹⁵Ibid 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 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
Highland Avenue at Webster Street												
<i>Weekday Morning:</i>												
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	--
<i>Weekday Evening:</i>												
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 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
Highland Avenue at Gould Street and Hunting Road												
<i>Weekday Morning:</i>												
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	--
<i>Weekday Evening:</i>												
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	--

^aVolume-to-capacity ratio.

^bControl (signal) delay per vehicle in seconds.

^cLevel-of-Service.

^dQueue length in vehicles based on 25-feet per vehicle.

^eIllegal 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

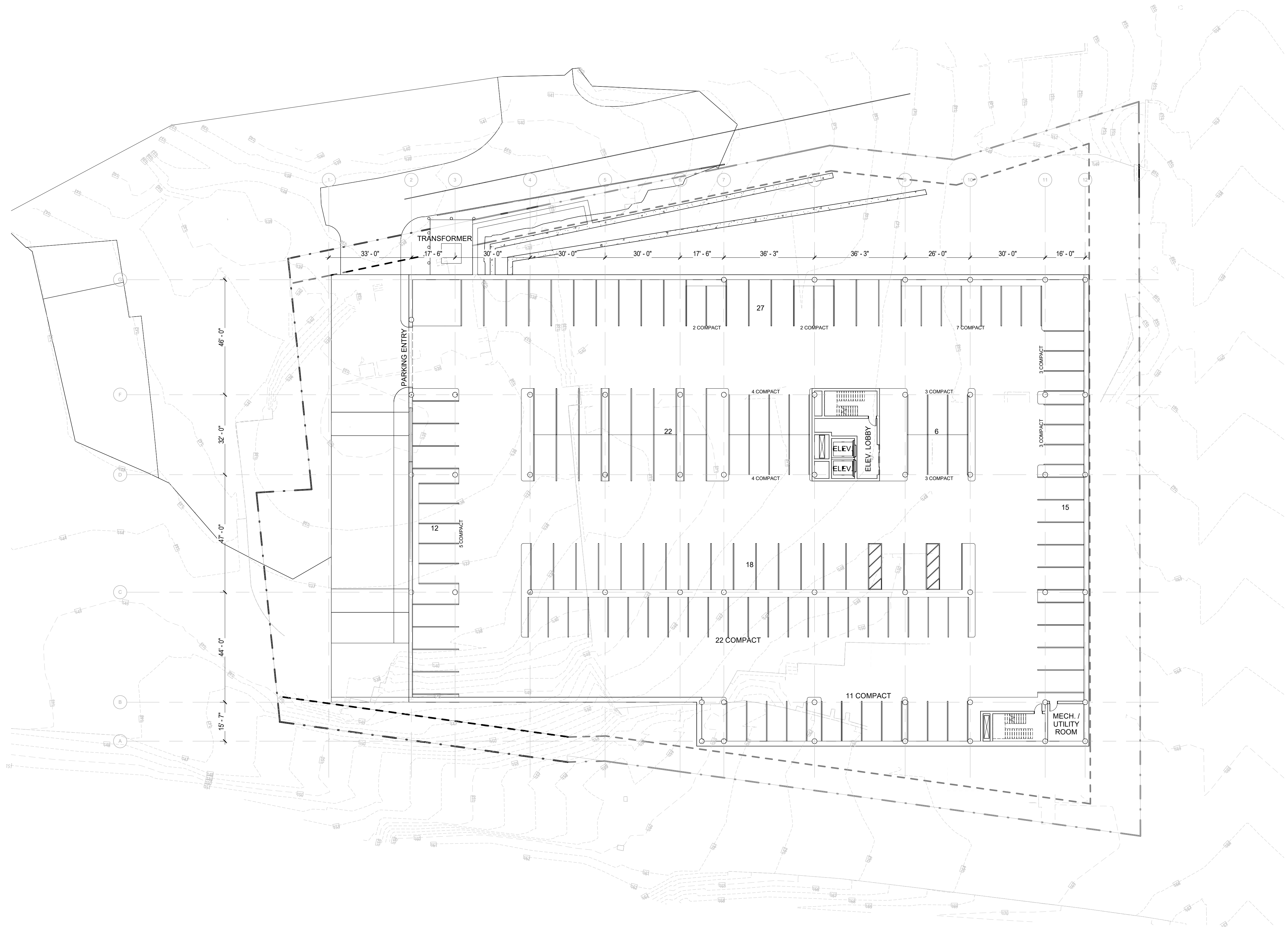
EXISTING TRIP-GENERATION CALCULATIONS

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:

XXXX

Date:

XXXX

Revisions:

Date:

Drawing Title:

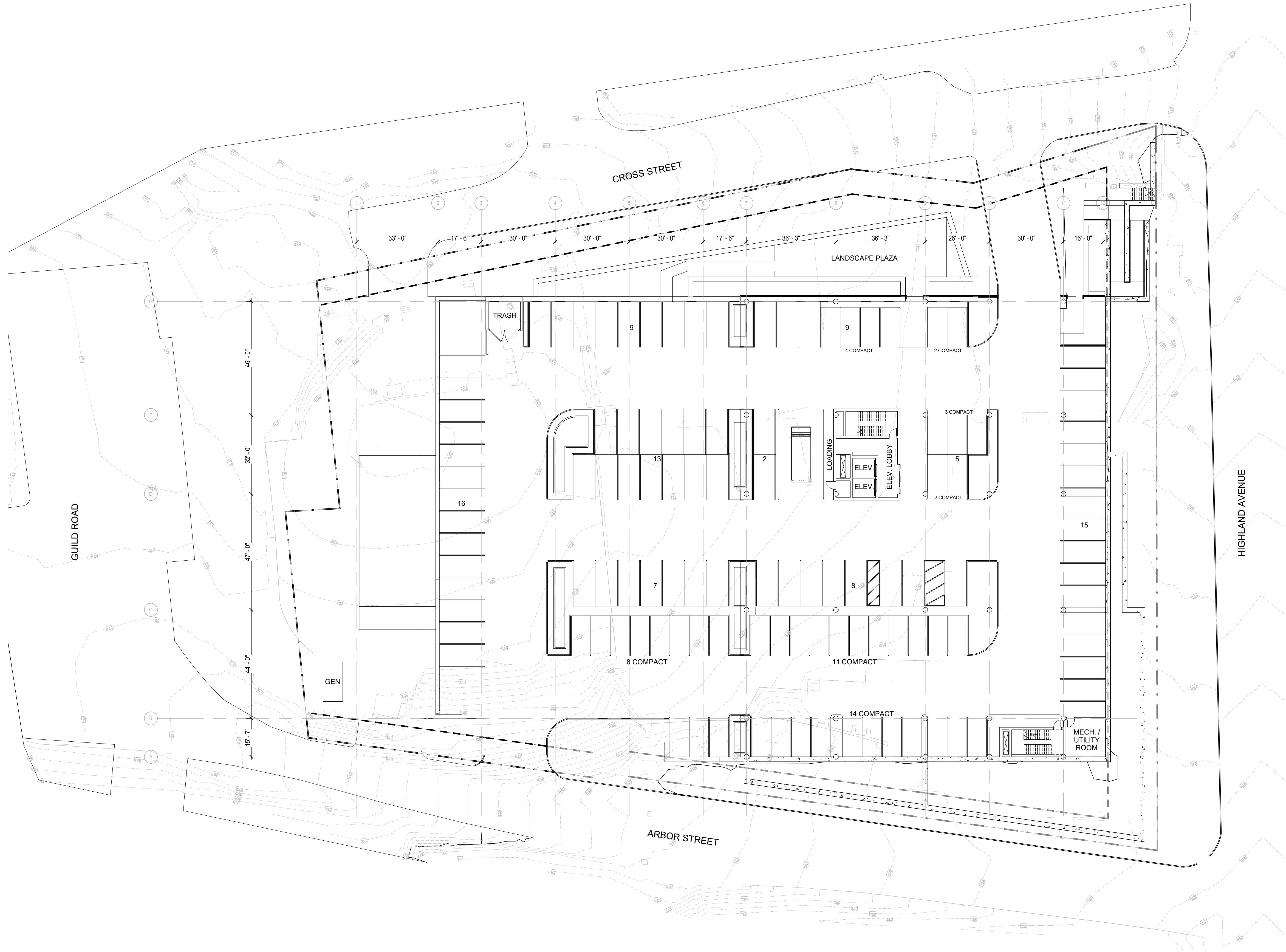
P-1 Parking Plan

Sheet Number:

A.101

MAUGEL ARCHITECTS
200 AYER ROAD / SUITE 200
HAVERHILL, MA 01831
978.456.2800
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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
	EXTERIOR 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 WALLS ARE DIMENSIONED TO THE CENTERLINE.	
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, JIC INDUSTRIES COSMIX 5X
FE-2	RECESSED FIRE EXTINGUISHER, 1-1/2" TRIM, JIC 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:

XXXX

Date:

XXXX

Revisions:

Date:

Drawing Title:

First Floor Plan

Sheet Number:

A.102

MAUGEL ARCHITECTS
200 AYER ROAD / SUITE 200
HAUOVER, MA 01831
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AUTOMATIC TRAFFIC RECORDER COUNT DATA



Accurate Counts
978-664-2565

Page 1

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

8315VOL1

Start Time	9/4/2019 Wed	EB		Hour Totals		WB		Hour Totals		Combined Totals	
		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		Hour Totals		WB		Hour Totals		Combined Totals	
		Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	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								

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

8315VOL1

Start Time	9/2/2019		Tue		Wed		Thu		Fri		Sat		Sun		Week Average	
	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
Location : West of Cross Street
City/State: Needham, MA

83150001

3/28/2023	EB		Hour Totals		WB		Hour Totals		Combined Totals	
Time	Morning	Afternoon	Morning	Afternoon	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	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	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	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	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	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	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	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	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	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	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	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	498	51	130	5	524	54	1022	105
Total		3032		4759		3057		5556		
Percent		38.9%		61.1%		35.5%		64.5%		
									6089	10315
									37.1%	62.9%

Accurate Counts
978-664-2565

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

83150001

3/29/2023		EB		Hour Totals		WB		Hour Totals		Combined Totals	
Time	Morning	Afternoon		Morning	Afternoon	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

83150001

Location : Highland Avenue
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
Page No : 1

Groups Printed- Cars - Trucks

	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Int. Total
07:00 AM	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

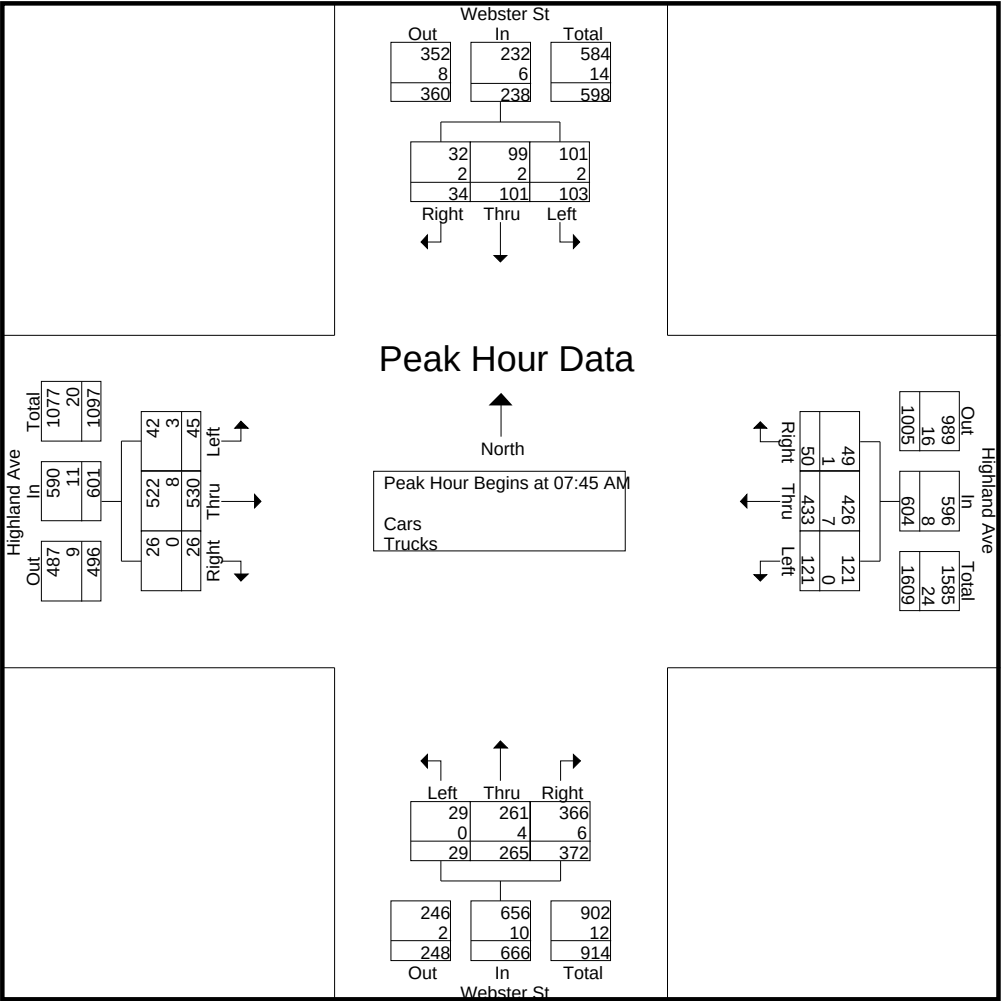
File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 2

	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



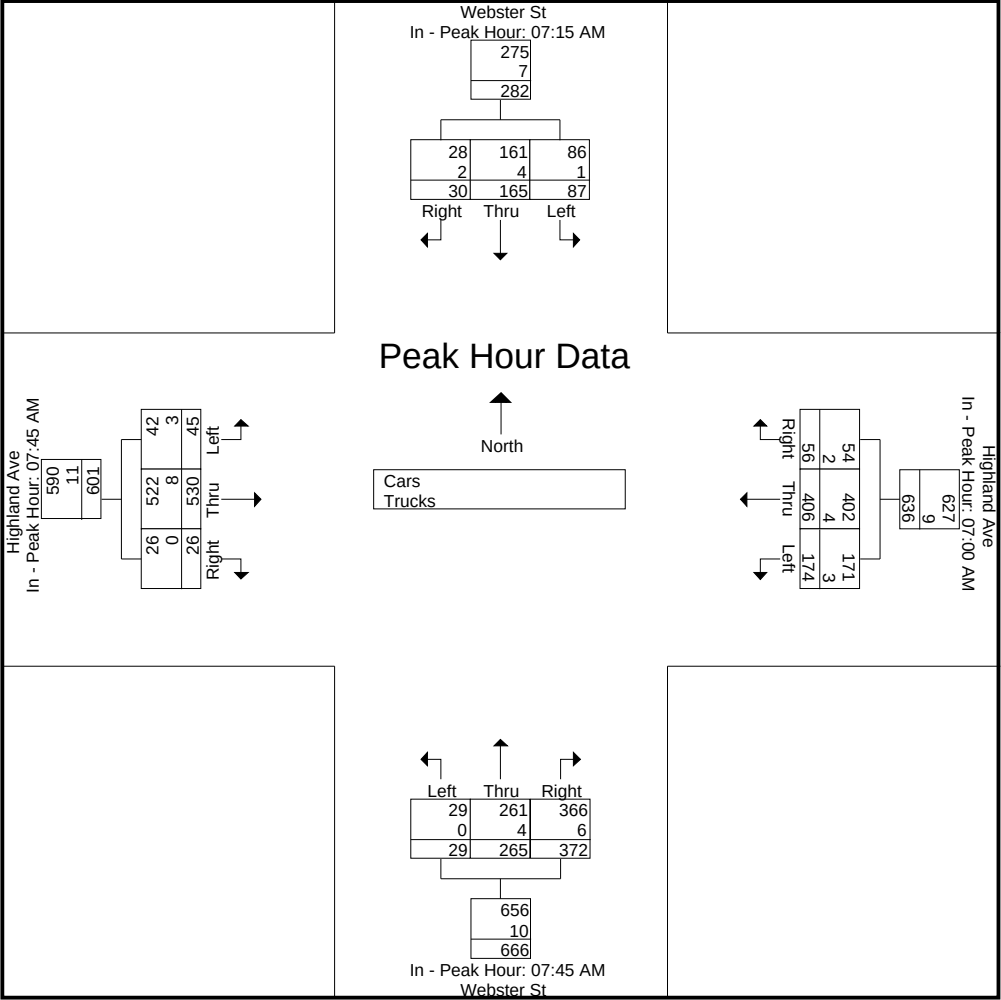
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 5

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

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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 6

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

	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

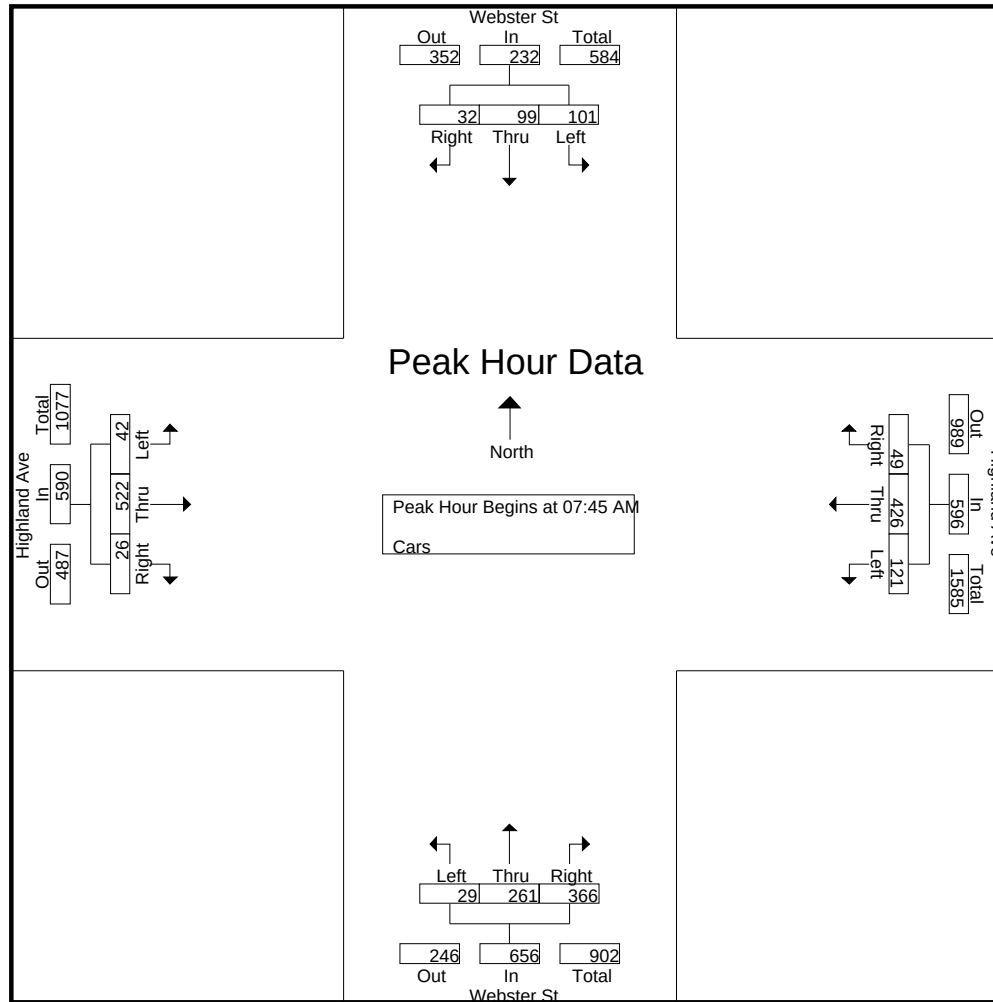
File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 7

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



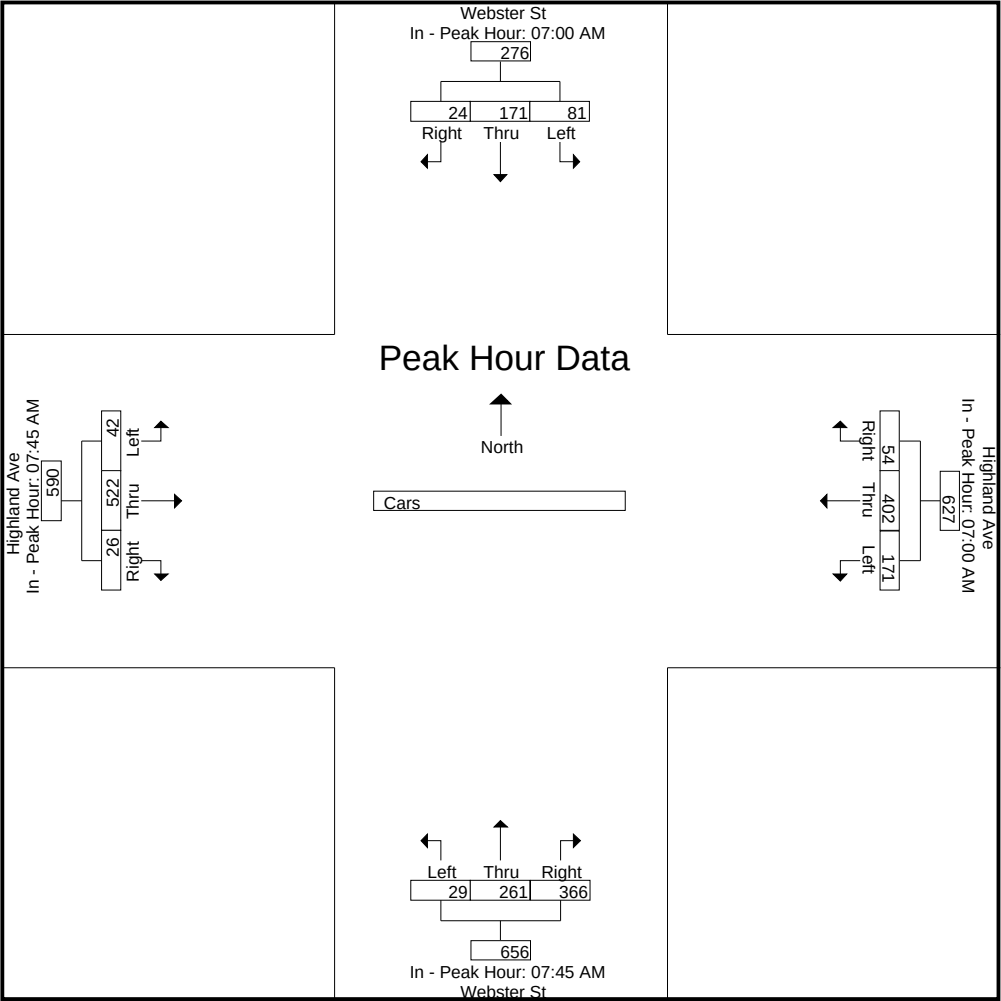
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 9

N/S Street : Webster Street

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

Groups Printed- Trucks

Start Time	Webster St From North			Highland Ave From East			Webster St From South			Highland Ave From West			Int. Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 10

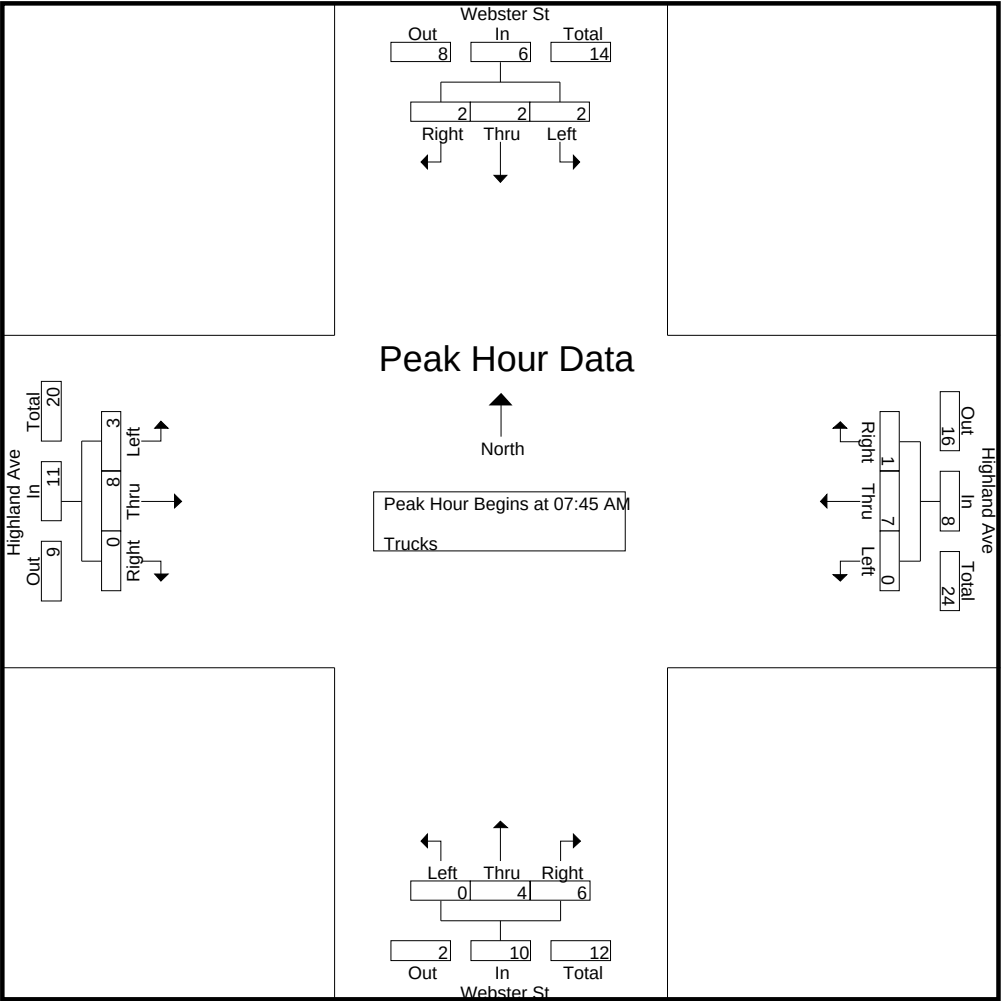
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



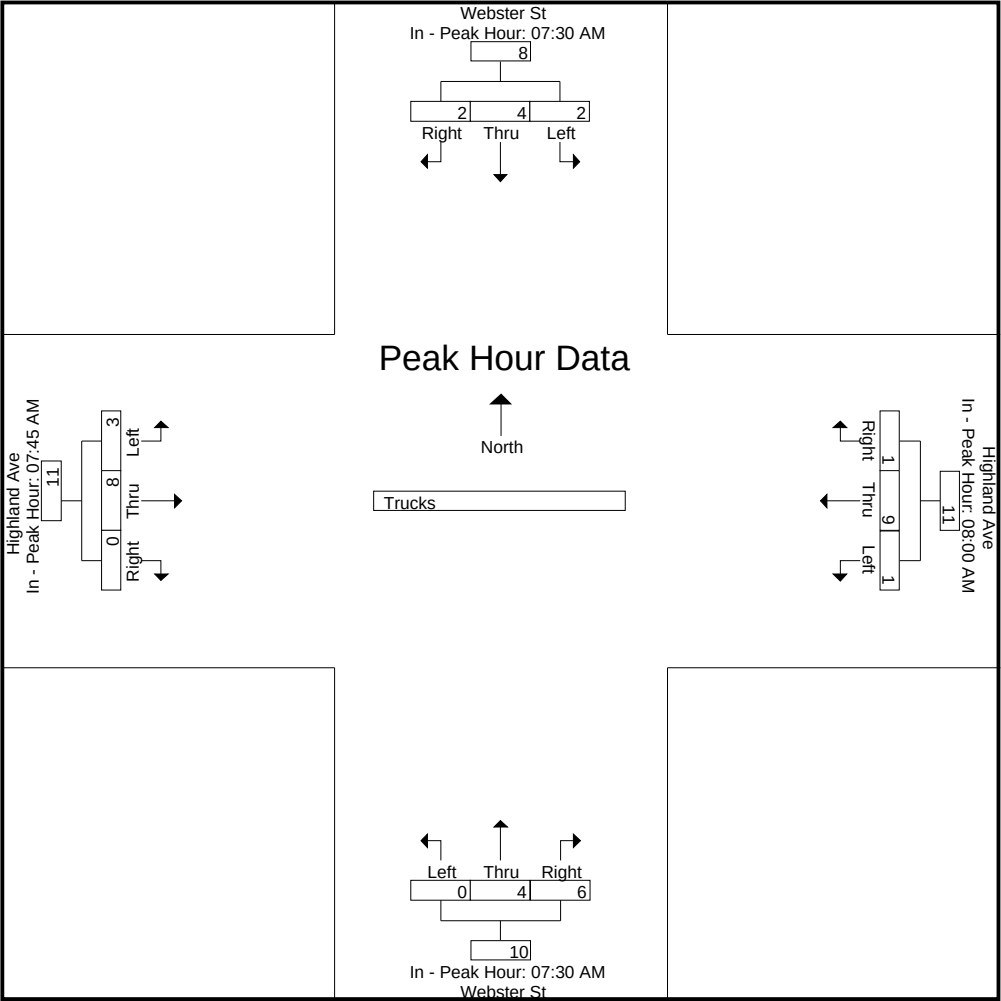
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 13

N/S Street : Webster Street

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

Groups Printed- Bikes Peds

Start Time	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds			
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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 14

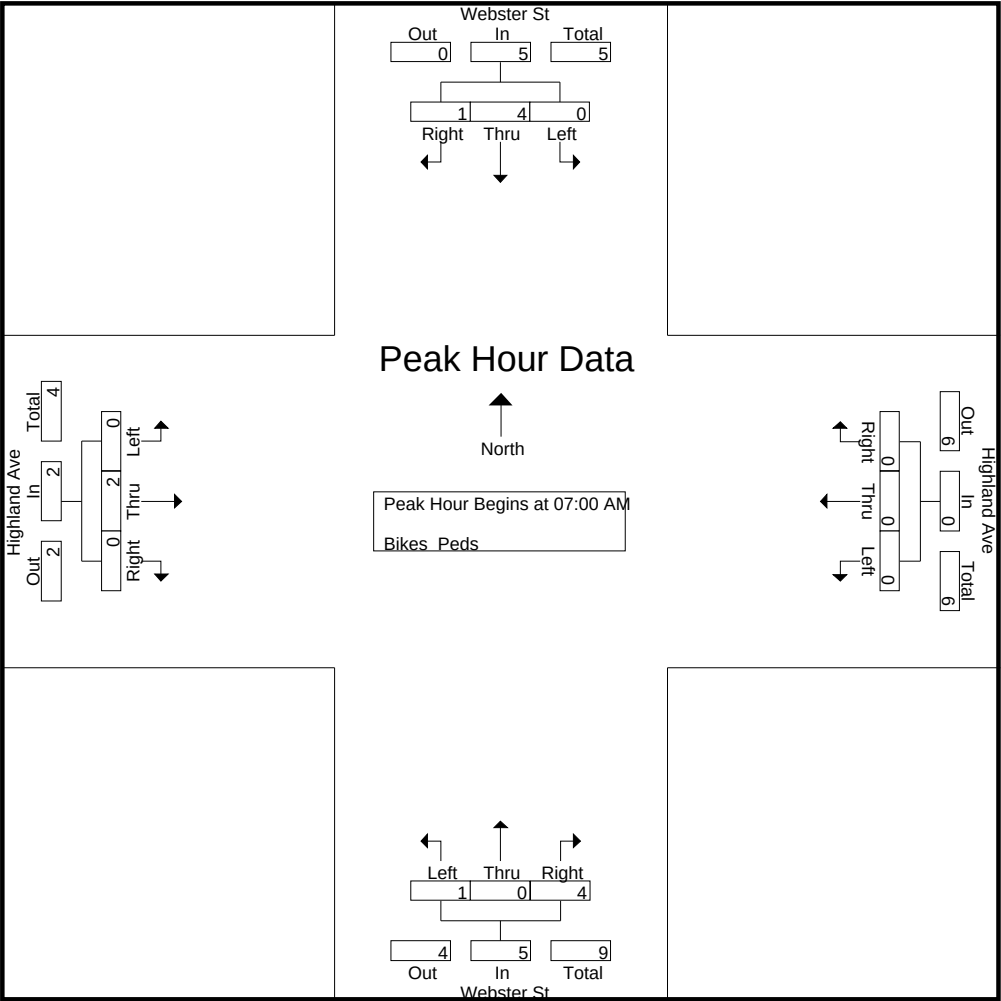
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



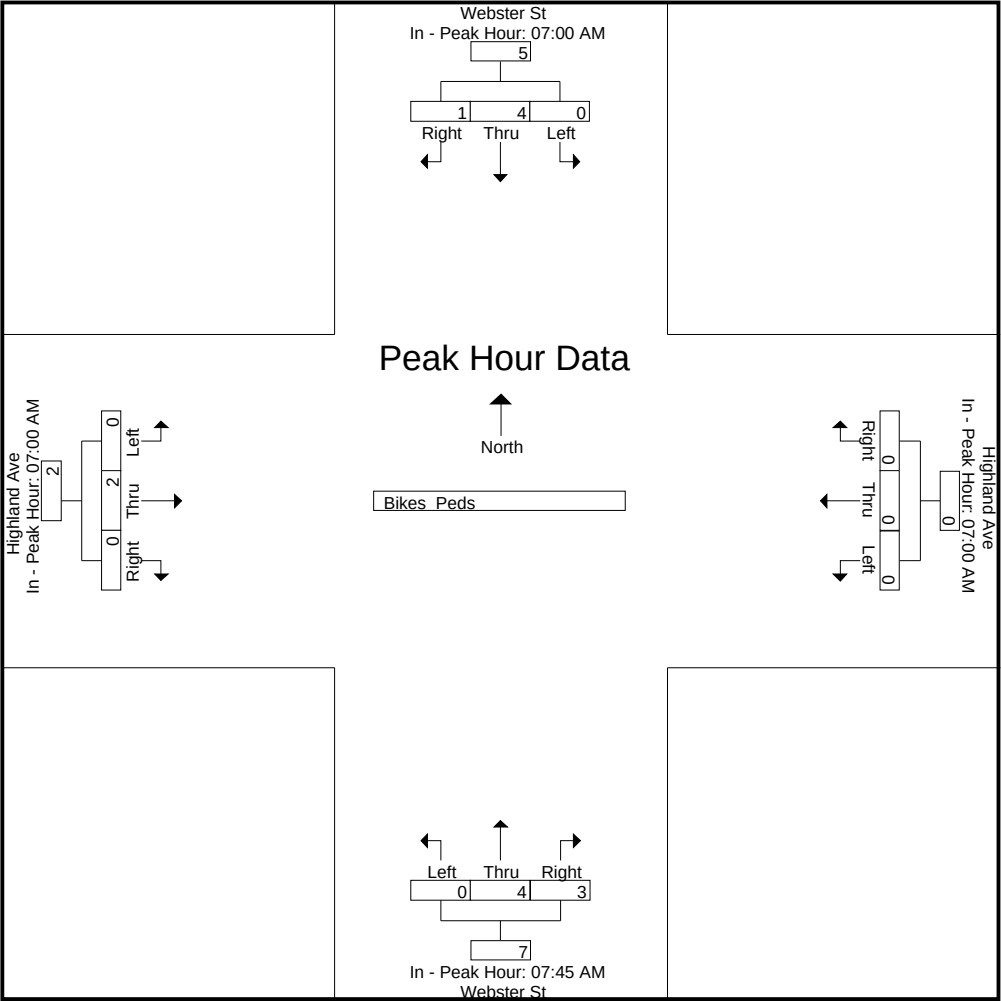
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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
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	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

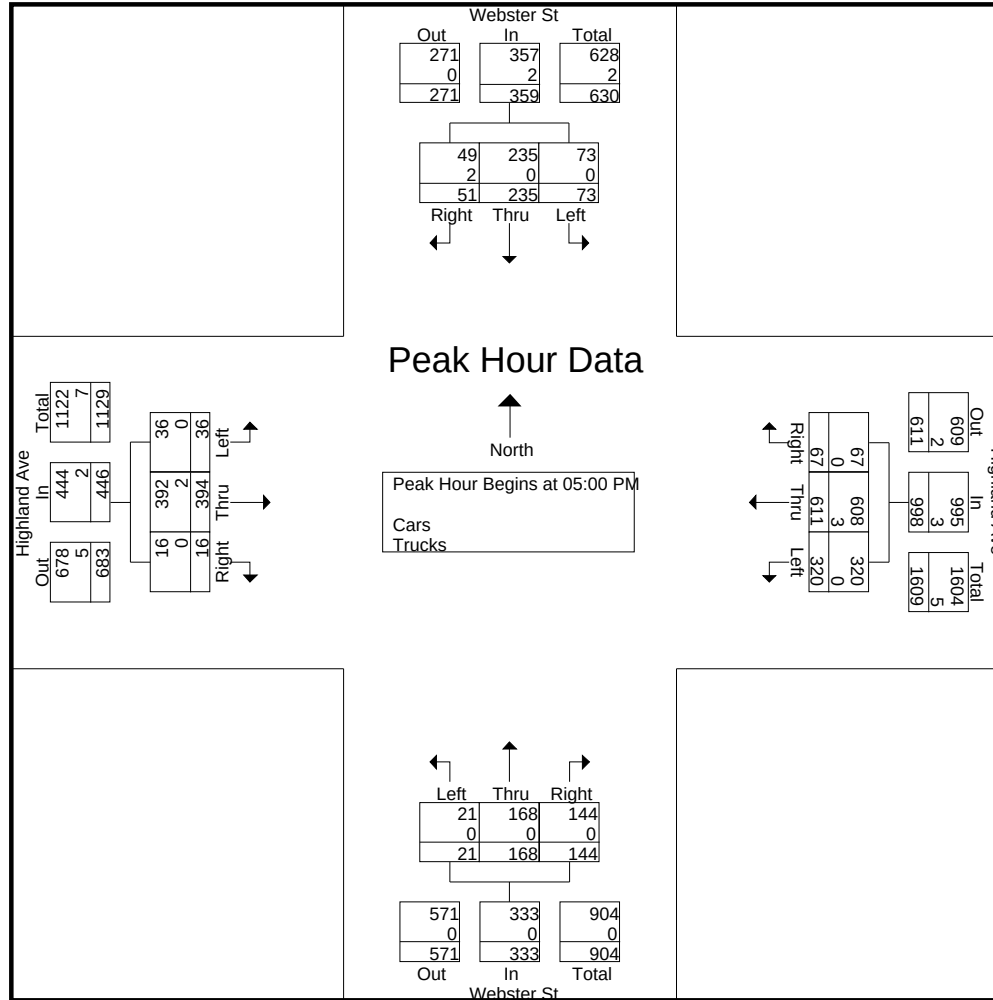
File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

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



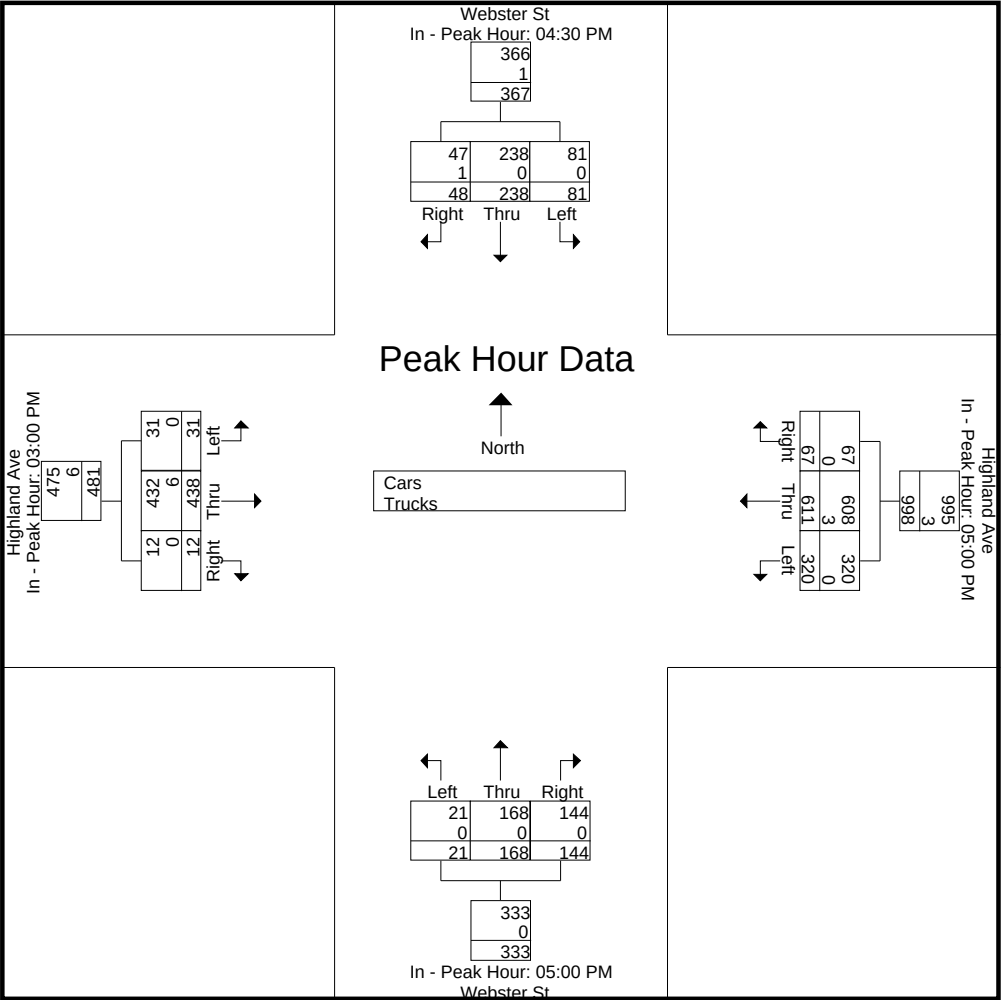
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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
Page No : 5

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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

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

	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

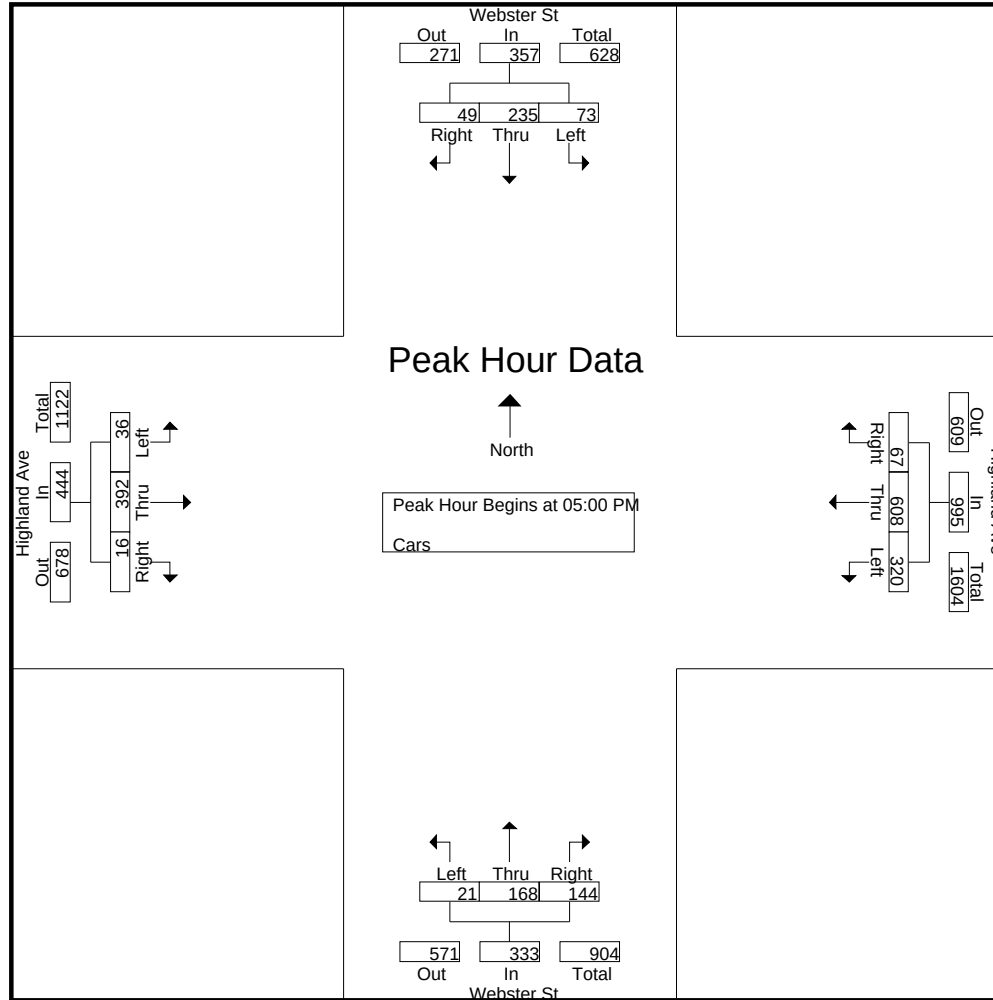
File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

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



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

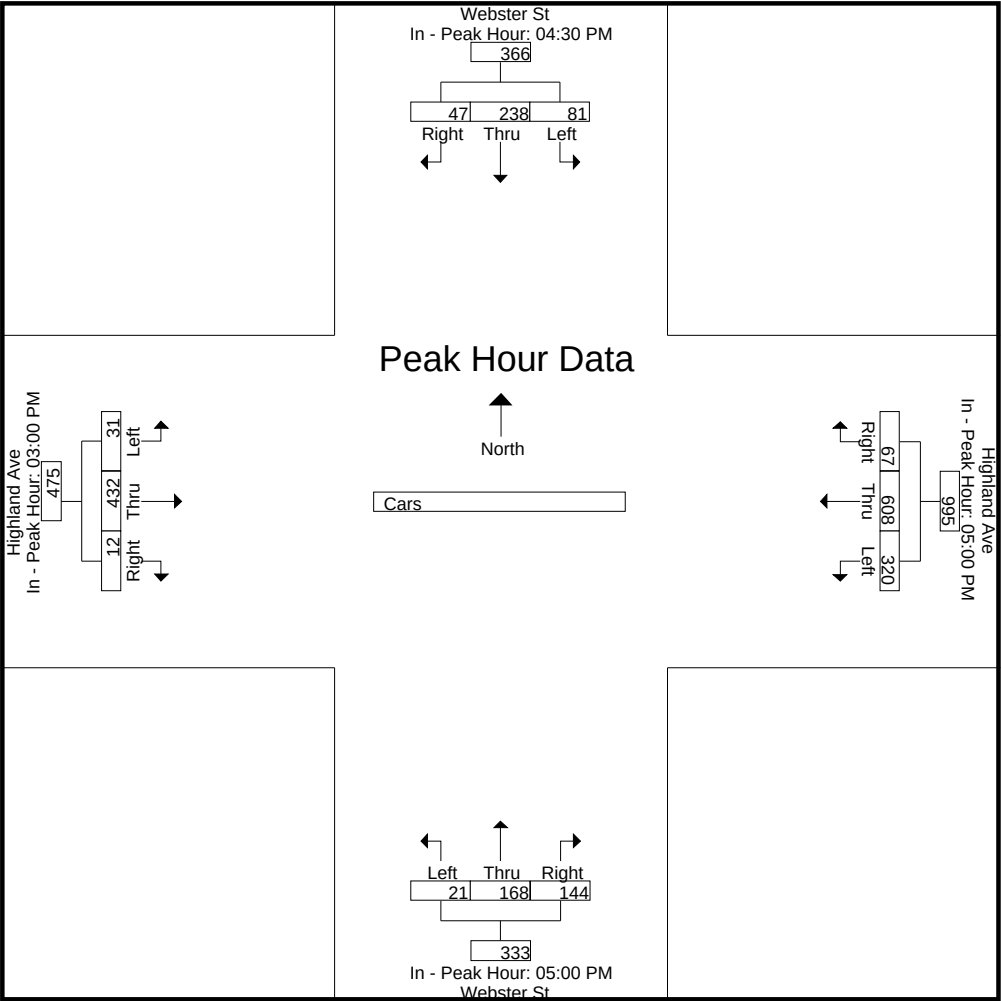
Peak Hour for Each Approach Begins at:

	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
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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 : 9

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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 10

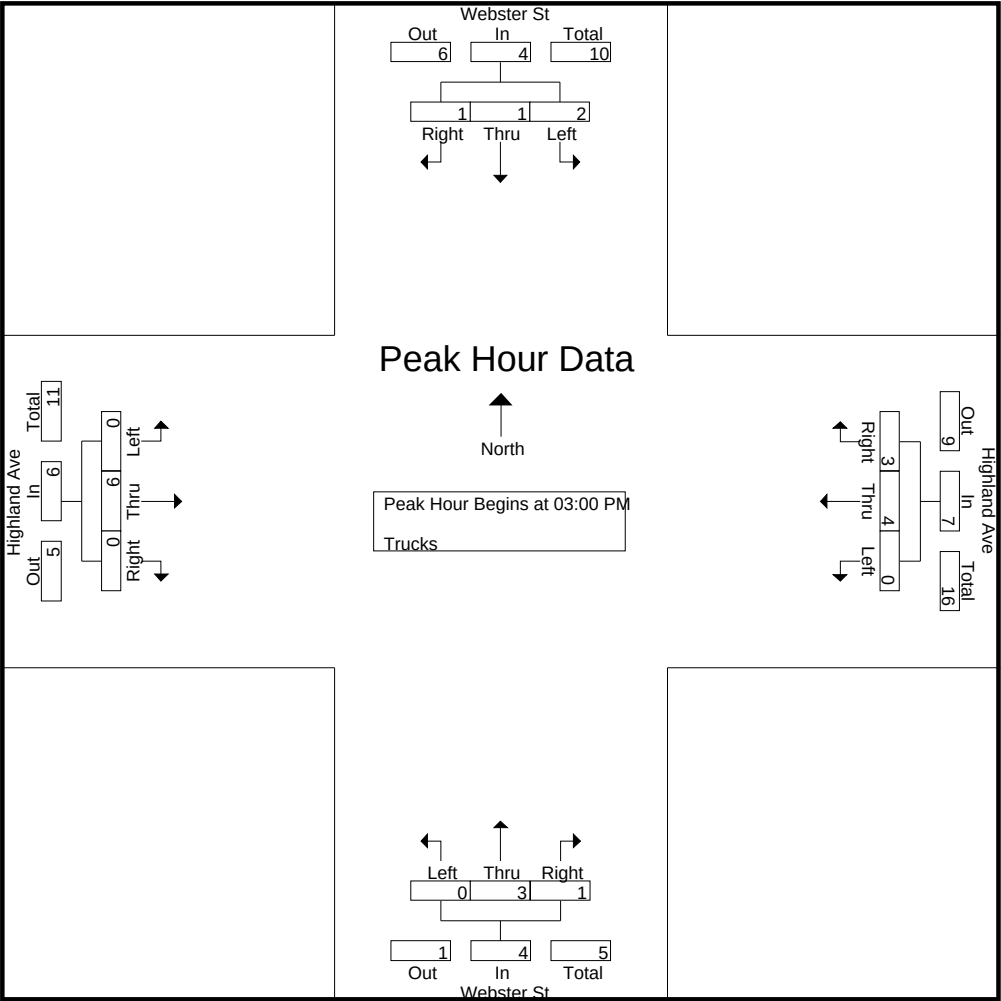
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



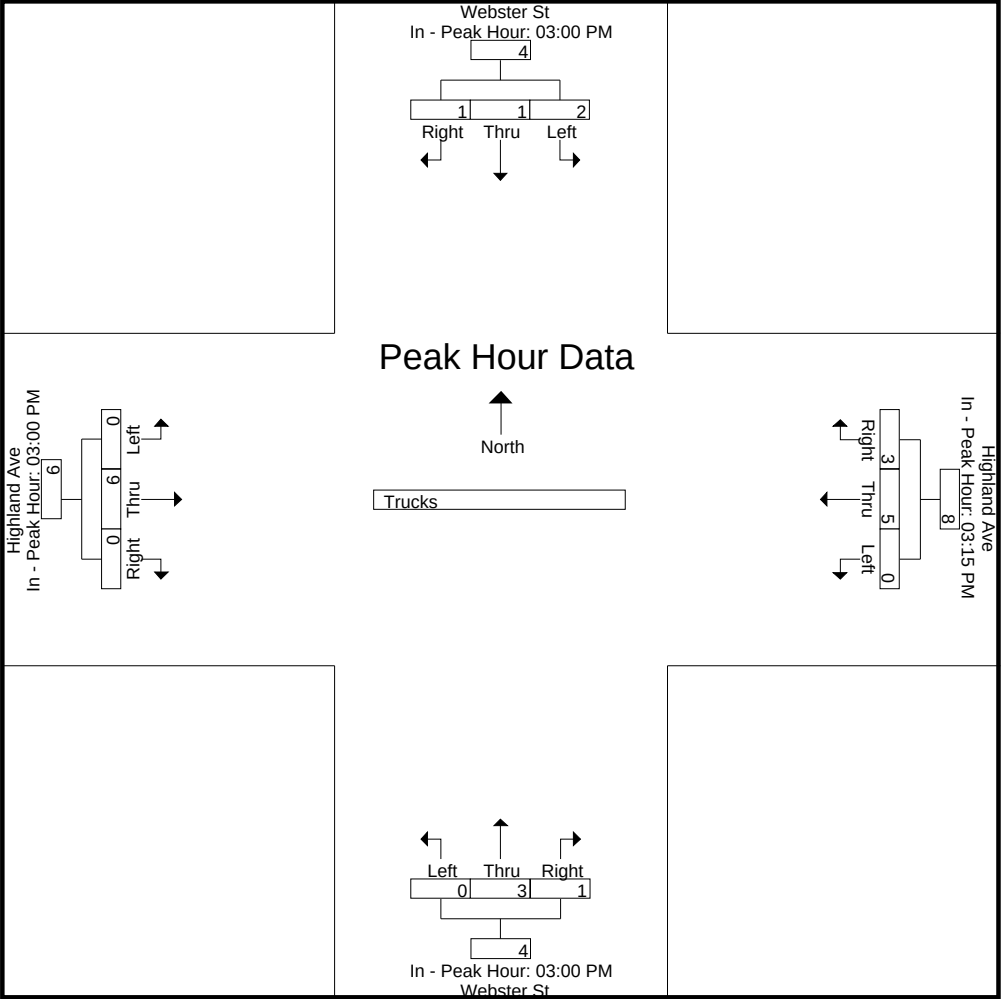
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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
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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 : 13

Groups Printed- Bikes Peds

	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				Exclu. Total	Inclu. Total	Int. Total
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds			
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

File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 14

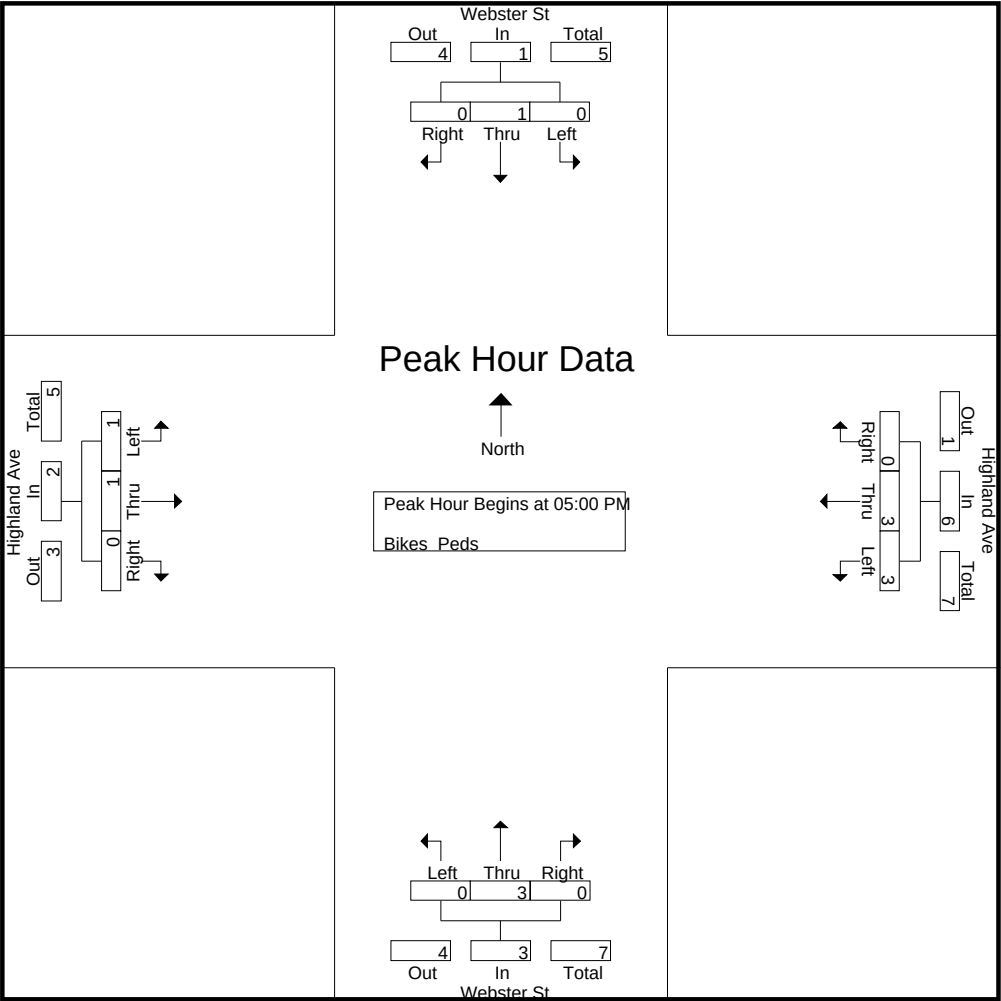
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



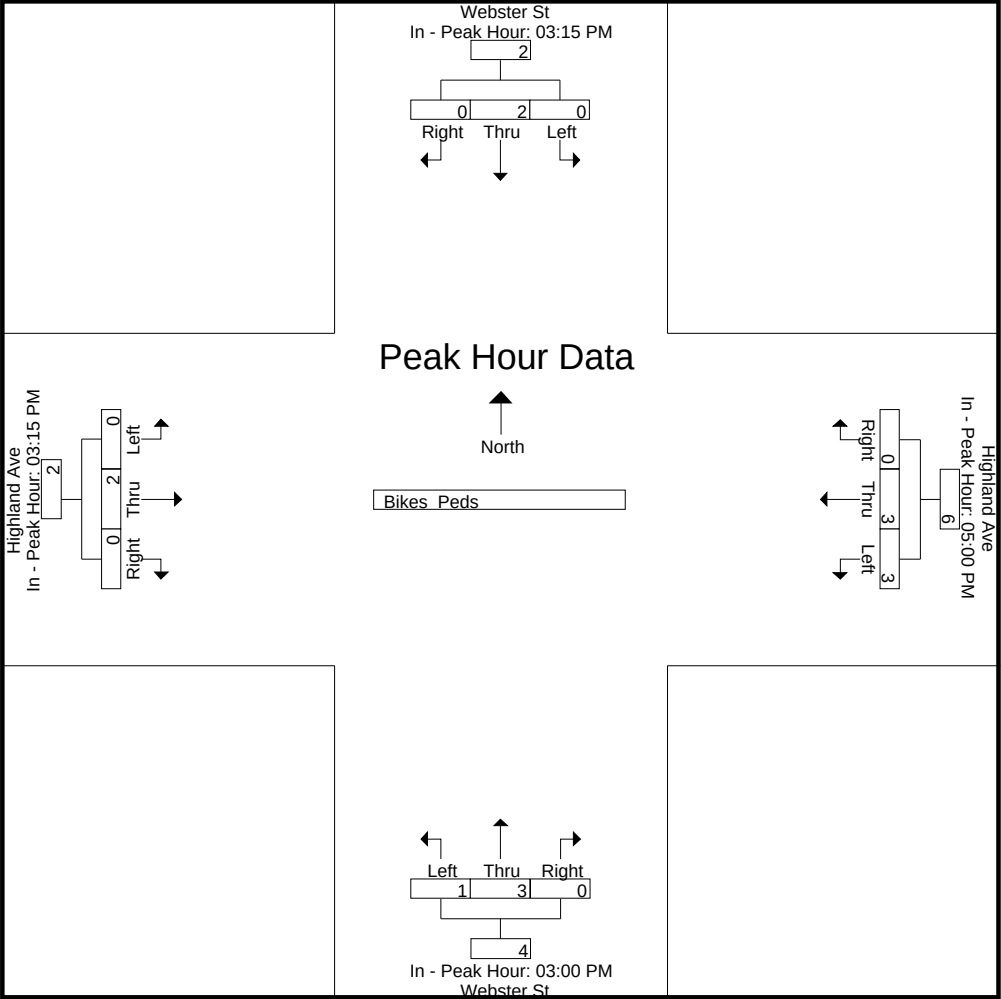
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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
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Accurate Counts

978-664-2565

File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

Page No : 1

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

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

File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

Page No : 2

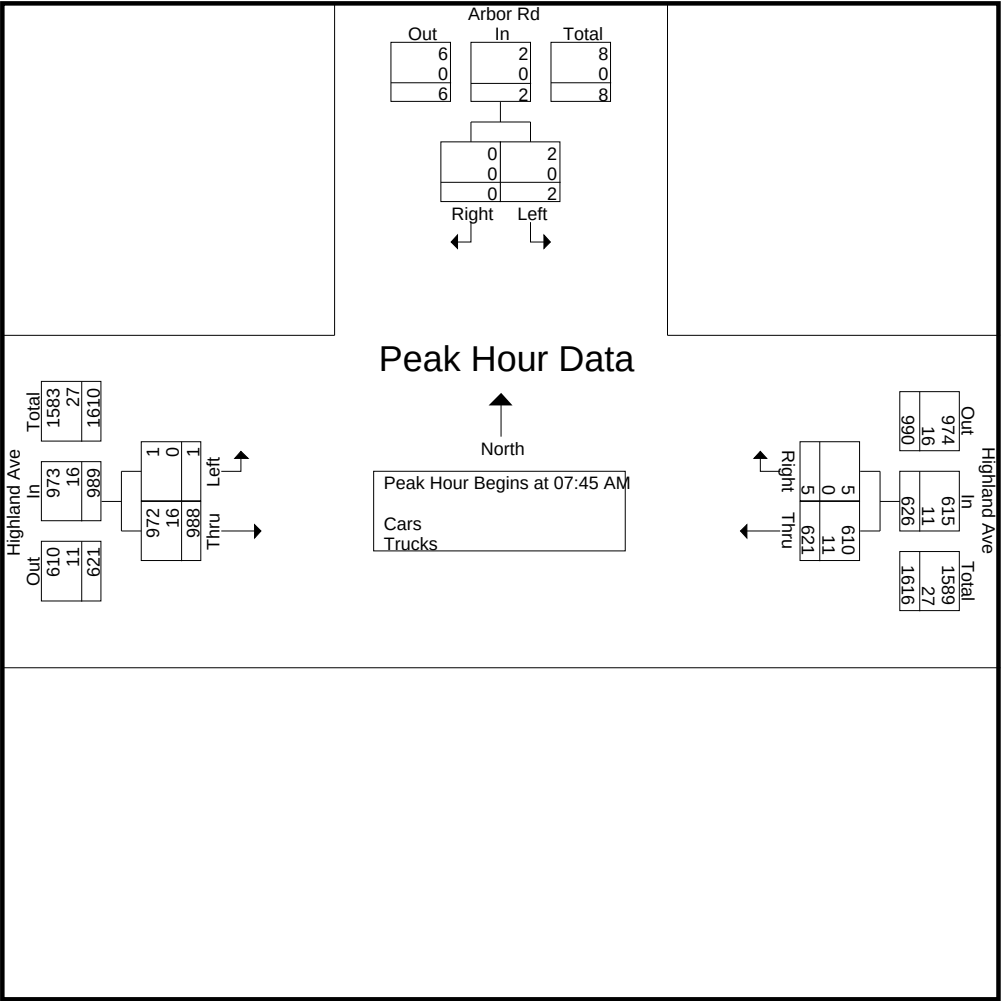
N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



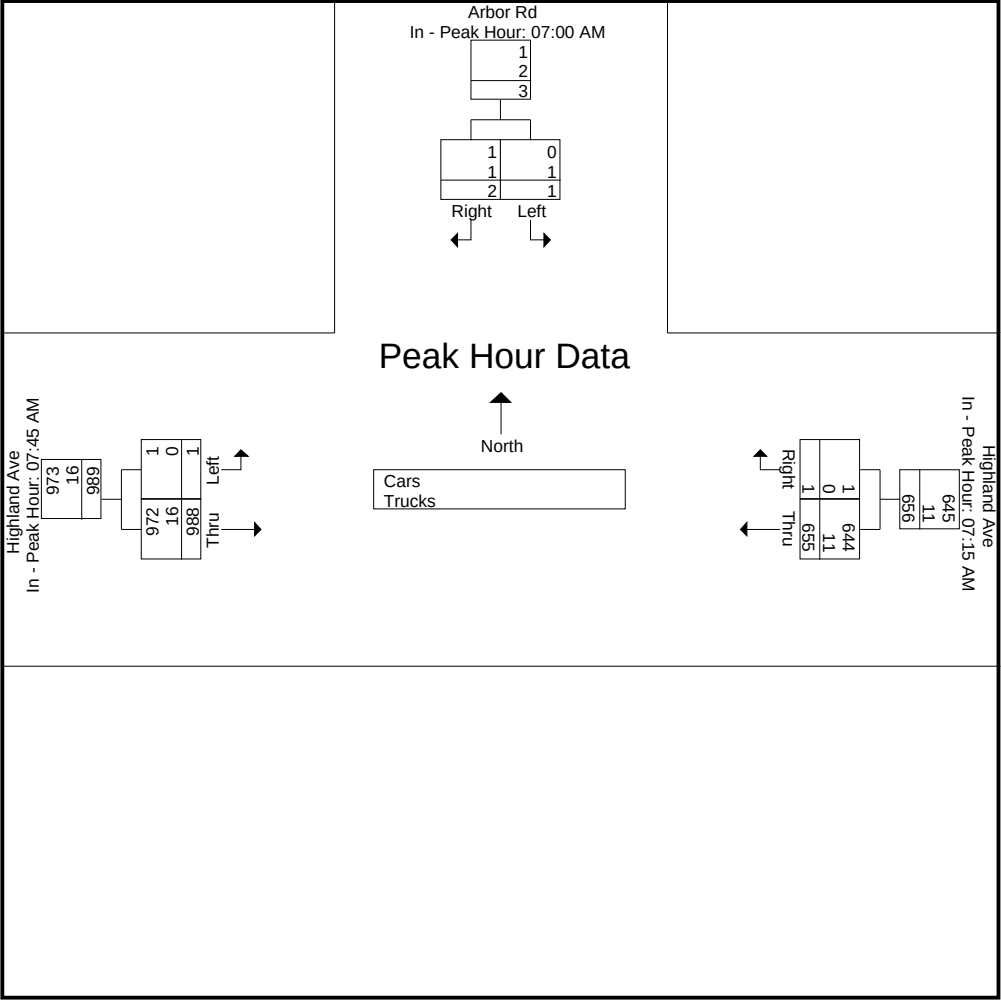
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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
Page No : 5

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

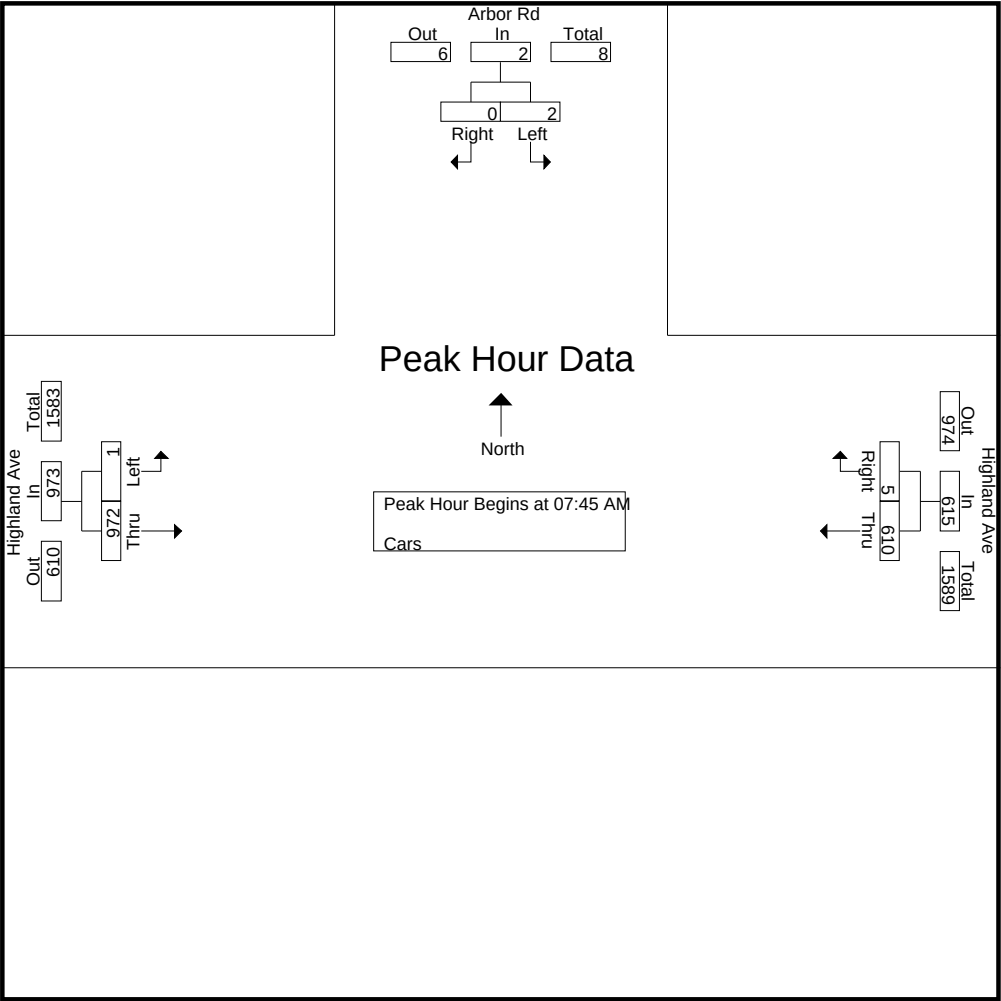
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 6

	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



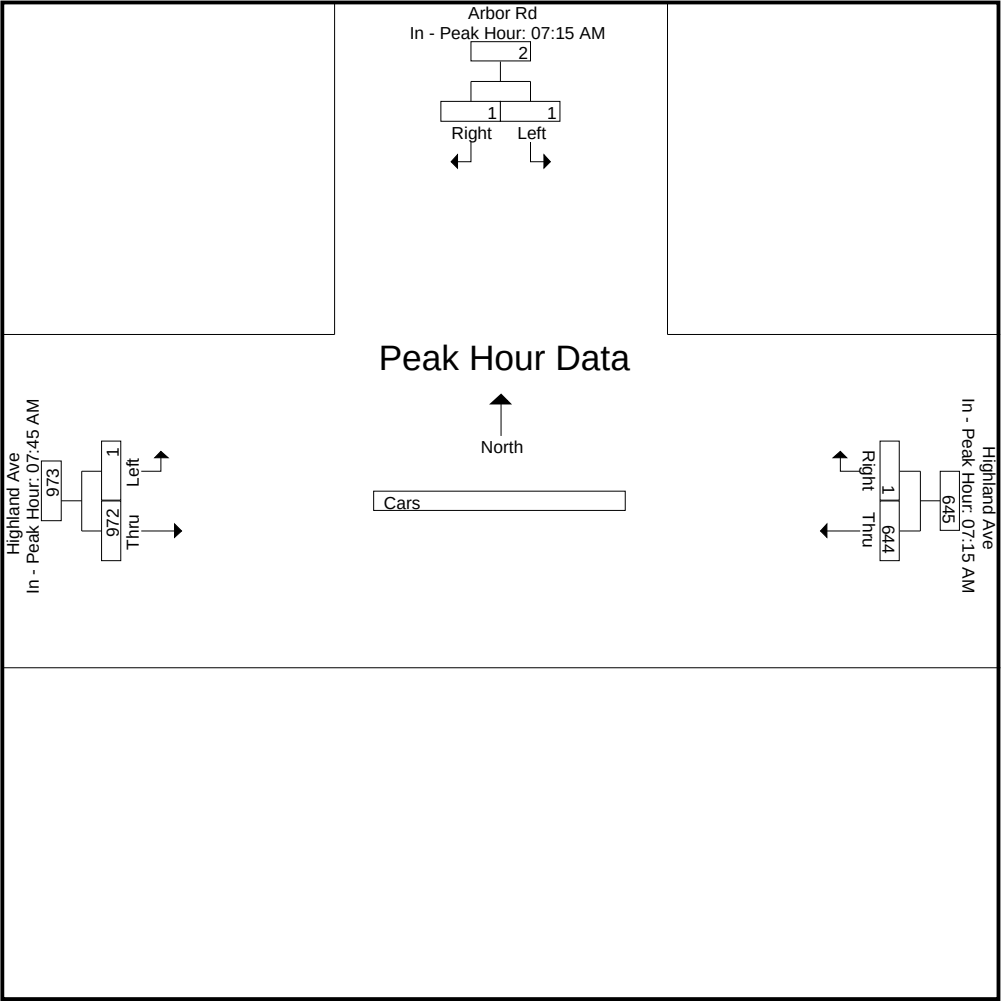
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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
Page No : 9

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

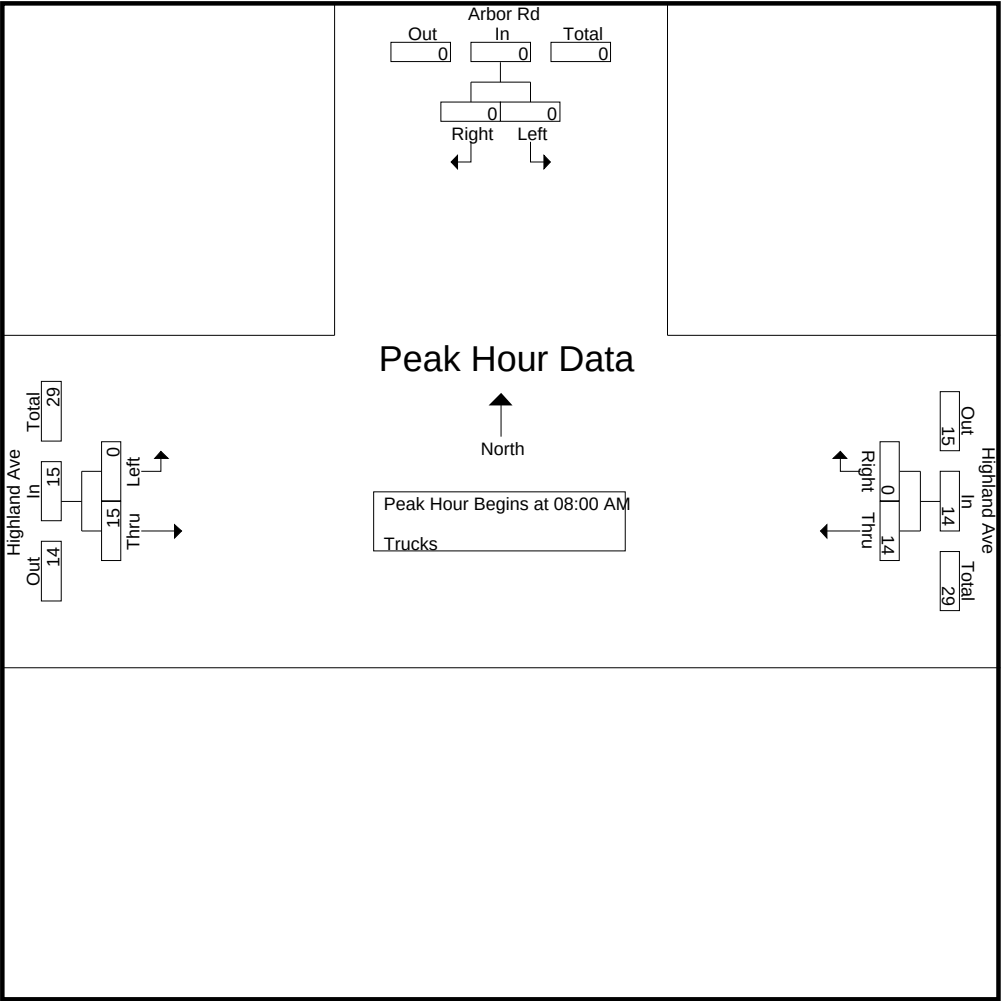
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 10

	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
Page No : 11



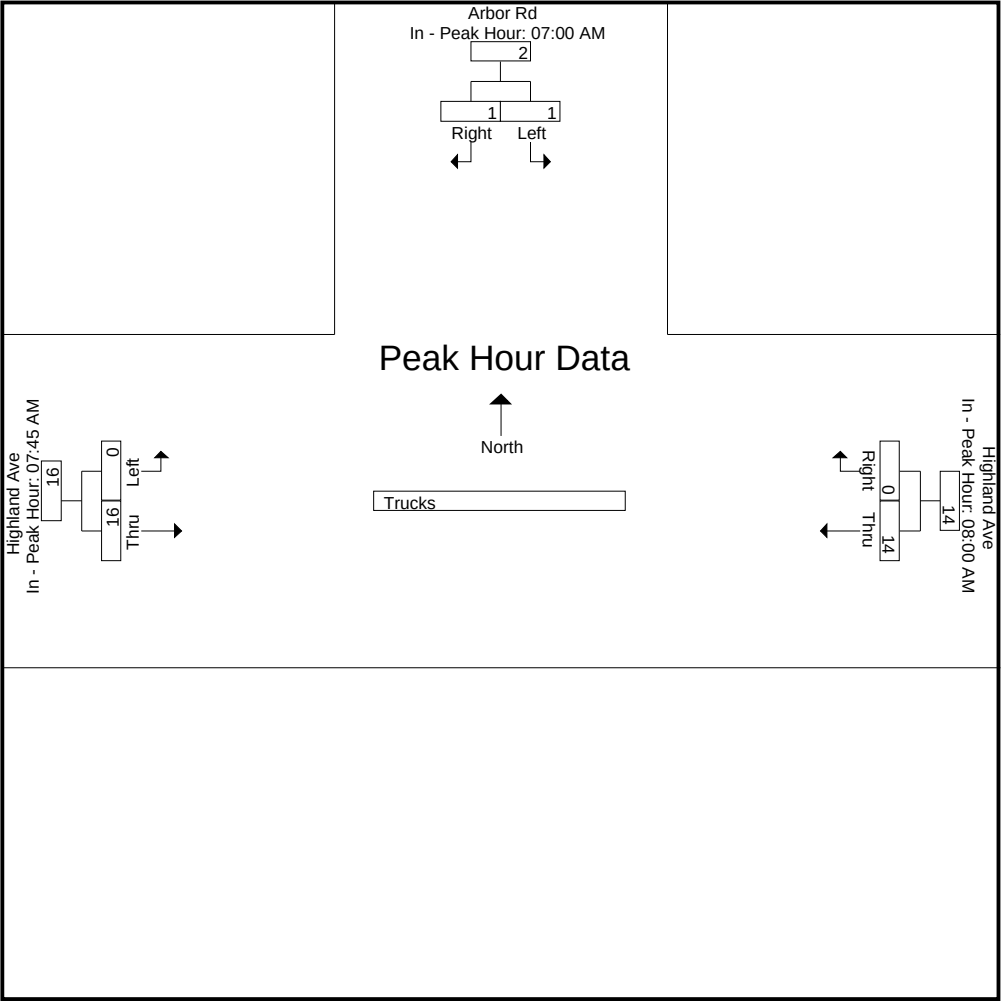
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	07:00 AM			08:00 AM			07:45 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	.667



Accurate Counts

978-664-2565

File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

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

Groups Printed- Bikes Peds

	Arbor Rd From North			Highland Ave From East			Highland Ave From West			Exclu. Total	Inclu. Total	Int. Total
Start Time	Left	Right	Peds	Thru	Right	Peds	Left	Thru	Peds			
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

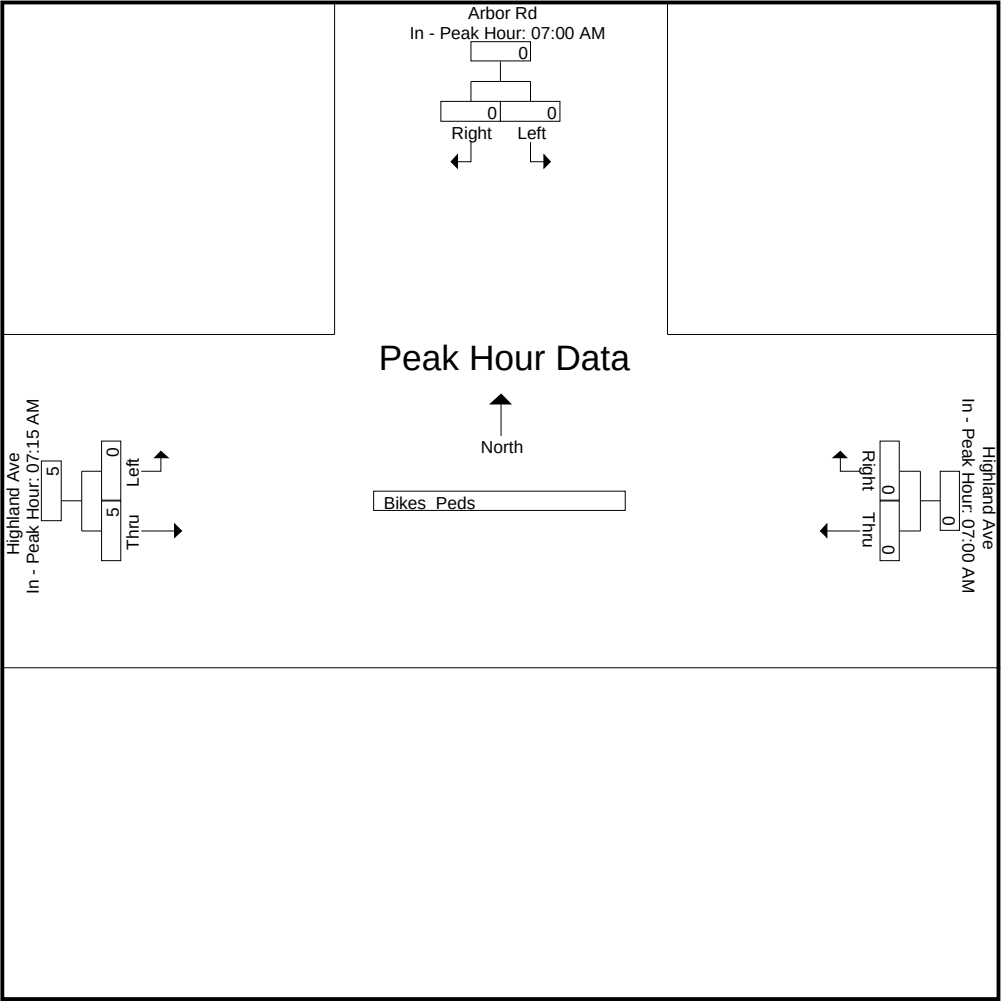
N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

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

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

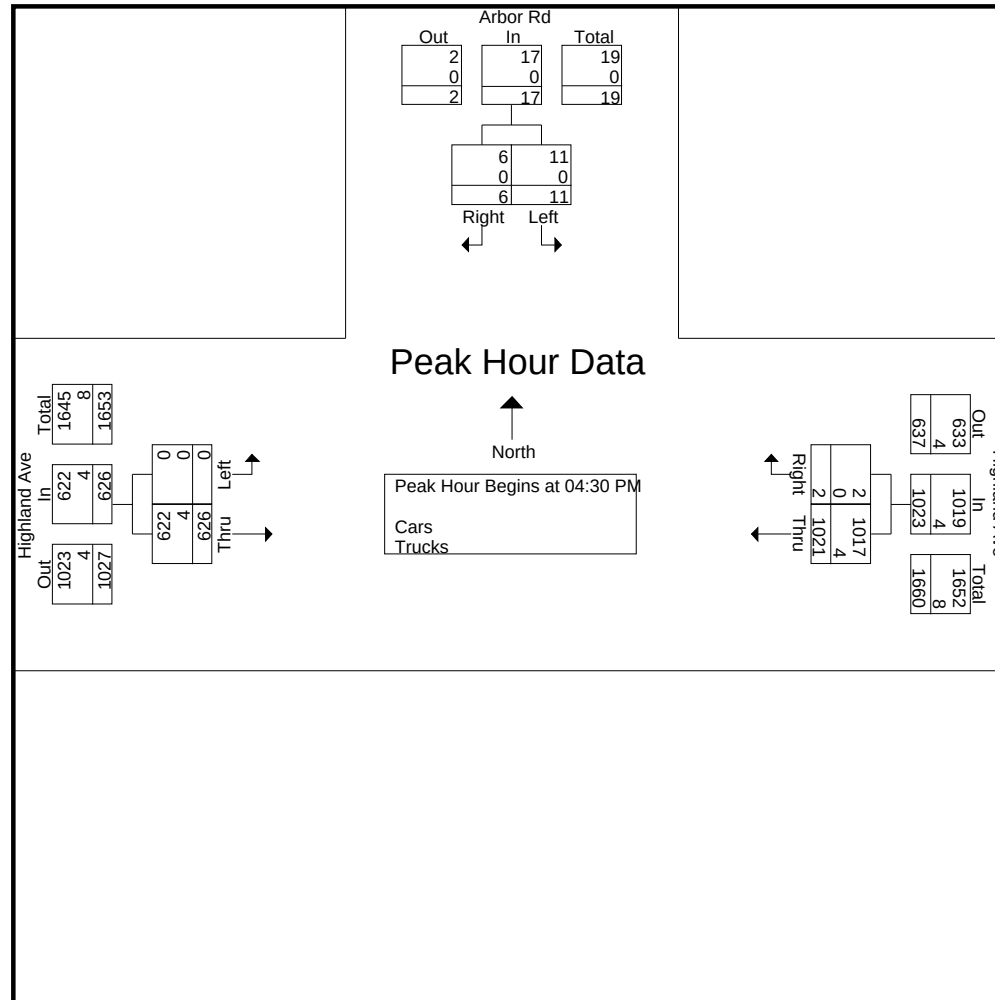
File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

Page No : 3

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



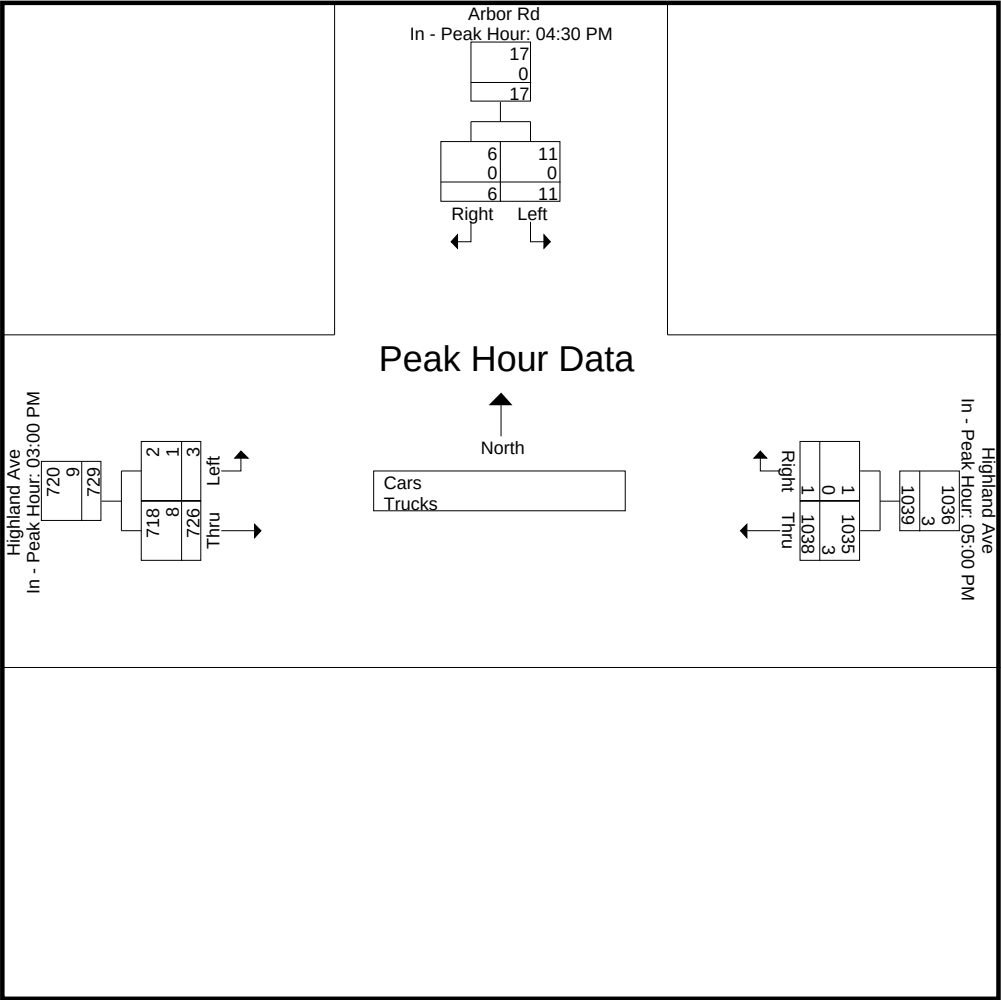
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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

File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

Page No : 5

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

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

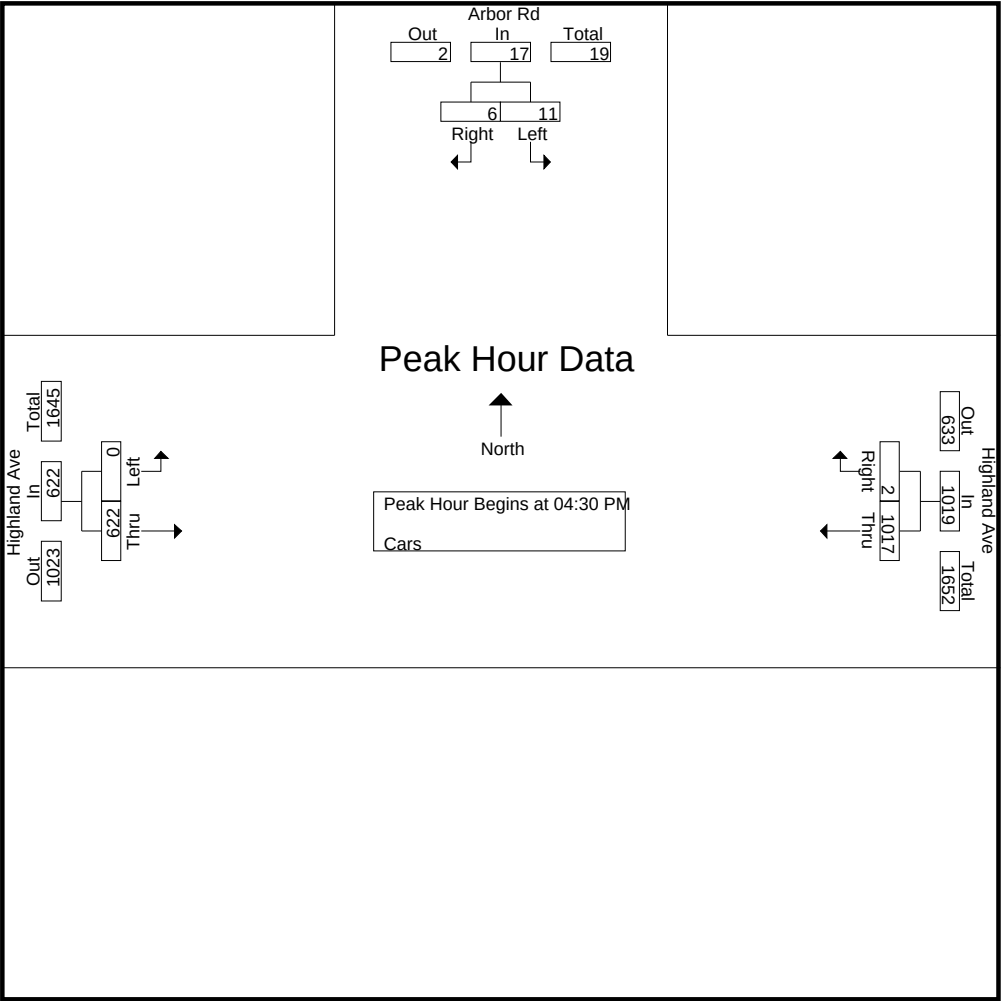
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 6

	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



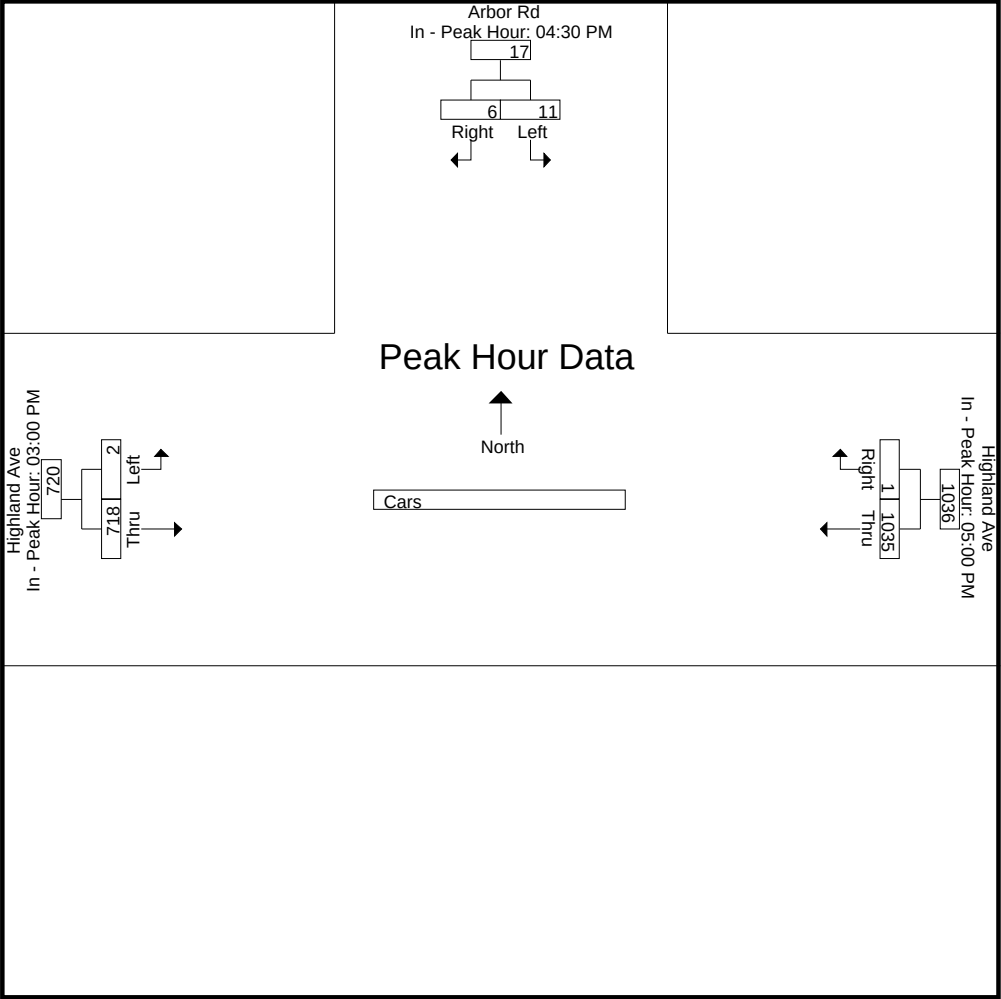
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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

File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

Page No : 9

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

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

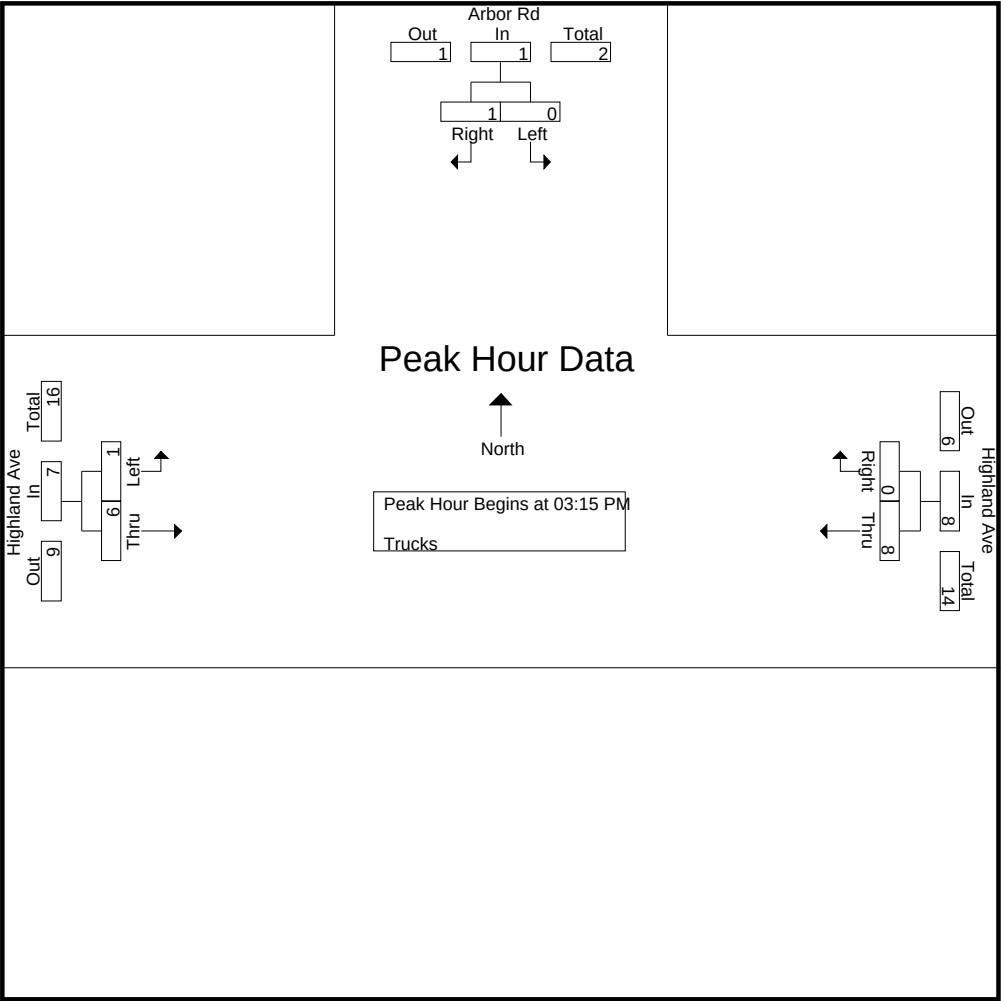
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 10

	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

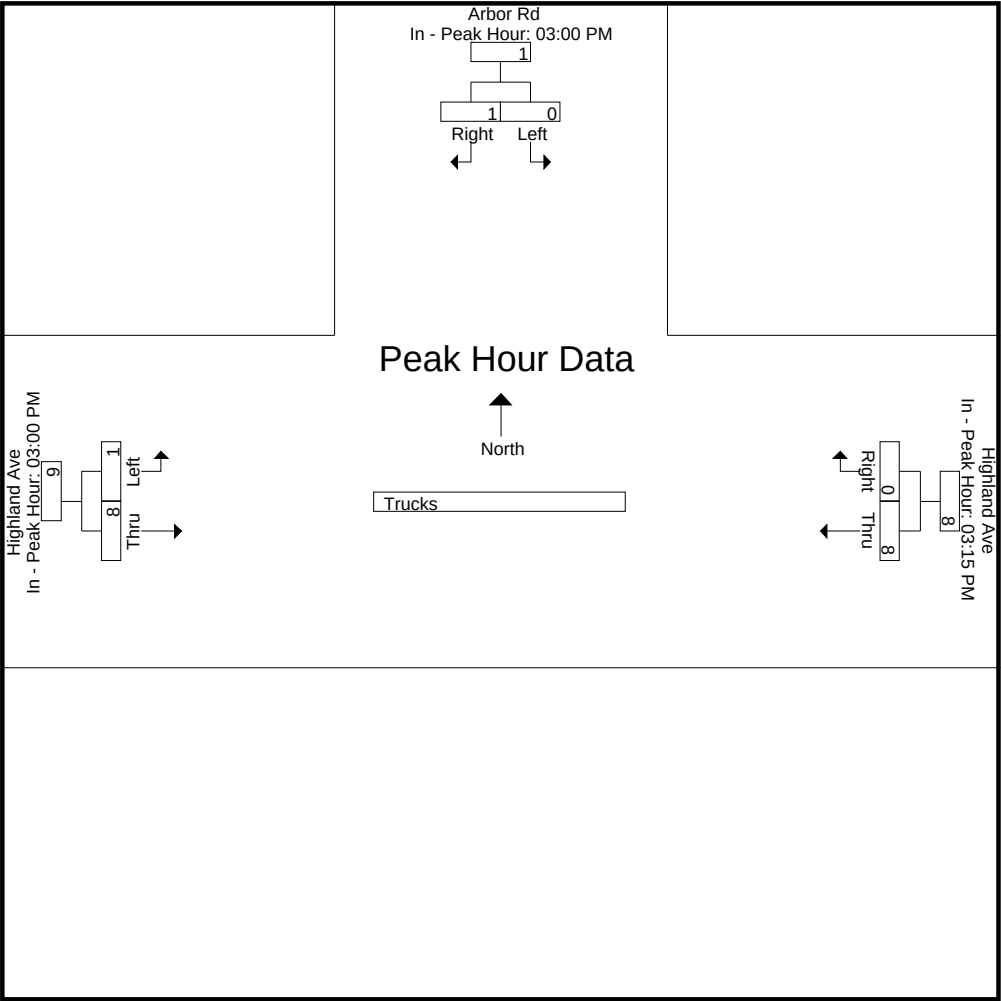
Peak Hour for Each Approach Begins at:

	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
Page No : 13

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

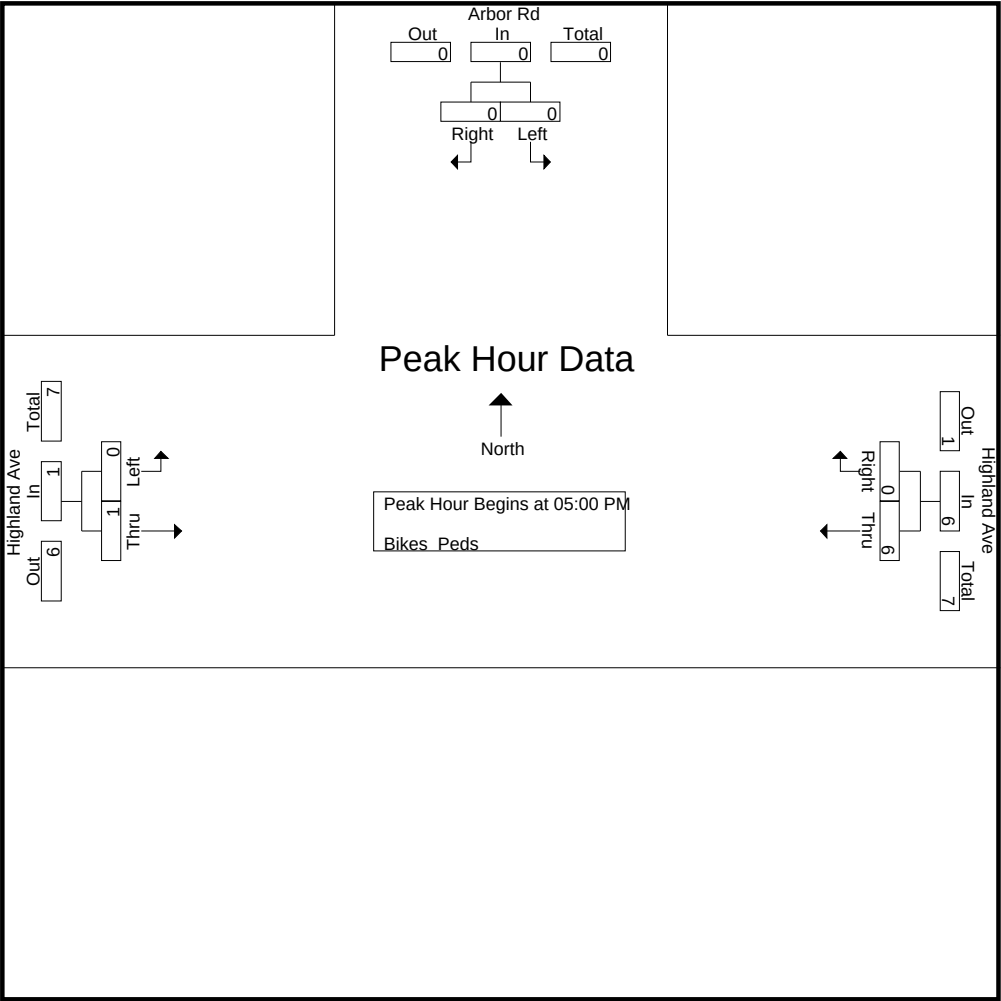
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 14

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

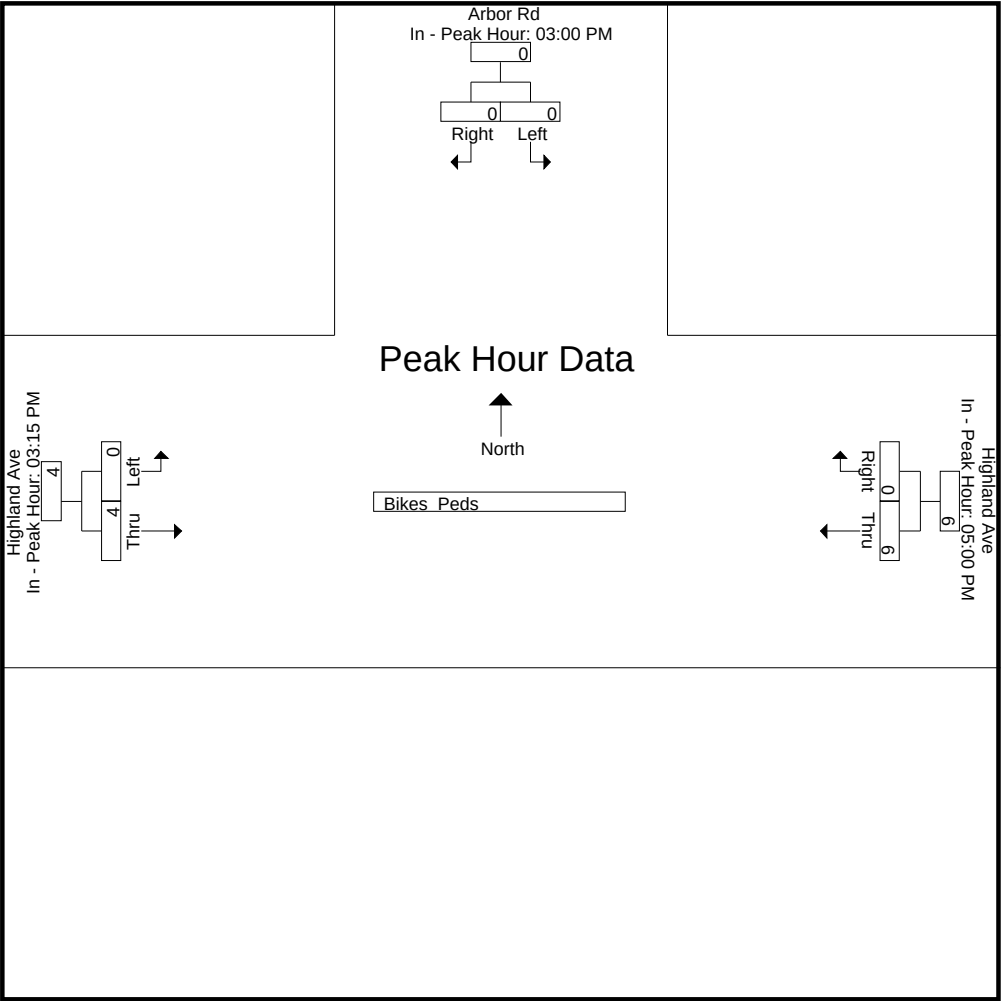
Peak Hour for Each Approach Begins at:

	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
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
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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

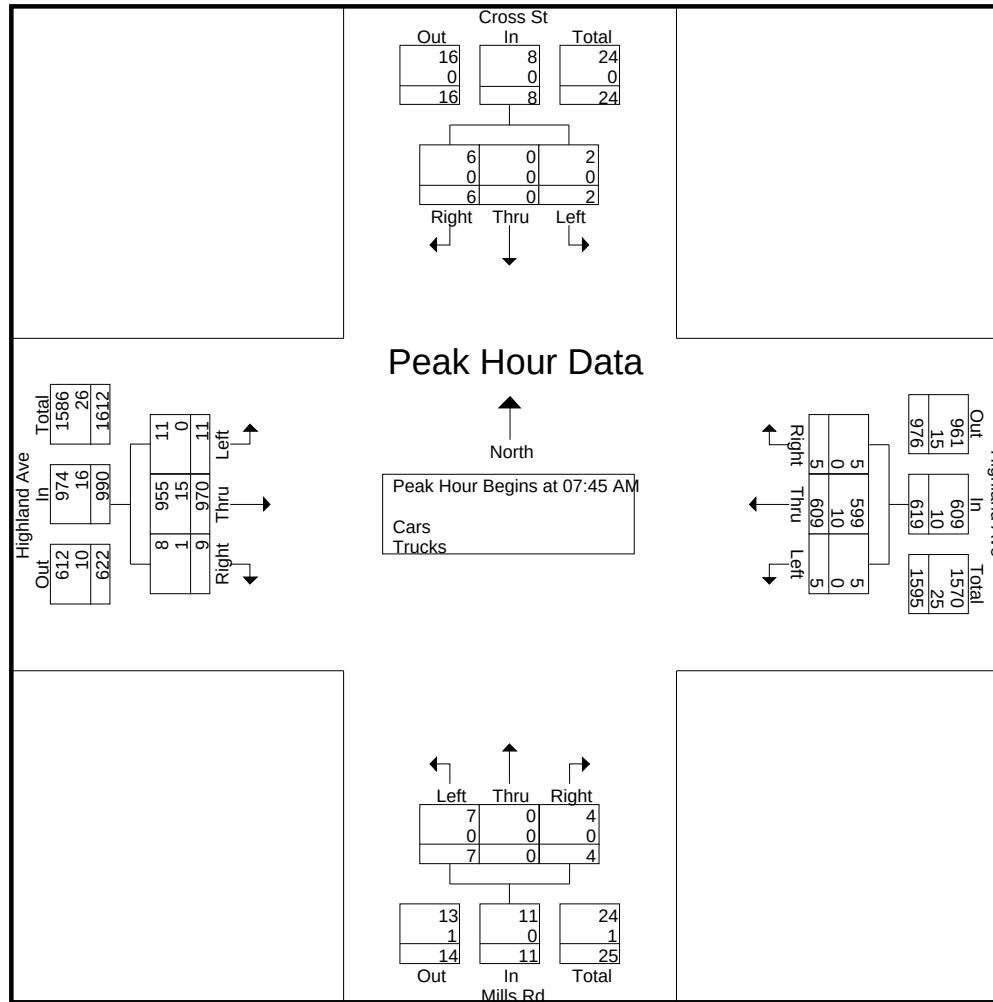
Page No : 3

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



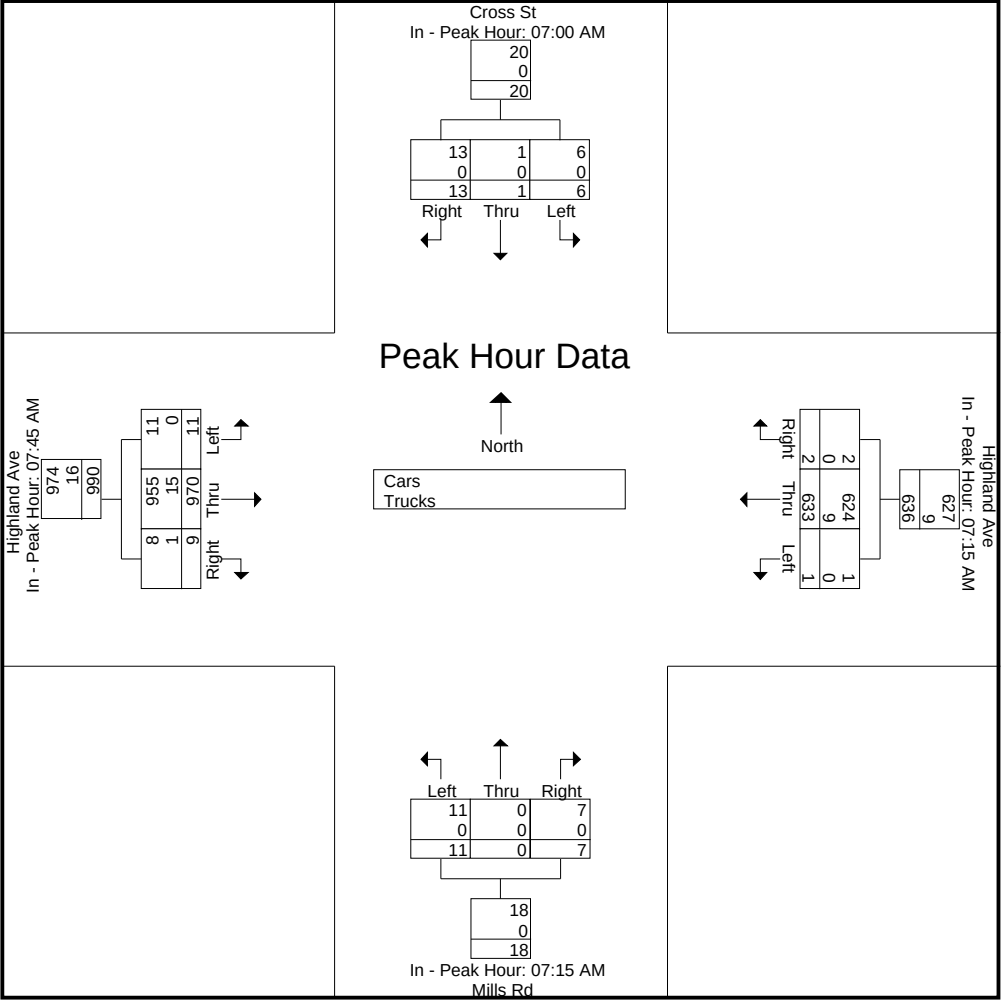
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	07:00 AM				07:15 AM				07:30 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
Page No : 5

Groups Printed- Cars

Start Time	Cross St From North			Highland Ave From East			Mills Rd From South			Highland Ave From West			Int. Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

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N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

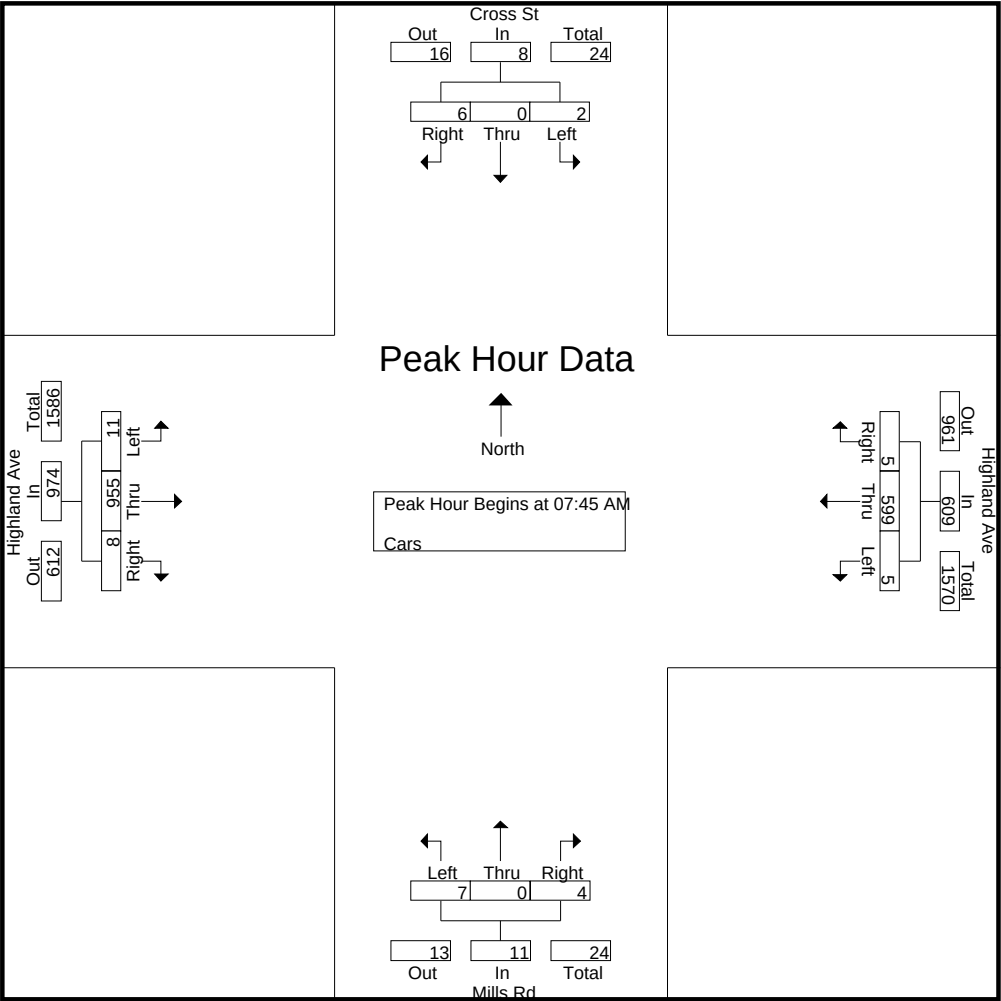
Weather : Cloudy

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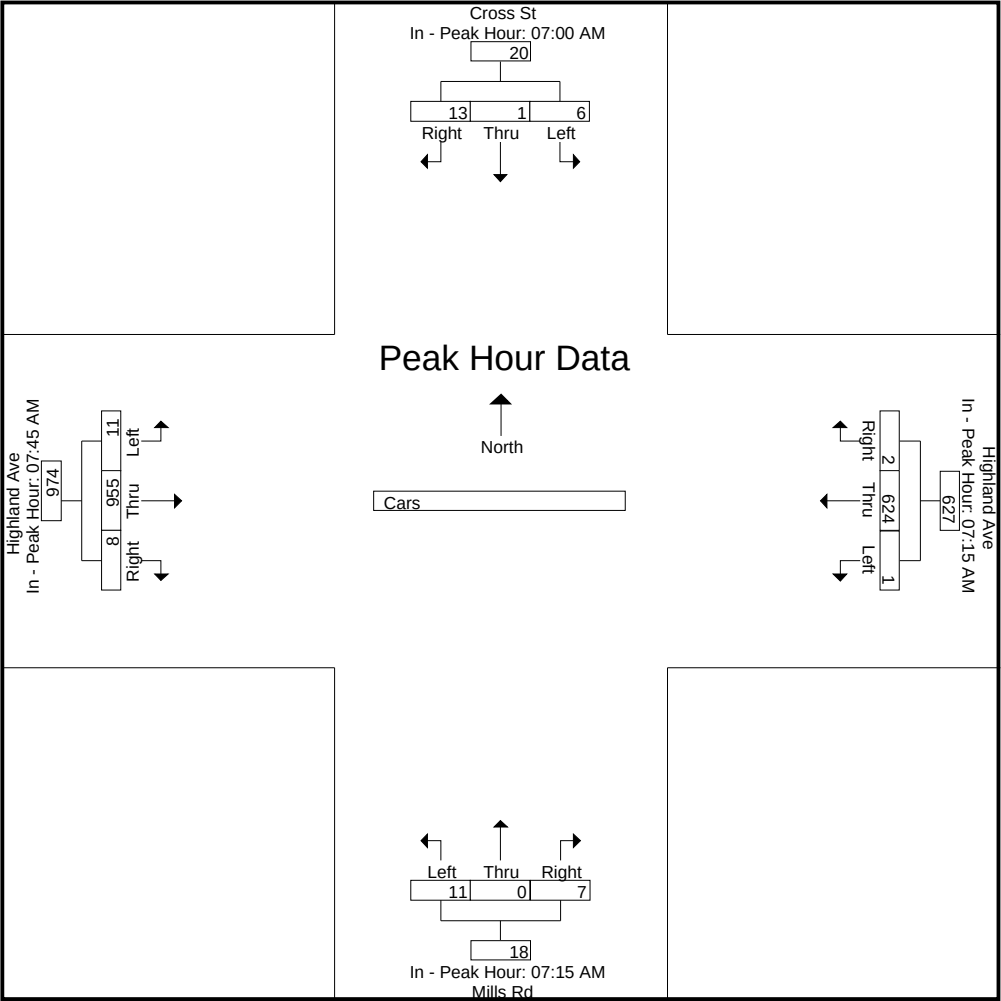
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

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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

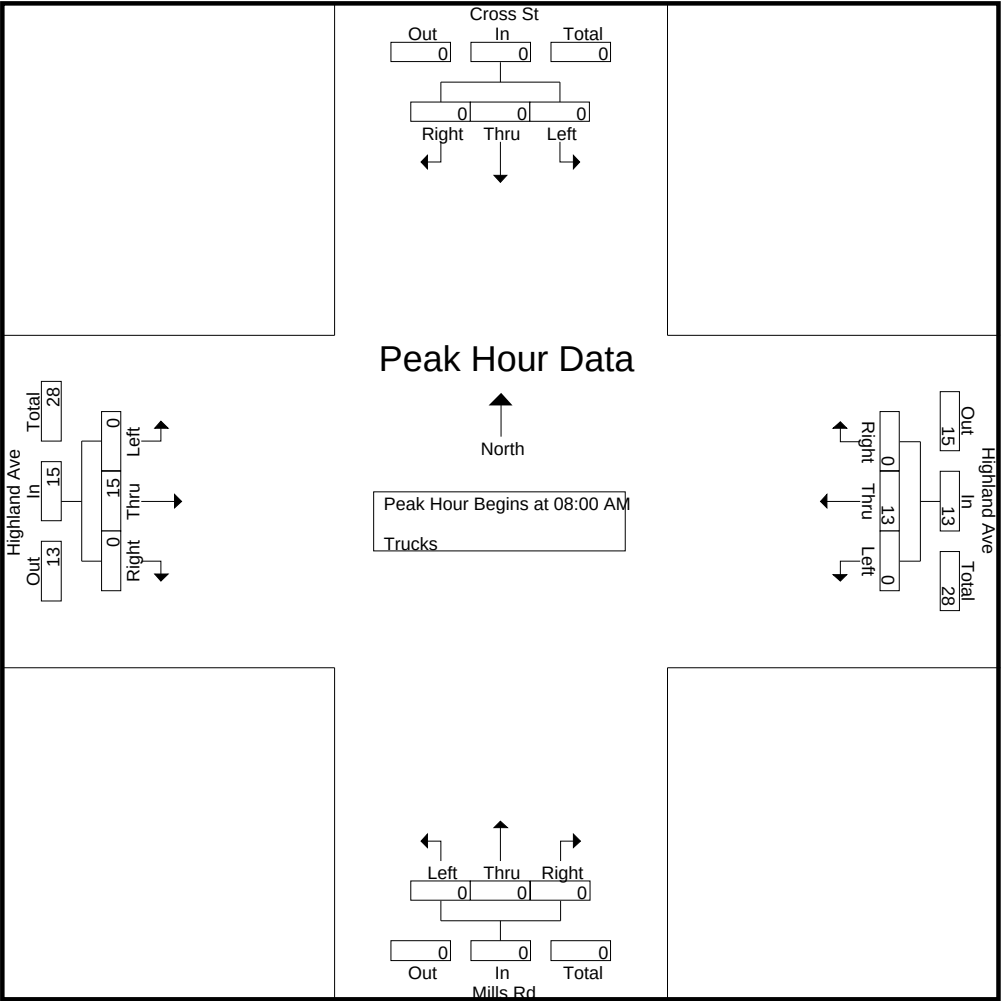
File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 10

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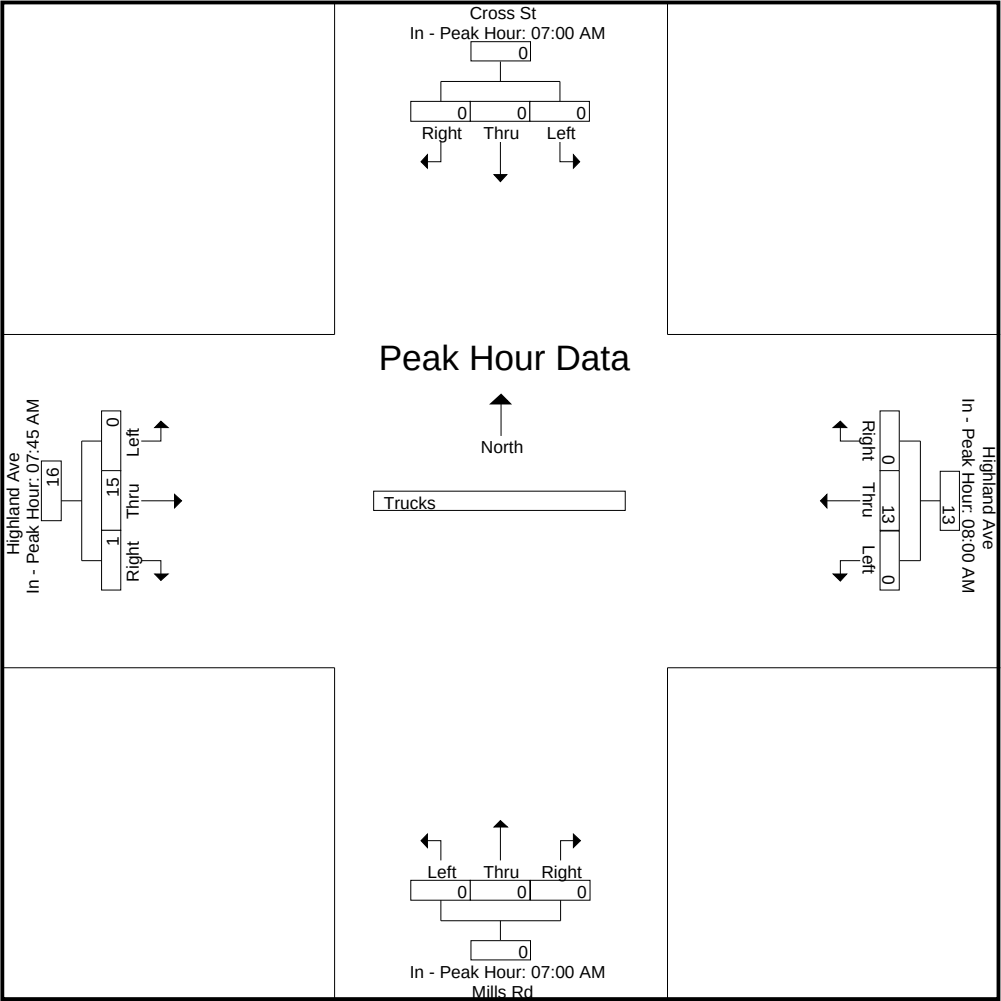
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

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N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

Groups Printed- Bikes Peds

Start Time	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				Exclu. Total	Inclu. Total	Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds			
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
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	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

978-664-2565

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

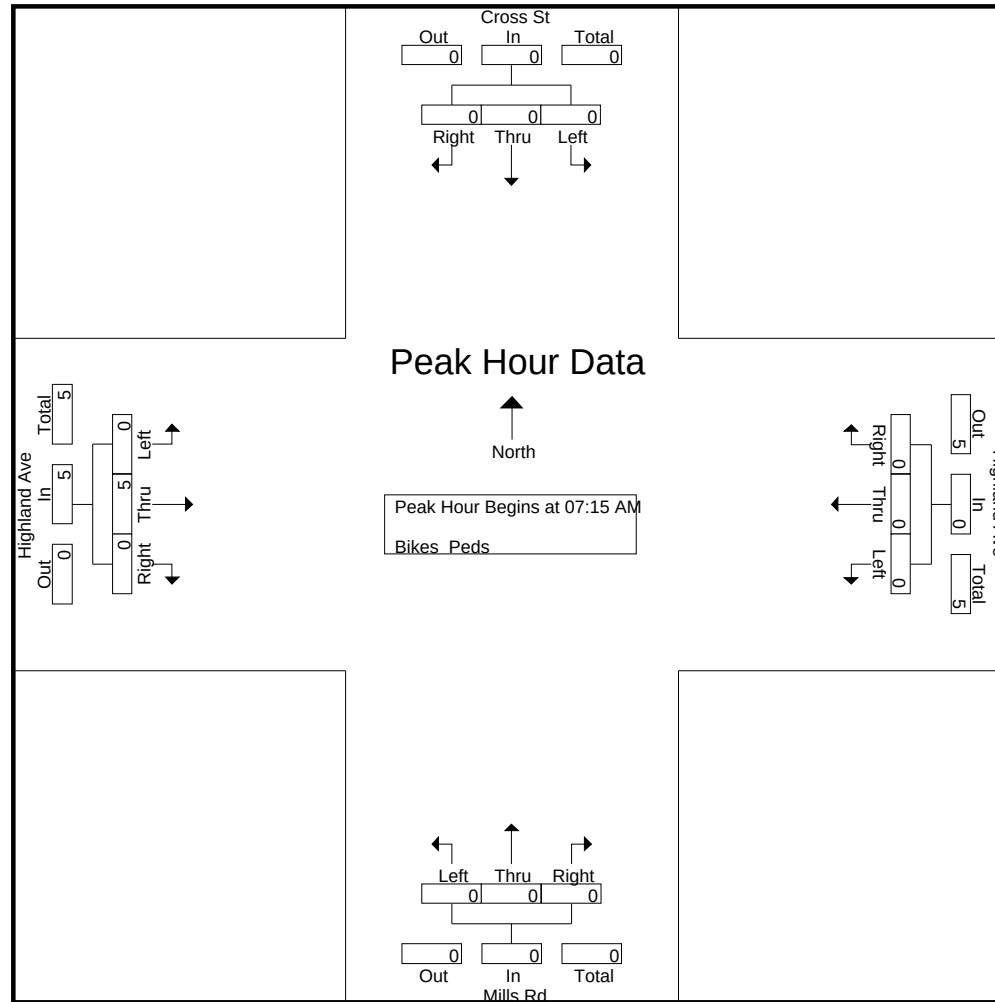
Page No : 15

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



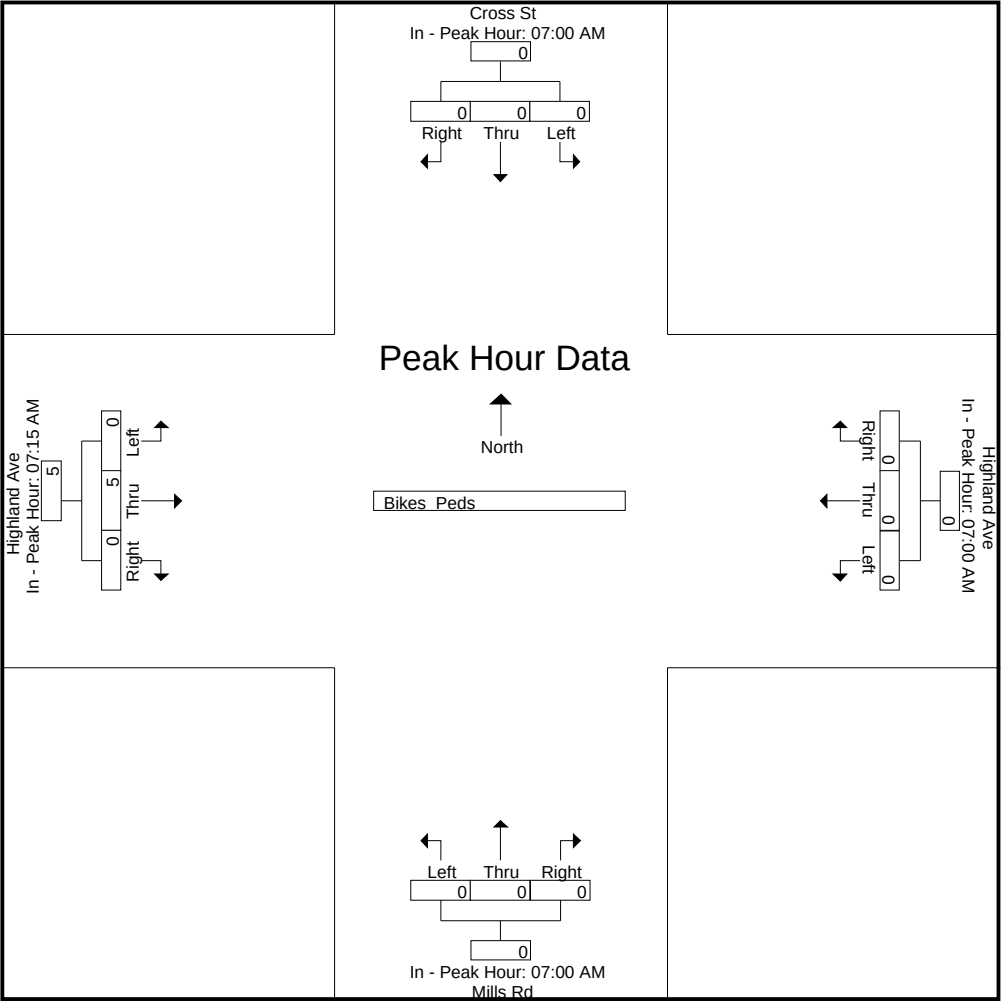
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

[illegible]

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



978-664-2565

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

	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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

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N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

	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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

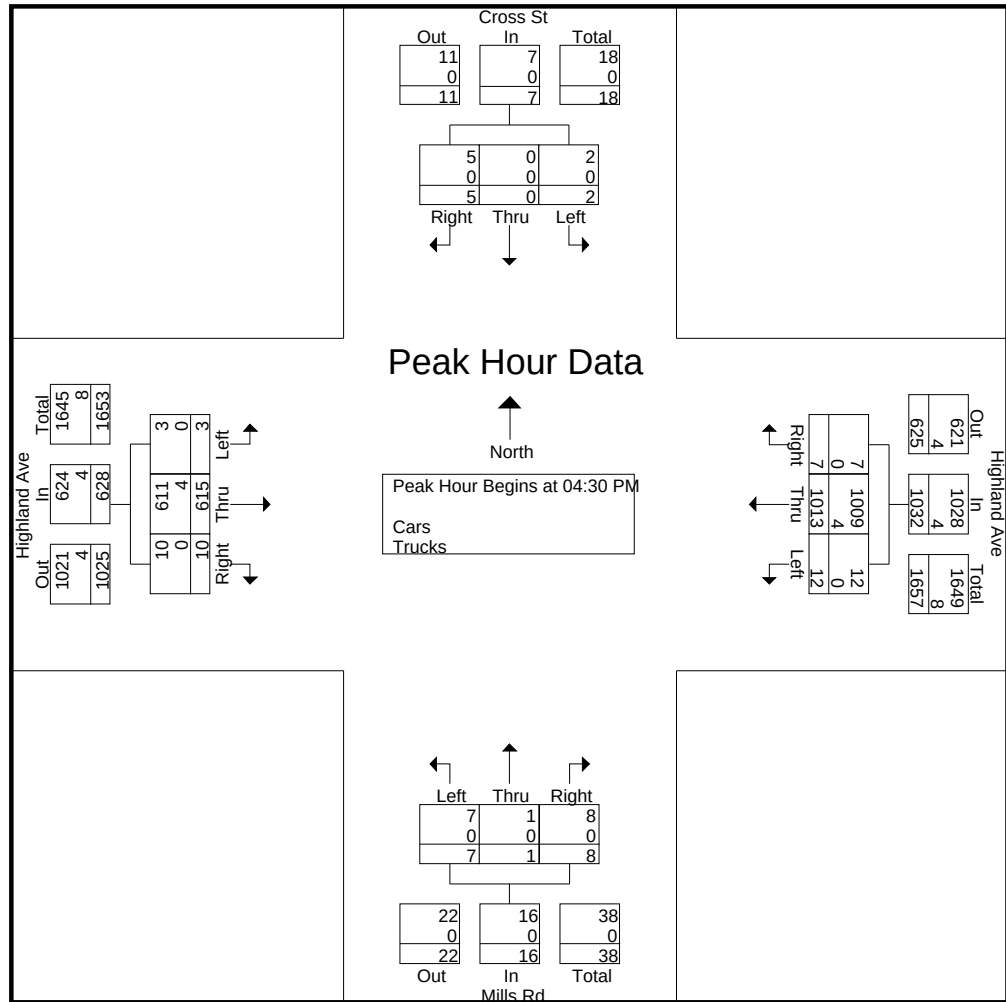
Page No : 3

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



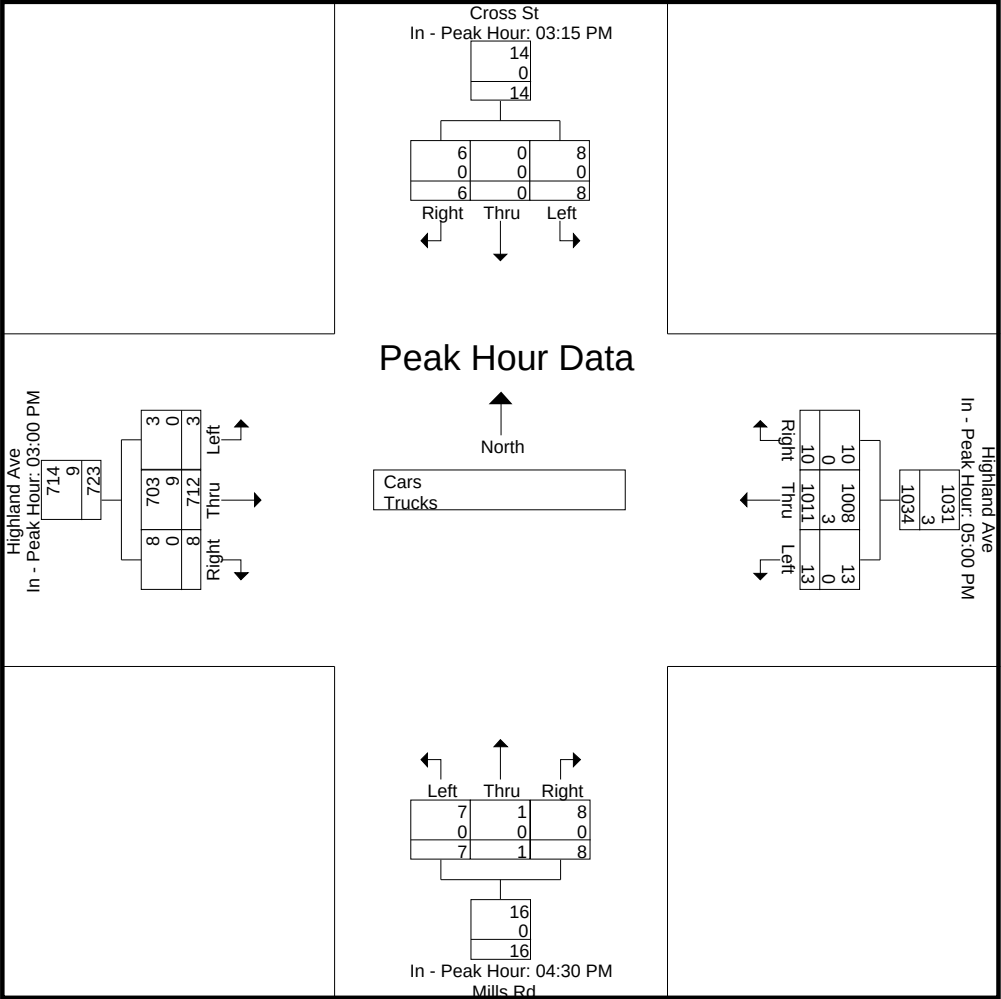
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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
Page No : 5

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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

Page No : 6

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

	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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

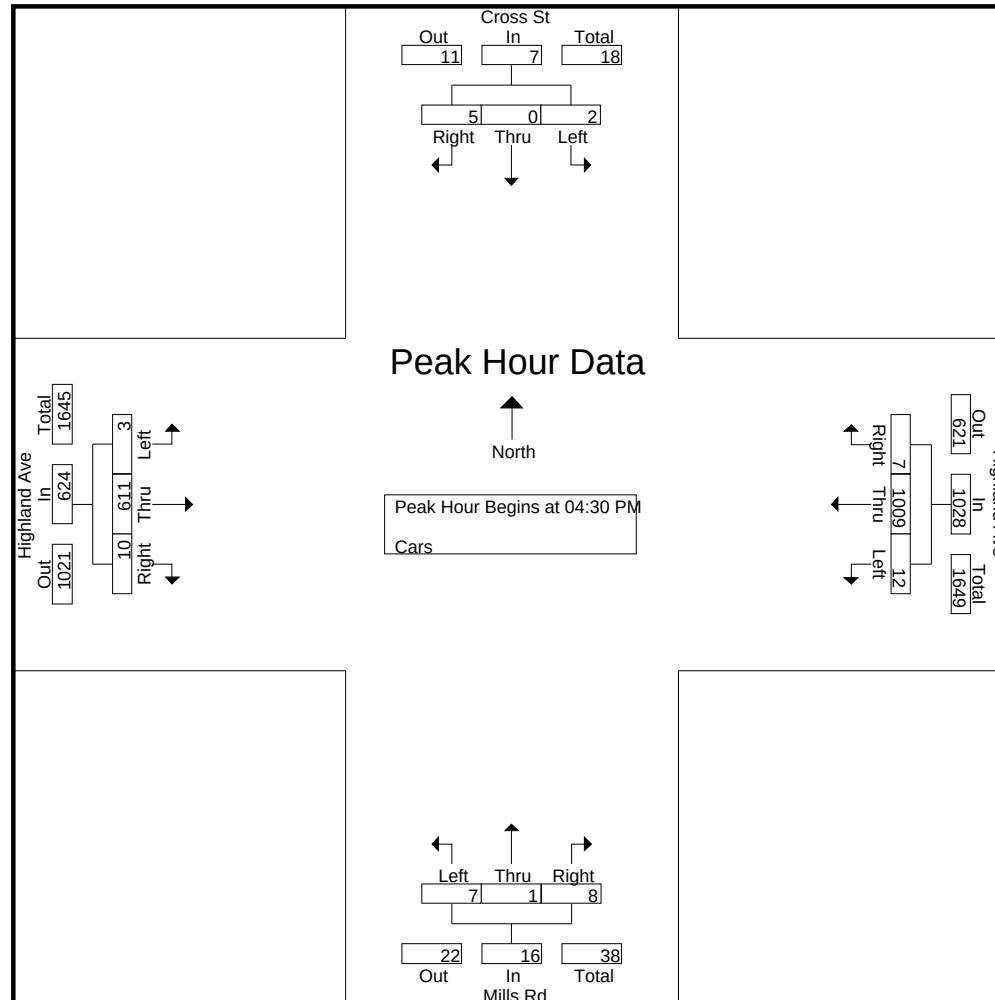
Page No : 7

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



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

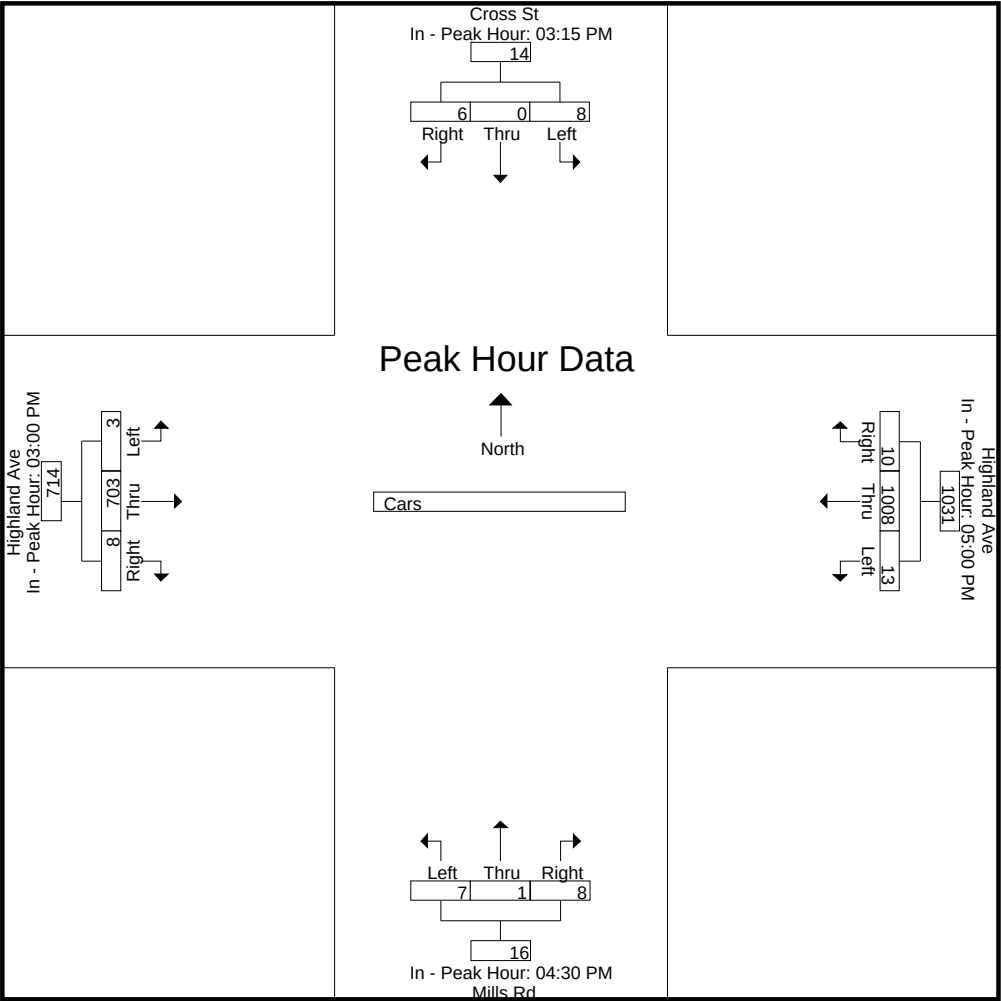
Peak Hour for Each Approach Begins at:

	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
Page No : 9

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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

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N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

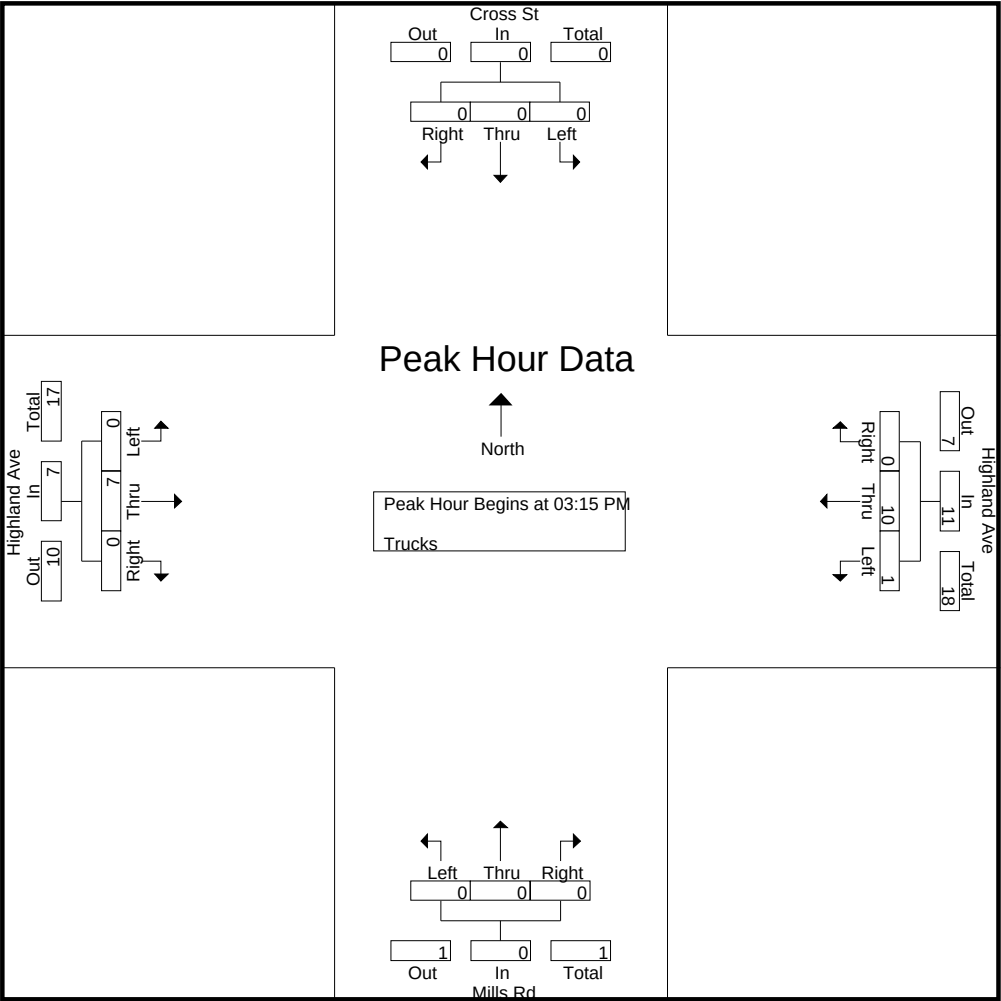
Weather : Cloudy

	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



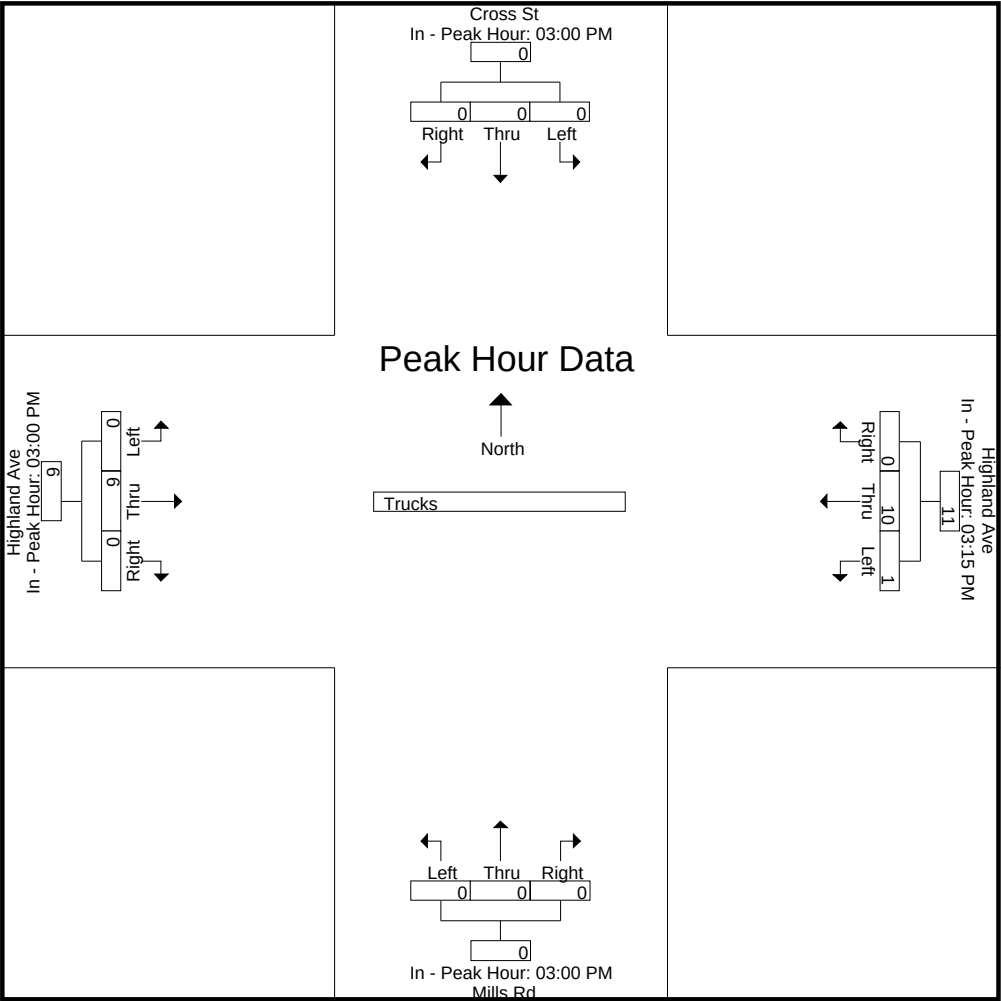
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

Page No : 13

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

Groups Printed- Bikes Peds

	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				Exclu. Total	Inclu. Total	Int. Total
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds			
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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

Page No : 14

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

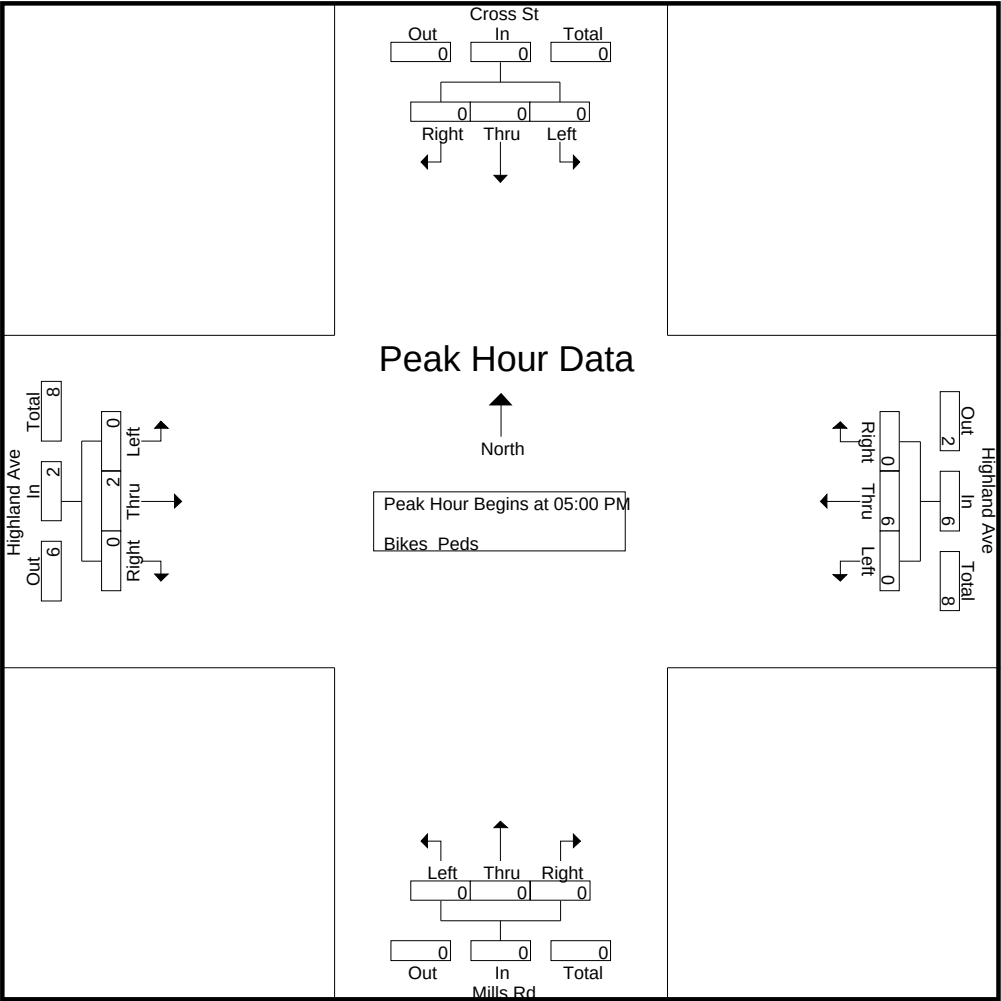
Weather : Cloudy

	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



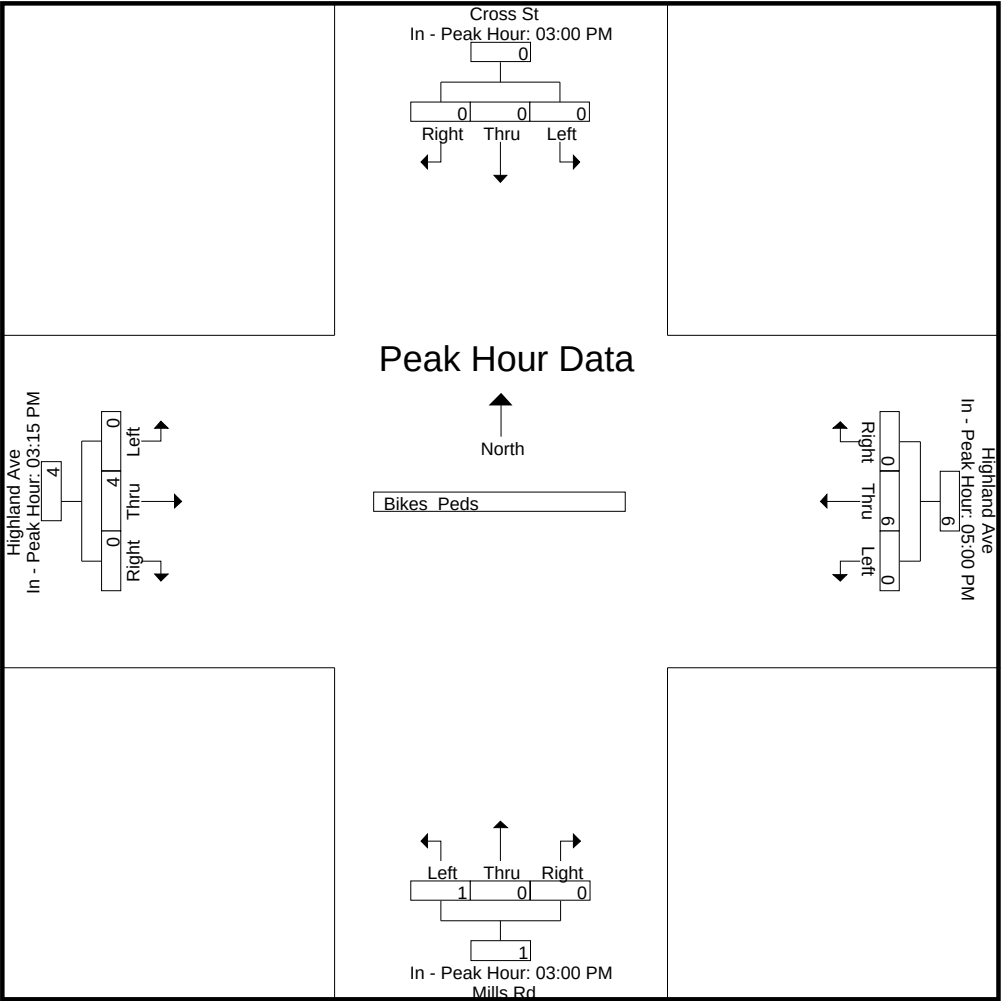
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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	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
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
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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

Page No : 2

N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

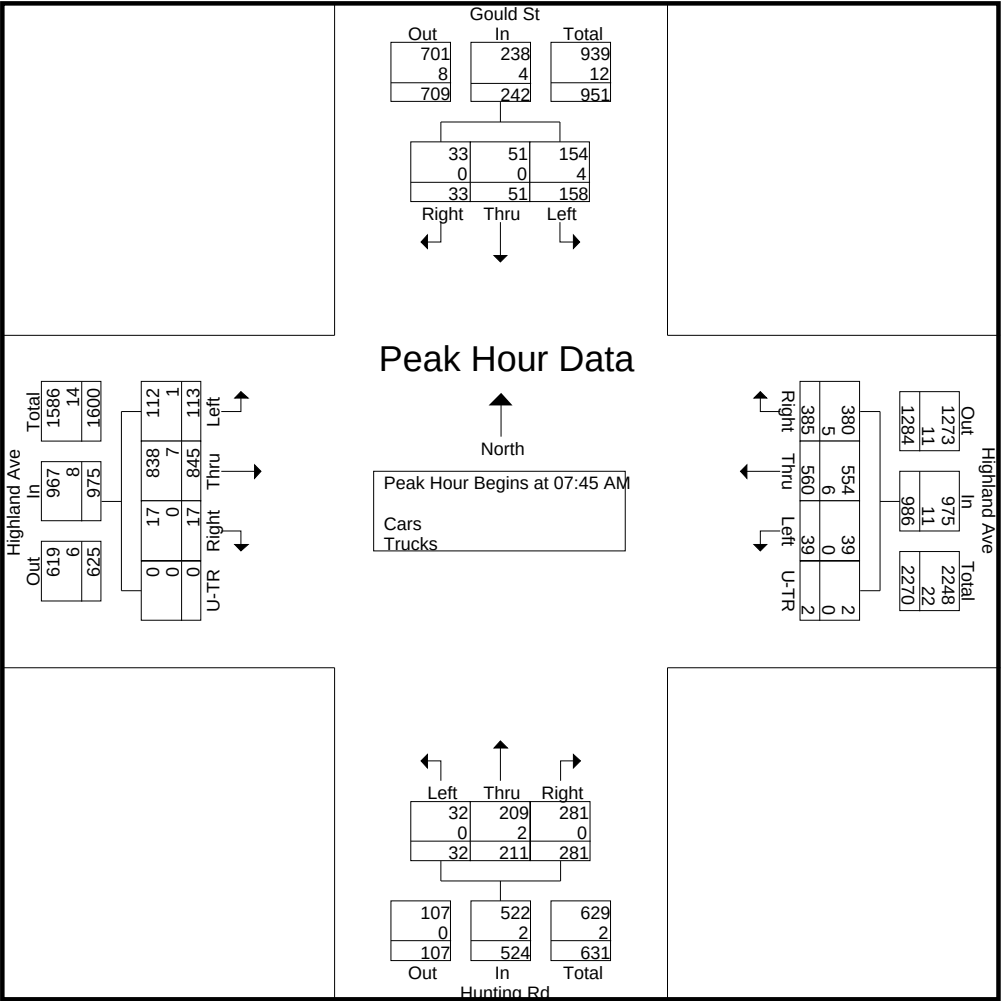
Weather : Clear

	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



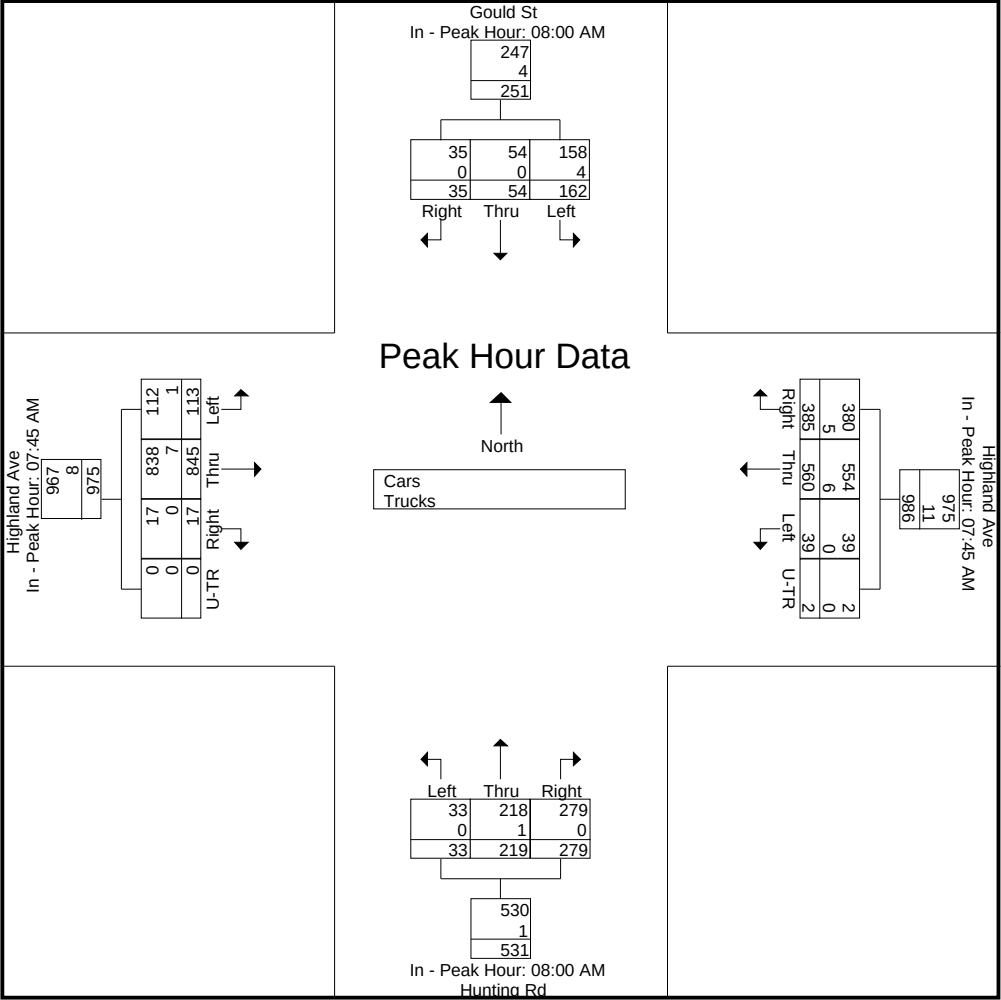
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

Page No : 1

N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Clear

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

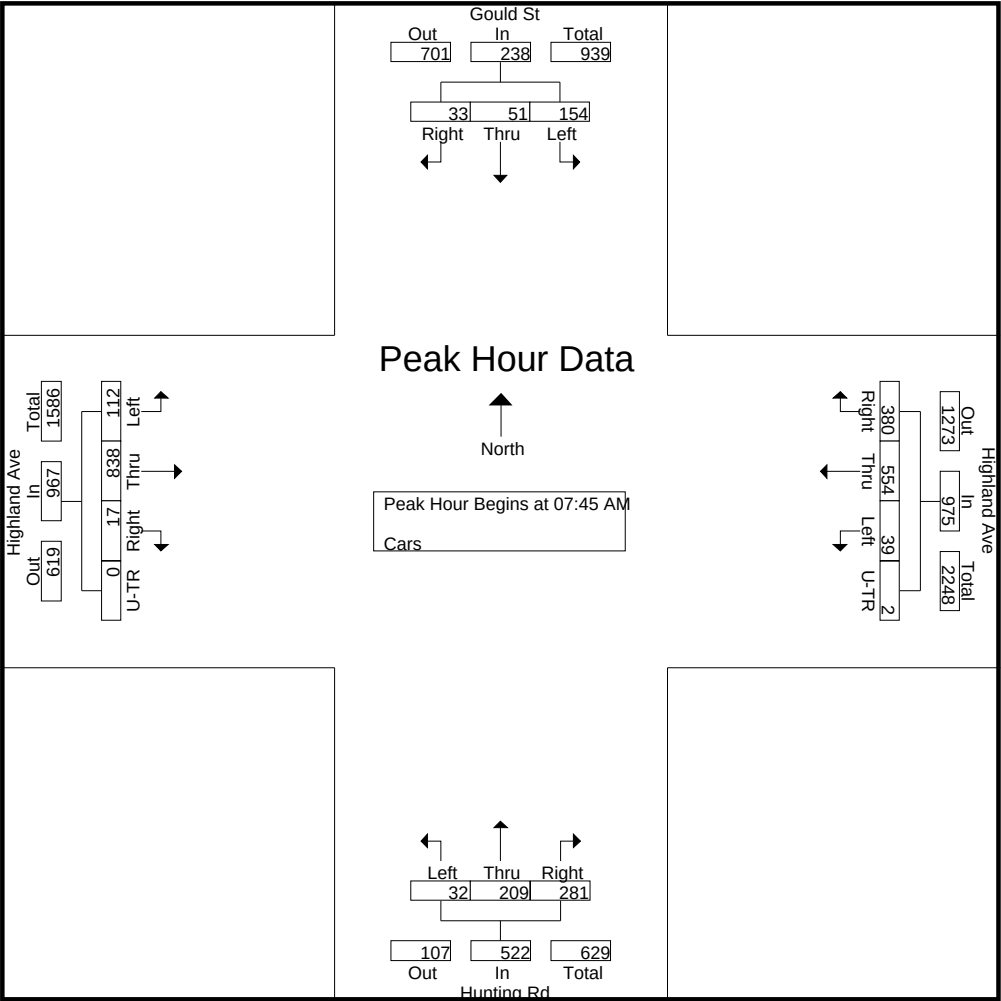
File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 2

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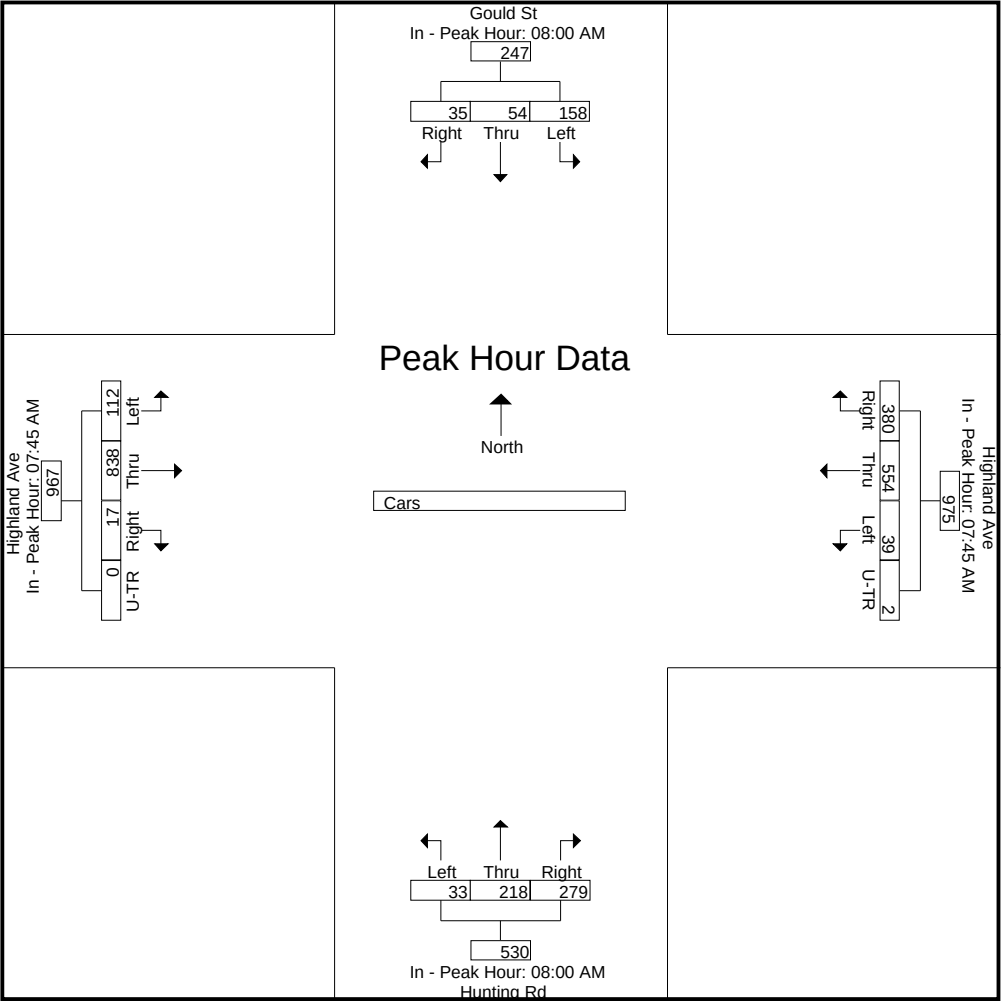
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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
Page No : 1

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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

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N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

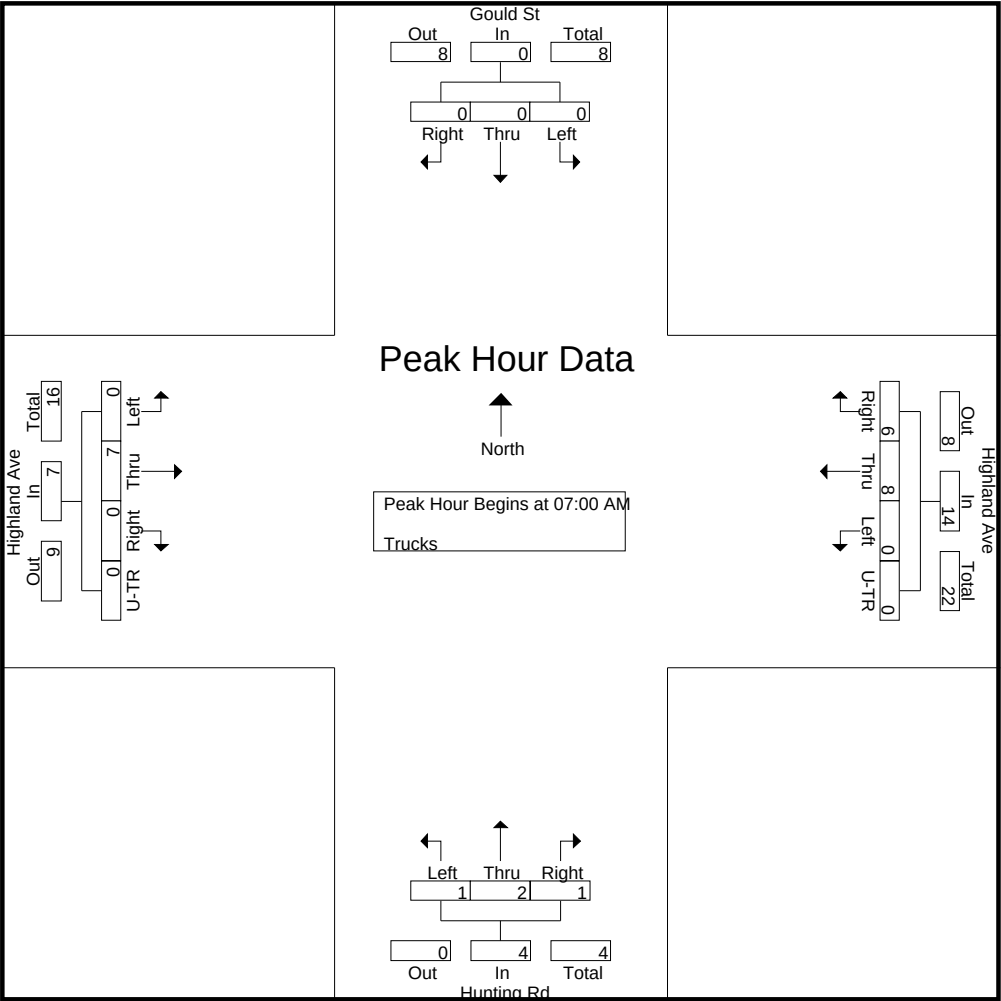
Weather : Clear

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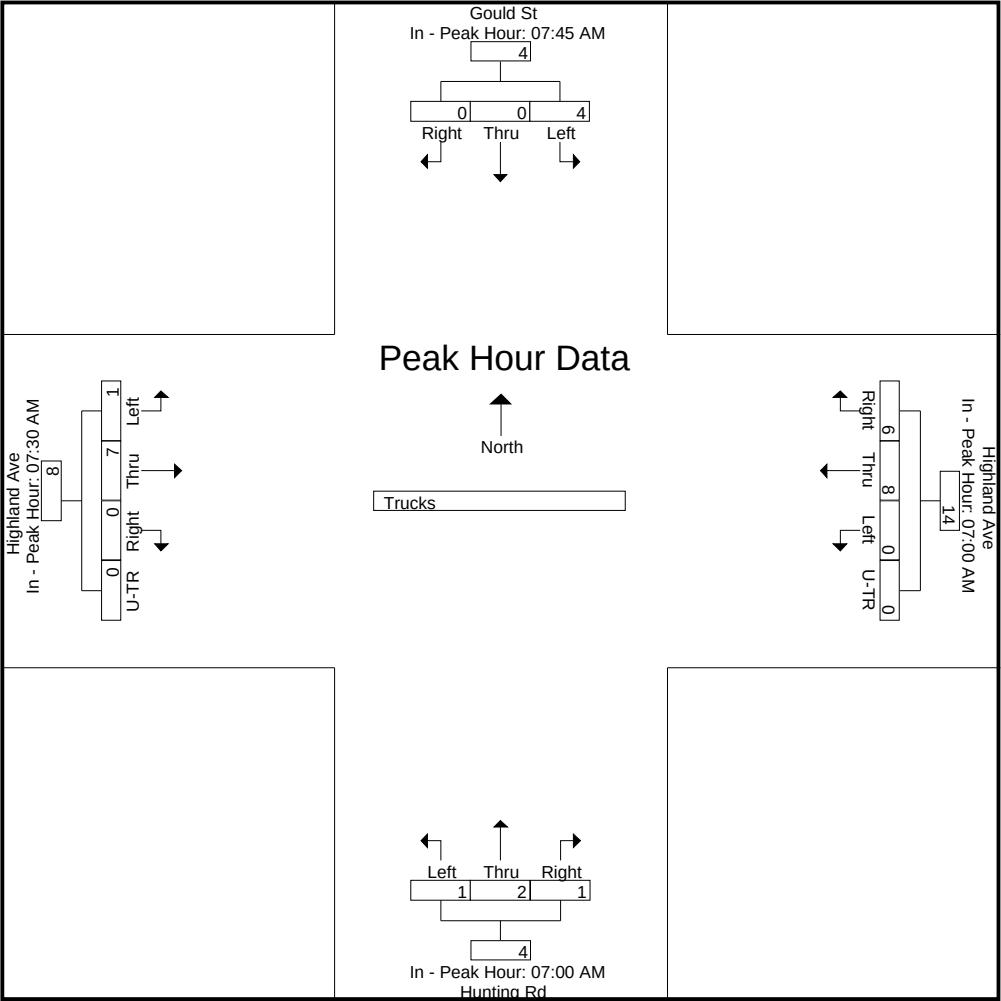
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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
Page No : 1

Groups Printed- Bikes Peds

	Gould St From North				Highland Ave From East				Hunting Rd From South				Highland Ave From West				Exclu. Total	Inclu. Total	Int. Total
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds			
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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

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N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

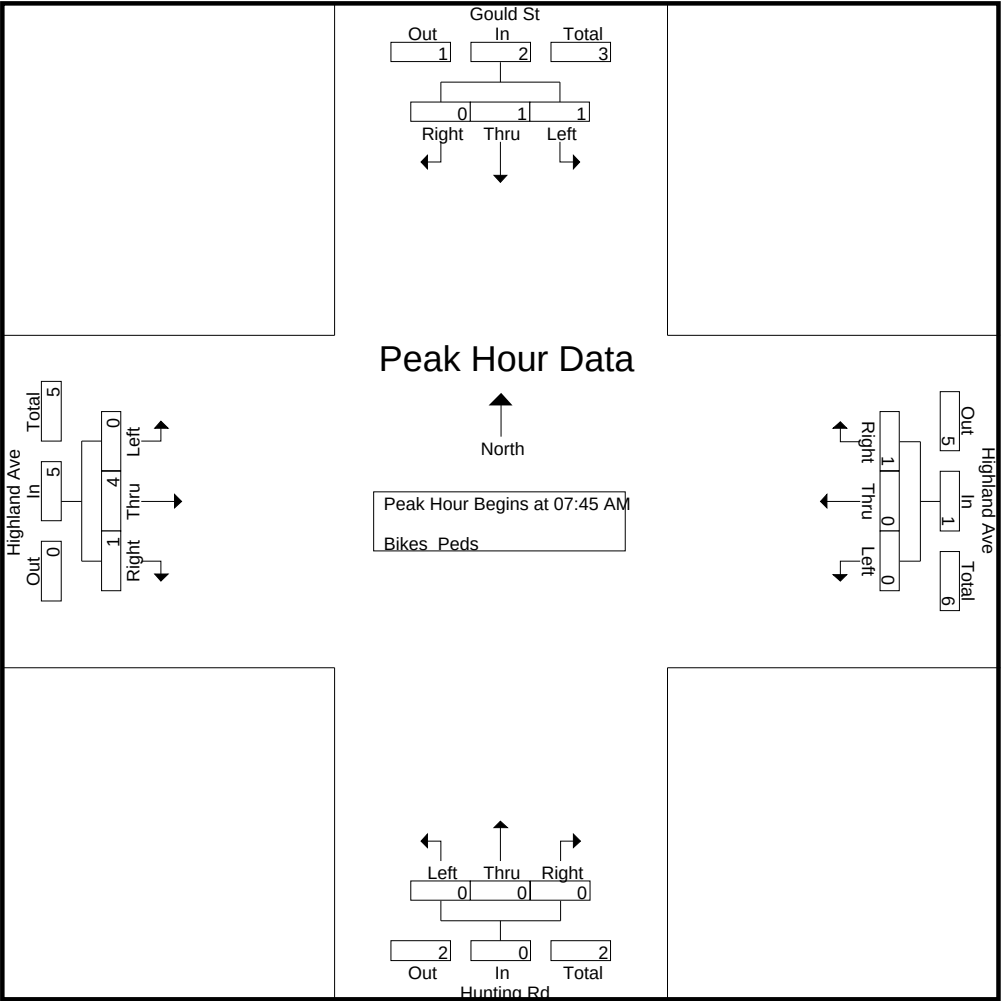
Weather : Clear

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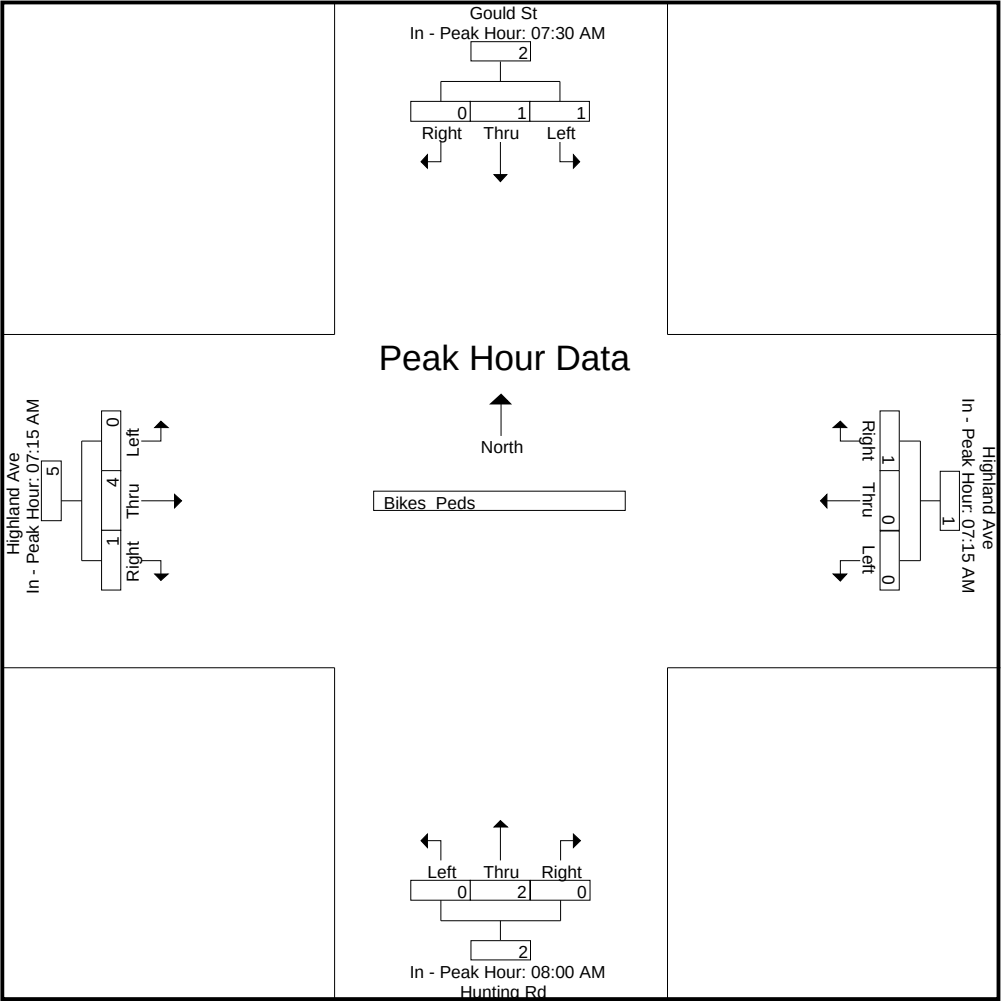
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

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N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Clear

	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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

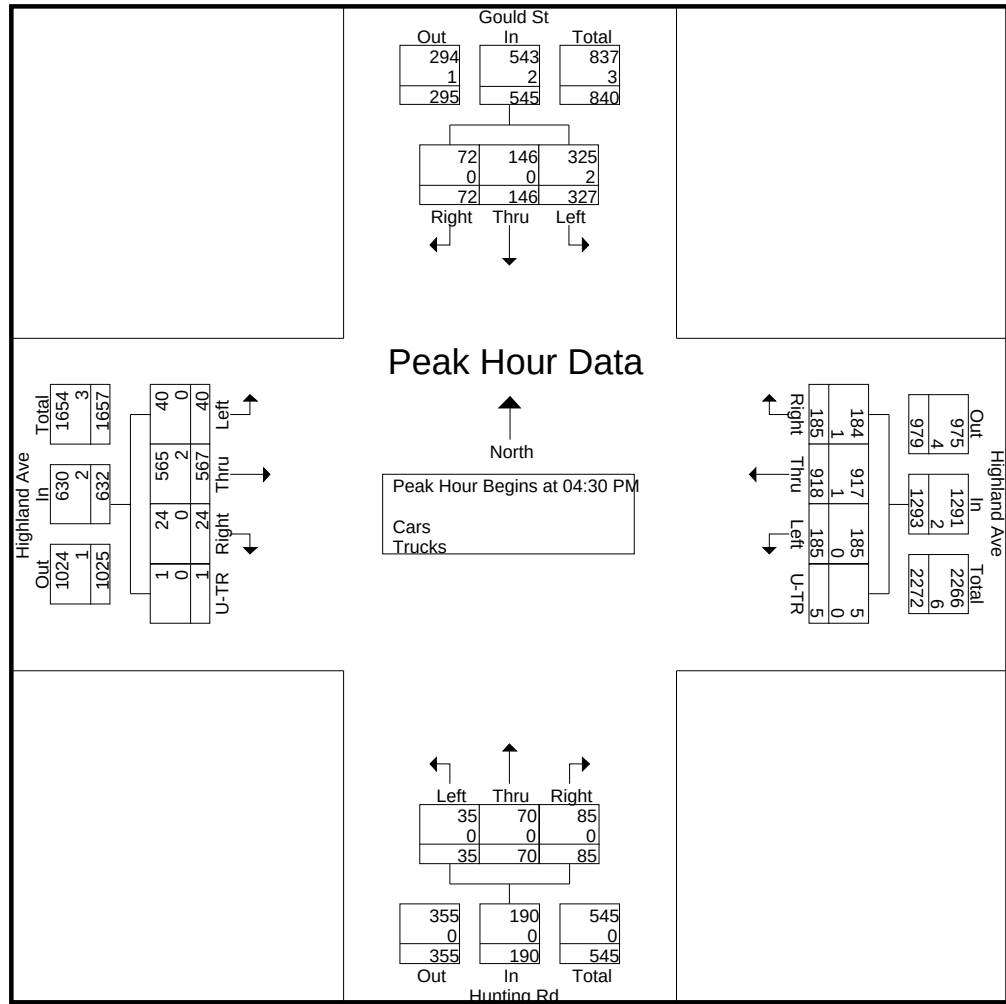
Page No : 3

N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Clear



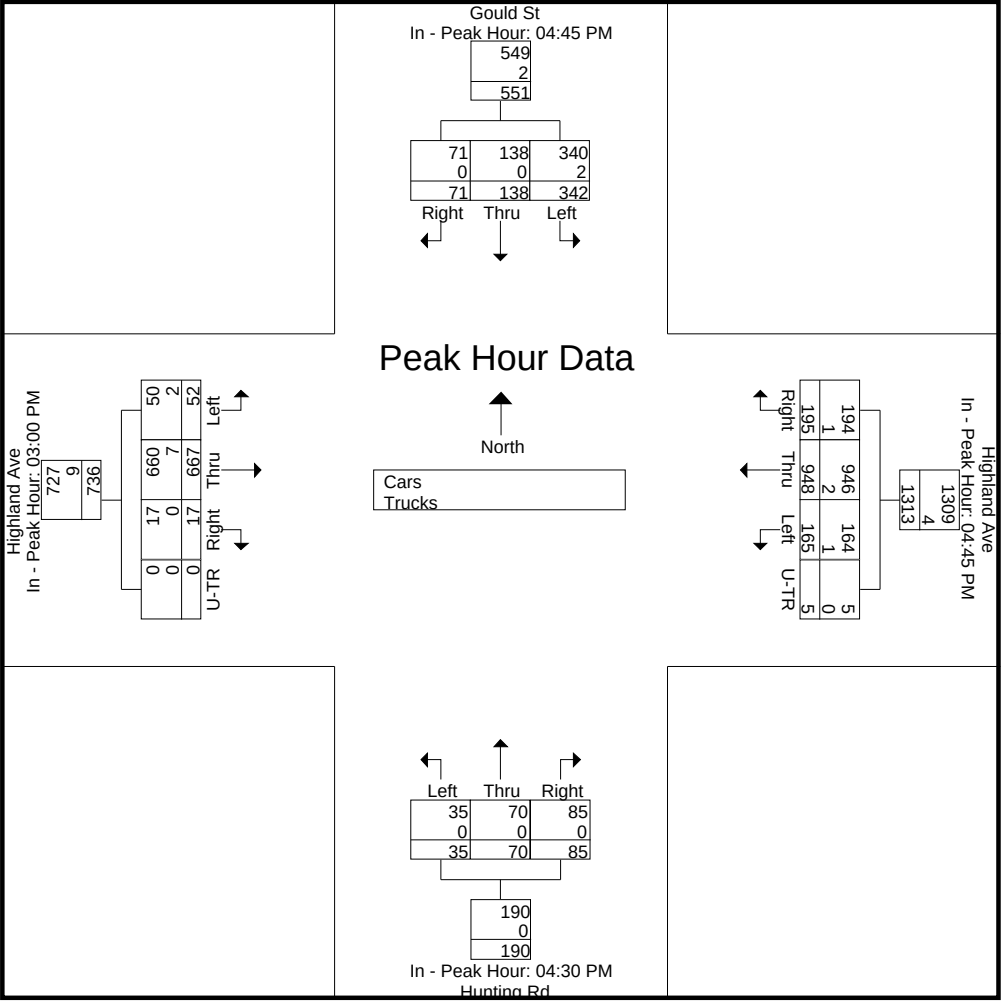
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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
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
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
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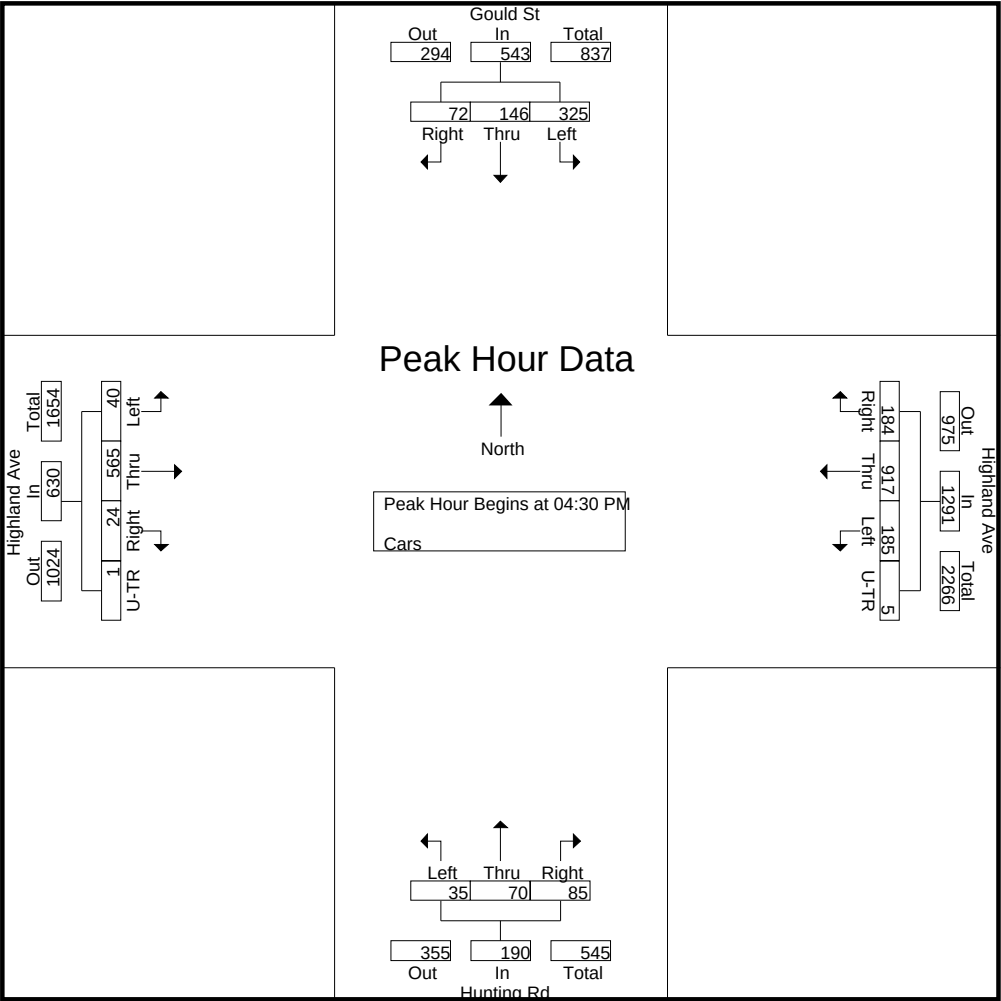
	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																			
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
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Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

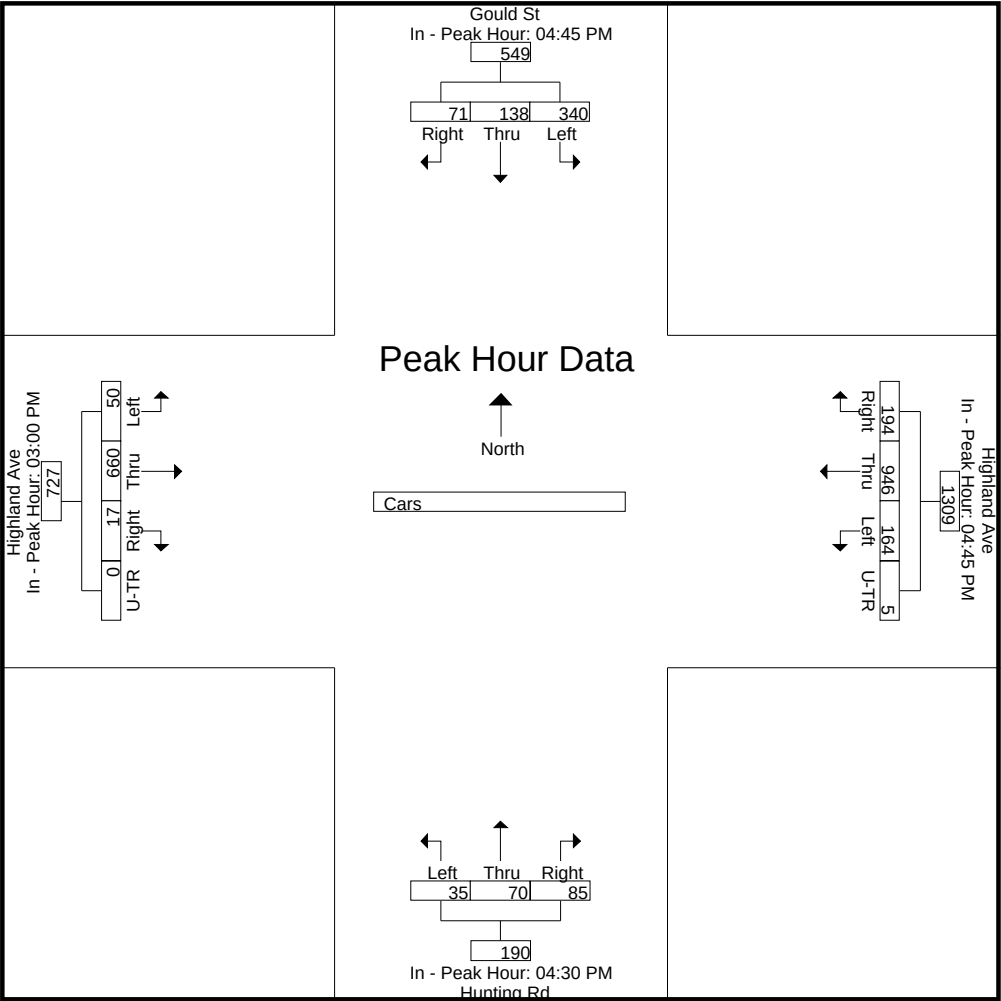
Peak Hour for Each Approach Begins at:

	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
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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- 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

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 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

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

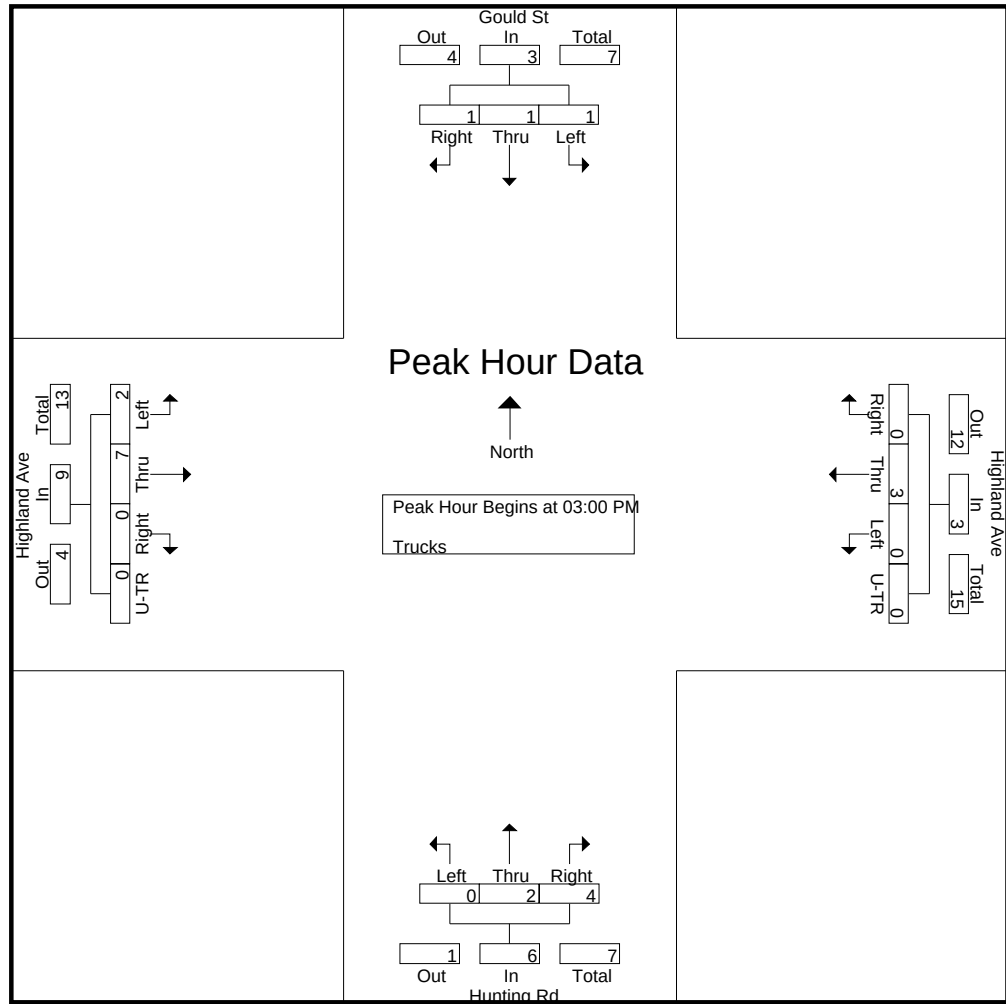
Page No : 3

N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Clear



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

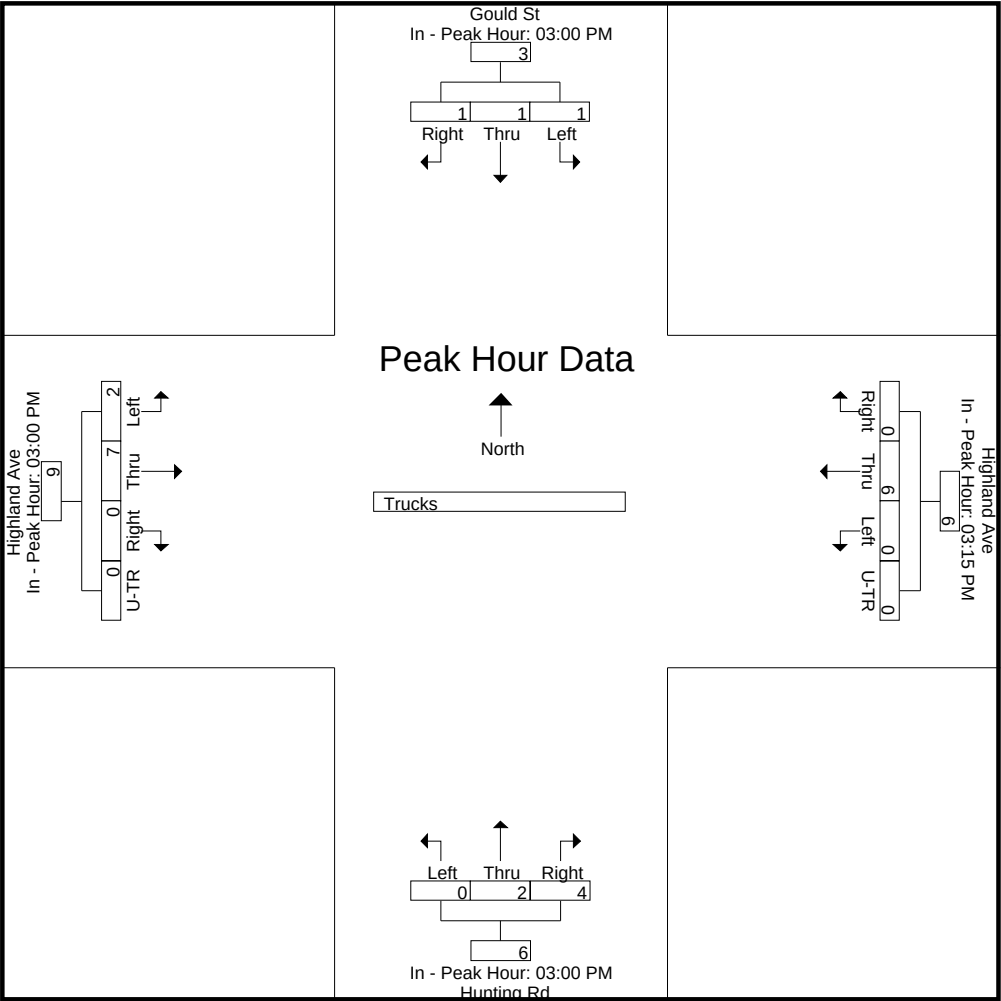
Peak Hour for Each Approach Begins at:

	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
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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- Bikes Peds

	Gould St From North				Highland Ave From East				Hunting Rd From South				Highland Ave From West				Exclu. Total	Inclu. Total	Int. Total
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds			
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

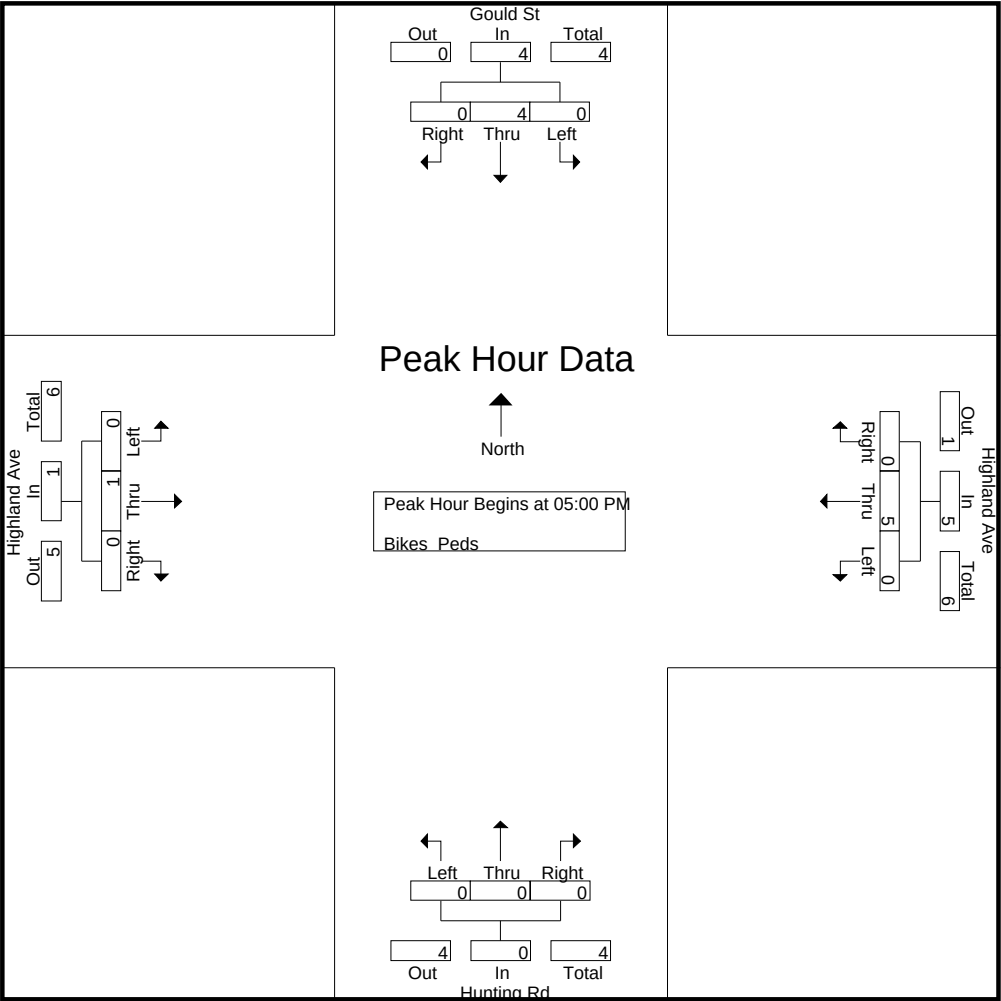
Page No : 2

	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 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
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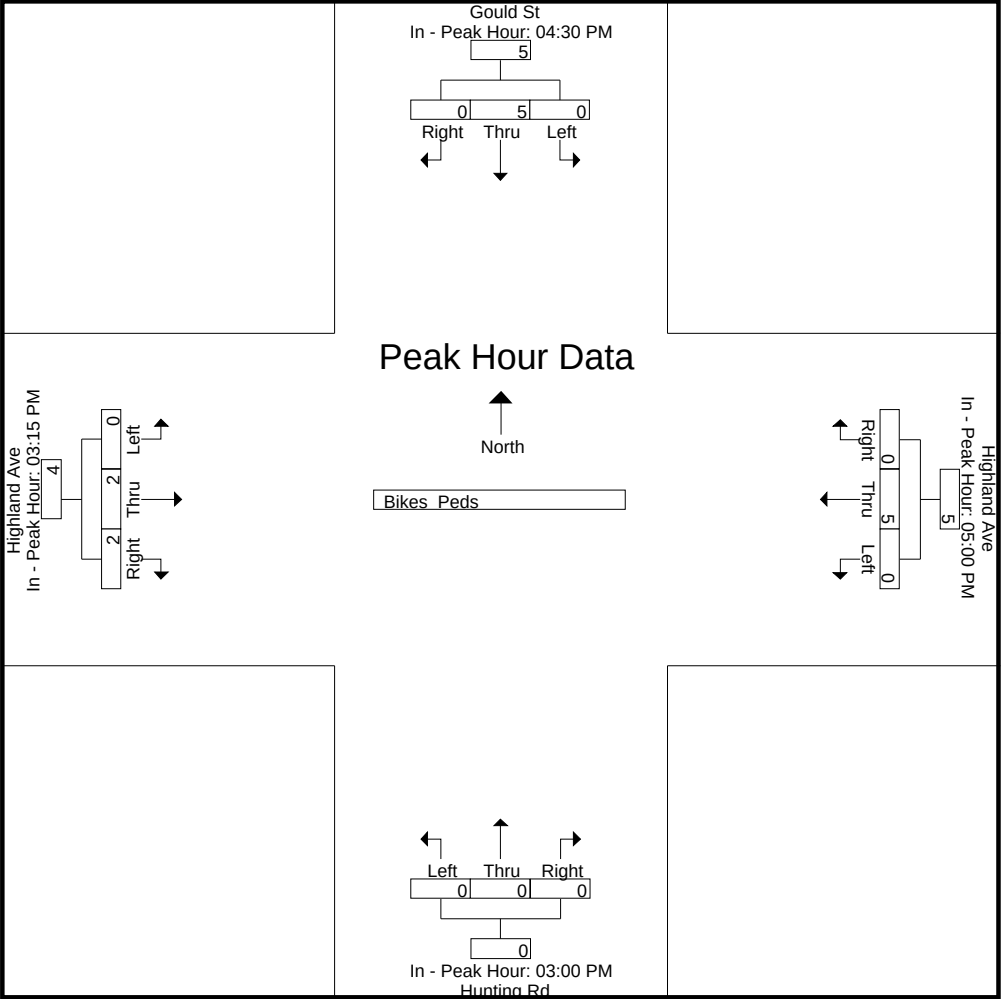
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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
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File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
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978-664-2565

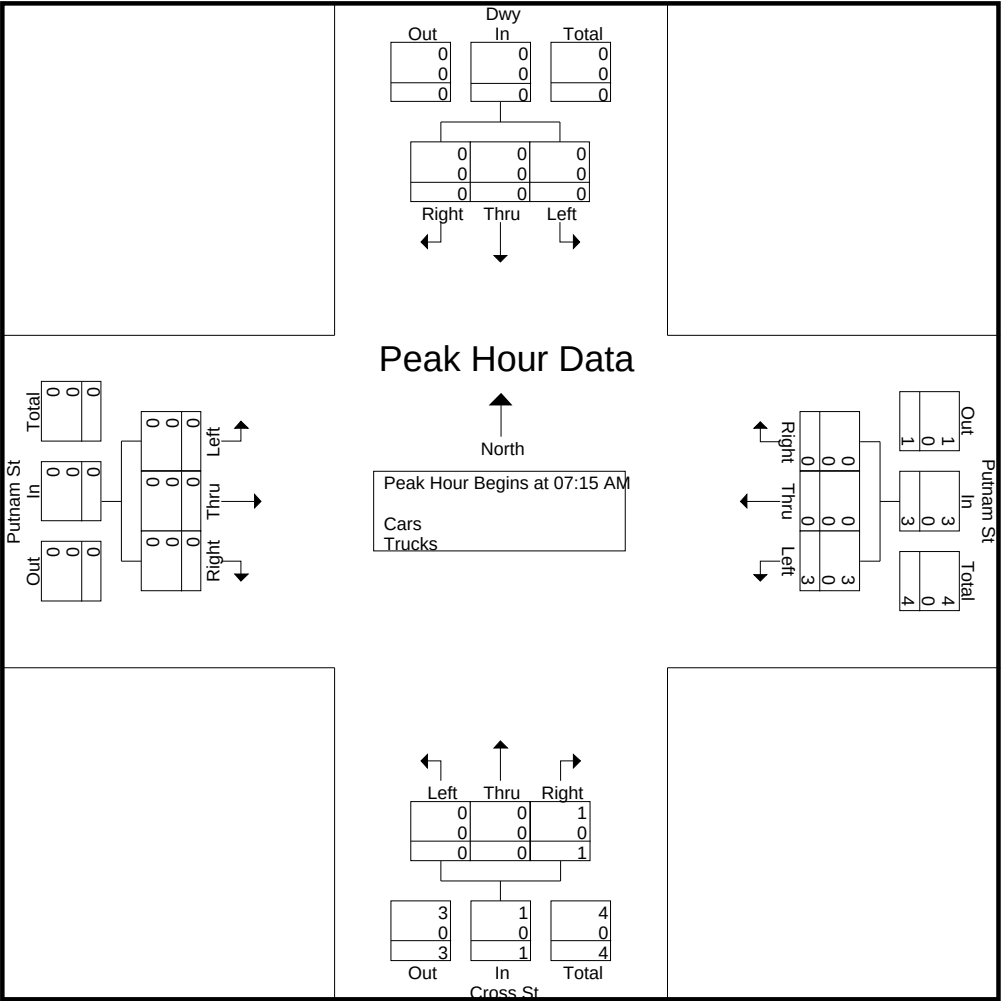
File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 2

[illegible]

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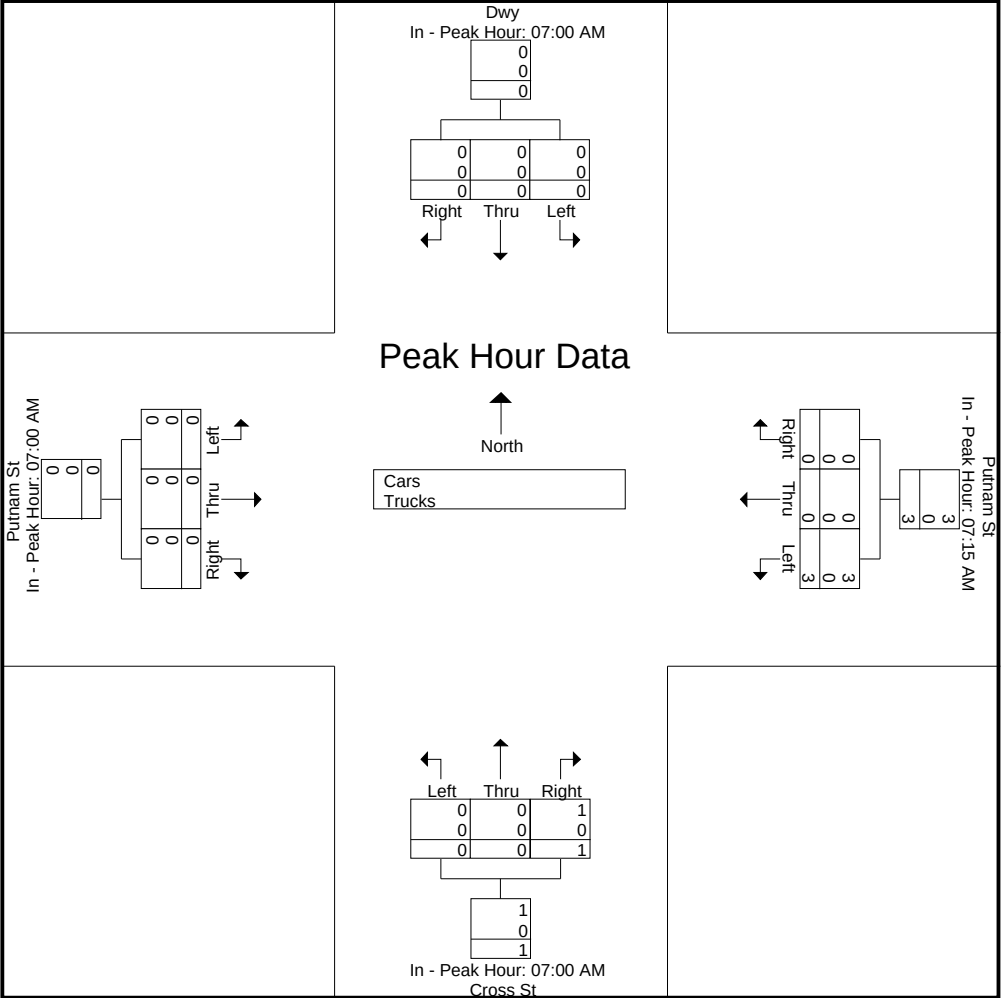
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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
Page No : 5

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

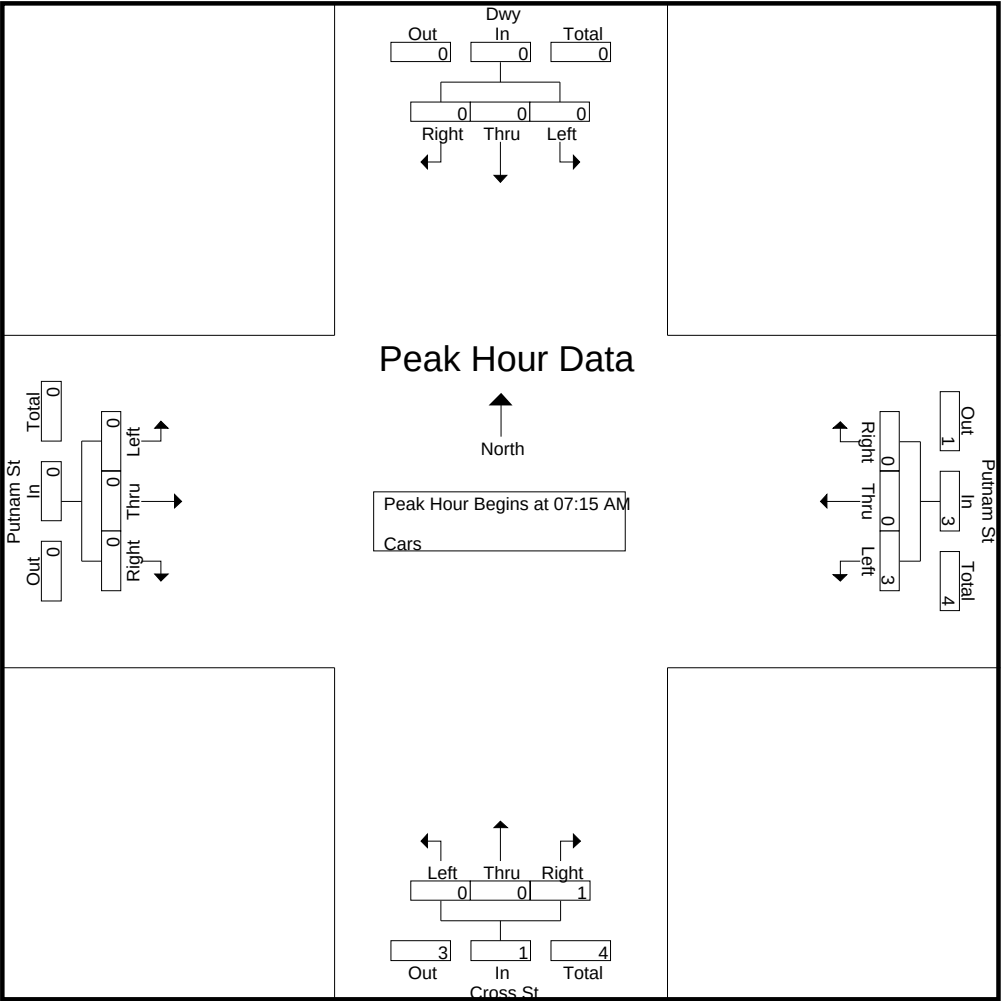
File Name : 83150005
 Site Code : 83150005
 Start Date : 9/4/2019
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	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	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
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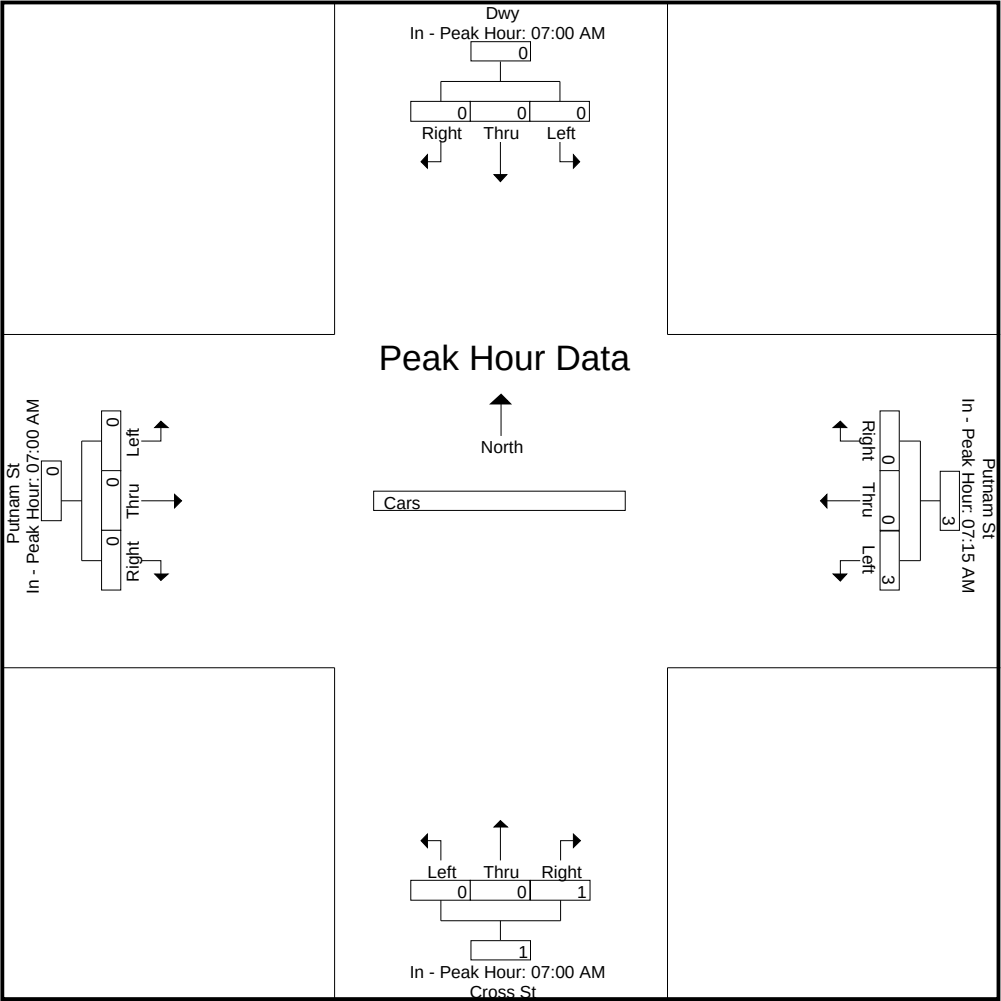
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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



978-664-2565

Weather : Cloudy

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[illegible]

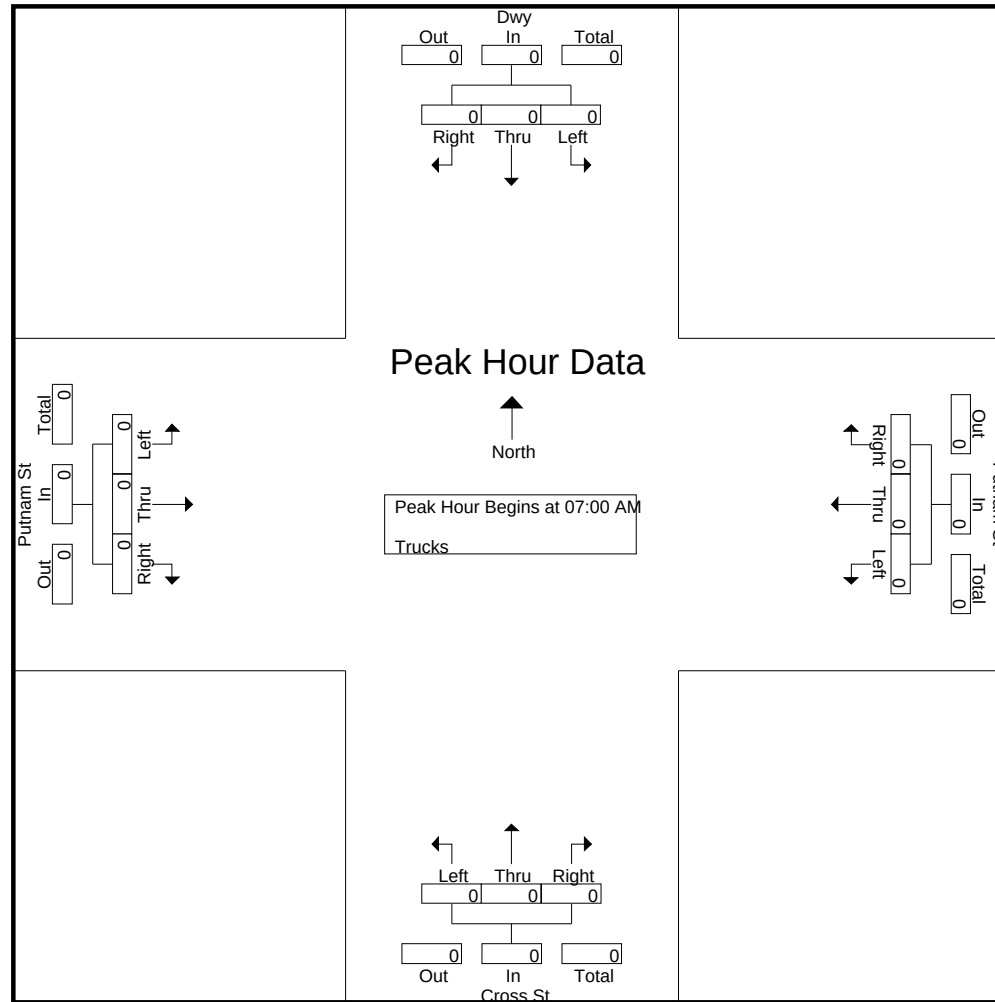
978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
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File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 11

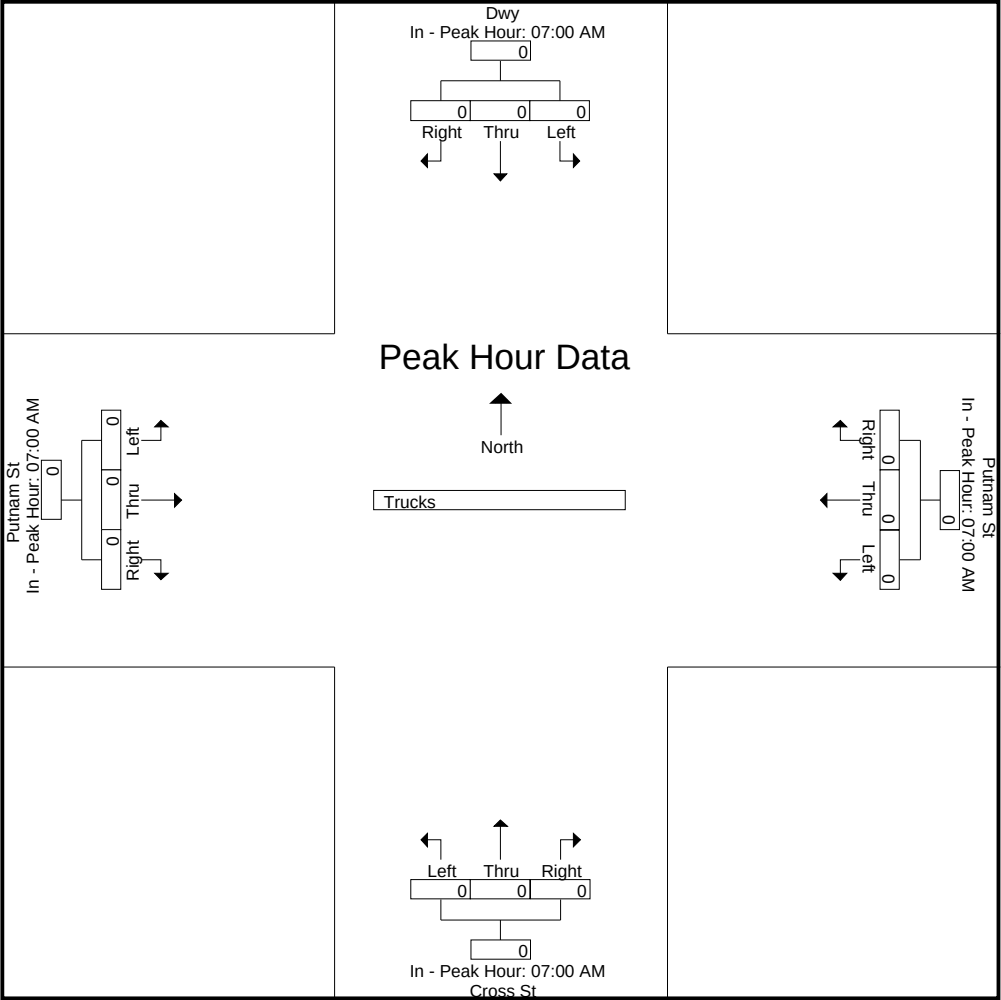


Peak Hour for Each Approach Begins at:

[illegible]

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



978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 13

Groups Printed- Bikes Peds

[illegible]

978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 14

[illegible]

978-664-2565

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

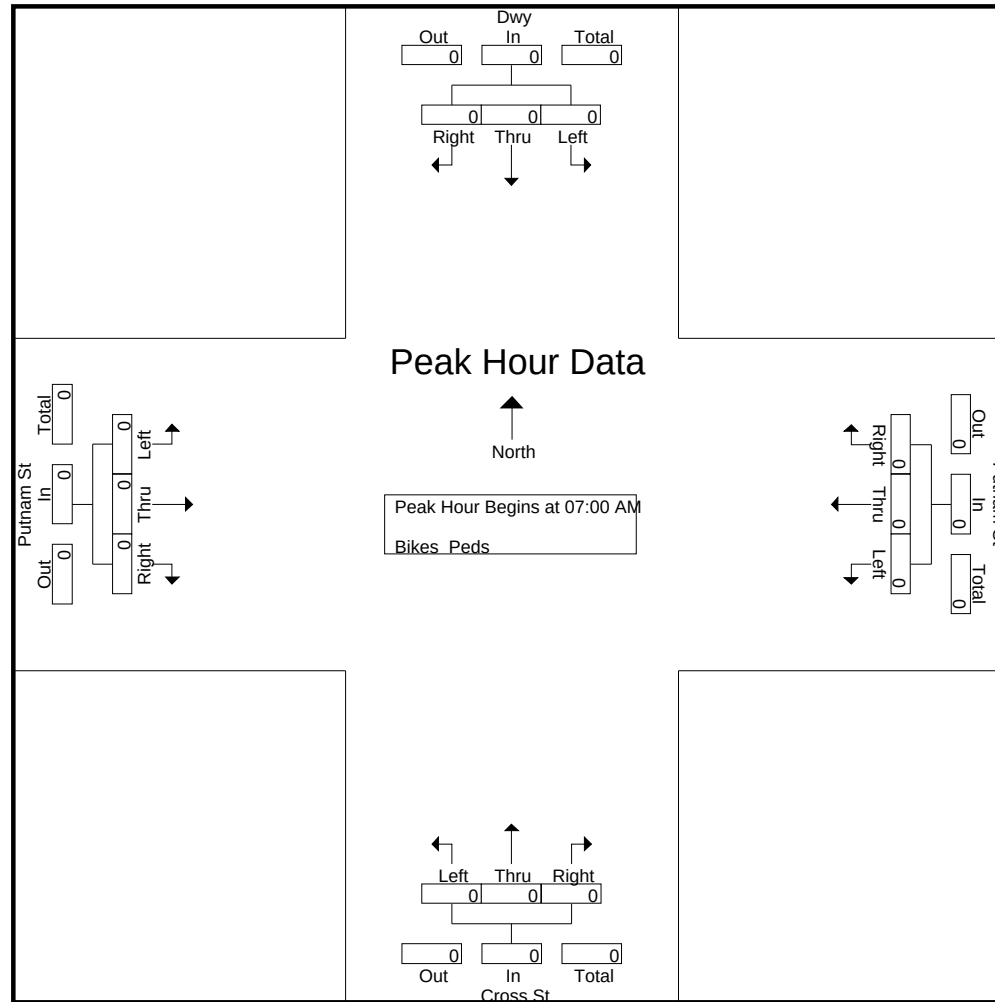
Page No : 15

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



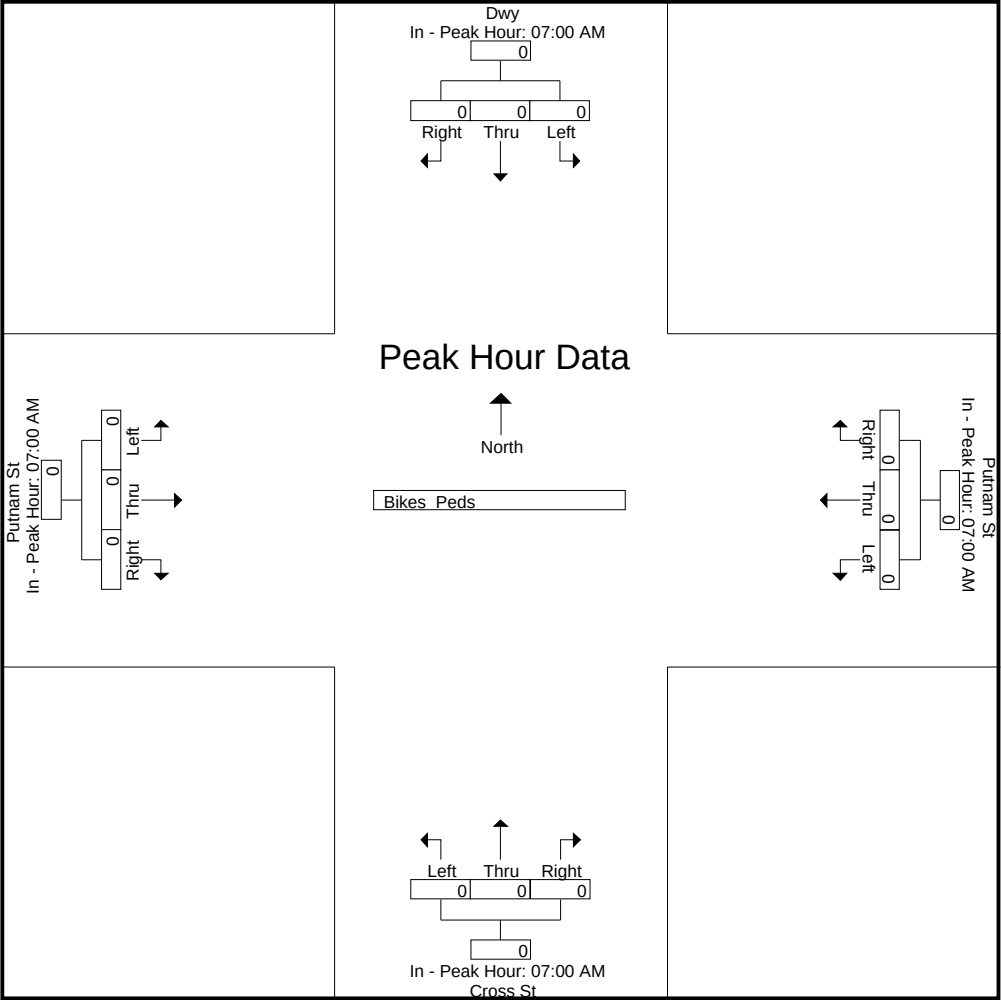
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

[illegible]

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



978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 1

[illegible]

978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 2

[illegible]

Accurate Counts

978-664-2565

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

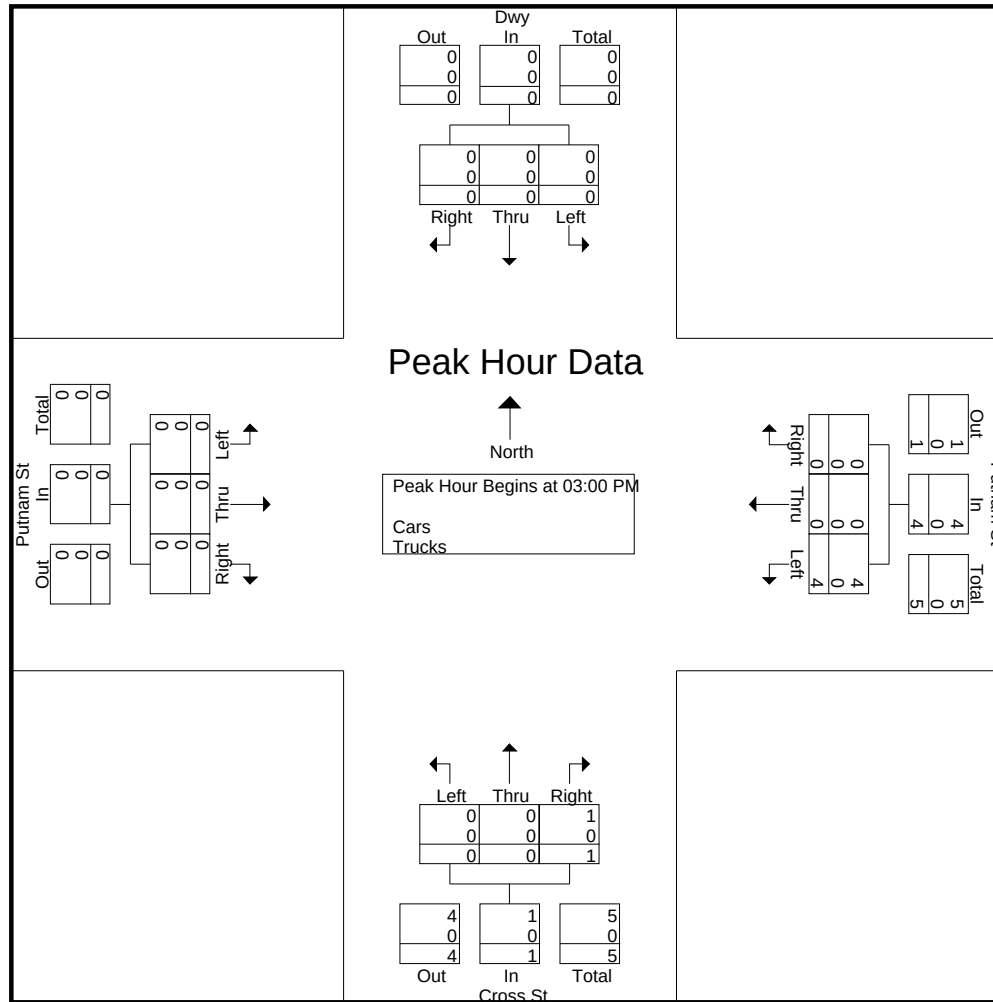
Page No : 3

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



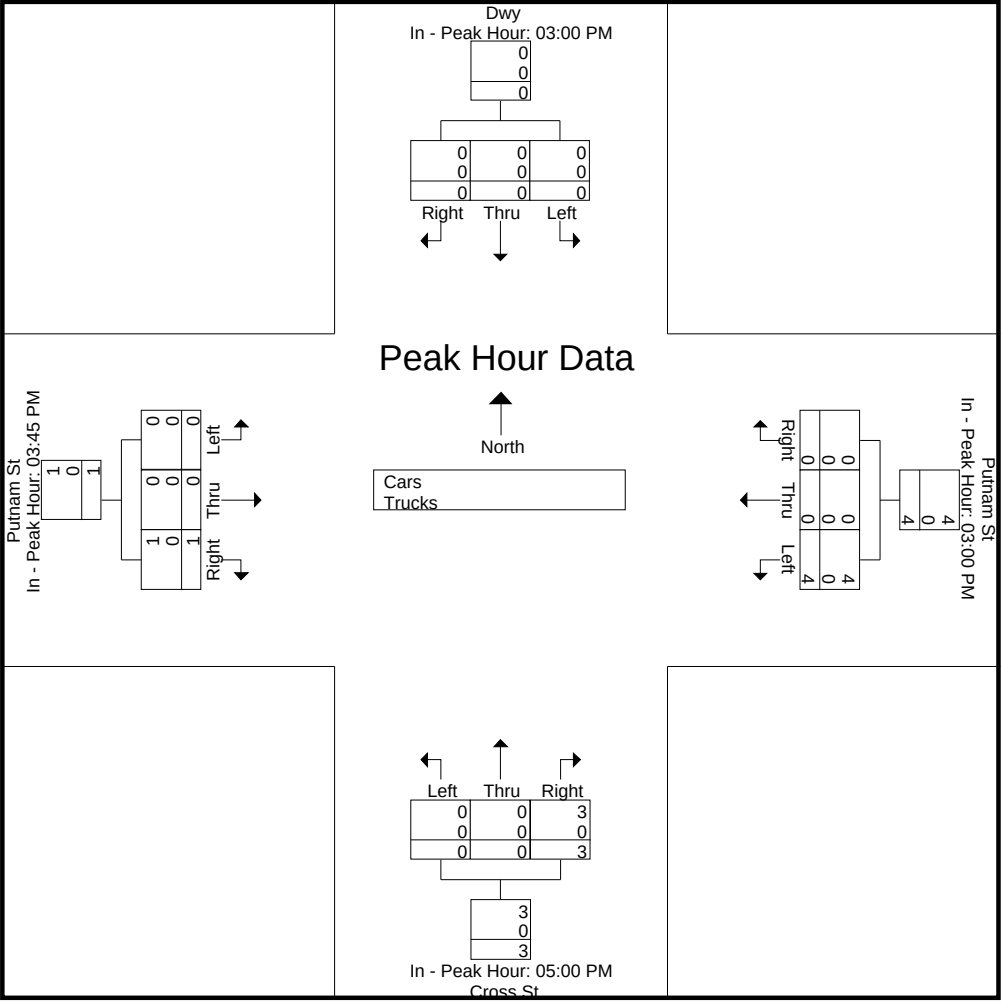
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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	0	100	0	0	100	0	0	100	100	0	0	100	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
Page No : 5

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

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

Page No : 6

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy

	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

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

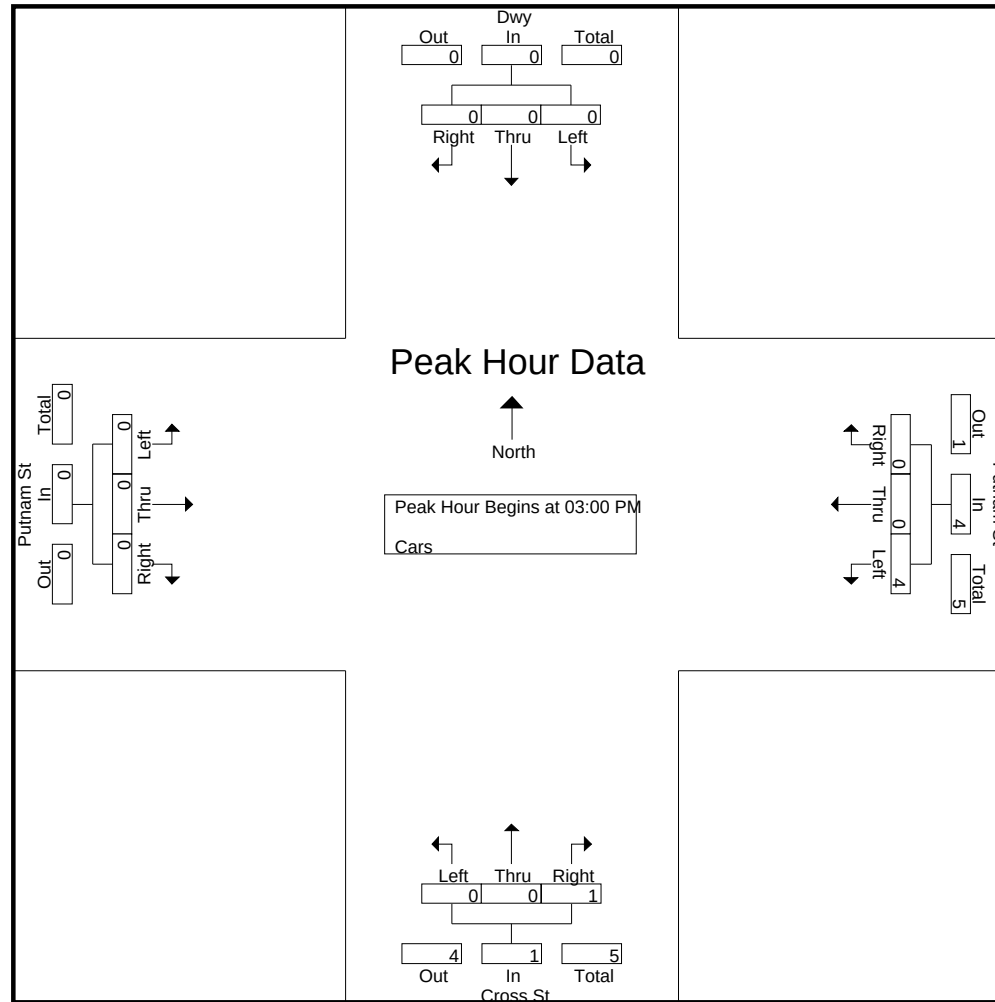
Page No : 7

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



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

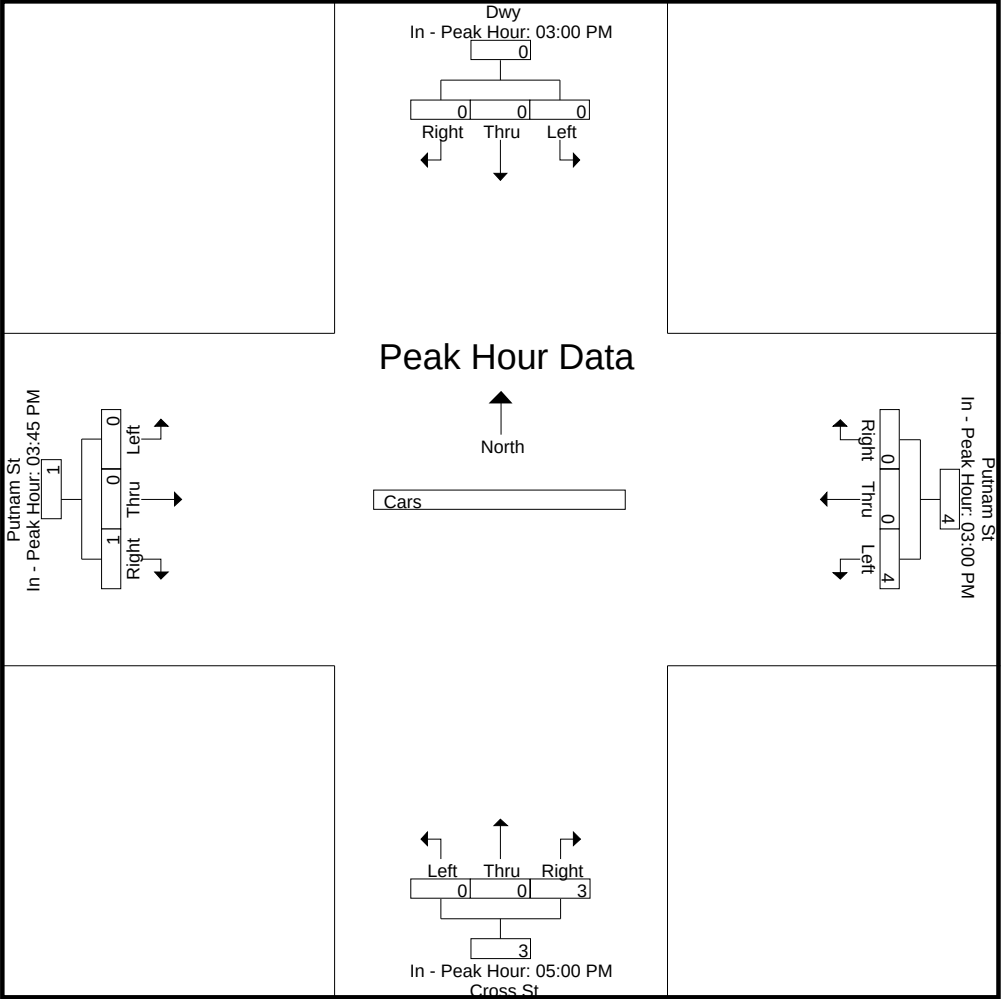
Peak Hour for Each Approach Begins at:

	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	0	100	0	0	100	0	0	100	100	0	0	100	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



978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 9

Groups Printed- Trucks

[illegible]

978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 10

[illegible]

978-664-2565

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

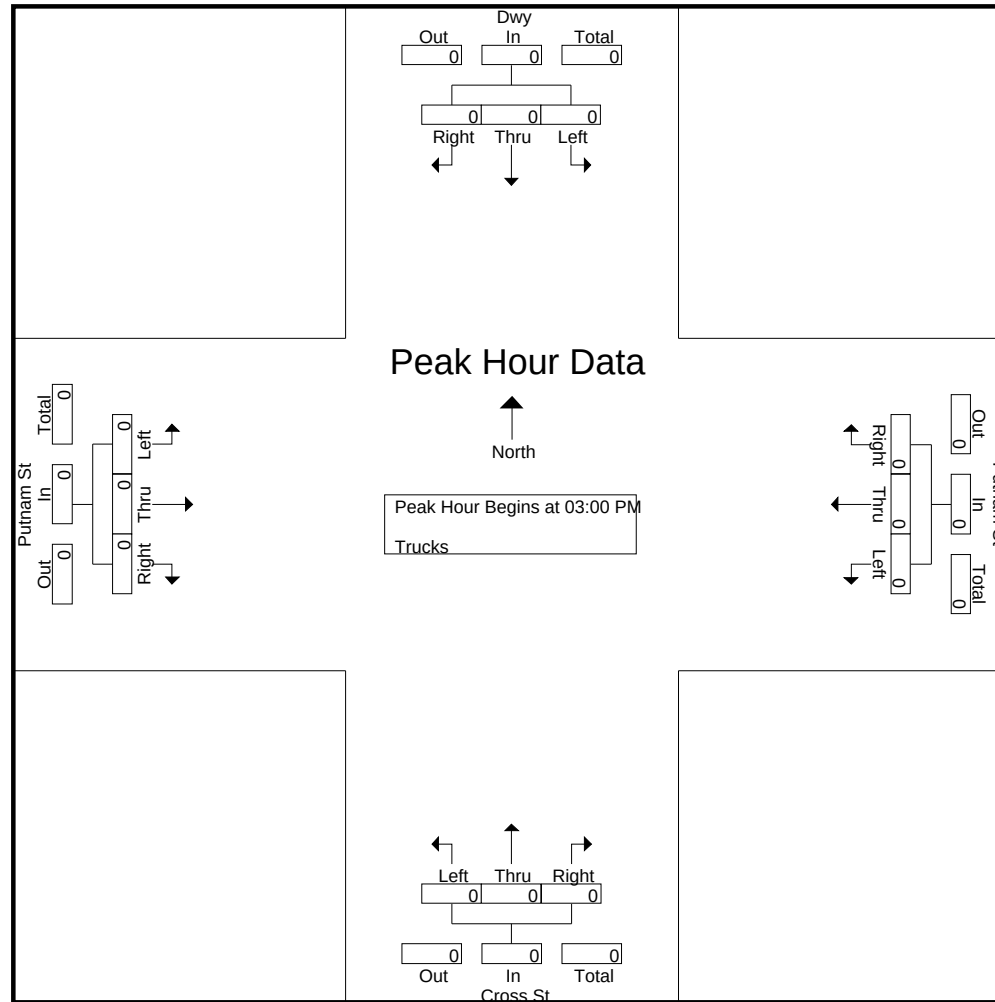
Page No : 11

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



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

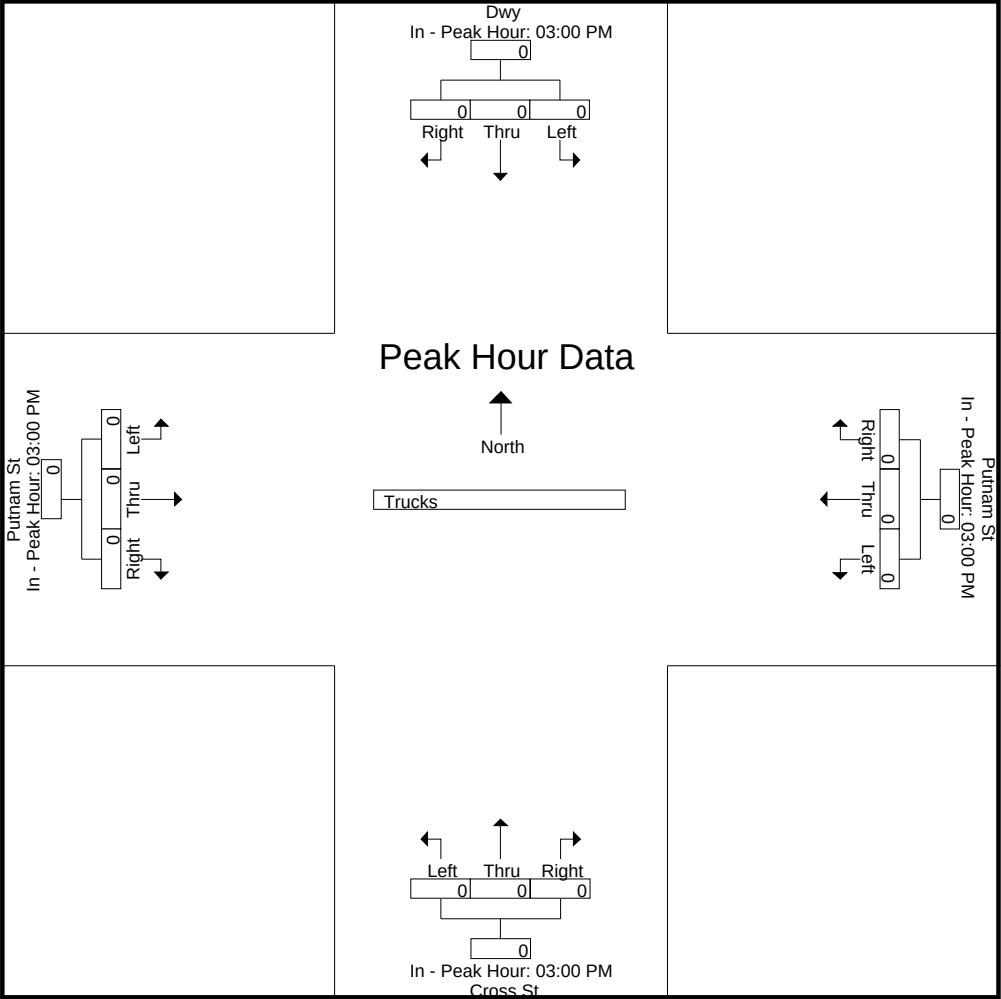
Peak Hour for Each Approach Begins at:

[illegible]

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



978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 13

[illegible]

978-664-2565

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 14

[illegible]

978-664-2565

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

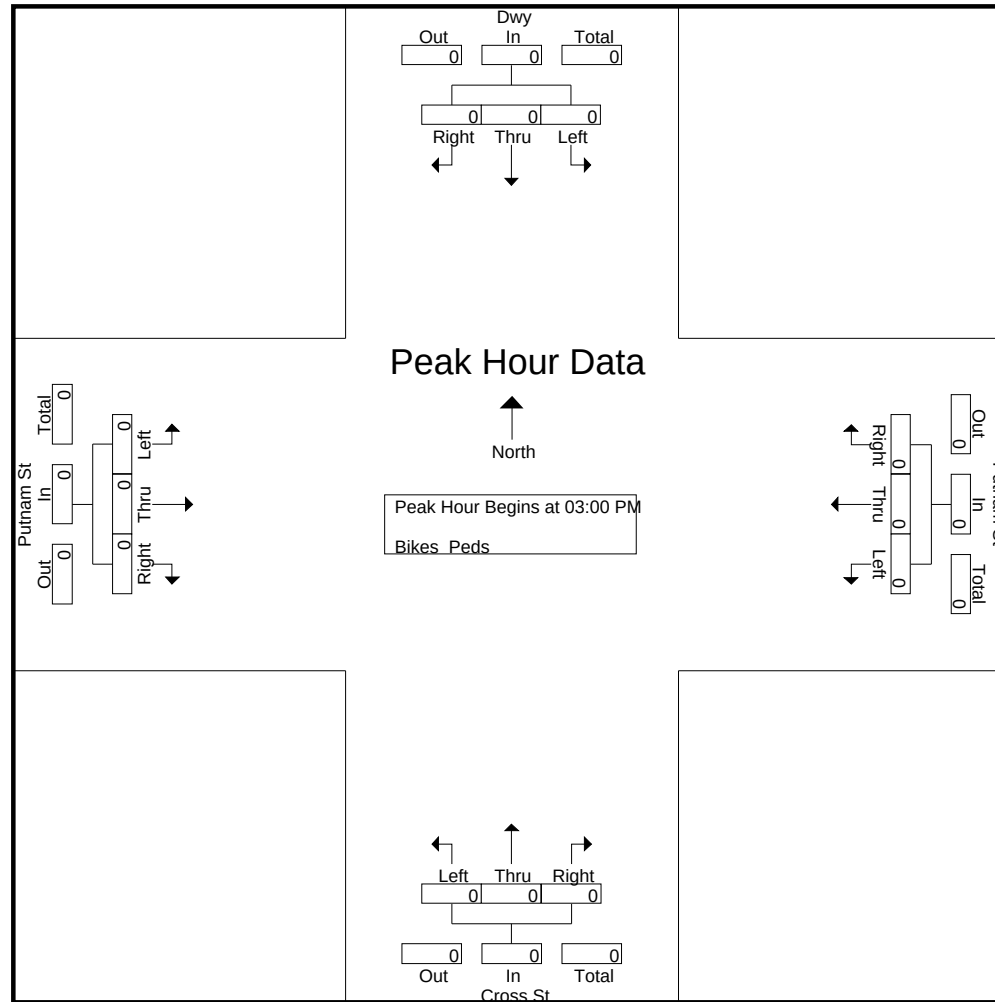
Page No : 15

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



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

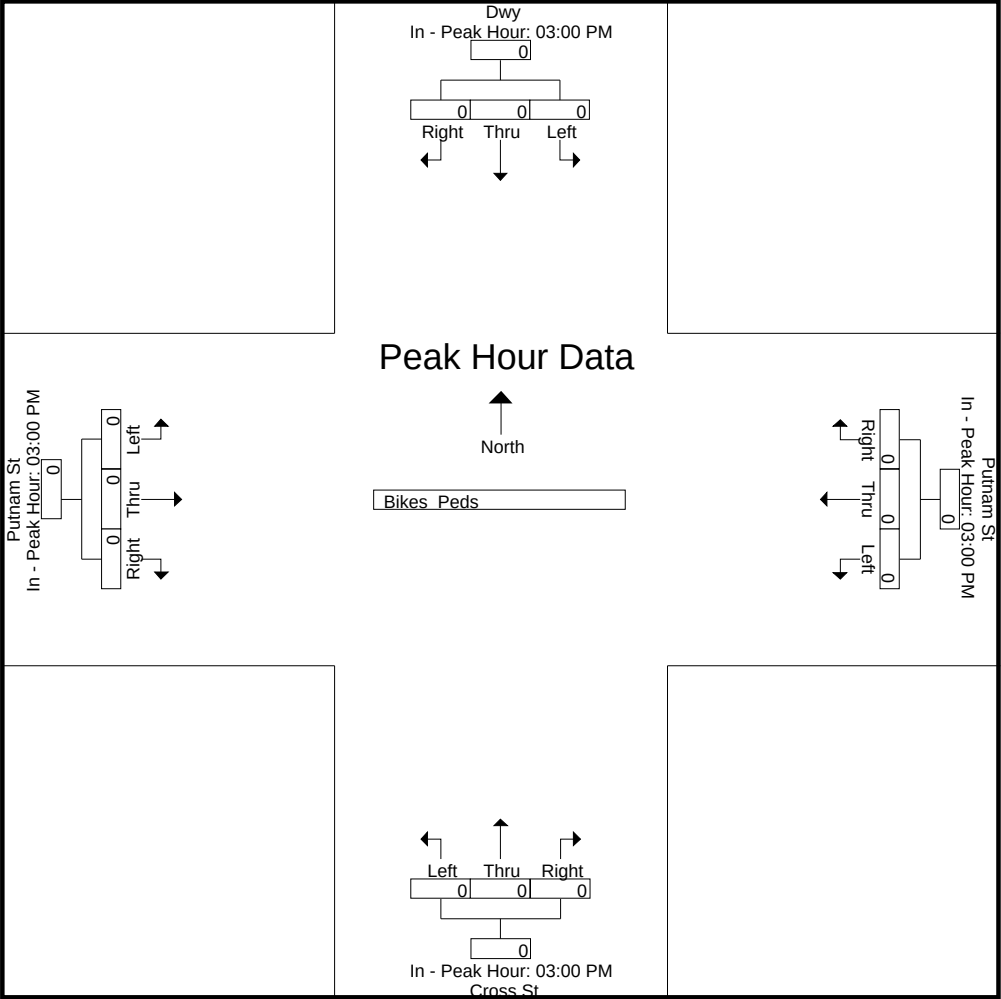
Peak Hour for Each Approach Begins at:

[illegible]

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.

VEHICLE TRAVEL SPEED DATA



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
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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
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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
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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

			AM								PM							
ZONE	STATION	TRAIN #	600	602	604	606	608	610	612	614	616	618	620	622	624	626	628	630
	Bikes Allowed																	
2	Needham Heights		5:05	6:05	7:05	8:05	9:05	10:05	11:05	12:05	1:05	2:05	3:05	4:05	5:05	6:05	7:05	8:50
2	Needham Center		5:09	6:09	7:09	8:09	9:09	10:09	11:09	12:09	1:09	2:09	3:09	4:09	5:09	6:09	7:09	8:54
2	Needham Junction		5:13	6:13	7:13	8:13	9:13	10:13	11:13	12:13	1:13	2:13	3:13	4:13	5:13	6:13	7:13	8:58
2	Hersey		5:16	6:16	7:16	8:16	9:16	10:16	11:16	12:16	1:16	2:16	3:16	4:16	5:16	6:16	7:16	9:01
1	West Roxbury		5:21	6:22	7:22	8:22	9:21	10:21	11:21	12:21	1:21	2:26	3:26	4:26	5:26	6:26	7:26	9:06
1	Highland		5:23	6:24	7:24	8:24	9:23	10:23	11:23	12:23	1:23	2:28	3:28	4:28	5:28	6:28	7:28	9:08
1	Bellevue		5:25	6:27	7:27	8:27	9:25	10:25	11:25	12:25	1:25	2:30	3:30	4:30	5:30	6:30	7:30	9:10
1	Roslindale Village		5:28	6:30	7:30	8:30	9:28	10:28	11:28	12:28	1:28	2:33	3:33	4:33	5:33	6:33	7:33	9:13
1A	Forest Hills		5:31	6:34	7:34	8:34	9:31	10:31	11:31	12:31	1:31	2:36	3:36	4:36	5:36	6:36	7:36	9:16
1A	Ruggles		L 5:37	L 6:40	L 7:40	L 8:40	L 9:37	L 10:37	L 11:37	L 12:37	L 1:37	L 2:42	L 3:42	L 4:42	L 5:42	L 6:42	L 7:42	L 9:22
1A	Back Bay		L 5:41	L 6:44	L 7:44	L 8:44	L 9:40	L 10:40	L 11:40	L 12:40	L 1:40	L 2:45	L 3:45	L 4:45	L 5:45	L 6:45	L 7:45	L 9:25
1A	South Station		5:47	6:50	7:50	8:50	9:46	10:45	11:45	12:45	1:45	2:50	3:50	4:51	5:51	6:50	7:50	9:30

Monday to Friday

Outbound from Boston

Outbound from Boston			AM						PM										
ZONE	STATION	TRAIN #	603	605	607	609	611	613	615	617	619	621	623	625	627	629	631	Providence 839	633
	Bikes Allowed																		
1A	South Station		6:50	7:50	8:50	9:50	10:50	11:50	12:50	1:55	2:55	3:55	4:55	5:55	6:55	7:55	9:20	11:00	Board Providence Train 839 and change trains at Forest Hills for a Needham connection
1A	Back Bay		6:55	7:55	8:55	9:55	10:55	11:55	12:55	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:25	11:05	
1A	Ruggles		6:58	7:58	8:58	9:58	10:58	11:58	12:58	2:03	3:03	4:03	5:03	6:03	7:03	8:03	9:28	11:08	
1A	Forest Hills		7:03	8:03	9:03	10:03	11:03	12:03	1:03	2:08	3:08	4:08	5:08	6:08	7:08	8:08	9:33	11:13	
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

			AM				PM			
SATURDAY TRAIN #			1600	1602	1604	1606	1608	1610	1612	1614
ZONE	STATION	SUNDAY TRAIN #	2600	2602	2604	2606	2608	2610	2612	2614
	Bikes Allowed									
2	Needham Heights		6:10	8:10	10:10	12:10	2:10	4:10	6:10	8:10
2	Needham Center		6:14	8:14	10:14	12:14	2:14	4:14	6:14	8:14
2	Needham Junction		6:18	8:18	10:18	12:18	2:18	4:18	6:18	8:18
2	Hersey		6:21	8:21	10:21	12:21	2:21	4:21	6:21	8:21
1	West Roxbury		6:26	8:26	10:26	12:26	2:26	4:26	6:26	8:26
1	Highland		6:28	8:28	10:28	12:28	2:28	4:28	6:28	8:28
1	Bellevue		6:30	8:30	10:30	12:30	2:30	4:30	6:30	8:30
1	Roslindale Village		6:33	8:33	10:33	12:33	2:33	4:33	6:33	8:33
1A	Forest Hills		6:36	8:36	10:36	12:36	2:36	4:36	6:36	8:36
1A	Ruggles		L 6:41	L 8:41	L 10:41	L 12:41	L 2:41	L 4:41	L 6:41	L 8:41
1A	Back Bay		L 6:45	L 8:45	L 10:45	L 12:45	L 2:45	L 4:45	L 6:45	L 8:45
1A	South Station		6:50	8:50	10:50	12:50	2:50	4:50	6:50	8:50

Weekend

Outbound from Boston

Outbound from Boston			AM			PM				
SATURDAY TRAIN #			1601	1603	1605	1607	1609	1611	1613	1615
ZONE	STATION	SUNDAY TRAIN #	2601	2603	2605	2607	2609	2611	2613	2615
Bikes Allowed										
1A	South Station		7:15	9:15	11:15	1:15	3:15	5:15	7:15	10:15
1A	Back Bay		7:20	9:20	11:20	1:20	3:20	5:20	7:20	10:20
1A	Ruggles		7:23	9:23	11:23	1:23	3:23	5:23	7:23	10:23
1A	Forest Hills		7:28	9:28	11:28	1:28	3:28	5:28	7:28	10:28
1	Roslindale Village		7:31	9:31	11:31	1:31	3:31	5:31	7:31	10:31
1	Bellevue		7:34	9:34	11:34	1:34	3:34	5:34	7:34	10:34
1	Highland		7:36	9:36	11:36	1:36	3:36	5:36	7:36	10:36
1	West Roxbury		7:38	9:38	11:38	1:38	3:38	5:38	7:38	10:38
2	Hersey		7:43	9:43	11:43	1:43	3:43	5:43	7:43	10:43
2	Needham Junction		7:46	9:46	11:46	1:46	3:46	5:46	7:46	10:46
2	Needham Center		7:50	9:50	11:50	1:50	3:50	5:50	7:50	10:50
2	Needham Heights		7:55	9:55	11:55	1:55	3:55	5:55	7:55	10:55



Times in blue with "L" indicate an early departure:
The train may leave ahead of schedule at these stops.



Bikes: Bicycles are allowed on trains with the bicycle symbol shown below the train number.



Connect to a different train for continued service outbound.



High level platform and bridge plate available. Visit [mbta.com/accessibility](https://www.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](https://www.mbta.com/holidays) or call 617-222-3200.



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INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham COUNT DATE : _____

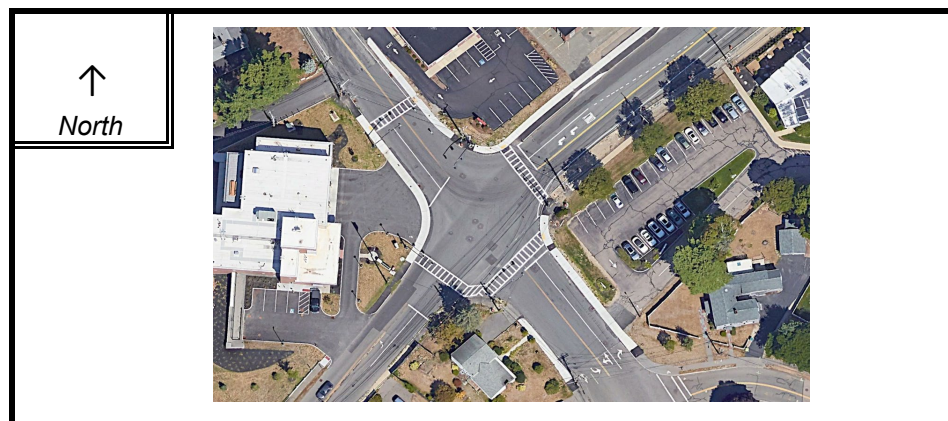
DISTRICT : 6 UNSIGNALIZED : ☐ SIGNALIZED : ☒

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Webster Street

**INTERSECTION
DIAGRAM**
(Label Approaches)



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

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

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 : _____

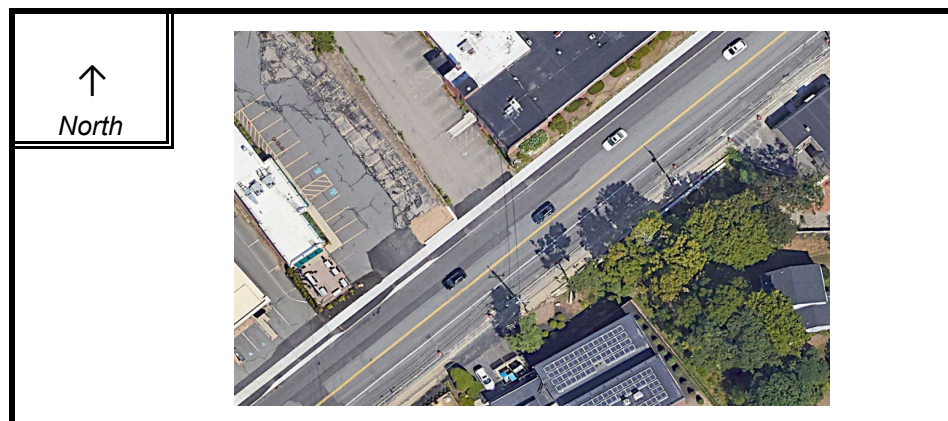
DISTRICT : 6 UNSIGNALIZED : ☒ SIGNALIZED : ☐

~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Arbor Street

**INTERSECTION
DIAGRAM**
(Label Approaches)



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

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

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)



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

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

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 : ☒

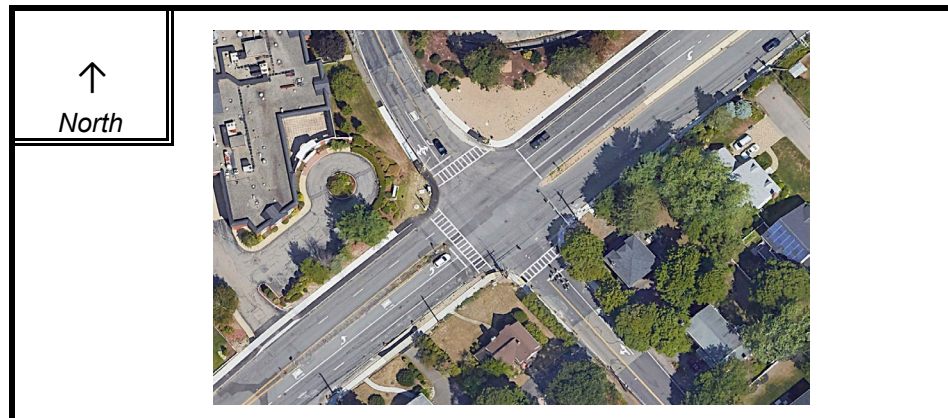
~ INTERSECTION DATA ~

MAJOR STREET : Highland Avenue

MINOR STREET(S) : Gould Street

Hunting Road

**INTERSECTION
DIAGRAM**
(Label Approaches)



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 :

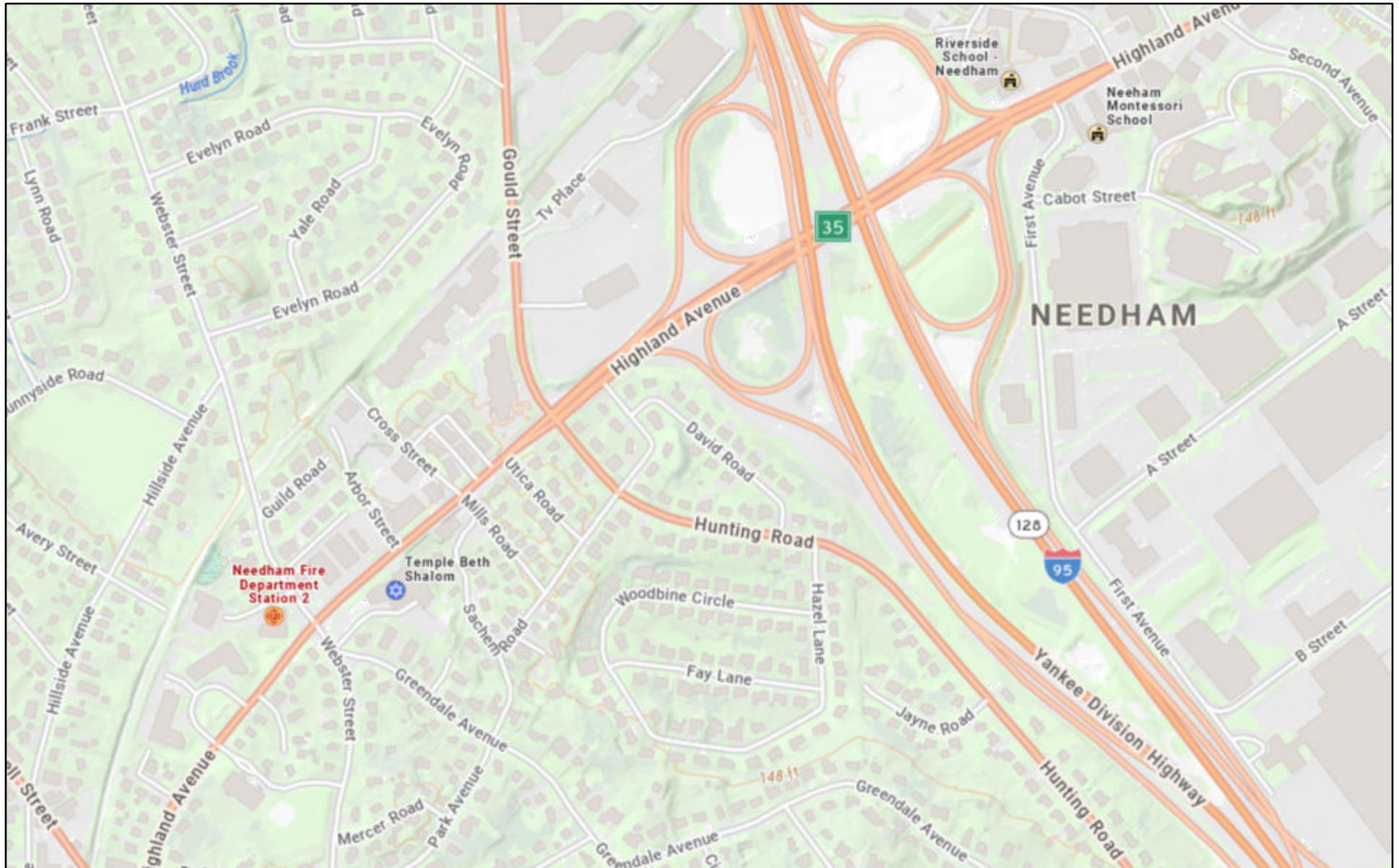
0.42

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

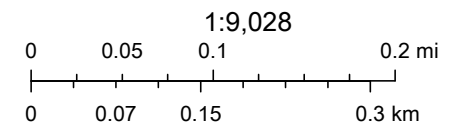
Comments : Below Statewide (0.78) and District (0.71) Crash Rates

Project Title & Date: Proposed Medical Office Building

MassDOT Top Crash Locations



5/30/2023, 12:20:34 PM



GENERAL BACKGROUND TRAFFIC GROWTH

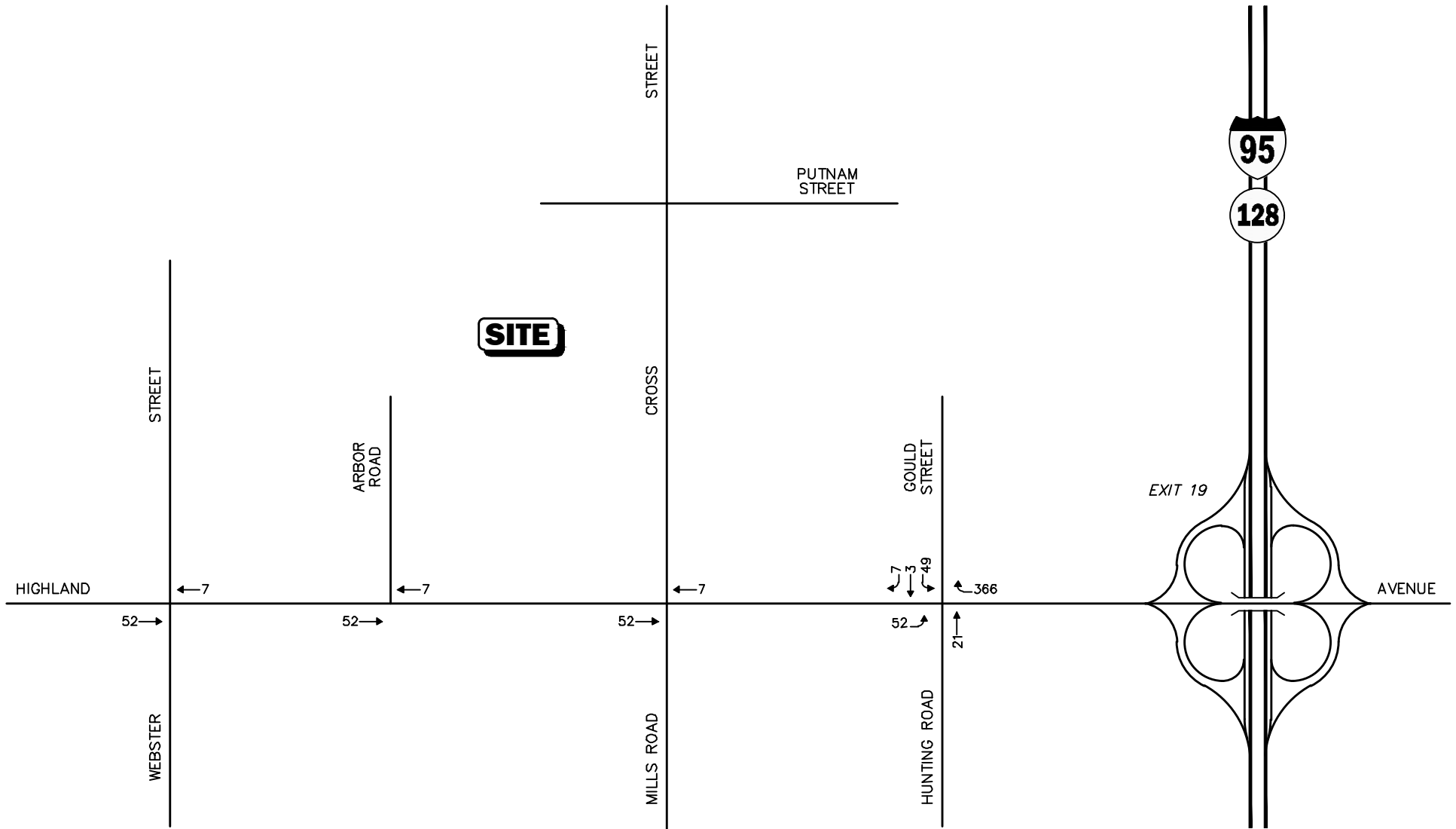


General Background Traffic Growth - Daily Traffic Volumes

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



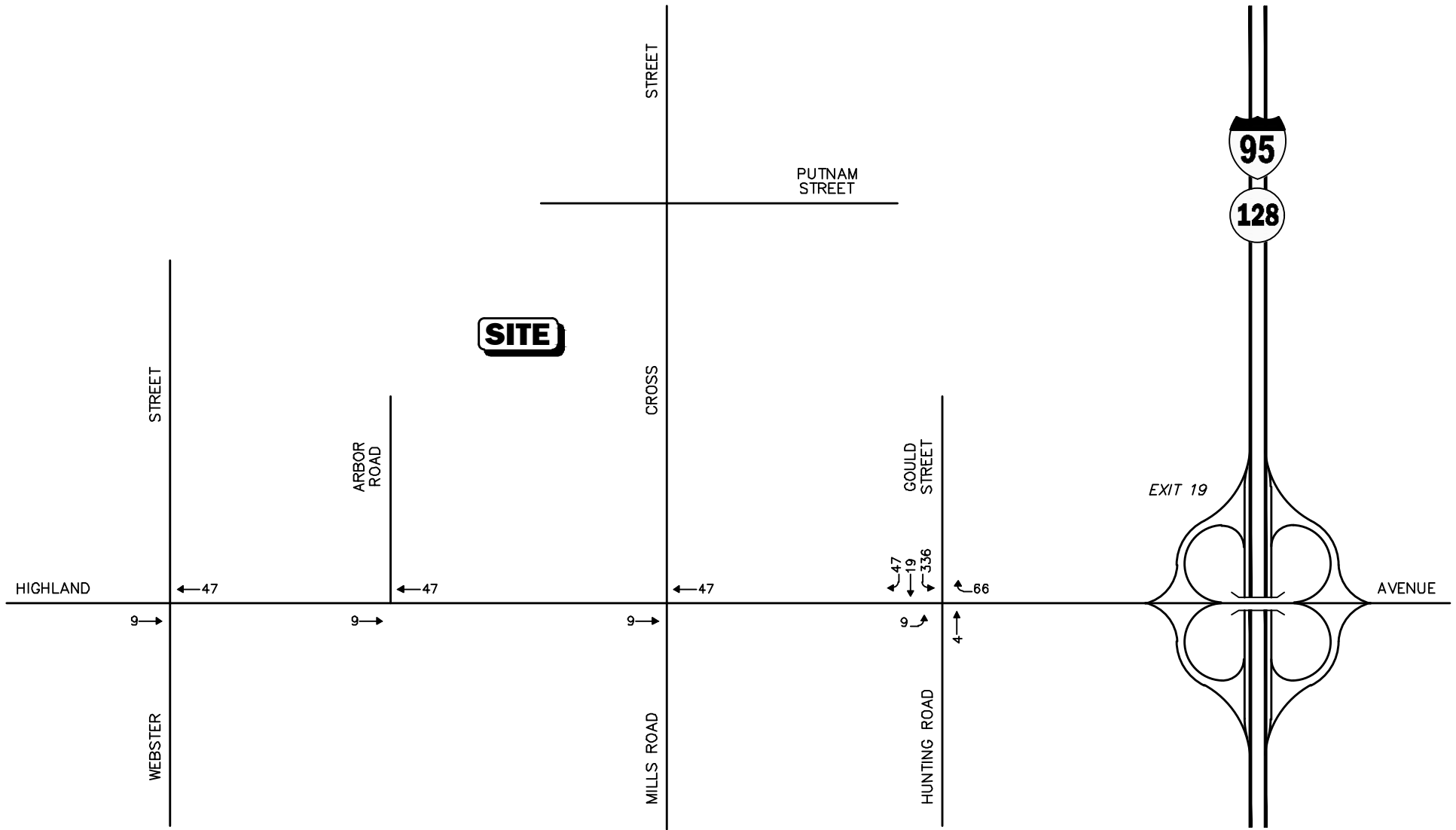


Not To Scale

VAI Vanasse & Associates inc

Figure A-1

Highland Science Center
Weekday Morning
Peak Hour Traffic Volumes

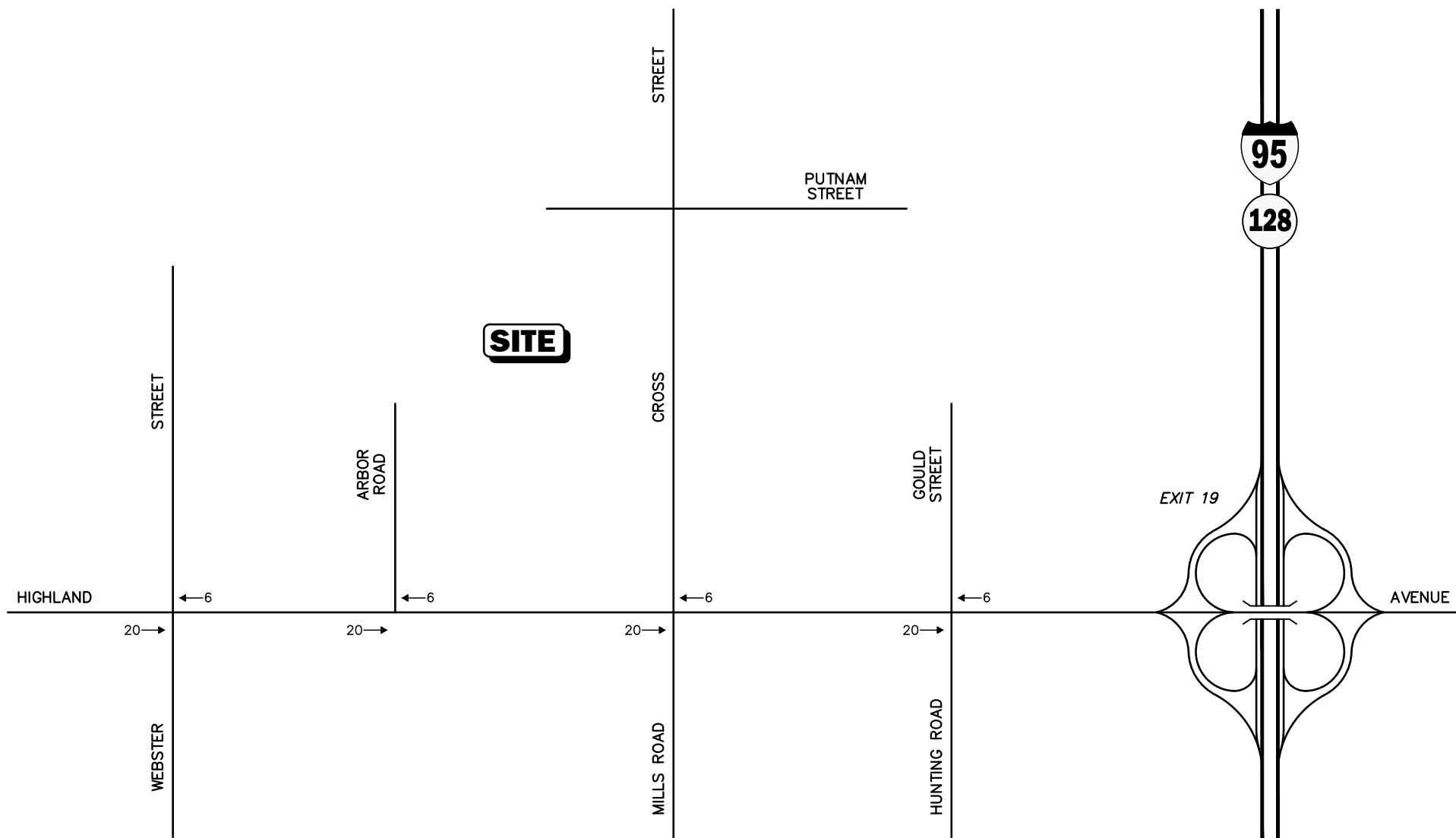


Not To Scale

VAI Vanasse & Associates inc

Figure A-2

Highland Science Center
Weekday Evening
Peak Hour Traffic Volumes

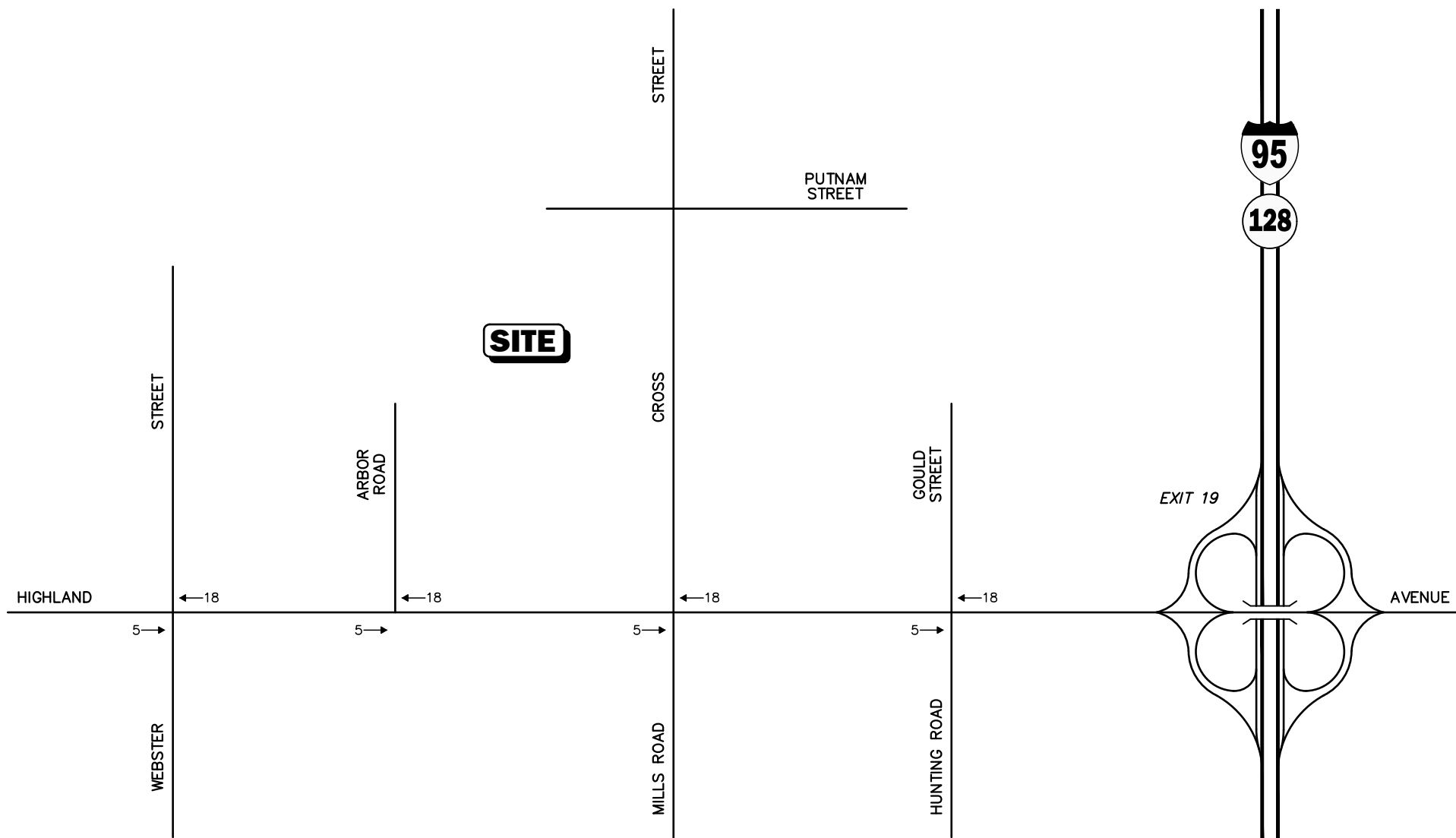


 Not To Scale

Vai Vanasse & Associates inc

Figure A-1

Boston Children's
Hospital Development
Weekday Morning



 Not To Scale

VAi Vanasse & Associates inc

Figure A-4

**Boston Children's
Hospital Development
Weekday Evening
Peak Hour Traffic Volumes**

PROPOSED TRIP-GENERATION CALCULATIONS



- 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

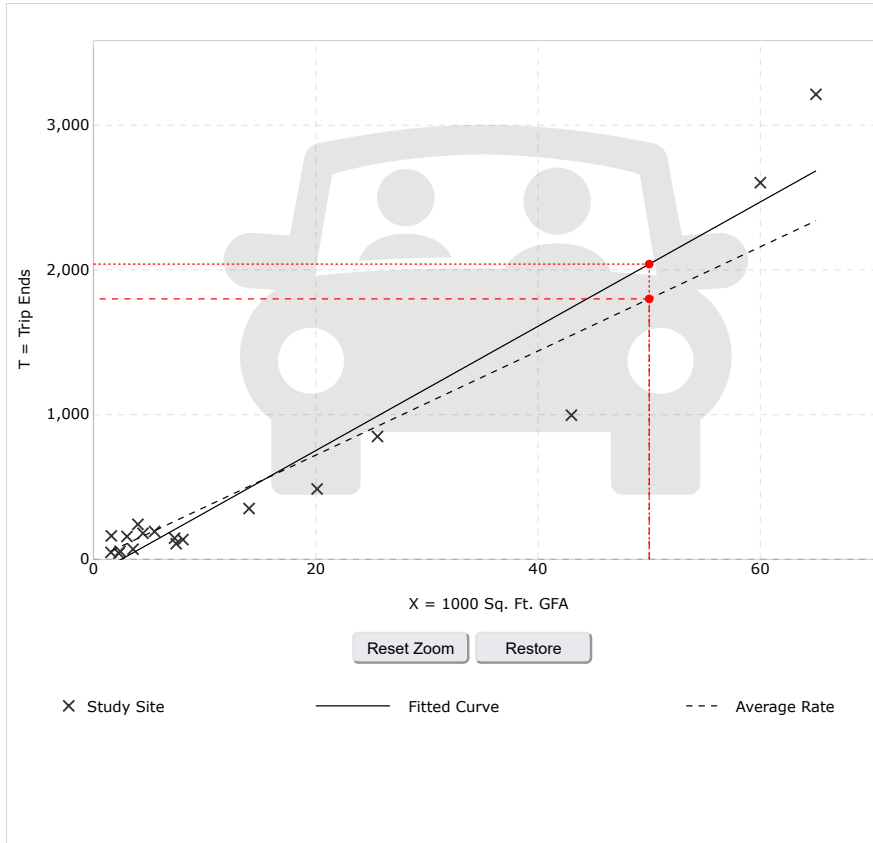
TRIP TYPE:

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:
 $T = 42.97(X) - 108.01$

R²:
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
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

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,

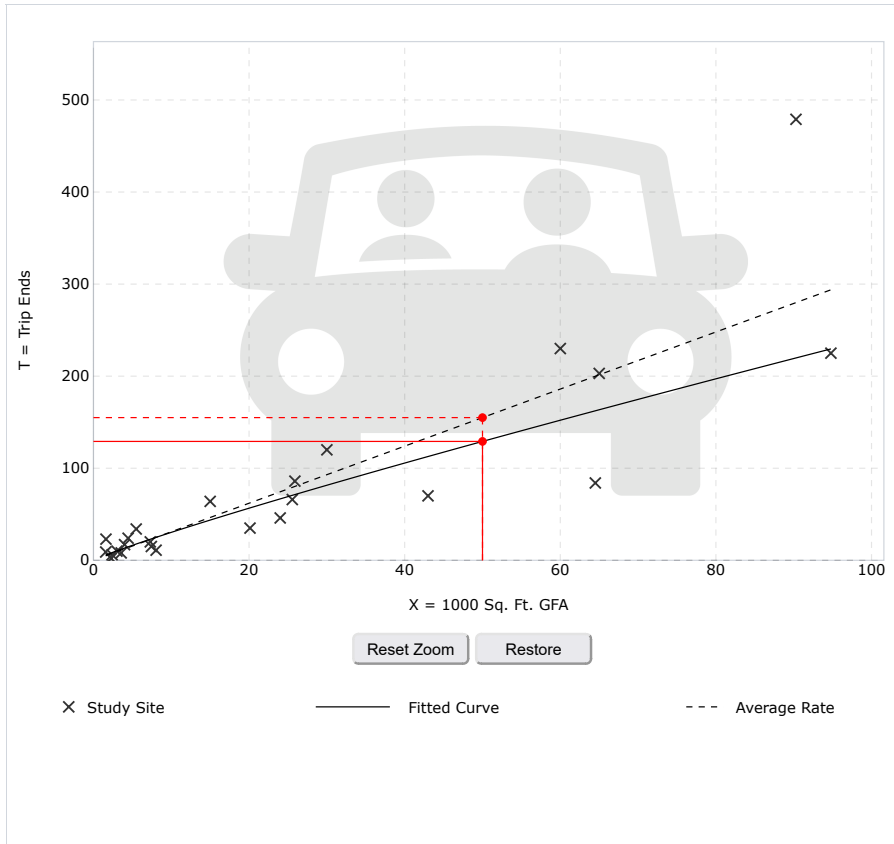
TRIP TYPE:

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
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

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,

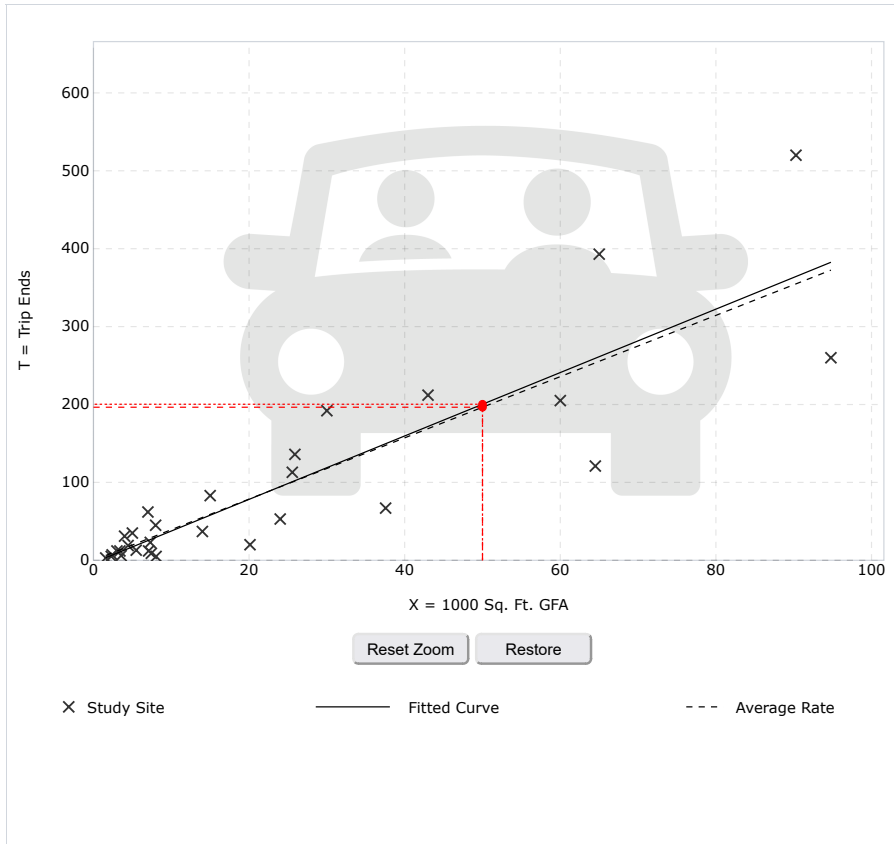
TRIP TYPE:

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:
 $T = 4.07(X) - 3.17$

R²:
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
-  How to Use ITETripGen
-  TGM Desk Reference
-  TGM Appendices
-  Support Documents
-  Add Users
-  Comments

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:

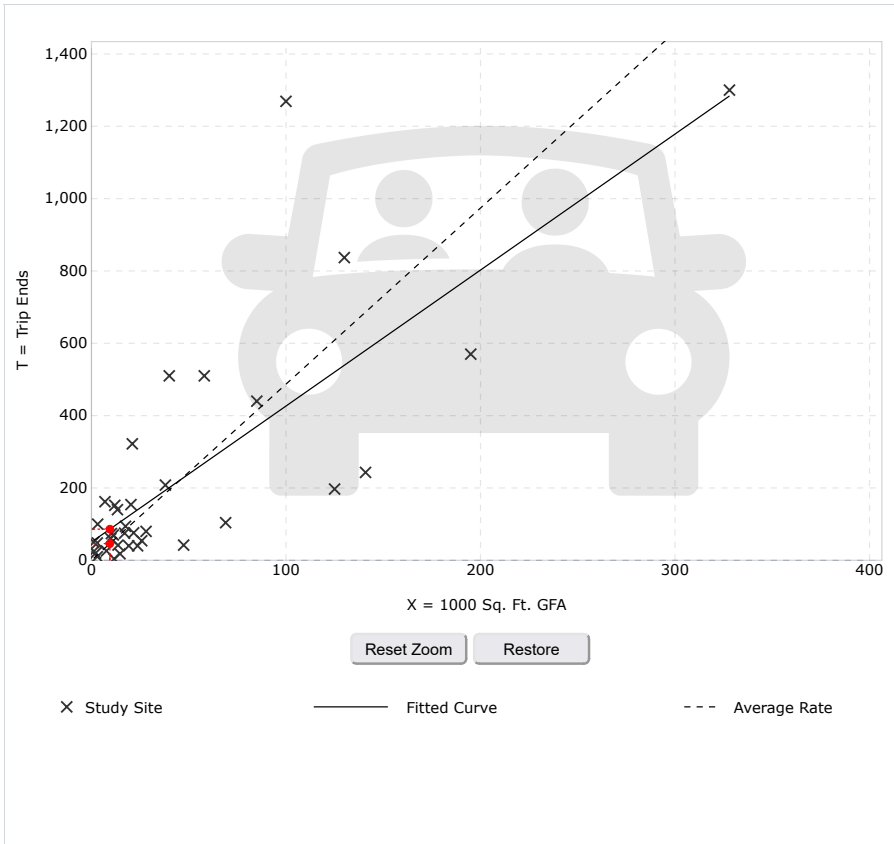
Vehicle

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:
 $T = 3.76(X) + 50.47$

R²:
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
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

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:

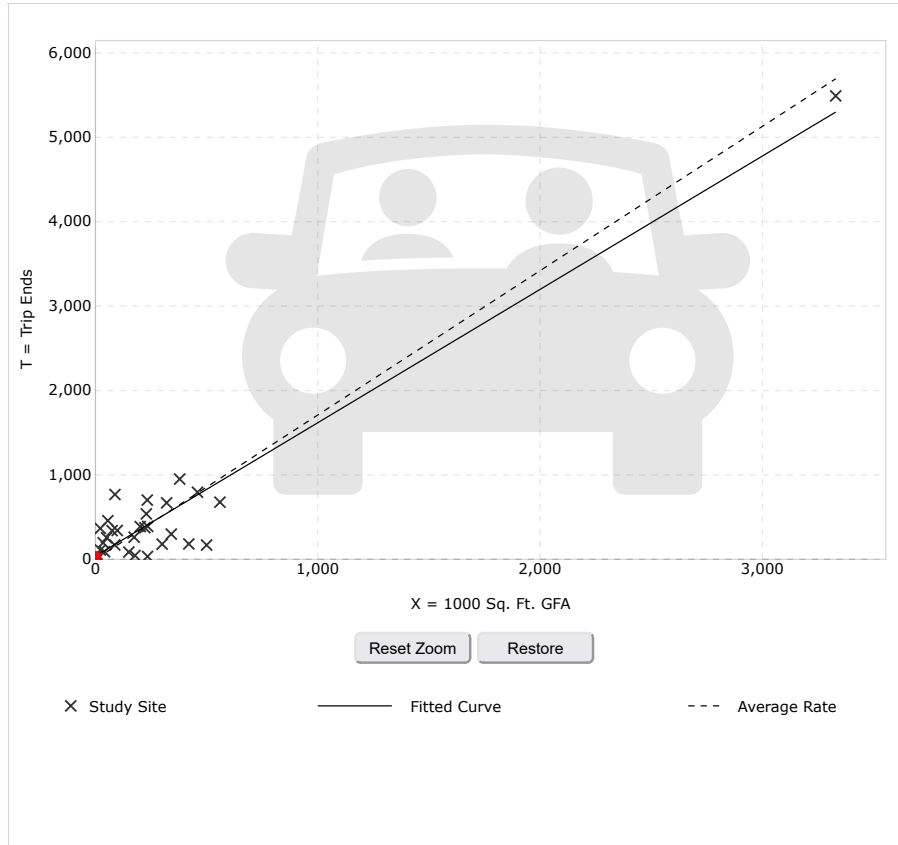
Vehicle

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:
 $T = 1.58(X) + 38.29$

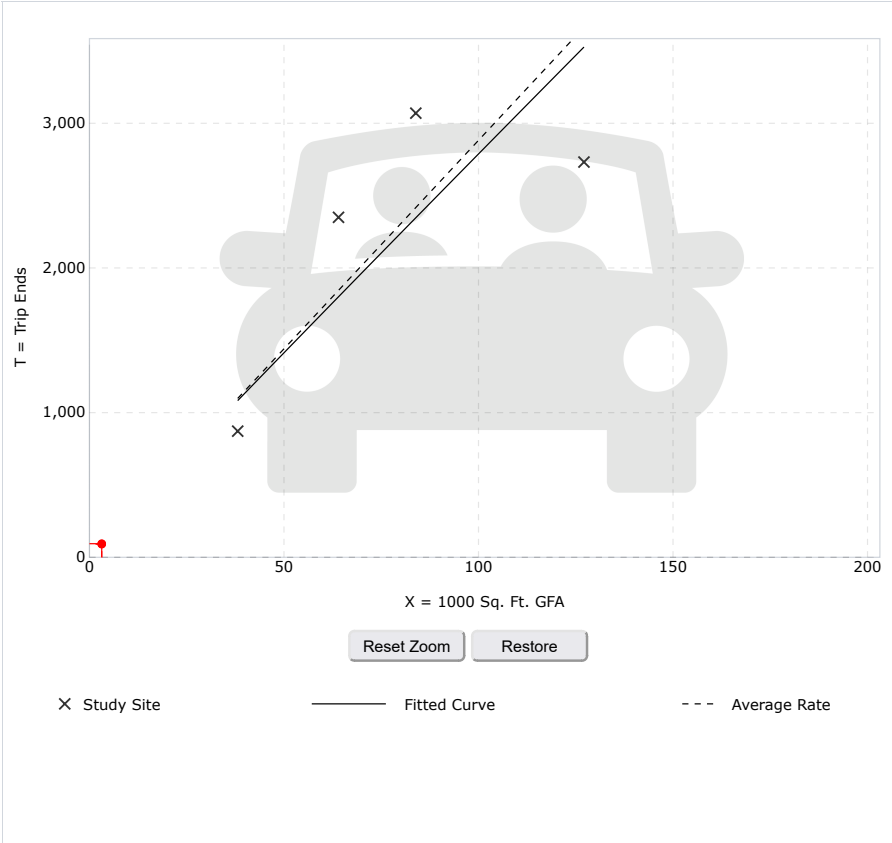
R²:
0.92

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)

Data Plot and Equation

Caution – Small Sample Size



Reset Zoom

Restore

X Study Site

— Fitted Curve

- - - Average Rate

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:
 $\ln(T) = 0.98 \ln(X) + 3.42$

R²:
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)

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:

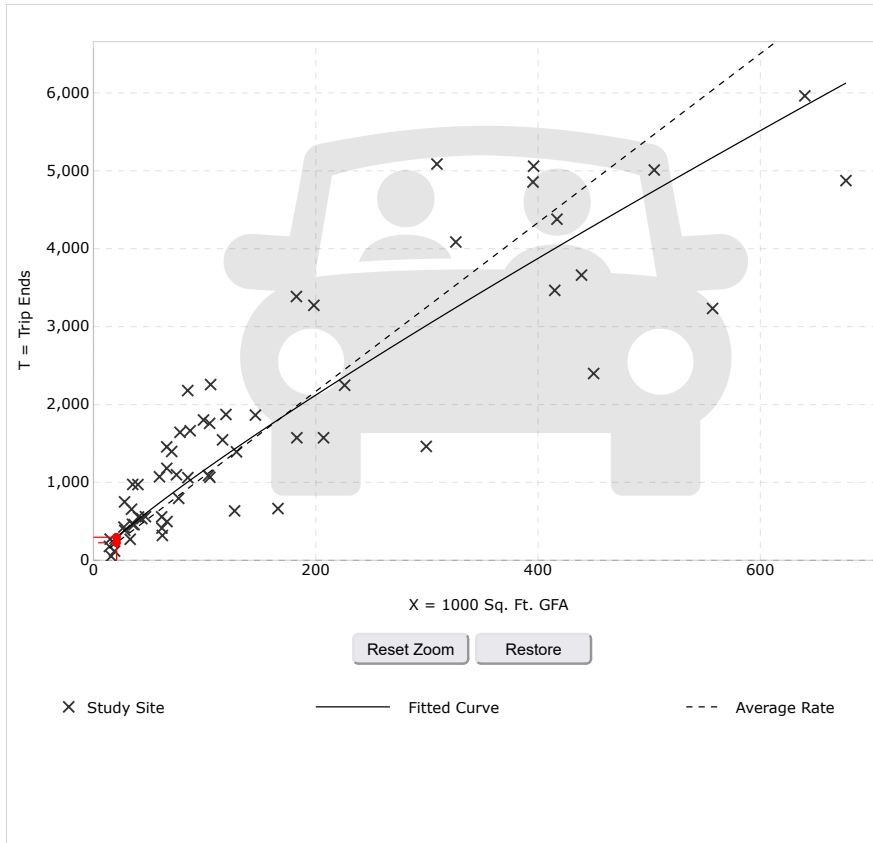
Vehicle

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
- How to Use ITETripGen
- TGM Desk Reference
- TGM Appendices
- Support Documents
- Add Users
- Comments

- Add-ons to do more
- Try OTISS Pro

QueryFilter

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

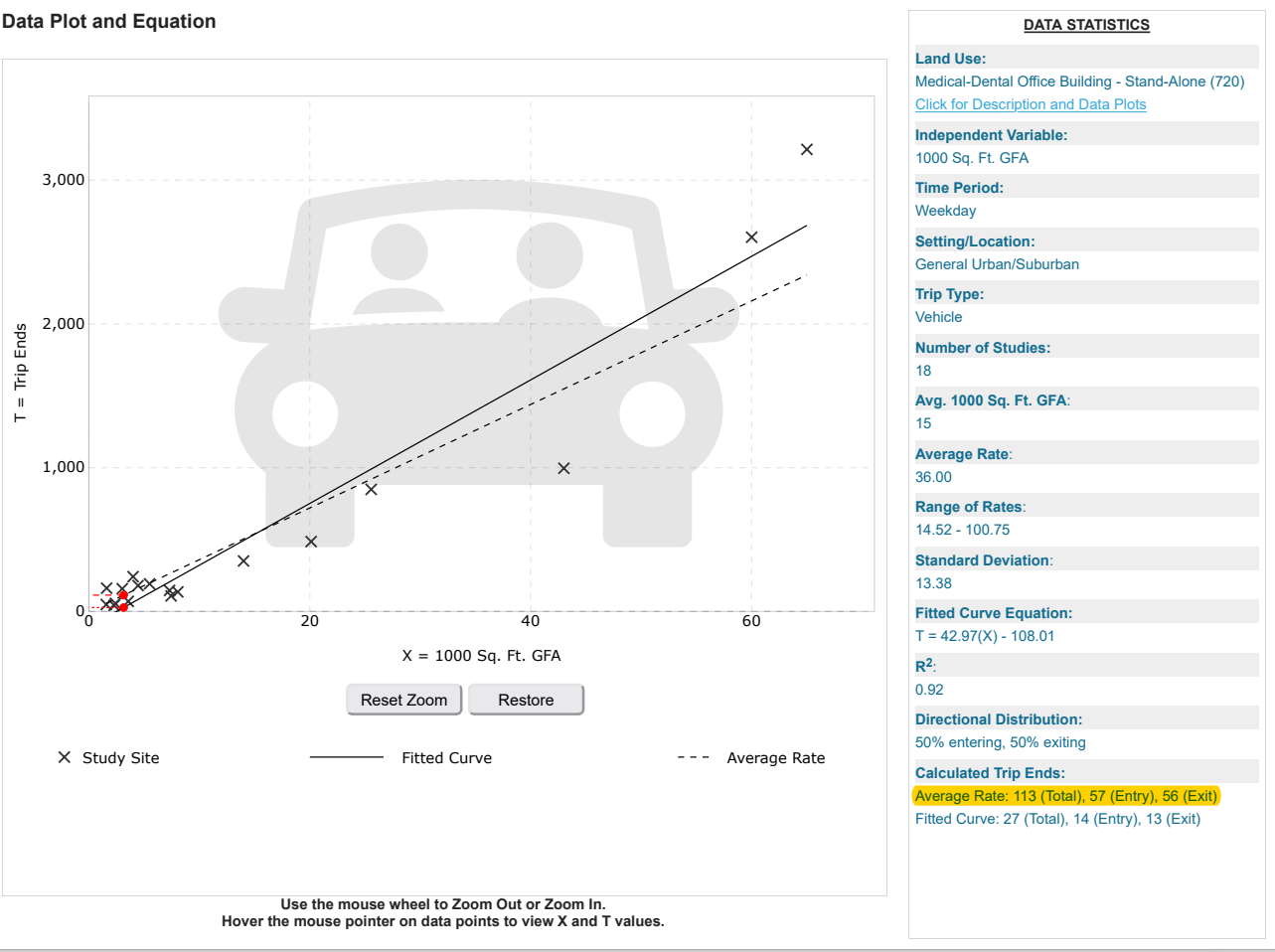
TRIP TYPE:

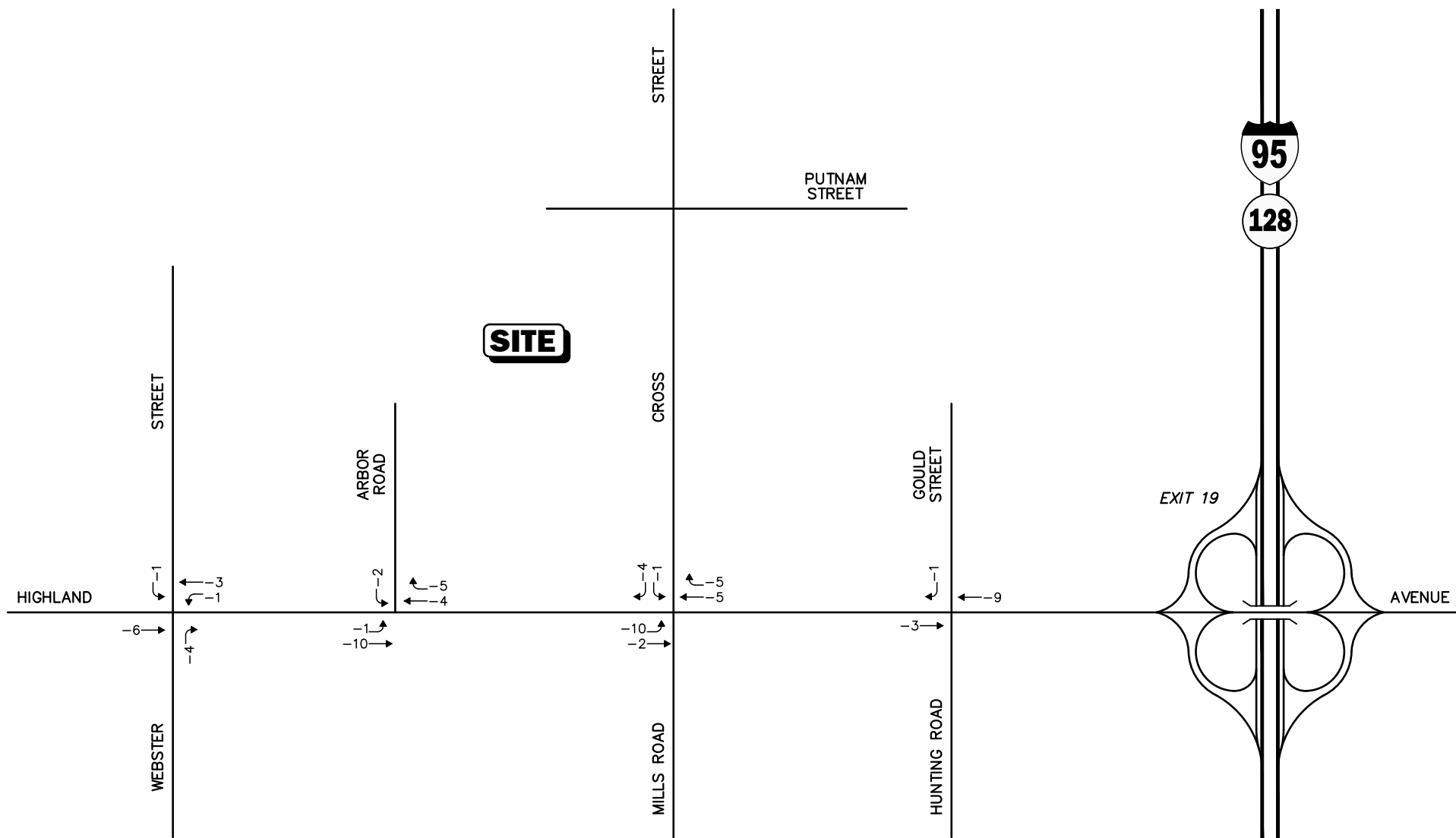
Vehicle

ENTER IV VALUE TO CALCULATE TRIPS:

3.15

Calculate



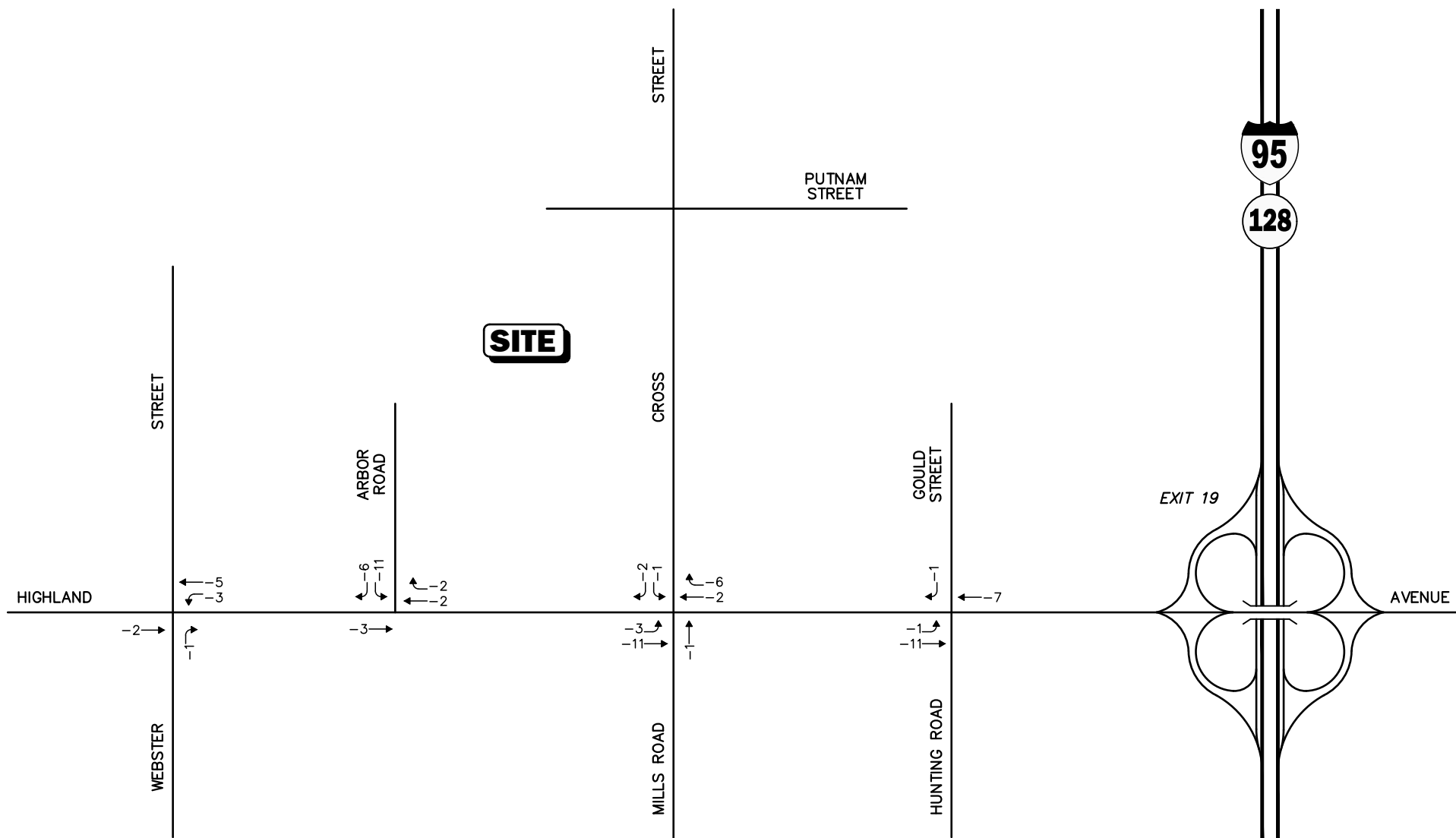


 Not To Scale

VAi Vanasse & Associates inc

Figure A-5

**Site Trips Removed
Weekday Morning
Peak Hour Traffic Volumes**



Not To Scale

VAI Vanasse & Associates inc

Figure A-6

Site Trips Removed
Weekday Evening
Peak Hour Traffic Volumes

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



2023 Existing Weekday Morning Peak Hour

1: Webster Street & Highland Avenue

												
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												

2023 Existing Weekday Morning Peak Hour

1: Webster Street & Highland Avenue

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	

2023 Existing Weekday Morning Peak Hour 1: Webster Street & Highland Avenue

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

 Ø2		 Ø4		 Ø9	
55 s		28.5 s		28 s	
 Ø5	 Ø6	 Ø8			
17.5 s	37.5 s	28.5 s			

2023 Existing Weekday Morning Peak Hour
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												

2023 Existing Weekday Morning Peak Hour
2: Highland Avenue & Arbor Street

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	

2023 Existing Weekday Morning Peak Hour
3: Mills Road/Cross Street & Highland Avenue

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				

2023 Existing Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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												

2023 Existing Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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	

2023 Existing Weekday Morning Peak Hour 4: Hunting Road/Gould Street & Highland Avenue

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

 Ø1	 Ø2	 Ø3	 Ø4
16 s	60 s	26 s	30 s
 Ø5	 Ø6		
26 s	50 s		

2023 Existing Weekday Morning Peak Hour
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												

2023 Existing Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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	

2023 Existing Weekday Morning Peak Hour
5: Cross Street & Driveway/Putnam Street

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



2023 Existing Weekday Evening Peak Hour

1: Webster Street & Highland Avenue

												
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												

2023 Existing Weekday Evening Peak Hour 1: Webster Street & Highland Avenue

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	

2023 Existing Weekday Evening Peak Hour 1: Webster Street & Highland Avenue

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

 Ø2		 Ø4		 Ø9	
60 s		31.5 s		28 s	
 Ø5	 Ø6	 Ø8			
22.5 s	37.5 s	31.5 s			

2023 Existing Weekday Evening Peak Hour
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												

2023 Existing Weekday Evening Peak Hour
2: Highland Avenue & Arbor Street

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	

2023 Existing Weekday Evening Peak Hour
3: Mills Road/Cross Street & Highland Avenue

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				

2023 Existing Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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												

2023 Existing Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2023 Existing Weekday Evening Peak Hour

4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 113.5

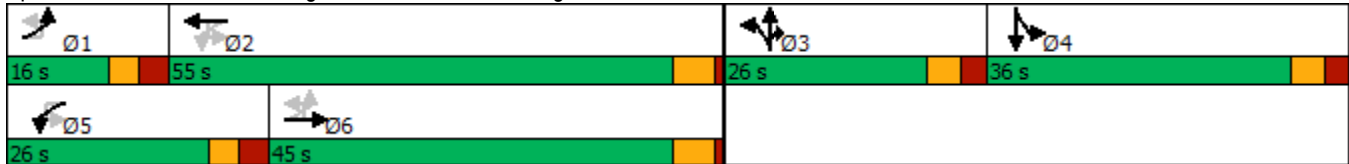
Natural Cycle: 90

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



2023 Existing Weekday Evening Peak Hour
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												

2023 Existing Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2023 Existing Weekday Evening Peak Hour
5: Cross Street & Driveway/Putnam Street

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



2030 No Build Weekday Morning Peak Hour

1: Webster Street & Highland Avenue

												
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												

2030 No Build Weekday Morning Peak Hour
1: Webster Street & Highland Avenue

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	

2030 No Build Weekday Morning Peak Hour 1: Webster Street & Highland Avenue

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

 Ø2		 Ø4		 Ø9
55 s		28.5 s		28 s
 Ø5	 Ø6	 Ø8		
17.5 s	37.5 s	28.5 s		

2030 No Build Weekday Morning Peak Hour

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												

2030 No Build Weekday Morning Peak Hour
2: Highland Avenue & Arbor Street

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	

2030 No Build Weekday Morning Peak Hour
3: Mills Road/Cross Street & Highland Avenue

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				

2030 No Build Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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	-4.0
Total Lost Time (s)	4.0	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												

2030 No Build Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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	

2030 No Build Weekday Morning Peak Hour

4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 110.7

Natural Cycle: 145

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

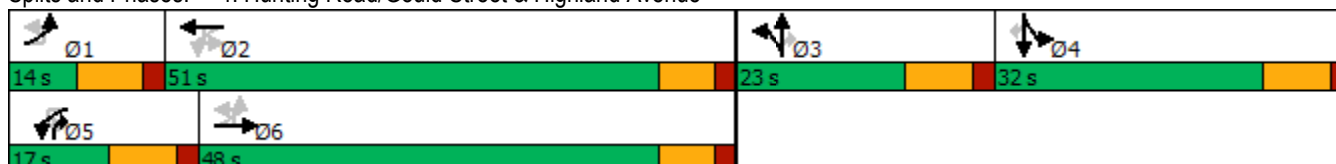
Queue shown is maximum after two cycles.

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



2030 No Build Weekday Morning Peak Hour
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												

2030 No Build Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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	

2030 No Build Weekday Morning Peak Hour
5: Cross Street & Driveway/Putnam Street

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



2030 No Build Weekday Evening Peak Hour

1: Webster Street & Highland Avenue

												
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												

2030 No Build Weekday Evening Peak Hour

1: Webster Street & Highland Avenue

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	

2030 No Build Weekday Evening Peak Hour
1: Webster Street & Highland Avenue

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

 Ø2		 Ø4		 Ø9	
60 s		31.5 s		28 s	
 Ø5	 Ø6		 Ø8		
22.5 s	37.5 s		31.5 s		

2030 No Build Weekday Evening Peak Hour

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												

2030 No Build Weekday Evening Peak Hour
2: Highland Avenue & Arbor Street

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	

2030 No Build Weekday Evening Peak Hour
3: Mills Road/Cross Street & Highland Avenue

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				

2030 No Build Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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												

2030 No Build Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2030 No Build Weekday Evening Peak Hour

4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 97.3

Natural Cycle: 95

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

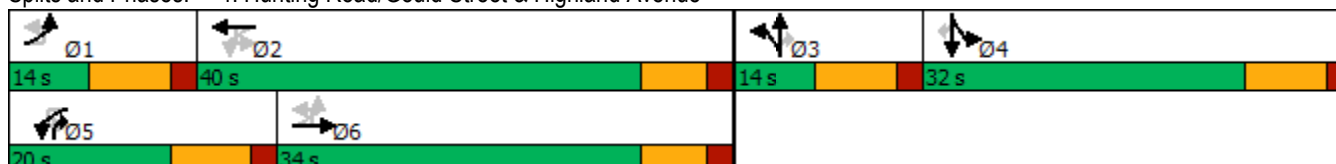
Queue shown is maximum after two cycles.

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



2030 No Build Weekday Evening Peak Hour
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												

2030 No Build Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2030 No Build Weekday Evening Peak Hour
5: Cross Street & Driveway/Putnam Street

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



2030 Build Weekday Morning Peak Hour

1: Webster Street & Highland Avenue

												
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												

2030 Build Weekday Morning Peak Hour
1: Webster Street & Highland Avenue

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	

2030 Build Weekday Morning Peak Hour 1: Webster Street & Highland Avenue

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

 Ø2 55 s		 Ø4 28.5 s		 Ø9 28 s
 Ø5 17.5 s	 Ø6 37.5 s	 Ø8 28.5 s		

2030 Build Weekday Morning Peak Hour

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												

2030 Build Weekday Morning Peak Hour
2: Highland Avenue & Arbor Street

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	

2030 Build Weekday Morning Peak Hour
3: Mills Road/Cross Street & Highland Avenue

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				

2030 Build Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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	-4.0
Total Lost Time (s)	4.0	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												

2030 Build Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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	

2030 Build Weekday Morning Peak Hour

4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 110.7

Natural Cycle: 145

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

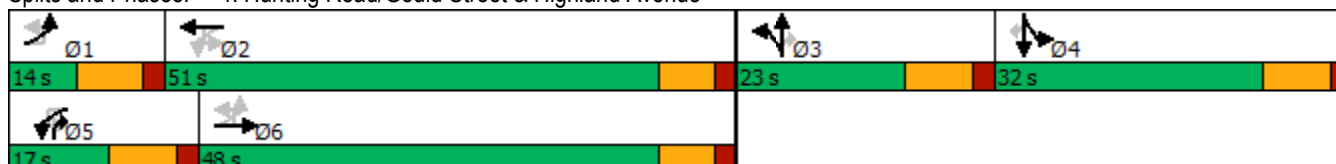
Queue shown is maximum after two cycles.

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



2030 Build Weekday Morning Peak Hour
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												

2030 Build Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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	

2030 Build Weekday Morning Peak Hour
5: Cross Street & Driveway/Putnam Street

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	-	-				

2030 Build Weekday Morning Peak Hour
6: Cross Street & Project Site Driveway

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	-	-	

2030 Build Weekday Morning Peak Hour
7: Arbor Street & Driveway

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
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	NBRWBLn1	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	-

2030 Build Weekday Morning Peak Hour
8: Arbor Street & Project Site Driveway

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	NBRWBLn1	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



2030 Build Weekday Evening Peak Hour

1: Webster Street & Highland Avenue

												
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												

2030 Build Weekday Evening Peak Hour
1: Webster Street & Highland Avenue

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	

2030 Build Weekday Evening Peak Hour

1: Webster Street & Highland Avenue

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

 Ø2 60 s		 Ø4 31.5 s		 Ø9 28 s
 Ø5 22.5 s	 Ø6 37.5 s	 Ø8 31.5 s		

2030 Build Weekday Evening Peak Hour

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												

2030 Build Weekday Evening Peak Hour
2: Highland Avenue & Arbor Street

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	

2030 Build Weekday Evening Peak Hour
3: Mills Road/Cross Street & Highland Avenue

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				

2030 Build Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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	-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
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												

2030 Build Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2030 Build Weekday Evening Peak Hour 4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 97.8

Natural Cycle: 95

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

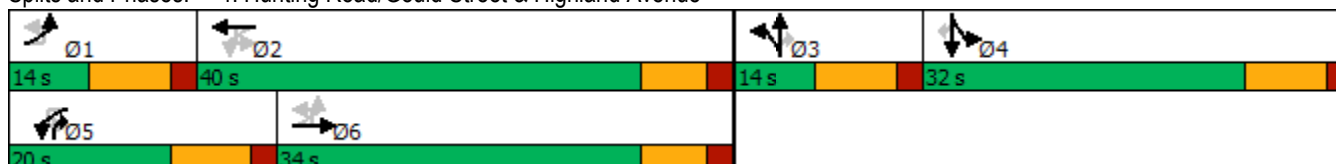
Queue shown is maximum after two cycles.

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



2030 Build Weekday Evening Peak Hour
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												

2030 Build Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2030 Build Weekday Evening Peak Hour
5: Cross Street & Driveway/Putnam Street

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	-	-				

2030 Build Weekday Evening Peak Hour
6: Cross Street & Project Site Driveway

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	-	-	

2030 Build Weekday Evening Peak Hour
7: Arbor Street & Driveway

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	NBRWBLn1	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	-	

2030 Build Weekday Evening Peak Hour
8: Arbor Street & Project Site Driveway

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	NBRWBLn1		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



2030 Mitigated Weekday Morning Peak Hour

1: Webster Street & Highland Avenue

												
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												

2030 Mitigated Weekday Morning Peak Hour
1: Webster Street & Highland Avenue

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	

2030 Mitigated Weekday Morning Peak Hour

1: Webster Street & Highland Avenue

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

 Ø2 71 s		 Ø4 29 s		 Ø9 28 s
 Ø5 14 s	 Ø6 57 s	 Ø8 29 s		

2030 Mitigated Weekday Morning Peak Hour

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												

2030 Mitigated Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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	-4.0
Total Lost Time (s)	4.0	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												

2030 Mitigated Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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	

2030 Mitigated Weekday Morning Peak Hour 4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 132.5

Natural Cycle: 145

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

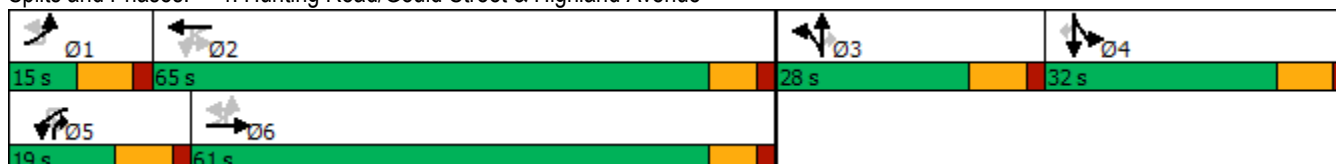
Queue shown is maximum after two cycles.

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



2030 Mitigated Weekday Morning Peak Hour
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												

2030 Mitigated Weekday Morning Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

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



2030 Mitigated Weekday Evening Peak Hour

1: Webster Street & Highland Avenue

												
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												

2030 Mitigated Weekday Evening Peak Hour

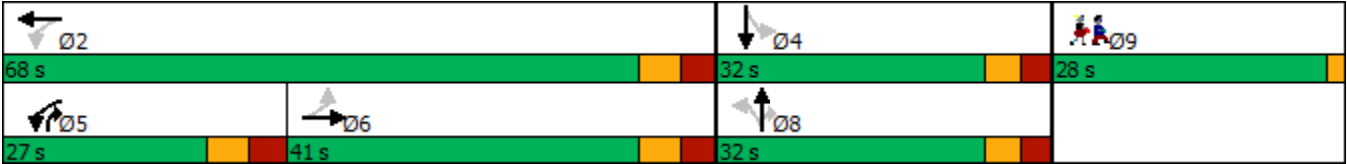
1: Webster Street & Highland Avenue

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	

2030 Mitigated Weekday Evening Peak Hour 1: Webster Street & Highland Avenue

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



2030 Mitigated Weekday Evening Peak Hour

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												

2030 Mitigated Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue

												
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												

2030 Mitigated Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

2030 Mitigated Weekday Evening Peak Hour 4: Hunting Road/Gould Street & Highland Avenue

Actuated Cycle Length: 107.2

Natural Cycle: 95

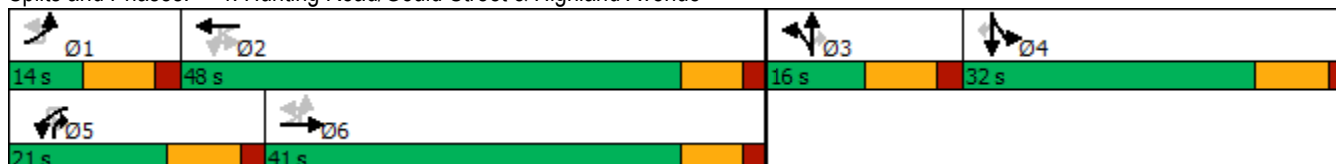
Control Type: Actuated-Uncoordinated

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



2030 Mitigated Weekday Evening Peak Hour
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												

2030 Mitigated Weekday Evening Peak Hour
4: Hunting Road/Gould Street & Highland Avenue



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		

Medical Office Building

629-661 Highland Avenue
Needham, MA

PREPARED FOR



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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 subcatchment 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.

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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 reduced by close to 100% for onsite areas. A phosphorus 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.



Locus Figure

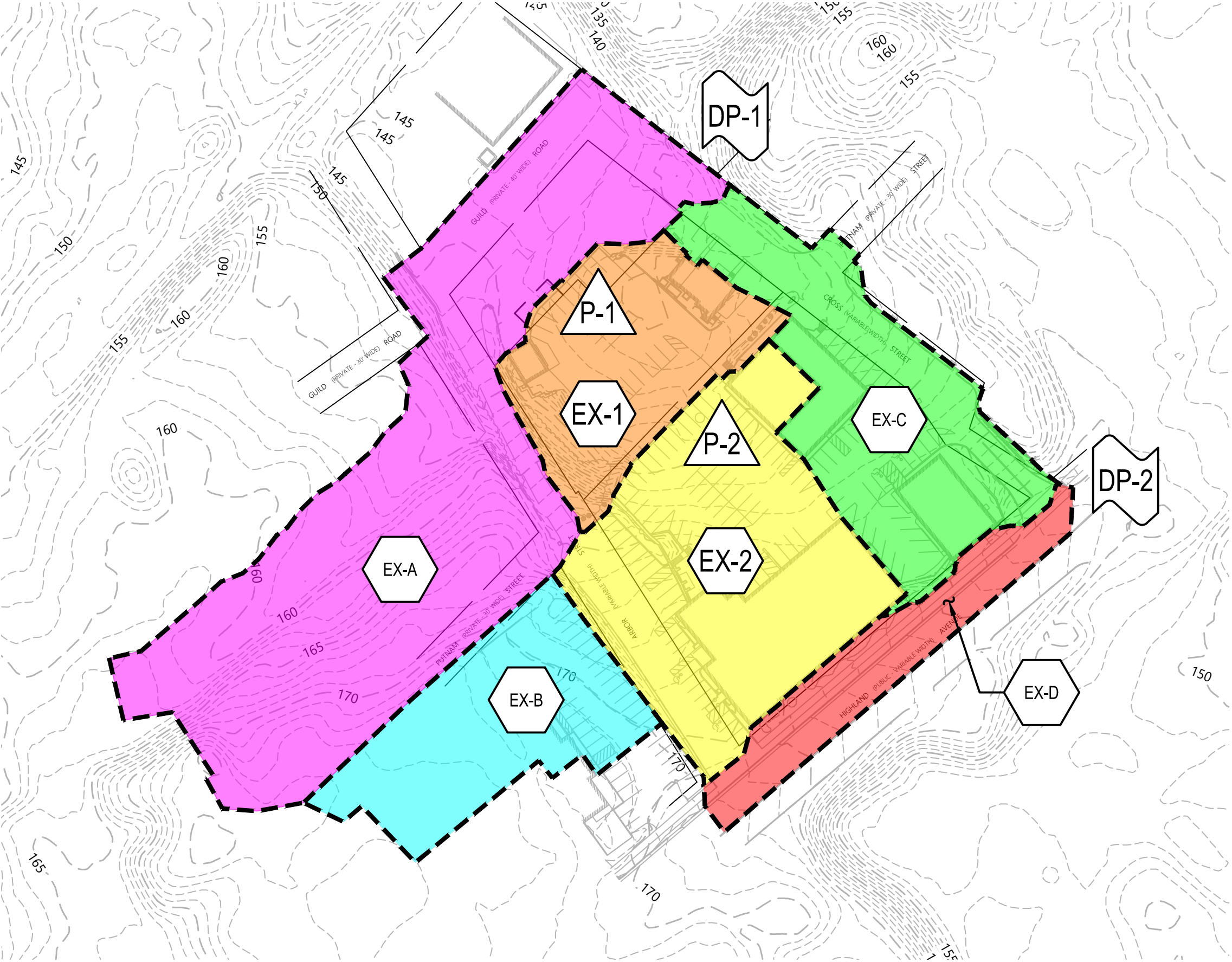
629 Highland Ave
Needham, MA

Figure 1

August 4, 2023



0 1000 2000 Feet



Legend

X

DESIGN POINT

X

DRAINAGE AREA DESIGNATION

X

POND

DRAINAGE AREA BOUNDARY

A north arrow pointing upwards and a scale bar indicating distances of 0, 40, and 80 feet.

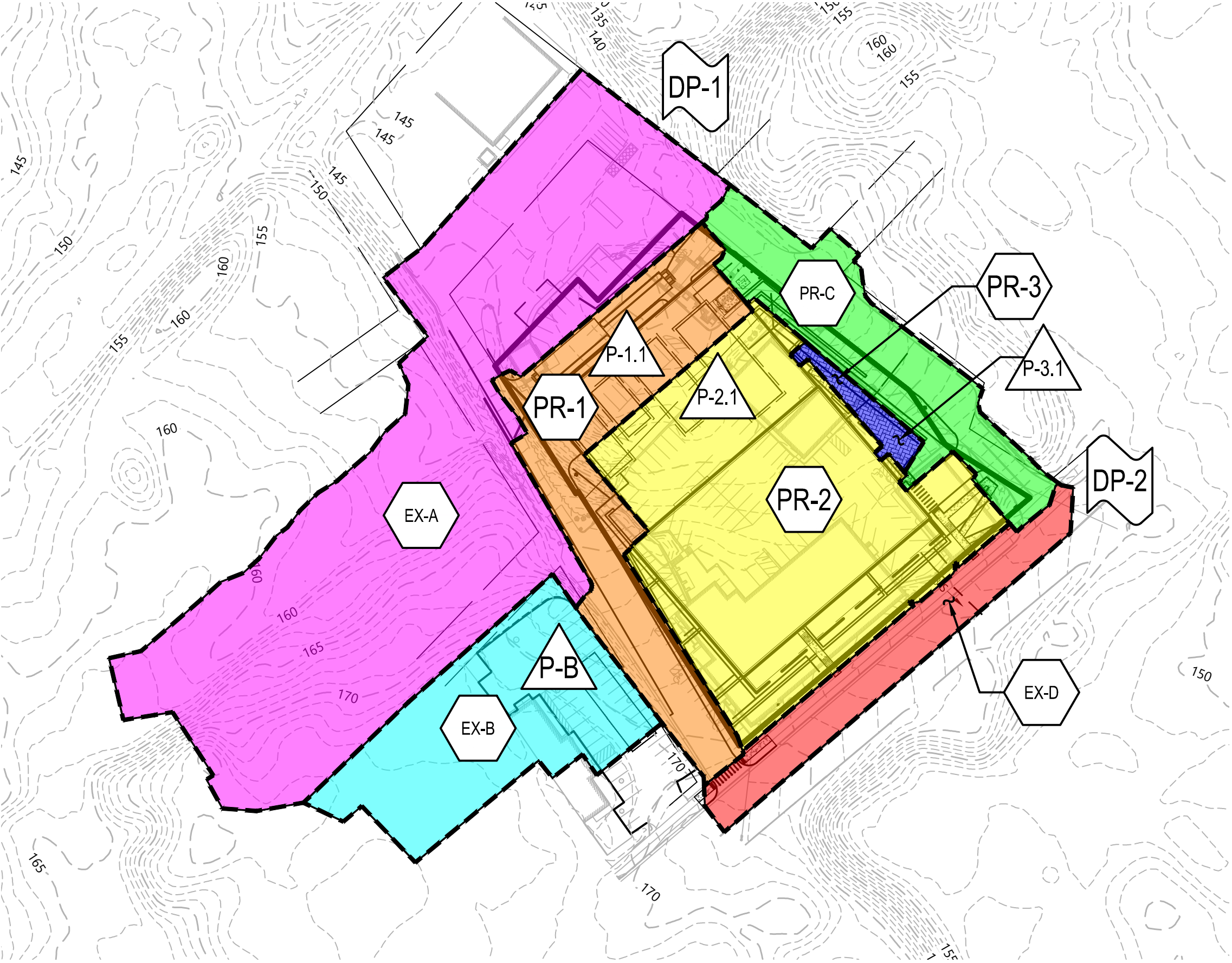
The logo for VHB, consisting of the letters 'vhb' in a stylized, lowercase font with a blue and green graphic element to the left.

Existing Drainage Conditions

Highland Ave MOB
Needham, MA

Figure 2

08/04/2023



Legend

SYMBOLS

X

DESIGN POINT

X

DRAINAGE AREA DESIGNATION

X

POND

LINETYPES

DRAINAGE AREA BOUNDARY

Proposed Drainage Conditions

Highland Ave MOB
Needham, MA

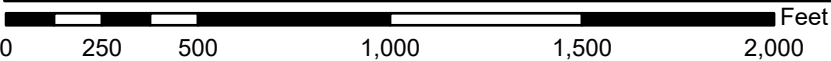
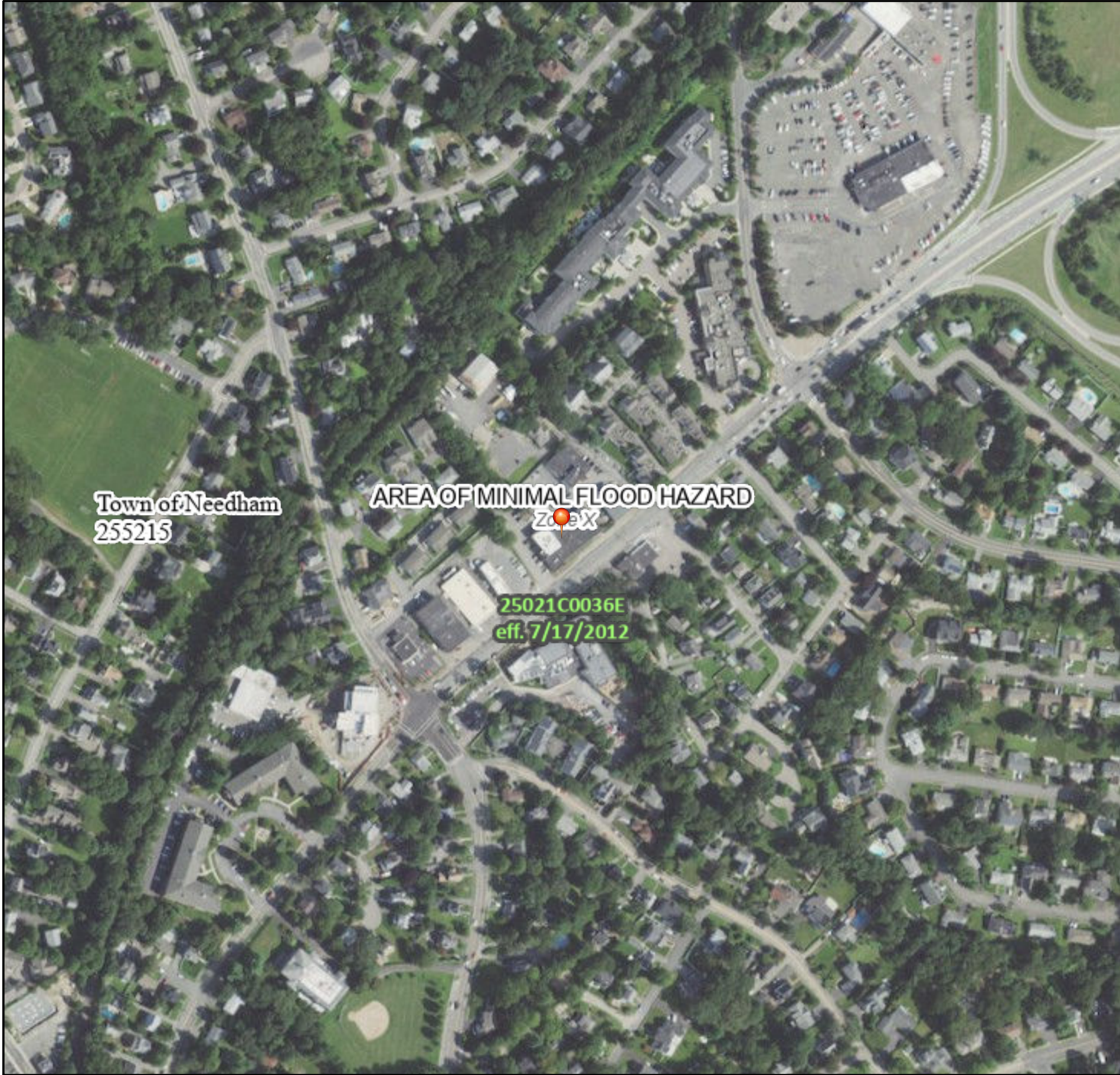
Figure 3

08/04/2023

National Flood Hazard Layer FIRMette



71°14'12"W 42°18'11"N



1:6,000

71°13'34"W 42°17'45"N

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
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



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

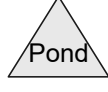
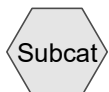
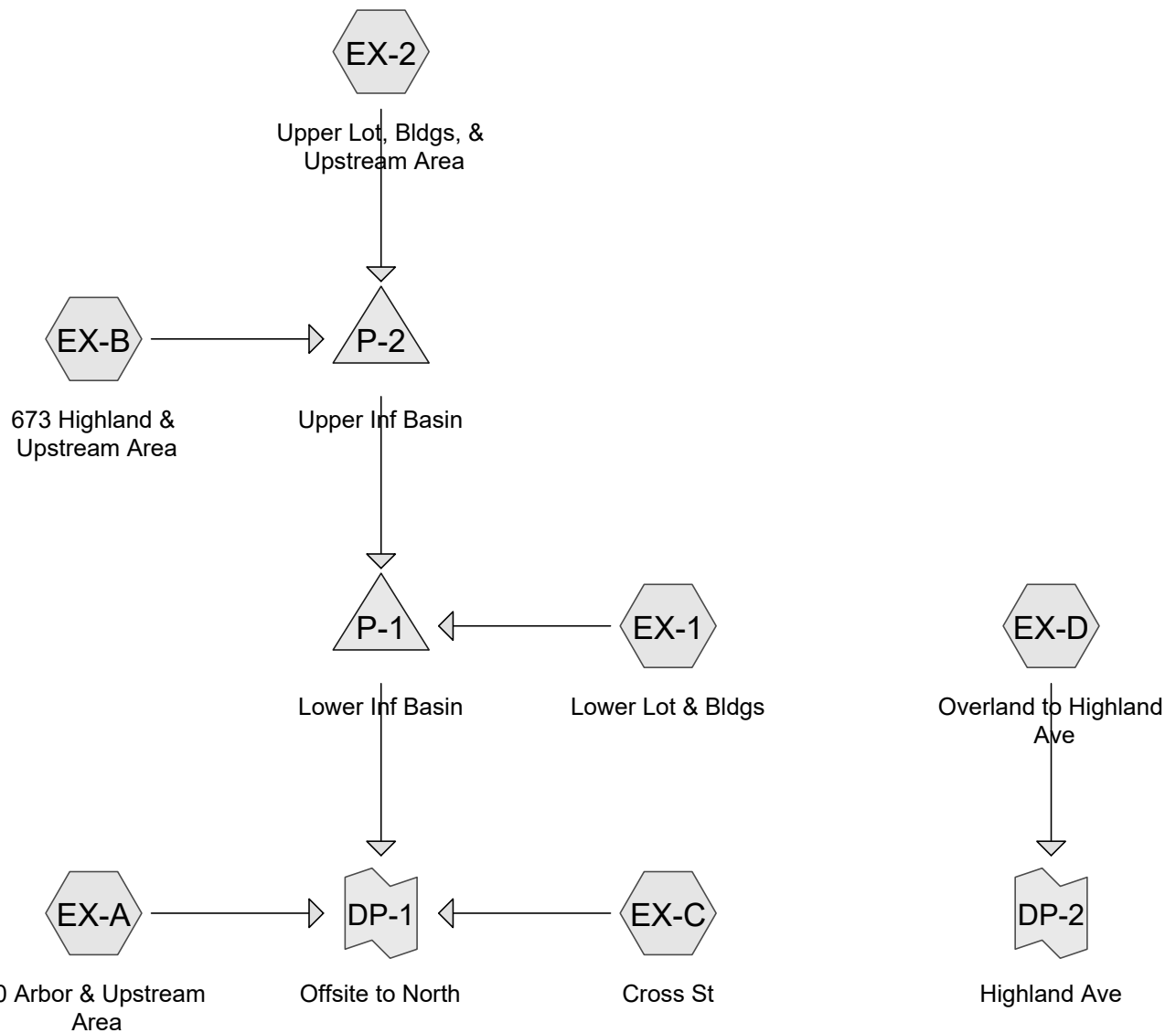
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/1/2023 at 9:19 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new 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



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Page 2

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

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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Page 3

Summary for Subcatchment EX-1: Lower Lot & Bldgs

Runoff = 0.8 cfs @ 12.08 hrs, Volume= 2,392 cf, Depth= 1.10"

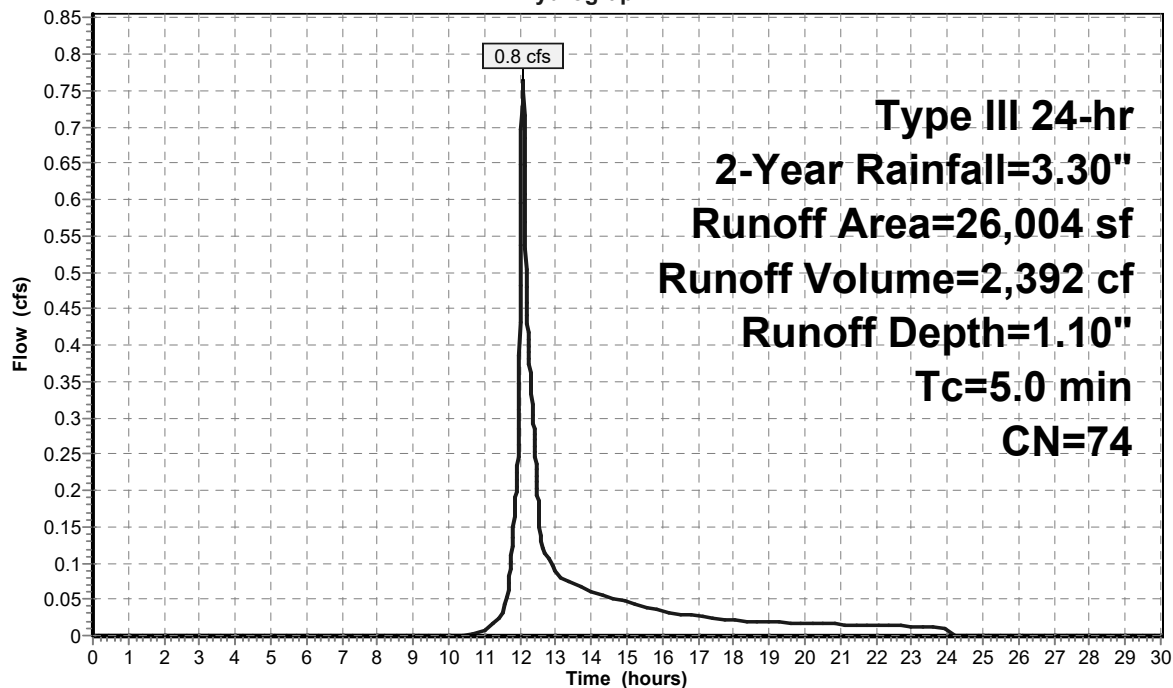
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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

Hydrograph



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

Runoff = 3.2 cfs @ 12.07 hrs, Volume= 9,742 cf, Depth= 2.54"

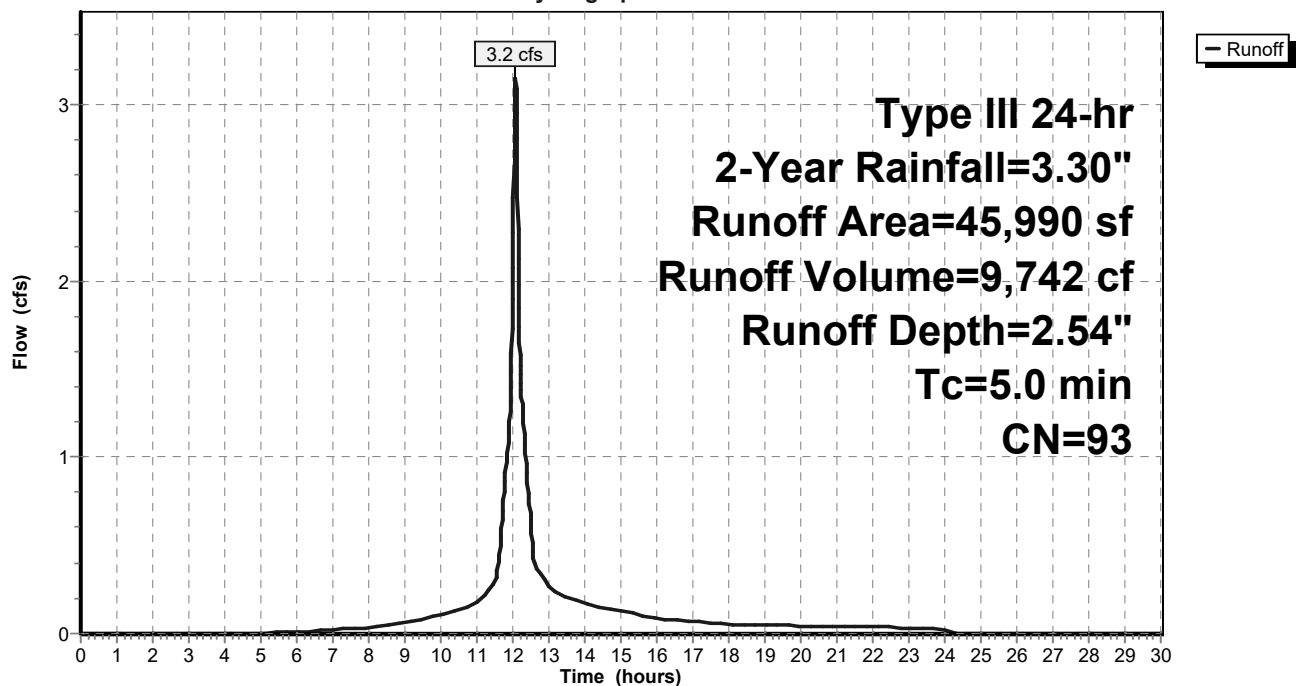
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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

Hydrograph



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

Runoff = 1.6 cfs @ 12.09 hrs, Volume= 5,640 cf, Depth= 0.79"

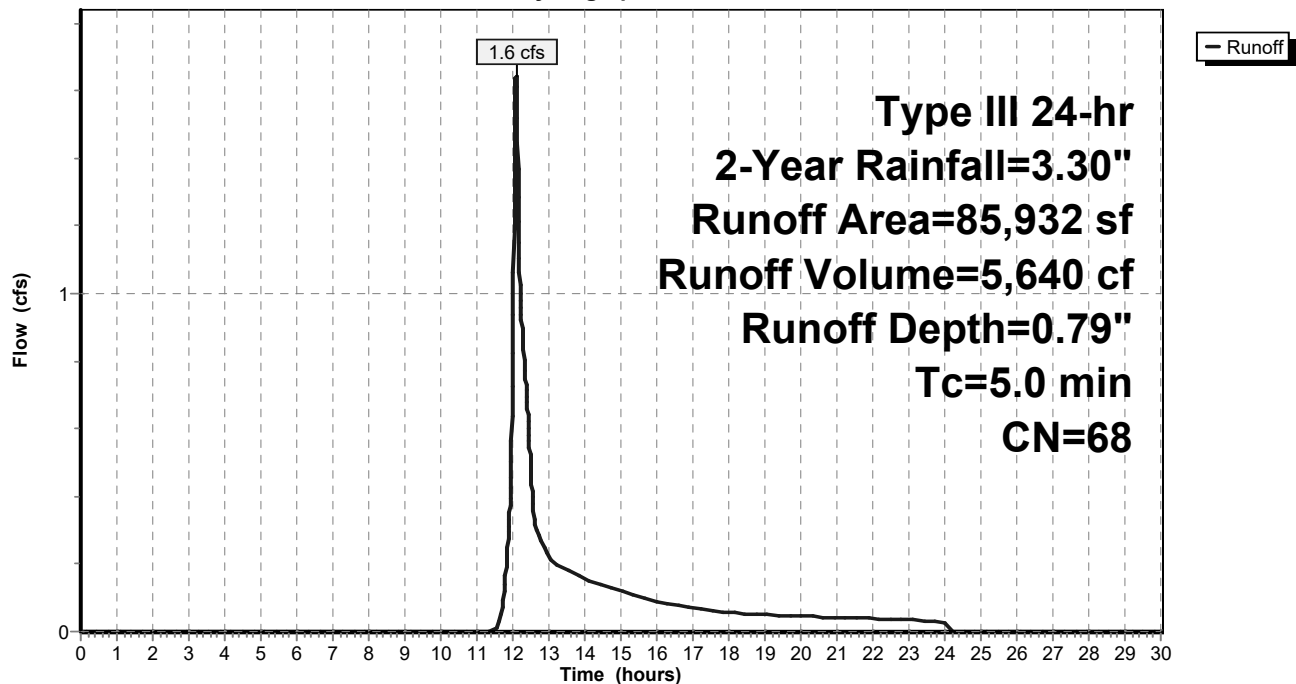
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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

Hydrograph



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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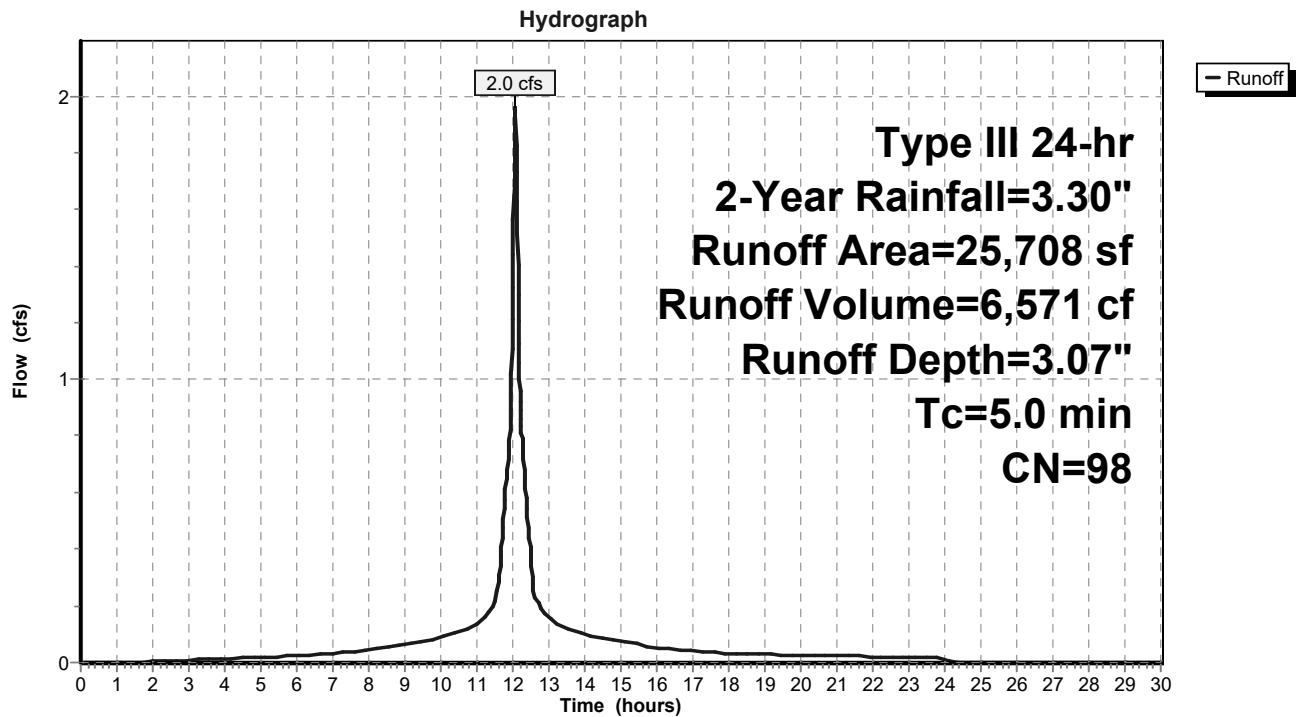
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Summary for Subcatchment EX-C: Cross St

Runoff = 2.0 cfs @ 12.07 hrs, Volume= 5,930 cf, Depth= 2.00"

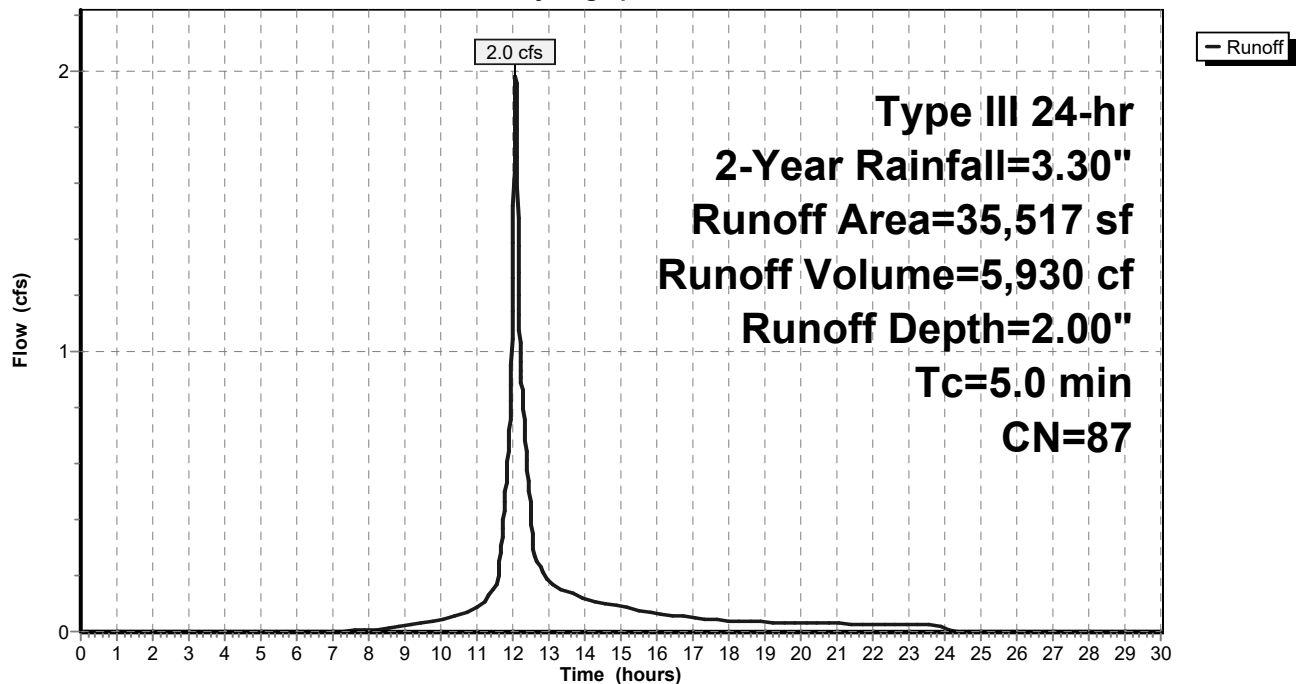
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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

Hydrograph



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 0.9 cfs @ 12.07 hrs, Volume= 2,675 cf, Depth= 2.17"

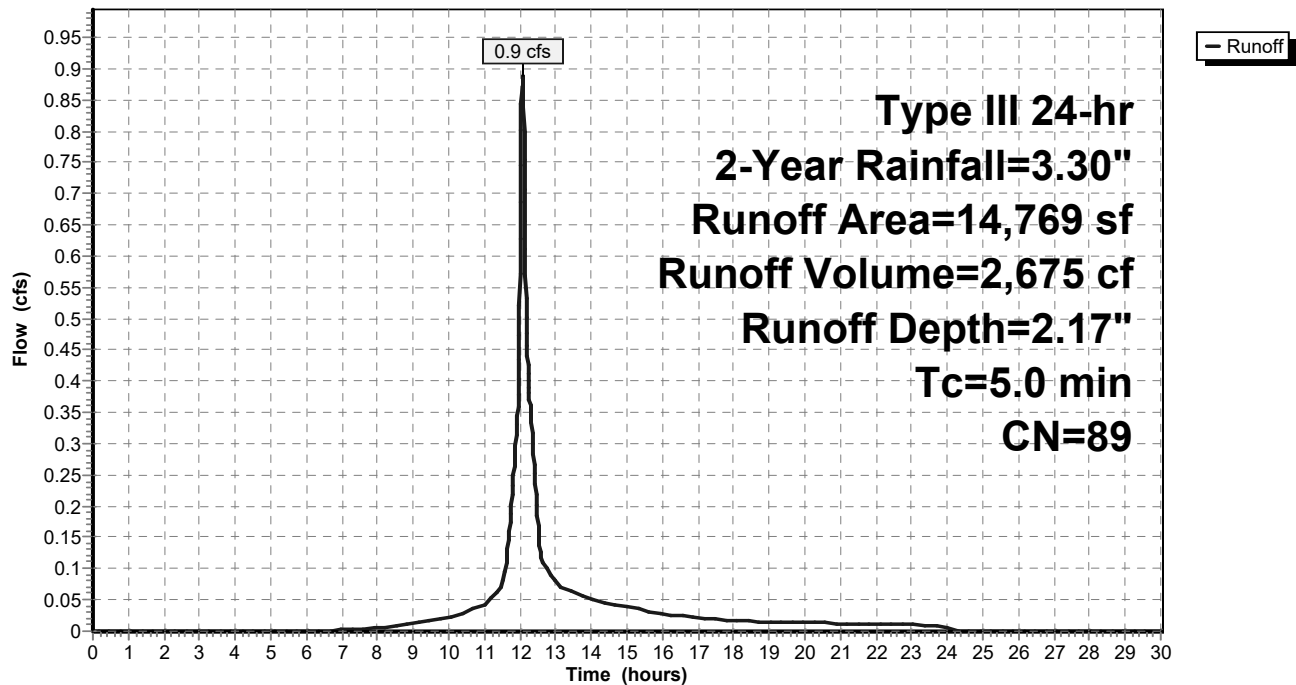
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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

Hydrograph



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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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)

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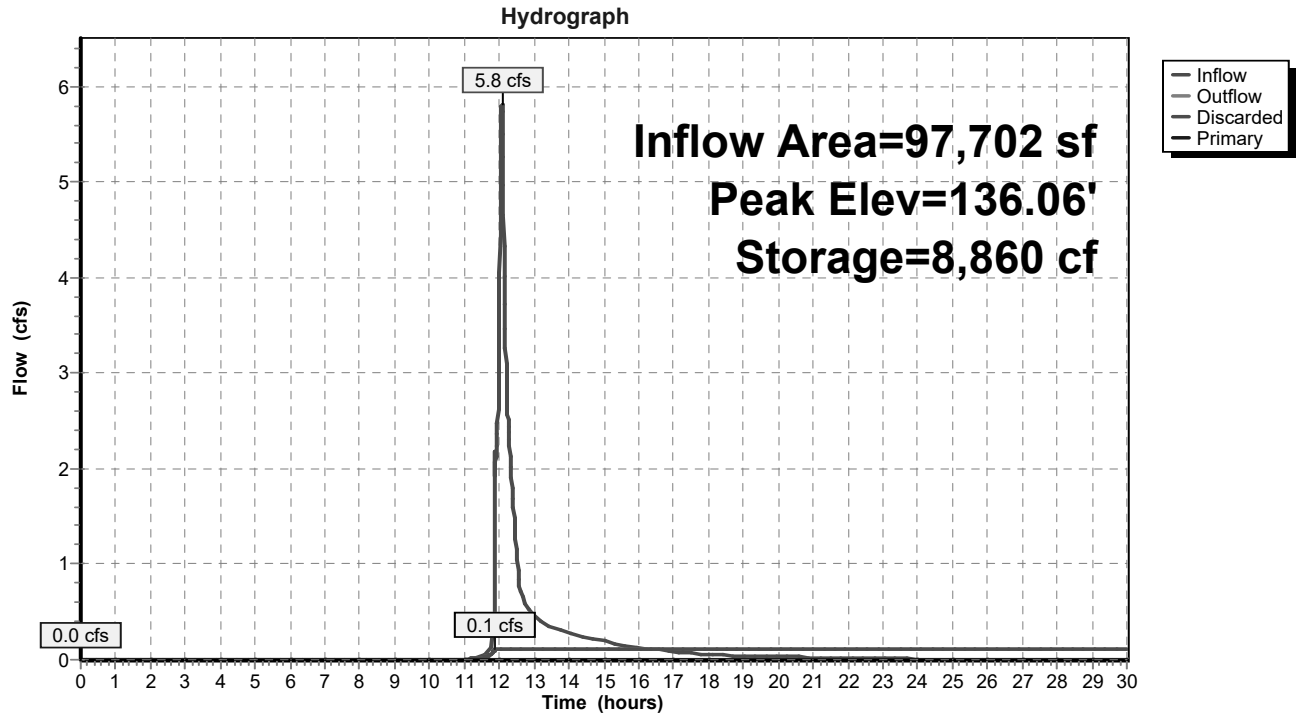
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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Pond P-1: Lower Inf Basin



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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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 (Prismatid) 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)

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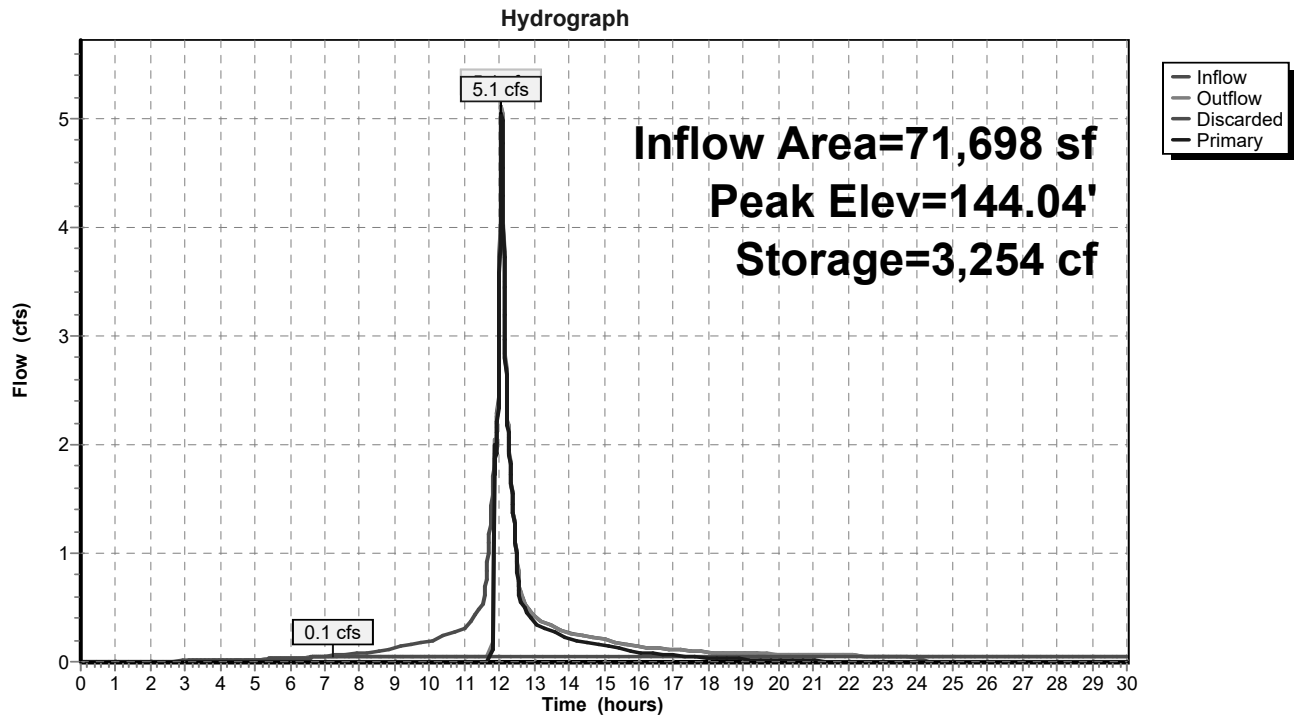
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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Pond P-2: Upper Inf Basin



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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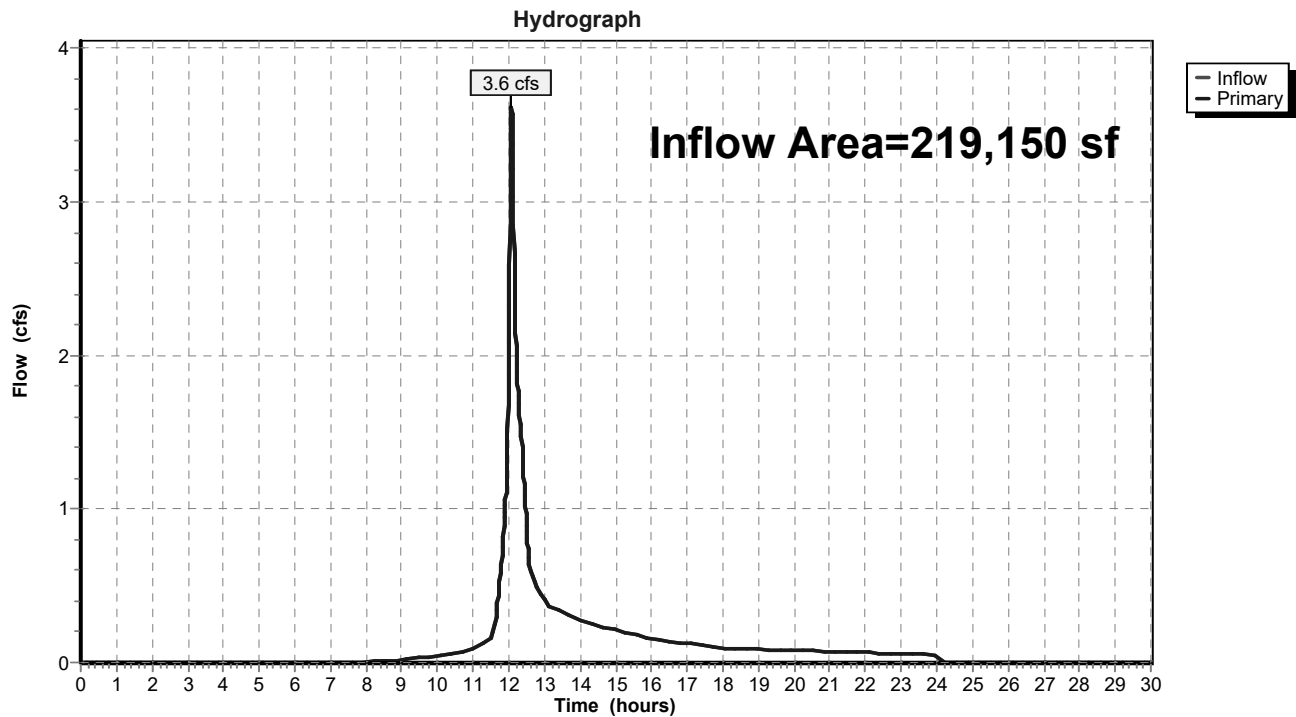
Page 13

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



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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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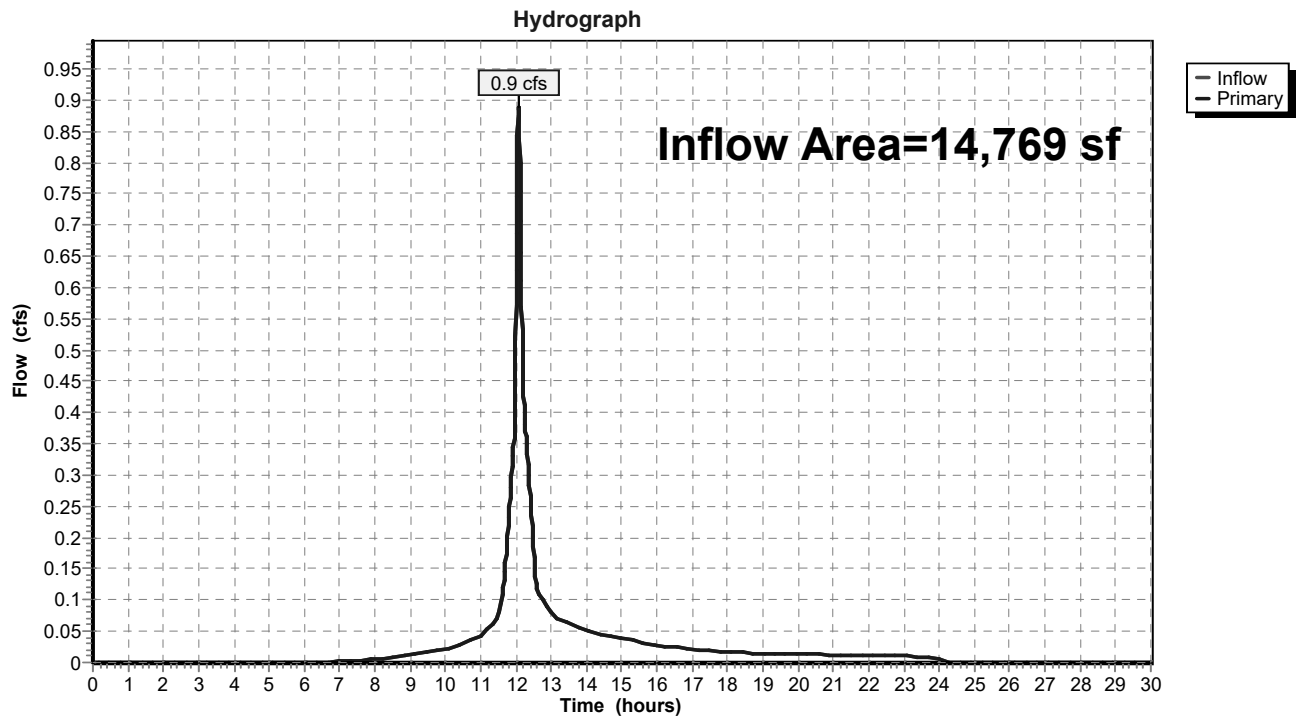
Page 14

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

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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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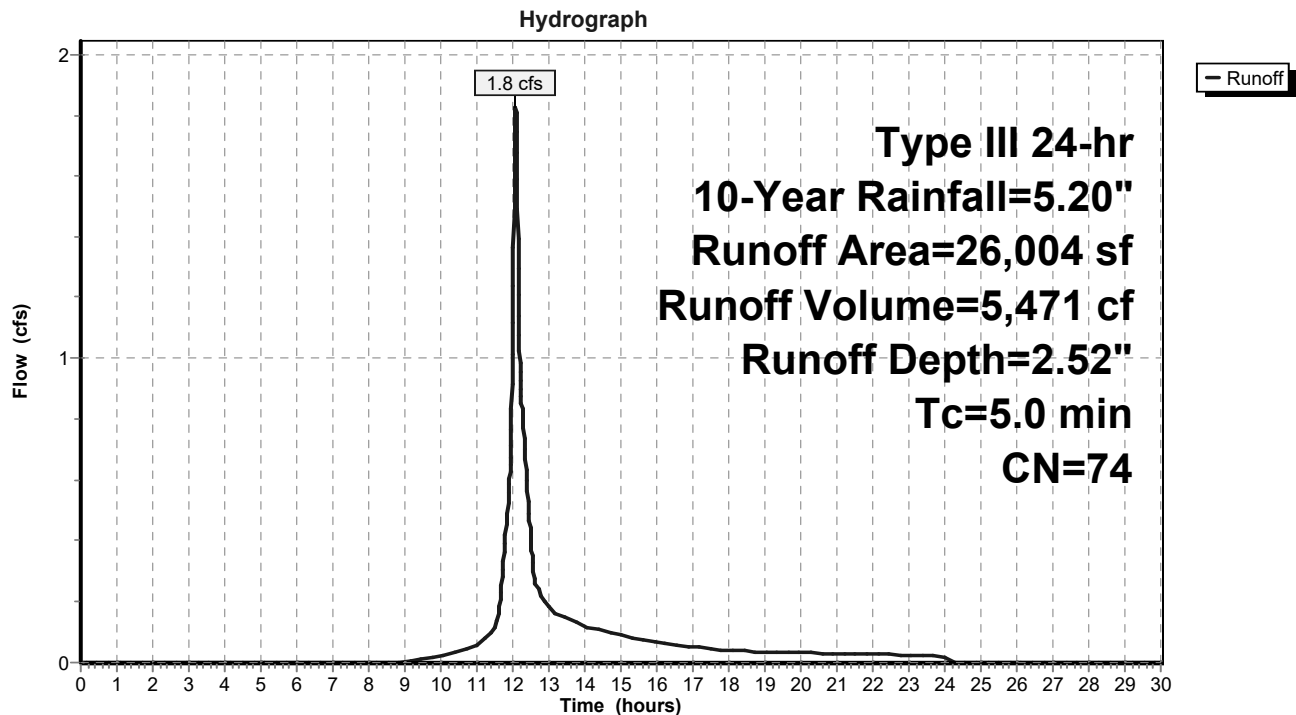
Summary for Subcatchment EX-1: Lower Lot & Bldgs

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

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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

Runoff = 5.3 cfs @ 12.07 hrs, Volume= 16,841 cf, Depth= 4.39"

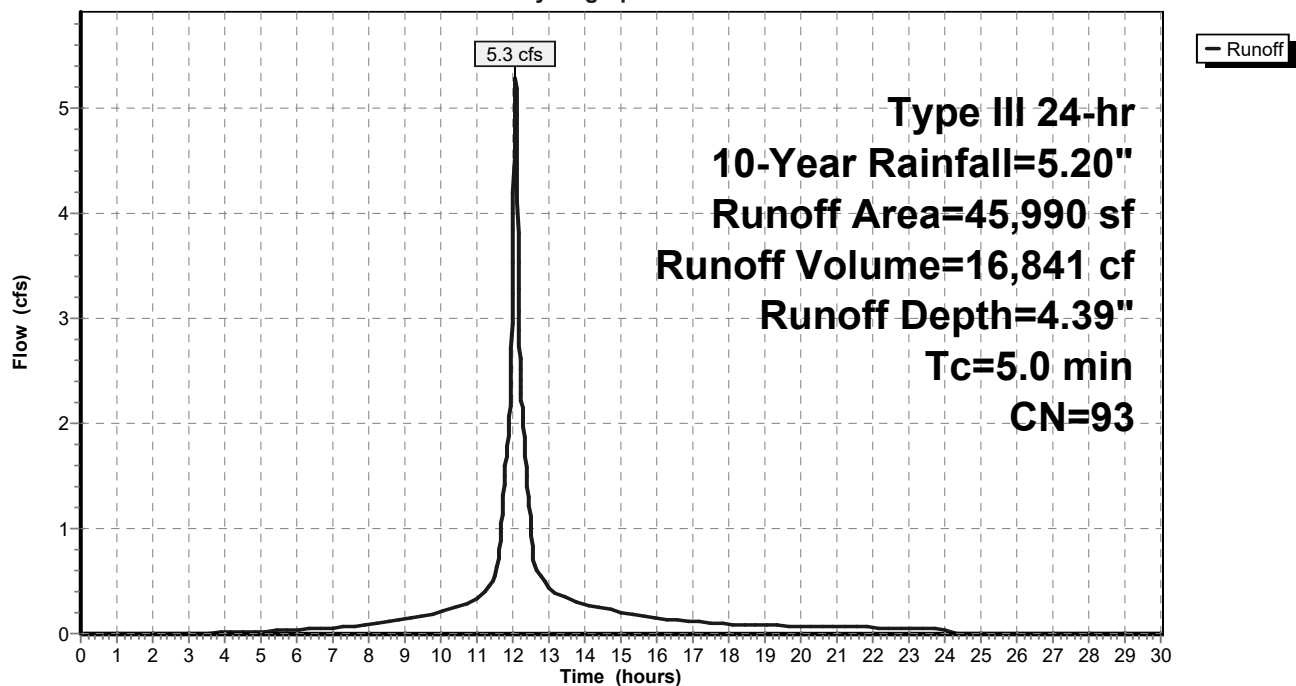
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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

Hydrograph



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

Runoff = 4.7 cfs @ 12.08 hrs, Volume= 14,488 cf, Depth= 2.02"

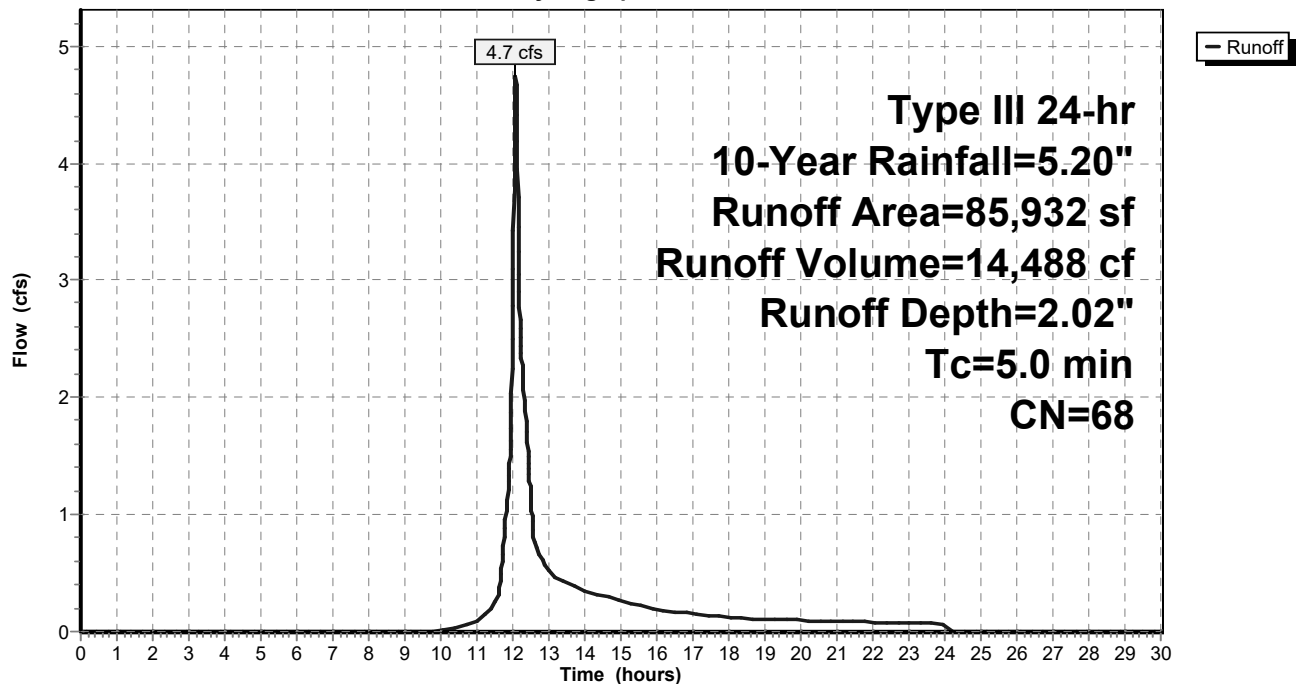
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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

Hydrograph



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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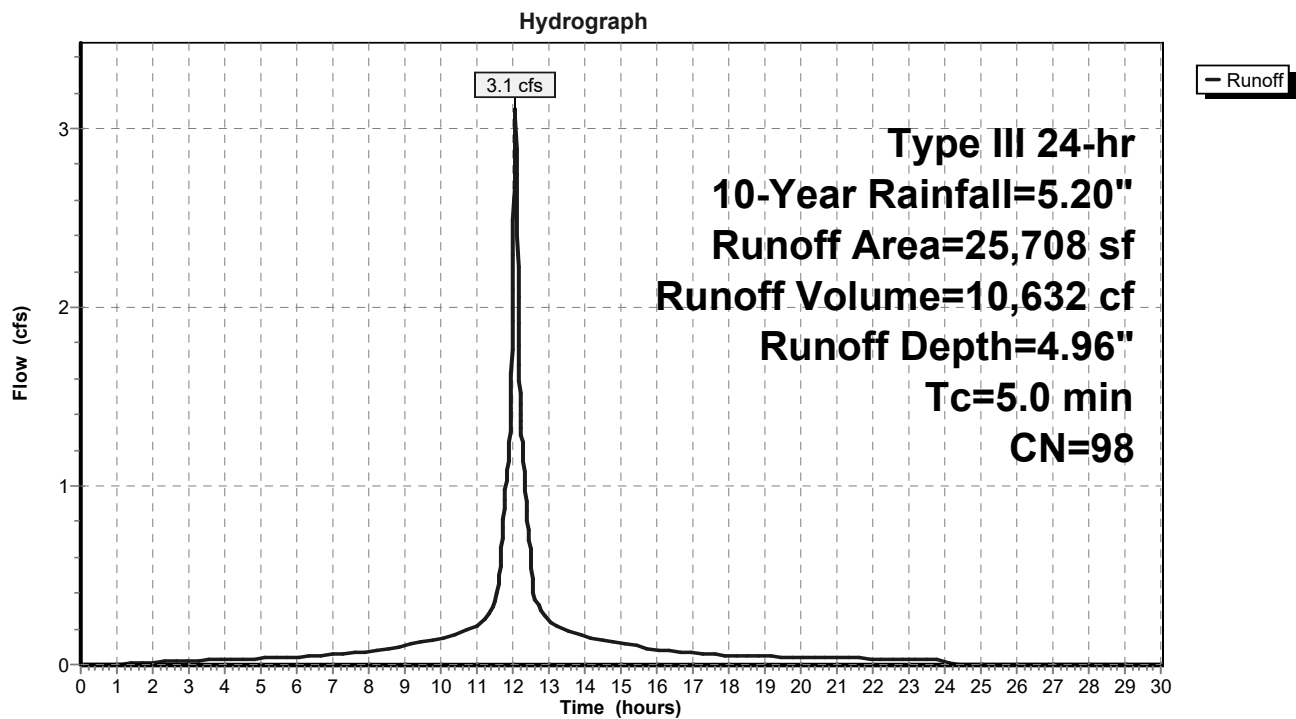
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Summary for Subcatchment EX-C: Cross St

Runoff = 3.6 cfs @ 12.07 hrs, Volume= 11,117 cf, Depth= 3.76"

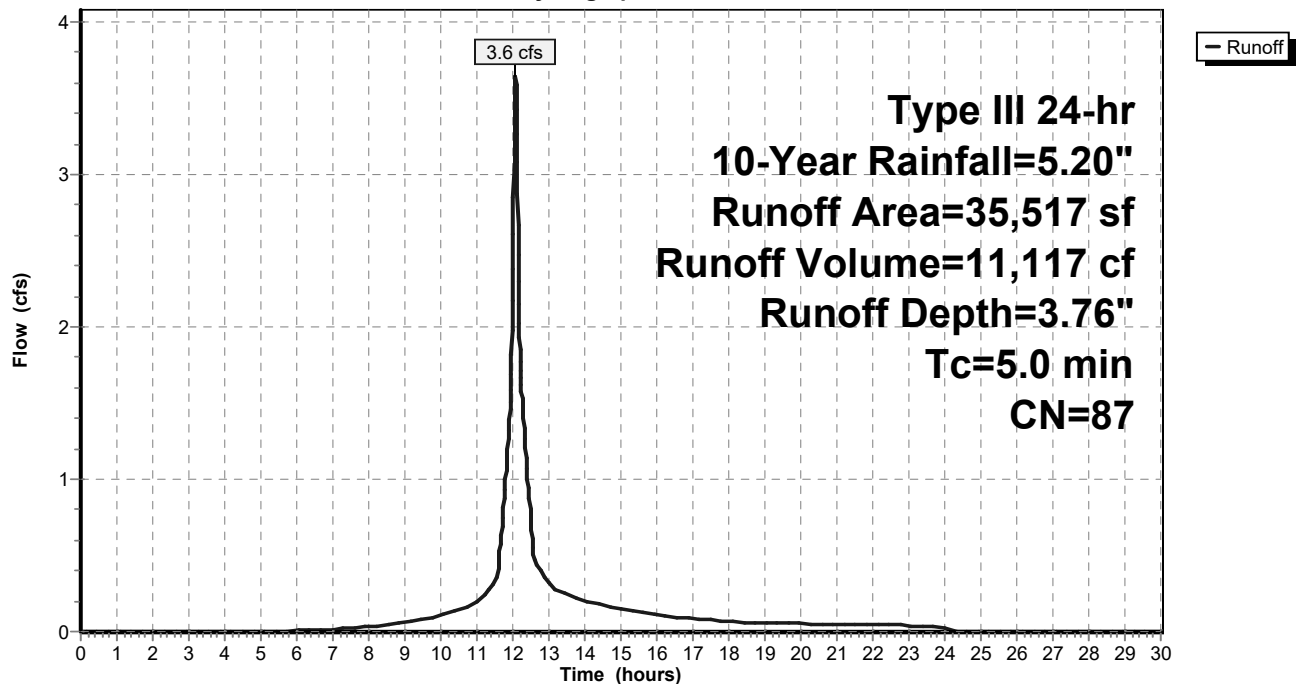
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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

Hydrograph



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 1.6 cfs @ 12.07 hrs, Volume= 4,878 cf, Depth= 3.96"

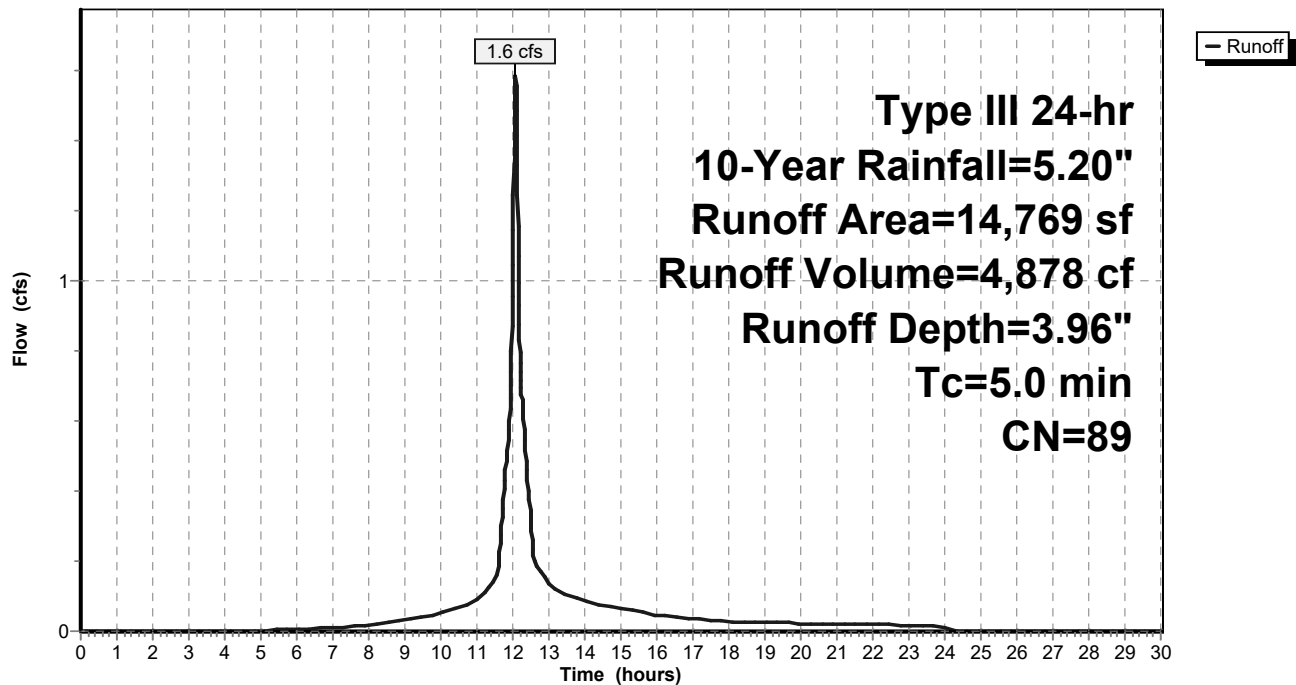
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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

Hydrograph



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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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)

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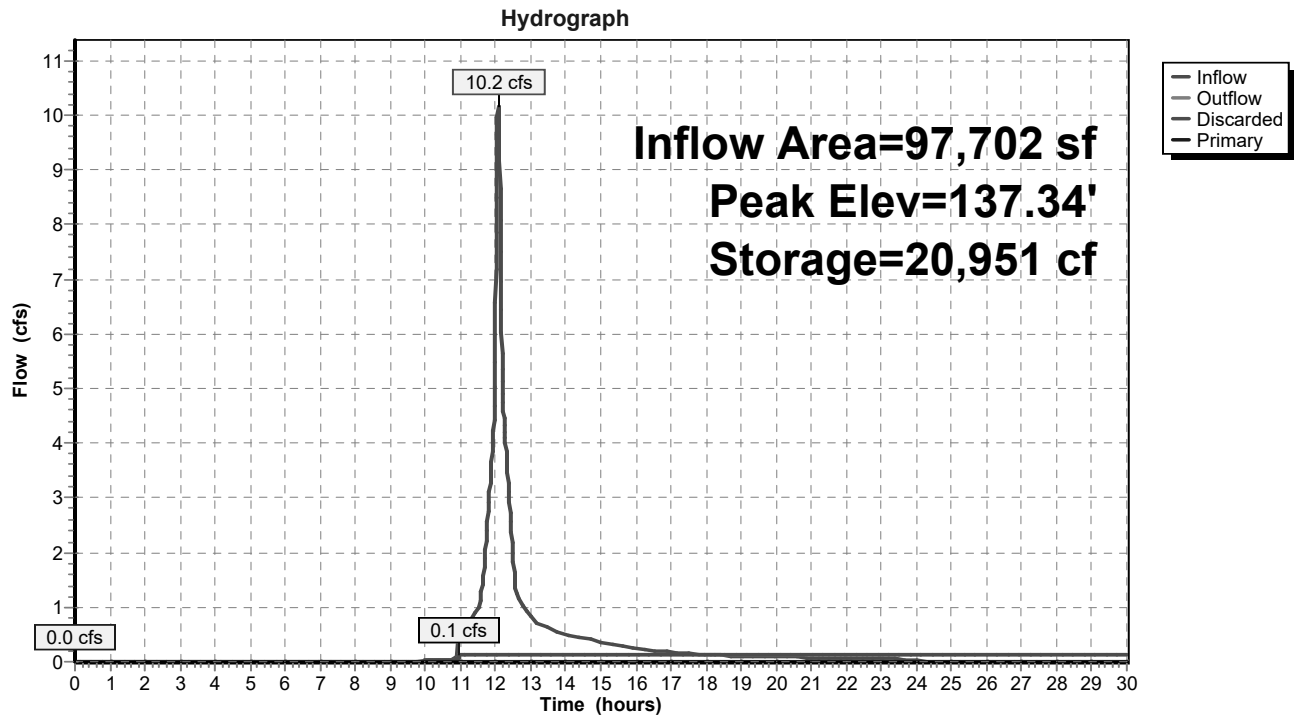
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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Pond P-1: Lower Inf Basin



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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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 (Prismatid) 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)

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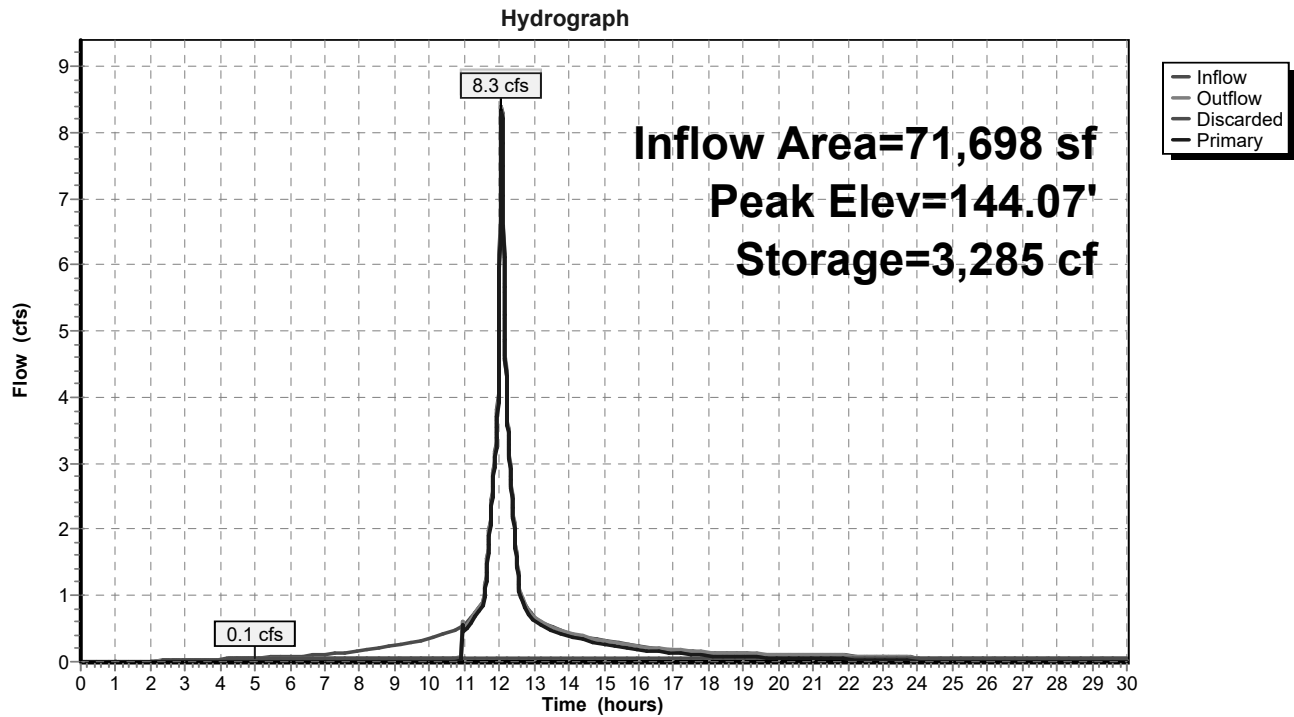
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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Pond P-2: Upper Inf Basin



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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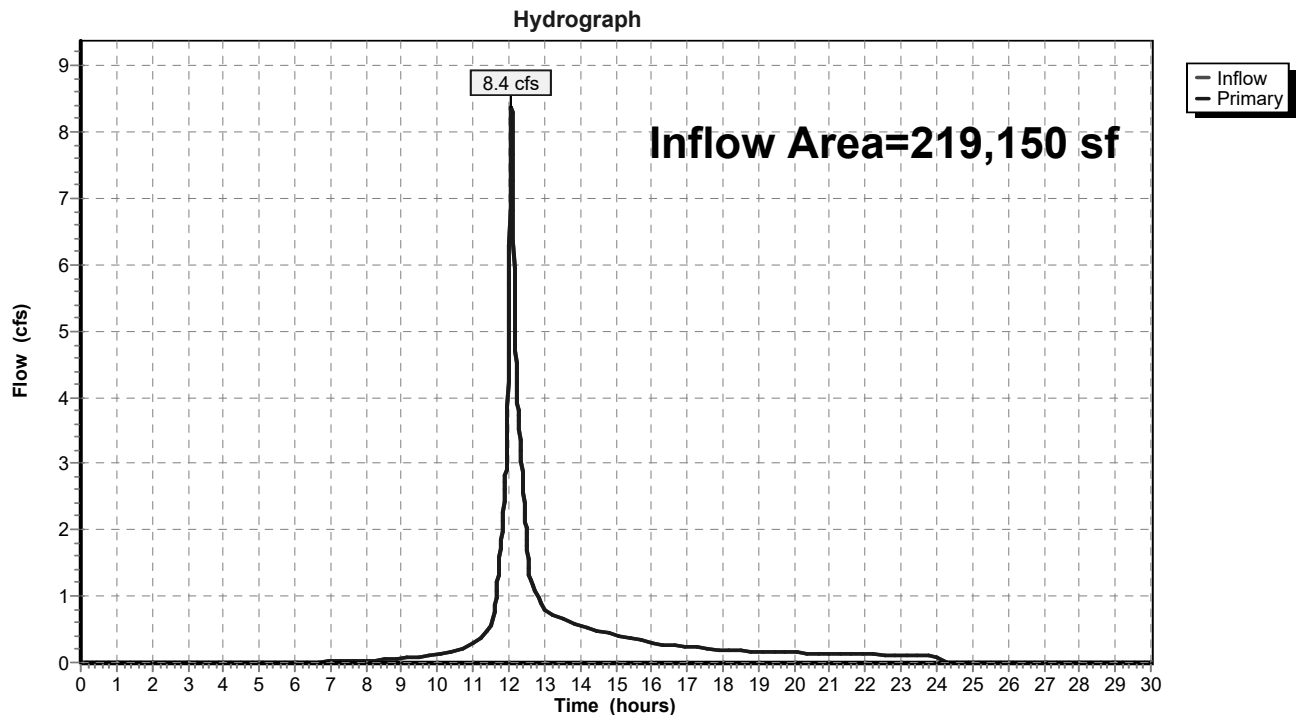
Page 25

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



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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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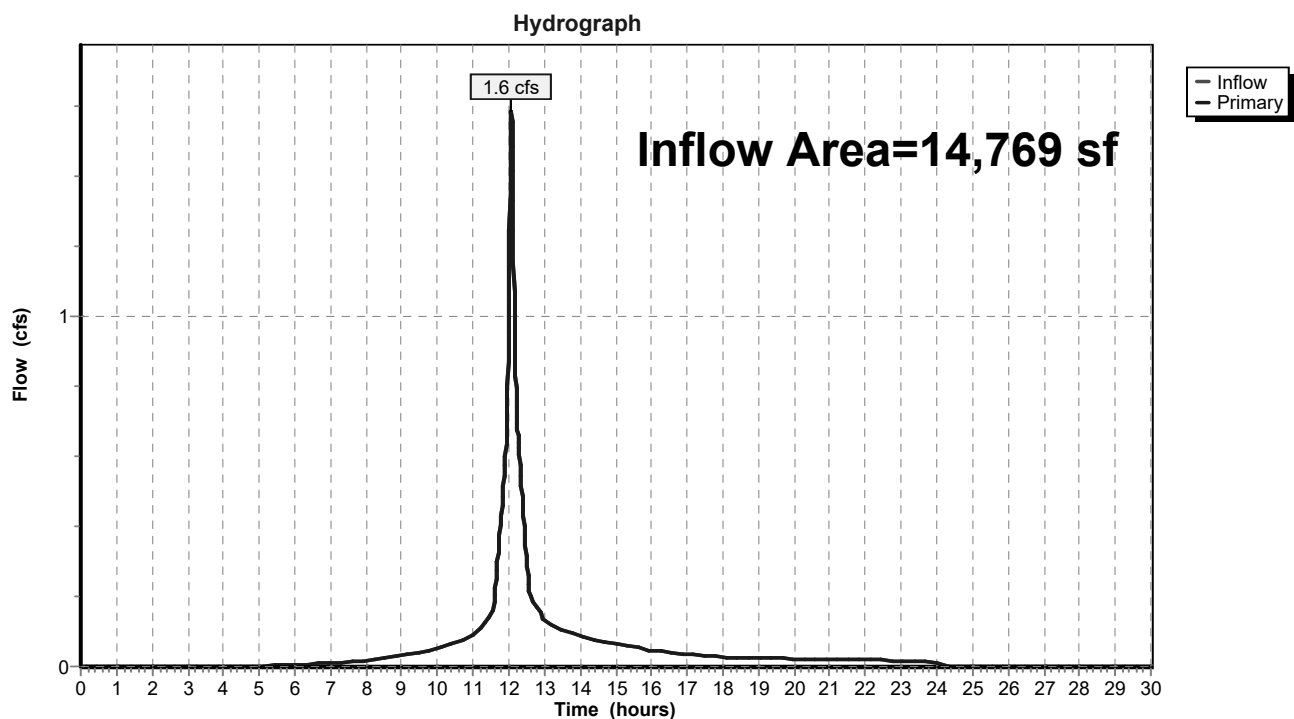
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Summary for Link DP-2: Highland Ave

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

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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Summary for Subcatchment EX-1: Lower Lot & Bldgs

Runoff = 2.6 cfs @ 12.07 hrs, Volume= 7,637 cf, Depth= 3.52"

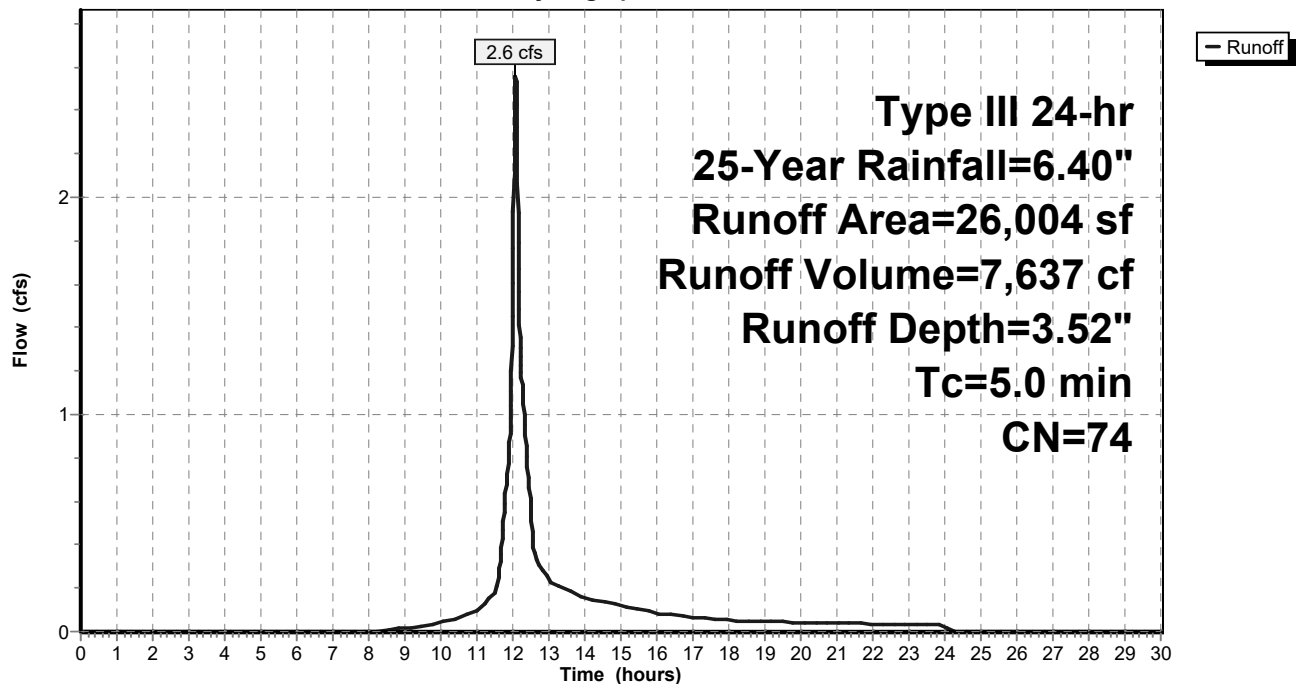
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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

Hydrograph



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

Runoff = 6.6 cfs @ 12.07 hrs, Volume= 21,376 cf, Depth= 5.58"

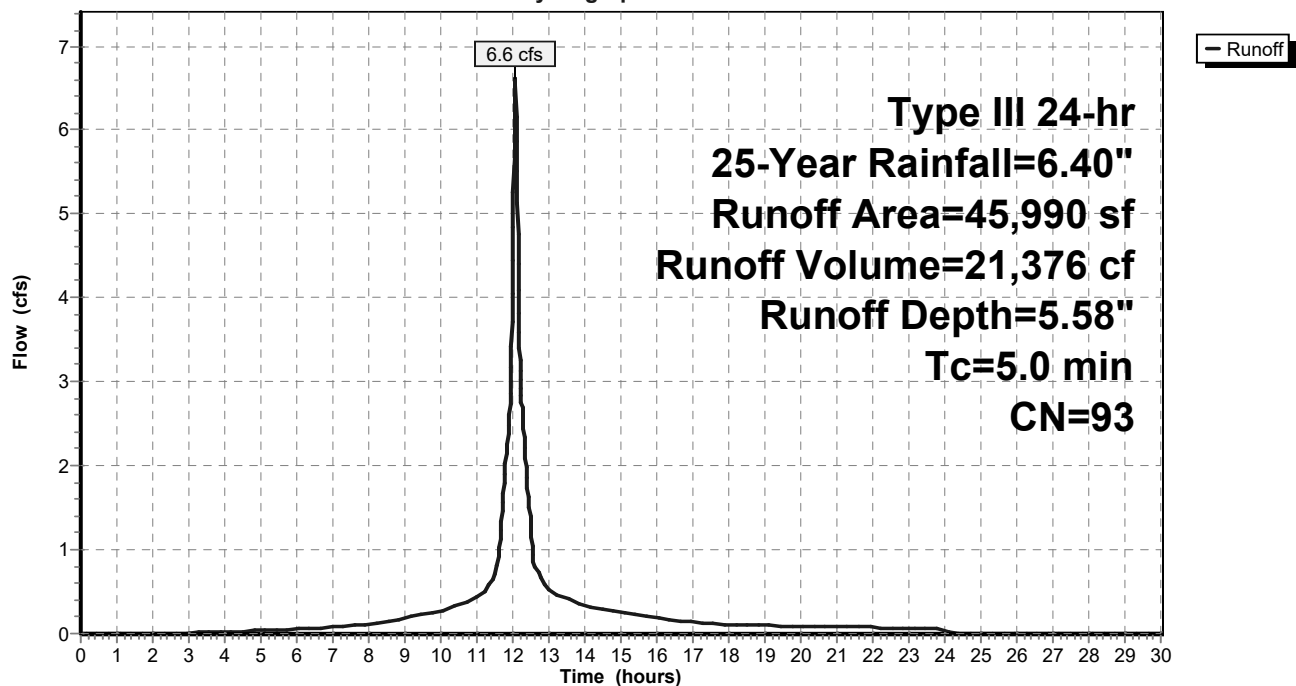
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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

Hydrograph



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

Runoff = 7.0 cfs @ 12.08 hrs, Volume= 20,993 cf, Depth= 2.93"

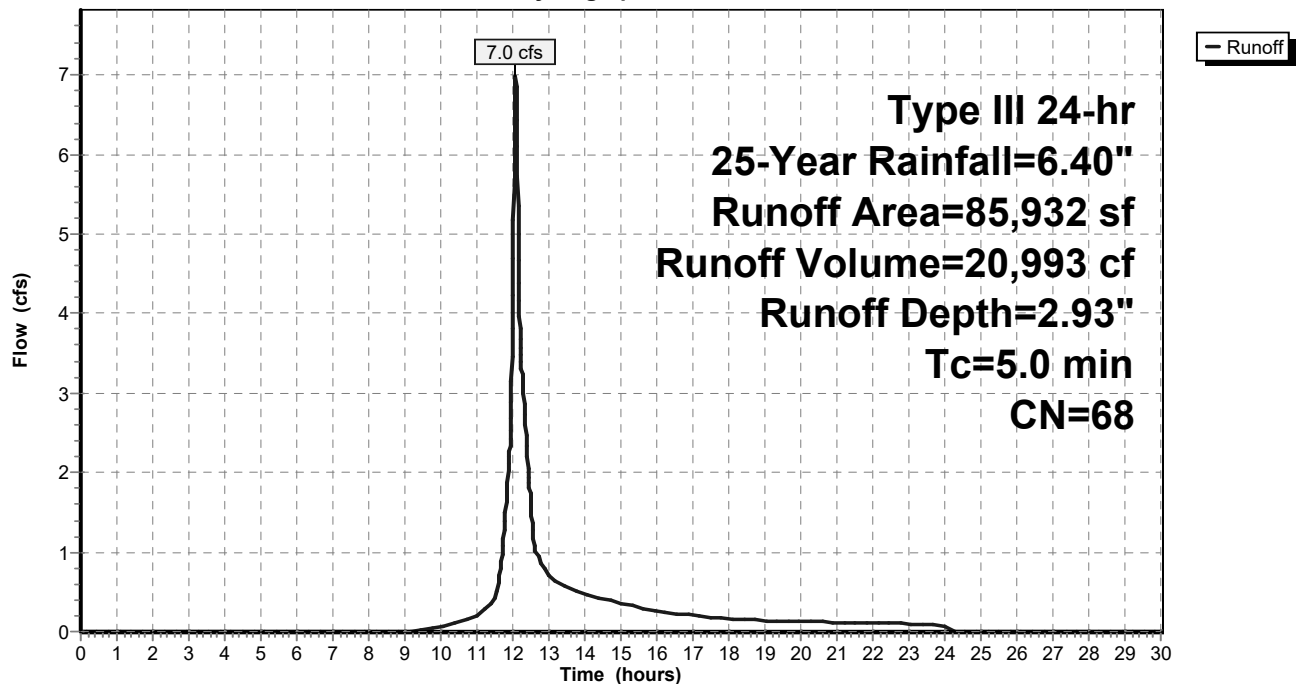
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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

Hydrograph



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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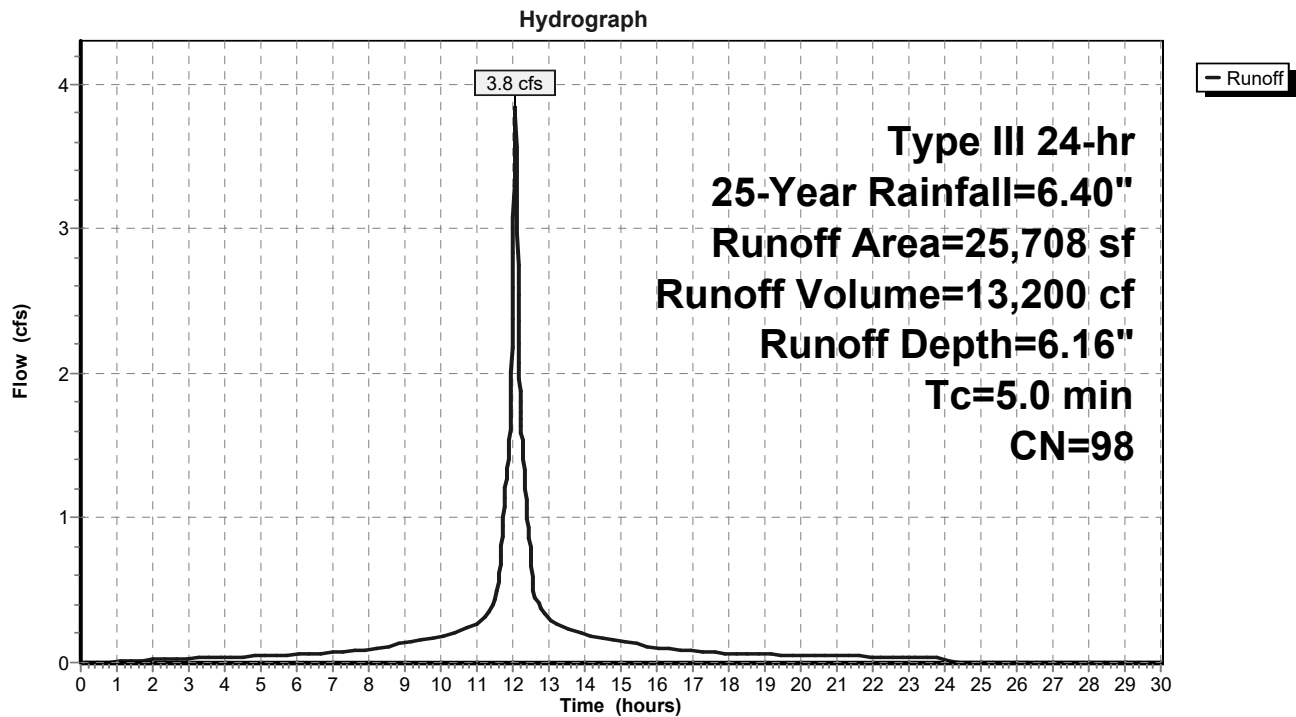
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Summary for Subcatchment EX-C: Cross St

Runoff = 4.7 cfs @ 12.07 hrs, Volume= 14,505 cf, Depth= 4.90"

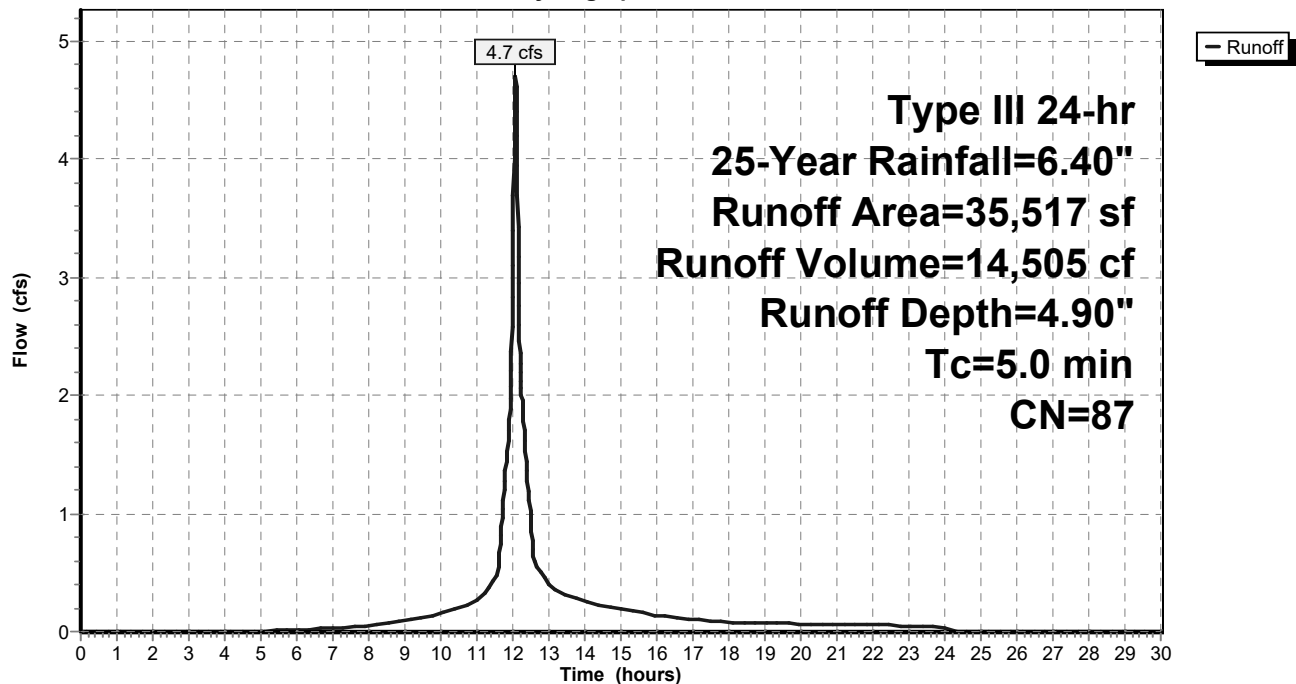
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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

Hydrograph



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 2.0 cfs @ 12.07 hrs, Volume= 6,306 cf, Depth= 5.12"

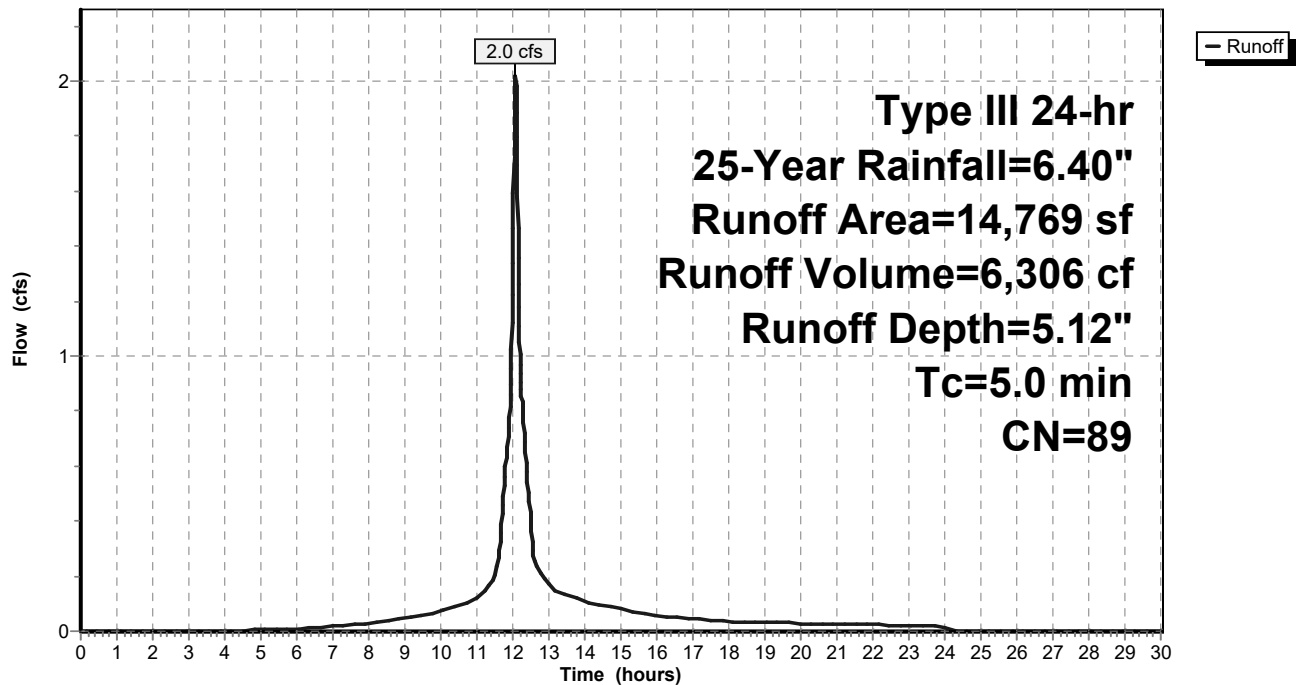
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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

Hydrograph



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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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)

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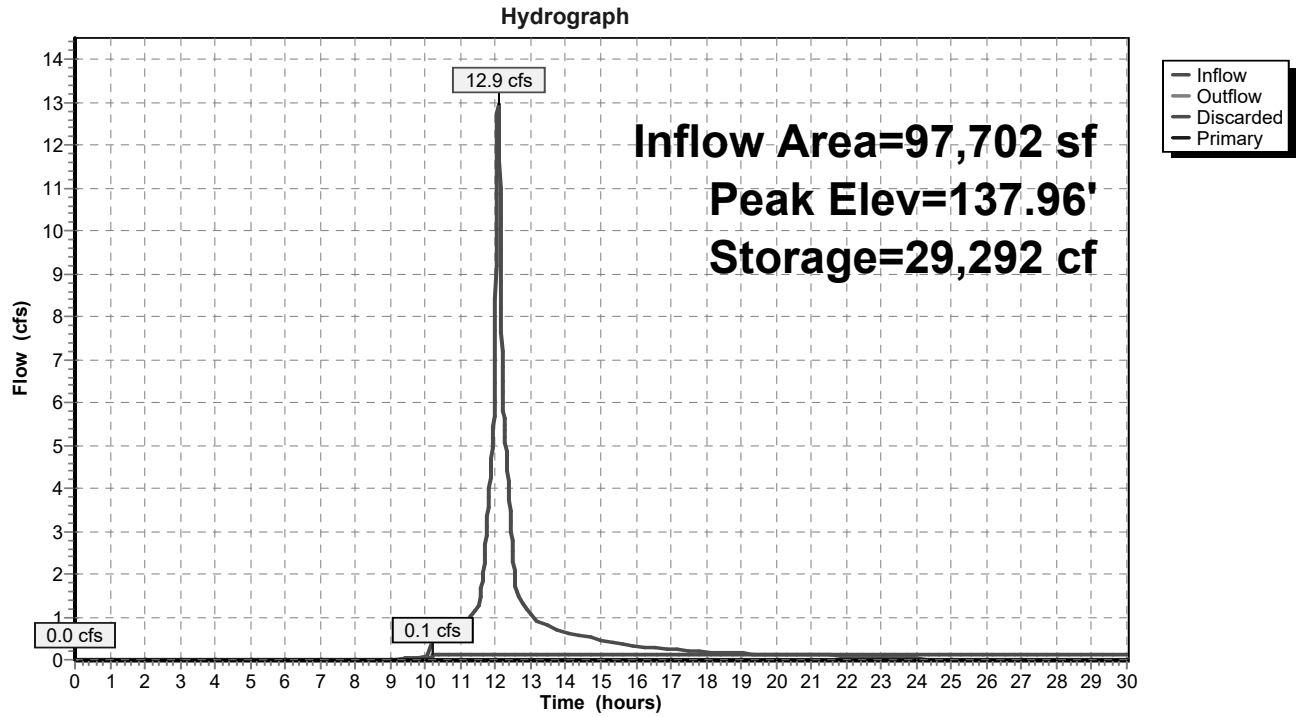
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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Pond P-1: Lower Inf Basin



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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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 (Prismatid) 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)

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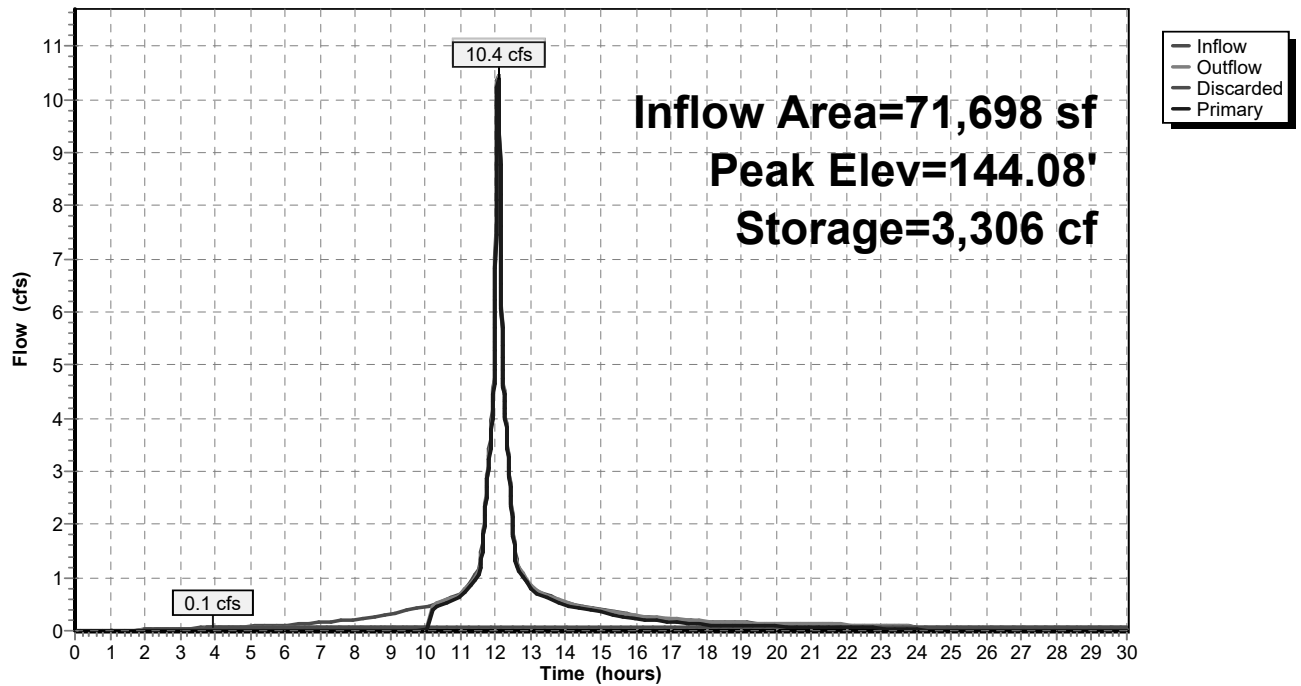
Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Pond P-2: Upper Inf Basin

Hydrograph



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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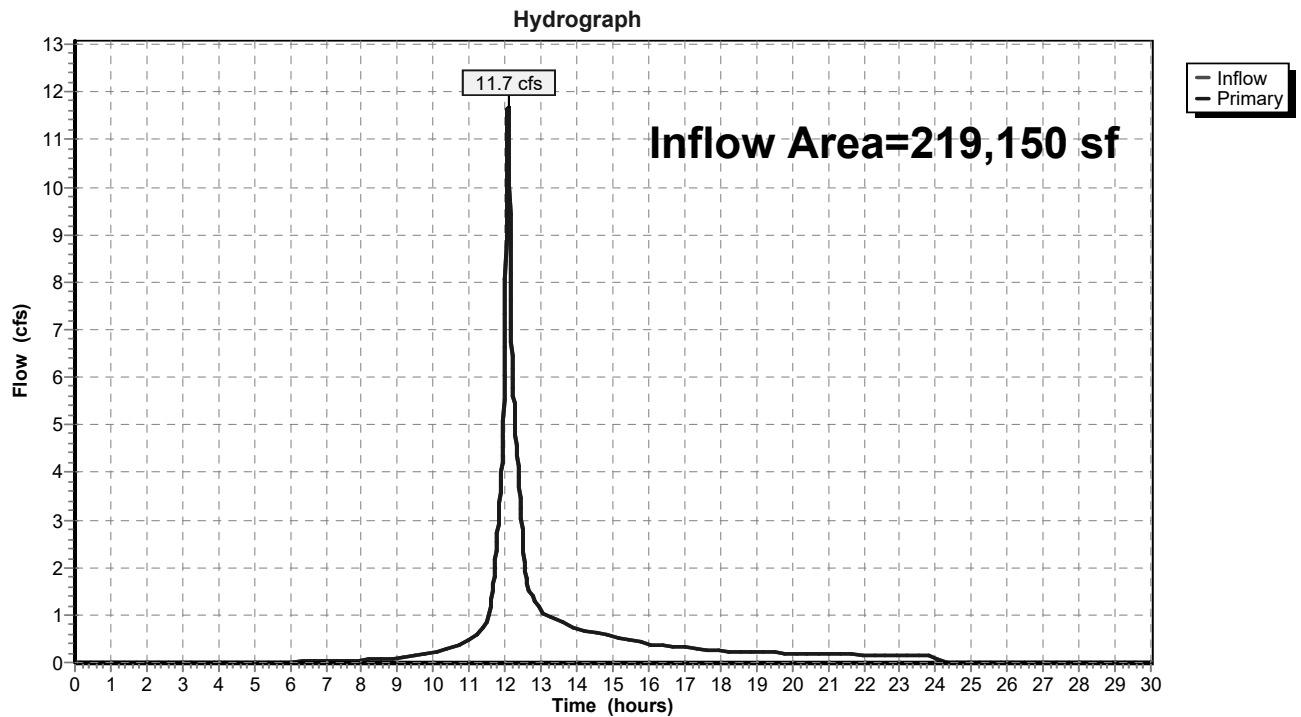
Page 37

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



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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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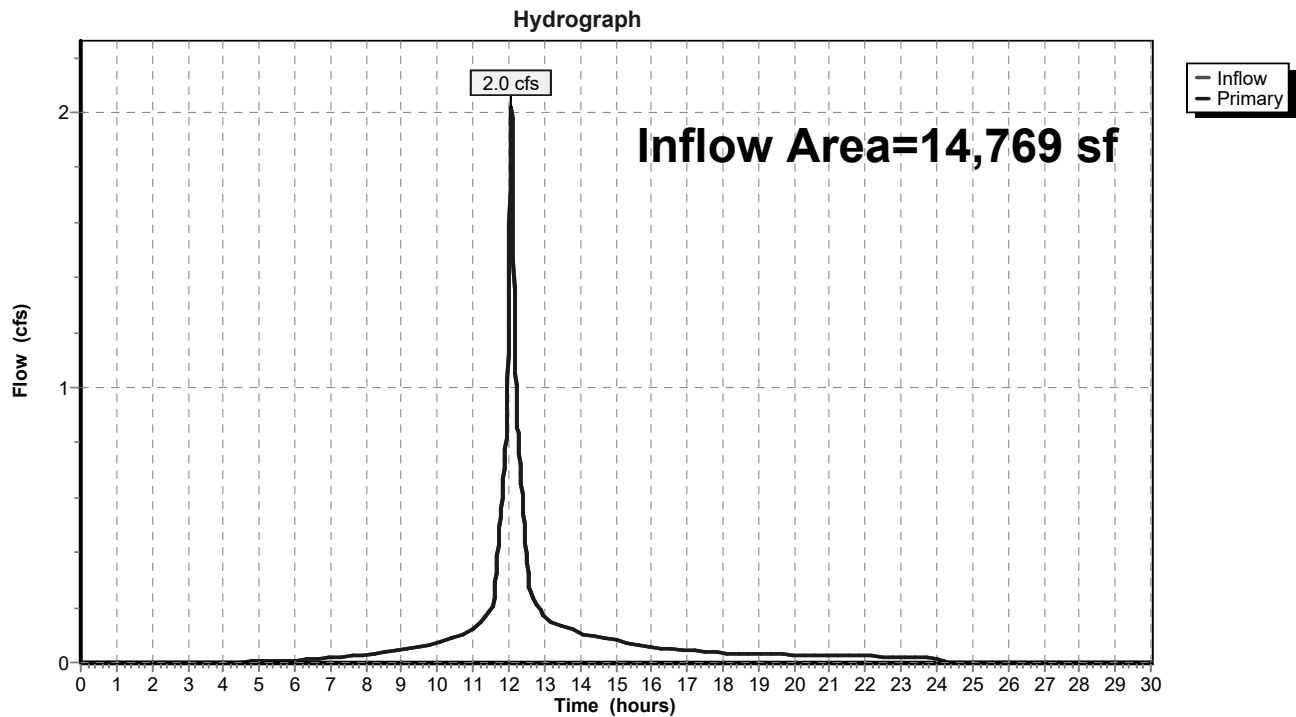
Page 38

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

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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Summary for Subcatchment EX-1: Lower Lot & Bldgs

Runoff = 3.7 cfs @ 12.07 hrs, Volume= 11,062 cf, Depth= 5.10"

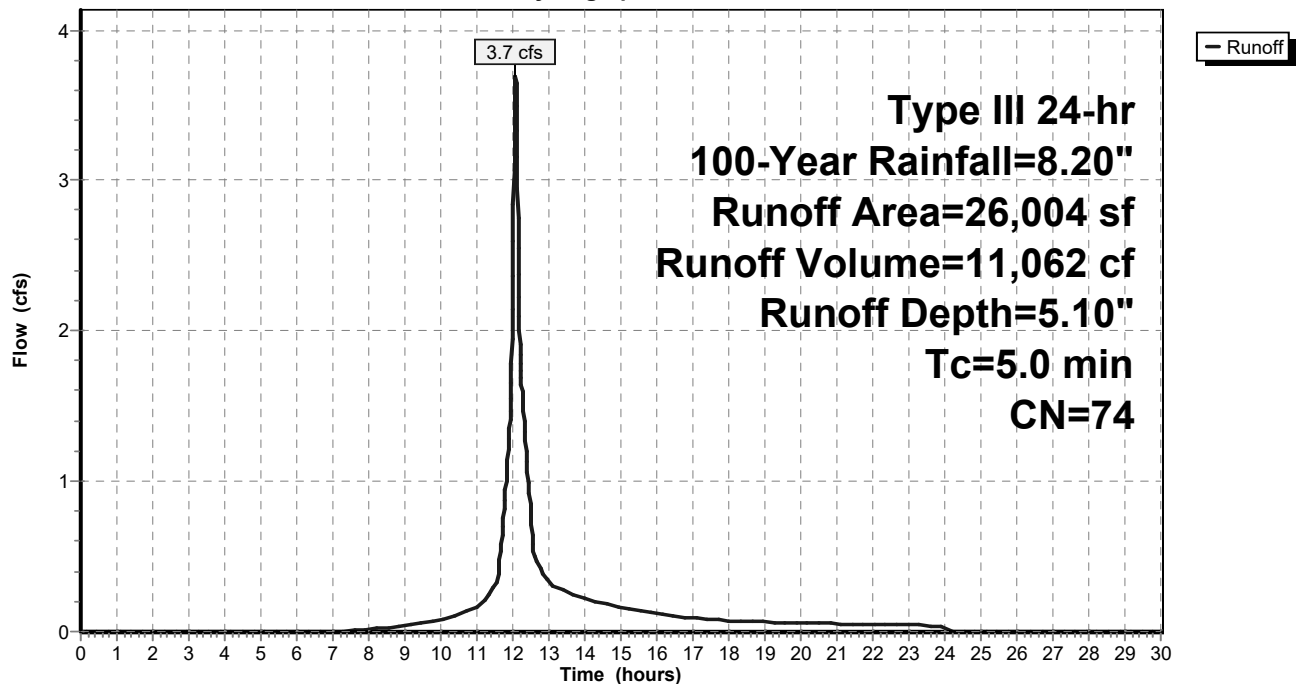
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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

Hydrograph



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Summary for Subcatchment EX-2: Upper Lot, Bldgs, & Upstream Area

Runoff = 8.6 cfs @ 12.07 hrs, Volume= 28,211 cf, Depth= 7.36"

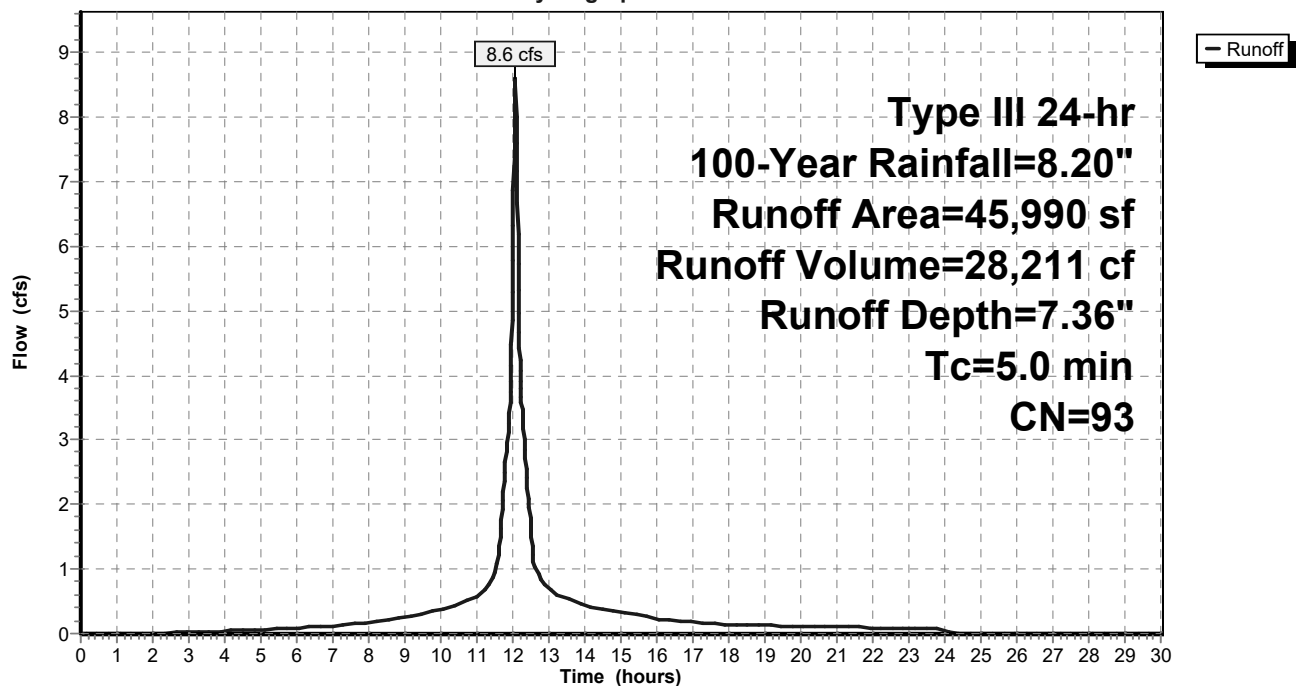
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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

Hydrograph



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

Runoff = 10.6 cfs @ 12.08 hrs, Volume= 31,536 cf, Depth= 4.40"

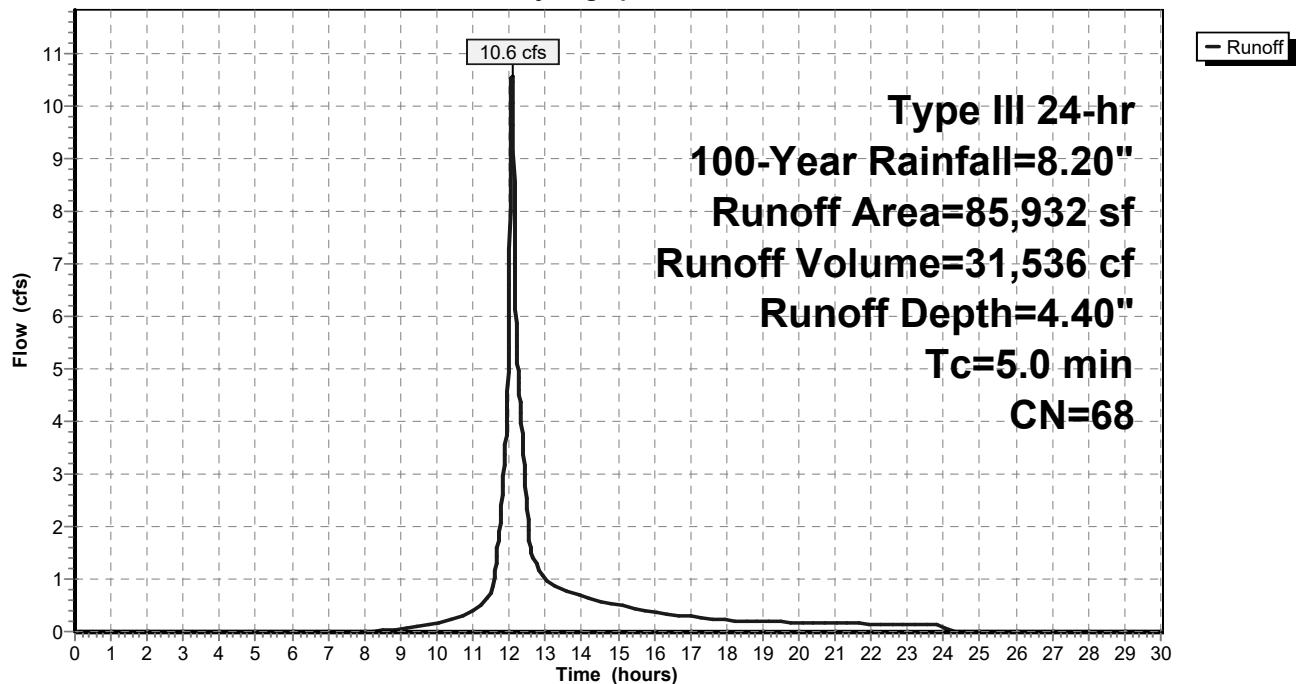
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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

Hydrograph



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Summary for Subcatchment EX-B: 673 Highland & Upstream Area

Runoff = 4.9 cfs @ 12.07 hrs, Volume= 17,053 cf, Depth= 7.96"

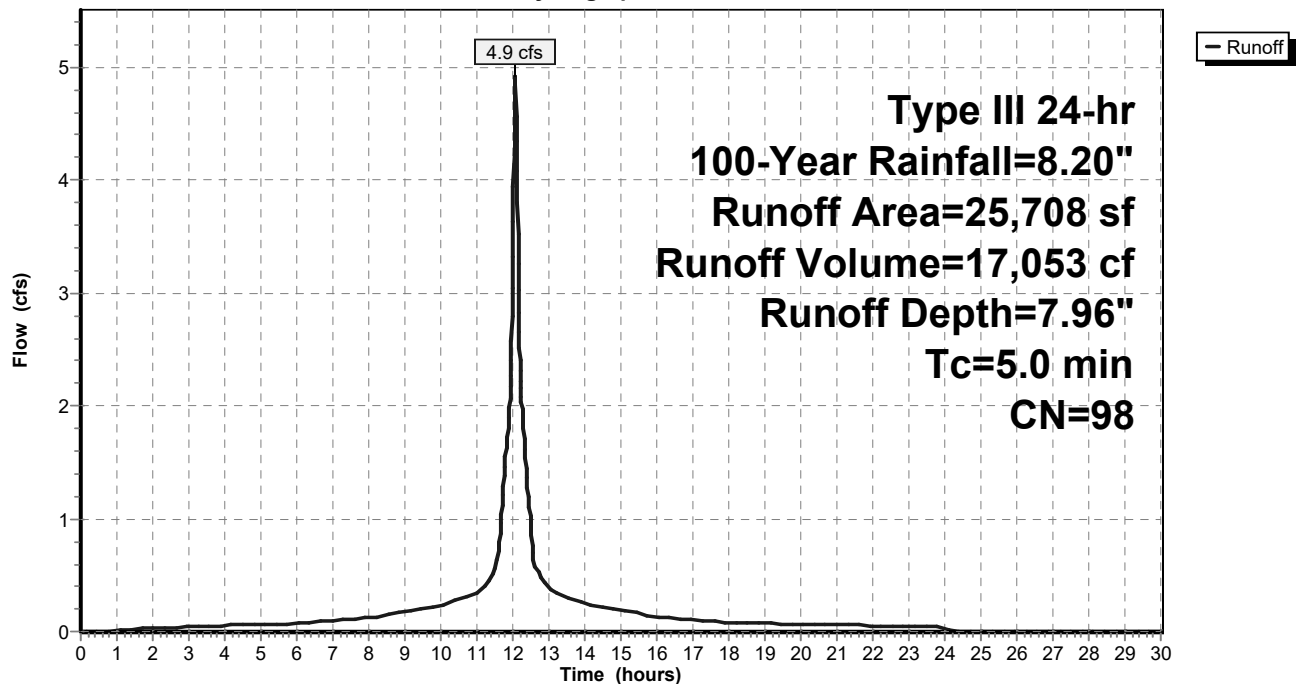
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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

Hydrograph



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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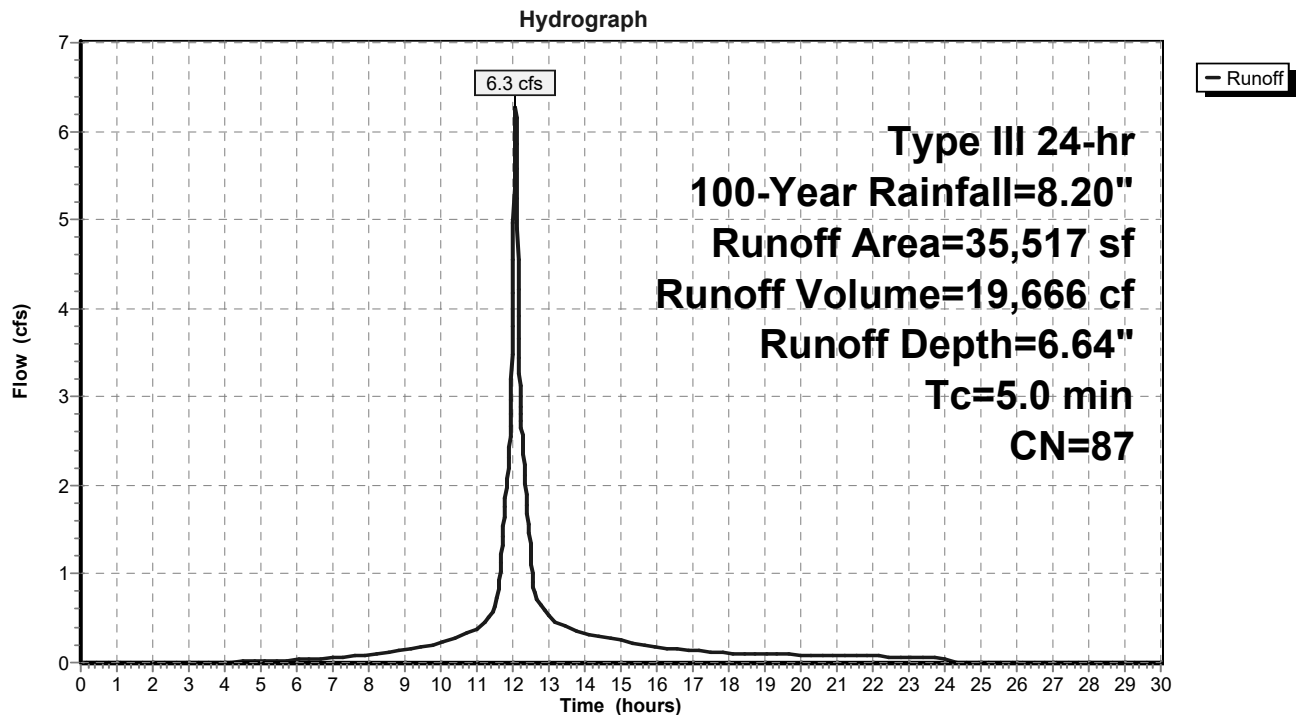
Summary for Subcatchment EX-C: Cross St

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

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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf, Depth= 6.88"

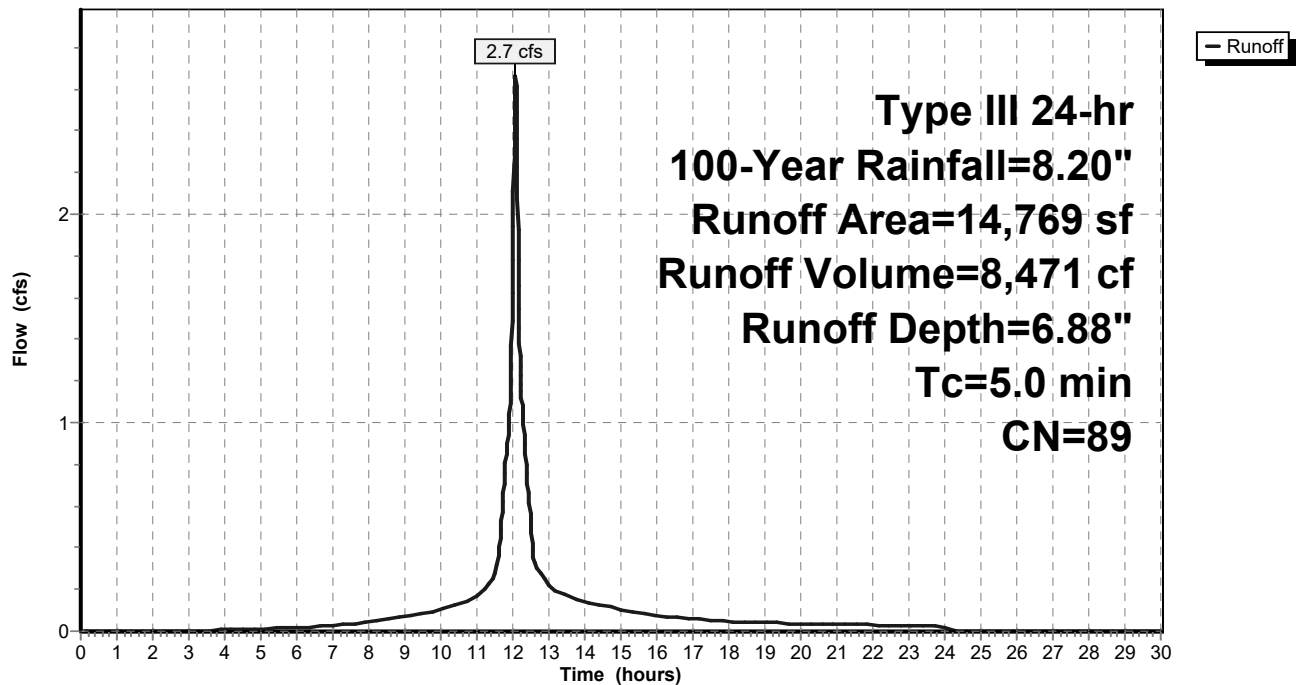
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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

Hydrograph



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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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)

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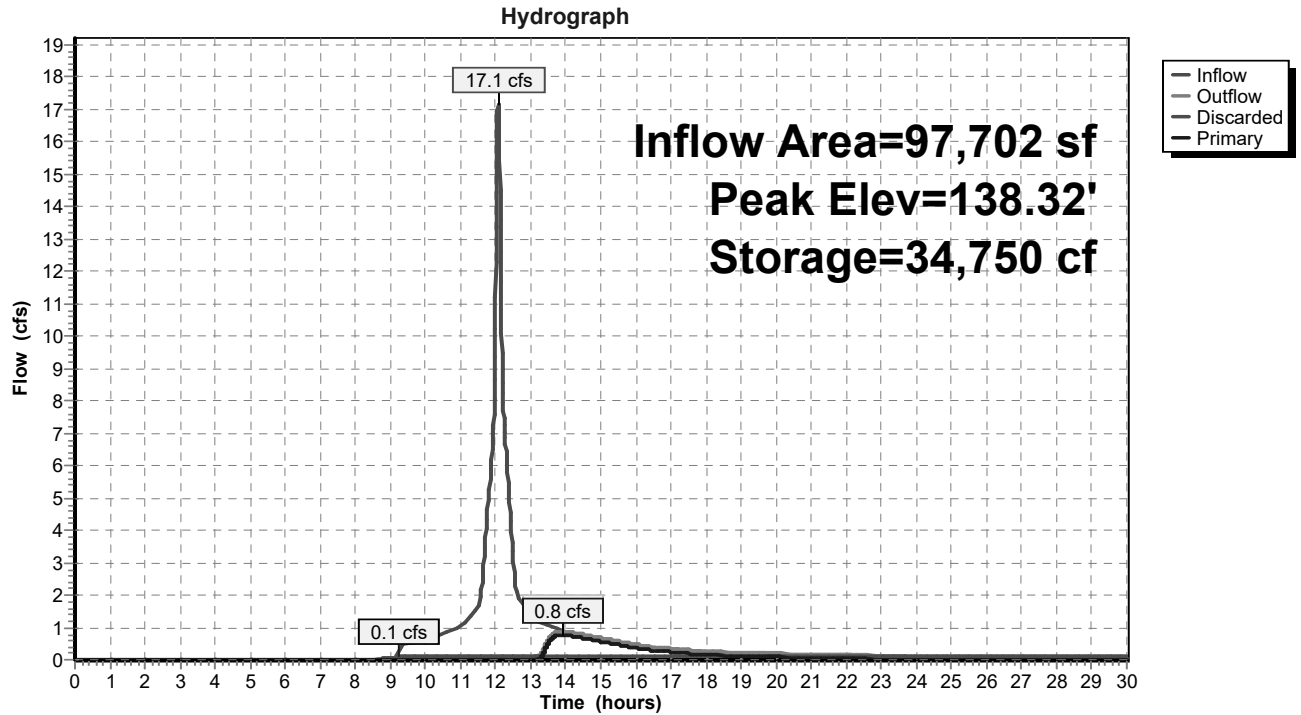
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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Pond P-1: Lower Inf Basin



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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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 (Prismatid) 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)

14781.00-EX

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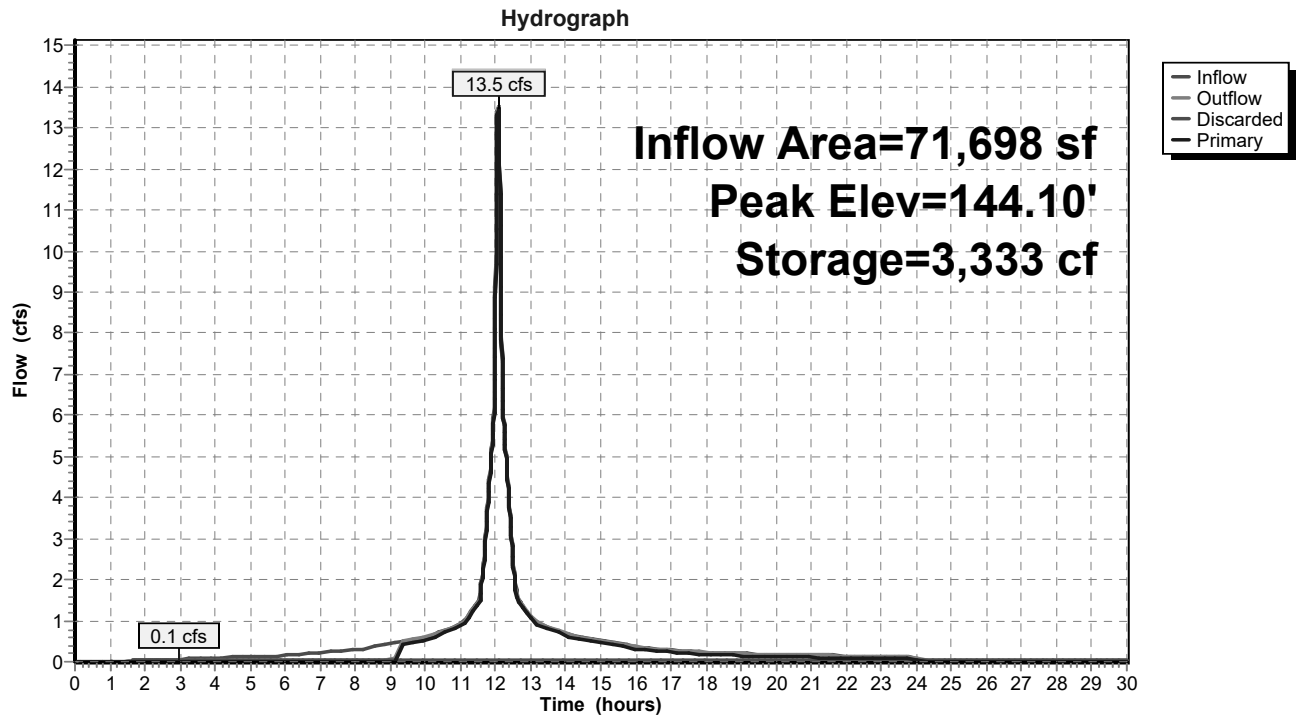
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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Pond P-2: Upper Inf Basin



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Existing
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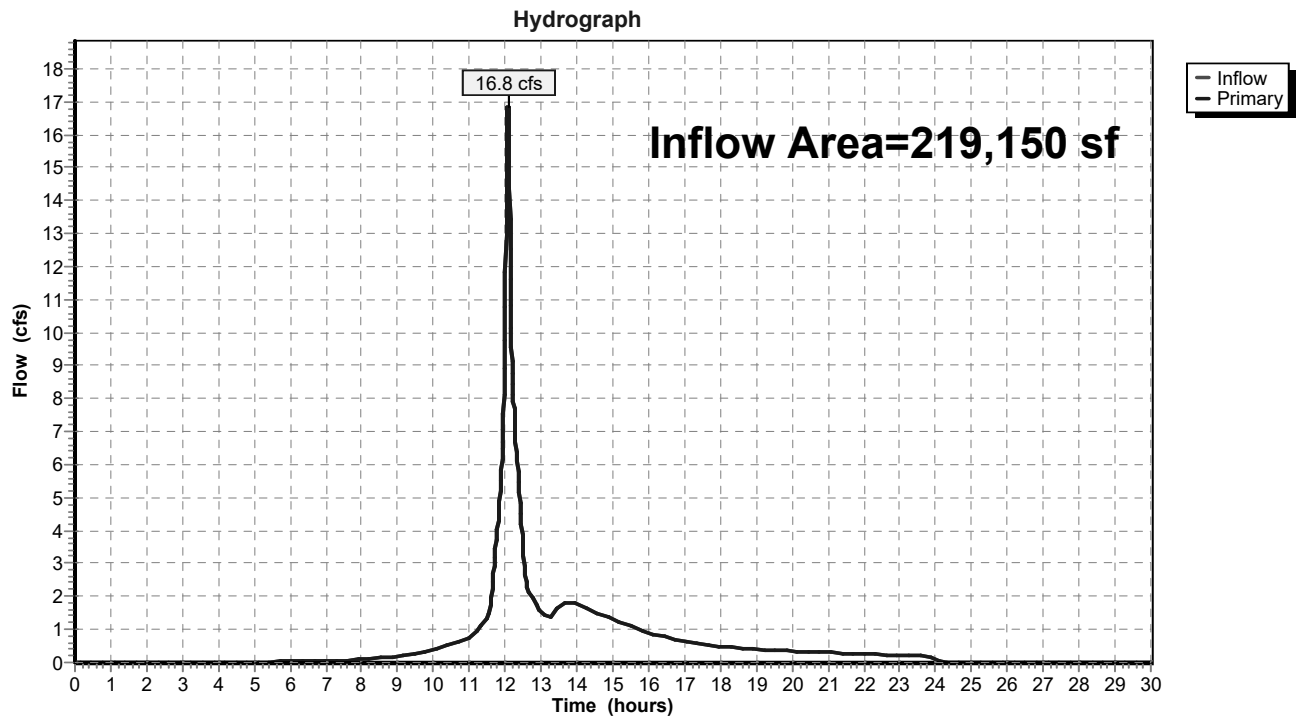
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Summary for Link DP-1: Offsite to North

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



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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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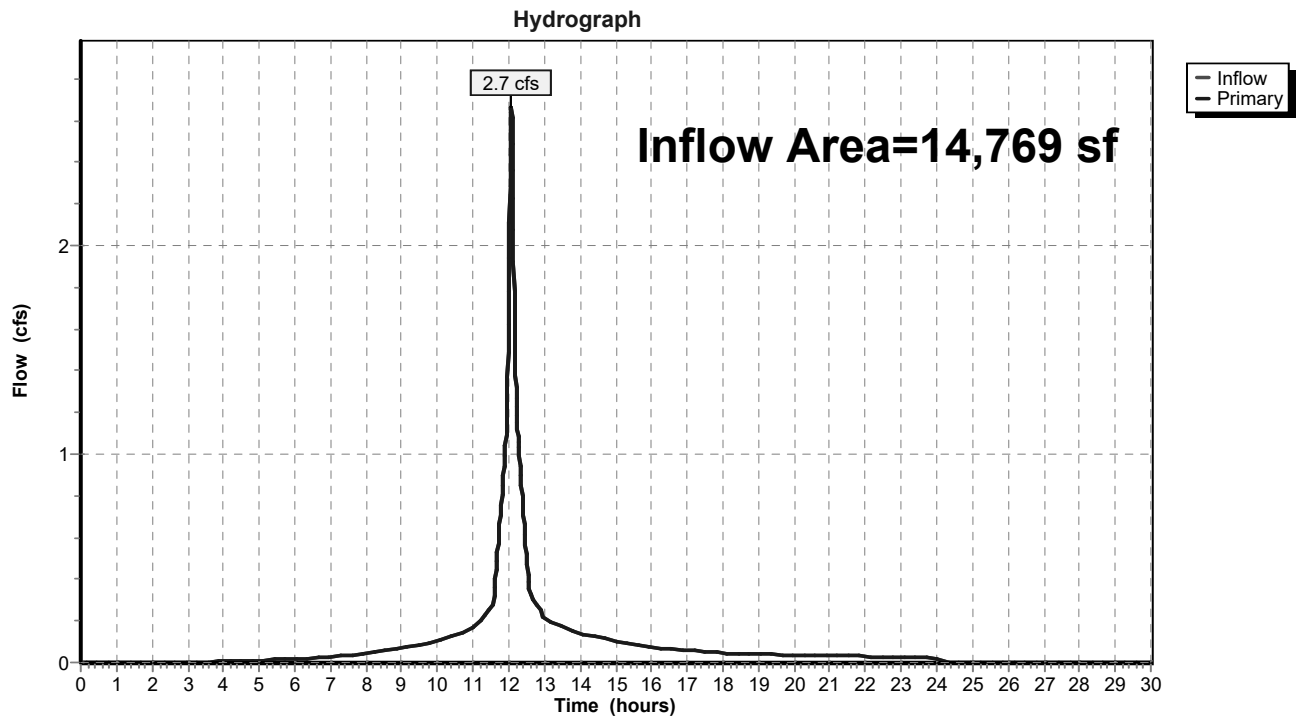
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Summary for Link DP-2: Highland Ave

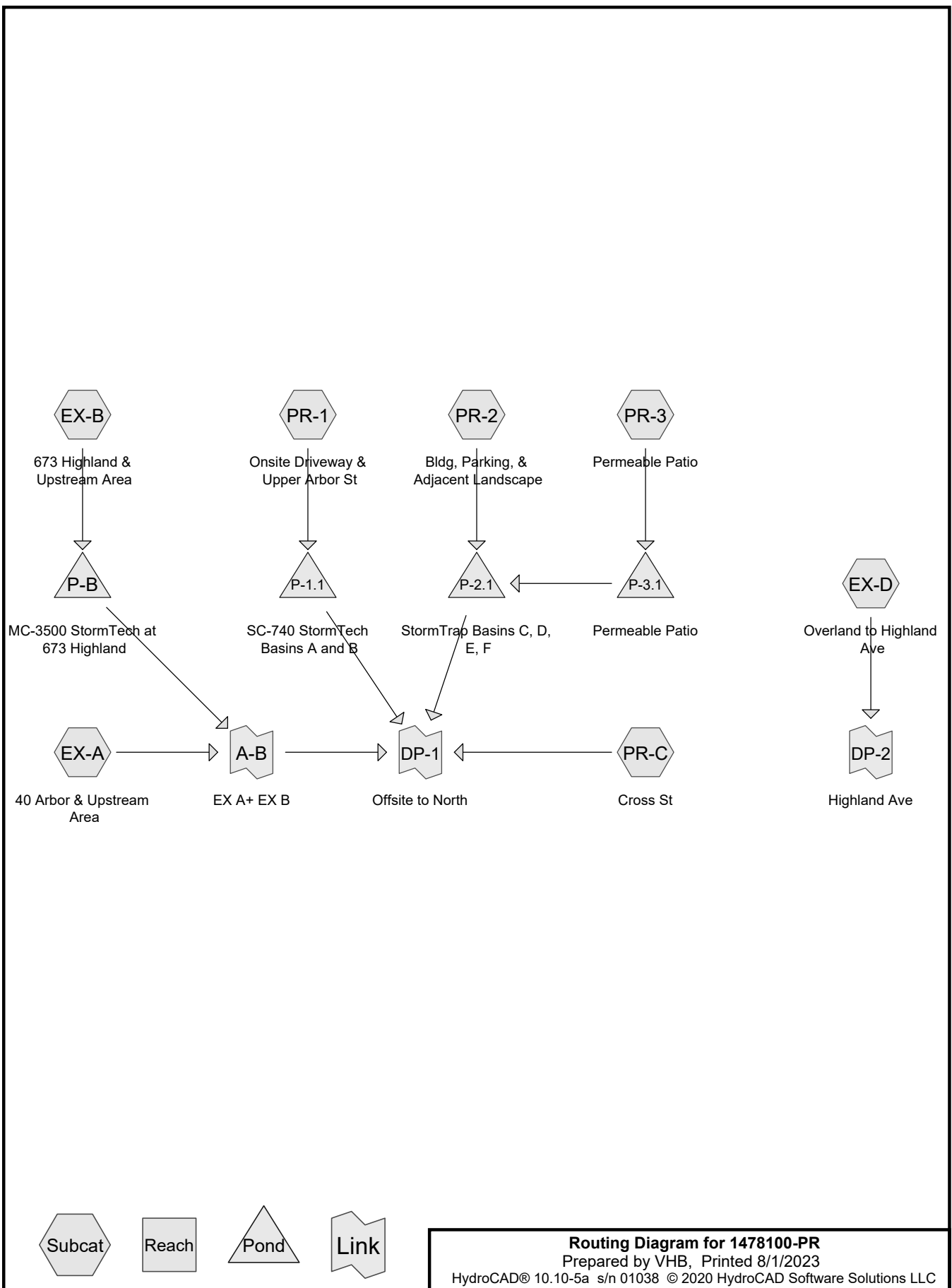
Inflow Area = 14,769 sf, 84.44% Impervious, Inflow Depth = 6.88" for 100-Year event
Inflow = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf
Primary = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Link DP-2: Highland Ave



HydroCAD Analysis: Proposed Conditions



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Page 2

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

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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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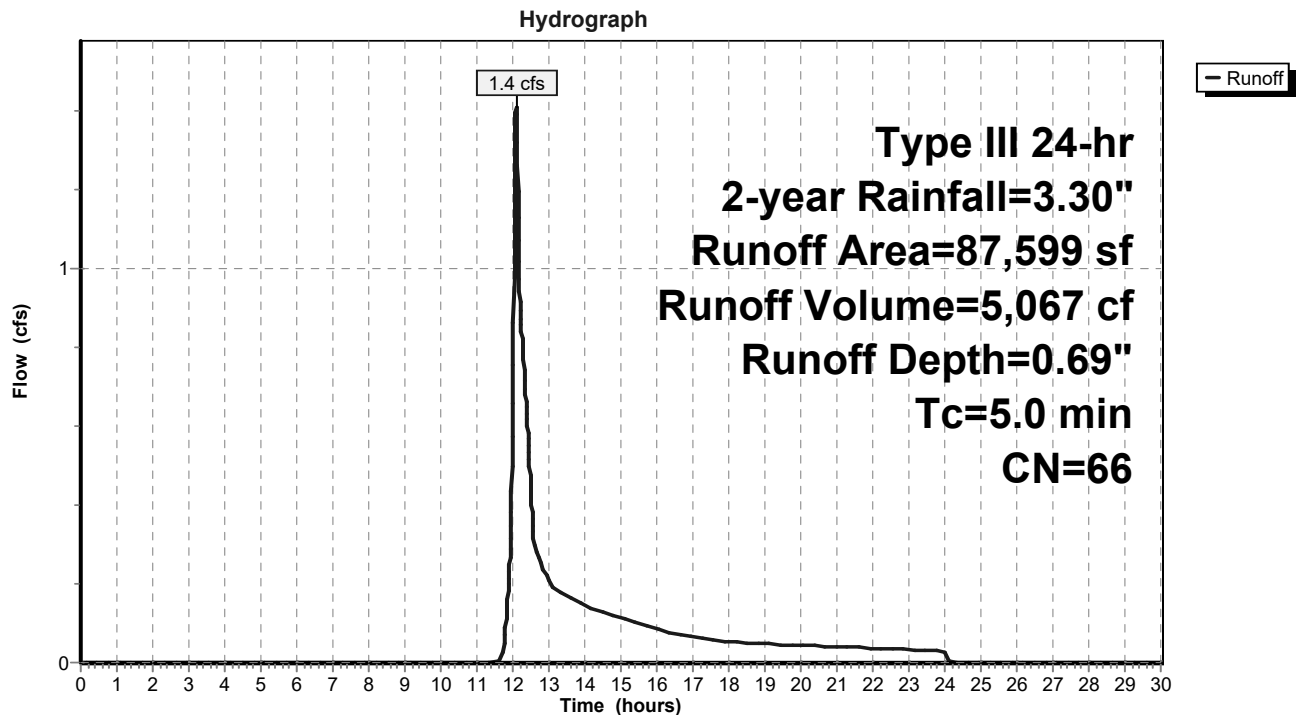
Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

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

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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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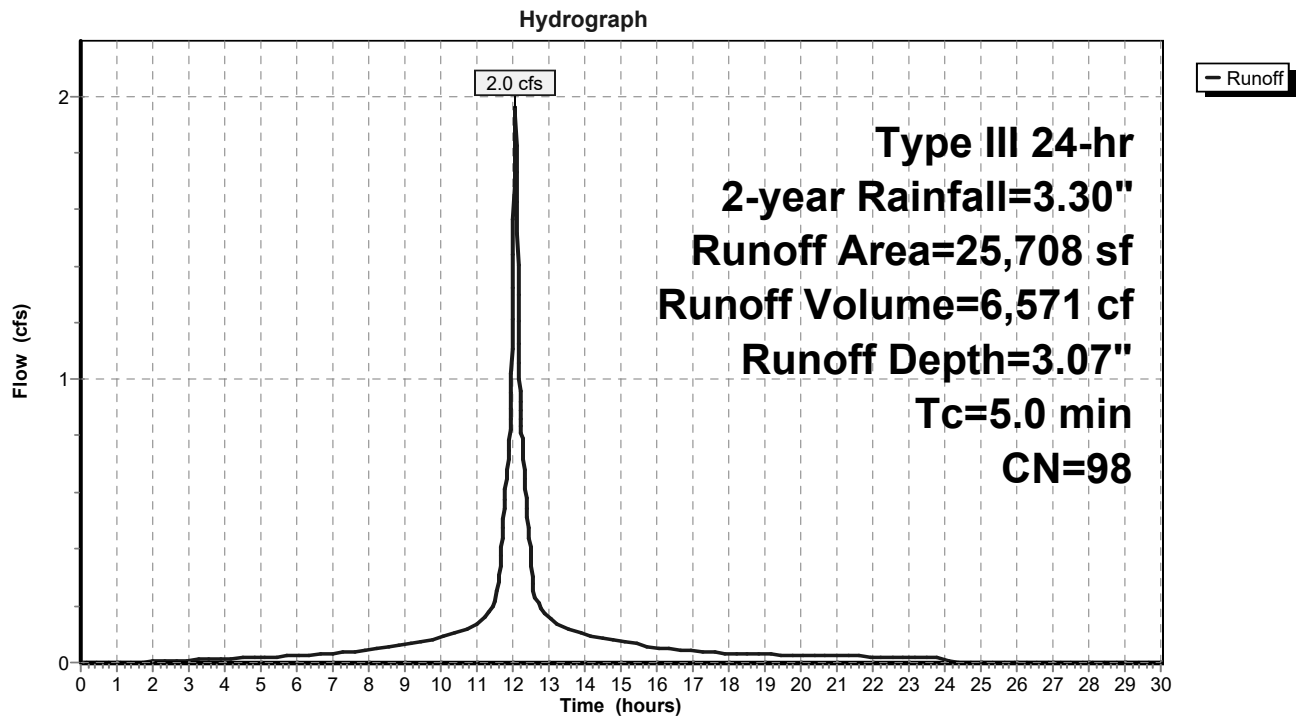
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 0.9 cfs @ 12.07 hrs, Volume= 2,971 cf, Depth= 2.74"

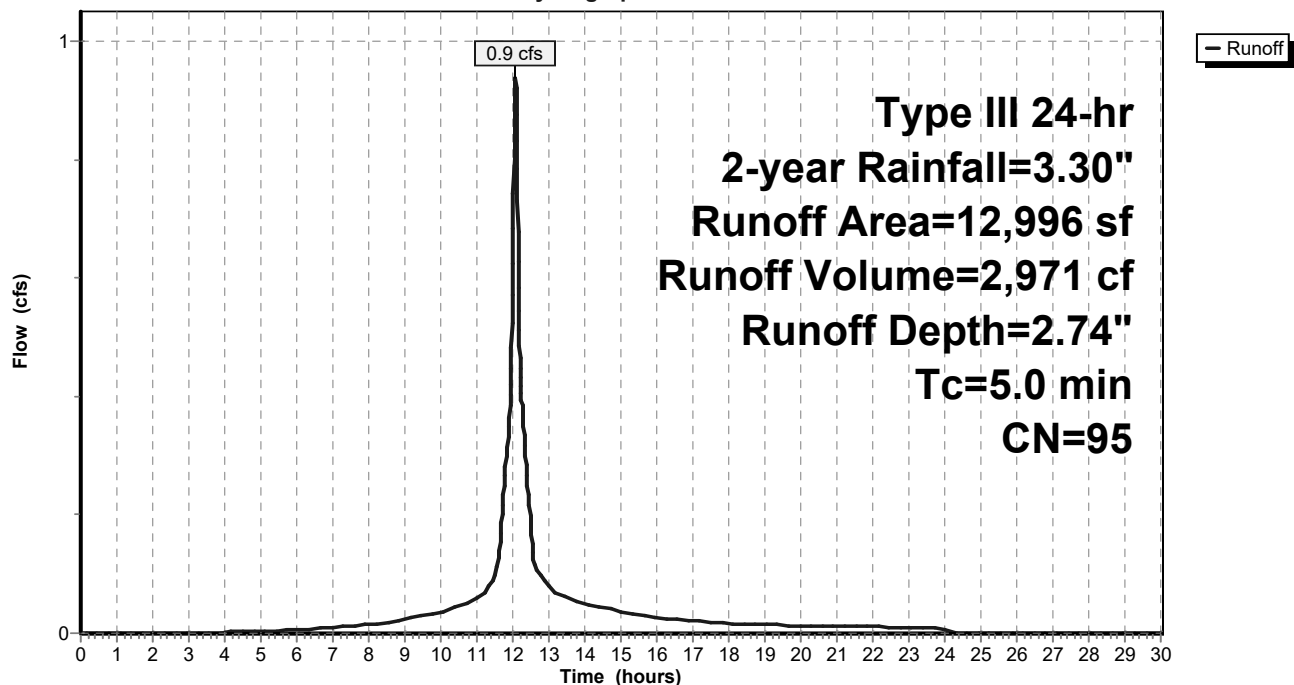
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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

Hydrograph



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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

Runoff = 0.7 cfs @ 12.08 hrs, Volume= 2,195 cf, Depth= 1.22"

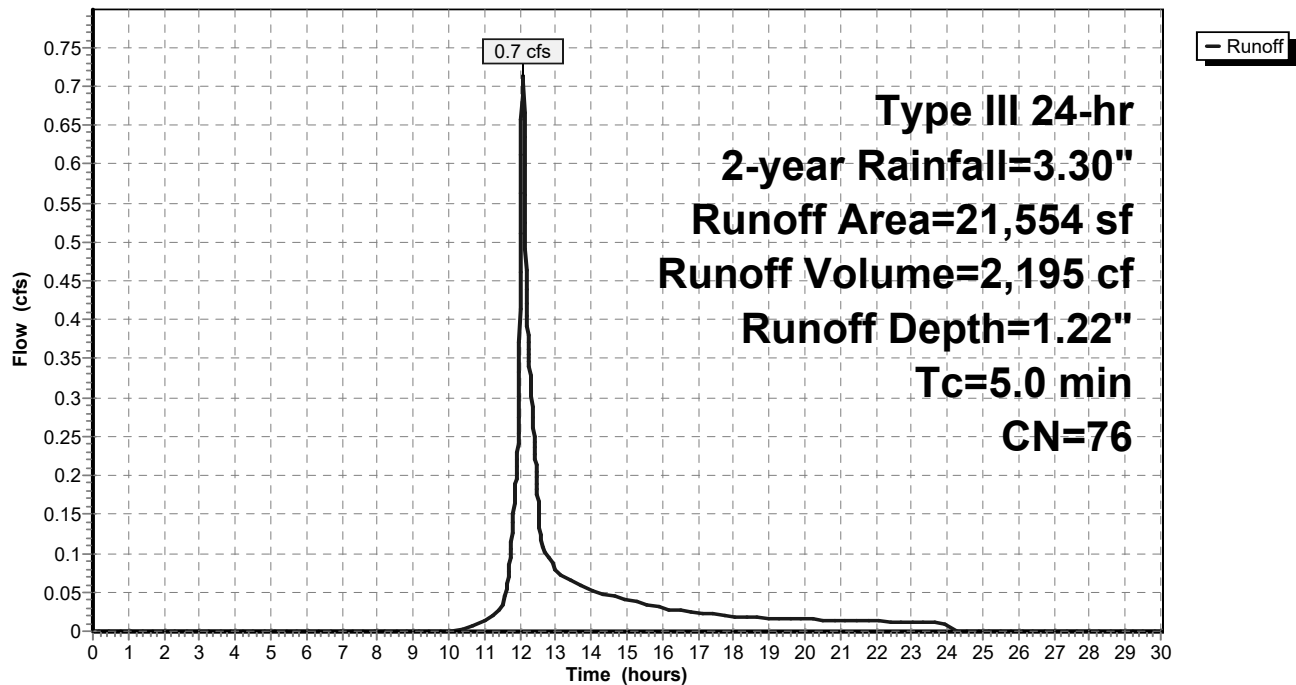
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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

Hydrograph



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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

Runoff = 3.2 cfs @ 12.08 hrs, Volume= 9,644 cf, Depth= 1.77"

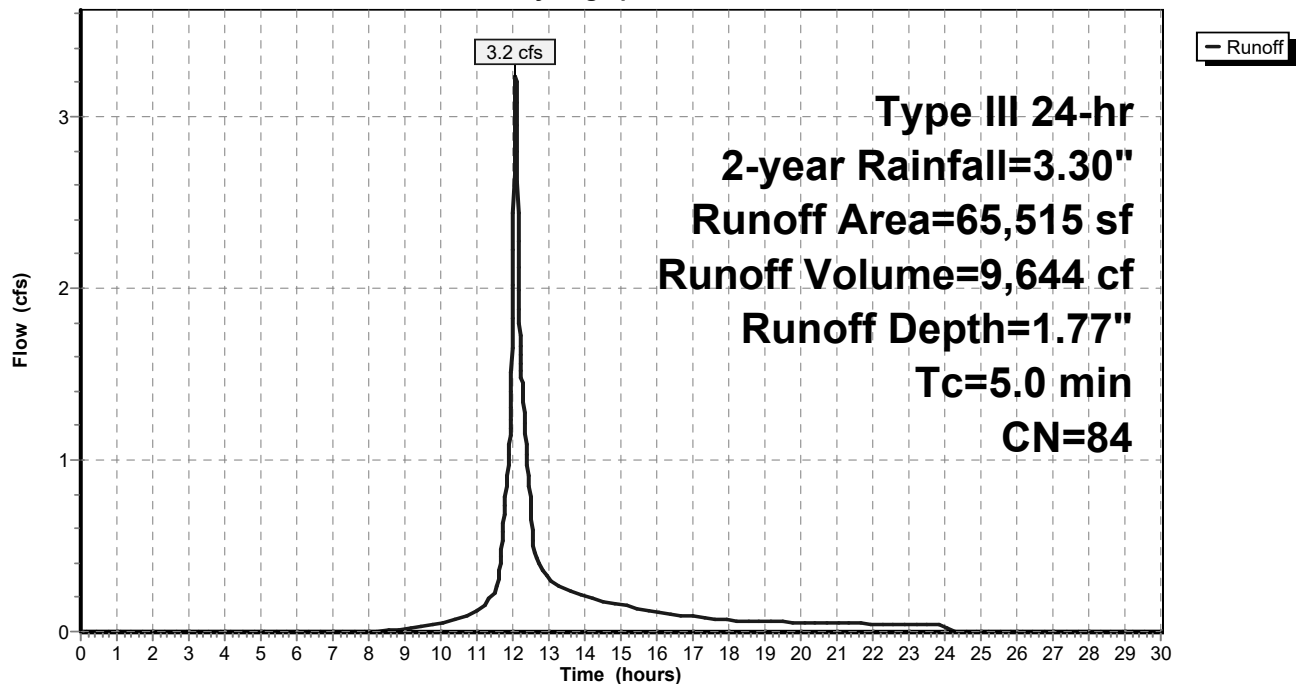
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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

Hydrograph



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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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Summary for Subcatchment PR-3: Permeable Patio

Runoff = 0.2 cfs @ 12.07 hrs, Volume= 639 cf, Depth= 3.07"

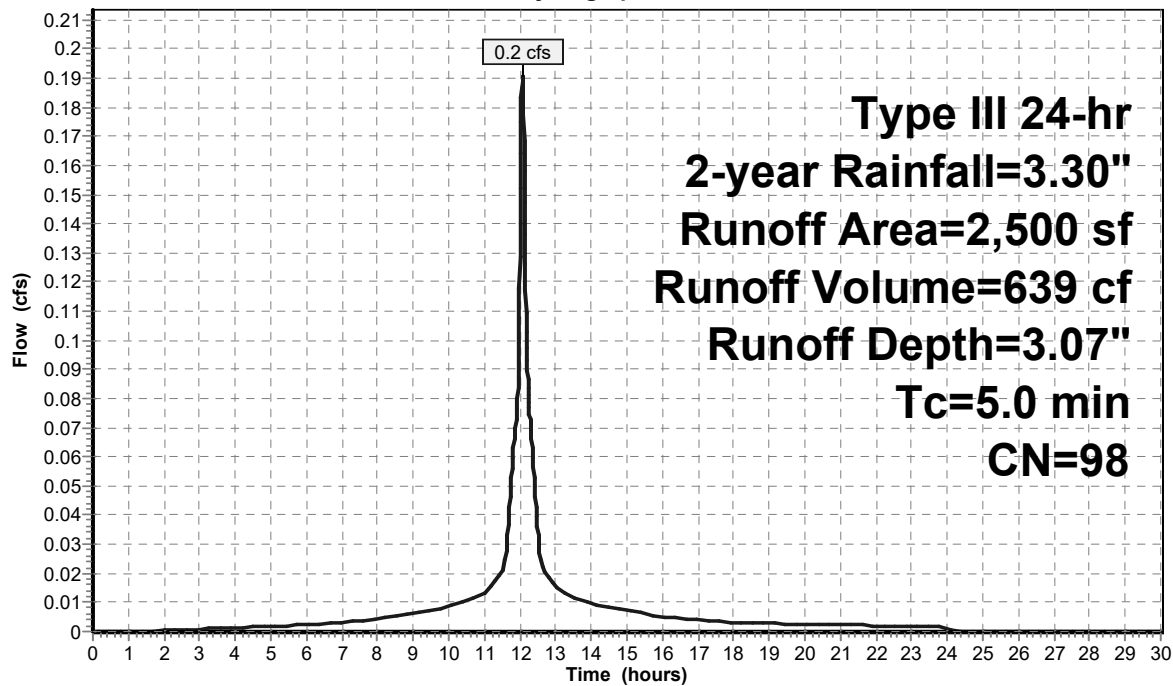
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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

Hydrograph



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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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Summary for Subcatchment PR-C: Cross St

Runoff = 0.6 cfs @ 12.08 hrs, Volume= 1,931 cf, Depth= 1.28"

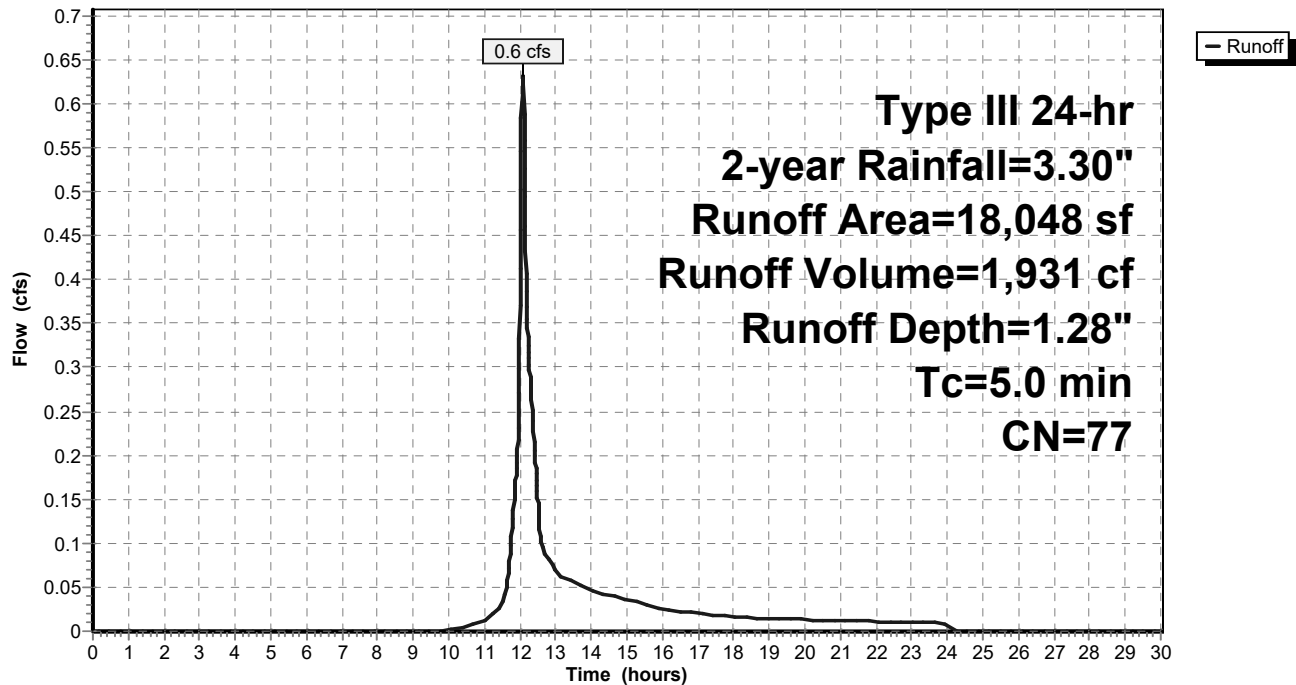
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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

Hydrograph



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)

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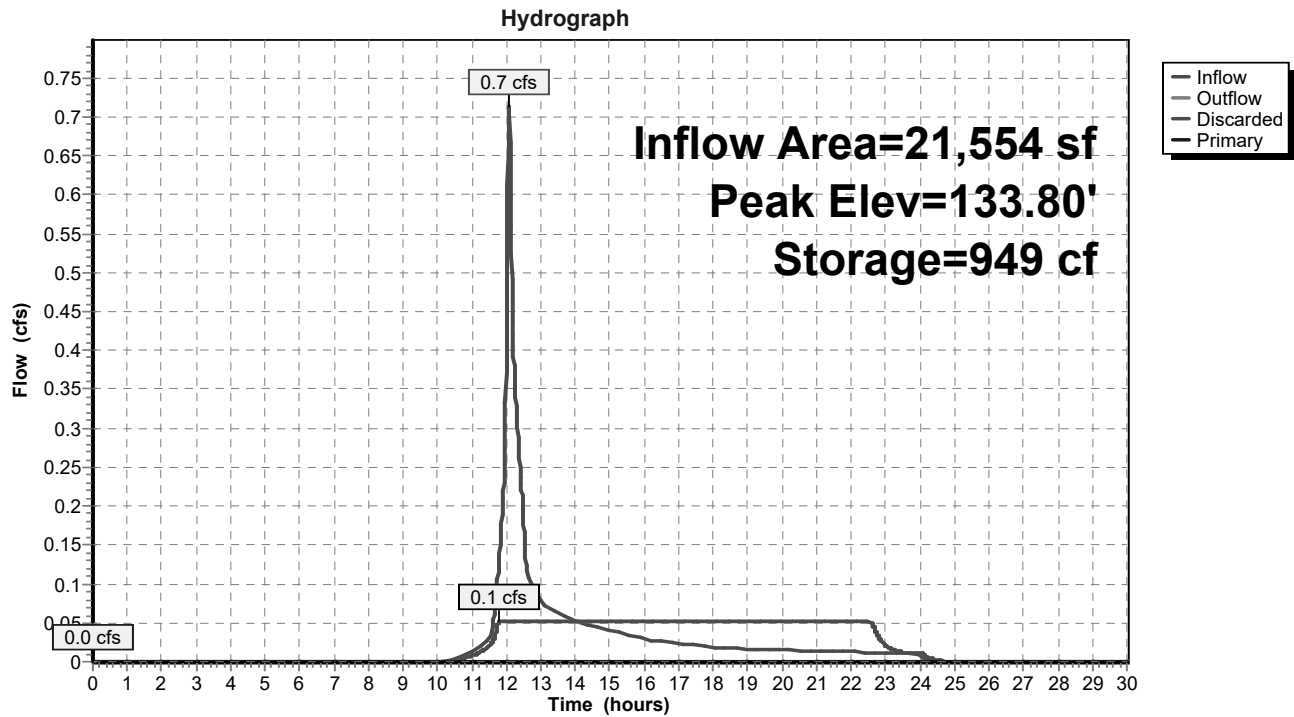
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Pond P-1.1: SC-740 StormTech Basins A and B



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 2-0x 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 2-0x 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 2-0x 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 2-0x 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

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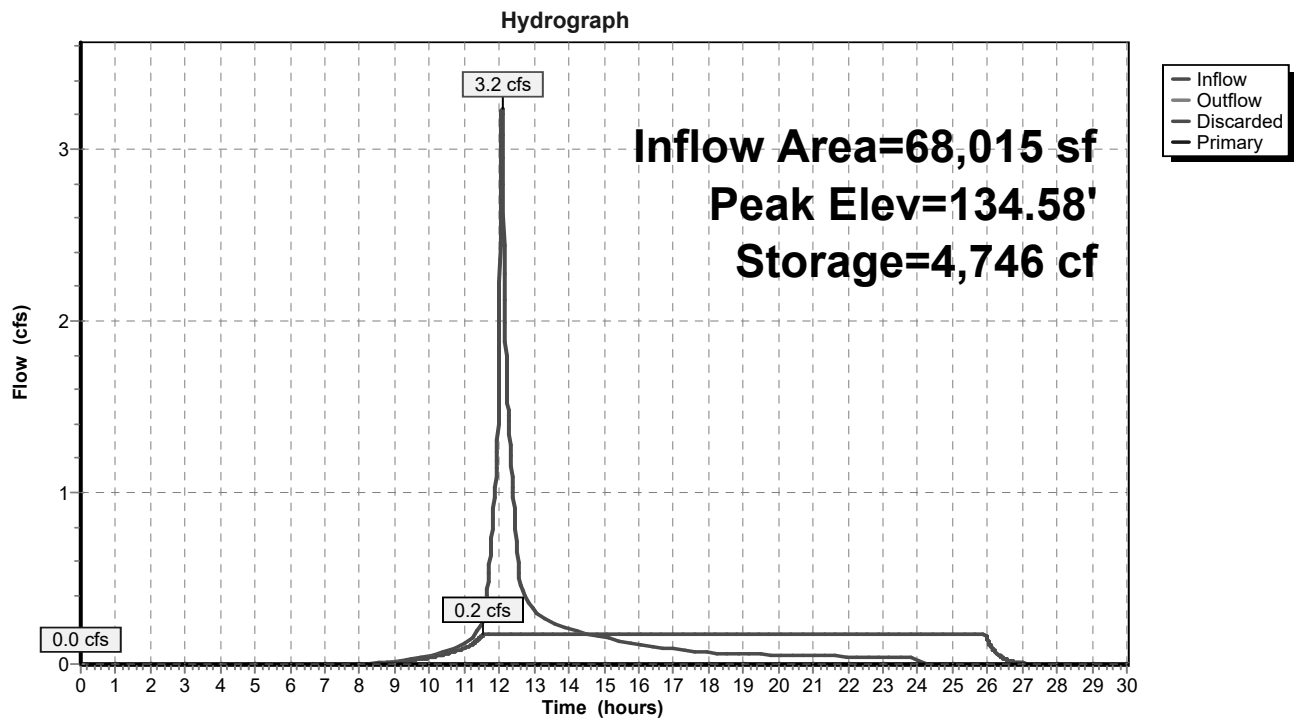
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Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	1.020 in/hr Exfiltration over Surface area
#2	Primary	139.00'	Special & User-Defined
			Head (feet) 0.00 0.50 1.00
			Disch. (cfs) 0.000 10.000 20.000

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)

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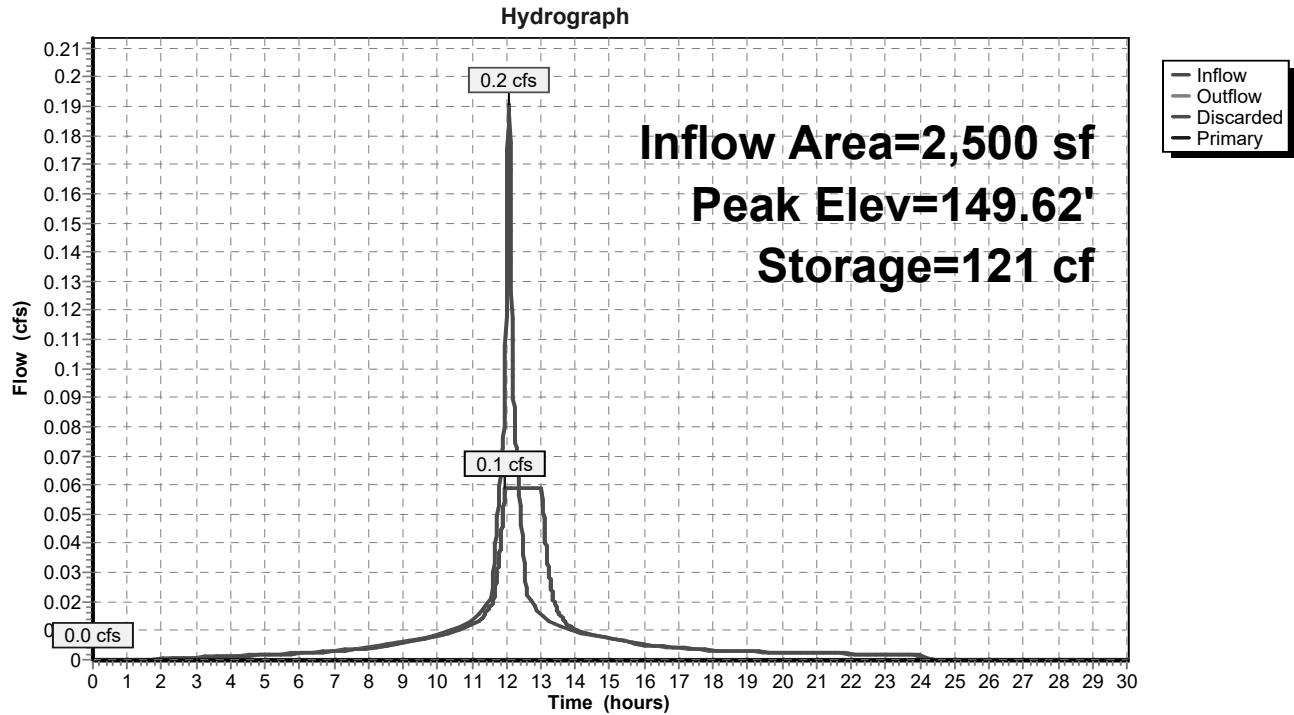
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Pond P-3.1: Permeable Patio



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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)

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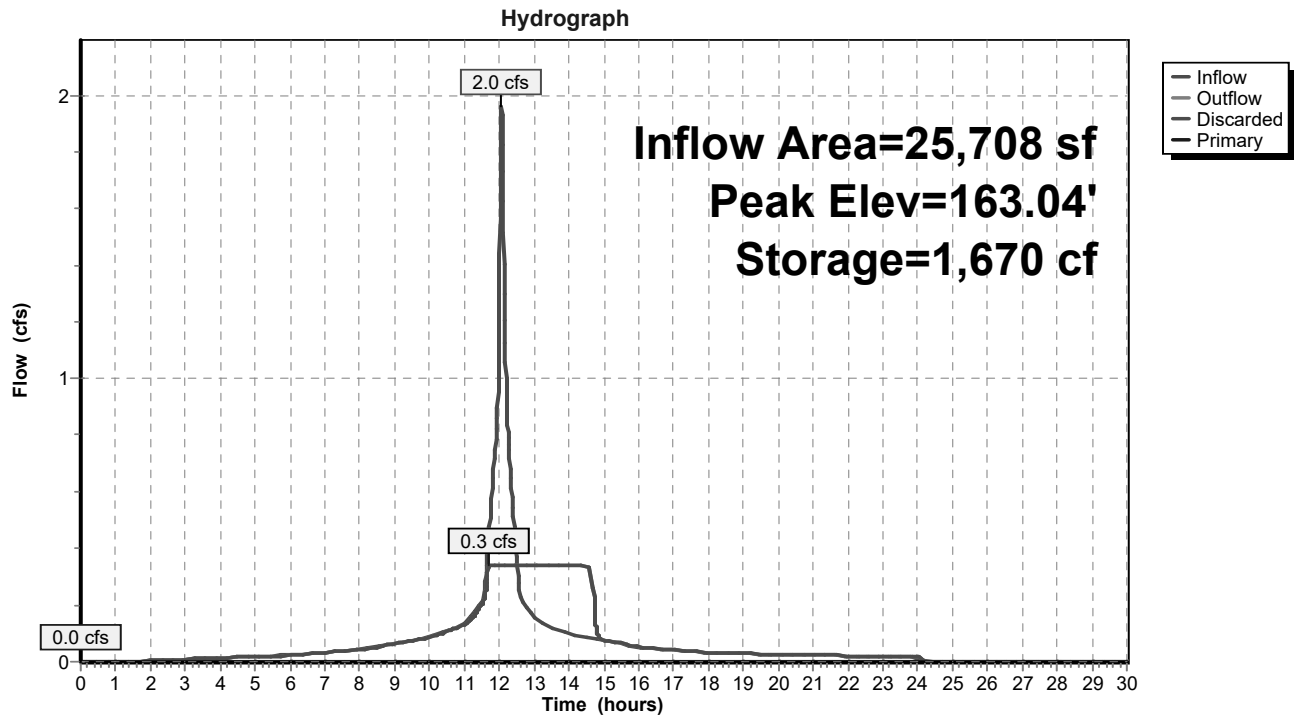
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Proposed
Type III 24-hr 2-year Rainfall=3.30"

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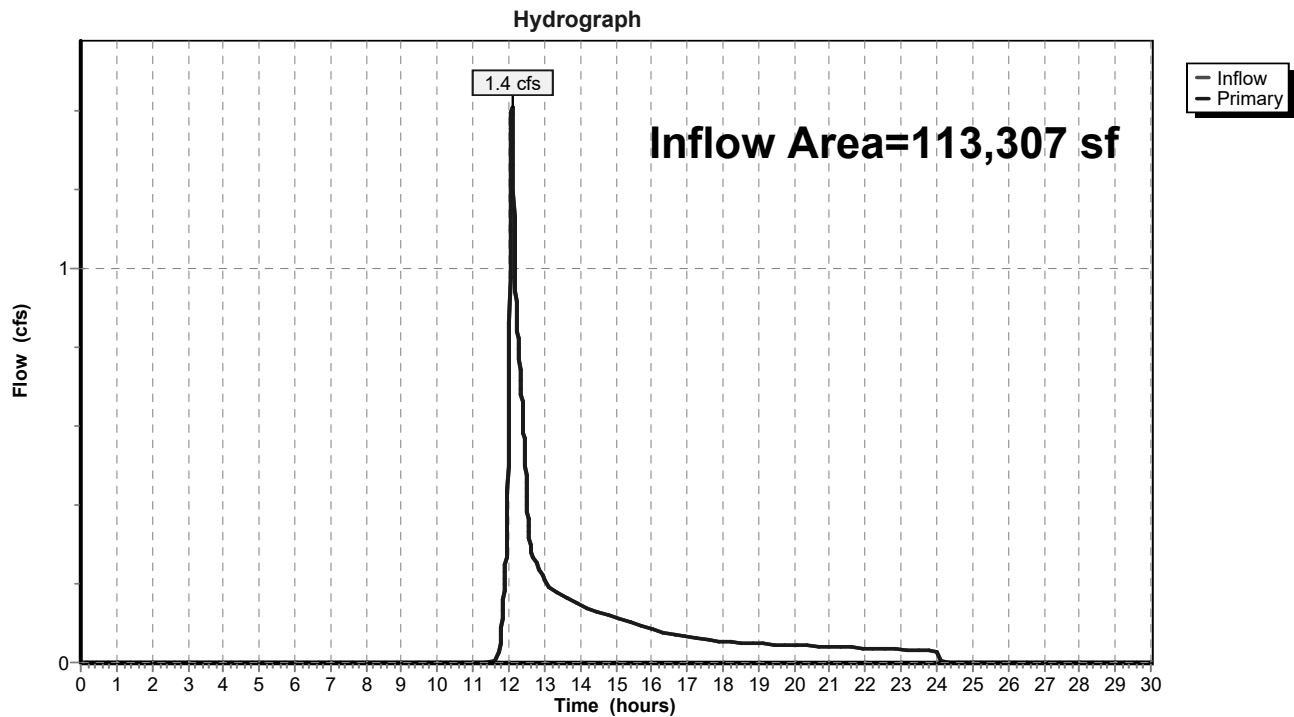
Pond P-B: MC-3500 StormTech at 673 Highland



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

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Type III 24-hr 2-year Rainfall=3.30"

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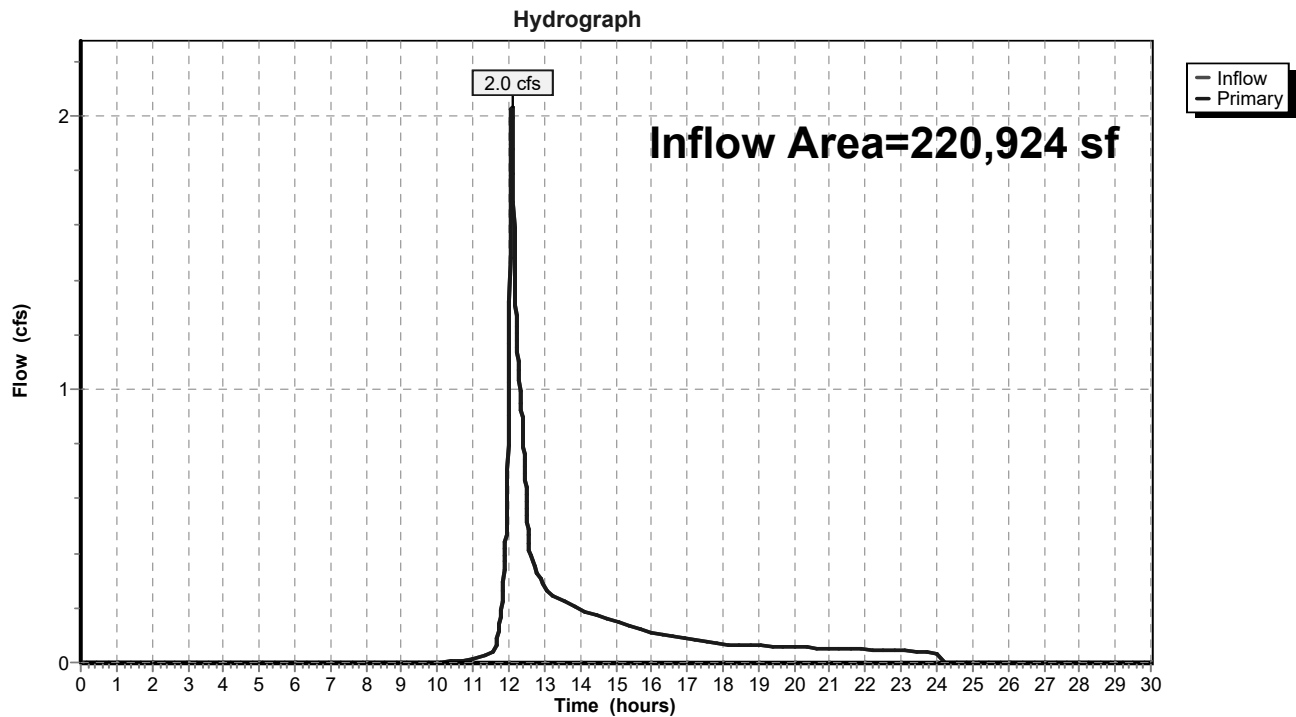
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Summary for Link DP-1: Offsite to North

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



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Type III 24-hr 2-year Rainfall=3.30"

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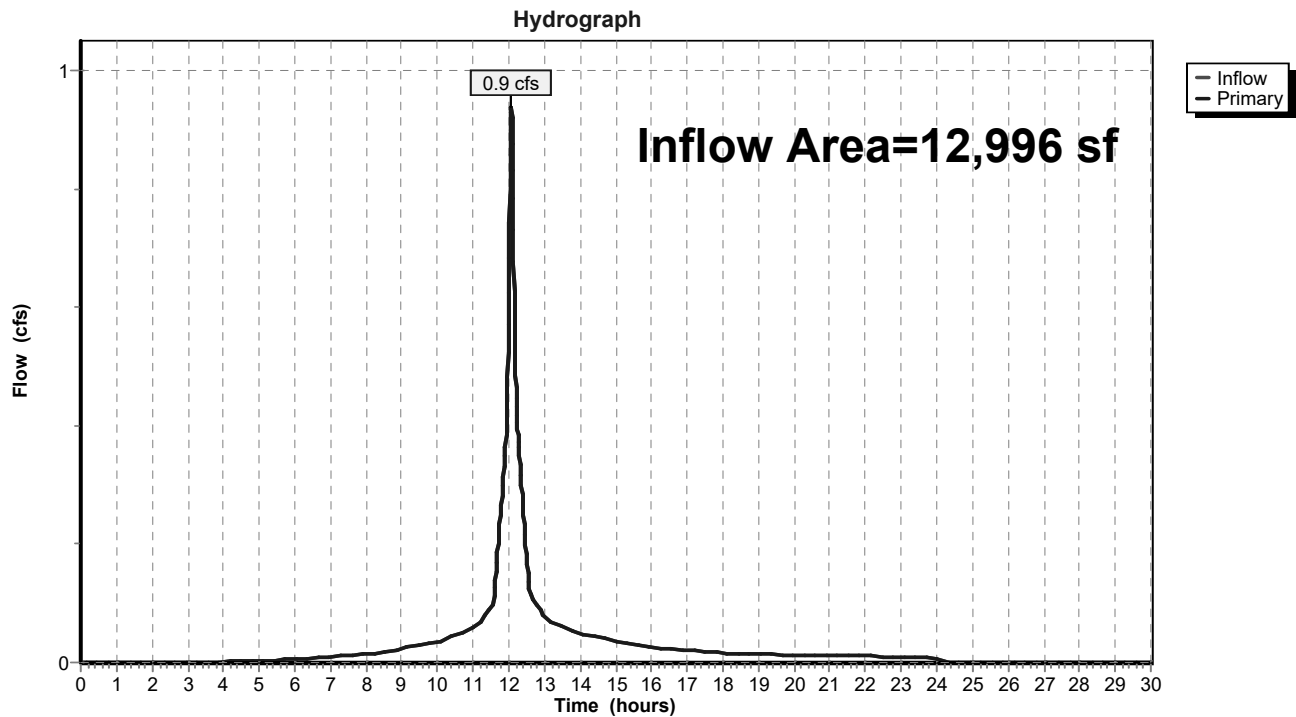
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Summary for Link DP-2: Highland Ave

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

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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

Runoff = 4.4 cfs @ 12.08 hrs, Volume= 13,616 cf, Depth= 1.87"

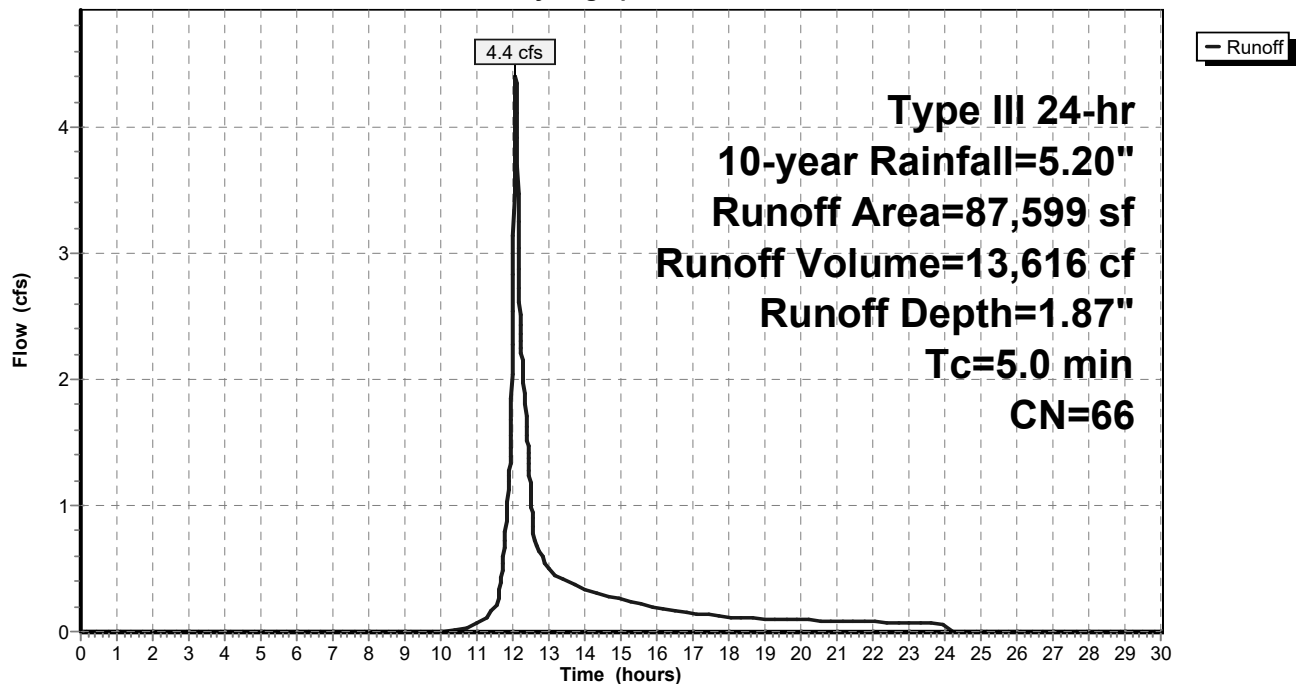
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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

Hydrograph



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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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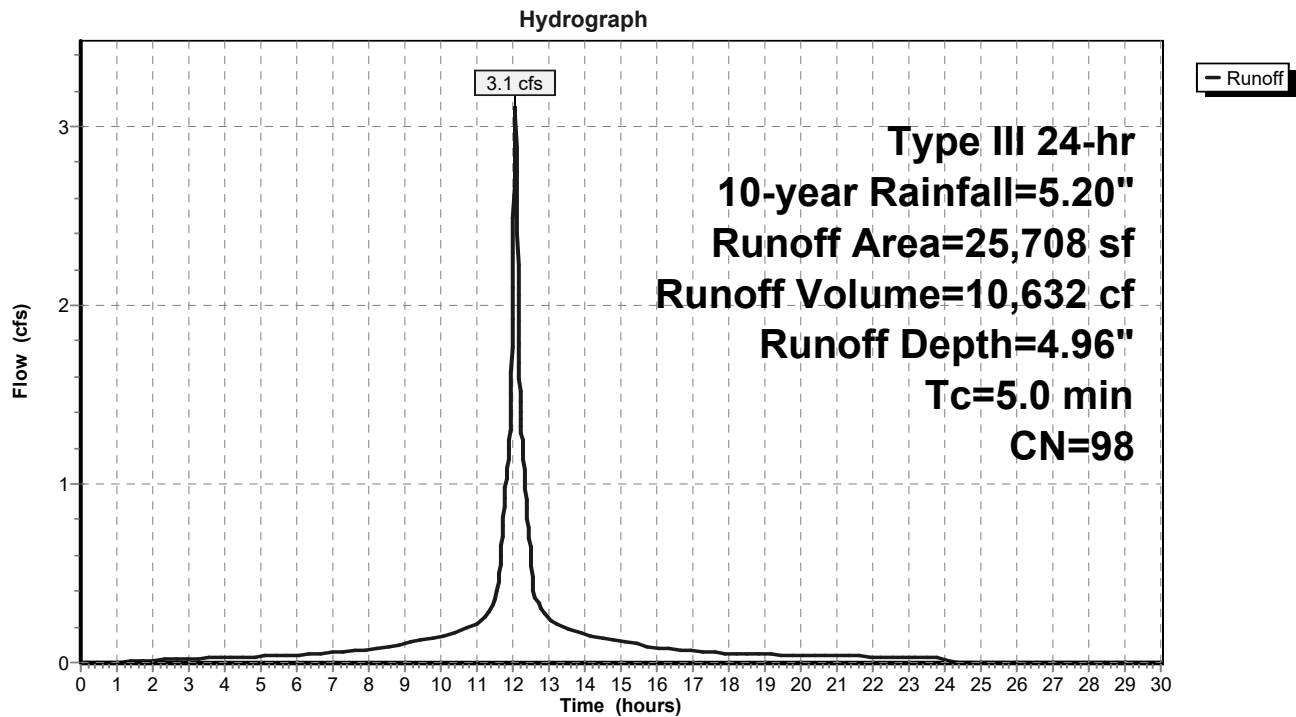
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 1.5 cfs @ 12.07 hrs, Volume= 5,001 cf, Depth= 4.62"

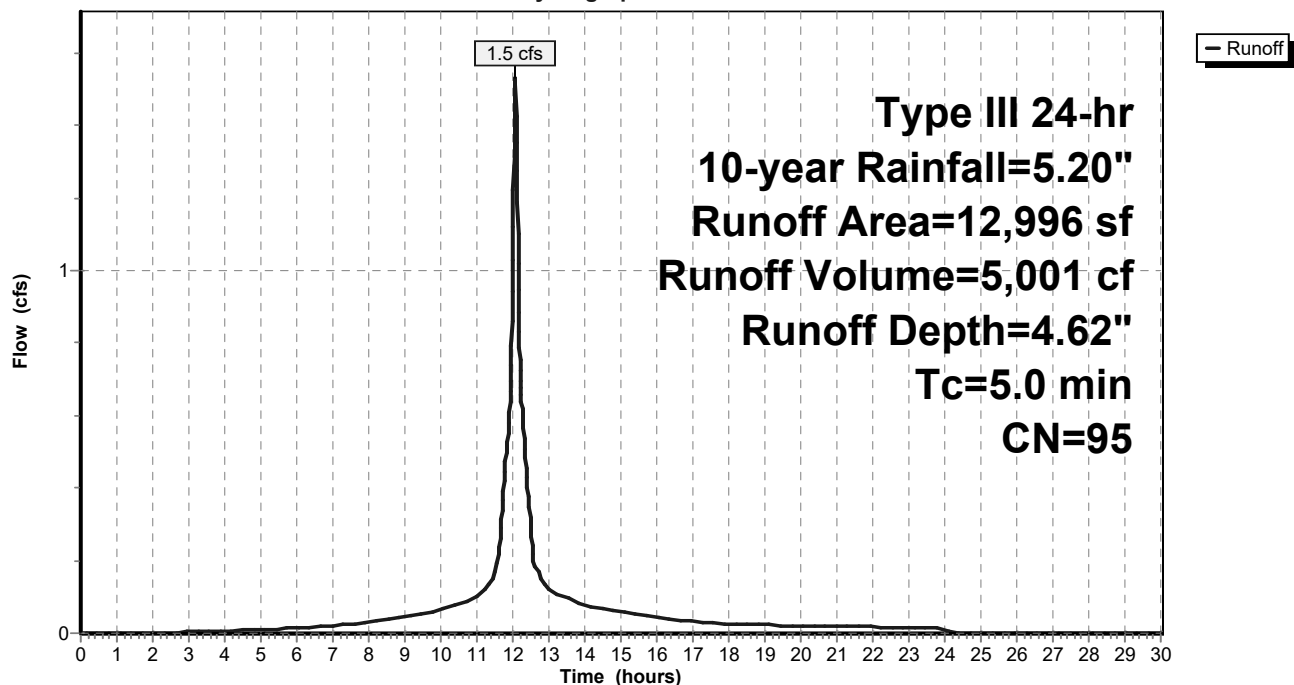
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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

Hydrograph



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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

Runoff = 1.6 cfs @ 12.08 hrs, Volume= 4,852 cf, Depth= 2.70"

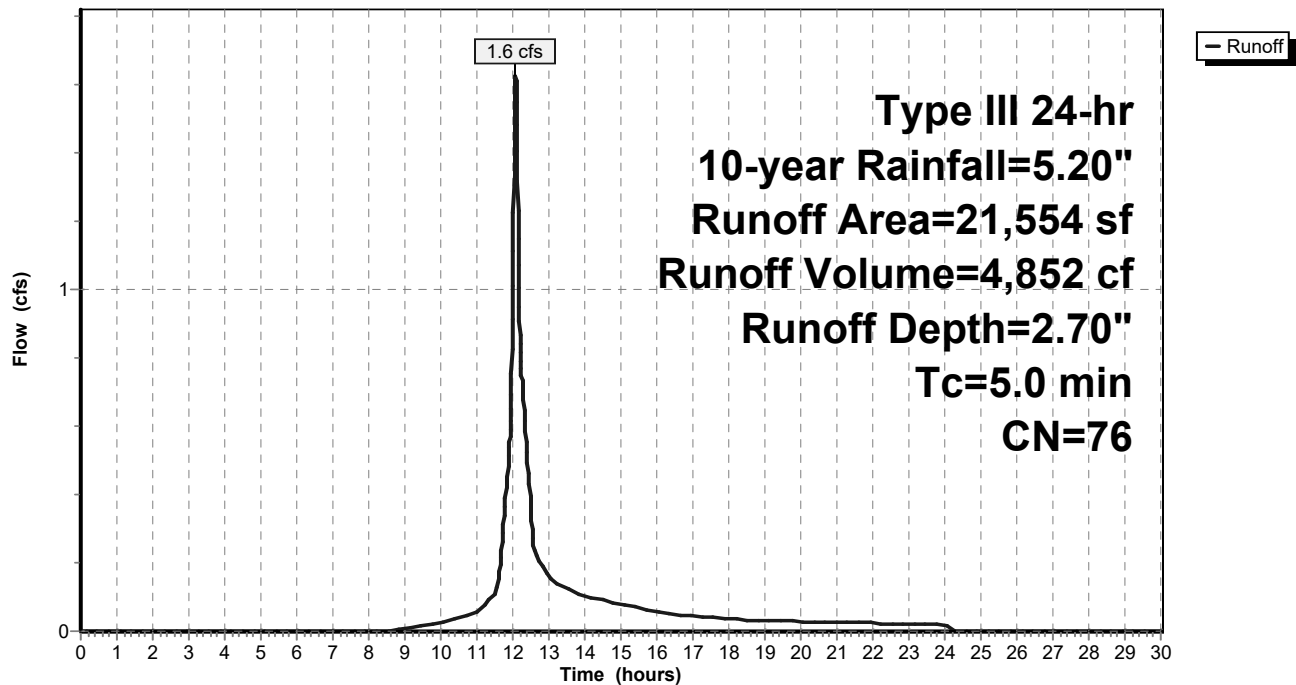
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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

Hydrograph



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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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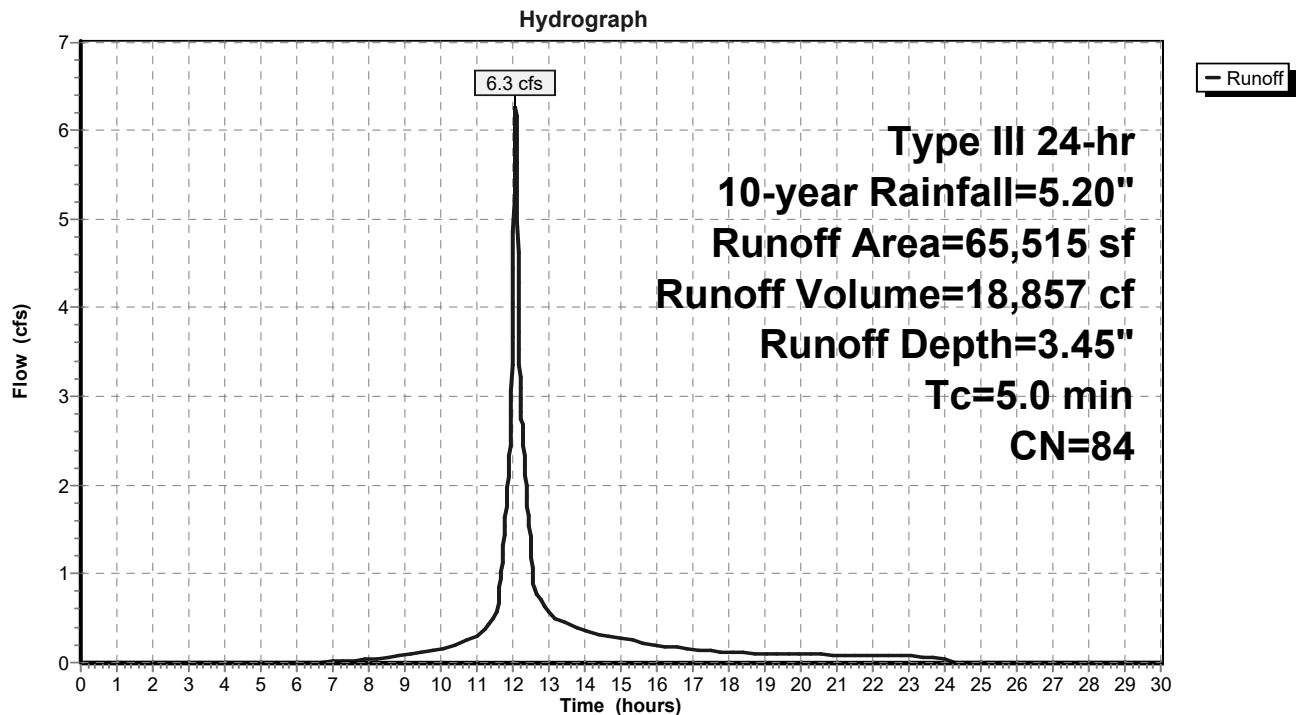
Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

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

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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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Summary for Subcatchment PR-3: Permeable Patio

Runoff = 0.3 cfs @ 12.07 hrs, Volume= 1,034 cf, Depth= 4.96"

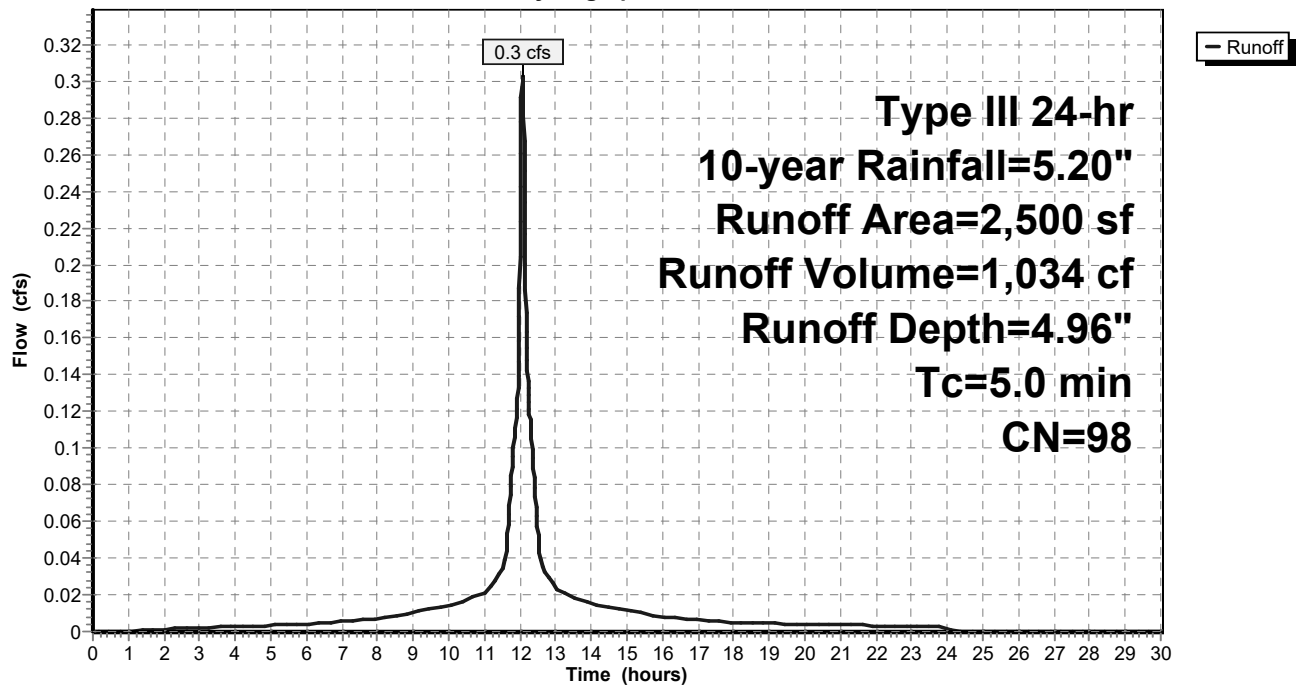
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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

Hydrograph



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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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Summary for Subcatchment PR-C: Cross St

Runoff = 1.4 cfs @ 12.08 hrs, Volume= 4,198 cf, Depth= 2.79"

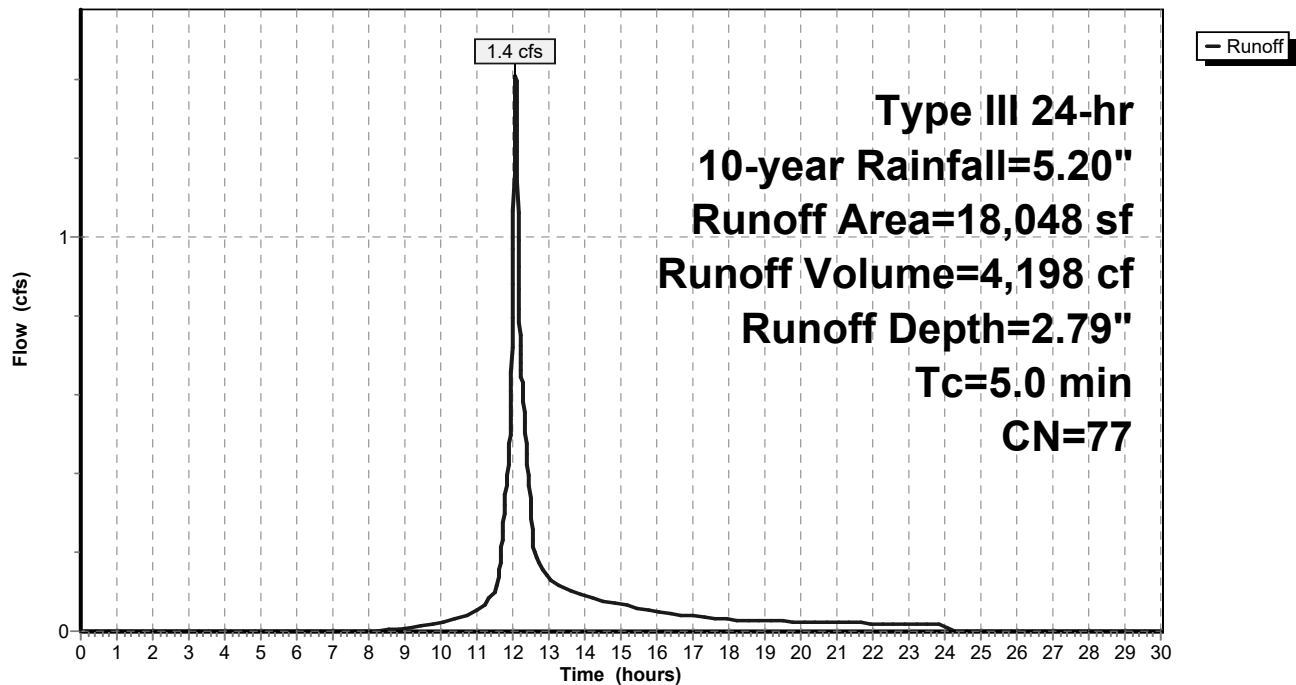
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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

Hydrograph



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)

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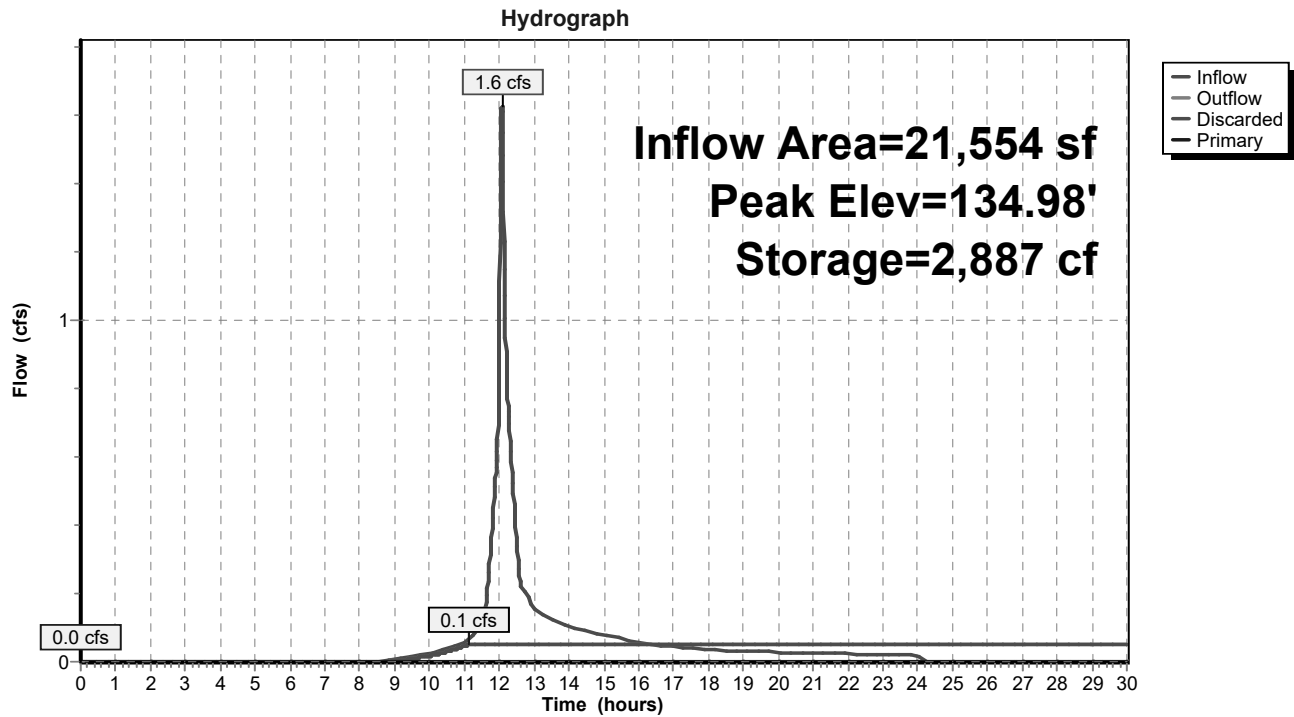
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Type III 24-hr 10-year Rainfall=5.20"

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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 2-0x 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 2-0x 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 2-0x 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 2-0x 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

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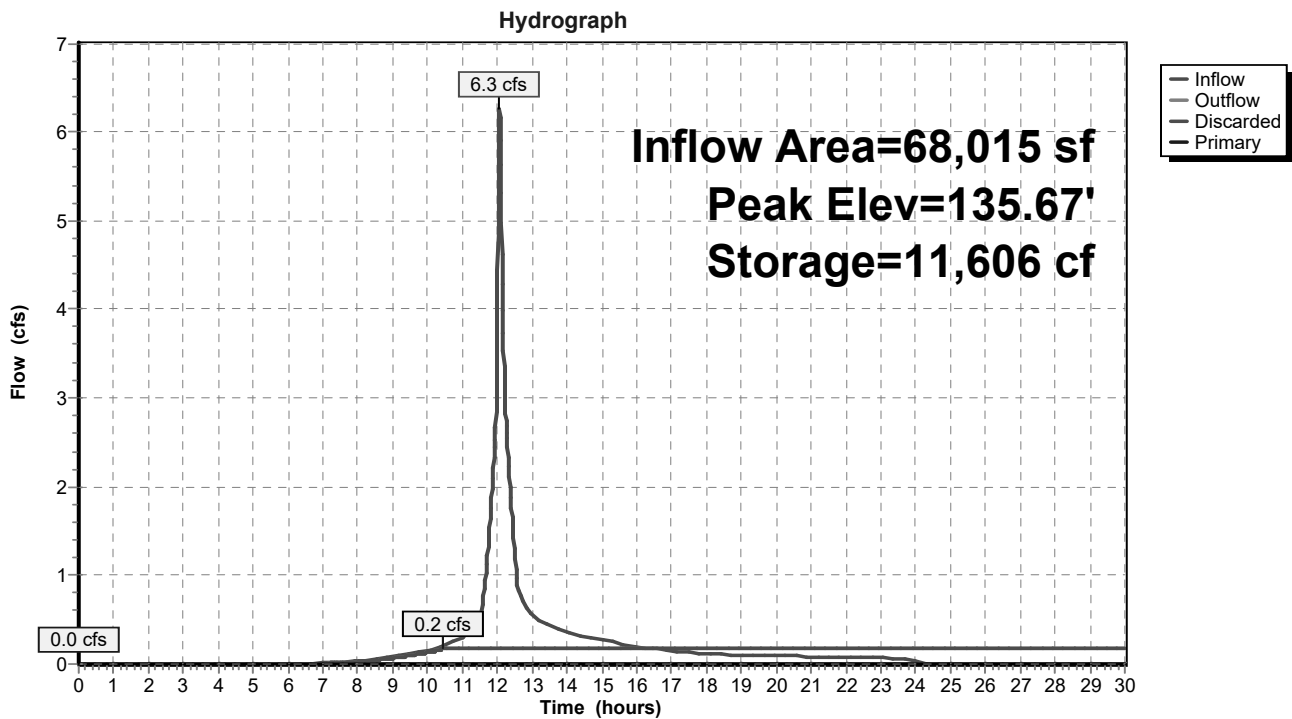
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Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	1.020 in/hr Exfiltration over Surface area Special & User-Defined Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000
#2	Primary	139.00'	

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)

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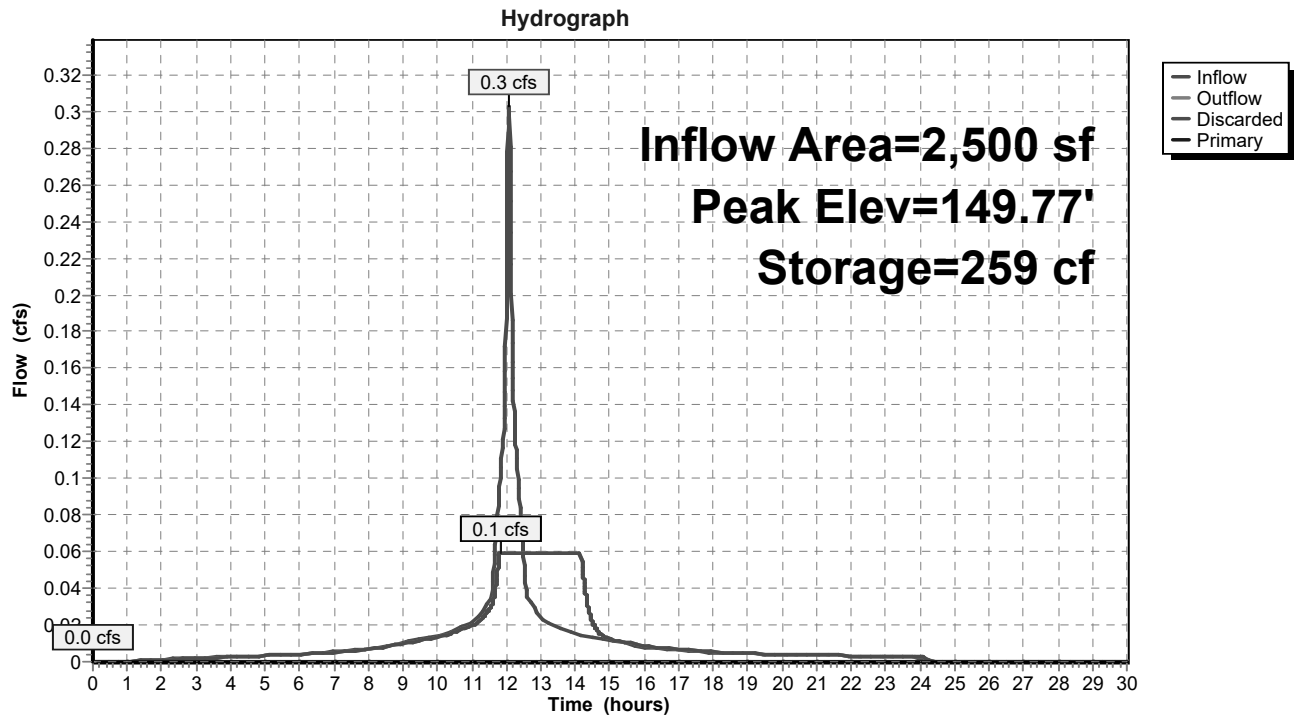
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Type III 24-hr 10-year Rainfall=5.20"

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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)

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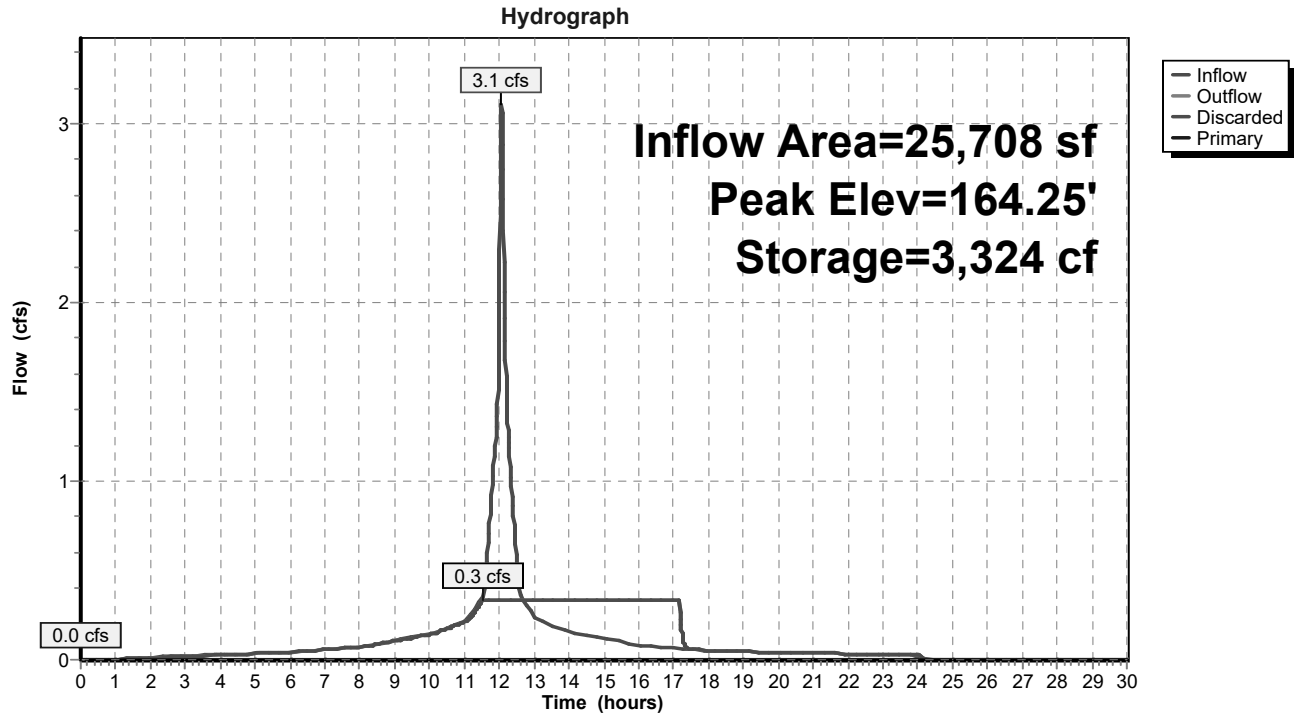
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Proposed
Type III 24-hr 10-year Rainfall=5.20"

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Pond P-B: MC-3500 StormTech at 673 Highland



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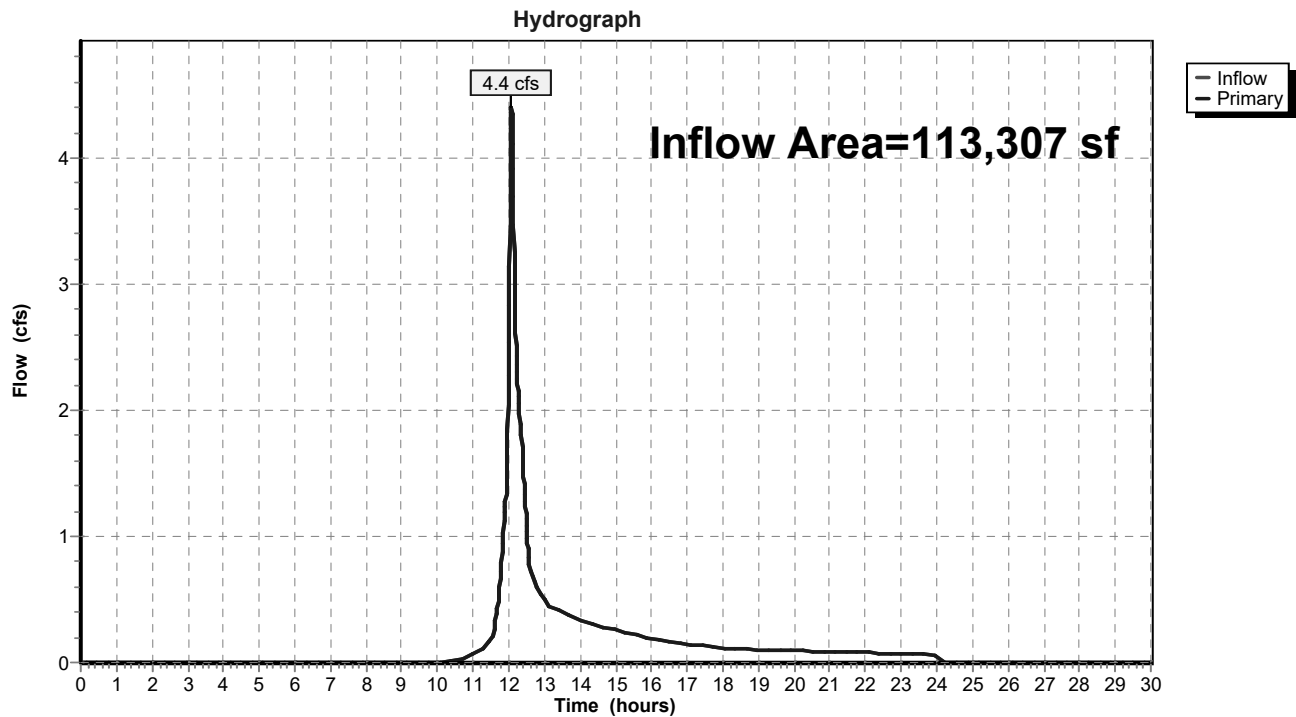
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Summary for Link A-B: EX A+ EX B

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



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Type III 24-hr 10-year Rainfall=5.20"

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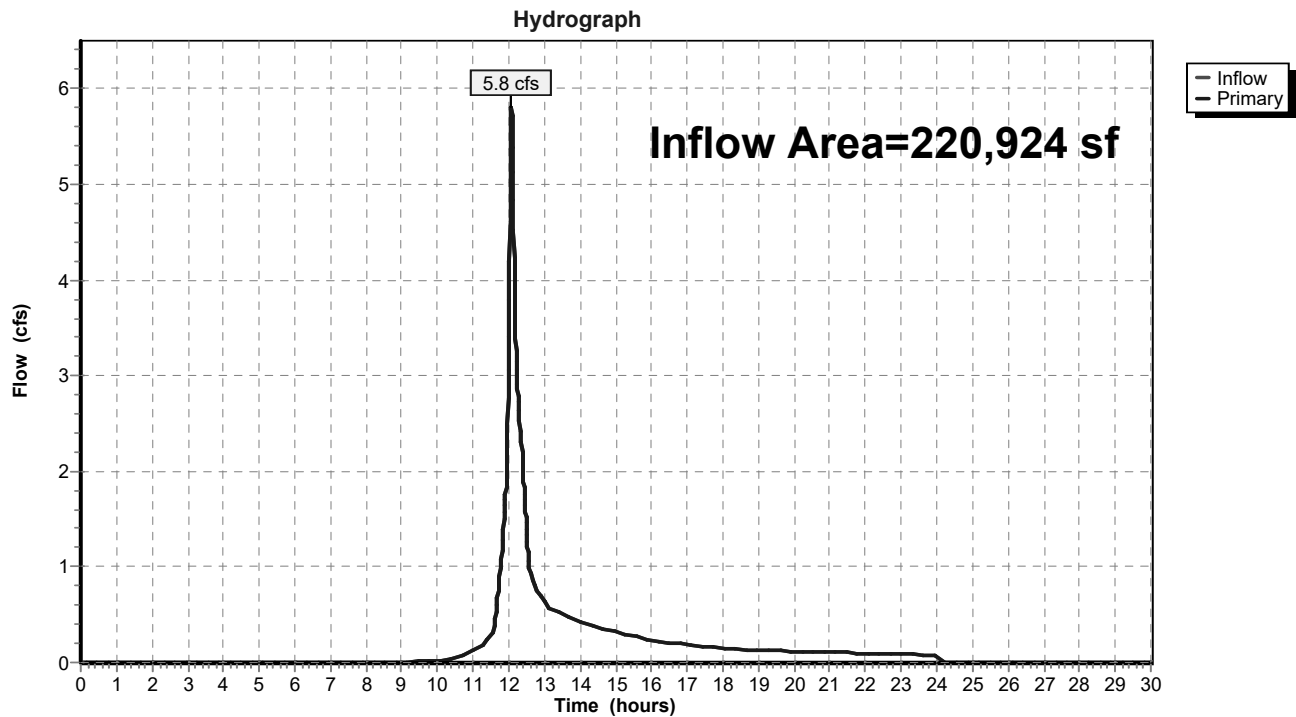
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Summary for Link DP-1: Offsite to North

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



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Type III 24-hr 10-year Rainfall=5.20"

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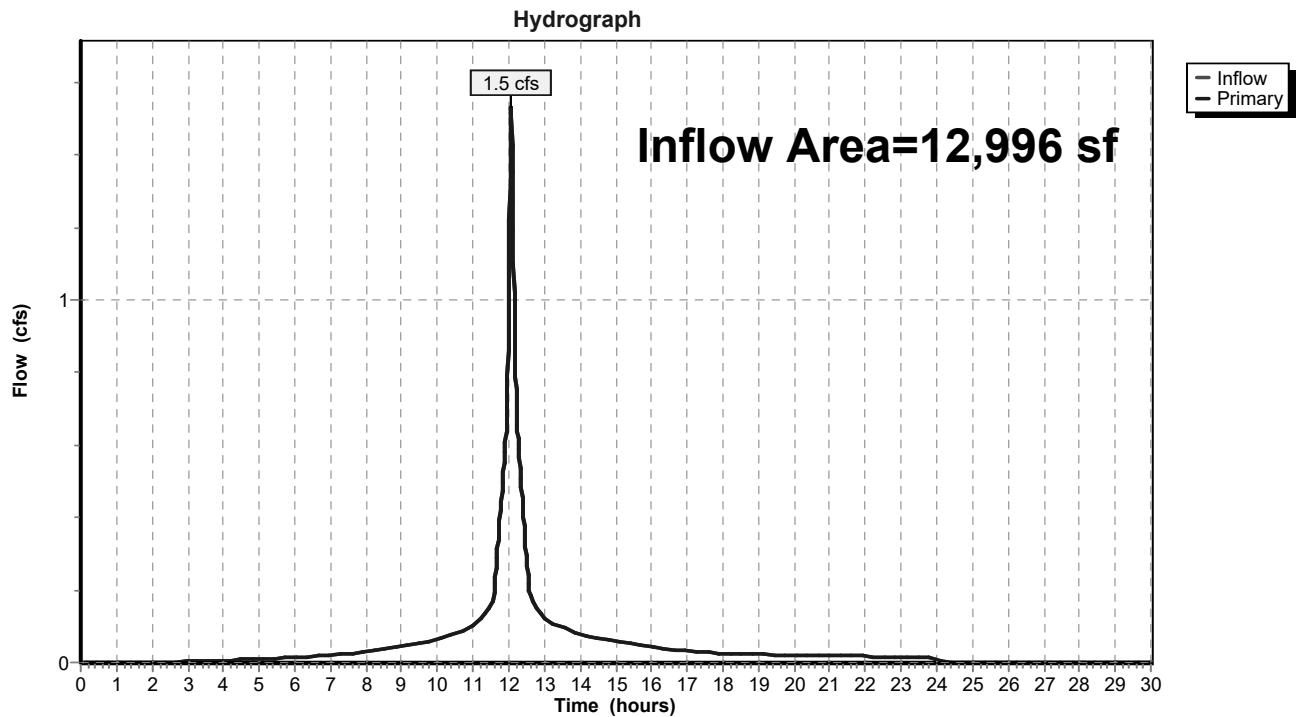
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Summary for Link DP-2: Highland Ave

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

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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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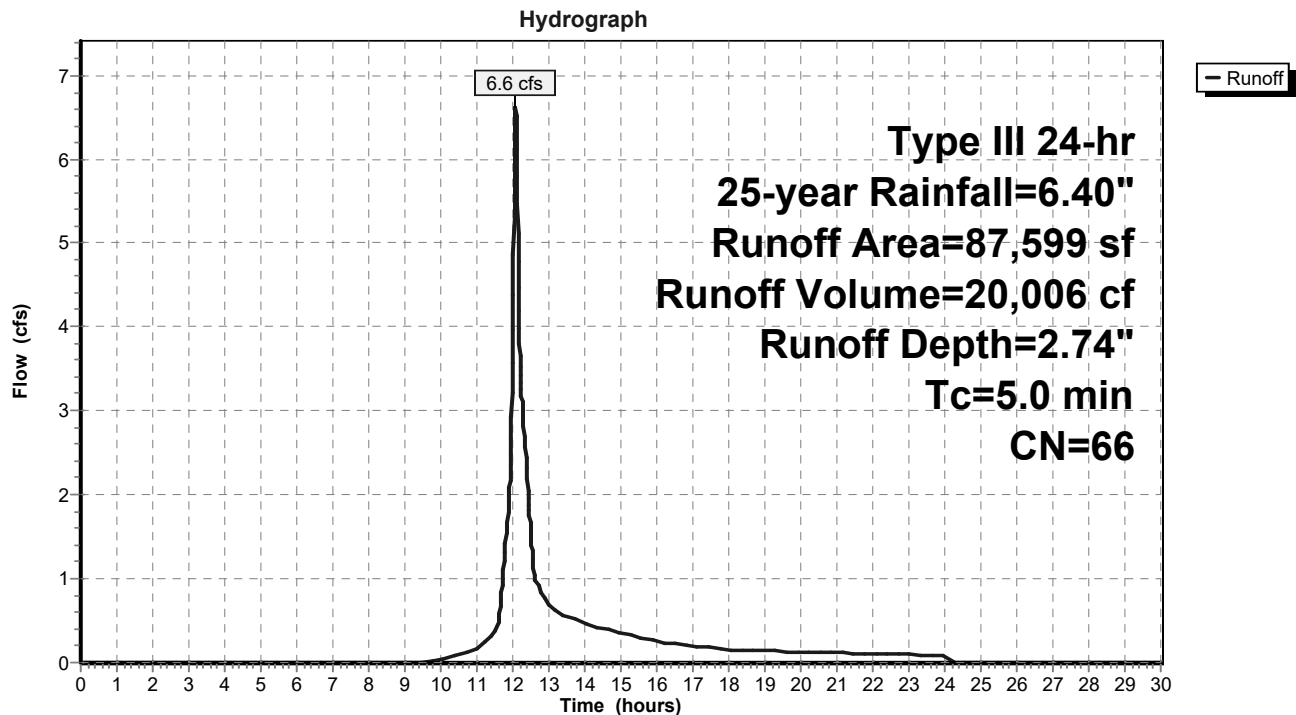
Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

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

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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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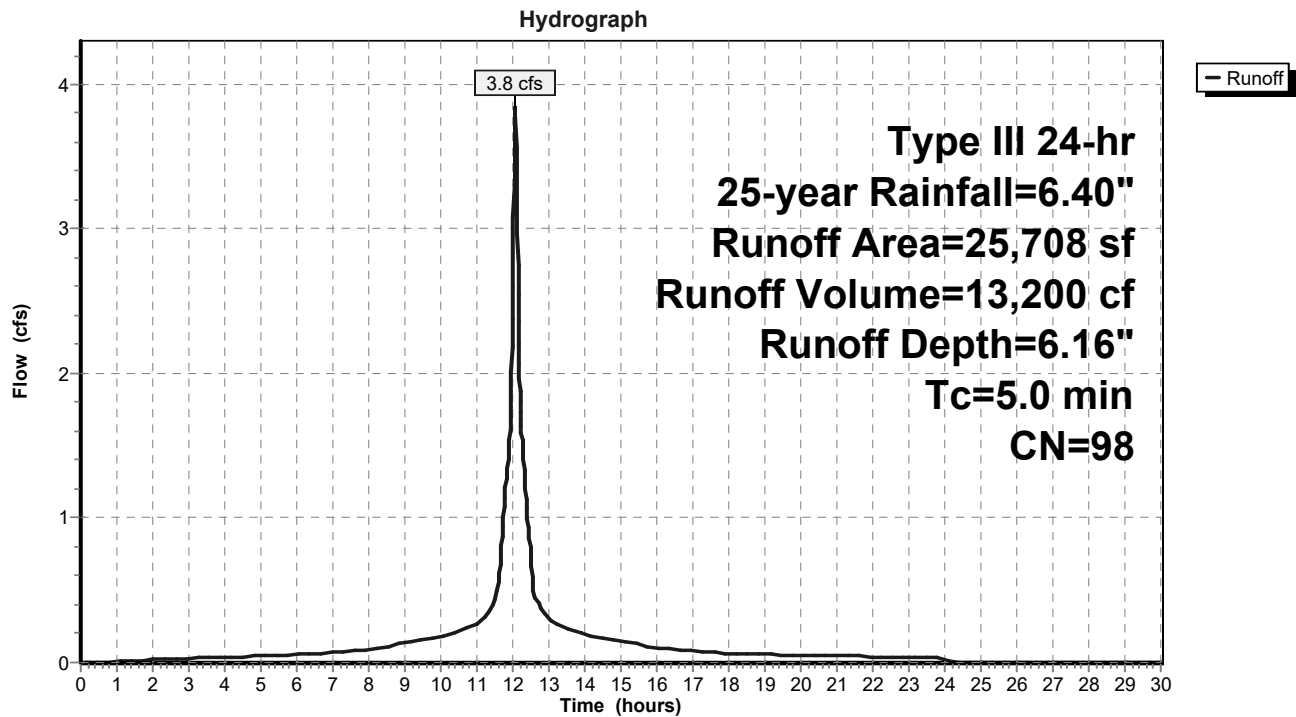
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Type III 24-hr 25-year Rainfall=6.40"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 1.9 cfs @ 12.07 hrs, Volume= 6,291 cf, Depth= 5.81"

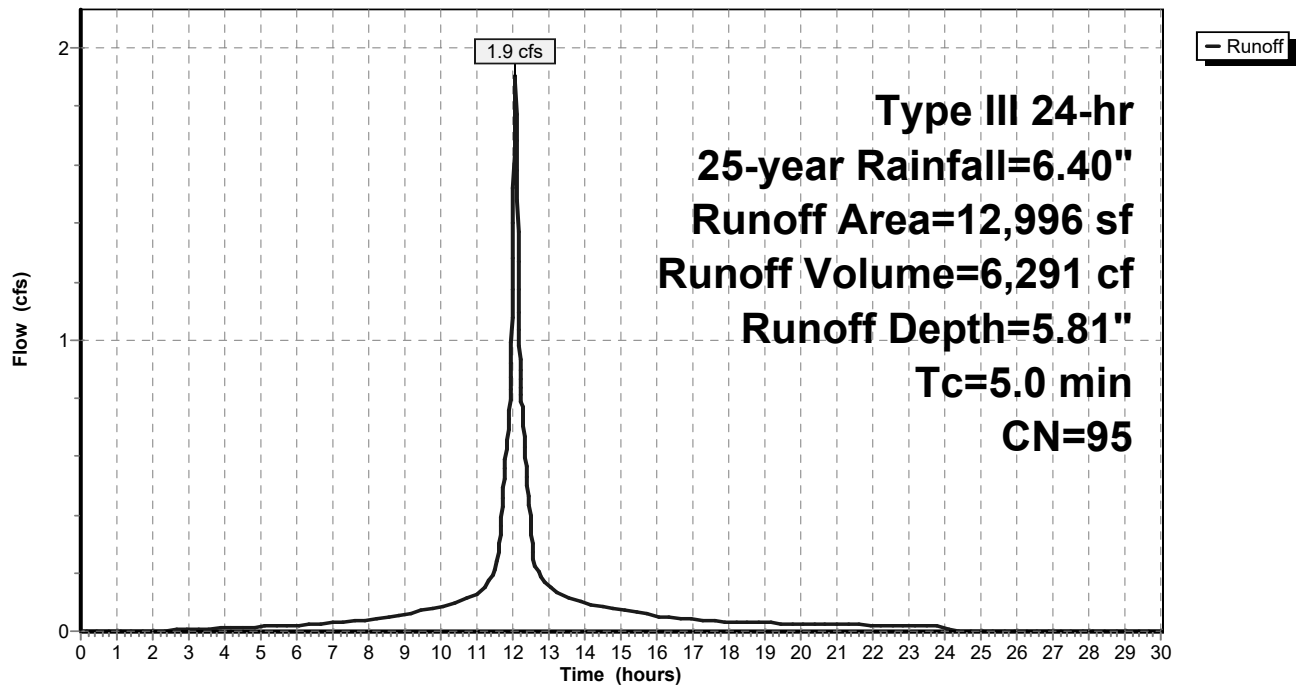
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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

Hydrograph



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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

Runoff = 2.2 cfs @ 12.07 hrs, Volume= 6,695 cf, Depth= 3.73"

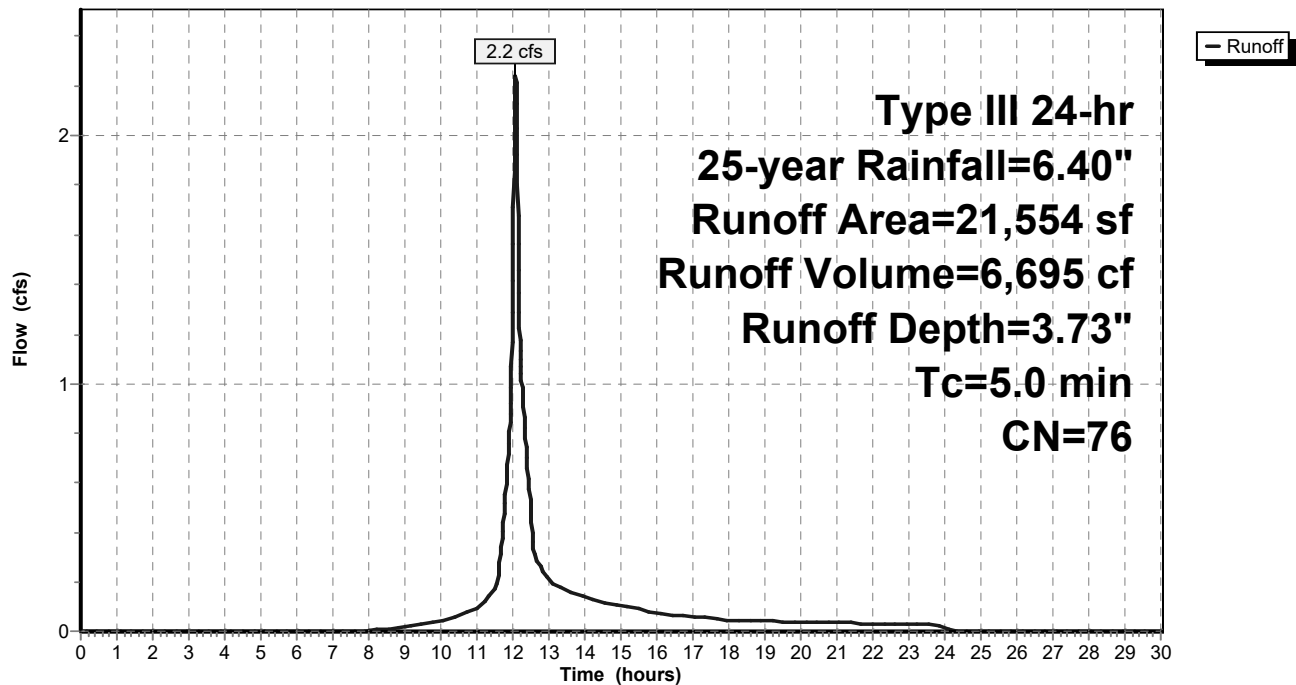
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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

Hydrograph



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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

Runoff = 8.2 cfs @ 12.07 hrs, Volume= 24,962 cf, Depth= 4.57"

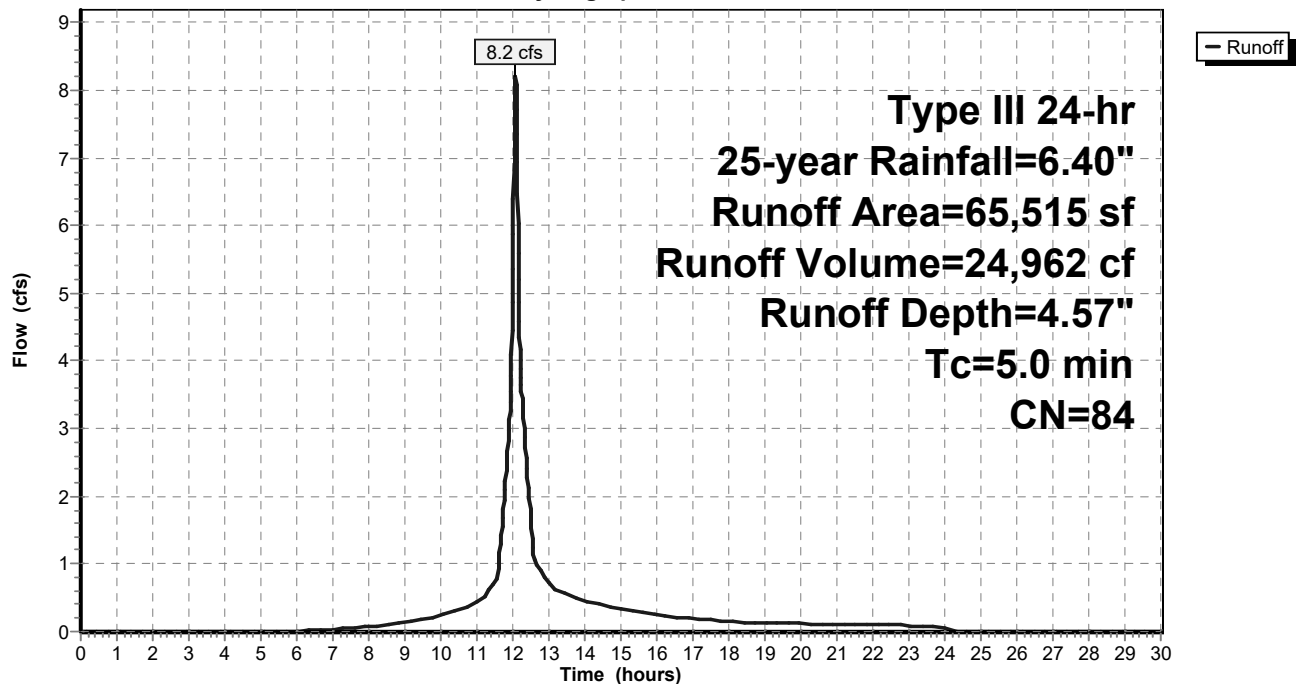
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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

Hydrograph



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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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Summary for Subcatchment PR-3: Permeable Patio

Runoff = 0.4 cfs @ 12.07 hrs, Volume= 1,284 cf, Depth= 6.16"

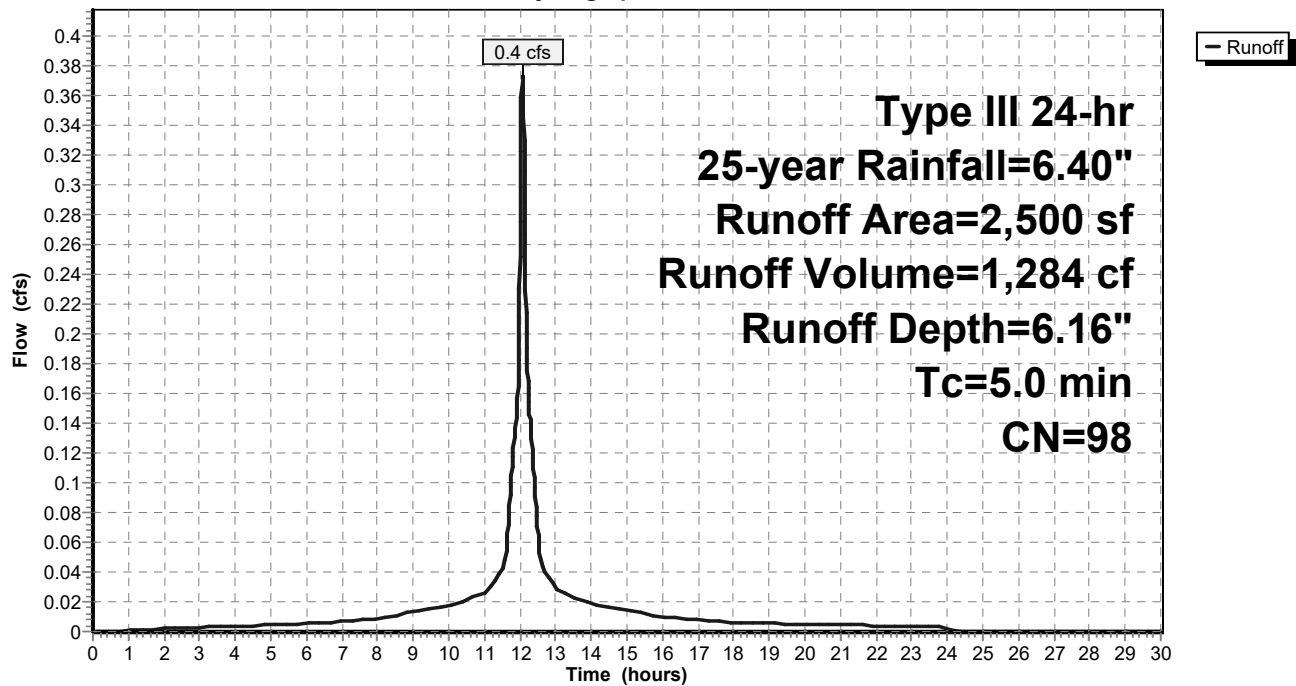
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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

Hydrograph



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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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Summary for Subcatchment PR-C: Cross St

Runoff = 1.9 cfs @ 12.07 hrs, Volume= 5,761 cf, Depth= 3.83"

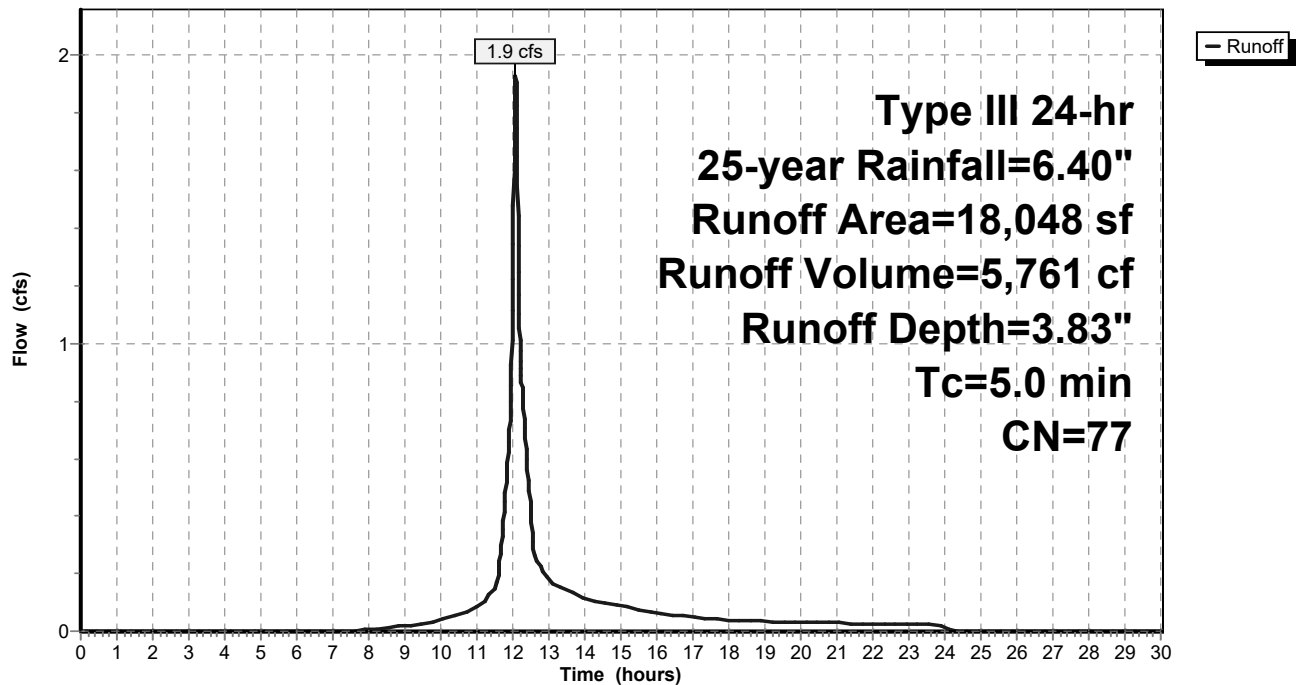
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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

Hydrograph



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)

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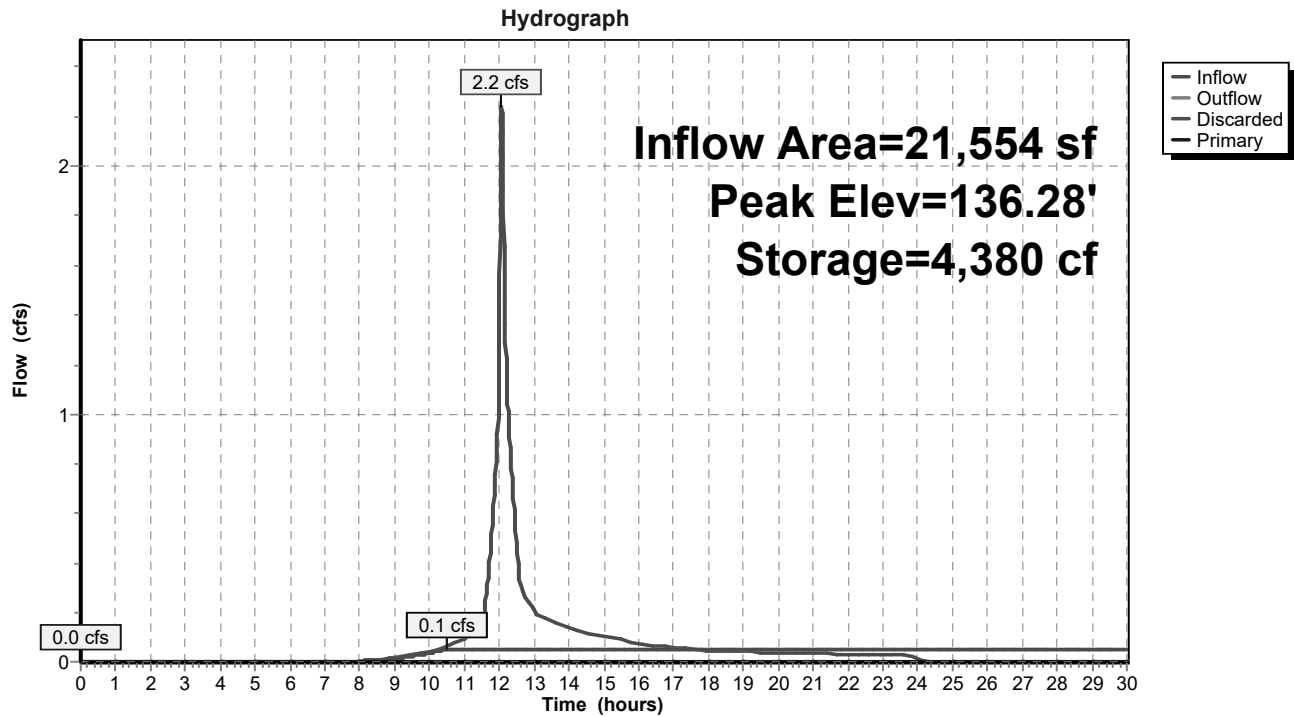
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Type III 24-hr 25-year Rainfall=6.40"

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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 2-0x 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 2-0x 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 2-0x 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 2-0x 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

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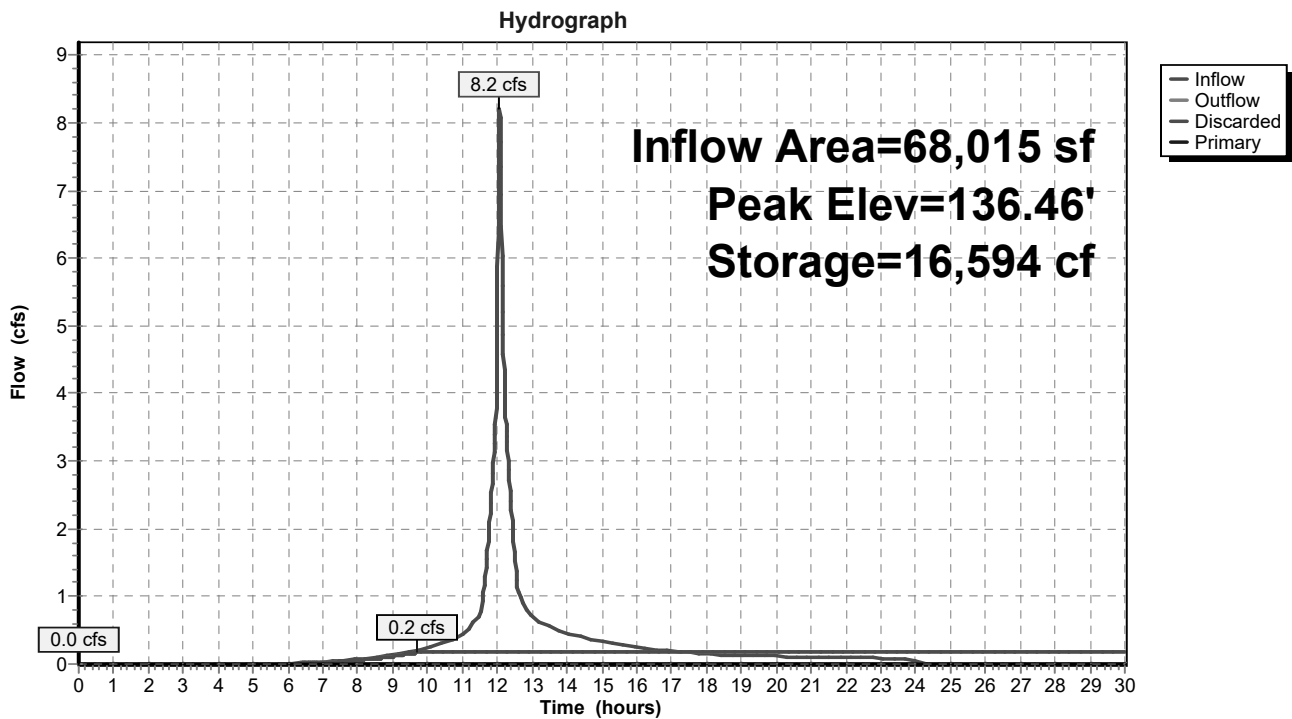
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Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	1.020 in/hr Exfiltration over Surface area Special & User-Defined Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000
#2	Primary	139.00'	

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)

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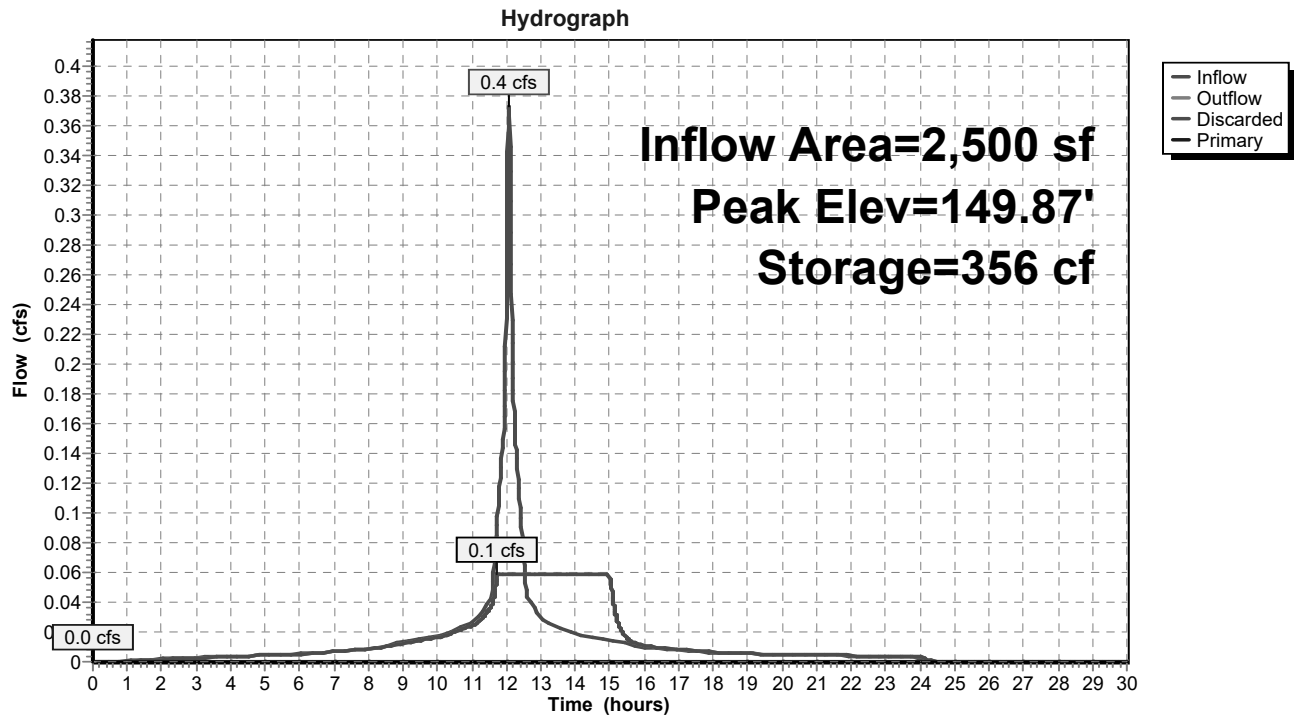
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Pond P-3.1: Permeable Patio



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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)

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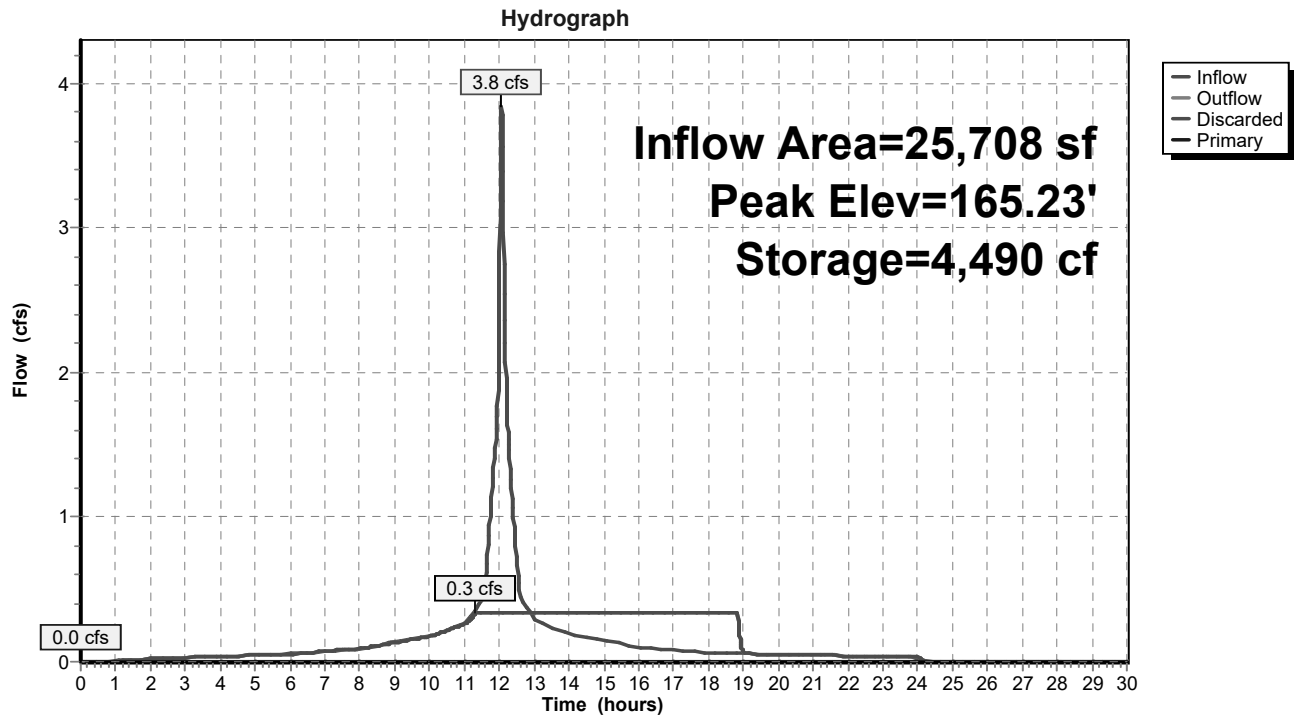
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Proposed
Type III 24-hr 25-year Rainfall=6.40"

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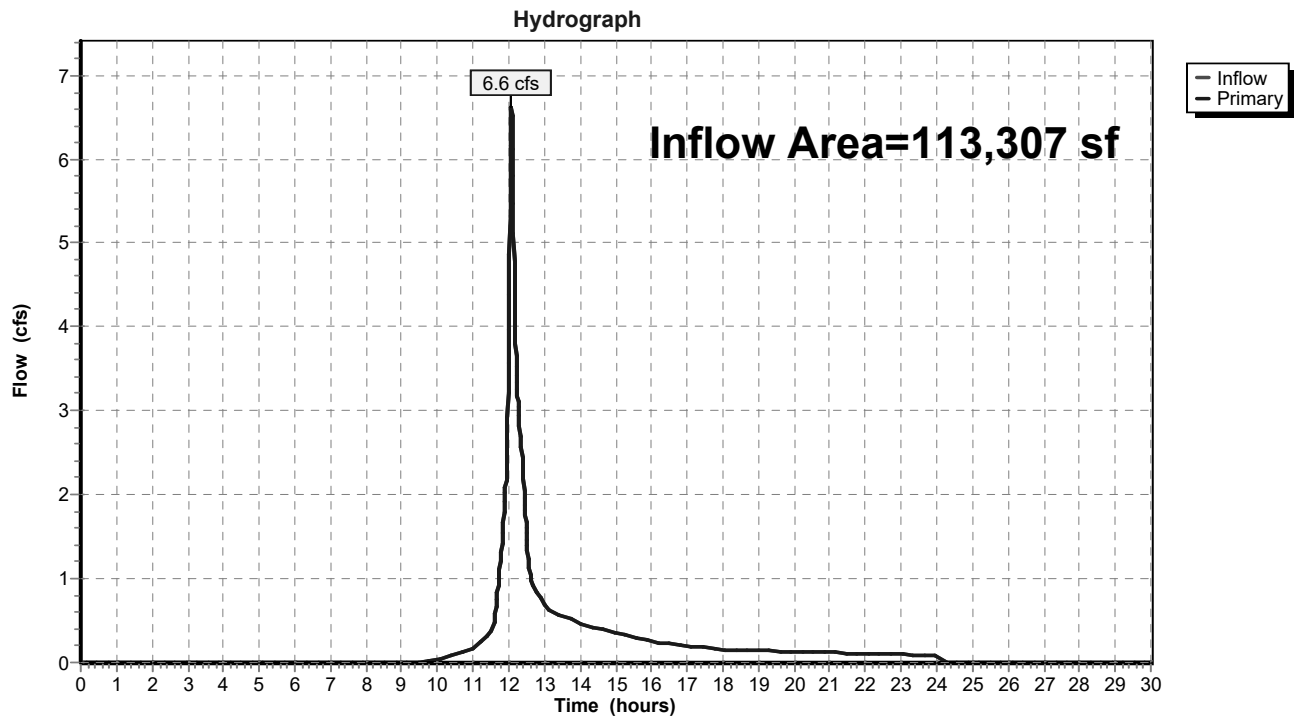
Pond P-B: MC-3500 StormTech at 673 Highland



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

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Type III 24-hr 25-year Rainfall=6.40"

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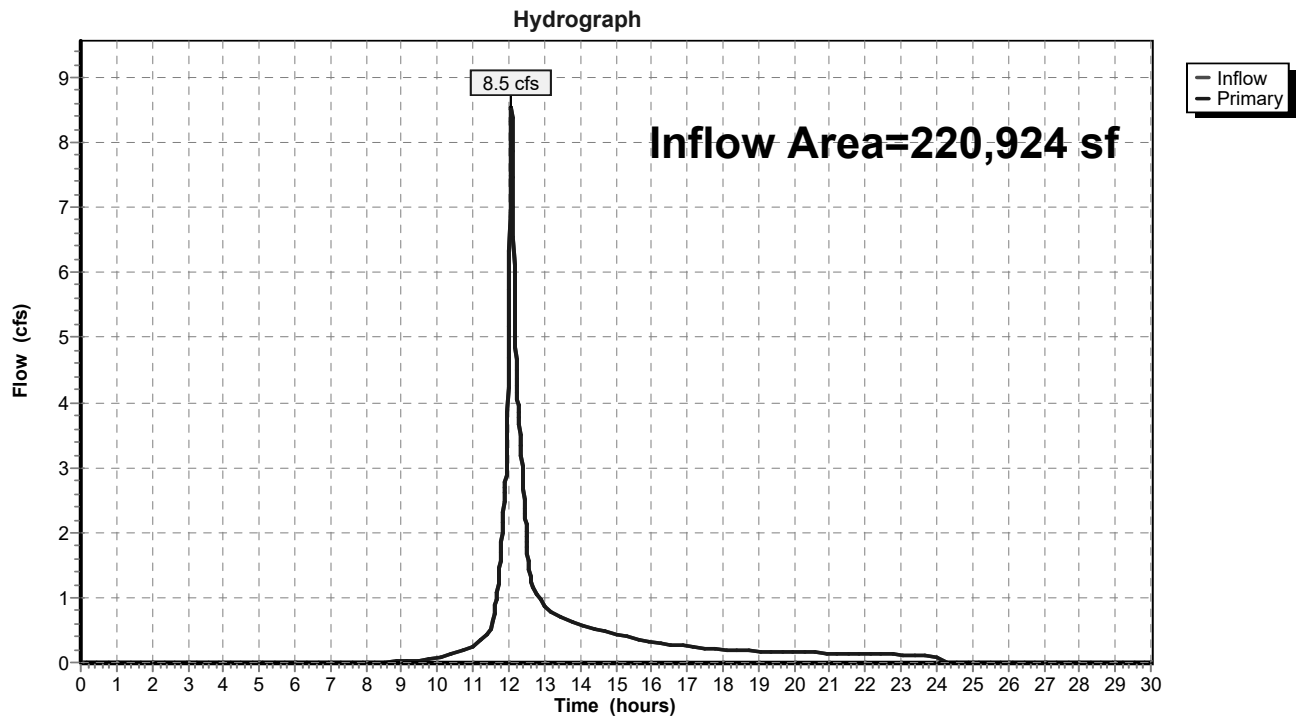
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Summary for Link DP-1: Offsite to North

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



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Type III 24-hr 25-year Rainfall=6.40"

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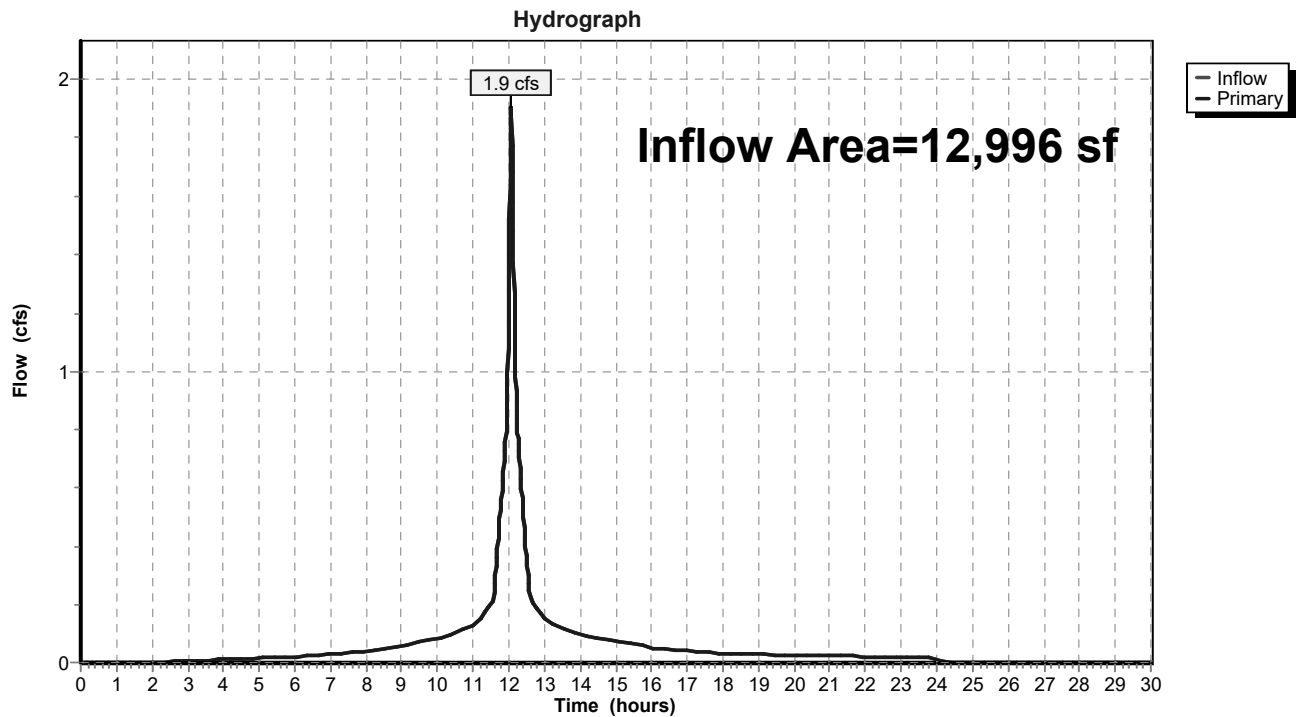
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Summary for Link DP-2: Highland Ave

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

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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

Runoff = 10.2 cfs @ 12.08 hrs, Volume= 30,455 cf, Depth= 4.17"

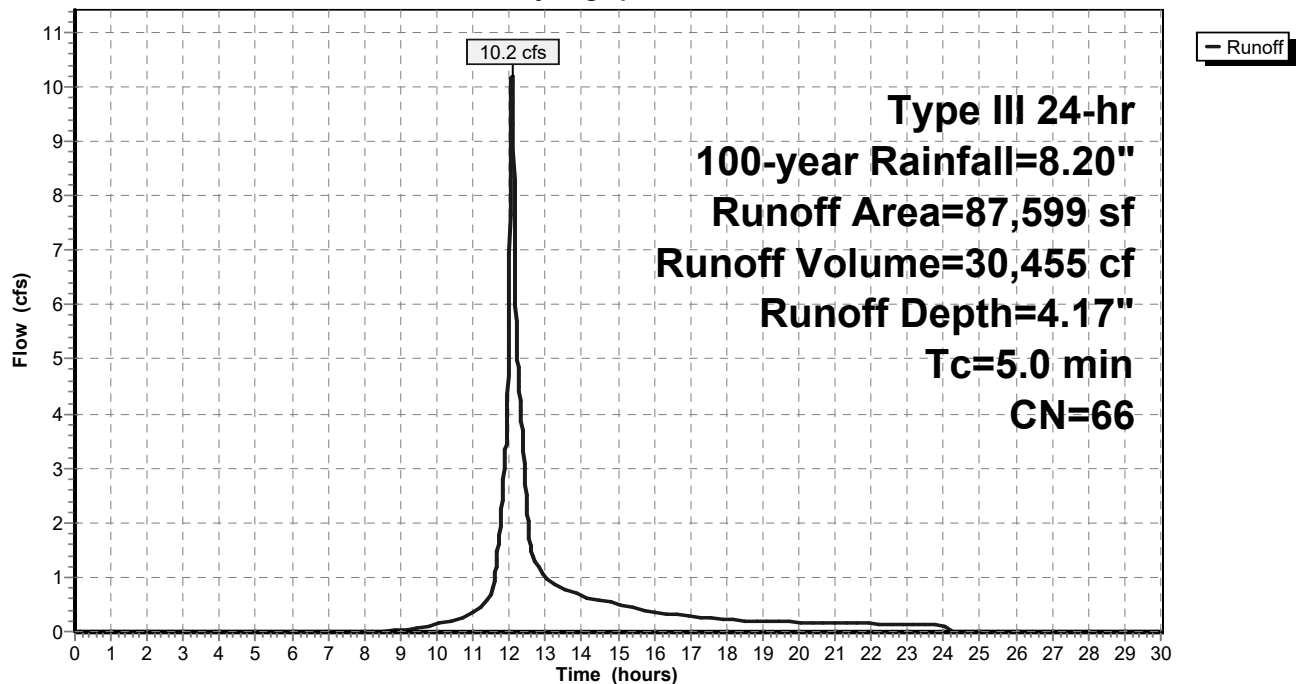
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment EX-B: 673 Highland & Upstream Area

Runoff = 4.9 cfs @ 12.07 hrs, Volume= 17,053 cf, Depth= 7.96"

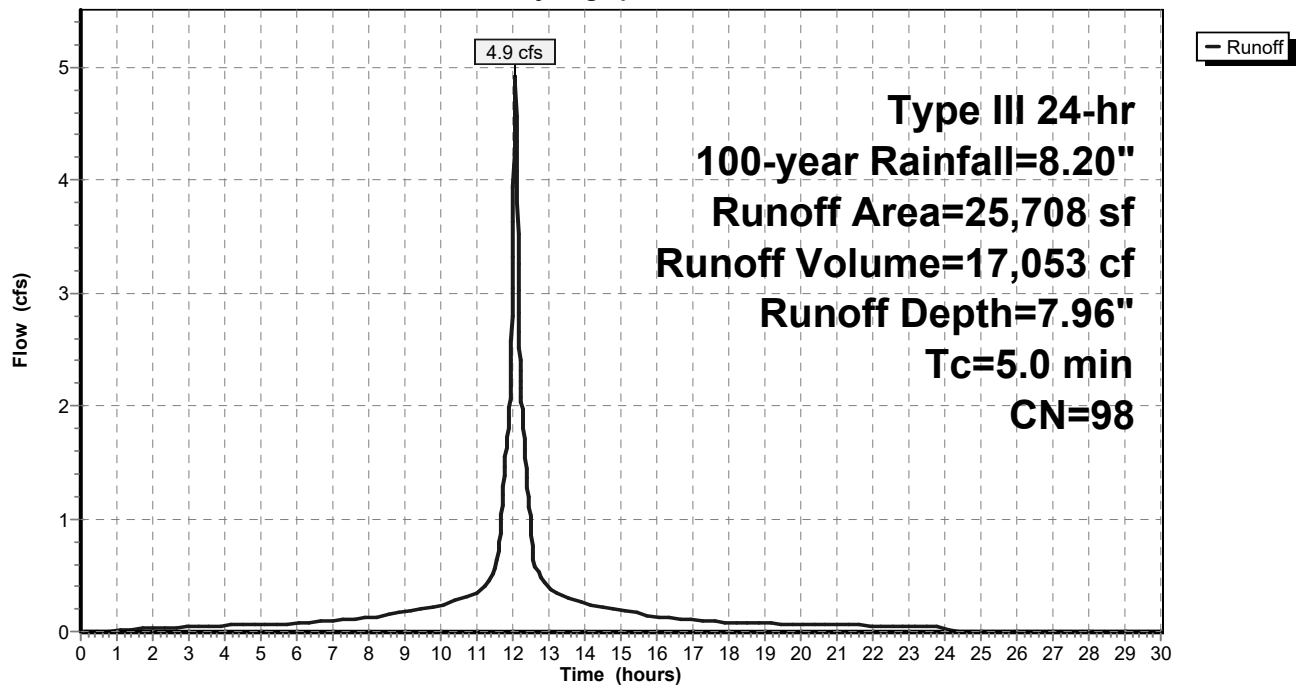
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment EX-D: Overland to Highland Ave

Runoff = 2.5 cfs @ 12.07 hrs, Volume= 8,231 cf, Depth= 7.60"

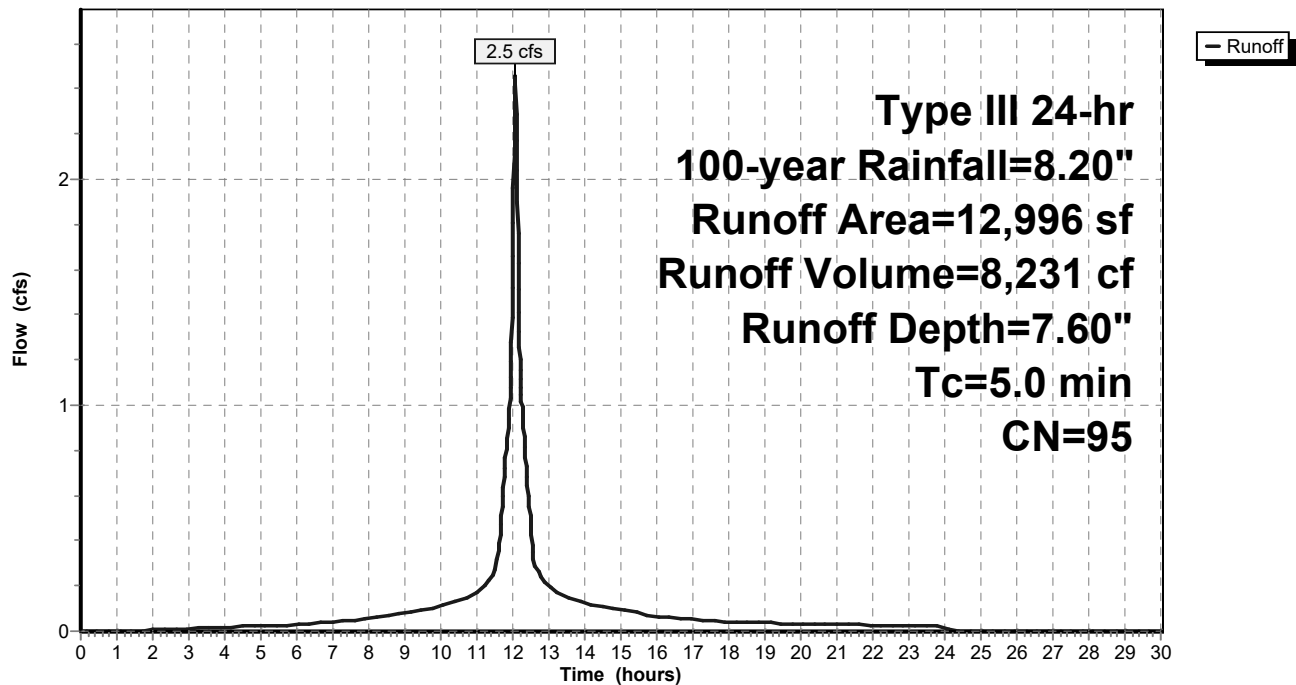
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment PR-1: Onsite Driveway & Upper Arbor St

Runoff = 3.2 cfs @ 12.07 hrs, Volume= 9,592 cf, Depth= 5.34"

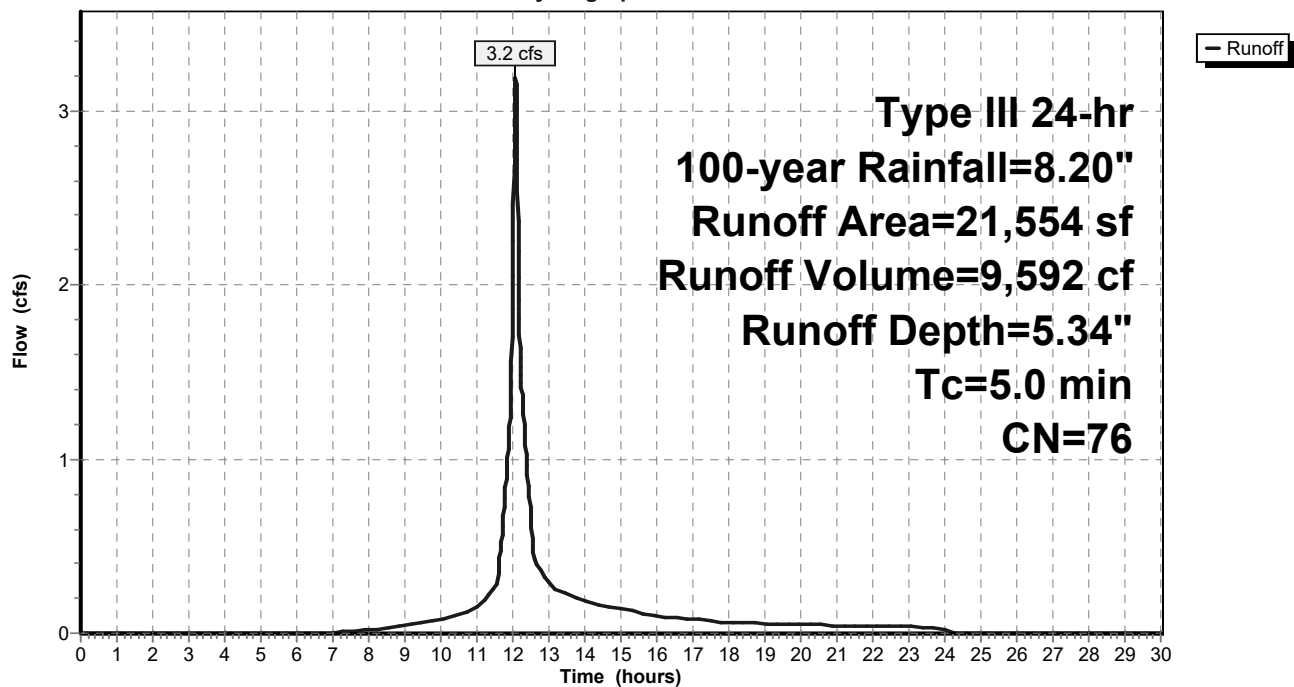
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

Runoff = 11.1 cfs @ 12.07 hrs, Volume= 34,327 cf, Depth= 6.29"

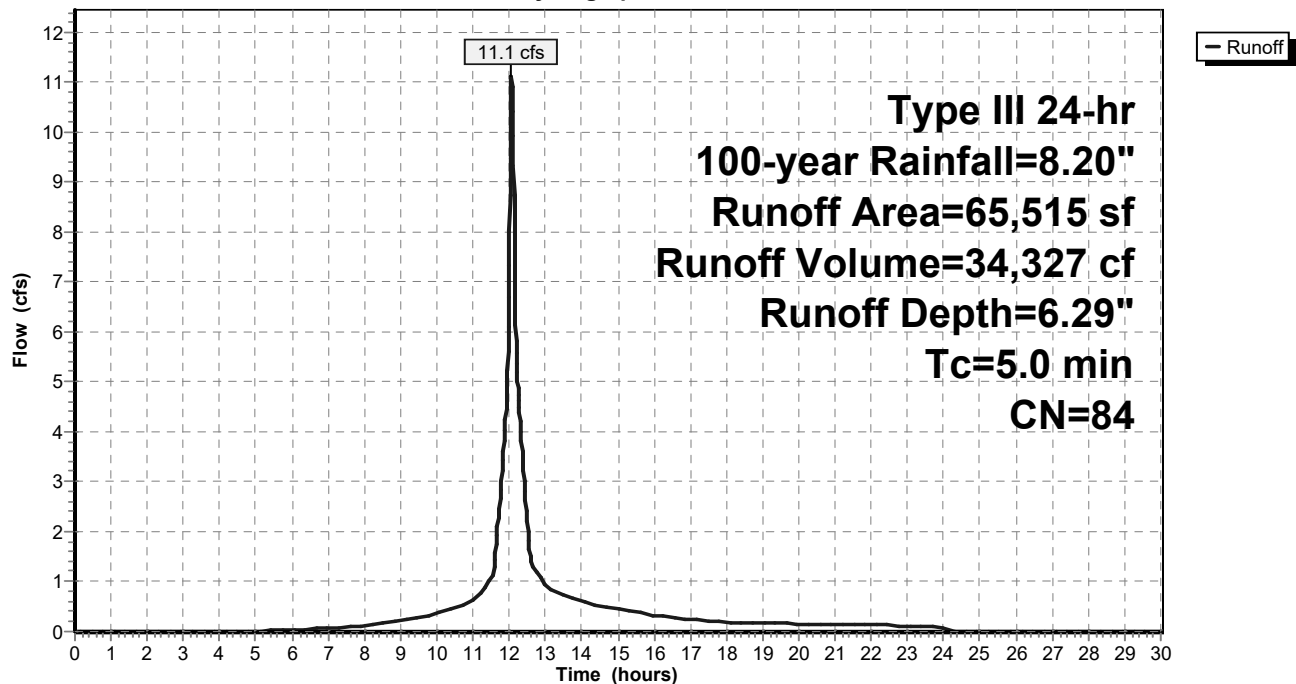
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment PR-3: Permeable Patio

Runoff = 0.5 cfs @ 12.07 hrs, Volume= 1,658 cf, Depth= 7.96"

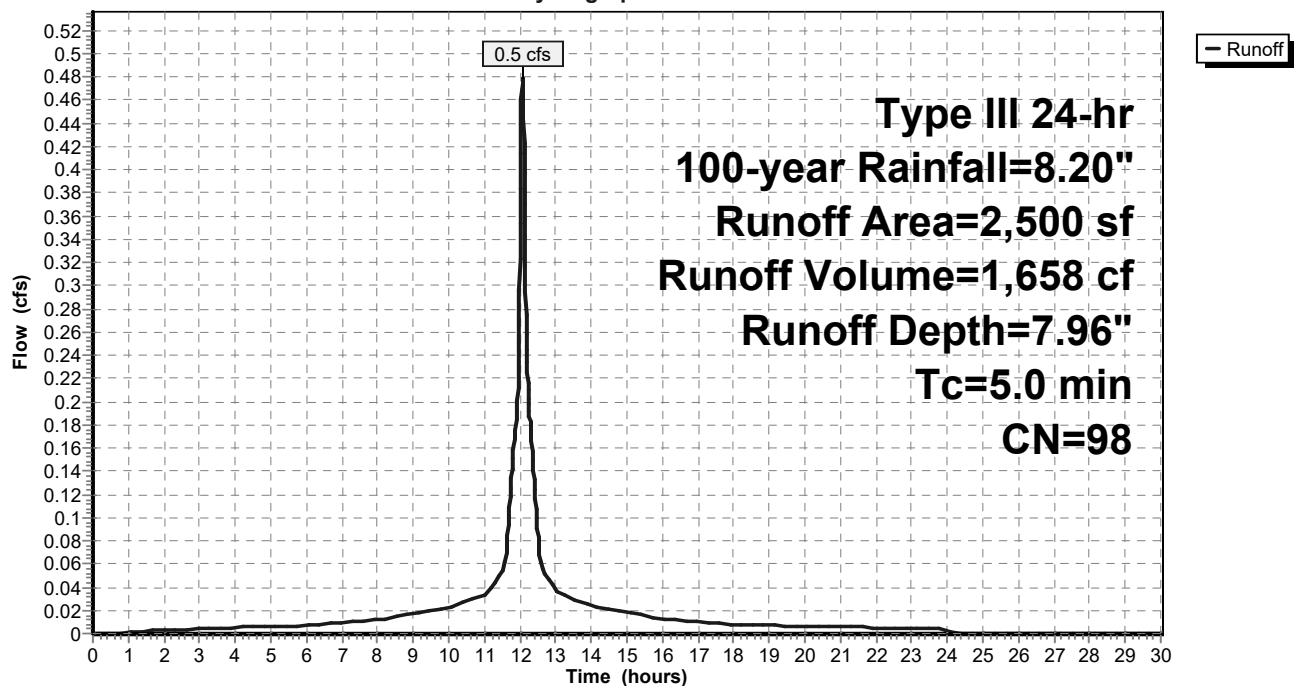
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Summary for Subcatchment PR-C: Cross St

Runoff = 2.7 cfs @ 12.07 hrs, Volume= 8,209 cf, Depth= 5.46"

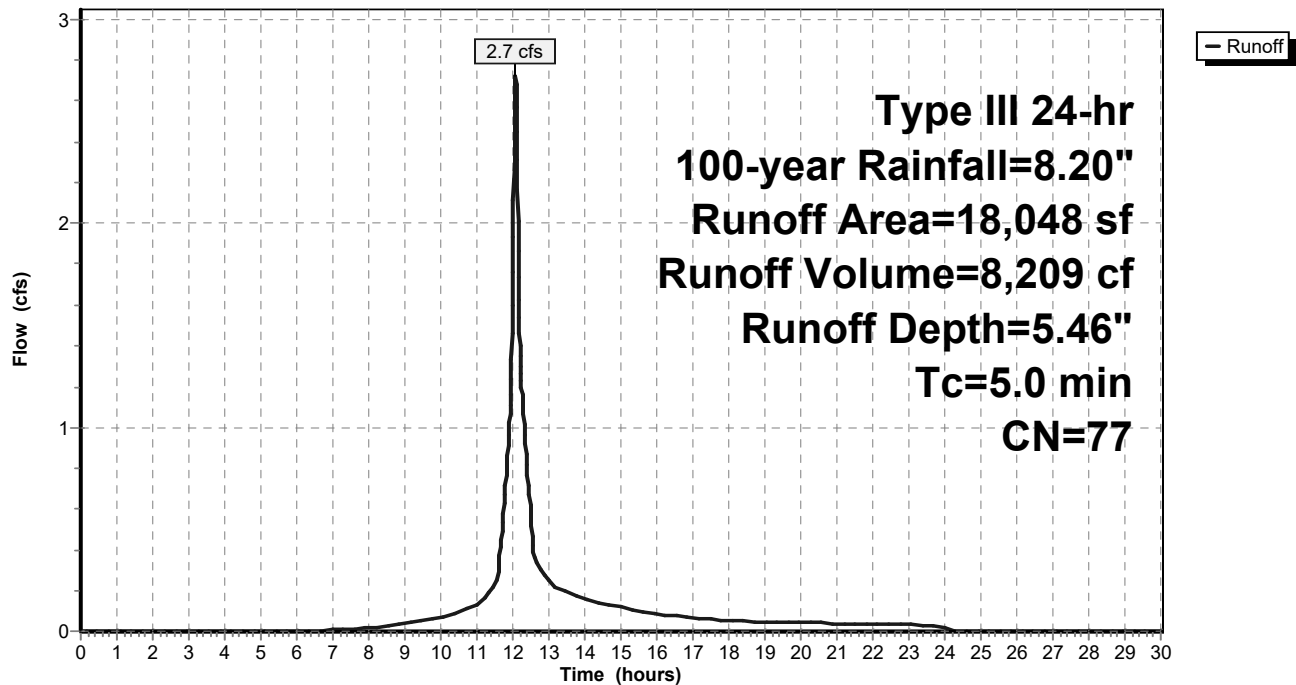
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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

Hydrograph



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)

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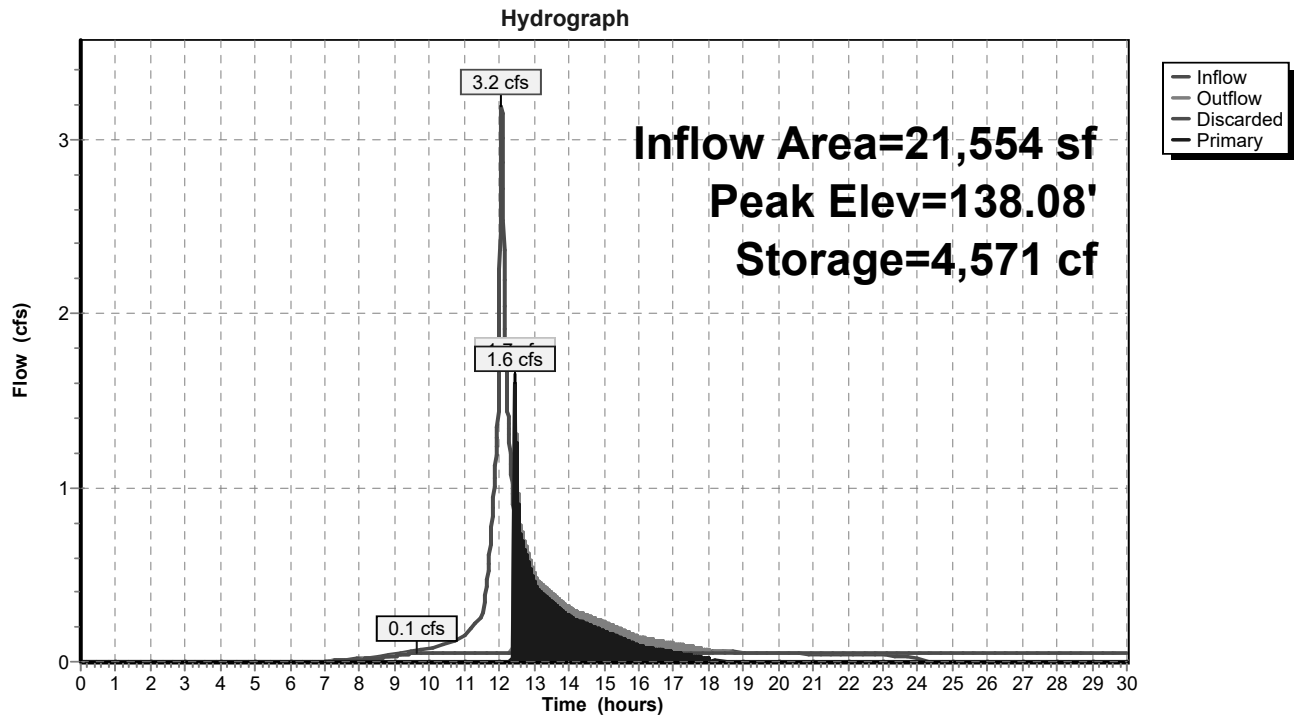
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Type III 24-hr 100-year Rainfall=8.20"

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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 2-0x 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 2-0x 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 2-0x 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 2-0x 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

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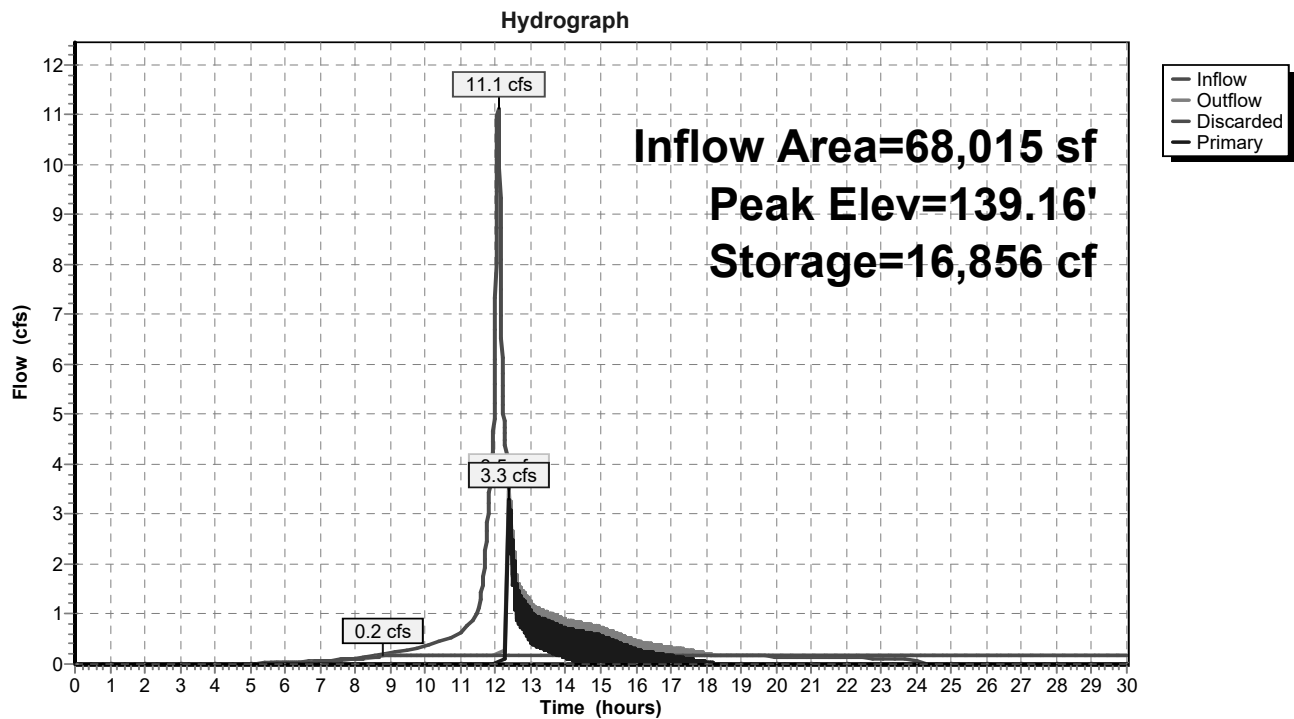
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Device	Routing	Invert	Outlet Devices
#1	Discarded	133.00'	1.020 in/hr Exfiltration over Surface area Special & User-Defined Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000
#2	Primary	139.00'	

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)

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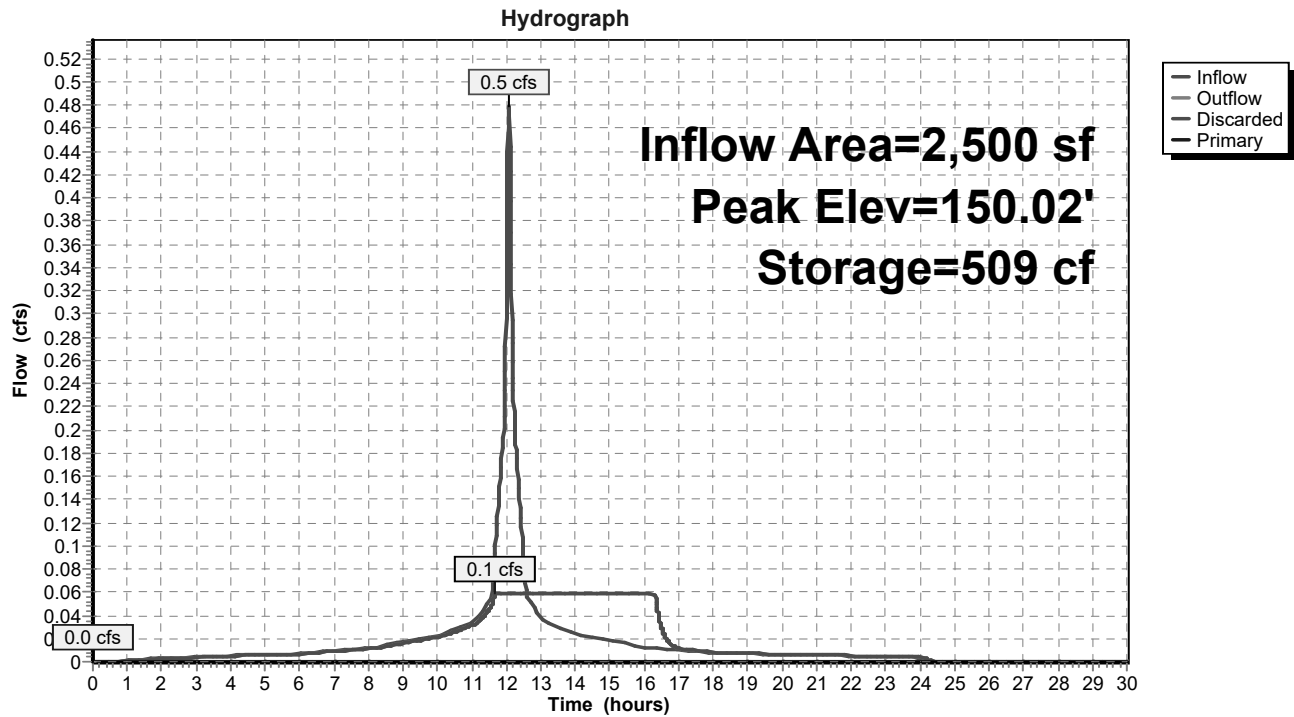
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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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Pond P-3.1: Permeable Patio



1478100-PR

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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)

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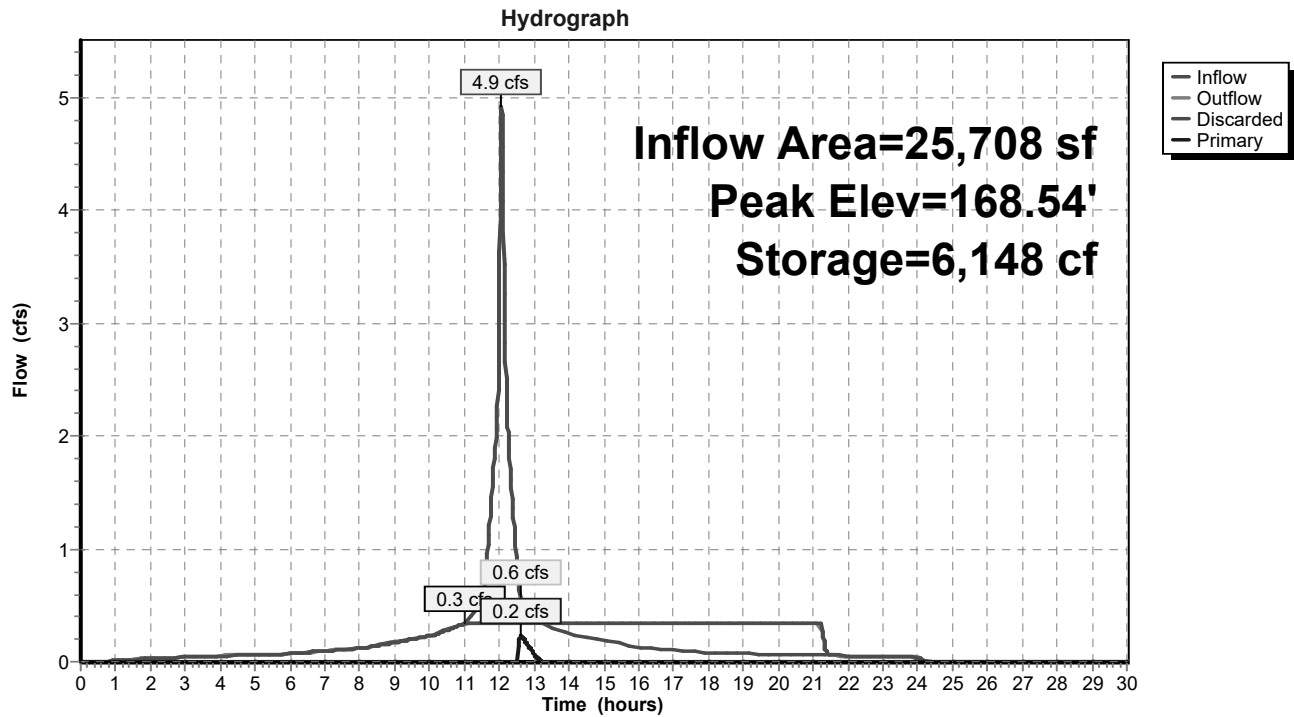
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Type III 24-hr 100-year Rainfall=8.20"

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Pond P-B: MC-3500 StormTech at 673 Highland



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Type III 24-hr 100-year Rainfall=8.20"

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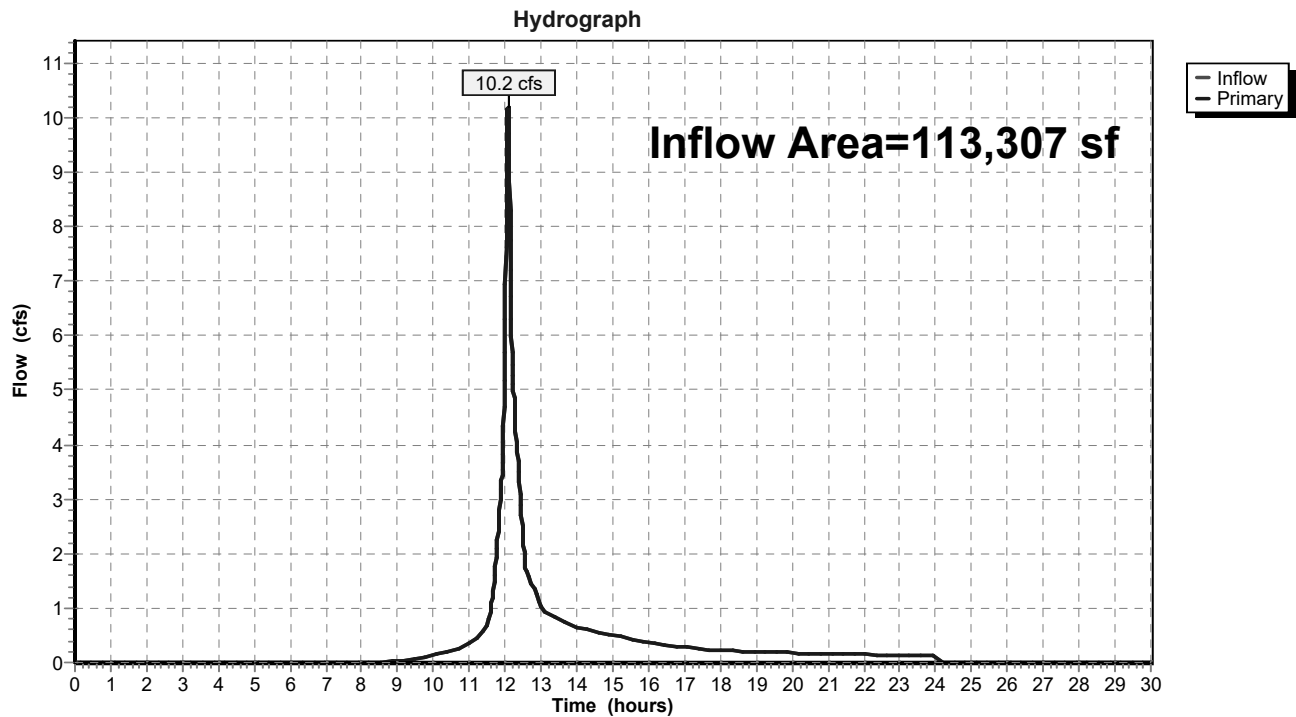
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Summary for Link A-B: EX A+ EX B

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



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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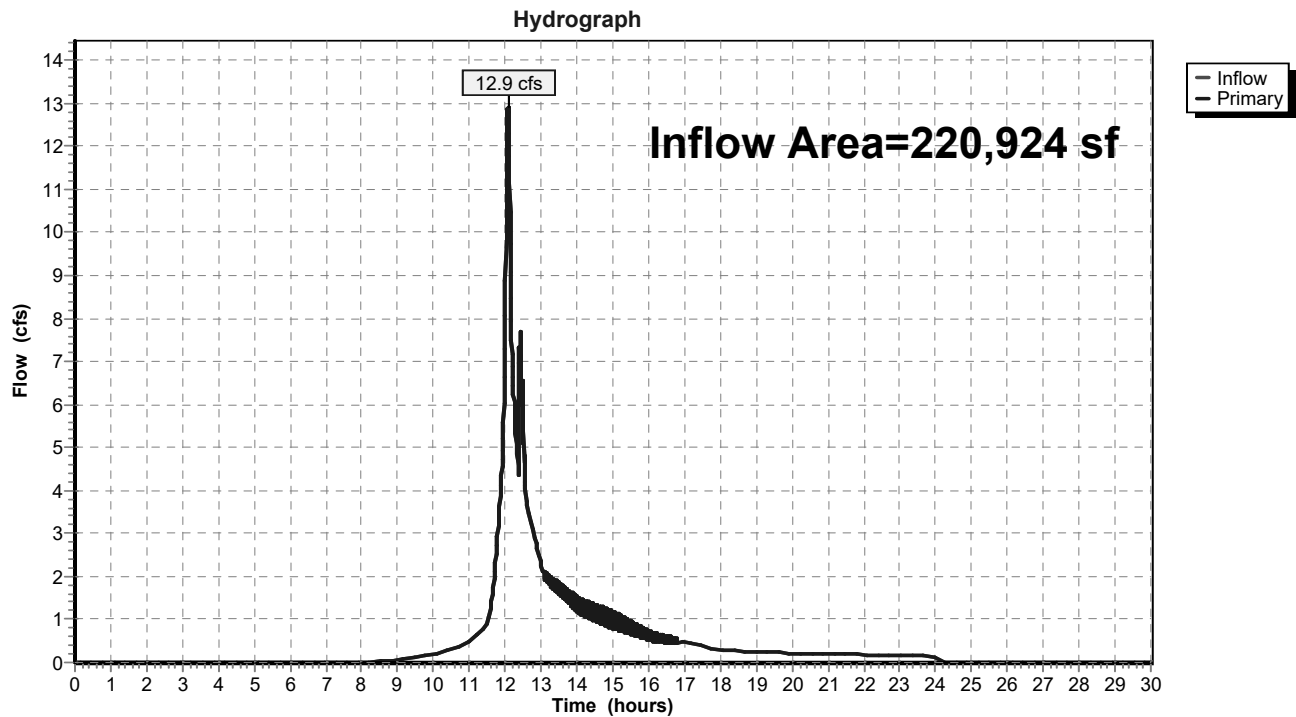
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Summary for Link DP-1: Offsite to North

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



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Proposed
Type III 24-hr 100-year Rainfall=8.20"

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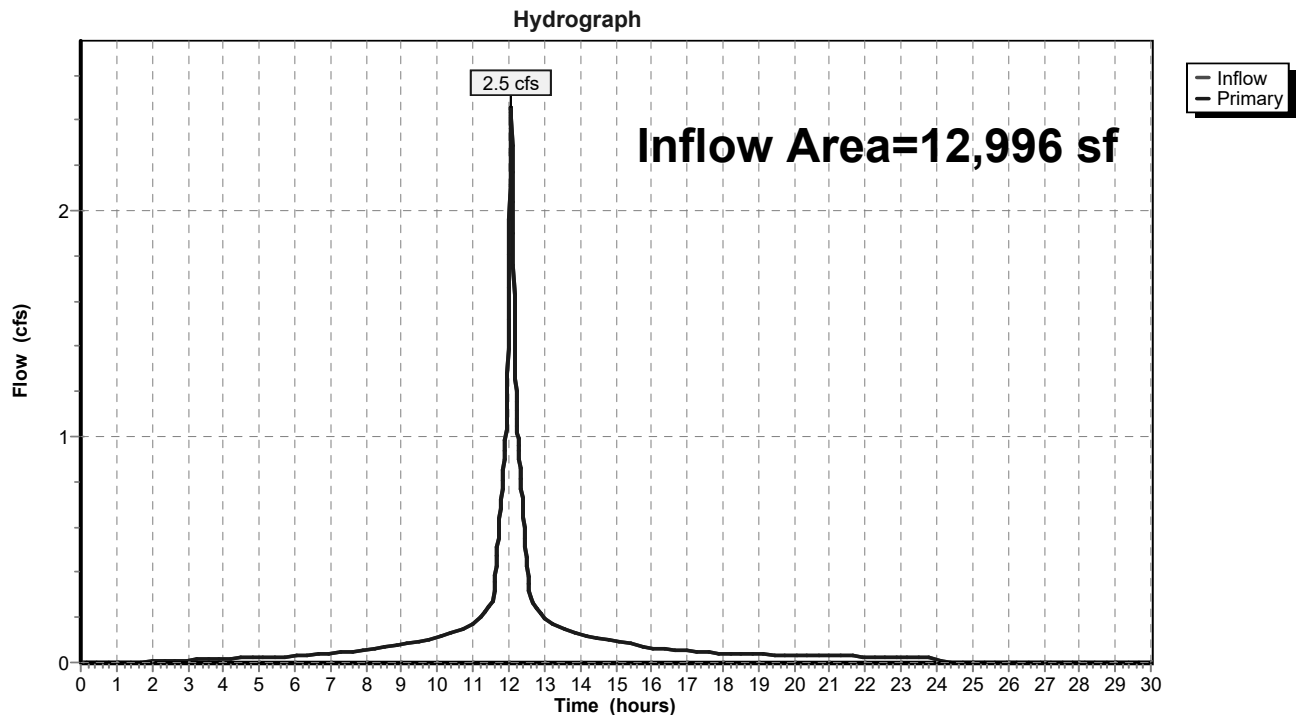
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Summary for Link DP-2: Highland Ave

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

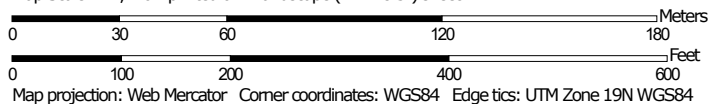
- › [NRCS Soils Map](#)
- › [Boring and Test Pit Logs](#)

Hydrologic Soil Group—Norfolk and Suffolk Counties, Massachusetts (HSGs)



Soil Map may not be valid at this scale.

Map Scale: 1:2,110 if printed on A landscape (11" x 8.5") sheet.



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

8/1/2023
Page 1 of 4

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

Project: 661 Highland Ave Location: Needham MA City/State: Needham Ma				Job #: 7076 Date Started: 12-11-20 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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
1	134		0.3 / 134.7	ASPHALT						
2	133			15	S1	24/10	1.0-3.0	15 5 10 67	Compact, brown to dark brown, SILTY SAND, trace gravel w/ concrete. (Fill)	
3	132									
4	131									
5	130			FILL						
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									
9	126		8.0 / 127.0	GLACIAL OUTWASH						
10	125									
11	124				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		14.0 / 121.0	WEATHERED BEDROCK						
14	121									
15	120				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									Note: Solid bedrock at 16' BGS
17	118		16.0 / 119.0	Bottom of borehole 16' BGS						
18	117									
19	116									
20	115									
21	114									
22	113									

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"



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Project: 661 Highland Ave Location: Needham MA City/State: Needham Ma				Job #: 7076 Date Started: 12-11-20 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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes	
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"		
1	137		0.5 / 137.5	ASPHALT							
2	136		FILL	3.0 / 135.0	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.	
3	135										
4	134		17.0 / 121.0	GLACIAL OUTWASH							
5	133										
6	132				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	
7	131										
8	130										
9	129										
10	128										
11	127				56	S3	24/12	10.0-12.0	48 30 26 24	Very dense, brown to pink, SAND and GRAVEL, some silt. (Glacial Outwash)	
12	126										
13	125										
14	124										
15	123										
16	122				45	S4	24/4	15.0-17.0	20 20 25 18	Dense, brown to gray, SILTY SAND and GRAVEL. (Glacial Outwash)	
17	121		21.5 / 116.5	GLACIAL TILL							
18	120										
19	119										
20	118										
21	117				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)	
22	116			WEATHERED BEDROCK							

GRANULAR SOILS		SOIL COMPONENT		
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
0-4	V.LOOSE	"TRACE"	0-10%	
4-10	LOOSE	"SOME"	10-20%	
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
30-50	DENSE	"AND"	35-50%	
50	V.DENSE			

COHESIVE SOILS		Notes: Truck rig with auto hammer. Weather:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	



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Project: 661 Highland Ave Location: Needham MA City/State: Needham Ma				Job #: 7076 Date Started: 12-11-20 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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th colspan="4">Groundwater Observations</th></tr> <tr> <th>Date</th><th>Depth</th><th>Elev.</th><th>Notes</th></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes	
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"		
24	114		26.0 / 112.0	WEATHERED BEDROCK							
25	113										
26	112										
27	111										
28	110										
29	109		31.0 / 107.0	BEDROCK	3	RC1	60/54	26.0-31.0		RQD: 26/60 RQD: 43% Medium hard, moderately weathered, severely fractured, some horizontal drilling fractures, green to gray, medium grained, no cavities observed.	
30	108			5							
31	107			3							
32	106			2							
33	105			8							
34	104			Bottom of borehole 31' BGS							
35	103										
36	102										
37	101										
38	100										
39	99										
40	98										
41	97										
42	96										
43	95										
44	94										
45	93										

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"



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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 <table border="1"> <thead> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>		Date	Depth	Elev.	Notes																
Date	Depth	Elev.	Notes																						

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
1	145		0.3 / 145.7	ASPHALT						
2	144		FILL		15	S1	24/10	1.0-3.0	8 8 7 7	Compact, brown to dark brown, SILTY SAND and GRAVEL. (Fill)
3	143									
4	142									
5	141		5.0 / 141.0	GLACIAL OUTWASH						
6	140		55		S2	24/14	5.0-7.0	13 24 31 32	Very dense, brown, SAND and GRAVEL, some silt. (Glacial Outwash)	
7	139									
8	138									
9	137			GLACIAL OUTWASH						
10	136									
11	135		120		S3	12/8	10.0-11.0	20 100/4	Very dense, brown to gray, SAND and GRAVEL, some silt. (Glacial Outwash)	
12	134								Note: Started casing	
13	133			GLACIAL TILL						
14	132									
15	131									
16	130		57		S5	24/12	15.0-17.0	19 27 30 19	Very dense, gray, SILTY SAND, trace gravel, w/ weathered bedrock. (Glacial Till)	
17	129		17.0 / 129.0	WEATHERED BEDROCK						
18	128		18.0 / 128.0							
19	127			BEDROCK						
20	126									
21	125							RQD: 33/60 RQD: 55%	Medium hard, gray, fine grained, slight weathering, moderately fractured, high angular fractures, trace horizontal drilling fractures, no cavities visible.	
22	124		5		RC1	60/56	20.0-25.0			

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"



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 FAX: 617-868-1423

Page 1 of 2

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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th colspan="4">Groundwater Observations</th></tr> <tr> <th>Date</th><th>Depth</th><th>Elev.</th><th>Notes</th></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
24	122		25.0 / 121.0	BEDROCK	9					
25	121			15						
26	120			7						
27	119			6						
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		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"



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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-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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
1	145		0.3 / 145.7	ASPHALT						
2	144		FILL	23	S1	24/10	1.0-3.0	7 15 8 43	Compact, brown to dark brown, SAND and GRAVEL, some silt. (Fill)	
3	143			3.0 / 143.0						
4	142			GLACIAL OUTWASH						
5	141									
6	140				136	S2	24/10	5.0-7.0	36 100/4	Very dense, brown to light brown, SAND and GRAVEL, trace silt. (Glacial Outwash)
7	139									
8	138									
9	137									
10	136									
11	135				104	S3	24/18	10.0-12.0	17 50 54 49	Very dense, brown to light brown, SAND and GRAVEL, trace silt. (Glacial Outwash)
12	134									
13	133		13.0 / 133.0 13.3 / 132.7	BEDROCK Bottom of borehole 13.3' BGS	100	S4	3/0	13.0-13.3	100/3	NO SAMPLE RECOVERED
14	132									
15	131									
16	130									
17	129									
18	128									
19	127									
20	126									
21	125									
22	124									

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"



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Page 1 of 1

Project: 661 Highland Ave Location: Needham MA City/State: Needham Ma				Job #: 7076 Date Started: 12-10-20 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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
1	161		0.5 / 161.5	ASPHALT						
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									
6	156		10.0 / 152.0	FILL	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									
11	151		10.0 / 152.0	GLACIAL OUTWASH	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									
16	146		20.0 / 142.0	GLACIAL TILL	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									
21	141		22.0 / 140.0	BOULDER	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									

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"



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Page 1 of 2

Project: 661 Highland Ave Location: Needham MA City/State: Needham Ma				Job #: 7076 Date Started: 12-10-20 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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
24	138		27.0 / 135.0	GLACIAL TILL						Very dense, gray, SAND, trace gravel and silt w/ petroleum odor. (Glacial Till) Note: Layer of dense coarse sand between 27' and 30' ("Running sand seam") kept getting stuck in pipes, had to put more casing down.
25	137				66	S6	24/10	25.0-27.0	25 52 14 13	
26	136									
27	135									
28	134		30.0 / 132.0	RUNNING SAND SEAM						
29	133				65	S7	24/14	30.0-32.0	31 38 27 38	
30	132									
31	131									
32	130		37.0 / 125.0	GLACIAL TILL						
33	129				100	S8	9/3	35.0-35.8	13 100/3	
34	128									
35	127									
36	126		42.0 / 120.0	BEDROCK						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.
37	125				6 6 6 6 10	RC1	60/56	37.0-42.0		
38	124									
39	123									
40	122		42.0 / 120.0	Bottom of borehole 42' BGS						
41	121									
42	120									
43	119									
44	118									
45	117									

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

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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				<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>				Groundwater Observations				Date	Depth	Elev.	Notes																
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Date	Depth	Elev.	Notes																																

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows Per 6"	
1	147		0.3 / 147.7	ASPHALT						
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									
5	143									
6	142			FILL						
7	141									
8	140									
9	139									
10	138									
11	137		8.0 / 140.0	BOULDER						
12	136				2	RC1	18/4	10.0-11.5	RQD: 4/18 RQD: 22%	Hard, pink/brown, coarse grained, no weathering, no fractures, no cavities.
13	135				3					
14	134				6					
15	133									
16	132		13.0 / 135.0	GLACIAL TILL						
17	131									
18	130									
19	129									
20	128									
21	127		17.0 / 131.0	WEATHERED ROCK						
22	126									
			18.0 / 130.0	BEDROCK						
			22.0 / 126.0	Bottom of borehole 22' BGS						

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Truck rig with auto hammer. Weather:
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

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Page 1 of 1

CARR-DEE CORP.

37 LINDEN STREET

MEDFORD, MA 02155-0001

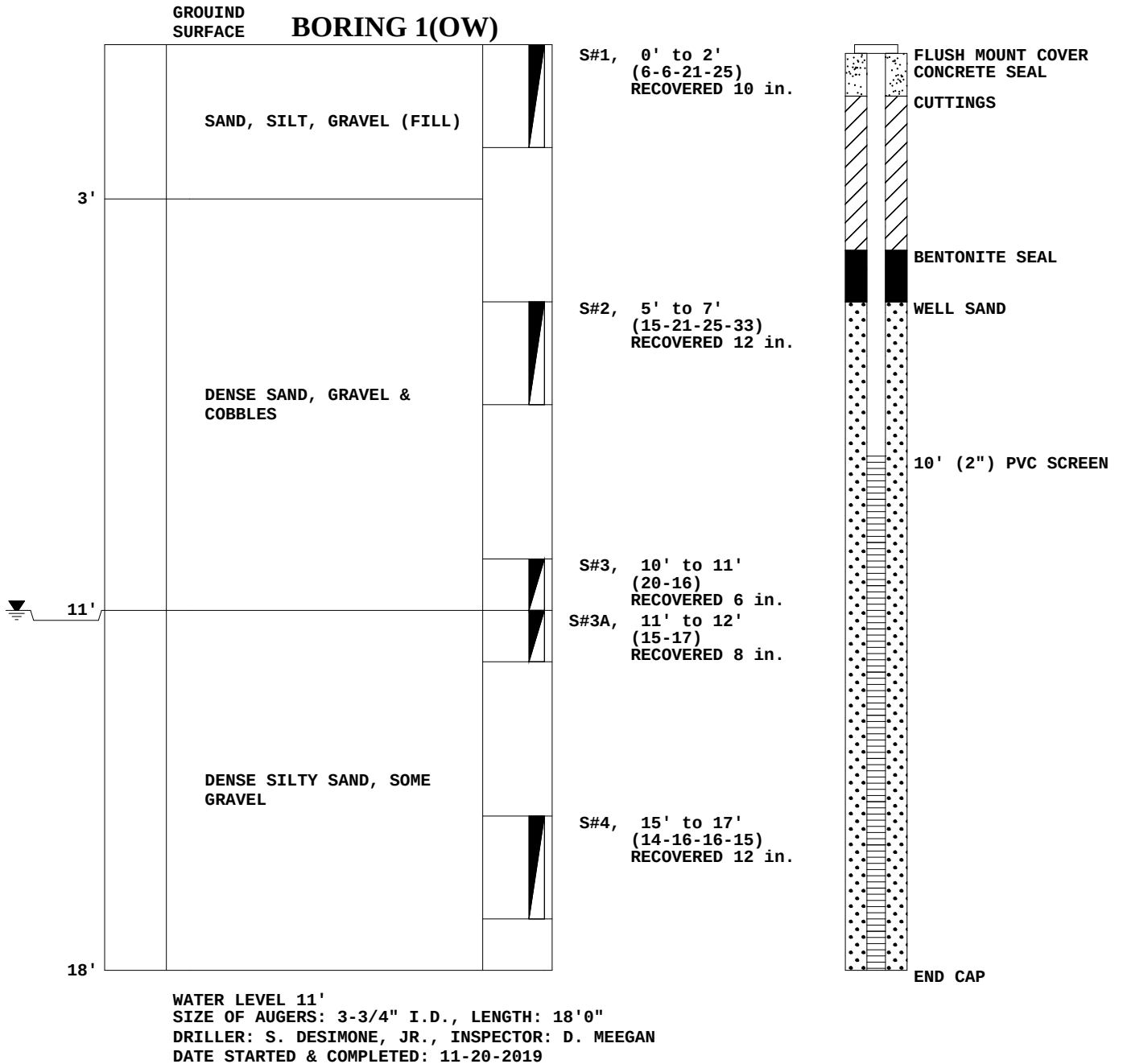
Telephone (781) 391-4500

To: BOSTON DEVELOPMENT GROUP, 93 UNION ST., NEWTON

Date: 11-21-2019 Job No.: 2019-241

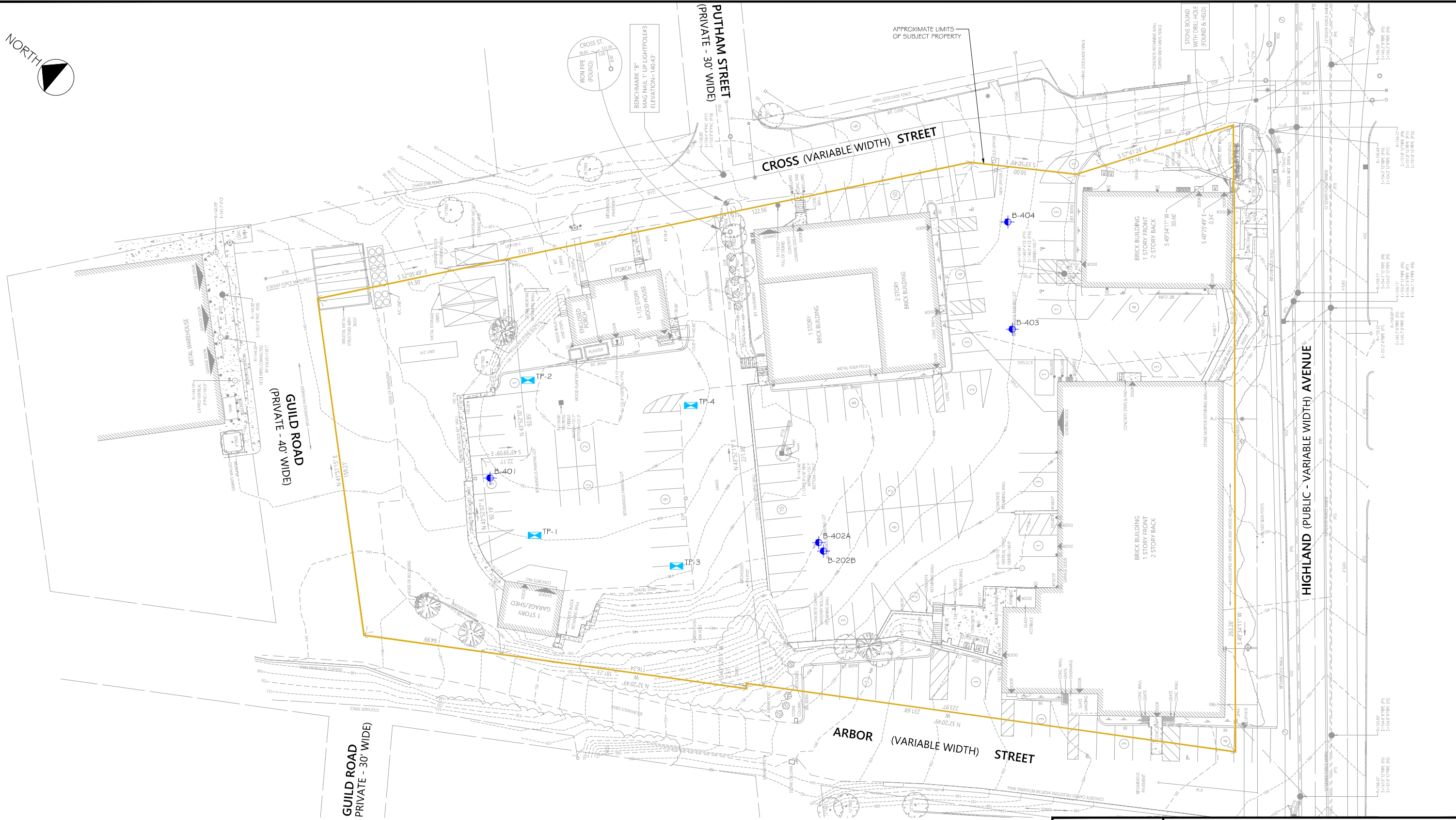
Location: 629-661 HIGHLAND AVENUE, NEEDHAM, MA

Scale: 1 in. = 3 ft.



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 (±).

FILE NAME: N:\A-2\A08570767076-F02-ec3.dwg



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



McPHAIL ASSOCIATES, LLC
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Geoenvironmental Engineers
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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.
Project No:	7076	Scale: 1" = 20'	
			FIGURE 2

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"																									
<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4" style="text-align: center;">Groundwater Observations</th> </tr> <tr> <th style="width:25%;">Date</th> <th style="width:25%;">Depth</th> <th style="width:25%;">Elev.</th> <th style="width:25%;">Notes</th> </tr> <tr> <td>4-3-23</td> <td>N.E.</td> <td></td> <td></td> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>						Groundwater Observations				Date	Depth	Elev.	Notes	4-3-23	N.E.														
Groundwater Observations																													
Date	Depth	Elev.	Notes																										
4-3-23	N.E.																												

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows/6" Min/ft	
					RQD					
	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									
4	132									
5	131		5.0 / 131.3	GLACIAL OUTWASH	10	S-2	24/10	3.0-5.0	4 5 5 8	Loose to compact, brown, silty SAND, some gravel. (FILL)
6	130									
7	129									
8	128									
			8.3 / 128.0		73	S-3	24/12	5.0-7.0	22 32 41 64	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)
9	127			Bottom of borehole extends 8.3 feet below ground surface.	191/11"	S-4	11/	7.0-7.9	91 100/5"	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)
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		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		
COHESIVE SOILS			
BLOWS/FT.	CONSISTENCY	Notes: Weather: Clear	
<2	V.SOFT		
2-4	SOFT		
4-8	FIRM		
8-15	STIFF		
15-30	V.STIFF		
>30	HARD		

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Page 1 of 1

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-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"		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr> <td>3-31-23</td> <td>12.5</td> <td>132.9</td> <td></td> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>		Groundwater Observations				Date	Depth	Elev.	Notes	3-31-23	12.5	132.9													
Groundwater Observations																													
Date	Depth	Elev.	Notes																										
3-31-23	12.5	132.9																											

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes	
					N-Value RQD	No.	Pen. /Rec. (in)	Depth (ft)	Blows/6" Min/ft		
	145		0.3 / 145.1	ASPHALT							
1	144			FILL	13	S-1	18/8	0.5-2.0	4 5 8	Compact, brown, SILT, SAND and GRAVEL. (FILL)	
2	143										Very dense, gray-brown, SAND and GRAVEL, trace silt. (FILL)
3	142				54	S-2	24/10	2.0-4.0	25 31 23 19		
4	141				33	S-3	12/6	4.0-5.0	14 19	Dense, light gray, SAND and GRAVEL, trace silt. (FILL)	
5	140								56	NOTE: Pulverized gravel/cobbles throughout sample.	
6	139				110	S-4	24/15	5.0-7.0	61 49 44	Very dense, light gray, GRAVEL, some sand, trace silt. (FILL) NOTE: Pulverized gravel/cobbles throughout sample.	
7	138		7.0 / 138.4	GLACIAL OUTWASH	142/10"	S-5	10/7	7.0-7.8	42 100/4"	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)	
8	137									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.	
9	136								31 45 38 53	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)	
10	135				83	S-6	24/16	9.0-11.0			
11	134		11.0 / 134.4	GLACIAL TILL					18 22 24 22	Dense, gray-brown, SILT, SAND and GRAVEL. (GLACIAL TILL) NOTE: Constant head infiltration test at 11'.	
12	133				46	S-7	24/18	11.0-13.0			
13	132								16 15 16 14	Dense, gray-brown, SILT, SAND and GRAVEL. (GLACIAL TILL)	
14	131				31	S-8	24/14	13.0-15.0			
15	130		15.0 / 130.4	Bottom of borehole extends 15 feet below ground surface.							
16	129										
17	128										
18	127										
19	126										
20	125										
21	124										
22	123										

GRANULAR SOILS		SOIL COMPONENT		
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
0-4	V.LOOSE	"TRACE"	0-10%	
4-10	LOOSE	"SOME"	10-20%	
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
30-50	DENSE	"AND"	35-50%	
>50	V.DENSE			

COHESIVE SOILS		Notes:
BLOWS/FT.	CONSISTENCY	
<2	V.SOFT	Weather: Clear
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	
>30	HARD	



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"		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th style="width:25%;">Date</th> <th style="width:15%;">Depth</th> <th style="width:15%;">Elev.</th> <th style="width:45%;">Notes</th> </tr> <tr> <td>3-31-23</td> <td>12</td> <td>135.1</td> <td></td> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>		Groundwater Observations				Date	Depth	Elev.	Notes	3-31-23	12	135.1													
Groundwater Observations																													
Date	Depth	Elev.	Notes																										
3-31-23	12	135.1																											

Depth (ft)	Elev. (ft)	Symbol	Depth/Elev. to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes	
					N-Value RQD	No.	Pen. /Rec. (in)	Depth (ft)	Blows/6" Min/ft		
			0.3 / 146.8	ASPHALT							
1	146			FILL	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										
3	144										
4	143				6	S-2	24/4	3.0-5.0	4 3 3 3	Loose, dark brown, SAND and GRAVEL, some silt. (FILL)	
5	142		5.0 / 142.1	GLACIAL OUTWASH							
6	141				36	S-3	24/10	5.0-7.0	8 16 20 35	Dense, gray-brown, silty SAND and GRAVEL. (GLACIAL OUTWASH)	
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				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'.	
11	136										
12	135				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)	
13	134		14.0 / 133.1	Bottom of borehole extends 14 feet below ground surface.							
14	133										
15	132										
16	131										
17	130										
18	129										
19	128										
20	127										
21	126										
22	125										

GRANULAR SOILS		SOIL COMPONENT		
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
0-4	V.LOOSE	"TRACE"	0-10%	
4-10	LOOSE	"SOME"	10-20%	
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
30-50	DENSE	"AND"	35-50%	
>50	V.DENSE			
COHESIVE SOILS				
BLOWS/FT.	CONSISTENCY	Notes: Weather: Clear		
<2	V.SOFT			
2-4	SOFT			
4-8	FIRM			
8-15	STIFF			
15-30	V.STIFF			
>30	HARD			

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Page 1 of 1

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"		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">Groundwater Observations</th> </tr> <tr> <th>Date</th> <th>Depth</th> <th>Elev.</th> <th>Notes</th> </tr> <tr> <td>4-3-23</td> <td>12</td> <td>134.3</td> <td></td> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </table>		Groundwater Observations				Date	Depth	Elev.	Notes	4-3-23	12	134.3													
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Date	Depth	Elev.	Notes																										
4-3-23	12	134.3																											

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes							
					N-Value RQD	No.	Pen. /Rec. (in)	Depth (ft)	Blows/6" Min/ft								
1	146		0.3 / 146.0	ASPHALT													
2	145			5.0 / 141.3	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)						
3	144						5.0 / 141.3	FILL	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	143									5.0 / 141.3	FILL	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)
5	142												5.0 / 141.3	FILL	86	S-4	24/16
6	141		5.0 / 141.3	FILL	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'.							
7	140					5.0 / 141.3	FILL	77	S-6	21/16	12.0-13.8	57 41 36 100/3"	Very dense, gray-brown, silty SAND and GRAVEL (GLACIAL TILL)				
8	139		5.0 / 141.3	FILL				Bottom of borehole extends 13.8 feet below ground surface.									
9	138					5.0 / 141.3	FILL										
10	137		5.0 / 141.3	FILL													
11	136					5.0 / 141.3	FILL										
12	135		5.0 / 141.3	FILL													
13	134					5.0 / 141.3	FILL										
14	133		5.0 / 141.3	FILL													
15	132					5.0 / 141.3	FILL										
16	131		5.0 / 141.3	FILL													
17	130					5.0 / 141.3	FILL										
18	129		5.0 / 141.3	FILL													
19	128					5.0 / 141.3	FILL										
20	127		5.0 / 141.3	FILL													
21	126					5.0 / 141.3	FILL										
22	125		5.0 / 141.3	FILL													
	124					5.0 / 141.3	FILL										

GRANULAR SOILS		SOIL COMPONENT	
BLOWS/FT.	DENSITY	DESCRIPTIVE TERM	PROPORTION OF TOTAL
0-4	V.LOOSE	"TRACE"	0-10%
4-10	LOOSE	"SOME"	10-20%
10-30	COMPACT	"ADJECTIVE" (eg SANDY, SILTY)	20-35%
30-50	DENSE	"AND"	35-50%
>50	V.DENSE		
COHESIVE SOILS			
BLOWS/FT.	CONSISTENCY		
<2	V.SOFT	Notes: Weather: Clear	
2-4	SOFT		
4-8	FIRM		
8-15	STIFF		
15-30	V.STIFF		
>30	HARD		

SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"

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Page 1 of 1



JOB NO. 7076
DATE APRIL 7, 2023

TEST PIT LOG

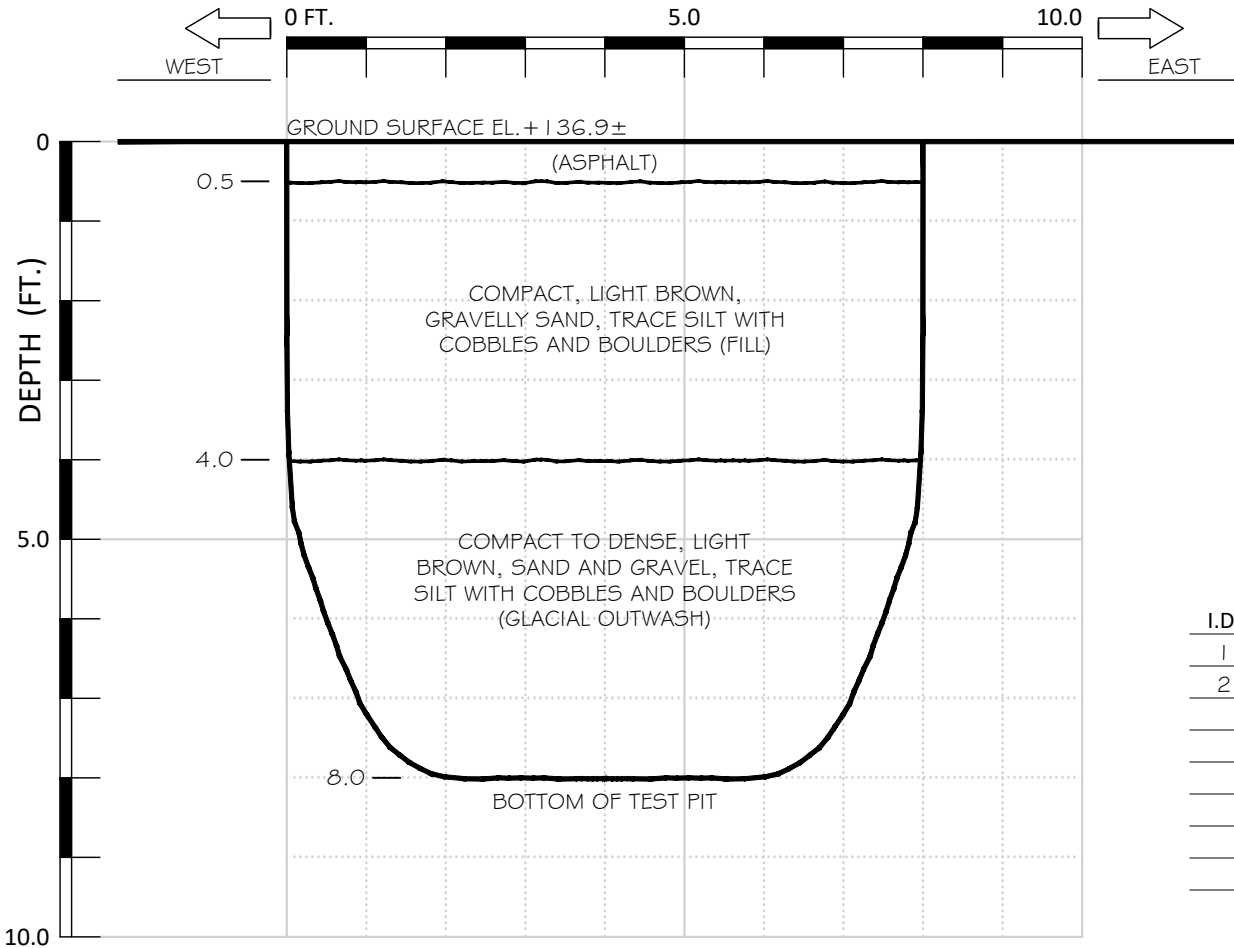
TEST PIT NO. 1

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

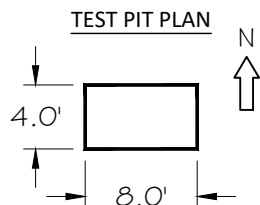
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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	



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	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
"TRACE"	0-10%	
"SOME"	10-20%	
"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
"AND"	35-50%	



JOB NO. 7076
DATE APRIL 7, 2023

TEST PIT LOG

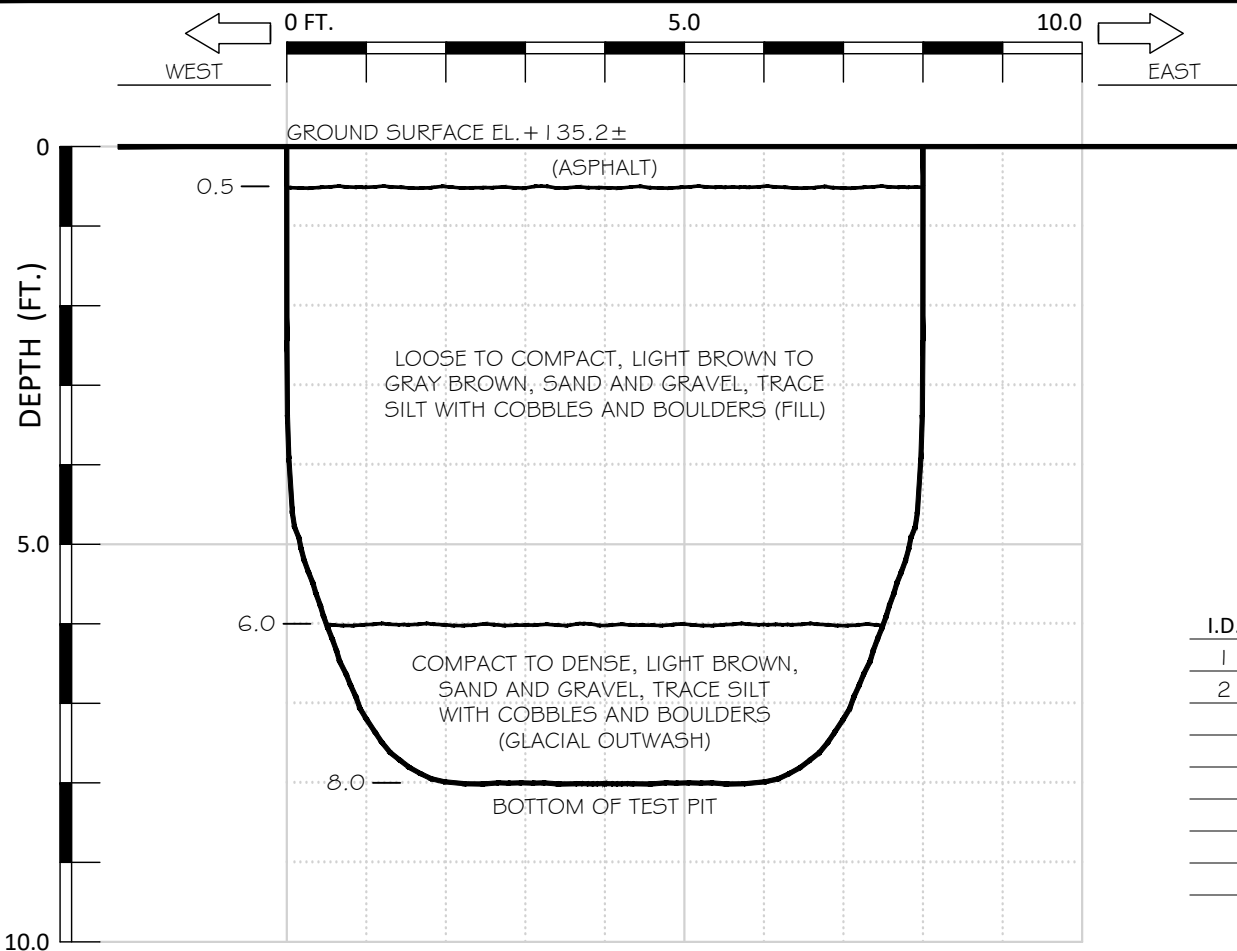
TEST PIT NO. 2

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

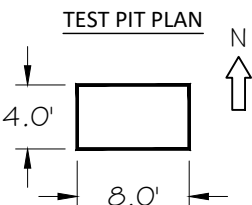
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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	



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	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
"TRACE"	0-10%	
"SOME"	10-20%	
"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
"AND"	35-50%	



JOB NO. 7076
DATE APRIL 7, 2023

TEST PIT LOG

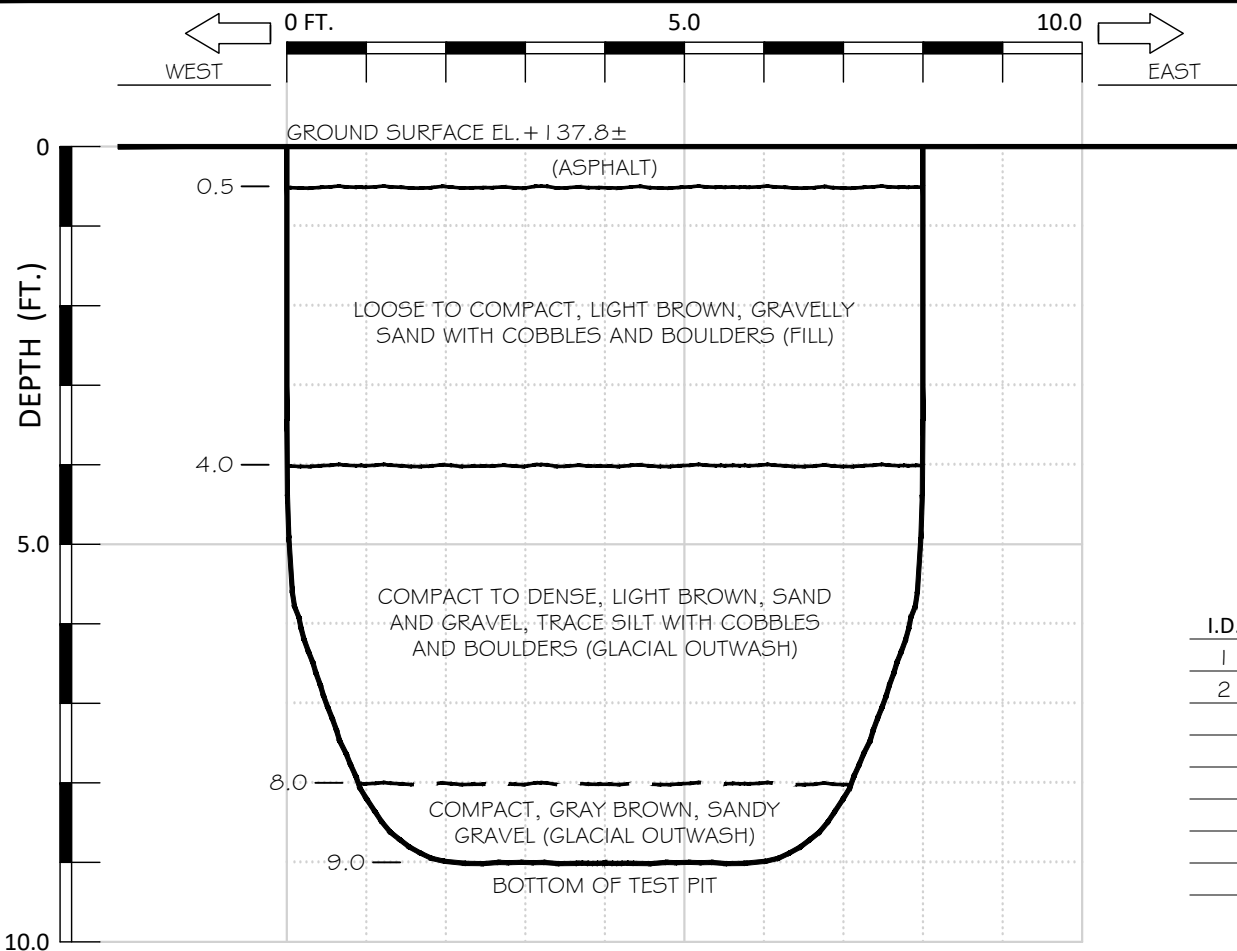
TEST PIT NO. 3

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

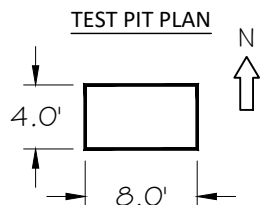
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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	



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	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
"TRACE"	0-10%	
"SOME"	10-20%	
"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
"AND"	35-50%	



JOB NO. 7076
DATE APRIL 7, 2023

TEST PIT LOG

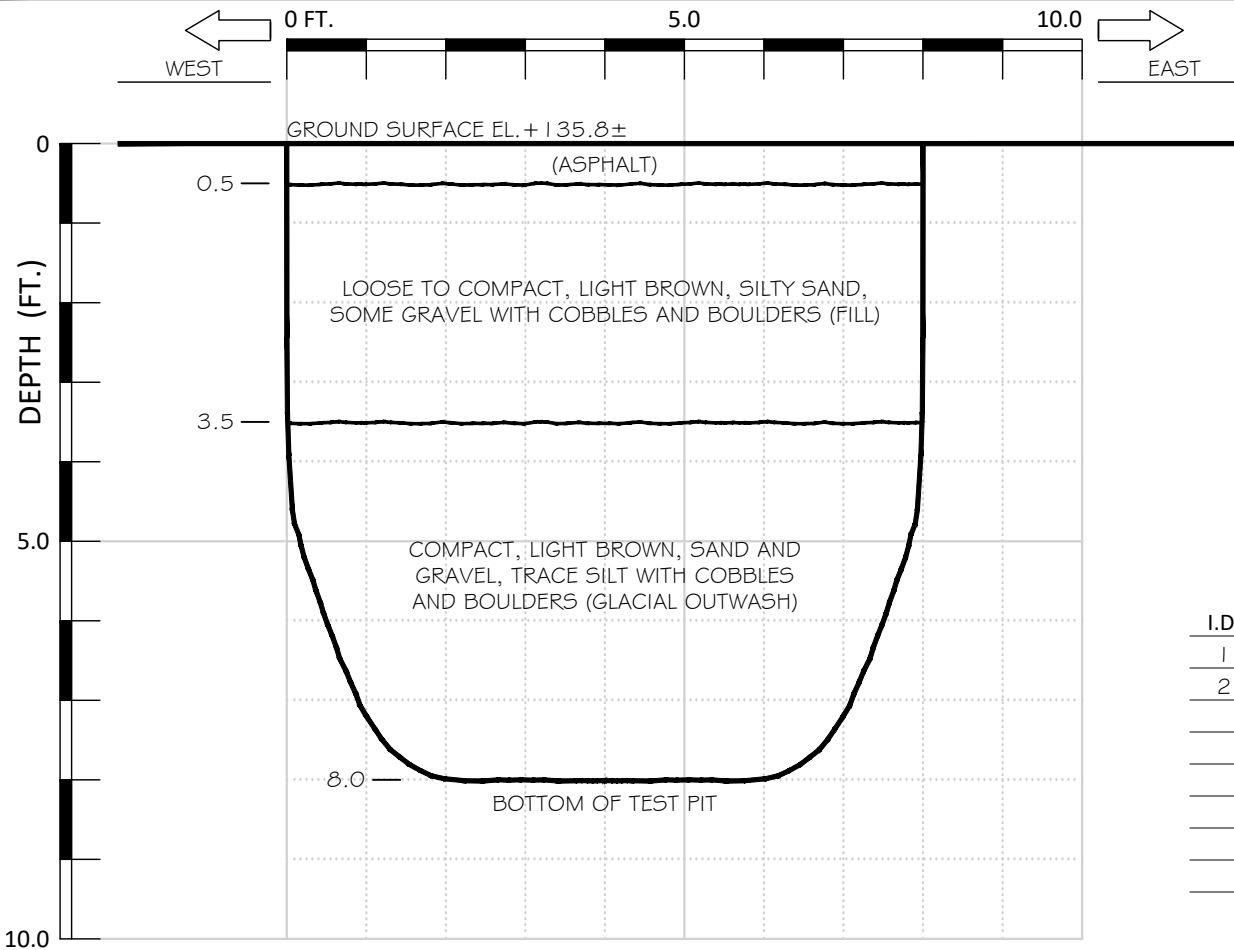
TEST PIT NO. 4

McPHAIL REP.: C. HENNINGSEN
WEATHER: SUNNY, 55° F

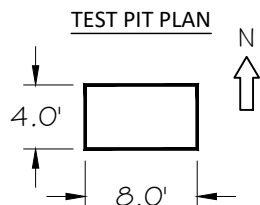
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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	



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	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"
"TRACE"	0-10%	
"SOME"	10-20%	
"ADJECTIVE" (eg SANDY, SILTY)	20-35%	
"AND"	35-50%	

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:	$(V_{\text{infiltration}}/A_{\text{bottom}})/\text{Recharge Rate}$	
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:	$(V_{\text{infiltration}}/A_{\text{bottom}})/\text{Rawl's Rate}$	
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 (ESHW), 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 (s)

From Table 4.2 Values of Specific Yield for Various Geologic Materials, Physical and Chemical Hydrogeology by Patrick A. Dimerico and Franklin W. Schwartz. [Sand](#), [medium](#).

Sy	28 %
-----------	-------------

Initial Saturated Thickness (h_i)

Estimated seasonal high groundwater (ESHW) 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.

ESHW	ESHW	130.6 FT
Bottom of Aquifer		127.2 FT
h_i	ESHW - Elevation at Bottom of Aquifer FT	
h_i		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 AQT SOLV. 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, $S_y = 0.28$
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.

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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, StormTrap, as the bottom of the system, 133.0, is within 4 feet of estimated seasonal high groundwater (ESHWG), 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 (s)

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 (ESHWG) 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.

ESHWG	ESHWG	130.6 FT
Bottom of Aquifer		127.8 FT
h_i	ESHWG - Elevation at Bottom of Aquifer FT	
h_i		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 AQTESOLV. 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, $S_y = 0.28$
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.

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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

Pond P-1.1: SC-740 StormTech B...		
Summary	Wizards	Hydrograph
Discharge	Storage	
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

Pond P-2.1: StormTrap Basins C,...			
Summary Wizards Hydrograph Discharge Storage			
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	4,529	
134.80	7,258	5,095	
135.00	7,258	5,661	
135.20	7,258	6,227	
135.40	7,258	6,793	
135.60	7,258	7,359	
135.80	7,258	7,925	
136.00	7,258	8,491	
136.20	7,258	9,057	
136.40	7,258	9,623	
136.60	7,258	10,189	
136.80	7,258	10,755	
137.00	7,258	11,321	
137.20	7,258	11,887	
137.40	7,258	12,453	
137.60	7,258	13,019	
137.80	7,258	13,585	
138.00	7,258	14,151	
138.20	7,258	14,717	
138.40	7,258	15,283	
138.60	7,258	15,849	
138.80	7,258	16,415	
139.00	7,258	16,981	
139.20	7,258	17,547	
139.40	7,258	18,113	



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



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TSS Removal Calculation Worksheet

Project Name: **Medical Office Building**
Project Number: **14781.00**
Location: **629-659 Highland Ave, Need**
Discharge Point: **DP-1**
Drainage Area(s): **PR-1**

Sheet: **1 of 3**
Date: _____
Computed by: **CJM**
Checked by: **SRK**

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%



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TSS Removal Calculation Worksheet

Project Name: **Medical Office Building**
Project Number: **14781.00**
Location: **629-659 Highland Ave, Need**
Discharge Point: **DP-1**
Drainage Area(s): **PR-2**

Sheet: **2 of 3**
Date: _____
Computed by: **CJM**
Checked by: **SRK**

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%



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TSS Removal Calculation Worksheet

Project Name: **Medical Office Building**
Project Number: **14781.00**
Location: **629 Highland Ave, Needham,**
Discharge Point: **P-2.1**
Drainage Area(s): **PR-3**

Sheet: **3 of 3**
Date: _____
Computed by: **CJM**
Checked by: **SRK**

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



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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)

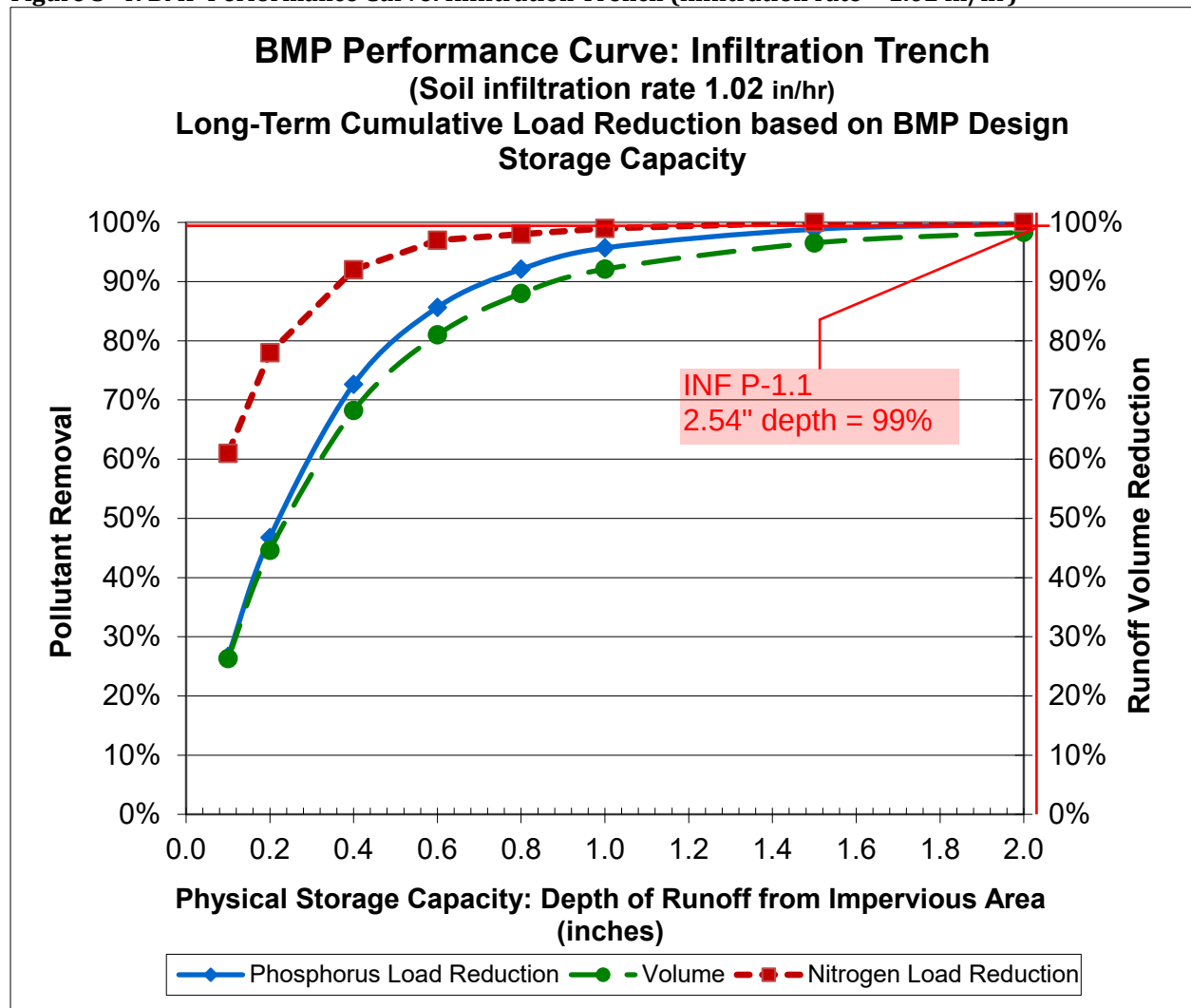


Table 3- 10: Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table

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%

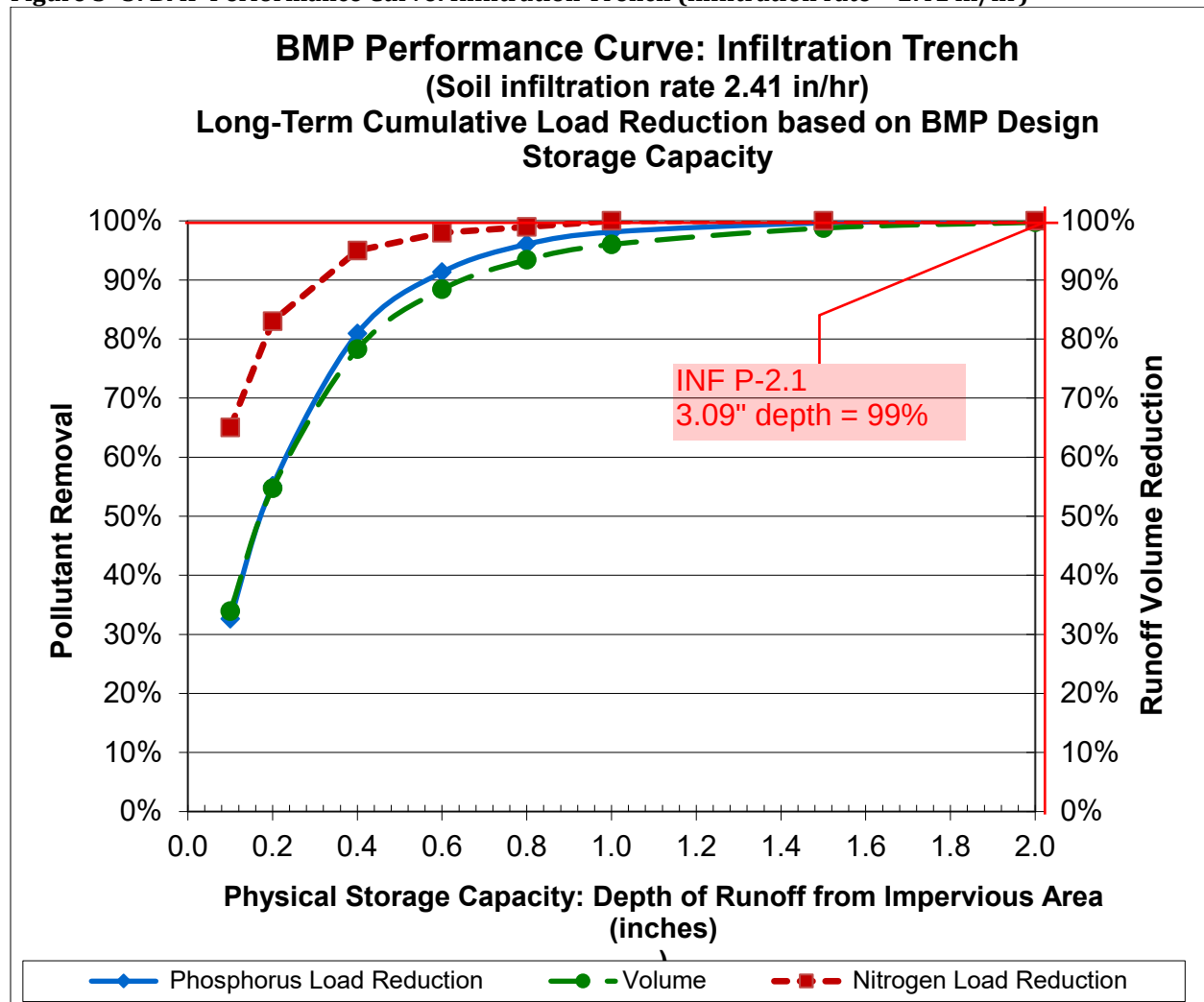
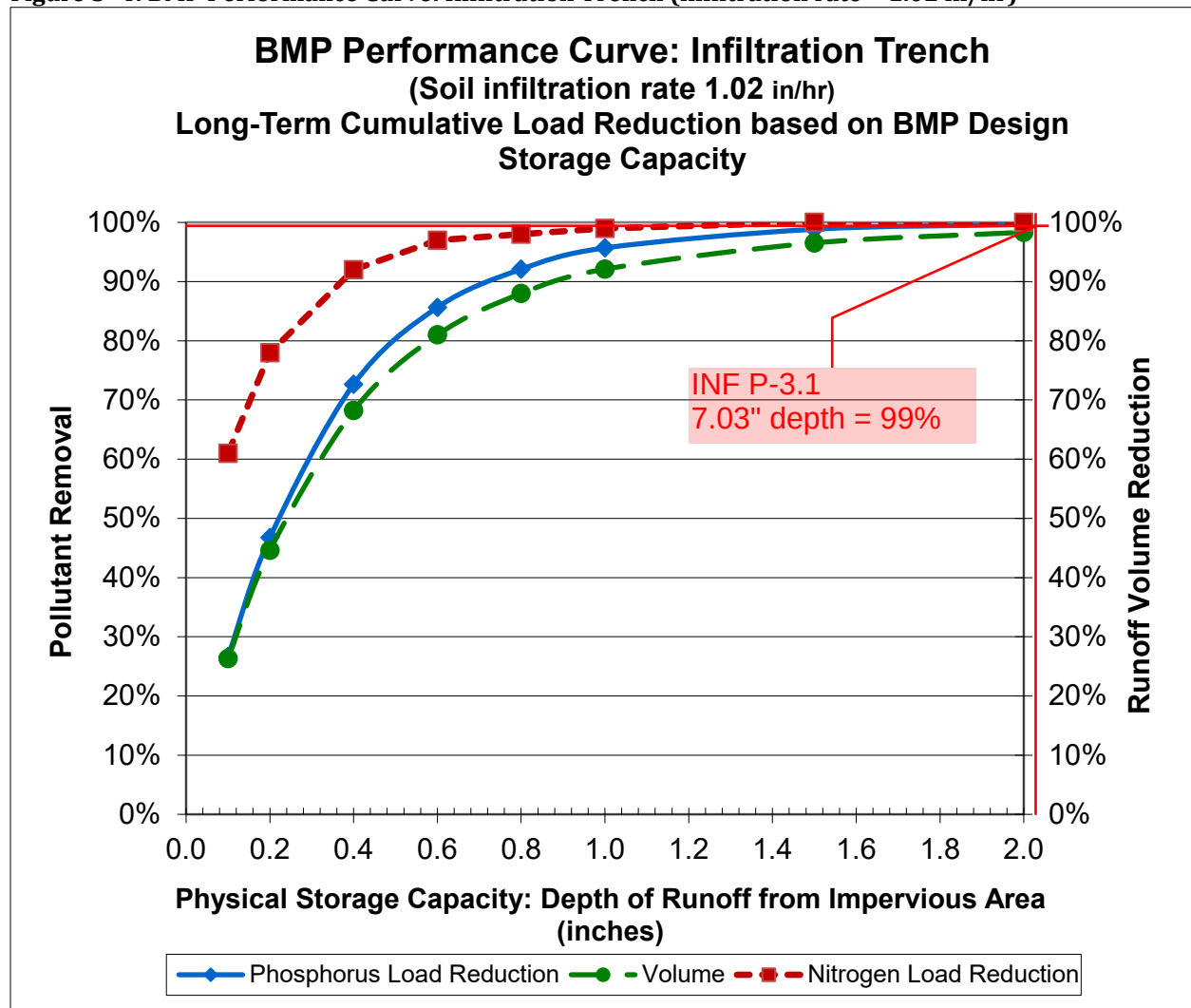
Figure 3- 5: BMP Performance Curve: Infiltration Trench (infiltration rate = 2.41 in/hr)

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 StormTraps, 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

[illegible]

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:

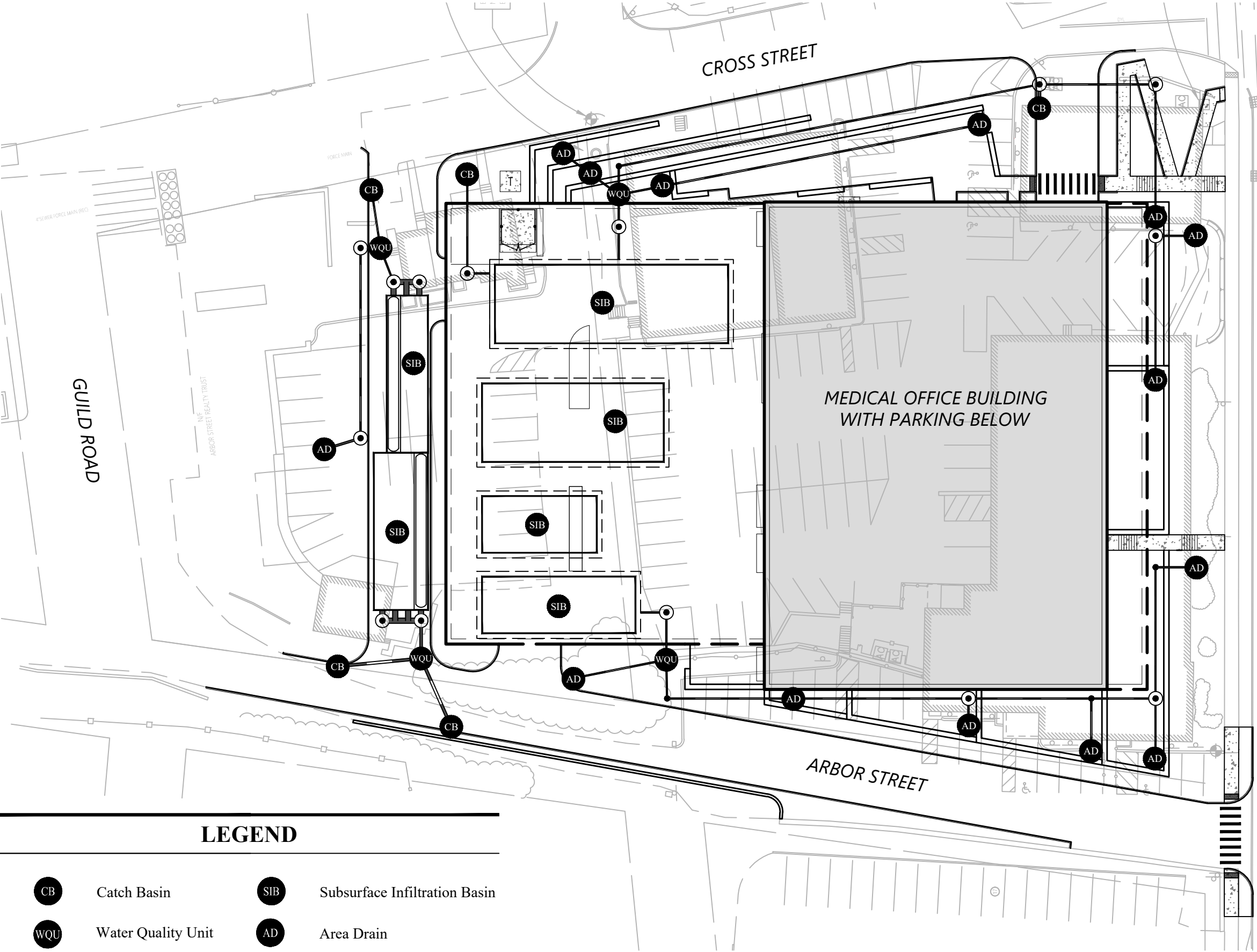
Inspect pavement and parking areas quarterly (minimum). Remove debris and vacuum sweep once annually in the spring following the last expected snowfall (at a minimum) or as necessary.

Area #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Sediment, Leaf litter, etc.)
				/ /	
				/ /	
				/ /	
				/ /	

Pervious Patio:

Inspect patio areas annually (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.)
				/ /	



LEGEND

- | | | | |
|-----|--------------------|-----|-------------------------------|
| CB | Catch Basin | SIB | Subsurface Infiltration Basin |
| WQU | Water Quality Unit | AD | Area Drain |

