

NEEDHAM PLANNING BOARD
Tuesday, September 5, 2023
7:00 p.m.

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

To view and participate in this virtual meeting on your phone, download the “Zoom Cloud Meetings” app in any app store or at www.zoom.us. At the above date and time, click on “Join a Meeting” and enter the following Meeting ID: **880 4672 5264**

To view and participate in this virtual meeting on your computer, at the above date and time, go to www.zoom.us click “Join a Meeting” and enter the following ID: **880 4672 5264**

Or to Listen by Telephone: Dial (for higher quality, dial a number based on your current location):
US: +1 312 626 6799 or +1 646 558 8656 or +1 301 715 8592 or +1 346 248 7799 or +1 669 900 9128 or +1 253 215 8782 Then enter ID: **880 4672 5264**

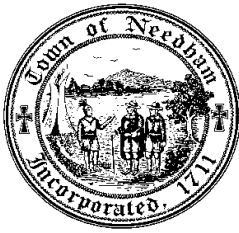
Direct Link to meeting: <https://us02web.zoom.us/j/88046725264>

1. Public Hearing:

7:00 p.m. Major Project Site Plan Special Permit No. 2023-03: Neehigh LLC, 93 Union Street, Suite 315, Newton Center, Petitioner. (Property located at 629-661 Highland Avenue, Needham, Massachusetts). Regarding request to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces.

2. ANR Plan – Arthur Fine Homes, LLC, Petitioner, (Property located at 248 Harris Avenue and 96 Bradford Road, Needham, MA).
3. Zoning for Regulation of Solar Energy Systems: Material Review, Zoning Priorities and Policy Considerations.
4. Board of Appeals – September 21, 2023.
5. Minutes.
6. Report from Planning Director and Board members.
7. Correspondence.

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



PLANNING & COMMUNITY
DEVELOPMENT
PLANNING DIVISION

LEGAL NOTICE
Planning Board
TOWN OF NEEDHAM
NOTICE OF HEARING

In accordance with the provisions of M.G.L., Chapter 40A, S.11; the Needham Zoning By-Laws, Sections 7.4, the Needham Planning Board will hold a public hearing on Tuesday, September 5, 2023 at 7:00 p.m. in the Charles River Room, Needham Public Services Administration Building, 500 Dedham Avenue, Needham, MA, as well as by Zoom Web ID Number 880 4672 5264 (further instructions for accessing by Zoom are below), regarding the application of Neehigh LLC, 93 Union Street, Suite 315, Newton Center, MA, 02459, for a Major Project Special Permit under Site Plan Review, Section 7.4 of the Needham Zoning By-Law.

The subject property is located at 629-661 Highland Avenue, Needham, MA, located in the Industrial Zoning District. The property is shown on Assessors Plan No. 77 as Parcels 62 and 63 containing a total of 81,973 square feet. The requested Major Project Site Plan Review Special Permit, would, if granted, permit the Petitioner to demolish the five existing buildings on the property and build a single two-story 50,000 square foot Medical Office Building (25,000 square foot 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.

In accordance with the Zoning By-Law, Section 7.4, a Site Plan Review Special Permit is required.

To view and participate in this virtual meeting on your phone, download the “Zoom Cloud Meetings” app in any app store or at www.zoom.us. At the above date and time, click on “Join a Meeting” and enter the following Meeting ID: 880 4672 5264

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

The application may be viewed at this link:

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

NEEDHAM PLANNING BOARD

Needham Hometown Weekly, August 17, 2023 and August 24, 2023

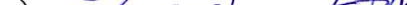
PLANNING BOARD

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
Page 2

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
August 4, 2023
Page 3

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.

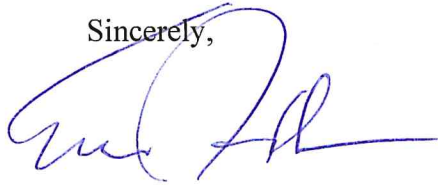
Pursuant to the Board's Covid-19 procedures, these documents are being submitted electronically; additionally three (3) hard copies of the application (with original signatures) and all supporting materials, including wet-stamped plans, are being hand delivered to the Planning Department along with the 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
August 4, 2023
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", with a large, stylized initial "E" and "H".

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

Needham Planning Board
August 7, 2023
Page 3

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.

Needham Planning Board
August 7, 2023
Page 4

(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

Needham Planning Board
August 7, 2023
Page 5

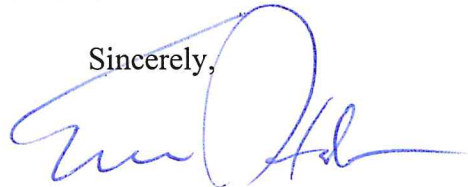
Review process, the site plans will be submitted to the Fire Department for review of the proposed fire truck access and hydrant coverage.

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				



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

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

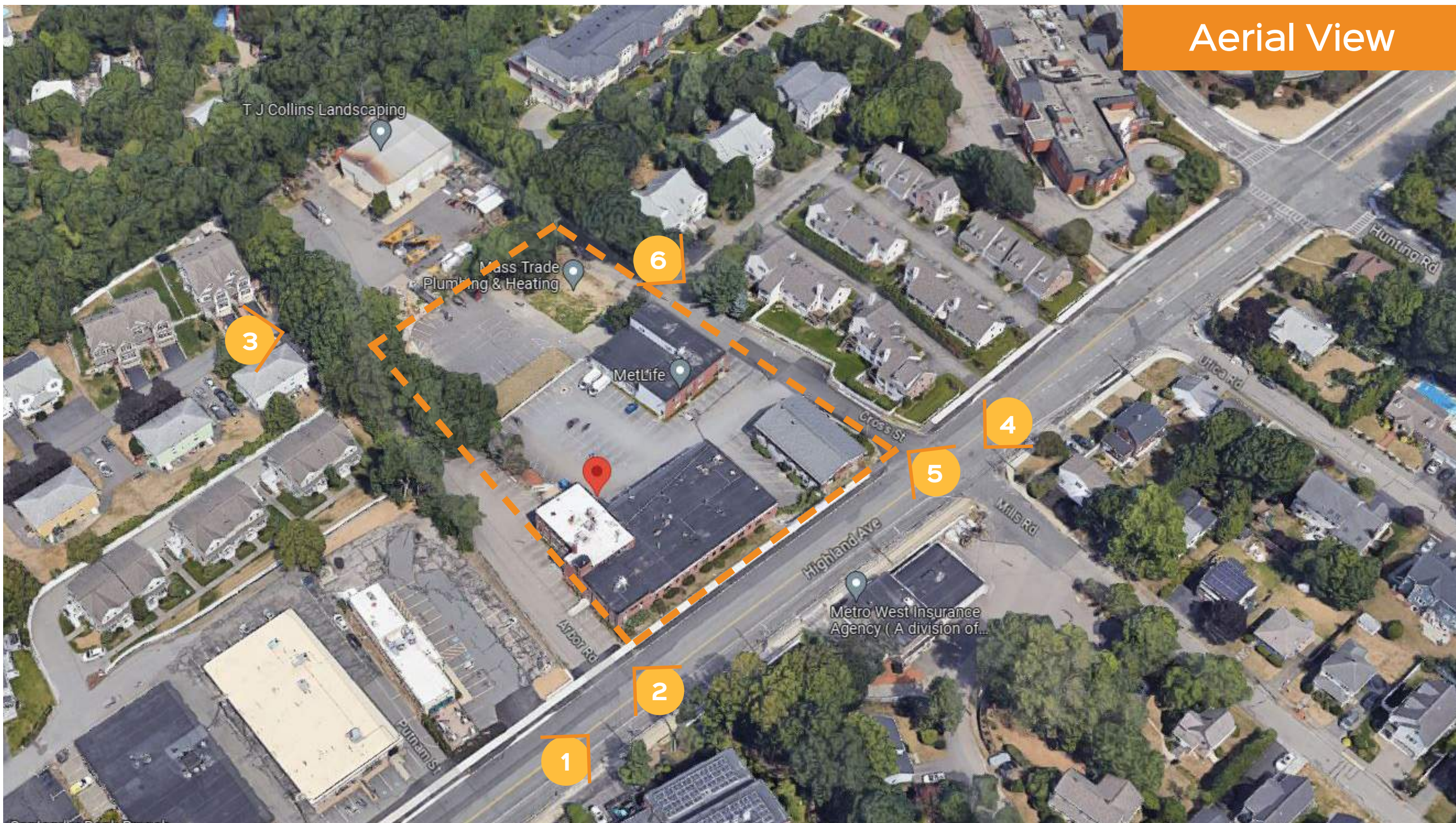
Traffic Engineer:

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

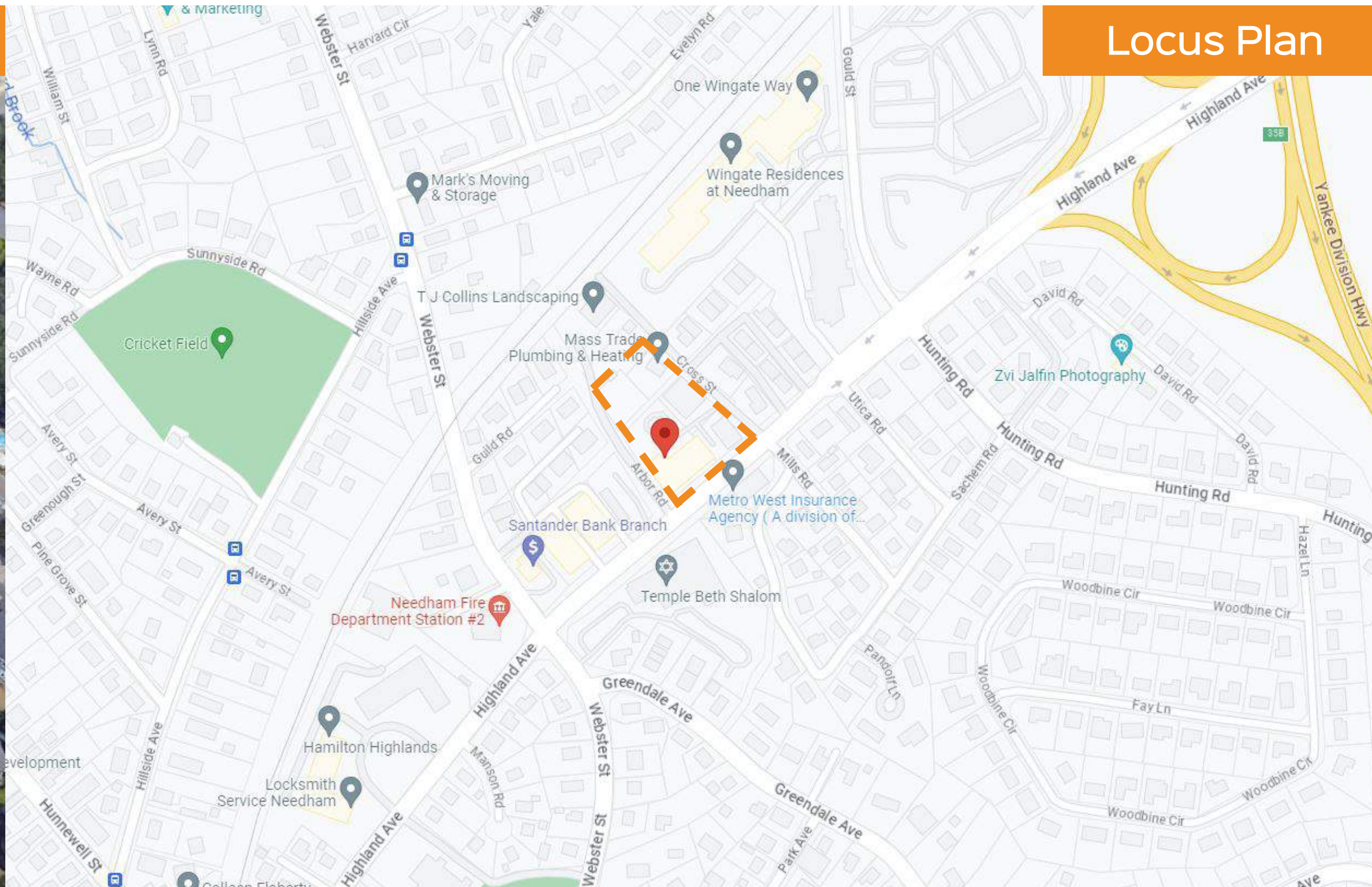


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PLANNING BOARD SUBMISSION



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

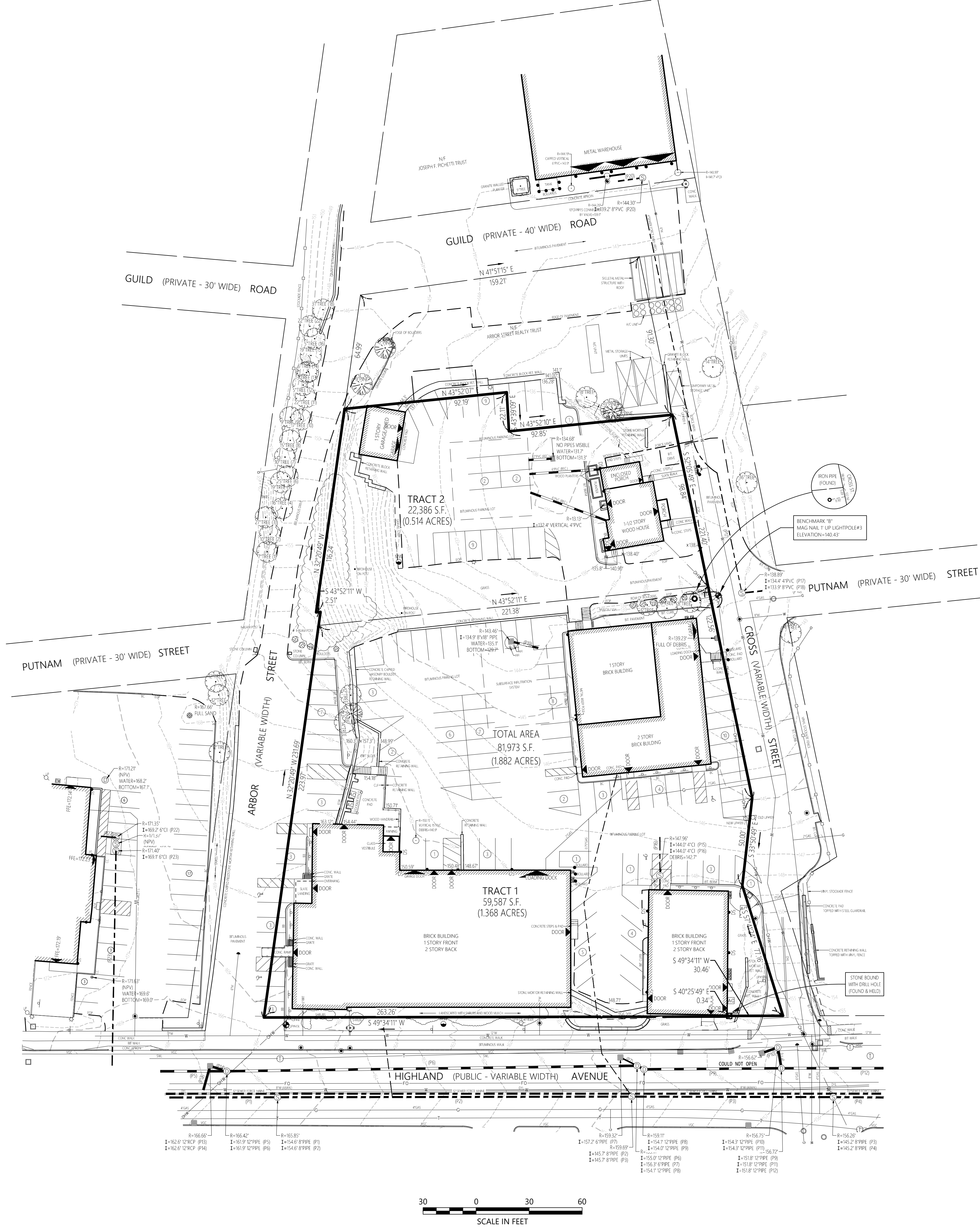
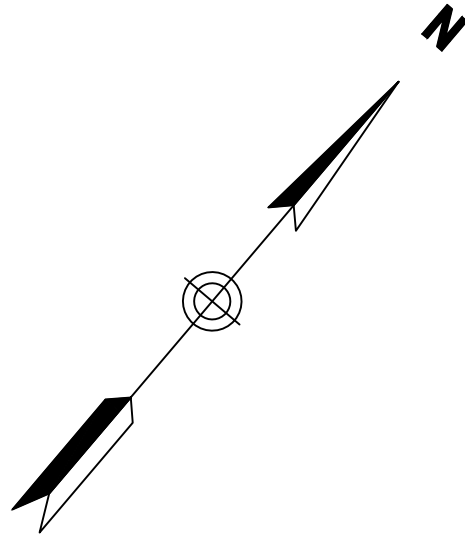


Total Existing Parking Spaces 152



Proposed Parking Spaces 250

Highland Ave MOB / Site Diagram / 14 July 2023



- Legend**
- ① DRAIN MANHOLE
 - CATCH BASIN
 - ⑤ SEWER MANHOLE
 - ⊕ ELECTRIC MANHOLE
 - ① 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

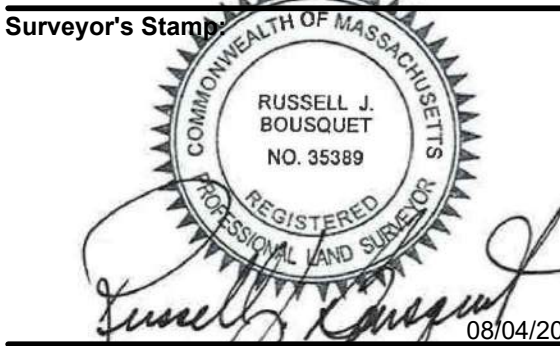
TRACT 2
J & C NOMINEE TRUST
0 ARBOR STREET & 26 CROSS STREET
NEEDHAM, MA
BOOK 14091, PAGE 452

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

- 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.



Project: Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client: Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00

Scale: 1"=30'

Issue: Date:
PLANNING BOARD 08/04/2023
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
		MINOR CONTOUR			LIGHT POLE
		MAJOR CONTOUR			TELEPHONE MANHOLE
		PARKING COUNT			TRANSFORMER PAD
		COMPACT PARKING STALLS			UTILITY POLE
		DOUBLE YELLOW LINE			GUY POLE
		STOP LINE			GUY WIRE & ANCHOR
		CROSSWALK			HAND HOLE
		ACCESSIBLE CURB RAMP			PULL BOX
		ACCESSIBLE PARKING			
		VAN-ACCESSIBLE PARKING			MATCHLINE

Abbreviations

General	
ABAN	ABANDON
ACR	ACCESSIBLE CURB RAMP
ADJ	ADJUST
APPROX	APPROXIMATE
BIT	BITUMINOUS
BS	BOTTOM OF SLOPE
BWLL	BROKEN WHITE LANE LINE
CONC	CONCRETE
DYCL	DOUBLE YELLOW CENTER LINE
EL	ELEVATION
ELEV	ELEVATION
EX	EXISTING
FDN	FOUNDATION
FFE	FIRST FLOOR ELEVATION
GRAN	GRANITE
GTD	GRADE TO DRAIN
LA	LANDSCAPE AREA
LOD	LIMIT OF DISTURBANCE
MAX	MAXIMUM
MIN	MINIMUM
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
PERF	PERFORATED
PROP	PROPOSED
REM	REMOVE
RET	RETAIN
R&D	REMOVE AND DISPOSE
R&R	REMOVE AND RESET
SWEL	SOLID WHITE EDGE LINE
SWLL	SOLID WHITE LANE LINE
TS	TOP OF SLOPE
TW	TOP OF WALL
TYP	TYPICAL
Utility	
CB	CATCH BASIN
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT
DCB	DOUBLE CATCH BASIN
DMH	DRAIN MANHOLE
CIP	CAST IRON PIPE
COND	CONDUIT
DIP	DUCTILE IRON PIPE
FES	FLARED END SECTION
FM	FORCE MAIN
F&G	FRAME AND GRATE
F&C	FRAME AND COVER
GI	GUTTER INLET
GT	GREASE TRAP
HDPE	HIGH DENSITY POLYETHYLENE PIPE
HH	HANDHOLE
HW	HEADWALL
HYD	HYDRANT
INV	INVERT ELEVATION
I=	INVERT ELEVATION
LP	LIGHT POLE
MES	METAL END SECTION
PIV	POST INDICATOR VALVE
PWW	PAVED WATER WAY
PVC	POLYVINYLCHLORIDE PIPE
RCP	REINFORCED CONCRETE PIPE
R=	RIM ELEVATION
RIM=	RIM ELEVATION
SMH	SEWER MANHOLE
TSV	TAPPING SLEEVE, VALVE AND BOX
UG	UNDERGROUND
UP	UTILITY POLE

Notes

- General
1.

CONTRACTOR SHALL NOTIFY "DIG-SAFE" (1-888-344-7233) AT LEAST 72 HOURS BEFORE EXCAVATING.

2.

CONTRACTOR SHALL BE RESPONSIBLE FOR SITE SECURITY AND JOB SAFETY. CONSTRUCTION ACTIVITIES SHALL BE IN ACCORDANCE WITH OSHA STANDARDS AND LOCAL REQUIREMENTS.

3.

ACCESSIBLE ROUTES, PARKING SPACES, RAMPS, SIDEWALKS AND WALKWAYS SHALL BE CONSTRUCTED IN CONFORMANCE WITH THE FEDERAL AMERICANS WITH DISABILITIES ACT AND WITH STATE AND LOCAL LAWS AND REGULATIONS (WHICHEVER ARE MORE STRINGENT).

4.

AREAS DISTURBED DURING CONSTRUCTION AND NOT RESTORED WITH IMPERVIOUS SURFACES (BUILDINGS, PAVEMENTS, WALKS, ETC) SHALL RECEIVE SIX INCHES (6") LOAM AND SEED.

5.

WITHIN THE LIMITS OF THE BUILDING FOOTPRINT, THE SITE CONTRACTOR SHALL PERFORM EARTHWORK OPERATIONS REQUIRED UP TO SUBGRADE ELEVATIONS.

6.

WORK WITHIN THE LOCAL RIGHTS-OF-WAY SHALL CONFORM TO LOCAL MUNICIPAL STANDARDS. WORK WITHIN STATE RIGHTS-OF-WAY SHALL CONFORM TO THE LATEST EDITION OF THE STATE HIGHWAY DEPARTMENTS STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES. WORK WITHIN PRIVATE RIGHTS-OF-WAY SHALL BE COORDINATED AMONG SHARED OWNERS/ACCESS HOLDERS.

7.

UPON AWARD OF CONTRACT, CONTRACTOR SHALL MAKE NECESSARY CONSTRUCTION NOTIFICATIONS AND APPLY FOR AND OBTAIN NECESSARY PERMITS, PAY FEES, AND POST BONDS ASSOCIATED WITH THE WORK INDICATED ON THE DRAWINGS, IN THE SPECIFICATIONS, AND IN THE CONTRACT DOCUMENTS. DO NOT CLOSE OR OBSTRUCT ROADWAYS, SIDEWALKS, AND FIRE HYDRANTS, WITHOUT APPROPRIATE PERMITS.

8.

TRAFFIC SIGNAGE AND PAVEMENT MARKINGS SHALL CONFORM TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.

9.

AREAS OUTSIDE THE LIMITS OF PROPOSED WORK DISTURBED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED BY THE CONTRACTOR TO THEIR ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE.

10.

IN THE EVENT THAT SUSPECTED CONTAMINATED SOIL, GROUNDWATER, AND OTHER MEDIA ARE ENCOUNTERED DURING EXCAVATION AND CONSTRUCTION ACTIVITIES BASED ON VISUAL, OLFACTORY, OR OTHER EVIDENCE, THE CONTRACTOR SHALL STOP WORK IN THE VICINITY OF THE SUSPECT MATERIAL TO AVOID FURTHER SPREADING OF THE MATERIAL, AND SHALL NOTIFY THE OWNER IMMEDIATELY SO THAT THE APPROPRIATE TESTING AND SUBSEQUENT ACTION CAN BE TAKEN.

11.

CONTRACTOR SHALL PREVENT DUST, SEDIMENT, AND DEBRIS FROM EXITING THE SITE AND SHALL BE RESPONSIBLE FOR CLEANUP, REPAIRS AND CORRECTIVE ACTION IF SUCH OCCURS.

12.

DAMAGE RESULTING FROM CONSTRUCTION LOADS SHALL BE REPAIRED BY THE CONTRACTOR AT NO ADDITIONAL COST TO OWNER.

13.

CONTRACTOR SHALL CONTROL STORMWATER RUNOFF DURING CONSTRUCTION TO PREVENT ADVERSE IMPACTS TO OFF SITE AREAS, AND SHALL BE RESPONSIBLE TO REPAIR RESULTING DAMAGES, IF ANY, AT NO COST TO OWNER.

14.

THIS PROJECT DISTURBS MORE THAN ONE ACRE OF LAND AND FALLS WITHIN THE NPDES CONSTRUCTION GENERAL PERMIT (CGP) PROGRAM AND EPA JURISDICTION. PRIOR TO THE START OF CONSTRUCTION CONTRACTOR IS TO FILE A CGP NOTICE OF INTENT WITH THE EPA AND PREPARE A STORMWATER POLLUTION PREVENTION PLAN IN ACCORDANCE WITH THE NPDES REGULATIONS. CONTRACTOR SHALL CONFIRM THE OWNER HAS ALSO FILED A NOTICE OF INTENT WITH THE EPA.

15.

THE PLANS INCLUDED HEREIN ASSUME THAT TRACT 1 AND TRACT 2 ON THE FOLLOWING PLANS WILL BE CONSOLIDATED INTO A SINGLE LOT.
- Layout and Materials
1.

DIMENSIONS ARE FROM THE FACE OF CURB, FACE OF BUILDING, FACE OF WALL, AND CENTER LINE OF PAVEMENT MARKINGS, UNLESS OTHERWISE NOTED.

2.

CURB RADII ARE THREE FEET (3') UNLESS OTHERWISE NOTED.

3.

CURBING SHALL BE VERTICAL GRANITE CURB (VGC) WITHIN THE SITE UNLESS OTHERWISE INDICATED ON THE PLANS.

4.

SEE ARCHITECTURAL DRAWINGS FOR EXACT BUILDING DIMENSIONS AND DETAILS CONTIGUOUS TO THE BUILDING, INCLUDING SIDEWALKS, RAMPS, BUILDING ENTRANCES, STAIRWAYS, UTILITY PENETRATIONS, CONCRETE DOOR PADS, COMPACTOR PAD, LOADING DOCKS, BOLLARDS, ETC.

5.

PROPOSED BOUNDS AND ANY EXISTING PROPERTY LINE MONUMENTATION DISTURBED DURING CONSTRUCTION SHALL BE SET OR RESET BY A PROFESSIONAL LAND SURVEYOR.

6.

PRIOR TO START OF CONSTRUCTION, CONTRACTOR SHALL VERIFY EXISTING PAVEMENT ELEVATIONS AT INTERFACE WITH PROPOSED PAVEMENTS, AND EXISTING GROUND ELEVATIONS ADJACENT TO DRAINAGE OUTLETS TO ASSURE PROPER TRANSITIONS BETWEEN EXISTING AND PROPOSED FACILITIES.
- Demolition
1.

CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING MANMADE SURFACE FEATURES WITHIN THE LIMIT OF WORK INCLUDING BUILDINGS, STRUCTURES, PAVEMENTS, SLABS, CURBING, FENCES, UTILITY POLES, SIGNS, ETC. UNLESS INDICATED OTHERWISE ON THE DRAWINGS, REMOVE AND DISPOSE OF EXISTING UTILITIES, FOUNDATIONS AND UNSUITABLE MATERIAL BENEATH AND FOR A DISTANCE OF 10 FEET BEYOND THE PROPOSED BUILDING FOOTPRINT INCLUDING EXTERIOR COLUMNS.

2.

EXISTING UTILITIES SHALL BE TERMINATED, UNLESS OTHERWISE NOTED, IN CONFORMANCE WITH LOCAL, STATE AND INDIVIDUAL UTILITY COMPANY STANDARD SPECIFICATIONS AND DETAILS. THE CONTRACTOR SHALL COORDINATE UTILITY SERVICE DISCONNECTS WITH THE UTILITY REPRESENTATIVES.

3.

CONTRACTOR SHALL DISPOSE OF DEMOLITION DEBRIS IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS, ORDINANCES AND STATUTES.

4.

THE DEMOLITION LIMITS DEPICTED IN THE PLANS IS INTENDED TO AID THE CONTRACTOR DURING THE BIDDING AND CONSTRUCTION PROCESS AND IS NOT INTENDED TO DEPICT EACH AND EVERY ELEMENT OF DEMOLITION. THE CONTRACTOR IS RESPONSIBLE FOR IDENTIFYING THE DETAILED SCOPE OF DEMOLITION BEFORE SUBMITTING ITS BID/PROPOSAL TO PERFORM THE WORK AND SHALL MAKE NO CLAIMS AND SEEK NO ADDITIONAL COMPENSATION FOR CHANGED CONDITIONS OR UNFORESEEN OR LATELY SITE CONDITIONS RELATED TO ANY CONDITIONS DISCOVERED DURING EXECUTION OF THE WORK.

5.

UNLESS OTHERWISE SPECIFICALLY PROVIDED ON THE PLANS OR IN THE SPECIFICATIONS, THE ENGINEER HAS NOT PREPARED DESIGNS FOR AND SHALL HAVE NO RESPONSIBILITY FOR THE PRESENCE, DISCOVERY, REMOVAL, ABATEMENT OR DISPOSAL OF HAZARDOUS MATERIALS, TOXIC WASTES OR POLLUTANTS AT THE PROJECT SITE. THE ENGINEER SHALL NOT BE RESPONSIBLE FOR ANY CLAIMS OF LOSS, DAMAGE, EXPENSE, DELAY, INJURY OR DEATH ARISING FROM THE PRESENCE OF HAZARDOUS MATERIAL AND CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS THE ENGINEER FROM ANY CLAIMS MADE IN CONNECTION THEREWITH. MOREOVER, THE ENGINEER SHALL HAVE NO ADMINISTRATIVE OBLIGATIONS OF ANY TYPE WITH REGARD TO ANY CONTRACTOR AMENDMENT INVOLVING THE ISSUES OF PRESENCE, DISCOVERY, REMOVAL, ABATEMENT OR DISPOSAL OF ASBESTOS OR OTHER HAZARDOUS MATERIALS.
- Erosion Control
1.

PRIOR TO STARTING ANY OTHER WORK ON THE SITE, THE CONTRACTOR SHALL NOTIFY APPROPRIATE AGENCIES AND SHALL INSTALL EROSION CONTROL MEASURES AS SHOWN ON THE PLANS AND AS IDENTIFIED IN FEDERAL, STATE, AND LOCAL APPROVAL DOCUMENTS PERTAINING TO THIS PROJECT.

2.

CONTRACTOR SHALL INSPECT AND MAINTAIN EROSION CONTROL MEASURES ON A WEEKLY BASIS (MINIMUM) OR AS REQUIRED PER THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP). THE CONTRACTOR SHALL ADDRESS DEFICIENCIES AND MAINTENANCE ITEMS WITHIN TWENTY-FOUR HOURS OF INSPECTION. CONTRACTOR SHALL PROPERLY DISPOSE OF SEDIMENT SUCH THAT IT DOES NOT ENCUMBER OTHER DRAINAGE STRUCTURES AND PROTECTED AREAS.

3.

CONTRACTOR SHALL BE FULLY RESPONSIBLE TO CONTROL CONSTRUCTION SUCH THAT SEDIMENTATION SHALL NOT AFFECT REGULATORY PROTECTED AREAS, WHETHER SUCH SEDIMENTATION IS CAUSED BY WATER, WIND, OR DIRECT DEPOSIT.

4.

CONTRACTOR SHALL PERFORM CONSTRUCTION SEQUENCING SUCH THAT EARTH MATERIALS ARE EXPOSED FOR A MINIMUM OF TIME BEFORE THEY ARE COVERED, SEEDED, OR OTHERWISE STABILIZED TO PREVENT EROSION.

5.

UPON COMPLETION OF CONSTRUCTION AND ESTABLISHMENT OF PERMANENT GROUND COVER, CONTRACTOR SHALL REMOVE AND DISPOSE OF EROSION CONTROL MEASURES AND CLEAN SEDIMENT AND DEBRIS FROM ENTIRE DRAINAGE AND SEWER SYSTEMS.
- Existing Conditions Information
1.

BASE PLAN: THE PROPERTY LINES SHOWN WERE DETERMINED BY AN ACTUAL FIELD SURVEY CONDUCTED BY VHB IN NOVEMBER, 2020 AND FROM DEEDS AND PLANS OF RECORD. THE EXISTING CONDITIONS SHOWN ON THIS PLAN ARE BASED ON AN ACTUAL ON-THE-GROUND INSTRUMENT SURVEY PERFORMED BY VHB IN NOVEMBER, 2020 AND UPDATED IN APRIL AND JUNE, 2023.

2.

TOPOGRAPHY: ELEVATIONS ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988.

3.

GEOTECHNICAL DATA INCLUDING TEST PIT AND BORING LOCATIONS AND ELEVATIONS WERE OBTAINED FROM McPHAIL ASSOCIATES, LLC. THE GEOTECHNICAL INFORMATION IS AVAILABLE TO THE CONTRACTOR UPON REQUEST.
- Document Use
1.

THESE PLANS AND CORRESPONDING CADD DOCUMENTS ARE INSTRUMENTS OF PROFESSIONAL SERVICE, AND SHALL NOT BE USED, IN WHOLE OR IN PART, FOR ANY PURPOSE OTHER THAN FOR WHICH IT WAS CREATED WITHOUT THE EXPRESSED, WRITTEN CONSENT OF VHB. ANY UNAUTHORIZED USE, REUSE, MODIFICATION OR ALTERATION, INCLUDING AUTOMATED CONVERSION OF THIS DOCUMENT SHALL BE AT THE USER'S SOLE RISK WITHOUT LIABILITY OR LEGAL EXPOSURE TO VHB.

2.

CONTRACTOR SHALL NOT RELY SOLELY ON ELECTRONIC VERSIONS OF PLANS, SPECIFICATIONS, AND DATA FILES THAT ARE OBTAINED FROM THE DESIGNERS, BUT SHALL VERIFY LOCATION OF PROJECT FEATURES IN ACCORDANCE WITH THE PAPER COPIES OF THE PLANS AND SPECIFICATIONS THAT ARE SUPPLIED AS PART OF THE CONTRACT DOCUMENTS.

3.

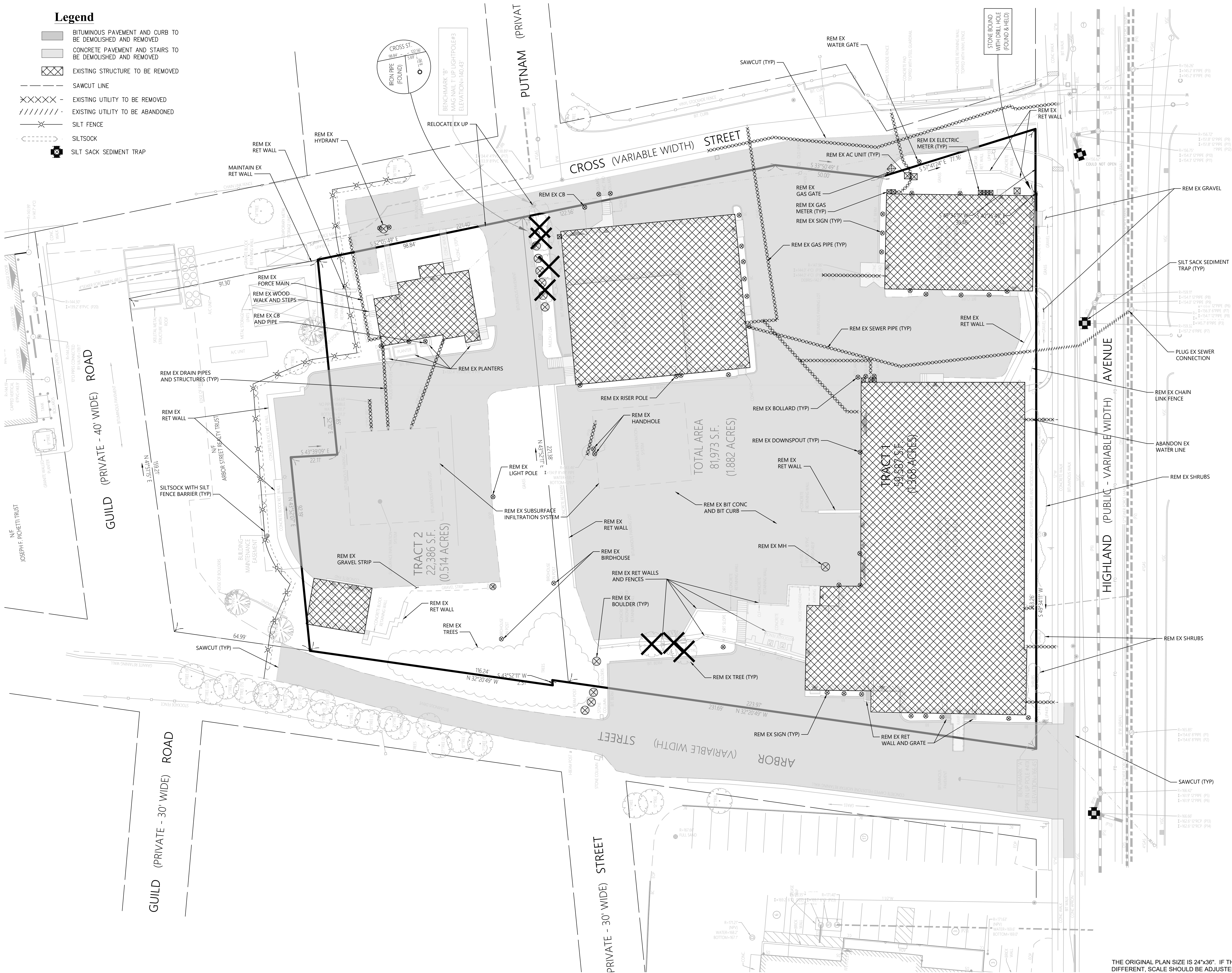
SYMBOLS AND LEGENDS OF PROJECT FEATURES ARE GRAPHIC REPRESENTATIONS AND ARE NOT NECESSARILY SCALED TO THEIR ACTUAL DIMENSIONS OR LOCATIONS ON THE DRAWINGS. THE CONTRACTOR SHALL REFER TO THE DETAIL SHEET DIMENSIONS, MANUFACTURERS' LITERATURE, SHOP DRAWINGS AND FIELD MEASUREMENTS OF SUPPLIED PRODUCTS FOR LAYOUT OF THE PROJECT FEATURES.
- Civil Sheet Index
- | 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:
- | | |
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| | |
- Drawing Title:
Legend and General Notes
- Sheet Number:
- C1.01
- 101 Walnut Street
PO Box 9151
Watertown, MA 02471
617-924-1770

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

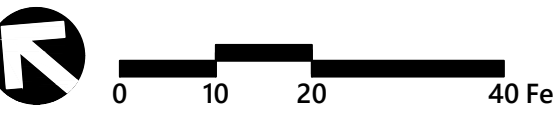
Legend

- 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

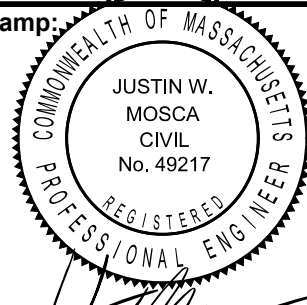


Notes:

- 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:

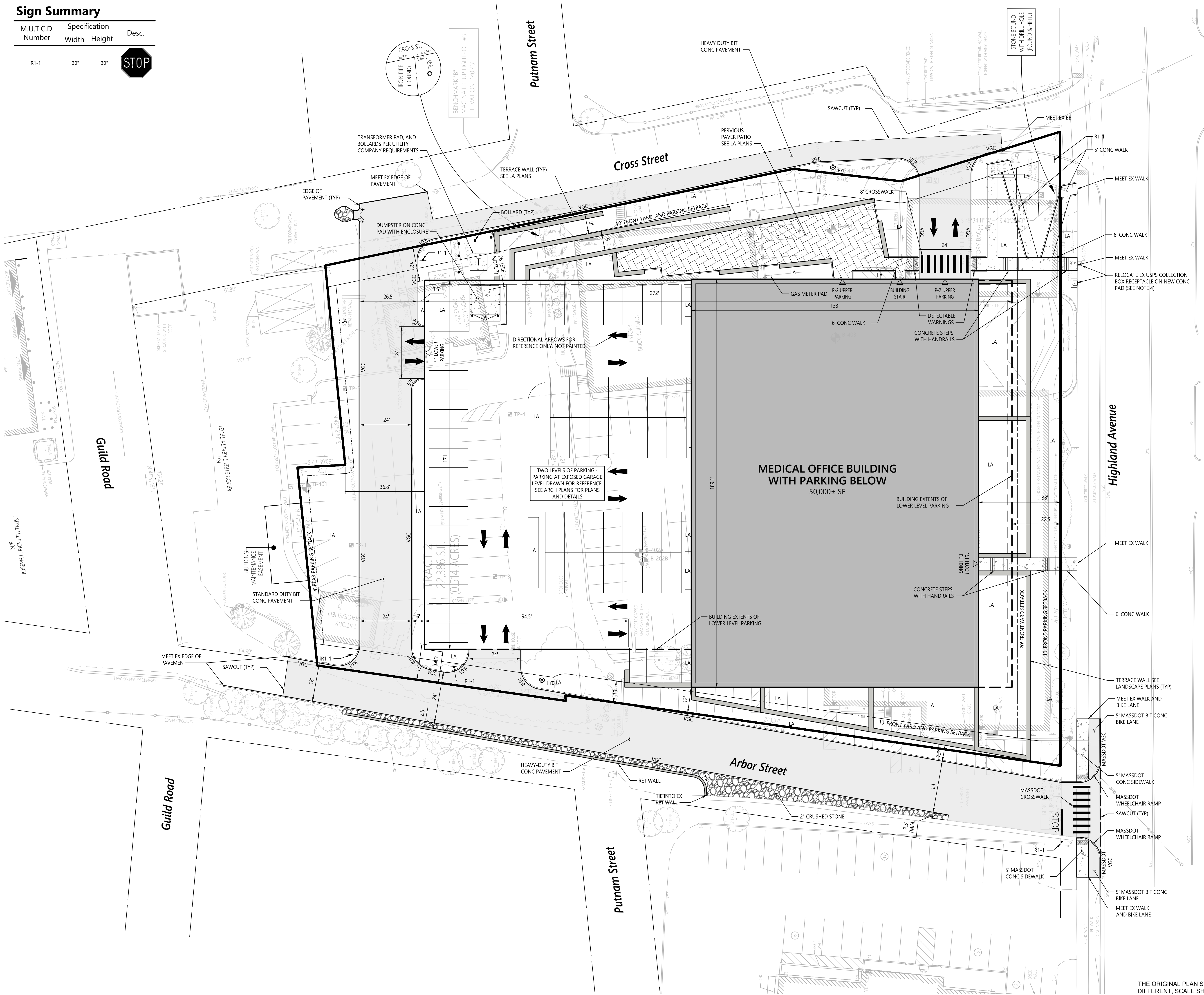
Site Preparation
Plan

Sheet Number:

C2.01

Sign Summary

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

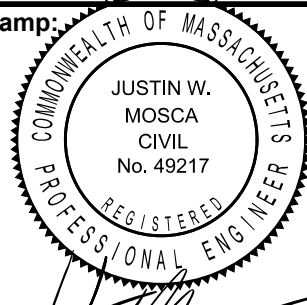


Notes:

- LIMITS OF VEGETATION SHOWN FOR REFERENCE ONLY. REFER TO LANDSCAPE PLANTING PLANS FOR LIMITS OF LANDSCAPE AREAS, TREE LOCATIONS, AND OTHER VEGETATION, AS INDICATED.
- REFER TO LIGHTING PLANS FOR PROPOSED SITE LIGHTING TYPES, LOCATIONS, HEIGHTS, AND FIXTURES.
- PARKING SETBACK DIMENSION PROVIDED TO NEAREST PARKING SPACE LOCATED ON LOWER PARKING LEVEL.
- CONTRACTOR SHALL WORK WITH OWNER TO RELOCATE EX USPS COLLECTION BOX RECEPTACLE.
- 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.
- SITE CONTRACTOR TO PROVIDE SLEEVES WHERE IRRIGATION LINES CROSS PAVED AREAS.



Engineer's Stamp:



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Scale: 1" = 20'

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

Revisions:	Date:

Drawing Title:
Layout and Materials Plan

Sheet Number:

C3.01

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

629-661 Highland Ave
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93 Union St, Suite 135
Newton Centre, MA 02459

Scale: 1" = 20'

PLANNING BOARD | 08/04/2023

[illegible]

Sheet Number:



vhb

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

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

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



Client:
Boston Development Group

Project #: 14781.00

Issue: _____ Date: _____

PLANNING BOARD | 08/04/2023

SUBMISSION	
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Circumstance	Percentage of respondents who believe that the use of force is justified in the circumstance
Self-defense	~85%
Other circumstances	~15%

[illegible]

Utilities Plan

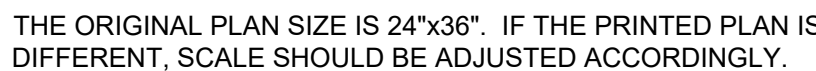
CONCLUSIONS

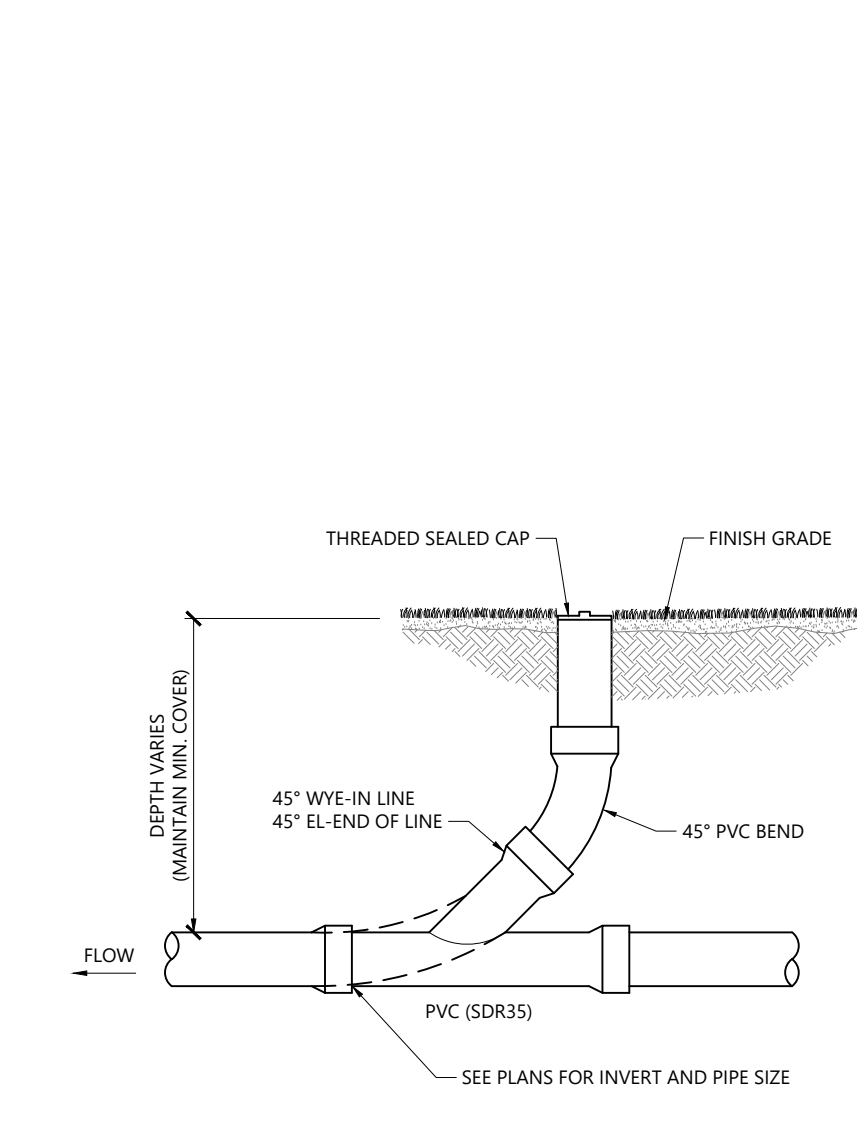


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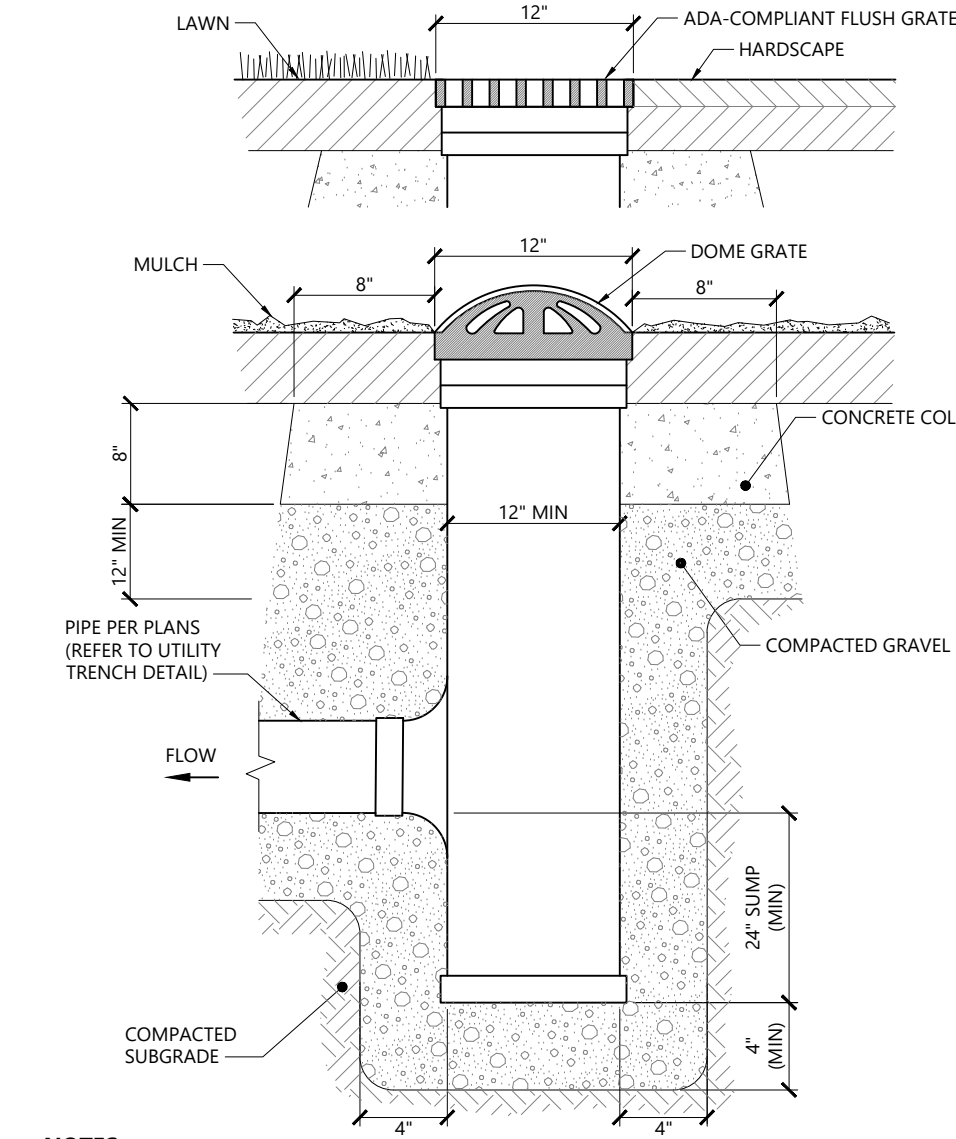
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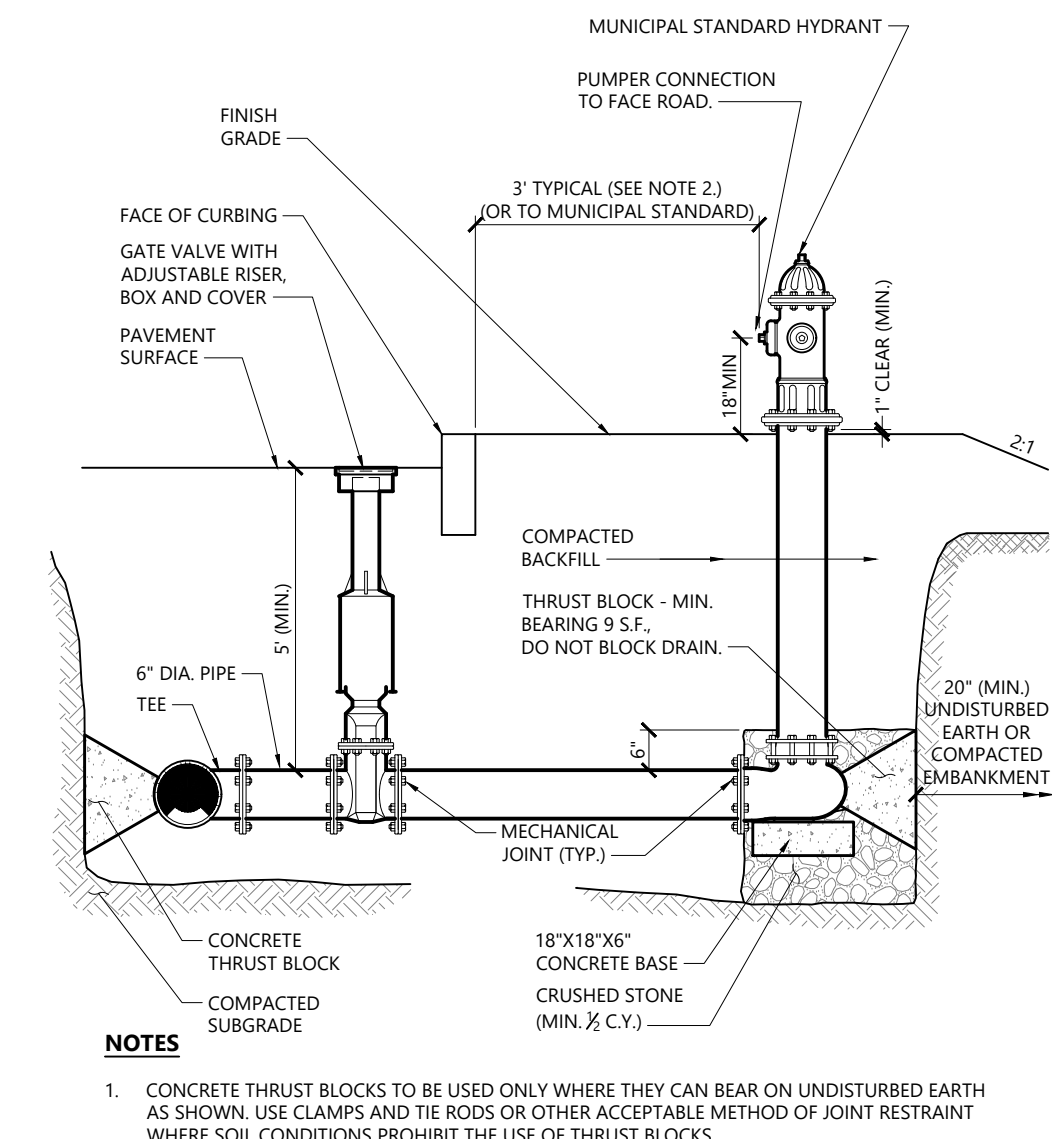


Cleanout (CO) - Landscape Area
N.T.S. Source: VHB 11/19 LD_302



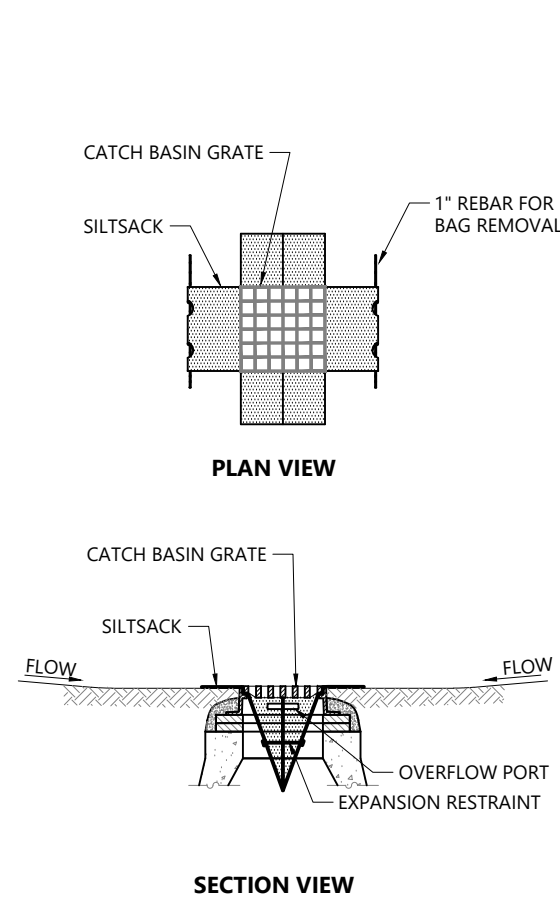
- NOTES:
- AREA DRAINS SHALL BE NYLOPLAST 12" DIAMETER DRAIN BASIN, OR APPROVED EQUAL.
 - GRATES SHALL BE NYLOPLAST 12" PEDESTRIAN MODEL 1299CGP OR 12" DOME GRATE MODEL 1299CGD (OR APPROVED EQUAL).

Area Drain (AD) Type 1
N.T.S. Source: VHB 12/19 LD_193



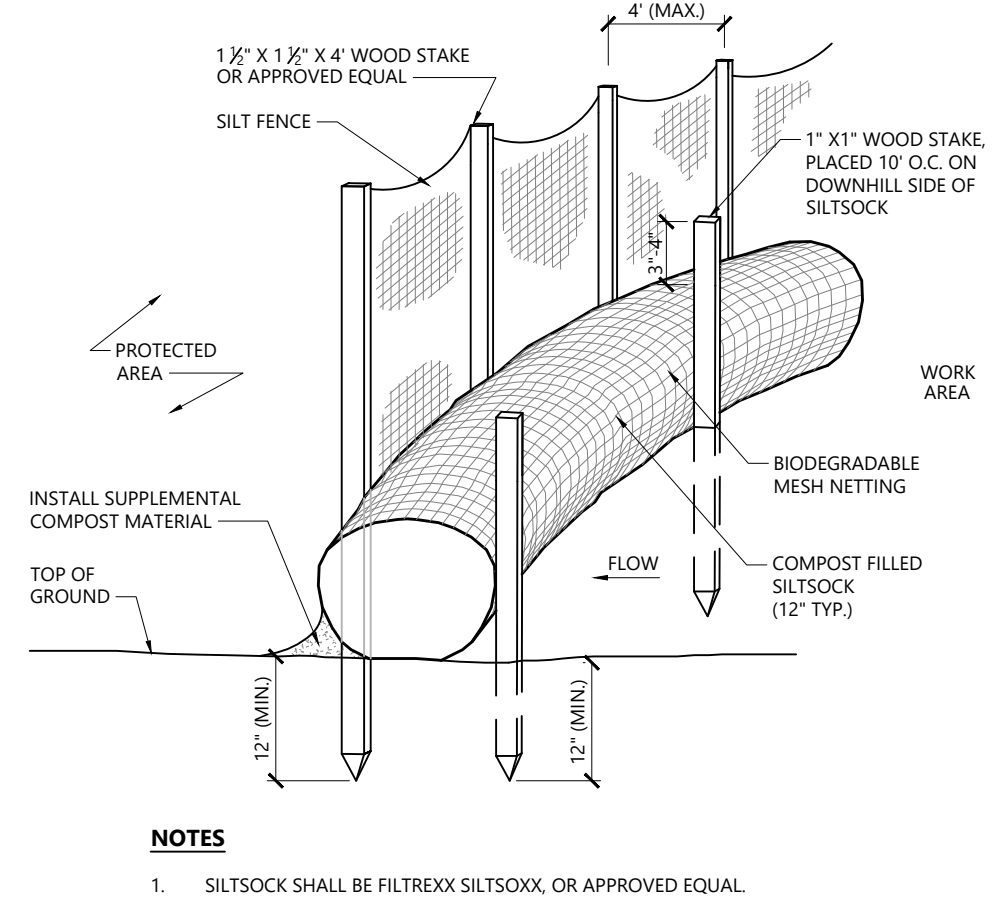
- NOTES
- CONCRETE THRUST BLOCKS TO BE USED ONLY WHERE THEY CAN BEAR ON UNDISTURBED EARTH AS SHOWN. USE CLAMPS AND TIE RODS OR OTHER ACCEPTABLE METHOD OF JOINT RESTRAINT WHERE SOIL CONDITIONS PROHIBIT THE USE OF THRUST BLOCKS.
 - HYDRANT IN SIDEWALK AREAS TO BE LOCATED TO PROVIDE MINIMUM CLEAR SIDEWALK 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



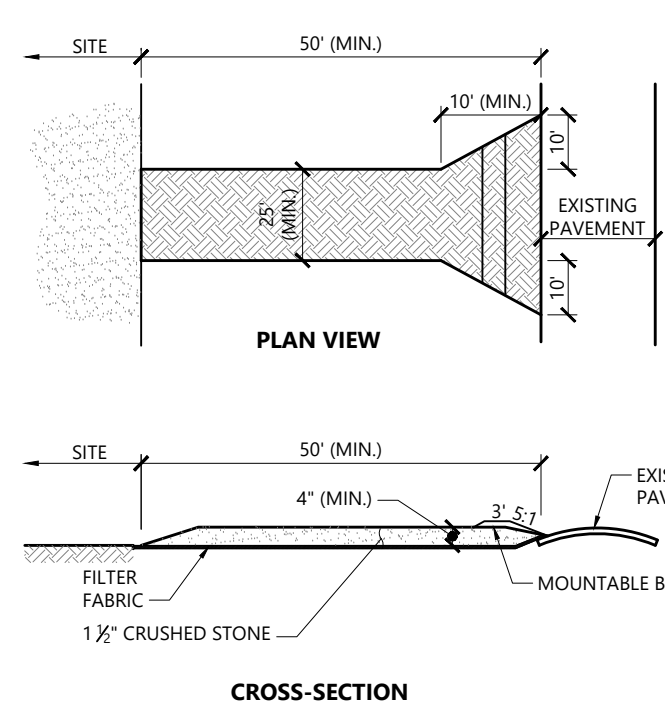
- NOTES
- INSTALL SILTSAK IN ALL CATCH BASINS WHERE INDICATED ON THE PLAN BEFORE COMMENCING WORK OR IN PAVED AREAS AFTER BINDER COURSE IS PLACED AND HAY BALES HAVE BEEN REMOVED.
 - GRATE TO BE PLACED OVER SILTSAK.
 - SILTSAK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS AND CLEANING OR REPLACEMENT 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



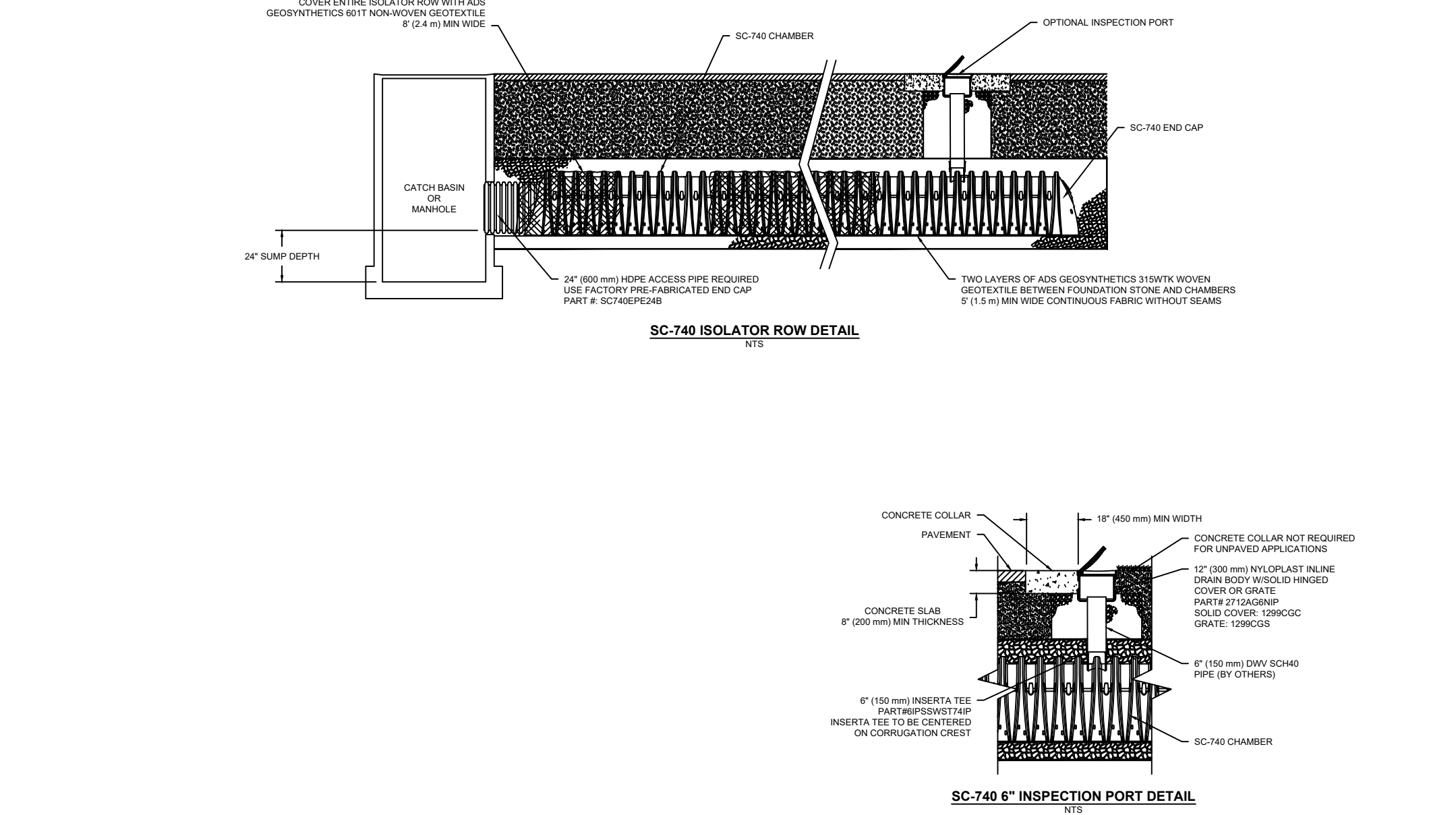
- NOTES
- SILTSAK SHALL BE FILTREXX SILTSAK, OR APPROVED EQUAL.
 - SILTSAKS SHALL OVERLAP A MINIMUM OF 12 INCHES.
 - SILTSAK SHALL BE INSPECTED PERIODICALLY AND AFTER ALL STORM EVENTS, AND REPAIR OR REPLACEMENT SHALL BE PERFORMED PROMPTLY AS NEEDED.
 - UPON SITE STABILIZATION, COMPOST MATERIAL SHALL 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



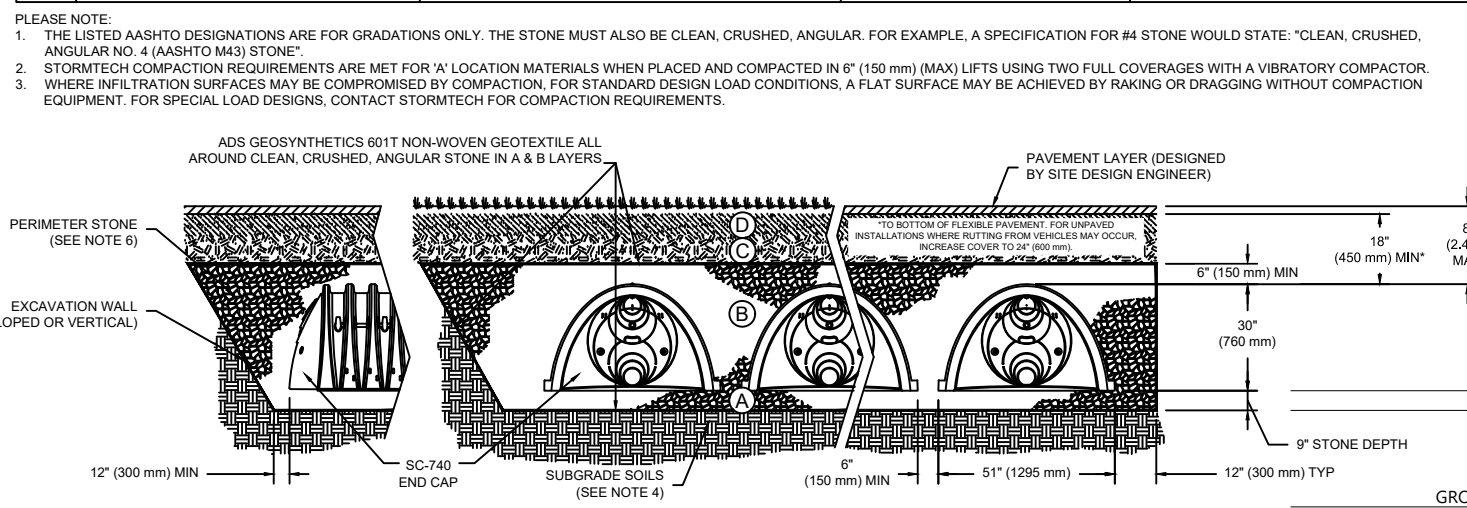
- NOTES
- EXIT WIDTH SHALL BE A TWENTY-FIVE (25) FOOT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
 - THE EXIT SHALL BE MAINTAINED IN A CONDITION WHICH SHALL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING 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.	N/A	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" LAYER) TO 18" (450 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'C' LAYER.	ASHTO M41 ¹ A-1, A-2.4, A-3 OR ASHTO M47 3, 3S7, 4, 4S7, 5, 5S, 57, 6, 67, 68, 7, 7B, 8, 8B, 9, 10	BEGIN COMPACTIONS AFTER 12" (300 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT FOOTING LAYERS IN 6" (150 mm) MAX. LIFT TO 1.0 M. 80% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 90% RELATIVE DENSITY FOR DISCRETELY GRADED MATERIALS. ROLLER CIRCLES VEHICLE WEIGHT NOT TO EXCEED 12,000 LB (5,443 kg). FORCE NOT TO EXCEED 20,000 LB (9,072 kg).
B	EMBEMENT STONE: FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE (A LAYER) TO THE 'C' LAYER ABOVE.	ASHTO M47 3, 3S7, 4, 4S7, 5, 5S, 57	NO COMPACTION REQUIRED.
A	FOUNDATION STONE: FILL BELOW CHAMBERS FROM THE SUBGRADE (UP TO THE FOOT) BOTTOM OF THE CHAMBERS.	ASHTO M47 3, 3S7, 4, 4S7, 5, 5S, 57	PLATE COMPACTION OR ROLL TO ACHIEVE A FLAT SURFACE. ¹



- PLEASE NOTE:
- 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".
 - STORMTECH COMPACTION REQUIREMENTS ARE MET FOR A LOCATION MATERIALS WHEN PLACED AND COMPACTIONED IN 6" (150 mm) MAX LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTION EQUIPMENT FOR SPECIAL LOAD DESIGN, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
 - WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT FOR SPECIAL LOAD DESIGN, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
- 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

Engineer's Stamp:
JUSTIN W. MOSCOW
CIVIL
No. 49217
8/1/2023

Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

93 Union St, Suite 135
Newton Centre, MA 02459

Project #: 14781.00
Scale: N/A

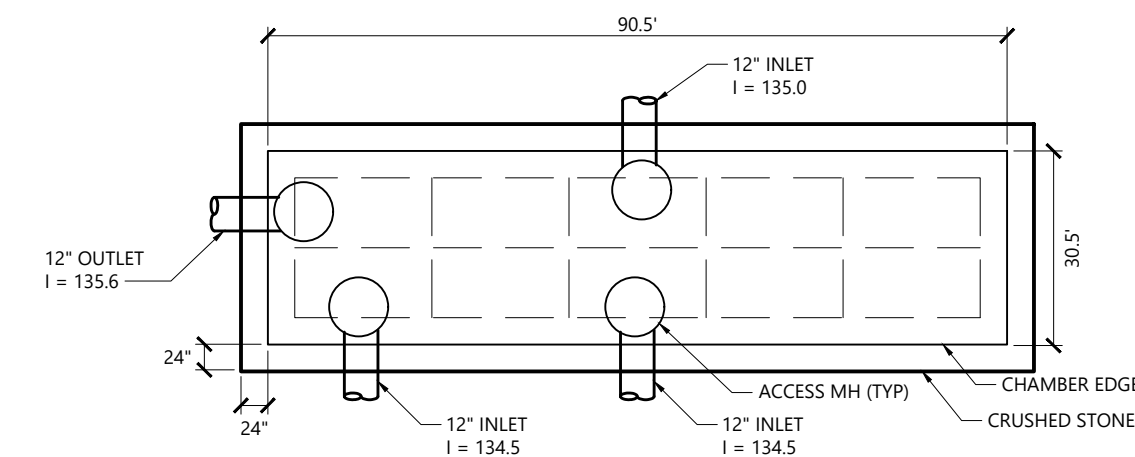
Issue:
PLANNING BOARD SUBMISSION

Date:
08/04/2023

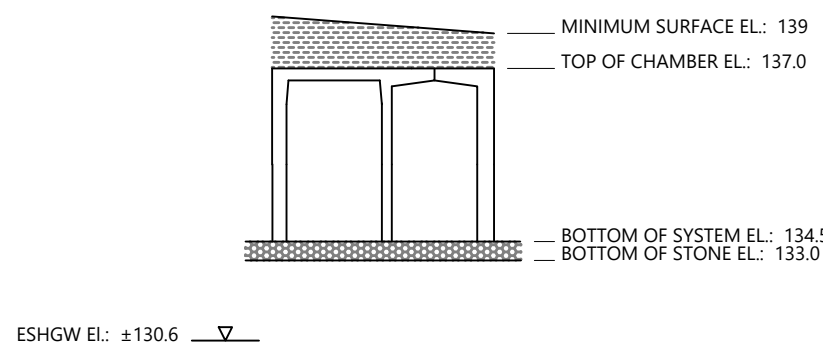
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Drawing Title:
Site Details 2

Sheet Number:
C6.02



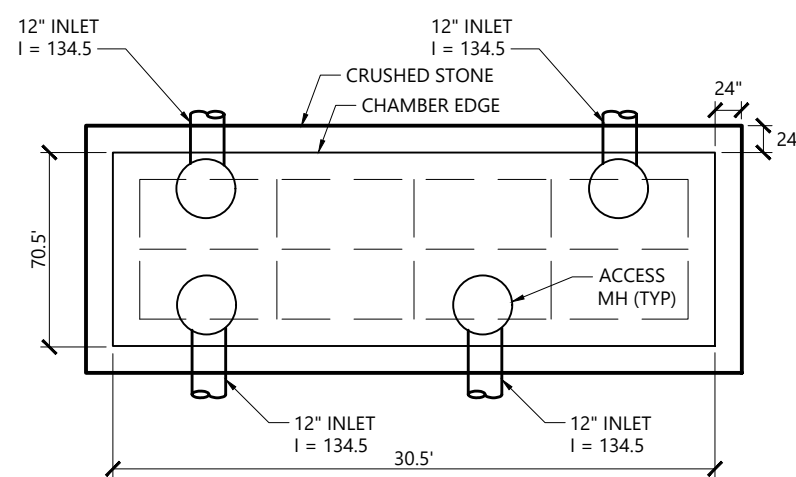
BASIN 2.1-C LAYOUT



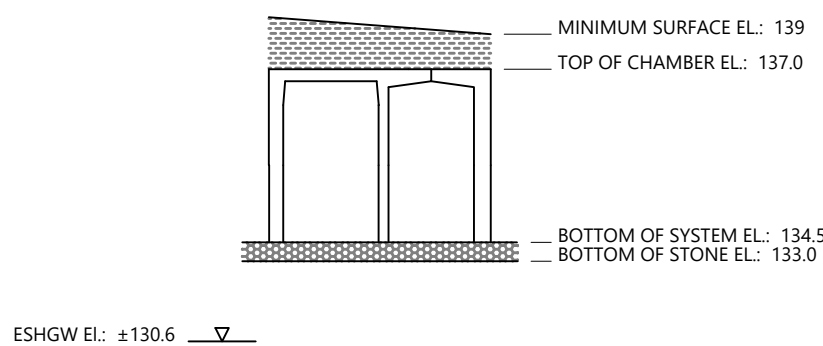
BASIN 2.1-C-SYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-C

N.T.S. Source: VHB



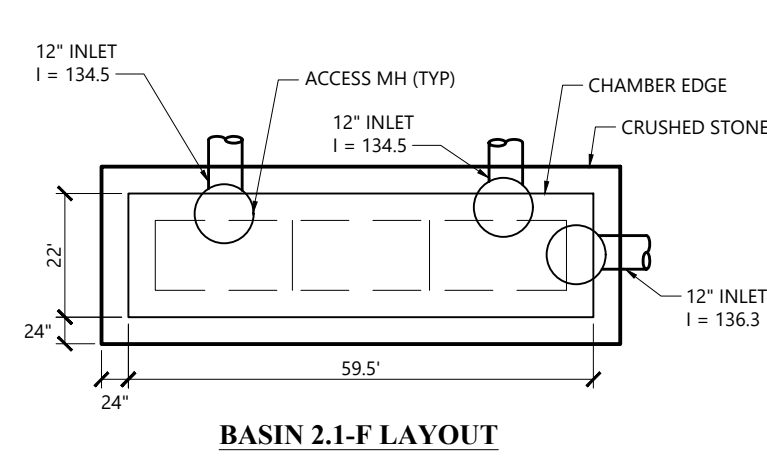
BASIN 2.1-D LAYOUT



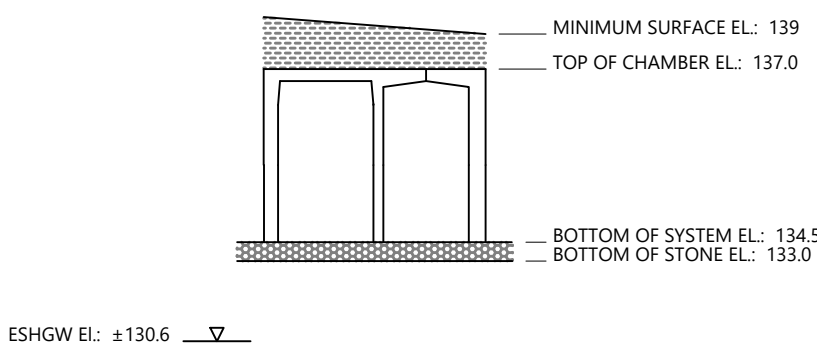
BASIN 2.1-C-SYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-D

N.T.S. Source: VHB



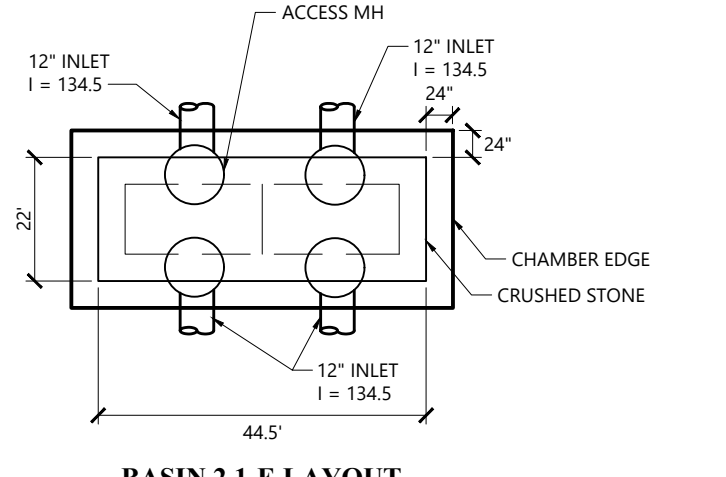
BASIN 2.1-F LAYOUT



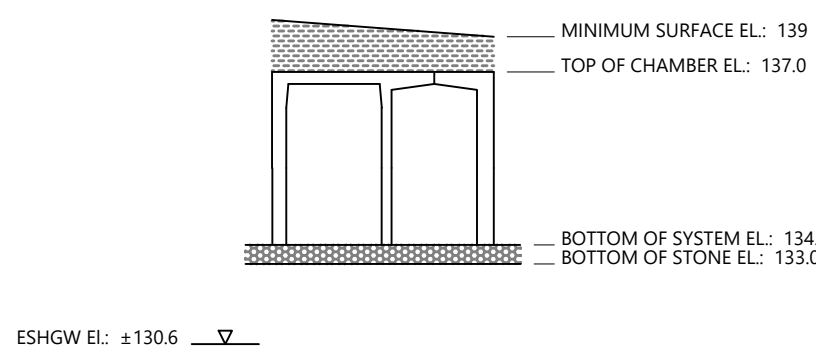
BASIN 2.1-C-SYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-E

N.T.S. Source: VHB



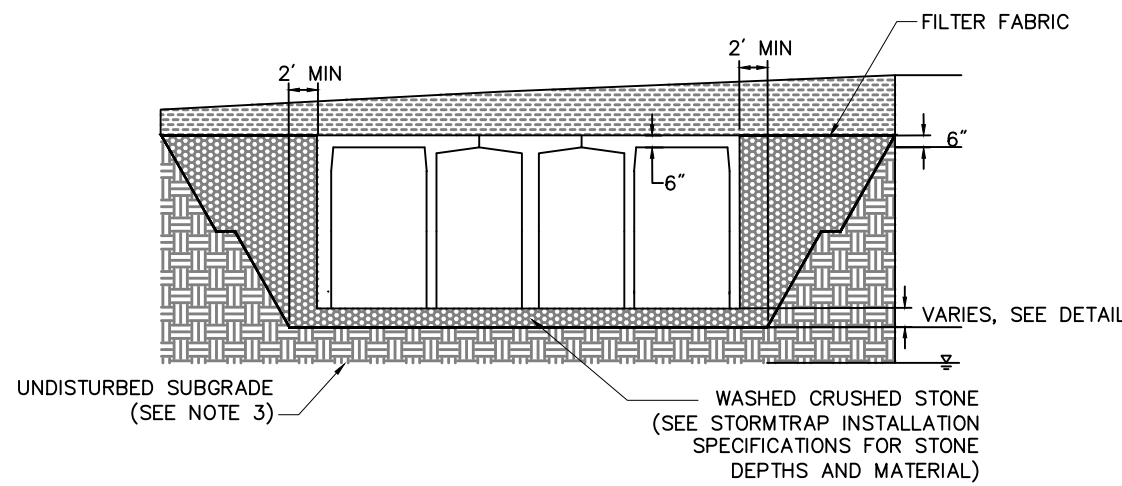
BASIN 2.1-E LAYOUT



BASIN 2.1-C-SYSTEM ELEVATIONS

StormTrap Infiltration System - Basins 2.1-F

N.T.S. Source: VHB



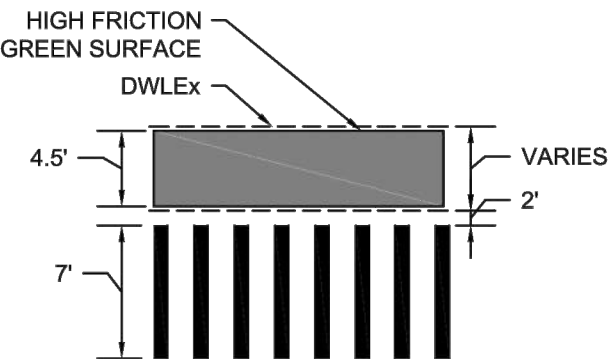
SINGLE TRAP (NO SLAB) - TYPICAL DETAIL

NOTES:

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

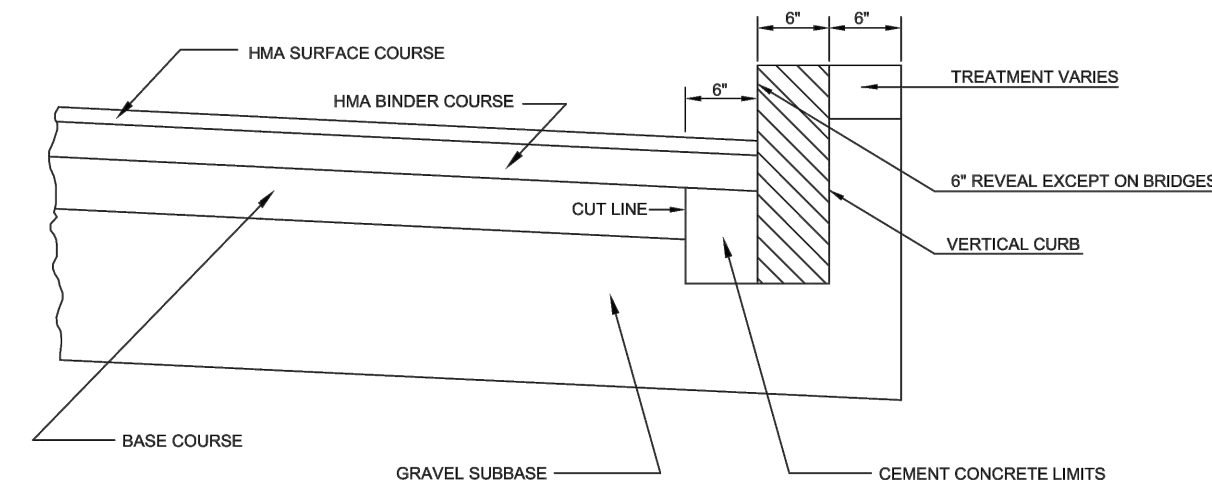
StormTrap Infiltration Systems - Basins 2.1-C, 2.1-D, 2.1-E, 2.1-F

N.T.S. Source: VHB



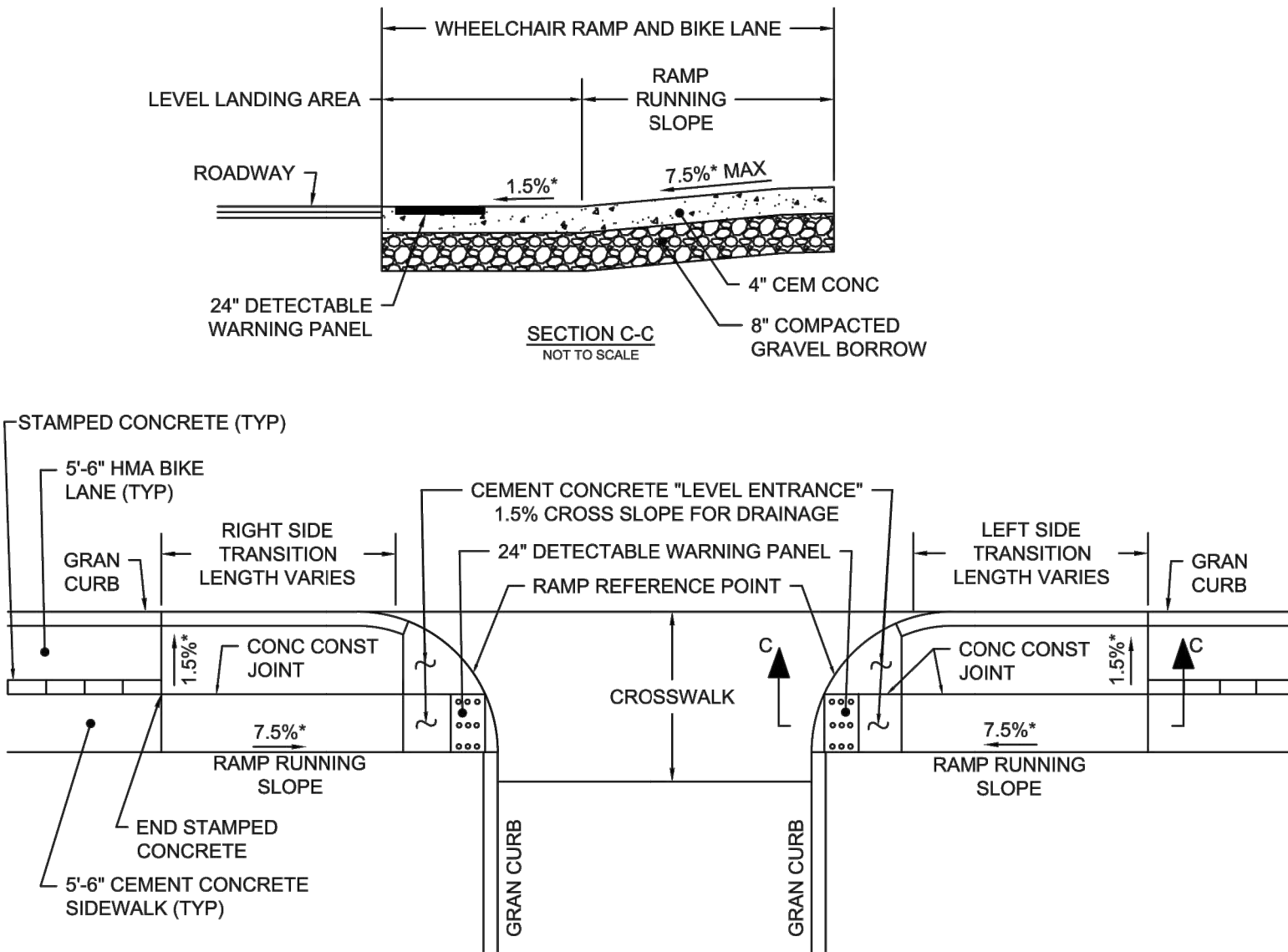
Crosswalk and Bike Lane Crossing

N.T.S. Source: MassDOT



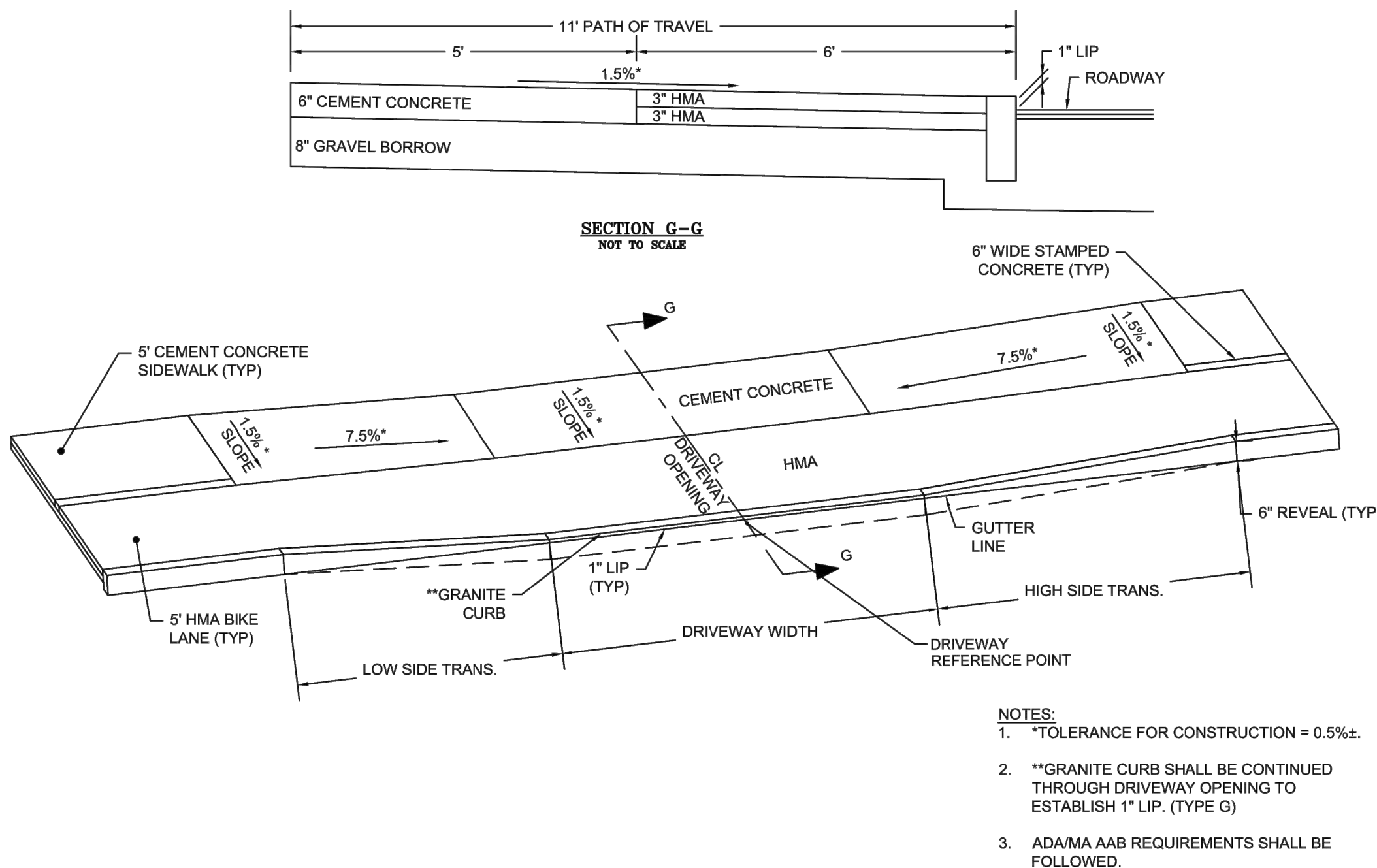
Method of Setting Vertical Curb

N.T.S. Source: MassDOT



Wheelchair Ramp Type C

N.T.S. Source: MassDOT

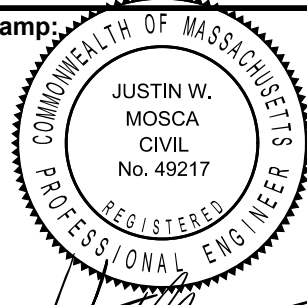


Cement Concrete Sidewalk Through Driveway with Straight Transistions - Type G

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.

Engineer's Stamp:



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Project #: 14781.00

Scale: N/A

Issue: 08/04/2023
PLANNING BOARD
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Revisions:

Date:	

Drawing Title:
Site Details 3

Sheet Number:

C6.03



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

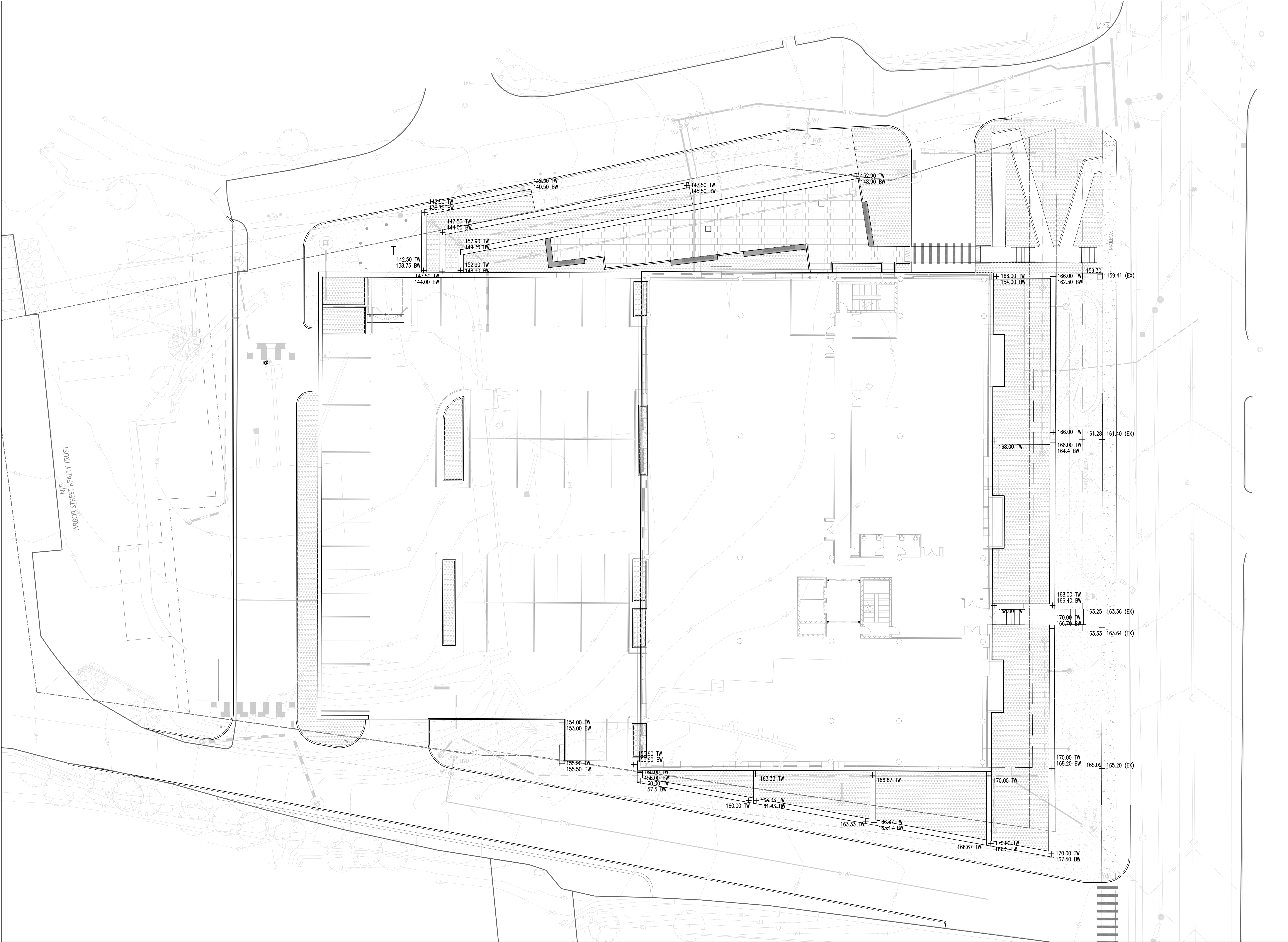
Scale: SCALE: 1/16"=1'-0"

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

Drawing Title:
RENDERED MATERIAL PLAN

Sheet Number:
L102



Notes:

Key Plan:

Architect's Stamp:



Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

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

Project #: 22090

Scale: 1:16

Issue:	Date:
PLANNING BOARD	08/04/2023
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Revisions:	Date:
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Drawing Title:
GRADING PLAN

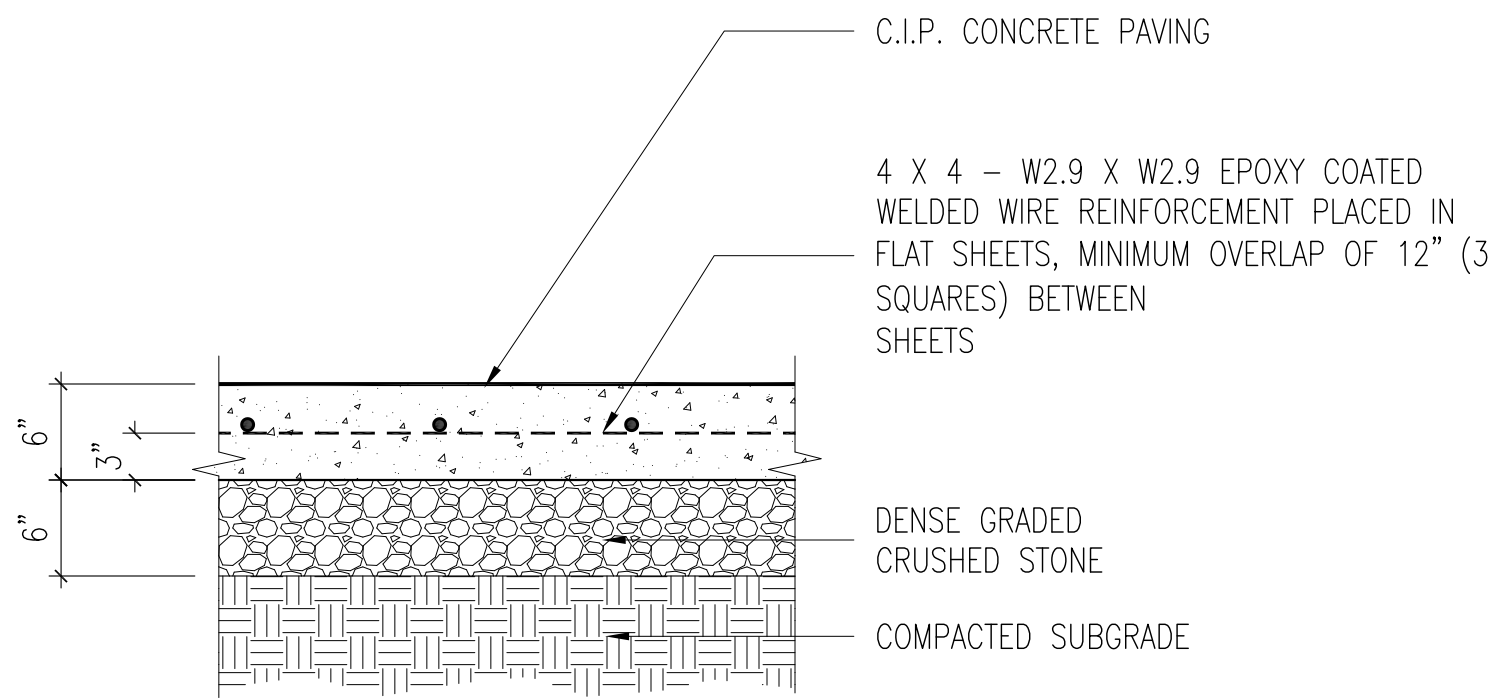
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L103

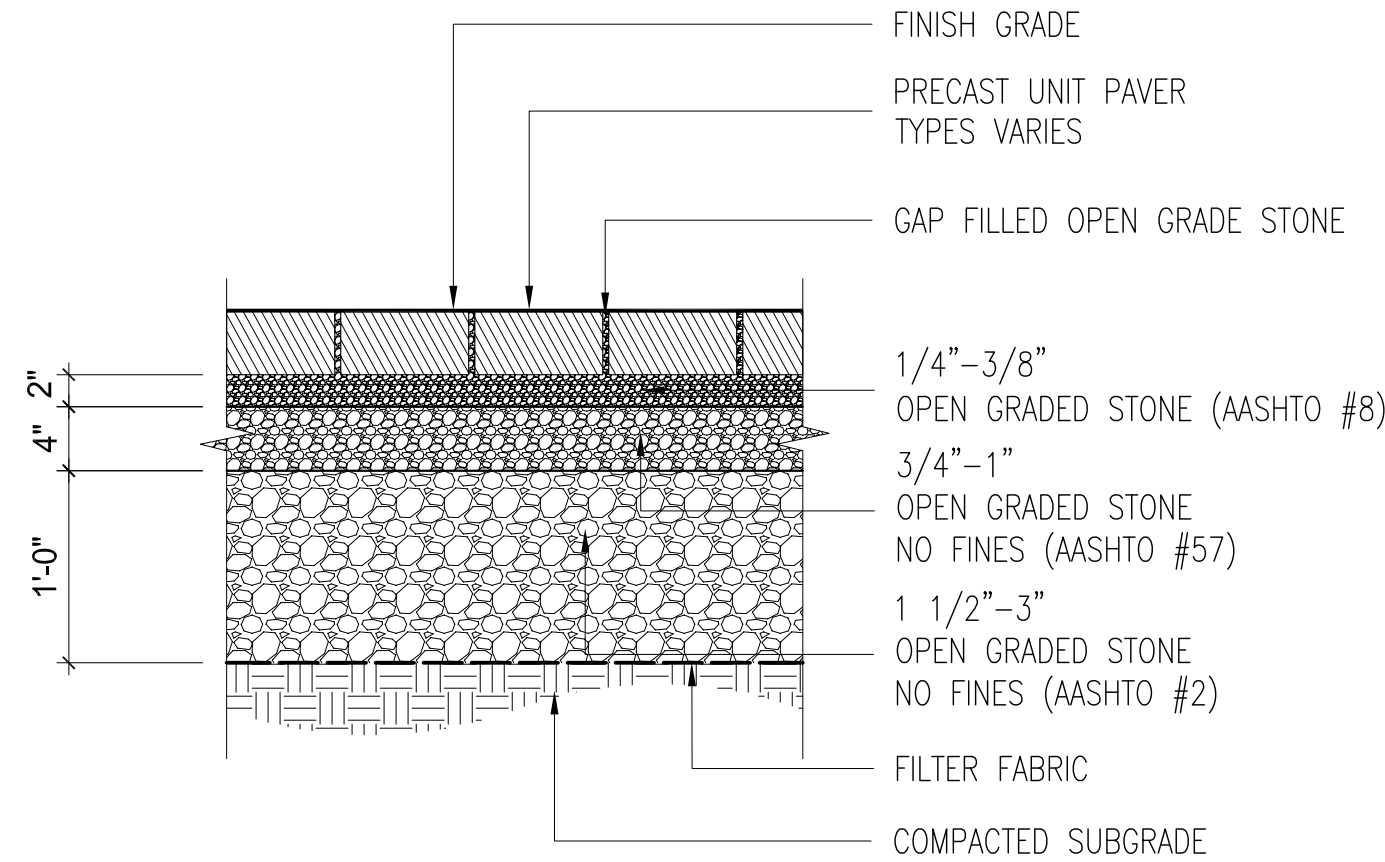
Ground Inc.
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617.778.0889 www.groundinc.com

ground

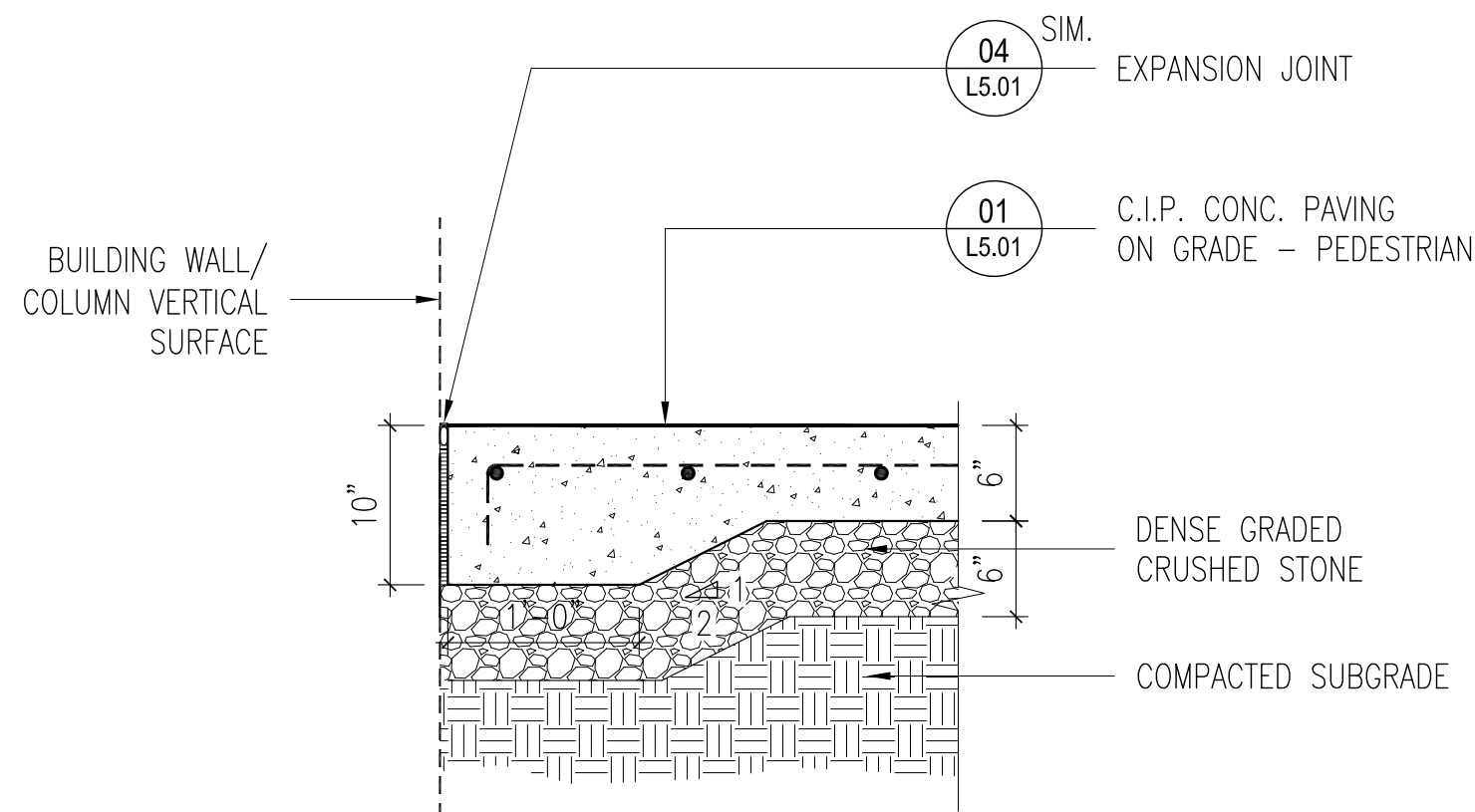
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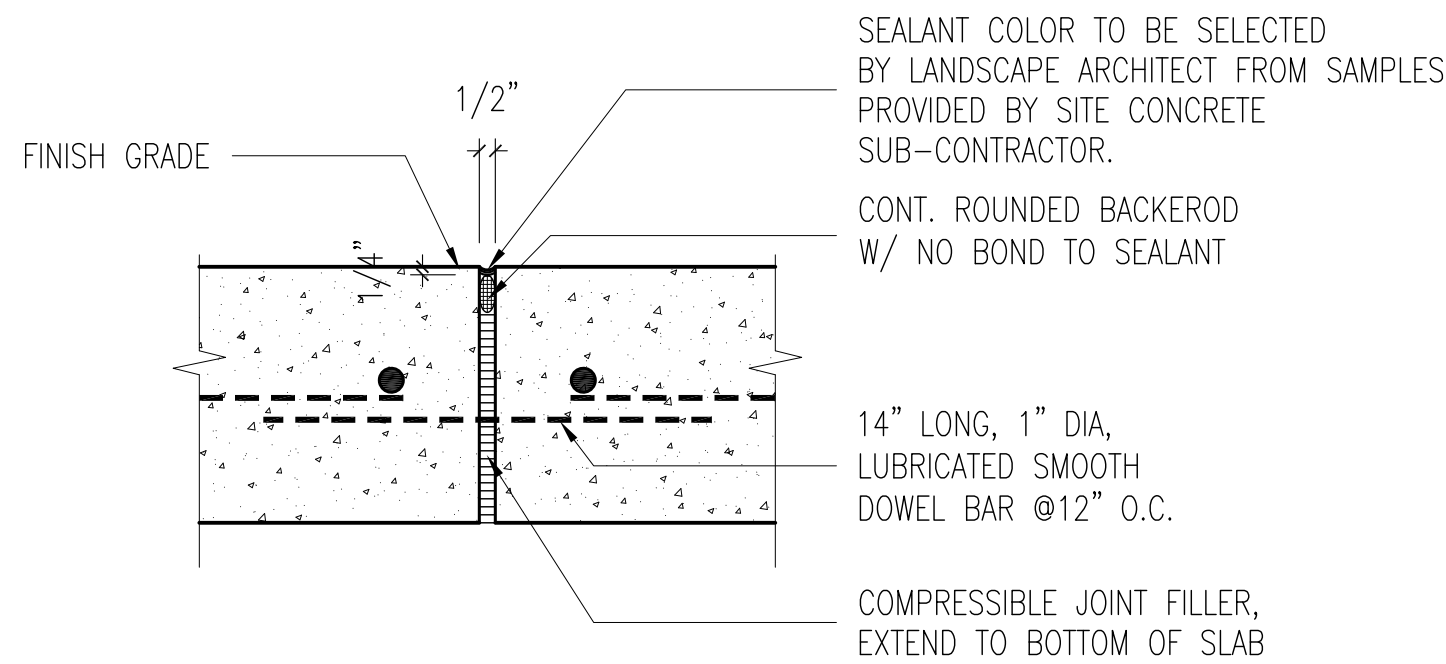
01 C.I.P. CONC. PAVING - PEDESTRIAN
SCALE: 1" = 1'-0"



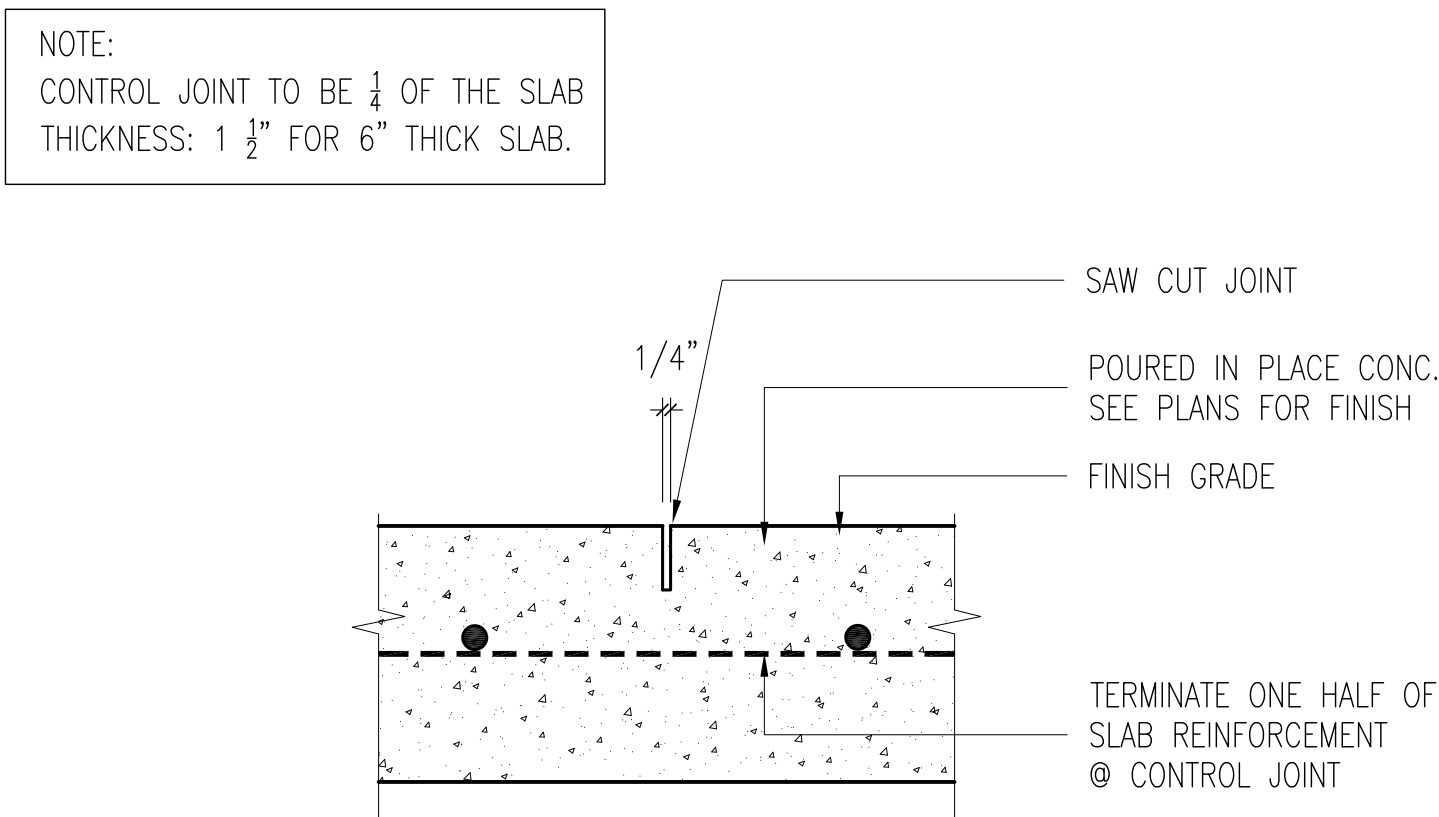
02 PERMEABLE PAVER ON CONCRETE SLAB
SCALE: 1" = 1'-0"



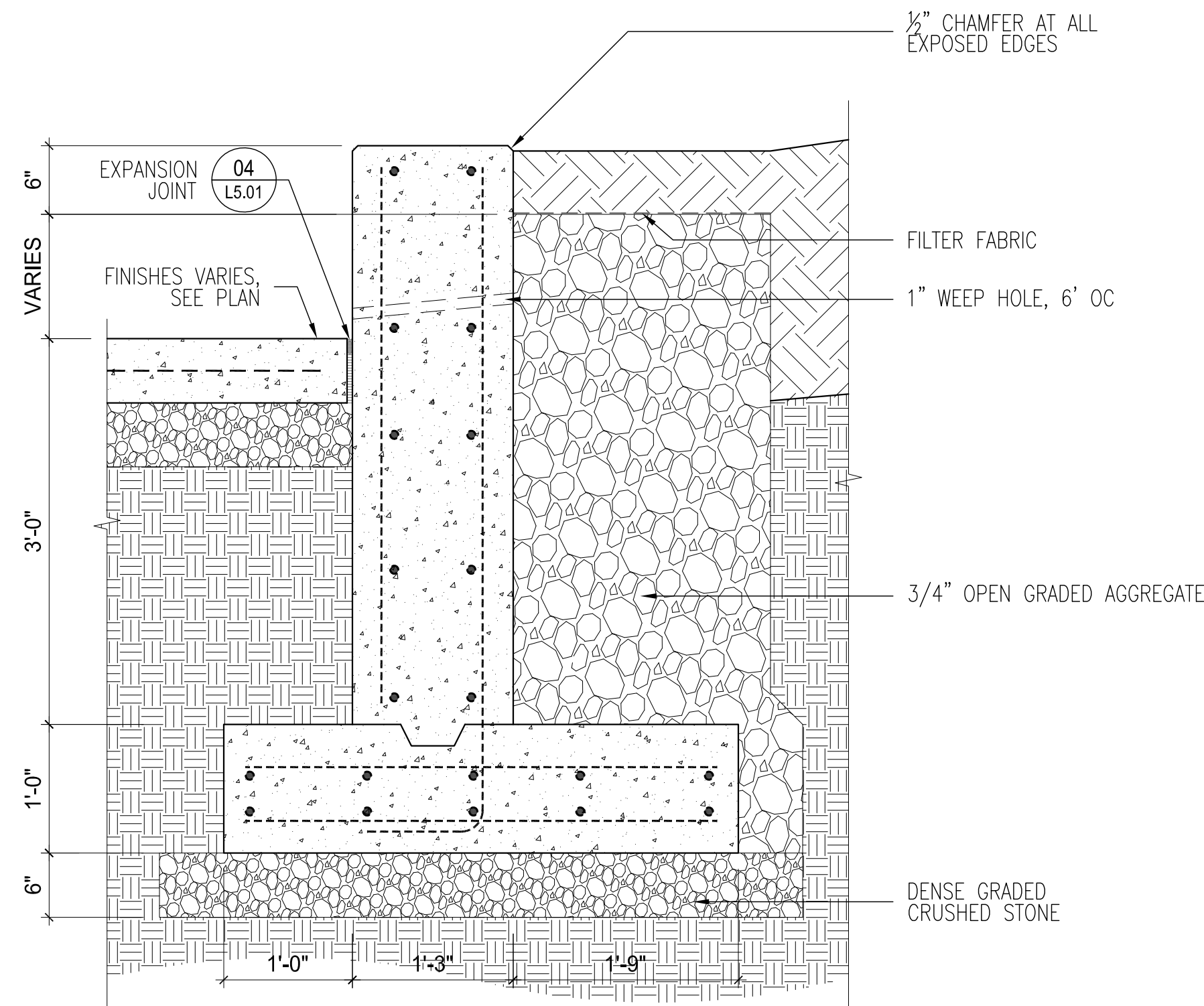
03 C.I.P. CONCRETE EDGE CONDITION
SCALE: 1" = 1'-0"



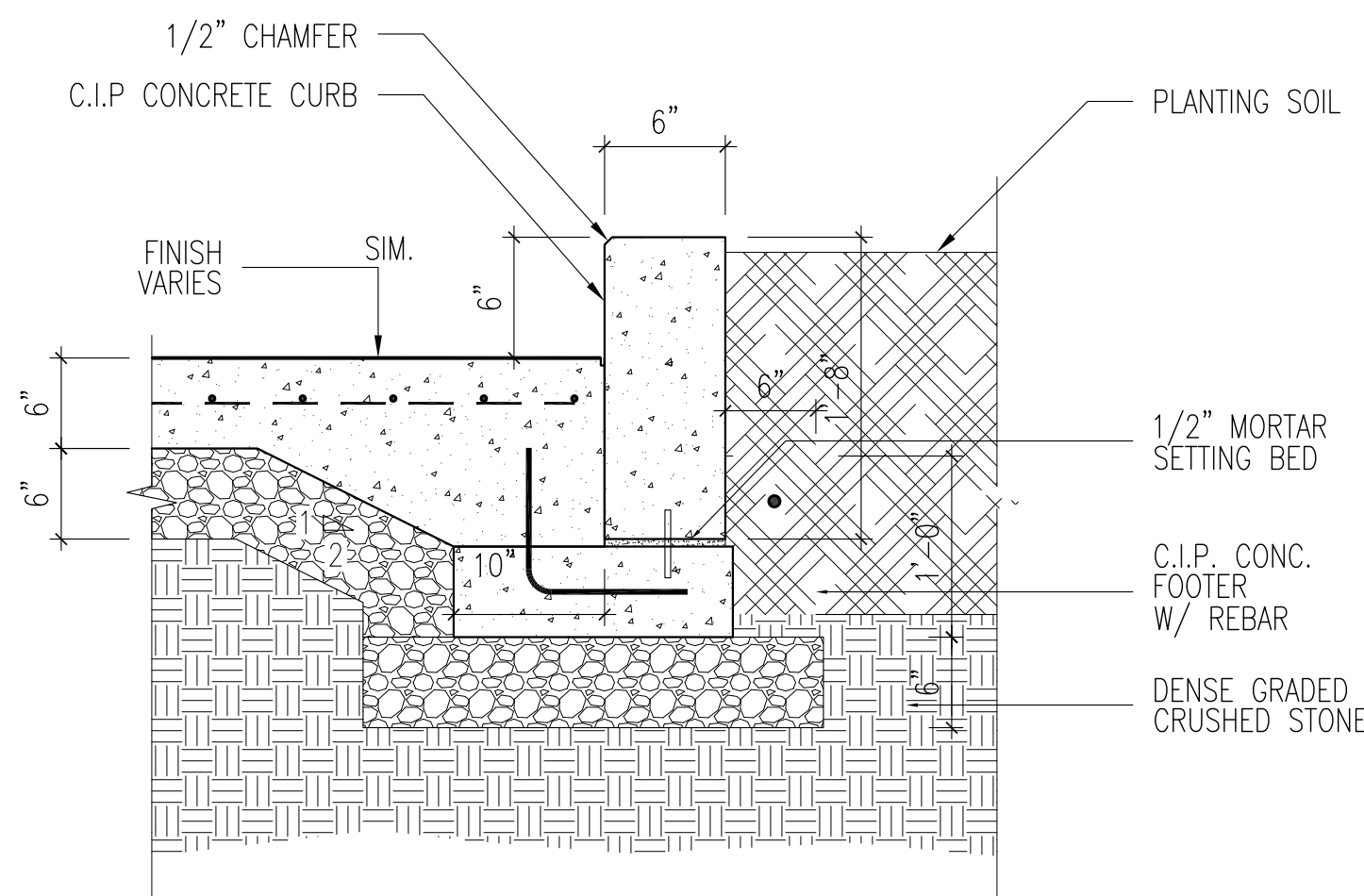
04 EXPANSION JOINT
SCALE: 2" = 1'-0"



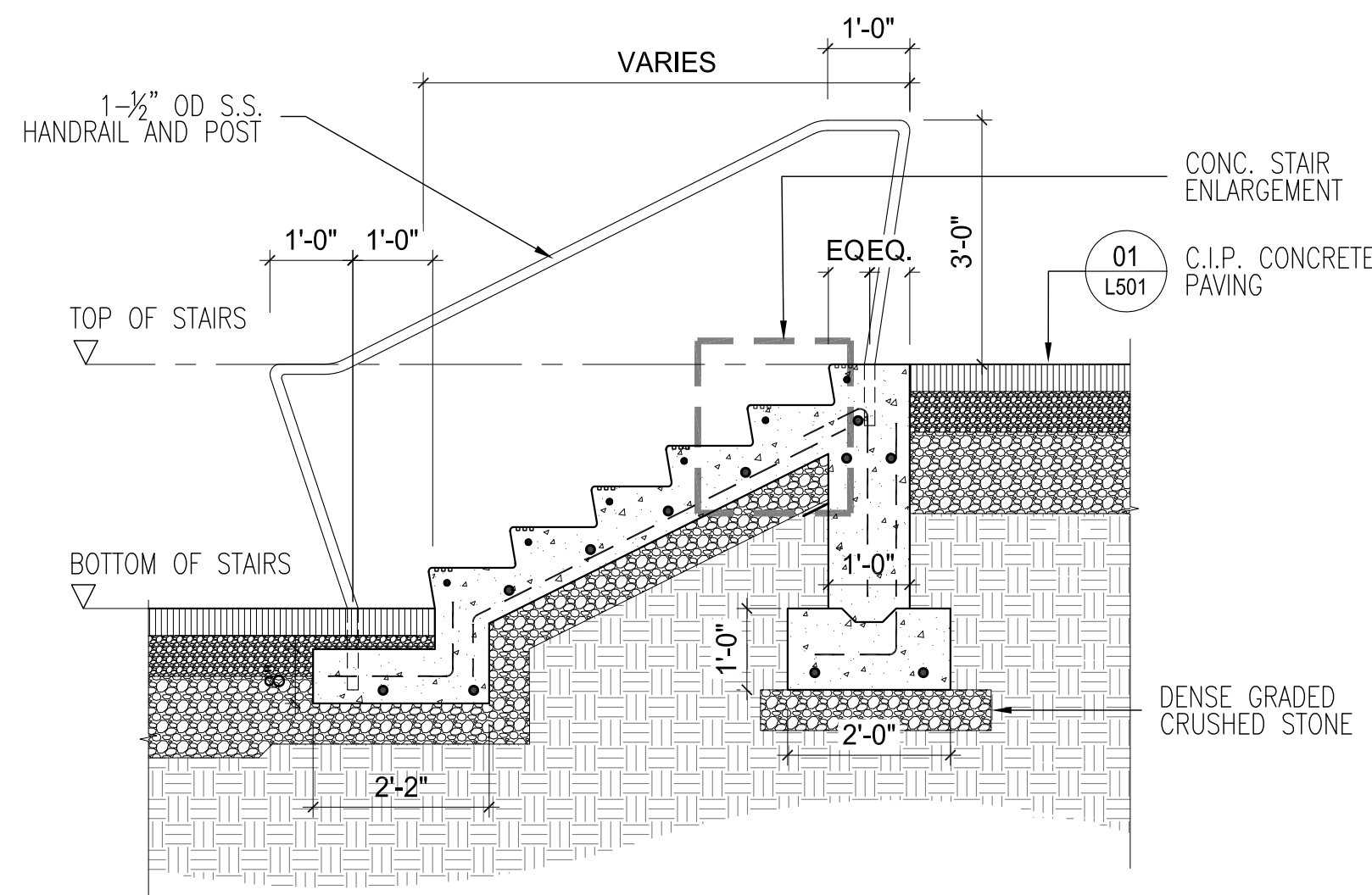
05 CONTROL JOINT
SCALE: 2" = 1'-0"



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:



Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

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

Project #: 22090

Scale:

Issue:

PLANNING BOARD
SUBMISSION

Date:

08/04/2023

Revisions:

Date:

Drawing Title:
DETAILS

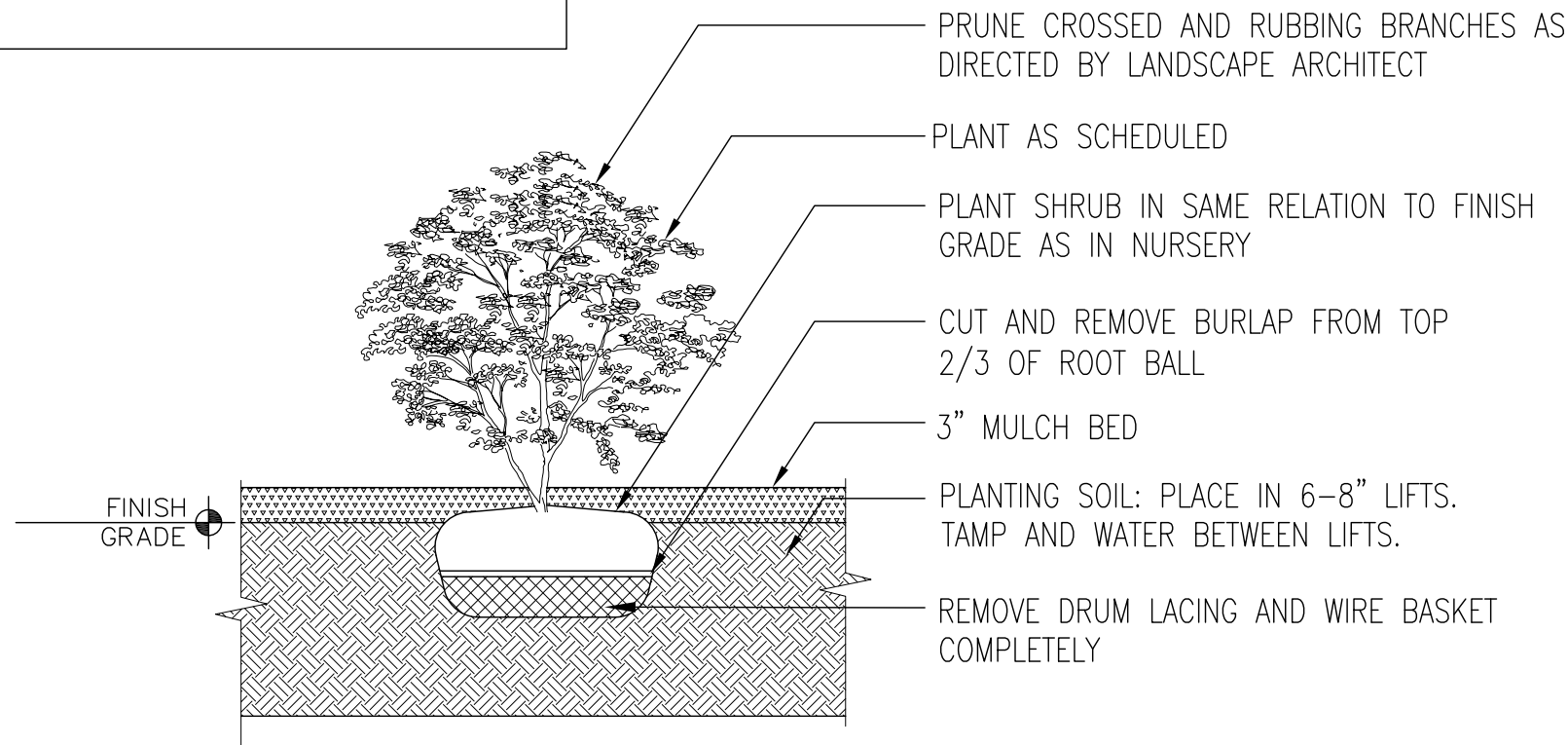
Sheet Number:

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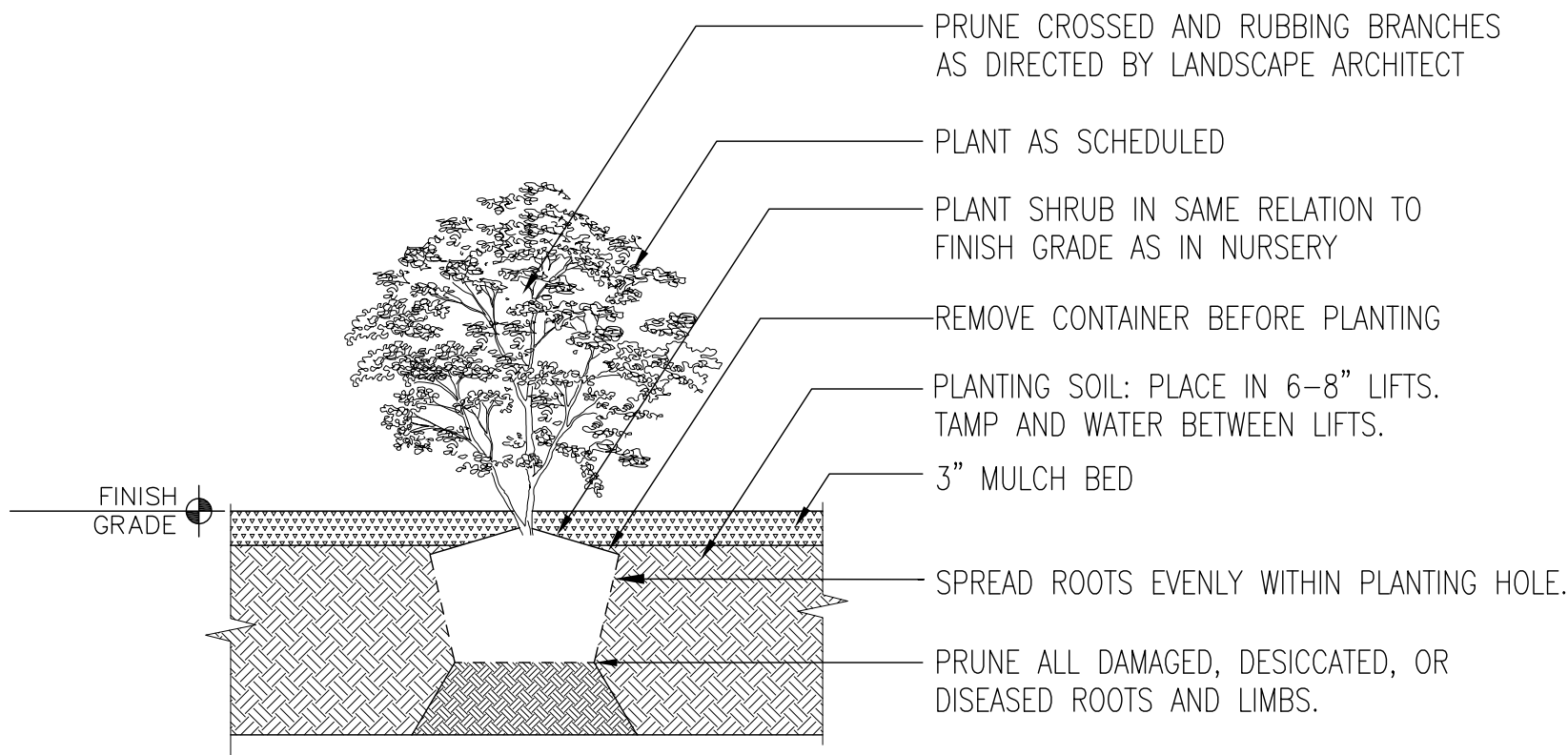
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NOTES:
- CLEANLY PRUNE ALL ROOT ENDS.
- DO NOT ALLOW ROOTS TO DRY OUT DURING THE INSTALLATION PROCESS.
- SOAK ROOTS OVERNIGHT BEFORE PLANTING.
- INSTALL BALLED AND BURLAPPED SHRUBS SIMULTANEOUSLY W/ INSTALLATION OF PLANTING SOIL



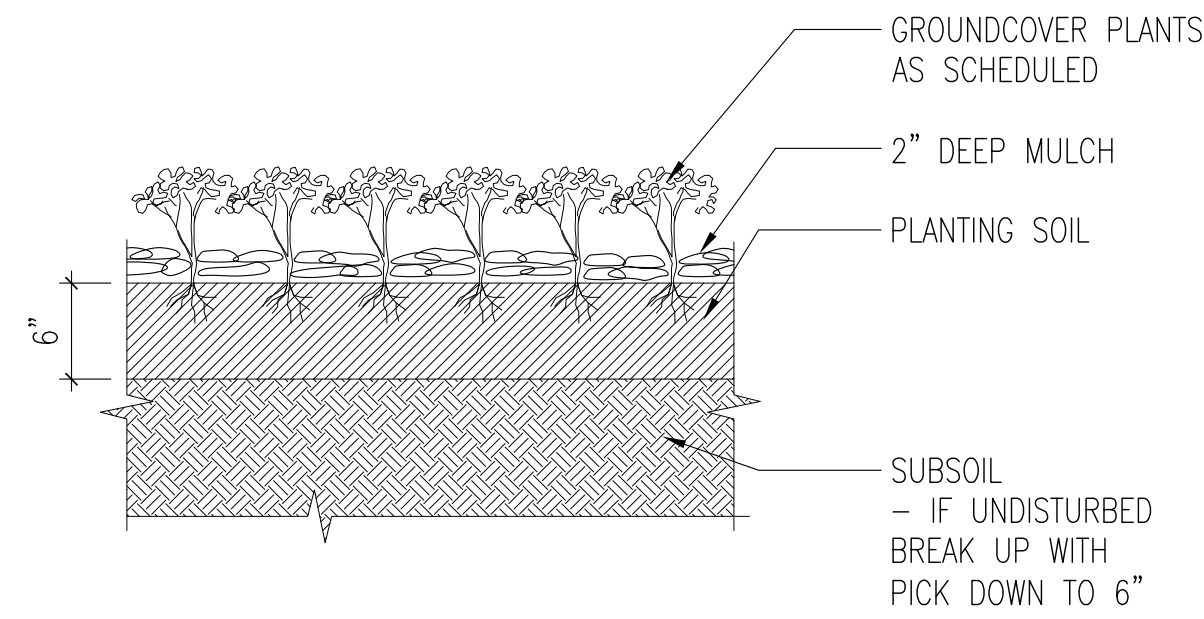
01 SHRUB PLANTING - B&B
SCALE: 3/4" = 1'-0"

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

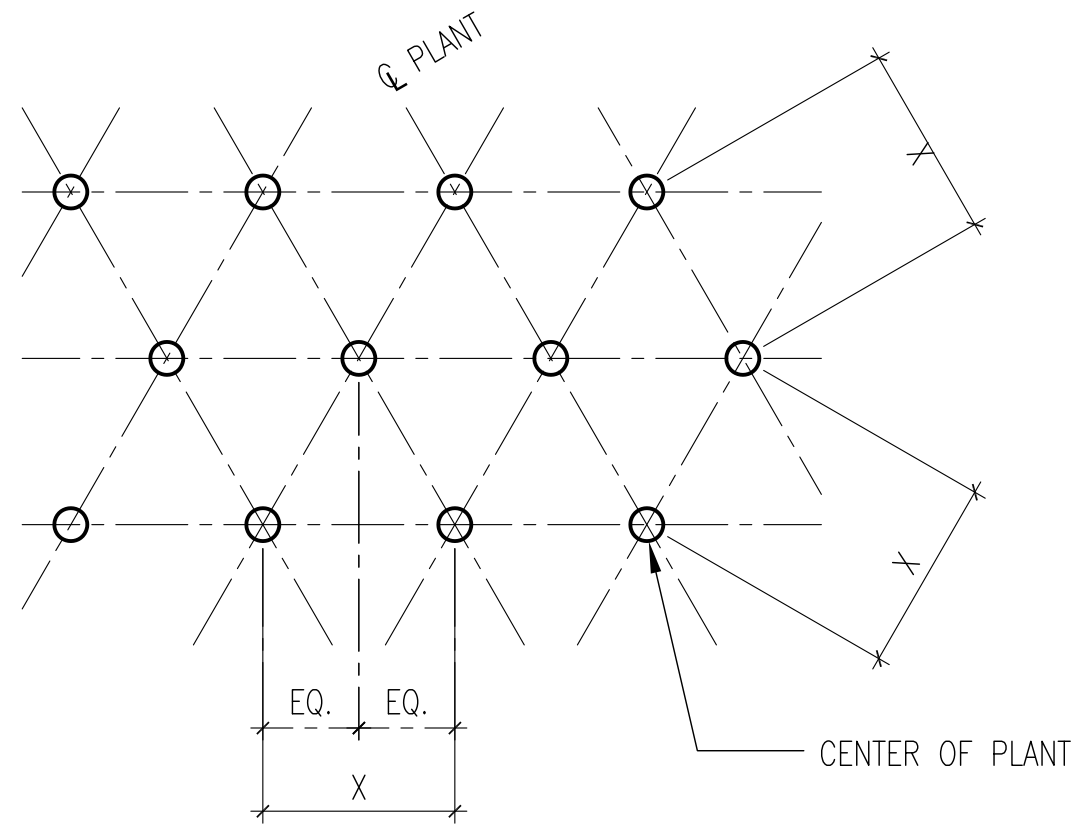


02 SHRUB/PERENNIAL - CONTAINER
SCALE: 3/4" = 1'-0"

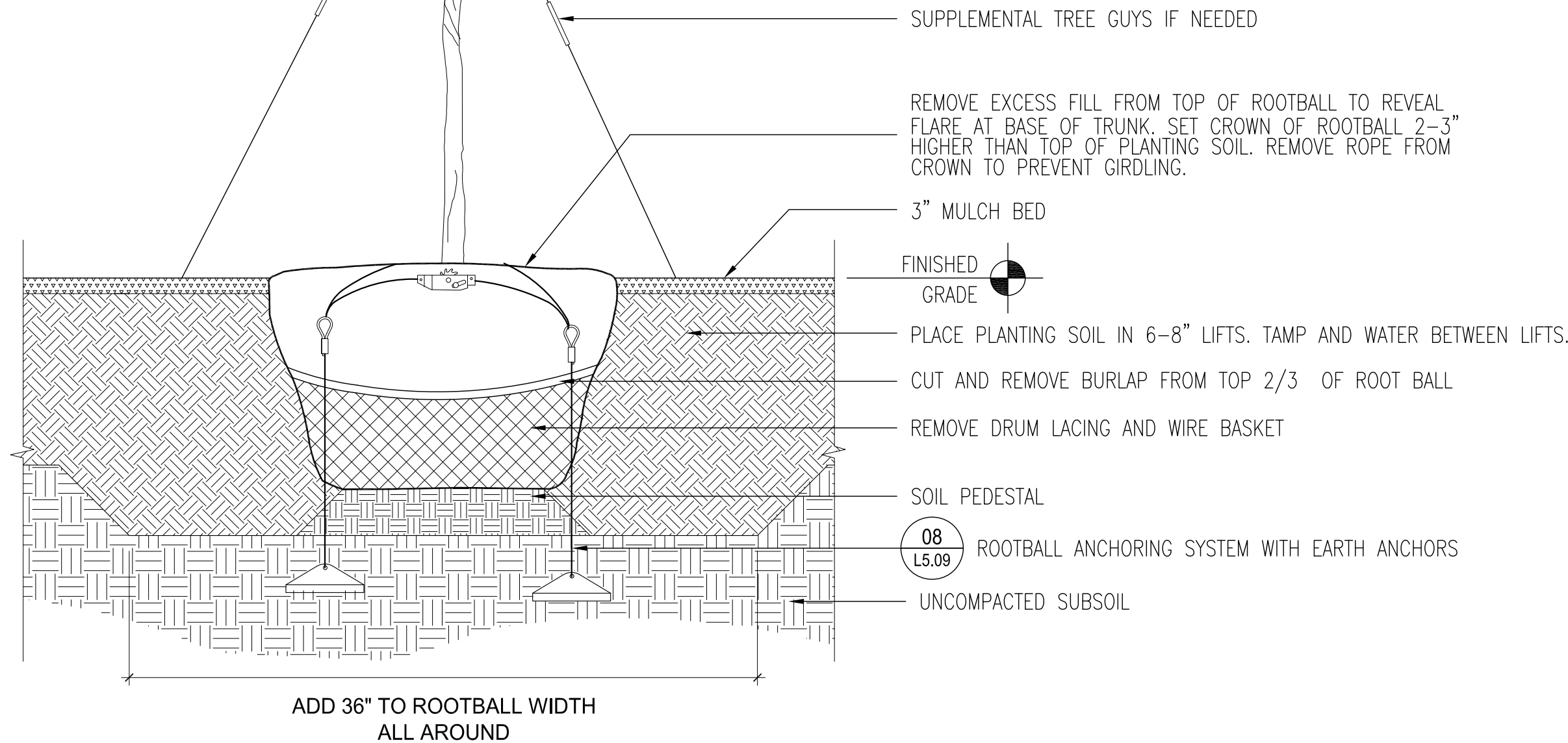
NOTE:
SEE PLANT SPACING DIAGRAM FOR GROUNDCOVER SPACING



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



04 PLANT SPACING DIAGRAM
SCALE: 1" = 1'-0"



05 TREE PLANTING IN PLANTING BED
SCALE: 3/4" = 1'-0"

Notes:

Key Plan:

Architect's Stamp:



Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

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

Project #: 22090

Scale:

Issue:

PLANNING BOARD
SUBMISSION

Date:

08/04/2023

Revisions:

Date:

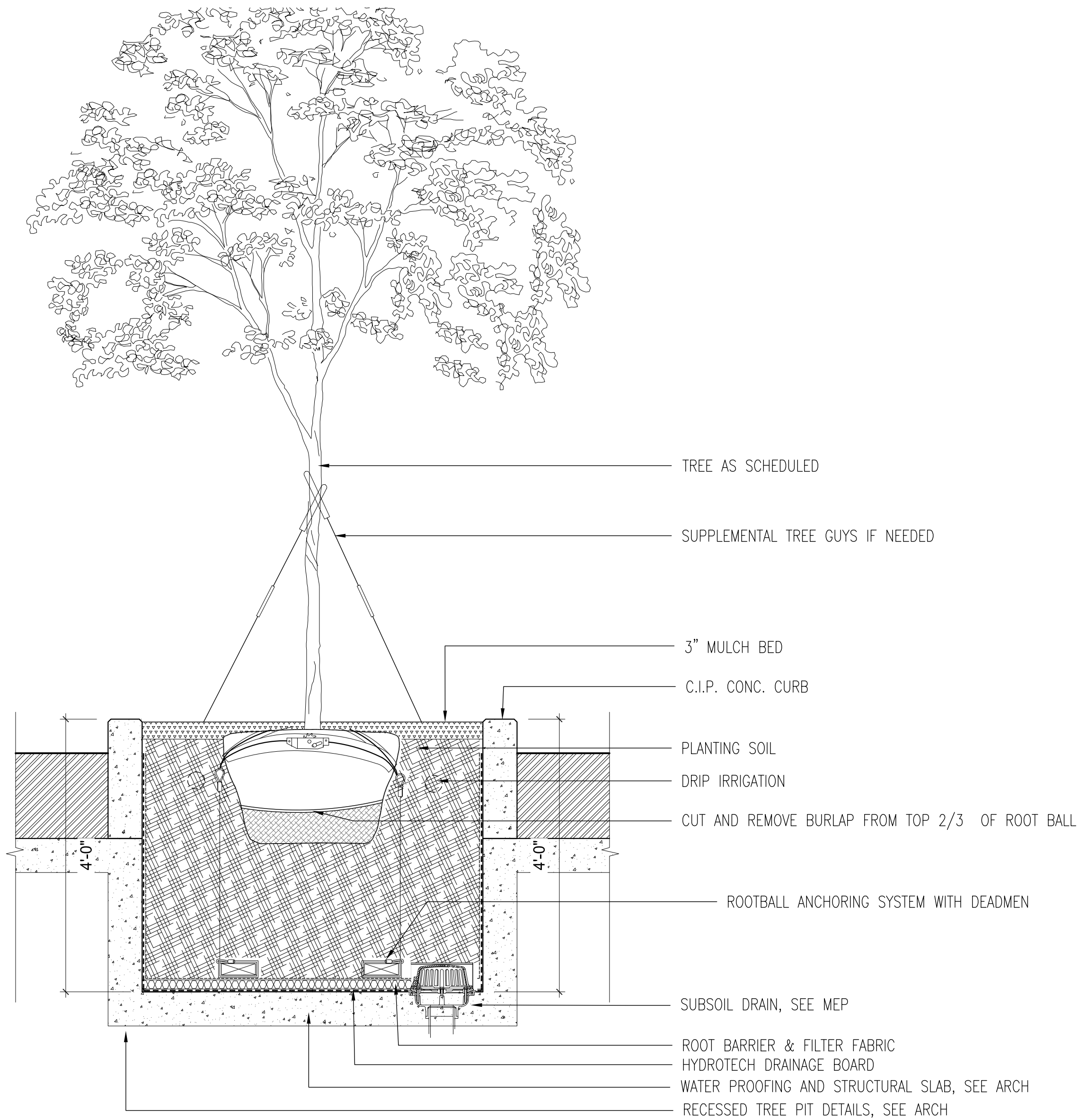
Drawing Title:
PLANTING DETAILS

Sheet Number:

L520

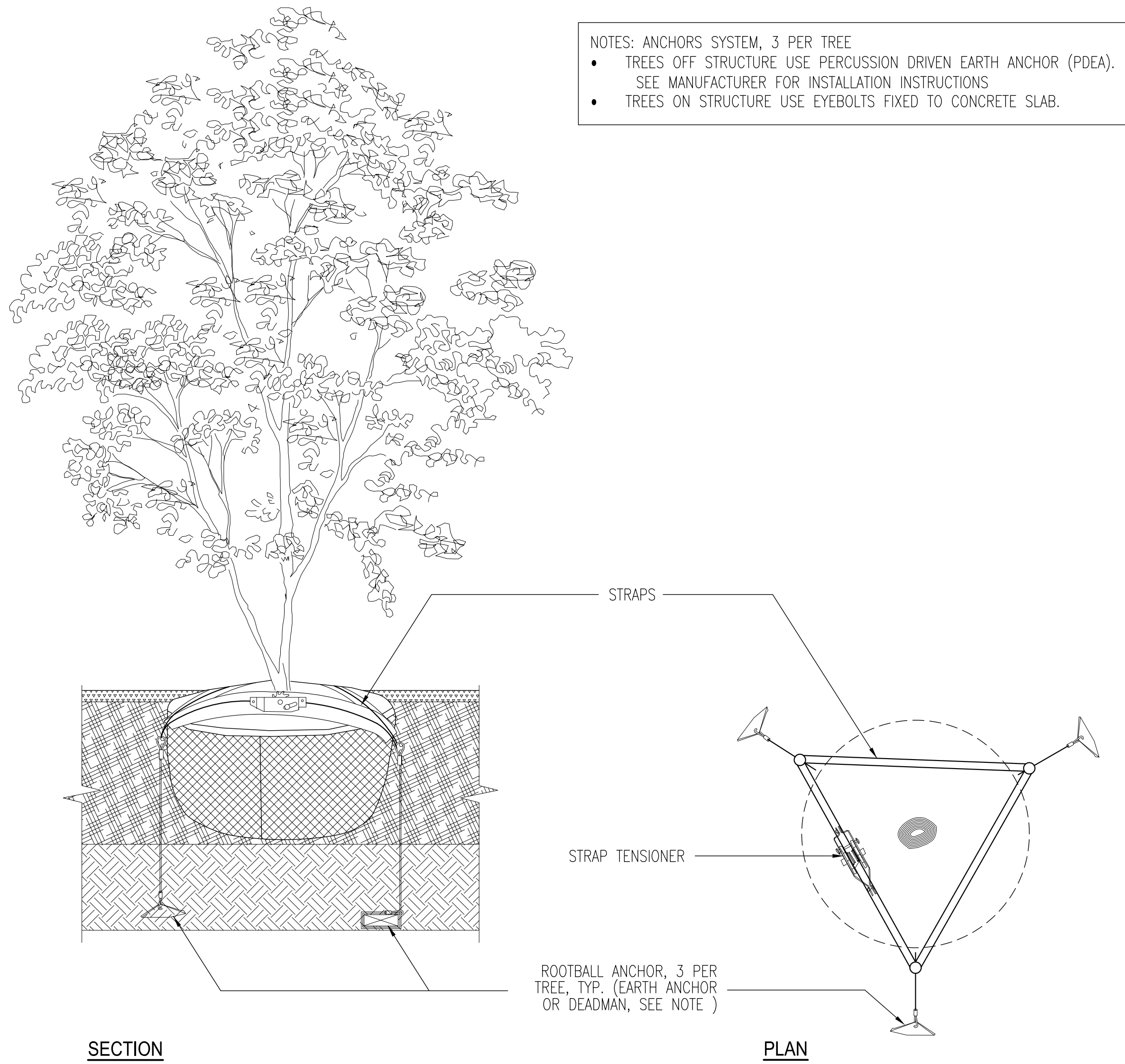
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01 TREE PLANTING AT PRECAST PAVER - ON STRUCTURE

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



02 TREE ANCHORING SYSTEM

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

Notes:

Key Plan:

Architect's Stamp:



Project:
Highland Ave MOB

629-661 Highland Ave
Needham, MA 02494

Client:
Boston Development Group

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

Project #: 22090

Scale:

Issue:

PLANNING BOARD
SUBMISSION

Date:

08/04/2023

Revisions:

Date:

Drawing Title:
PLANTING DETAILS

Sheet Number:

L521

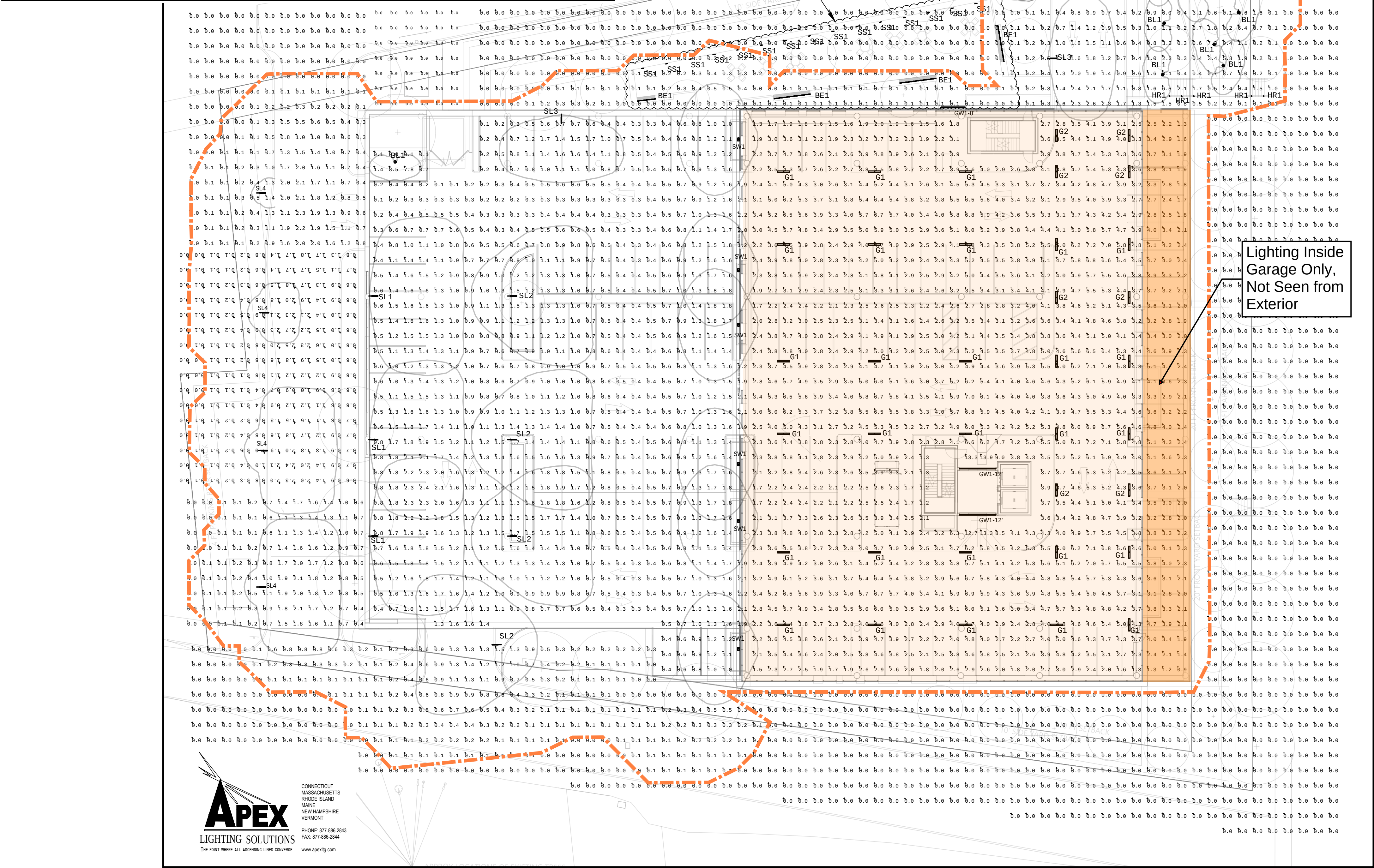
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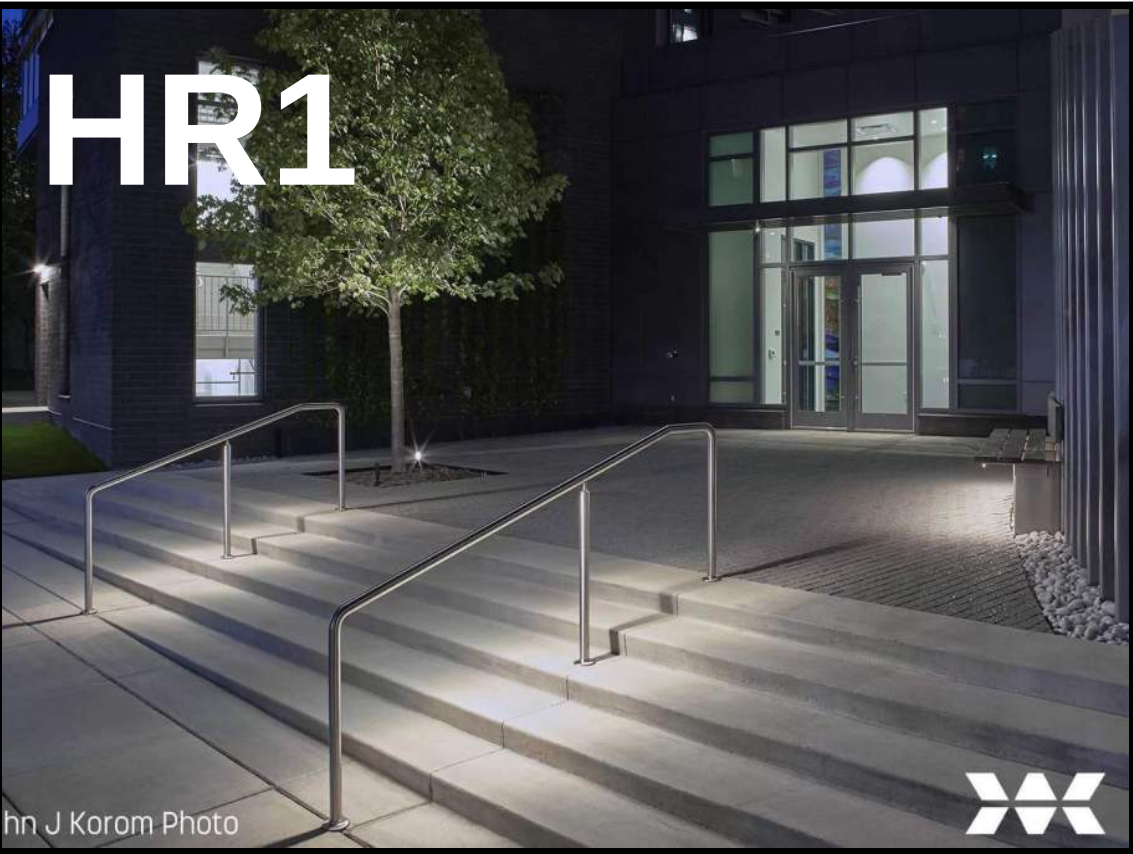
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JOB NAME: HIGHLAND M.O.B. DATE: 02/2023 APEX LIGHTING SOLUTIONS REFLECTANCES: PARKING SURFACE & WALLS=20%; CEILING IN COVERED PARKING=60% WORKPLANE: @ GROUND				
Luminaire Schedule				
Qty	Label	Wattage	Luminaire Lumens	LUF Description
3	SL1	36	2379	0.900 SELUX ACL-R4-S1-SG1530-30-FINISH-UNV-DM-HS Mounted to A-A40-250-16-FINISH-HC1-BC w/Optical Center @ ~16 AFG
4	SL2	24	2362	0.900 SELUX ACL-R4-S1-SG1530-30-FINISH-UNV-DM-HS Mounted to A-A40-250-16-FINISH-HC1-BC w/Optical Center @ ~16 AFG
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 AFG
4	SL4	36	2379	0.900 SELUX ACL-R4-S1-SG1530-30-FINISH-UNV-DM-HS Mounted to A-A40-250-14-FINISH-HC1-BC w/Optical Center @ ~14A AFG
6	SW1	30.2	1467	0.900 GARUDA HS-AS-435-TAM-UNV-CL-4-FINISH Mounted to Structure @ ~12ft AFG
20	G1	40.4	3462	0.900 SELUX L225-2020-30-CW-F-54-FINISH-UNV-DM-Surface Mounted to Ceiling @ ~14ft AFG
8	G2	20.4	1504	0.900 SELUX L225-1820-30-CW-F-54-FINISH-UNV-DM-Surface Mounted to Ceiling @ ~14ft AFG
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 @ 9ft AFG
2	GW1-12"	57.9	5772	0.900 SELUX L60-1220-30-M-W-LENGTH-FINISH-UNV-DM-CL Mounted to Wall @ 9ft AFG
42	HR1	107	10768	0.010 Q-TRAN-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 36in AFG
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	2.1
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



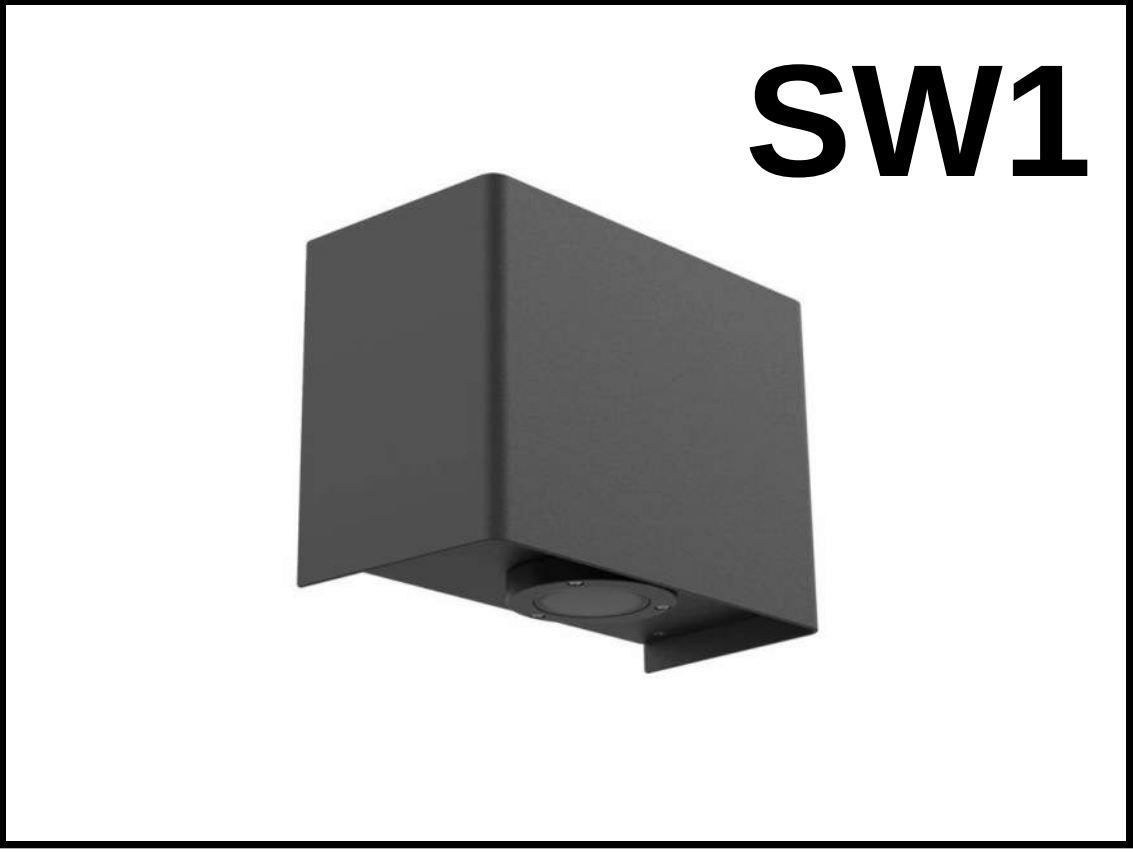
BL1 Accessible Route Lighting and Landscaped Corner at Upper Parking



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

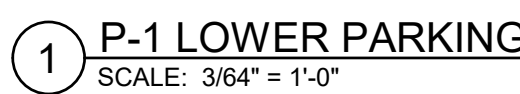
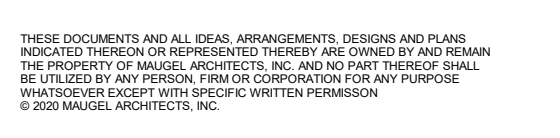
Client:
Boston Development Group

Project #: 22090

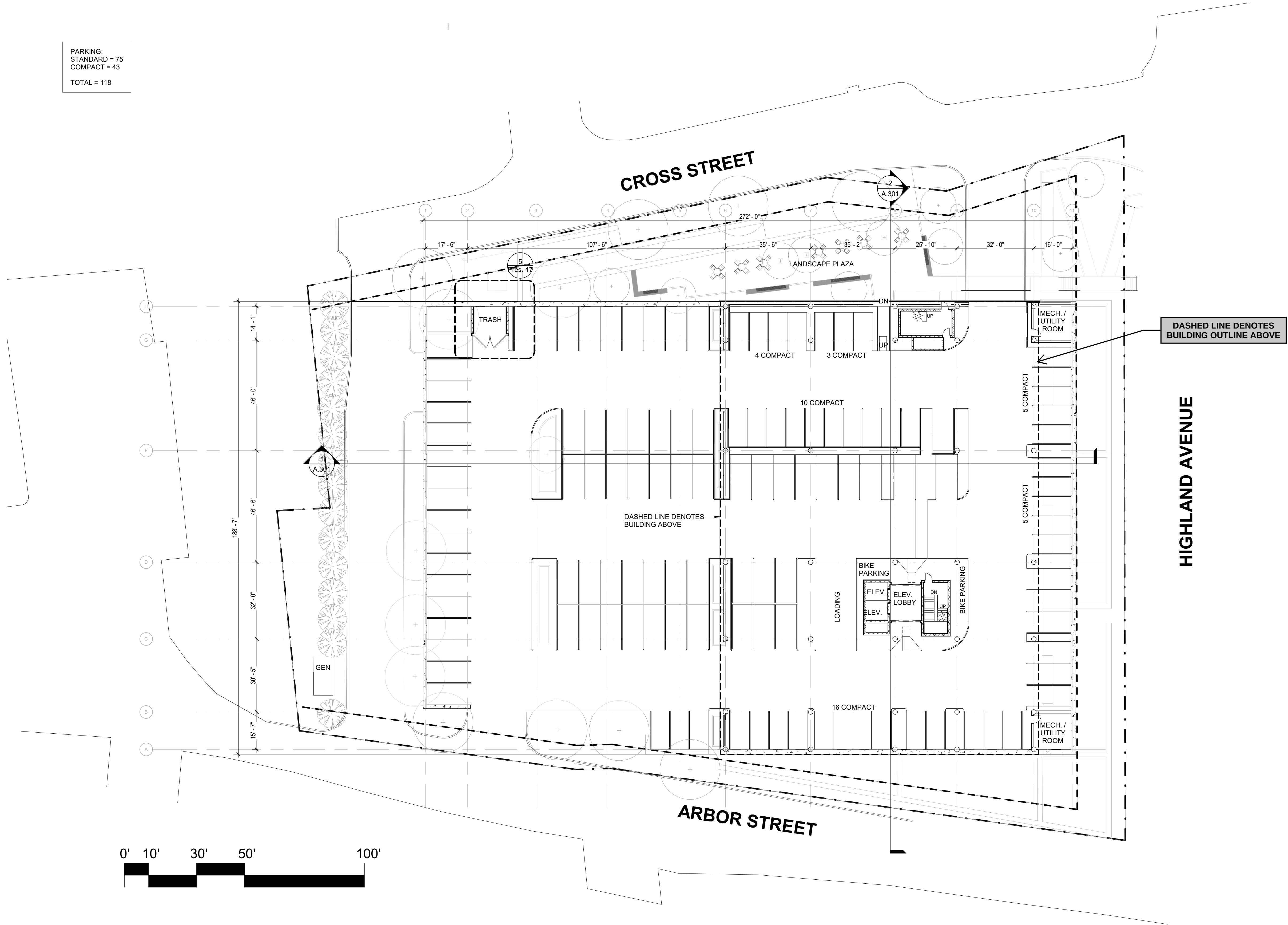
Issue: _____ Date: _____

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A.101

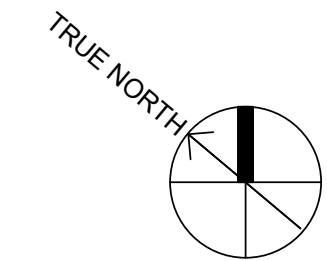


PARKING:
STANDARD = 75
COMPACT = 43
TOTAL = 118



1 P-2 UPPER 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
SUBMISSION

Date:

08/04/2023

Revisions:

Date:

Drawing Title:

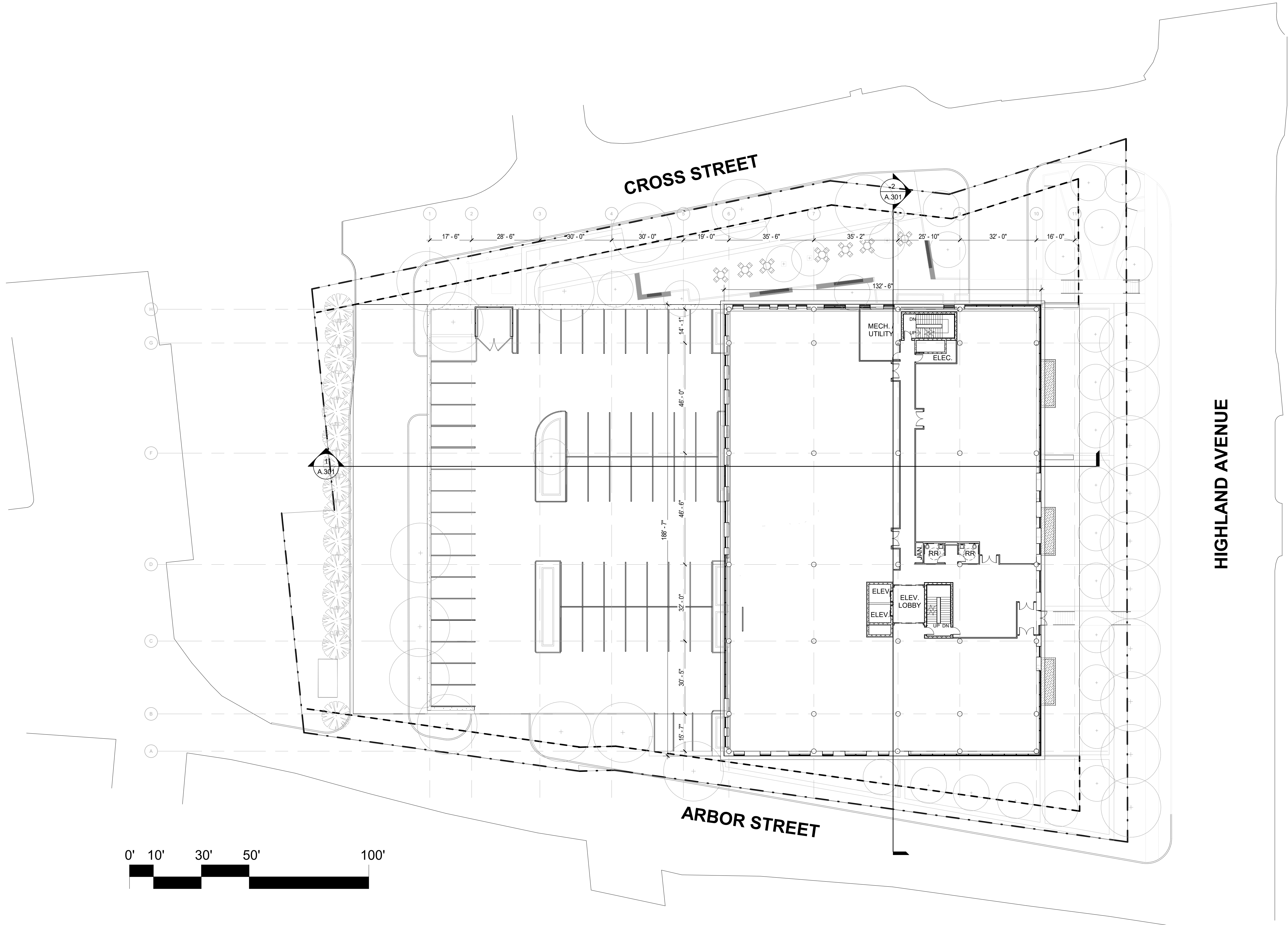
P-2 Upper Parking Plan

Sheet Number:

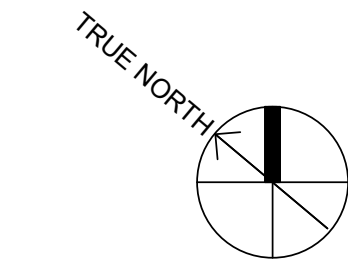
A.102



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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
SUBMISSION

Date:
08/04/2023

Revisions:

Date:

Drawing Title:
First Floor Plan

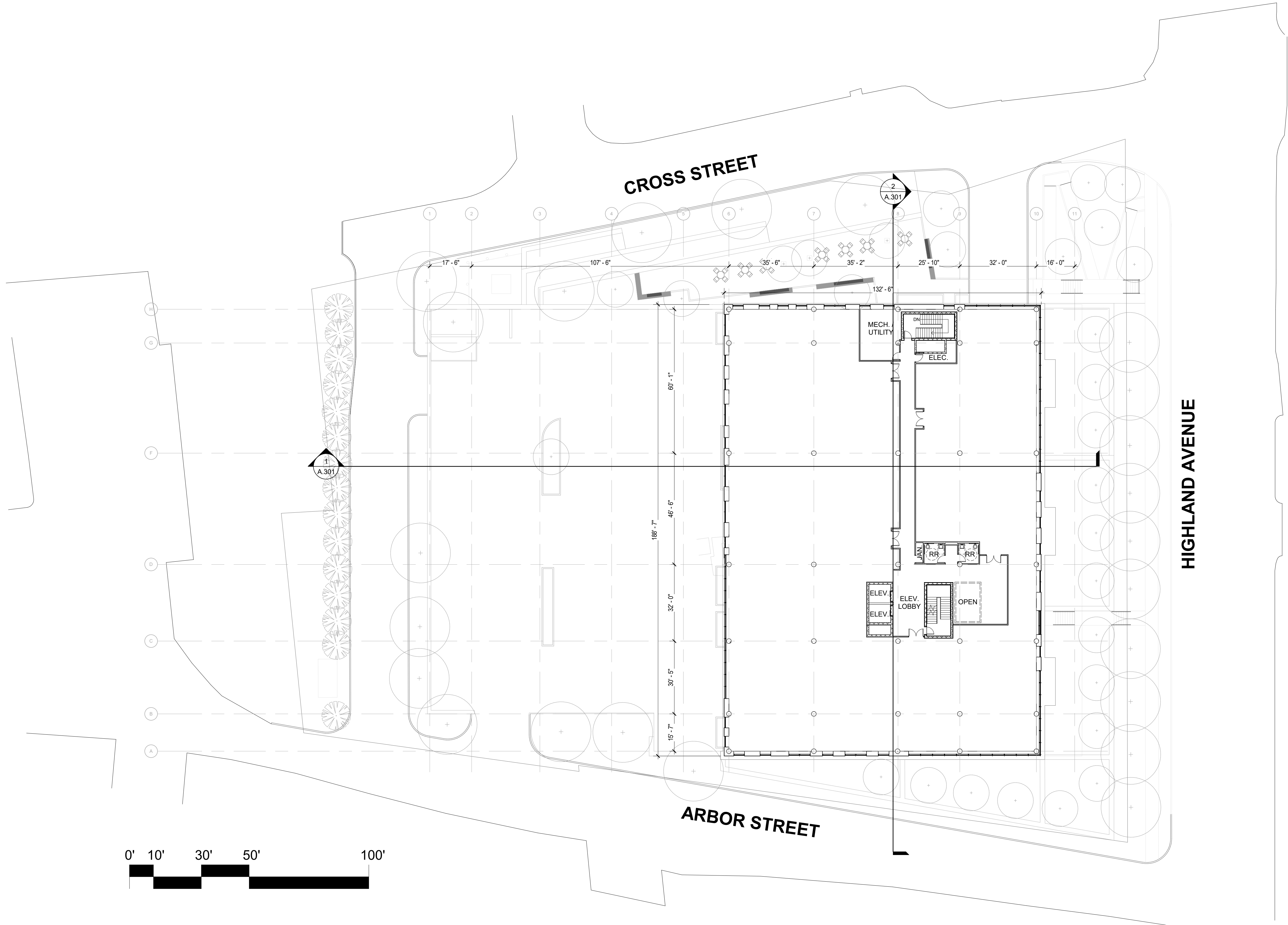
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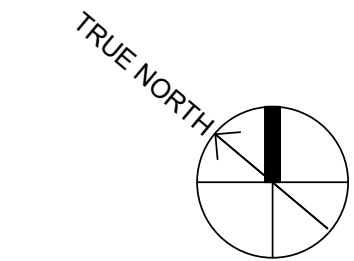


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Notes:



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 SUBMISSION
Date: 08/04/2023

Revisions:	Date:

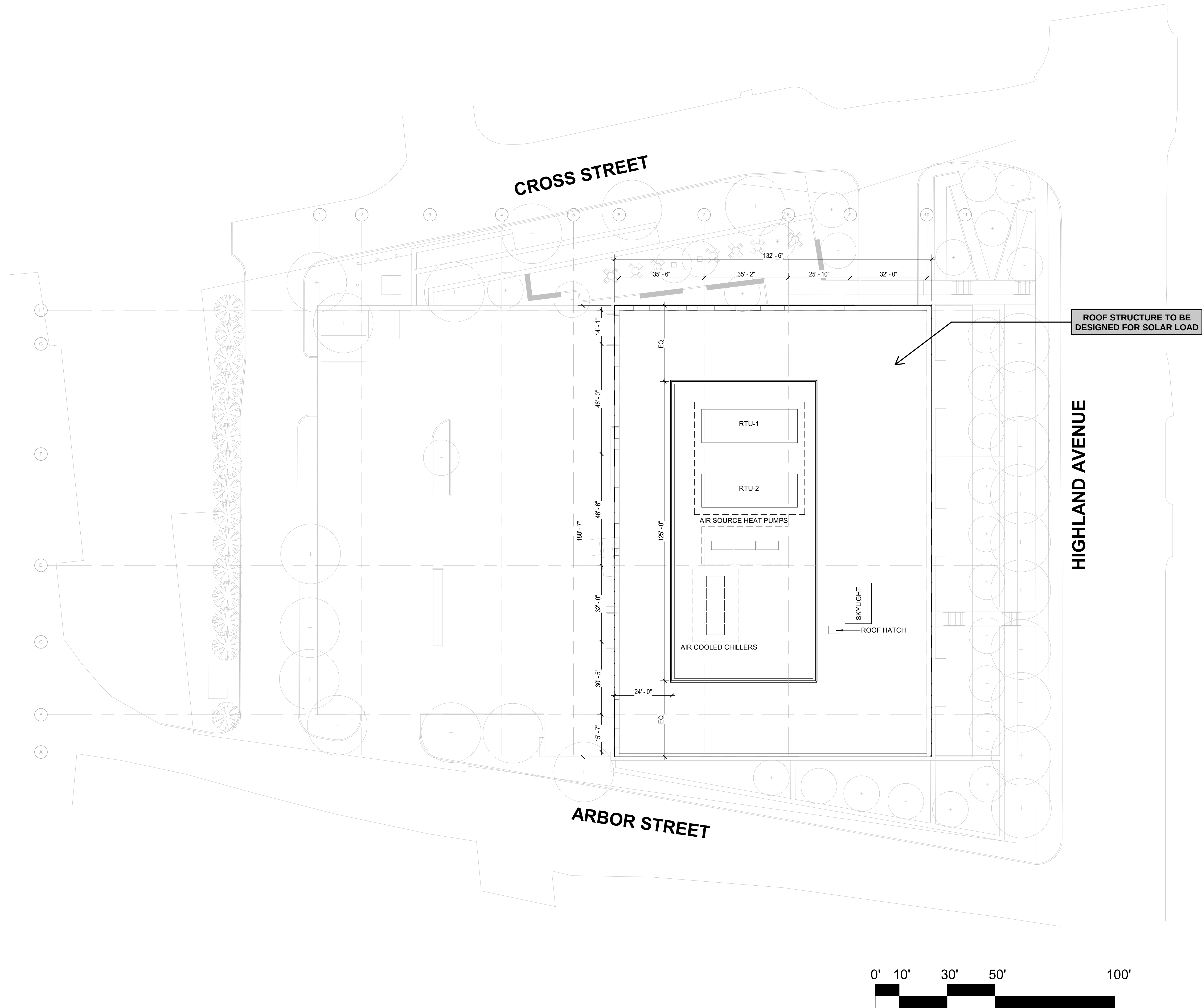
Drawing Title:
Second Floor Plan

Sheet Number:

A.104



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1 ROOF
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: Date:
PLANNING BOARD 08/04/2023
SUBMISSION

Revisions:	Date:

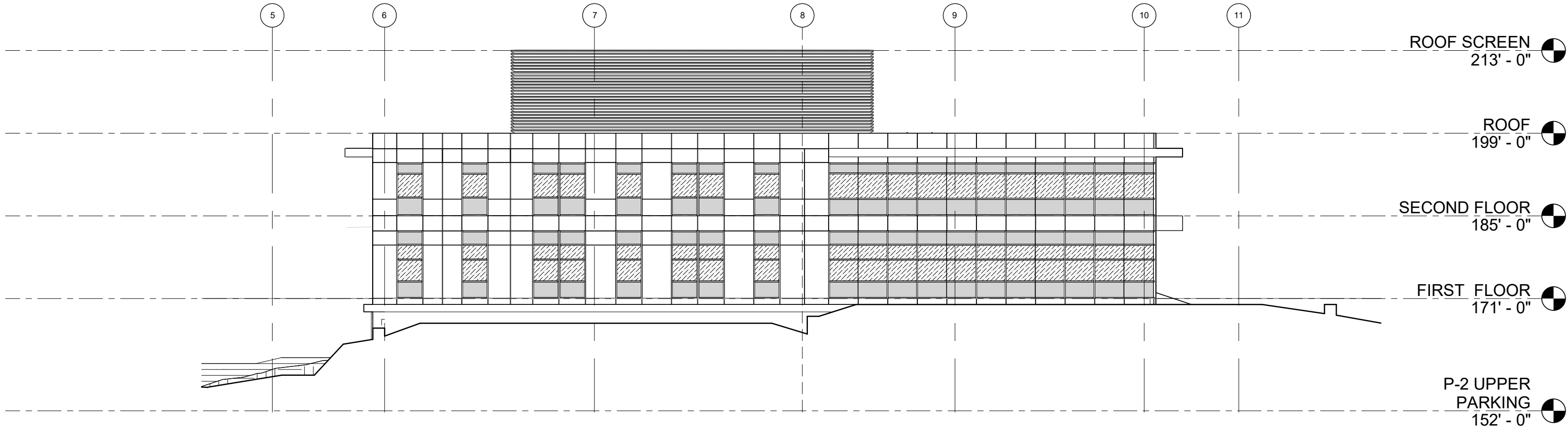
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Roof Plan

Sheet Number:

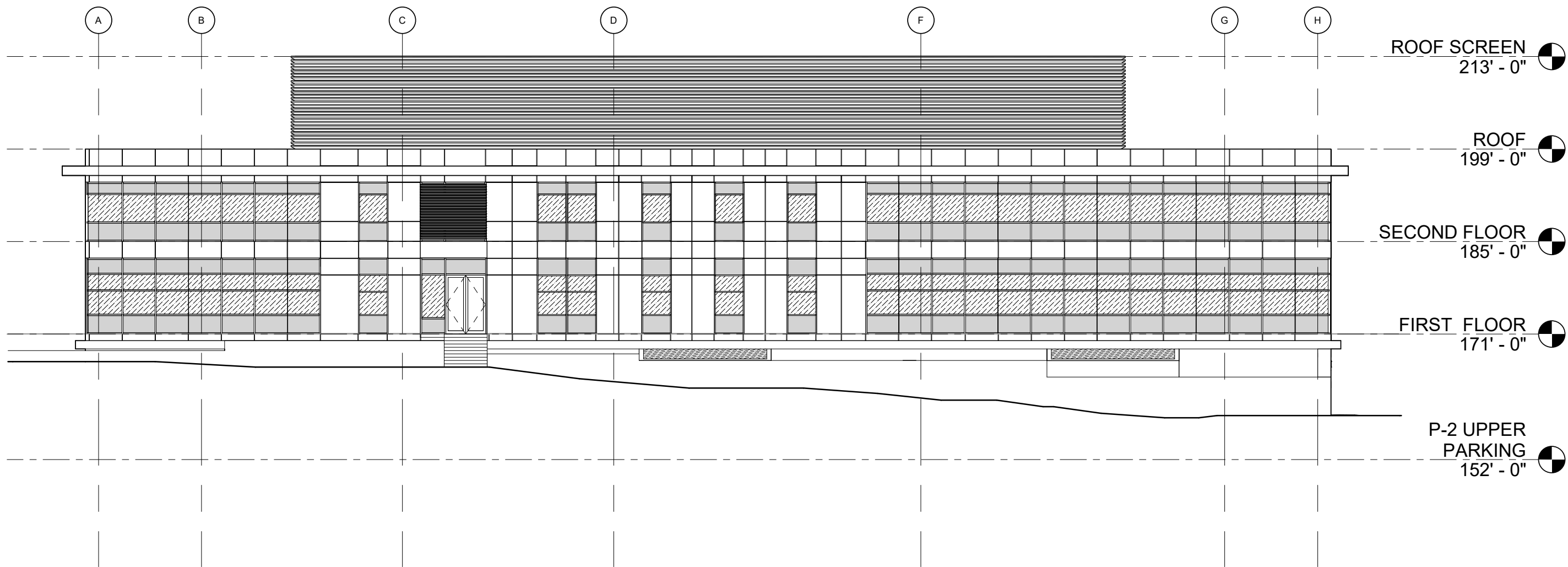
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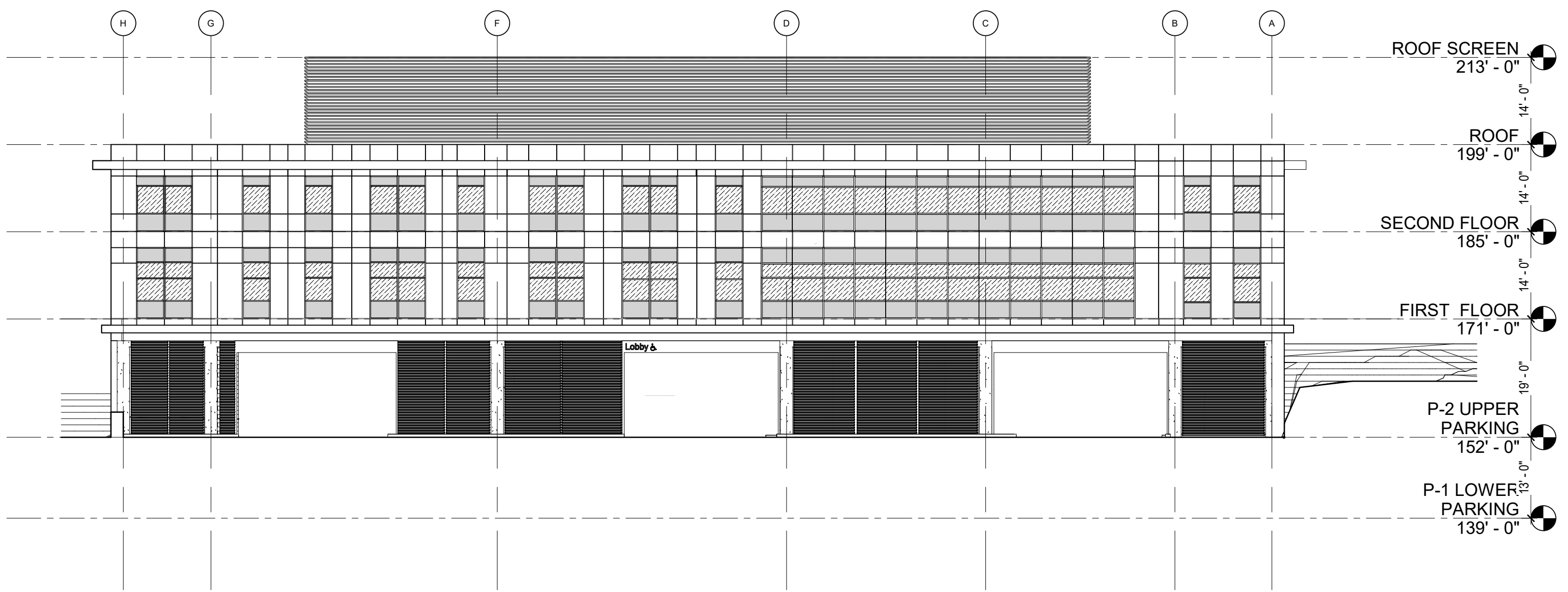
4 ARBOR STREET (SOUTH WEST) ELEVATION
SCALE: 1/16" = 1'-0"



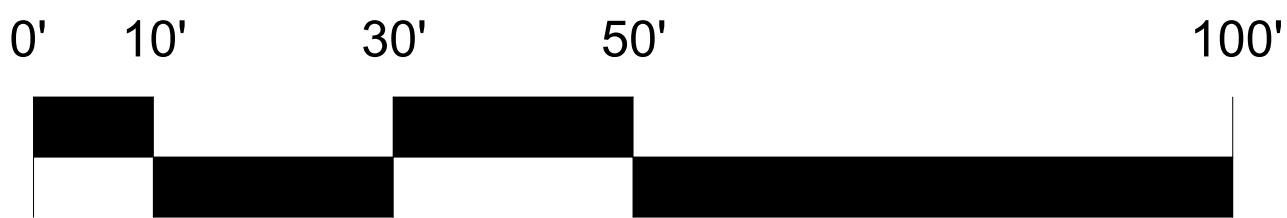
3 HIGHLAND AVE (SOUTH EAST) ELEVATION
SCALE: 1/16" = 1'-0"



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



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



Notes:

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: 1/16" = 1'-0"

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

Revisions:	Date:

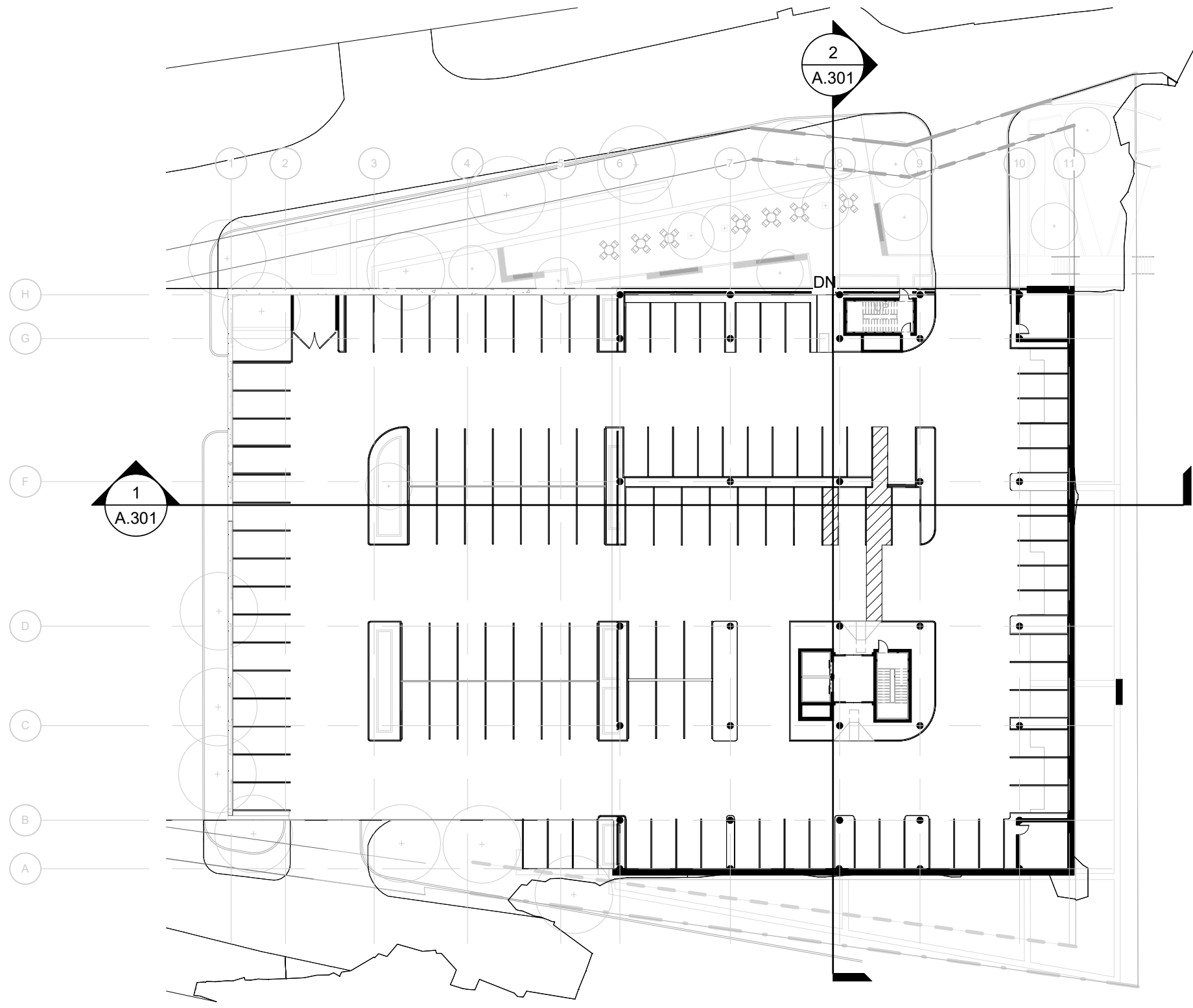
Drawing Title:
Elevations

Sheet Number:

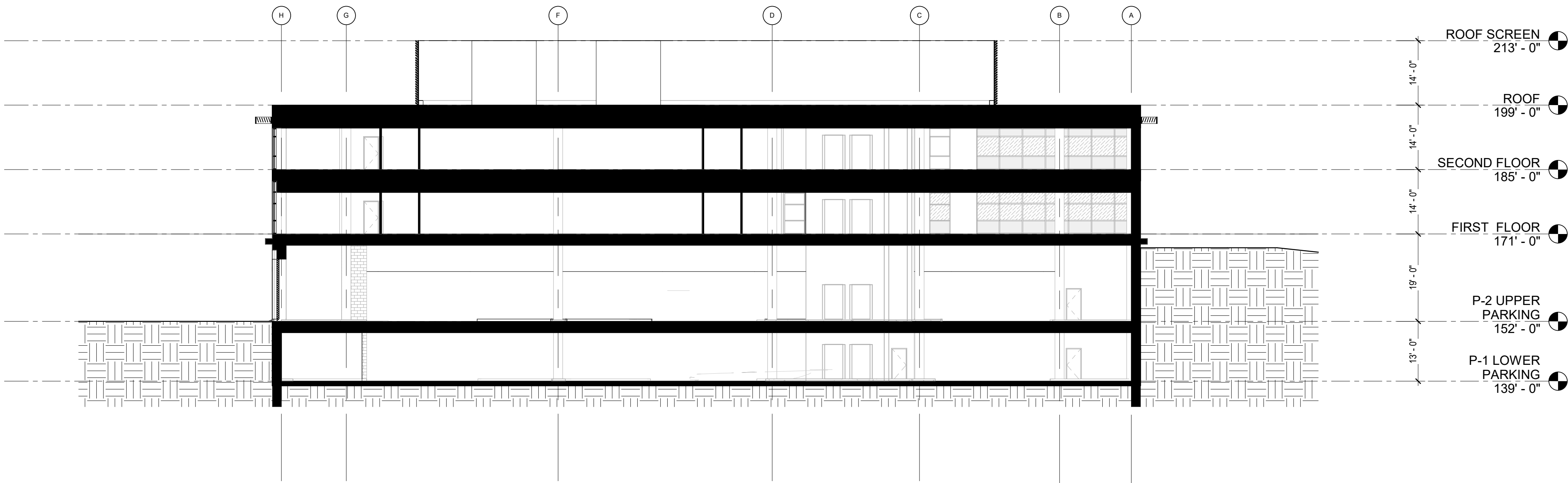
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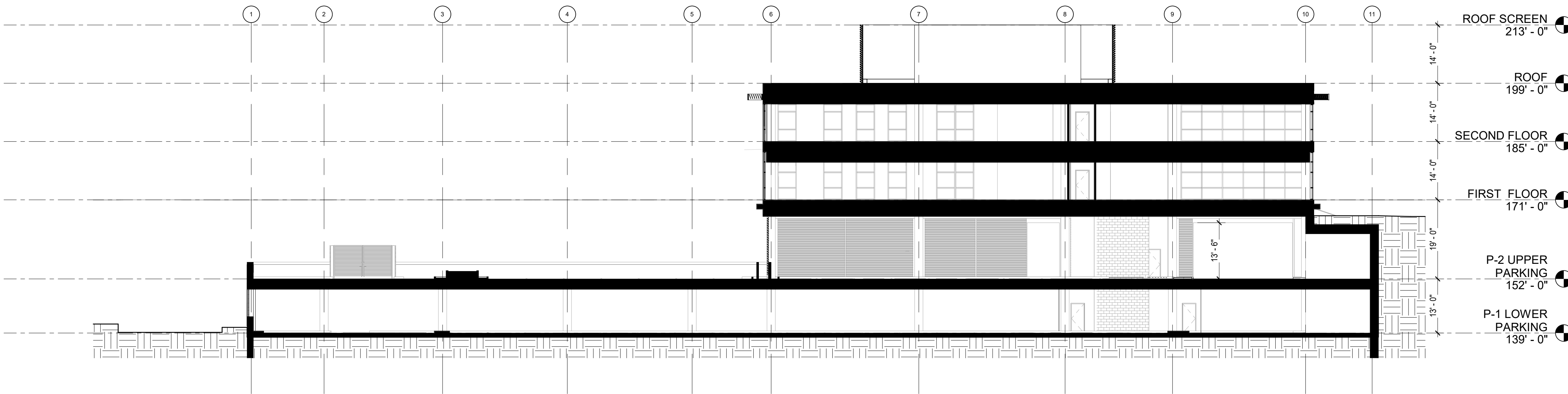
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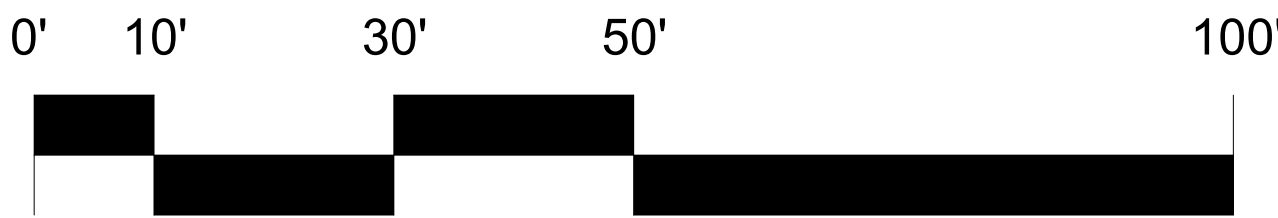
3 SECTION KEY PLAN
SCALE: 1" = 40'-0"



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



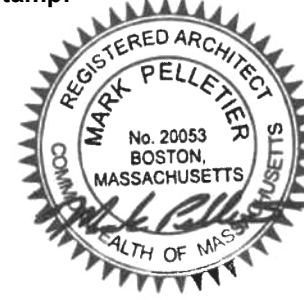
1 BUILDING SECTION 1
SCALE: 1/16" = 1'-0"



Notes:

Key Plan:

Architect's Stamp:



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

Client:
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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

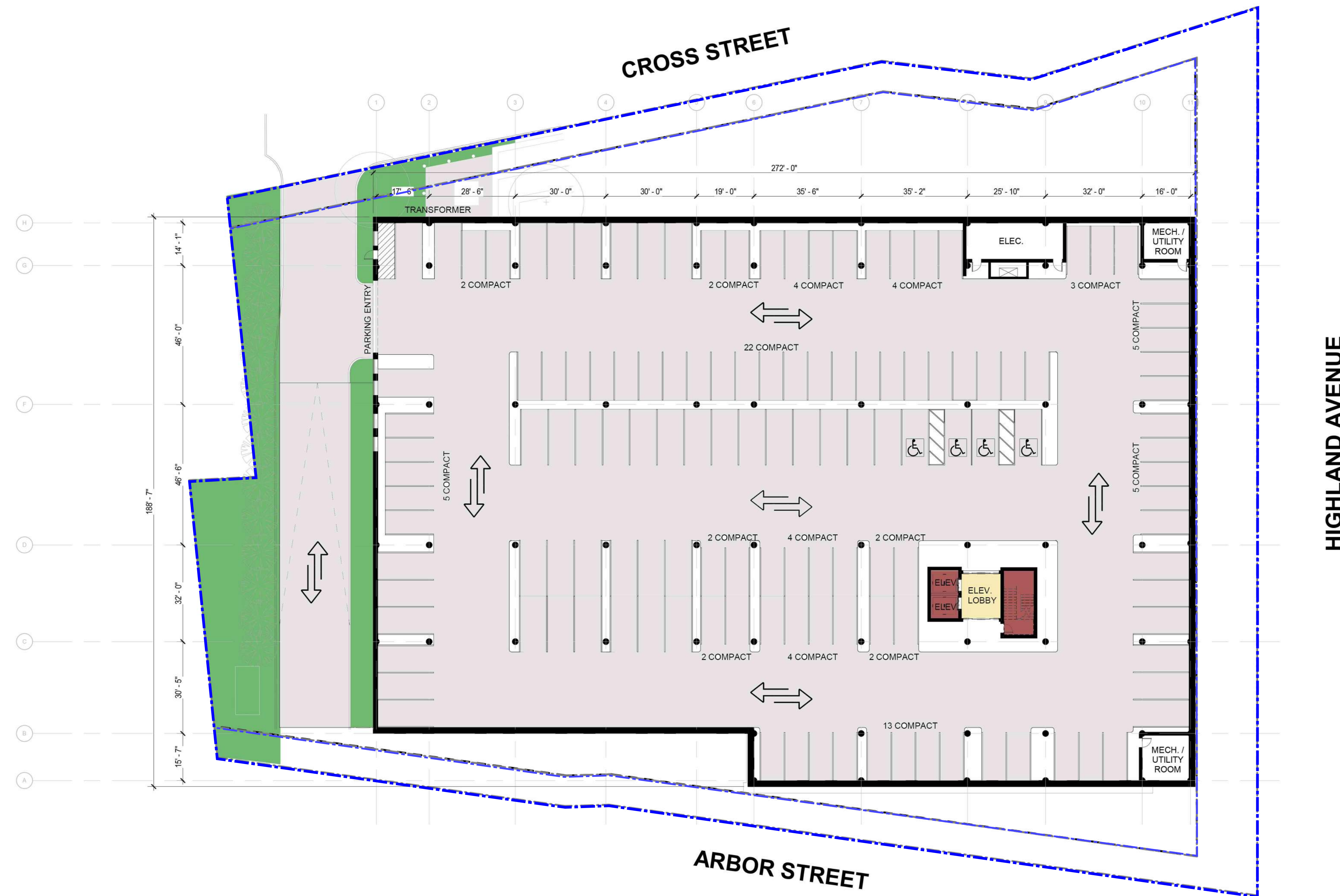
Sheet Number:

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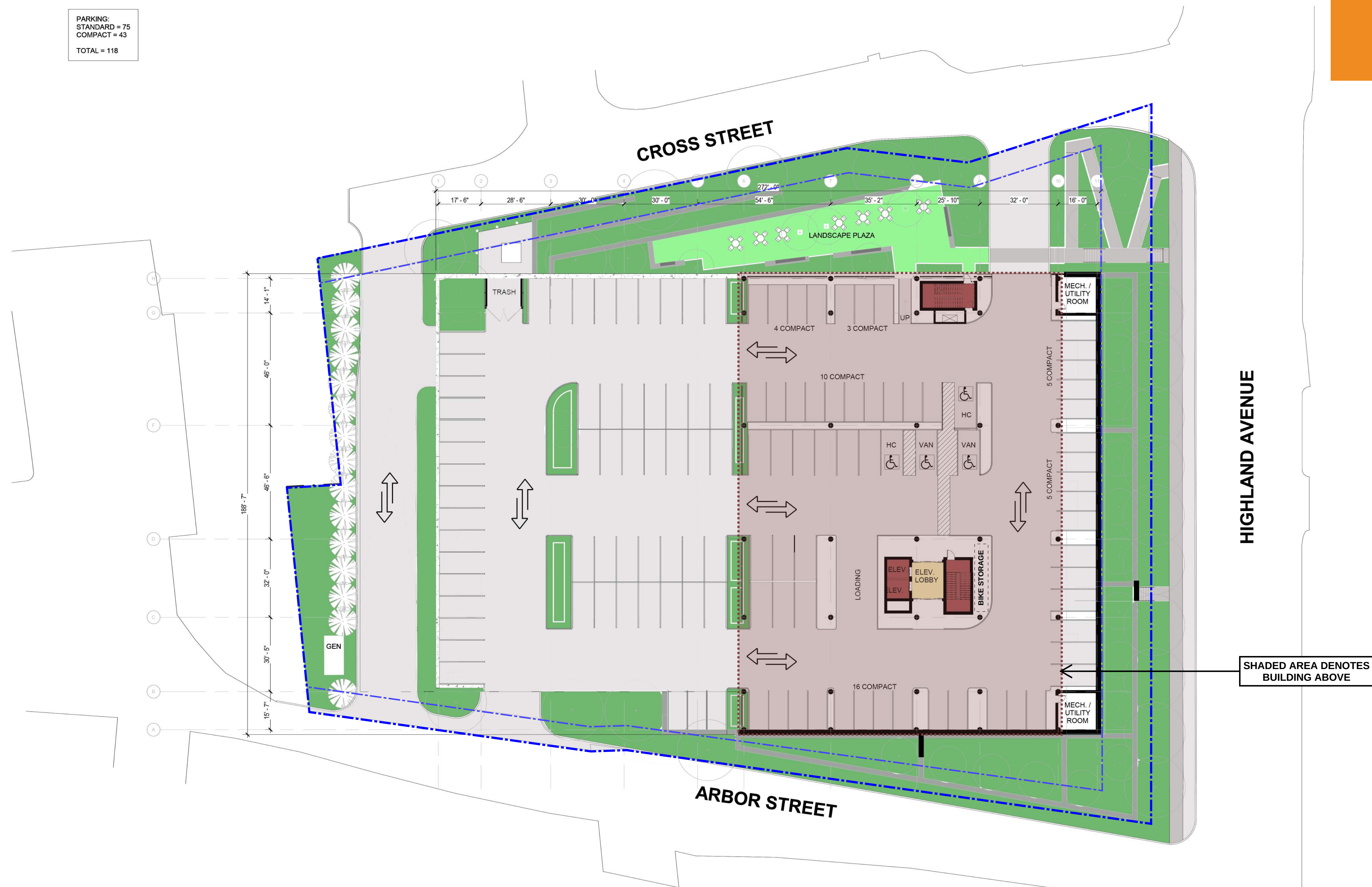
Medical Office Building
50,000 SF
250 Parking Spaces



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



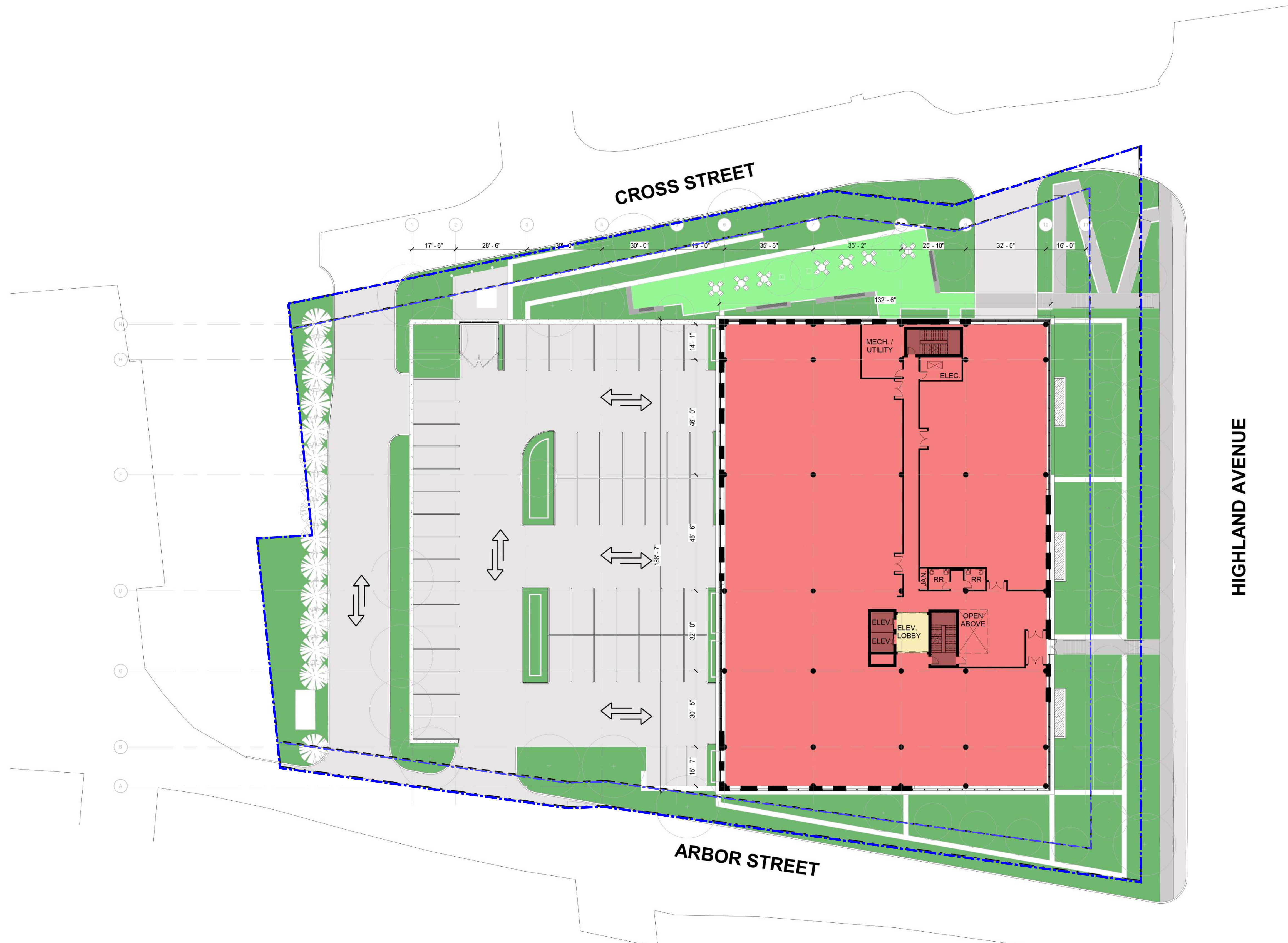
Highland Ave MOB / P-2 Upper Parking / 14 July 2023



Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / MAUGEL.COM

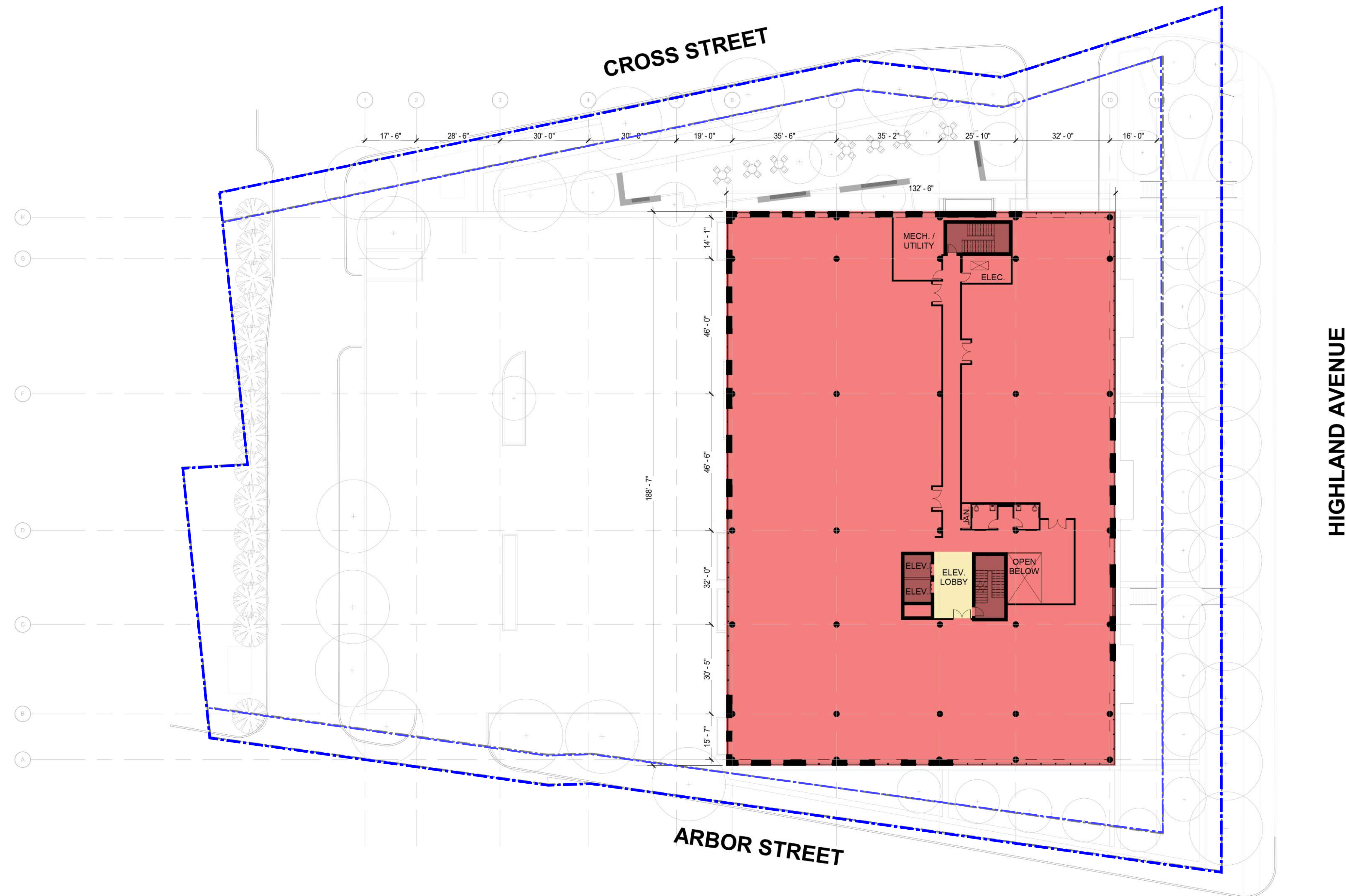


Medical Office Building
50,000 SF
250 Parking Spaces



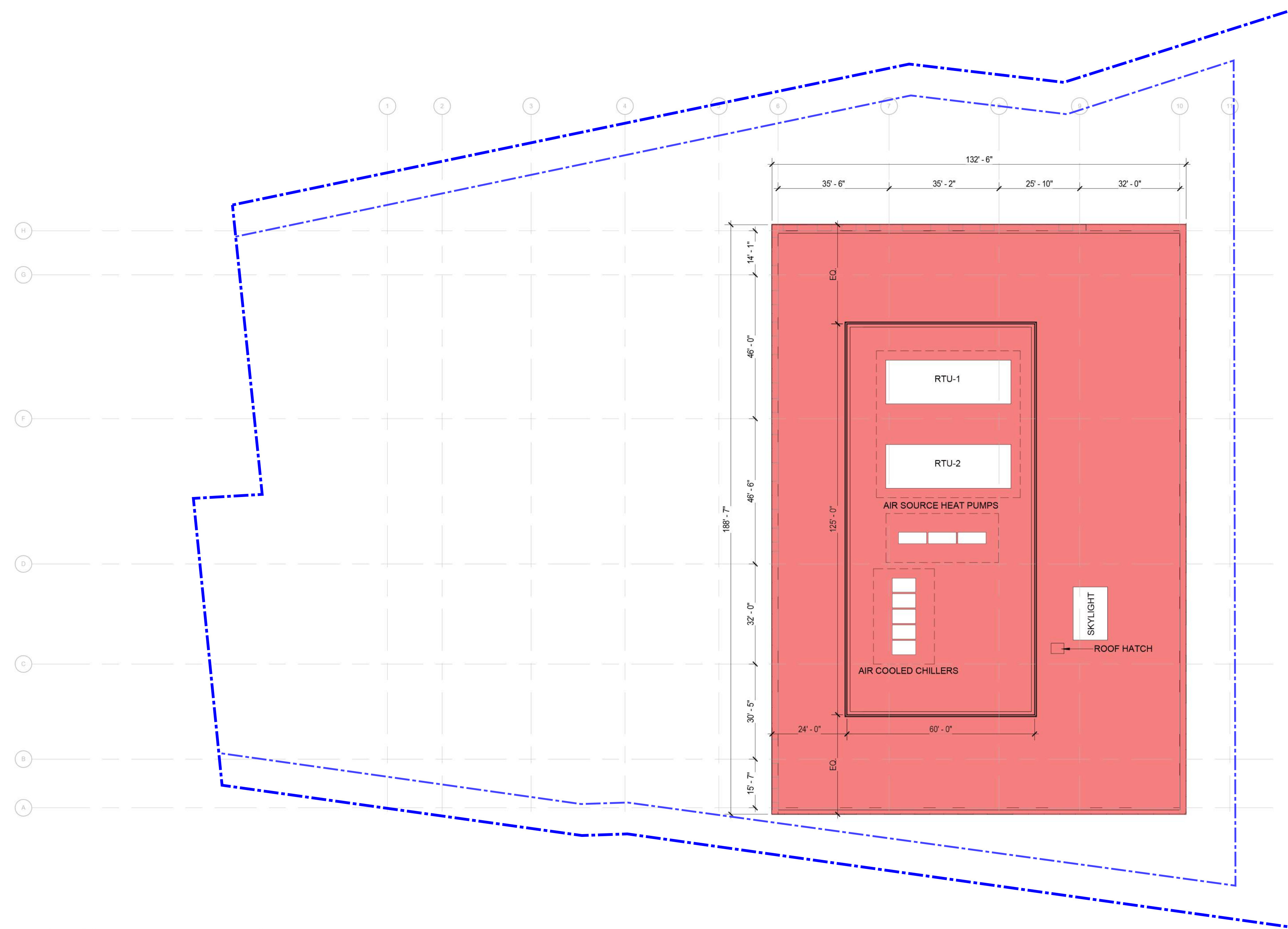
Highland Ave MOB / First Floor Plan / 14 July 2023

Medical Office Building
50,000 SF
250 Parking Spaces

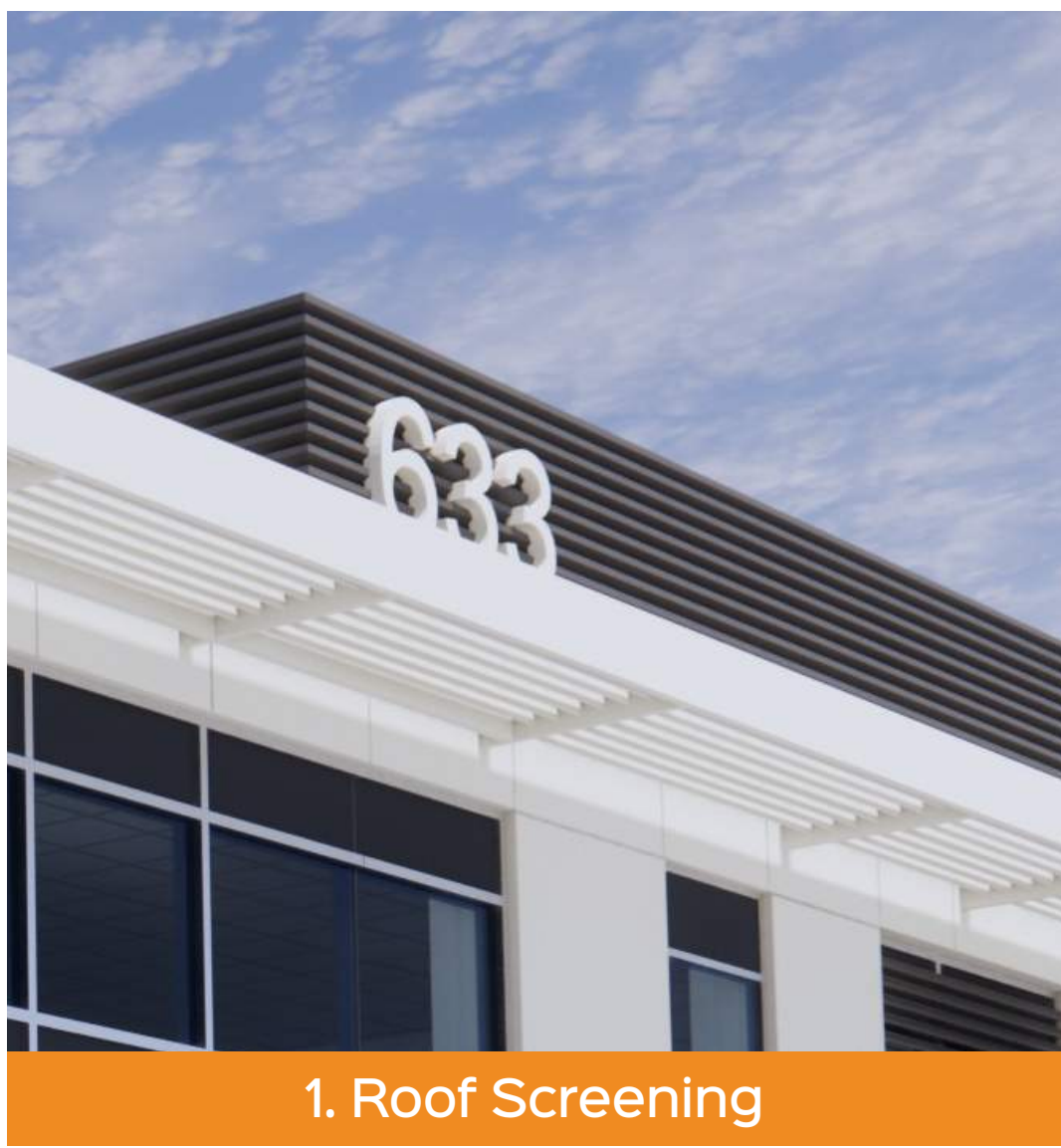


Highland Ave MOB / Second Floor Plan / 14 July 2023

Medical Office Building
50,000 SF
250 Parking Spaces



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



1. Roof Screening



4. Sunscreen



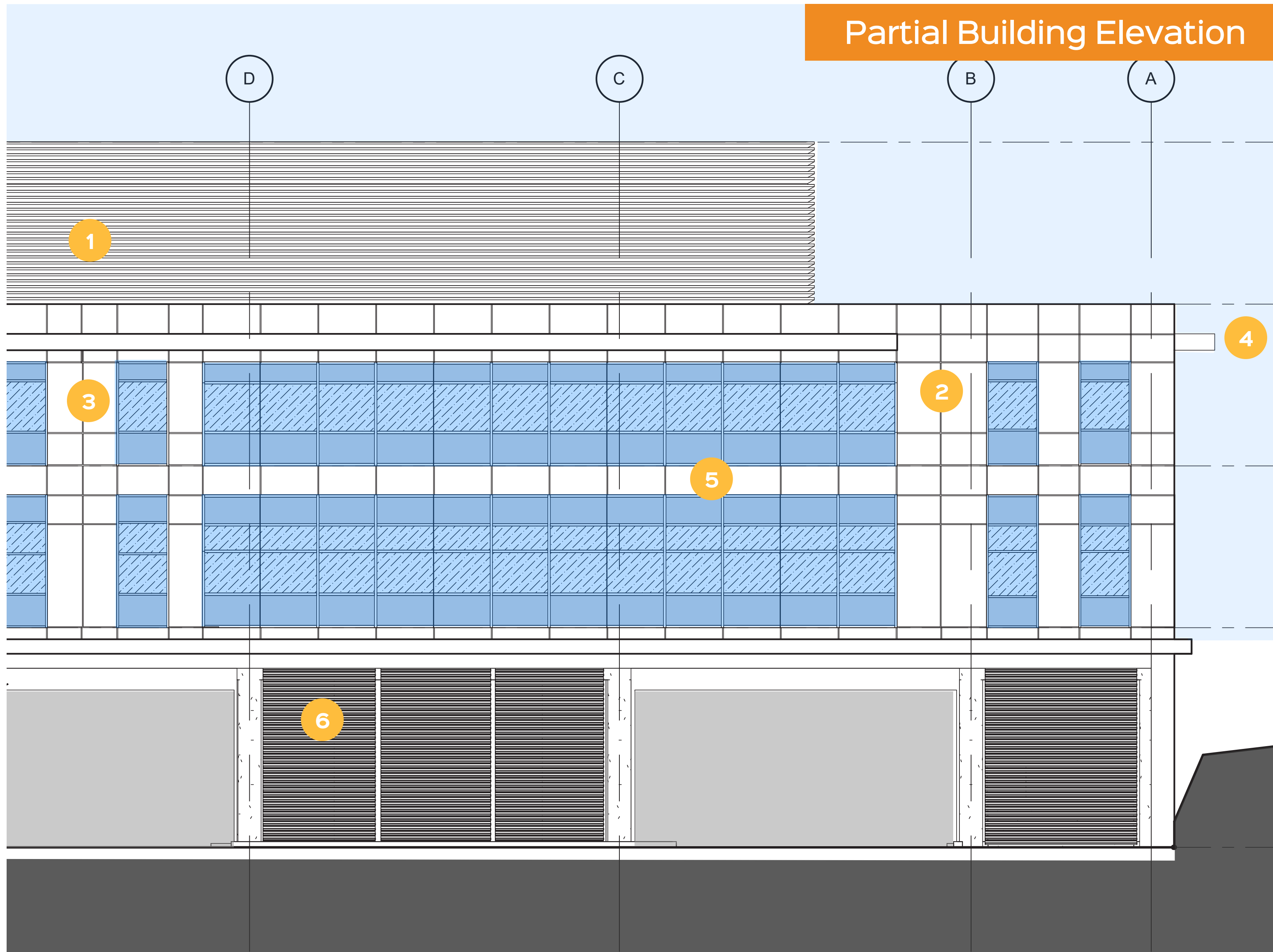
5. Curtainwall



2. Metal Panel



3. Windows











View at Cross Street Below Grade Garage Entrance



Highland Ave MOB / Concept Renderings / 14 July 2023



Shaping the Exceptional / 200 Ayer Road Suite 200 / Harvard, MA 01451 / 978 456 2800 / [MAUGEL.COM](https://maugel.com)





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

CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION.....	5
Project Description.....	5
Study Methodology	6
EXISTING CONDITIONS	7
Roadways	7
Intersections.....	8
Traffic Volumes	10
Pedestrian and Bicycle Facilities.....	11
Public Transportation	11
Spot Speed Measurements.....	12
Motor Vehicle Crash Data.....	12
FUTURE CONDITIONS	15
Future Traffic Growth	15
Project-Generated Traffic.....	17
Trip Distribution and Assignment.....	18
Future Traffic Volumes - Build Condition.....	18
TRAFFIC OPERATIONS ANALYSIS	20
Methodology	20
Analysis Results	23

CONTENTS (Continued)

SIGHT DISTANCE EVALUATION.....	30
CONCLUSIONS AND RECOMMENDATIONS	32
Conclusions	32
Recommendations	33

FIGURES

No.	Title
1	Site Location Map
2	Existing Intersection Lane Use, Travel Lane Width and Pedestrian Facilities
3	2023 Existing Weekday Morning Peak-Hour Traffic Volumes
4	2023 Existing Weekday Evening Peak-Hour Traffic Volumes
5	2030 No Build Weekday Morning Peak-Hour Traffic Volumes
6	2030 No Build Weekday Evening Peak-Hour Traffic Volumes
7	Trip Distribution Map
8	Project Generated Weekday Morning Peak-Hour Traffic Volumes
9	Project Generated Weekday Evening Peak-Hour Traffic Volumes
10	2030 Build Weekday Morning Peak-Hour Traffic Volumes
11	2030 Build Weekday Evening Peak-Hour Traffic Volumes

TABLES

No.	Title
1	Study Area Intersection Description
2	2023 Existing Traffic Volumes
3	Vehicle Travel Speed Measurements
4	Motor Vehicle Crash Data Summary
5	Trip-Generation Summary
6	Traffic Volume Comparison
7	Peak-Hour Traffic-Volume Increases
8	Level-of-Service Criteria for Signalized Intersections
9	Level-of-Service Criteria for Unsignalized Intersections
10	Signalized Intersection Level-of-Service and Vehicle Queue Summary
11	Unsignalized Intersection Level-of-Service and Vehicle Queue Summary
12	Sight Distance Measurements
13	Mitigated Signalized Intersection Level-of-Service and Vehicle Queue Summary

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.

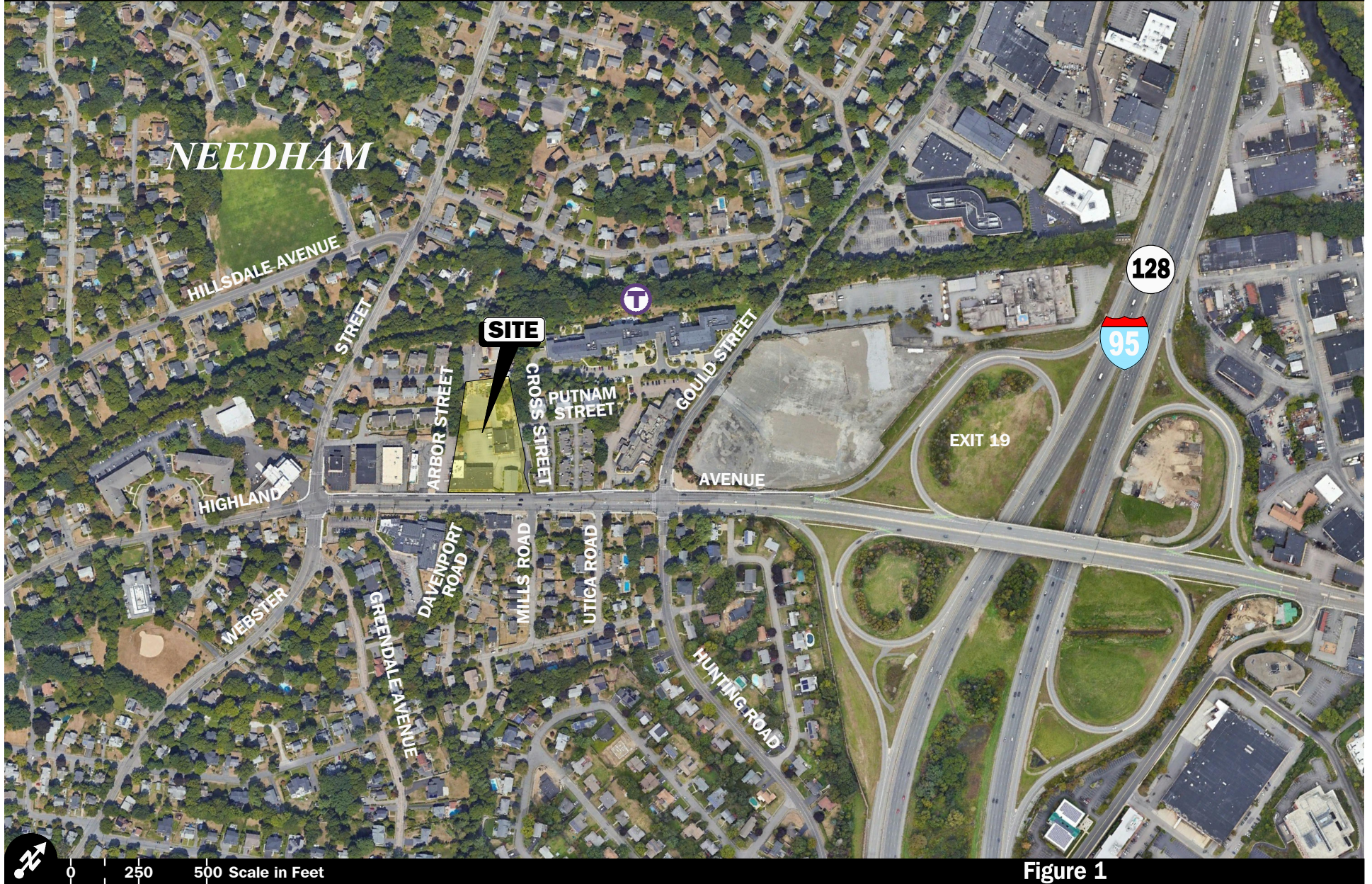


Figure 1

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

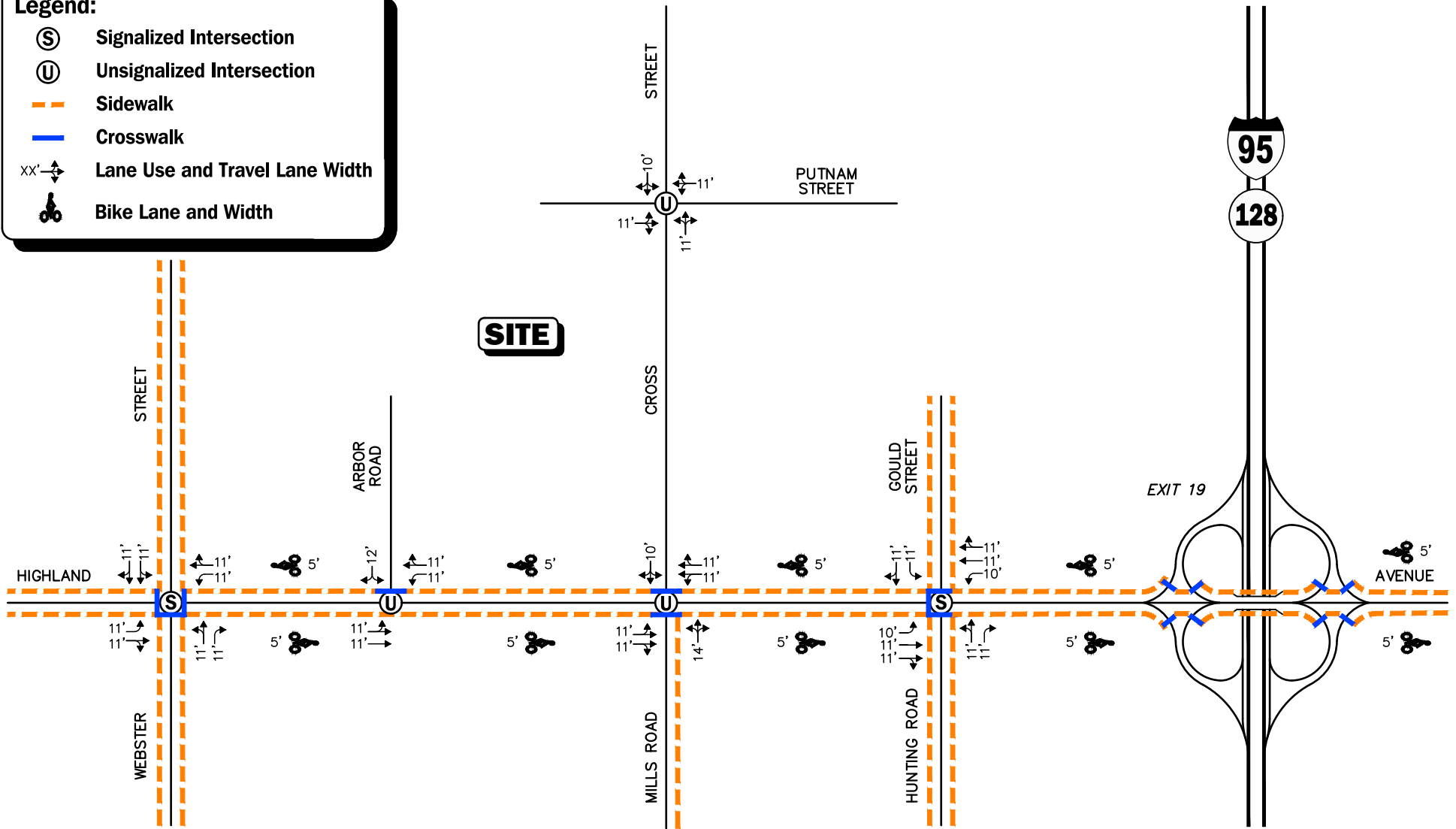
Intersection	Traffic Control Type^a	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
Highland Ave./ Webster St.	TS	1 left-turn lane and 1 through/right-turn lane on Highland Ave.; 1 left-turn/through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

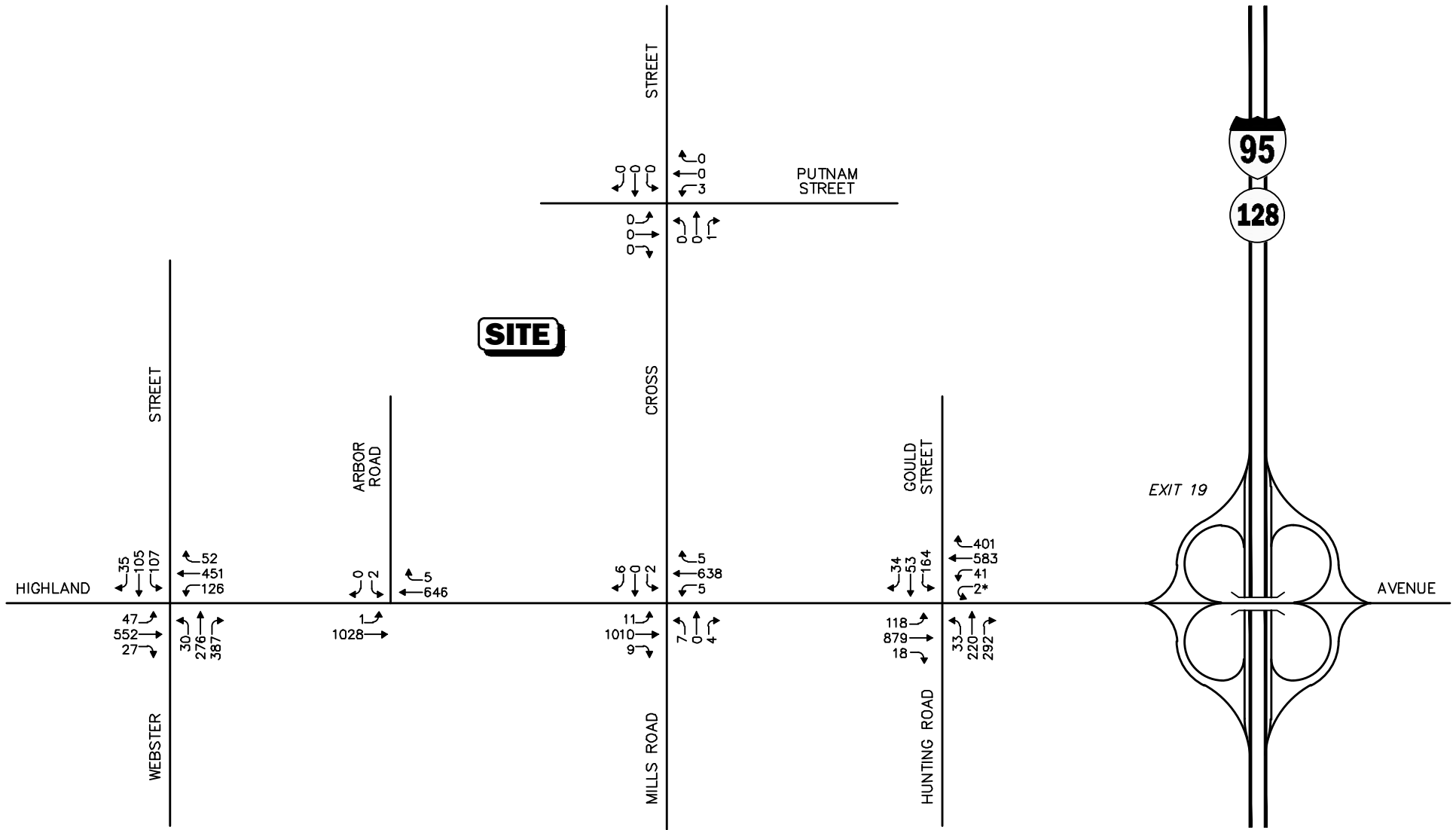
Traffic-Volume Adjustments

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.



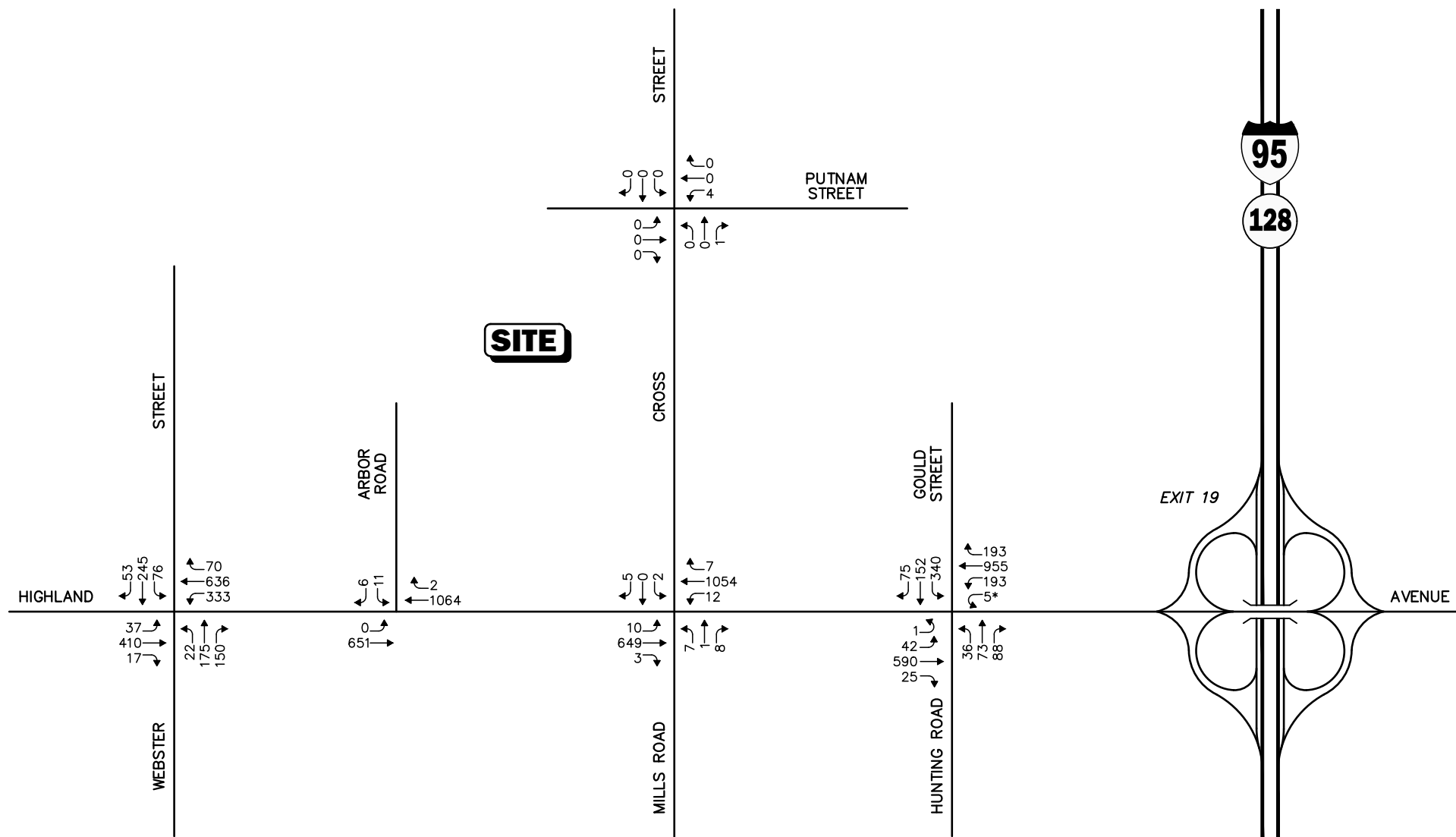
*Illegal maneuver

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

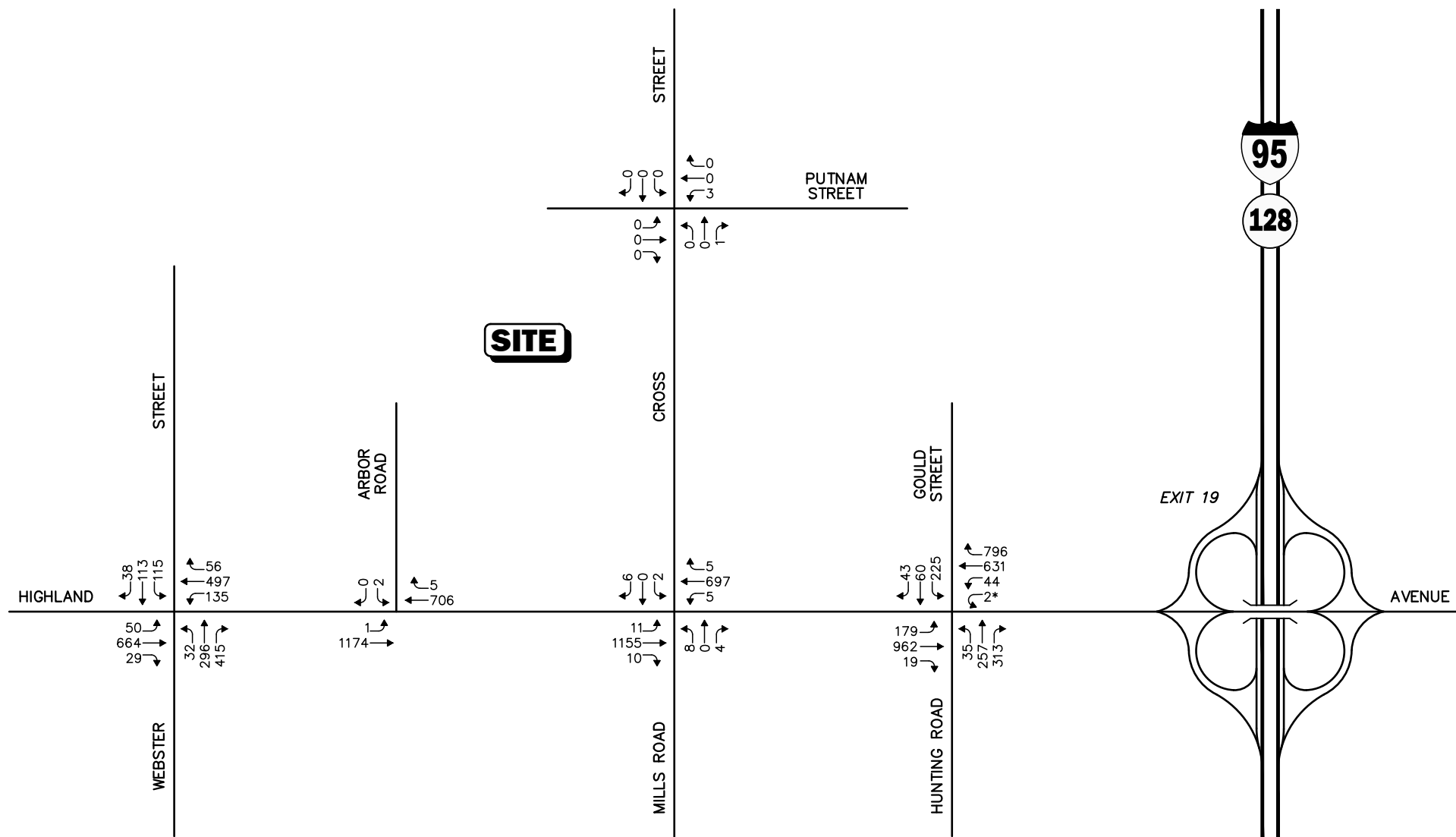
Time Period	Vehicle Trips ^a		
	Entering	Exiting	Total
<i>Average Weekday:</i>	900	900	1,800
<i>Weekday Morning Peak-Hour:</i>	102	27	129
<i>Weekday Evening Peak-Hour:</i>	60	140	200

^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

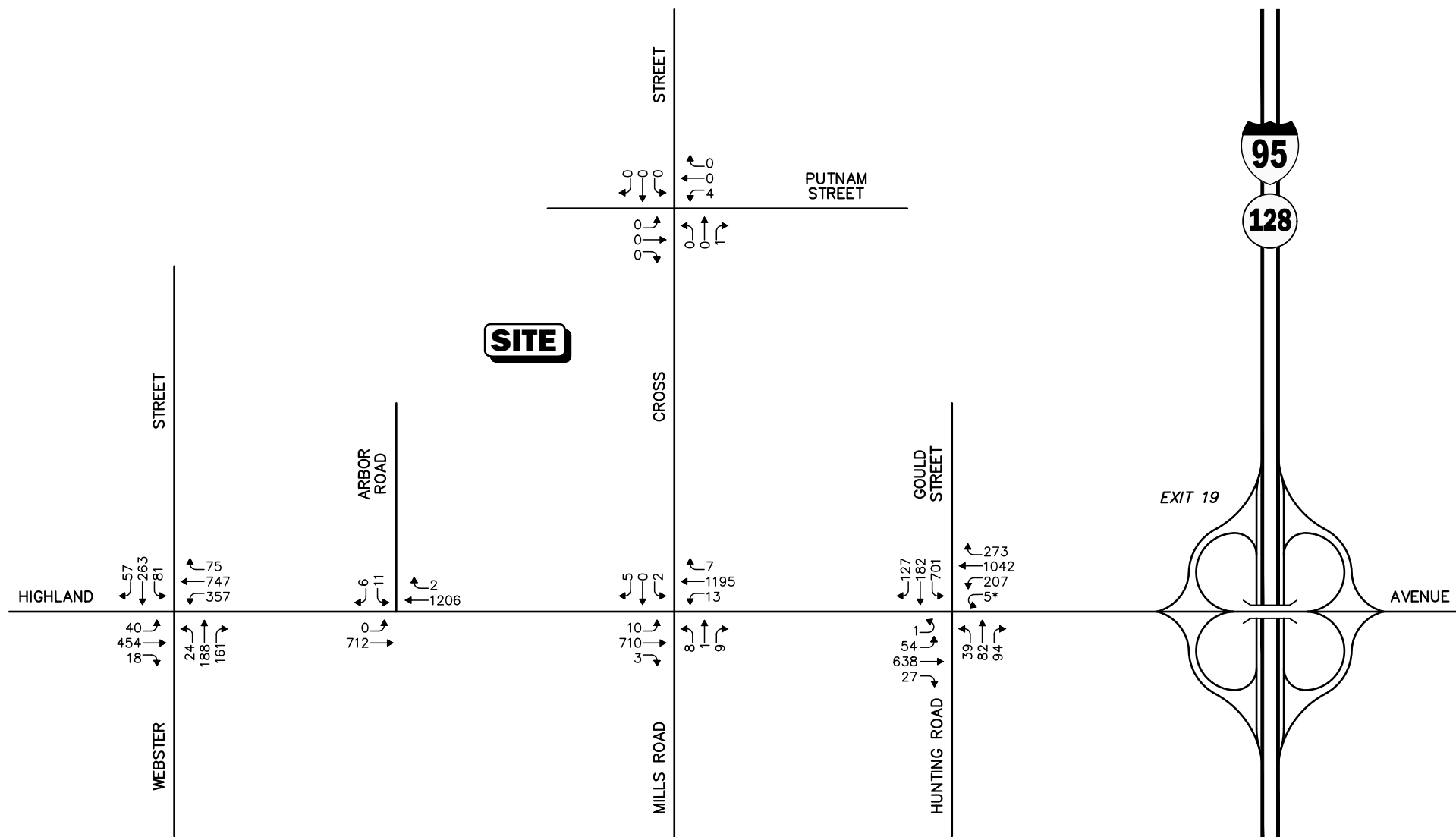
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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

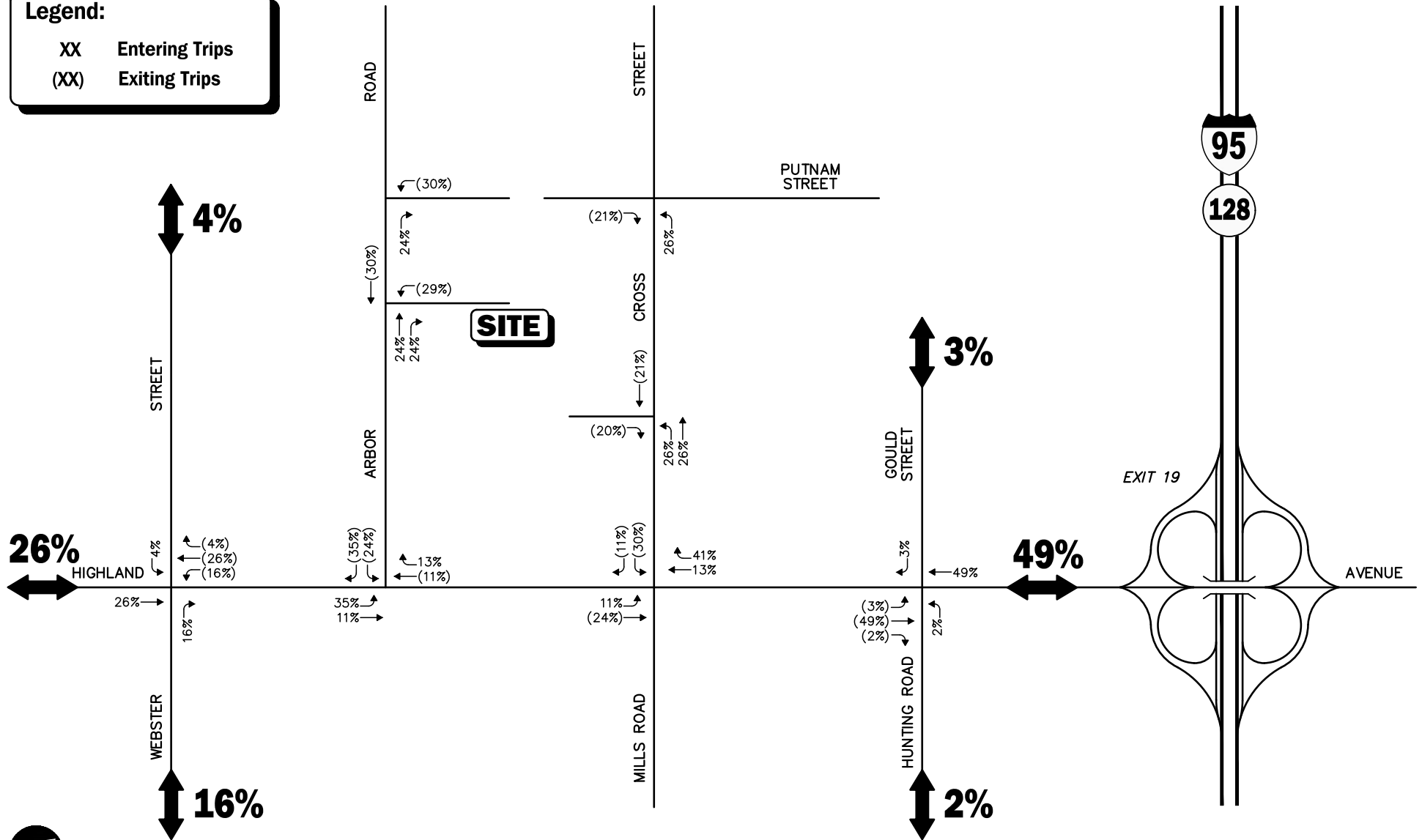
The directional distribution of generated trips to and from the Project site was developed based on a review of existing traffic patterns within the study area. The general trip distribution for the Project is graphically depicted on Figure 7. The additional traffic expected to be generated by the Project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



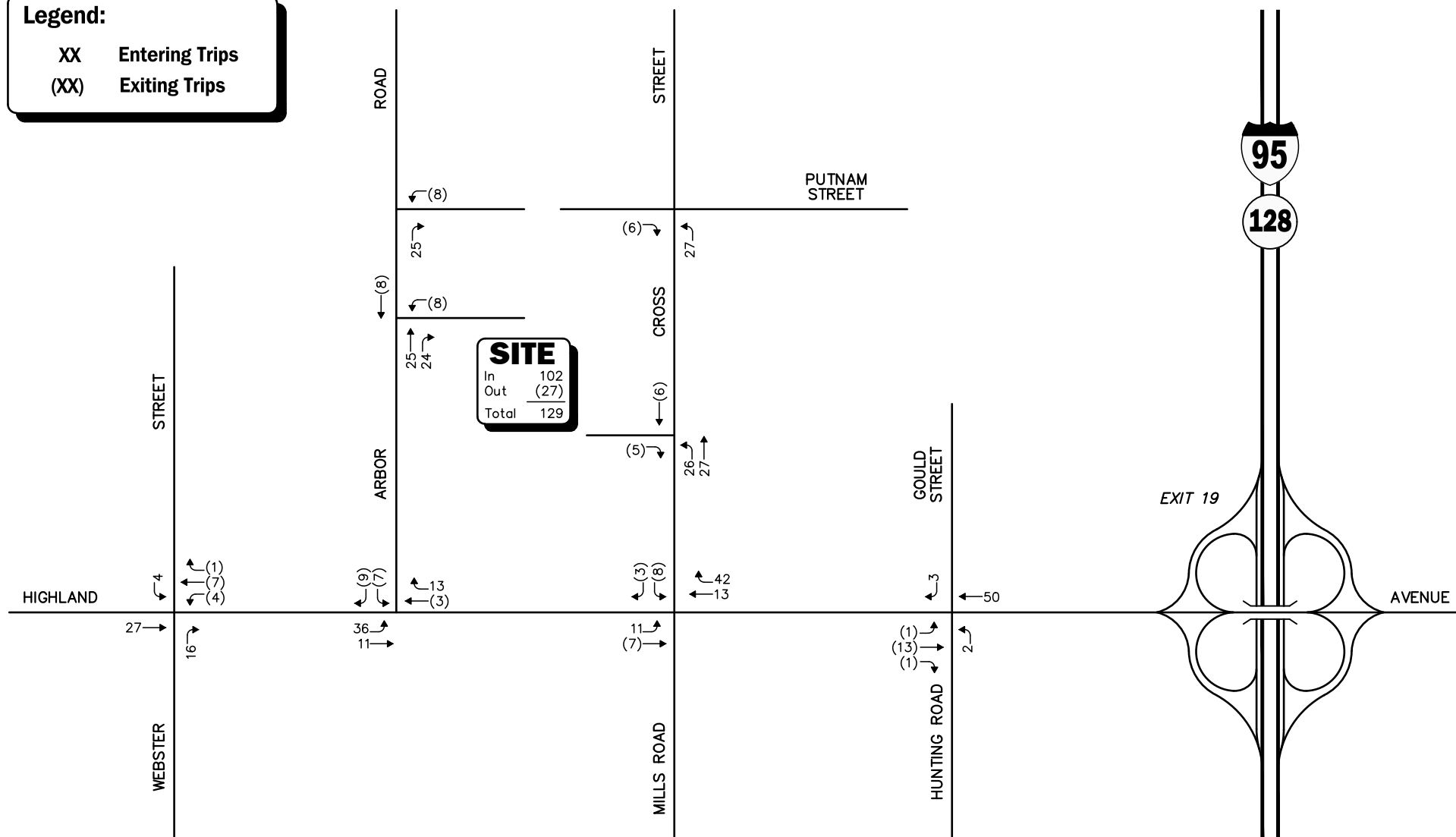
Not To Scale

Figure 7

Trip Distribution Map

Legend:

XX Entering Trips
(XX) Exiting Trips



Not To Scale

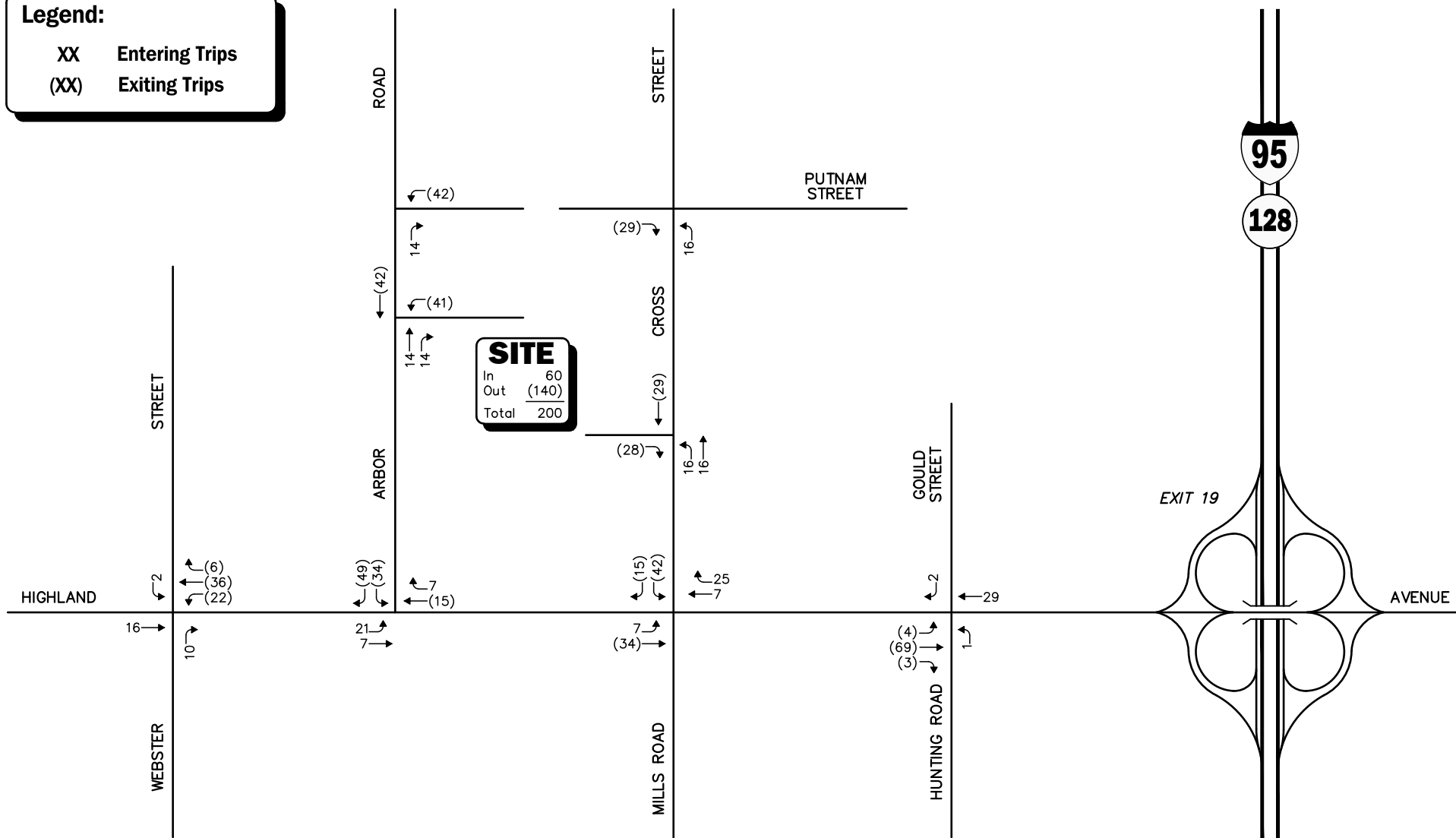
VA Vanasse & Associates inc

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**



Not To Scale

2030 Build Weekday Morning Peak Hour Traffic Volumes

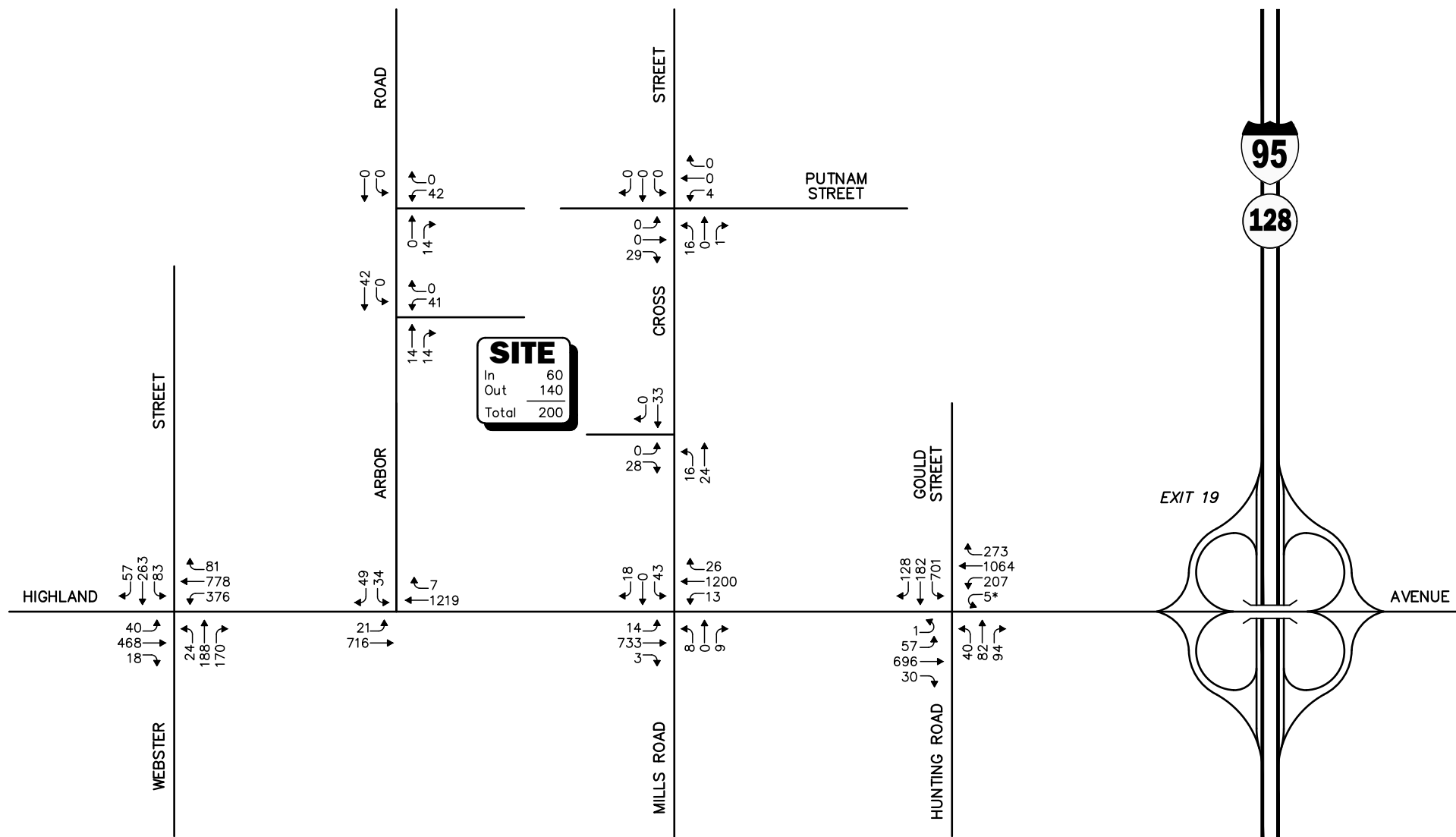


Figure 11

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

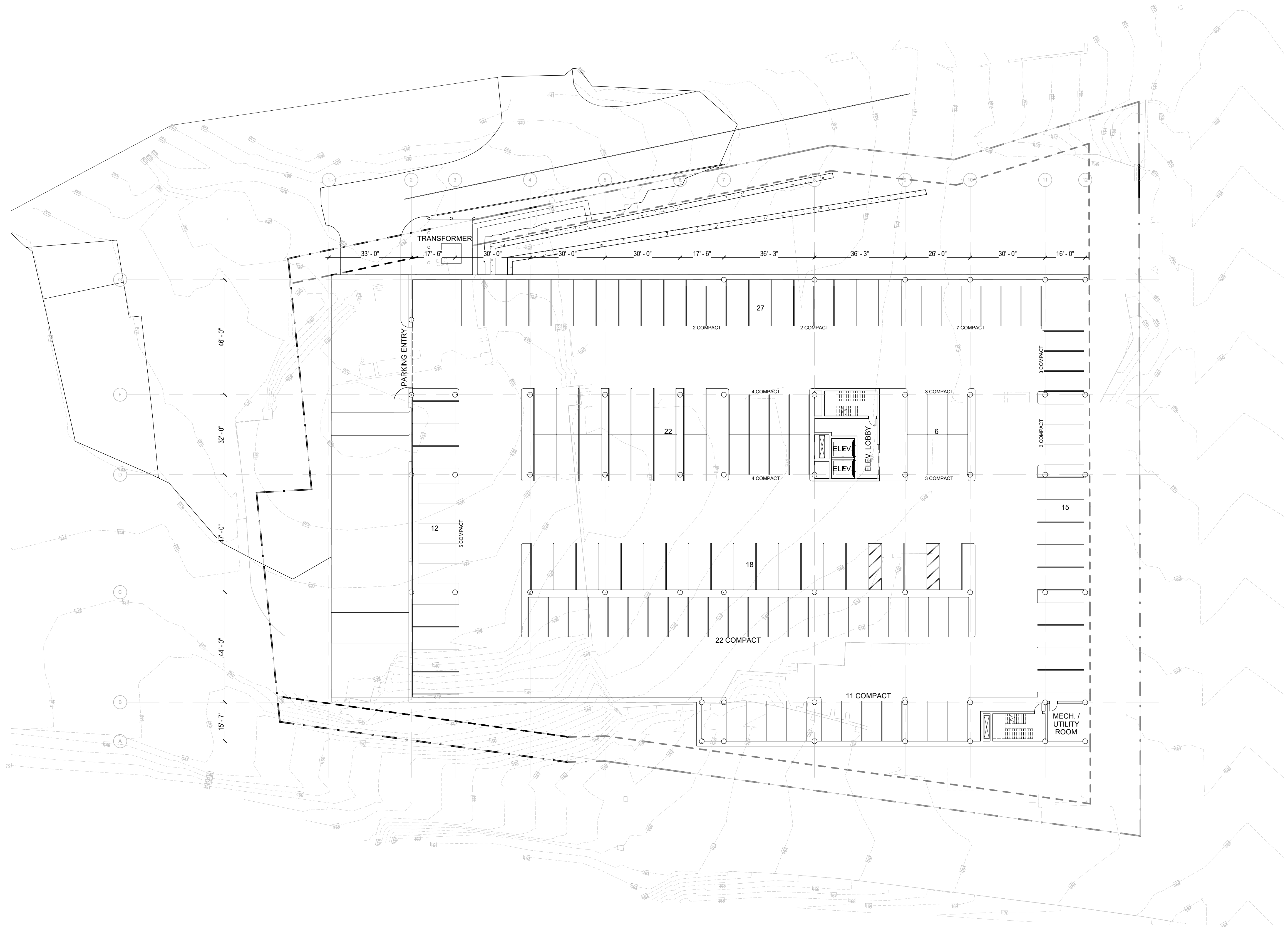
EXISTING TRIP-GENERATION CALCULATIONS

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:

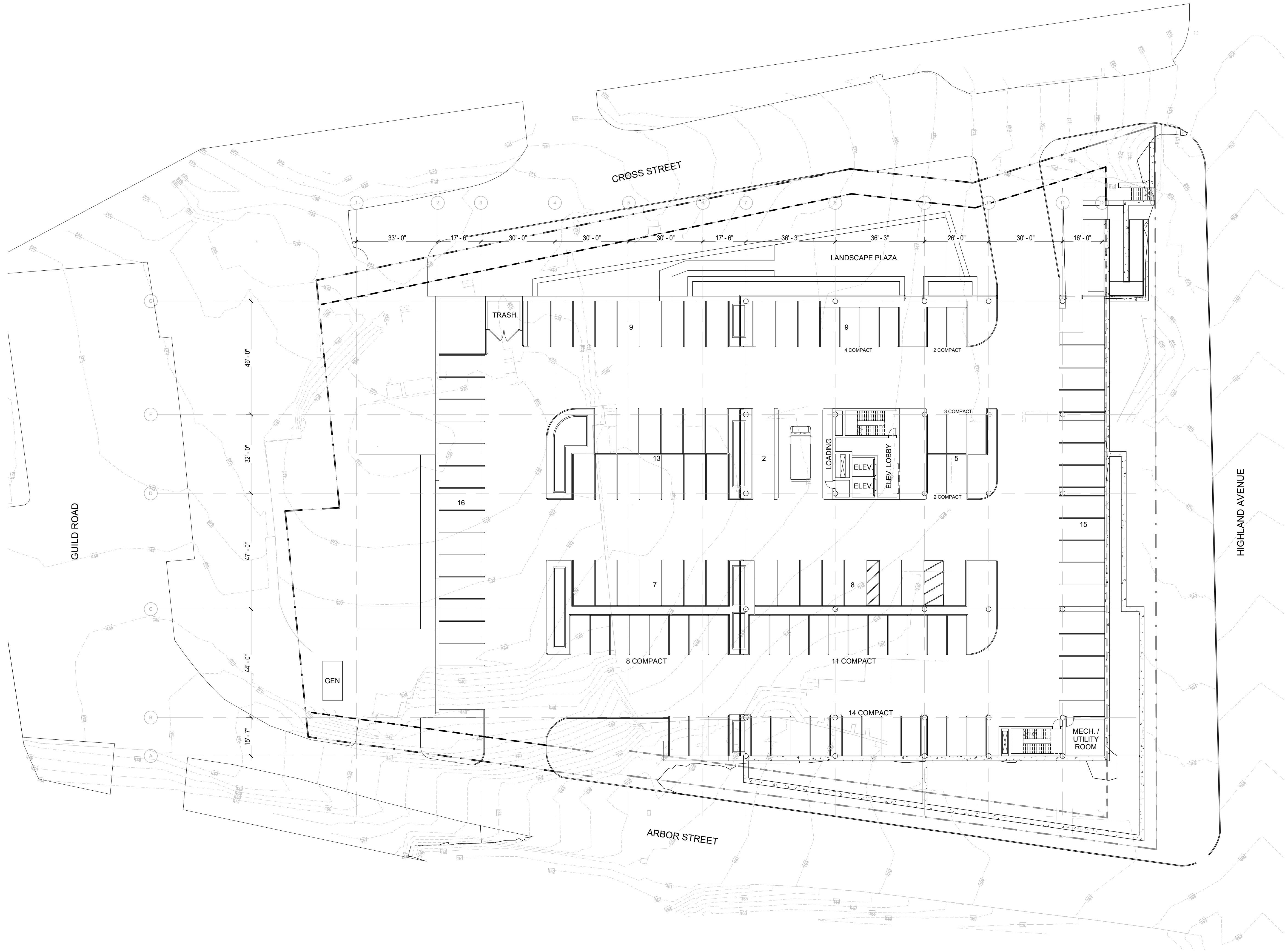
P-1 Parking Plan

Sheet Number:

A.101

MAUGEL ARCHITECTS
200 AYER ROAD / SUITE 200
HAVERHILL, MA 01831
978 456 2800
MAUGEL.COM

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

Comb. Total	0	0	19169	19337	0	0	0	19252
ADT	ADT 19,253	AADT 19,253						

Accurate Counts
978-664-2565

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

Accurate Counts
978-664-2565

Location : Highland Avenue
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

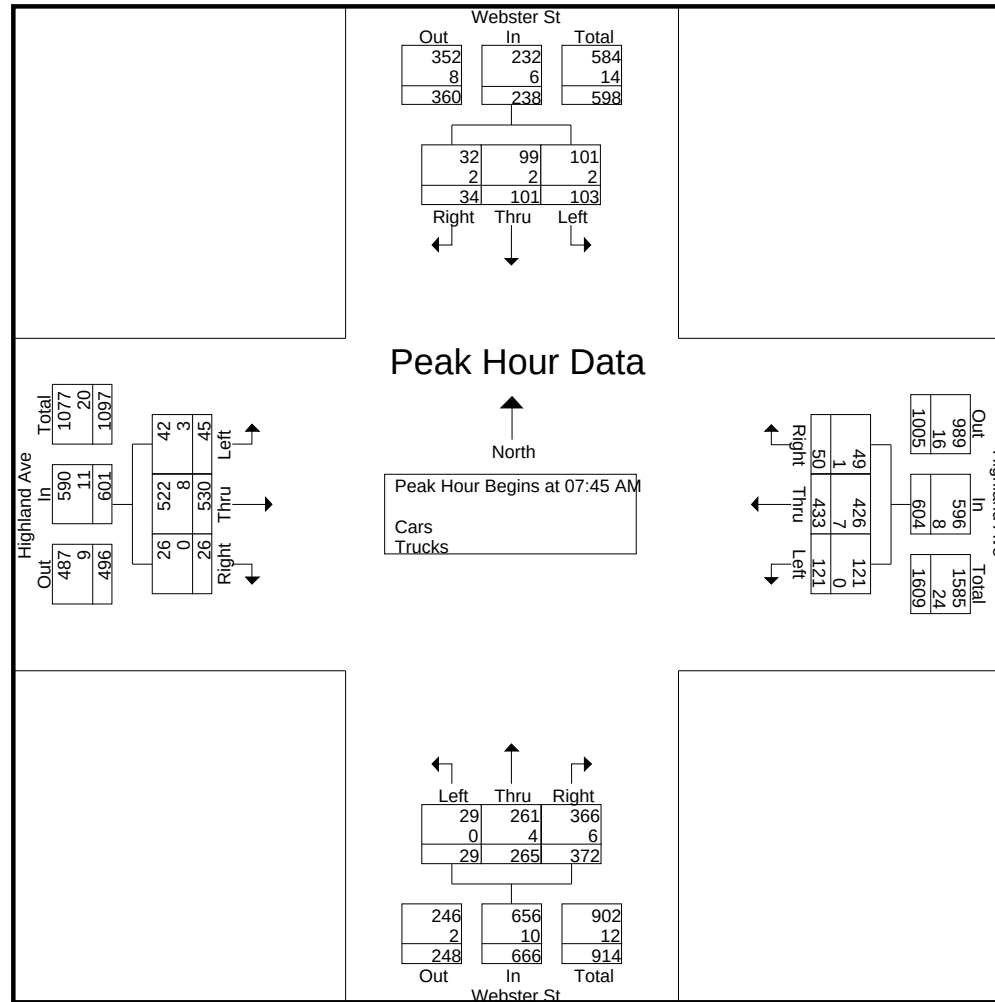
	Webster St From North				Highland Ave From East				Webster St From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
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



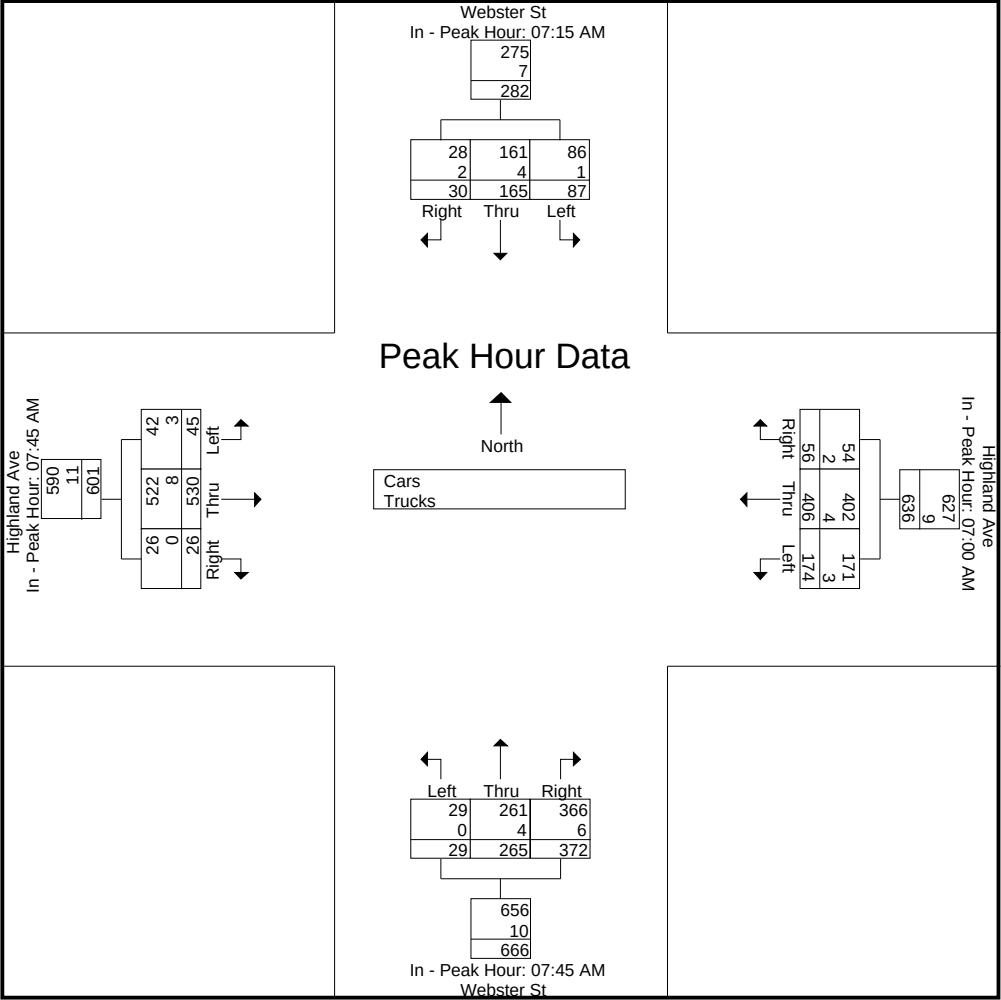
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

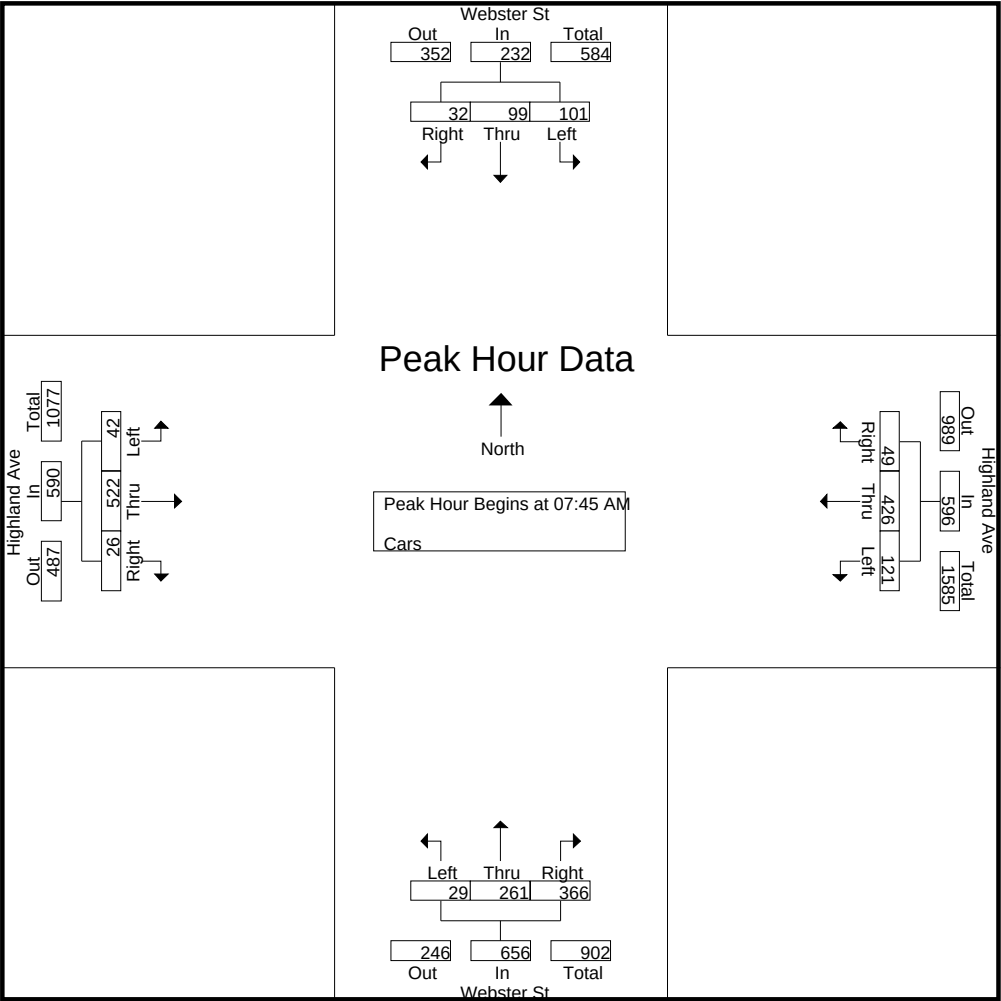
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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

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

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



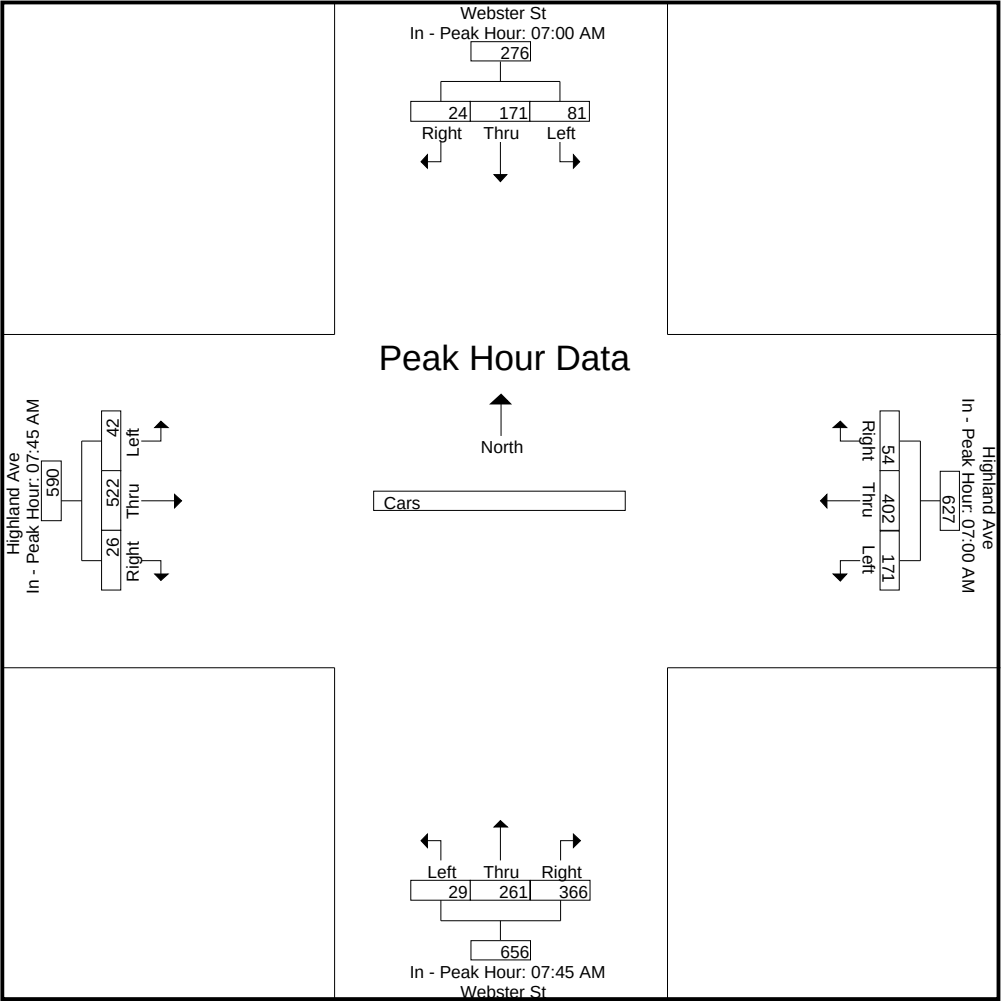
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

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



Accurate Counts

978-664-2565

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

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

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

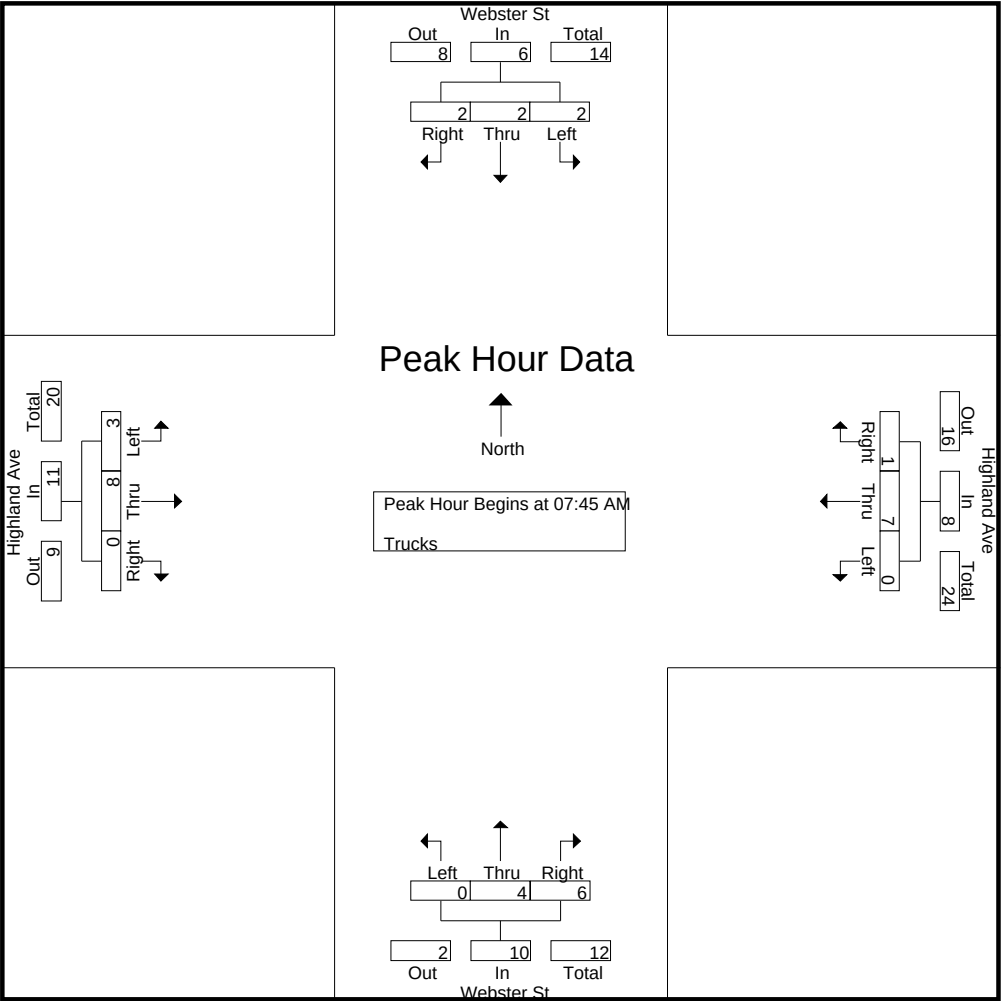
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



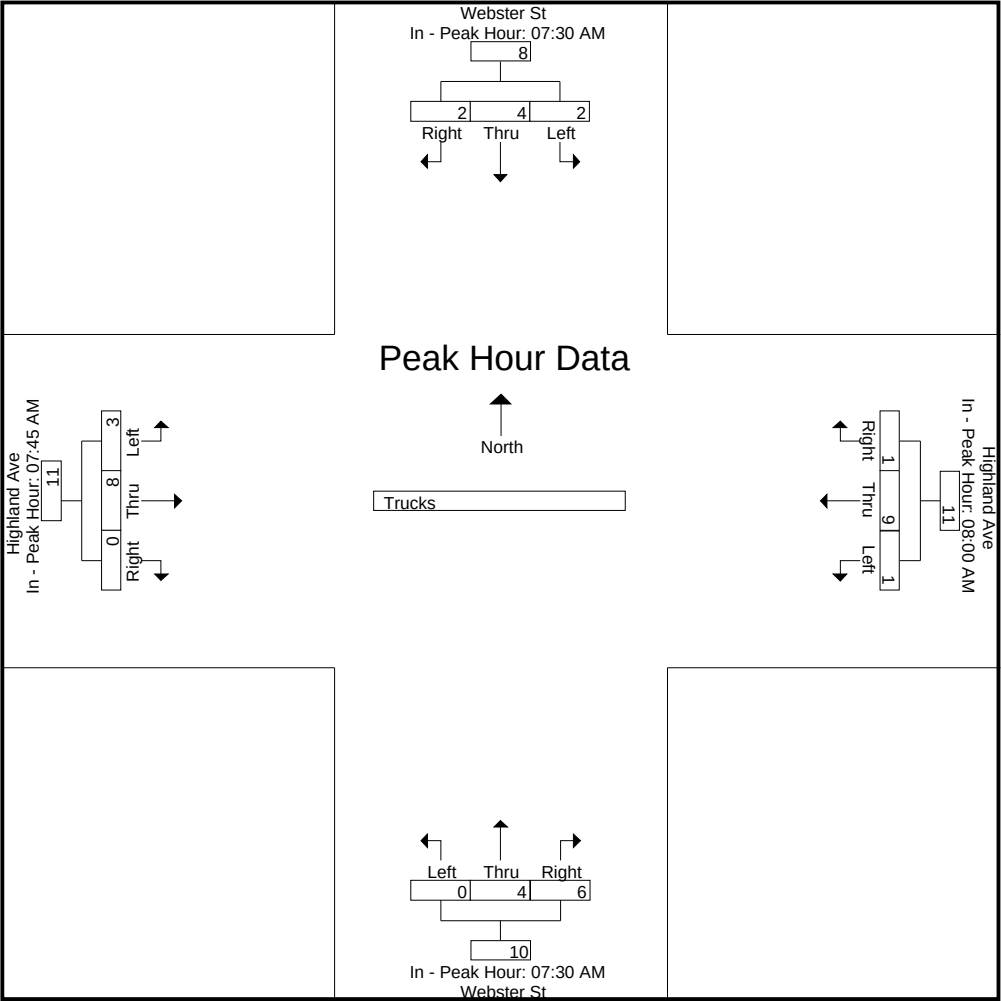
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

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

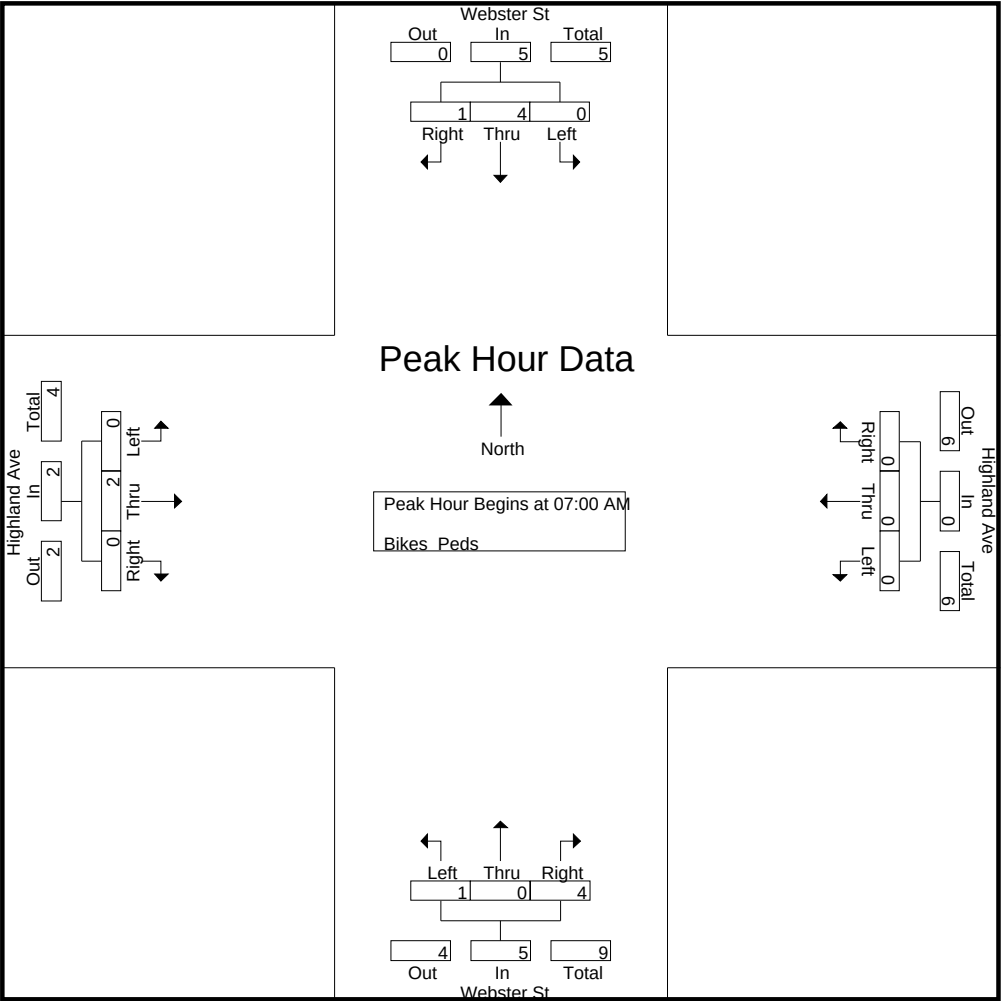
File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 14

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

Accurate Counts
978-664-2565

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

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



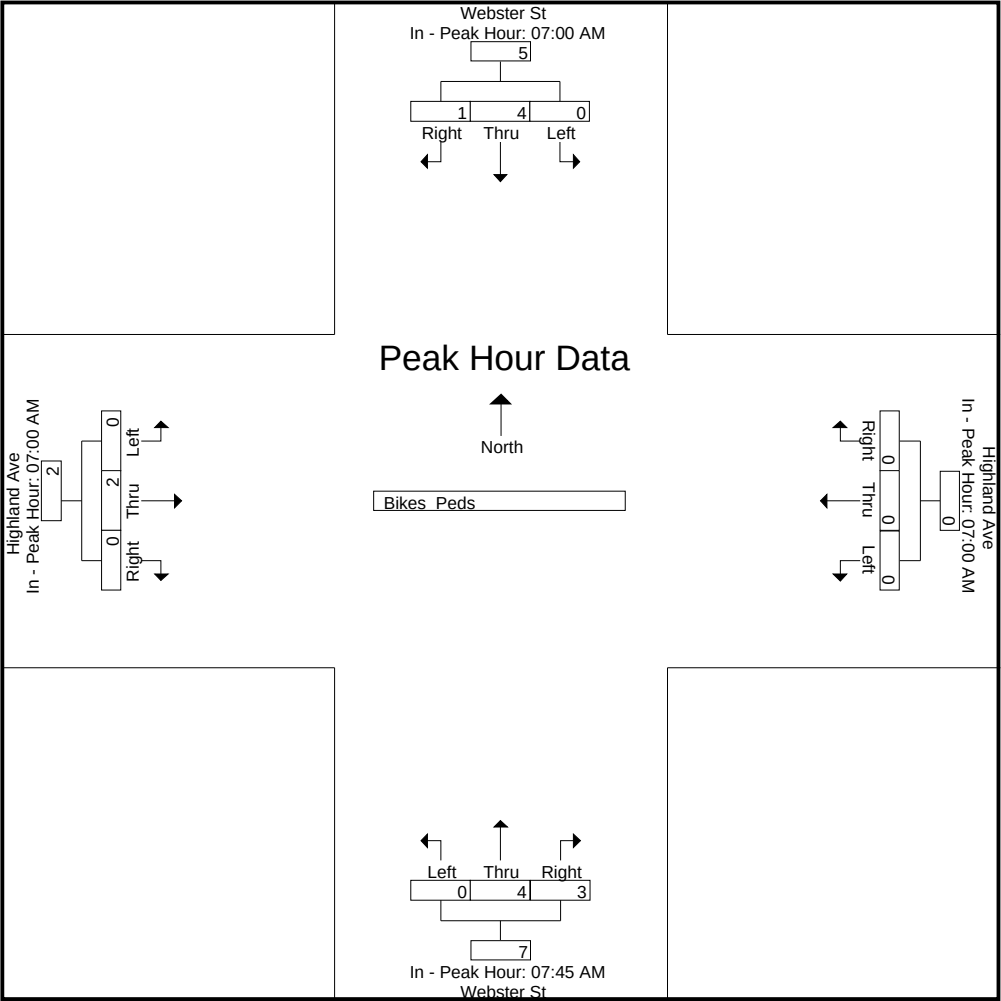
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

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



Accurate Counts

978-664-2565

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

File Name : 83150001
Site Code : 83150001
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars - Trucks

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

Accurate Counts

978-664-2565

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

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

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

Accurate Counts

978-664-2565

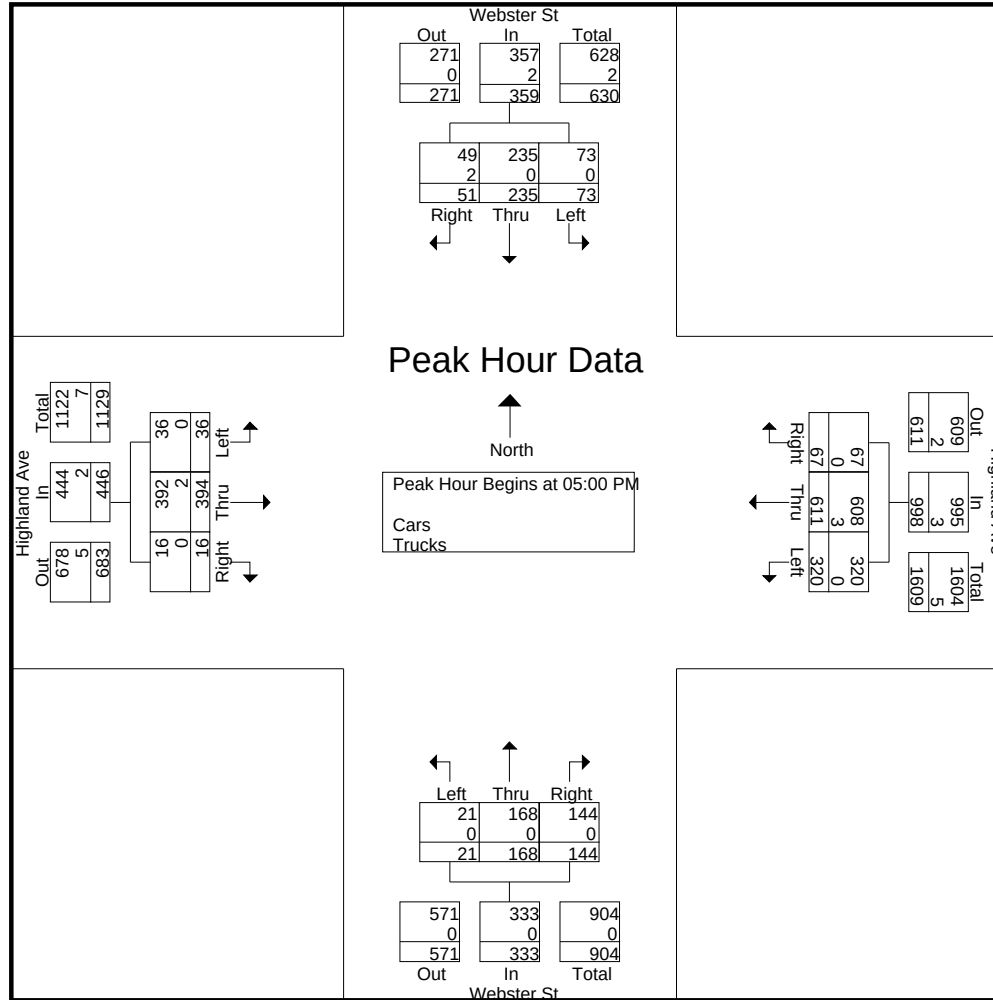
File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 3

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



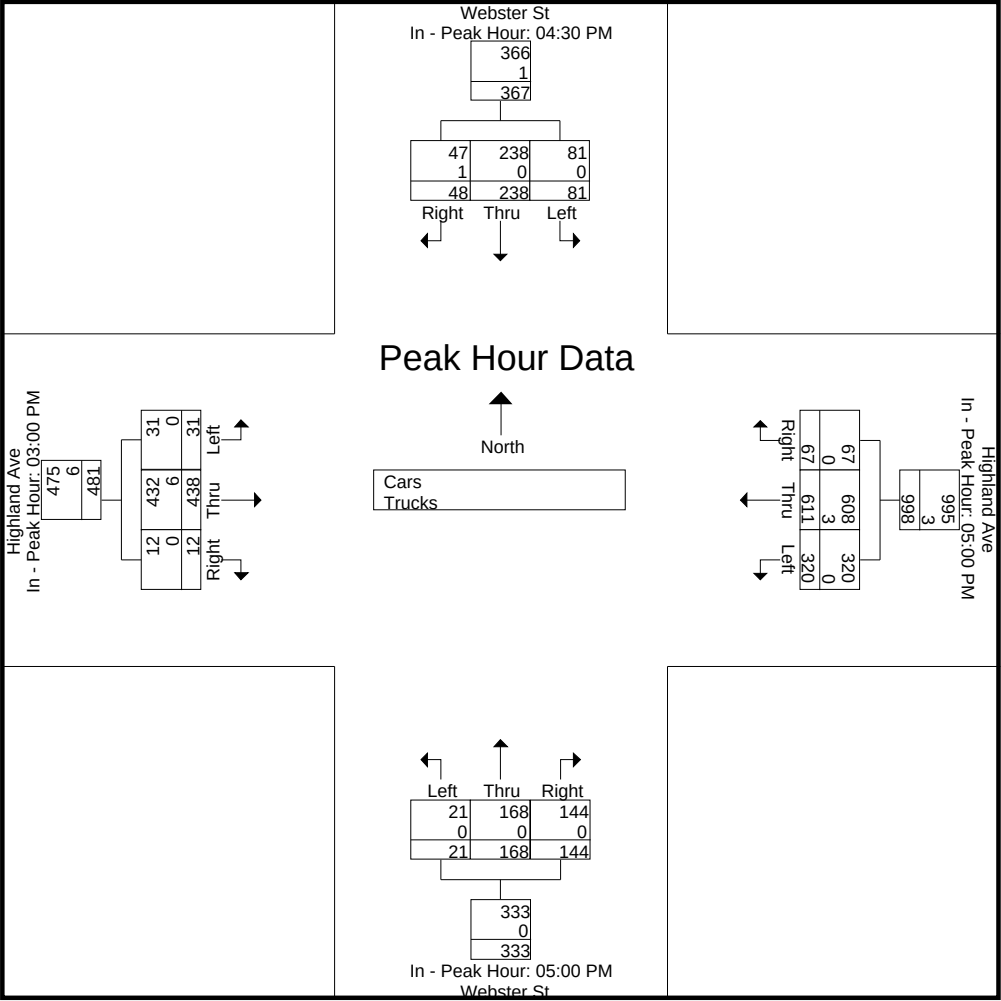
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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

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 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

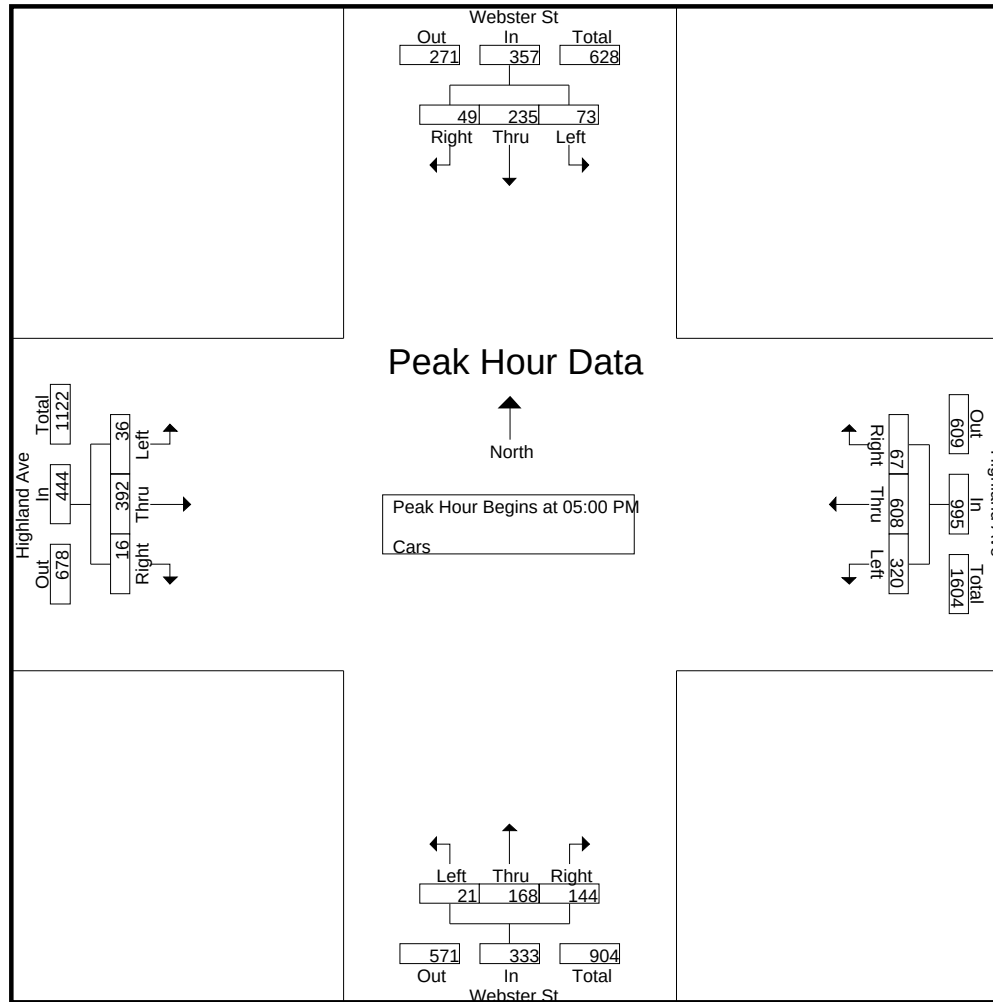
File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 7

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

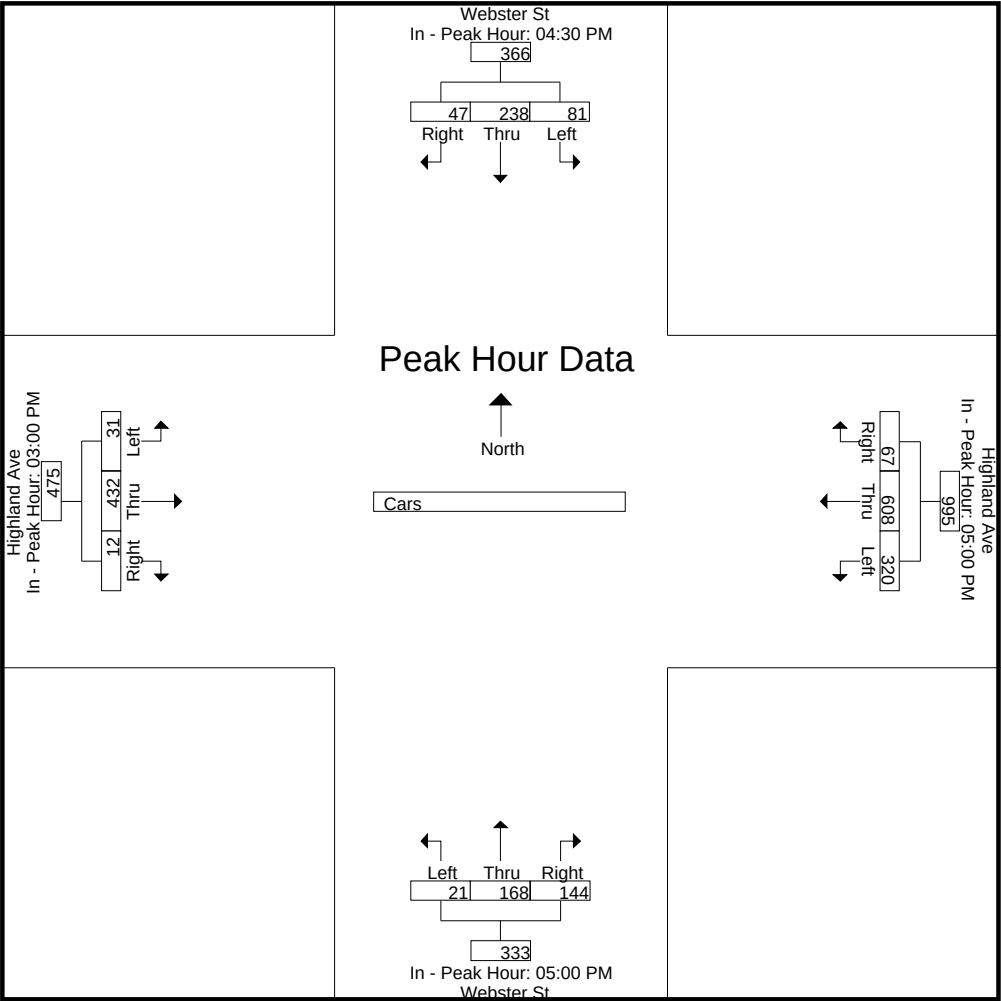
Peak Hour for Each Approach Begins at:

	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
Page No : 8



Accurate Counts

978-664-2565

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

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

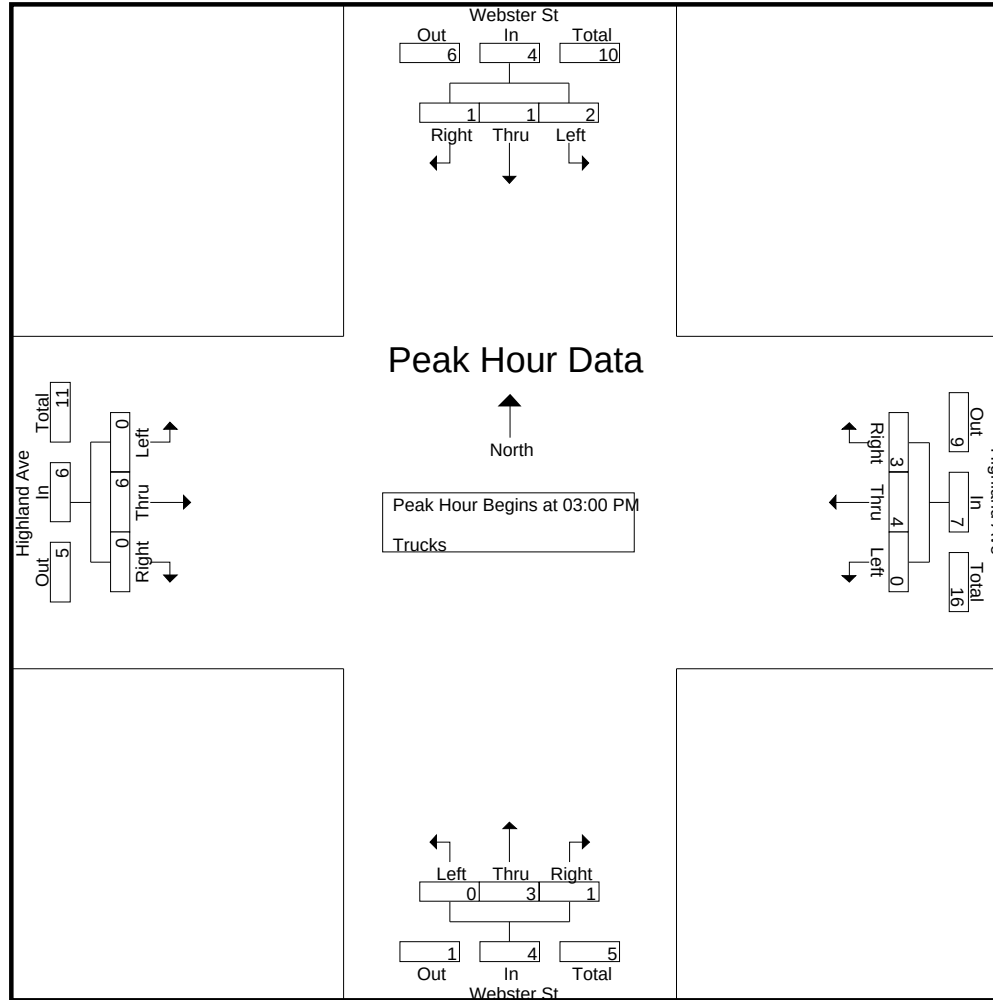
File Name : 83150001

Site Code : 83150001

Start Date : 9/4/2019

Page No : 11

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

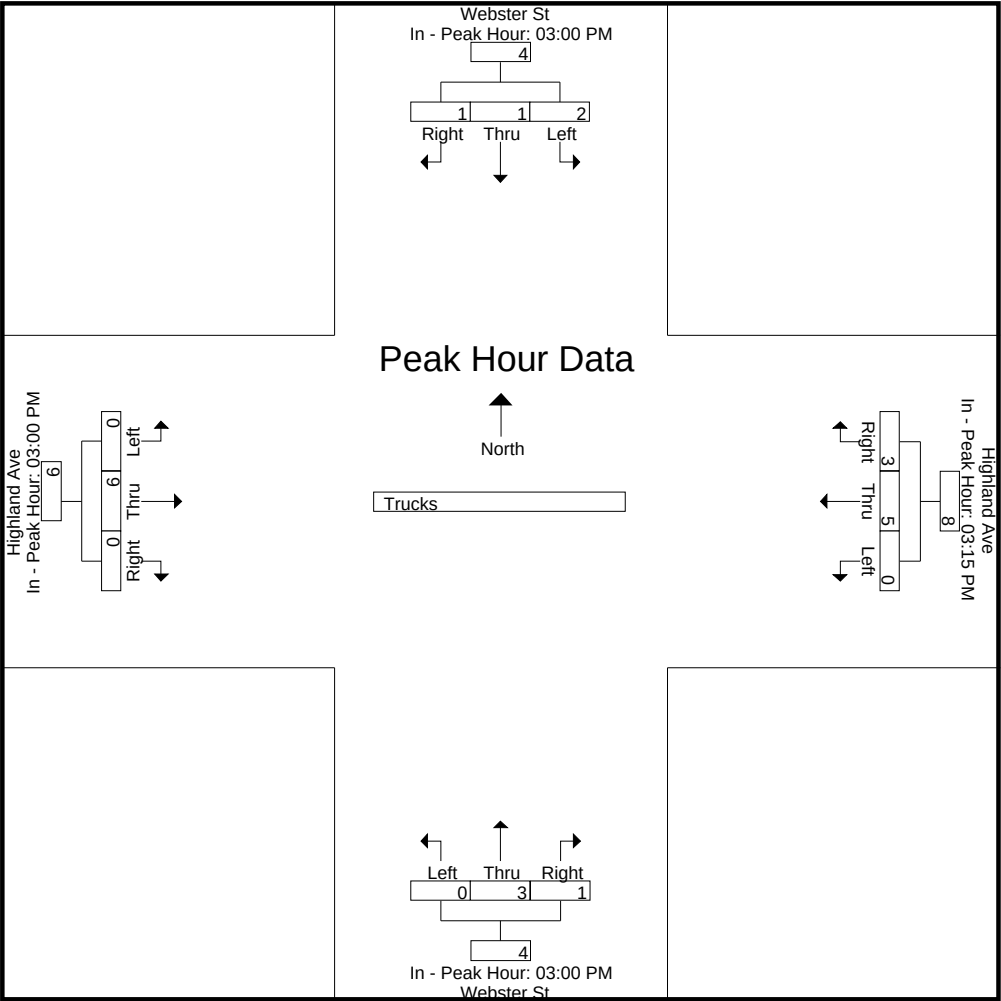
Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

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

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



Accurate Counts

978-664-2565

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

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

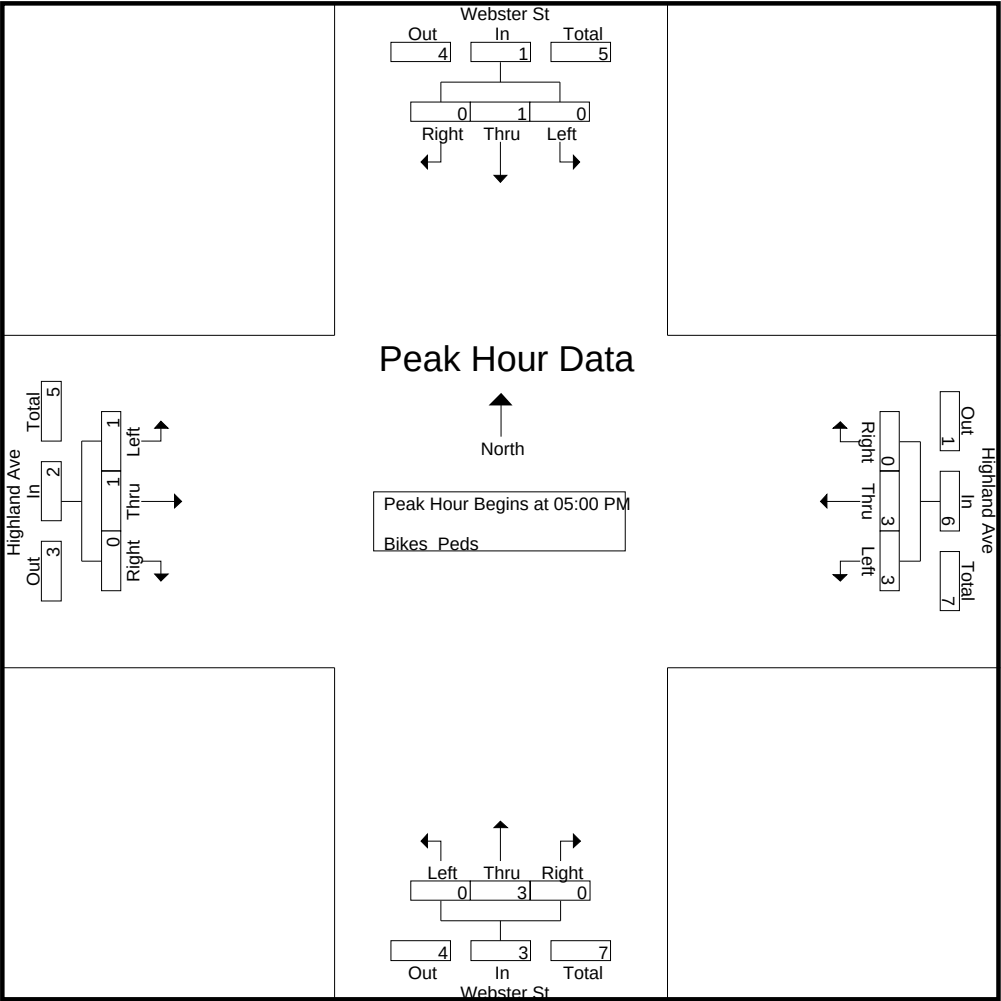
N/S Street : Webster Street
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



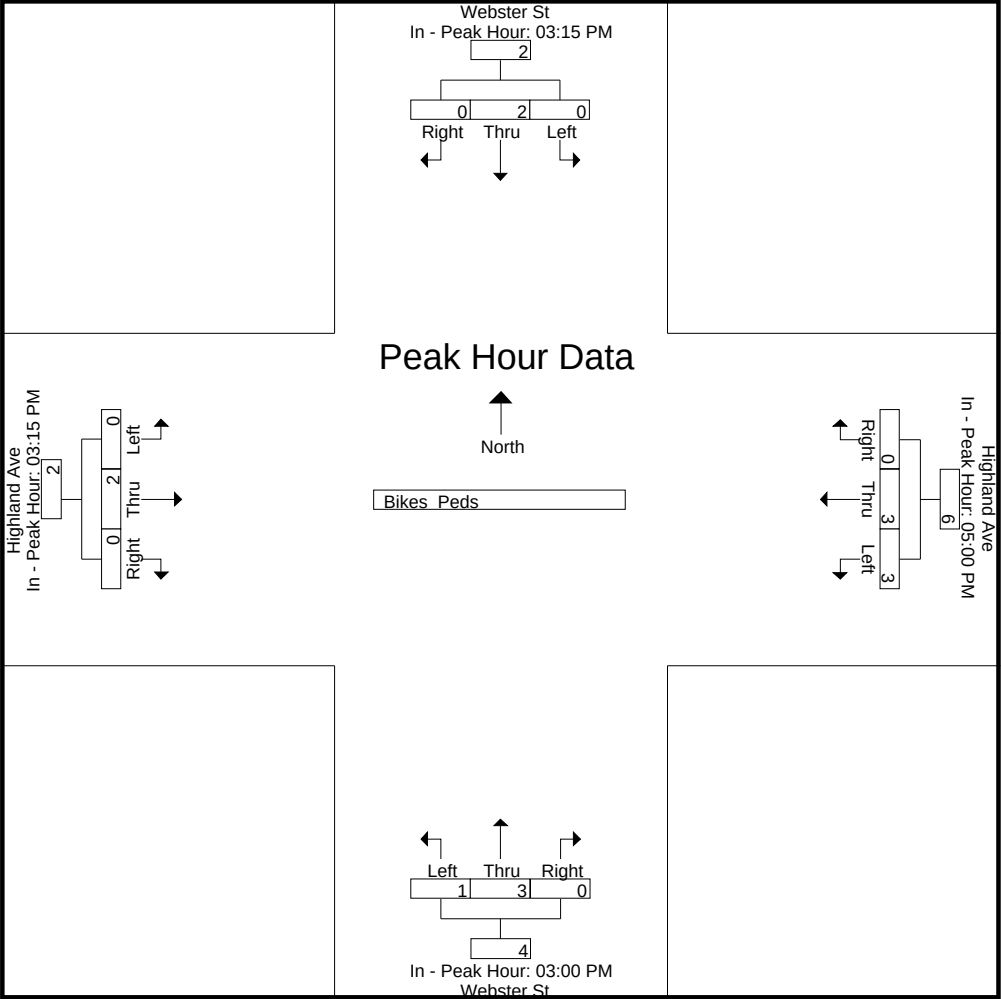
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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
Page No : 16



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

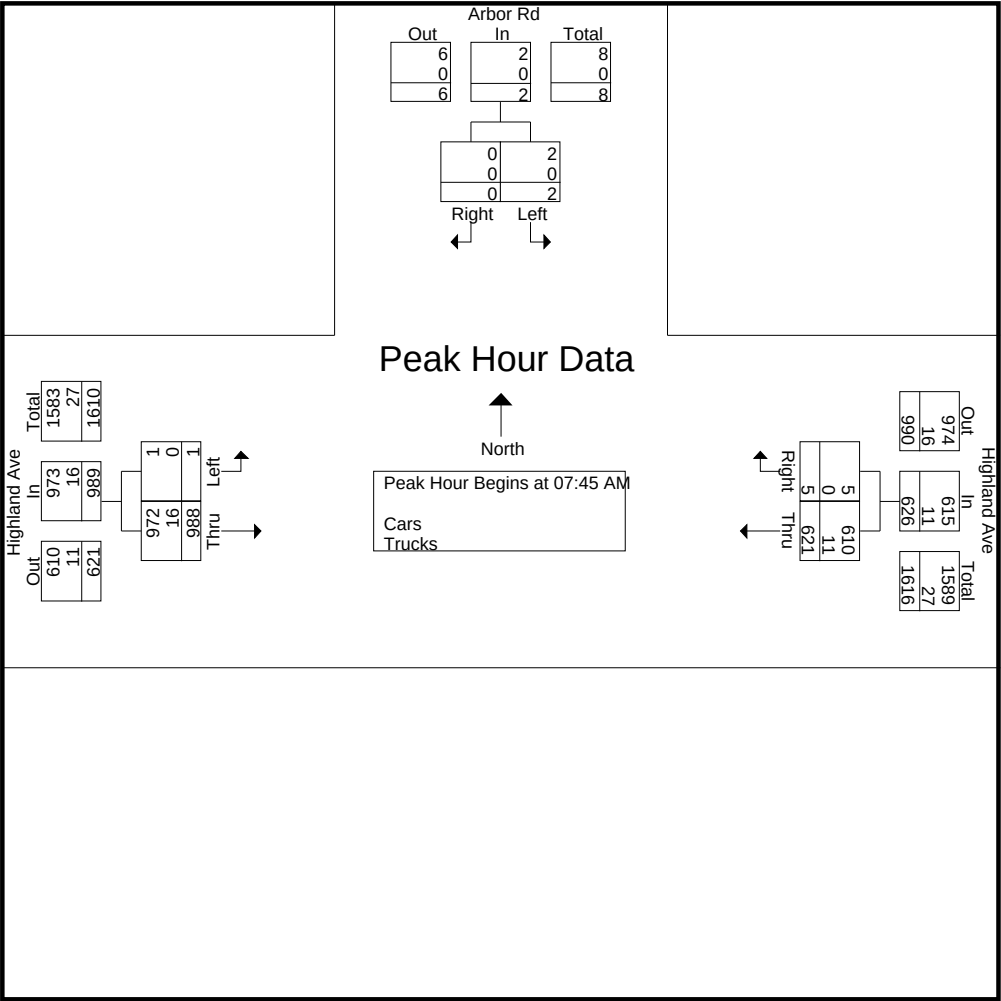
N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

	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



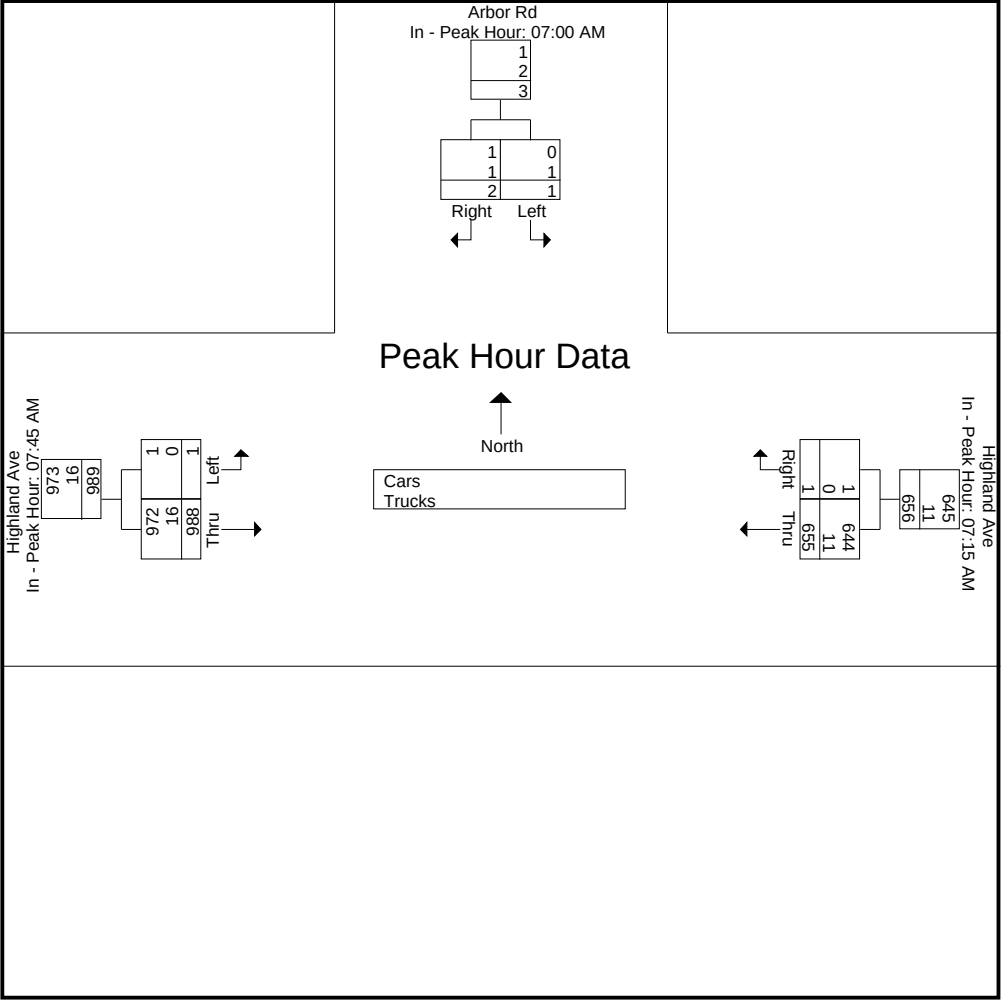
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

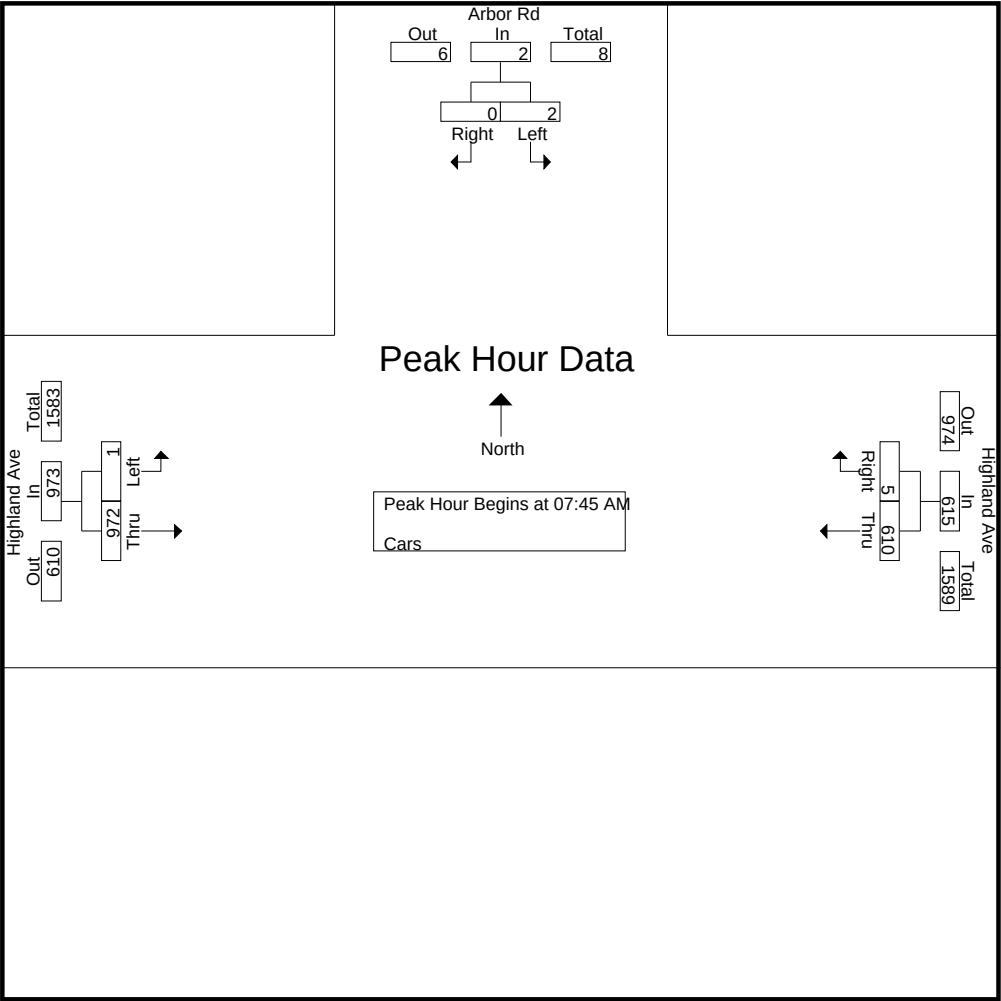
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 6

	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

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

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



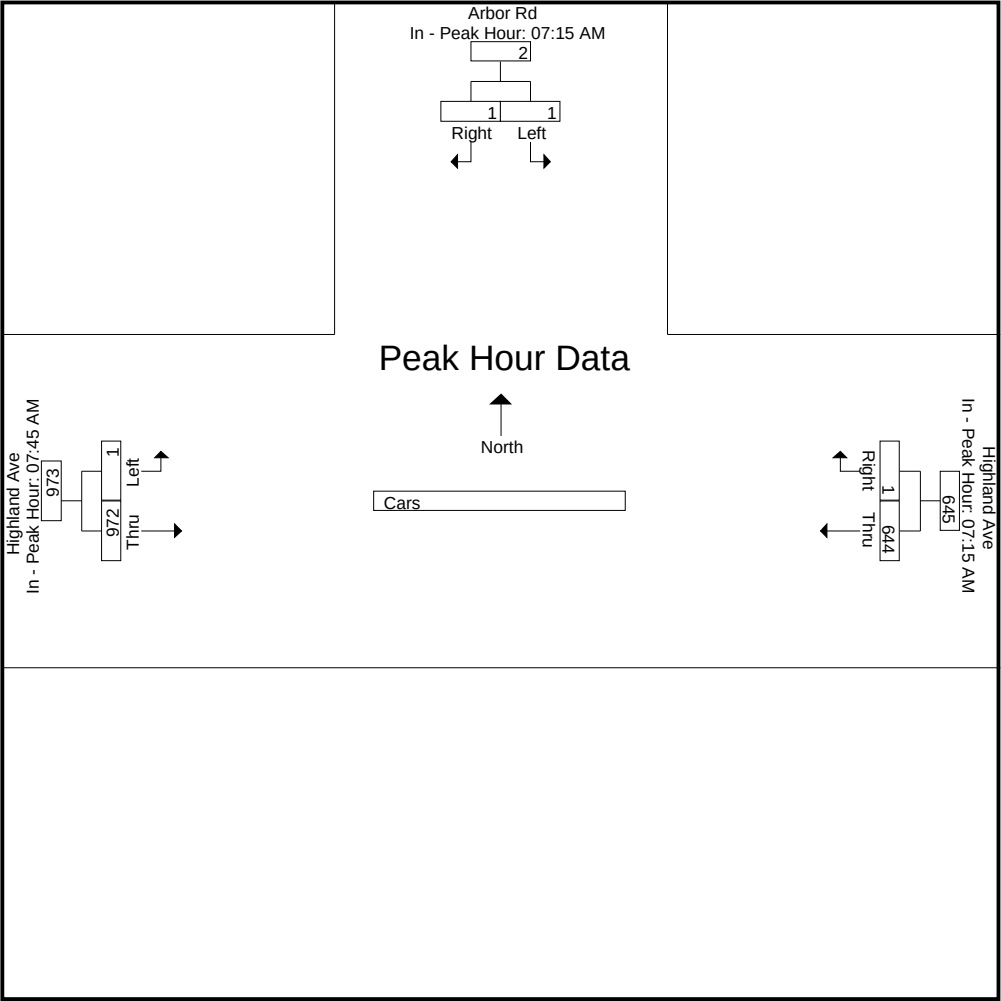
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	07:15 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

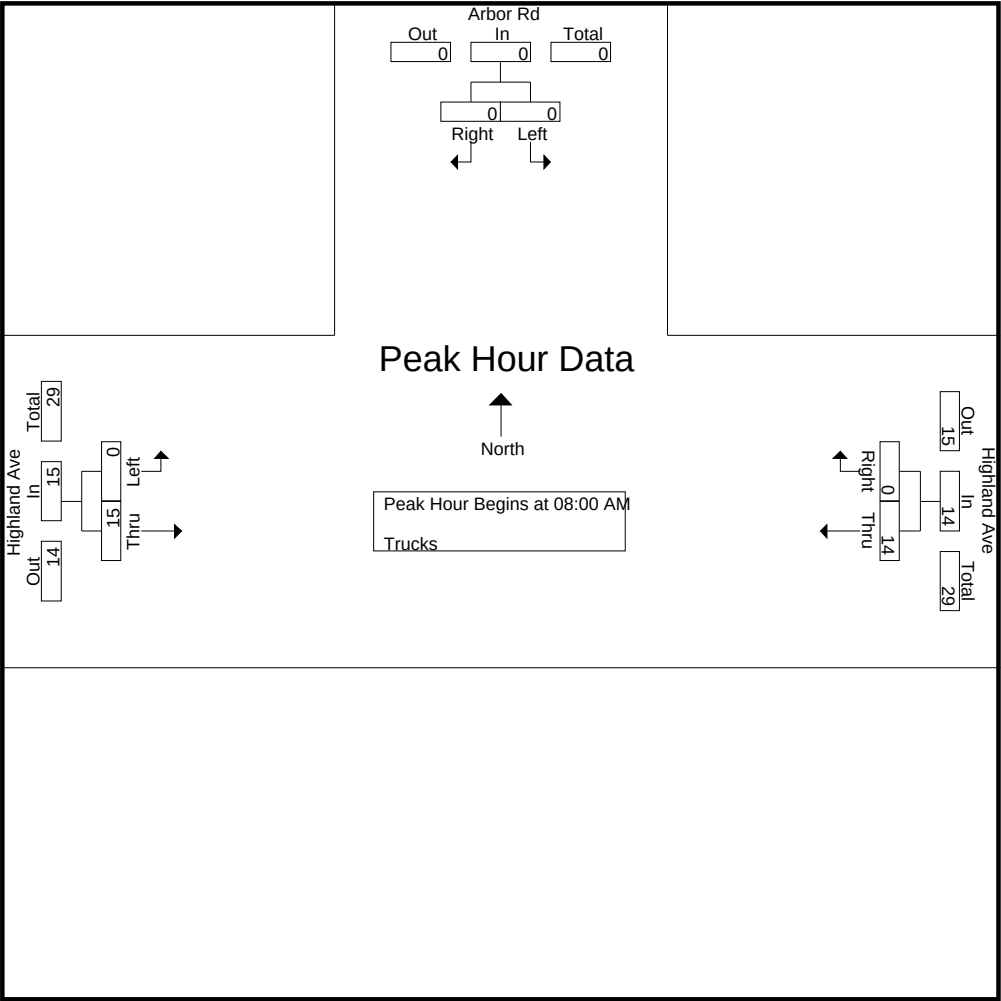
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 10

	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



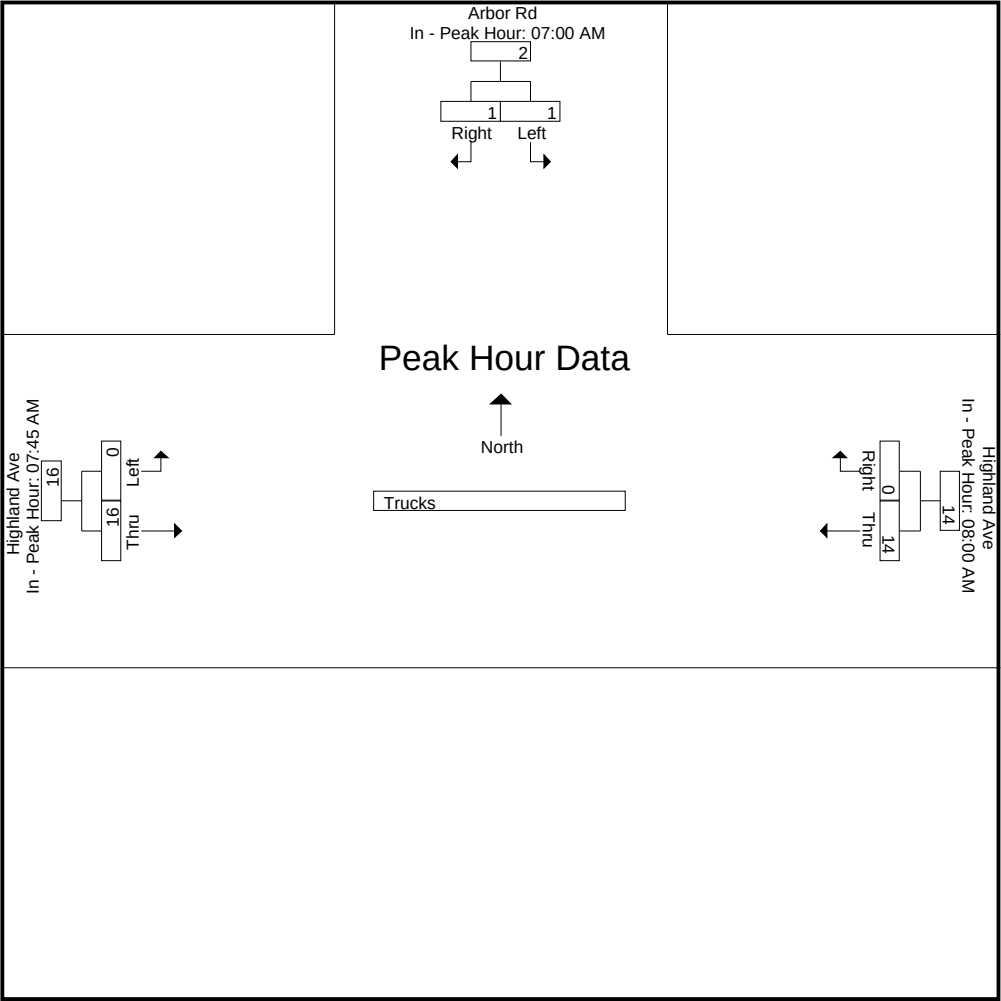
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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	.500	.000	.667	.667



Accurate Counts

978-664-2565

File Name : 83150002

Site Code : 83150002

Start Date : 9/4/2019

Page No : 13

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

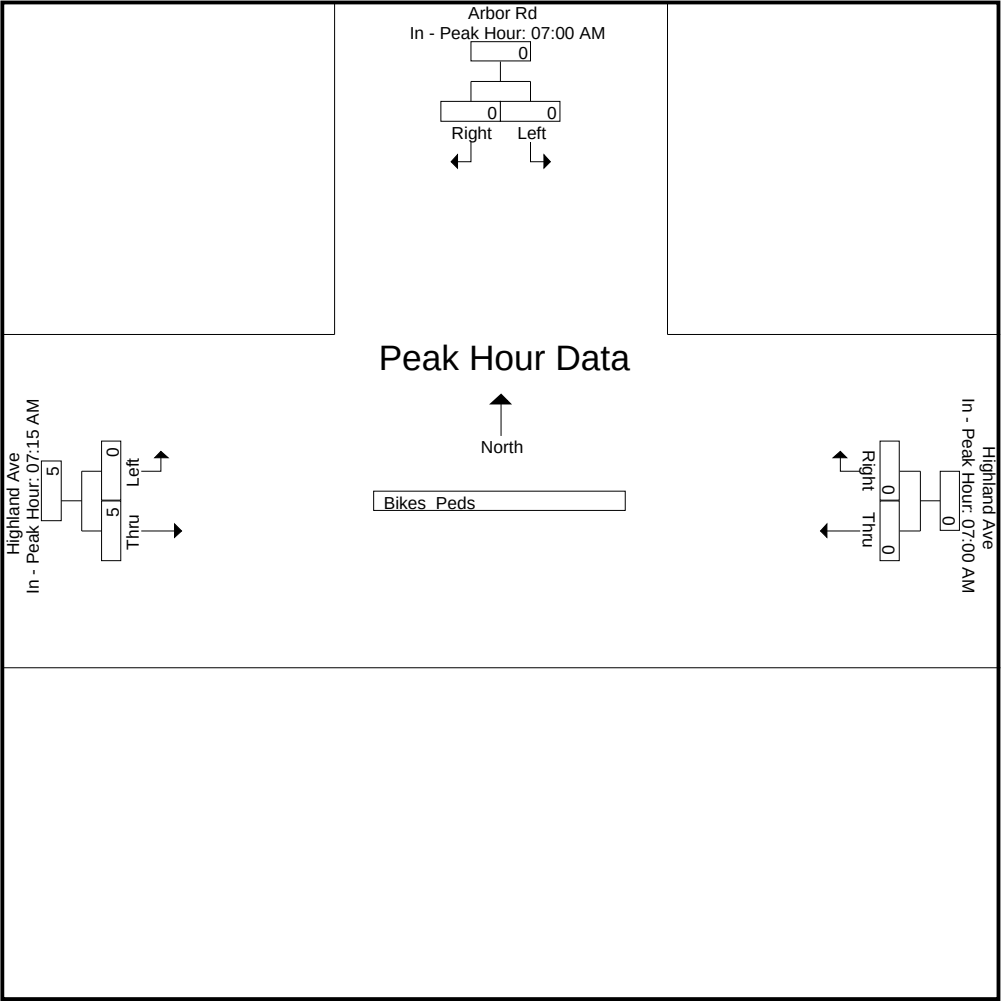
N/S Street : Arbor Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Cloudy

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

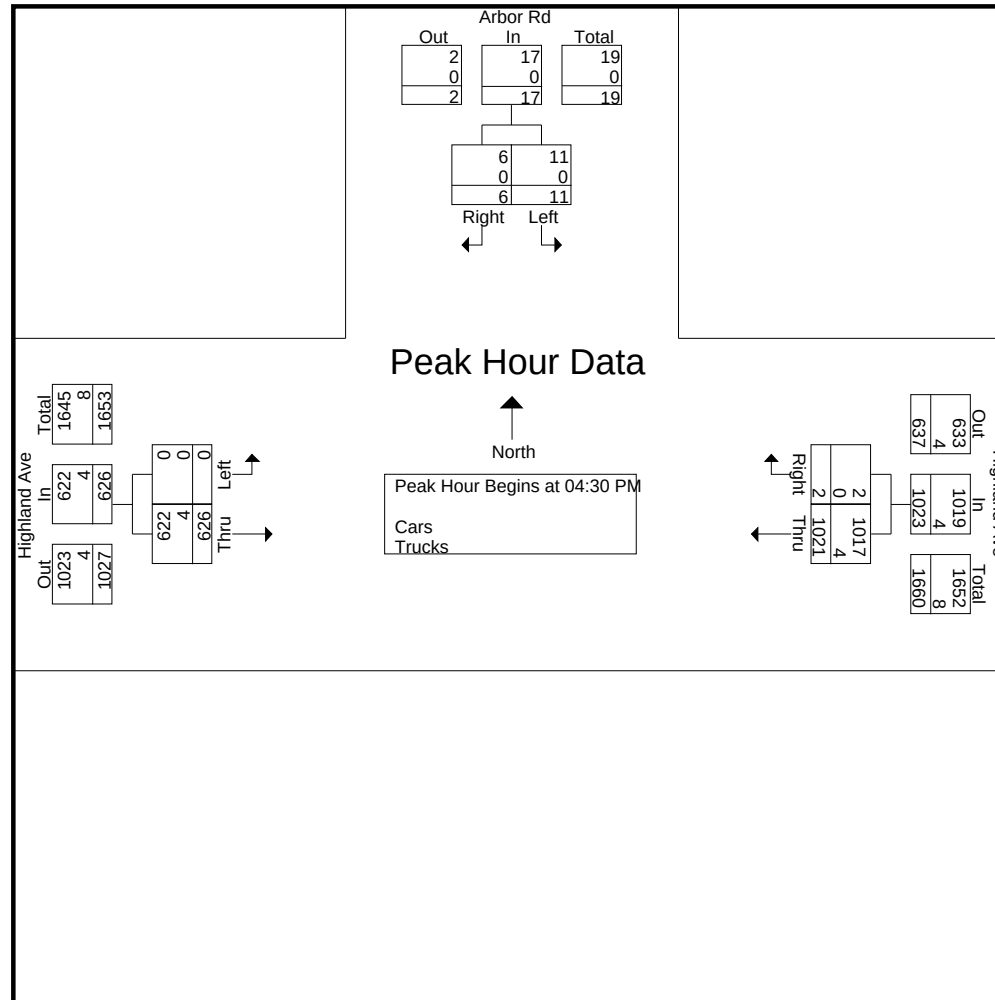
File Name : 83150002

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



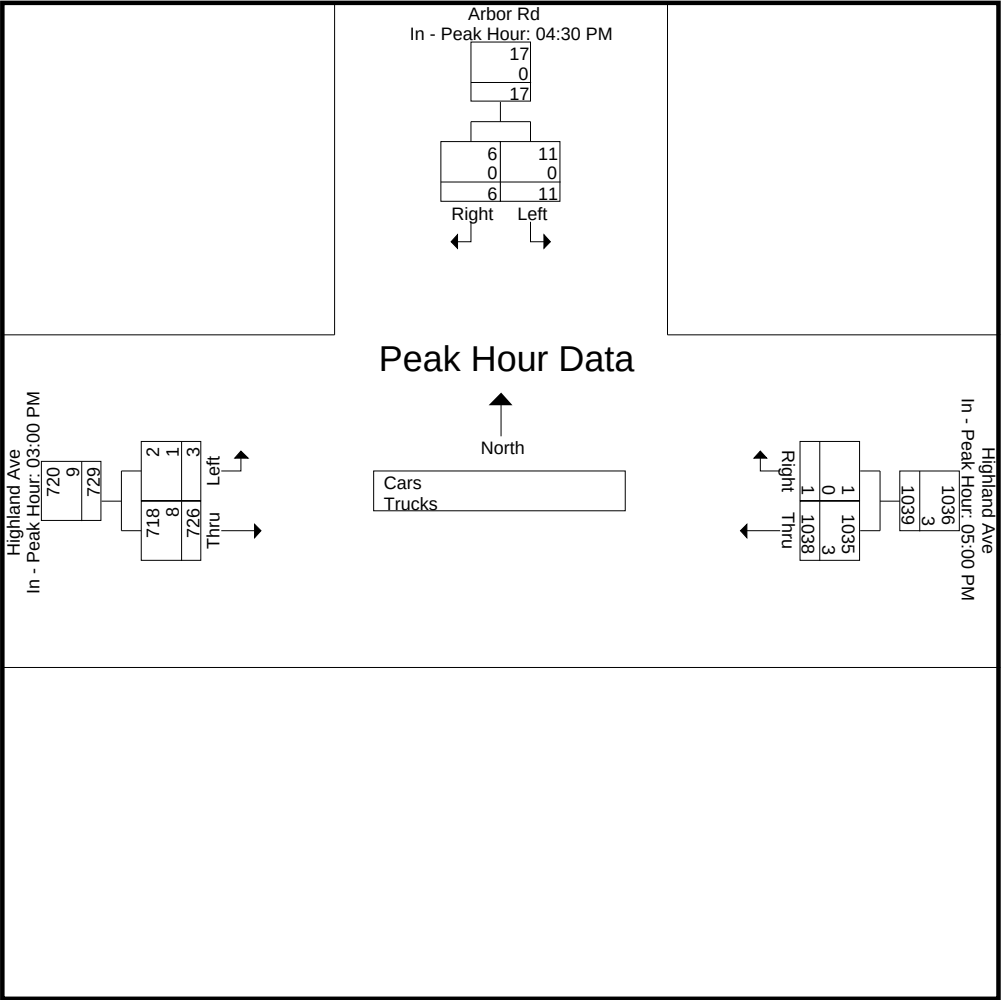
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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

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
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

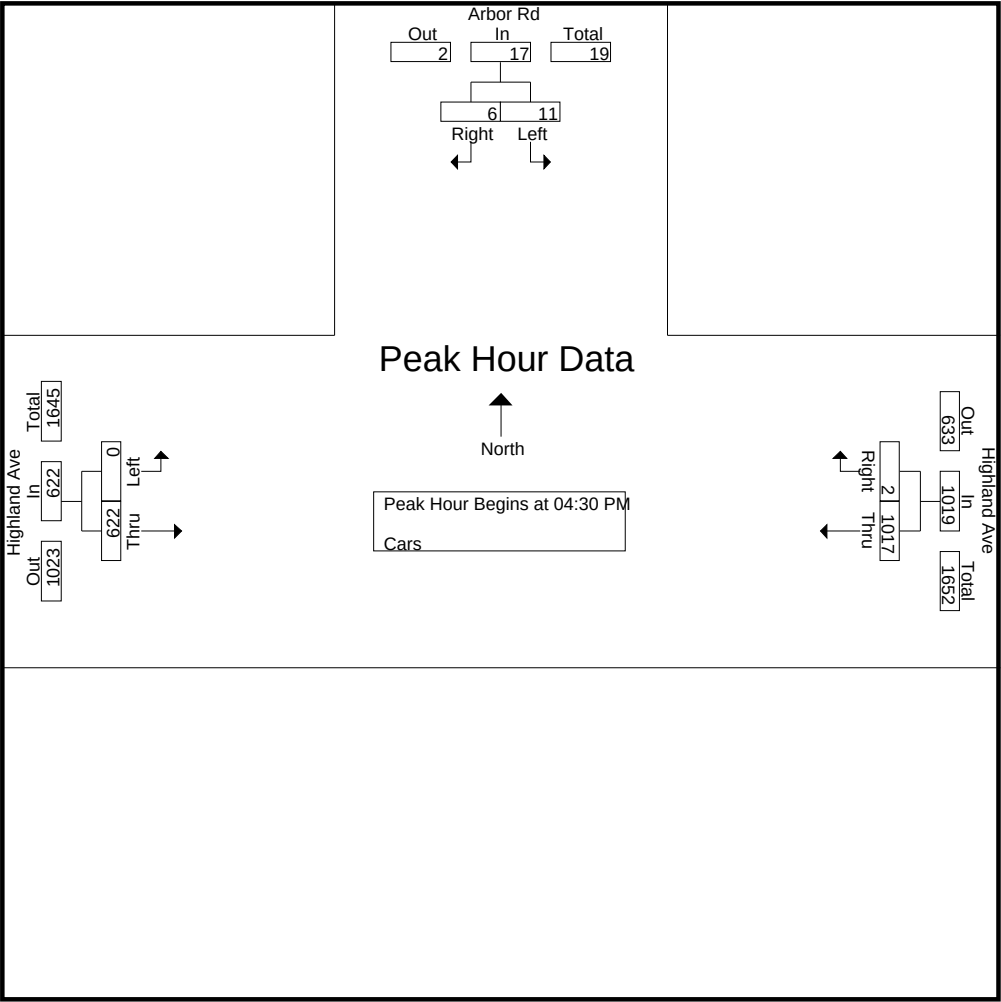
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 6

	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



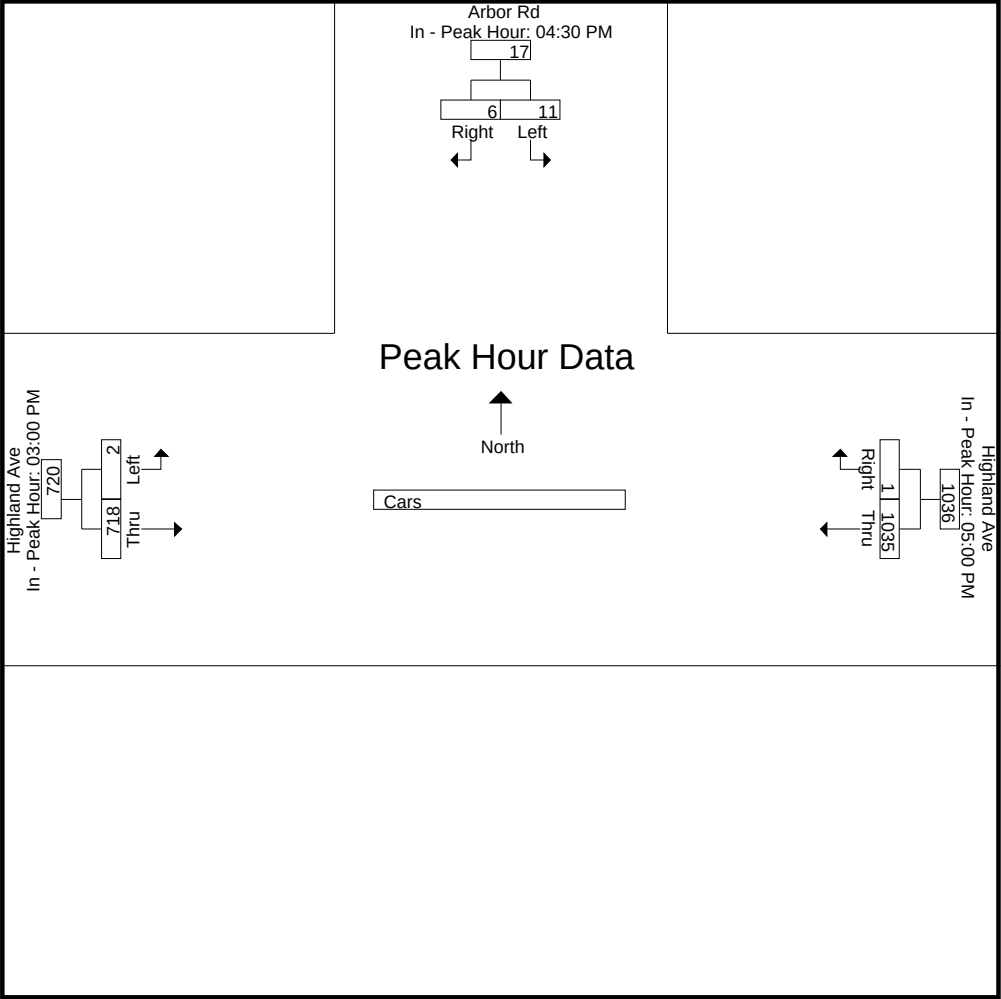
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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

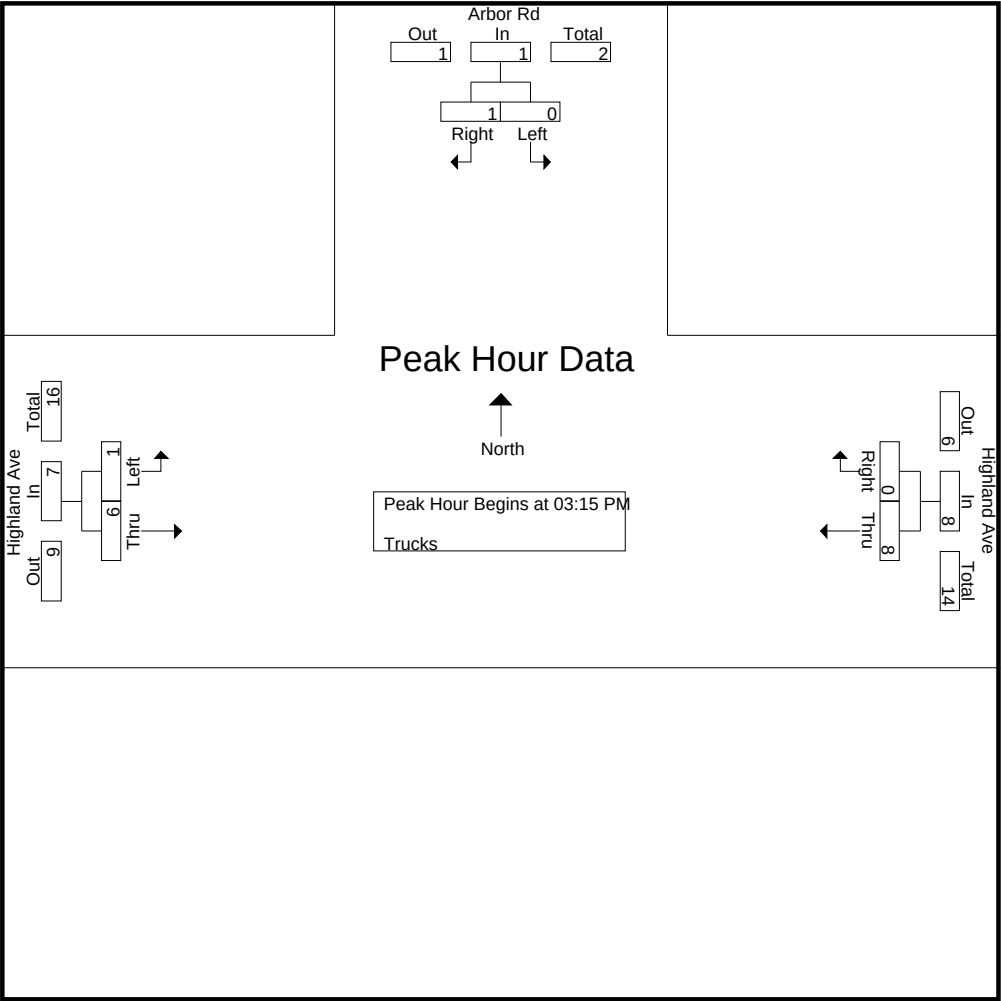
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 10

	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



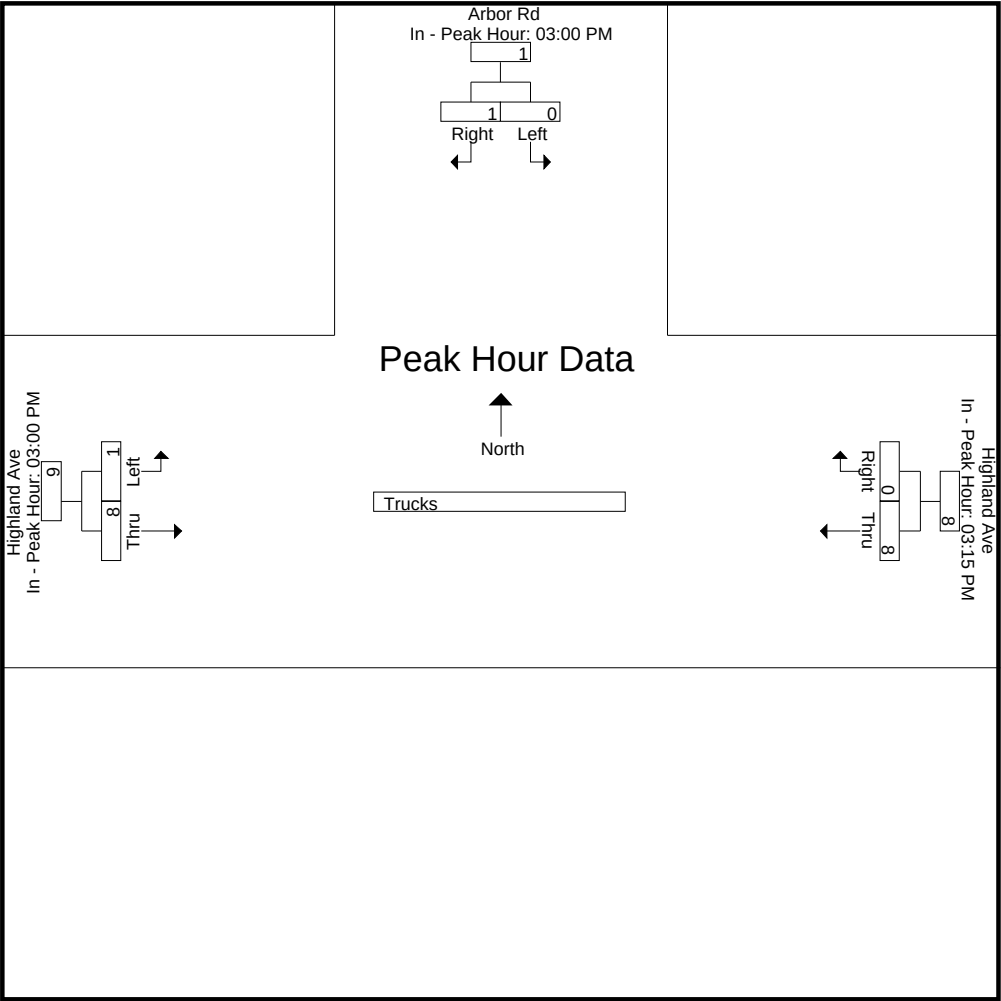
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	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			Exclu. Total	Inclu. Total	Int. Total
Start Time	Left	Right	Peds	Thru	Right	Peds	Left	Thru	Peds			
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

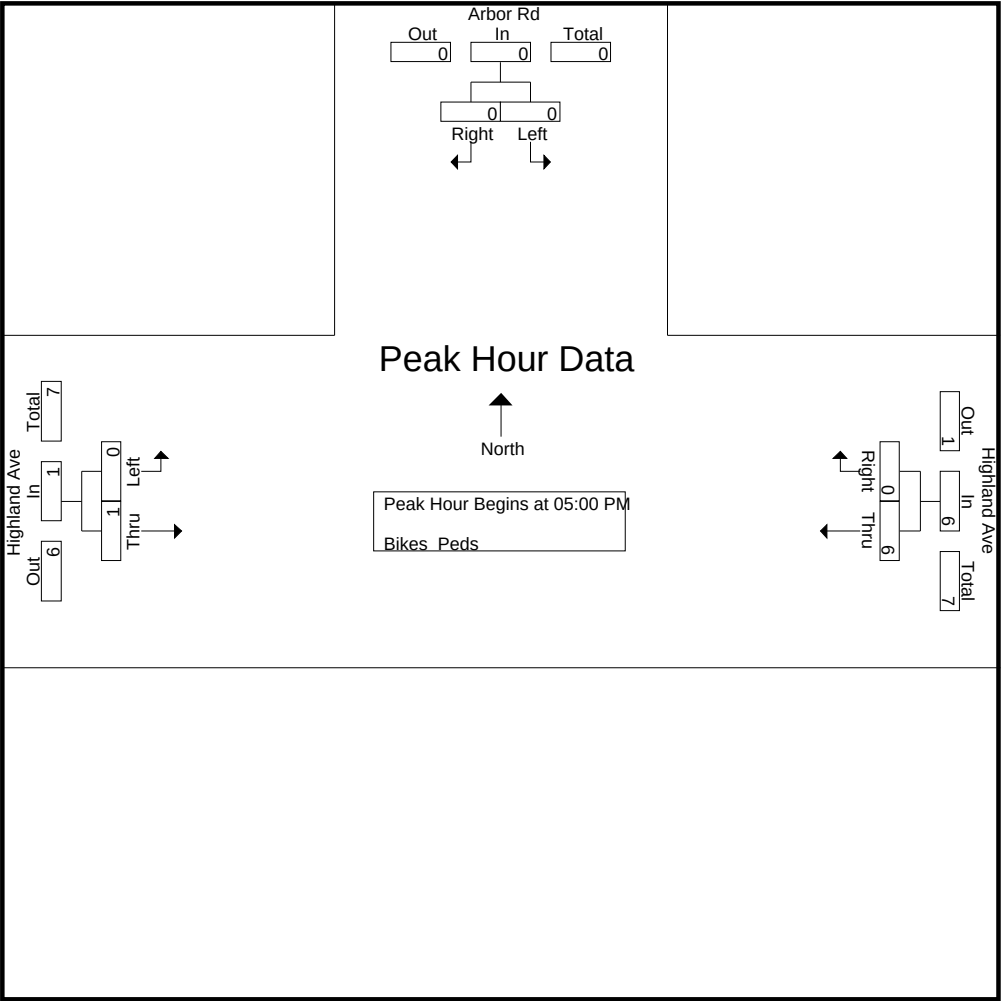
File Name : 83150002
Site Code : 83150002
Start Date : 9/4/2019
Page No : 14

	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
Page No : 15



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

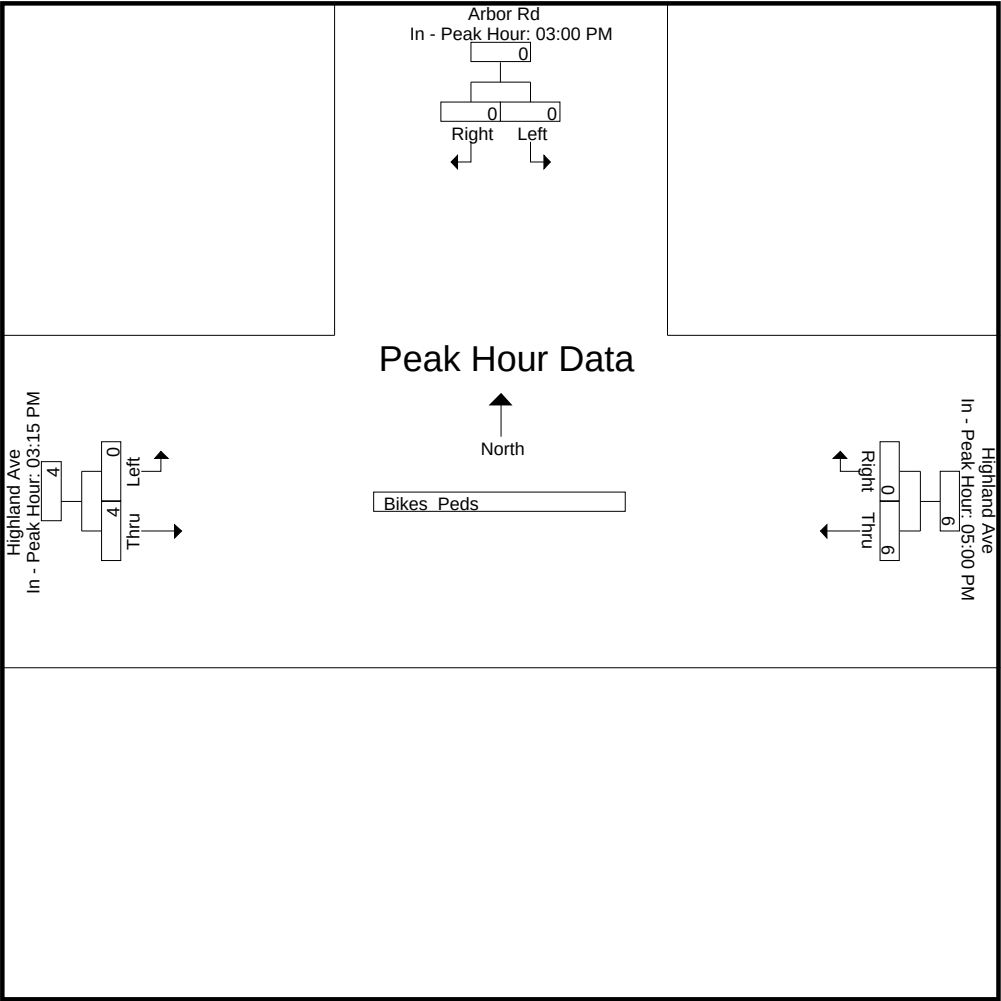
Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

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

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



Accurate Counts

978-664-2565

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

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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

Page No : 2

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	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

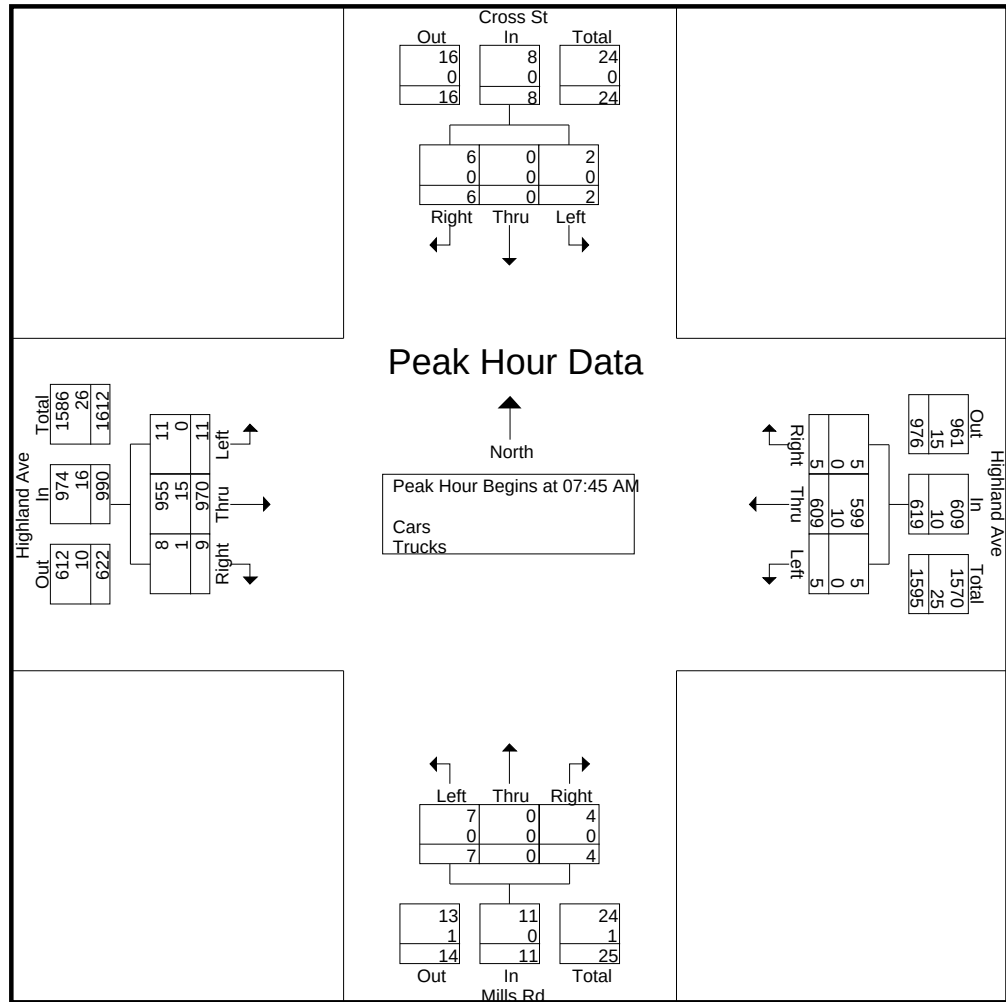
Page No : 3

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



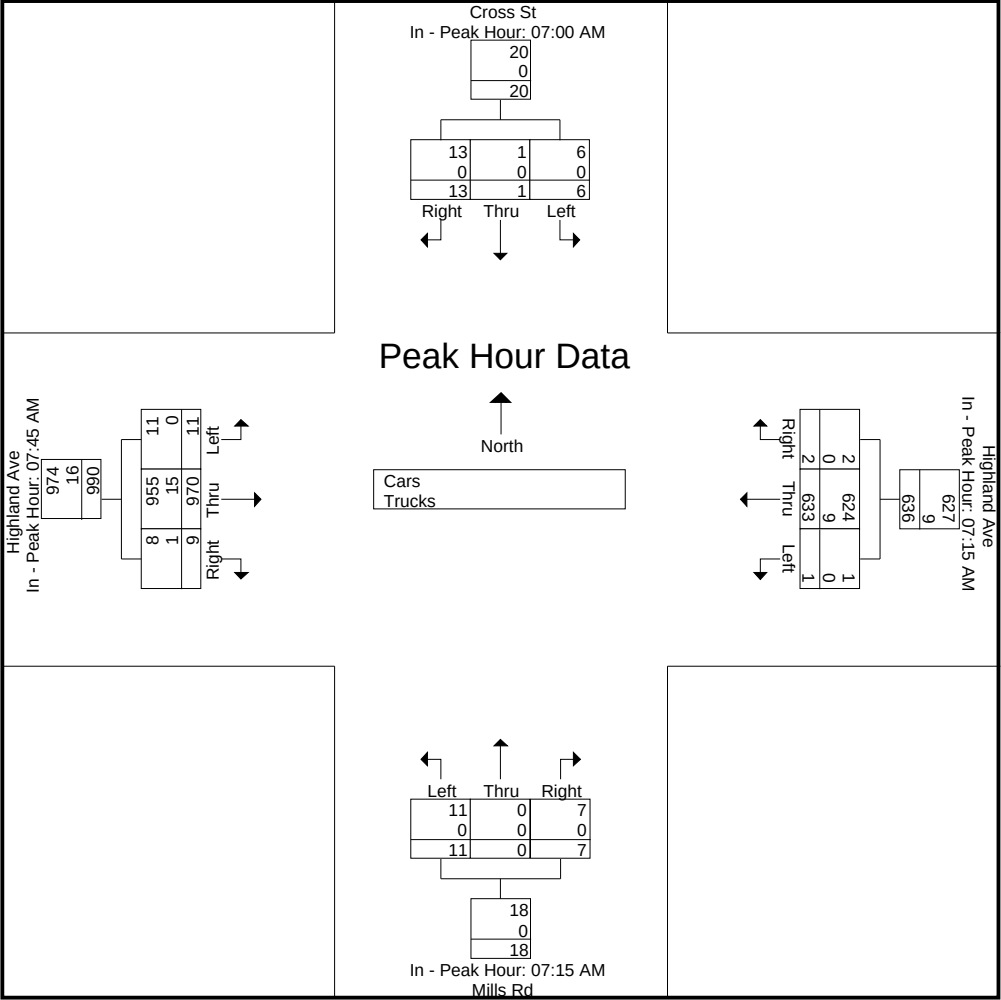
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

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

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

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

Accurate Counts

978-664-2565

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

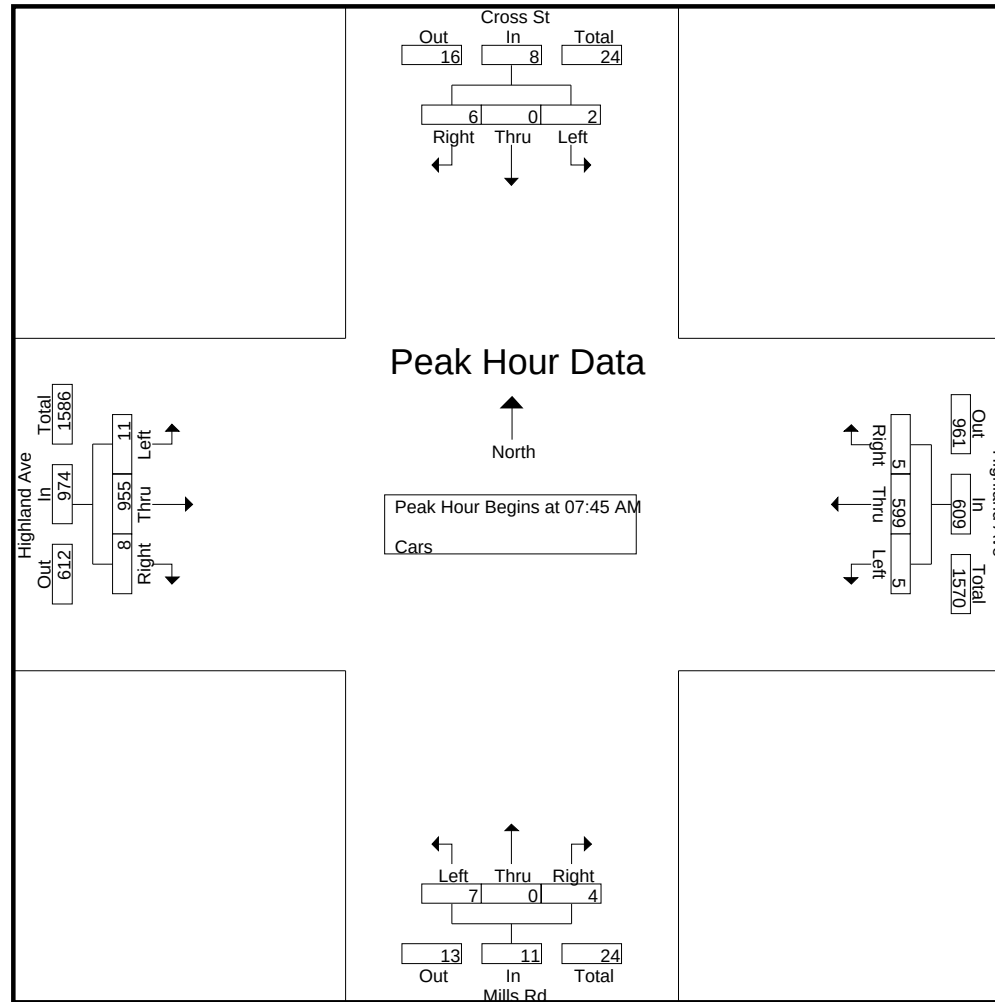
Page No : 7

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



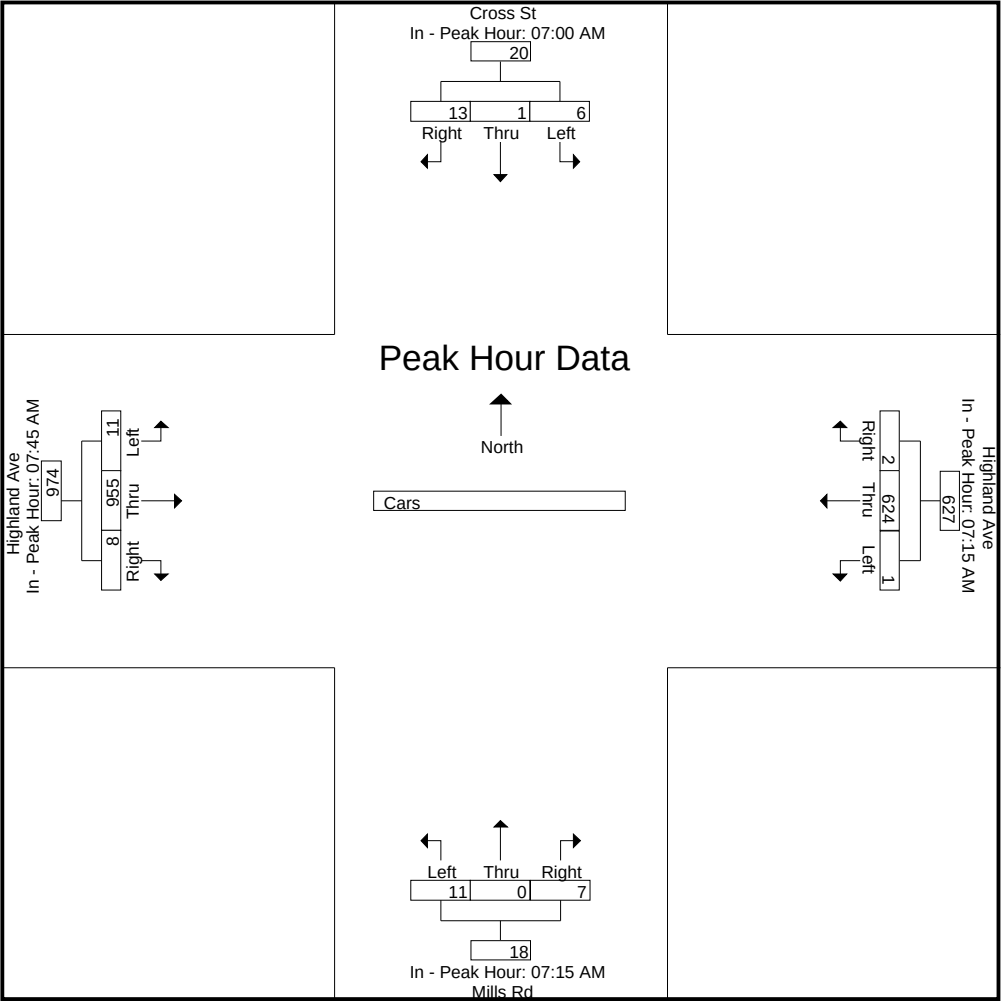
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

Page No : 9

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

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

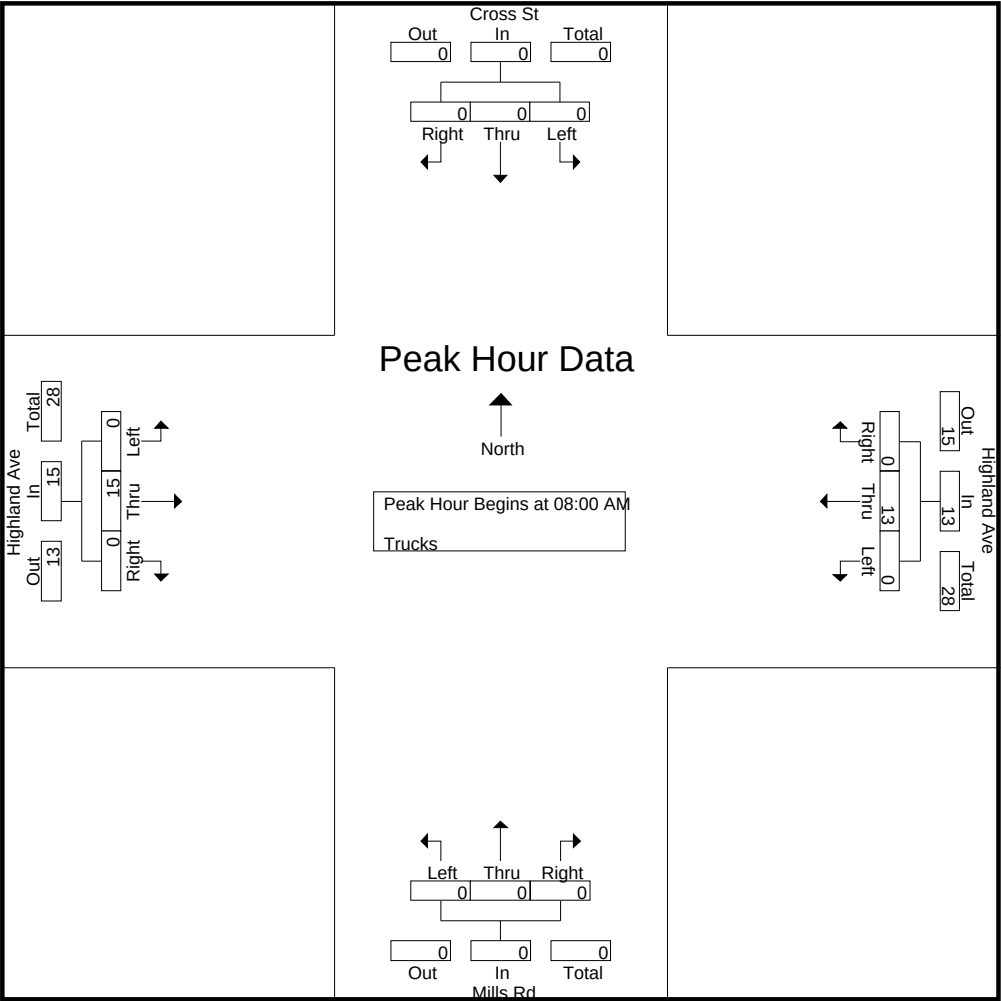
File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 10

	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
Page No : 11



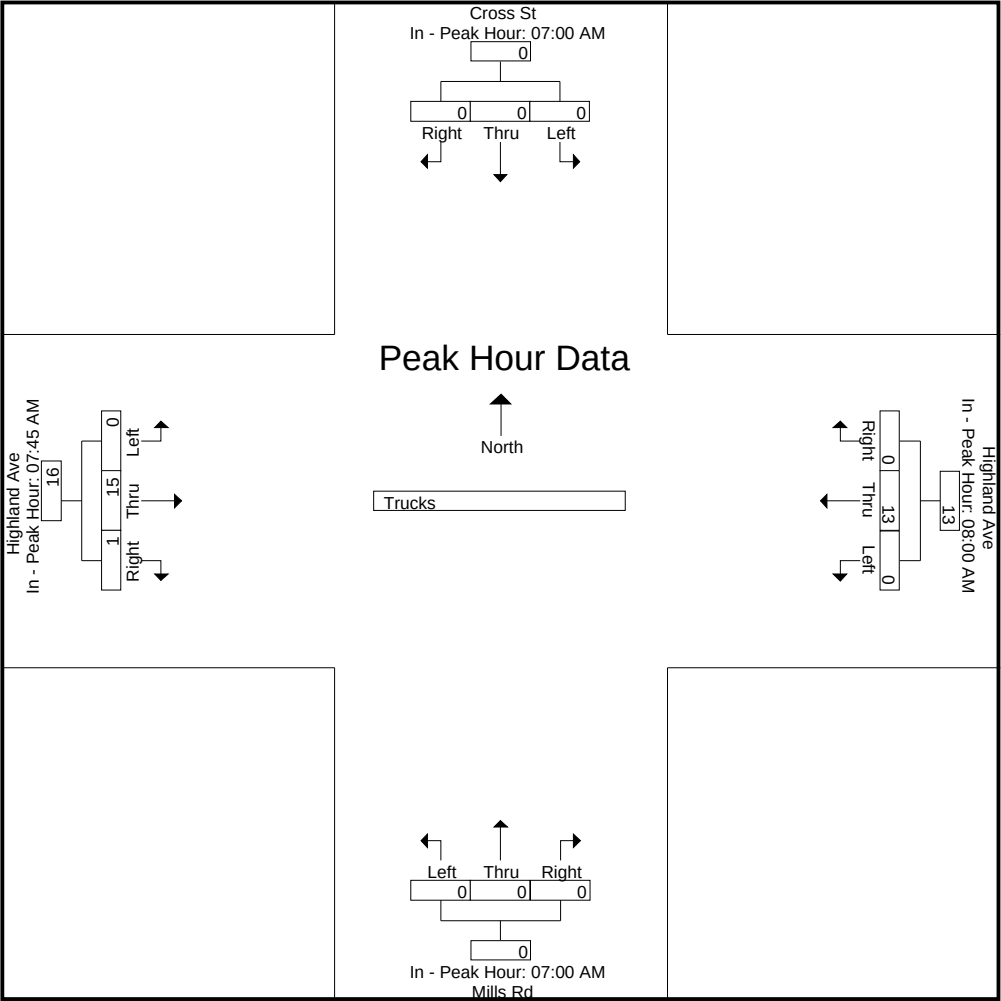
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

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



Accurate Counts

978-664-2565

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

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
Page No : 14

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

978-664-2565

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

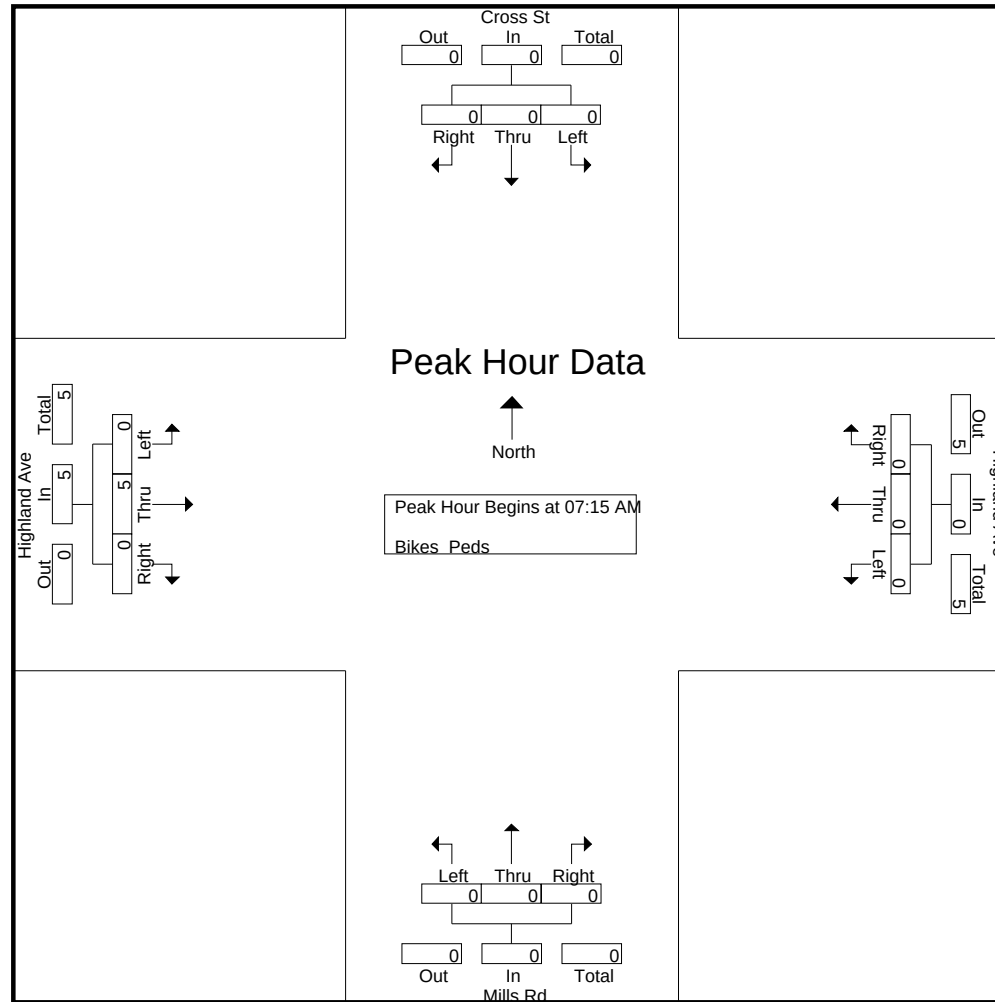
Page No : 15

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



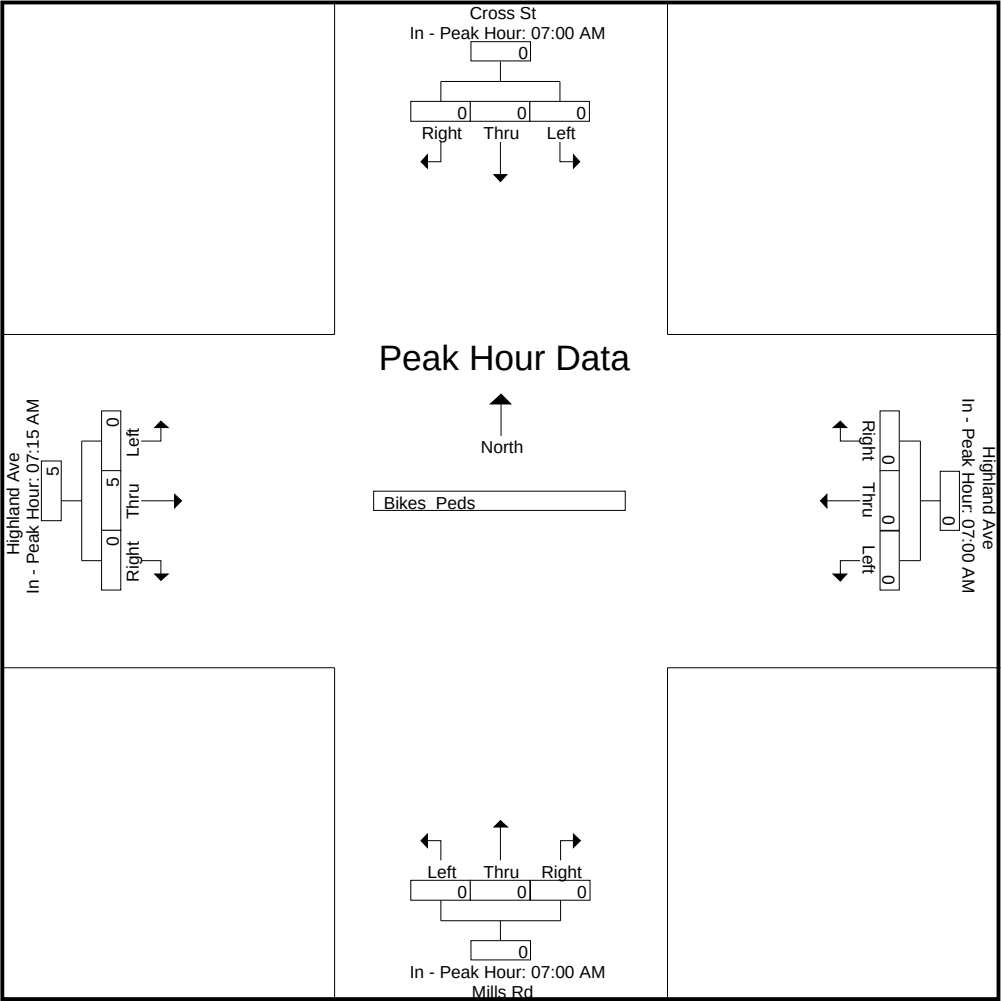
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

Page No : 2

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

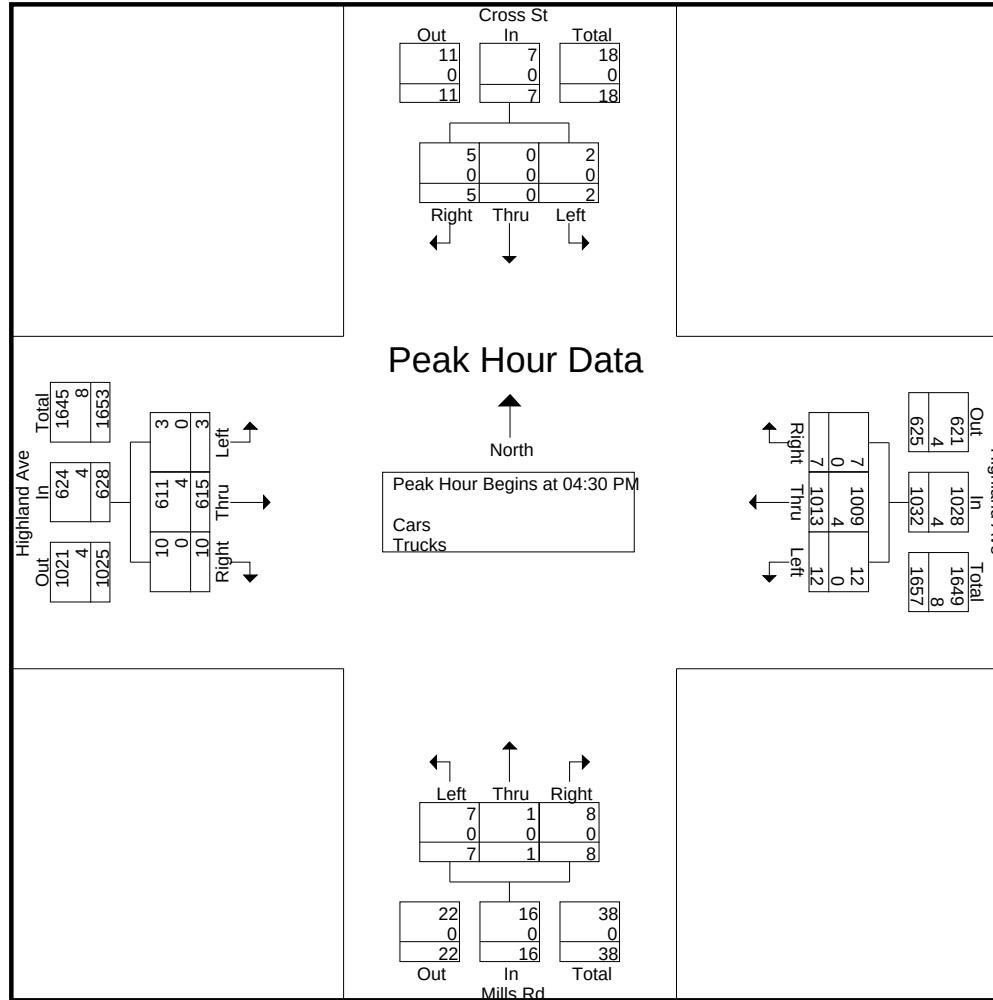
Page No : 3

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy



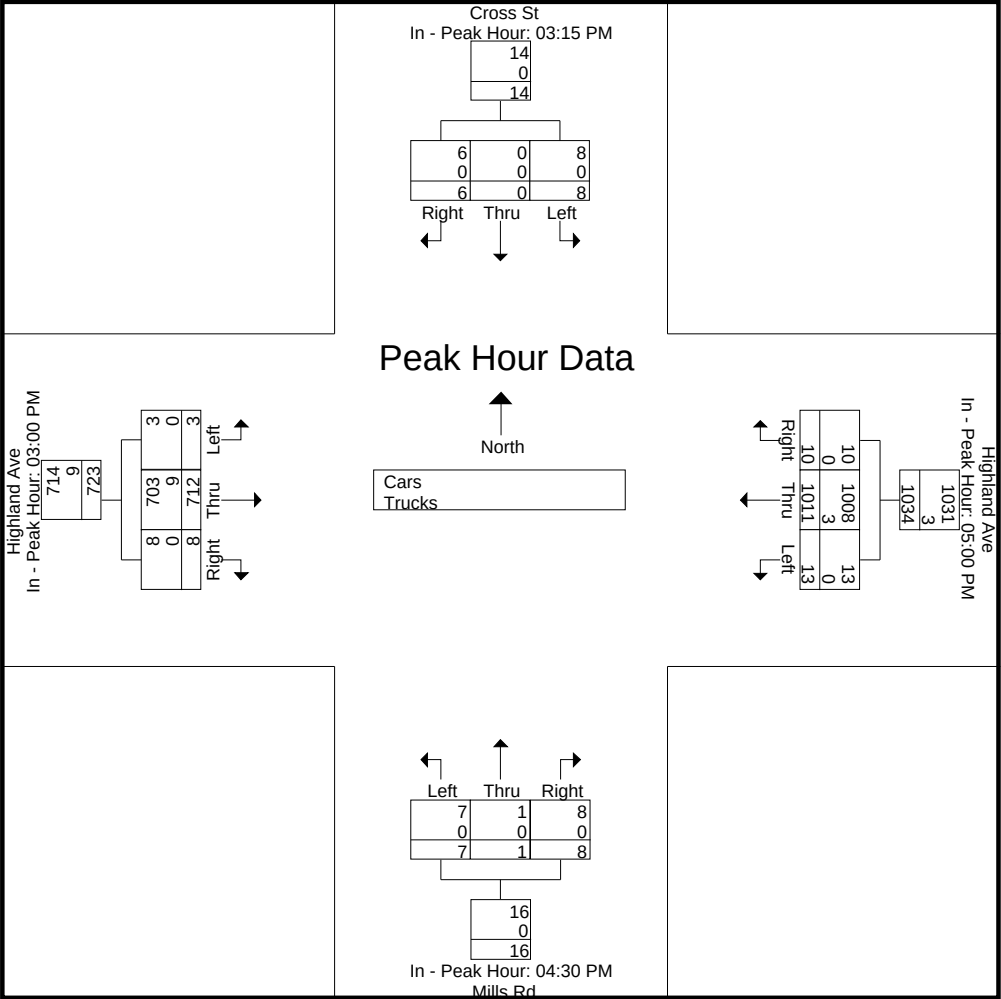
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

Page No : 6

	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	1	0	1	2	4	260	1	265	1	0	3	4	0	143	3	146	417
04:45 PM	0	0	1	1	1	253	2	256	1	1	1	3	0	150	2	152	412
05:00 PM	1	0	2	3	2	242	2	246	3	0	1	4	2	159	3	164	417
05:15 PM	0	0	1	1	5	254	2	261	2	0	3	5	1	159	2	162	429
Total Volume	2	0	5	7	12	1009	7	1028	7	1	8	16	3	611	10	624	1675
% App. Total	28.6	0	71.4		1.2	98.2	0.7		43.8	6.2	50		0.5	97.9	1.6		
PHF	.500	.000	.625	.583	.600	.970	.875	.970	.583	.250	.667	.800	.375	.961	.833	.951	.976

Accurate Counts

978-664-2565

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

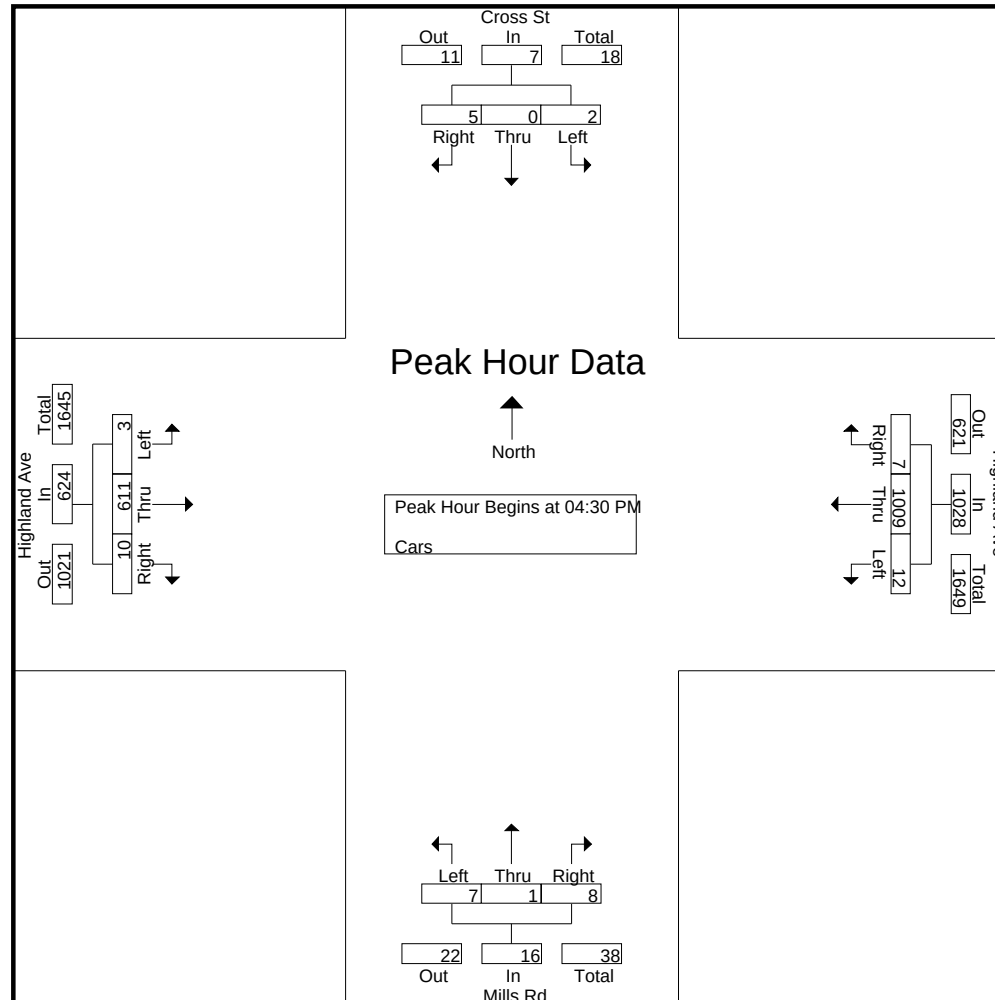
Page No : 7

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

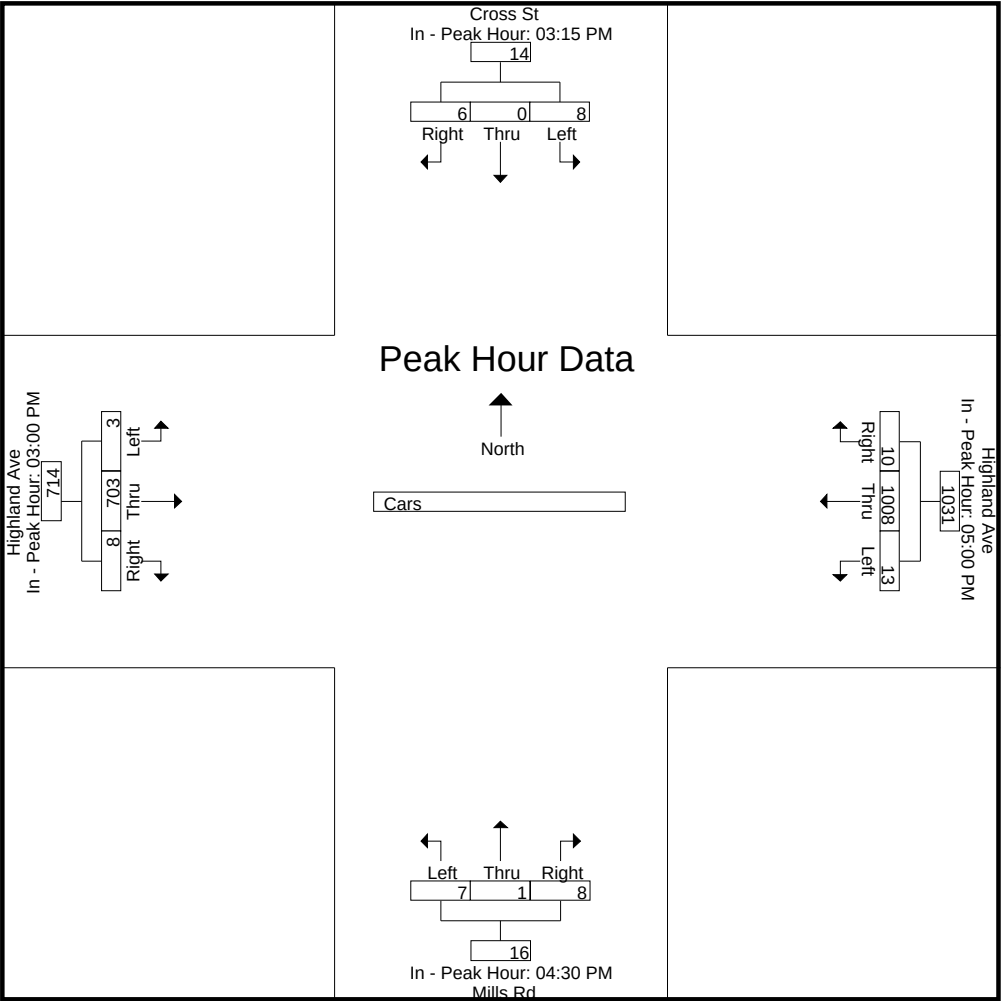
Peak Hour for Each Approach Begins at:

	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

N/S Street : Cross Street / Mills Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Cloudy

File Name : 83150003

Site Code : 83150003

Start Date : 9/4/2019

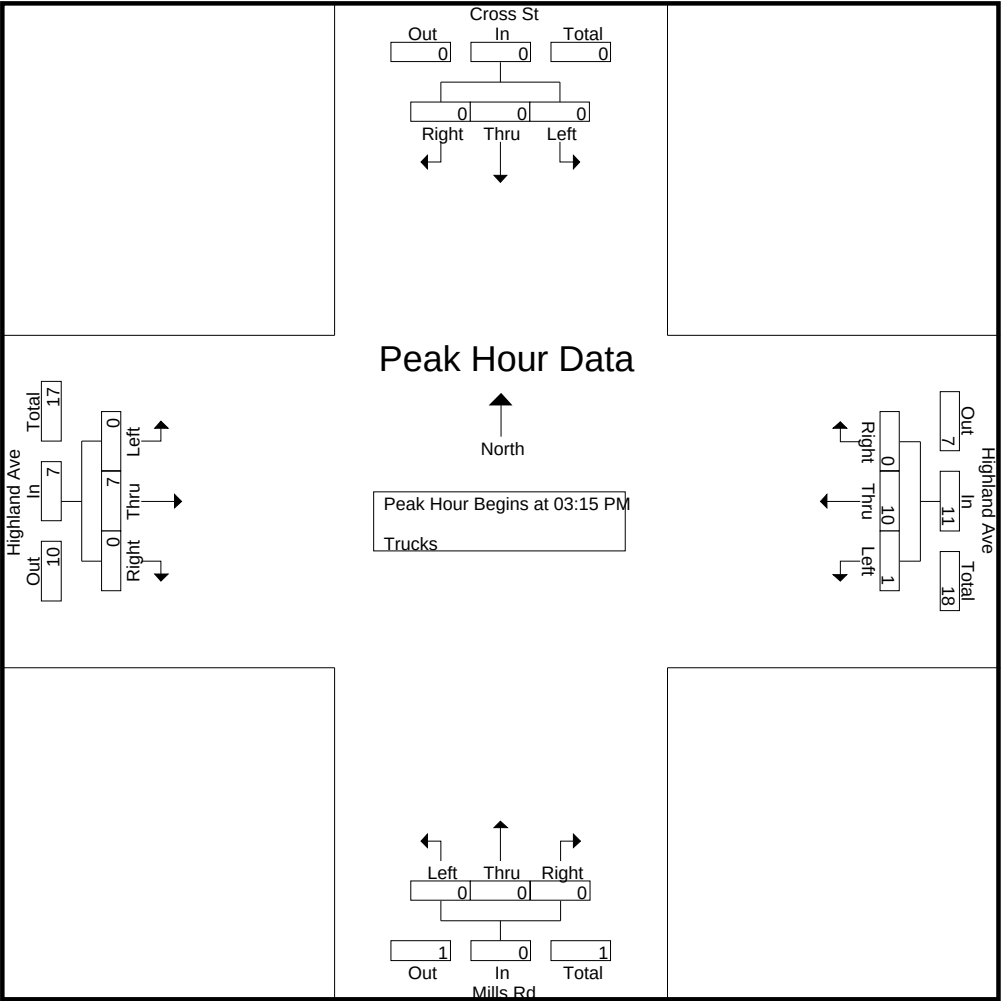
Page No : 10

	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:15 PM																	
03:15 PM	0	0	0	0	1	3	0	4	0	0	0	0	0	5	0	5	9
03:30 PM	0	0	0	0	0	3	0	3	0	0	0	0	0	1	0	1	4
03:45 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	2
04:00 PM	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	3
Total Volume	0	0	0	0	1	10	0	11	0	0	0	0	0	7	0	7	18
% App. Total	0	0	0		9.1	90.9	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.250	.833	.000	.688	.000	.000	.000	.000	.000	.350	.000	.350	.500

Accurate Counts
978-664-2565

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

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



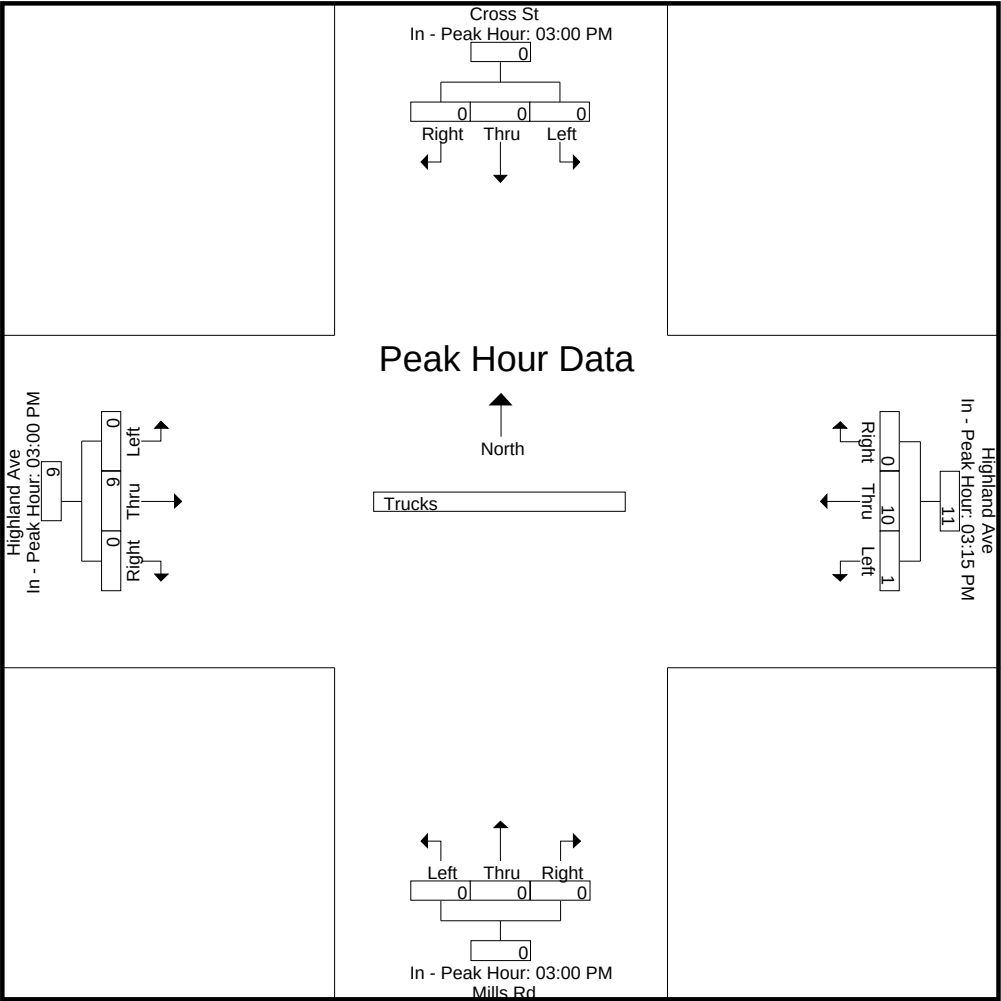
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	03:00 PM				03:15 PM				03:00 PM				03:00 PM			
+0 mins.	0	0	0	0	1	3	0	4	0	0	0	0	0	2	0	2
+15 mins.	0	0	0	0	0	3	0	3	0	0	0	0	0	5	0	5
+30 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1
+45 mins.	0	0	0	0	0	3	0	3	0	0	0	0	0	1	0	1
Total Volume	0	0	0	0	1	10	0	11	0	0	0	0	0	9	0	9
% App. Total	0	0	0		9.1	90.9	0		0	0	0		0	100	0	
PHF	.000	.000	.000	.000	.250	.833	.000	.688	.000	.000	.000	.000	.000	.450	.000	.450

Accurate Counts
978-664-2565

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

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 12



Accurate Counts

978-664-2565

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

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

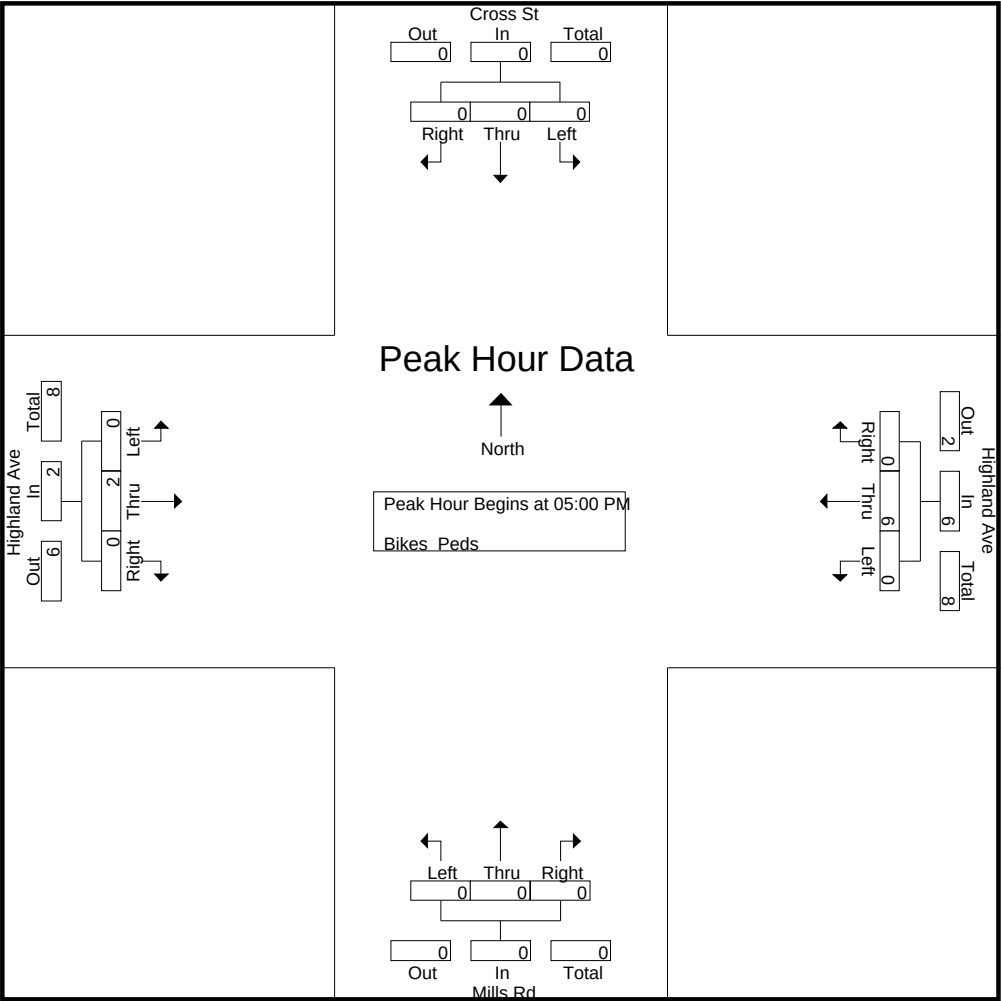
File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 14

	Cross St From North				Highland Ave From East				Mills Rd From South				Highland Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	0	0	0	0	0	2	0	2	0	0	0	0	0	2	0	2	4
05:15 PM	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	2
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	2
Total Volume	0	0	0	0	0	6	0	6	0	0	0	0	0	2	0	2	8
% App. Total	0	0	0		0	100	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.000	.750	.000	.750	.000	.000	.000	.000	.000	.250	.000	.250	.500

Accurate Counts
978-664-2565

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

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



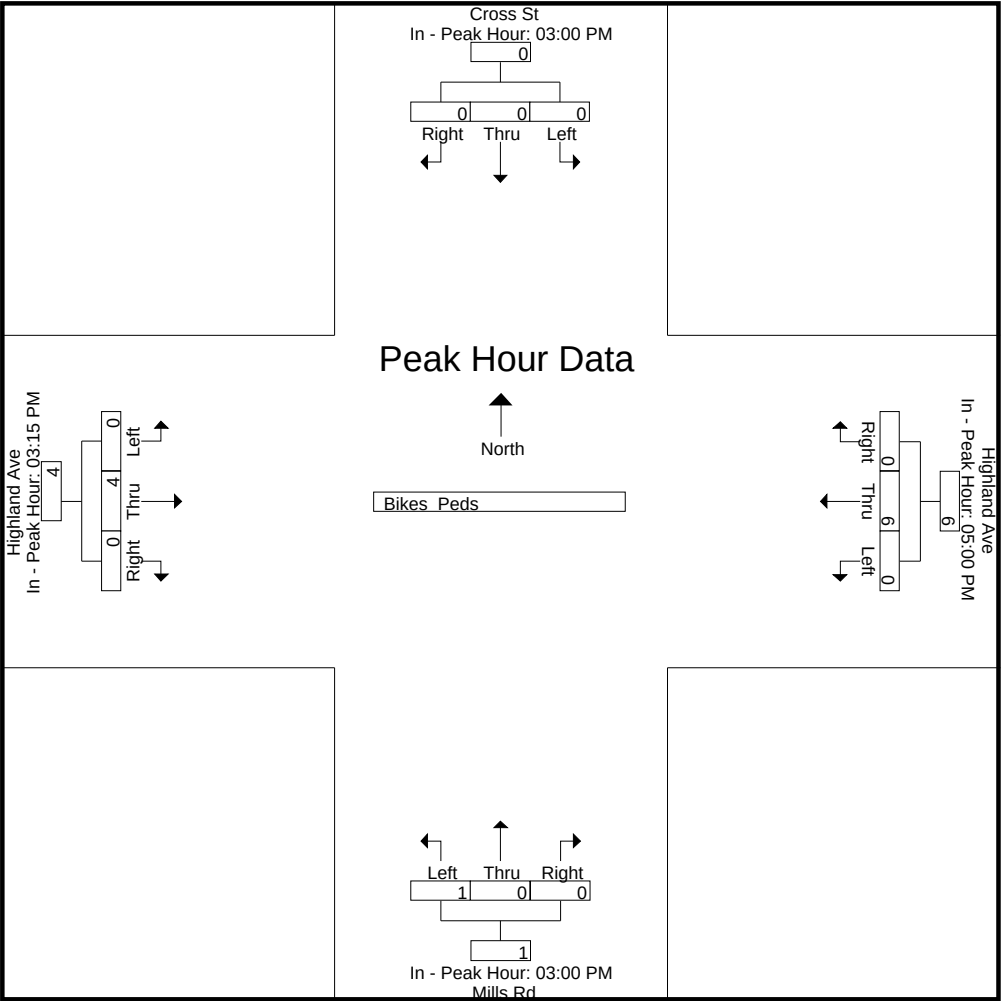
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

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

File Name : 83150003
Site Code : 83150003
Start Date : 9/4/2019
Page No : 16



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
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

N/S Street : Gould Street / Hunting Road
 E/W Street: Highland Avenue
 City/State : Needham, MA
 Weather : Clear

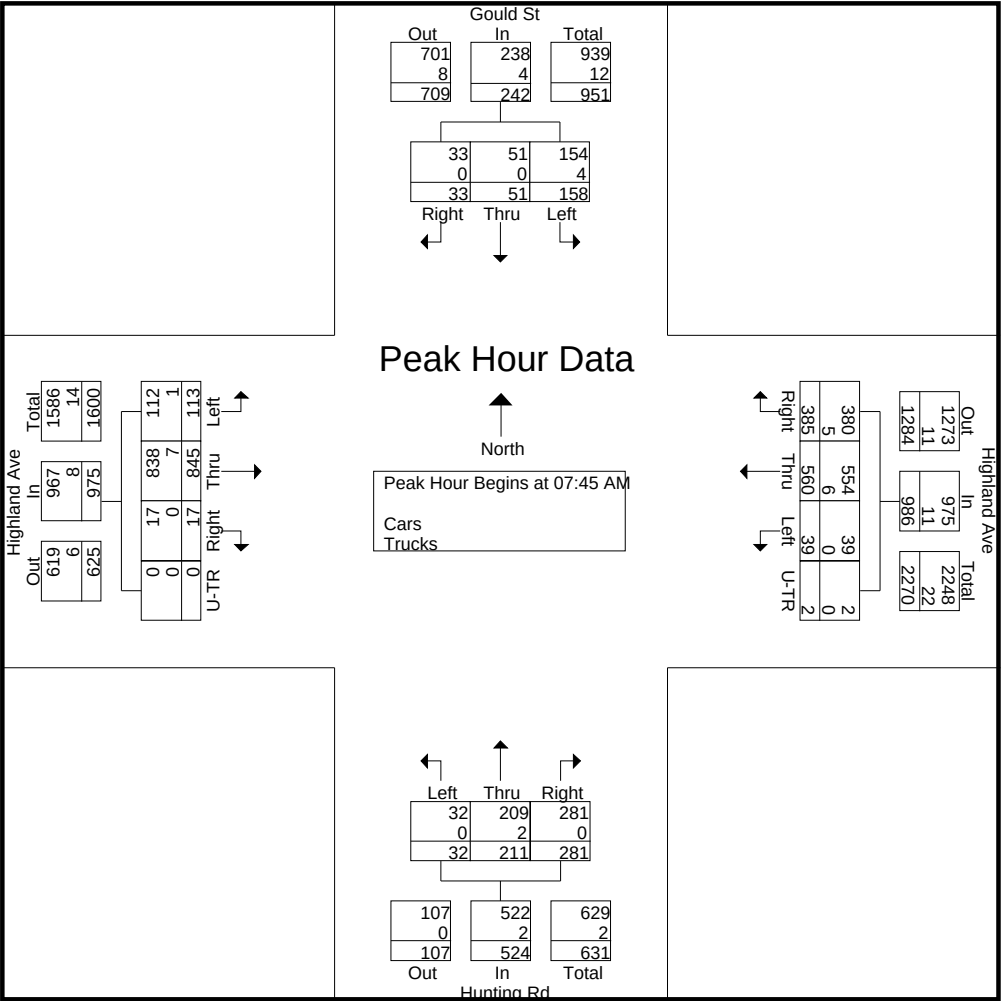
File Name : 83150004
 Site Code : 83510004
 Start Date : 9/4/2019
 Page No : 2

	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 07:45 AM																			
07:45 AM	34	10	7	51	7	154	120	1	282	9	46	46	101	33	176	7	0	216	650
08:00 AM	44	17	5	66	11	128	72	0	211	12	59	80	151	18	222	2	0	242	670
08:15 AM	31	10	12	53	8	142	95	0	245	4	47	69	120	28	243	1	0	272	690
08:30 AM	49	14	9	72	13	136	98	1	248	7	59	86	152	34	204	7	0	245	717
Total Volume	158	51	33	242	39	560	385	2	986	32	211	281	524	113	845	17	0	975	2727
% App. Total	65.3	21.1	13.6		4	56.8	39	0.2		6.1	40.3	53.6		11.6	86.7	1.7	0		
PHF	.806	.750	.688	.840	.750	.909	.802	.500	.874	.667	.894	.817	.862	.831	.869	.607	.000	.896	.951
Cars	154	51	33	238	39	554	380	2	975	32	209	281	522	112	838	17	0	967	2702
% Cars	97.5	100	100	98.3	100	98.9	98.7	100	98.9	100	99.1	100	99.6	99.1	99.2	100	0	99.2	99.1
Trucks	4	0	0	4	0	6	5	0	11	0	2	0	2	1	7	0	0	8	25
% Trucks	2.5	0	0	1.7	0	1.1	1.3	0	1.1	0	0.9	0	0.4	0.9	0.8	0	0	0.8	0.9

Accurate Counts
978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



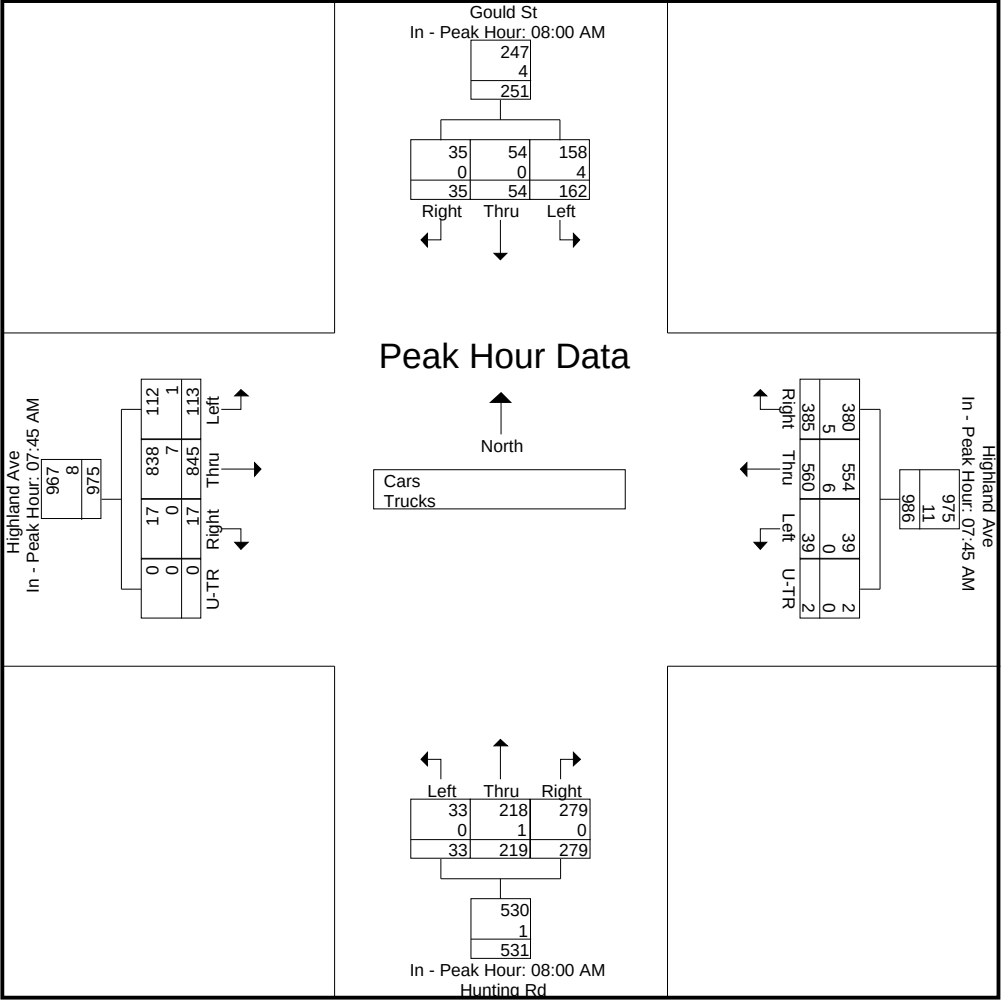
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	08:00 AM				07:45 AM					08:00 AM				07:45 AM				
+0 mins.	44	17	5	66	7	154	120	1	282	12	59	80	151	33	176	7	0	216
+15 mins.	31	10	12	53	11	128	72	0	211	4	47	69	120	18	222	2	0	242
+30 mins.	49	14	9	72	8	142	95	0	245	7	59	86	152	28	243	1	0	272
+45 mins.	38	13	9	60	13	136	98	1	248	10	54	44	108	34	204	7	0	245
Total Volume	162	54	35	251	39	560	385	2	986	33	219	279	531	113	845	17	0	975

Accurate Counts
978-664-2565

% App. Total	64.5	21.5	13.9		4	56.8	39	0.2		6.2	41.2	52.5		11.6	86.7	1.7	0	
PHF	.827	.794	.729	.872	.750	.909	.802	.500	.874	.688	.928	.811	.873	.831	.869	.607	.000	.896
Cars	158	54	35	247	39	554	380	2	975	33	218	279	530	112	838	17	0	967
% Cars	97.5	100	100	98.4	100	98.9	98.7	100	98.9	100	99.5	100	99.8	99.1	99.2	100	0	99.2
Trucks	4	0	0	4	0	6	5	0	11	0	1	0	1	1	7	0	0	8
% Trucks	2.5	0	0	1.6	0	1.1	1.3	0	1.1	0	0.5	0	0.2	0.9	0.8	0	0	0.8



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
07:00 AM	39	7	9	16	125	74	0	14	20	41	9	183	1	0	538
07:15 AM	27	8	5	15	144	56	0	8	22	58	13	221	2	0	579
07:30 AM	44	12	11	7	138	59	1	8	29	60	20	182	3	0	574
07:45 AM	34	10	7	7	153	117	1	9	45	46	33	173	7	0	642
Total	144	37	32	45	560	306	2	39	116	205	75	759	13	0	2333
08:00 AM	44	17	5	11	125	71	0	12	58	80	17	221	2	0	663
08:15 AM	30	10	12	8	140	94	0	4	47	69	28	241	1	0	684
08:30 AM	46	14	9	13	136	98	1	7	59	86	34	203	7	0	713
08:45 AM	38	13	9	16	124	121	3	10	54	44	35	154	2	0	623
Total	158	54	35	48	525	384	4	33	218	279	114	819	12	0	2683
Grand Total	302	91	67	93	1085	690	6	72	334	484	189	1578	25	0	5016
Apprch %	65.7	19.8	14.6	5	57.9	36.8	0.3	8.1	37.5	54.4	10.5	88.1	1.4	0	
Total %	6	1.8	1.3	1.9	21.6	13.8	0.1	1.4	6.7	9.6	3.8	31.5	0.5	0	

Accurate Counts
978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

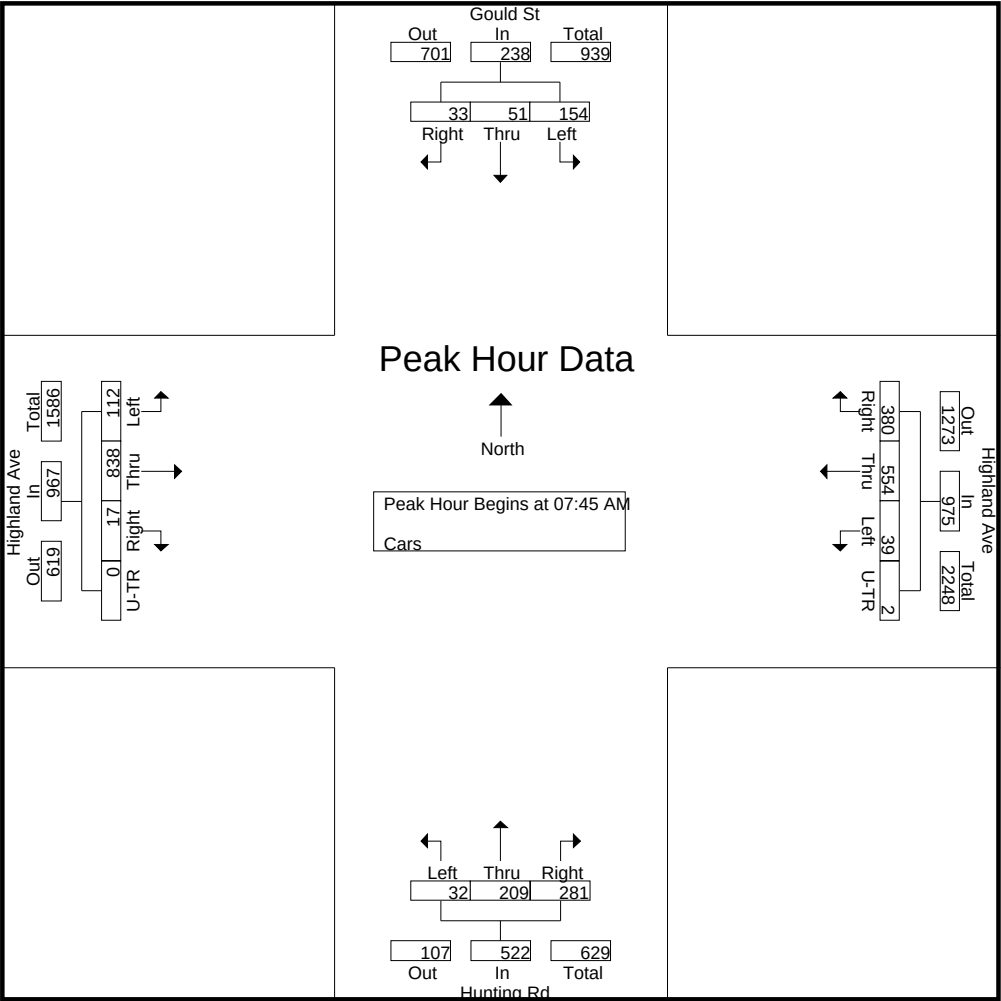
File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 2

	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
Page No : 3



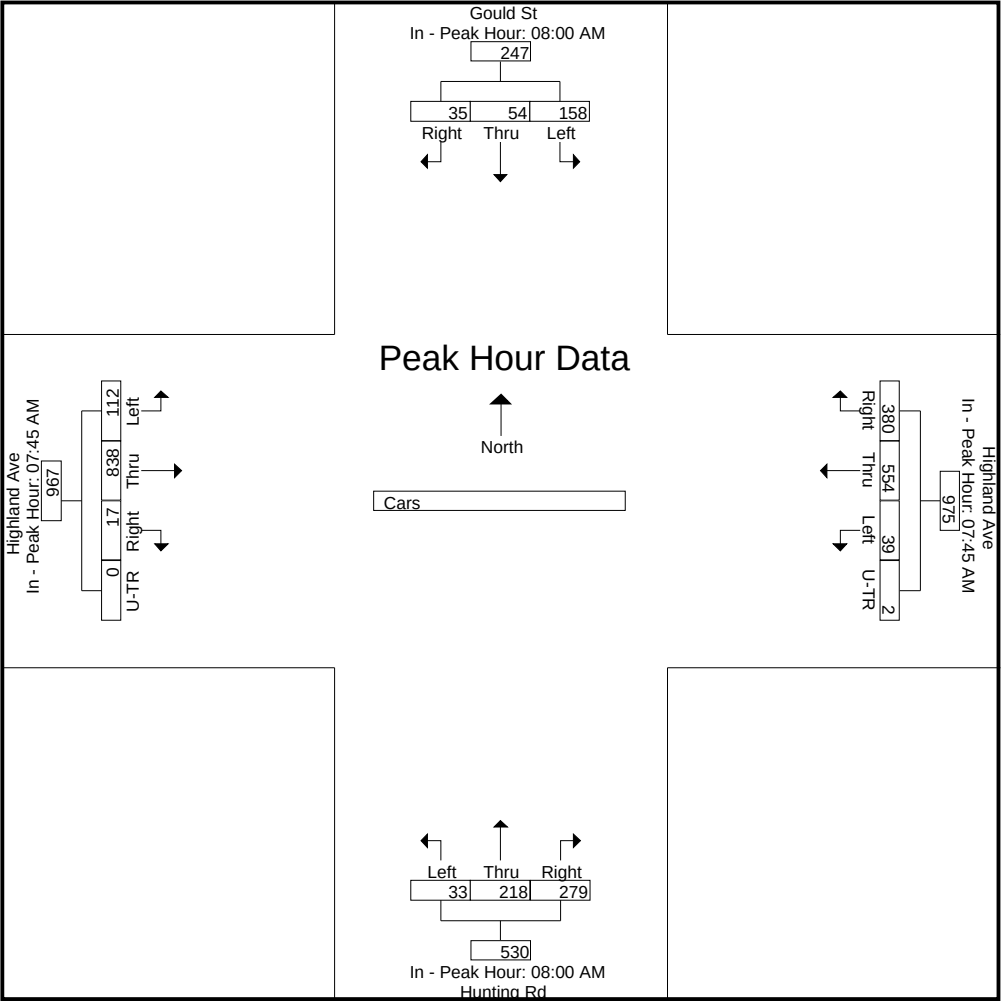
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	08:00 AM				07:45 AM					08:00 AM				07:45 AM				
+0 mins.	44	17	5	66	7	153	117	1	278	12	58	80	150	33	173	7	0	213
+15 mins.	30	10	12	52	11	125	71	0	207	4	47	69	120	17	221	2	0	240
+30 mins.	46	14	9	69	8	140	94	0	242	7	59	86	152	28	241	1	0	270
+45 mins.	38	13	9	60	13	136	98	1	248	10	54	44	108	34	203	7	0	244
Total Volume	158	54	35	247	39	554	380	2	975	33	218	279	530	112	838	17	0	967

Accurate Counts
978-664-2565

% App. Total	64	21.9	14.2		4	56.8	39	0.2		6.2	41.1	52.6		11.6	86.7	1.8	0	
PHF	.859	.794	.729	.895	.750	.905	.812	.500	.877	.688	.924	.811	.872	.824	.869	.607	.000	.895



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
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

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

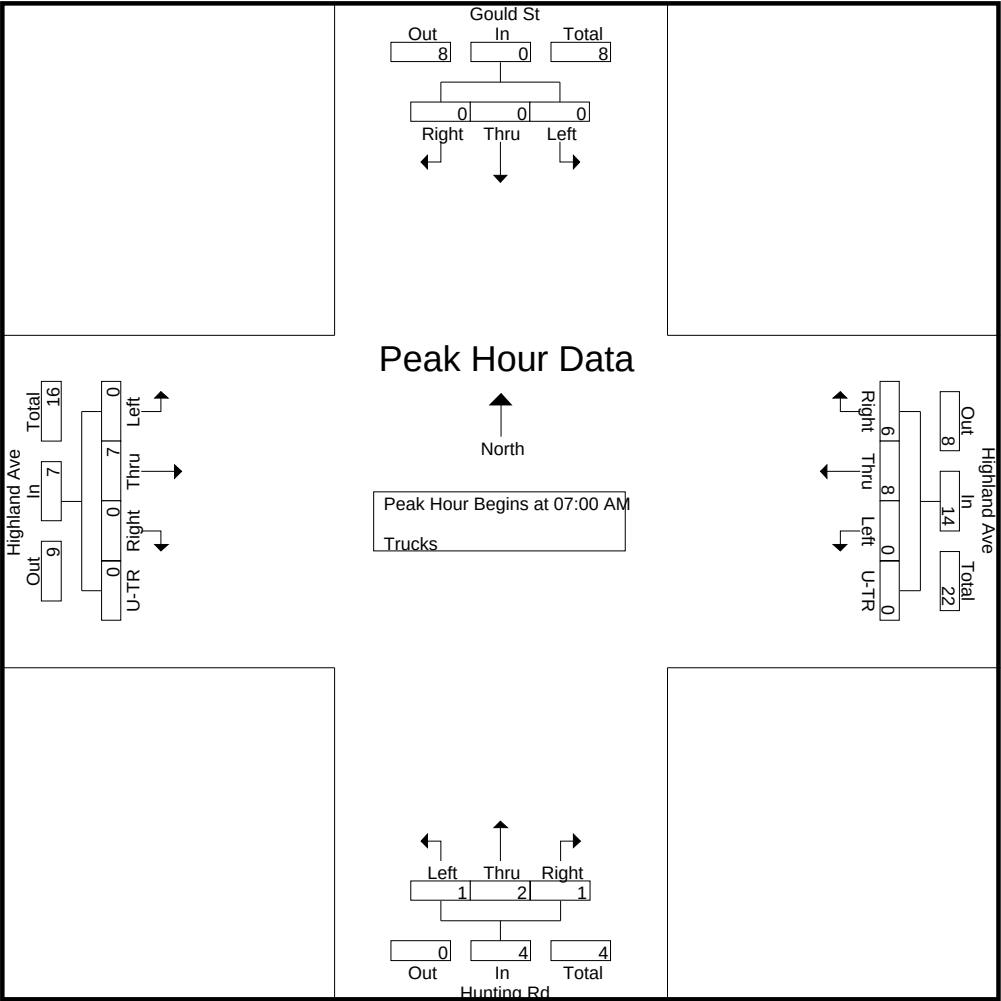
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Site Code : 83510004
Start Date : 9/4/2019
Page No : 2

	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 07:00 AM																			
07:00 AM	0	0	0	0	0	5	1	0	6	1	0	0	1	0	2	0	0	2	9
07:15 AM	0	0	0	0	0	1	2	0	3	0	0	0	0	0	1	0	0	1	4
07:30 AM	0	0	0	0	0	1	0	0	1	0	1	1	2	0	1	0	0	1	4
07:45 AM	0	0	0	0	0	1	3	0	4	0	1	0	1	0	3	0	0	3	8
Total Volume	0	0	0	0	0	8	6	0	14	1	2	1	4	0	7	0	0	7	25
% App. Total	0	0	0		0	57.1	42.9	0		25	50	25		0	100	0	0		
PHF	.000	.000	.000	.000	.000	.400	.500	.000	.583	.250	.500	.250	.500	.000	.583	.000	.000	.583	.694

Accurate Counts
978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



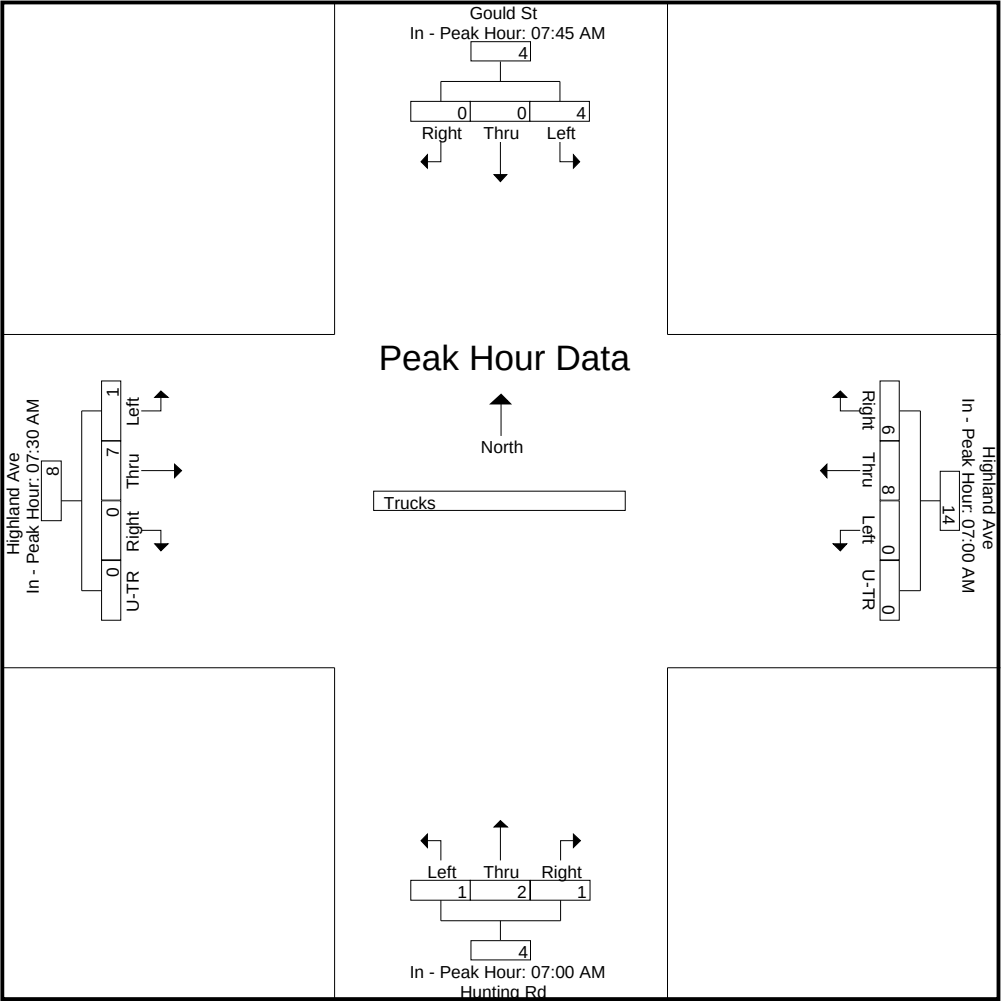
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	07:45 AM				07:00 AM					07:00 AM				07:30 AM				
+0 mins.	0	0	0	0	0	5	1	0	6	1	0	0	1	0	1	0	0	1
+15 mins.	0	0	0	0	0	1	2	0	3	0	0	0	0	0	3	0	0	3
+30 mins.	1	0	0	1	0	1	0	0	1	0	1	1	2	1	1	0	0	2
+45 mins.	3	0	0	3	0	1	3	0	4	0	1	0	1	0	2	0	0	2
Total Volume	4	0	0	4	0	8	6	0	14	1	2	1	4	1	7	0	0	8

Accurate Counts
978-664-2565

% App. Total	100	0	0		0	57.1	42.9	0		25	50	25		12.5	87.5	0	0	
PHF	.333	.000	.000	.333	.000	.400	.500	.000	.583	.250	.500	.250	.500	.250	.583	.000	.000	.667



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
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

Page No : 2

N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

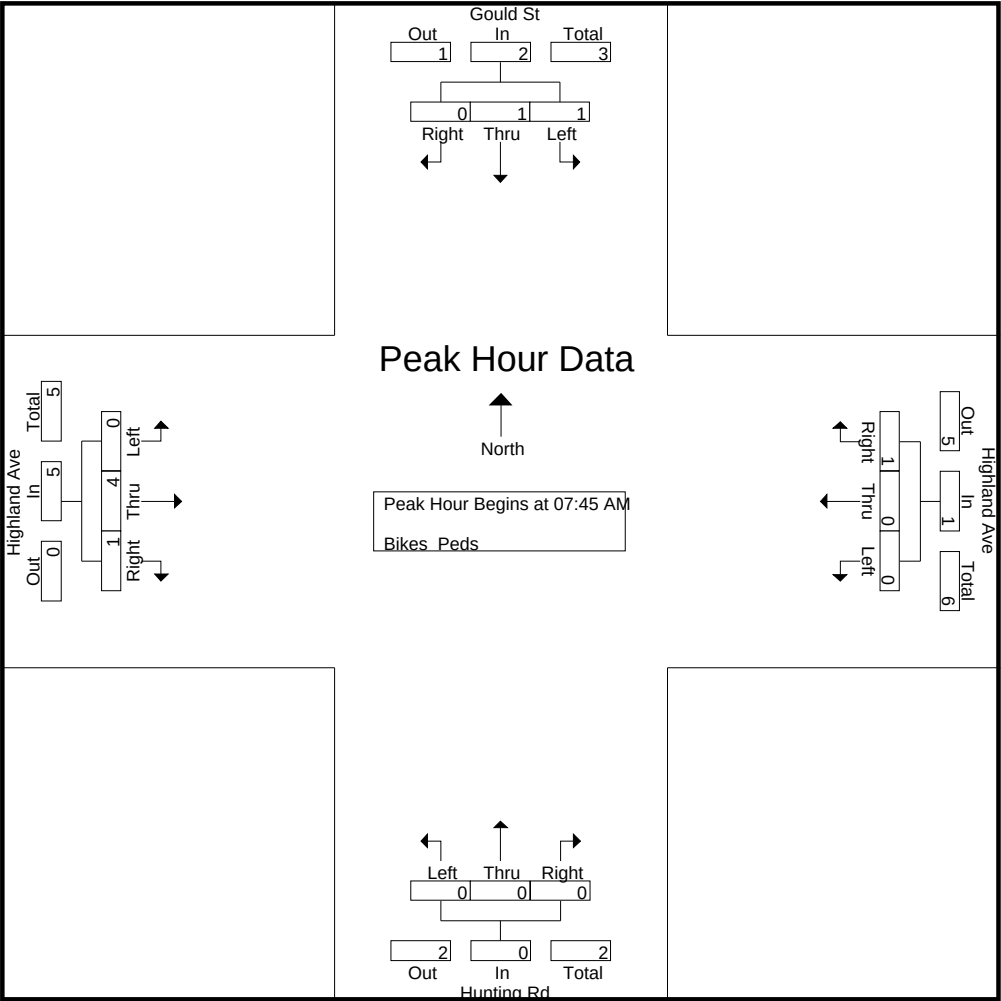
Weather : Clear

	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	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	2	3
08:00 AM	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0	2	3
08:15 AM	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Total Volume	1	1	0	2	0	0	1	1	0	0	0	0	0	4	1	5	8
% App. Total	50	50	0		0	0	100		0	0	0		0	80	20		
PHF	.250	.250	.000	.500	.000	.000	.250	.250	.000	.000	.000	.000	.000	.500	.250	.625	.667

Accurate Counts
978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 3



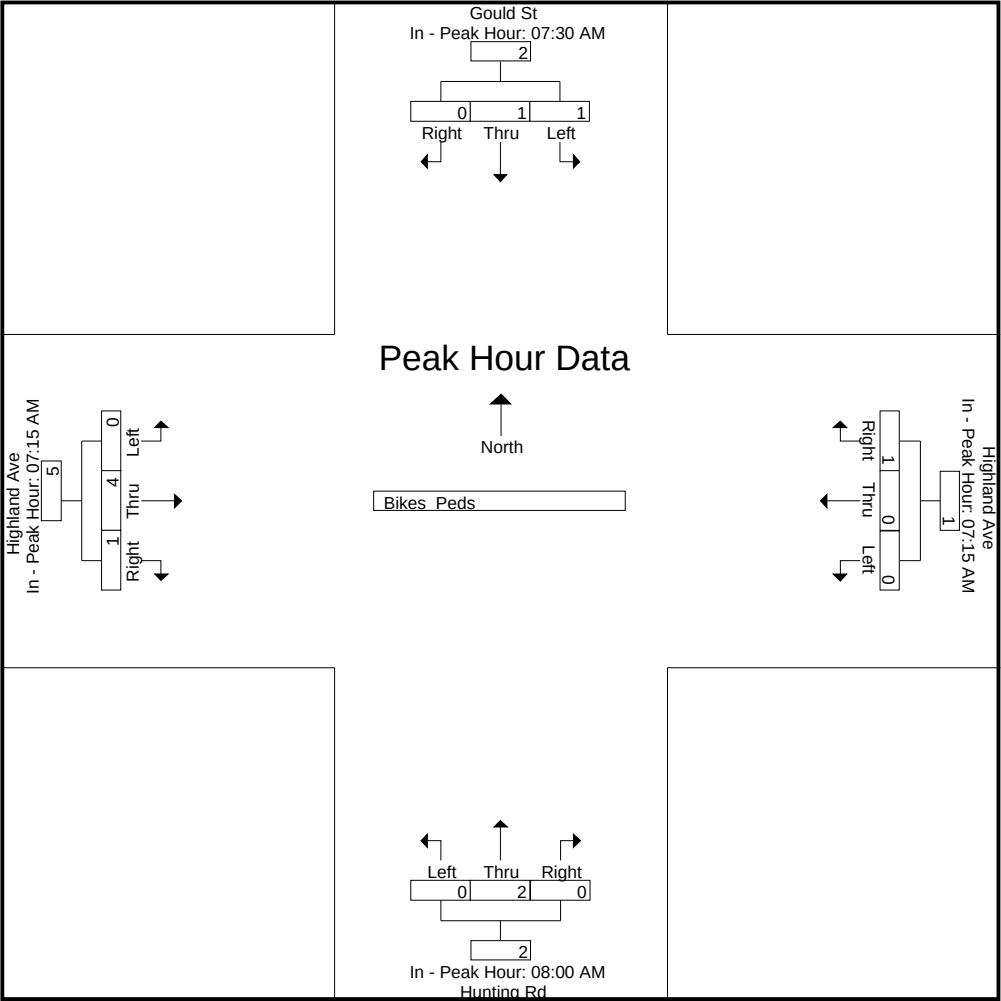
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

	07:30 AM				07:15 AM				08:00 AM				07:15 AM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
+15 mins.	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
+45 mins.	1	0	0	1	0	0	1	1	0	2	0	2	0	2	0	2
Total Volume	1	1	0	2	0	0	1	1	0	2	0	2	0	4	1	5

Accurate Counts
978-664-2565

% App. Total	50	50	0		0	0	100		0	100	0		0	80	20	
PHF	.250	.250	.000	.500	.000	.000	.250	.250	.000	.250	.000	.250	.000	.500	.250	.625



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
Page No : 1

Groups Printed- Cars - Trucks

	Gould St From North			Highland Ave From East				Hunting Rd From South			Highland Ave From West				
Start Time	Left	Thru	Right	Left	Thru	Right	U-TR	Left	Thru	Right	Left	Thru	Right	U-TR	Int. Total
03:00 PM	71	32	10	20	156	56	0	4	9	23	16	188	7	0	592
03:15 PM	54	24	15	20	151	50	0	4	13	24	13	159	2	0	529
03:30 PM	82	29	14	26	199	51	0	4	10	23	9	183	3	0	633
03:45 PM	55	30	17	26	170	47	3	6	23	23	14	137	5	0	556
Total	262	115	56	92	676	204	3	18	55	93	52	667	17	0	2310
04:00 PM	80	29	18	35	216	29	5	6	12	22	4	154	6	0	616
04:15 PM	49	27	10	37	208	36	2	2	13	32	6	169	7	0	598
04:30 PM	70	44	22	48	224	42	1	8	15	19	10	135	8	0	646
04:45 PM	82	31	19	41	240	47	2	11	16	18	5	139	5	0	656
Total	281	131	69	161	888	154	10	27	56	91	25	597	26	0	2516
05:00 PM	105	35	15	47	232	49	2	10	15	26	11	152	5	0	704
05:15 PM	70	36	16	49	222	47	0	6	24	22	14	141	6	1	654
05:30 PM	85	36	21	28	254	52	1	10	10	11	4	120	5	2	639
05:45 PM	66	26	11	32	240	42	1	8	18	18	8	131	5	0	606
Total	326	133	63	156	948	190	4	34	67	77	37	544	21	3	2603
Grand Total	869	379	188	409	2512	548	17	79	178	261	114	1808	64	3	7429
Apprch %	60.5	26.4	13.1	11.7	72.1	15.7	0.5	15.3	34.4	50.4	5.7	90.9	3.2	0.2	
Total %	11.7	5.1	2.5	5.5	33.8	7.4	0.2	1.1	2.4	3.5	1.5	24.3	0.9	0	
Cars	866	378	187	408	2503	547	17	79	176	257	112	1797	64	3	7394
% Cars	99.7	99.7	99.5	99.8	99.6	99.8	100	100	98.9	98.5	98.2	99.4	100	100	99.5
Trucks	3	1	1	1	9	1	0	0	2	4	2	11	0	0	35
% Trucks	0.3	0.3	0.5	0.2	0.4	0.2	0	0	1.1	1.5	1.8	0.6	0	0	0.5

Accurate Counts

978-664-2565

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 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

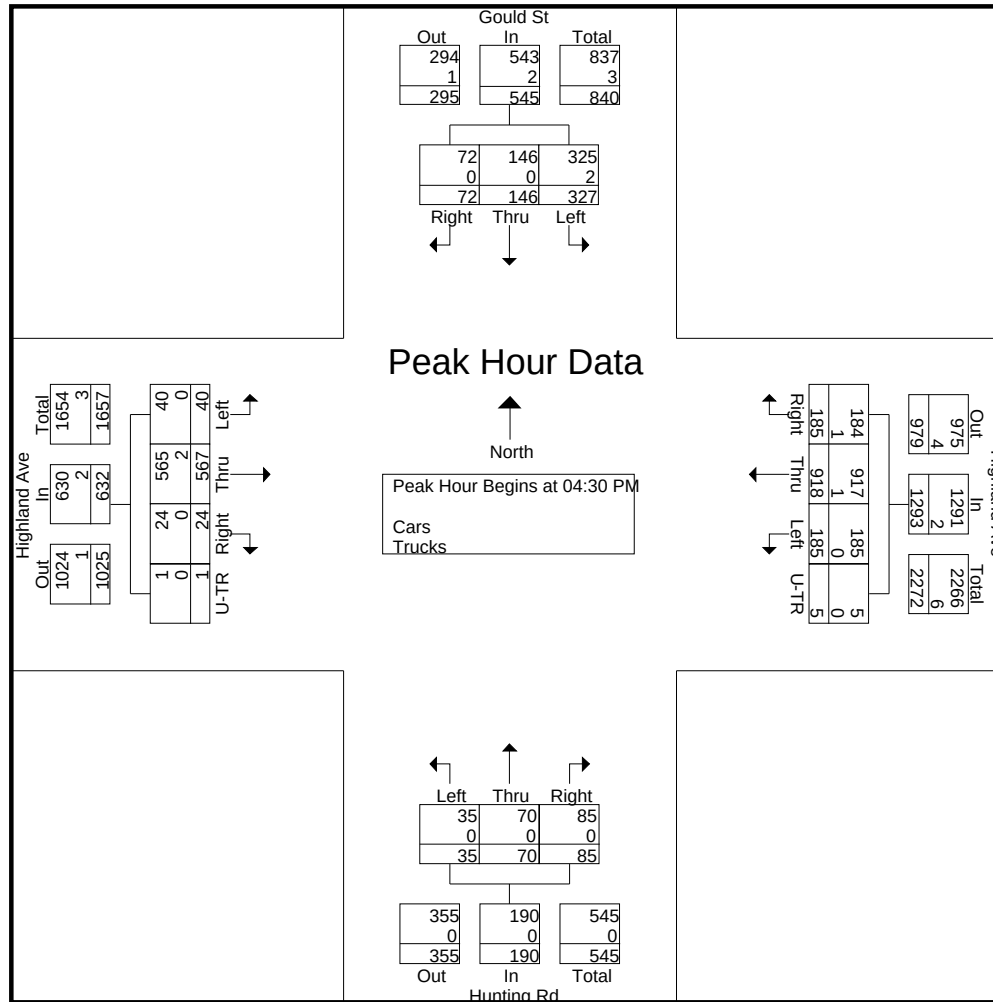
Page No : 3

N/S Street : Gould Street / Hunting Road

E/W Street: Highland Avenue

City/State : Needham, MA

Weather : Clear



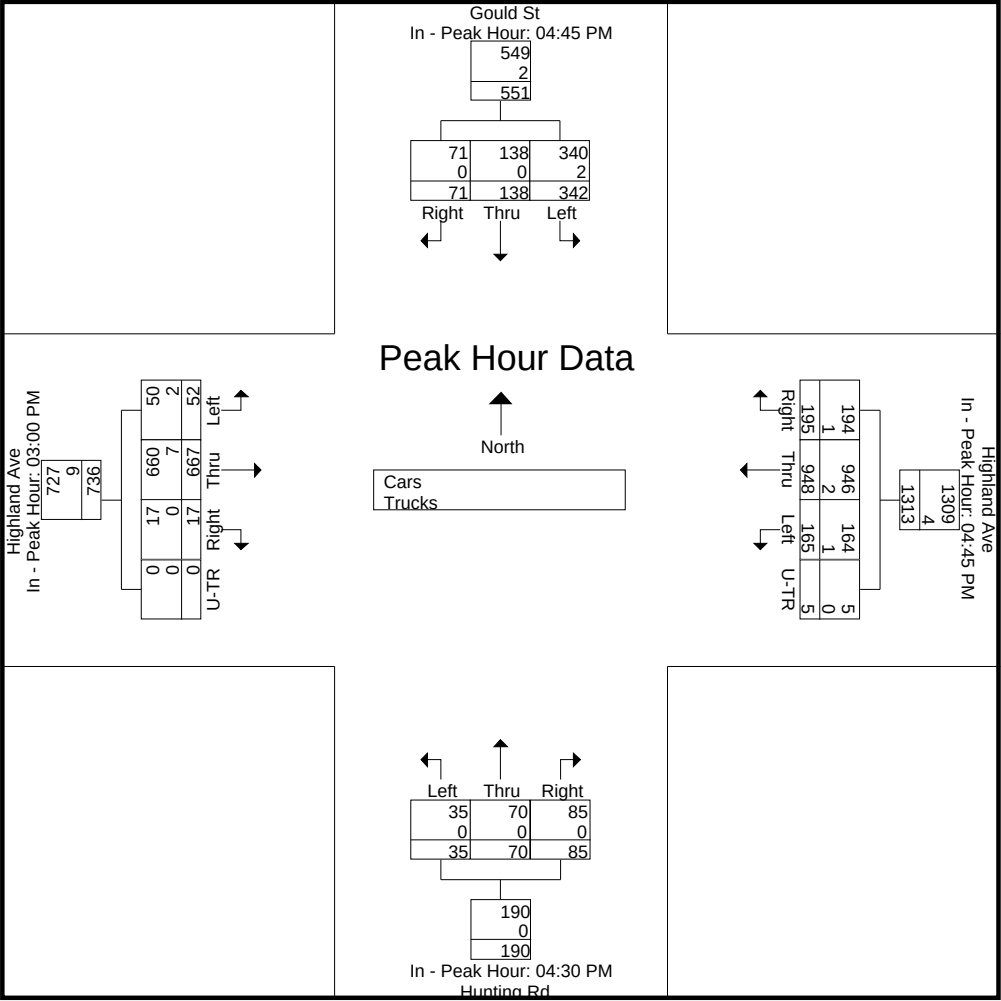
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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
Page No : 2

	Gould St From North				Highland Ave From East					Hunting Rd From South				Highland Ave From West					
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	U-TR	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 04:30 PM																			
04:30 PM	70	44	22	136	48	224	42	1	315	8	15	19	42	10	133	8	0	151	644
04:45 PM	81	31	19	131	41	239	47	2	329	11	16	18	45	5	139	5	0	149	654
05:00 PM	104	35	15	154	47	232	49	2	330	10	15	26	51	11	152	5	0	168	703
05:15 PM	70	36	16	122	49	222	46	0	317	6	24	22	52	14	141	6	1	162	653
Total Volume	325	146	72	543	185	917	184	5	1291	35	70	85	190	40	565	24	1	630	2654
% App. Total	59.9	26.9	13.3		14.3	71	14.3	0.4		18.4	36.8	44.7		6.3	89.7	3.8	0.2		
PHF	.781	.830	.818	.881	.944	.959	.939	.625	.978	.795	.729	.817	.913	.714	.929	.750	.250	.938	.944

Accurate Counts

978-664-2565

File Name : 83150004

Site Code : 83510004

Start Date : 9/4/2019

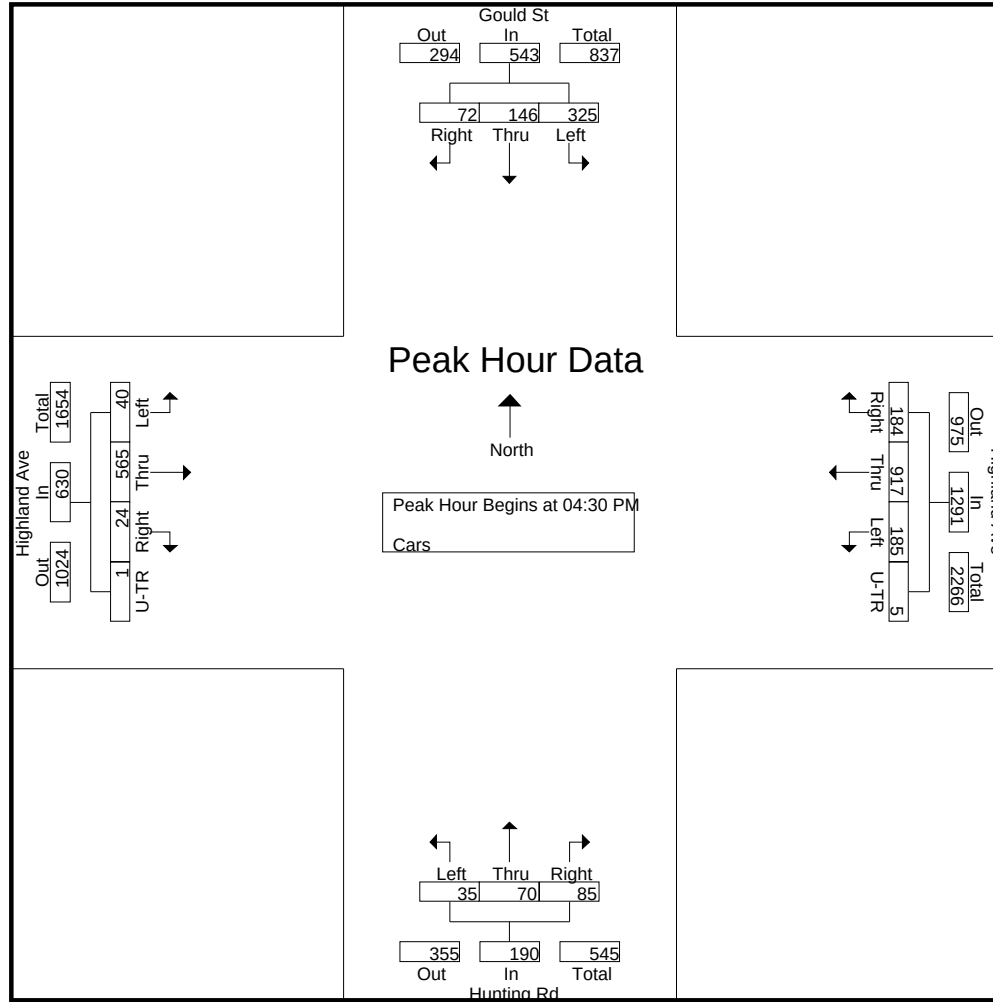
Page No : 3

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

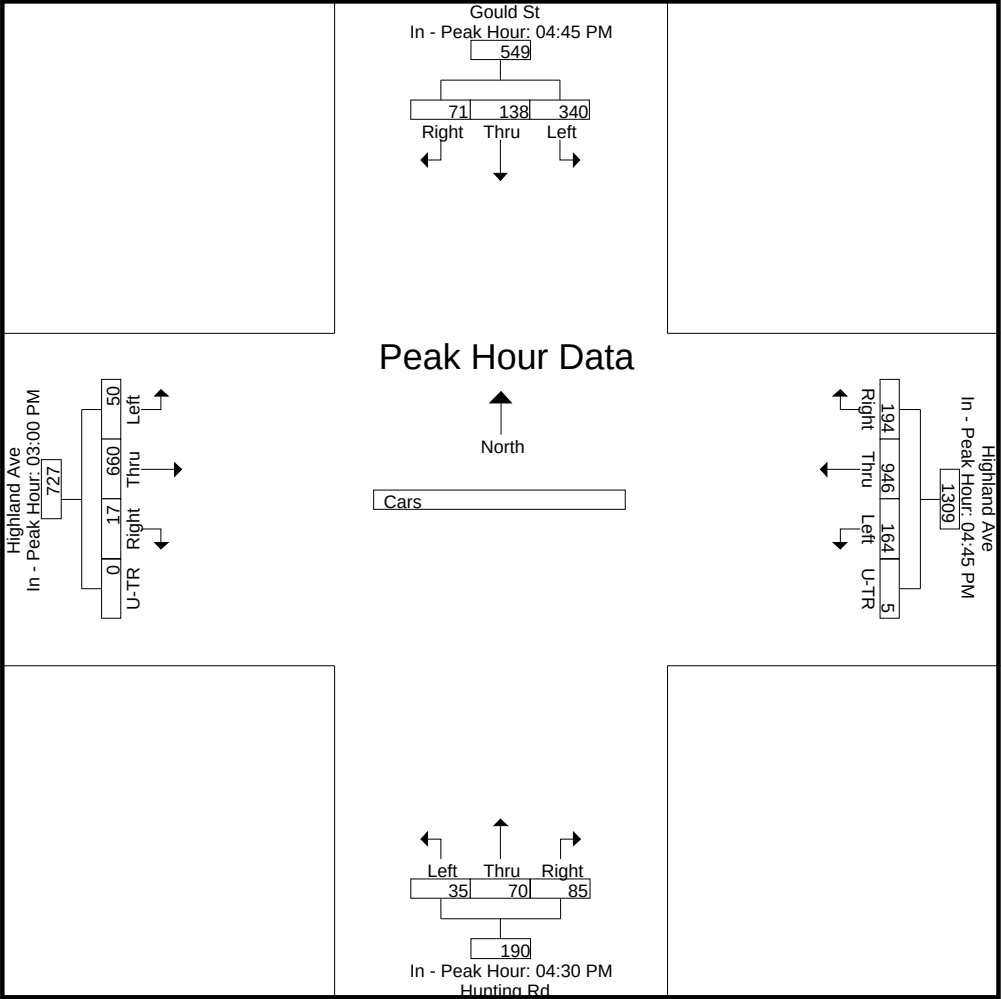
Peak Hour for Each Approach Begins at:

	04:45 PM				04:45 PM					04:30 PM				03:00 PM				
+0 mins.	81	31	19	131	41	239	47	2	329	8	15	19	42	14	187	7	0	208
+15 mins.	104	35	15	154	47	232	49	2	330	11	16	18	45	13	155	2	0	170
+30 mins.	70	36	16	122	49	222	46	0	317	10	15	26	51	9	182	3	0	194
+45 mins.	85	36	21	142	27	253	52	1	333	6	24	22	52	14	136	5	0	155
Total Volume	340	138	71	549	164	946	194	5	1309	35	70	85	190	50	660	17	0	727
% App. Total	61.9	25.1	12.9		12.5	72.3	14.8	0.4		18.4	36.8	44.7		6.9	90.8	2.3	0	
PHF	.817	.958	.845	.891	.837	.935	.933	.625	.983	.795	.729	.817	.913	.893	.882	.607	.000	.874

Accurate Counts
978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

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



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
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

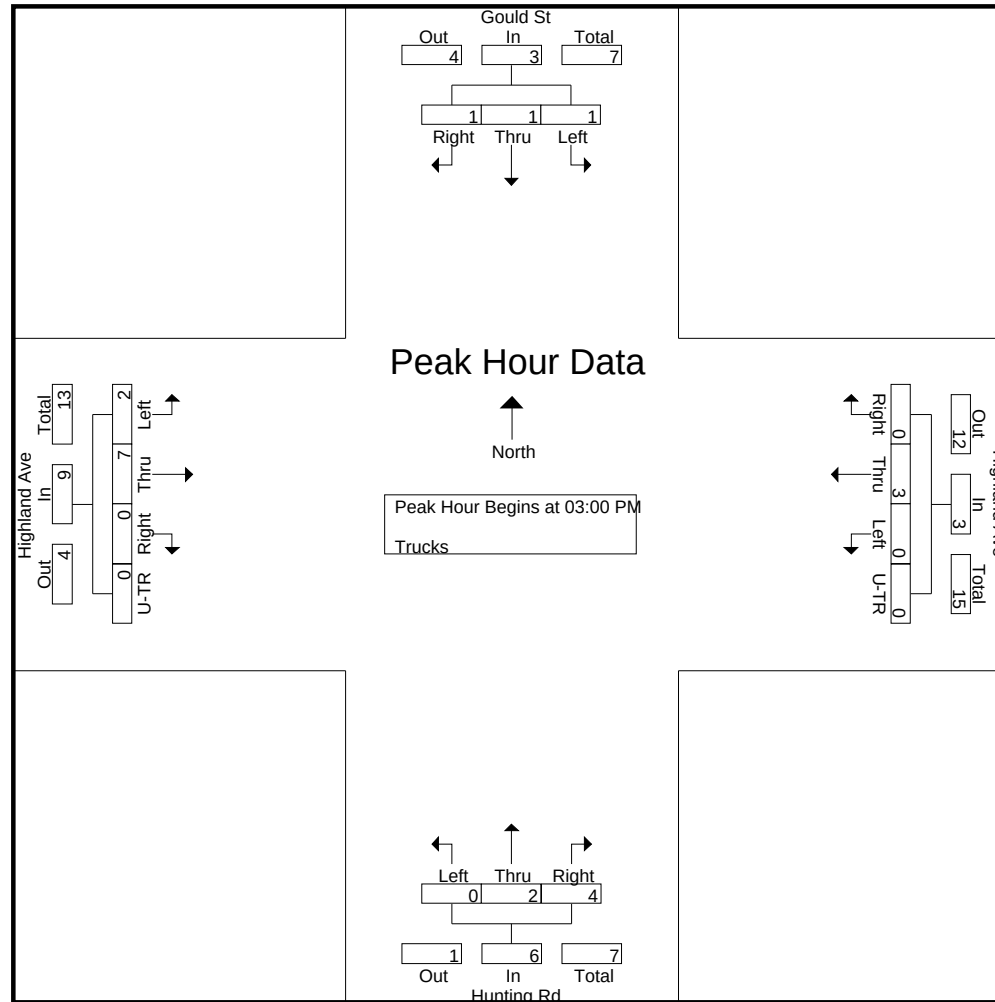
Page No : 3

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

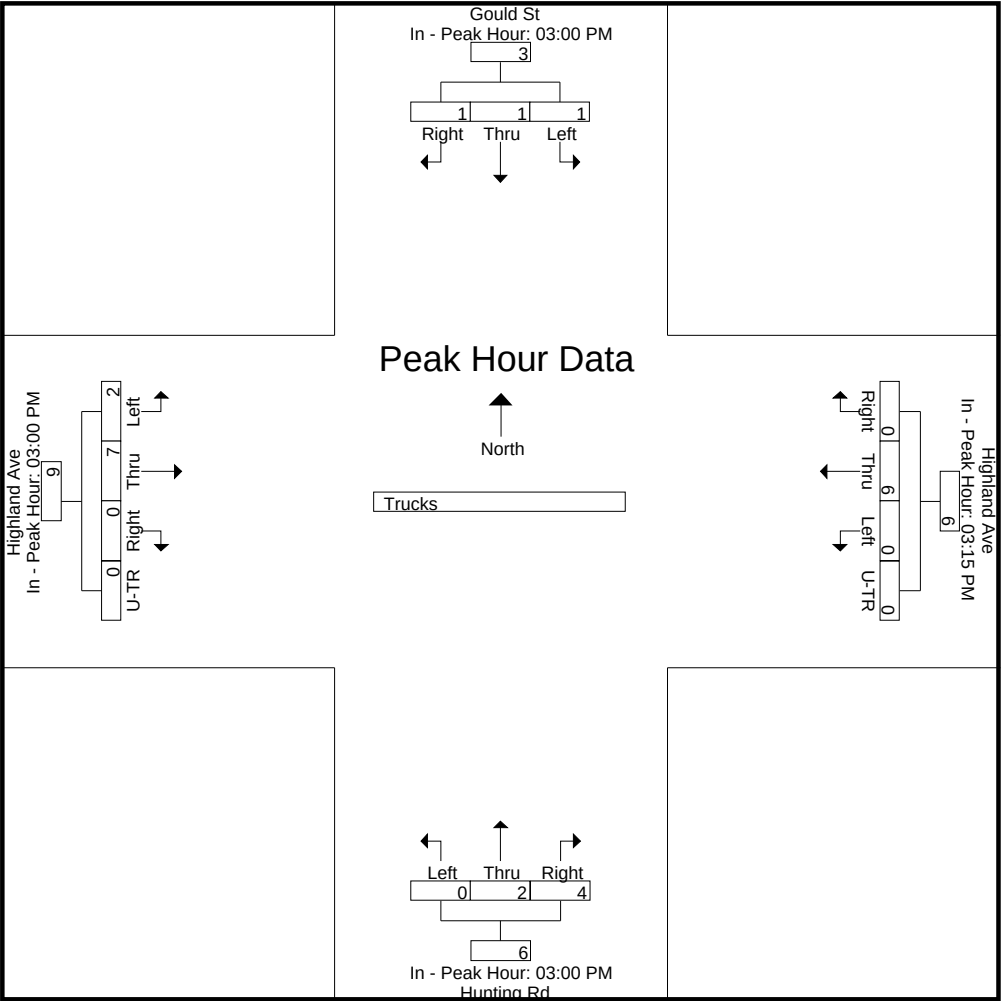
Peak Hour for Each Approach Begins at:

	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
Page No : 4



Accurate Counts

978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

File Name : 83150004
Site Code : 83510004
Start Date : 9/4/2019
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

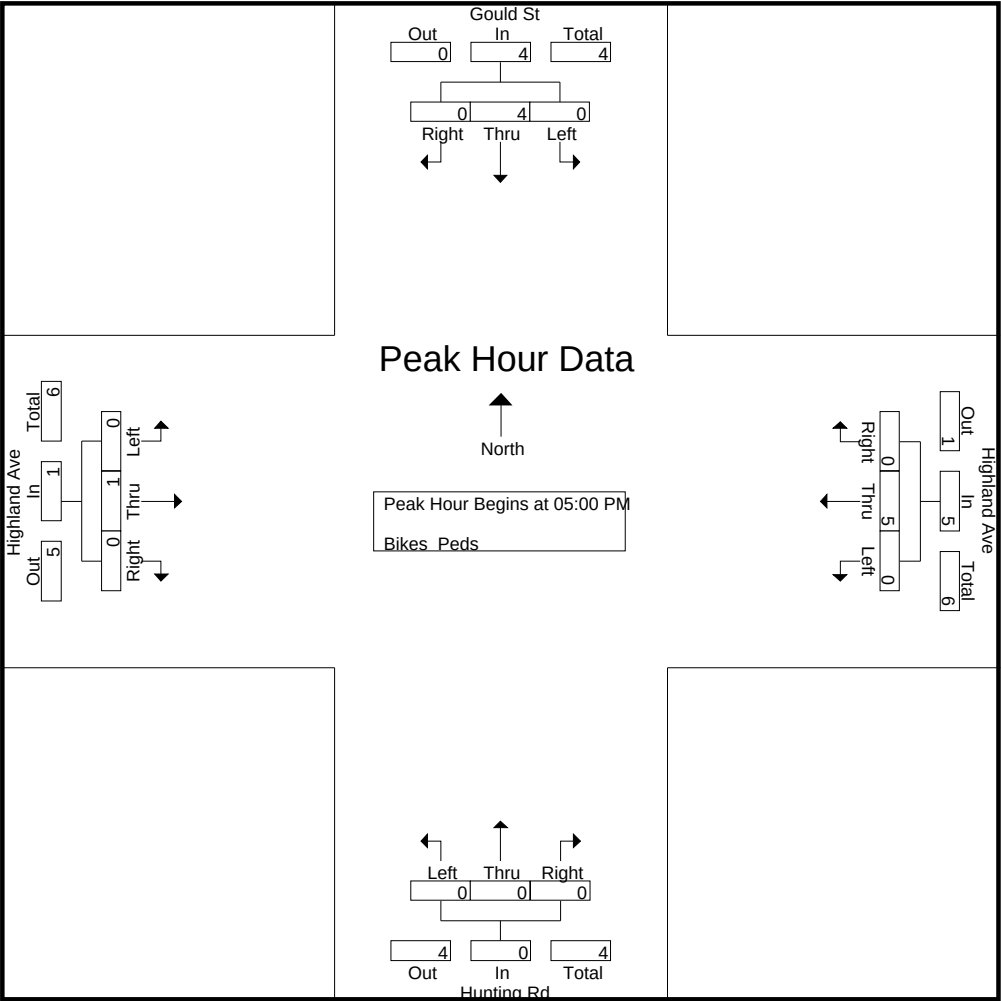
Page No : 2

	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
Page No : 3



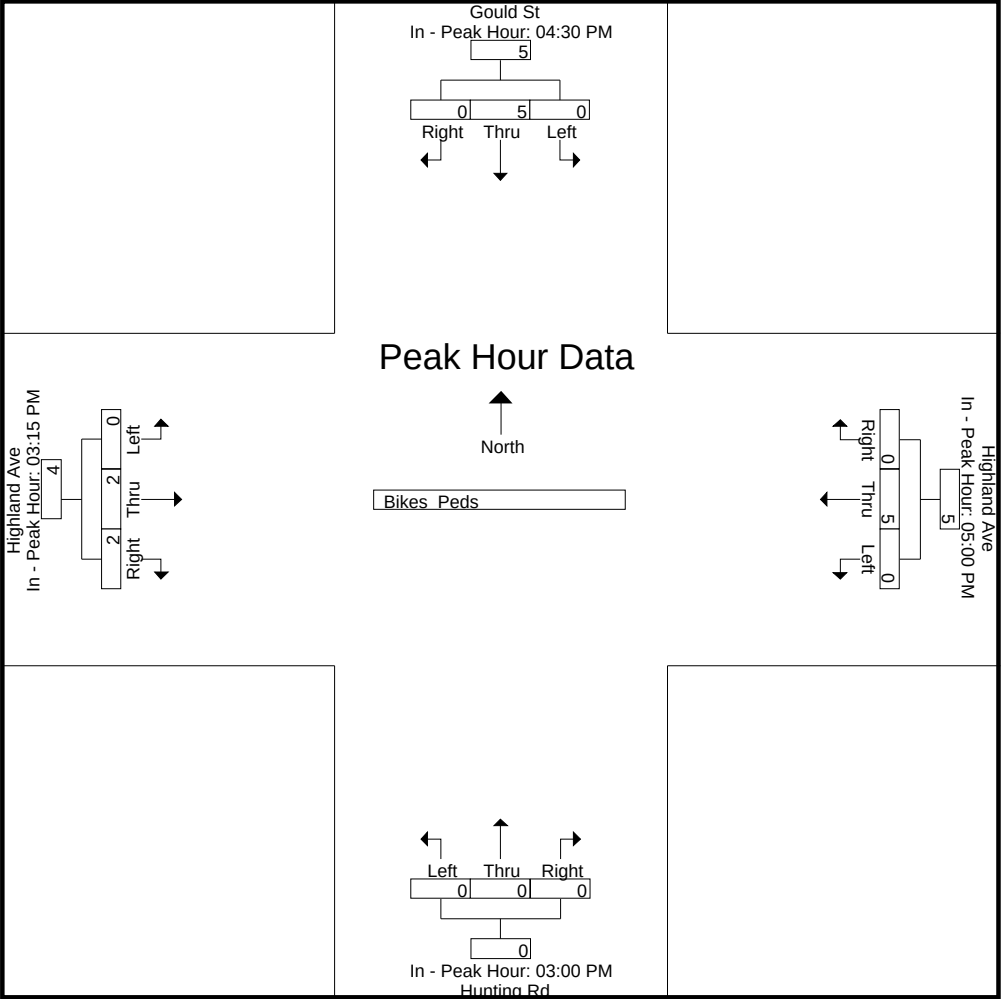
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	04:30 PM				05:00 PM				03:00 PM				03:15 PM			
+0 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1
+15 mins.	0	1	0	1	0	2	0	2	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
+45 mins.	0	4	0	4	0	2	0	2	0	0	0	0	0	2	0	2
Total Volume	0	5	0	5	0	5	0	5	0	0	0	0	0	2	2	4
% App. Total	0	100	0		0	100	0		0	0	0		0	50	50	
PHF	.000	.313	.000	.313	.000	.625	.000	.625	.000	.000	.000	.000	.000	.250	.500	.500

Accurate Counts
978-664-2565

N/S Street : Gould Street / Hunting Road
E/W Street: Highland Avenue
City/State : Needham, MA
Weather : Clear

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



978-664-2565

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

[illegible]

978-664-2565

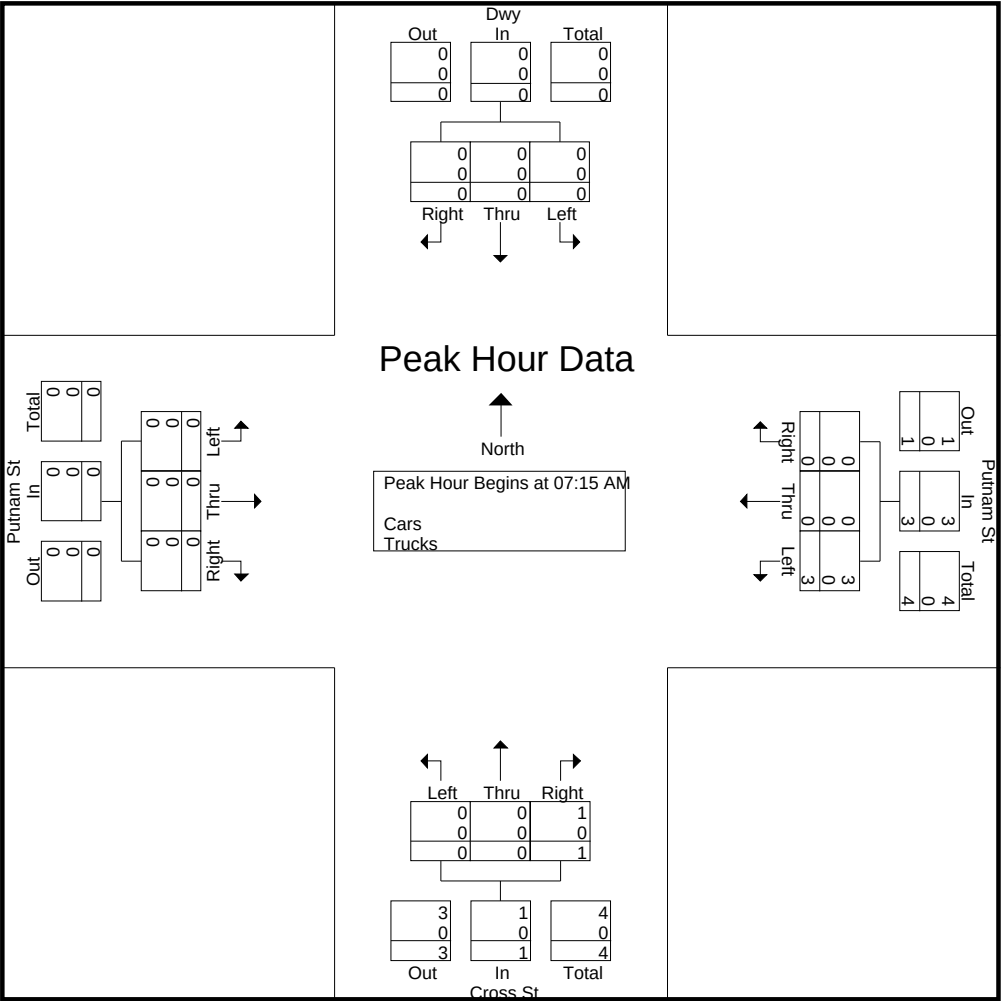
File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 2

[illegible]

Accurate Counts
978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 3



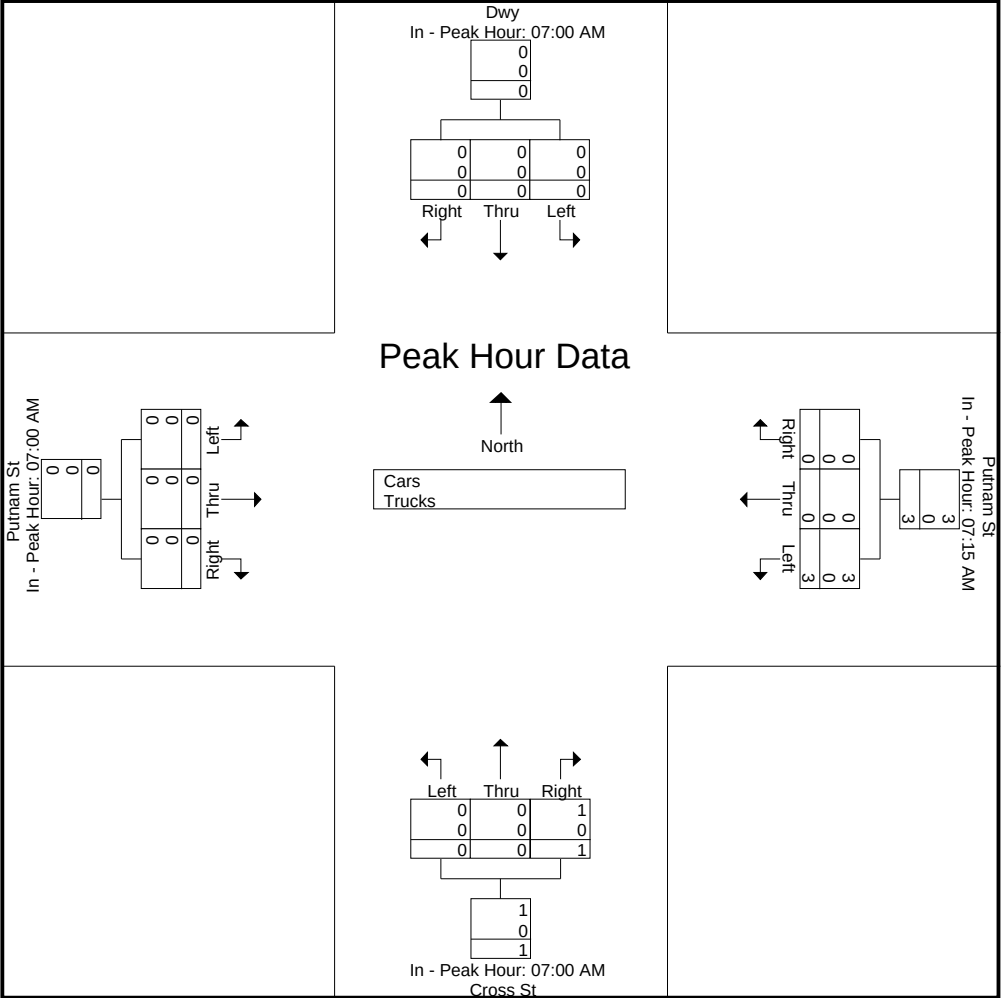
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

% App. Total	0	0	0		100	0	0		0	0	100		0	0	0	
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000
Cars	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0
% Cars	0	0	0	0	100	0	0	100	0	0	100	100	0	0	0	0
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Accurate Counts

978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
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

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

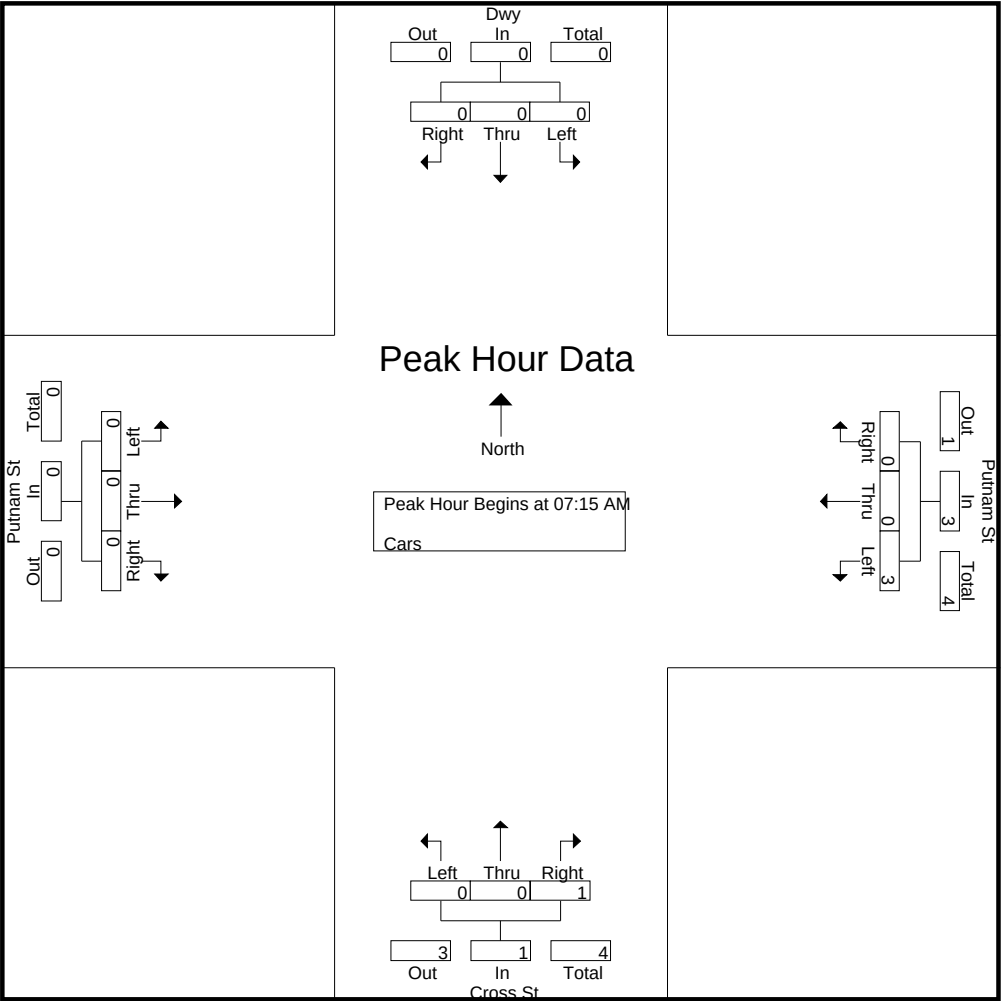
Weather : Cloudy

	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 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	2
07:30 AM	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
Total Volume	0	0	0	0	3	0	0	3	0	0	1	1	0	0	0	0	4
% App. Total	0	0	0		100	0	0		0	0	100		0	0	0		
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000	.500

Accurate Counts
978-664-2565

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 7



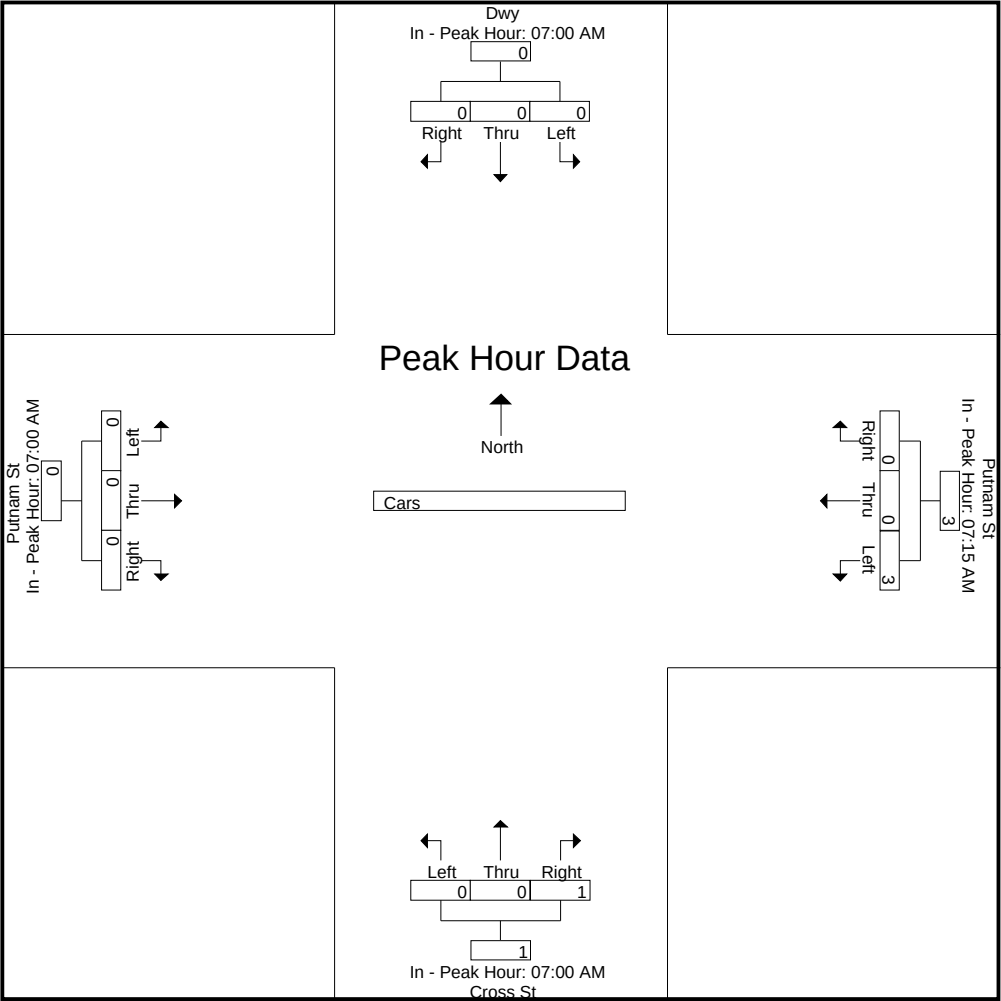
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

Peak Hour for Each Approach Begins at:

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

Accurate Counts
978-664-2565

% App. Total	0	0	0		100	0	0		0	0	100		0	0	0	
PHF	.000	.000	.000	.000	.375	.000	.000	.375	.000	.000	.250	.250	.000	.000	.000	.000



978-664-2565

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

Groups Printed- Trucks

[illegible]

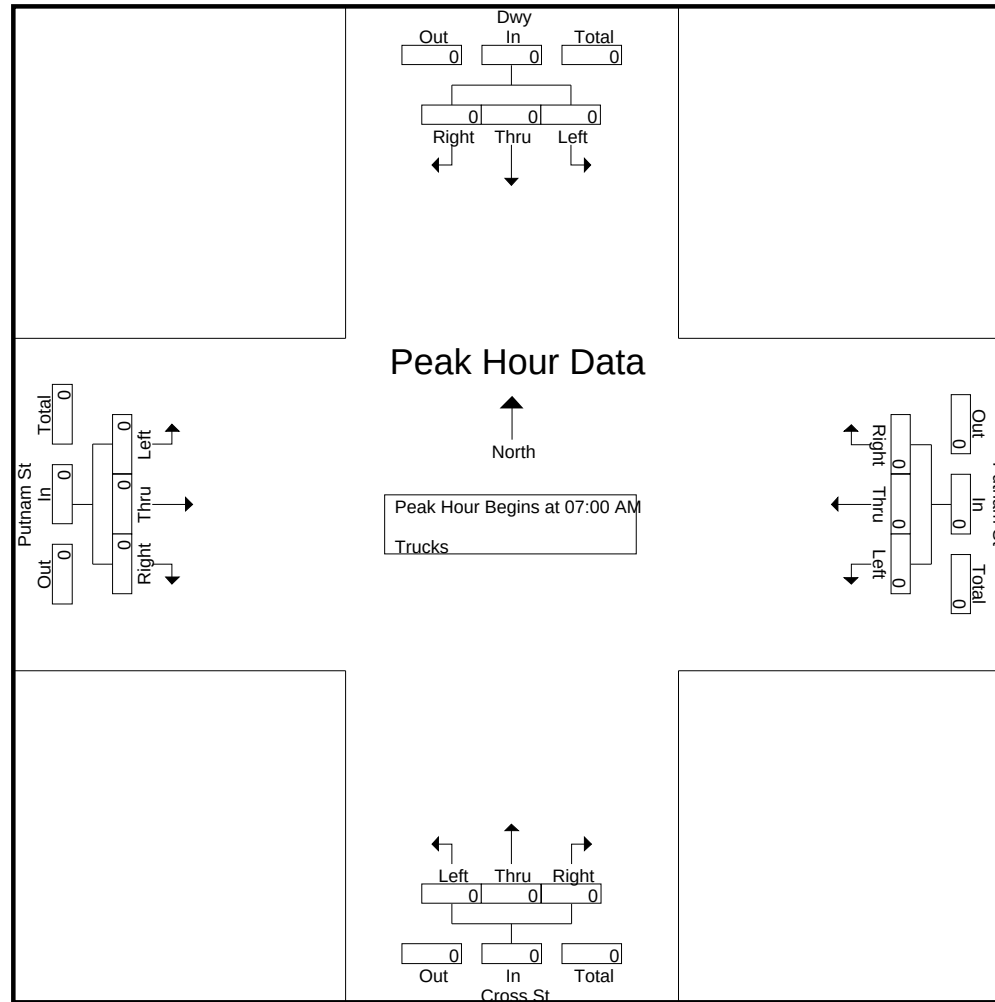
978-664-2565

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

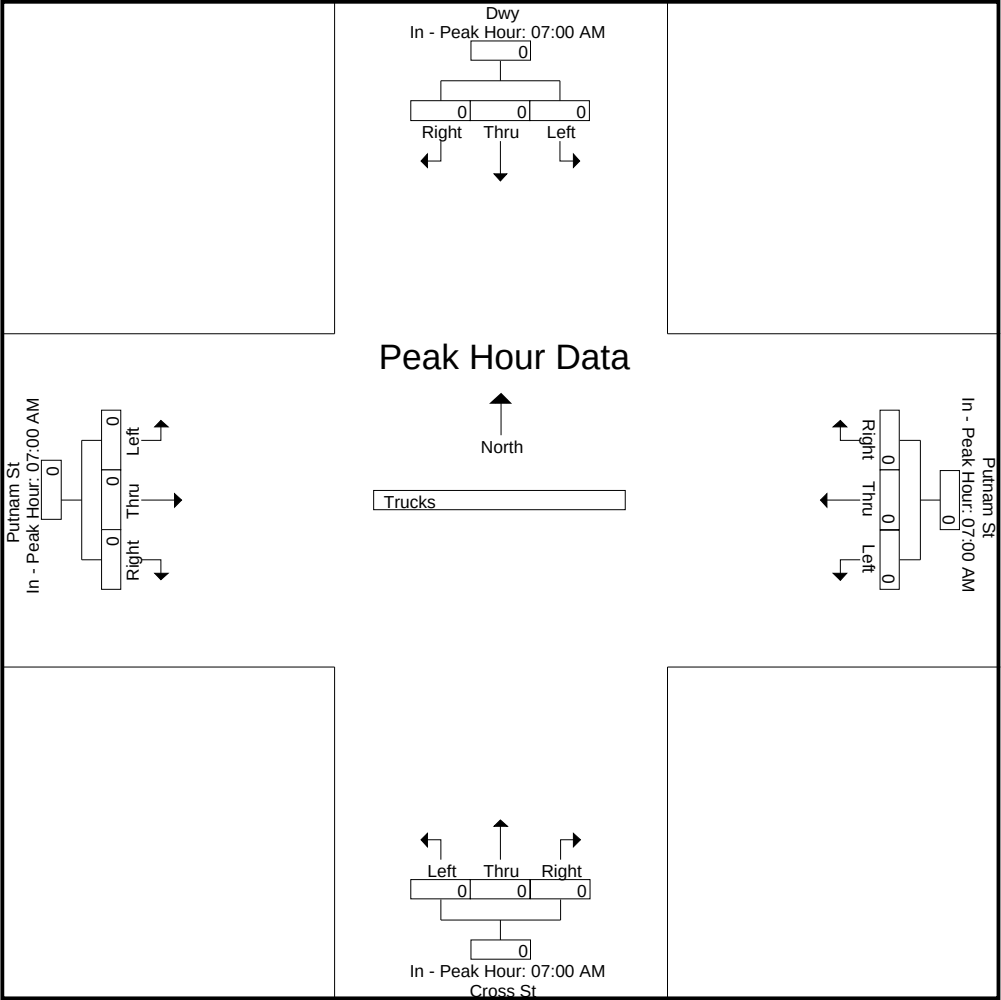


Peak Hour for Each Approach Begins at:

[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

[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

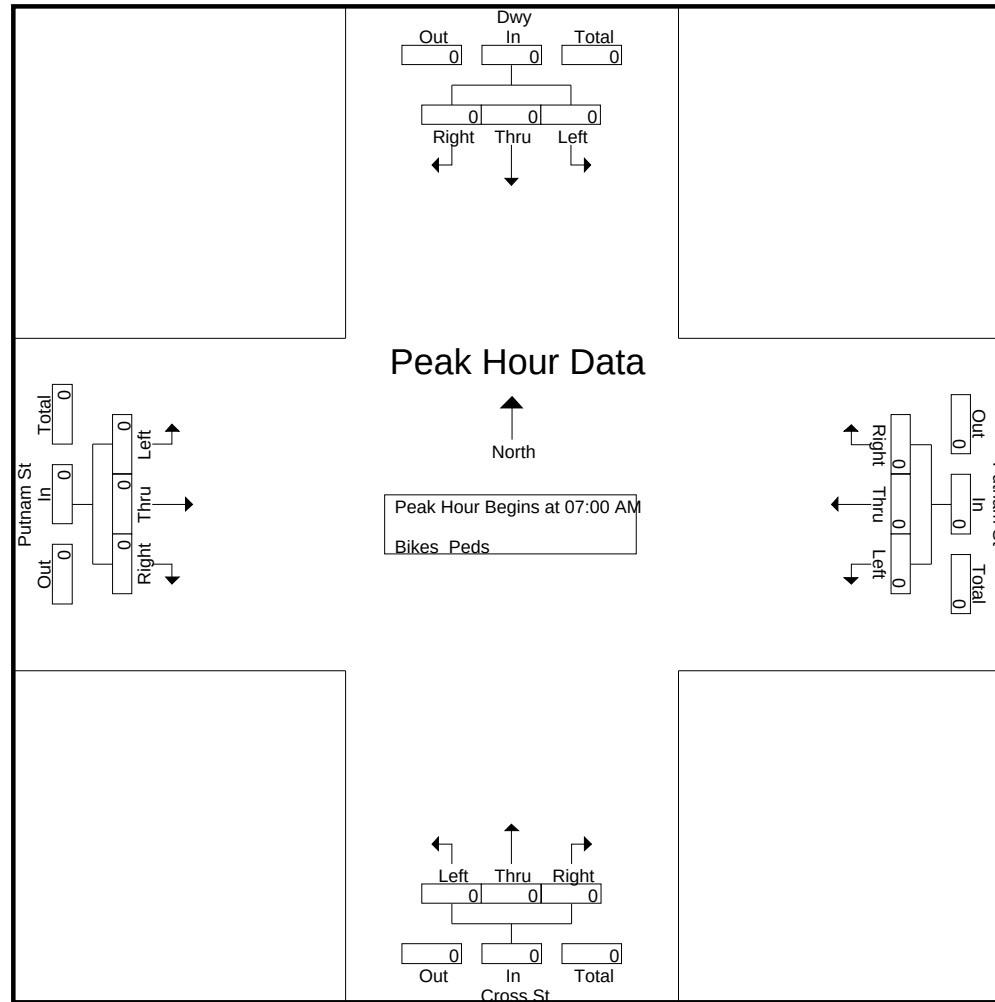
Page No : 15

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



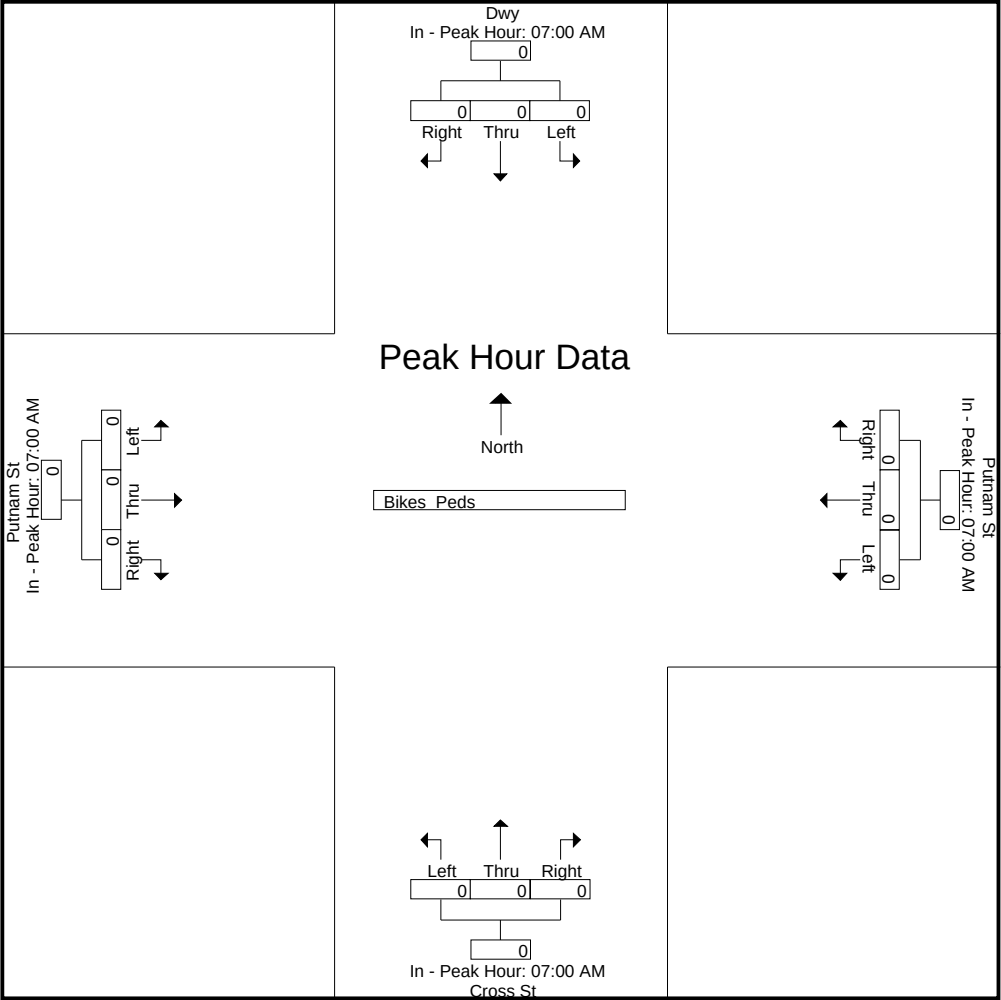
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1

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

Weather : Cloudy

Page No : 2

[illegible]

Accurate Counts

978-664-2565

File Name : 83150005

Site Code : 83150005

Start Date : 9/4/2019

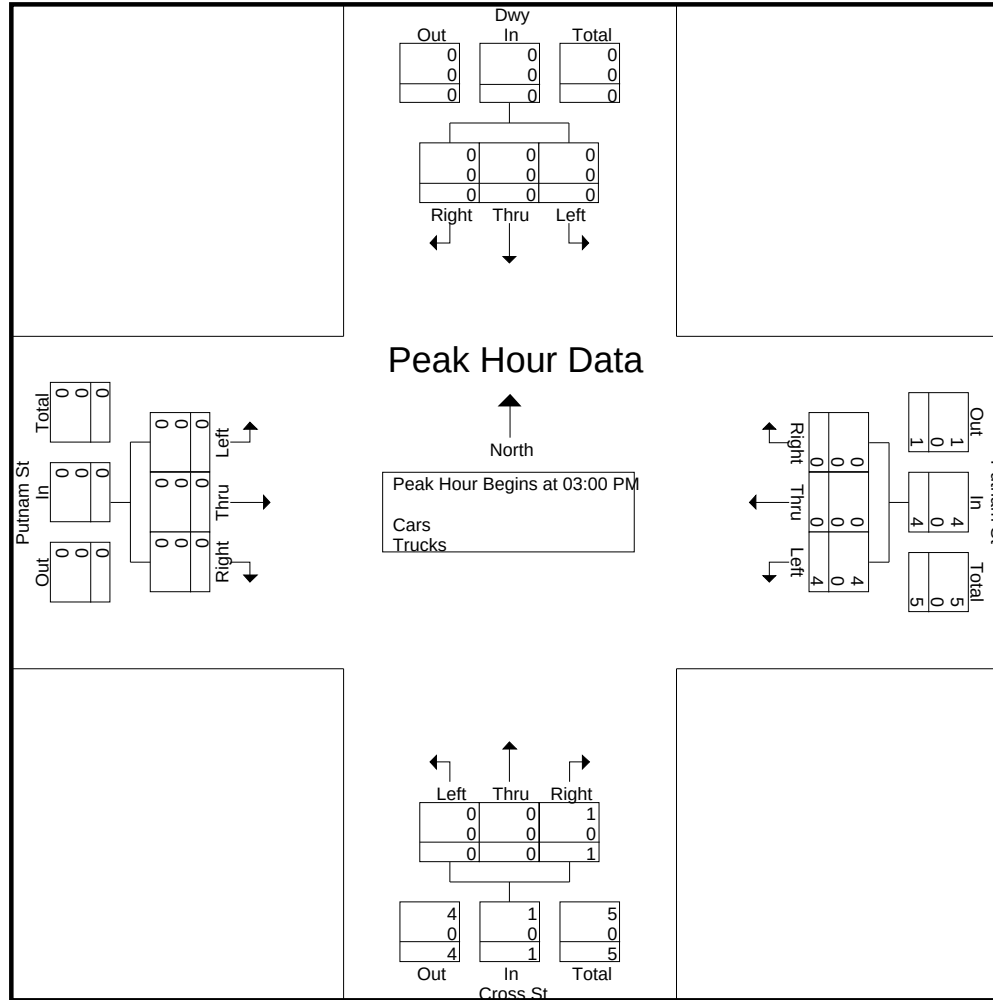
Page No : 3

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



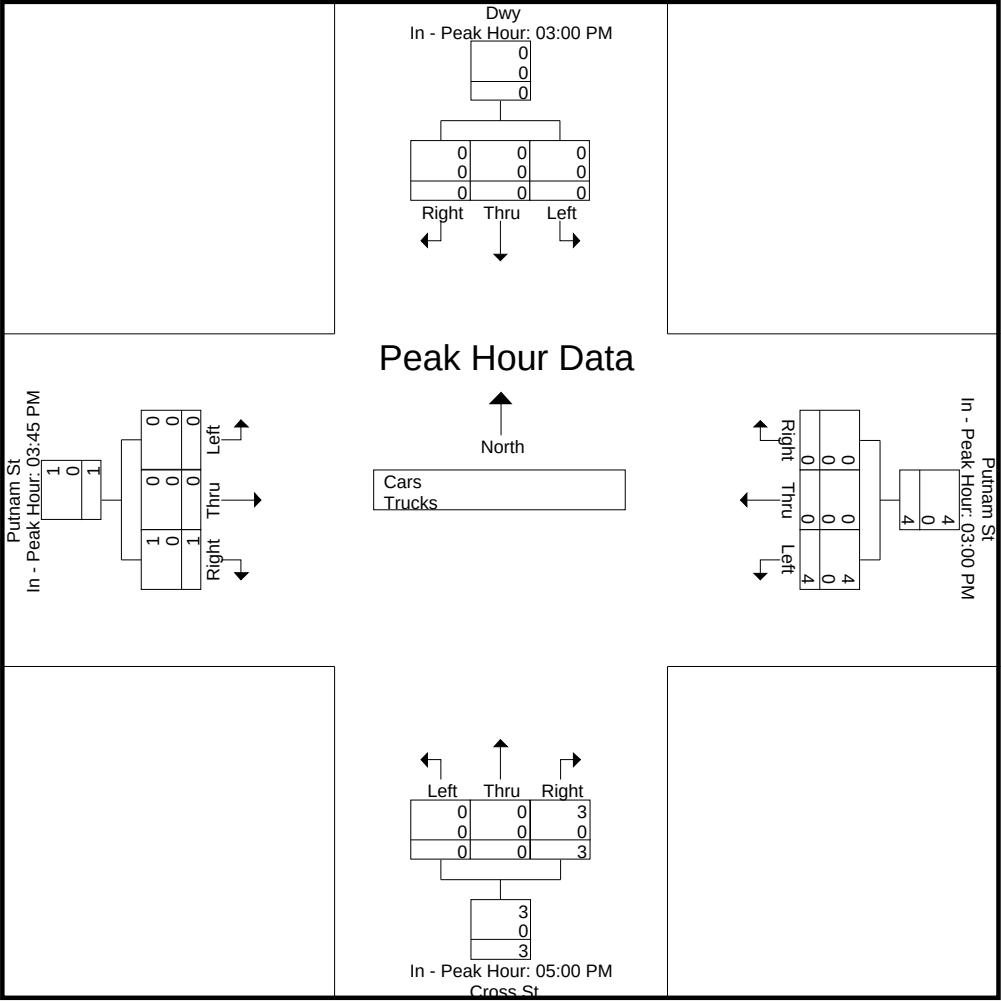
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1

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

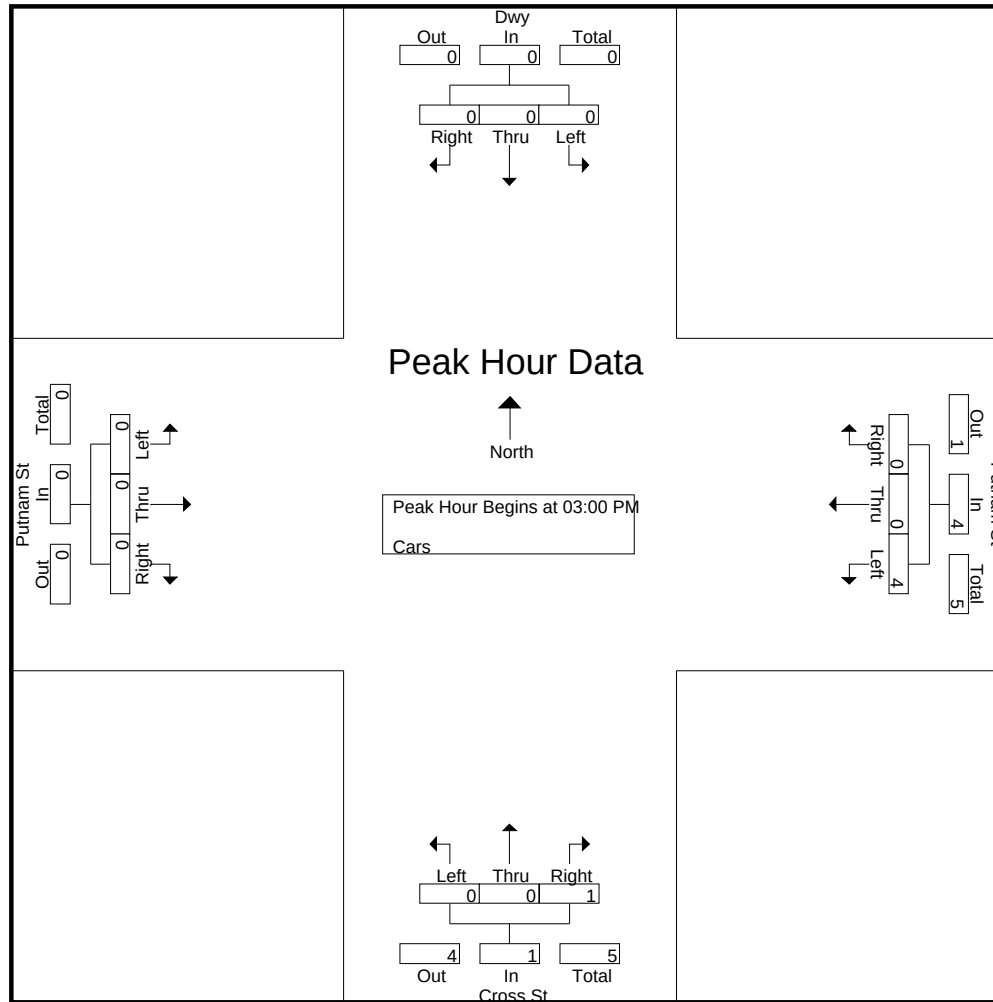
	Dwy From North				Putnam St From East				Cross St From South				Putnam St From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour 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

N/S Street : Driveway / Cross Street
E/W Street: Putnam Street
City/State : Needham, MA
Weather : Cloudy

File Name : 83150005
Site Code : 83150005
Start Date : 9/4/2019
Page No : 7



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

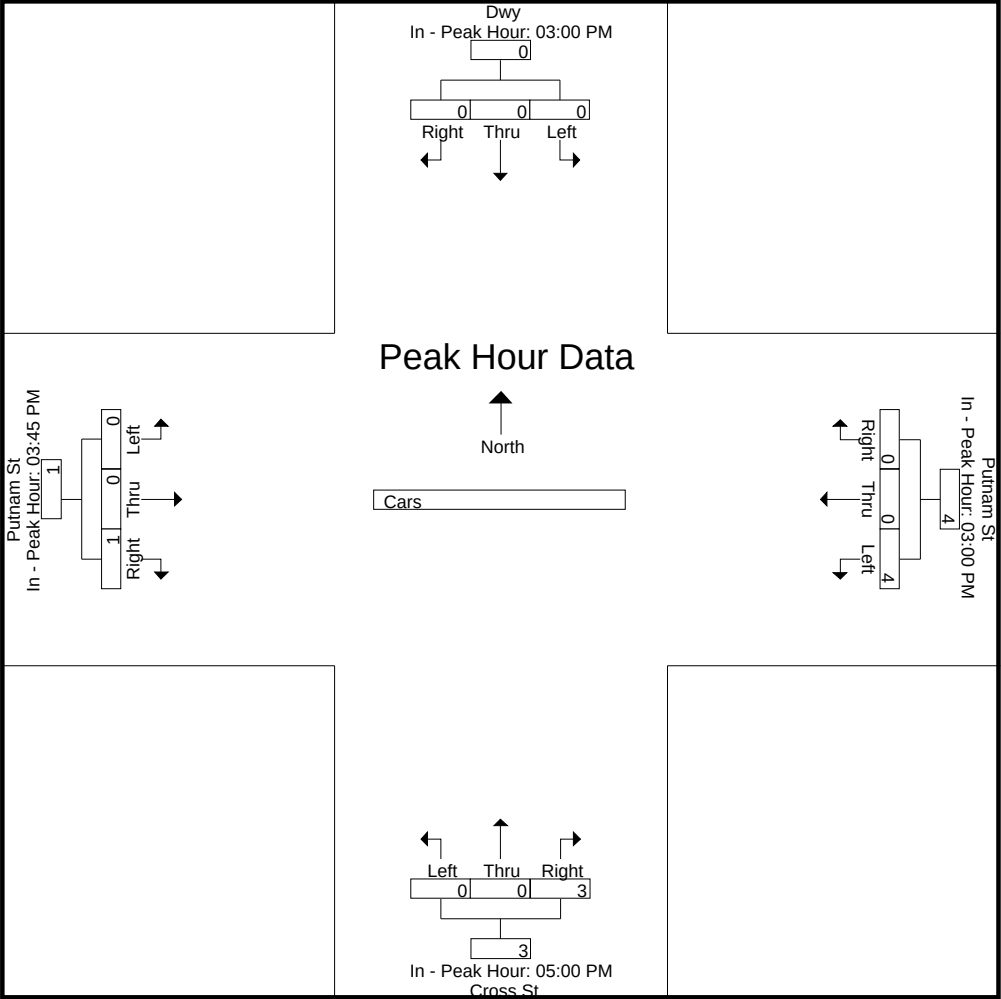
Peak Hour for Each Approach Begins at:

	03:00 PM				03:00 PM				05:00 PM				03:45 PM			
+0 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
+15 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
+30 mins.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
+45 mins.	0	0	0	0	1	0	0	1	0	0	1	1	0	0	1	1
Total Volume	0	0	0	0	4	0	0	4	0	0	3	3	0	0	1	1
% App. Total	0	0	0	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

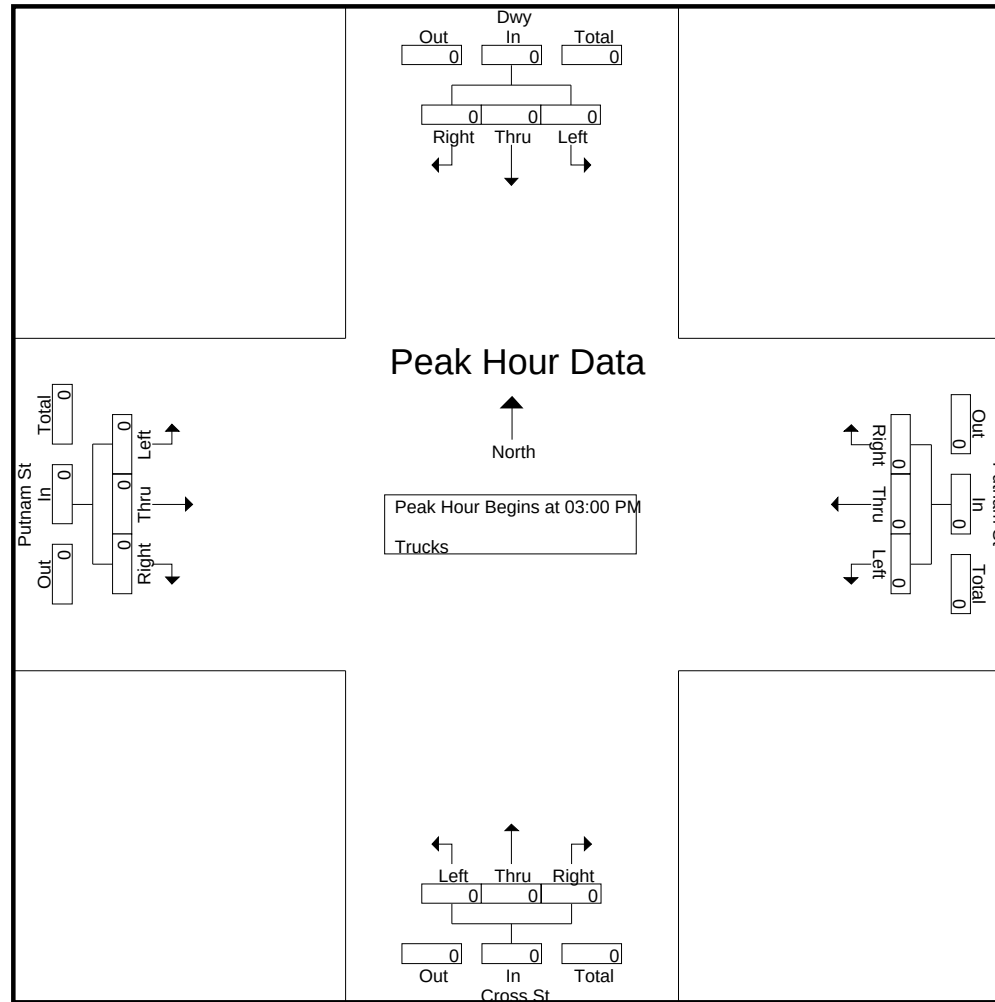
Page No : 11

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

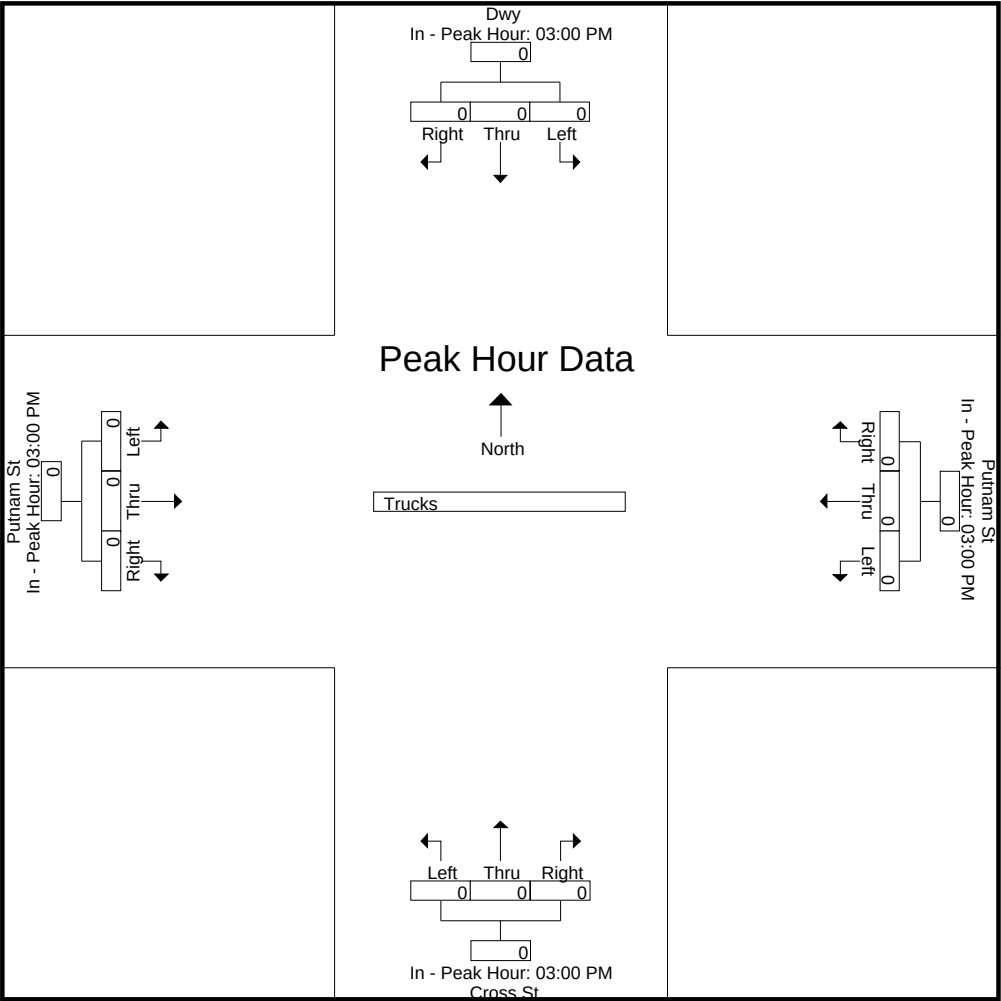
Peak Hour for Each Approach Begins at:

[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

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

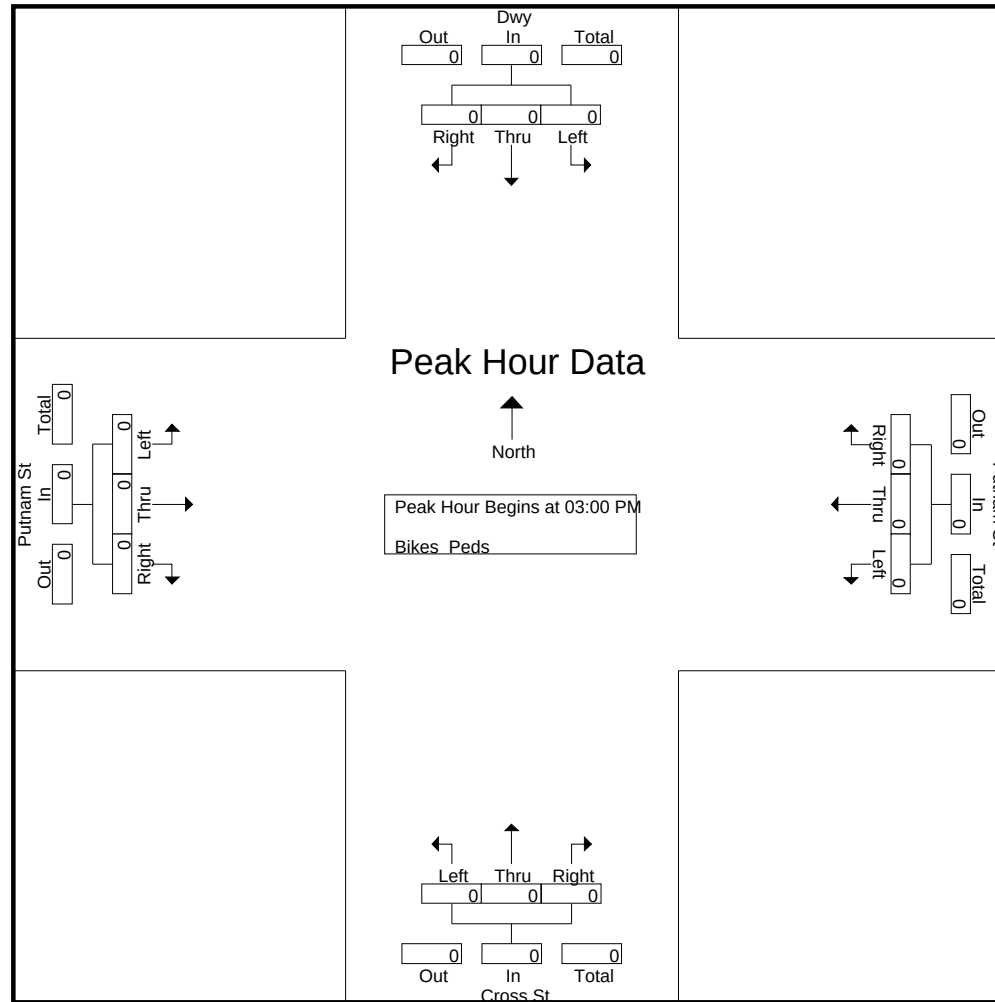
Page No : 15

N/S Street : Driveway / Cross Street

E/W Street: Putnam Street

City/State : Needham, MA

Weather : Cloudy



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

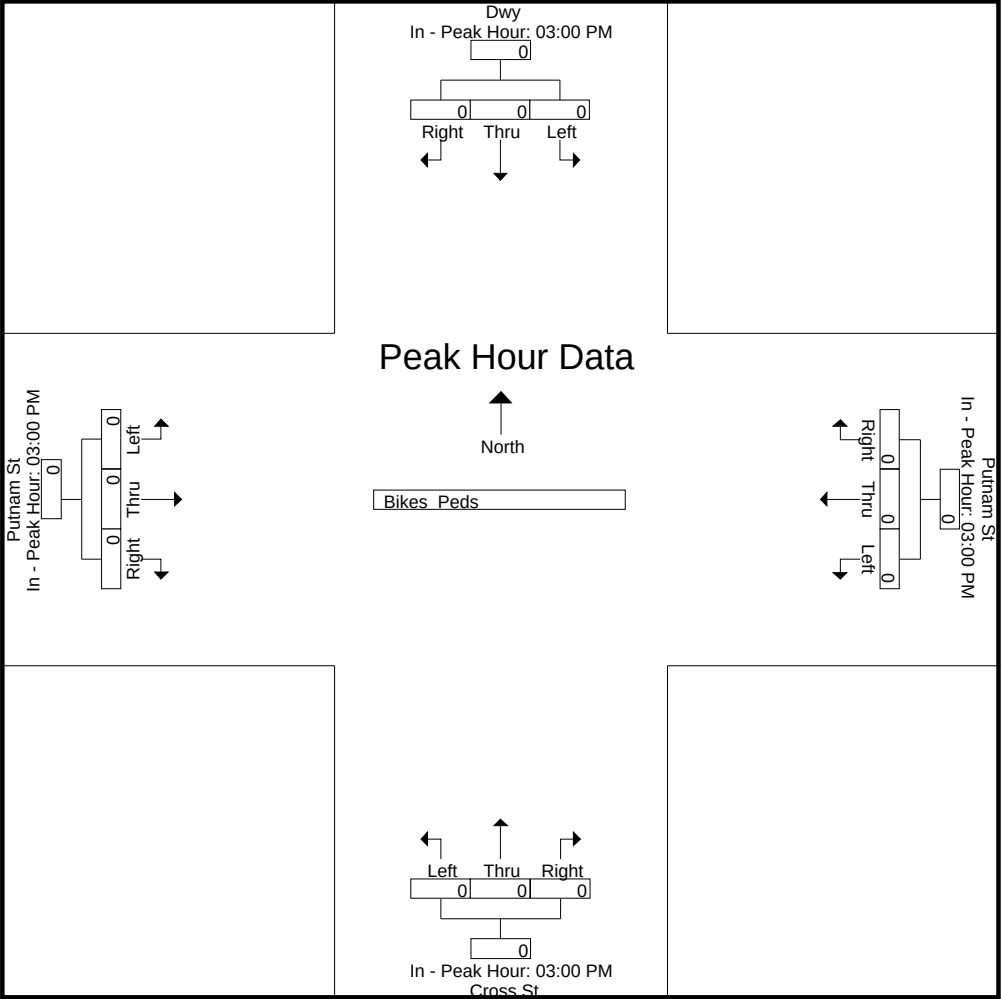
Peak Hour for Each Approach Begins at:

[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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MASSDOT CRASH RATE WORKSHEETS AND HIGH CRASH LOCATION MAPPING



INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Needham COUNT DATE : _____

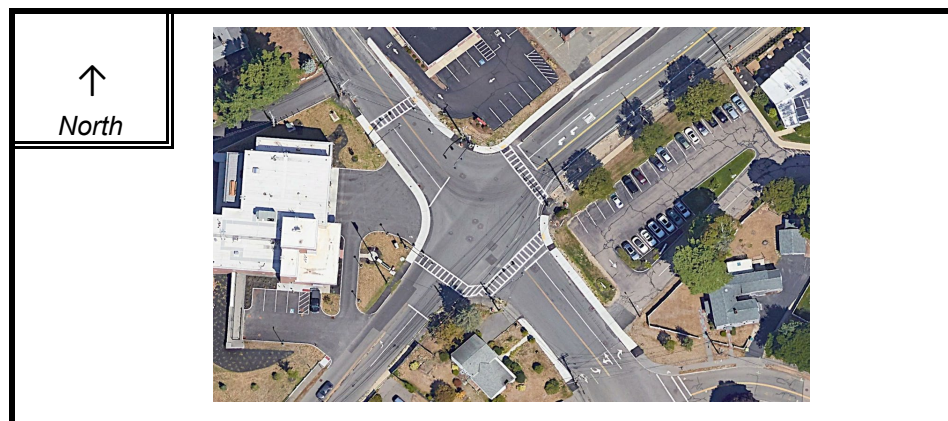
DISTRICT : 6 UNSIGNALIZED : ☐ SIGNALIZED : ☒

~ 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 : _____

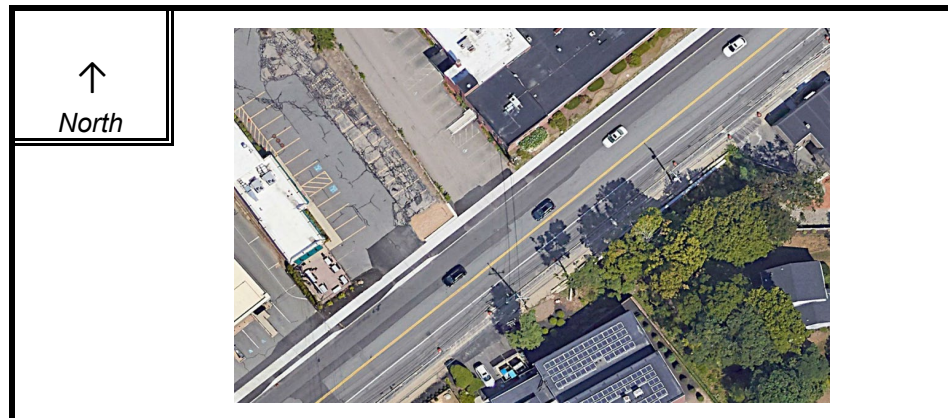
DISTRICT : 6 UNSIGNALIZED : ☒ X SIGNALIZED : ☐

~ 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 : ☒

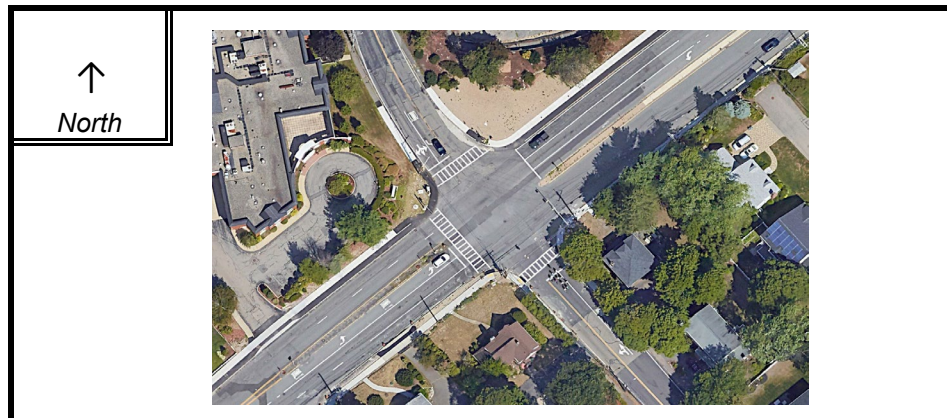
~ INTERSECTION DATA ~

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 :

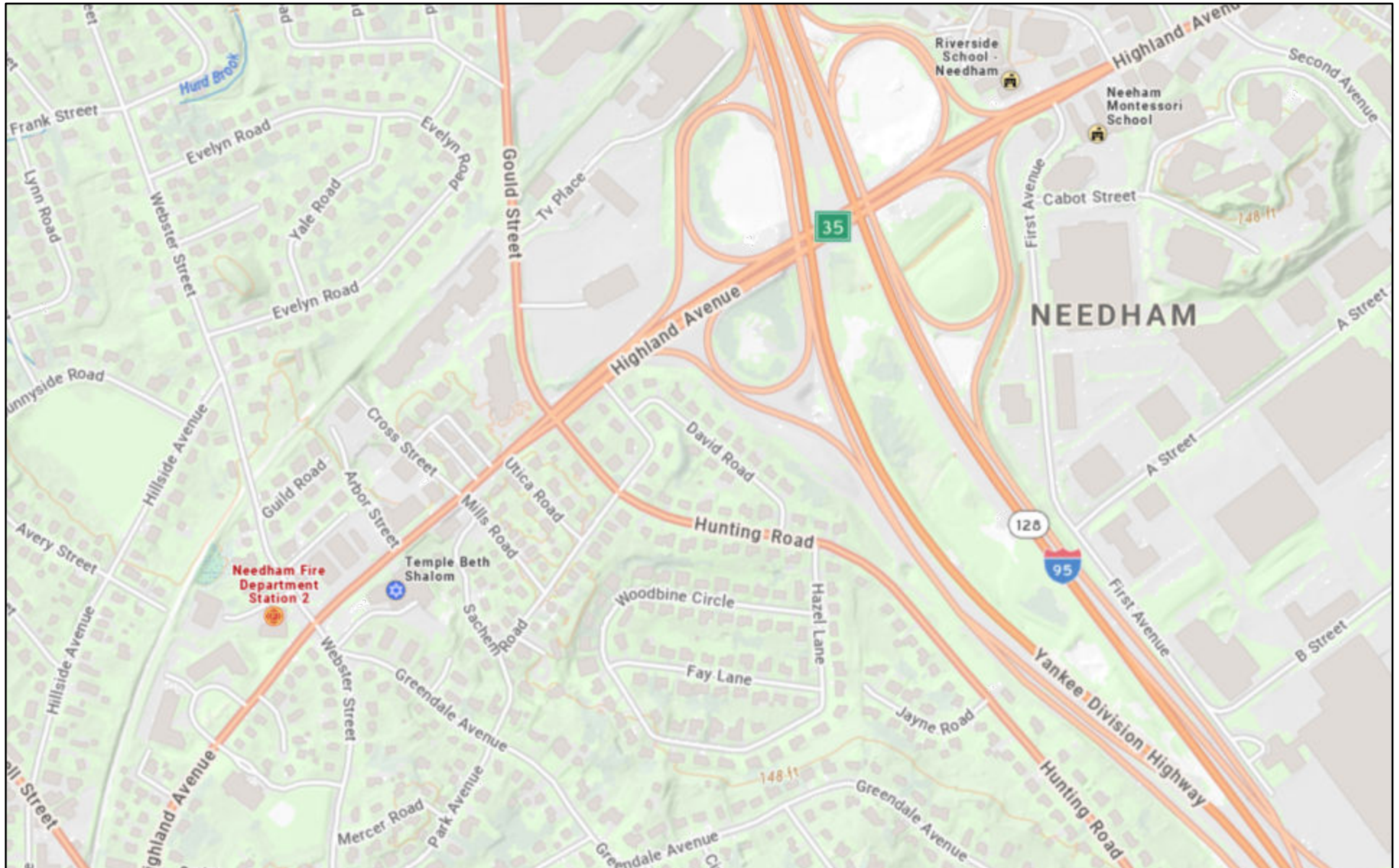
0.42

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

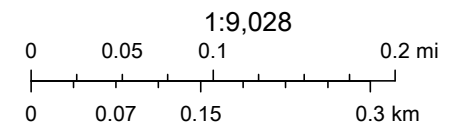
Comments : Below Statewide (0.78) and District (0.71) Crash Rates

Project Title & Date: Proposed Medical Office Building

MassDOT Top Crash Locations



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



GENERAL BACKGROUND TRAFFIC GROWTH

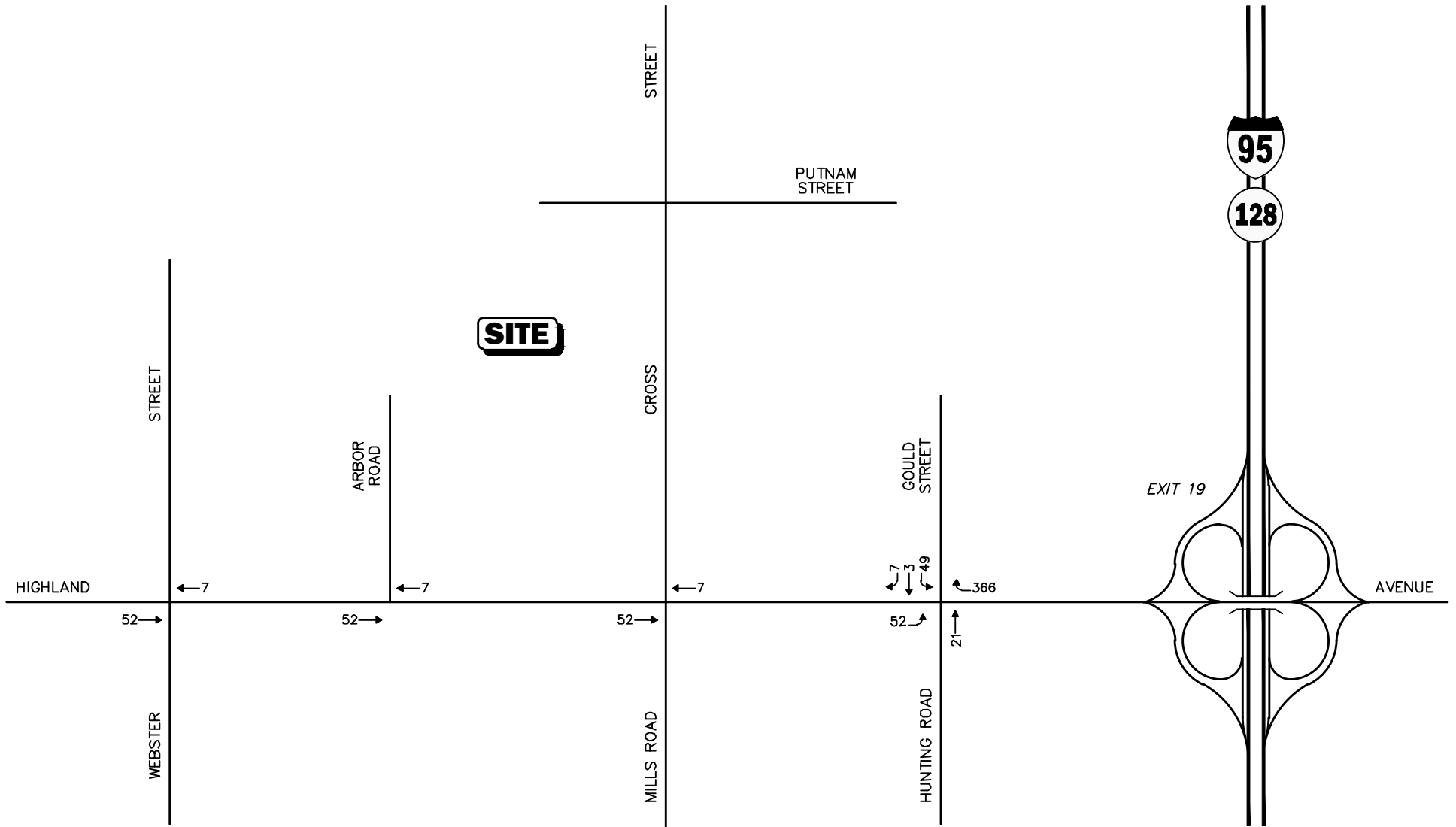


General Background Traffic Growth - Daily Traffic Volumes

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



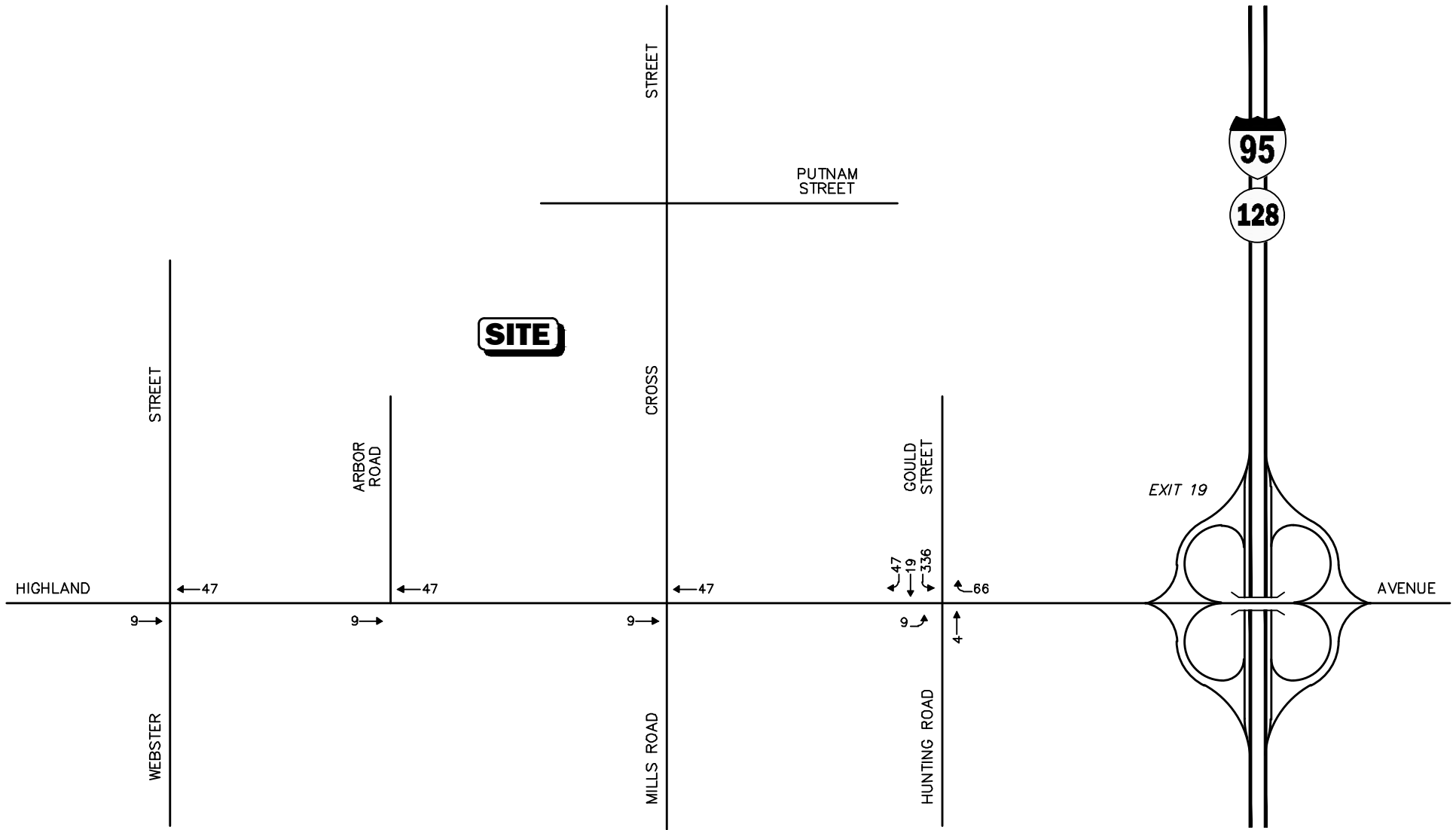


Not To Scale

VAI Vanasse & Associates inc

Figure A-1

Highland Science Center
Weekday Morning
Peak Hour Traffic Volumes

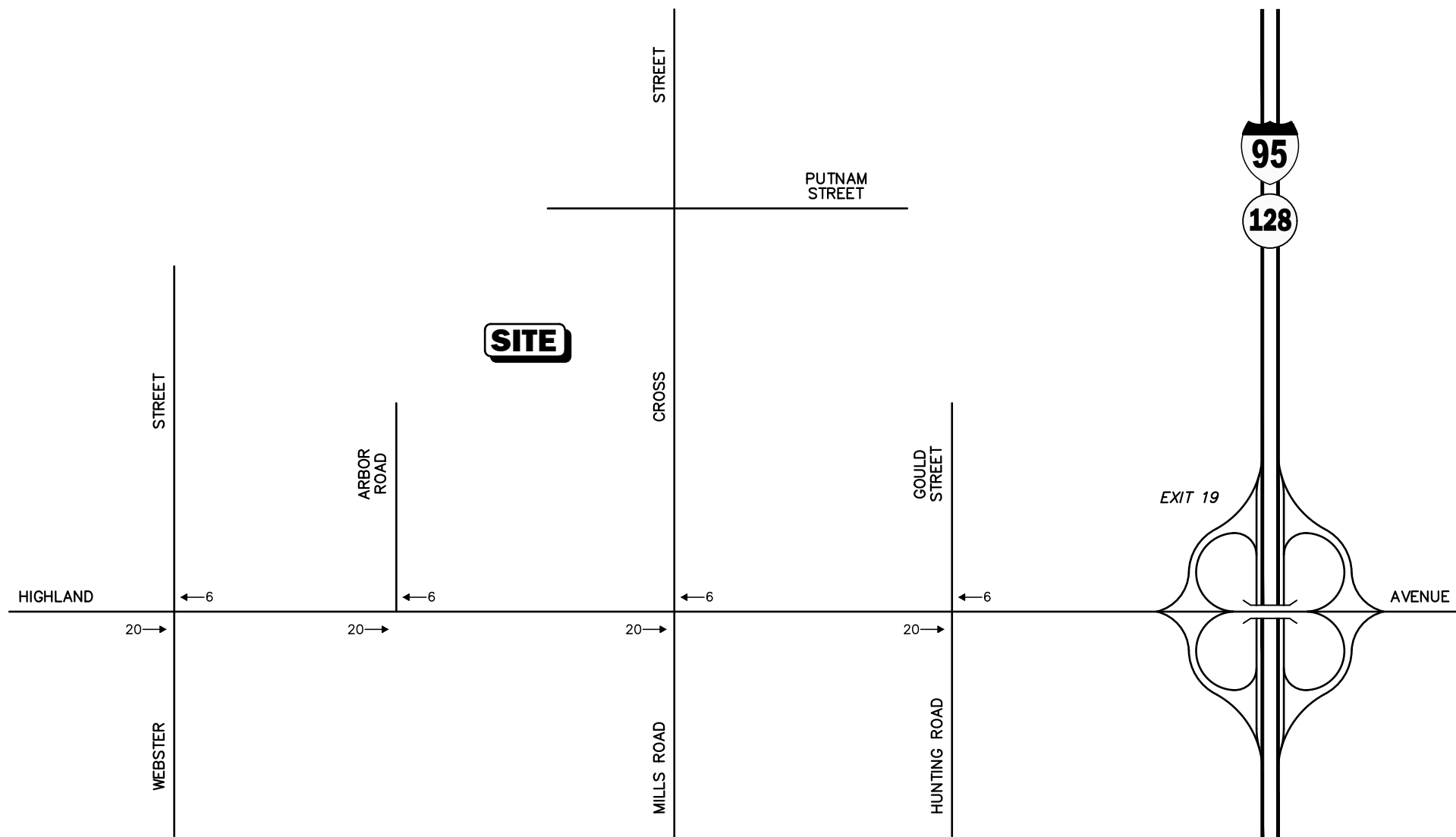


Not To Scale

VAI Vanasse & Associates inc

Figure A-2

Highland Science Center
Weekday Evening
Peak Hour Traffic Volumes

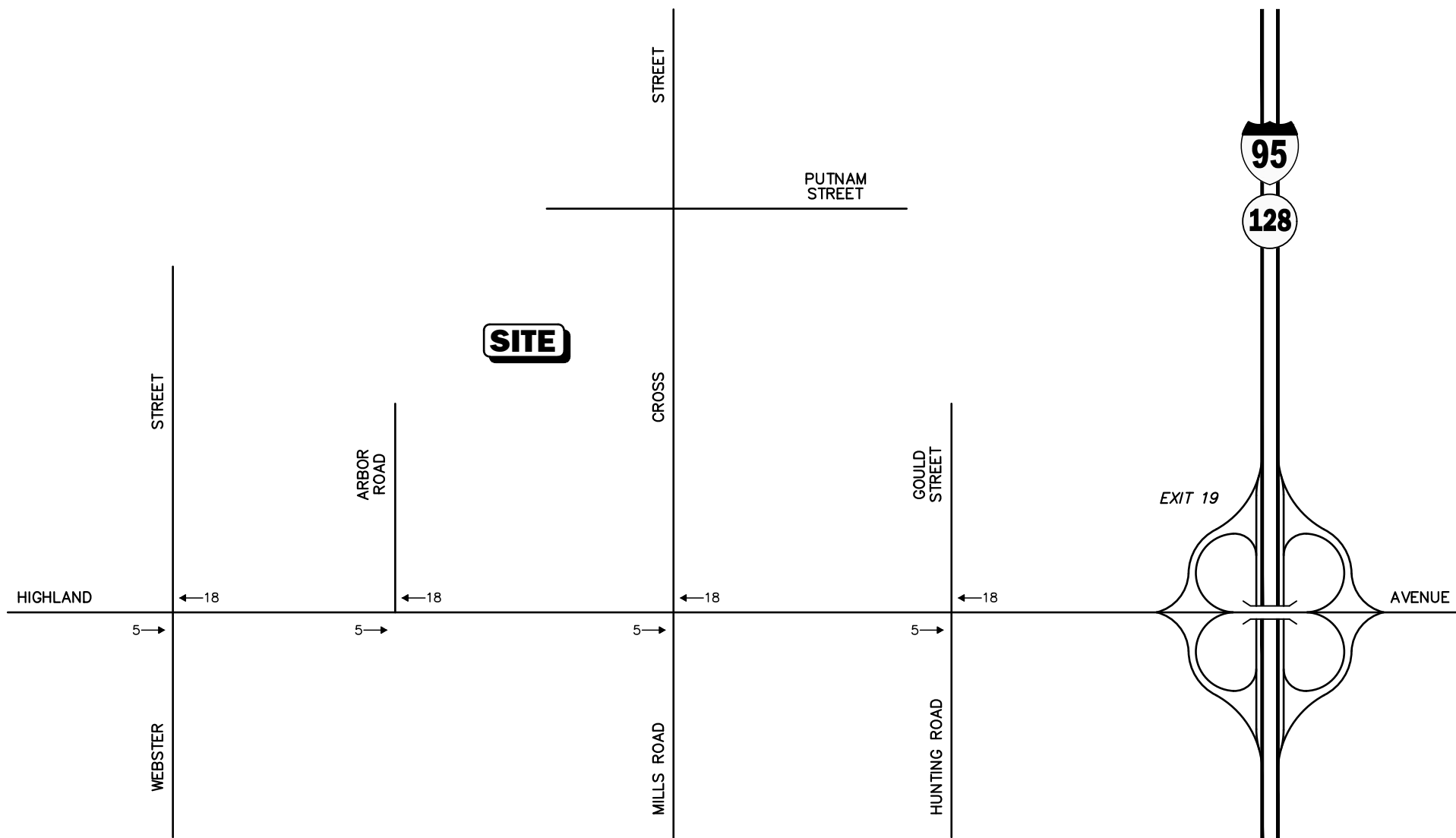


 Not To Scale

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

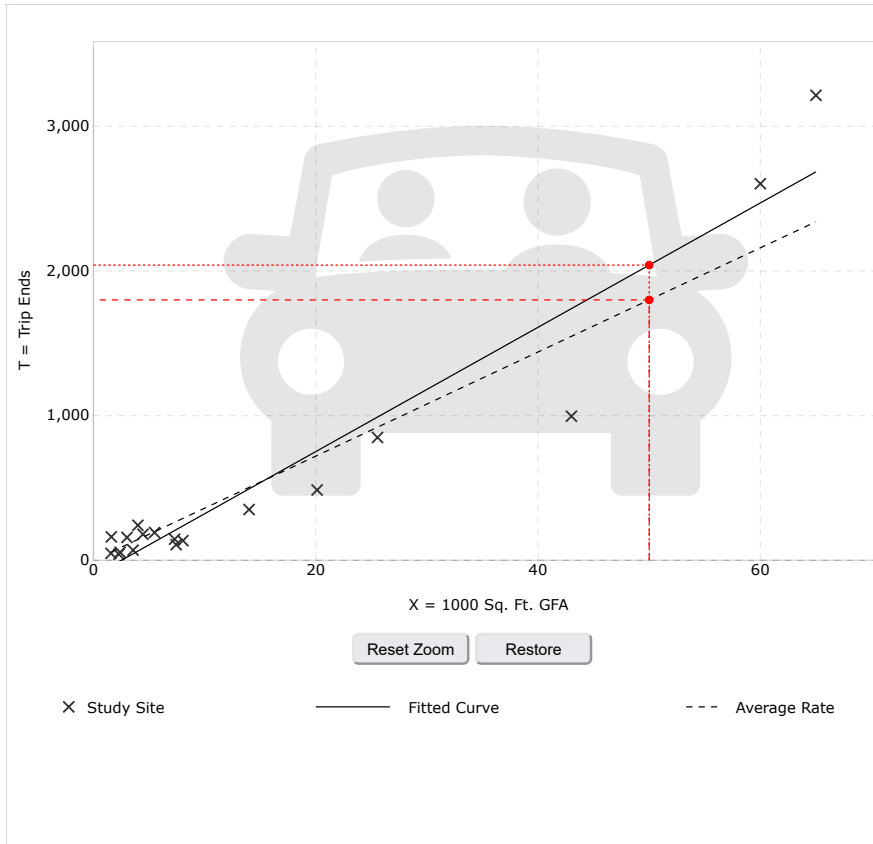
TRIP TYPE:

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,

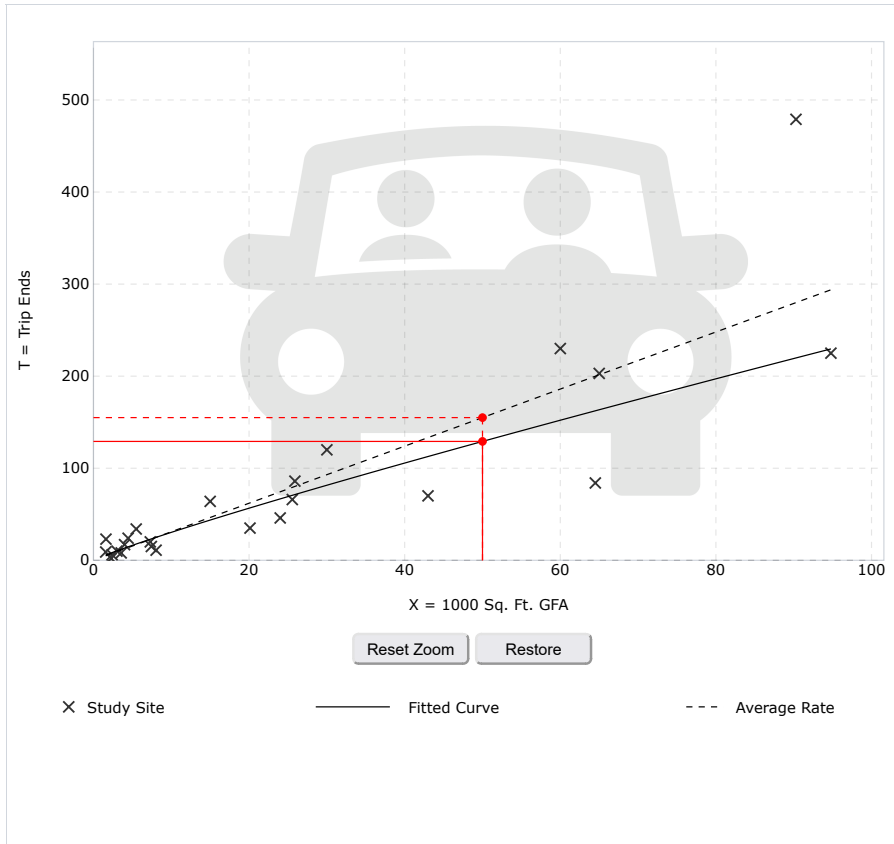
TRIP TYPE:

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:

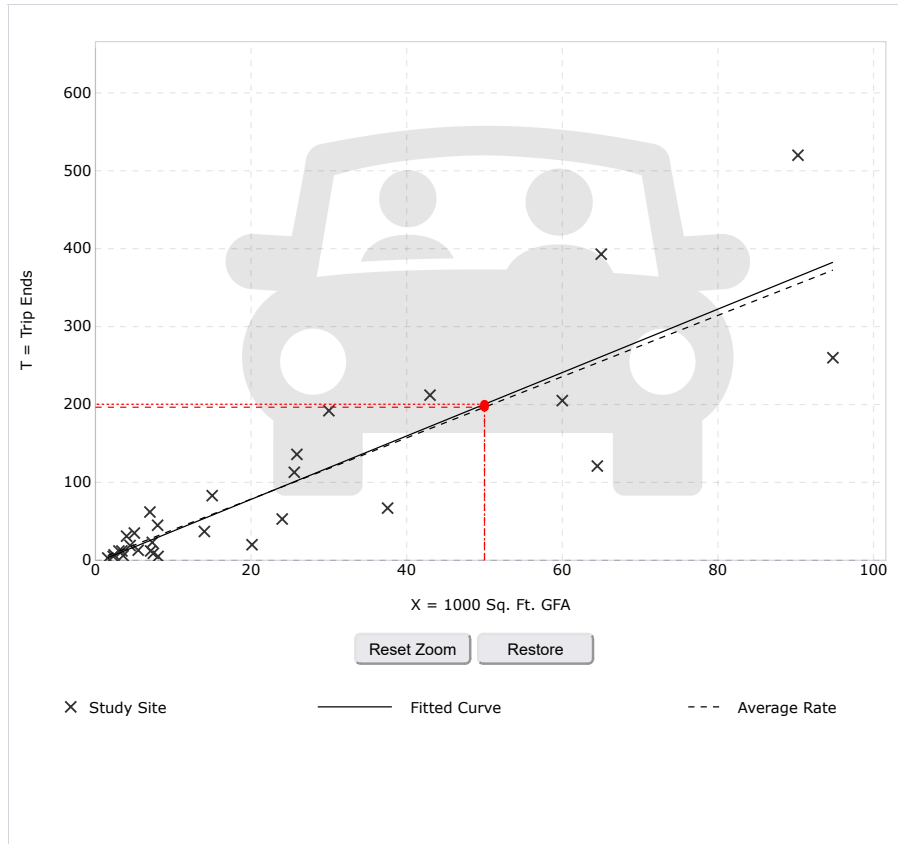
Vehicle

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:	$T = 4.07(X) - 3.17$
R ² :	0.77
Directional Distribution:	30% entering, 70% exiting
Calculated Trip Ends:	Average Rate: 197 (Total), 59 (Entry), 138 (Exit) Fitted Curve: 200 (Total), 60 (Entry), 140 (Exit)

EXISTING TRIP-GENERATION CALCULATIONS





- Graph Look Up
- 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:

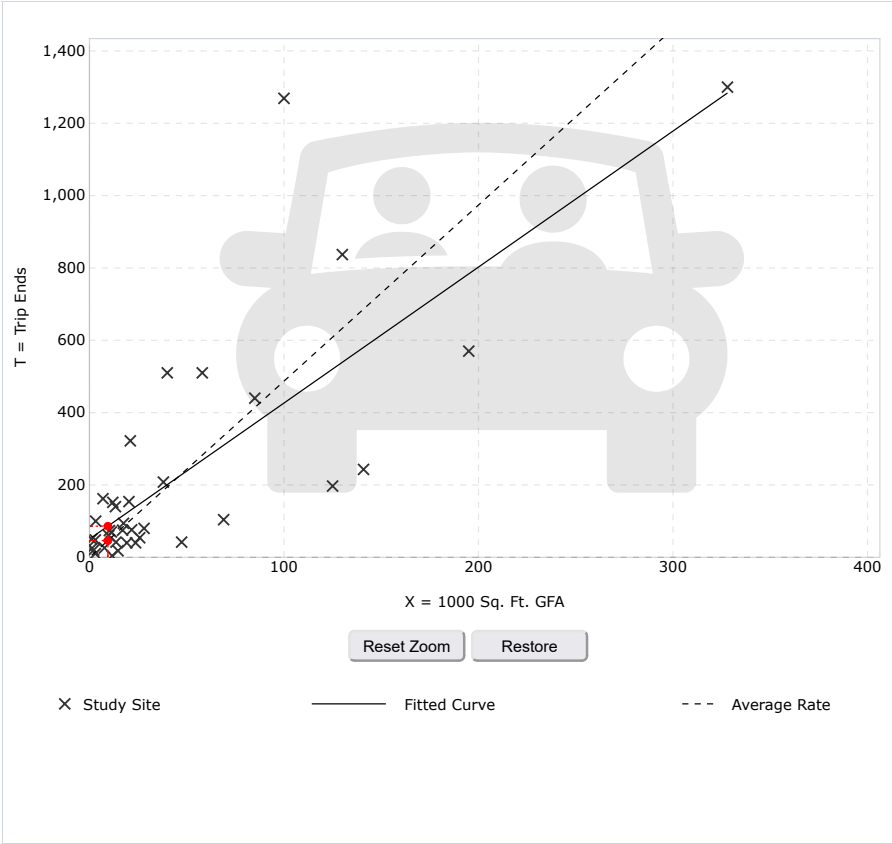
Vehicle

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:	$T = 3.76(X) + 50.47$
R ² :	0.61
Directional Distribution:	50% entering, 50% exiting
Calculated Trip Ends:	Average Rate: 46 (Total), 23 (Entry), 23 (Exit) Fitted Curve: 86 (Total), 43 (Entry), 43 (Exit)

- Graph Look Up
- 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:

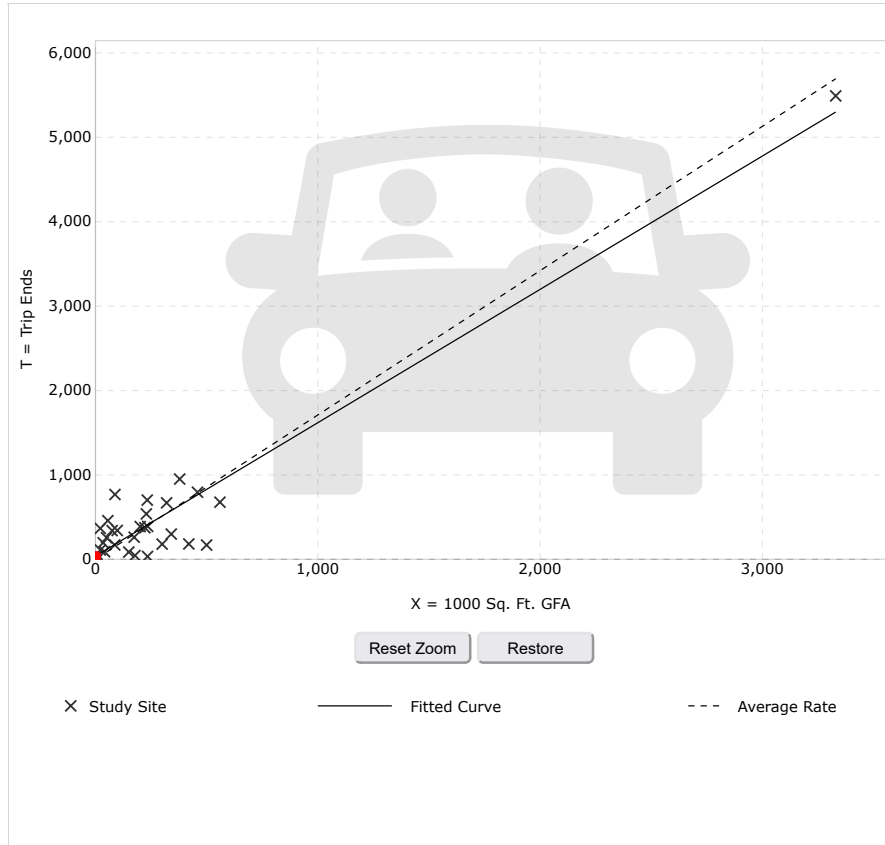
Vehicle

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)



Query

Filter

DATA SOURCE:

Trip Generation Manual, 11th Ed

SEARCH BY LAND USE CODE:

495



LAND USE GROUP:

(400-499) Recreational

LAND USE :

495 - Recreational Community Center

LAND USE SUBCATEGORY:

All Sites

SETTING/LOCATION:

General Urban/Suburban

INDEPENDENT VARIABLE (IV):

1000 Sq. Ft. GFA

TIME PERIOD:

Weekday

TRIP TYPE:

Vehicle

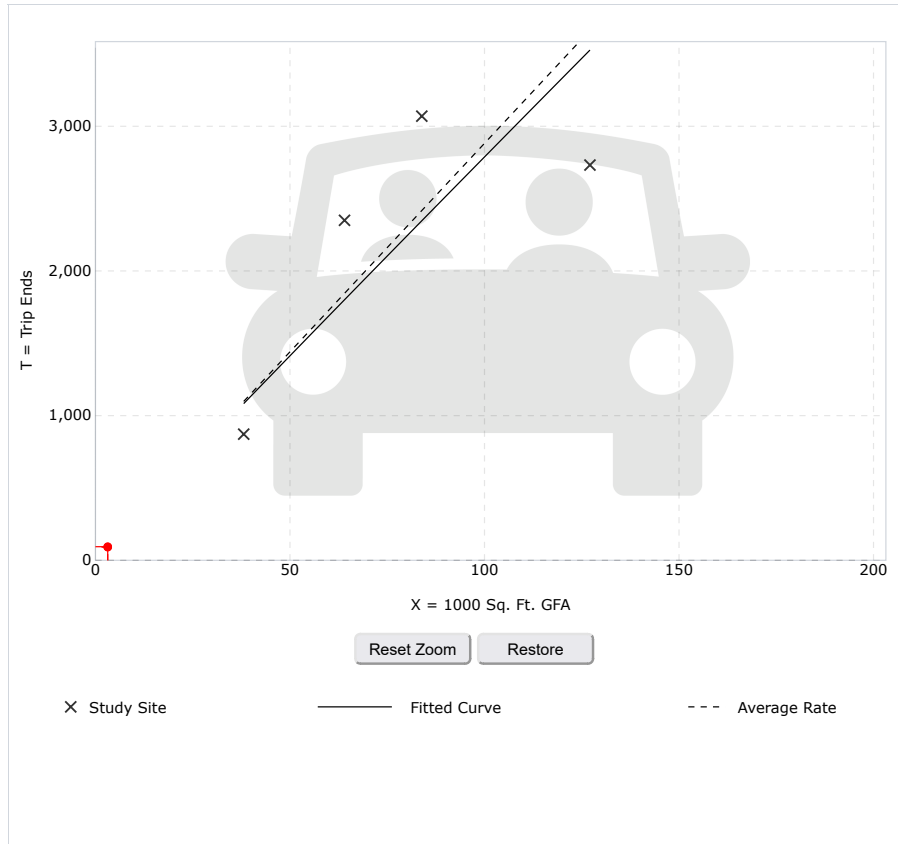
ENTER IV VALUE TO CALCULATE TRIPS:

3.15

Calculate

Data Plot and Equation

Caution – Small Sample Size



Use the mouse wheel to Zoom Out or Zoom In.
Hover the mouse pointer on data points to view X and T values.

DATA STATISTICS

Land Use:
Recreational Community Center (495) [Click for Description and Data Plots](#)

Independent Variable:
1000 Sq. Ft. GFA

Time Period:
Weekday

Setting/Location:
General Urban/Suburban

Trip Type:
Vehicle

Number of Studies:
4

Avg. 1000 Sq. Ft. GFA:
78

Average Rate:
28.82

Range of Rates:
21.49 - 36.71

Standard Deviation:
8.56

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

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)

- 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:

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:

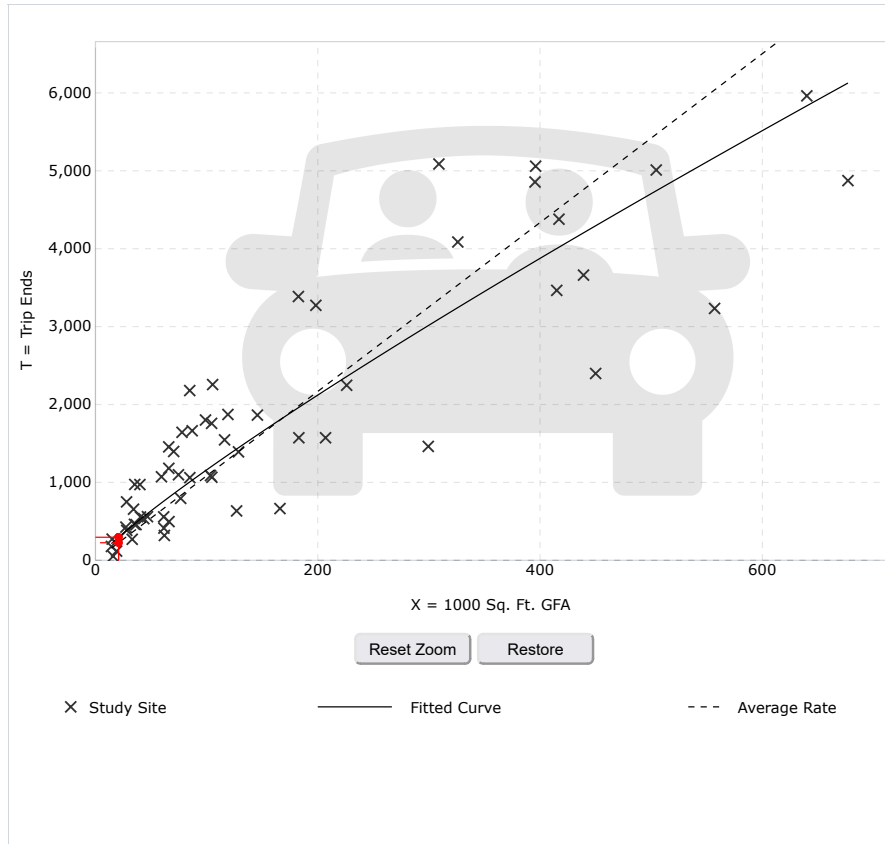
Vehicle

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:
 $\ln(T) = 0.87 \ln(X) + 3.05$

R²:
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

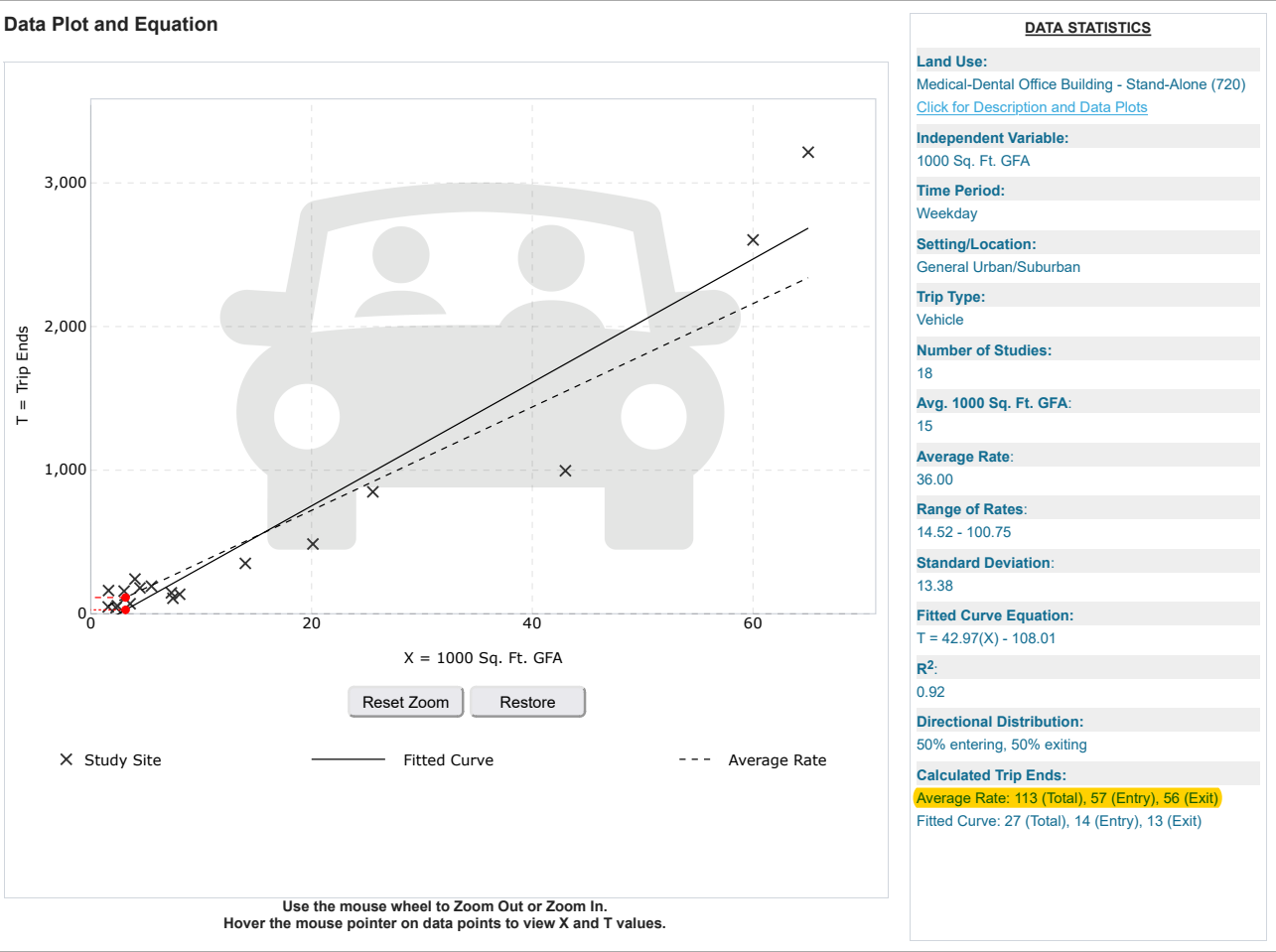
TRIP TYPE:

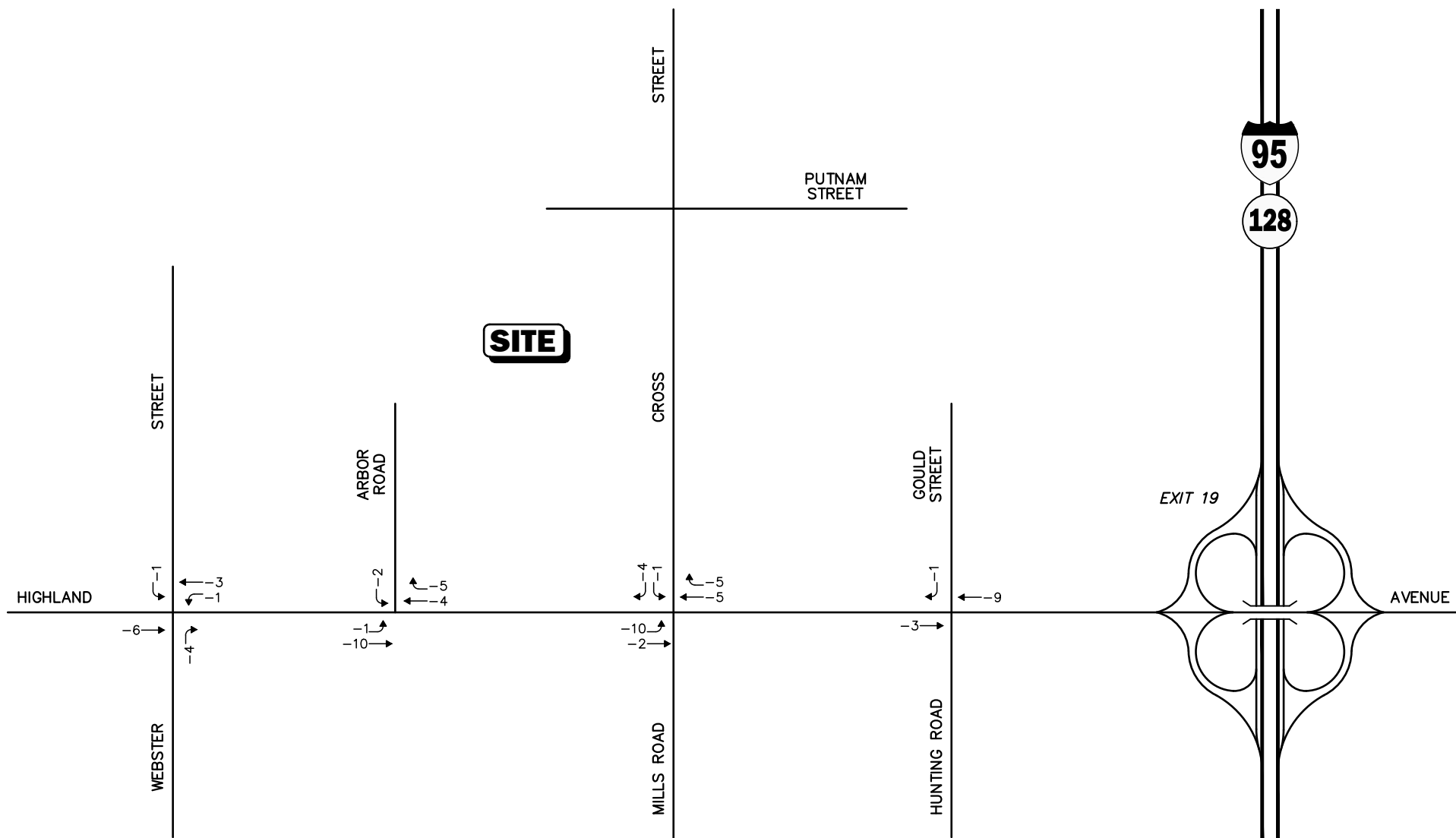
Vehicle

ENTER IV VALUE TO CALCULATE TRIPS:

3.15

Calculate



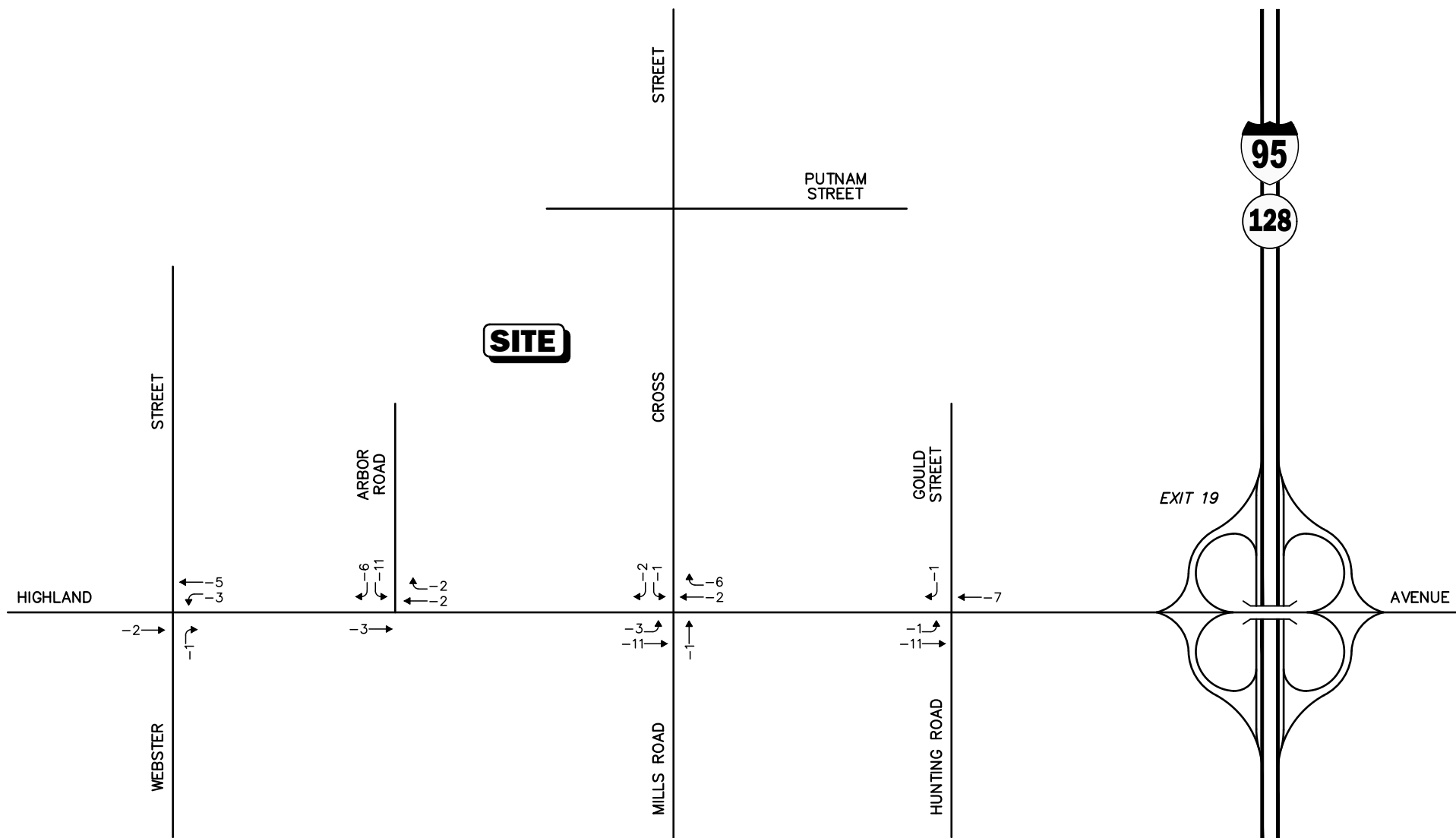


 Not To Scale

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

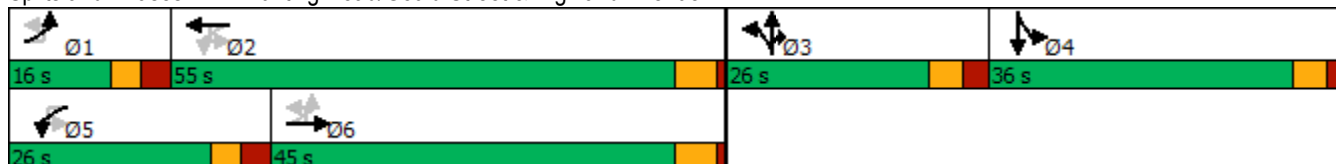
Natural Cycle: 90

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

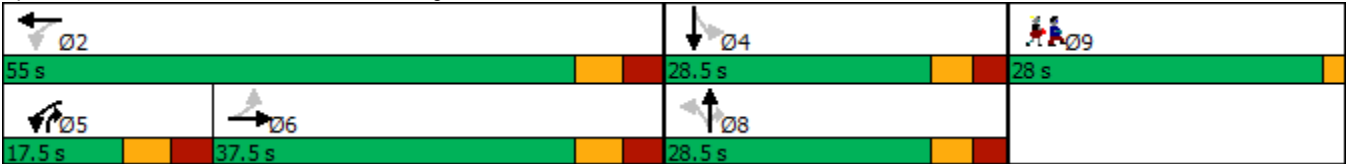
Natural Cycle: 150

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



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.

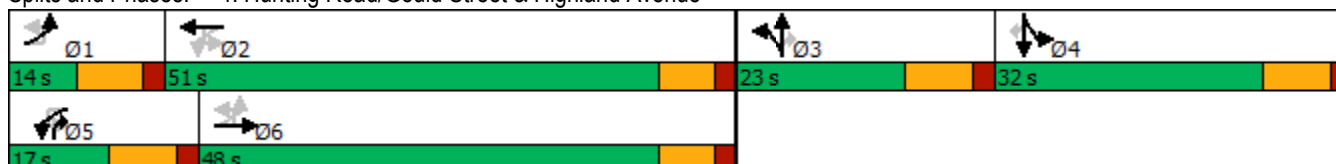
Queue shown is maximum after two cycles.

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.

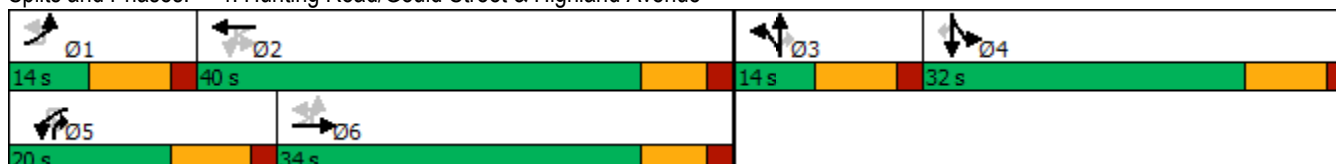
Queue shown is maximum after two cycles.

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.

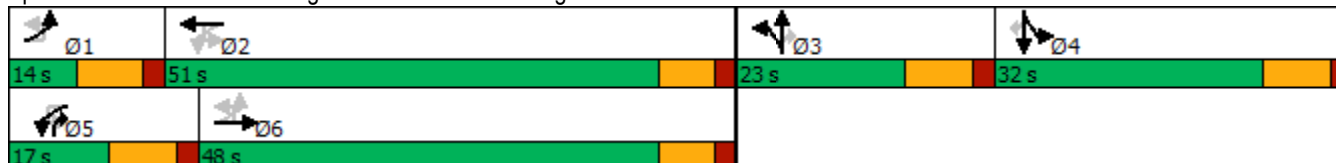
Queue shown is maximum after two cycles.

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	0
Stage 1	14	-	-	-	-	-
Stage 2	1	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	1004	1066	-	-	1587	-
Stage 1	1009	-	-	-	-	-
Stage 2	1022	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	1004	1066	-	-	1587	-
Mov Cap-2 Maneuver	1004	-	-	-	-	-
Stage 1	1009	-	-	-	-	-
Stage 2	1022	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.6	0		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBT	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		 Ø4		 Ø9	
60 s		31.5 s		28 s	
 Ø5	 Ø6	 Ø8			
22.5 s	37.5 s	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.

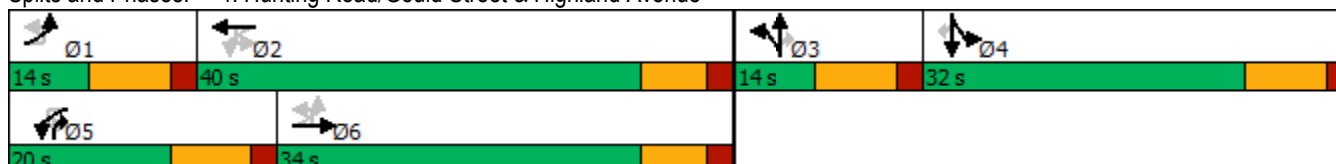
Queue shown is maximum after two cycles.

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
Total Lost Time (s)	4.0	4.0			4.0	4.0			4.0	4.0	4.0	4.0
Lead/Lag	Lead	Lag			Lead	Lag		Lead	Lead	Lead	Lag	Lag
Lead-Lag Optimize?	Yes	Yes			Yes	Yes		Yes	Yes	Yes	Yes	Yes
Vehicle Extension (s)	3.0	3.0			3.0	3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	None	Min			None	Min		None	None	None	None	None
Walk Time (s)		4.0				4.0					4.0	4.0
Flash Dont Walk (s)		12.0				12.0					20.0	20.0
Pedestrian Calls (#/hr)		1				0					0	0
v/c Ratio	1.05	0.73			0.19	1.05			1.04	0.70	0.53	0.25
Control Delay	114.7	35.1			15.0	66.1			113.6	25.9	55.5	51.3
Queue Delay	0.0	0.0			0.0	0.0			0.0	0.0	0.0	0.0
Total Delay	114.7	35.1			15.0	66.1			113.6	25.9	55.5	51.3
Queue Length 50th (ft)	~140	407			19	~754			~316	139	110	54
Queue Length 95th (ft)	#319	530			41	#894			#502	200	144	94
Internal Link Dist (ft)		411				548			225			114
Turn Bay Length (ft)	115				190					100	80	
Base Capacity (vph)	190	1505			283	1609			328	526	695	388
Starvation Cap Reductn	0	0			0	0			0	0	0	0
Spillback Cap Reductn	0	0			0	0			0	0	0	0
Storage Cap Reductn	0	0			0	0			0	0	0	0
Reduced v/c Ratio	1.05	0.73			0.19	1.05			1.04	0.69	0.39	0.18
Intersection Summary												
Cycle Length: 140												

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.

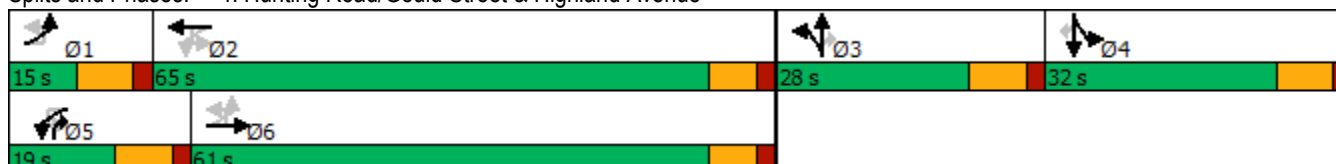
Queue shown is maximum after two cycles.

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												

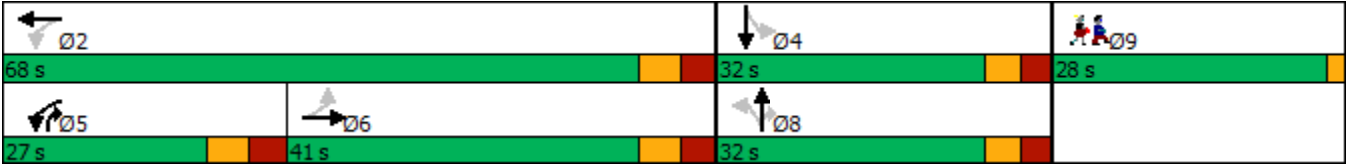
2030 Mitigated Weekday Evening Peak Hour
1: Webster Street & Highland Avenue

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	-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		0.28	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

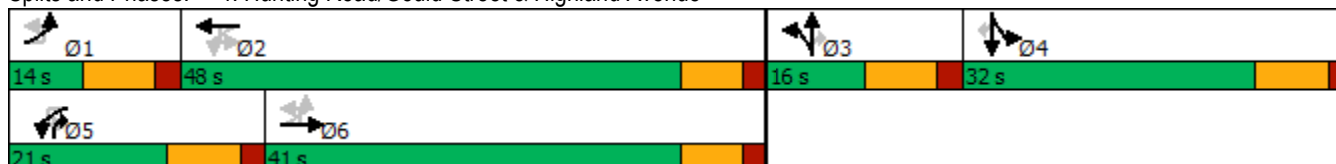
Control Type: Actuated-Uncoordinated

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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PREPARED BY



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Table of Contents

Stormwater Report Narrative.....	3
Project Description.....	3
Site Description	3
Existing Drainage Conditions.....	5
Proposed Drainage Conditions.....	6
Environmentally Sensitive and Low Impact Development (LID) Techniques.....	9
Regulatory Compliance.....	11
Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards	11
Standard 1: No New Untreated Discharges or Erosion to Wetlands.....	11
Standard 2: Peak Rate Attenuation	11
Standard 3: Stormwater Recharge.....	12
Standard 4: Water Quality.....	13
Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)	13
Standard 6: Critical Areas	13
Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable.....	14
Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls	14
Standard 9: Operation and Maintenance Plan.....	14
Standard 10: Prohibition of Illicit Discharges	14
Town of Needham Stormwater Bylaw and Regulations.....	15
Appendices	
Appendix A: Standard 2 Computations and Supporting Information	
Appendix B: Standard 3 Computations and Supporting Information	
Appendix C: Standard 4 Computations and Supporting Documentation	
Appendix D: Standard 8 Computations and Supporting Information	
Appendix E: Standard 9 Supporting Information	

List of Tables

Table No.	Description	Page
Table 1	Existing Conditions Hydrologic Data.....	6
Table 2	Proposed Conditions Hydrologic Data.....	8
Table 4	Peak Discharge Rates (cfs*).....	11
Table 5	Summary of Recharge Calculations.....	12



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

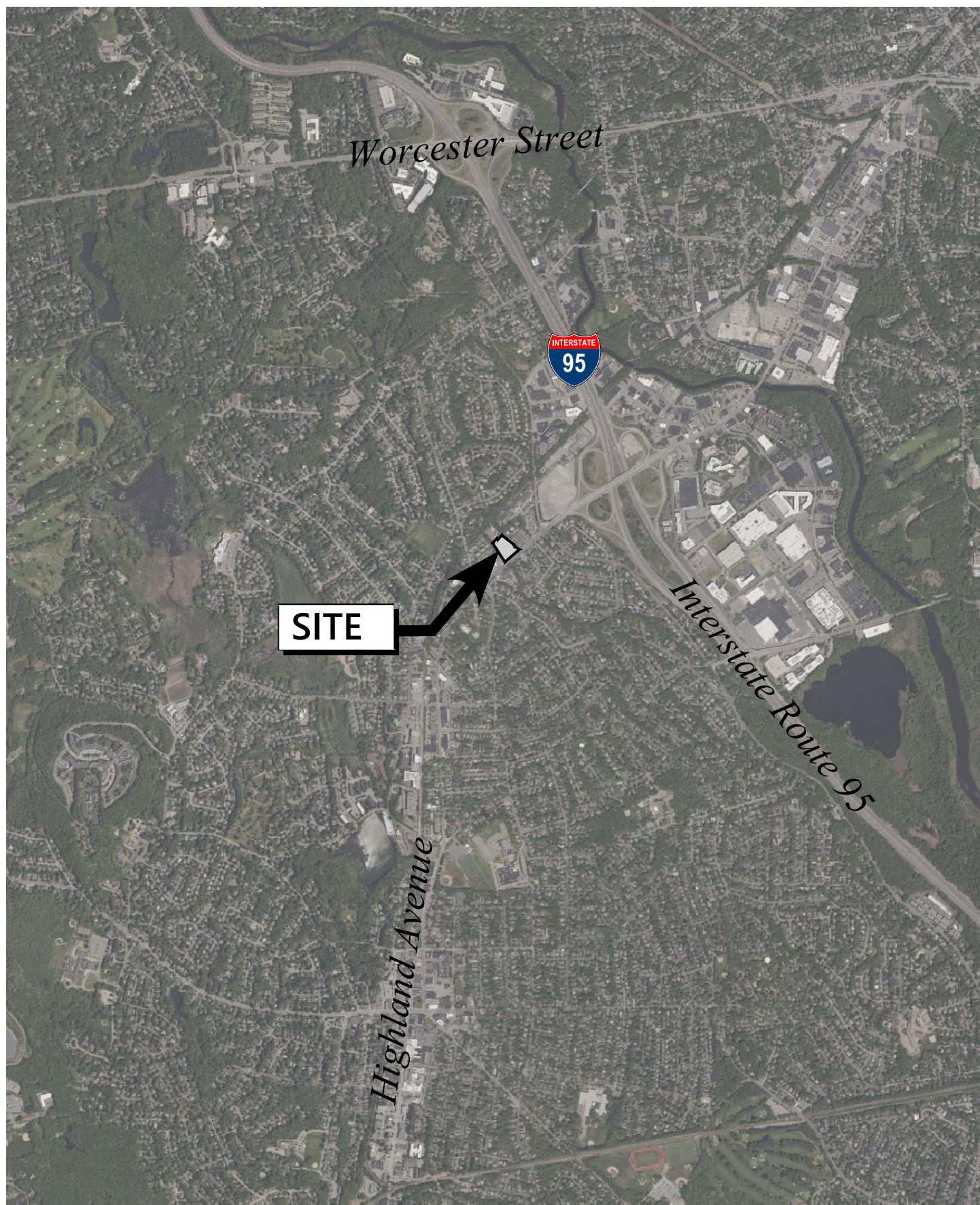
Sanitary sewer and storm drainage structures which were part of the previous development on this site will be removed during the site redevelopment. The design plans submitted with this report have been designed in full compliance with current standards. The Long-Term Pollution Prevention Plan includes 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

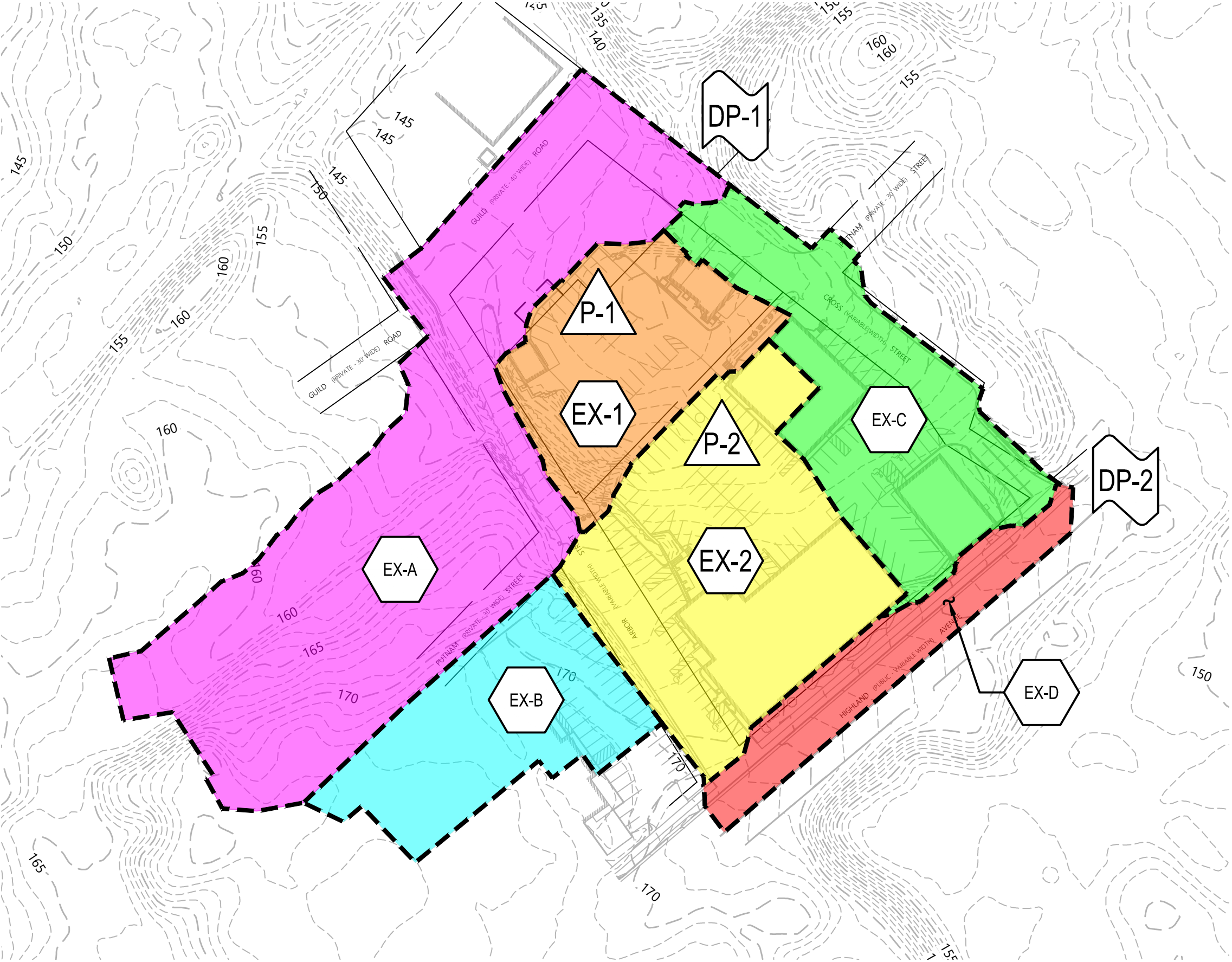
629 Highland Ave
Needham, MA

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.

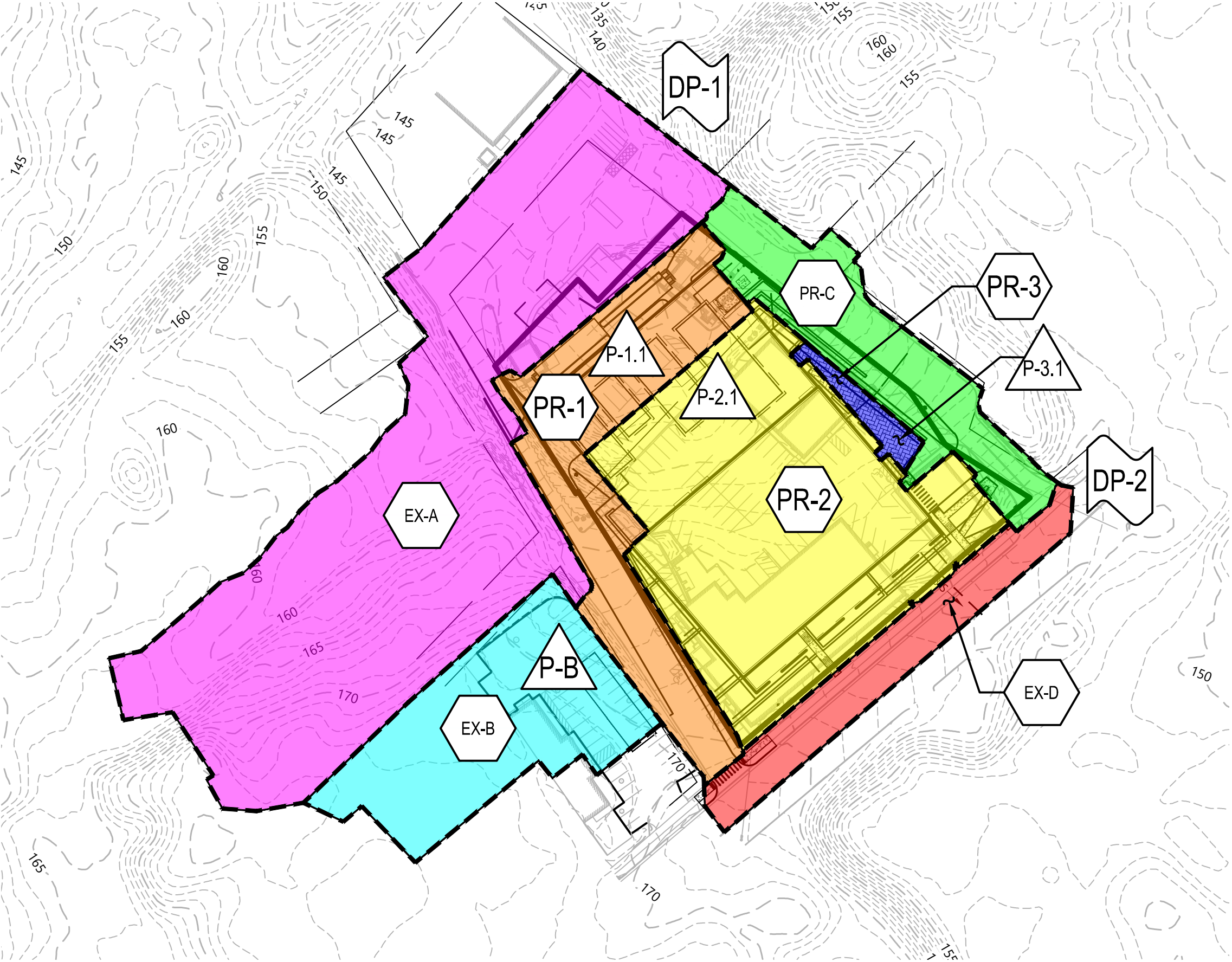
The logo for VHB, consisting of the letters 'vhb' in a stylized, lowercase font with a blue and green graphic element to the left.

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

A north arrow pointing upwards and a scale bar marked 0, 50, and 100 Feet.

The logo for VHB, consisting of a stylized 'v' and 'h' in blue and green.

Proposed Drainage Conditions

Highland Ave MOB
Needham, MA

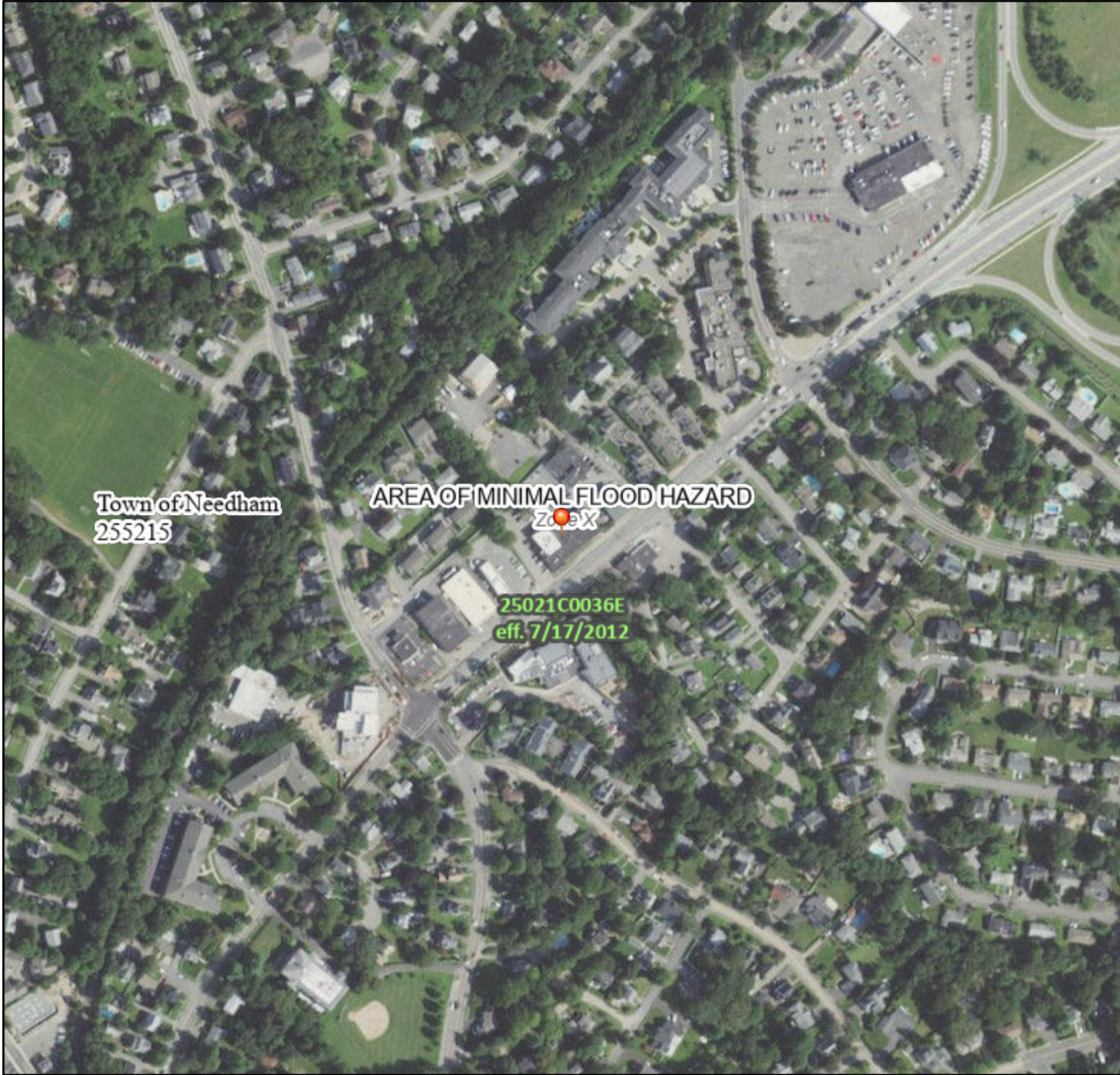
Figure 3

08/04/2023

National Flood Hazard Layer FIRMette



71°14'12"W 42°18'11"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		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

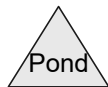
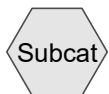
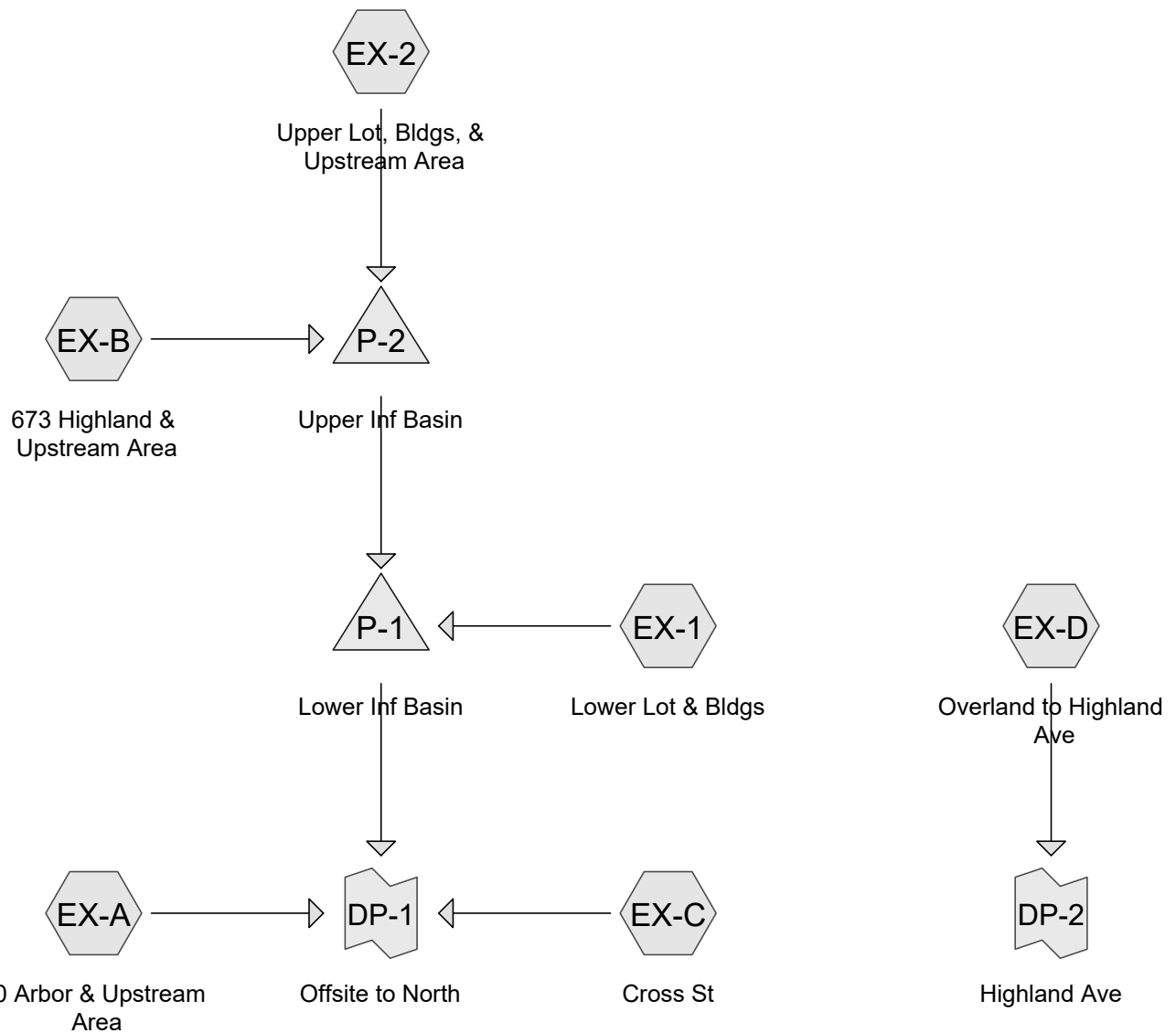
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/1/2023 at 9:19 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new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



Routing Diagram for 14781.00-EX

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14781.00-EX

Prepared by VHB

Printed 8/1/2023

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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

14781.00-EX

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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"

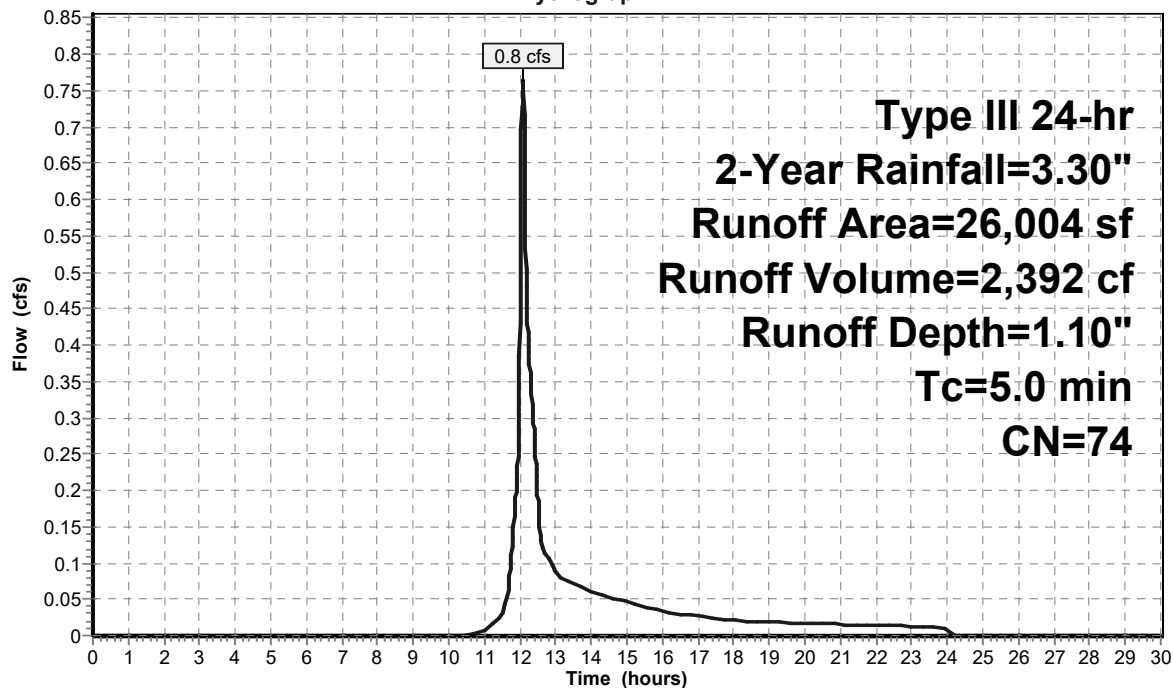
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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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Page 4

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

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

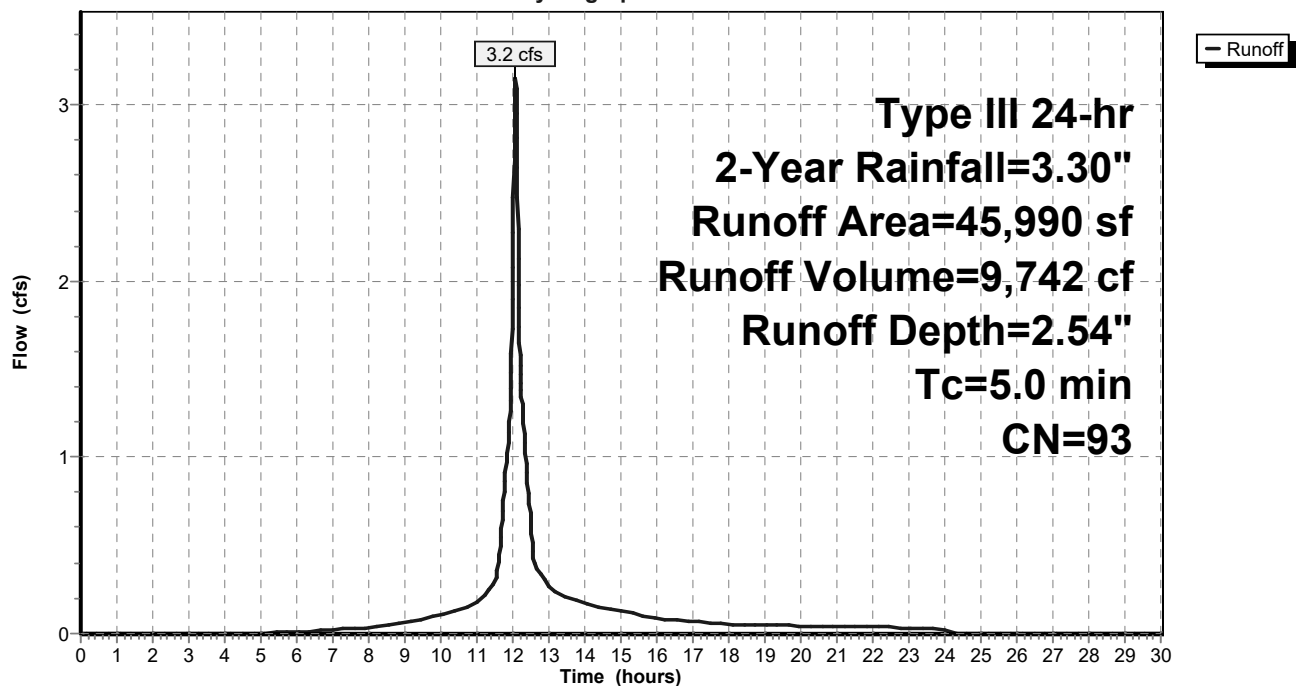
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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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Page 5

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

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

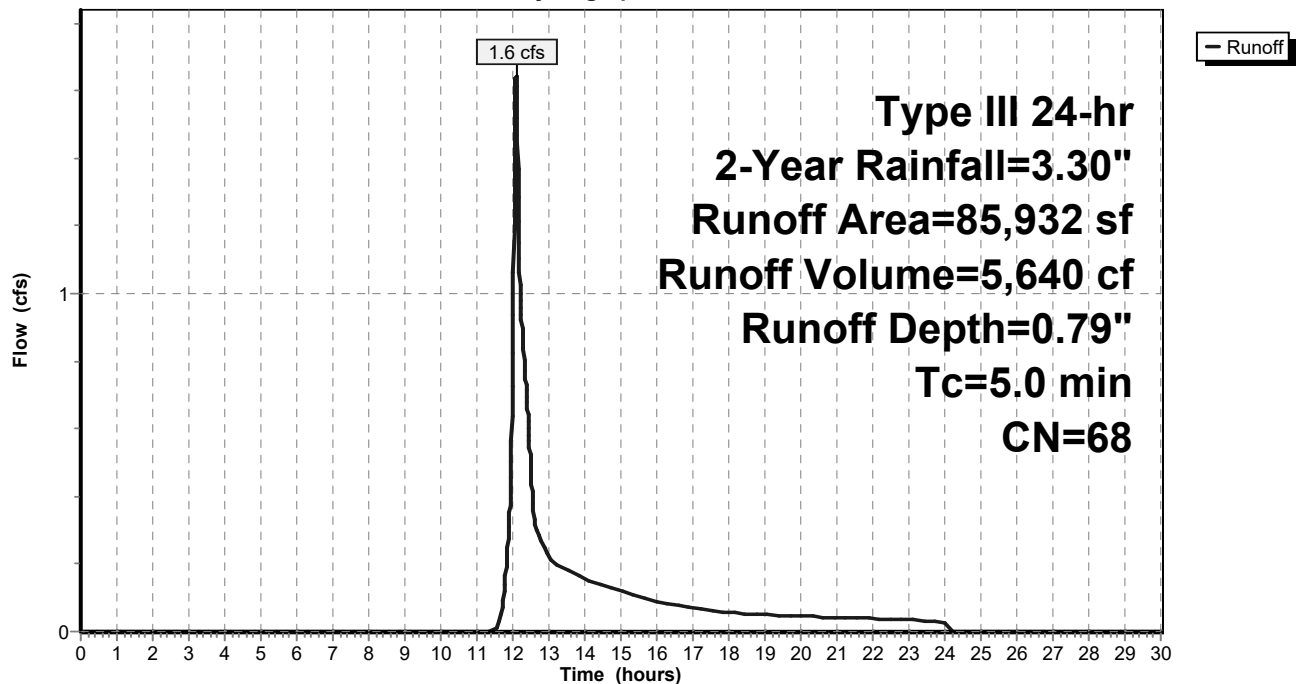
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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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Page 6

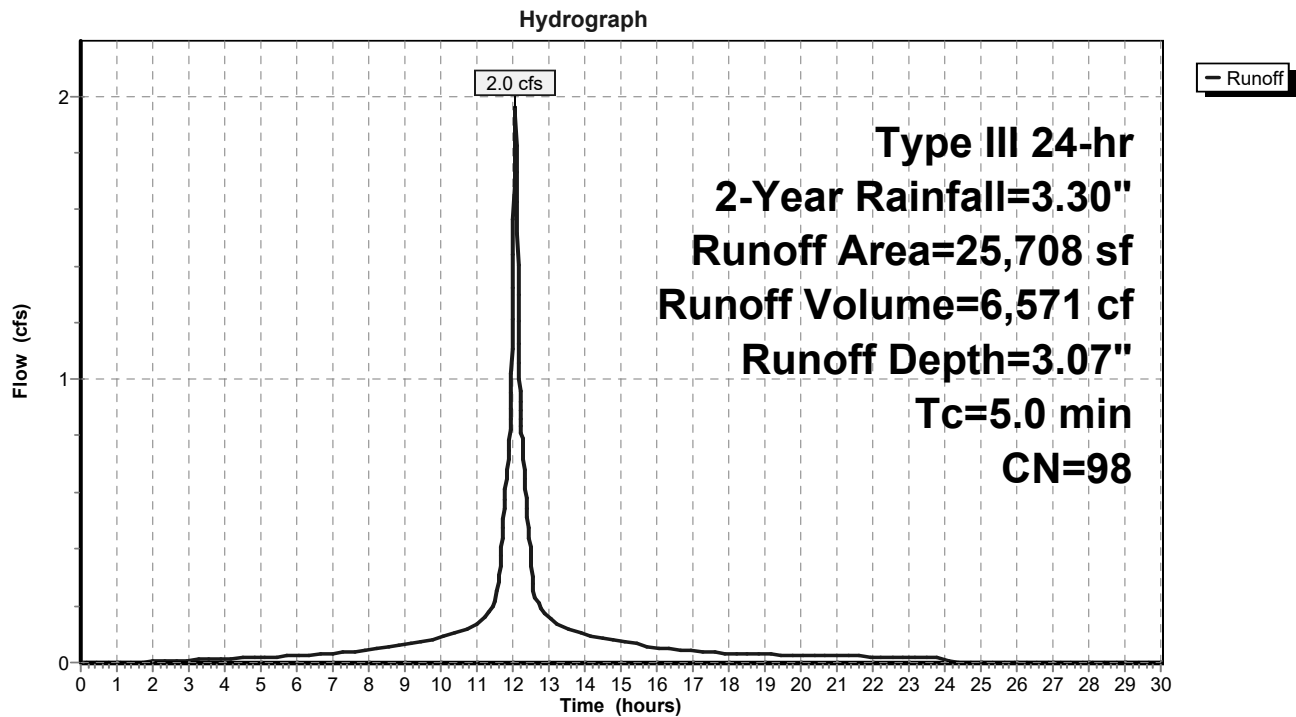
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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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Page 7

Summary for Subcatchment EX-C: Cross St

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

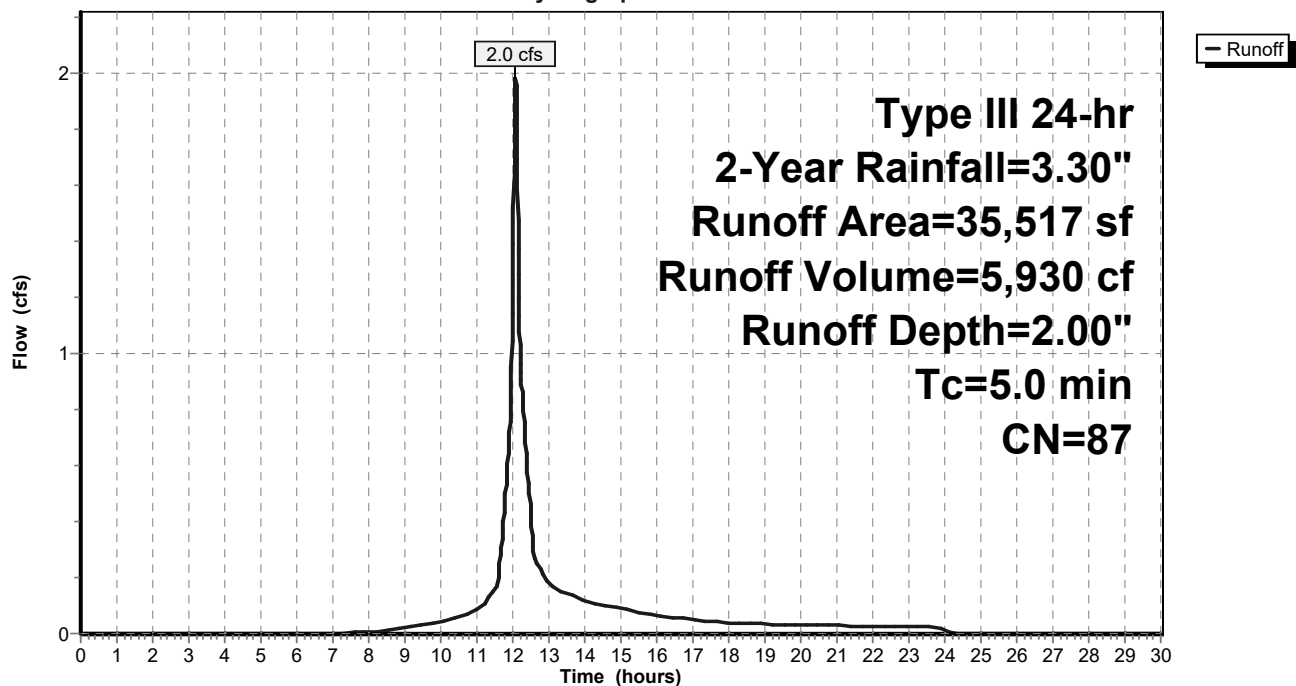
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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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Page 8

Summary for Subcatchment EX-D: Overland to Highland Ave

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

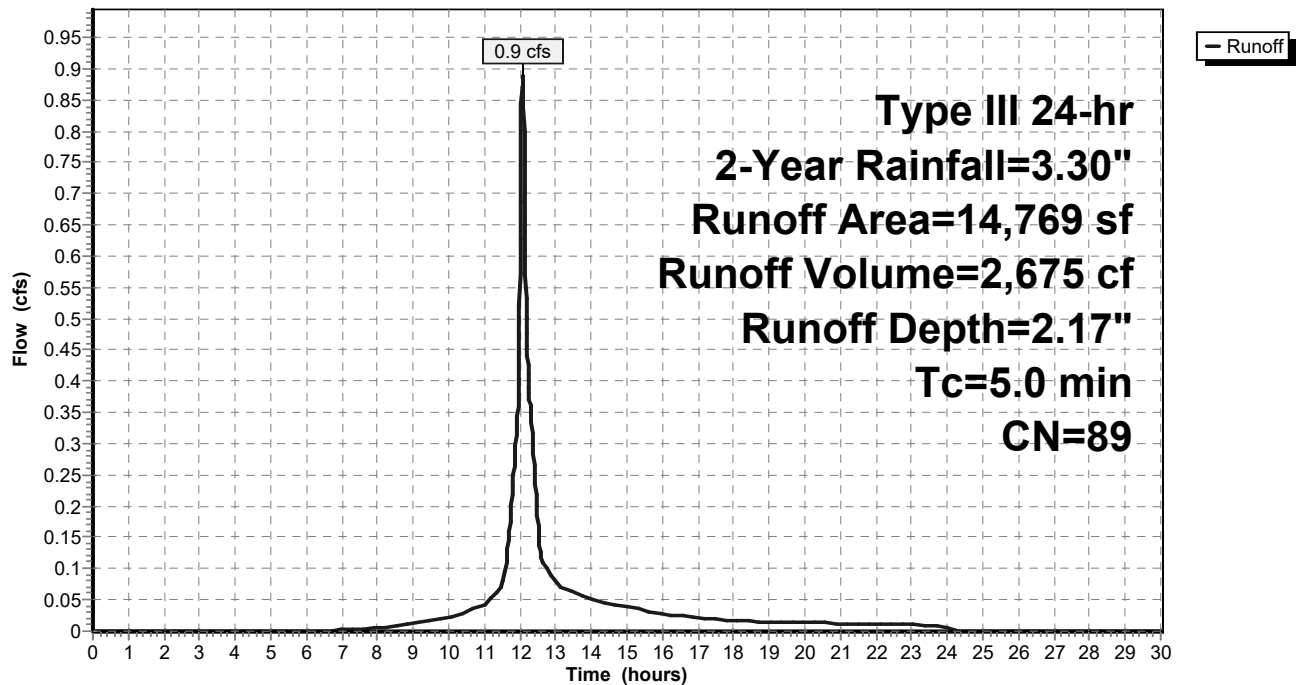
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

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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Page 9

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)

14781.00-EX

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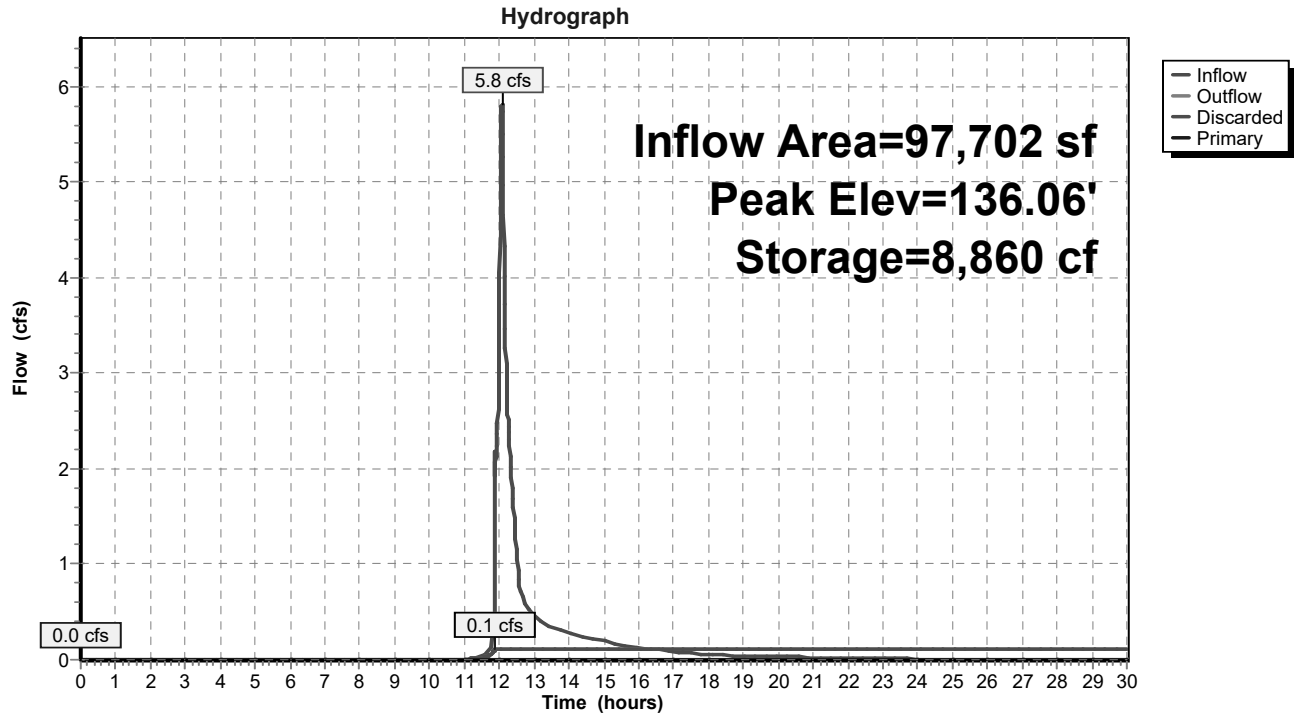
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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Page 10

Pond P-1: Lower Inf Basin



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

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Page 11

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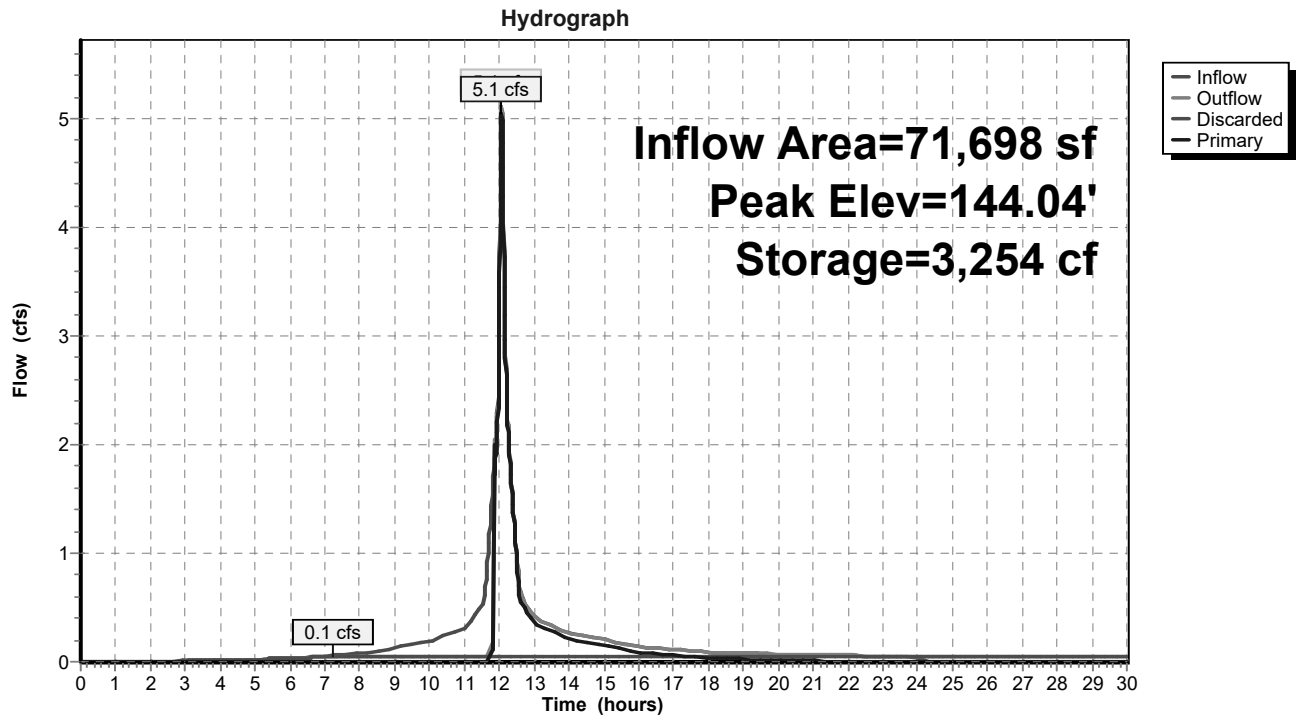
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Existing
Type III 24-hr 2-Year Rainfall=3.30"

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Page 12

Pond P-2: Upper Inf Basin



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

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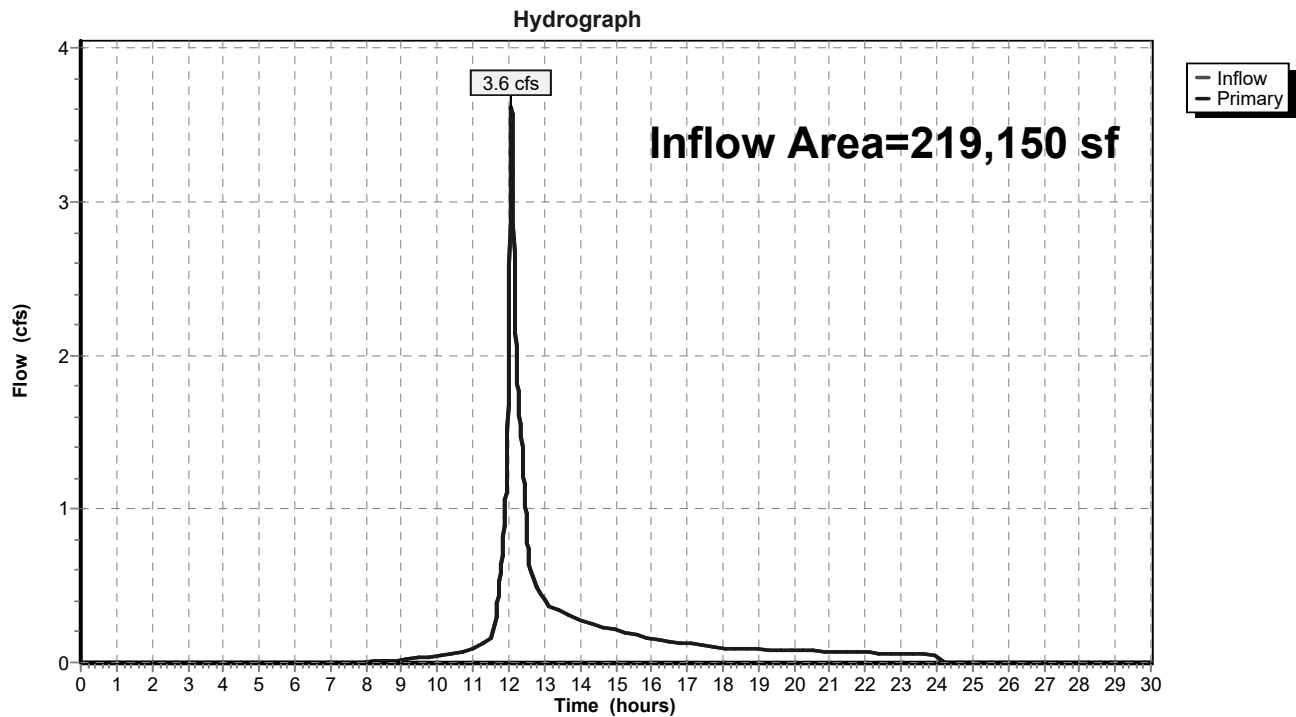
Page 13

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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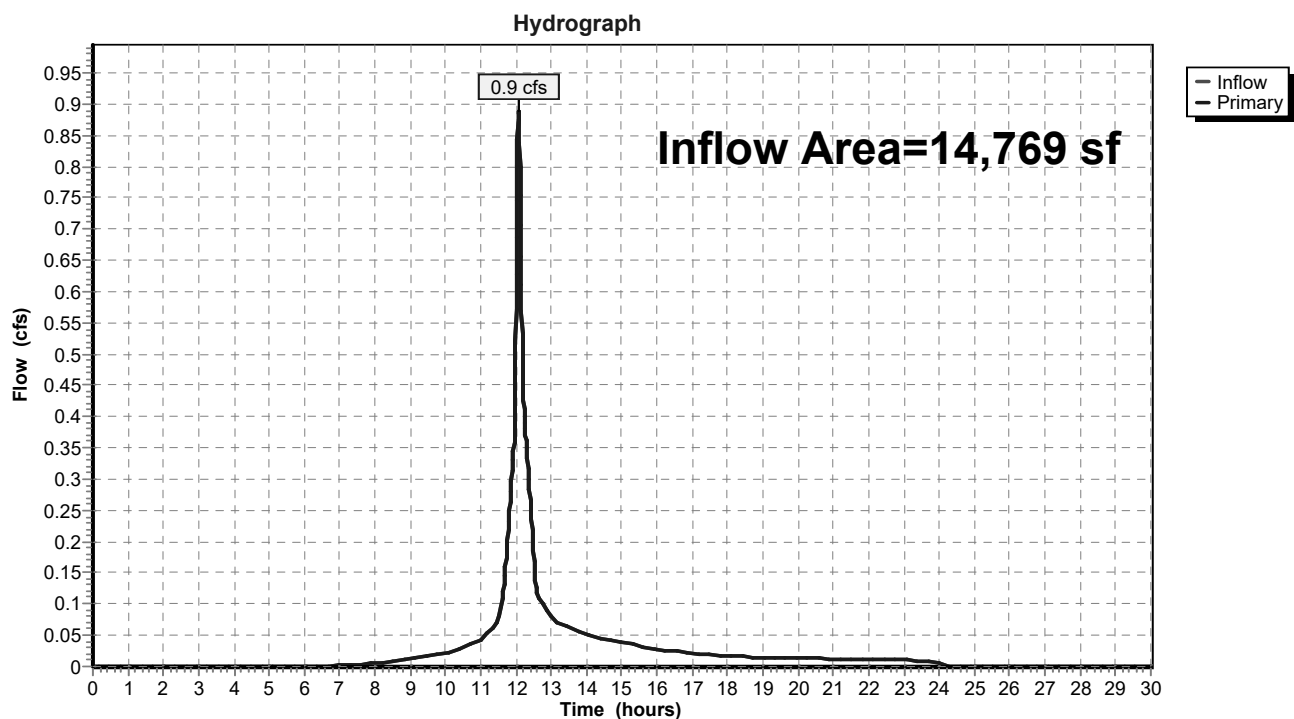
Page 14

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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Page 15

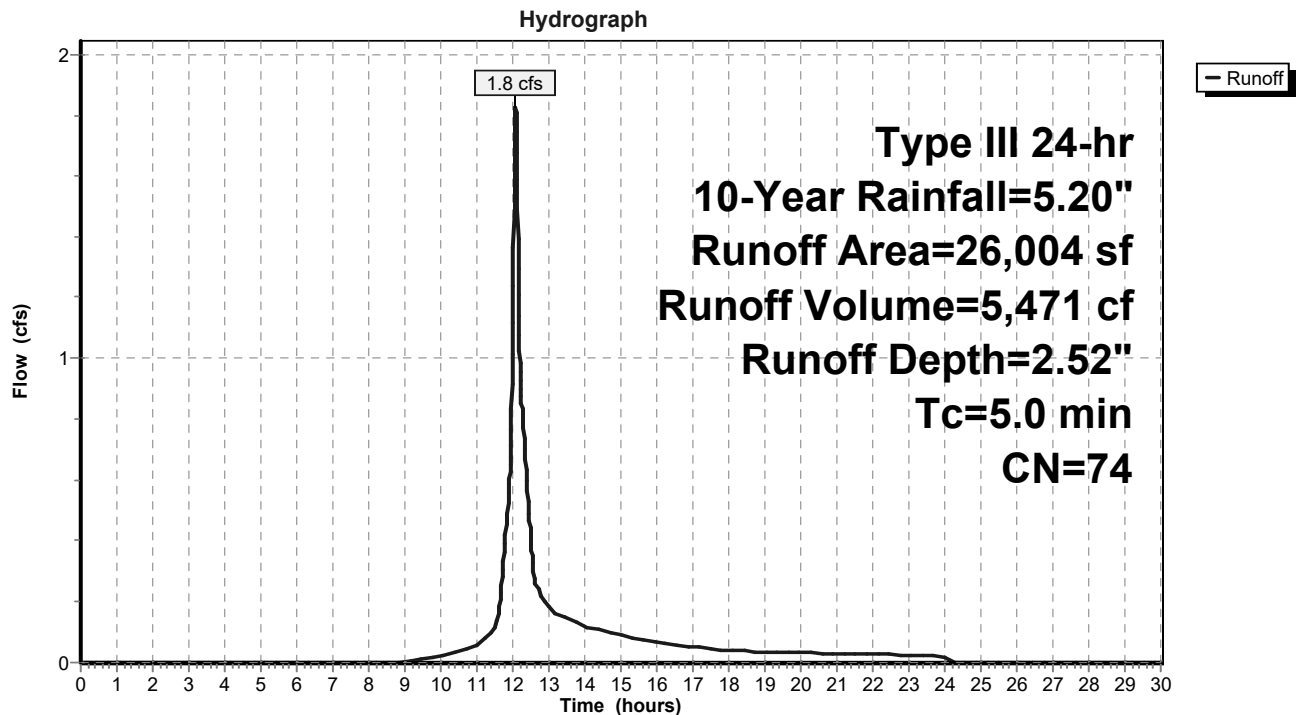
Summary for Subcatchment EX-1: Lower Lot & Bldgs

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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Page 16

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

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

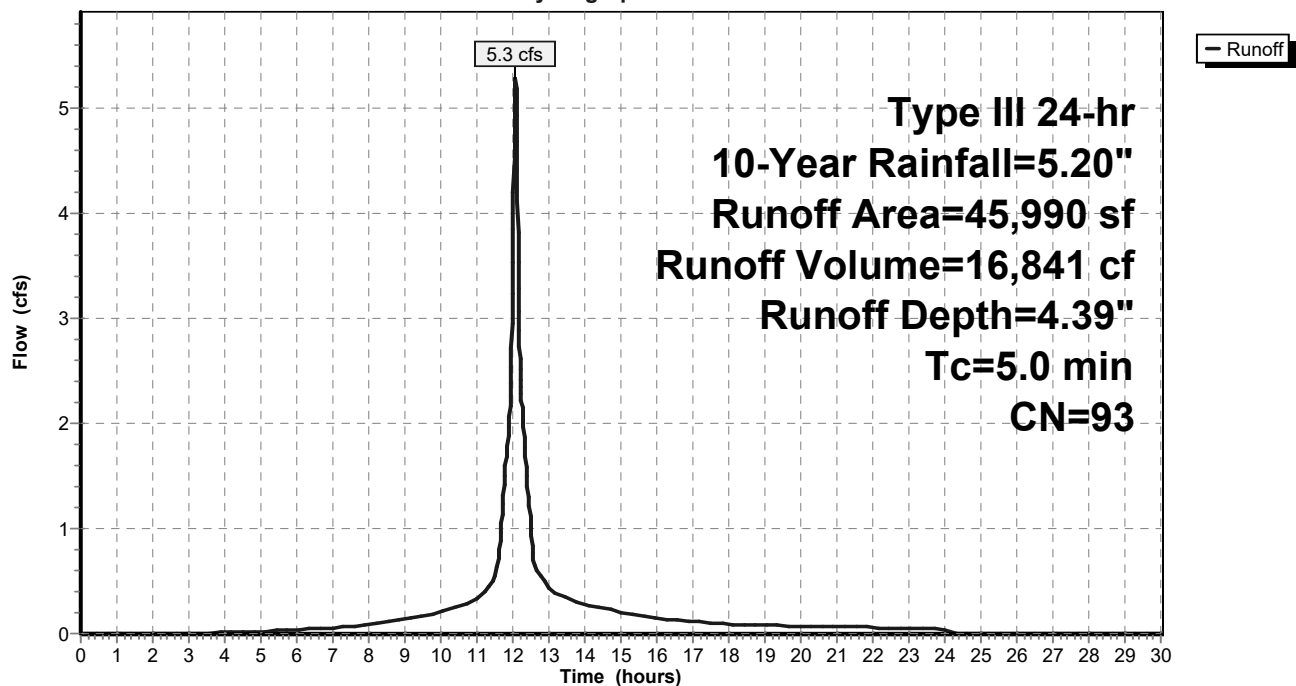
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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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Page 17

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

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

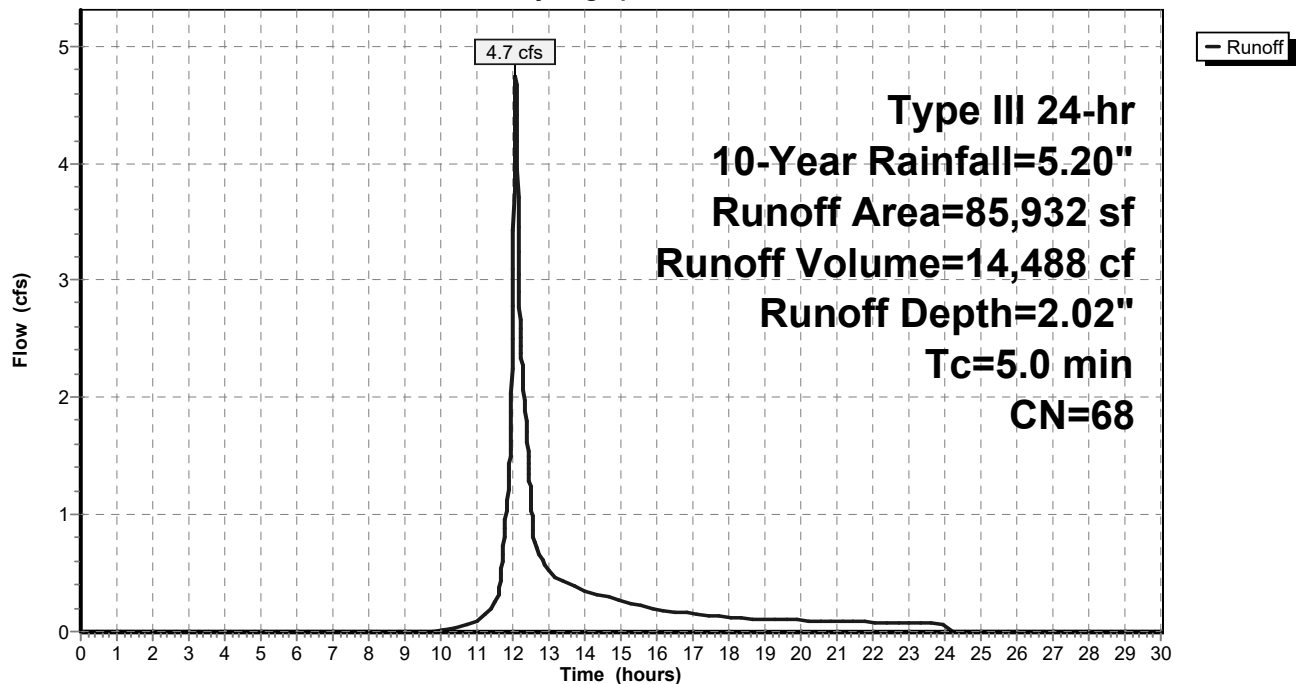
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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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Page 18

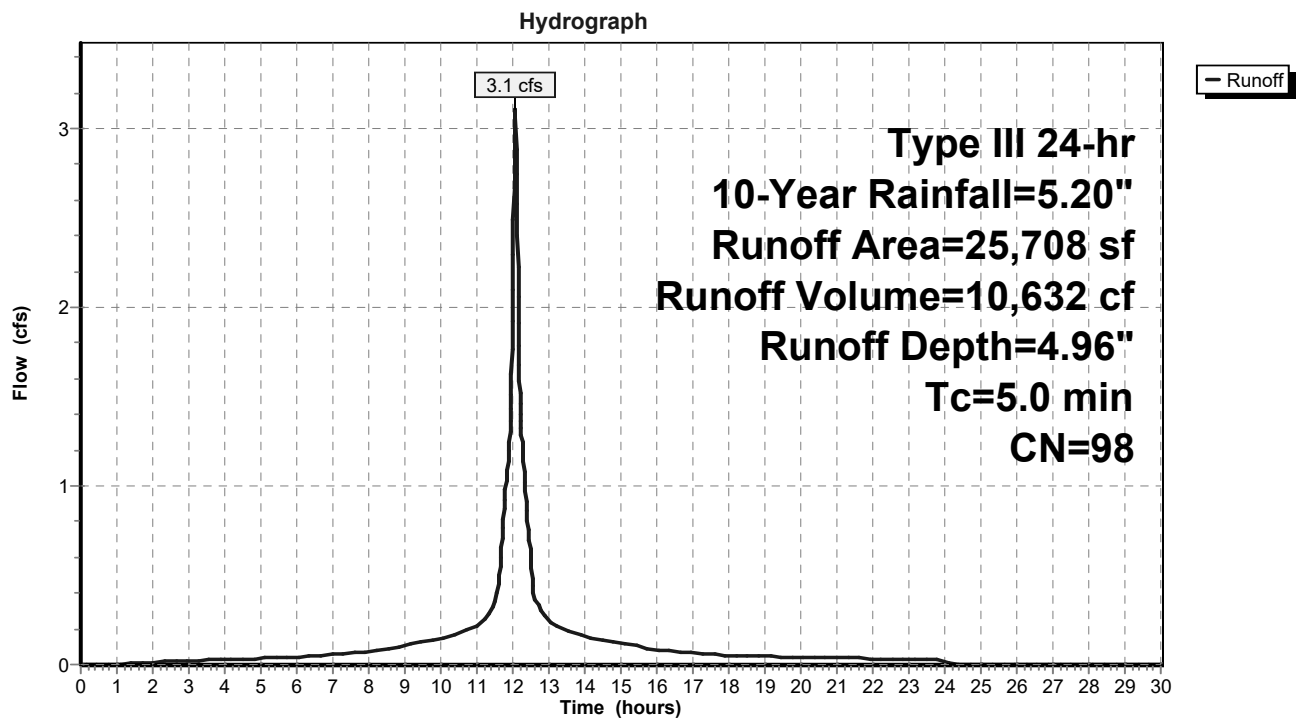
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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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Page 19

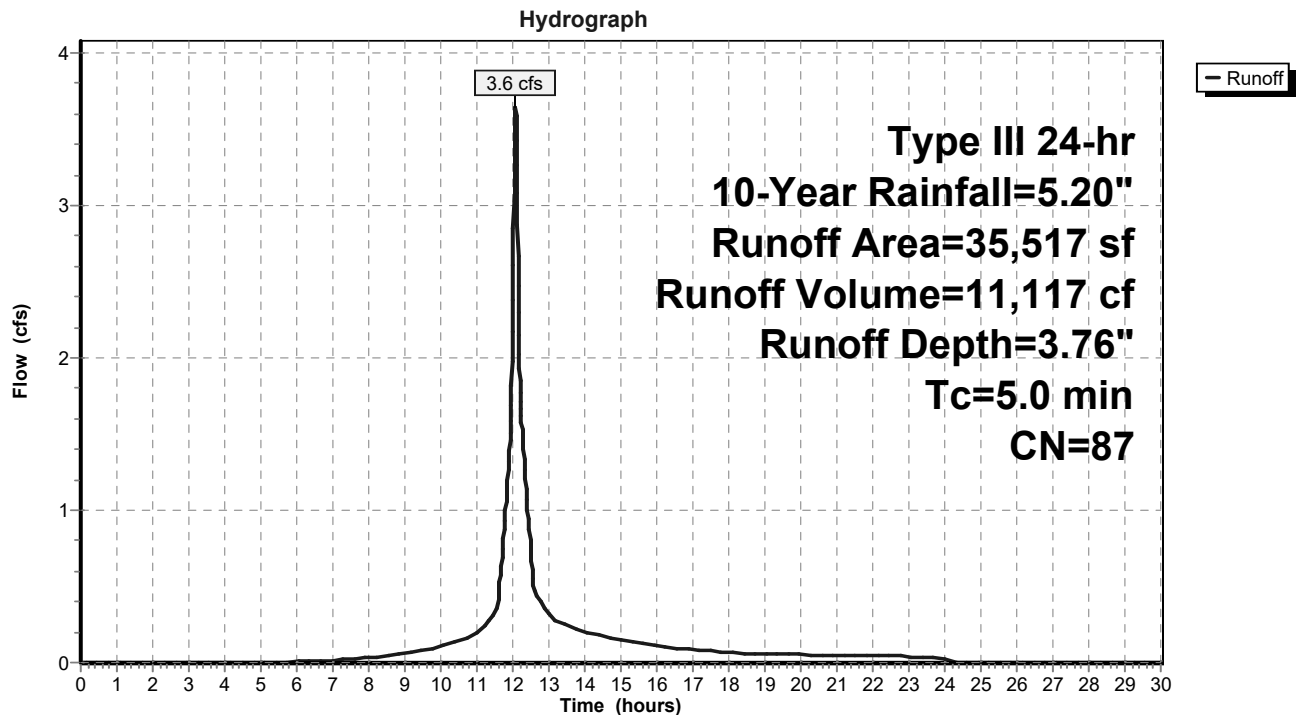
Summary for Subcatchment EX-C: Cross St

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

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

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Page 20

Summary for Subcatchment EX-D: Overland to Highland Ave

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

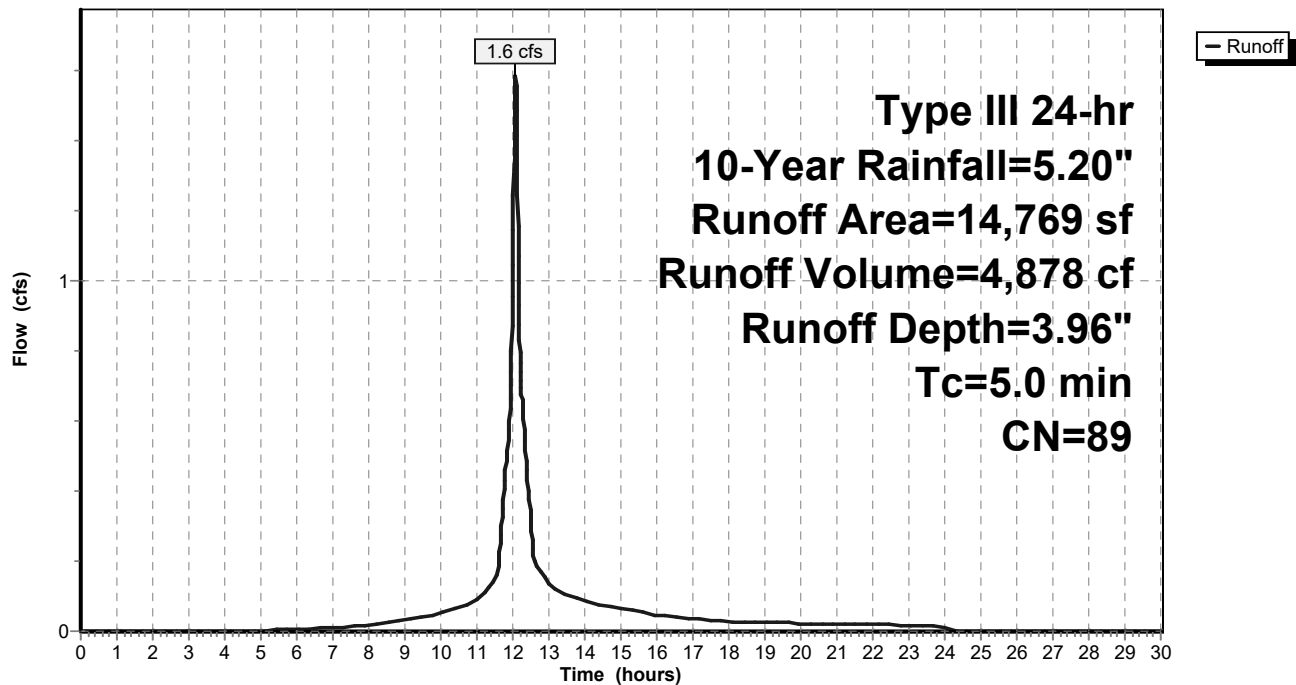
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

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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Page 21

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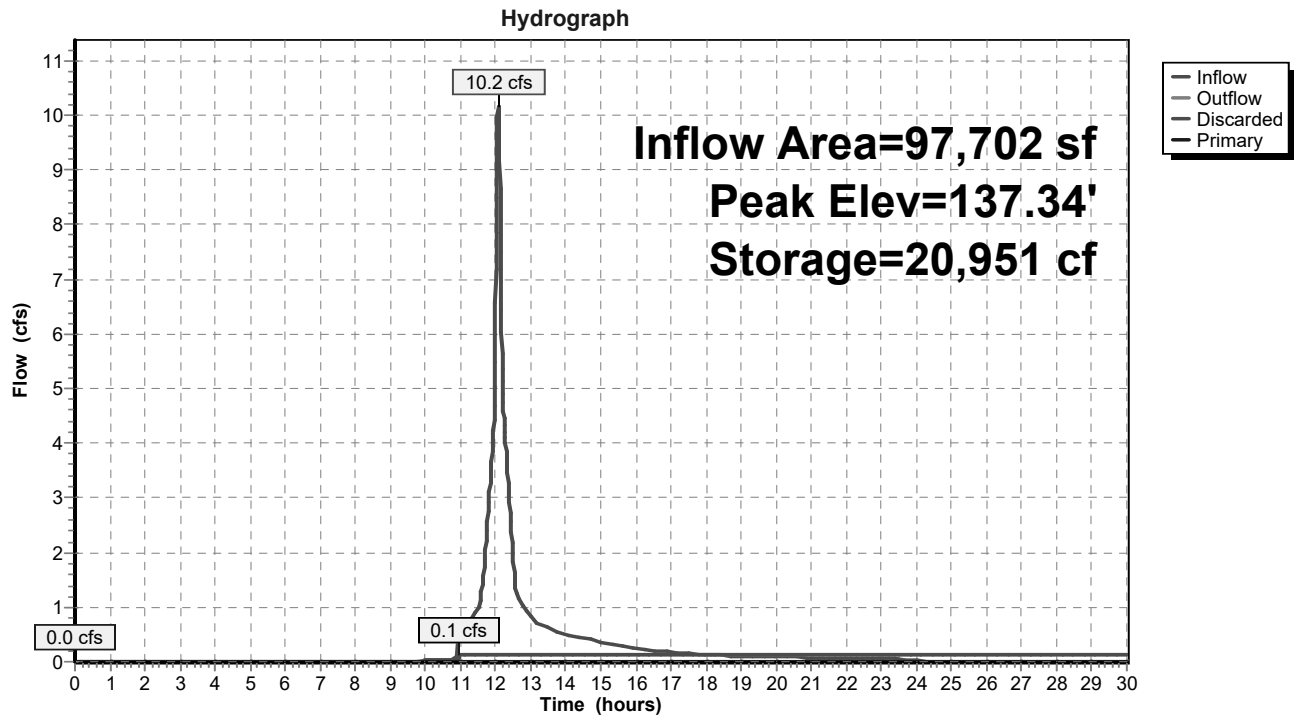
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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Page 22

Pond P-1: Lower Inf Basin



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

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Page 23

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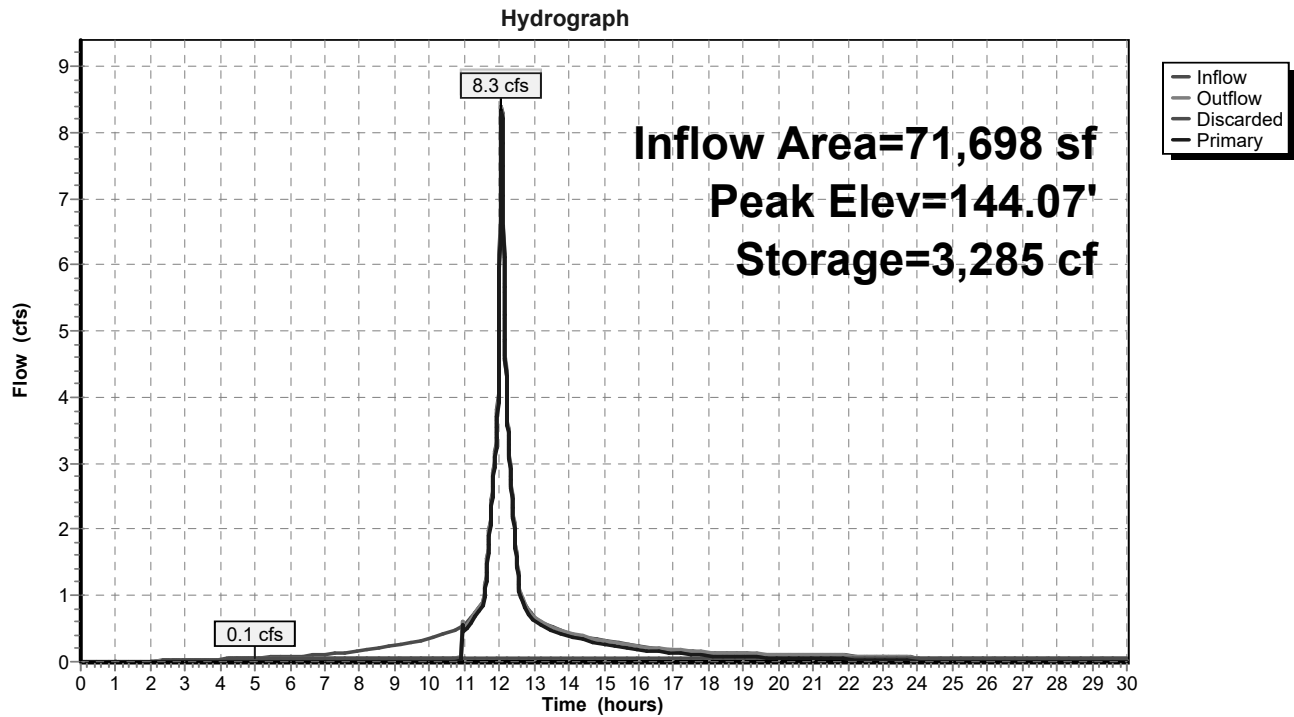
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Existing
Type III 24-hr 10-Year Rainfall=5.20"

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Page 24

Pond P-2: Upper Inf Basin



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

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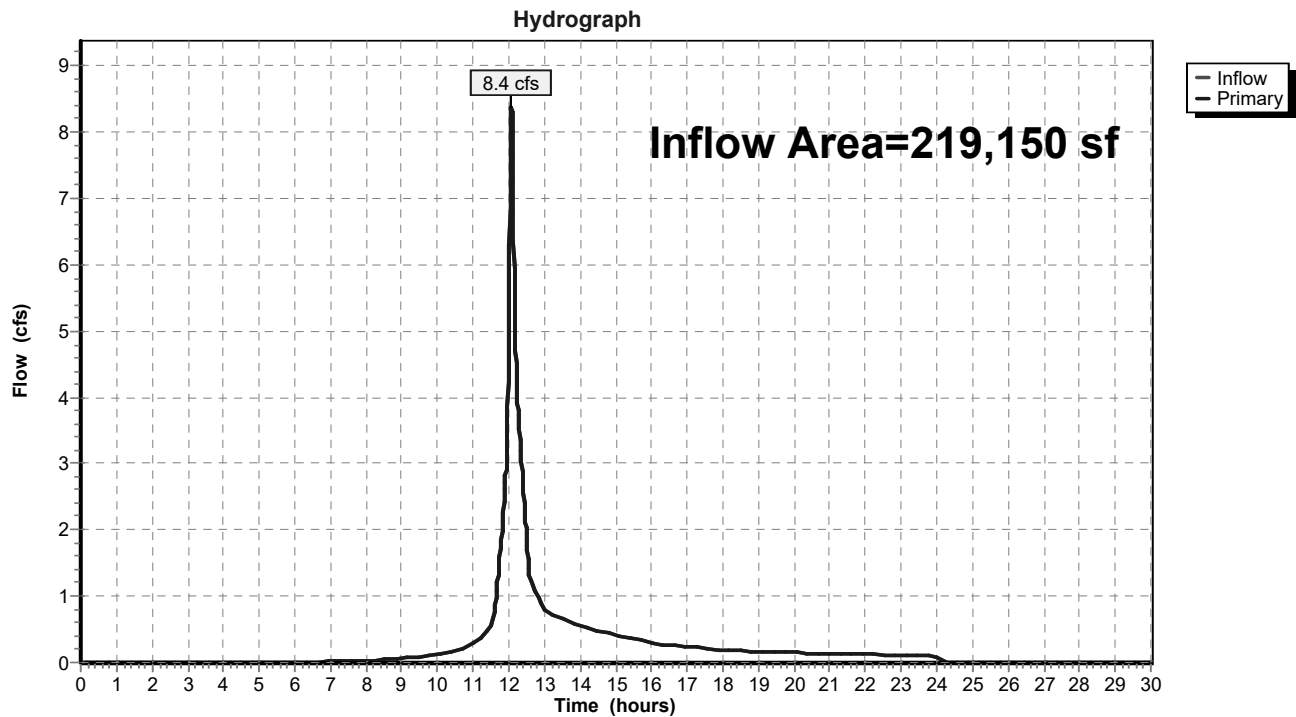
Page 25

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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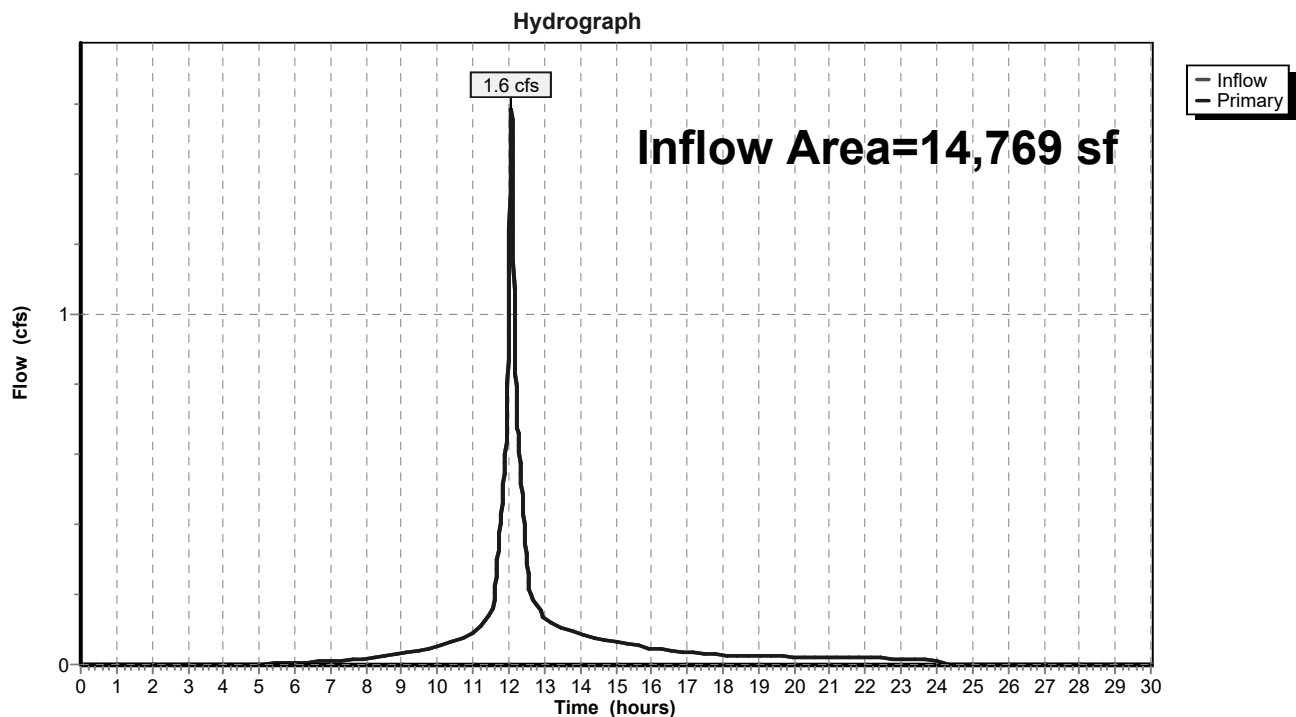
Page 26

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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Page 27

Summary for Subcatchment EX-1: Lower Lot & Bldgs

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

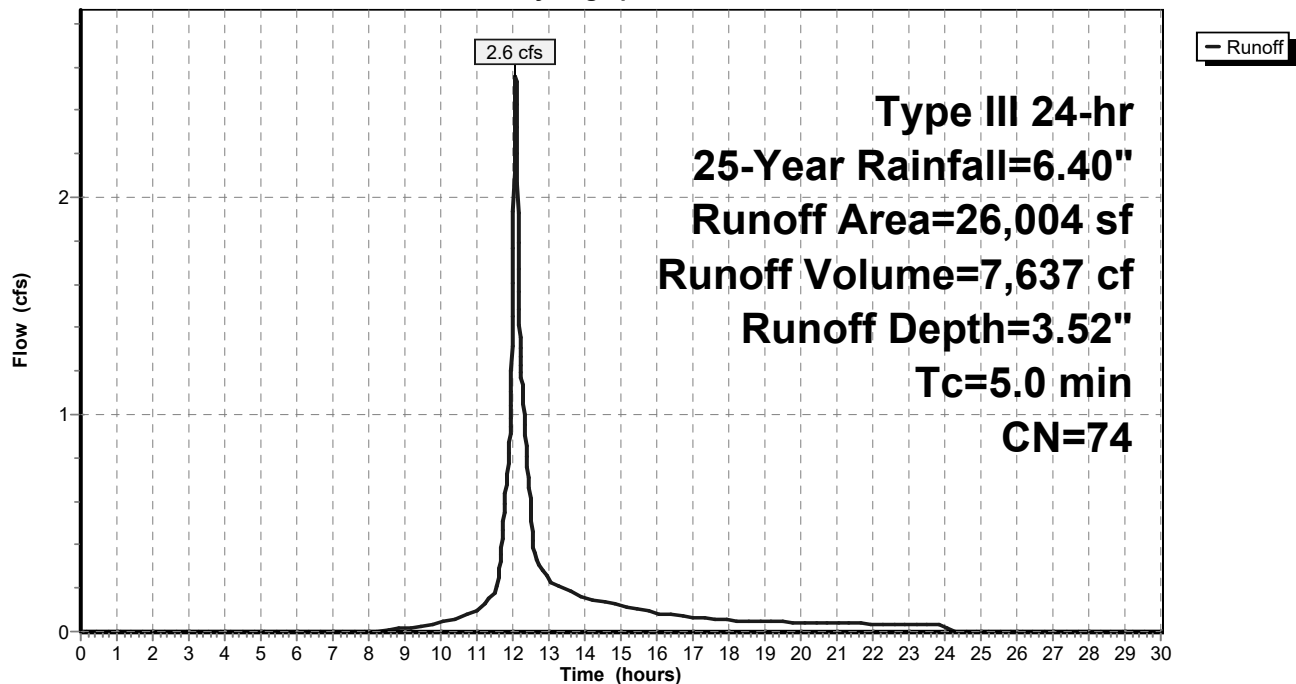
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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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Page 28

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

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

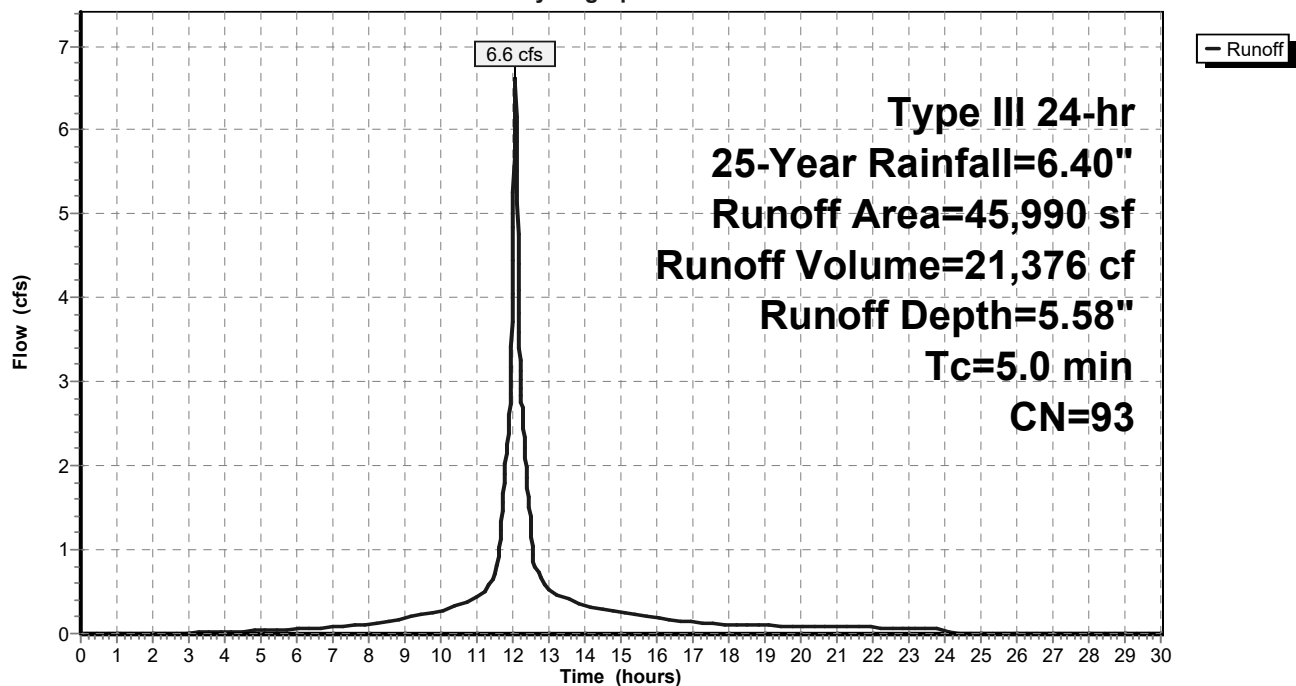
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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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Page 29

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

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

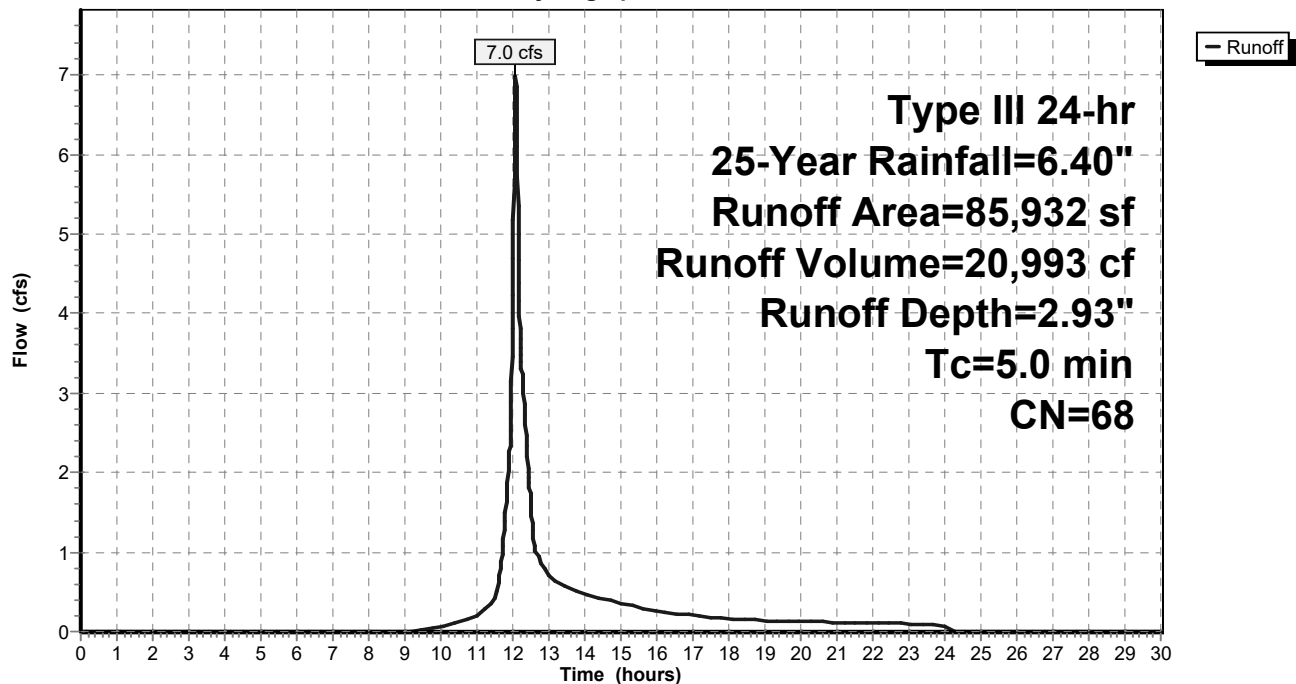
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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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Page 30

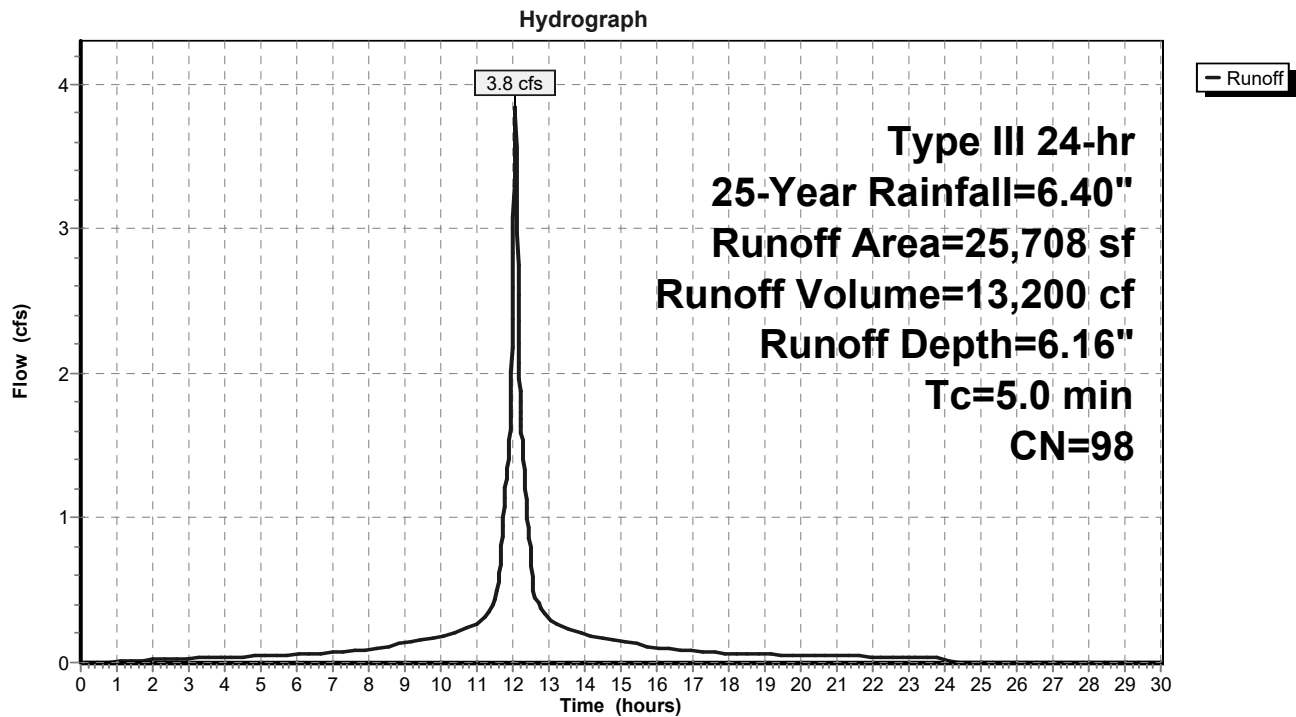
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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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Page 31

Summary for Subcatchment EX-C: Cross St

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

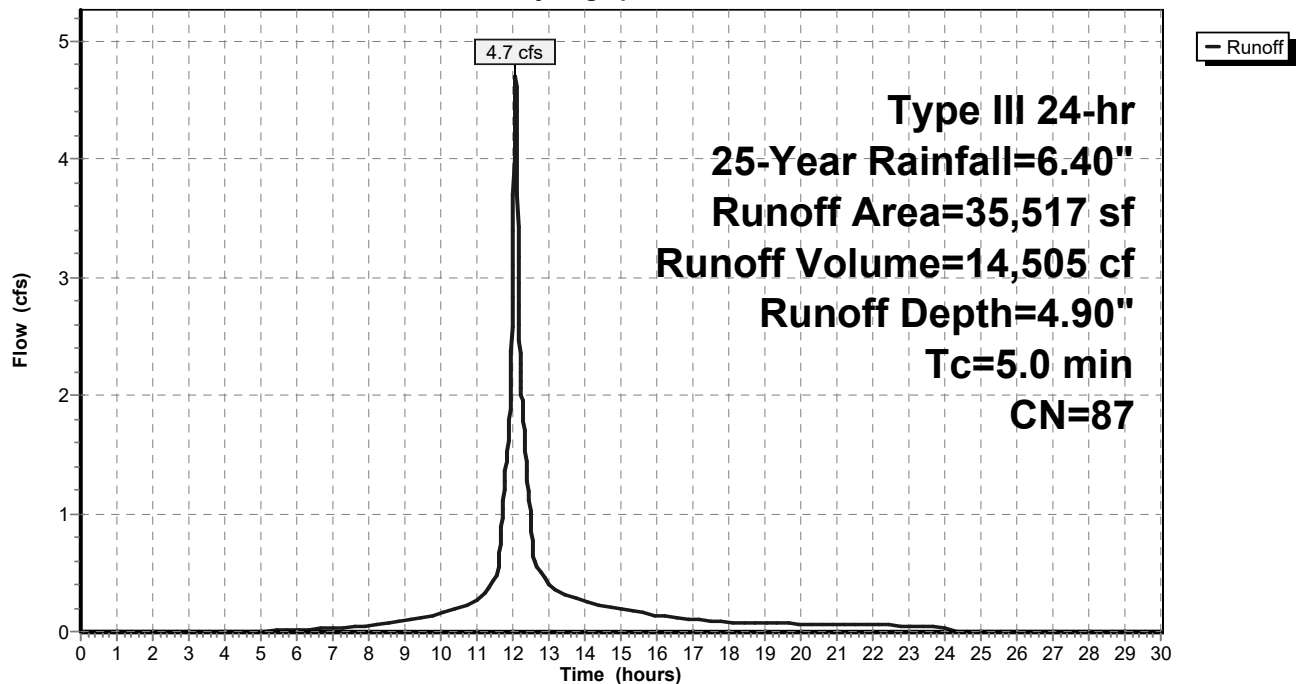
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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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Page 32

Summary for Subcatchment EX-D: Overland to Highland Ave

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

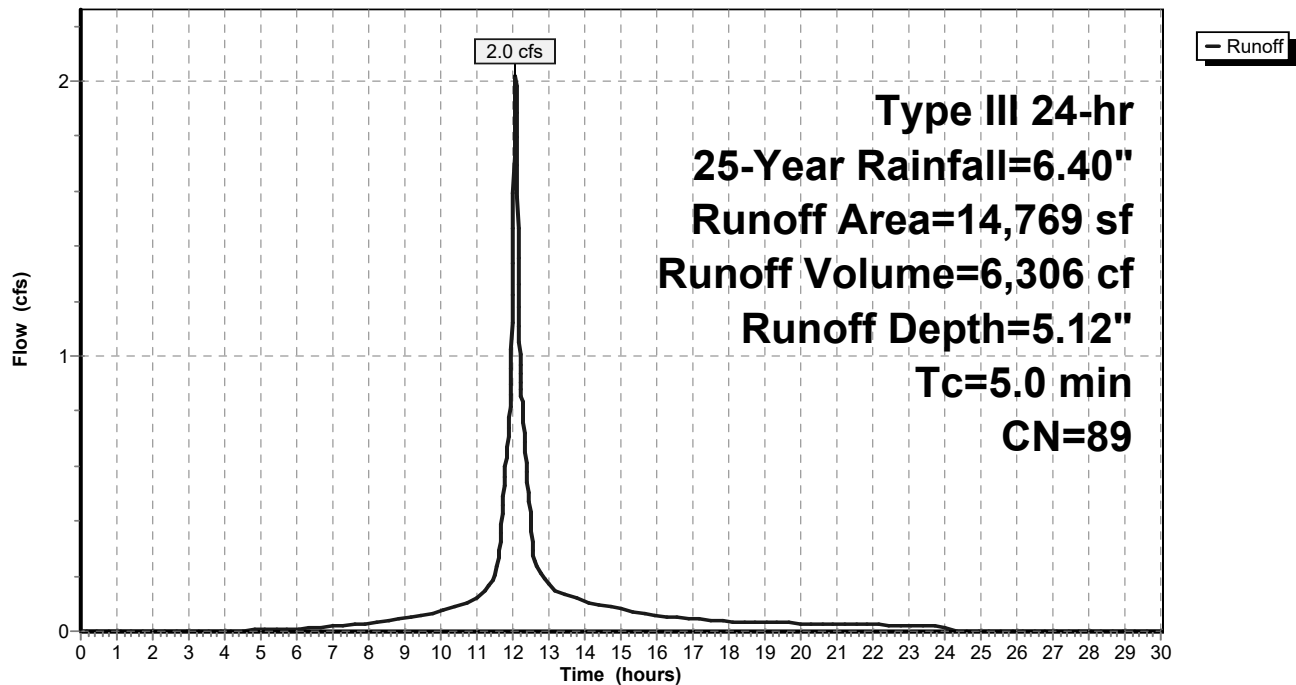
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.40"

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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Page 33

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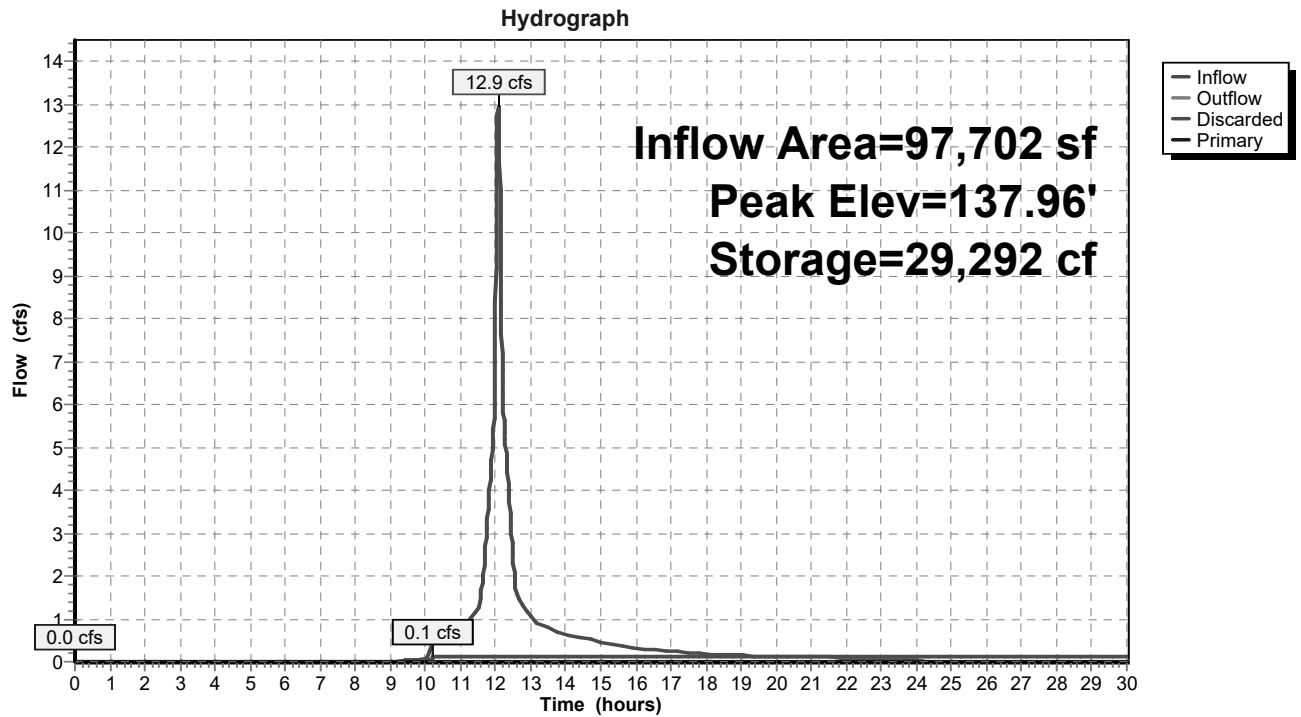
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Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Page 34

Pond P-1: Lower Inf Basin



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

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Page 35

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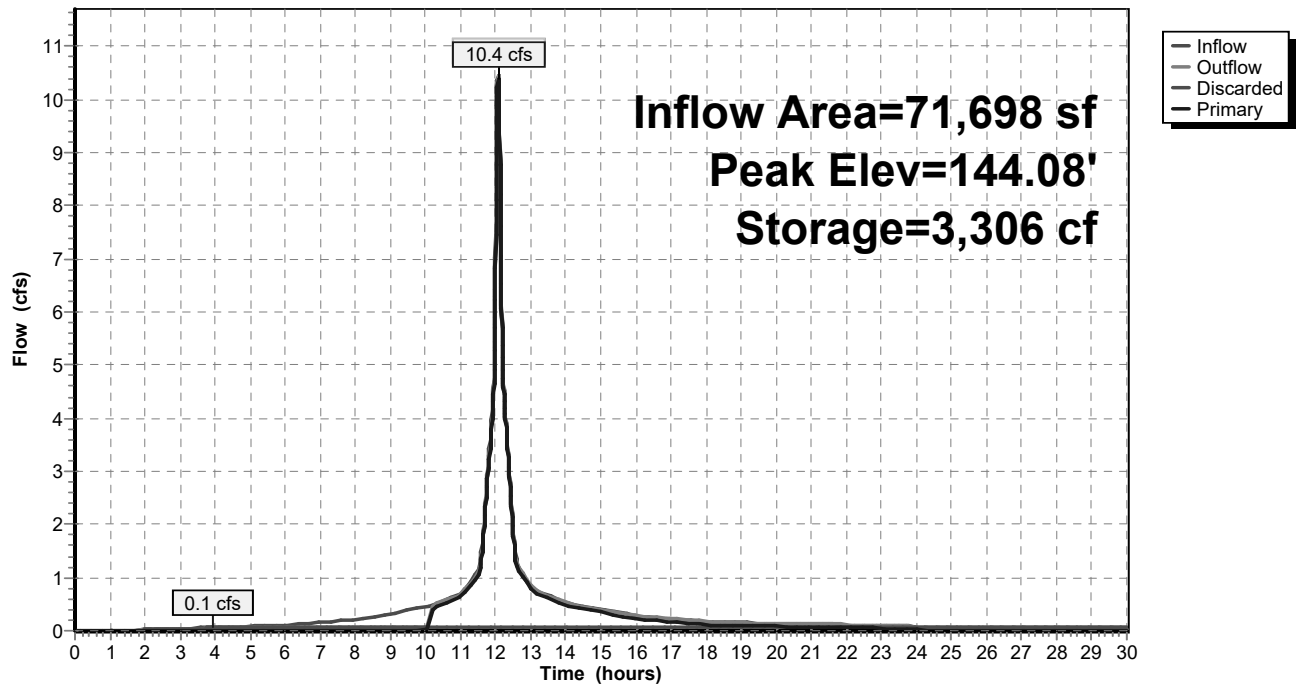
Existing
Type III 24-hr 25-Year Rainfall=6.40"

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Page 36

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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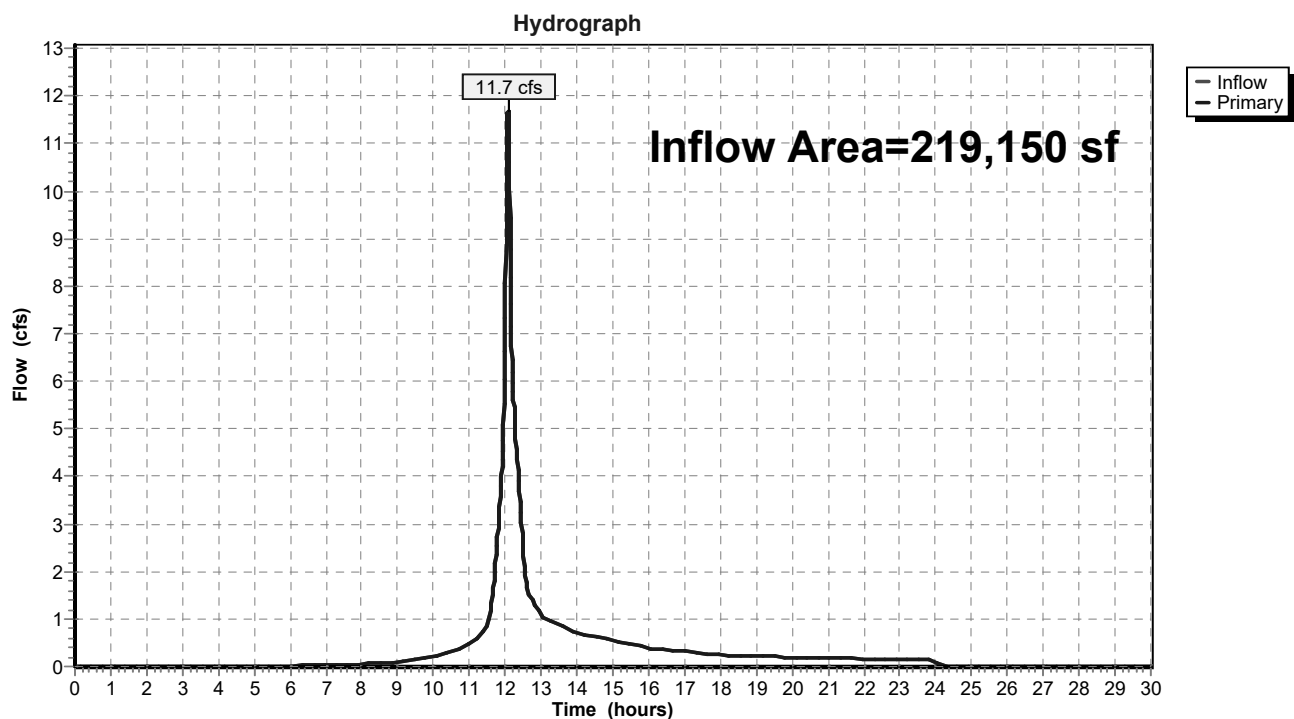
Page 37

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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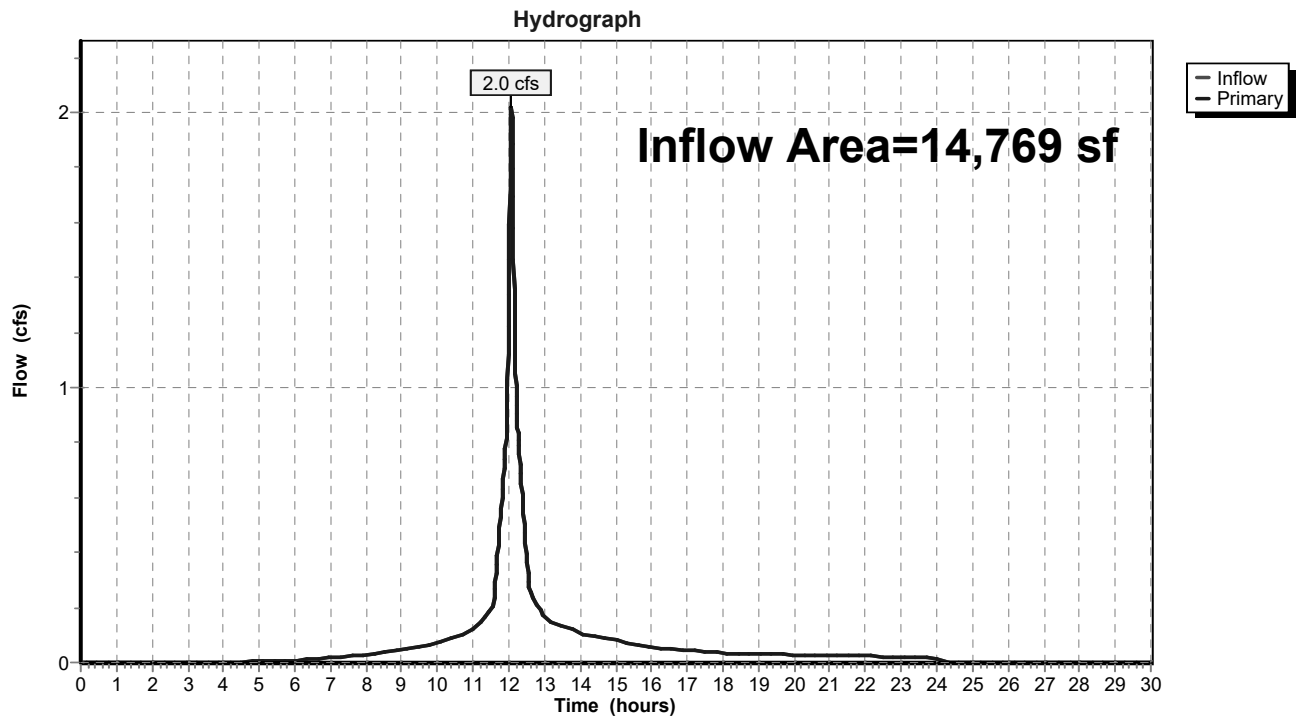
Page 38

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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Page 39

Summary for Subcatchment EX-1: Lower Lot & Bldgs

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

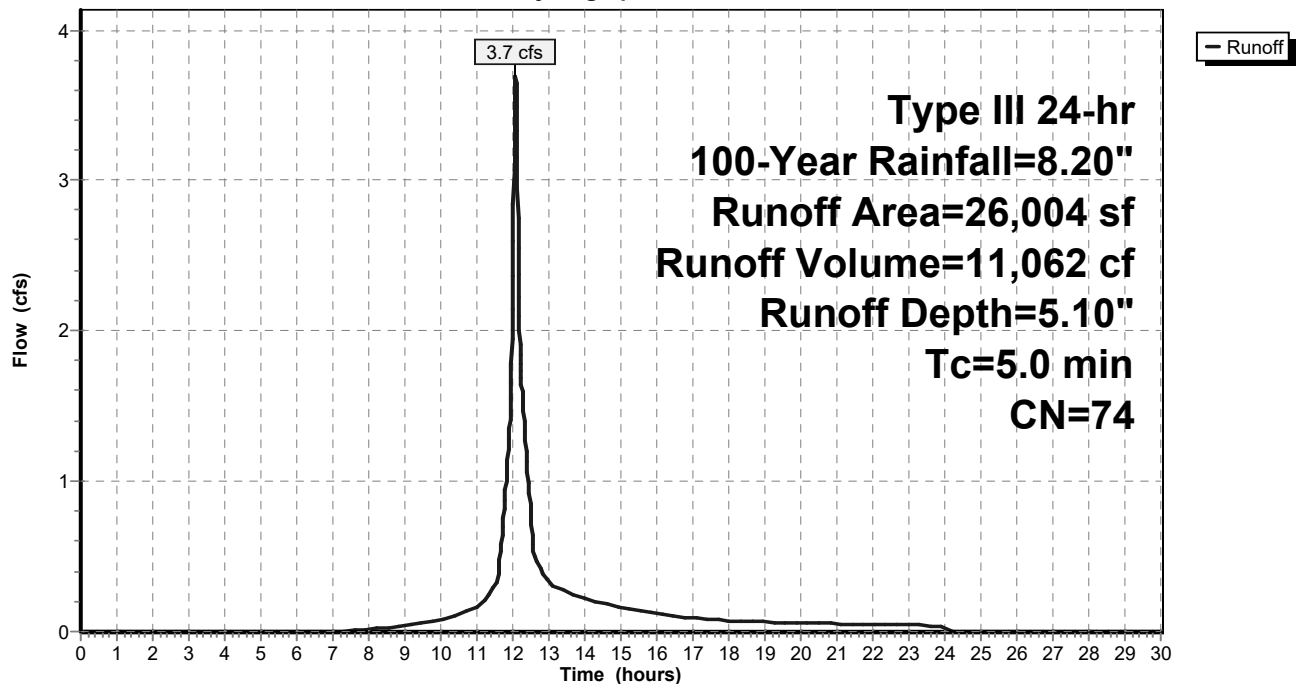
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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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Page 40

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

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

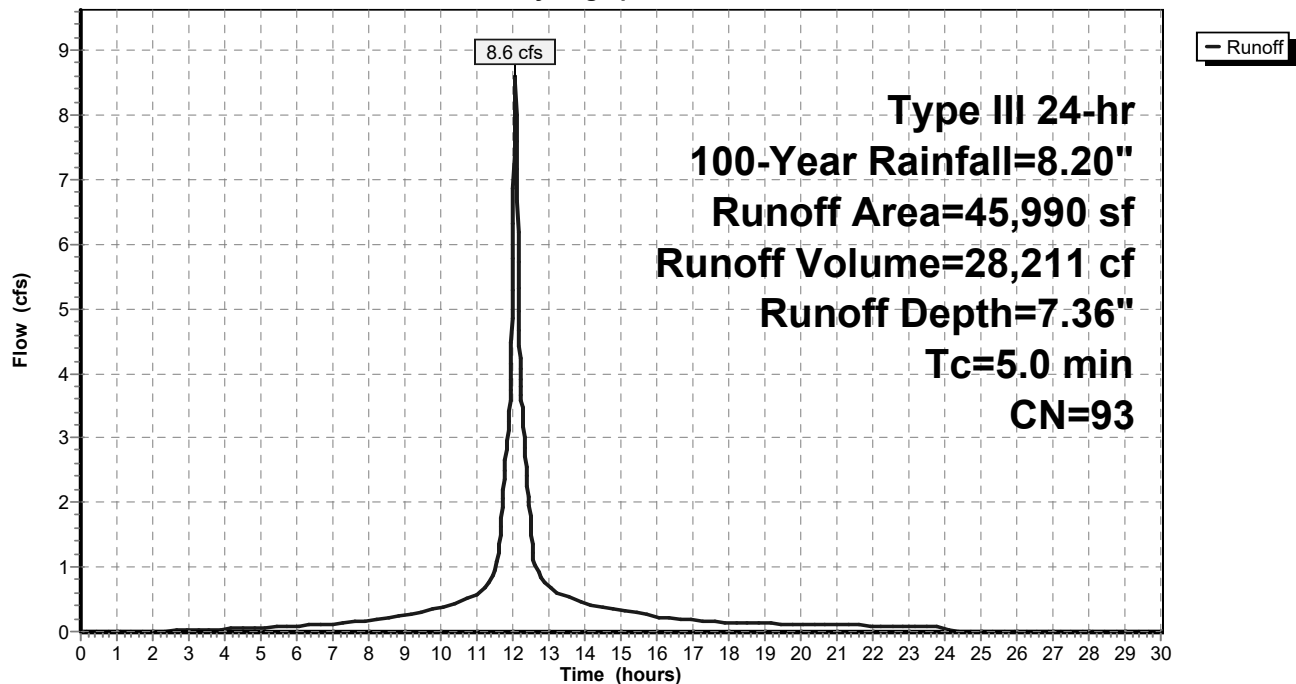
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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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Page 41

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

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

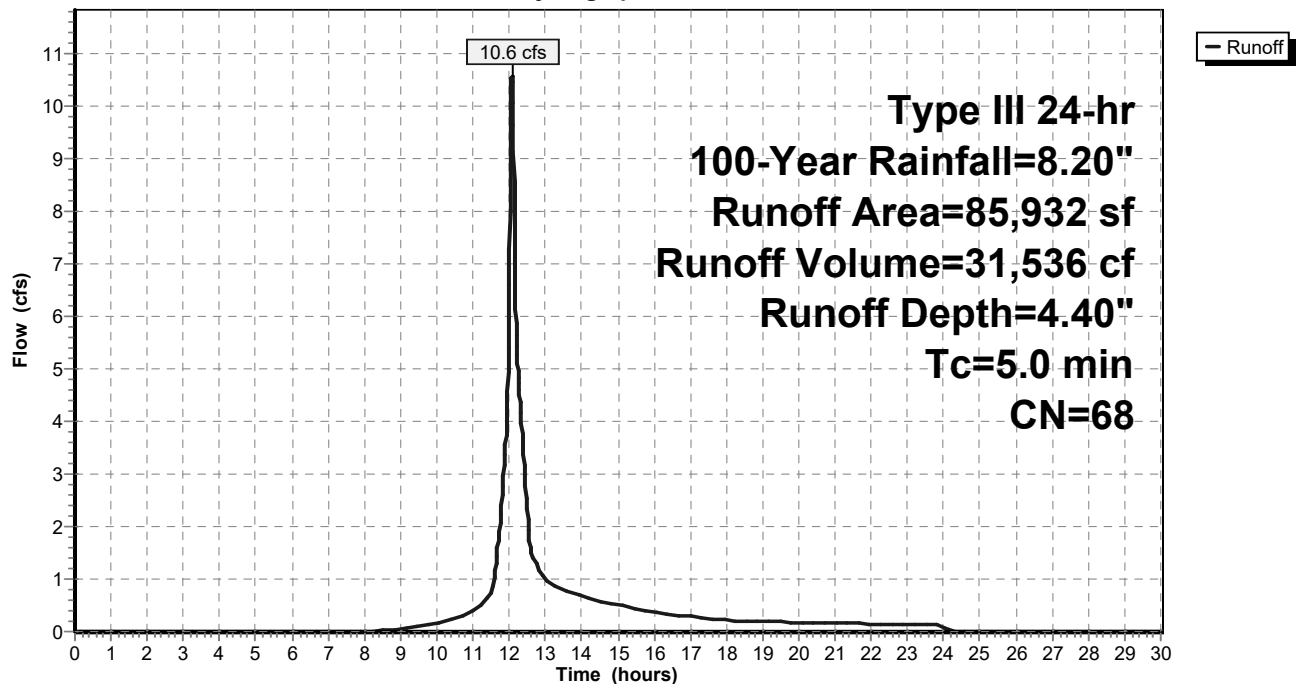
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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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Page 42

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

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

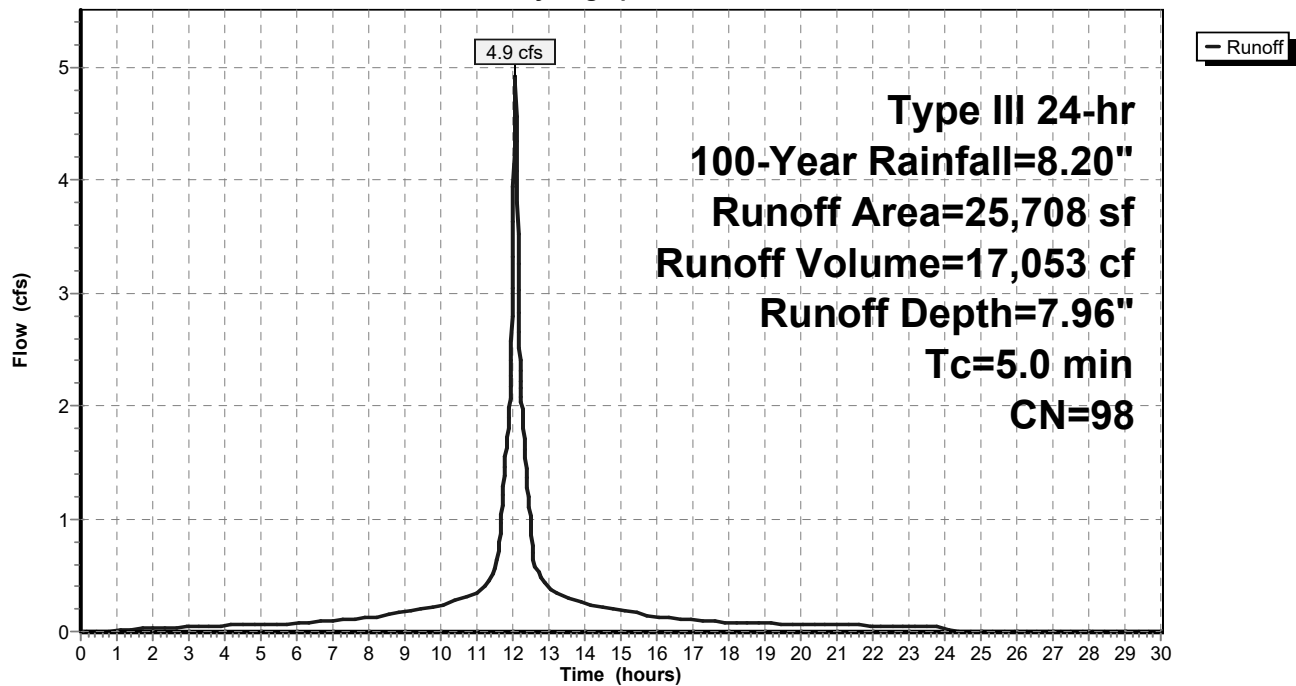
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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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Page 43

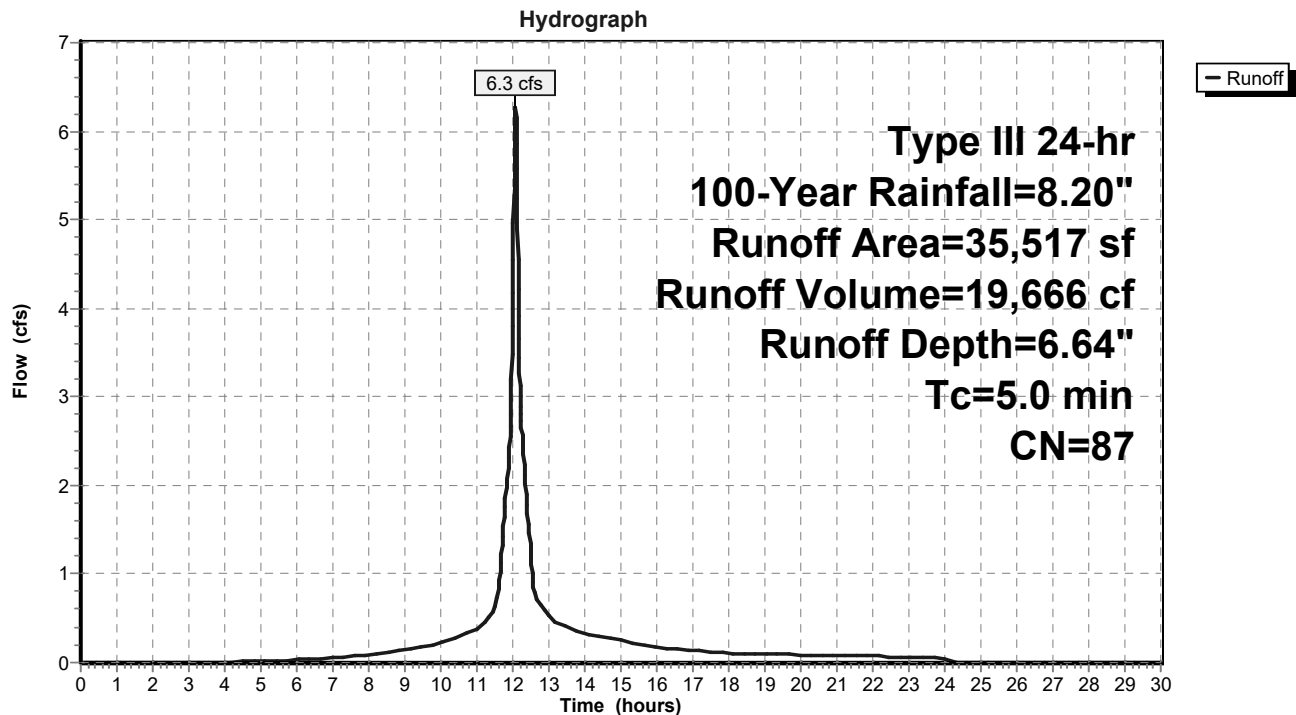
Summary for Subcatchment EX-C: Cross St

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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Page 44

Summary for Subcatchment EX-D: Overland to Highland Ave

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

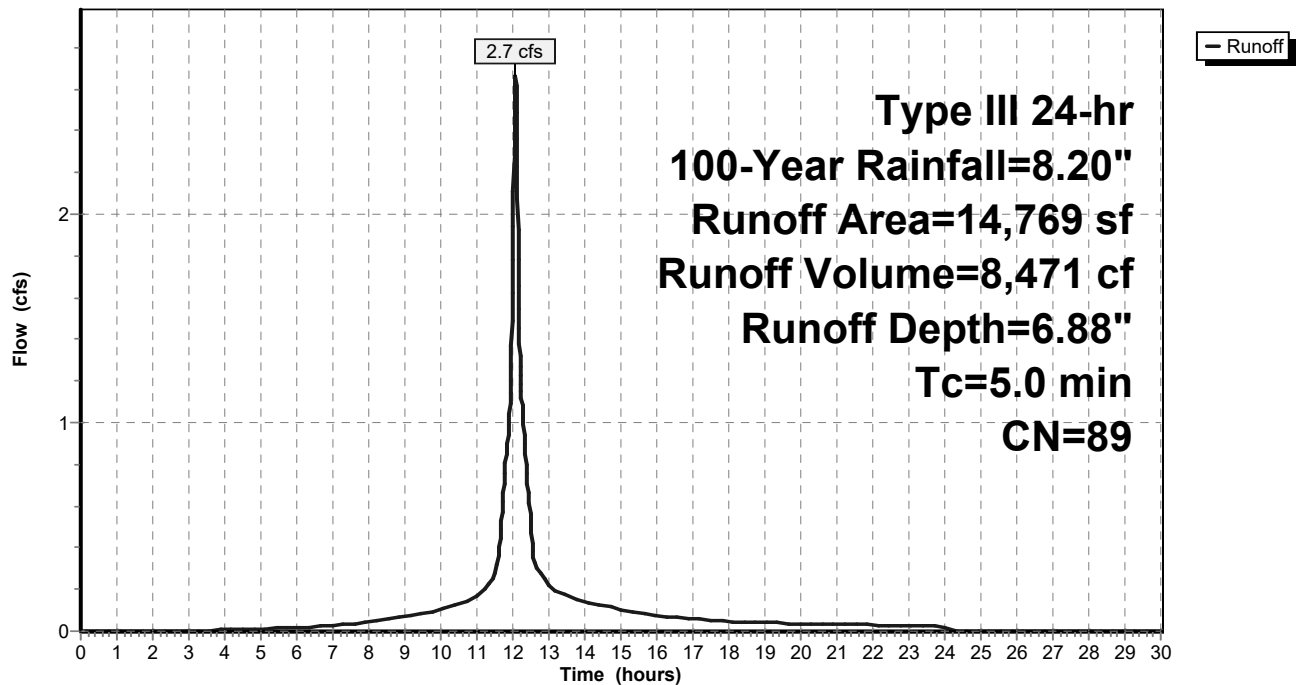
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.20"

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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Page 45

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 (Recalculated)
		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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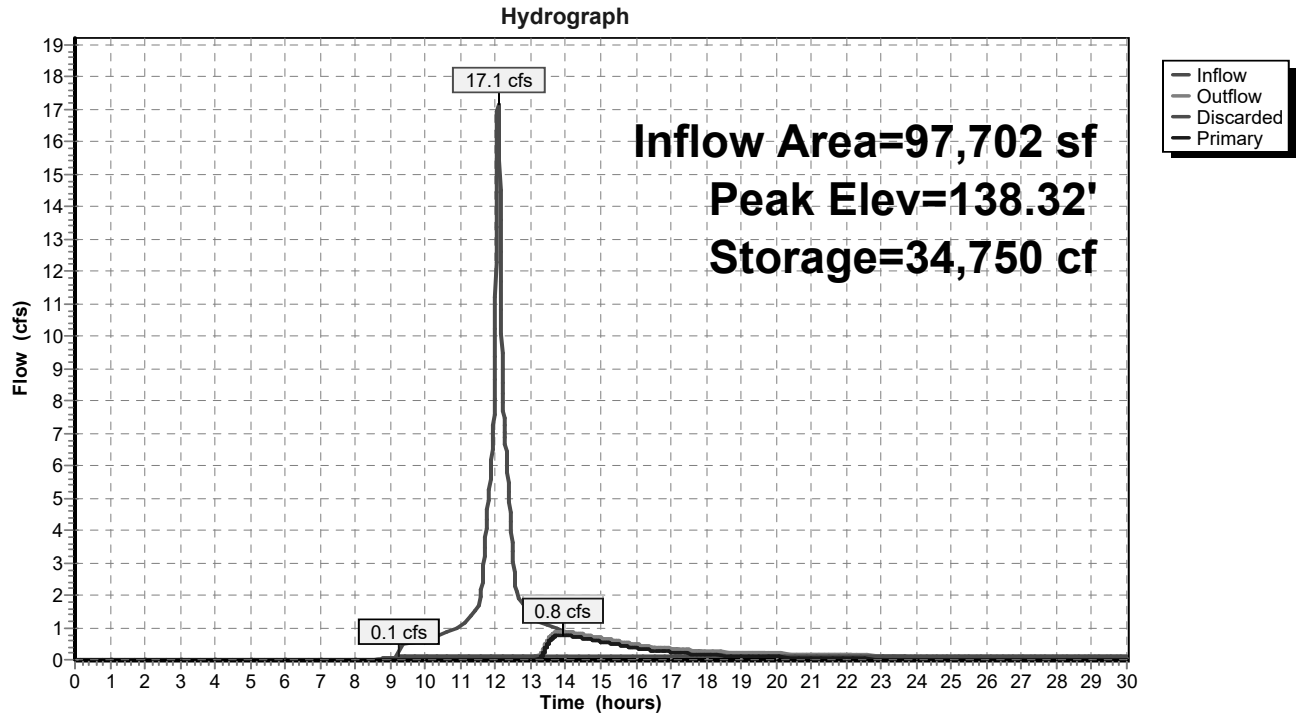
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Existing
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Page 46

Pond P-1: Lower Inf Basin



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

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Page 47

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)

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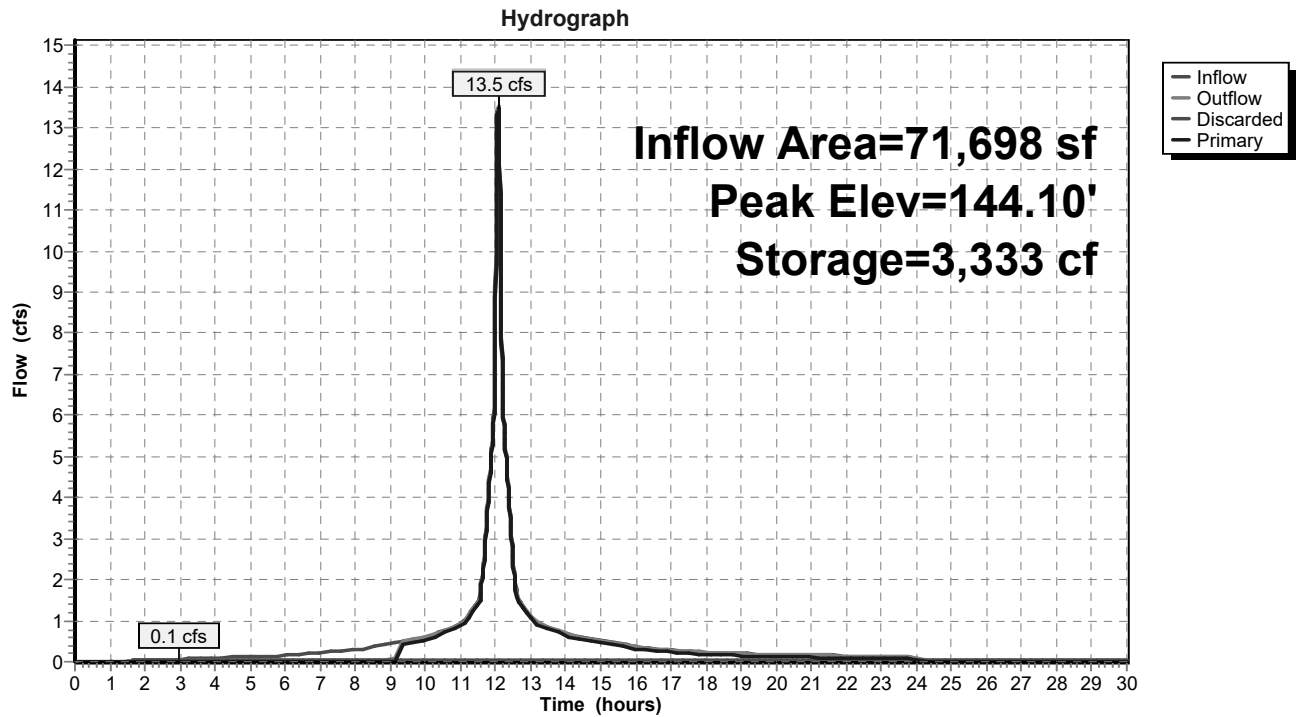
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Existing
Type III 24-hr 100-Year Rainfall=8.20"

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Page 48

Pond P-2: Upper Inf Basin



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Existing
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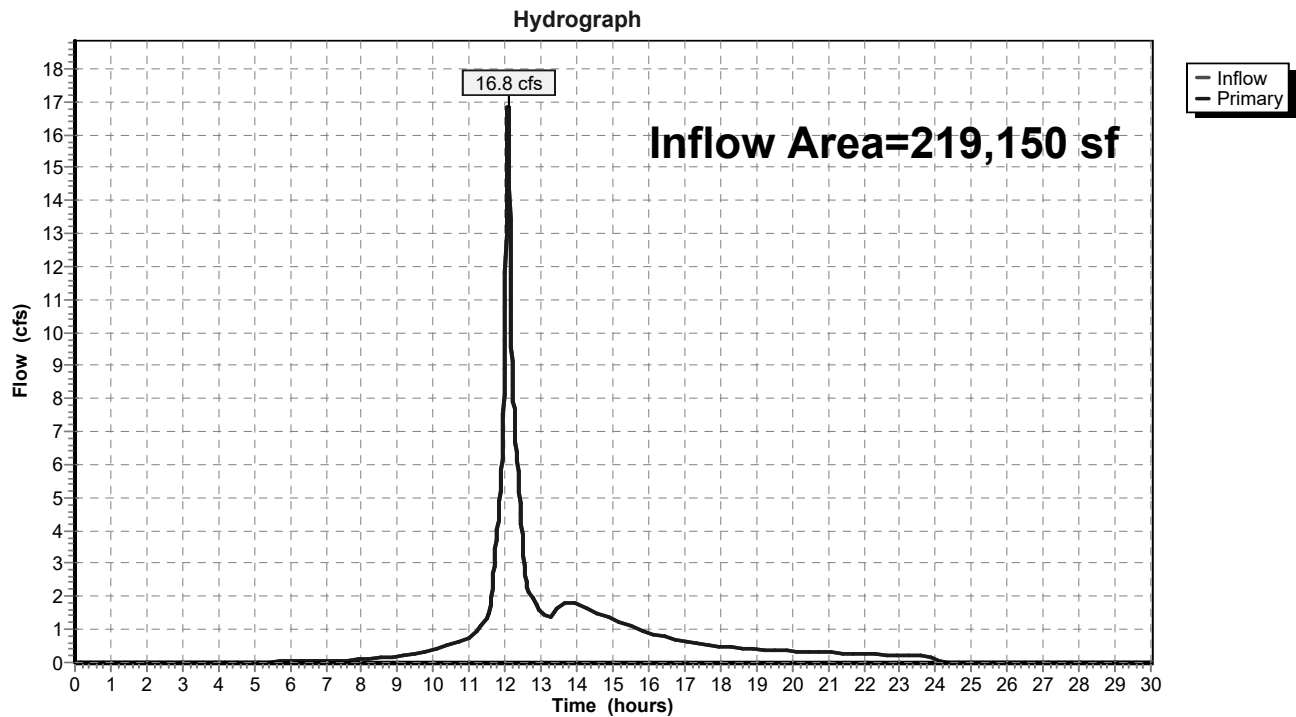
Page 49

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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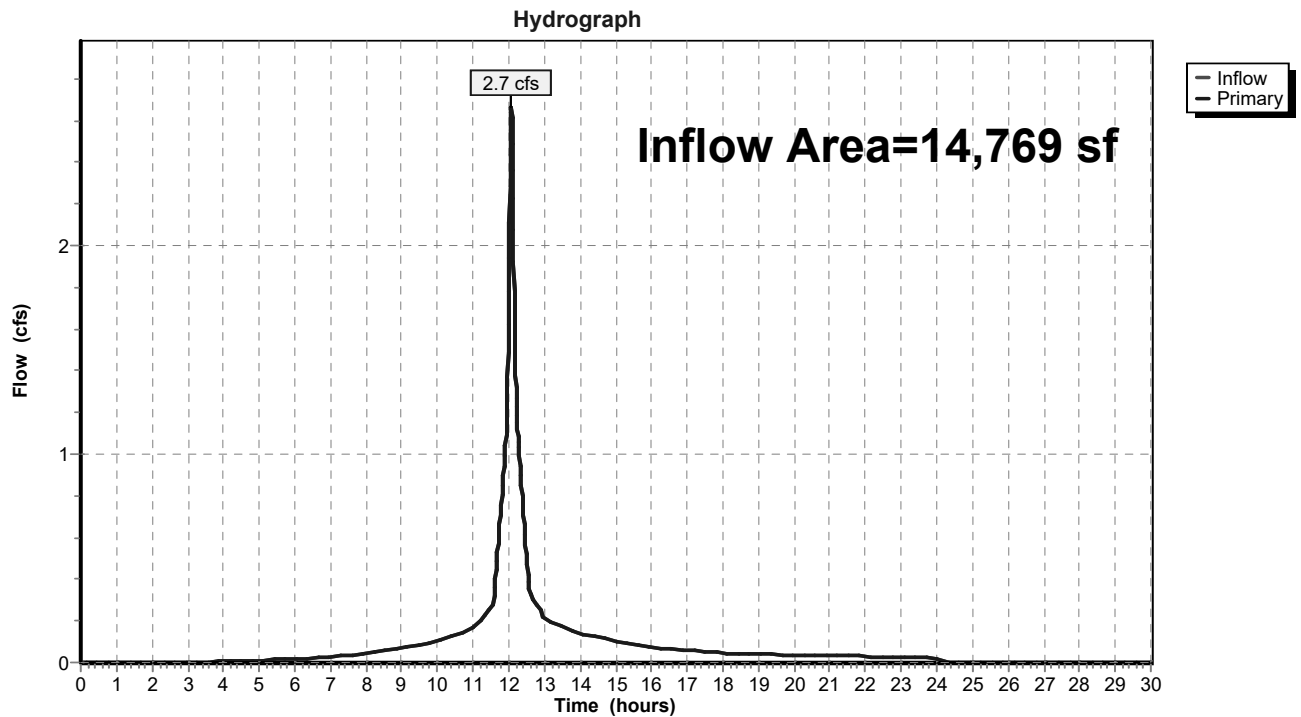
Page 50

Summary for Link DP-2: Highland Ave

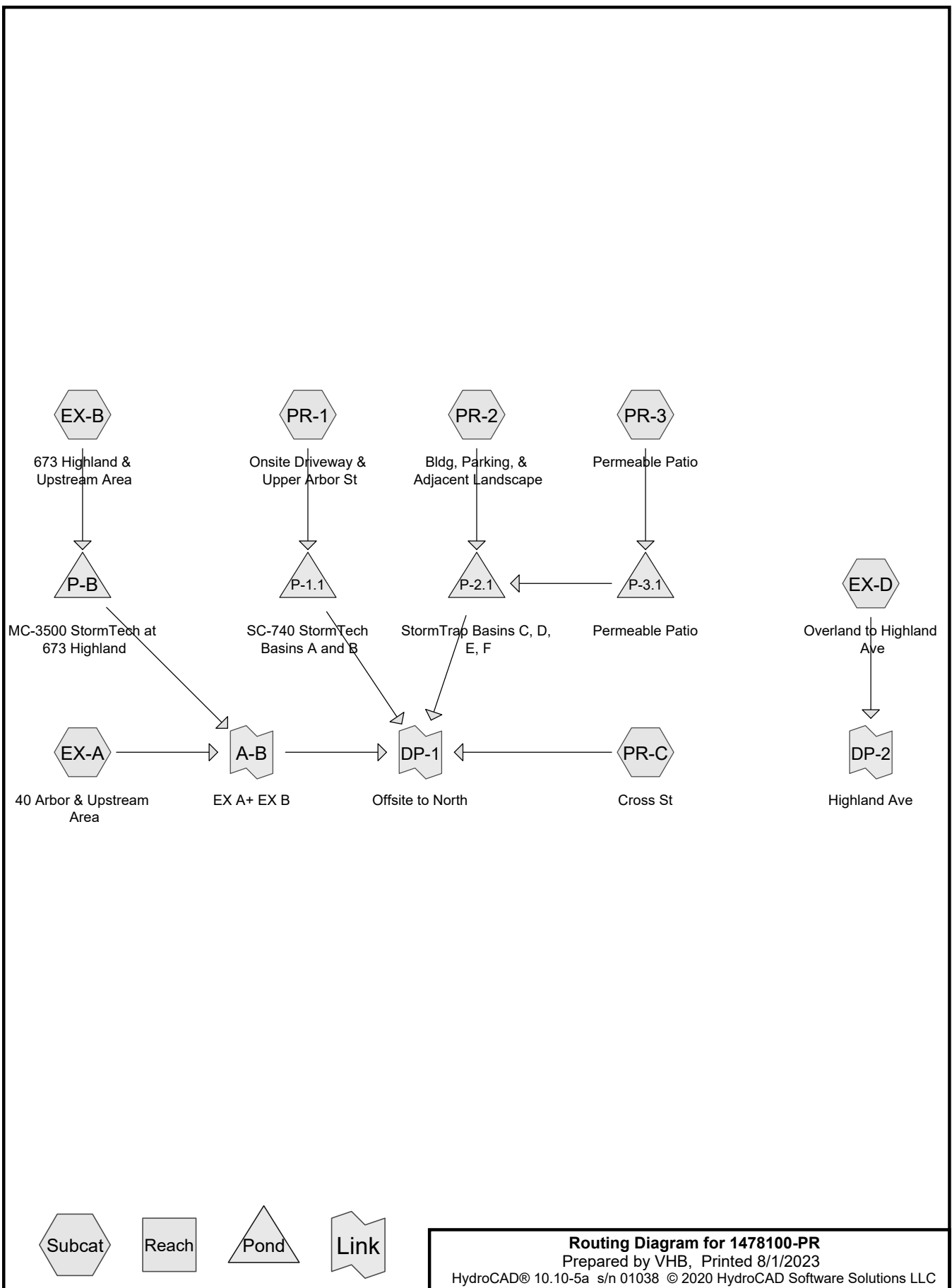
Inflow Area = 14,769 sf, 84.44% Impervious, Inflow Depth = 6.88" for 100-Year event
Inflow = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf
Primary = 2.7 cfs @ 12.07 hrs, Volume= 8,471 cf, Atten= 0%, Lag= 0.0 min

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

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Page 3

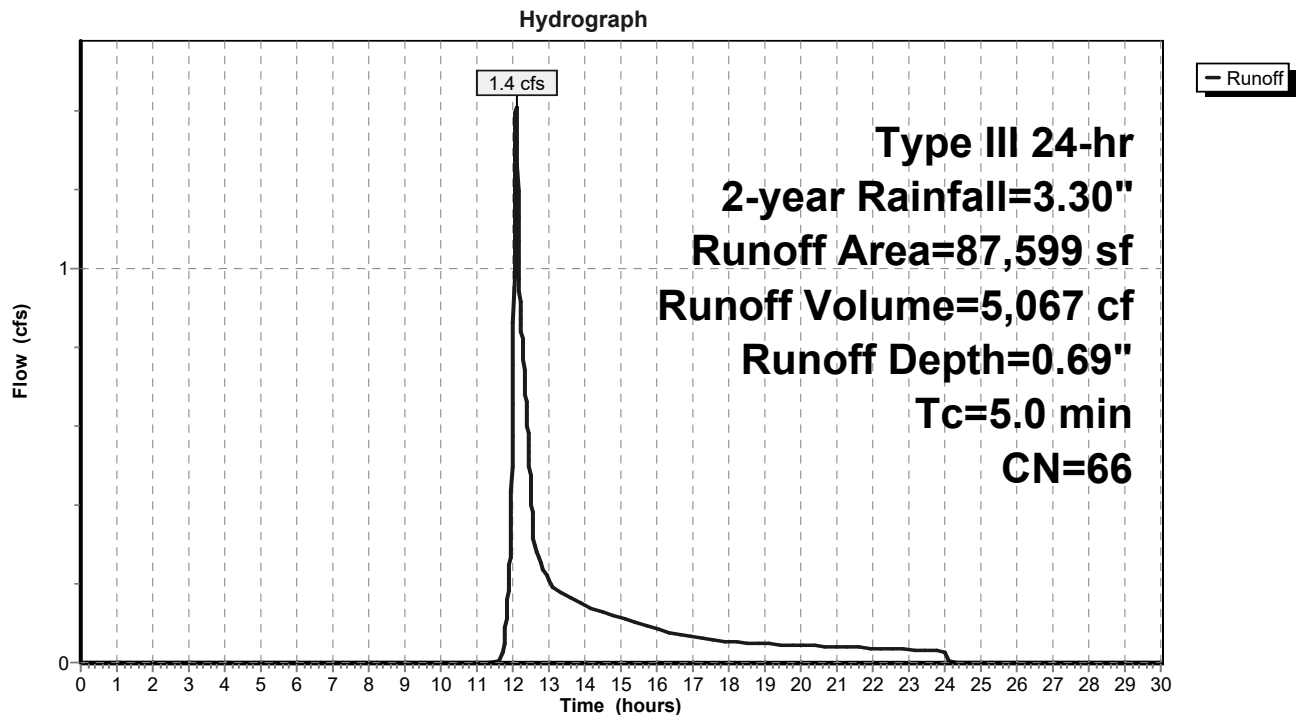
Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

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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Page 4

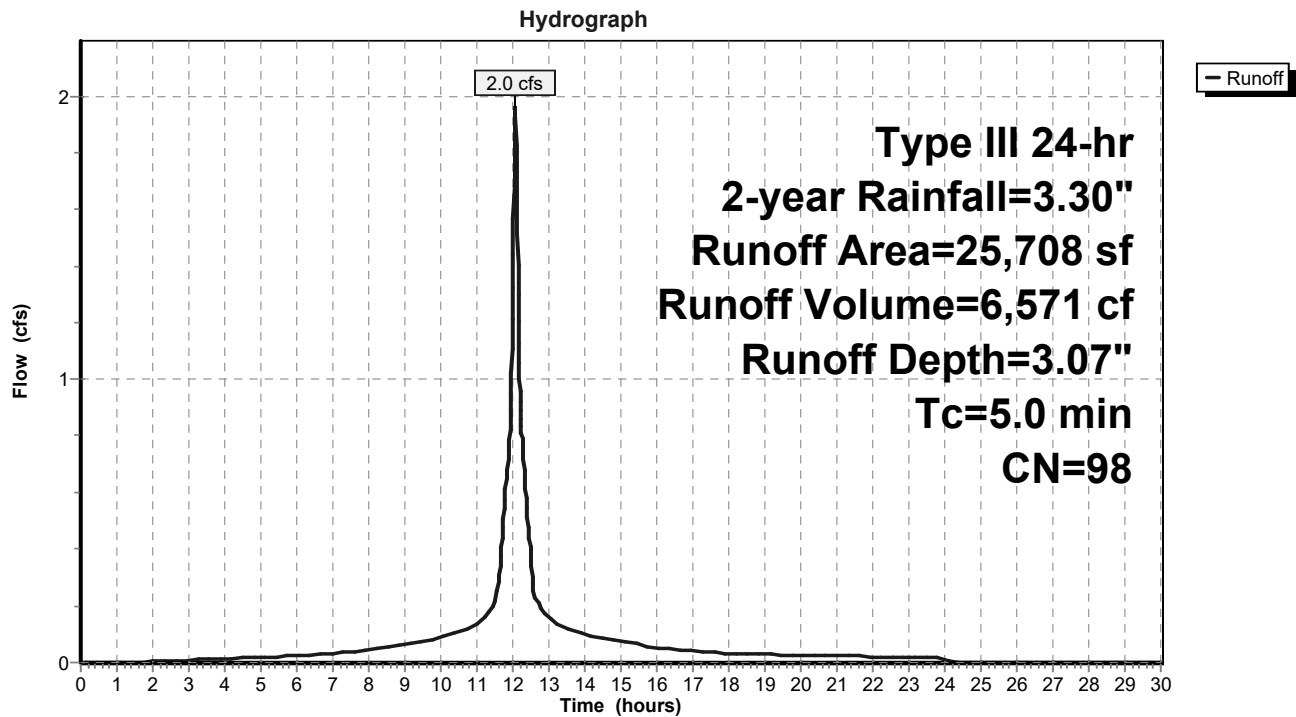
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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

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Page 5

Summary for Subcatchment EX-D: Overland to Highland Ave

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

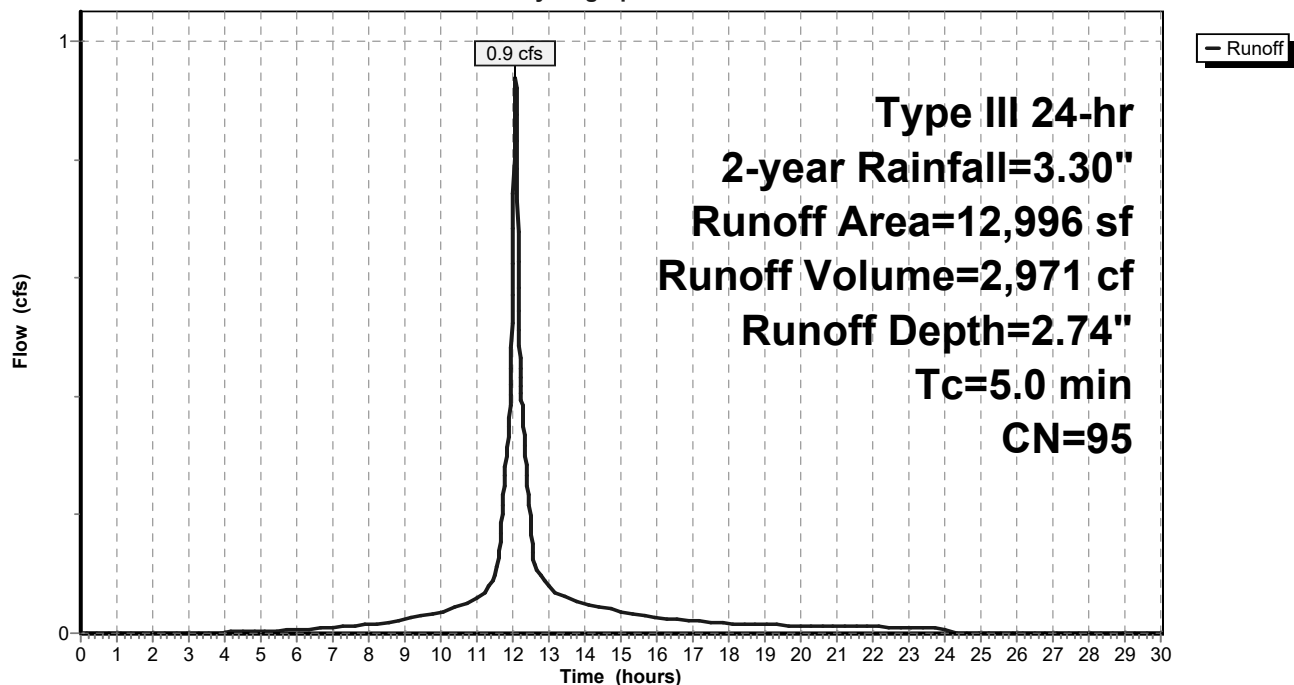
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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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Page 6

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

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

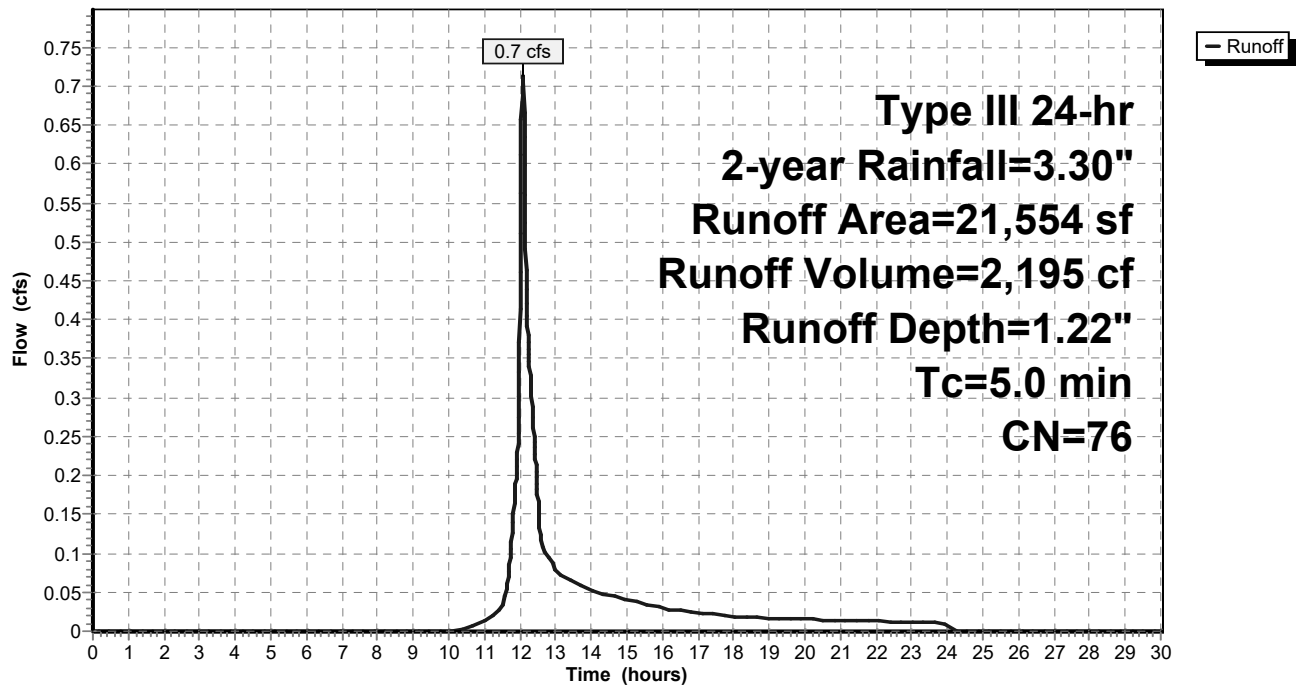
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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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Page 7

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

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

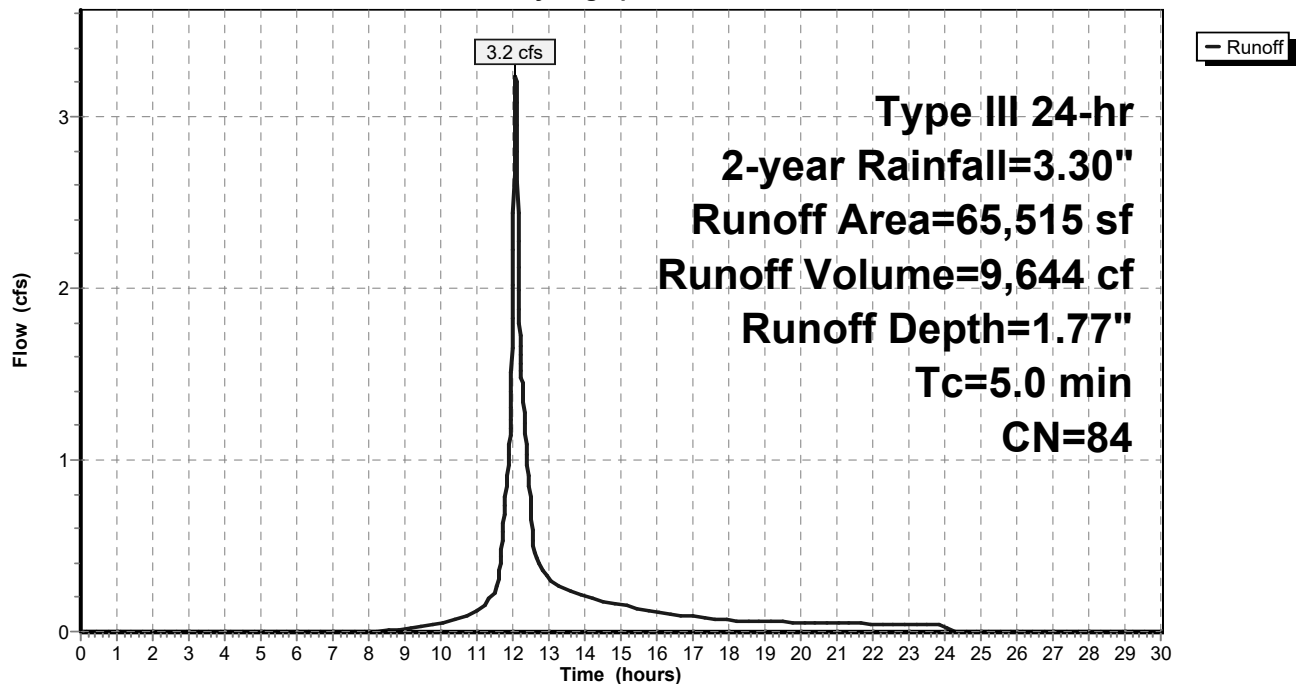
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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

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Page 8

Summary for Subcatchment PR-3: Permeable Patio

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

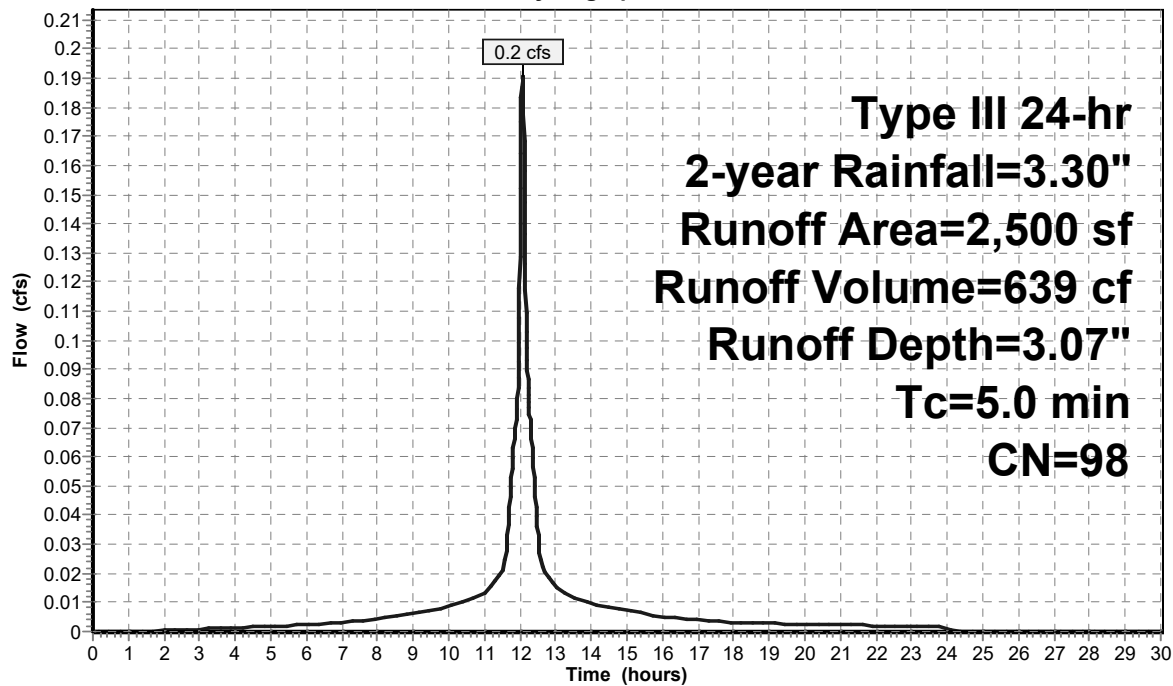
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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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Page 9

Summary for Subcatchment PR-C: Cross St

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

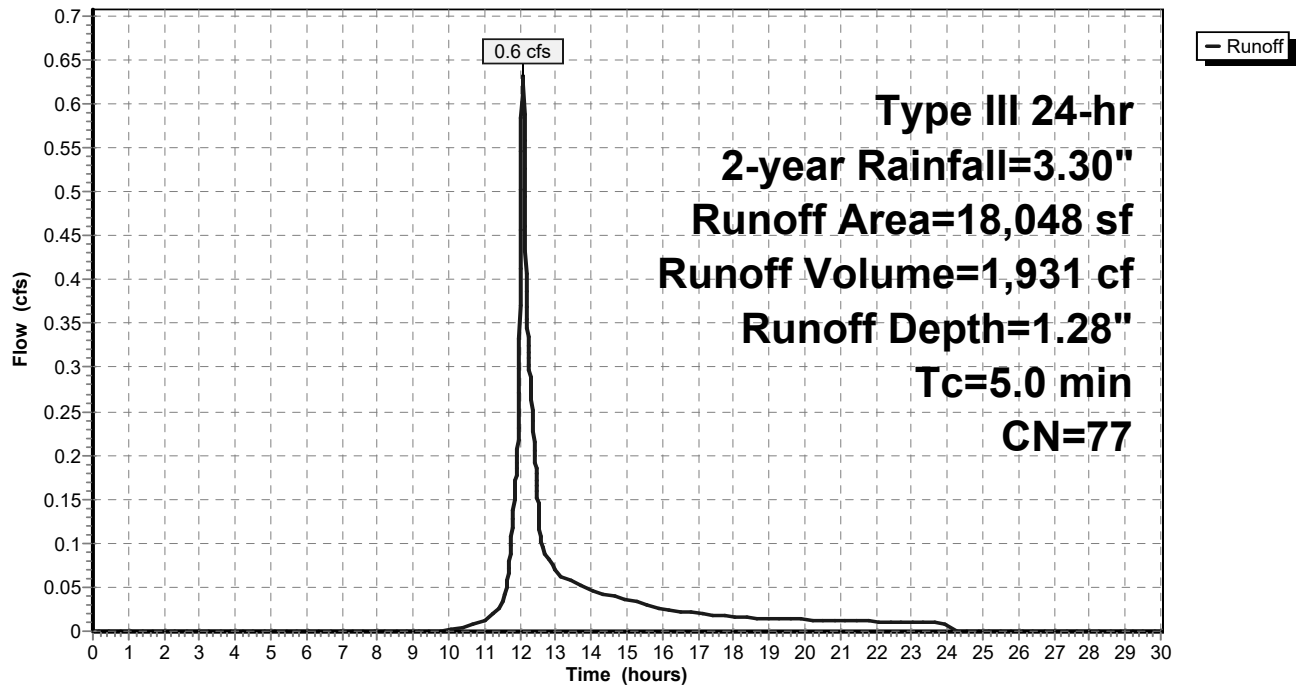
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.30"

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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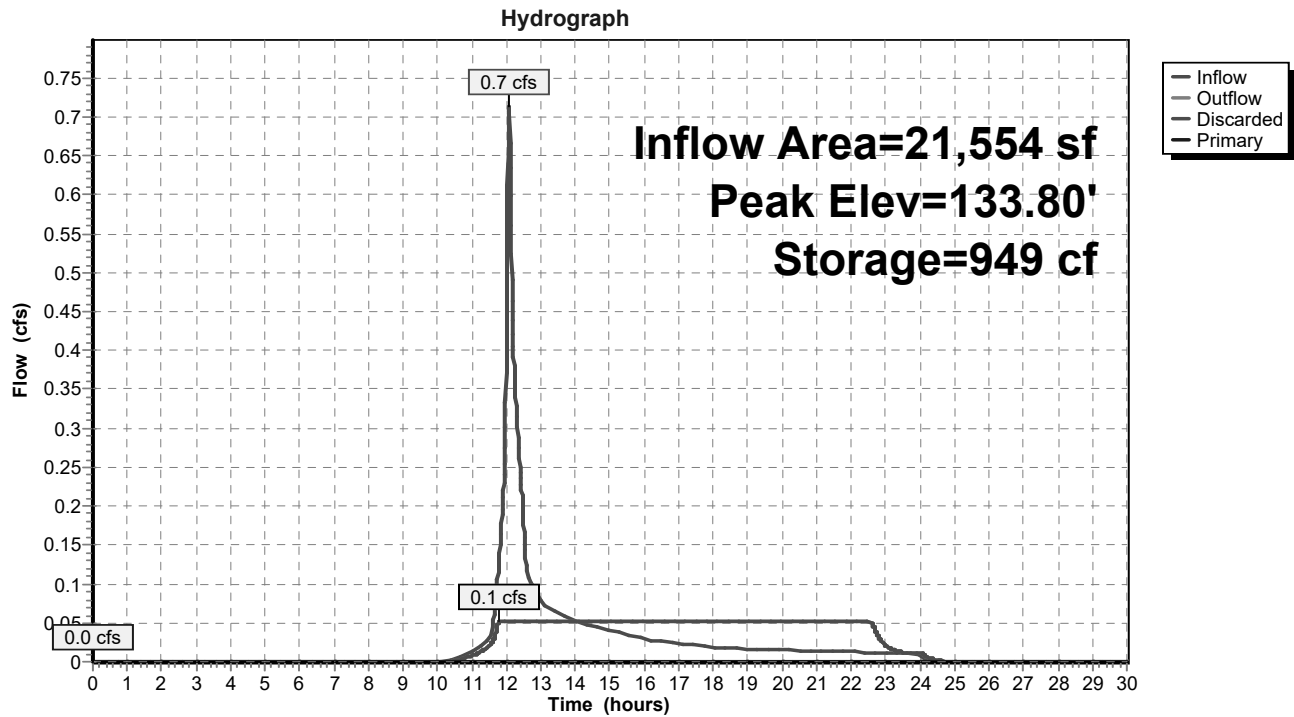
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Page 11

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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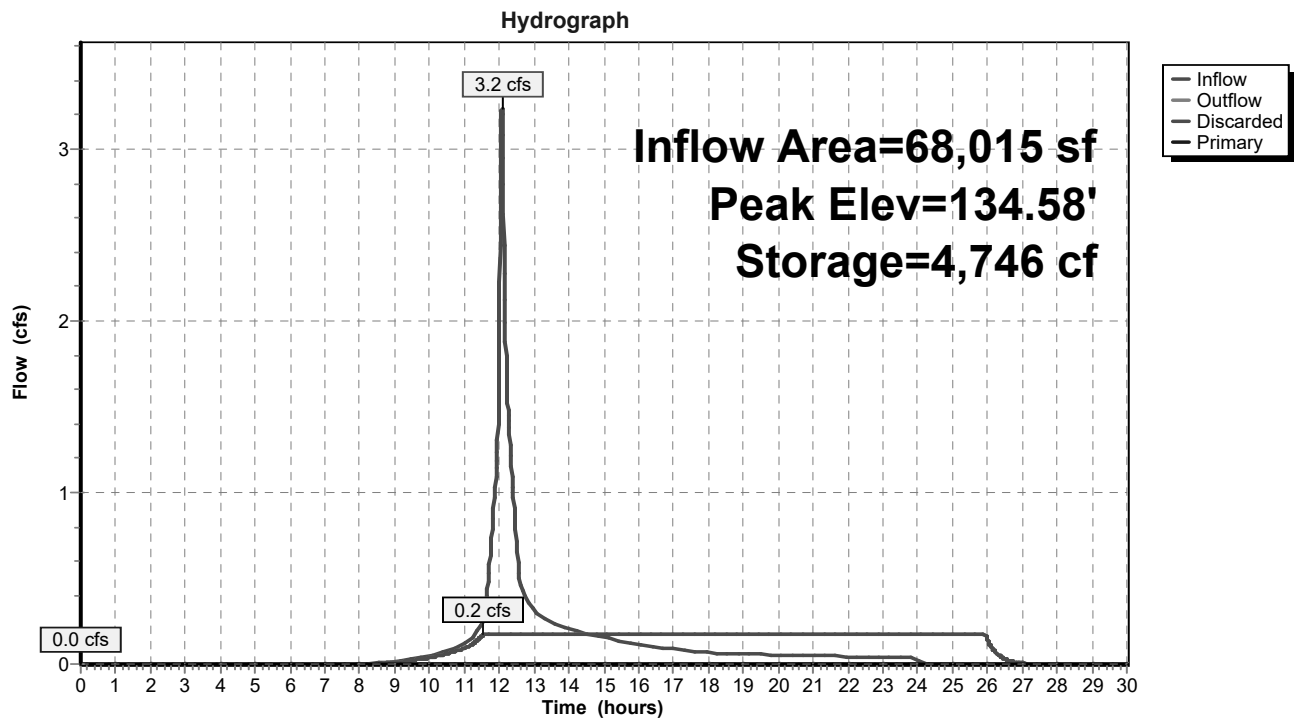
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Page 13

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**

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Page 14

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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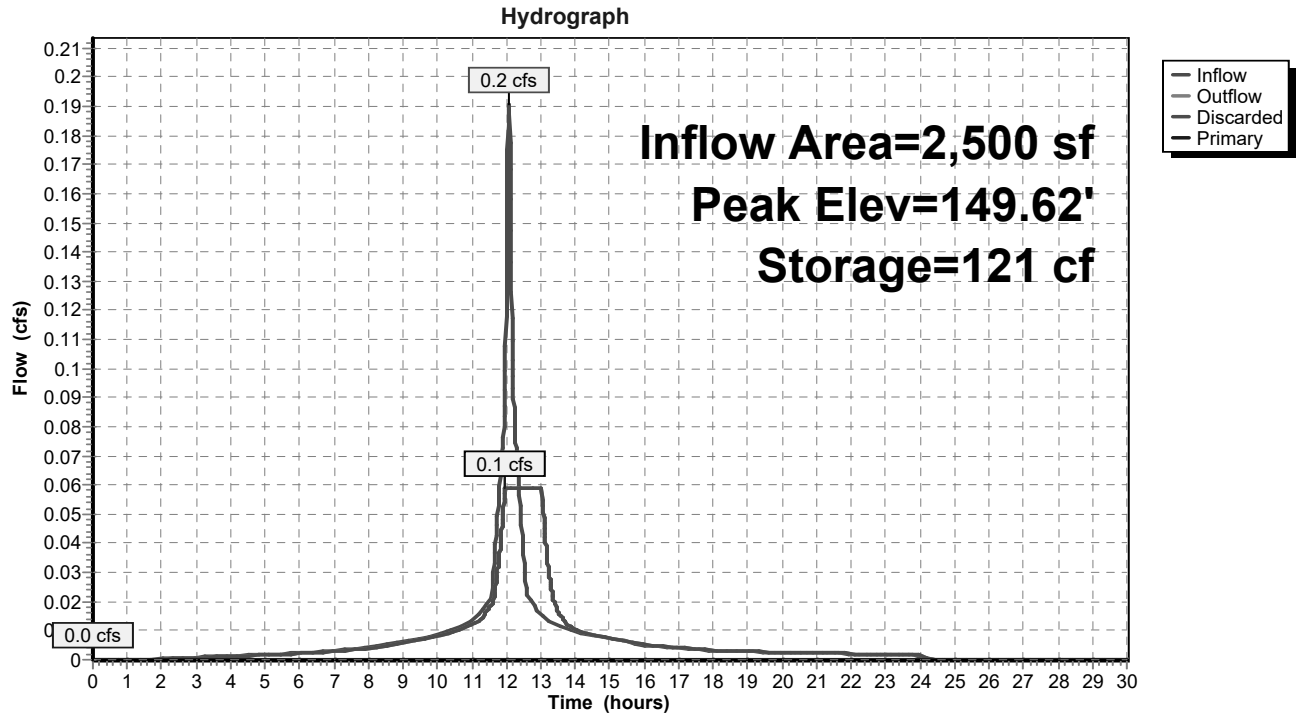
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Page 15

Pond P-3.1: Permeable Patio



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

Inflow Area = 25,708 sf, 100.00% Impervious, Inflow Depth = 3.07" for 2-year event
 Inflow = 2.0 cfs @ 12.07 hrs, Volume= 6,571 cf
 Outflow = 0.3 cfs @ 11.69 hrs, Volume= 6,571 cf, Atten= 83%, Lag= 0.0 min
 Discarded = 0.3 cfs @ 11.69 hrs, Volume= 6,571 cf
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
 Peak Elev= 163.04' @ 12.52 hrs Surf.Area= 1,761 sf Storage= 1,670 cf

Plug-Flow detention time= 27.3 min calculated for 6,571 cf (100% of inflow)
 Center-of-Mass det. time= 27.3 min (782.1 - 754.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	161.50'	2,456 cf	22.75'W x 77.40'L x 5.50'H Stone Bed for StormTech-673 9,685 cf Overall - 3,388 cf Embedded = 6,297 cf x 39.0% Voids
#2A	162.25'	3,388 cf	ADS_StormTech MC-3500 d +Cap x 30 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 30 Chambers in 3 Rows Cap Storage= +14.9 cf x 2 x 3 rows = 89.4 cf
#3	167.00'	3 cf	2.00'D x 1.00'H Structure with Grate Inlet Impervious
#4	167.67'	3,741 cf	Parking Lot Surface Storage (Prismatic) listed below (Recalc) -Impervious
		9,588 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.67	0	0	0
167.70	16	0	0
168.00	155	26	26
169.00	1,500	828	853
170.00	4,275	2,888	3,741

Device	Routing	Invert	Outlet Devices
#1	Discarded	161.50'	8.270 in/hr Exfiltration over Surface area
#2	Primary	168.50'	12.0' long x 5.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.3 cfs @ 11.69 hrs HW=161.59' (Free Discharge)

↑ **1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=161.50' (Free Discharge)

↑ **2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

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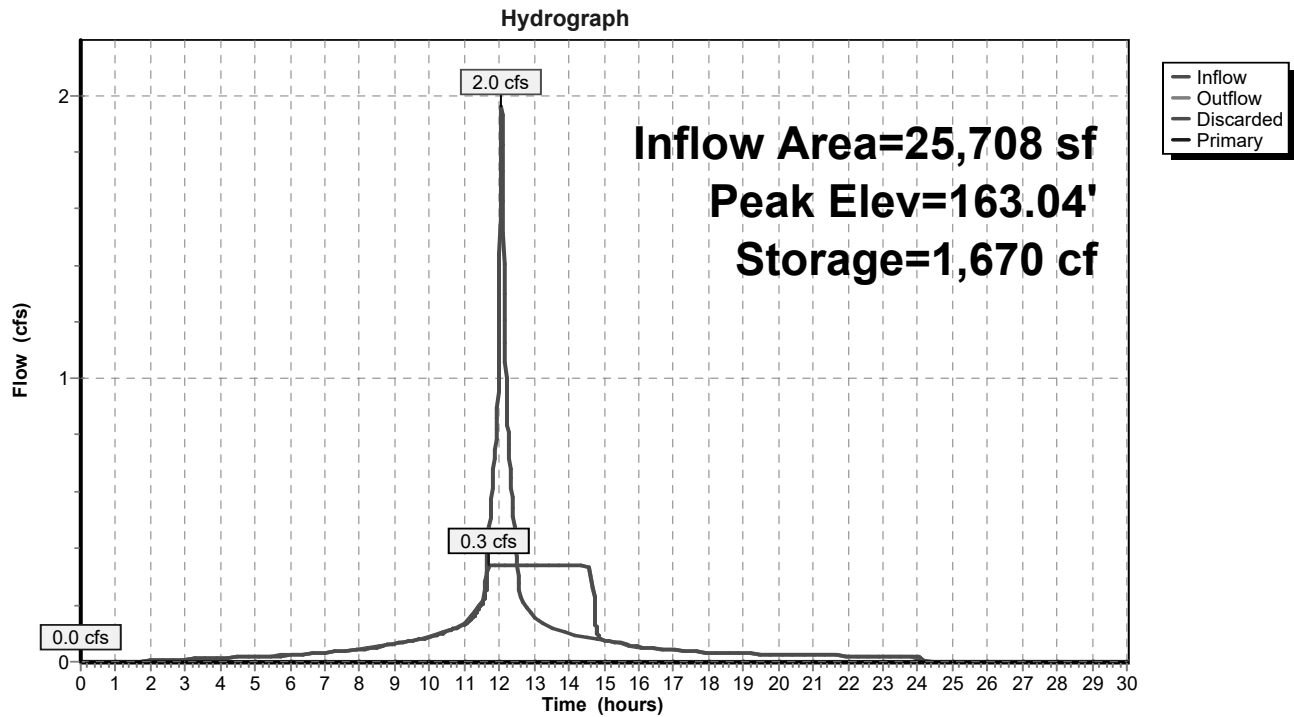
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Page 17

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



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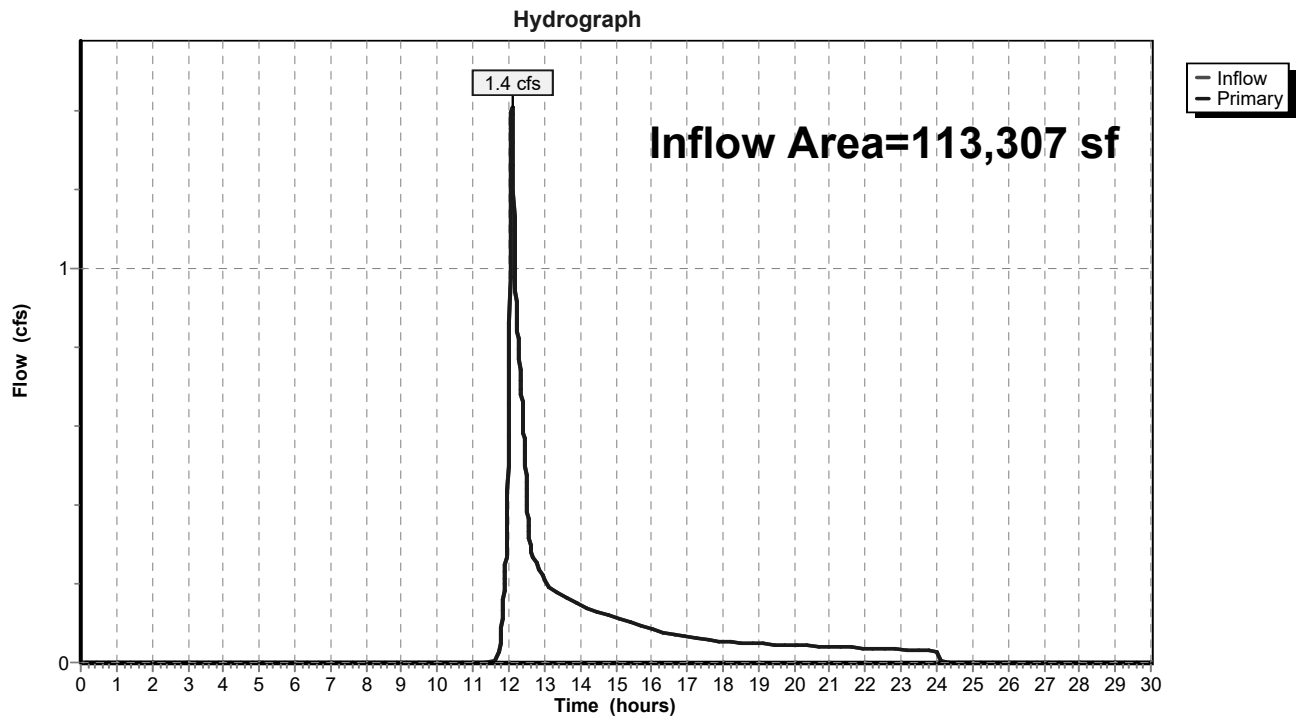
Page 18

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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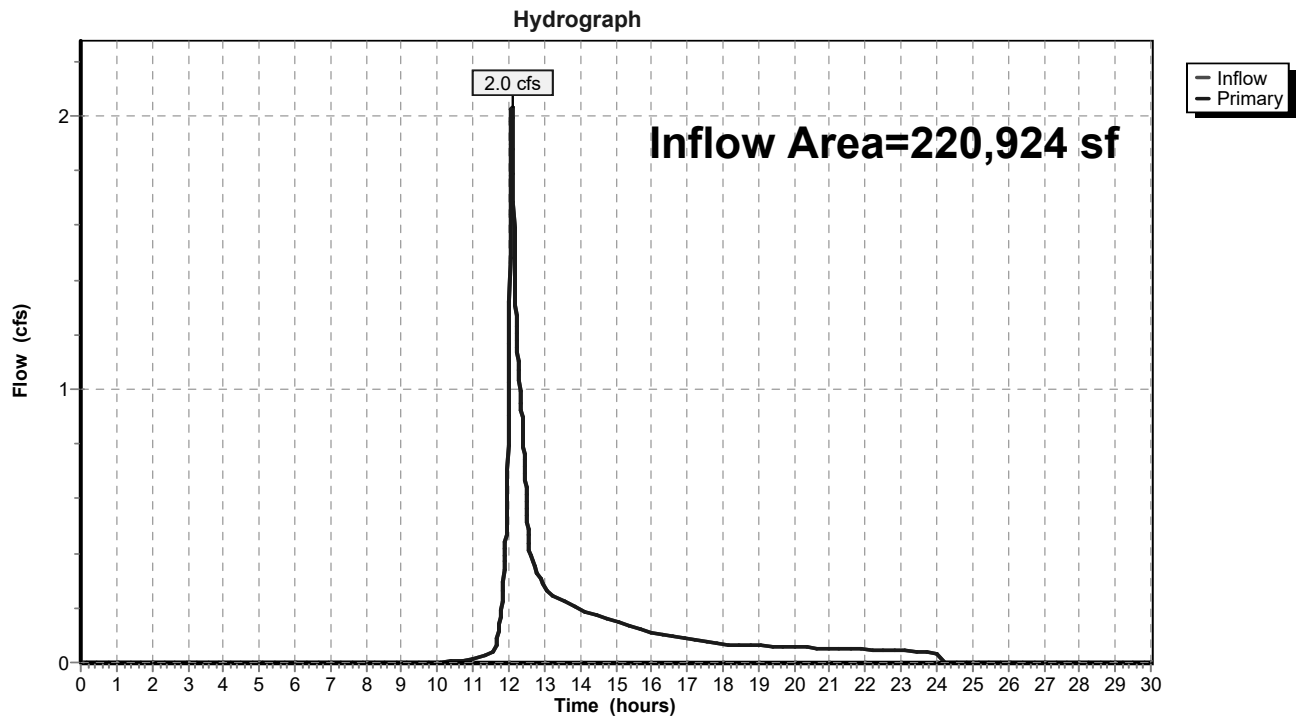
Page 19

Summary for Link DP-1: Offsite to North

Inflow Area = 220,924 sf, 65.05% Impervious, Inflow Depth = 0.38" for 2-year event
Inflow = 2.0 cfs @ 12.09 hrs, Volume= 6,998 cf
Primary = 2.0 cfs @ 12.09 hrs, Volume= 6,998 cf, Atten= 0%, Lag= 0.0 min

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

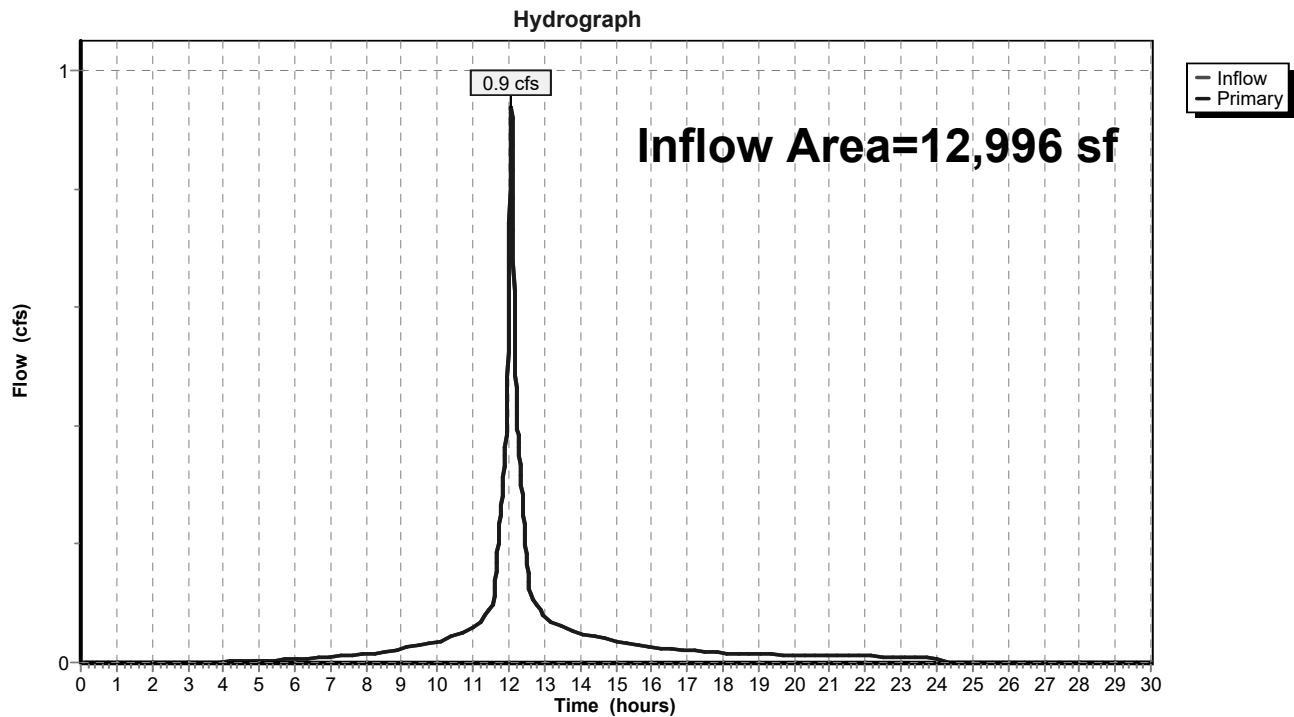
Link DP-1: Offsite to North



Summary for Link DP-2: Highland Ave

Inflow Area = 12,996 sf, 95.14% Impervious, Inflow Depth = 2.74" for 2-year event
Inflow = 0.9 cfs @ 12.07 hrs, Volume= 2,971 cf
Primary = 0.9 cfs @ 12.07 hrs, Volume= 2,971 cf, Atten= 0%, Lag= 0.0 min

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

Link DP-2: Highland Ave

10-Year Storm Event – Proposed

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

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Page 21

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

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

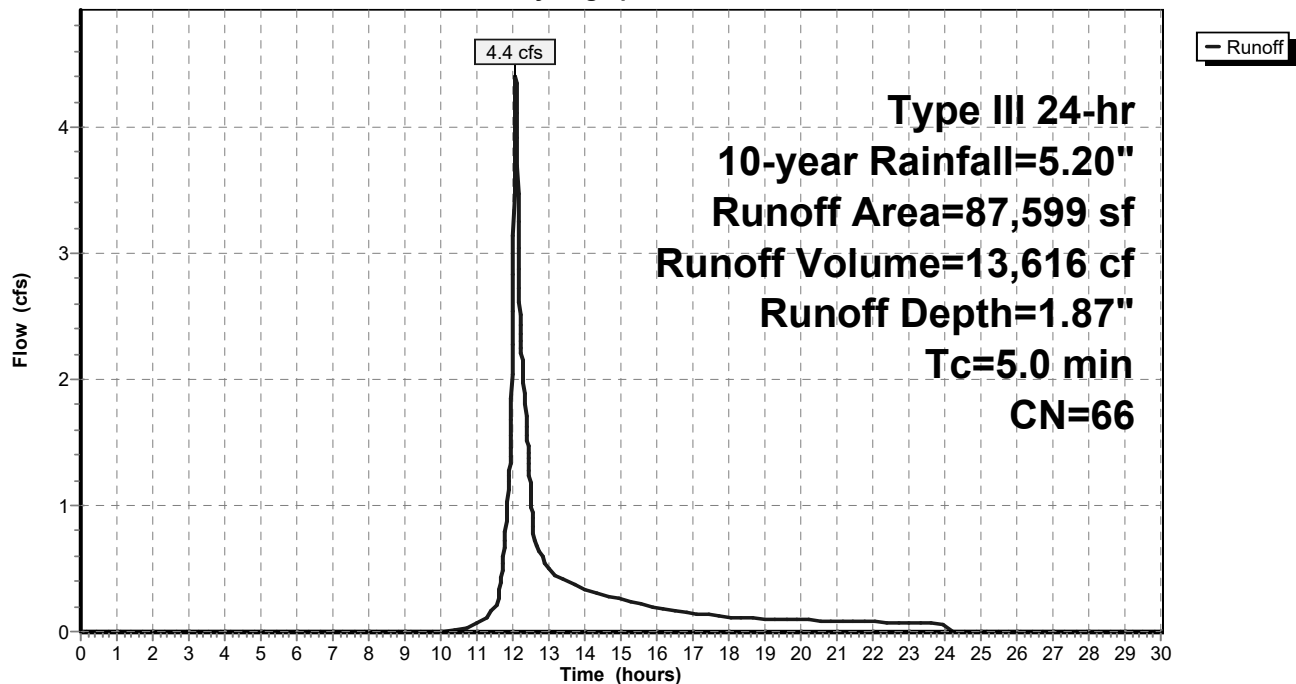
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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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Page 22

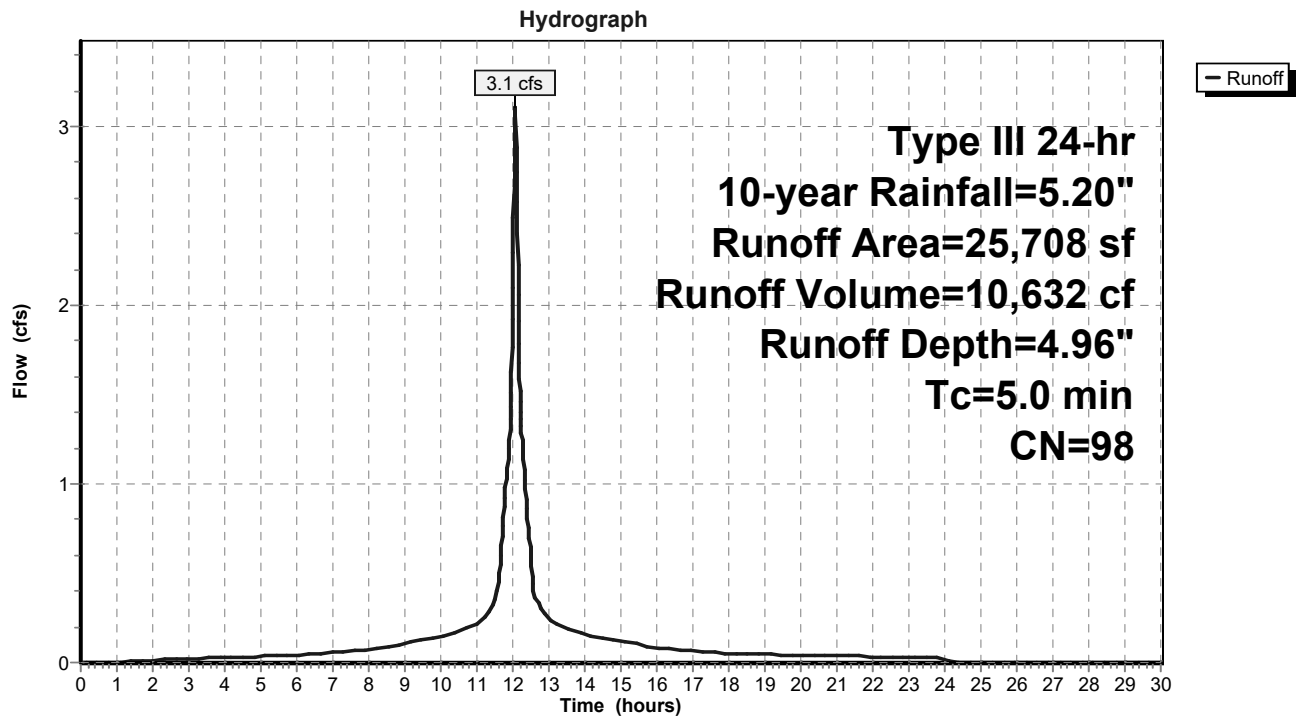
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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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Page 23

Summary for Subcatchment EX-D: Overland to Highland Ave

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

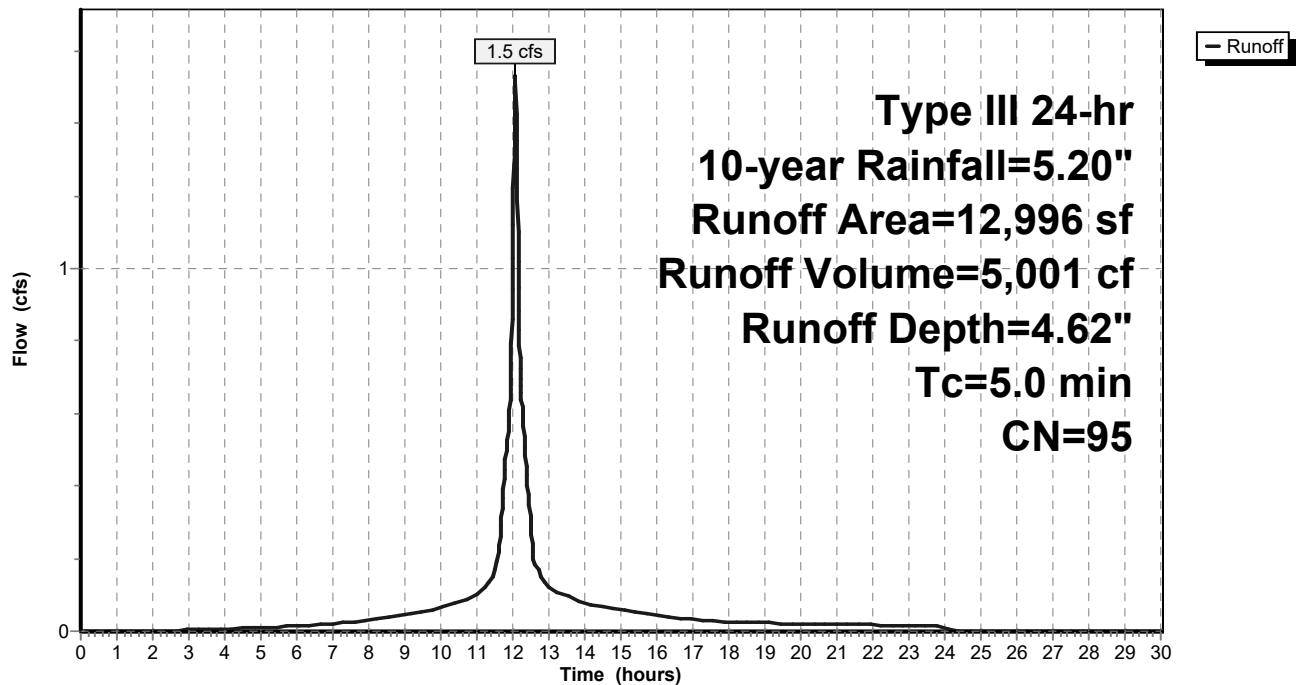
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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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Page 24

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

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

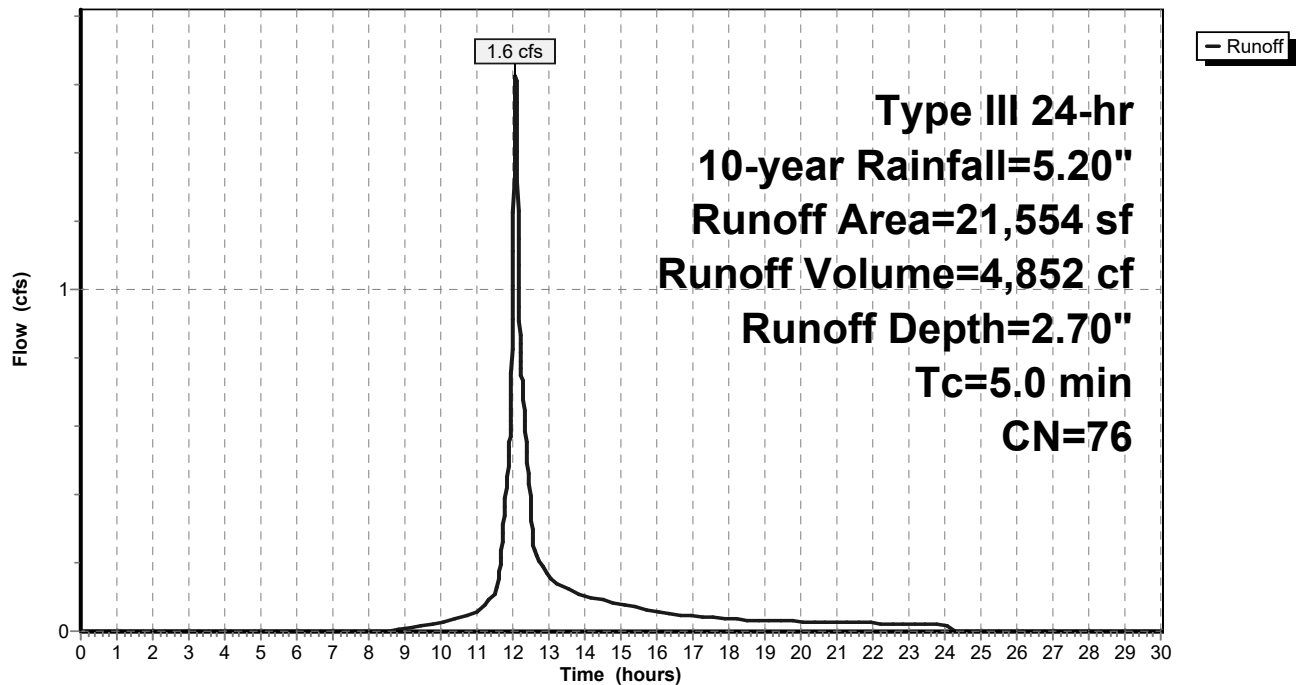
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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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Page 25

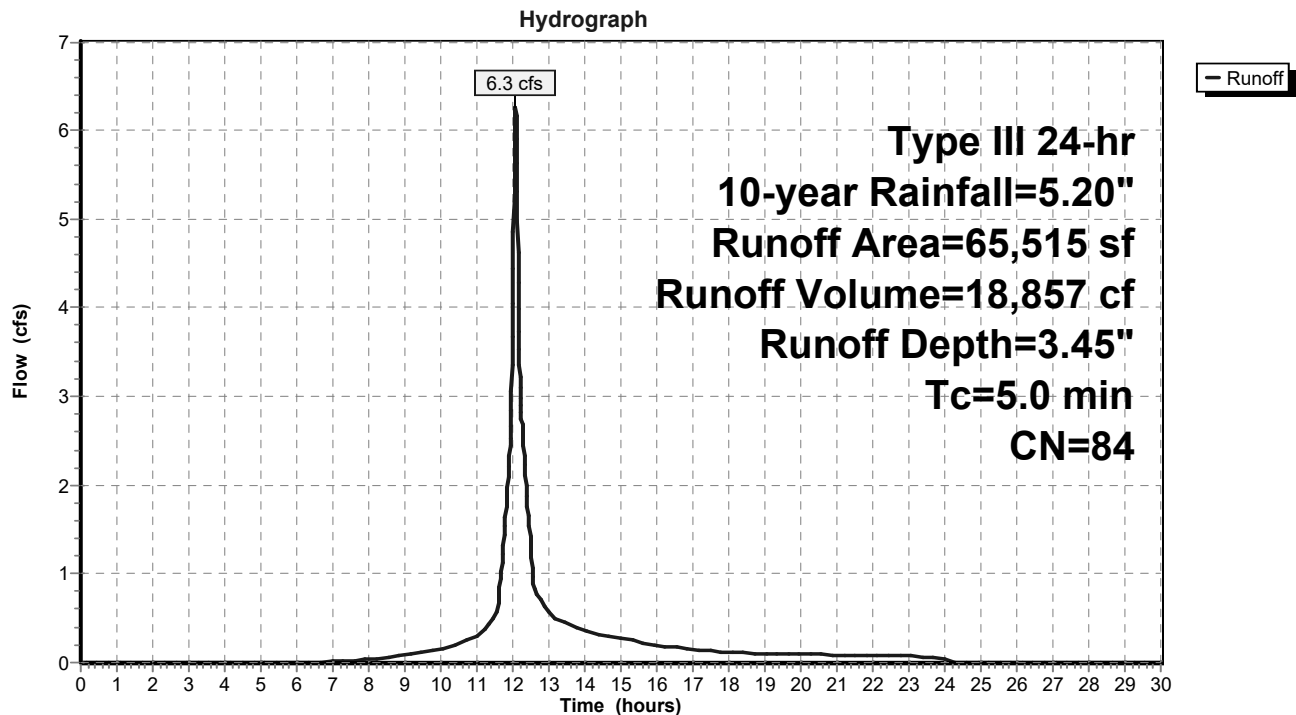
Summary for Subcatchment PR-2: Bldg, Parking, & Adjacent Landscape

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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Page 26

Summary for Subcatchment PR-3: Permeable Patio

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

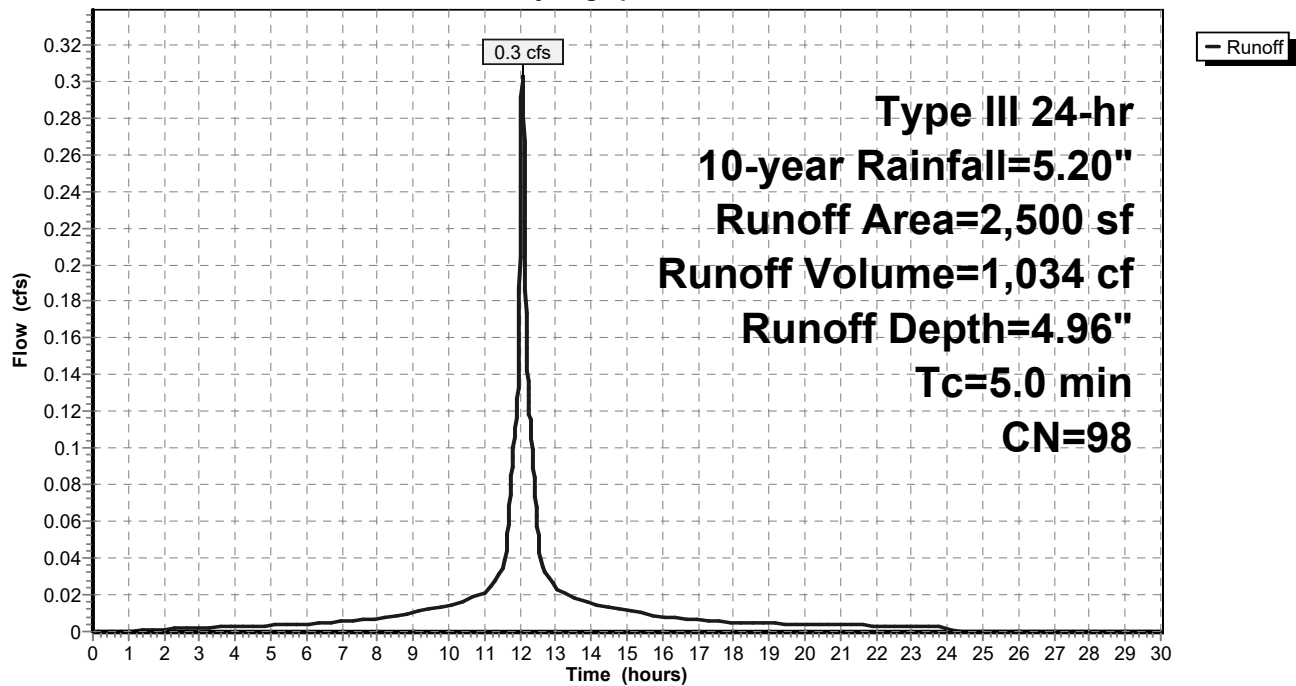
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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

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Page 27

Summary for Subcatchment PR-C: Cross St

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

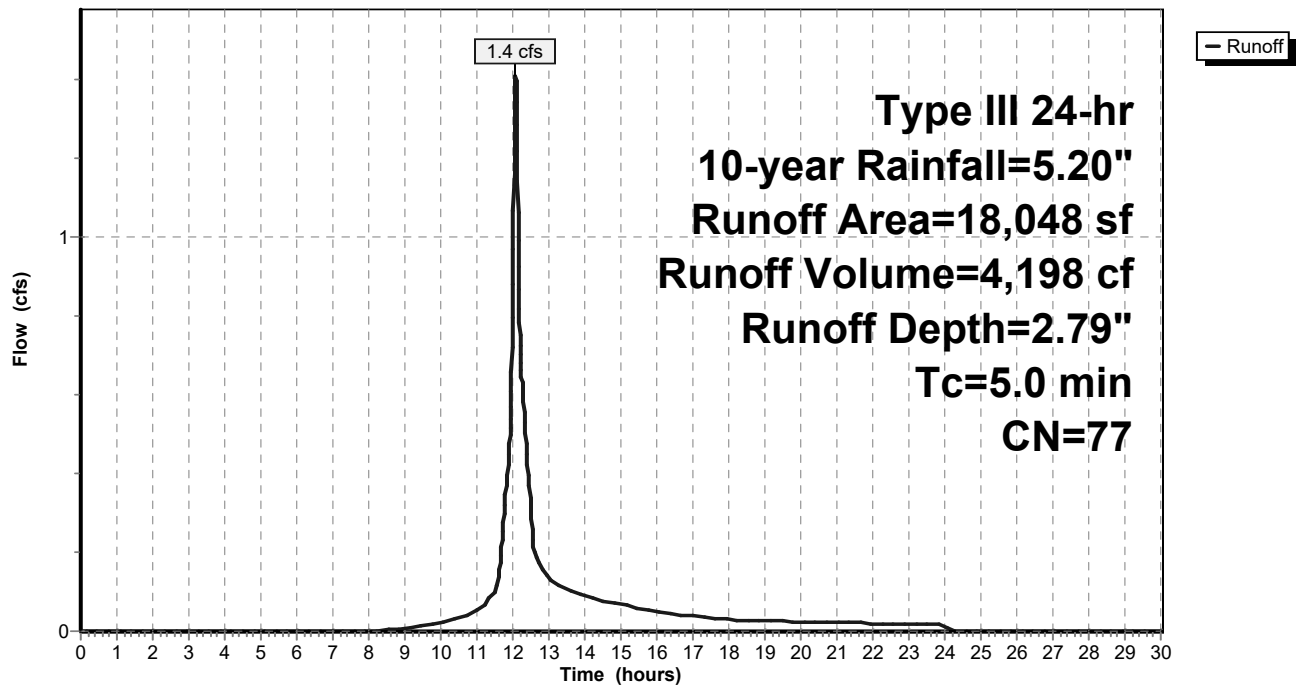
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.20"

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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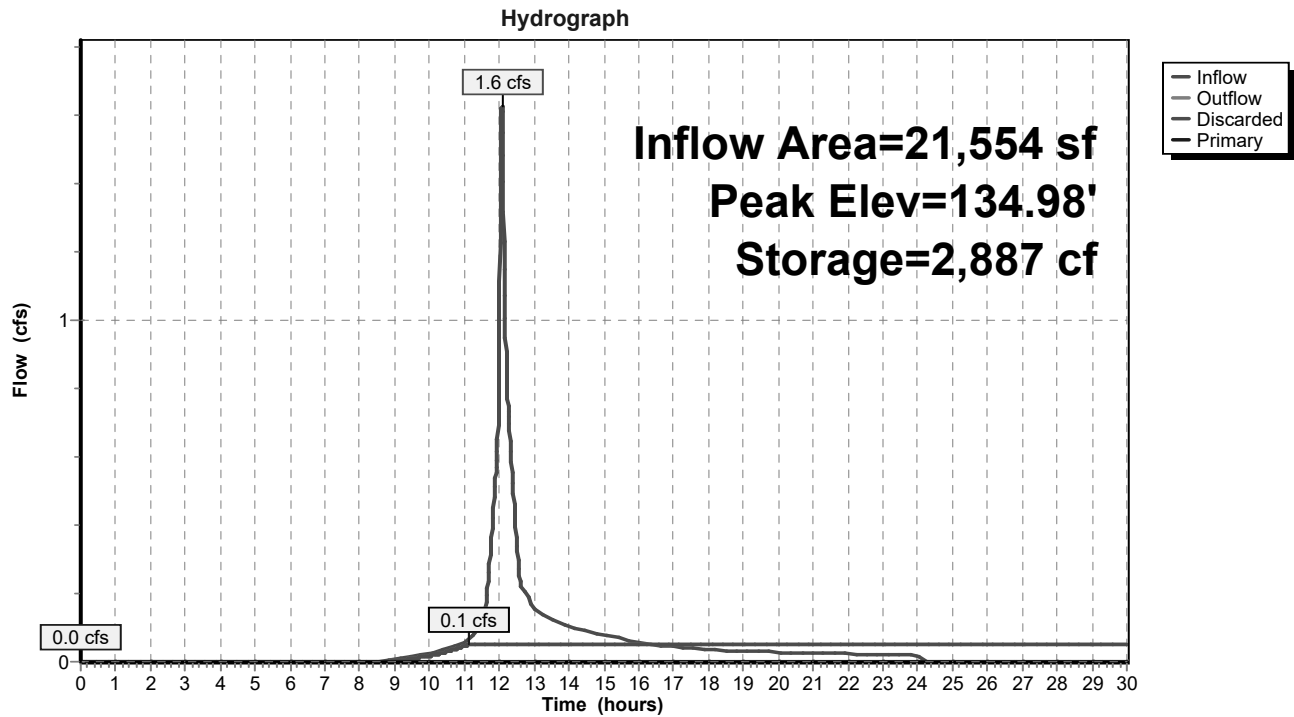
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Page 29

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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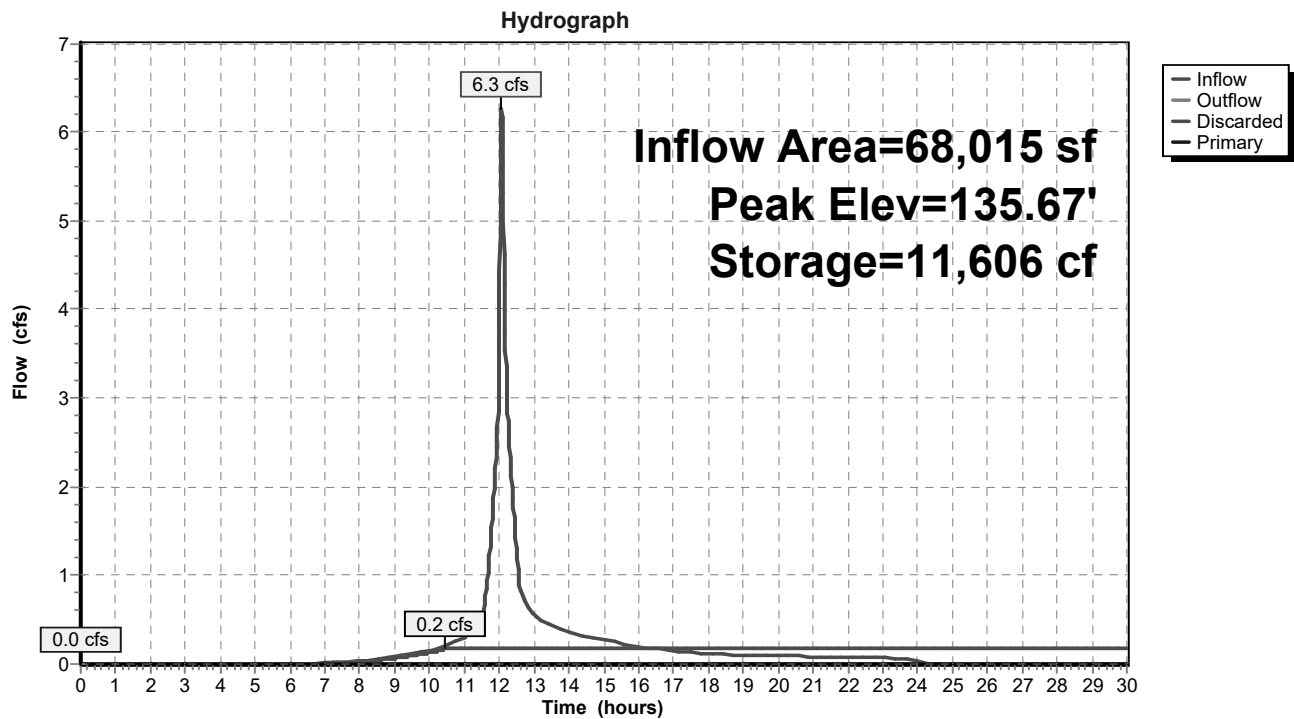
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Page 31

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

Discarded OutFlow Max=0.2 cfs @ 10.42 hrs HW=133.07' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.2 cfs)**Primary OutFlow** Max=0.0 cfs @ 0.00 hrs HW=133.00' (Free Discharge)↑**2=Special & User-Defined** (Controls 0.0 cfs)**Pond P-2.1: StormTrap Basins C, D, E, F**

Summary for Pond P-3.1: Permeable Patio

Inflow Area = 2,500 sf, 100.00% Impervious, Inflow Depth = 4.96" for 10-year event
 Inflow = 0.3 cfs @ 12.07 hrs, Volume= 1,034 cf
 Outflow = 0.1 cfs @ 11.81 hrs, Volume= 1,034 cf, Atten= 80%, Lag= 0.0 min
 Discarded = 0.1 cfs @ 11.81 hrs, Volume= 1,034 cf
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
 Peak Elev= 149.77' @ 12.49 hrs Surf.Area= 2,500 sf Storage= 259 cf

Plug-Flow detention time= 28.2 min calculated for 1,034 cf (100% of inflow)
 Center-of-Mass det. time= 28.2 min (774.6 - 746.4)

Volume	Invert	Avail.Storage	Storage Description
#1	149.50'	1,463 cf	Porous Pavement Stone (Prismatic) Listed below (Recalc) 3,750 cf Overall x 39.0% Voids
#2	151.00'	1 cf	Patio Drain (Prismatic) Listed below (Recalc) -Impervious
#3	152.00'	2,500 cf	Patio Surface Storage (Prismatic) Listed below (Recalc) -Impervious
		3,964 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
149.50	2,500	0	0
150.50	2,500	2,500	2,500
151.00	2,500	1,250	3,750

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
151.00	1	0	0
152.00	1	1	1

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	2,500	0	0
153.00	2,500	2,500	2,500

Device	Routing	Invert	Outlet Devices
#1	Discarded	149.50'	1.020 in/hr Exfiltration over Surface area
#2	Primary	152.50'	Special & User-Defined Head (feet) 0.00 0.50 1.00 Disch. (cfs) 0.000 10.000 20.000

Discarded OutFlow Max=0.1 cfs @ 11.81 hrs HW=149.54' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=149.50' (Free Discharge)
 ↑2=Special & User-Defined (Controls 0.0 cfs)

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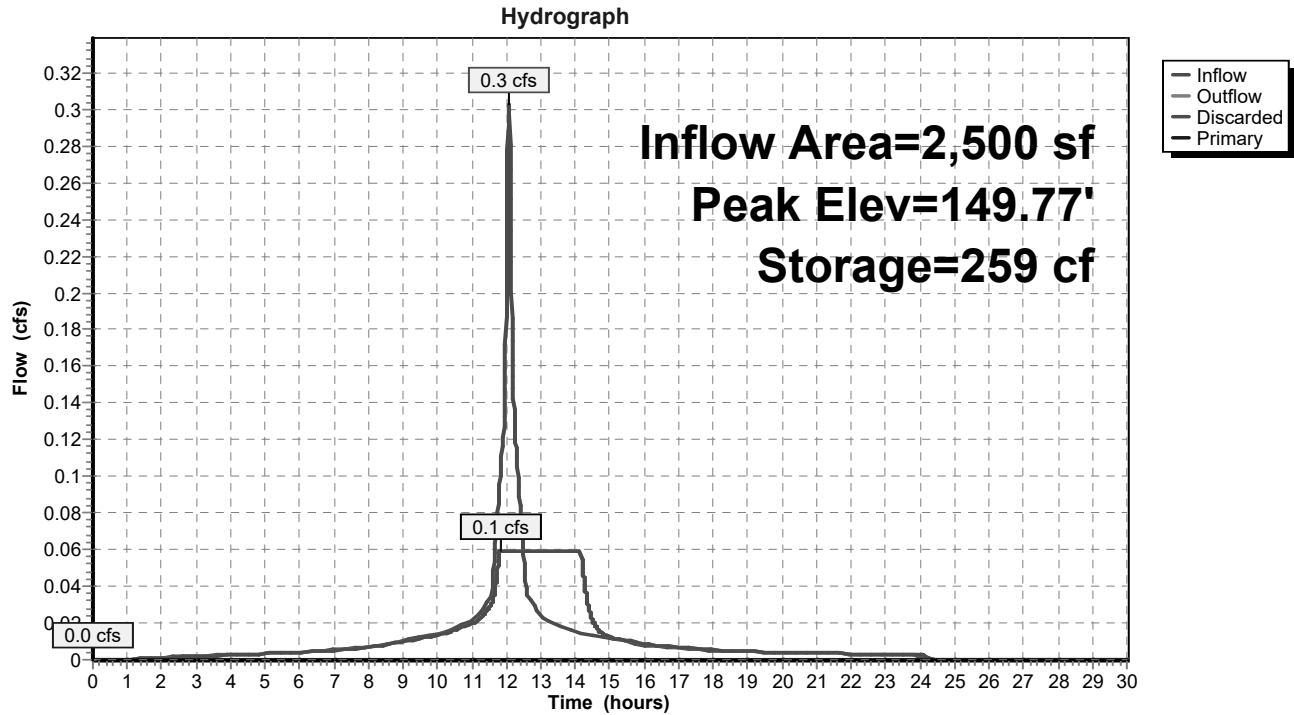
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Page 33

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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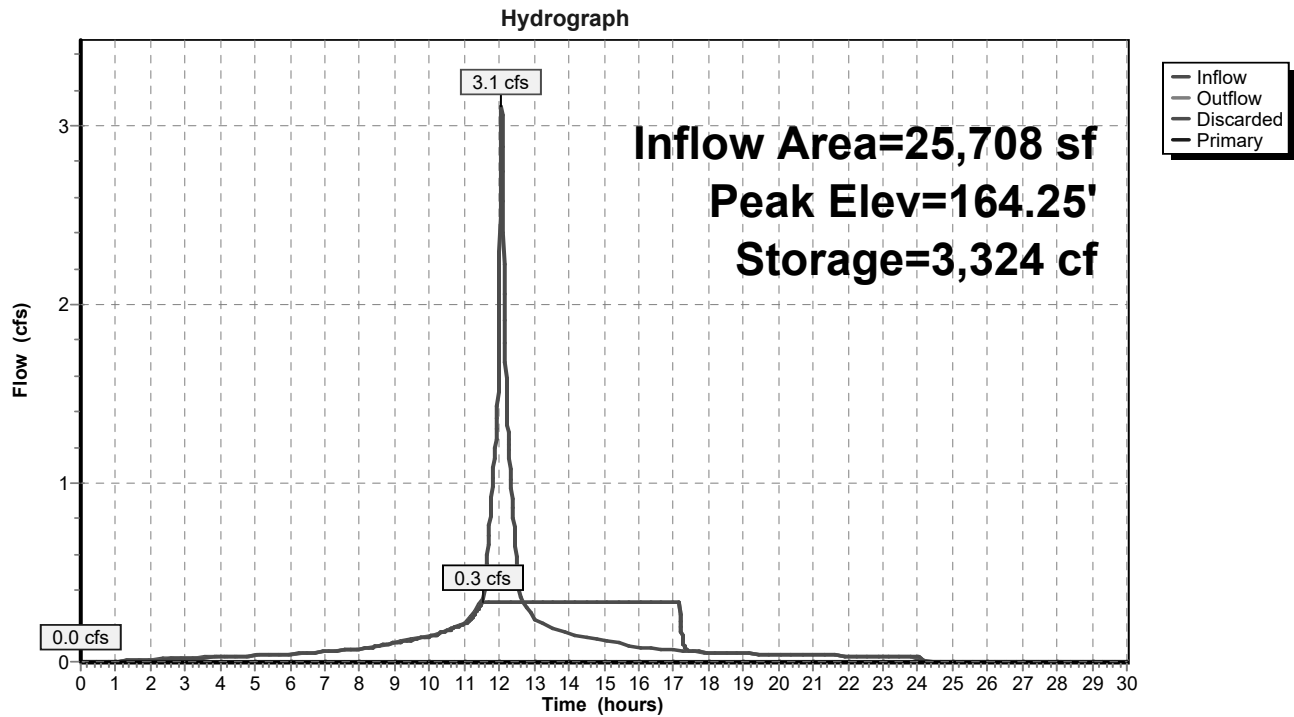
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Page 35

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



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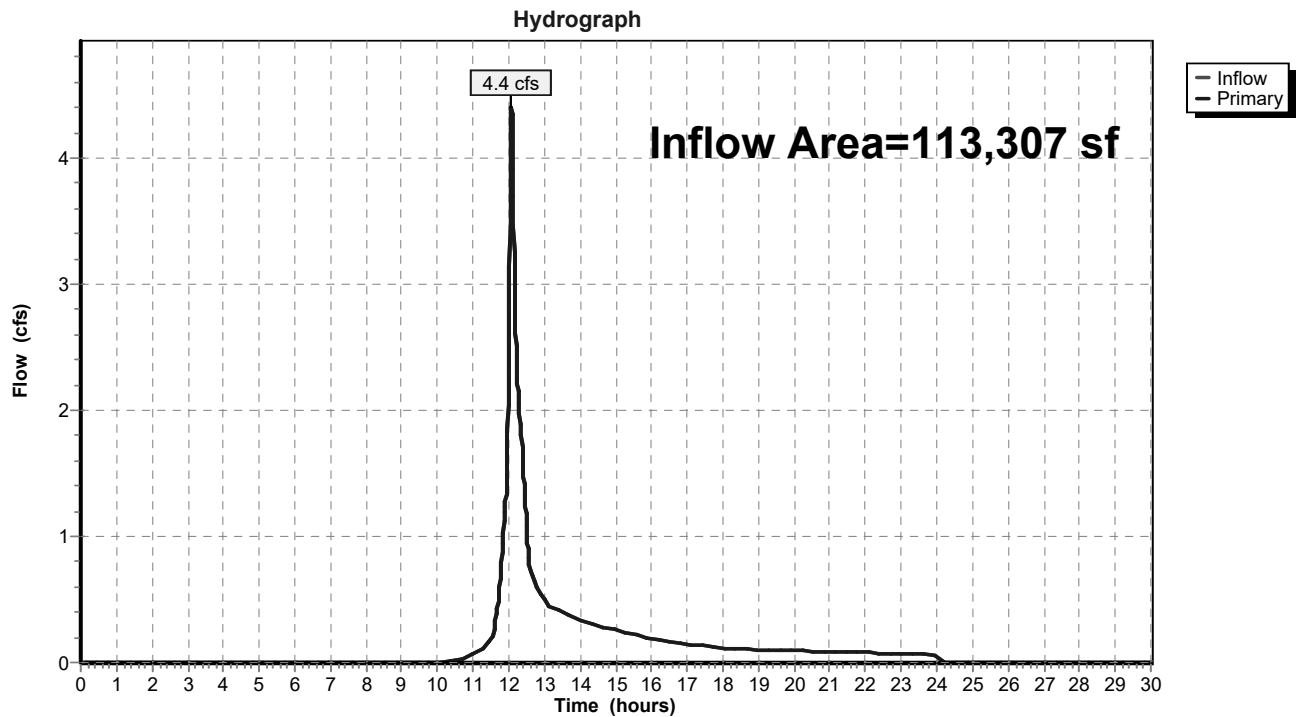
Page 36

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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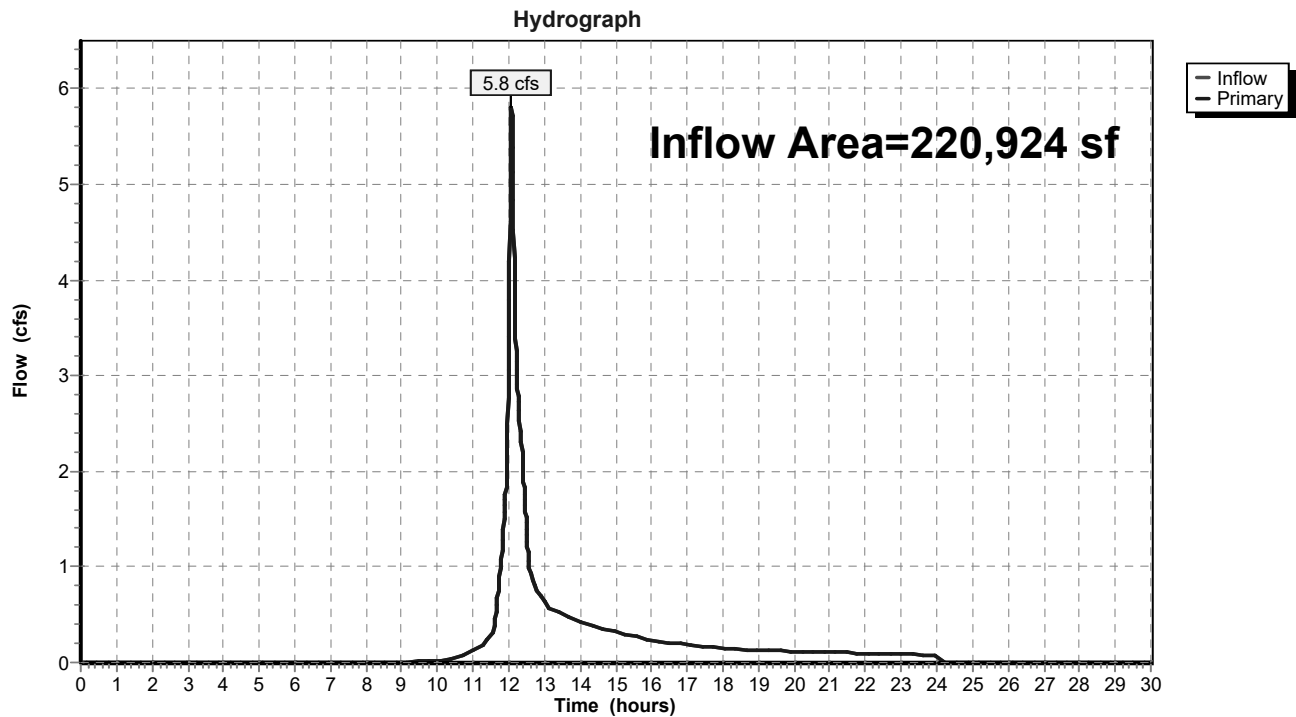
Page 37

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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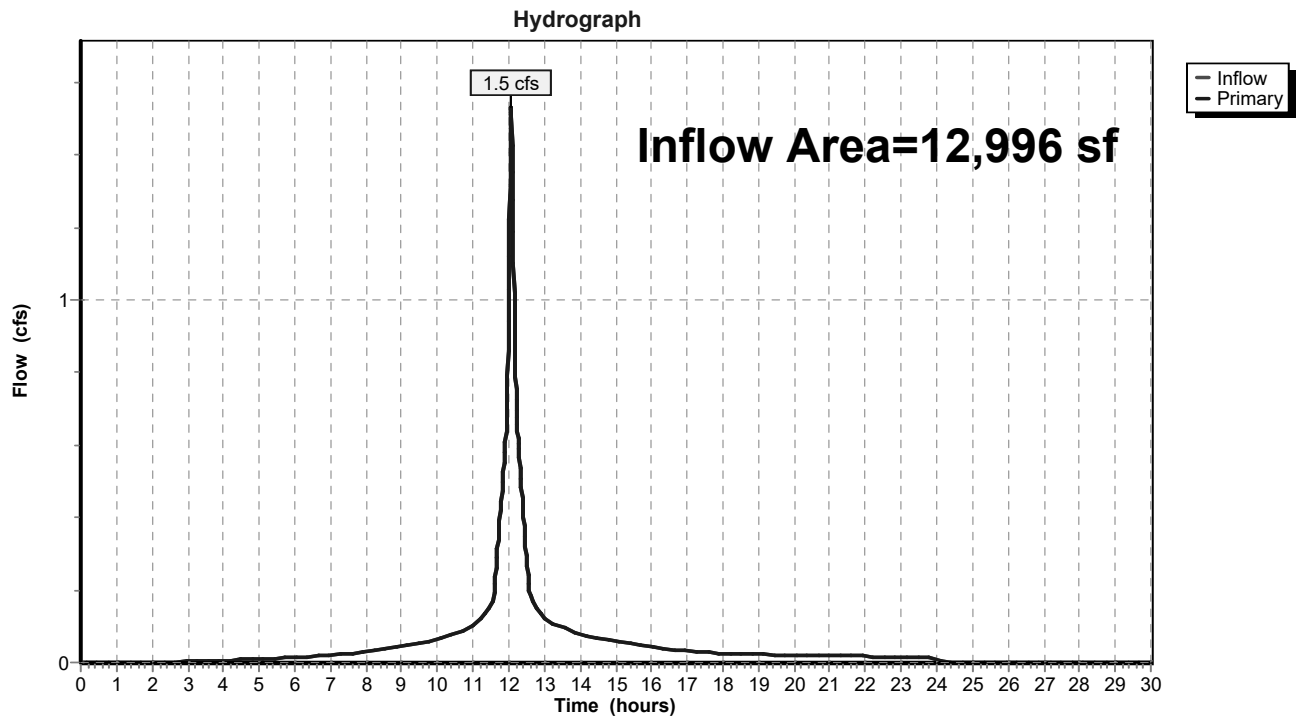
Page 38

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

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Page 39

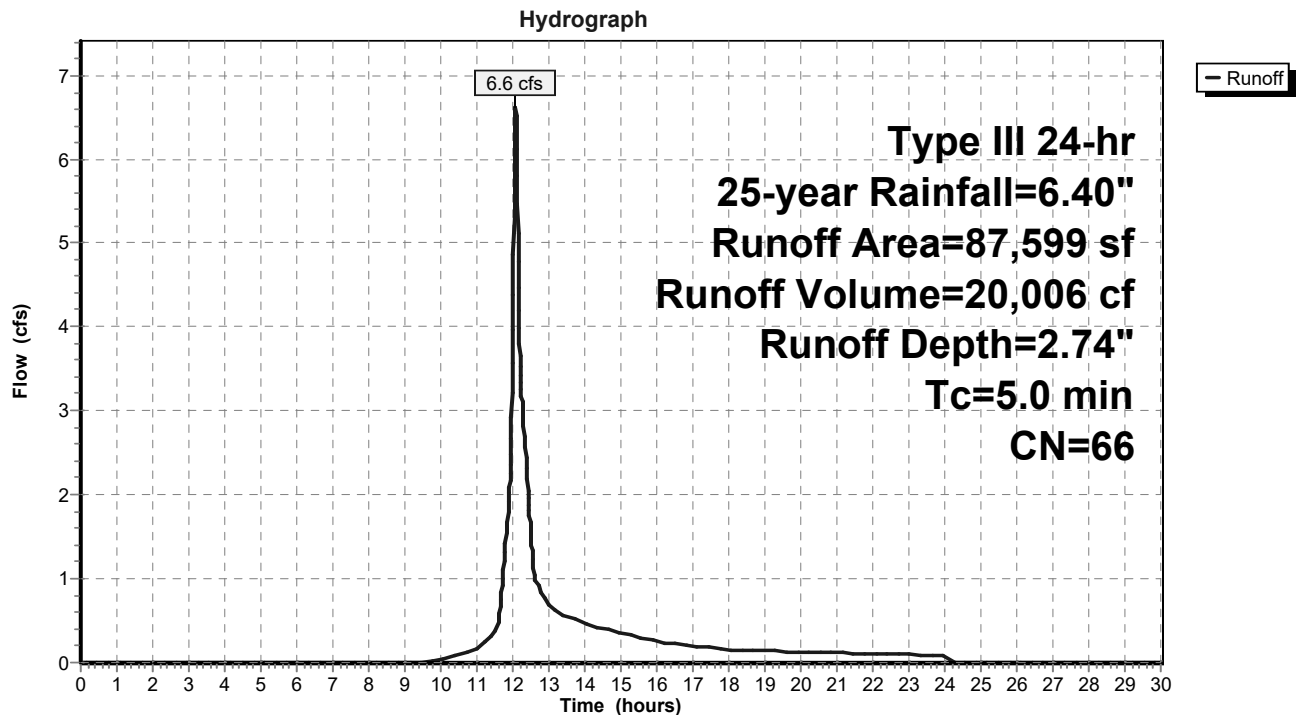
Summary for Subcatchment EX-A: 40 Arbor & Upstream Area

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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Page 40

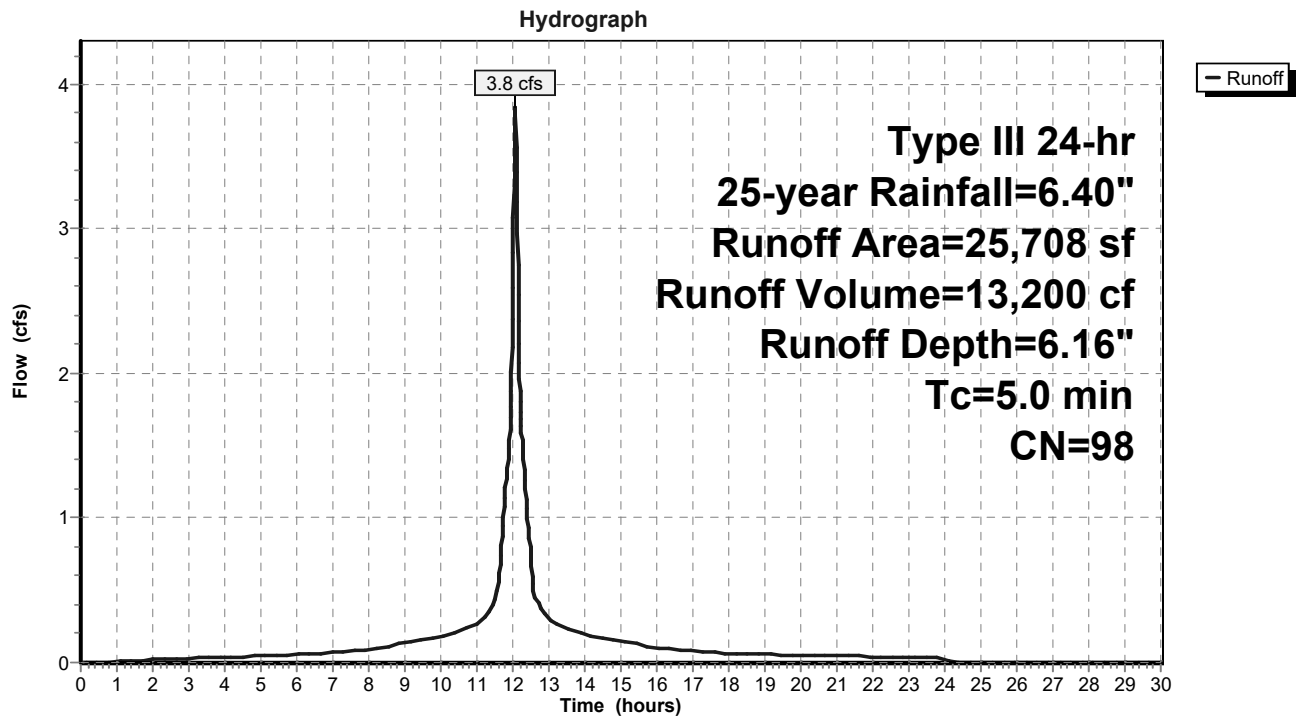
Summary for Subcatchment EX-B: 673 Highland & Upstream Area

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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Page 41

Summary for Subcatchment EX-D: Overland to Highland Ave

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

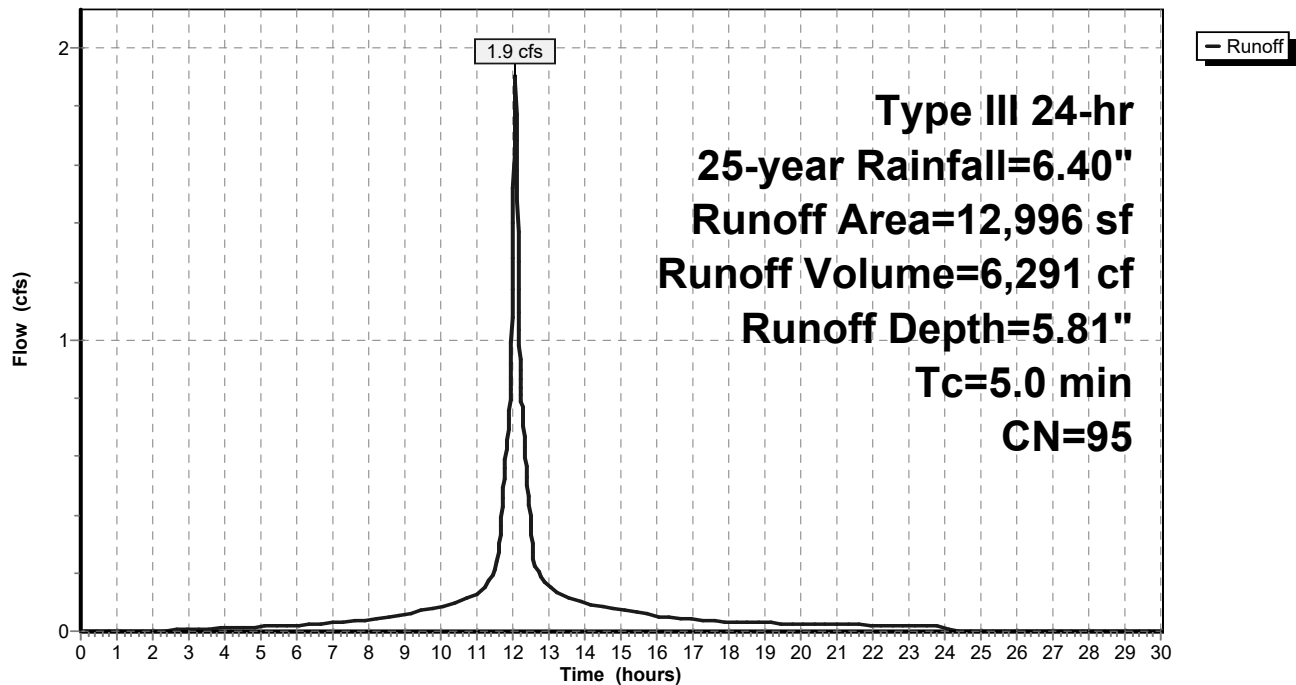
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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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Page 42

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

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

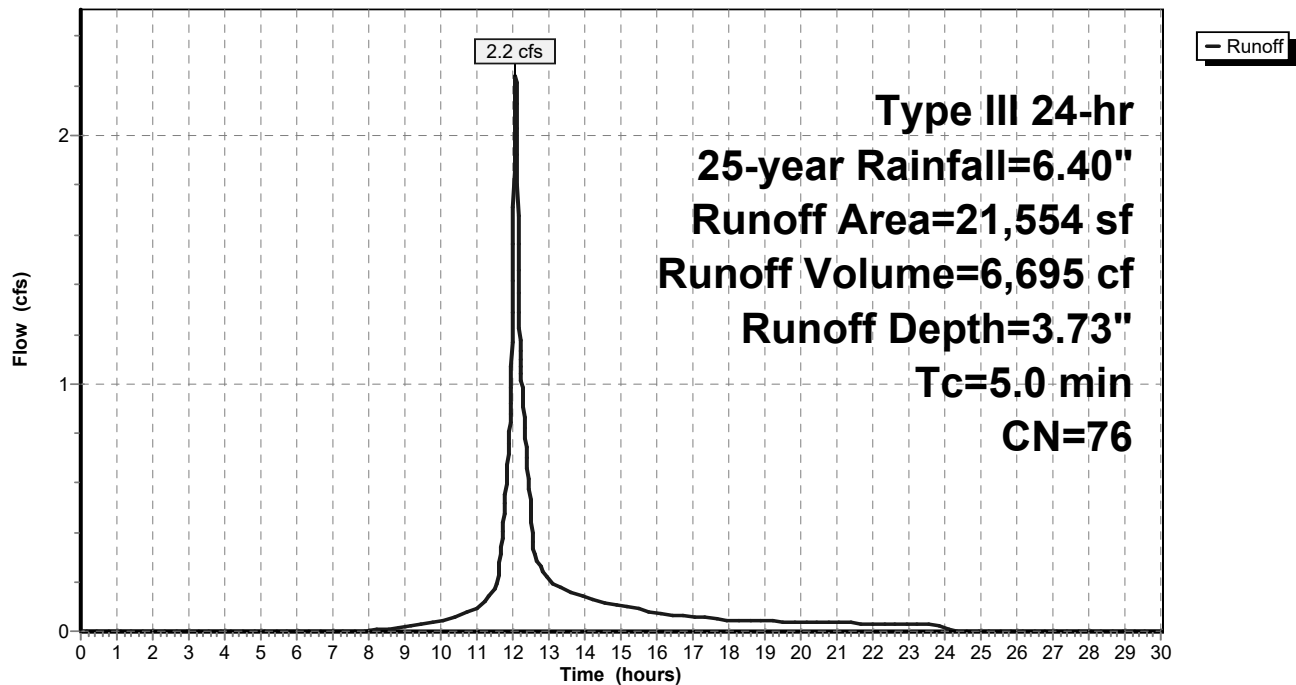
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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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Page 43

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

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

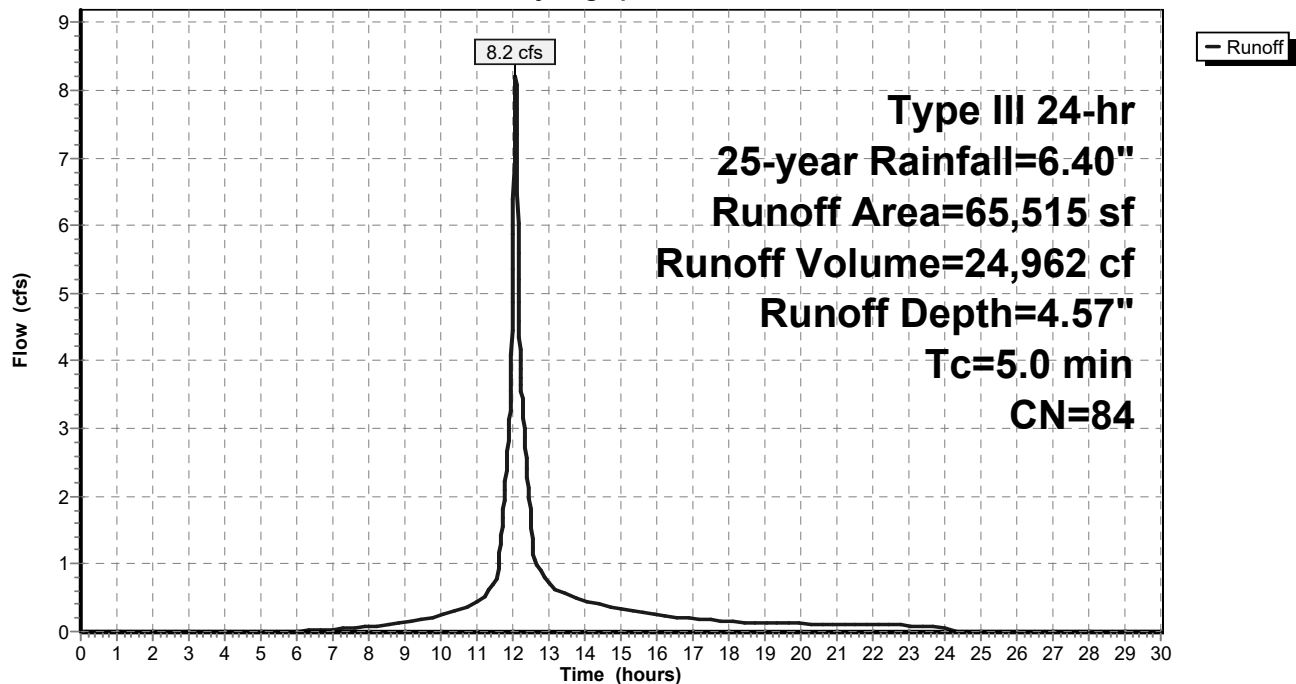
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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

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Page 44

Summary for Subcatchment PR-3: Permeable Patio

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

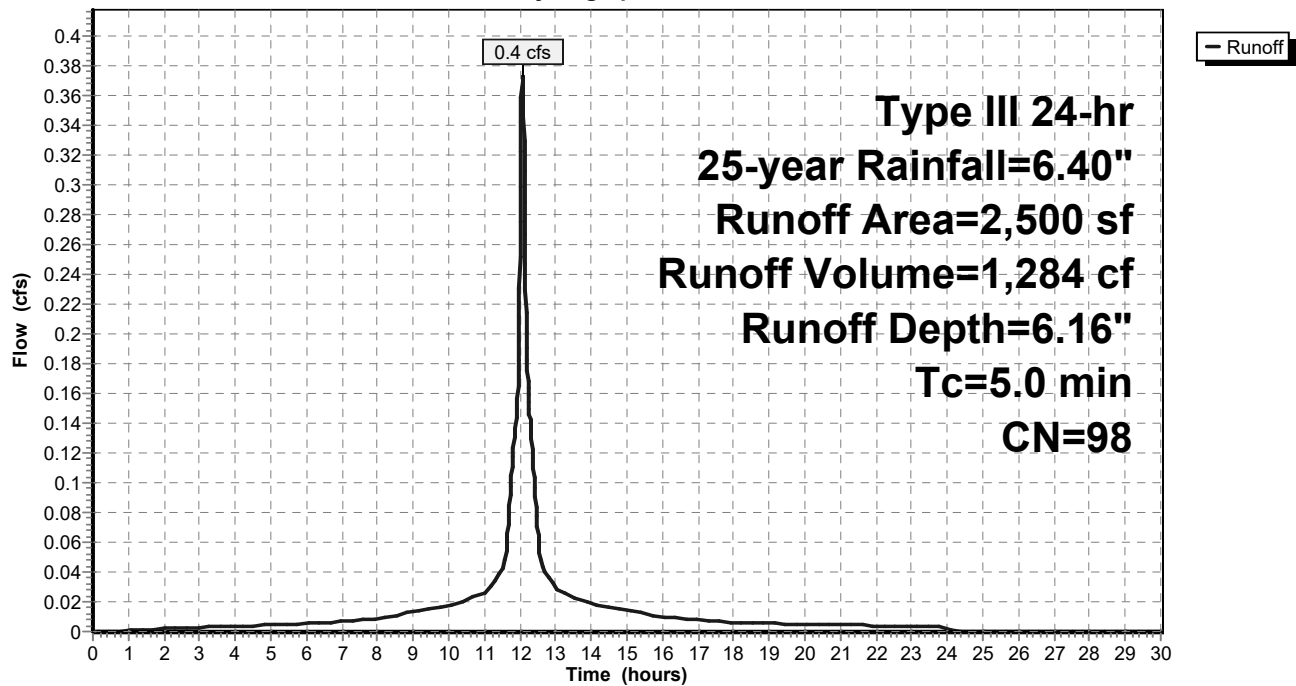
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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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Page 45

Summary for Subcatchment PR-C: Cross St

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

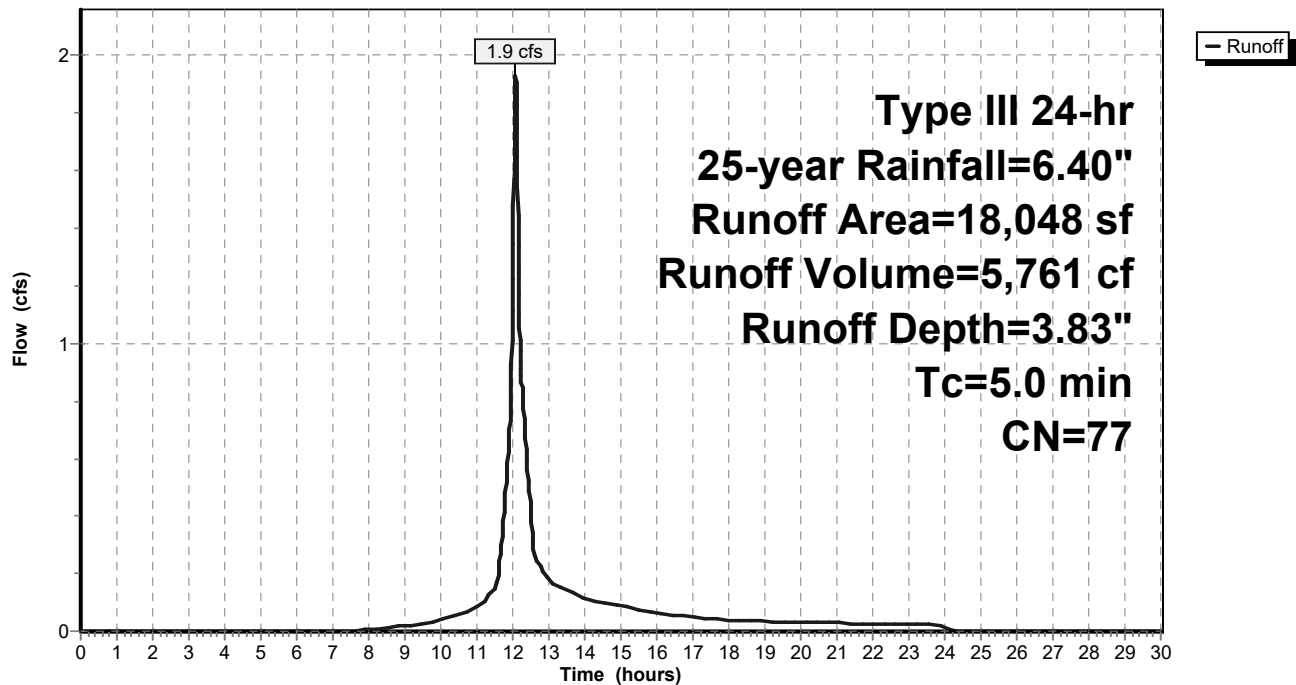
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

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



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

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Page 46

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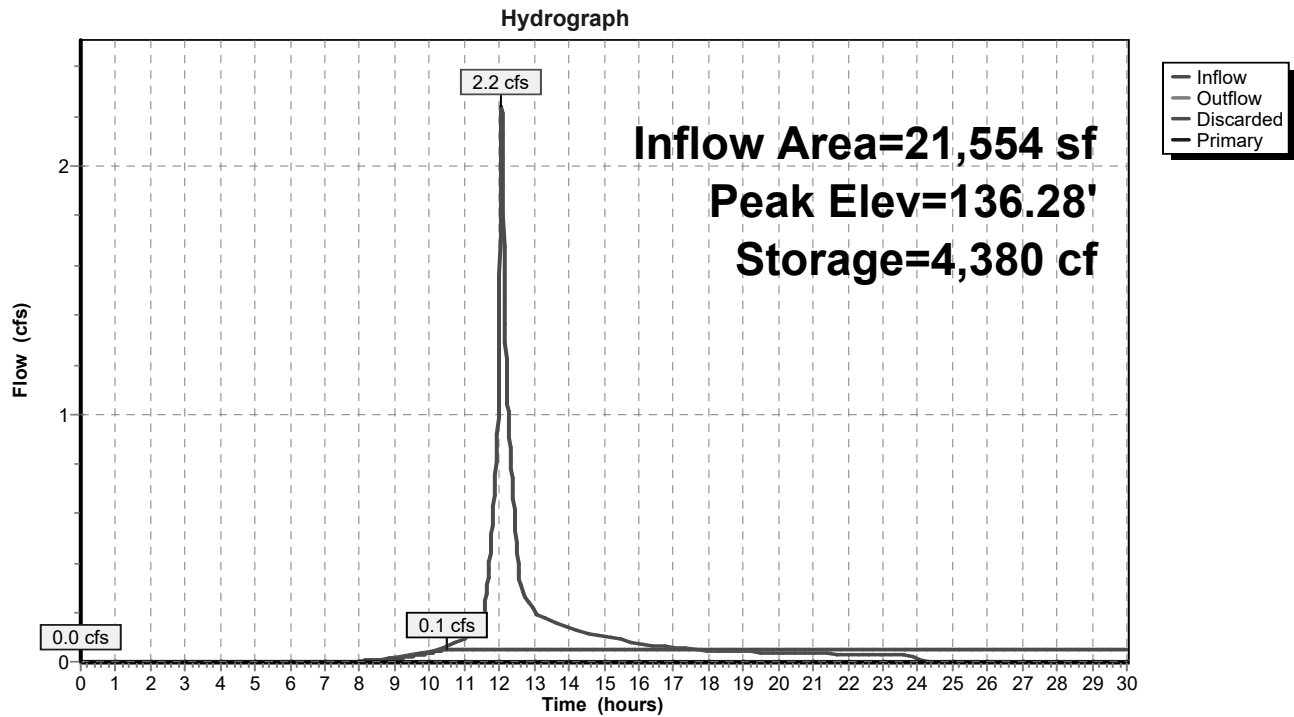
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Type III 24-hr 25-year Rainfall=6.40"

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Page 47

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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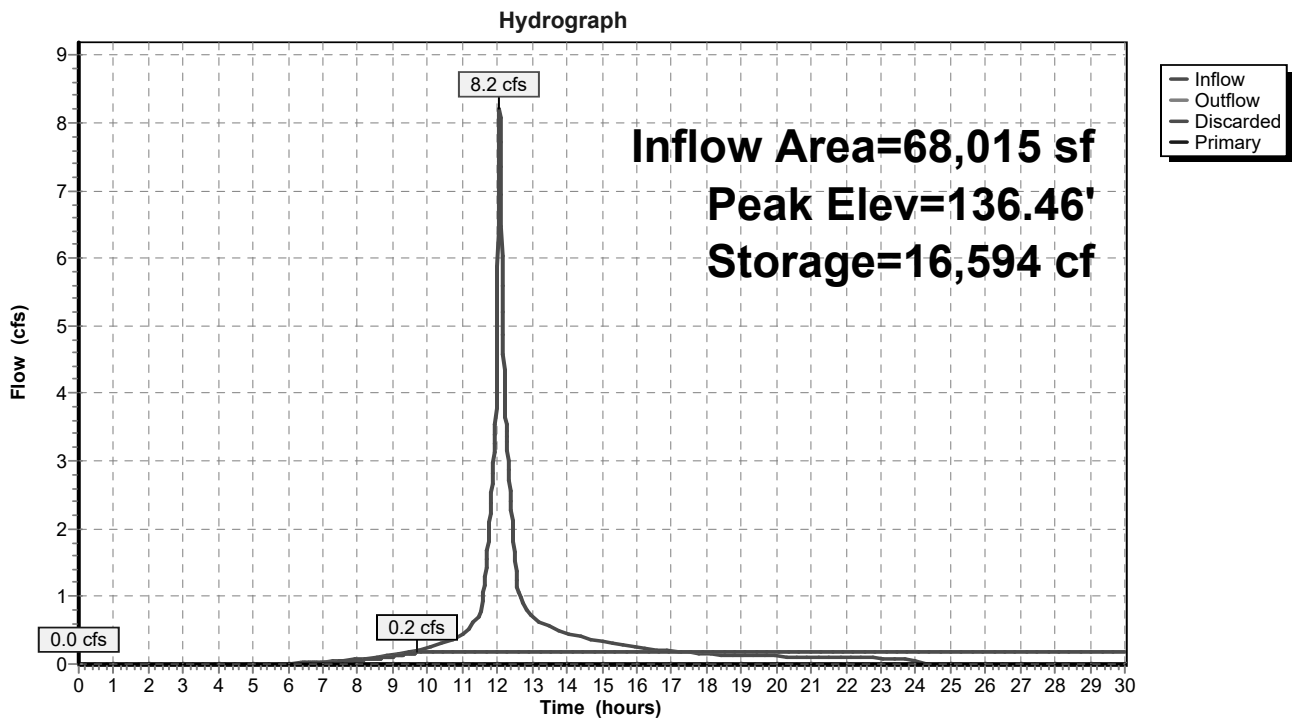
Page 49

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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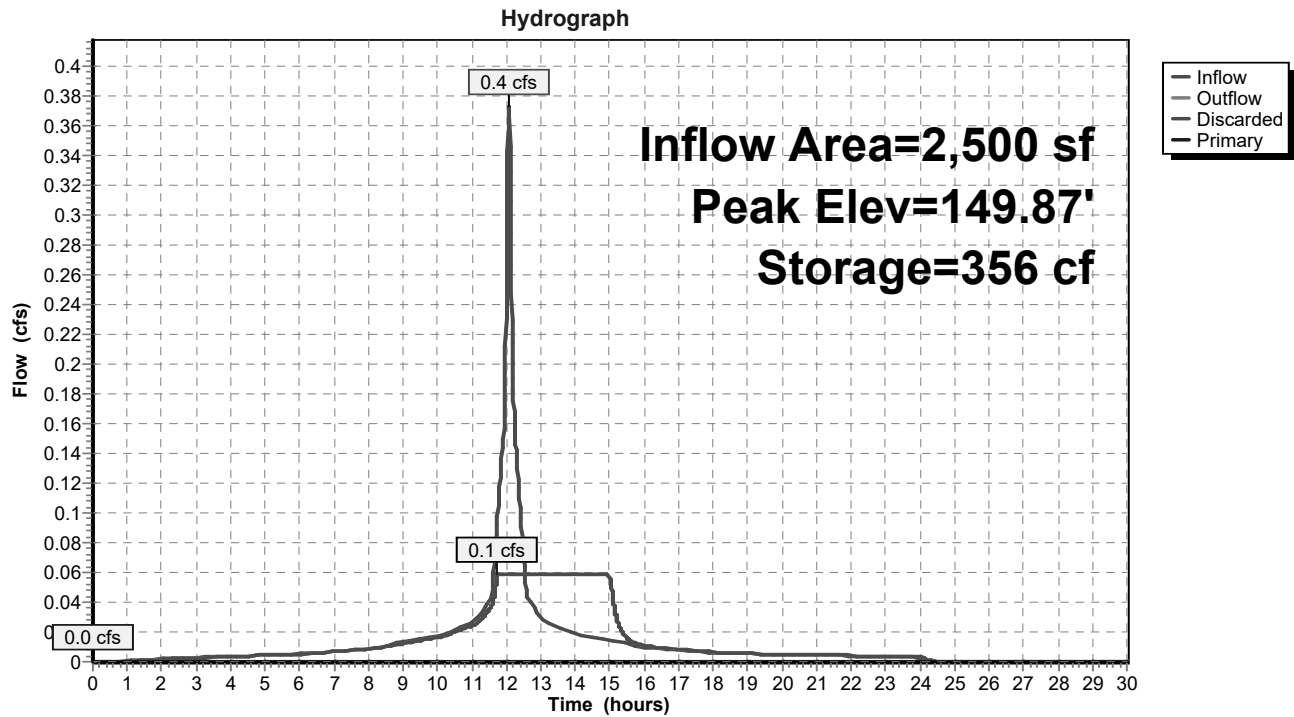
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Page 51

Pond P-3.1: Permeable Patio



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Page 52

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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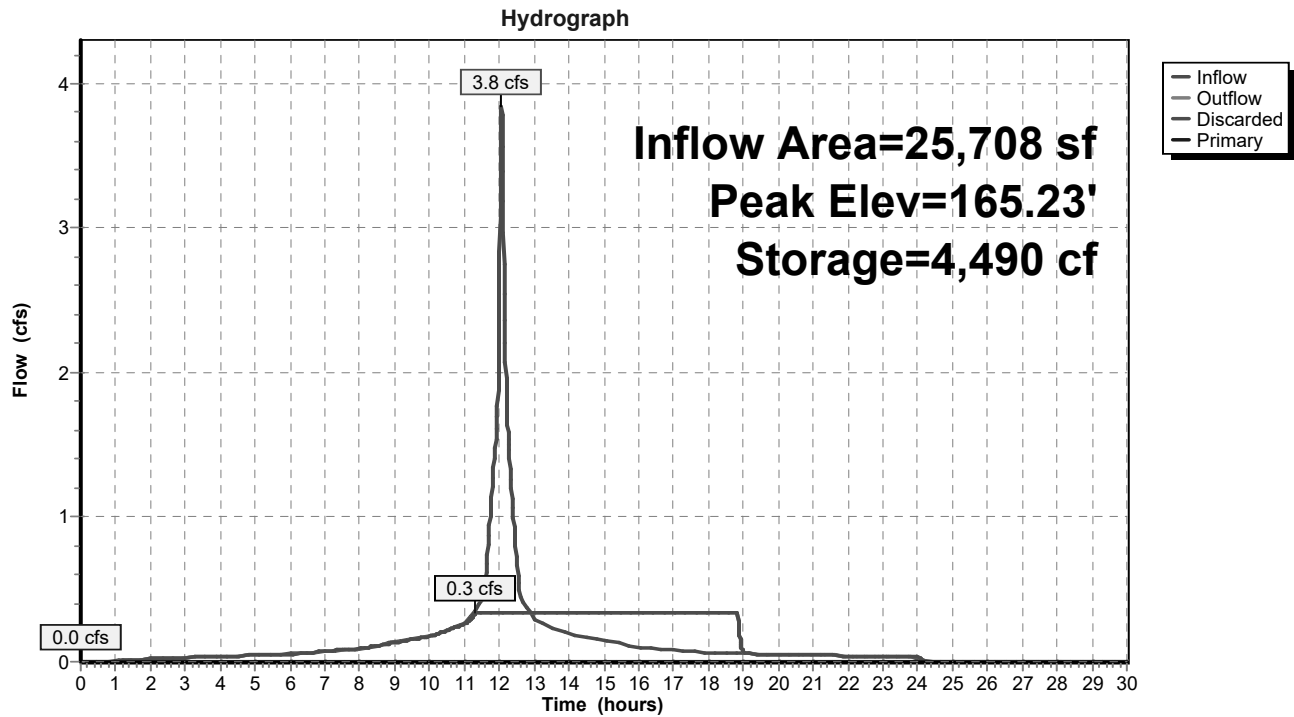
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Page 53

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



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

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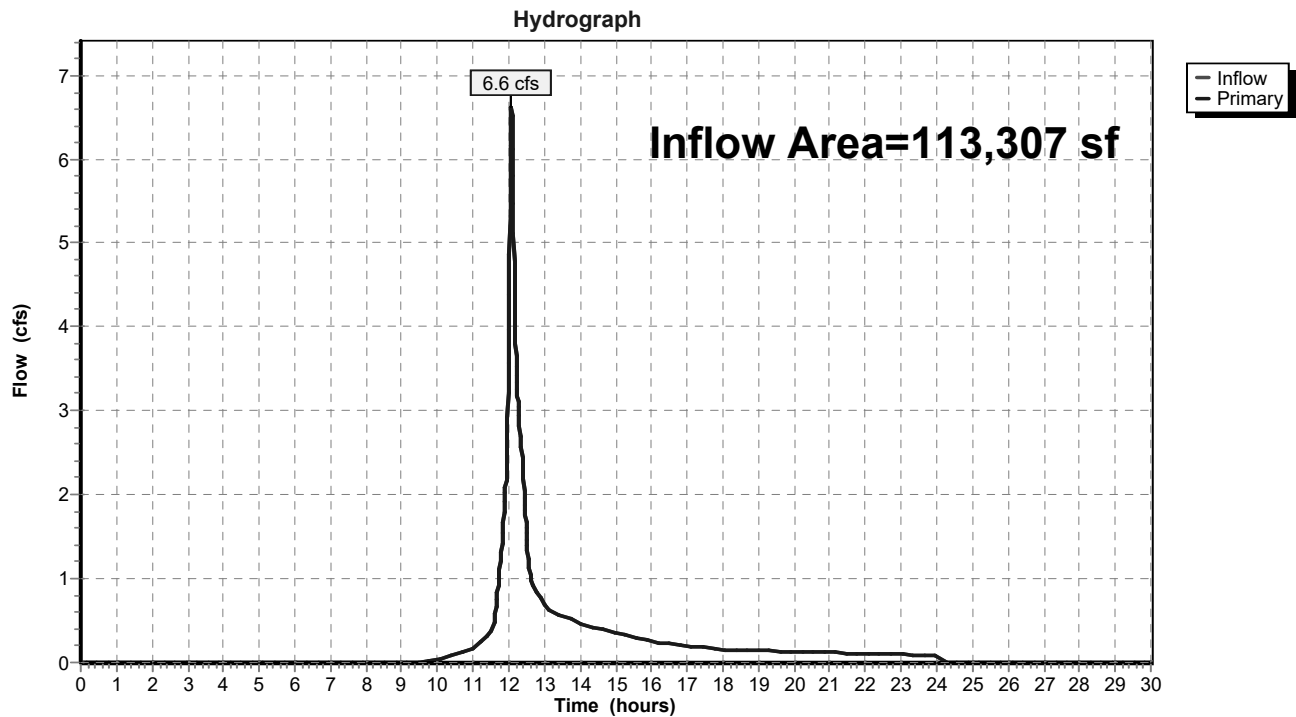
Page 54

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

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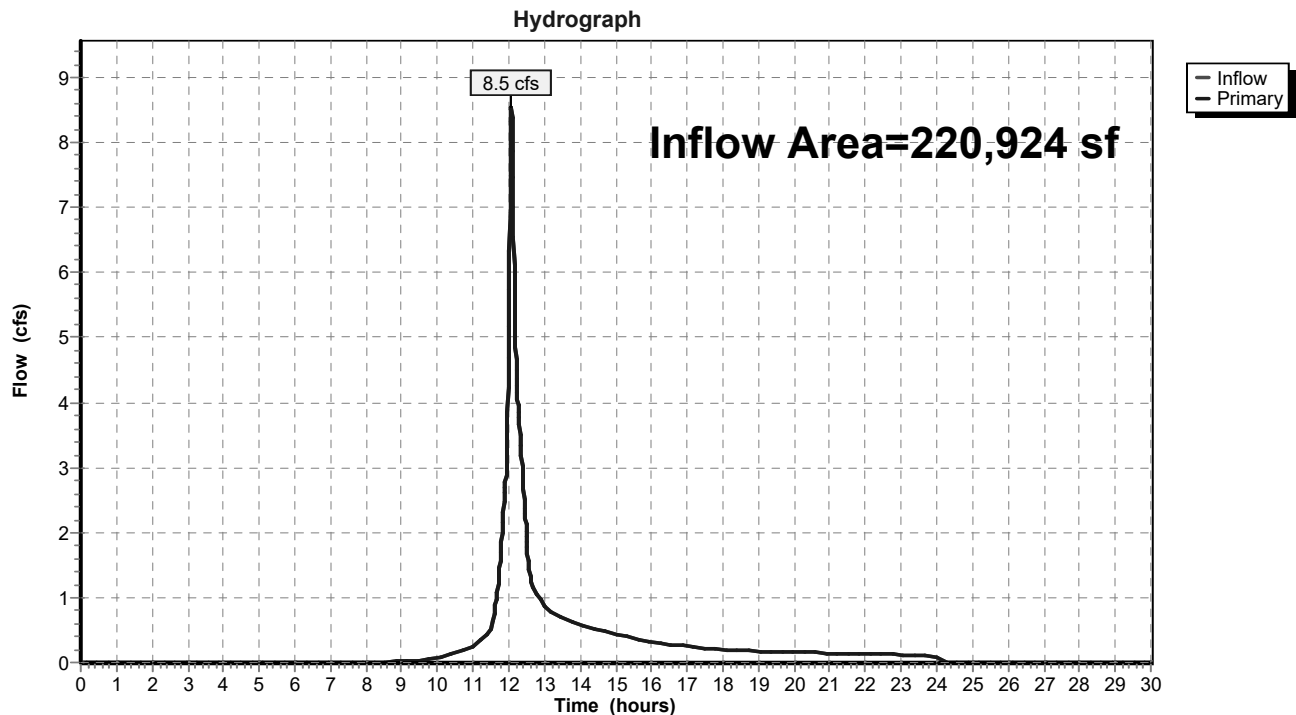
Page 55

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

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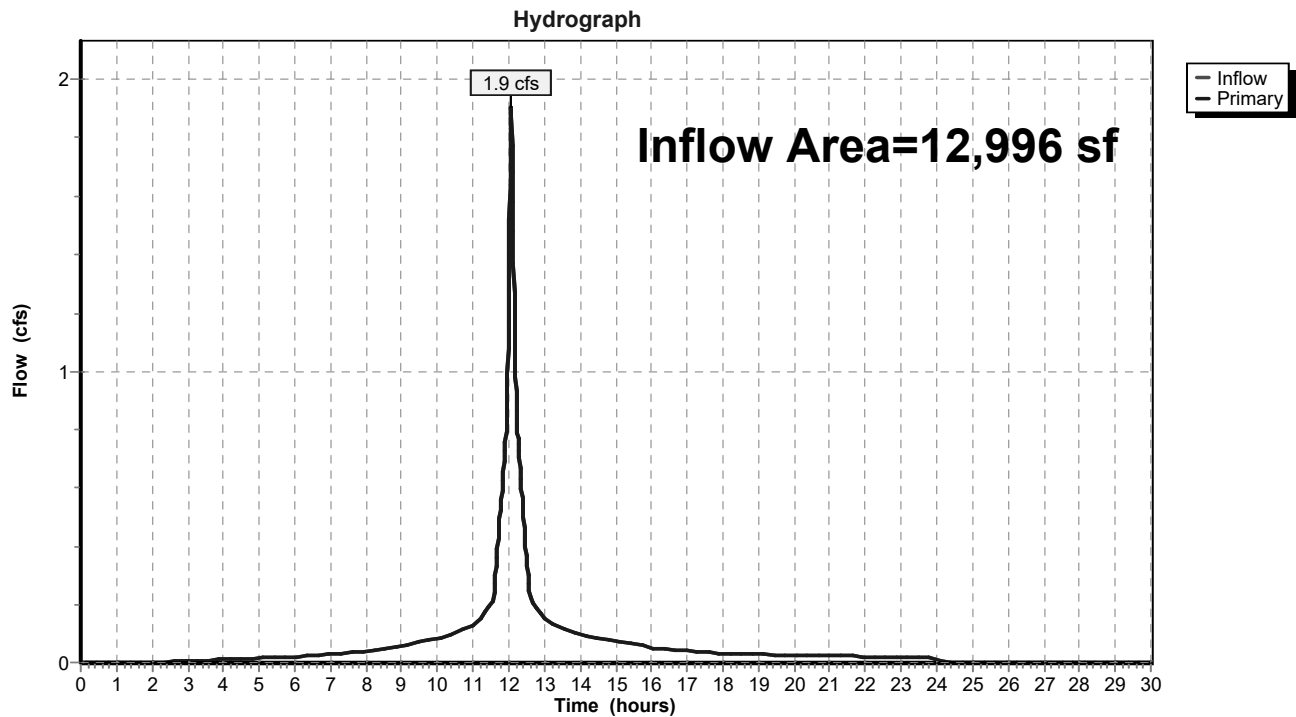
Page 56

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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Page 57

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

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

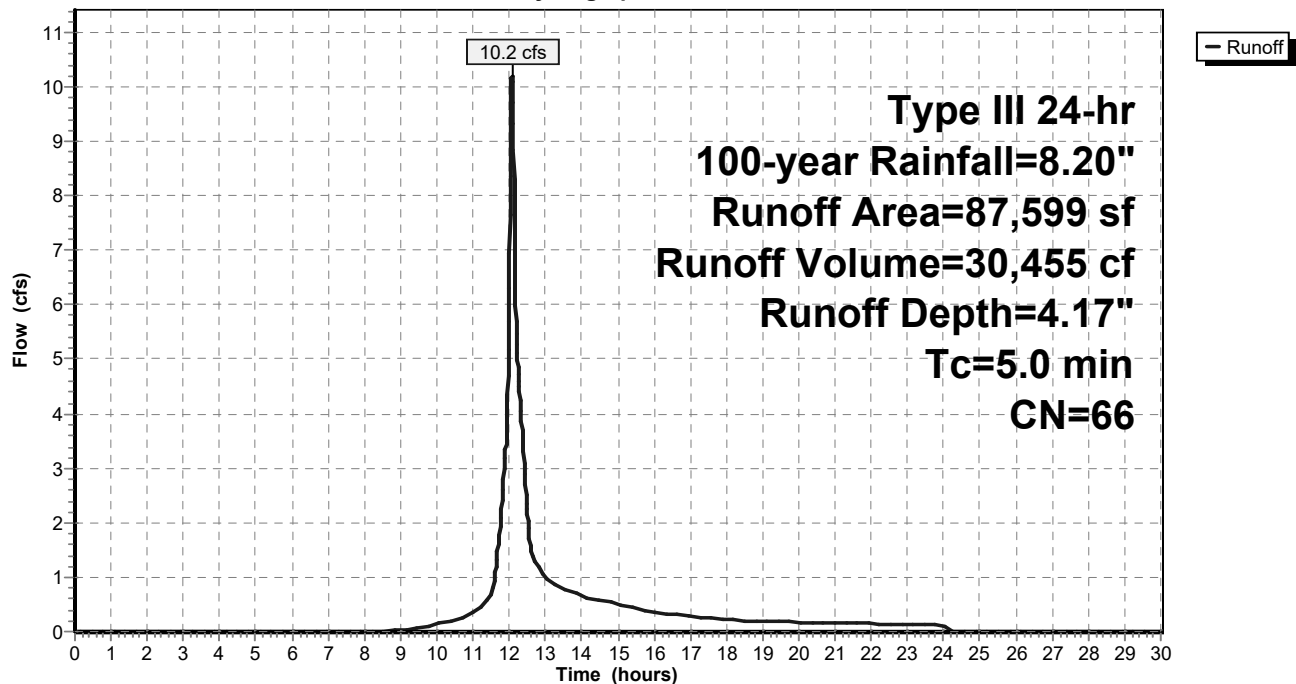
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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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Page 58

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

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

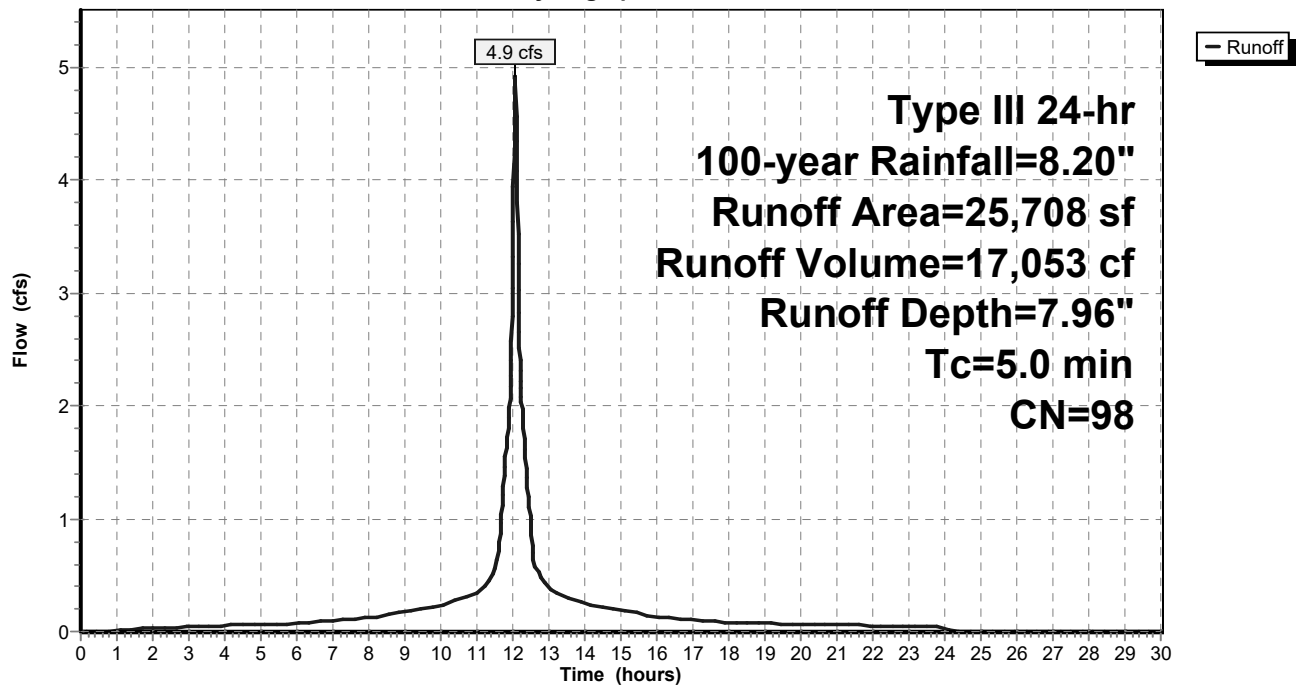
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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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Page 59

Summary for Subcatchment EX-D: Overland to Highland Ave

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

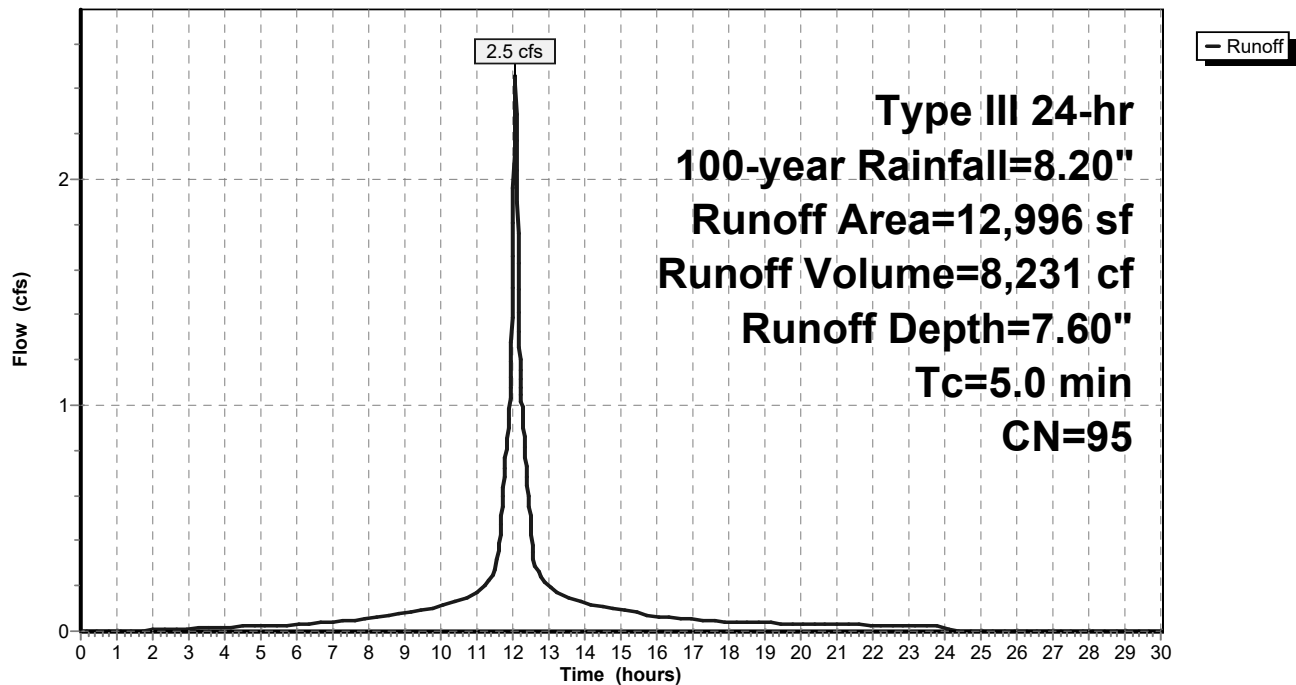
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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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Page 60

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

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

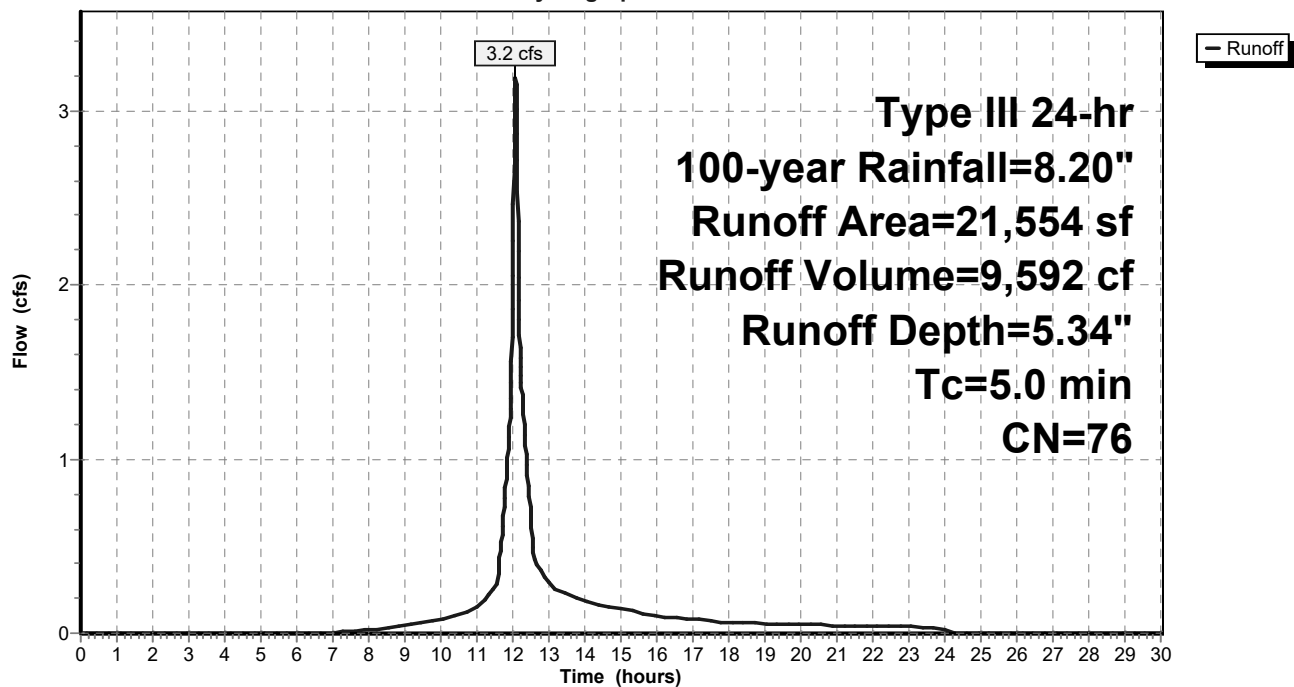
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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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Page 61

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

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

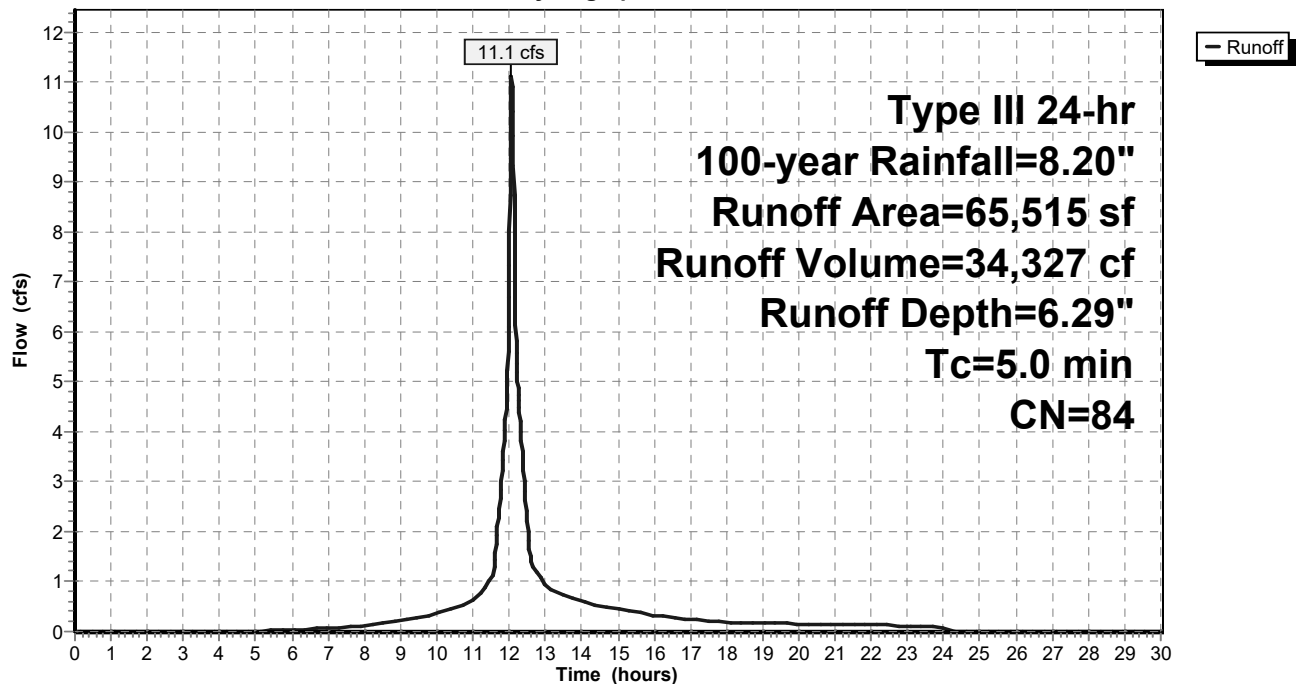
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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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Page 62

Summary for Subcatchment PR-3: Permeable Patio

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

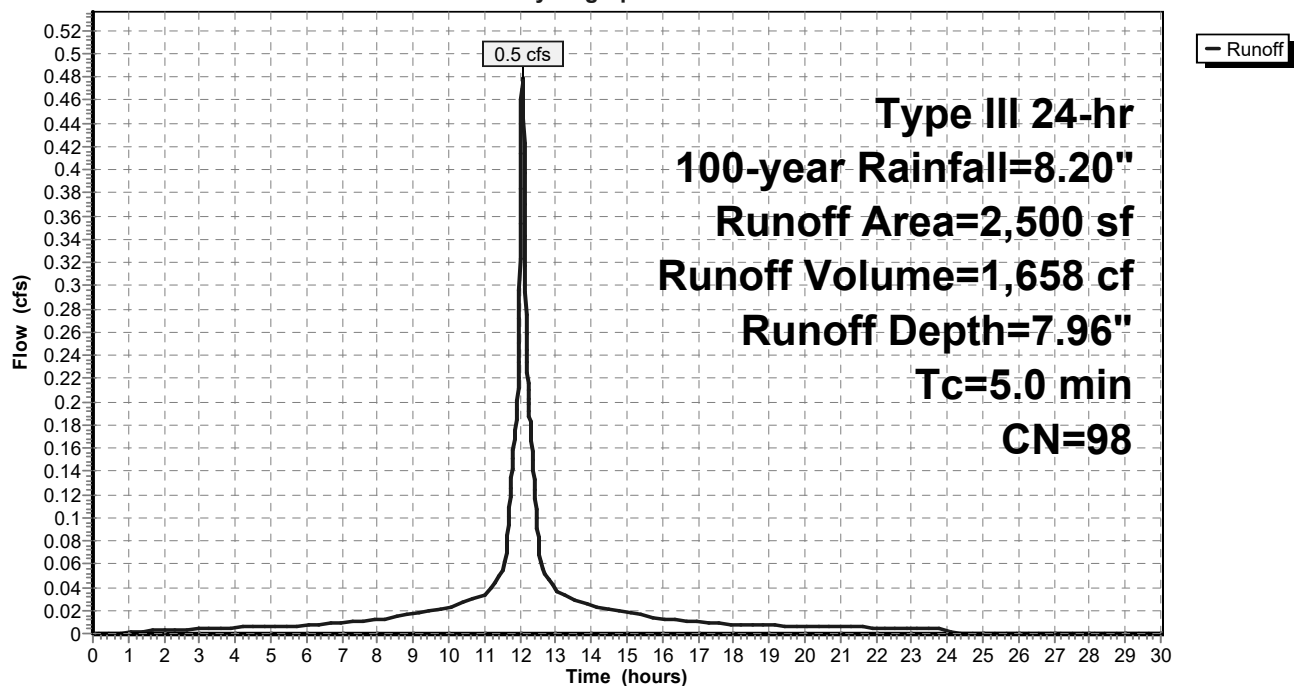
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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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Page 63

Summary for Subcatchment PR-C: Cross St

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

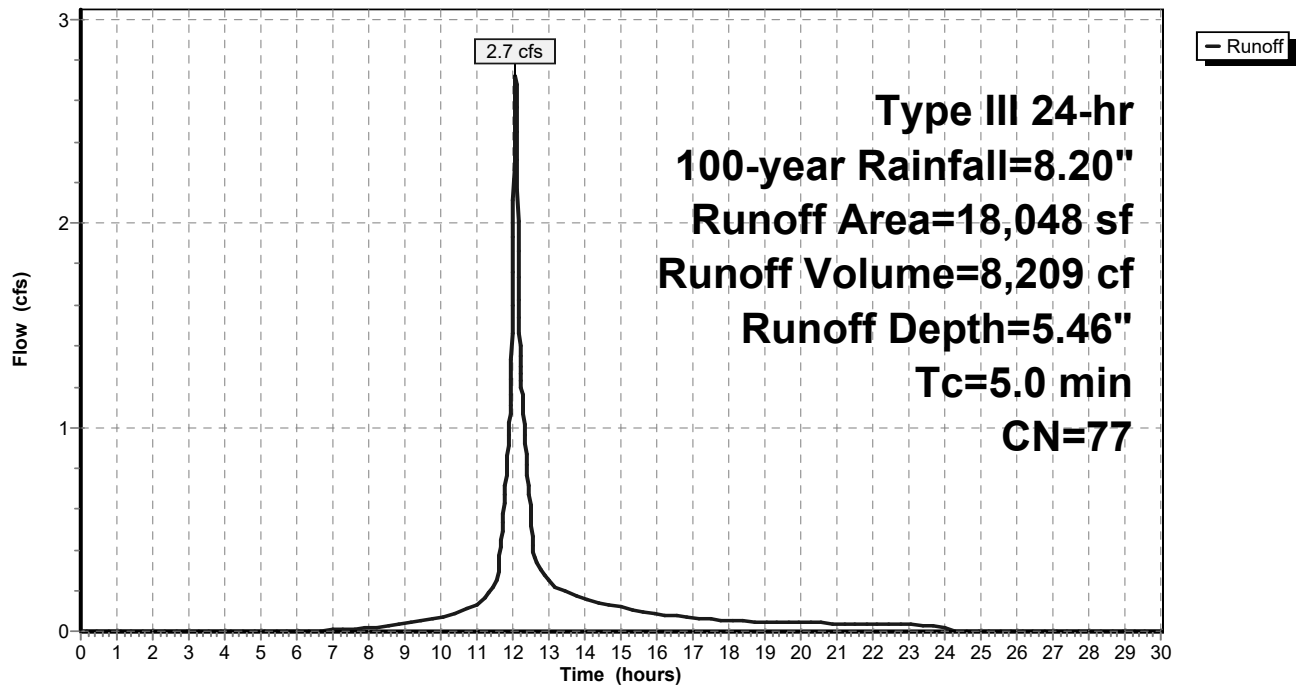
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.20"

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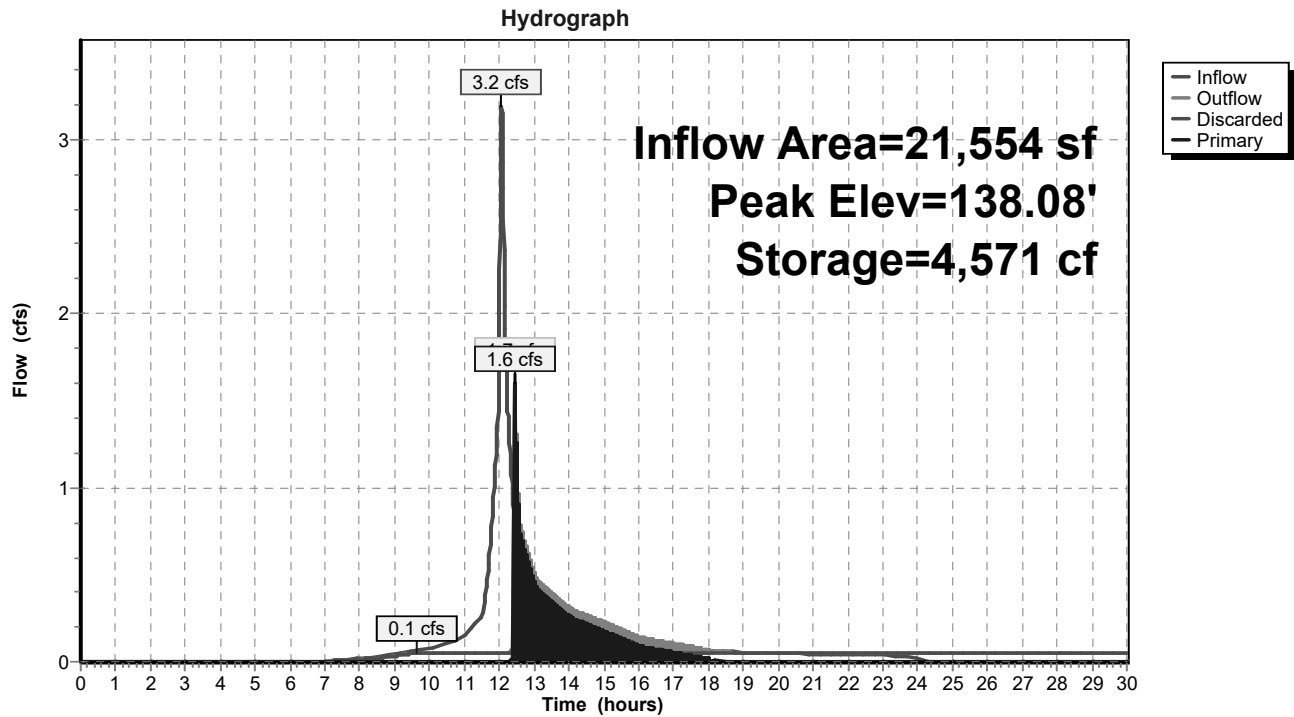
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Type III 24-hr 100-year Rainfall=8.20"

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Page 65

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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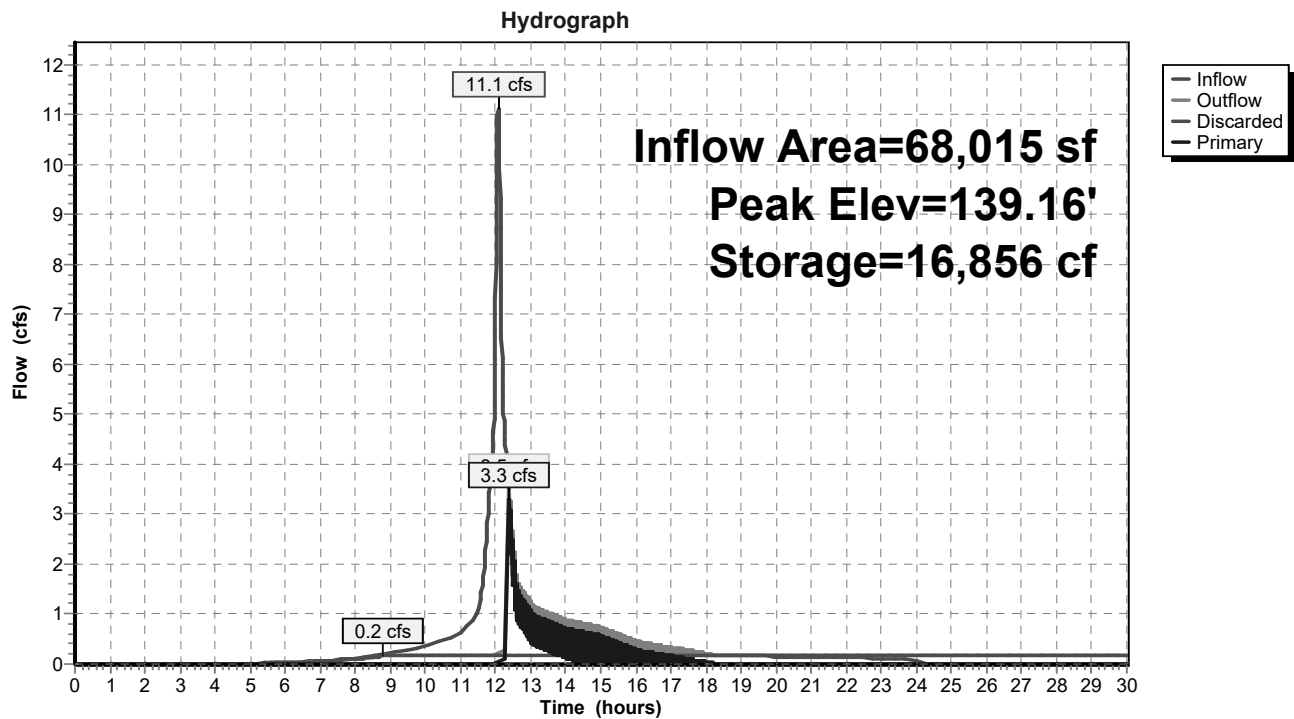
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Page 67

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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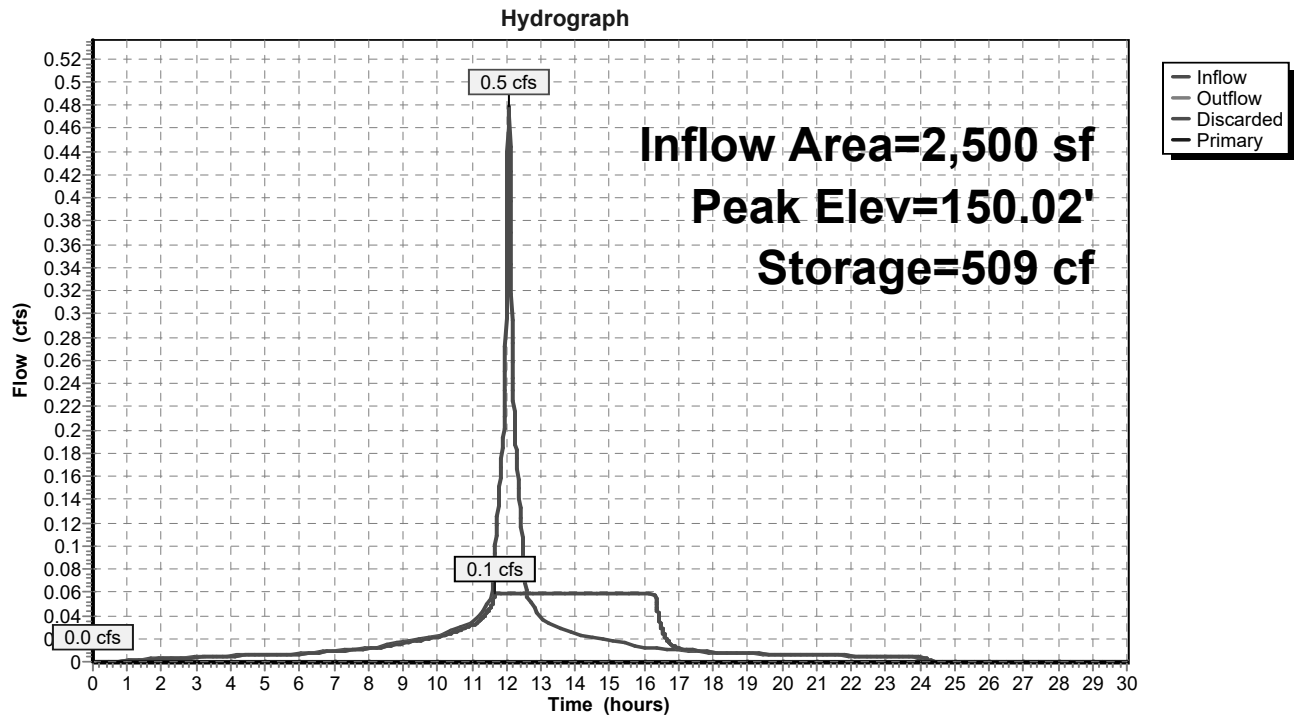
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Page 69

Pond P-3.1: Permeable Patio



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Page 70

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)

1478100-PR

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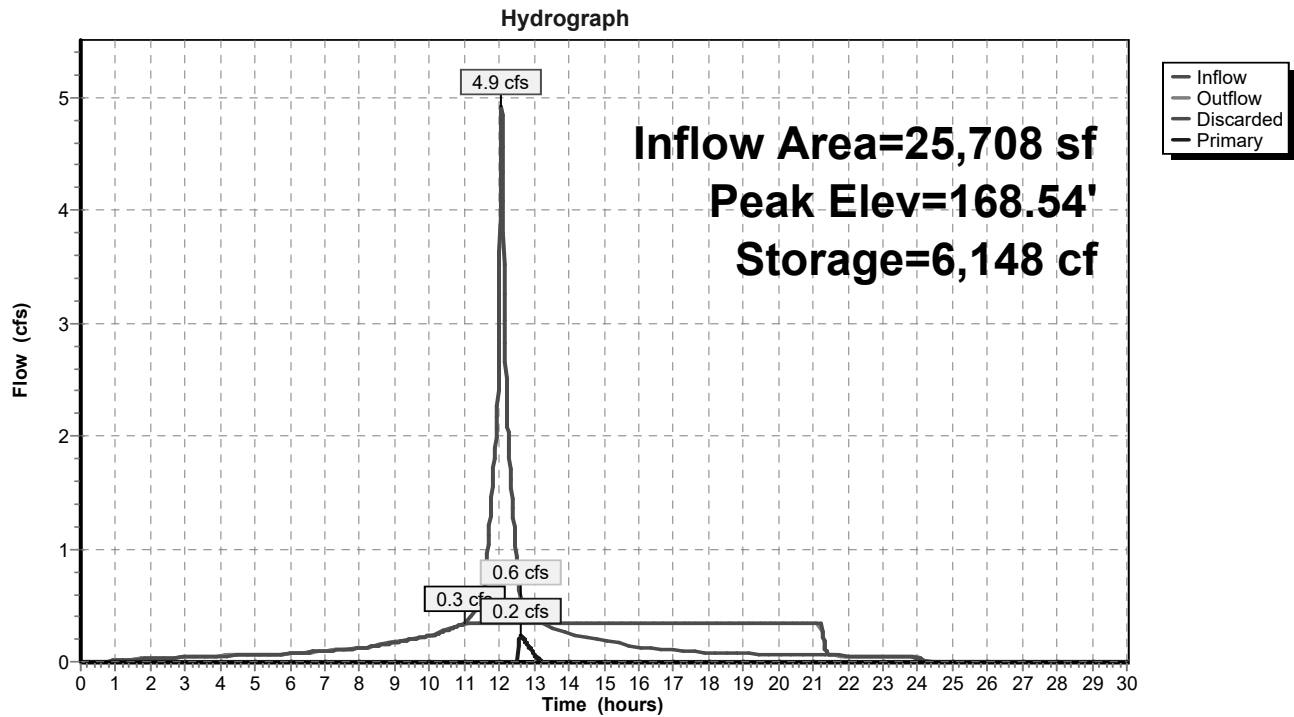
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Proposed
Type III 24-hr 100-year Rainfall=8.20"

Printed 8/1/2023

Page 71

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



1478100-PR

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

Printed 8/1/2023

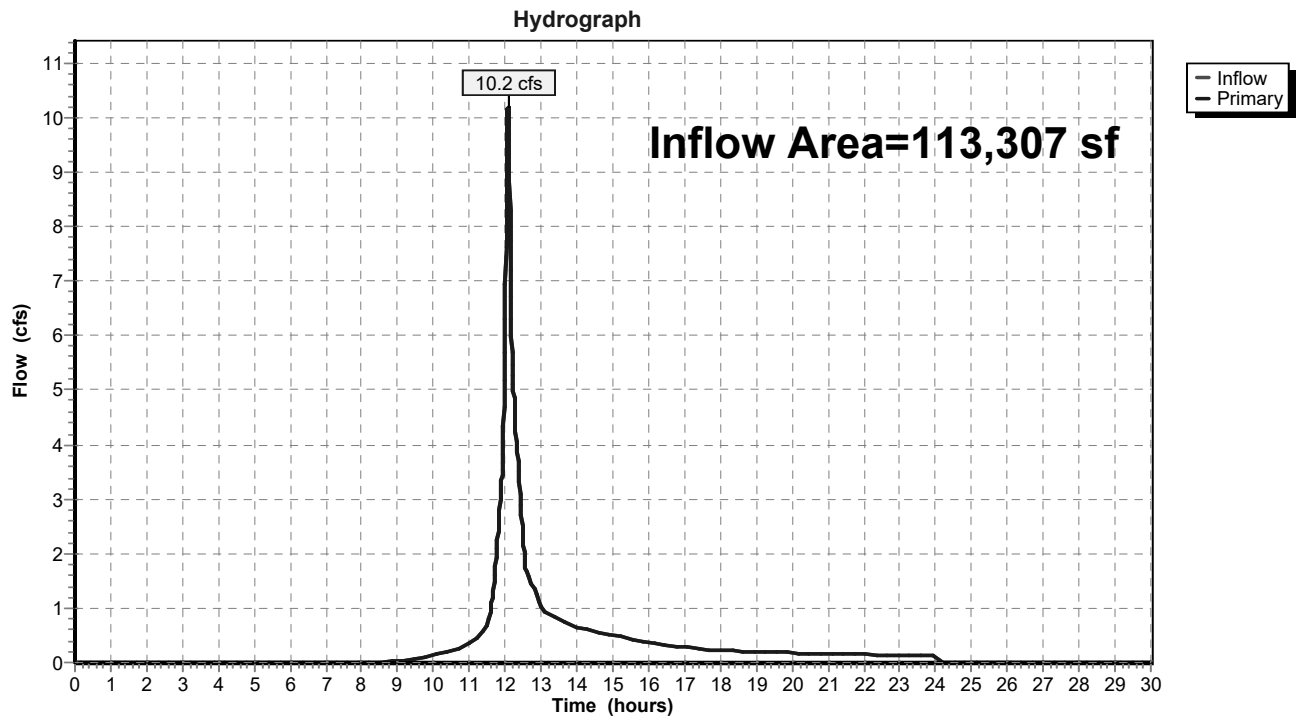
Page 72

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"

Printed 8/1/2023

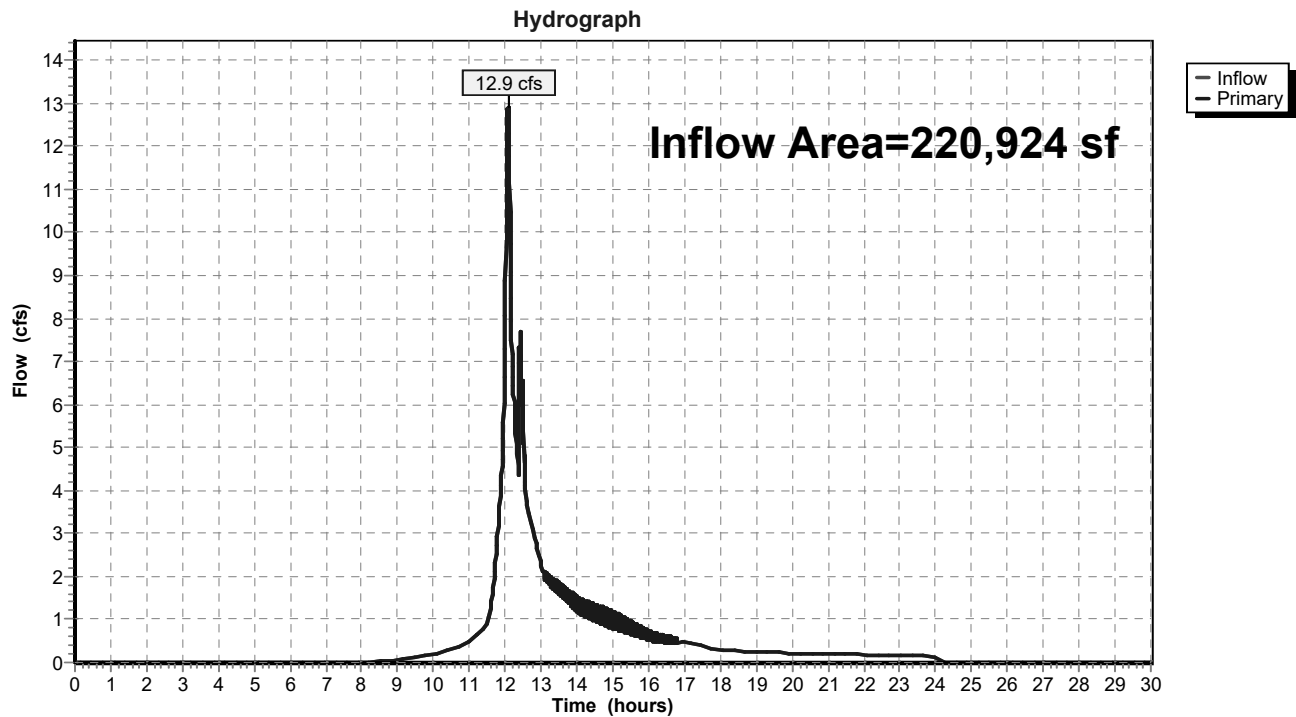
Page 73

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"

Printed 8/1/2023

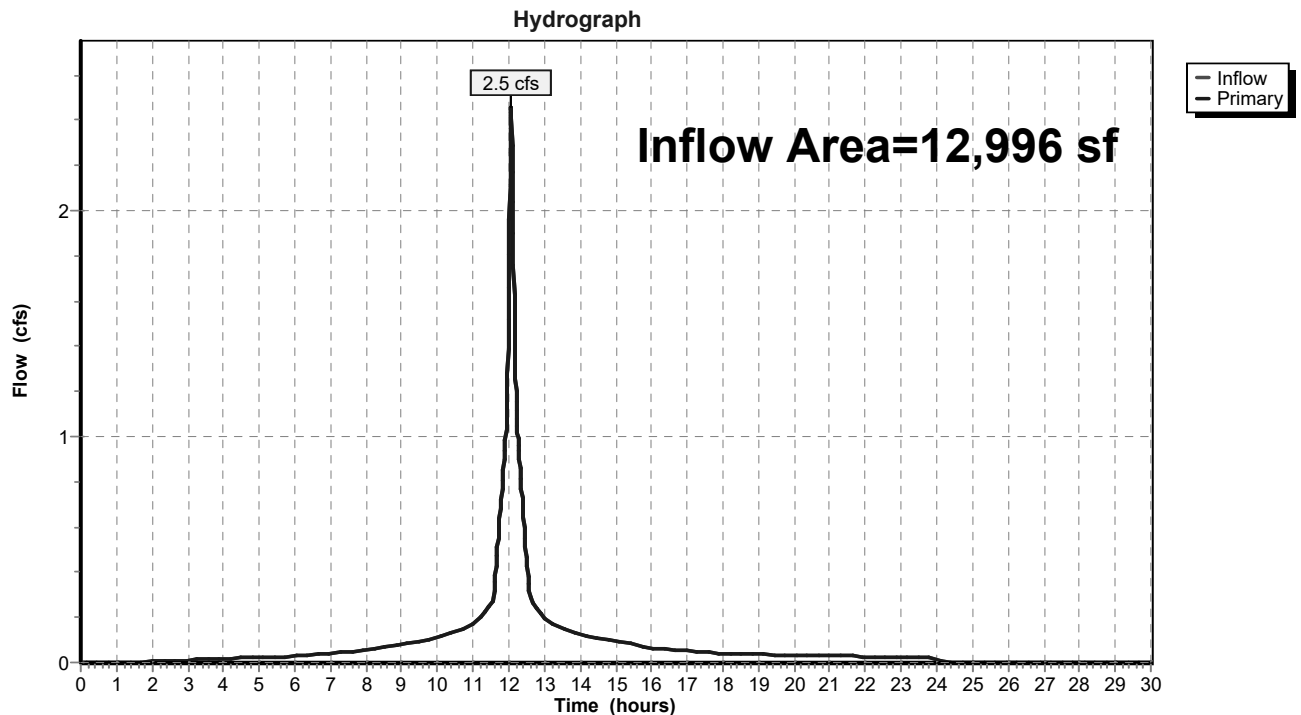
Page 74

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

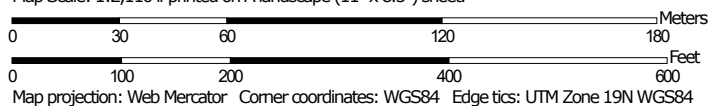
- › [NRCS Soils Map](#)
- › [Boring and Test Pit Logs](#)

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																
Groundwater Observations																																			
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								
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								
14	121										
15	120										
16	119				16.0 / 119.0	WEATHERED BEDROCK	147	S4	9/10	15.0-15.8	47 100/3
17	118			Bottom of borehole 16' BGS						Note: Solid bedrock at 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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 CAMBRIDGE, MA 02140
 TEL: 617-868-1420
 FAX: 617-868-1423

Page 1 of 1

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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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	114		26.0 / 112.0	WEATHERED BEDROCK						RQD: 26/60 RQD: 43% Medium hard, moderately weathered, severely fractured, some horizontal drilling fractures, green to gray, medium grained, no cavities observed.	
25	113										
26	112										
27	111										
28	110										
29	109		31.0 / 107.0	BEDROCK	3	RC1	60/54	26.0-31.0			
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				<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		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		11.0 / 135.0	GLACIAL TILL						
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	

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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			 McPHAIL ASSOCIATES, LLC 2269 MASSACHUSETTS AVENUE CAMBRIDGE, MA 02140 TEL: 617-868-1420 FAX: 617-868-1423
BLOWS/FT.	DENSITY	<u>DESCRIPTIVE TERM</u>	<u>PROPORTION OF TOTAL</u>		
0-4	V.LOOSE	"TRACE"	0-10%	SOIL CONTAINING THREE COMPONENTS EACH OF WHICH COMPRISE AT LEAST 25% OF THE TOTAL ARE CLASSIFIED AS "A WELL-GRADED MIXTURE OF"	
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: Truck rig with auto hammer. Weather:			
<2	V.SOFT				
2-4	SOFT				
4-8	FIRM				
8-15	STIFF				
15-30	V.STIFF				
>30	HARD				



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 FAX: 617-868-1423

Project: 661 Highland Ave Location: Needham MA City/State: Needham Ma				Job #: 7076 Date Started: 12-15-20 Date Finished: 12-15-20				Boring No. MA-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									
4	142		3.0 / 143.0	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"



McPHAIL ASSOCIATES, LLC
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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		FILL	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			14	S2	24/4	5.0-7.0	8 5 9 9	Compact, brown, SILTY SAND, trace to some gravel. (Fill)	
7	155									
8	154									
9	153									
10	152		10.0 / 152.0	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)
11	151									
12	150									
13	149									
14	148									
15	147				43	S4	24/10	15.0-17.0	60 29 14 14	Dense, brown, SAND and GRAVEL, trace silt. (Glacial Outwash)
16	146									
17	145									
18	144									
19	143									
20	142		20.0 / 142.0	GLACIAL TILL	127	S5	15/3	20.0-21.3	14 27 100/3	Very dense, brown, SILTY SAND, trace gravel. (Glacial Outwash) Note: Water coming up from casing smells of petroleum
21	141									
22	140			22.0 / 140.0	BOULDER					
			23.0 / 139.0							

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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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	RQD: 51/60 RQD: 85%	
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	

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 2 of 2

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"> <thead> <tr> <th colspan="4">Groundwater Observations</th> </tr> <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>		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	[Symbol]	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	[Symbol]	8.0 / 140.0	FILL	17	S2	24/10	5.0-7.0	2 9 8 9	Compact, brown to light brown, SILTY SAND. (Fill) Note: Started casing. Also hit boulder around 8' bgs, roller bit 2' into it decided to core.
7	141									
8	140									
9	139									
10	138									
11	137	[Symbol]	13.0 / 135.0	BOULDER	2 3 6	RC1	18/4	10.0-11.5	RQD: 4/18 RQD: 22%	Hard, pink/brown, coarse grained, no weathering, no fractures, no cavities.
12	136									
13	135									
14	134	[Symbol]	17.0 / 131.0	GLACIAL TILL	102	S3	24/12	15.0-17.0	38 43 59 76	Very dense, gray to light brown, SILTY SAND, trace gravel w/ weathered bedrock. (Glacial Till)
15	133									
16	132									
17	131	[Symbol]	18.0 / 130.0	WEATHERED ROCK						
18	130									
19	129									
20	128	[Symbol]	22.0 / 126.0	BEDROCK	4 6	RC2	24/24	20.0-22.0	RQD: 14/24 RQD: 58%	Medium hard to hard, gray and blue, fine grained, trace horizontal drilling fractures, some angular fractures, no weathering, no cavities visible. Note: Due to a large fracture in the rock too much water was lost and was only able to core 2 feet of rock.
21	127									
22	126									
				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

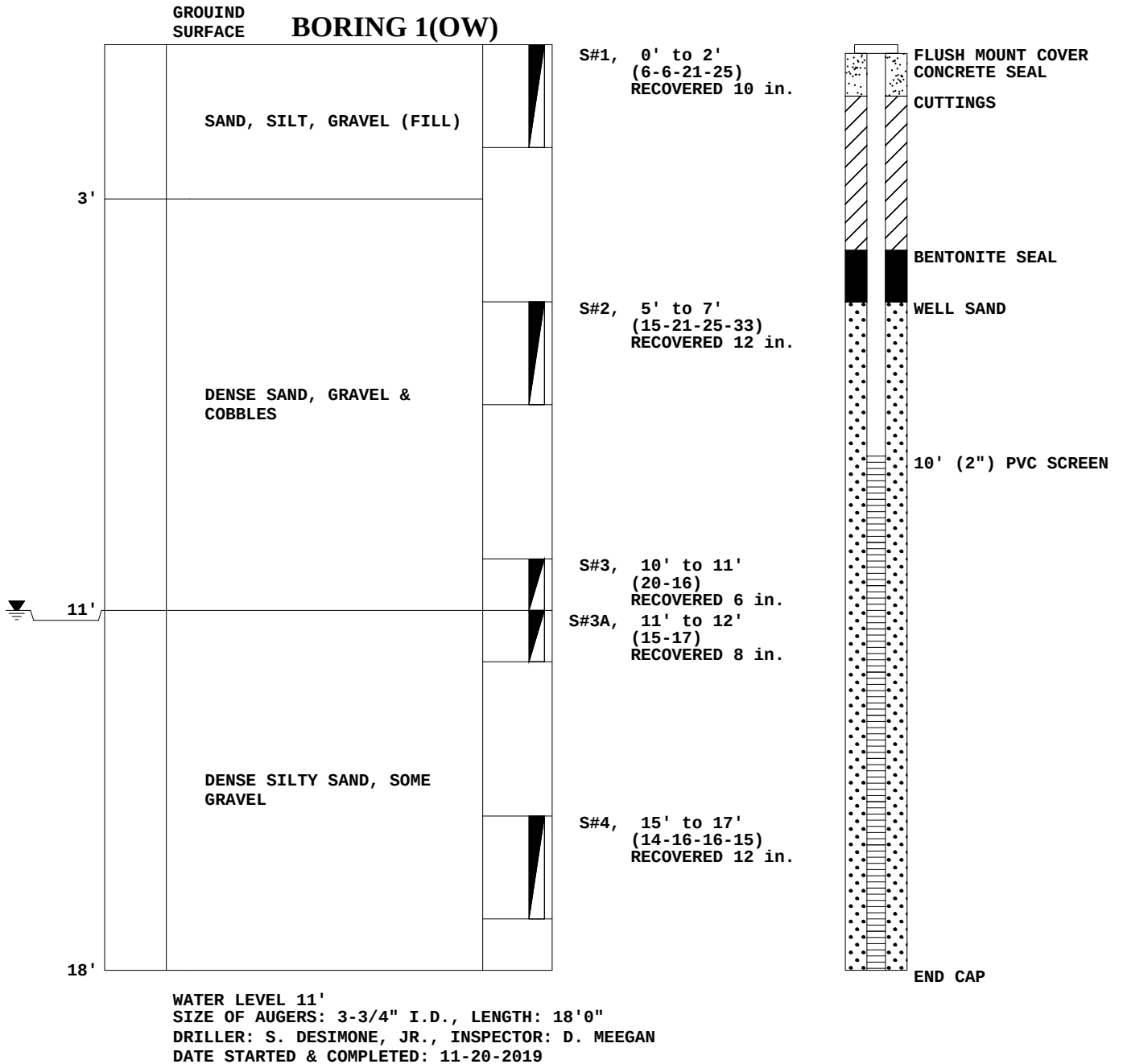
Telephone (781) 391-4500

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



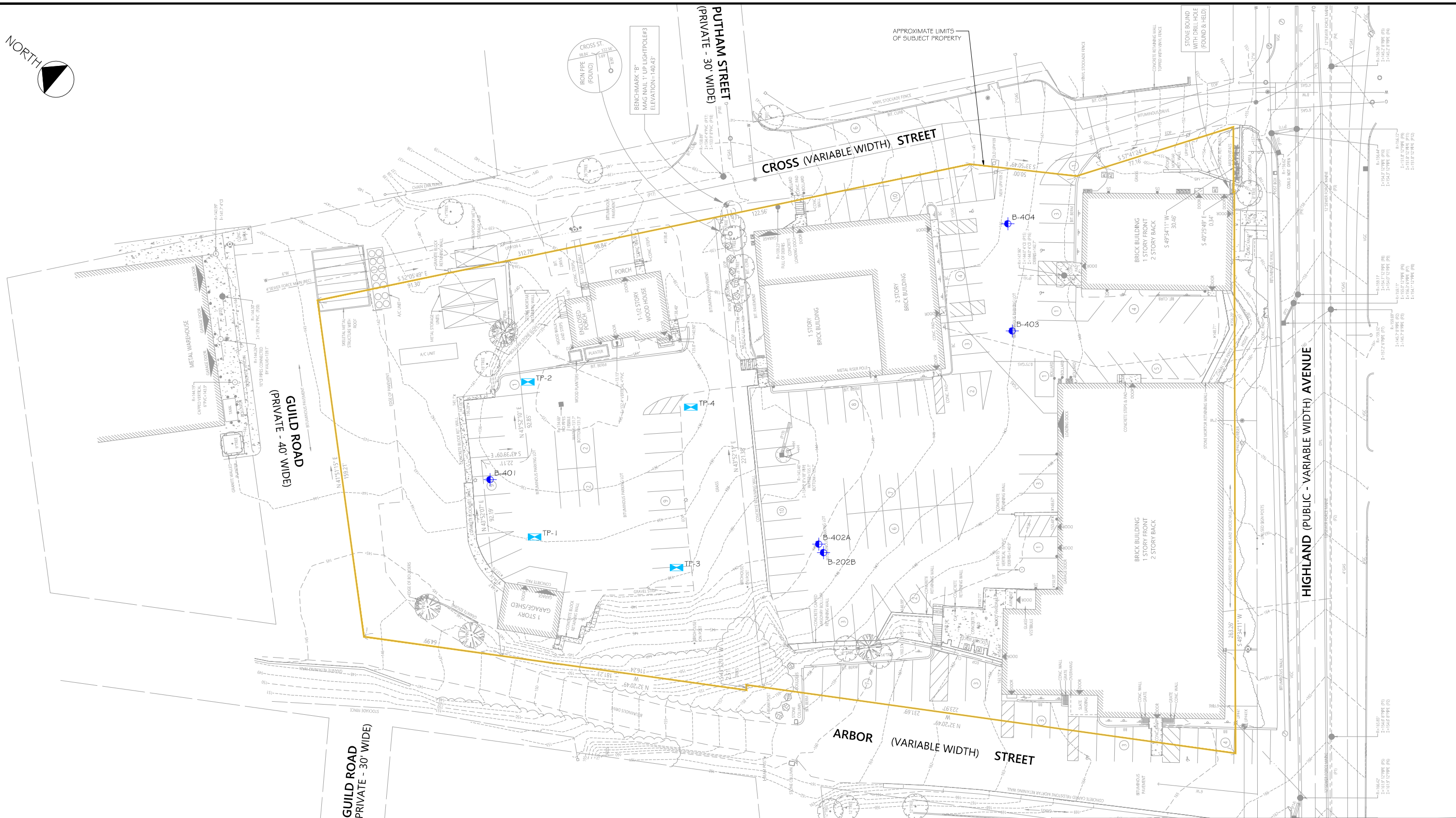
- LEGEND**
- APPROXIMATE LOCATION OF BORING PERFORMED BY CARR-DEE CORP. DURING THE PERIOD OF MARCH 31 THROUGH APRIL 3, 2023 FOR McPHAIL ASSOCIATES, LLC
 - APPROXIMATE LOCATION OF TEST PIT PERFORMED BY GUARINO SITE AND UTILITY CONTRACTING LLC ON APRIL 7, 2023 FOR McPHAIL ASSOCIATES, LLC

REFERENCE: THIS PLAN WAS PREPARED FROM A 20-SCALE DRAWING ENTITLED, "EXISTING CONDITIONS PLAN OF LAND" DATED NOVEMBER 16, 2020 PREPARED BY VHB



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">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>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.														
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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"		
					RQD				Min/ft		
	136		0.3 / 136.0	ASPHALT							
1	135			FILL	8	S-1	24/10	1.0-3.0	6	Loose, dark brown, gravelly SAND and SILT, with brick and asphalt. (FILL)	
2	134								4		
3	133								4		
4	132								7		
5	131		5.0 / 131.3	GLACIAL OUTWASH	10	S-2	24/10	3.0-5.0	4	Loose to compact, brown, silty SAND, some gravel. (FILL)	
6	130	5									
7	129	5									
8	128	8									
6	130			GLACIAL OUTWASH	73	S-3	24/12	5.0-7.0	22	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)	
7	129								32		
8	128								41		
									64		
8	128		8.3 / 128.0	Bottom of borehole extends 8.3 feet below ground surface.	191/11"	S-4	11/	7.0-7.9	91	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)	
9	127	100/5"									
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	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	
2-4	SOFT	
4-8	FIRM	
8-15	STIFF	
15-30	V.STIFF	Weather: Clear
>30	HARD	



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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	No.	Pen. /Rec. (in)	Depth (ft)	Blows/6" Min/ft		
					RQD						
	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										
3	142				54	S-2	24/10	2.0-4.0	25 31 23 19	Very dense, gray-brown, SAND and GRAVEL, trace silt. (FILL)	
4	141										
5	140				33	S-3	12/6	4.0-5.0	14 19	Dense, light gray, SAND and GRAVEL, trace silt. (FILL)	
6	139										
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										
9	136										
10	135	83	S-6		24/16	9.0-11.0	31 45 38 53	NOTE: Pulverized gravel/cobbles throughout sample. Very dense, light gray, GRAVEL, some sand, trace silt. (FILL) NOTE: Pulverized gravel/cobbles throughout sample.			
11	134		11.0 / 134.4	GLACIAL TILL							
12	133				46	S-7	24/18	11.0-13.0	18 22 24 22	Dense, gray-brown, SILT, SAND and GRAVEL. (GLACIAL TILL) NOTE: Constant head infiltration test at 11'.	
13	132										
14	131	31	S-8		24/14	13.0-15.0	16 15 16 14	Dense, gray-brown, SILT, SAND and GRAVEL. (GLACIAL TILL)			
15	130		15.0 / 130.4	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	



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 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>Date</th> <th>Depth</th> <th>Elev.</th> <th>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/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		
			0.3 / 146.8	ASPHALT							
1	146			FILL					7 5 5 4	Loose to compact, dark brown, silty SAND and GRAVEL, with asphalt. (FILL)	
2	145				10	S-1	24/6	1.0-3.0			
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										
6	141										
7	140		5.0 / 142.1	GLACIAL OUTWASH	36	S-3	24/10	5.0-7.0	8 16 20 35	Dense, gray-brown, silty SAND and GRAVEL. (GLACIAL OUTWASH)	
8	139				152/10"	S-4	10/8	7.0-7.8	52 100/4"		Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)
9	138										
10	137				114	S-5	18/13	8.5-10.0	10 32 82	Very dense, gray-brown, SAND and GRAVEL, some silt. (GLACIAL OUTWASH)	
11	136				42	S-6	24/11	10.0-12.0	17 22 20 15	Dense, gray-brown, SAND and GRAVEL, trace to some silt. (GLACIAL OUWASH) NOTE: Constant head infiltration test at 10'.	
12	135										
13	134				25	S-7	24/10	12.0-14.0	7 11 14 12	Dense, gray-brown, SAND and GRAVEL, trace to some silt. (GLACIAL OUWASH)	
14	133		14.0 / 133.1	Bottom of borehole extends 14 feet below ground surface.							
15	132										
16	131										
17	130										
18	129										
19	128										
20	127										
21	126										
22	125										

GRANULAR SOILS		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"		Groundwater Observations			
				Date	Depth	Elev.	Notes
				4-3-23	12	134.3	

Depth (ft)	Elev. (ft)	Symbol	Depth/EL to Strata Change (ft)	Stratum	Sample					Sample Description and Boring Notes
					N-Value	No.	Pen. /Rec. (in)	Depth (ft)	Blows/6"	
					RQD				Min/ft	
	146		0.3 / 146.0	ASPHALT						
1	145			FILL	16	S-1	24/5	1.0-3.0	16 9 7 23	Compact, dark brown, sandy SILT, some gravel, with brick and asphalt. (FILL)
2	144									
3	143									
4	142									
5	141		5.0 / 141.3	GLACIAL OUTWASH	127/8"	S-3	20/8	5.0-6.7	14 23 27 100/2"	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH)
6	140									
7	139									
8	138									
9	137				86	S-4	24/16	8.0-10.0	25 34 52 61	Very dense, gray-brown, SAND and GRAVEL, trace silt. (GLACIAL OUTWASH) NOTE: Constant head infiltration test at 8'
10	136				100/4"	S-5	4/4	10.0-10.3	100/4"	Very dense, gray-brown, sandy GRAVEL, trace to some silt. (GLACIAL OUTWASH) NOTE: Constant head infiltration test at 10'. Infiltration test potentially influenced by obstruction encountered at 10'.
11	135		12.0 / 134.3	GLACIAL TILL						
12	134									
13	133		13.8 / 132.5		77	S-6	21/16	12.0-13.8	57 41 36 100/3"	Very dense, gray-brown, silty SAND and GRAVEL (GLACIAL TILL)
14	132			Bottom of borehole extends 13.8 feet below ground surface.						
15	131									
16	130									
17	129									
18	128									
19	127									
20	126									
21	125									
22	124									

GRANULAR SOILS		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	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

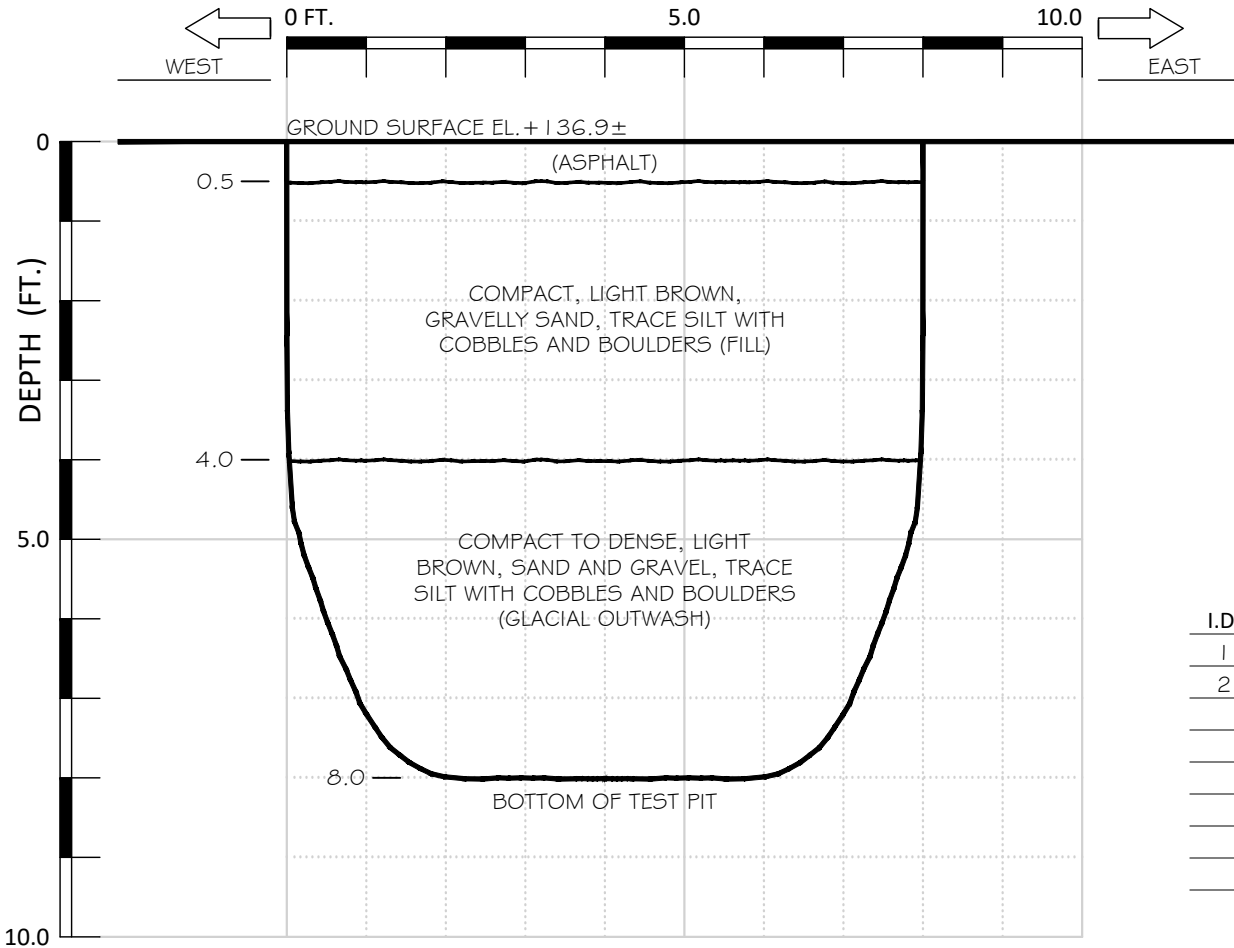
TEST PIT NO. 1

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

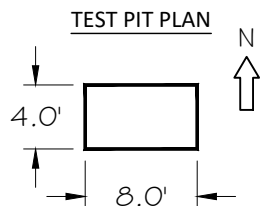
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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

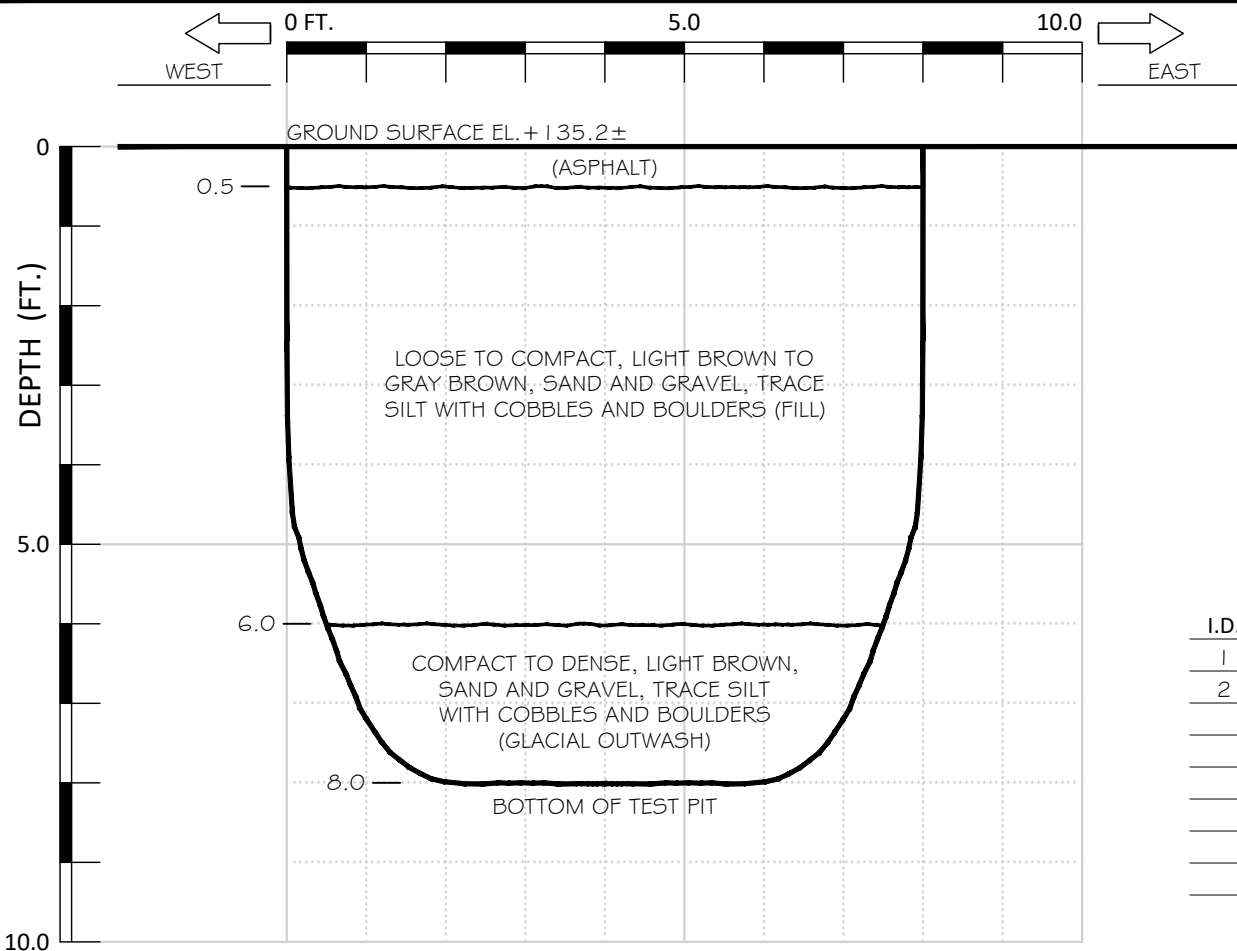
TEST PIT NO. 2

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

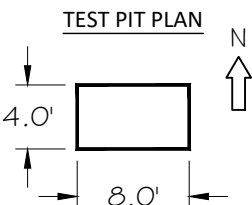
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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

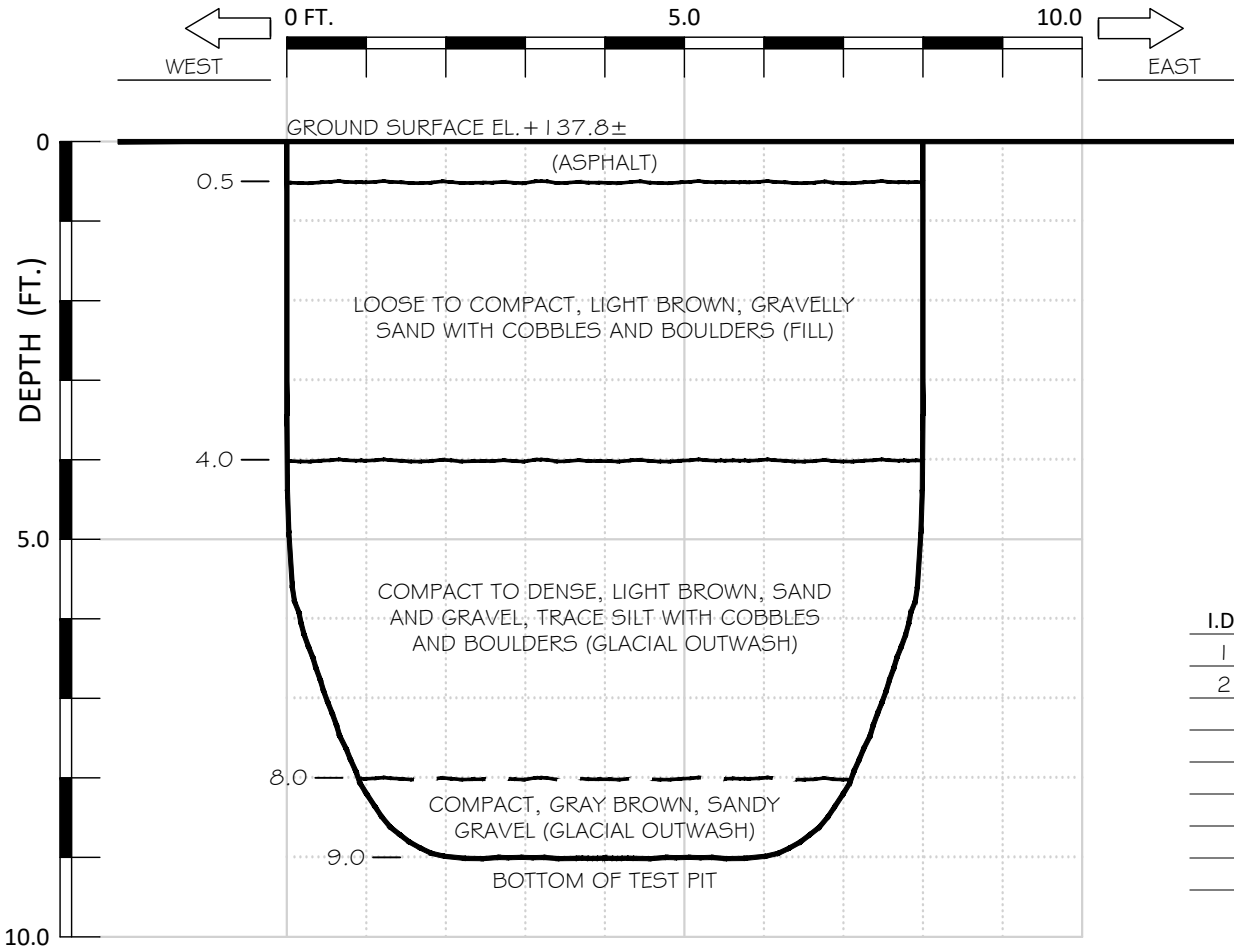
TEST PIT NO. 3

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

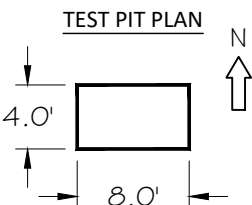
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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

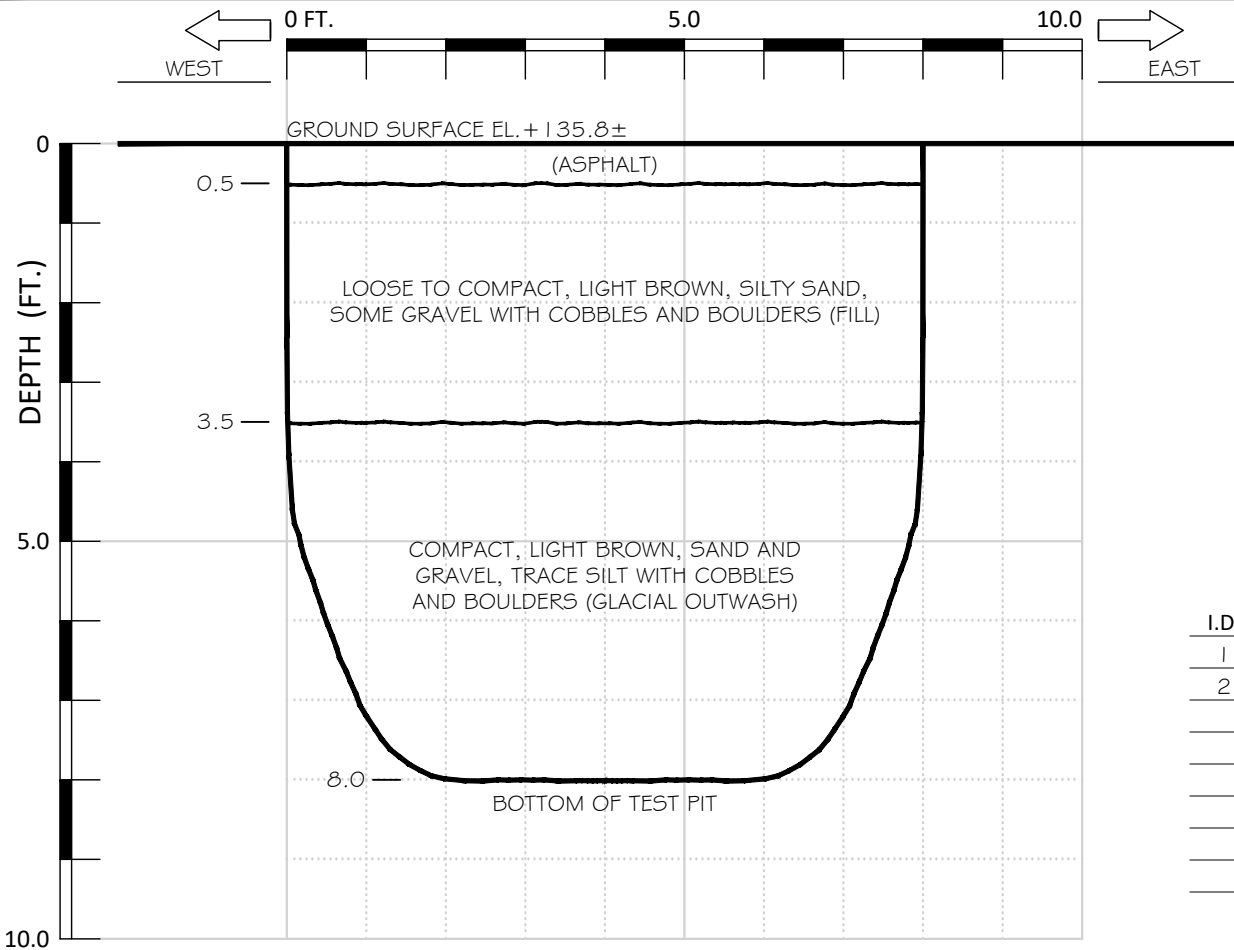
TEST PIT NO. 4

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

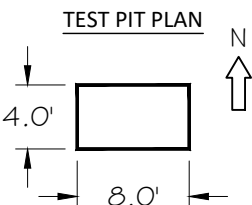
CONTRACTOR: GSV CONTRACTING
OPERATOR: DAVE

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.



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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.

Report generated by AQT SOLV v4.50.002 (www.aqtesolv.com) on 08/02/23 at 08:06:34.
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Watertown, MA 02472
P 617.924.1770

Mounding Analysis - Infiltration System 2.1: StormTrap

Project:	Highland Ave MOB Needham, MA	Project #:	14781.00
Calculated by:	PTM	Date:	August 2023
Checked by:		Date:	

In accordance with MassDEP Stormwater Management Standards, mounding analysis is required for the proposed stormwater infiltration system 2.1, 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



101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

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%



101 Walnut Street
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Watertown, MA 02471
P 617.924.1770

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%



VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

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



101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Phosphorus Removal Calculation Worksheet

Project Name: **Highland Ave MOB**
Project Number: **14781.00**
Location: **Needham, MA**

Sheet: **1 of 1**
Date: **August 2023**
Computed by: **JWM**

Proposed Total Phosphorus (TP) Annual Load - Onsite (Areas PR-1, PR-2, & PR-3)			
Land Use	Area (ac)	TP Load Export Rate (lb/acre/year) ¹	TP Annual Load (lbs/year)
Impervious - Com/Ind	1.52	1.78	2.70
Pervious - Dev. Land	0.54	0.21	0.11
Total:	2.06		2.81

Removal Percentage Calculation					
Catchment Delineation	Total Area (ac)	Static Volume Below Lowest Outlet (cf)	Effective Rainfall Depth (volume/area)	Infiltration Rate (in/hr)	TP Load Reduction Rate
Infiltration Basin P-1.1	0.49	4,571	2.54	1.02	99% (2)
Infiltration Basin P-2.1	1.50	16,855	3.09	1.02	99% (2)
Infiltration Basin P-3.1	0.06	1,464	7.03	1.02	99% (2)

Proposed Total Phosphorus (TP) Annual Load Reduction				
Catchment	Area (ac)	TP Load Export Rate (lb/acre/year) ¹	BMP Cumulative TP Load Reduction Rate	TP Load Reduction (lb/acre/year)
PR-1 - Impervious (to INF P-1.1)	0.31	1.78	99%	0.55
PR-1 - Pervious (to INF P-1.1)	0.18	0.21	99%	0.04
PR-2.1 - Impervious (to INF P-2.1)	1.14	1.78	99%	2.02
PR-2.1 - Pervious (to INF P-2.1)	0.36	0.21	99%	0.07
PR-3.1 - Impervious (to INF P-3.1)	0.06	1.78	99%	0.10
PR-3.1 - Pervious (to INF P-3.1)	0.00	0.21	99%	0.00
Total:	2.06			2.78

TP Annual Load Reduction from Proposed Condition (removal/load):	99.0%
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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)

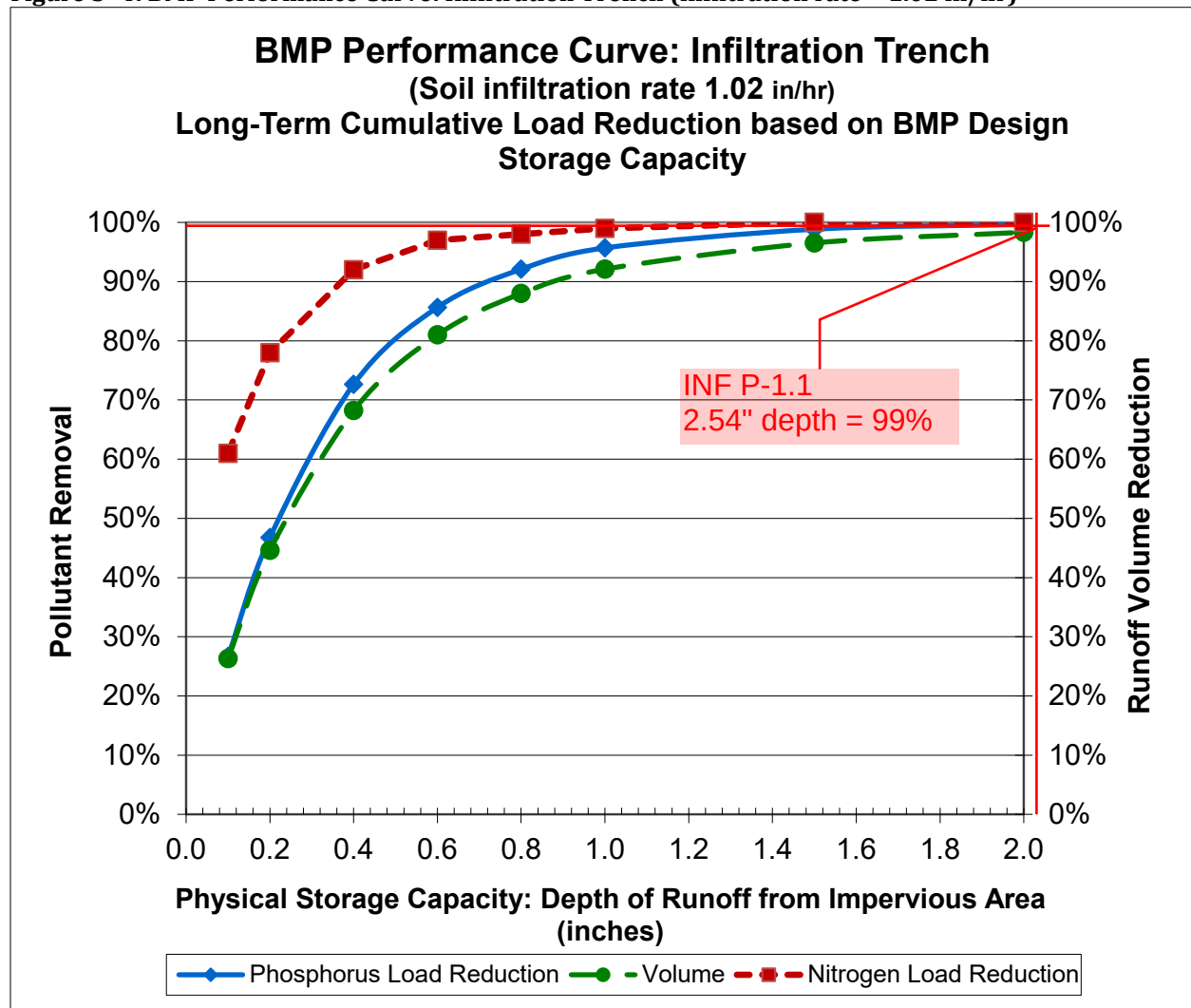


Table 3- 10: Infiltration Trench (IR = 2.41 in/hr) BMP Performance Table

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%

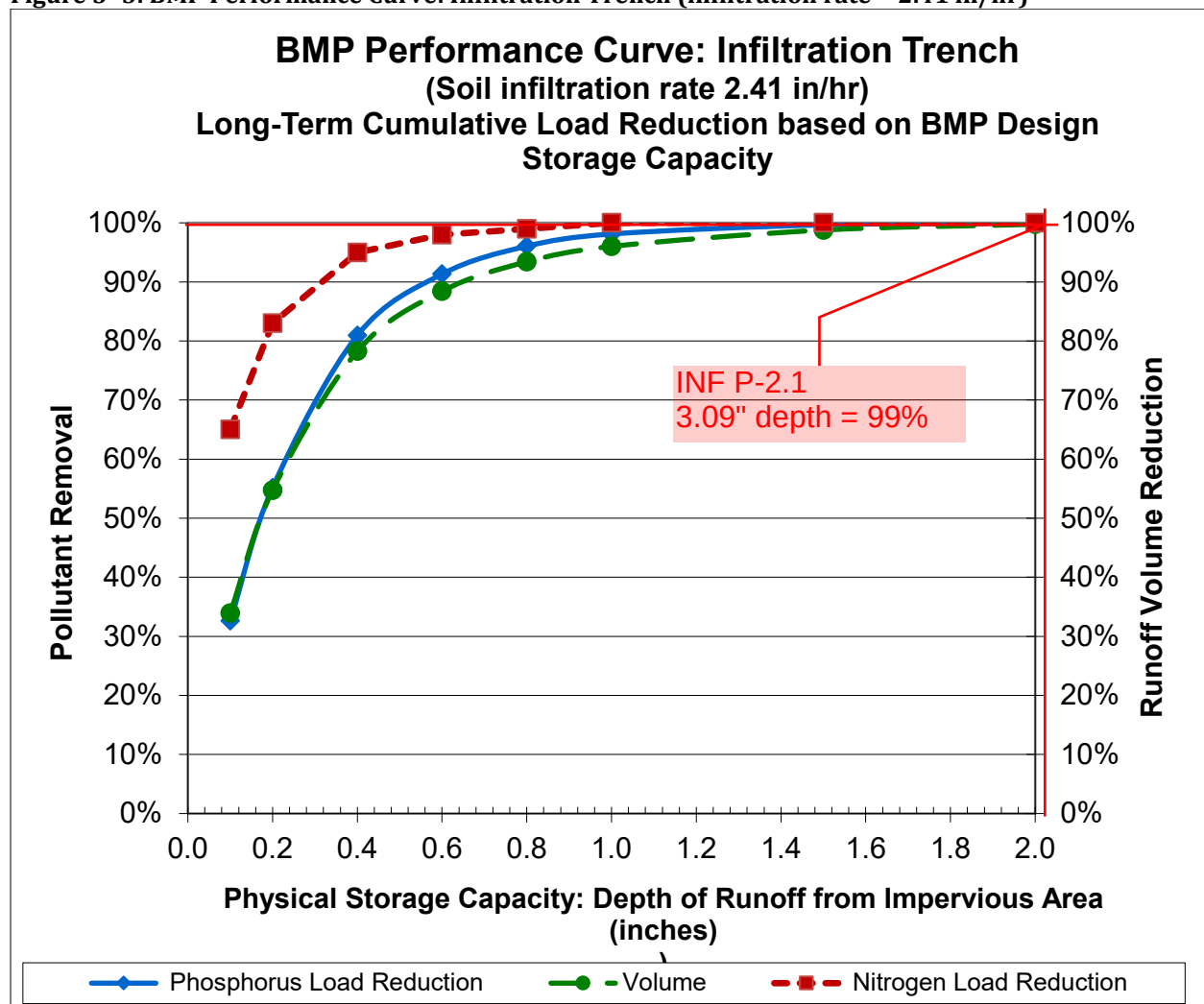
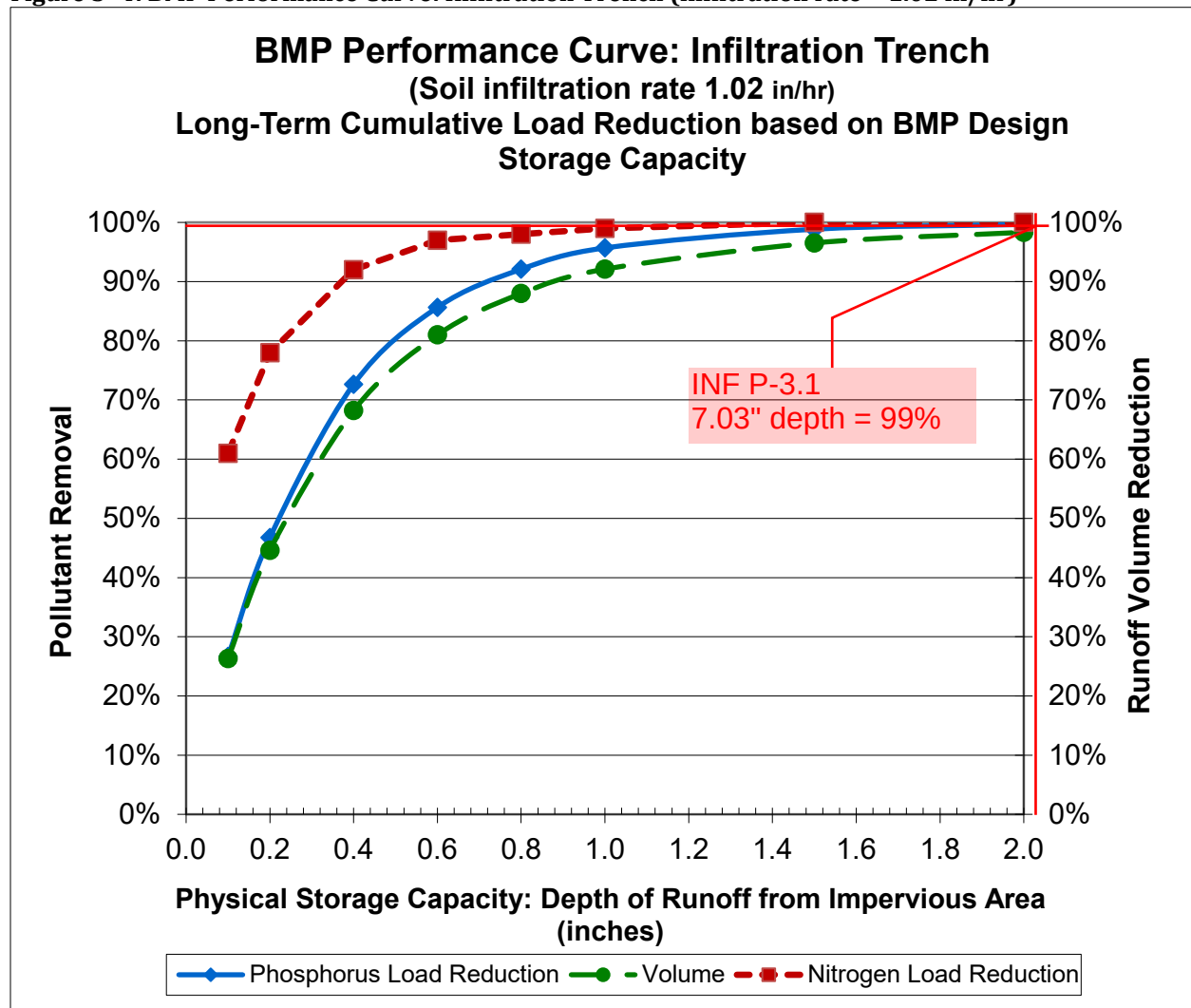
Figure 3- 5: BMP Performance Curve: Infiltration Trench (infiltration rate = 2.41 in/hr)

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:

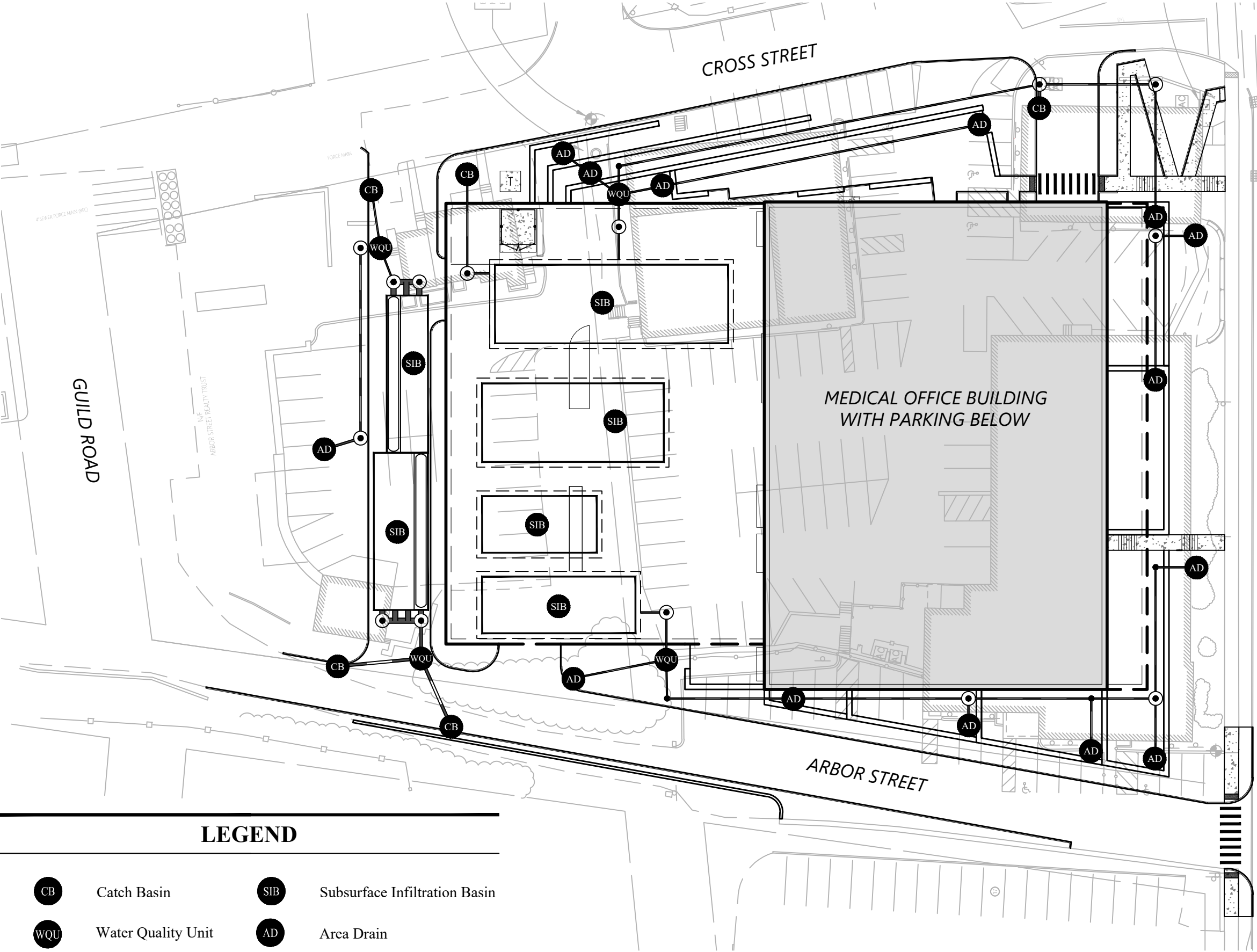
Inspect pavement and parking areas quarterly (minimum). Remove debris and vacuum sweep once annually in the spring following the last expected snowfall (at a minimum) or as necessary.

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

Pervious Patio:

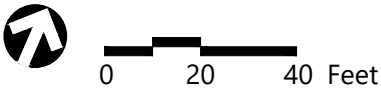
Inspect patio areas annually (minimum). Remove debris and vacuum sweep or pressure wash once annually (at a minimum) or as necessary.

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 |





TOWN OF NEEDHAM

TOWN HALL
1471 Highland Avenue
Needham, MA 02492-2669

Design Review Board

August 8, 2023

Memo: Site Plan Review, 629 Highland Avenue

The proposal is a new 50,000 square foot medical office building with associated parking.

The site has a large change in elevation from Highland Avenue to the rear of the property. The proposed building sits above a portion of 2 levels of parking. The parking areas encompass a large portion of the site. The lowest level is at the elevation of the rear of the property. The upper parking level is accessed from the adjacent side streets. The building sits at the front of the site, but is well set back approximately 60 feet, the area will be well landscaped. Due to the parking garage ceiling height, which is designed for emergency and delivery vehicle access, the first floor of the building is above the grade at Highland Avenue. The design incorporates the use of terraced landscaping on both the front and the sides. Low retaining walls create a variety of planting beds. The plan is to also create a small outdoor plaza. The applicant noted the new design significantly increases the landscaped area and reduces the impervious surface area compared to the existing site development. The Board believes the site development is very well done. The design deals very well with the potentially difficult topographic changes.

The landscaping is very well done. The plant selections include many native plants. There is not a large amount of grass area, which will help conserve water use. They propose red oak trees for the street tree. These trees will be dropping acorns, which is not great in areas with sidewalks or the plaza, they may want to consider an alternative. There was some discussion of the root system for the trees but the landscape areas seem large enough to support the trees proposed. One of the ground cover vines, *Euonymus fortunei* 'Coloratus' can turn into a climbing vine if used in beds near trees. The Board noted there are existing power poles. The applicant hopes to remove them.

Site lighting is limited to meet required levels. The fixtures are dark sky compliant and there is no off-site spillover.

The building has 2 stories with a mechanical roof screen which is set back from the roof edges. It is clad in white metal panels. There is a shade screen above the second-floor windows. Window openings are aluminum frame system with glazing and black spandrel panels. The louvered mechanical screen will hide the mechanical equipment well and complements the material and color choices for the building walls. The Board approves of the exterior materials and overall building design.

The Board believes the site and building design are well designed and deal well with complicated topography.
End of notes.

From: [John Schlittler](#)
To: [Alexandra Clee](#)
Subject: RE: Request for comment - 629-661 Highland Ave
Date: Tuesday, August 15, 2023 3:16:00 PM

Alex,

I am concerned with the additional 1,166 vehicle trips per day and its impact to the area. I think consideration should be made of the potential transportation impact of the future Muzi project development (The Muzi location was not mentioned in the Specific Development by Others section in Transportation Impact Assessment.)

I question whether the Transportation Management Association encouragement of carpooling and other measures to discourage commuting and off-site trips will provide impactful relief from vehicle congestion.

With its proximity to Route 95 one would assume that most traffic exiting the location would turn left towards 95. This vehicle movement would require a vehicle to cross a sidewalk, bike lane and two vehicular travel lanes that are heading into Needham. Exiting vehicles would have successfully navigate those issues to enter the two outbound lanes and then later be able to merge onto the Highway.

What steps are being taken to restrict vehicular traffic off Putnam St as a cut through to Highland Ave.

Chief John Schlittler

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcDonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square feet Medical Office Building (25,000 square feet footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments

by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661_Highland_Neehigh_LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.
2. Letter from Attorney Evans Huber, dated August 4, 2023.
3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.
4. Letter from Attorney Evans Huber, dated August 7, 2023.
5. Plan entitled "Highland Ave Medical Office Building," prepared by Mangel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled "Existing Conditions Plan of Land," dated August 4, 2023; Sheet 5, Sheet C1.01, entitled "Legend and General Notes," dated August 4, 2023; Sheet 6, Sheet C2.01, entitled "Site Preparation Plan," dated August 4, 2023; Sheet 7, Sheet C3.01, entitled "Layout and Materials Plan," dated August 4, 2023; Sheet 8, Sheet C4.01, entitled "Grading and Drainage Plan," dated August 4, 2023; Sheet 9, Sheet C5.01, entitled "Utilities Plan," dated August 4, 2023; Sheet 10, Sheet C6.01, entitled "Site Details 1," dated August 4, 2023; Sheet 11, Sheet C6.02, entitled "Site Details ," dated August 4, 2023; Sheet 12, Sheet C6.03, entitled "Site Details 3," dated August 4, 2023; Sheet 13, Sheet L102, entitled "Rendered Material plan," dated August 4, 2023; Sheet 14, Sheet L103, entitled "Grading Plan," dated August 4, 2023; Sheet 15, Sheet L104, entitled "Planting Plan," dated August 4, 2023; Sheet 16, Sheet L501, entitled "Details," dated August 4, 2023; Sheet 17, Sheet L520, entitled "Planting Details," dated August 4, 2023; Sheet 18, Sheet L521, entitled "Planting Details," dated August 4, 2023; Sheet 19, entitled "Site Lighting Photometric Plan," dated July 14, 2023; Sheet 20, Sheet A.101, entitled "F-1 Lower Parking plan," dated August 4, 2023; Sheet 21, Sheet A.102, entitled "F-2 Upper parking Plan," dated August 4, 2023; Sheet 22, Sheet A.103, entitled "First Floor Plan," dated August 4, 2023; Sheet 23, Sheet A.104, entitled "Second Floor Plan," dated August 4, 2023; Sheet 24, Sheet A.105, entitled "Roof Plan," dated August 4, 2023; Sheet 25, Sheet A.201, entitled "Elevations," dated August 4, 2023; Sheet 26, Sheet A.301, entitled "Building Sections," dated August 4, 2023; Sheet 27, entitled "P-1 Lower Below Grade Parking," dated July 14, 2023; Sheet 28, entitled "P-2 Upper Parking," dated July 14, 2023; Sheet 29, entitled "First Floor Plan," dated July 14, 2023; Sheet 30, entitled "Second Floor Plan," dated July 14, 2023; Sheet 31, entitled "Roof Plan," dated July 14, 2023; Sheet 32, entitled "Materials of Major Architectural Elements," dated July 14, 2023; Sheet 33, entitled "Concept Renderings, View at Highland Ave & Cross Street" dated July 14, 2023; Sheet 34, entitled "Concept Renderings, View at P-2 parking Level (South)" dated July 14, 2023; Sheet

35, entitled "Concept Renderings, View at P-2 Parking Level (West)" dated July 14, 2023; Sheet 36, entitled "Concept Renderings, View along highland Ave (North)" dated July 14, 2023; Sheet 37, entitled "Concept Renderings, View at Cross Street Below Grade Garage Entrance" dated July 14, 2023; Sheet 38, entitled "Concept Renderings, View at Arbor Street Above Grade Parking Entrance" dated July 14, 2023; Sheet 39, entitled "Concept Renderings, View at Landscape Plaza" dated July 14, 2023.

6. Transportation Impact Assessment, prepared by Vanasse & Associates, 35 New England Business Center Drive, Suite 140, Andover, MA 01810, dated July 2023.
7. Stormwater Report, prepared by Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, dated August 4, 2023.

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

From: [Tara Gurge](#)
To: [Alexandra Clee](#)
Cc: [Lee Newman](#)
Subject: RE: Request for comment - 629-661 Highland Ave
Date: Wednesday, August 30, 2023 1:34:13 PM
Attachments: [image002.png](#)
[image003.png](#)

Hello Alex –

Here are the Public Health Divisions comments for the proposed Planning Board project up for discussion located at **629-661 Highland Avenue**. See below:

- If any retail/food establishments are proposed in the new Medical Office Building to be located on this property there would need to be an online Food Permit Plan Review application completed, along with proposed food establishment design plans, which will need to be submitted and reviewed and approved by the Public Health Division prior to start of construction. Here is the direct link to the online Food Establishment Plan Review permit application - <https://needhamma.viewpointcloud.com/categories/1073/record-types/1006516> .
- Please keep in mind, if a retail food establishment plan review is approved, sufficient space must be made available in the parking lot for both a solid waste (trash) dumpster and a separate recycling dumpster, along with waste oil/grease containment (if applicable.) These dumpsters must be placed in an easily accessible area outside of the new facility. An exterior grease interceptor may also need to be installed.
- Prior to demolition of the five structures on site, the owner must apply for the Demolition reviews online, via our online permit application system. See direct link to this permit review application --<https://needhamma.viewpointcloud.com/categories/1073/record-types/1006508>. This form will need to be completed for each separate structure to be demolished, along with the uploading of the required supplemental report documents for our review and approval (as noted on the form.) **PLEASE NOTE:** Pest control reports, along with the asbestos sampling reports, etc., must be uploaded to our online system for review for each structure to be demolished, prior to the issuance of the Demolition permits by the Building Department.
- On-going pest control must be conducted during demolition of the structures AND on-going pest control must be conducted throughout construction of the new office building.

Please let us know if you have any follow-up questions or if you need any additional information from us on those requirements.

Thanks,



TARA E. GURGE, R.S., C.E.H.T., M.S. (she/her/hers)
ASSISTANT PUBLIC HEALTH DIRECTOR
Needham Public Health Division
Health and Human Services Department
178 Rosemary Street

Needham, MA 02494
Ph- (781) 455-7940; Ext. 211/Fax- (781) 455-7922
Mobile- (781) 883-0127
Email - tgurge@needhamma.gov
Web- www.needhamma.gov/health



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[Follow Needham Public Health on Twitter!](#)

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square foot Medical Office Building (25,000 square foot footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

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The entire filing includes:

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3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.
4. Letter from Attorney Evans Huber, dated August 7, 2023.
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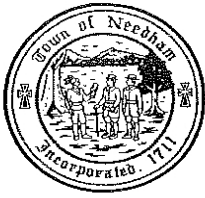
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Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov



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

August 30, 2023

Needham Planning Board
Needham Public Safety Administration Building
Needham, MA 02492

RE: Major Project Special Permit No. 2023-03
629-661 Highland Ave- Neehigh, LLC

Dear Members of the Board,

The Department of Public Works has completed its review of the above referenced application for the proposed work at 629-661 Highland Ave. The project includes the redevelopment of the site for a new two-story medical office building and 250 car, two-story parking garage. The project also includes the demolition of five existing buildings, new utility upgrades and the addition of storm water management system.

The documents submitted for review are as follows:

- Cover Letter Prepared by Frieze Cramer Rosen & Hubber llp dated 8/4/23.
- Cover Letter Prepared by Frieze Cramer Rosen & Hubber llp dated 8/7/23.
- Application for Special Permit dated No.2023-03
- Letter of Authorization Neehigh LLC dated 8/3/23.
- Plan set entitled "Highland Ave Medical Office Building," prepared by Mangel DeStefano Architects, Inc. dated 8/4/23 consisting of 39 Sheets.
- Transportation Impact Assessment, prepared by Vanasse & Associates, dated July 2023.
- Stormwater Report, prepared by Vanesse Hangen Brustlin, dated 8/4/23.

Our comments and recommendations are as follows:

- The Engineering Division has met with the applicant's Engineers and will provide additional information on the utilities and work with them to investigate if gravity sewer connections are possible through the Putnam Street sewer system.
- The Water and Sewer Division will have comments as the project design progresses and may have additional Water and Sewer permit requirements prior to construction. Which may include possible looping of the water main and upgrading the existing 6" water main on Cross Street to accommodate the new domestic water and fire protection services.

- The Transportation Impact Assessment incorporates potential future transportation mitigation that is proposed for the 557 Highland Avenue project. The Engineering Division concurs with the Police Department's comments and suggests a peer review from assess the traffic mitigation proposal with this project.
- For the new facility, two times the 3,750 GPD expected generated in wastewater flow equates to a total of 7,500 GPD I/I removal anticipated from the development. This may be satisfied by either undertaking a construction project or paying a fee to the Town's I&I program at a rate of \$8.00 per gallon required to be removed.
- A separate MassDOT approval is required for any work for this section of Highland Ave right of way.
- As part of the NPDES requirements, the applicant must comply with the Public Outreach & Education and Public Participation & Involvement control measures. The applicant shall submit a letter to the town identifying the measures selected and dates by which the measures will be completed in order to incorporate it into the Planning Board's decision.

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

Truly yours,

Thomas A Ryder
Town Engineer



Town of Needham
Building Department
500 Dedham Ave.
Needham, MA 02492

Tel. 781-455-7550 x 308

August 31, 2022

Town of Needham Planning Board
Lee Newman / Town Planner
500 Dedham Ave.
Needham, MA. 024902

Re: 629-661 Highland Ave./ Medical Office Building/ Major Project

Dear Planning Board Members,

Please be advised that I have reviewed the proposed plan for the new medical office building proposed by Neehigh LLC at 629-661 Highland Ave. have the following comments:

The proposal shows a new medical office building. The grade of the site slopes down, approximately 20' from Highland Ave. to Guild St. The 2 uppermost levels will contain 50,000 square feet of medical office space and the two lower levels contain 250 parking spaces. Because the lowest level is mostly below grade, the building is considered only 3 stories. The plans, at this point show a "shell" building. Presumably, various suites will be designed for each tenant as they are acquired.

The building itself, based on the plans submitted, does appear to be compliant with all relevant sections of the Zoning Bylaw.

There appears to be a discrepancy/error in the table on page P3 (Site Diagram) of the plans, which indicates the setback from Highland to be 57.75'/62.25'. This conflicts with the site plan on page C3.01 which shows a uniform setback of 38' from Highland.

Also, there is no access shown for persons with disabilities at the front entry, facing Highland Ave. There is only a set of stairs shown here but no access ramp. The Mass Architectural Access Code, 521CMR requires ALL entrances to be fully accessible.

Sincerely,

Joe Prondak
Needham Building Commissioner

From: [Tom Conroy](#)
To: [Alexandra Clee](#)
Cc: [Donald Anastasi](#); [Jay Steeves](#); [Ronnie Gavel](#)
Subject: RE: Request for comment - 629-661 Highland Ave
Date: Wednesday, August 30, 2023 9:17:51 AM
Attachments: [image002.png](#)

Hi Alex,

Sorry for the late response. Would it be possible to get more detail on the hydrant location and the fire department sprinkler intake connection?

Thank you.



Thomas M. Conroy

Fire Chief - Needham Fire Department

tconroy@needhamma.gov

Ph (781) 455-7580

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Tuesday, August 29, 2023 5:23 PM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>
Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

Hi there,

Sending a reminder to please send your comments by tomorrow.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov/planning

From: Alexandra Clee
Sent: Friday, August 11, 2023 11:34 AM
To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John

Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>

Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>

Subject: Request for comment - 629-661 Highland Ave

Dear all,

We have received the attached application materials for a proposal from Neehigh LLC at 629-661 Highland Ave to demolish the five existing buildings on the property and build a single two-story 50,000 square foot Medical Office Building (25,000 square foot footprint) with two levels of parking (one at-grade and one below grade) totaling two hundred and fifty (250) spaces. More information can be found in the attachments.

The Planning Board has scheduled this matter for September 5, 2023. Please send your comments by Wednesday August 30, 2023 at the latest.

The materials are too large to include all of them in this email. Please see this folder for the entire filing: K:\Planning Board Applications\Planning_629-661_Highland_Neehigh_LLC

The entire filing includes:

1. Application for Special Permit No. 2023-03.
2. Letter from Attorney Evans Huber, dated August 4, 2023.
3. Letter from James Curtin, Neehigh LLC, dated August 3, 2023.
4. Letter from Attorney Evans Huber, dated August 7, 2023.
5. Plan entitled "Highland Ave Medical Office Building," prepared by Mangel DeStefano Architects, Inc., 200 Ayer Road, Harvard, MA 01451, Vanesse Hangen Brustlin, 101 Walnut Street, Watertown, MA 02472, Ground, Inc., 285 Washington Street, Unit G, Somerville, MA, 02143, consisting of 39 sheets: Sheet 1, Cover Sheet, dated August 4, 2023; Sheet 2, Existing Site Photographs, dated July 14, 2023; Sheet 3, Site Diagram, dated July 14, 2023; Sheet 4, Sheet SV1.00, entitled "Existing Conditions Plan of Land," dated August 4, 2023; Sheet 5, Sheet C1.01, entitled "Legend and General Notes," dated August 4, 2023; Sheet 6, Sheet C2.01, entitled "Site Preparation Plan," dated August 4, 2023; Sheet 7, Sheet C3.01, entitled "Layout and Materials Plan," dated August 4, 2023; Sheet 8, Sheet C4.01, entitled "Grading and Drainage Plan," dated August 4, 2023; Sheet 9, Sheet C5.01, entitled "Utilities Plan," dated August 4, 2023; Sheet 10, Sheet C6.01, entitled "Site Details 1," dated August 4, 2023; Sheet 11, Sheet C6.02, entitled "Site Details ," dated August 4, 2023; Sheet 12, Sheet C6.03, entitled "Site Details 3," dated August 4, 2023; Sheet 13, Sheet L102, entitled "Rendered

Material plan,” dated August 4, 2023; Sheet 14, Sheet L103, entitled “Grading Plan,” dated August 4, 2023; Sheet 15, Sheet L104, entitled “Planting Plan,” dated August 4, 2023; Sheet 16, Sheet L501, entitled “Details,” dated August 4, 2023; Sheet 17, Sheet L520, entitled “Planting Details,” dated August 4, 2023; Sheet 18, Sheet L521, entitled “Planting Details,” dated August 4, 2023; Sheet 19, entitled “Site Lighting Photometric Plan,” dated July 14, 2023; Sheet 20, Sheet A.101, entitled “F-1 Lower Parking plan,” dated August 4, 2023; Sheet 21, Sheet A.102, entitled “F-2 Upper parking Plan,” dated August 4, 2023; Sheet 22, Sheet A.103, entitled “First Floor Plan,” dated August 4, 2023; Sheet 23, Sheet A.104, entitled “Second Floor Plan,” dated August 4, 2023; Sheet 24, Sheet A.105, entitled “Roof Plan,” dated August 4, 2023; Sheet 25, Sheet A.201, entitled “Elevations,” dated August 4, 2023; Sheet 26, Sheet A.301, entitled “Building Sections,” dated August 4, 2023; Sheet 27, entitled “P-1 Lower Below Grade Parking,” dated July 14, 2023; Sheet 28, entitled “P-2 Upper Parking,” dated July 14, 2023; Sheet 29, entitled “First Floor Plan,” dated July 14, 2023; Sheet 30, entitled “Second Floor Plan,” dated July 14, 2023; Sheet 31, entitled “Roof Plan,” dated July 14, 2023; Sheet 32, entitled “Materials of Major Architectural Elements,” dated July 14, 2023; Sheet 33, entitled “Concept Renderings, View at Highland Ave & Cross Street” dated July 14, 2023; Sheet 34, entitled “Concept Renderings, View at P-2 parking Level (South)” dated July 14, 2023; Sheet 35, entitled “Concept Renderings, View at P-2 Parking Level (West)” dated July 14, 2023; Sheet 36, entitled “Concept Renderings, View along highland Ave (North)” dated July 14, 2023; Sheet 37, entitled “Concept Renderings, View at Cross Street Below Grade Garage Entrance” dated July 14, 2023; Sheet 38, entitled “Concept Renderings, View at Arbor Street Above Grade Parking Entrance” dated July 14, 2023; Sheet 39, entitled “Concept Renderings, View at Landscape Plaza” dated July 14, 2023.

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

I have attached a few documents to this email – items 1-4 listed above. The rest are in the K Drive as noted.

Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

From: [Justin Mosca](#)
To: [Tom Conroy](#)
Cc: [Donald Anastasi](#); [Jay Steeves](#); [Ronnie Gavel](#); [Alexandra Clee](#); [Lee Newman](#); [Evans Huber](#)
Subject: RE: Request for comment - 629-661 Highland Ave
Date: Wednesday, August 30, 2023 2:51:29 PM
Attachments: [image001.png](#)
[Highland MOB-Fire Truck Routing.pdf](#)

Chief Conroy,

VHB was forwarded your request below regarding additional information on hydrant locations and fire dept. connections for the proposed MOB on Highland Avenue. Please find attached a figure which shows our anticipated hydrant coverage and fire truck routing around the site using Needham's aerial tower truck. One of the hydrants (along Highland Ave) is existing to remain. The other two are new proposed hydrants to provide no more than 250' between a hydrant and building points.

With regards to the fire department connection, the location is flexible and I think we'd be interested to hear your opinion on where you'd like it to be located, since you'll know where you'd like to set up with the pumper truck. It should be within 100' of a hydrant to meet code requirements, but other than that, I believe it can be on whichever face of the building you'd prefer. We're also curious if you have a preferred style of connection (Siamese or Storz).

Please let us know your thoughts. Feel free to give me a call to talk it through if easier.

Thank you,

Justin Mosca, PE

Project Manager

Licensed in MA

P [617.607.2727](tel:617.607.2727)

www.vhb.com

From: Tom Conroy <TConroy@needhamma.gov>
Sent: Wednesday, August 30, 2023 9:17:48 AM
To: Alexandra Clee <aclee@needhamma.gov>
Cc: Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>;
Ronnie Gavel <rgavel@needhamma.gov>
Subject: RE: Request for comment - 629-661 Highland Ave

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Thank you.



Thomas M. Conroy

Fire Chief - Needham Fire Department

tconroy@needhamma.gov

Ph (781) 455-7580

From: Alexandra Clee <aclee@needhamma.gov>

Sent: Tuesday, August 29, 2023 5:23 PM

To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>

Cc: Elisa Litchman <elitchman@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>; Justin Savignano <jsavignano@needhamma.gov>; Donald Anastasi <DAnastasi@needhamma.gov>; Jay Steeves <steevesj@needhamma.gov>; Ronnie Gavel <rgavel@needhamma.gov>

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Alexandra Clee
Assistant Town Planner
Needham, MA
www.needhamma.gov/planning

From: Alexandra Clee

Sent: Friday, August 11, 2023 11:34 AM

To: Joseph Prondak <jprondak@needhamma.gov>; Thomas Ryder <tryder@needhamma.gov>; John Schlittler <JSchlittler@needhamma.gov>; Tara Gurge <TGurge@needhamma.gov>; Timothy McDonald <tmcdonald@needhamma.gov>; Tom Conroy <TConroy@needhamma.gov>; Carys Lustig <clustig@needhamma.gov>

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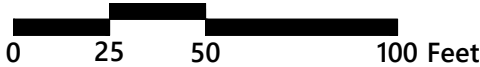
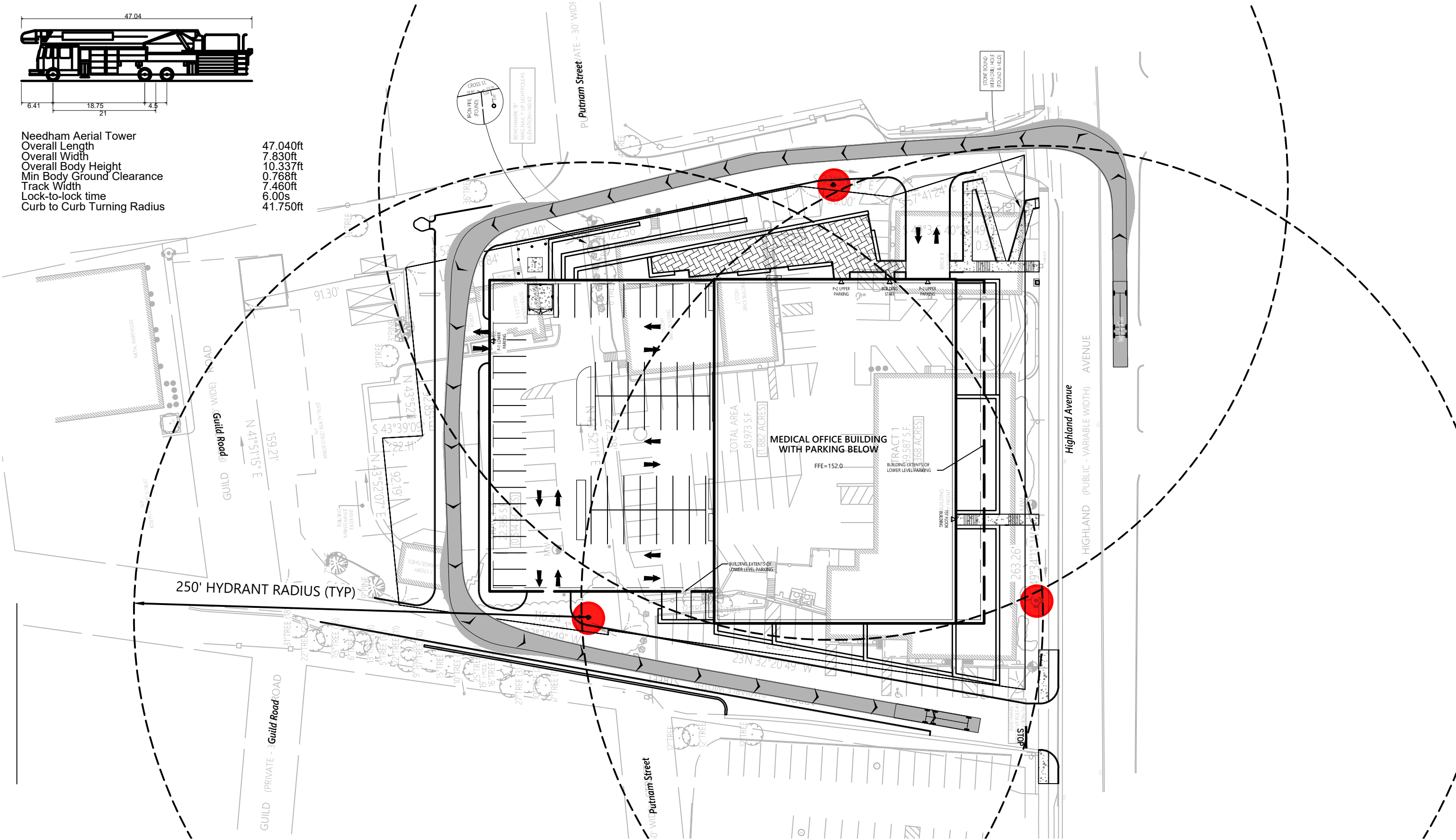
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Thank you, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov



Fire Access Plan

Needham Medical Office
Highland Ave, Needham, MA

Figure FT-1

August 4, 2023



31 August 2023

Town of Needham Planning Board
Lee Newman/ Town Planner
500 Dedham Ave.
Needham, MA 02492

RE: 629-661 Highland Ave./ Proposed Medical Office Building/ Building Commissioner Letter

Dear Ms. Newman and Planning Board Members,

Thank you for forwarding the Building Commissioner's letter dated August 31, 2023. Before meeting with the Board next Tuesday evening, we wanted to provide the following clarifications regarding two of Mr. Prondak's comments.

Discrepancy/error in the table on Page P3 (Site Diagram)

The Site Diagram distances listed under "Setback from Highland" refer to the space between the face of the building(s) and the pavement edge along Highland Avenue. This information differs from the zoning setback relative to the property line. The zoning setback is accurately indicated on the civil plans---38' from the property line to the face of the medical office building, and 22.5' to the concealed underground parking structure. We apologize for any confusion with our use of the term "setback" on Page P3.

No access for persons with disabilities at the front entry, facing Highland Ave.

The door facing Highland Avenue is being provided for emergency building egress only, and it will be outfitted with hardware and signed accordingly. The building's entrance is located beneath the building and is designed to be fully accessible. It is served by adjacent accessible parking spaces, accessible drop-off areas, and an accessible pedestrian route from the corner of Cross Street and Highland Avenue.

We trust that this information is helpful, and please do not hesitate to reach out should you have any further questions. We look forward to meeting with the Board next week and, in the future, working with the Building Department to review and coordinate code compliance for the project.

Sincerely,

A handwritten signature in black ink, appearing to read "Daniel Barton", with a stylized flourish at the end.

Daniel Barton AIA
Principal

978 273-3291
dbarton@maugel.com

Ref: 8315

August 31, 2023

Ms. Alexandra Clee
Assistant Town Planner
Town of Needham
Planning and Community Development Department
Public Services Administration Building
500 Dedham Avenue
Needham, MA 02492

Re: Response to Police Department Comments
Proposed Medical Office Building – 629-661 Highland Avenue
Needham, Massachusetts

Dear Alex:

Vanasse & Associates, Inc. (VAI) is providing responses to the initial comments that were offered by Chief John Schlittler of the Needham Police Department concerning his review of the July 2023 *Transportation Impact Assessment* (the “July 2023 TIA”) prepared by VAI in support of the proposed medical office building to be located at 629-661 Highland Avenue in Needham, Massachusetts (hereafter referred to as the “Project”). Listed below are the comments that were offered by Chief Schlittler in his August 15, 2023 email followed by our response on behalf of the Applicant:

Comment 1: *I am concerned with the additional 1,166 vehicle trips per day and its impact to the area. I think consideration should be made of the potential transportation impact of the future Muzi project development (The Muzi location was not mentioned in the Specific Development by Others section in Transportation Impact Assessment.)*

Response: The impacts associated with the redevelopment of the former Muzi Ford site were considered in the July 2023 TIA and the cumulative impact of both the Project and the redevelopment of the Muzi Ford site (a.k.a. Highland Science Center) were assessed (see page 15 of the July 2023 TIA and the “Background Development Traffic-Volume Networks” section of the accompanying Technical Appendix). Based on this evaluation and with consideration of the improvements that will be advanced as a part of the Highland Science Center and those proposed as a part of the Project (traffic signal timing improvements at the Highland Avenue/Webster Street and Highland Avenue/Gould Street/Hunting Road intersections), overall motorist delays and vehicle queuing will be reduced to the extent that there will be a general improvement over No-Build conditions (see Table 13 on page 35 of the July 2023 TIA. The column in Table 13 titled: “2030 Build with Mitigation” details the improved conditions along Highland Avenue, which include a general reduction in motorist delay over No-Build conditions of up to 14.3 seconds).

Comment 2: *I question whether the Transportation Management Association encouragement of carpooling and other measures to discourage commuting and off-site trips will provide impactful relief from vehicle congestion.*

Response: The elements of the Transportation Demand Management (TDM) program include proven measures that have been successful at reducing employee related automobile trips. An effectively marketed TDM program can achieve trip reductions of 10 percent or more over baseline (no TDM program) conditions. Any reduction in trips that may result from the TDM program will be beneficial to reducing the impact of the Project on the transportation infrastructure.

Comment 3: *With its proximity to Route 95 one would assume that most traffic exiting the location would turn left towards 95. This vehicle movement would require a vehicle to cross a sidewalk, bike lane and two vehicular travel lanes that are heading into Needham. Exiting vehicles would have successfully navigate those issues to enter the two outbound lanes and then later be able to merge onto the Highway.*

Response: It is anticipated that 54 percent of the trips associated with the Project will be oriented to and from the east of the Project site and toward Interstate 95. The analyses presented in the July 2023 TIA reflect the increased time required for a motorist to complete a left-turn movement exiting from the Project site to Highland Avenue. Based on this analysis, motorists exiting the Project site will experience delays due to the volume of traffic on Highland Avenue; however, the residual vehicle queuing was found to range from one (1) to five (5) vehicles (see Table 11 on page 28 of the July 2023 TIA), and can be contained along Arbor Street and Cross Street without impeding the movement of vehicles, pedestrians or bicyclists along Highland Avenue. It is important to note that the traffic signals along Highland Avenue on either side of the Project at Hunting Road/Gould Street and at Webster Street create gaps in the flow of traffic along Highland Avenue that will allow motorists to exit the Project site with less delay than predicted by the analysis model. Further, when there is extended vehicle queuing along Arbor Street or Cross Street, the residual queue will extend into the Project site and not necessarily along these roadways.

Further and most importantly, the sight distance measurements for a motorist exiting from the Project site also considers these conditions and the need for an exiting motorist to observe a pedestrian in the sidewalk and a bicyclist in the bicycle lane before entering the traveled-way to complete a left or right-turn movement. The available lines of sight to and from Arbor Street and Cross Street along Highland Avenue will allow for these intersections to continue to function in a safe manner (see pages 30 and 31 of the July 2023 TIA).

Comment 4: *What steps are being taken to restrict vehicular traffic off Putnam St as a cut through to Highland Ave.?*

Response: The Applicant has agreed to implement specific measures to reduce the potential for the use of Putnam Street by Project-related traffic. These measures may include the following:

- Installation of “No Thru Traffic” signs on both Cross Street and Highland Avenue at Putnam Street; and/or



Ms. Alexandra Clee
August 31, 2023
Page 3 of 3

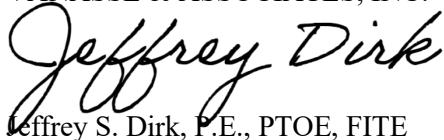
- Installation of turn restriction signs on Cross Street at Putnam Avenue (“No Left Turn” for traffic exiting from Putnam Street to Cross Street and for traffic on Cross Street approaching Putnam Lane).

The specific measures would be designed and constructed by the Applicant subject to receipt of all necessary rights, permits and approvals.

We trust that this information is responsive to the initial comments that were offered by Chief Schlittler concerning his review of the July 2023 TIA. If you should have any questions regarding this information, please feel free to contact me.

Sincerely,

VANASSE & ASSOCIATES, INC.



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

Professional Engineer in CT, MA, ME, NH, RI, and VA

JSD/jsd



From: [Joseph Prondak](#)
To: [Alexandra Clee](#)
Cc: [Lee Newman](#)
Subject: RE: Highland MOB - PB Response to Bldg. Commissioner's Letter
Date: Tuesday, September 5, 2023 8:37:16 AM

Thanks, Alex,

I am good w/ that response.

Joe P.

From: Alexandra Clee <aclee@needhamma.gov>
Sent: Friday, September 1, 2023 5:40 PM
To: Joseph Prondak <jprondak@needhamma.gov>
Cc: Lee Newman <LNewman@needhamma.gov>
Subject: FW: Highland MOB - PB Response to Bldg. Commissioner's Letter

Hi Joe,

Please find letter attached replying to your comments on this project.

Thanks, alex.

Alexandra Clee
Assistant Town Planner
Needham, MA
781-455-7550 ext. 271
www.needhamma.gov

From: Evans Huber <eh@128law.com>
Sent: Friday, September 1, 2023 1:59 PM
To: Alexandra Clee <aclee@needhamma.gov>; Lee Newman <LNewman@needhamma.gov>
Subject: FW: Highland MOB - PB Response to Bldg. Commissioner's Letter

Alex and Lee: please see the attached response from our architectural team regrading a couple of issues raised by the building commissioner. Please forward this to him as well as to members of the Board.

Thanks, Evans

Evans Huber
Frieze Cramer Rosen & Huber, LLP
62 Walnut Street, Suite 6
Wellesley, MA 02481
781-943-4000 (main)

781-943-4043 (direct)

781-799-9272 (cell)

eh@128law.com

www.128law.com

From: [Glenn Mulno](#)
To: [Planning](#)
Subject: Boston Development Group plans for 629-661 Highland Ave.
Date: Thursday, August 31, 2023 10:44:35 AM

Hi Planning Board

I wanted to provide some feedback on a hearing you will be holding next week regarding Boston Development Group plans for 629-661 Highland Ave.

I trust that you will do all the right things for the town and neighborhood with respect to size and traffic. But I wanted to take this also as an opportunity to seek to address the worsening housing crisis we face. The biggest concern around housing is always lack of land to build adequate housing. Which only gets exacerbated when developers tear down smaller homes to build much more expensive larger homes.

It seems to me that the development planned for 629-661 Highland Ave could help address the situation. Could we explore "encouraging" and allowing the developer to add a 3rd and maybe 4th floor of residential units on top of the medical building? Let them build 2 floors of medical office space, but why not take advantage of the project space to also build housing on top of that? It obviously would require no additional land, and would likely enable the developer to make even more money.

Needham would gain additional housing, additional tax revenue and the developer would make more money - seems like a win-win!

Please consider.

Glenn Mulno
TMM - Precinct I

RECEIVED TOWN CLERK
NEEDHAM, MA 02452

2023 AUG 29 PM 4:51

TOWN OF NEEDHAM
MASSACHUSETTS



PLANNING BOARD

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

APPLICATION FOR ENDORSEMENT OF PLAN
BELIEVED NOT TO REQUIRE APPROVAL

Submit three (3) copies. One copy to be filed with the Planning Board and one with the Town Clerk as required by Section 81-P, Chapter 41 of the General Laws. This application must be accompanied by the **Original Tracing** and **three (3) copies of the plan**.

To the Planning Board:

The undersigned, believing that the accompanying plan of land in the Town of Needham does not constitute a subdivision within the meaning of the Subdivision Control Law, for the reasons outlined below, herewith submits said plan for a determination and endorsement that Planning Board approval under the Subdivision Control Law is not required.

1. Name of Applicant ARTHUR FINE HOMES, LLC
Address 7 HUNTERS LANE, NATICK, MA 01760
2. Name of Engineer or Surveyor FIELD RESOURCES
Address 281 CHESTNUT STREET, NEEDHAM, MA 02492
3. Deed of property recorded in NORFOLK COUNTY Registry,
Book 40284, Page 443
4. Location and description of property 248 HARRIS AVE, NEEDHAM
NORTH-WESTERY CORNER OF HARRIS AVE AND BRADFORD STREET, NEEDHAM
5. Reasons approval is not required (check as applicable):
 - a) Every lot shown has the area and frontage required by the Zoning By-Law on a way, as defined by Section 81-L, Chapter 41 of the General Laws.
 - b) Land designated SEE ADENDUM shall not be used as separate building lot(s) but only together with adjacent lots having the required area and frontage.
 - c) Lot(s) having less than required frontage or area resulted from a taking for public purpose or have been recorded prior to 3/26/1925, no land is available to make up the deficiency and the frontage and land area of such lots are not being reduced by the plan.
 - d) SEE ADENDUM

(If the applicant is not the owner, written authorization to act as agent must be attached)

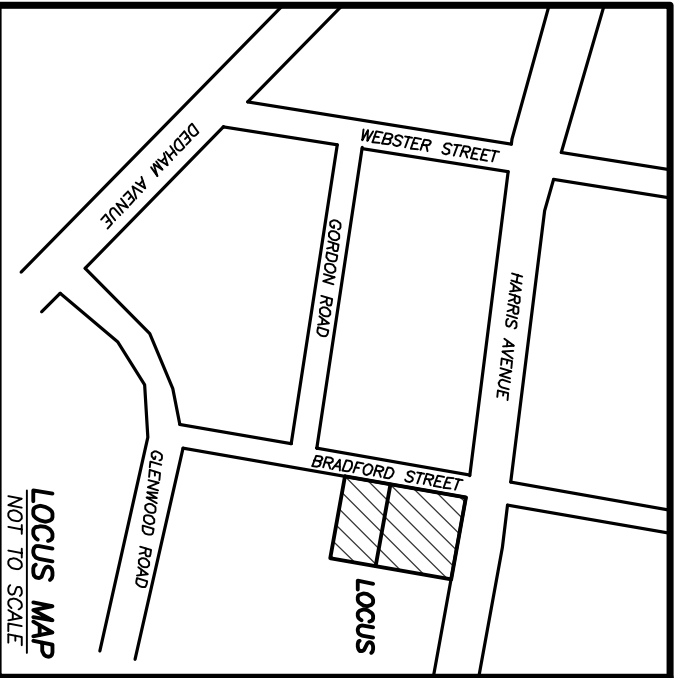
Signature of Applicant *Arthur Fine* (Mencare)

Address 7 HUNTERS LANE, NATICK, MA 01760

By _____ (agent)

Application accepted this 29 day of August 20 23
as duly submitted under the rules and regulations of the Planning Board.

By *Adam Clarke*



- IRON PIPE
□ STONE BOUND WITH DRILL HOLE
IP IRON PIPE
SB/DH . . . STONE BOUND WITH DRILL HOLE
FND: FOUND

LEGEND:

REFERENCES:

- DEEDS:
BOOK 19339 PAGE 56 (LOCUS)
BOOK 40284 PAGE 443 (LOCUS)

PLANS:

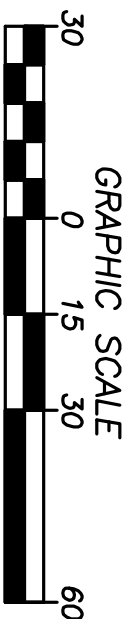
- DEED BOOK 833 PAGE 441 (LOCUS PLAN)
PLAN BOOK 21 PLAN 975 (LAYOUT)



I CERTIFY THAT THIS PLAN CONFORMS WITH THE RULES AND REGULATIONS OF THE REGISTERS OF DEEDS.
I CERTIFY THAT THIS PLAN IS BASED UPON AN ACTUAL FIELD SURVEY, AND THE LATEST PLANS AND DEEDS OF RECORD.

OWNERS/APPLICANTS:
JAMES E REULBACH
96 BRADFORD STREET
NEEDHAM, MA

NICK ARTHUR
ARTHUR FINE HOMES
7 HUNTRERS LANE
NATICK, MA



JOB NO. 170-21

Field Resources, Inc.
LAND SURVEYORS

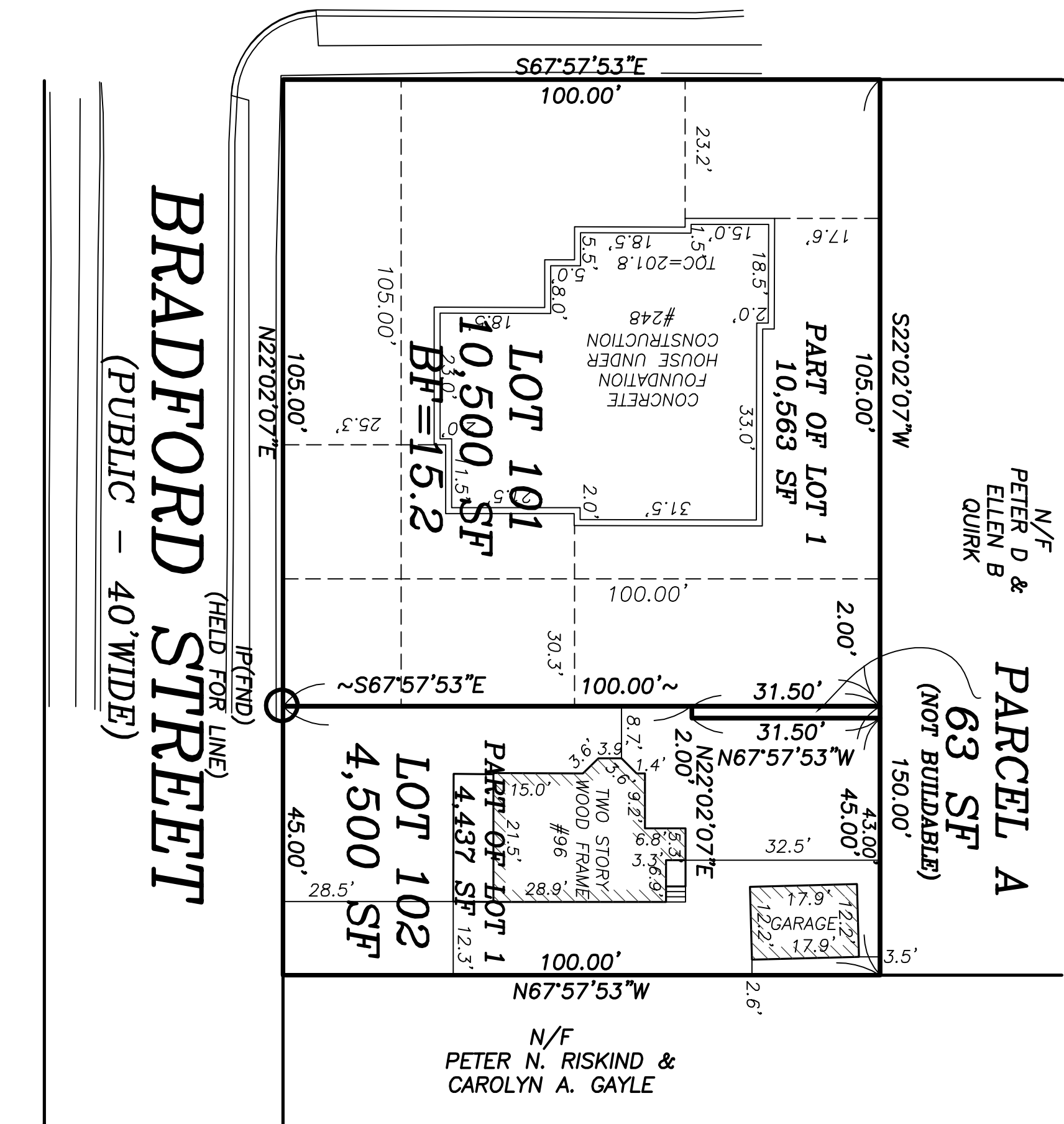
AUGUST 18, 2022 SCALE 1"=30'
P.O. BOX 324 281 CHESTNUT ST.
AUBURN, MA NEEDHAM, MA.
781 444 5936

REVISED:

office@fielddresources.net

HARRIS AVENUE
(PUBLIC - 92' WIDE)

BRADFORD STREET
(PUBLIC - 40' WIDE)



FOR REGISTRY USE ONLY

APPROVAL UNDER THE SUBDIVISION
CONTROL LAW NOT REQUIRED
NEEDHAM PLANNING BOARD

DATE:

NO DETERMINATION AS TO COMPLIANCE
WITH ZONING REQUIREMENTS IS MADE
OR INTENDED.

THE PURPOSE OF THIS PLAN IS TO
DIVIDE PARCEL A FROM 284 HARRIS
AVENUE LEAVING LOT 101 AND COMBINE
IT WITH 96 BRADFORD STREET TO
CREATE LOT 102.

SB/DH
(FND)

SB/DH
(HELD)

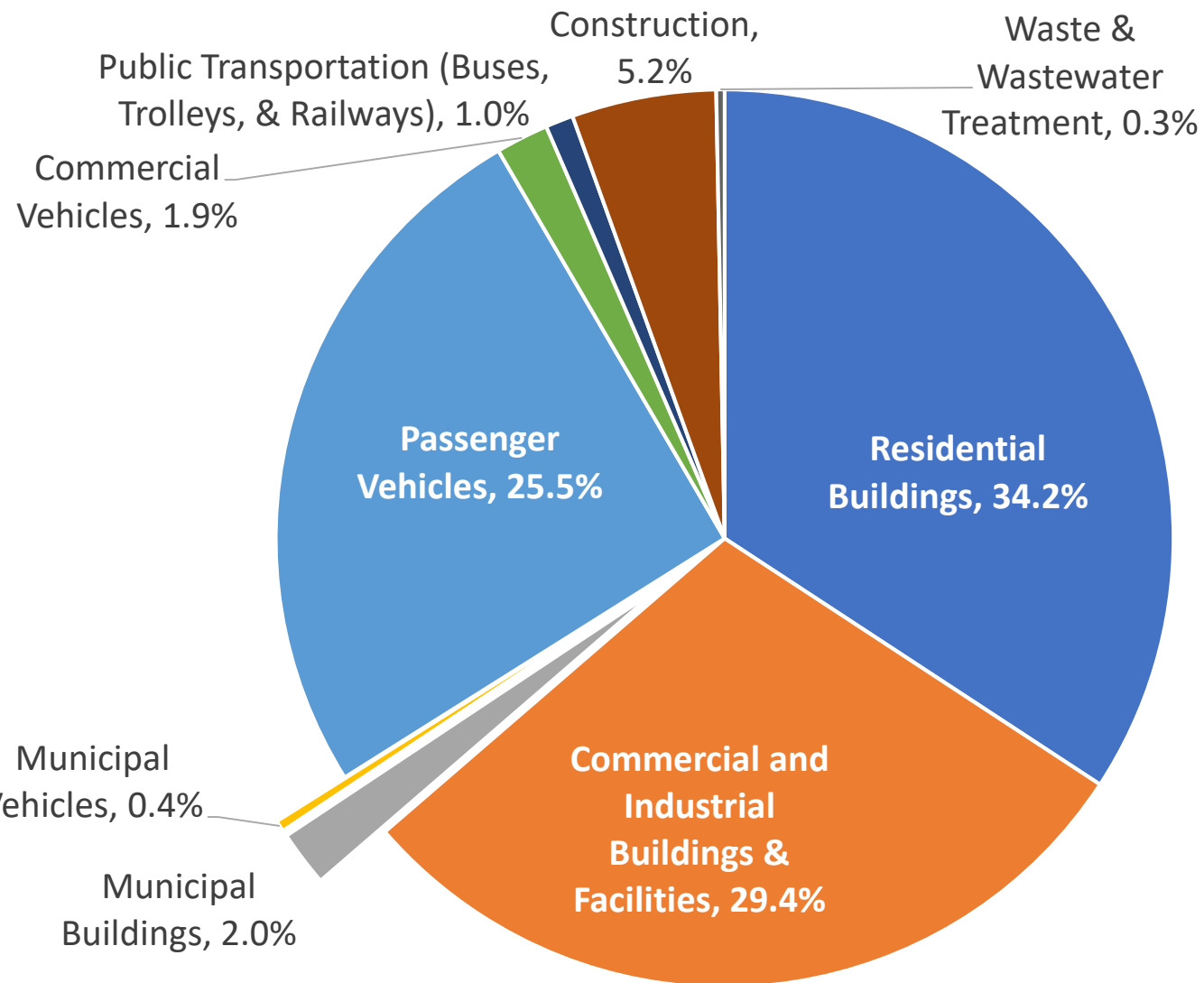
170-21

ZONING INFORMATION: SINGLE RESIDENCE B (SRB)

CAPC Presentation to Select Board

April 4, 2023

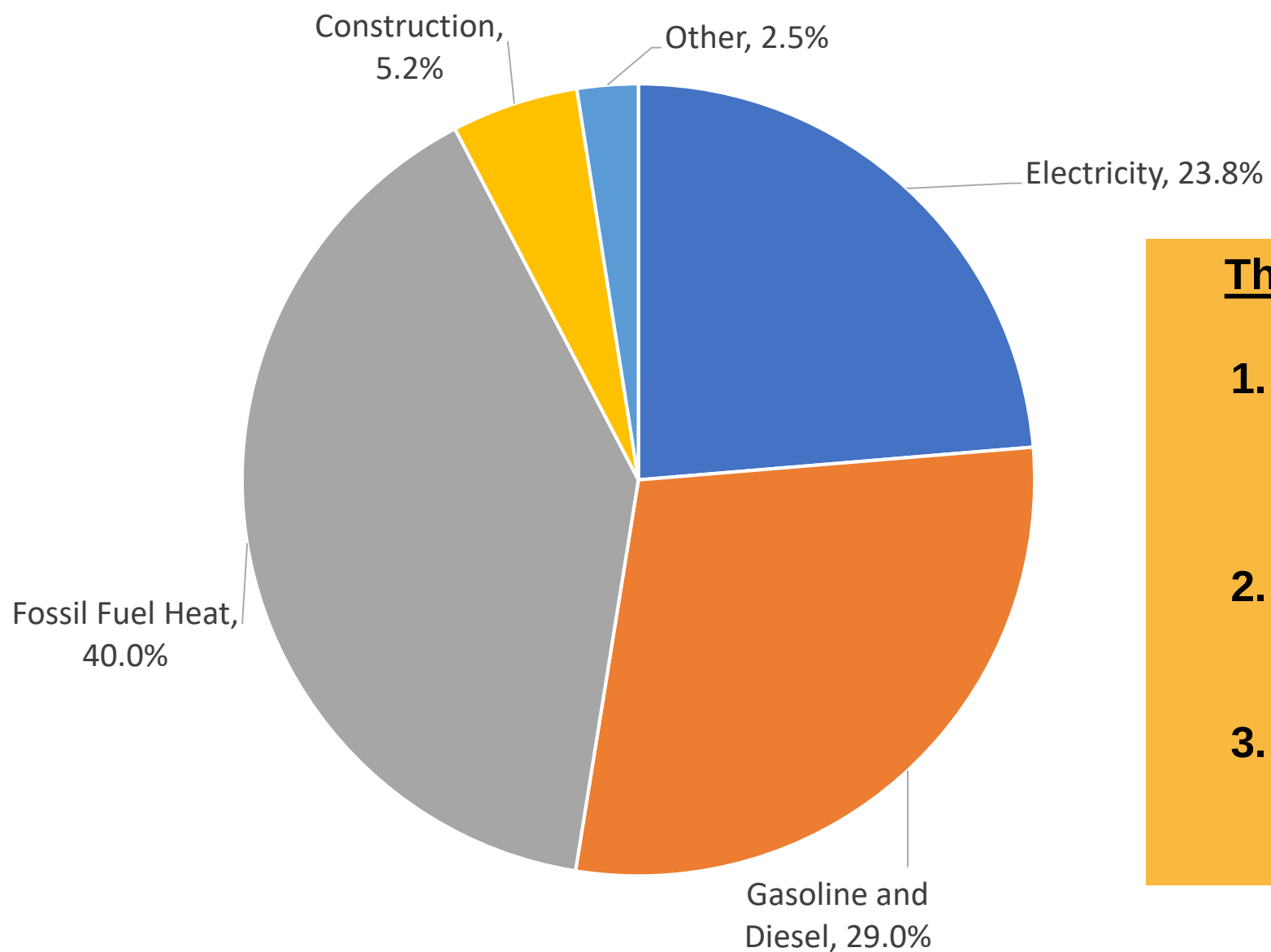
Climate Smart Zoning and Permitting
Updated Stretch Code and Opt-In Specialized Energy Code



Town of
Needham's Share
of GHG is only
2.4%

Reducing GHG Emissions
will require a collective
effort by Town residents,
businesses, and other
organizations

NEEDHAM'S GREENHOUSE GAS EMISSIONS BY SECTOR



The Basic Formula to Net Zero

- 1. Make buildings as efficient as possible**
(insulation, windows, doors)
- 2. Electrify everything**
(heat pumps, EVs)
- 3. Green the electricity grid**
(solar, wind, geothermal, etc.)

NEEDHAM'S GREENHOUSE GAS EMISSIONS BY SOURCE

How do we accelerate decarbonization of buildings?

Zoning and Permitting

- Remove barriers to adoption of solar, heat pumps, energy storage, and other GHG reduction technologies in residential and commercial buildings

Building Codes

- Improve the energy performance of all buildings

How do we accelerate decarbonization of buildings?

Smart Zoning and Permitting Working Group	Action 1 Remove zoning barriers to installing solar, heat pumps, geothermal, and energy efficiency measures for commercial/municipal/multi-family/single family residential buildings.
Net Zero Buildings	Action 2 Adopt Specialized Code (“Net-Zero”) for all new construction including municipal buildings, residential and commercial developments

Smart Zoning and Permitting

Key questions

- What should be by right, by right with site plan review, and what should be by special permit?
- What should we include in our definitions: rooftop solar, ground-based solar, solar canopies, how to define size, energy storage, heat pumps, wind turbines, etc?
- How should setbacks be decided upon for each type of solar?
- What should a site plan review process be?
- How much emphasis on pollinator protection, canopy preservation, vegetation management, stormwater runoff, mitigation for loss of carbon sequestration and forest habitat?

Existing Solar Zoning in Needham

- Large-Scale Ground-Mounted Solar Photovoltaic Installation Overlay District
 - >250 kW DC
 - Allowed by right in Overlay District
 - Requires Major Project Site Plan Review by Planning Board
 - Minimum lot area: 20 Acres
 - Setbacks 50 feet
 - Maximum lot coverage 50%
 - Height restricted to 25 feet
 - Sections similar to what is provided in DOER model language

Existing Solar Zoning in Needham

- Commercial district rooftop solar
 - Solar and HVAC may exceed height restrictions of building by up to 15 feet
 - Total horizontal coverage of all structures does not exceed 25 percent
 - All structures must be set back from roof edge by distance no less than their height
 - Planning Board may require screening of equipment

“As a reminder, while regulating aesthetics can arguably be considered a matter of protecting public welfare, attempting to place restrictions on dimensional standards, such as setbacks or height, as they relate to aesthetics can create roadblocks to actual installation. It is therefore not recommended that communities regulate aesthetics of solar energy systems due to the strong statutory protections in Chapter 40A Section 3, or that they do so very carefully.”

Metropolitan Area Planning Council sample recommendations for zoning/permitting

- Focusing on expediting solar installations
- Provide permitting checklists to make process easier to follow
- Utilize narrow inspection time windows to lower costs
- Develop a solar permitting website
- Offer online permitting
- Reduce or eliminate permitting fees for solar projects

Source: <https://www.mapc.org/wp-content/uploads/2017/10/Solar-Permitting-and-Zoning-Bylaw-Guidance.pdf>

Summary of CAPC Discussion

- Consensus was that the following items are not blocked by current zoning:
 - Residential heat pumps
 - Residential roof top solar
 - Large-Scale Ground-Mounted Solar PV Installations (covered in 3.13)

Summary of CAPC Discussion

- Consensus was that the following items are not blocked by current zoning by laws:
 - Residential roof top solar (over 500 installations in Needham)
 - Residential heat pumps (treated like bay windows or accessory structure)
 - Small residential ground-based solar systems (a couple of been approved)

Summary of CAPC Discussion

- Highest priority items to address
 - Solar canopies over parking lots / structures
 - Commercial rooftop solar
 - Small and medium sized ground-based solar

Summary of CAPC Discussion

- Recommend zoning for solar canopies “as-a-right” – with site plan approval
 - Why as-a-right?
Remove barriers to the quickest way to add local green energy production
 - Why a site plan approval?
Need to handle stormwater, minimum height to allow planes and emergency vehicles, impact on parking, impact on paving
 - Allow canopies on parking garage roofs
Helps with snowmelt, safety, and protects cars parked on roof

Summary of CAPC Discussion

- Add zoning for small- and medium ground-based solar
 - Small- and medium ground-based solar not defined in our bylaw
 - Clarify for permitting process for ground-based solar arrays based upon size
 - Recommend Small systems be as-a-right (subject to lot coverage limits and setbacks) and Medium systems be as-a-right with site plan review (with additional requirements spelled out in site plan review process)

Summary of CAPC Discussion

- Recommend that the Town separate out height and set back restrictions for commercial rooftop solar installations
 - Why?

Current zoning unnecessarily restricts solar arrays on commercial structures because it includes solar panels in the limits the total horizontal coverage of a structure

- Example: 4.5 (3) (See also in 4.8 (1), 4.9 (1), 4.11 (1))

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

Resources for Climate Smart Zoning

- Model Zoning for the Regulation of Solar Energy Systems
(DOER, 2014)
<https://www.mass.gov/doc/model-solar-zoning-0/download>
- MAPC Climate Smart Zoning and Permitting
https://www.mapc.org/wp-content/uploads/2021/11/FINAL-Playbook_Climate-Smart-Zoning-Permitting-Chapter.pdf
 - Action A: Allow by-right the installation and operation of net zero enabling technologies.
 - Action B: Include net zero enabling technologies and related terms in zoning definitions.
 - Action C: Exempt net zero enabling technologies from height and setback requirements.
- Solar Best Practices Guide
(Pioneer Valley Planning Commission)
<https://www.pvpc.org/sites/default/files/doc-solar-best-practices-guide4180.pdf>
- Community Planning for Solar Toolkit
(UMASS Clean Energy Extension)
<https://ag.umass.edu/clean-energy/research-new-initiatives/solarplanning>

Resources for Climate Smart Zoning

[Draft Climate Smart Zoning language for Needham](#)

Needham Climate Action Planning Committee

Updated Stretch Code and Opt-In Specialized Code

Needham has already adopted the Stretch Code

- The Stretch Code is an above-code appendix designed “to result in cost-effective construction that is more energy-efficient than what is built under the base code” – Massachusetts Municipal Association
- Needham adopted the Stretch Code at May 2019 Town Meeting
- >300 Massachusetts cities and towns have adopted the stretch code
- In 2022, Massachusetts updated the Stretch Code

Key Changes to Stretch Code

- Stricter efficiency standards (HERS ratings or Passive House) for both new construction and alterations
 - Some types of renovations must meet HERS ratings
- New construction requires ventilation and heat capture
- Requirements for homes to include EV wiring
- High ventilation buildings such as labs and hospitals get exemptions

Updated Stretch Code

Needham has already opted in, so these will take effect without the need of Town Meeting taking an affirmative vote

On-site Clean Energy Application	Maximum HERS Index score (before renewable energy credit)				
	New construction			Alterations, Additions and Change of use	
	Current Stretch Code	Updated Stretch Code Through 6/30/2024	Updated Stretch Code Effective 7/1/2024	Current Stretch Code	Updated Stretch Code
None (Fossil fuels)	55	52	42	65	52
Solar	60	55		70	55
All-Electric	60	55	45	70	55
Solar & All-Electric	65	58		75	58

New Opt-in Specialized Code

- Written to encourage Net Zero building construction
- Requires an affirmative vote by Town Meeting
- Goes into effect at least 6 months after an affirmative vote, on a Jan 1 or July 1 date
- Applicable for new construction only

Net Zero pathways for Single-Family New Construction under the Opt-in Specialized code

Building Size	Fuel Type	Minimum Efficiency	Electrification	Min. EV wiring	Renewable Generation
Dwelling units up to 4,000 sf	All Electric	HERS 45 or Phius CORE or PHI	Full	1 parking space	Optional
Dwelling units up to 4,000 sf	Mixed-fuel	HERS 42 or Phius CORE or PHI	Pre-wiring	1 parking space	Solar PV (except shaded sites)
Dwelling units > 4,000 sf	All Electric	HERS 45 or Phius CORE or PHI	Full	1 parking space	Optional
Dwelling units > 4,000 sf	Mixed-fuel	HERS 0 or Phius ZERO	Pre-wiring	1 parking space	Solar PV or other renewables

Net Zero pathways for Multi-Family New Construction under the Opt-in Specialized code

Building Size	Fuel Type	Minimum Efficiency	Electrification	Min. EV wiring	Renewable Generation
Multi-family >12,0000 sf	All Electric	Phius CORE or PHI	Full	20% of parking spaces	Optional
Multi-family >12,0000 sf	Mixed-fuel	Phius CORE or PHI	Pre-wiring	20% of parking spaces	Optional

Net Zero pathways for Commercial New Construction under the Opt-in Specialized code

Pathway	Energy Efficiency Requirements	Performance Standard
All-electric Building Performance Standard	Same energy efficiency requirements as the Updated Stretch Code for all building types except multi-family	All space heating, water heating, cooking equipment and drying equipment is powered by electricity and meets minimum efficiency standards.
Mixed-Fuel Building Performance Standard	Multi-family buildings built to the Commercial Specialized Code must achieve precertification to Passive House standards (either from PHI or Phius)	Allows fossil fuels Onsite solar required Pre-wiring for electrical service required
Zero Energy Building Performance Standard		Net Zero on annual basis On-site renewable generation can offset energy use HERS 0 available for multi-family

SOLAR BEST PRACTICES GUIDE

A GUIDE TO ASSIST
MUNICIPALITIES WITH SOLAR
LAND USE REGULATIONS

Prepared by Pioneer Valley Planning Commission with assistance from towns and cities in the Pioneer Valley:
Belchertown, Blandford, Easthampton, East Longmeadow, Hadley, Northampton, Pelham, Ware, Westhampton, Wilbraham, and Williamsburg, with Support from the Massachusetts District Local Technical Assistance Fund

COMMUNITIES & PARTNER ORGANIZATIONS

Town of Belchertown
Town of Blandford
City of Easthampton
Town of East Longmeadow
Town of Hadley
City of Northampton
Town of Pelham
Town of Ware
Town of Westhampton
Town of Wilbraham
Town of Williamsburg

University of Massachusetts Clean Energy Extension
State Representative Lindsay Sabadosa

SPECIAL THANKS TO

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Patty Gambarini, Pioneer Valley Planning Commission
Mike Petrin, VHB
Gerry Palano, MA Department of Agricultural Resources
Tim Roughan, National Grid
Mark Stinson, MA Department of Environmental Protection

Some content within this guide has been adapted from resources developed by the Massachusetts Department of Energy Resources, UMass Clean Energy Extension, the Massachusetts Citizen Planner Training Collaborative, and the Cape Cod Commission

Prepared by:

Pioneer Valley Planning Commission

Kenneth Comia, AICP, Senior Planner

Eric Weiss, Municipal Services Manager

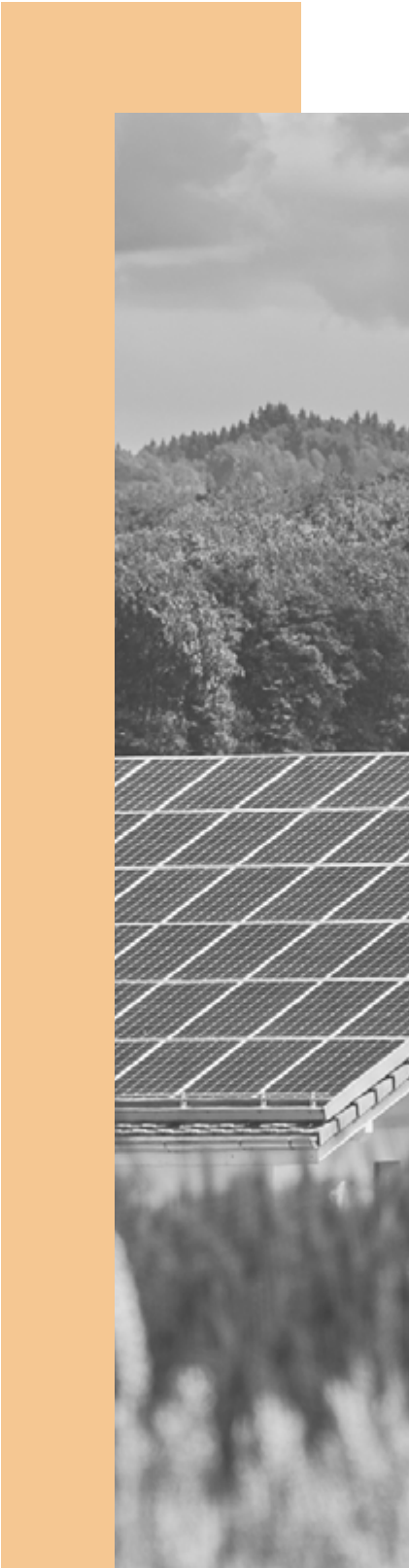


**Pioneer Valley
Planning Commission**

TABLE OF CONTENTS

SECTION 1	INTENT OF GUIDE	1
SECTION 2	SOLAR PV IN MASSACHUSETTS	2
SECTION 3	DEVELOPING OR UPDATING A SOLAR BYLAW OR ORDINANCE	7
SECTION 4	COMPONENTS OF A MUNICIPAL SOLAR BYLAW OR ORDINANCE	12
SECTION 5	APPLICABILITY	13
SECTION 6	DEFINITIONS	18
SECTION 7	STANDARDS FOR SMALL-SCALE SOLAR ARRAYS	21
SECTION 8	SITE PLAN APPROVAL	22
SECTION 9	SITE PLAN REVIEW STANDARDS	31
SECTION 10	ENVIRONMENTAL STANDARDS	43
SECTION 11	CONSTRUCTION, MAINTENANCE, MONITORING & MODIFICATIONS	51
SECTION 12	DISCONTINUANCE & REMOVAL	55
SECTION 13	FINANCIAL SURETY	59
SECTION 14	PAYMENT IN LIEU OF TAXES (PILOT) LOCAL TAX PAYMENTS	61
SECTION 15	THE PERMITTING PROCESS	62
APPENDICES	A - INSTRUCTIONS AND COMPLETE APPLICATION CHECKLIST	
	B - RESOURCES REGARDING AGRICULTURAL EXEMPTION	
	C - EXAMPLE SOLAR MORATORIUM BYLAW/ORDINANCE	
	D - SAFETY IN ENERGY STORAGE	
	E - EXAMPLE TREE REPLACEMENT BYLAW/ORDINANCE	
	F - SAMPLE MUNICIPAL BYLAWS/ORDINANCES	
	G - SAMPLE PILOT AGREEMENT	
	H - ADDITIONAL RESOURCES	

1 INTENT OF GUIDE



Installation of large-scale solar energy arrays has been increasing rapidly across the Commonwealth of Massachusetts; many communities with limited capacity are having to address proposals for solar installations on forest and prime farm lands, and other lands that are identified as resource-rich.

The intent of this guide is to assist communities with the regulation and development of Solar Photovoltaic Installations by providing standards for their placement, design, construction, operation, monitoring, modifications, and removal; to protect public health, safety or welfare in accordance with M.G.L. c. 40A, § 3; to protect and preserve farmland, forests, and open space as promoted by the Commonwealth of Massachusetts; to protect the scenic, natural, and historic resources; and to provide adequate financial assurance for the eventual decommissioning of such installations.

Throughout, this document provides helpful resources and examples that communities can use to develop effective solar energy zoning regulations and policies.

SOLAR PV IN MASSACHUSETTS 2

SOLAR PV BASICS

Solar photovoltaic systems, commonly abbreviated as solar PV, are the primary technology used to harness solar energy for electricity production. Solar PV cells, made primarily from silicon, convert sunlight directly into electricity. Multiple cells are connected in a solar panel or module, in which the cells are encased in protective glass, metal, and/or plastic. Panels can be used individually or connected to form an array. Solar PV panels are a different technology from solar thermal panels, which are used to produce domestic hot water, or the concentrated solar power systems of the southwestern United States, which use mirrors to concentrate sunlight and heat water into steam to generate electricity.

In addition to solar PV panels, a solar PV system includes an inverter, which converts the direct current (DC) electricity generated by the panels into the alternating current (AC) electricity used for local transmission within the electric grid, and fed into homes and businesses. Other components include mounting structures, wiring to connect system components, meters, and additional electrical accessories. Some solar arrays, especially larger systems, may also include an energy storage system, typically in the form of a set of batteries. Because the amount of sunlight available to generate energy varies depending on the time of day, season of the year, and weather conditions, solar PV is a variable source of energy. Battery storage systems are therefore useful for moderating the flow of electricity into the grid, and allowing solar-generated electricity to be used even at night when the sun is not shining.

Due to their modularity, solar PV systems can vary greatly in size. The size of a solar array is typically described in terms of its capacity, which is a measure of the instantaneous power output of the array at top production (i.e., in full sun). It is usually measured in kilowatts (kW) or megawatts (MW), where 1 MW equals 1000 kW. In our region, small-scale systems used to power an individual home, business, or municipal facility tend to be less than 25 kW. Commercial-scale solar arrays, which sell power directly to the grid, are often 1 MW or greater in size. An average 1 MW array would cover approximately 4-5 acres of land.

In Massachusetts, most solar PV systems are distributed energy resources – small or medium-sized power sources that are connected to the lower-voltage distribution lines which provide power to residential and business customers. The current state solar incentive program limits the size of solar PV arrays eligible for incentives to 5 MW AC, and so, at present, that is the largest size project many municipalities may see proposed. However, in some cases, electricity utilities or other entities may find it economical to propose much larger, “utility-scale” projects, which are greater than 5 MW AC, and which may be connected directly to transmission lines rather than distribution lines.

It is important to note that the capacity of a solar PV system is different when measured in units AC versus units DC. The DC capacity of a solar array is a good indication of its size, and footprint on the landscape. The AC capacity of a solar array is an indication of the maximum amount of energy flowing from the array into the grid, after it has gone through the inverter. In the absence of energy storage, a typical DC to AC ratio for solar array capacity is about 1.25:1. However, with energy storage, that ratio can be significantly higher (close to 2:1), since excess electricity can be stored in batteries during the day, and released into the grid during the night, when the panels are not generating electricity. This means that a solar array with a capacity of 5 MW AC might be as large as 10 MW DC.

The annual generation of a solar array is a measure of the yearly energy output produced by the panels. It is typically measured in kilowatt-hours (kWh) or megawatt-hours (MWh). In New England, annual generation is approximately equal to the array's capacity (in DC) * 14% * 8760 hours per year.



STATE INCENTIVES FOR SOLAR PV DEVELOPMENT

The state of Massachusetts has implemented three successive programs to provide incentives for solar development, which have been overseen by the state Department of Energy Resources (DOER).

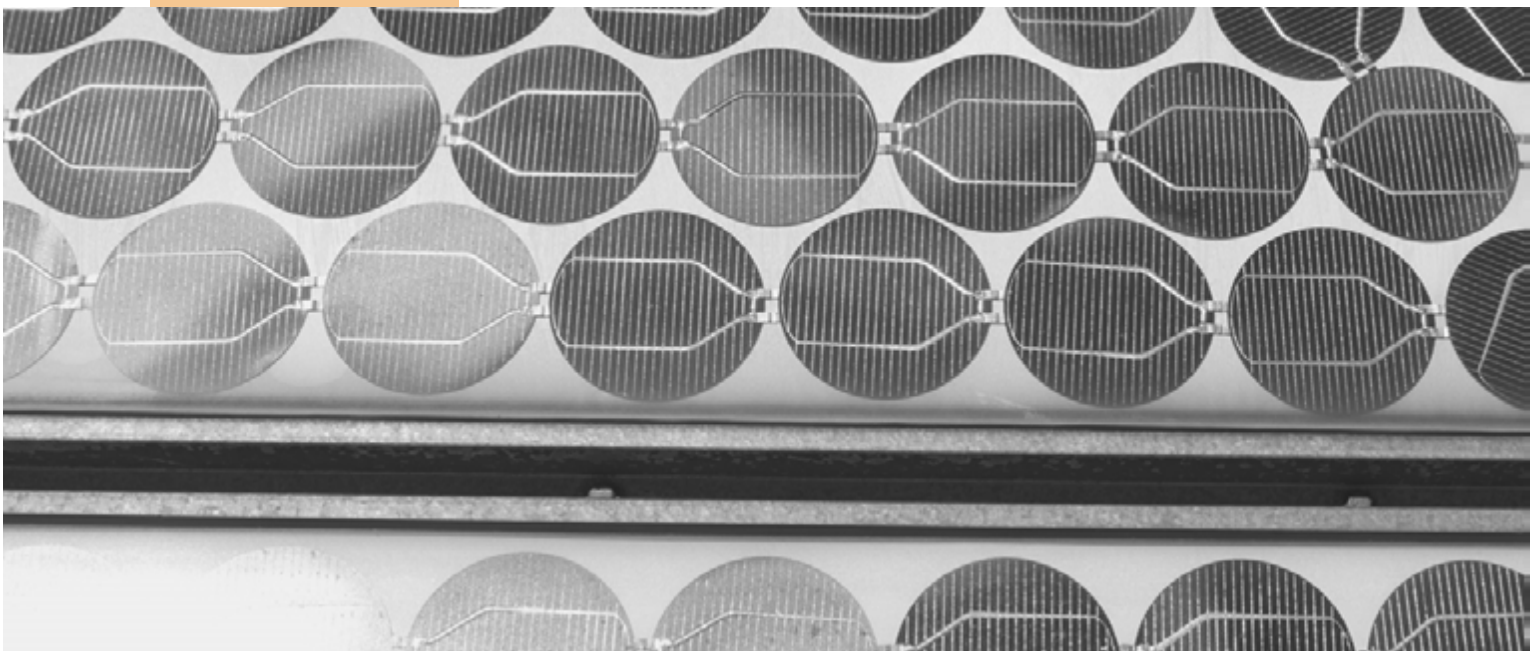
Under the **Solar Carve-Out** (2010-2013) and **Solar Carve-Out II** (2014-2018) programs, new solar PV systems within the state were eligible to qualify for Solar Renewable Energy Credits (SRECs). SRECs were issued to system owners based on how much electricity their solar panels generated; depending on the size and type of PV system, the system owner would earn up to 1 SREC for each MWh of power generated by the solar array. Systems that qualified under these programs could earn SRECs for a period of 10 years from the date they are first interconnected and operational. Utility companies which supply electricity to Massachusetts are required to purchase a certain number of SRECs every year, which they tend to do in bulk at auction. DOER sets a floor and ceiling on the auction price for SRECs, with prices that decline by a small percentage each cycle. After 10 years of operation, solar systems built under these programs no longer earn SRECs, but continue to be eligible for renewable energy credits (RECs), as well as generating saleable electricity for the system owner. RECs are worth less than SRECs, but can still be aggregated and sold at auction to utility companies. **About 2,100 MW of solar PV capacity were installed in the state under these two programs.**

In November 2018, the Solar Carve-out II program was replaced by the **Solar Massachusetts Renewable Target Program**, or **SMART**. The SMART regulation provides incentives in the form of direct “tariff” payments to the system owner for each kWh of power generated, with credit for the renewable content of the electricity going directly to the utility company in the form of RECs. SMART provides a base compensation incentive rate for solar arrays, based on system size, utility service area, and timing of entrance into the program. Additional incentives are available for projects located on buildings, parking lot canopies, landfills, brownfields, and “dual-use” solar and agriculture projects, as well as certain types of projects that benefit public entities, like municipalities, or that provide lower-cost electricity to multiple customers (“community-shared”). The SMART program initially was designed to provide incentives for 1,600 MW of solar development. The program was subject to an emergency regulation in April 2020, which further expanded the program to a total of **3,200 MW**.

The updated regulation places restrictions on what types of large, ground-mounted projects can receive incentives when they are sited on undeveloped land designated as BioMap2 Critical Natural Landscapes or Core Habitat by the state MassWildlife Natural Heritage and Endangered Species Program.

FUTURE SOLAR DEVELOPMENT IN MASSACHUSETTS

As part of the 2008 Global Warming Solutions Act, Massachusetts set mandated greenhouse gas emission reduction targets, including an 80% reduction in emissions relative to 1990 levels by 2050. In order to reach these goals, large amounts of renewable electricity-generating capacity will have to be added to the New England grid, with solar photovoltaic (PV) systems representing a significant portion of that added capacity. But how much solar PV capacity will ultimately be needed? The state of Massachusetts has set short-term targets for solar PV development, such as the 3,200 MW cap established for the SMART solar incentives program. However, the state currently has no long-term vision of how much solar will ultimately need to be developed. Of course, future electricity needs are impossible to predict exactly, and the changing economics of other types of technologies – particularly offshore wind – will play an important role in the mix of renewable sources that will power the electric grid in the future.



Nevertheless, a number of organizations have conducted economic and energy modeling to estimate how much solar PV capacity may ultimately be needed to help power a clean grid in Massachusetts.

- The **Stanford Solutions Project**¹ estimates **38.4 GW** of solar PV will be needed state-wide to achieve 100% renewable fuel use across Massachusetts, including electrified heating and transportation sectors. Under this scenario, 29.5% of Massachusetts electricity comes from solar.
- The **Brattle Group**² estimates about 107 GW of solar PV must be built across New England to achieve an 80% reduction in greenhouse gas emissions for the region. Massachusetts represents about 46% of New England electricity use, so could be considered responsible for up to **50 GW** of solar PV development – although wind development off the coast of Massachusetts will also represent an important portion of the state's contribution to the New England electricity supply. Under this scenario, solar would provide 37% of electricity generation.
- The **National Renewable Energy Laboratory**³ estimates 715 GW of solar PV are needed nationwide by 2050 to achieve 27% of electricity generation from this source. Massachusetts is envisioned to contribute **10-30 GW** to this total.

The state of Massachusetts currently has about 2.5 GW of solar installed. In order to reach the capacity levels described above, solar capacity would need to expand to 4-20 times what it is currently. Therefore, we can expect to see continued pressure for solar development in coming decades..

¹Delucchi, M.A., M.Z. Jacobson, G. Bazouin, and Z.A.F. Bauer, 2015. Spreadsheets for 50-state 100% wind, water, and solar roadmaps, <http://web.stanford.edu/group/efmh/jacobson/Articles/I/WWS-50-USState-plans.html>

²Weiss, J. and J.M. Hagerty, 2019. Achieving 80% GHG reduction in New England by 2050, https://brattlefiles.blob.core.windows.net/files/17233_achieving_80_percent_ghg_reduction_in_new_england_by_20150_september_2019.pdf

³SunShot, E.E., US Department of Energy, 2012. SunShot Vision Study: February 2012. NREL Report No. BK5200-47927. DOE/GO-102012-3037.

3 DEVELOPING OR UPDATING A SOLAR BYLAW OR ORDINANCE

DEFINING A CLEAR PROCESS

A municipal solar bylaw or ordinance should proscribe the process for solar array development and operation within the community, from initial permitting, to site clearing and construction, to annual maintenance, management, and reporting, and through eventual decommissioning. The bylaw or ordinance should be thorough and lay out a clear process, so as to provide clarity to both the solar developer and solar PV system owner (if the facility changes hands), as well as to board members reviewing the project.

However, because any amendments to a zoning bylaw or ordinance require approval at Town Meeting or by Town or City Council, it may also be wise to allow sufficient flexibility in the bylaw or ordinance to permit updates to minor components of the permitting process without amending the bylaw.

After reviewing several proposed projects, the Site Review Approval Authority (typically the Planning Board or Zoning Board of Appeals) may recognize that there are additional types of documents or specific information which would be of use in reviewing future applications. A municipality's Site Plan Review Rules and Regulations can lay out the requirements that could be provided in a typical application. Keep in mind that requirements for construction, maintenance, or reporting relevant to a specific site could be put into the final conditions associated with the permit for that project, rather than included in a bylaw, ordinance governing all projects. See *Appendix A* for an example. Rules and regulations can be adopted by the Site Plan Authority with a majority vote during an appropriately advertised Public Hearing.

PLANNING FOR SOLAR DEVELOPMENT IN YOUR COMMUNITY

Solar development is coming to represent a large source of new development in many Massachusetts communities. Mass Audubon's 2020 *Losing Ground* report estimated that solar development has represented as much as a quarter of all new land development in the state in recent years. As noted in *Section 2* of this guide, significant additional solar development is necessary in Massachusetts over the coming decades, if the state is to meet its mandated greenhouse gas emission reduction goals. With this in mind, communities may wish to conduct specific planning for solar development, and to develop solar zoning bylaws that are compatible with these plans. As detailed below, municipalities cannot "unreasonably" regulate or restrict solar development, but bylaws can be designed to guide development towards certain locations or certain types of projects. For example, many municipalities allow as-of-right siting of solar PV development on former landfill properties; others streamline development of building-mounted and parking lot canopy arrays by requiring only a building permit for their construction.

There is not currently a template to guide municipal-level solar development planning in Massachusetts, but the UMass Clean Energy Extension is working with a diverse team to create just such a document, which will be completed in mid-2021. In the meantime, existing municipal planning documents - such as a Master Plan or Open Space & Recreation Plan - can help identify where a community prefers to see, and prefers not to see, solar development. Hazard Mitigation Plans can also help to identify where a community could benefit from solar development paired with energy storage, potentially allowing for electrical power at an emergency shelter during a black-out. Where there are appropriate sites for solar development on public land or with willing private landowners, communities can consider taking a proactive approach, actively soliciting proposals for development of a site, rather than solely responding to permitting applications from developers.



STATE REQUIREMENTS REGARDING SOLAR BYLAWS AND ORDINANCES

PROTECTION FROM "UNREASONABLE" REGULATION

Massachusetts General Laws (MGL) Chapter 40A, Section 3, protects solar energy systems and the building of structures that facilitate the collection of solar energy as follows:

No zoning ordinance or by-law shall prohibit or unreasonably regulate the installation of solar energy systems or the building of structures that facilitate the collection of solar energy, except where necessary to protect the public health, safety or welfare.

The challenge in interpreting this statement lies in defining what constitutes "unreasonable" regulation of solar, and what requirements are necessary to protect the public welfare. In the review of new solar bylaws performed by the Massachusetts Attorney General's Office, the office frequently comments:

There are no court decisions to guide the Municipality and this Office in determining what qualifies as an unreasonable regulation of solar uses in contravention of G.L. c. 40A, § 3. However, the Municipality should be mindful of this requirement in applying the amendments adopted and consult closely with Town Counsel during the process.

The Massachusetts Department of Energy Resources (DOER) model solar bylaw/ordinance also addresses this statute, and notes the lack of court precedent in defining "unreasonable" regulation:

Although these systems must be allowed within the community, they may be regulated where necessary to protect public health, safety or welfare through other provisions of the Zoning Bylaw/Ordinance. For example, these systems will still need to meet dimensional regulations and other performance standards necessary to protect public health, safety or welfare. In addition, a Site Plan Review process may be used to collect information that will ensure compliance with the performance standards in the Zoning Bylaw/Ordinance. Where some communities include Design Review in their permit processes, these communities will need to balance their desire for certain design objectives with the Commonwealth's protection of solar energy systems. Finally, this suggested bylaw/ordinance document requires a special permit for a large-scale ground-mounted facility in a residential district and prohibits such systems in another residential district. While a special permit is discretionary, and language expressing uncertainty and cautioning communities about the lack of case law regarding Chapter 40A Section 3 has been included, the Attorney General's Office has approved local zoning using this permitting mechanism.

While DOER cannot offer a definitive interpretation, limited use of special permits when applied to the largest of solar systems, especially when these systems are allowed elsewhere by right, may well be reasonable regulation. In DOER's view, given the plain language of the statute, it is prudent to allow opportunity to site all scales of solar energy systems somewhere in the community.

This guide and the model bylaw/ordinance language provided herein have been constructed based on existing solar bylaws that were reviewed by the respective municipal counsels of the municipalities that implemented them. Approved bylaws and ordinances have placed constraints on where and how solar arrays can be built, including limits on forest clearing, maximum grades of slope where solar can be developed, and property line setbacks. However, it is important to recognize that there remains little clear guidance on what constitutes “unreasonable” regulation. Further, it is possible that reasonable regulation could be context-dependent. For example, barring forest clearing from more than 2 acres of land may eliminate the potential for most solar development on 90% of potential sites in a town that is heavily forested, while not doing so in another municipality with more unforested land. The constrictions imposed by specific siting requirements are worth considering carefully in development of a municipal solar zoning bylaw or ordinance.

PROTECTION OF AGRICULTURAL ENERGY SYSTEMS

Massachusetts General Laws (MGL) Chapter 40A, Section 3, provides further protection of certain solar photovoltaic systems that are built for the exclusive purpose of providing electricity for agricultural activities on a property that is primarily in agricultural use (where solar is accessory to the agricultural use). In this case, the system may not be prohibited, unreasonably regulated, or require a special permit.

*No zoning ordinance or by-law shall ... prohibit, unreasonably regulate, or require a special permit for the use of land for the primary purpose of commercial agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture, **nor prohibit, unreasonably regulate or require a special permit for the use, expansion, reconstruction or construction of structures thereon for the primary purpose of commercial agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture...***

Note that this law does not exempt a proposed solar PV system from regulation, but indicates it must not require a special permit to build– that is, that it must be allowed as-of-right, but can be subject to site plan review to ensure it meets relevant laws and is eligible for issuance of a building permit. In order to be eligible for this protection, the property on which the project is sited must meet specific requirements in terms of commercial agricultural sales and parcel size, which are further detailed in Section 3. See additional resources in the appendix for questions on the applicability of agricultural exemption to specific solar energy systems. (See Appendix B)

GREEN COMMUNITIES STATUS

Many towns and cities across the Commonwealth participate in the Green Communities program, which assists municipalities in setting and achieving goals for energy efficiency. One of the five criteria to earn designation as a Green Community is passage of a zoning bylaw related to renewable energy which provides for as-of-right siting of at least one type of renewable energy manufacturing or generation facility in at least one zoning district or designated location, as follows:

To qualify as a green community, a municipality or other local governmental body shall...provide for the as-of-right siting of renewable or alternative energy generating facilities, renewable or alternative energy research and development facilities, or renewable or alternative energy manufacturing facilities in designated locations.

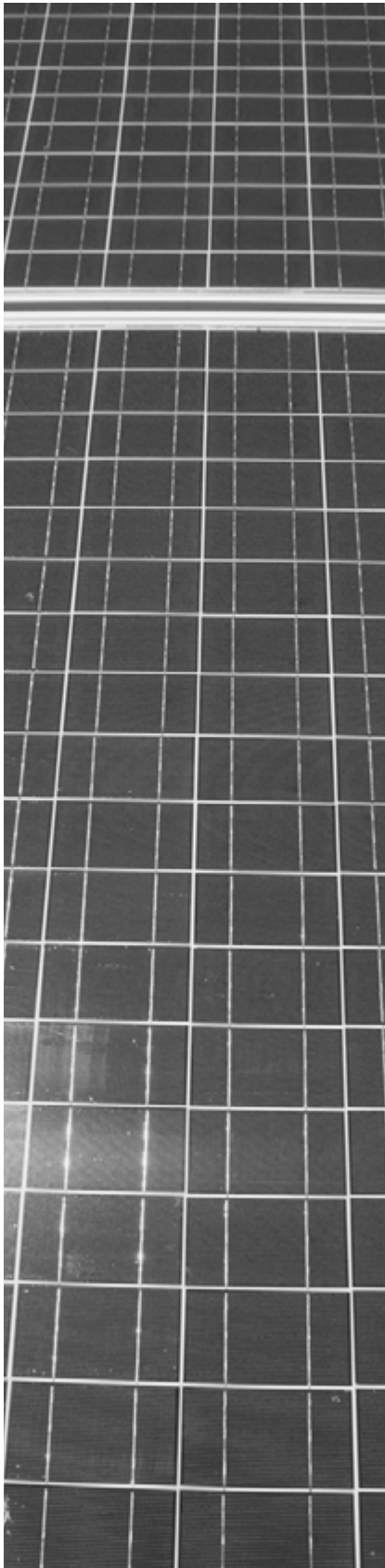
This criterion is relatively straightforward to fulfill and maintain. For example, it could be met by allowing as-of-right siting of residential-scale solar arrays in a zoning district, or establishing a solar overlay district which allows for siting of commercial-scale solar development on one or more parcels in town. It does not prohibit inclusion of site plan review in the as-of-right process.

IMPOSING A TEMPORARY SOLAR MORATORIUM

In some communities, the municipality need may arise to pass a temporary moratorium on the development of large-scale solar systems, to allow the municipality time to update and modernize its existing solar bylaw. This can be done by putting into place a temporary moratorium for a period of up to 12 months.

It is important to present to the community and the Attorney General's Office if you have Town Meeting, that there is a reasoning behind adopting a temporary solar moratorium. For example, understanding the impacts of solar development on prime farmland, especially if the community had just approved multiple solar projects.

See Appendix C for Example Moratorium Bylaw/Ordinance



4 COMPONENTS OF A MUNICIPAL SOLAR BYLAW OR ORDINANCE

This section and the following sections (5-12) describe nine components that we recommend be included in any municipal solar bylaw or ordinance: ***Purpose; Applicability; Definitions; Standards for Small-Scale Solar Arrays; Site Plan Approval; Site Plan Review Standards; Construction, Maintenance, Monitoring, and Modifications; Discontinuance and Removal; Financial Surety.***

Each section provides a basic overview of the importance of that bylaw or ordinance component, followed by example language. In some cases, we provide language that we recommend be included in any solar regulation. In other cases, municipalities have taken different approaches, and we provide alternative language to address the issue at hand. Finally, we also include language regarding optional provisions that a municipality may wish to consider including. Depending on the format of the municipality's existing zoning bylaws or ordinance, the language provided herein may be incorporated as a stand-alone section, or included piecemeal in the appropriate sections of the zoning regulations.



SAMPLE BYLAW/ ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE ***PURPOSE*** SECTION AND SAMPLE LANGUAGE

A. Purpose. The purpose of this bylaw (or ordinance) is to provide for the construction and operation of solar energy facilities and to provide standards for the placement, design, construction, monitoring, modification and removal of solar facilities that address public safety, minimize impacts on scenic, natural and historic resources of the town (or city) and provide adequate financial assurance for decommissioning.

Additionally, the solar energy facilities shall be consistent with community planning documents including but not limited to the Town's (or City's) Open Space and Recreation Plan or Master Plan

The provisions set forth in this section shall take precedence over all other sections when considering applications related to the construction, operation, and/or repair of solar energy facilities.

5

APPLICABILITY

Solar projects range in size, from residential-scale arrays sited on top of a home roof or in the backyard, to large commercial solar array installations covering multiple acres of land.

Under the State Zoning Act, solar PV arrays can be allowed As-of-Right (with a building permit only), allowed As-of-Right (with Site Plan Review), or approved through a Special Permit (with Site Plan Review). Because the size of these systems can vary so greatly, municipalities often choose to regulate different sizes or types of systems differently. Examples include allowing roof-mounted units As-of-Right (with a building permit only), while requiring a Special Permit for the construction of commercial-scale arrays in certain zones. As described above in Section 3, the State Zoning Act also protects developers from “unreasonable regulation” of solar development in your city or town.

The contents of this section can apply to a primary use of property or an accessory use, whether the solar array is providing energy for on-site use, or selling power directly to the grid.

AS-OF-RIGHT VS. SPECIAL PERMIT

As-of-Right and Special Permit zoning are applicable to many kinds of development, not just solar PV systems. Both permitting processes can incorporate Site Plan Review (SPR), but the outcomes of that review differ.

As-of-Right Siting means that development may proceed without the need for a special permit, variance, amendment, or other discretionary approval. As-of-right development may be subject to non-discretionary Site Plan Review to determine conformance with local zoning bylaws as well as state and federal law. As-of-right zoning bylaws or ordinances can apply appropriate standards that protect public health and safety. Reasonable environmental performance standards per the developed bylaw or ordinance may be incorporated into the Site Plan Review process (e.g. height, setback, etc.), but cannot be so stringent as to make the use infeasible. The key is that Site Plan Review must be truly non-discretionary – *i.e., if the standards and zoning requirements are met, the project can be built*. In this context, Site Plan Review can only be used to shape a project; it cannot be used to deny a project, except in rare circumstances. As-of-right development projects that are consistent with zoning bylaws and ordinances and with state and federal law cannot be prohibited.

This is distinct from the **Special Permit (SP)**. In the special permit process, the full range of discretion is available to the special permit granting authority:

Neither the Zoning Enabling Act nor the town zoning bylaw gives...an absolute right to the special permit...The board is not compelled to grant the permit. It has discretionary power in acting thereon. MacGibbon v. Board of Appeals of Duxbury, 356 Mass. 635, 638-639 (1970).

The Special Permit may be denied if the Planning Board or other permit granting authority is not satisfied with the project.

DEFINING SOLAR ARRAY SIZE AND TYPE

As noted above, many municipalities choose to regulate solar PV arrays of different sizes differently, typically differentiating between “small,” “medium,” and “large” projects. Municipalities have taken different approaches to defining the size of solar installations. Options for defining project size include:

1. Project Capacity: The total wattage of the solar installation in kW or MW DC. (See *Section 2*, Solar PV Basics for a definition of project capacity).
2. Solar Panel Area: The total area of solar panels, typically in square feet.
3. Project Footprint: The total footprint of the project, typically in square feet for small and roof-mounted installations, and in acres for larger projects.

Of course, these three definitions of solar array size are related, but may vary with project type and over time. For example, as solar PV panels become more efficient, less space will be required to provide a project with the same capacity.

As a rough rule of thumb for roof-mounted projects, 100 square feet of roof space is required per 1.6 kW of solar. For smaller projects, there may not be a great discrepancy between the solar panel area and project footprint. However, large ground-mounted projects require multiple components, including, but not limited to: the solar PV system, spaces between rows of panels, cleared buffers, access and maintenance roads, and a utility interconnection site. Traditional ground-mounted arrays provide roughly 200-250 kW per acre, equivalent to roughly 18,000 square feet of panels. Parking lot canopies provide roughly 263 kW per acre, equivalent to roughly 18,936 square feet of panels.

In addition to distinguishing between projects of different sizes, some municipalities choose to differentiate among projects based on type – such as roof-mounted systems, ground-mounted systems, or parking lot canopies.

However defined, these categories should be included in the **Definitions** section of the zoning bylaw or ordinance (see next section, *Section 6*).

RECOMMENDATIONS

- As-of-Right (building permit) – Allowing rooftop installations and small, residential-scale ground-mounted projects as-of-right in all zoning districts will streamline the permitting process, encouraging local solar projects and minimizing staff or Board review time. Defining what constitutes a small-sized solar energy project will clarify which systems may proceed straight to obtaining a building permit.
- As-of-Right (with Site Plan Review) – Allowing large rooftop installations and medium-scale, ground-mounted projects as-of-right, but subject to site plan review, will lay out the requirements for a straightforward and streamlined permitting process, while allowing Board review to ensure projects are meeting state and local standards.
- Special Permit (with Site Plan Review) – Municipalities may choose to allow large-scale projects to proceed either through an As-of-Right or Special Permit process with Site Plan Review, depending on degree of flexibility and control desired within the municipality.
- Project Size – Solar array project sizes should be defined relevant to the manner in which they are regulated, and these definitions should be included in the Definitions section of the bylaw (*see Section 6 of this document*). We recommend including a definition for projects that require Site Plan Review. In this guide, we refer to these systems as Commercial Solar Photovoltaic Installations (CSPIs), and define them as solar installations with a minimum rated nameplate capacity of 250 kW DC – equivalent to about 1 acre in project footprint.



SAMPLE BYLAW/ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE APPLICABILITY SECTION AND SAMPLE LANGUAGE

The bylaw or ordinance should define which types of projects are allowed as-of-right (with issuance of a building permit), as-of-right (with site plan approval), and by special permit. Example language is provided below.

A. As-of-Right: The following solar photovoltaic installations, as defined herein, are allowed as of right with issuance of a valid building permit from the building inspector in all zoning districts:

1. Any such roof-mounted installation on an existing structure. *[Note that a maximum capacity could be listed to limit the size of roof-mounted project requiring only a building permit.]*
2. Any such ground-mounted installation less than or equal to 25 kW DC in capacity.

B. As-of-Right: The following solar photovoltaic installations, as defined herein, are allowed as of right with site plan approval in all zoning districts:

1. Any ground-mounted installation greater than 25 kW DC over an existing parking surface, pedestrian walkway, or other paved area in a manner that maintains the function of the area beneath the canopy. *[Note that some municipalities allow parking lot canopies as of right with issuance of a building permit in order to streamline development.]*
2. Any other ground-mounted installation greater than 25 kW DC but less than 250 kW DC in capacity.

C. Special Permit: Any solar photovoltaic installation not specified in (A) or (B) requires a special permit in all zoning districts from the Special Permit Granting Authority. For all special permit applications, site plan approval as described below is required, but shall not require a second public hearing, per bylaw or ordinance addressing site plan approval.

The municipality may also choose to limit solar PV projects based on size or location. Additionally, a community may also choose *Special Permit* versus *Site Plan Approval* thresholds based on their own values since impacts tend to increase on sites of more than one acre. Example language is in *Section 6 Definitions*. Note that the number values provided (maximum acreage for array, maximum forest clearing, maximum slope) are provided as examples only, and should be determined based on the community values, land use, and topography of your municipality.

D. Not Permitted: No commercial solar photovoltaic installation may be permitted as follows:

1. Any solar photovoltaic installation of greater than 20 acres of previously undeveloped land in a fenced array area.
2. Any solar photovoltaic installation requiring forest clearing greater than ten acres.
3. Any solar photovoltaic installation on slopes of 15% or greater as averaged over fifty horizontal feet; the Special Permitting Granting Authority may consider waiving this up to 18% based on site-specific parameters. No cutting or filling may be done to reduce natural slopes.

DEFINITIONS 6

Zoning codes can sometimes fail to identify and define specific terms and types of solar energy systems. The lack of clear definitions can lead to future misinterpretation and create uncertainty about the legality of solar use.

Typical definitions related to solar development are provided on the next page; these can be adopted into a solar bylaw or ordinance.

These definitions should be placed in a general definitions section of the municipal bylaw or ordinance.



GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A solar photovoltaic installation that is directly mounted to structural supports on the ground and not mounted on a roof or other previously existing structure.

RATED NAMEPLATE CAPACITY: The maximum rated output of electric power production of the commercial solar photovoltaic installation in Direct Current (DC).

SITE PLAN APPROVAL AUTHORITY: The site plan approval authority as designated by the Zoning Guide.

SOLAR ENERGY: Radiant energy received from the sun that can be collected in the form of heat or light by a solar energy system.

SOLAR PHOTOVOLTAIC INSTALLATION: A solar energy system that converts solar energy directly into electricity through an arrangement of solar photovoltaic panels.

As noted in Section 5, it is often appropriate to include definitions of solar PV array system sizes in the bylaw/ordinance, as they relate to how different systems are regulated (e.g. as-of-right or by special permit). Also as described in Section 5, project size can be defined by solar PV system capacity (kW DC), the area occupied by solar PV panels, or the project footprint. Examples of these different ways of defining project size are provided below and on the following page. Note that the number values provided (maximum nameplate rated capacity, maximum surface area of panels, maximum project footprint) are provided as examples only, and should be determined based on the different regulatory pathways for different project sizes, and your community's values and vision for the land.

Capacity

SMALL-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation with a rated nameplate capacity of 25 kW DC or less.

MEDIUM-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation with a rated nameplate capacity greater than 25 kW DC but less than or equal to 250 kW DC.

COMMERCIAL SOLAR PHOTOVOLTAIC INSTALLATION (CSPI): A Ground-Mounted Solar Photovoltaic Installation with a rated nameplate capacity greater than 250 kW DC.

Solar Panel Area

SMALL-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation that occupies 2,100 square feet or less of surface area of solar panels.

MEDIUM-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation that occupies more than 2,100 but less than 32,000 square feet of surface area of solar panels.

LARGE-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation that occupies 32,000 square feet or more of surface area of solar panels.

Project Footprint

Size requirements regarding project footprints are often provided as alternatives to the nameplate capacity definition. For example:

MEDIUM-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation with a rated nameplate capacity greater than 25 kW but no more than 250 kW and that occupies no more than 40,000 square feet of surface area.

-OR-

MEDIUM-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation with a rated nameplate capacity greater than 25 kW but no more than 250 kW and does not occupy more than one (1) acre of land.

LARGE-SCALE GROUND-MOUNTED SOLAR PHOTOVOLTAIC INSTALLATION: A Ground-Mounted Solar Photovoltaic Installation with a rated nameplate capacity greater than 250 kW or that occupies more than one (1) acre of land.

7 STANDARDS FOR SMALL-SCALE SOLAR ARRAYS

The majority of this guide addresses commercial-scale solar photovoltaic systems. For roof-mounted and small-scale ground-mounted solar PV system, the the DOER model bylaw does provide the following recommendations regarding standards.

A. All Small and Medium-Scale Solar Photovoltaic Installations shall adhere to the following Design and Operation Standards.

1. Utility Notification. No grid-intertie photovoltaic system shall be installed until evidence has been given to the Site Plan Review Authority that the owner has submitted notification to the utility company of the customer's intent to install an interconnected customer-owned generator. Off-grid systems are exempt from this requirement.
2. Emergency Access. Solar energy systems shall be located in such a manner as to ensure emergency access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunities, and provide emergency egress from the roof.
 - a. For buildings with pitched roofs, solar collectors shall be located in a manner that provides a minimum of one three-foot wide clear access pathway from the eave to the ridge on each roof slope where solar energy systems are located as well as one three-foot smoke ventilation buffer along the ridge.
 - b. Residential rooftops that are flat shall have a minimum three-foot wide clear perimeter and commercial buildings that are flat shall have a minimum four-foot wide clear perimeter between a solar energy system and the roofline, as well as a three-foot wide clear perimeter around roof-mounted equipment such as HVAC units.
 - c. To the extent practicable, the access pathway shall be located at a structurally strong location on the building (such as a bearing wall).

Building and Fire Department personnel should be involved in the development of emergency access standards, and any zoning standards that are adopted should be consistent with local building and fire codes.

3. Safety. No roof-mounted solar energy system shall be located in a manner that would cause the shedding of ice or snow from the roof into a porch, stairwell or pedestrian travel area.

SITE PLAN APPROVAL 8

This section presents regulations that the municipality may choose to include in a bylaw or ordinance in a site plan review setting, either in coordination with as-of-right siting or a special permit, as described in Section 5.

The contents of this section are intended to apply to large-scale solar photovoltaic installations, however they may be defined in your municipality. For the purposes of this guide, we refer to these installations as Commercial-Scale Solar Photovoltaic Installations, or CSPIs, defined as solar photovoltaic installations with a minimum capacity of 250 kW DC, equivalent to about 1 acre in project footprint for a ground-mounted installation. The contents of this section also apply to modifications that materially alter the type, configuration, or size of these installations or related equipment. **If the Applicability portion of your bylaw requires Site Plan Review for Medium-Scale Solar PV Installations (e.g. less than 250 kW DC), you may wish to identify an abbreviated list of requirements for these smaller-scale projects.**



THE PERMITTING TIMELINE & INTERCONNECTION

Local permitting is one of many administrative steps that solar developers must go through in order to develop and build a commercial-scale solar facility. Where municipal permitting falls in the administrative process is dependent to an extent on utility and state requirements, but can also be influenced by what documentation municipal boards require in the permit application, and what steps in the process are required to be completed before the project proponent comes before the municipal board.

Municipalities that require numerous documents may receive applications for projects that are later in the process and have already received approvals from other entities. The advantage here is that the developers are serious in their intent to move forward with project development. The disadvantage is that the project is later in the design phase, it may be more constrained by approvals that have already been received, and developers may be less open to local concerns that could modify the project plan. In addition, the project proponents will have sunk significant funds into development of the project, and be more adamant (and potentially litigious) in ensuring the project moves forward.

The alternative is to allow projects to come before municipal boards before they have received approvals from other entities. The advantage here is that the project developers may be more open to modifications that address local concerns. One disadvantage is that many solar projects that go through the initial stages of development are never built; hence, significant volunteer and staff time may be wasted reviewing projects that never progress. In addition, projects that do progress may have to come back before a municipal board for approval of modifications made based on review by other entities.

Some municipalities require documentation that a commercial-scale project is at a specific stage in the interconnection process before it may come before a municipal board for review. Interconnection is the process via which a solar PV facility receives permission from the utility and connects to the electric grid. As a first step, the system developer must submit an application to obtain formal written approval from the local utility. For commercial-scale systems, once the utility has determined that an application is complete, the utility typically requires that the developer pay for a study to establish the impacts of interconnection of the facility to the grid system, and to determine if upgrades are required before interconnection can occur. The utility and developer then commit to an *Interconnection Service Agreement* (ISA) for the project, which includes a requirement for the developer to cover the cost of system upgrades. After the project has been built, the developer then submits to receive an *Authorization to Connect*.



SAMPLE BYLAW/ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE *SITE PLAN APPROVAL* SECTION AND SAMPLE LANGUAGE

Municipalities may want to identify specific standards or criteria for the site plan approval of solar photovoltaic installations and its related application requirements. Suggestions below may or may not be appropriate for your community.

A. Site Plan Approval. The construction, installation or modification of a ground-mounted solar photovoltaic installation, whether as-of-right or by special permit, shall be subject to site plan approval by the Site Plan Approval Authority in accordance with the Applicability Section of the zoning bylaw.

1. General. All plans and maps shall be prepared, stamped and signed by a Professional Engineer licensed to practice in Massachusetts.

2. Required Documents. The project proponent shall provide the following documents:

a. A site plan showing:

i. An existing conditions plan with property lines and physical features, including topography and roads, characteristics of vegetation (trees-mature, old growth, shrubs, open field, etc), wetlands, streams, ledge, for the project site;

ii. Proposed changes to the landscape of the site, including grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures, driveways, snow storage, and storm water management systems; including total acreage of disturbed area, total vegetation cleared, not including mowed fields;

- iii. Trees with a DBH of 20" or greater within project parcel(s) shall be identified to determine tree loss, along with inventorying of diseased or hazard trees slated to be removed due to proposed development;
- iv. Drawings of the solar photovoltaic installation signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts showing the proposed layout of the system and any potential shading from nearby structures;
- v. Three line electrical diagram detailing the solar photovoltaic installation, associated components, and electrical interconnection methods, with all National Electrical Code compliant disconnects and overcurrent devices;
- vi. Documentation of the major system components to be used, including the PV panels, mounting system, and inverter;
- vii. Name, address, and contact information for proposed system installer;
- viii. Name, address, phone number and signature of the project proponent, as well as all co-proponents or property owners, if any;
- ix. The name, contact information and signature of any agents representing the project proponent.

If the following are not addressed in general site plan review regulations for all types of development, then the community may wish to include them for CSPIs specifically:

- x. Locations of active farmland and prime farmland soils, wetlands, permanently protected open space, Priority Habitat Areas and BioMap 2 Critical Natural Landscape Core Habitat mapped by the Natural Heritage & Endangered Species Program (NHESP) and "Important Wildlife Habitat" mapped by the DEP.
- xi. Locations of floodplains or inundation areas for moderate or high hazard dams;
- xii. Locations of local or National Historic Districts.
- xiii. Stormwater management and erosion and sediment control (*See discussion under Chapter 10*)

Further recommended language regarding Required Documents continues, as follows:

- b. Documentation of actual or committed prospective access and control of the project site sufficient to allow for construction and operation of the proposed solar photovoltaic installation.
- c. A plan for the operation and maintenance of the solar photovoltaic installation as detailed in A(3): Operation and Maintenance Plan.
- d. Proof of liability insurance.
- e. Description of financial surety that satisfies Financial Surety.
- f. Pre-construction photos from the right-of-way and nearest abutters. These photos should include tree coverage.
- g. Zoning district designation for the parcel(s) of land comprising the project site.
- h. Visualization of post-construction solar development, including perspectives from right-of-way(s), nearest abutting properties or residential structures, and tree coverage. The Site Plan Approval Authority may determine additional visualizations to be submitted for review.
- i. Proof that the project proponent will meet the required Site Plan Review notification procedures.

Required Document (i) above should reference the municipality's existing Site Plan Review public and/or abutter notification procedures, if applicable. For example, a community may require projects that are subject to Site Plan Review to notify all property owners within 100 feet of the project site.

See Figures 8-1, 8-2 and 8-3 for an example of what site plan approval authorities may ask for applicants to submit to ensure minimal visual impact to abutters and protected corridors.

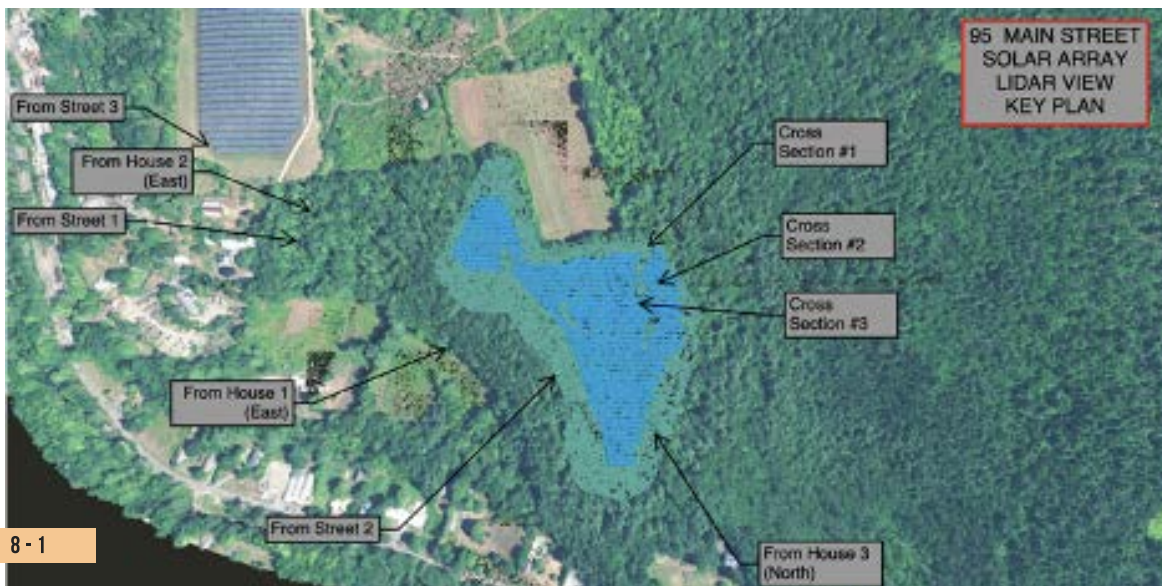


FIG. 8-1

Summary of Visualizations (Courtesy of Williamsburg Zoning Board of Appeals)

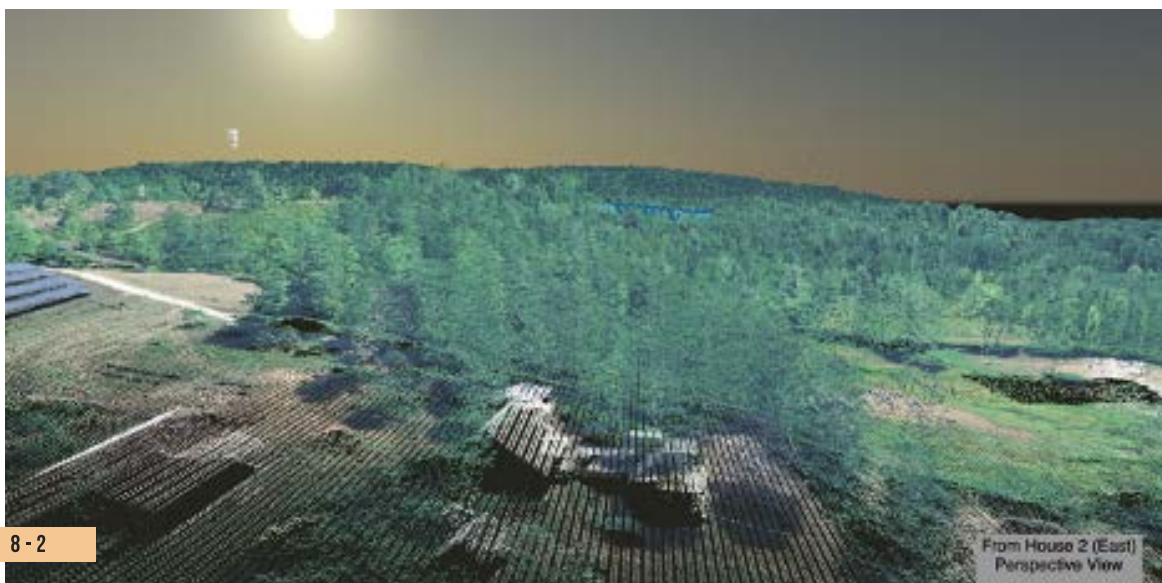


FIG. 8-2

Visualization from Abutter's Perspective (Courtesy of Williamsburg Zoning Board of Appeals)

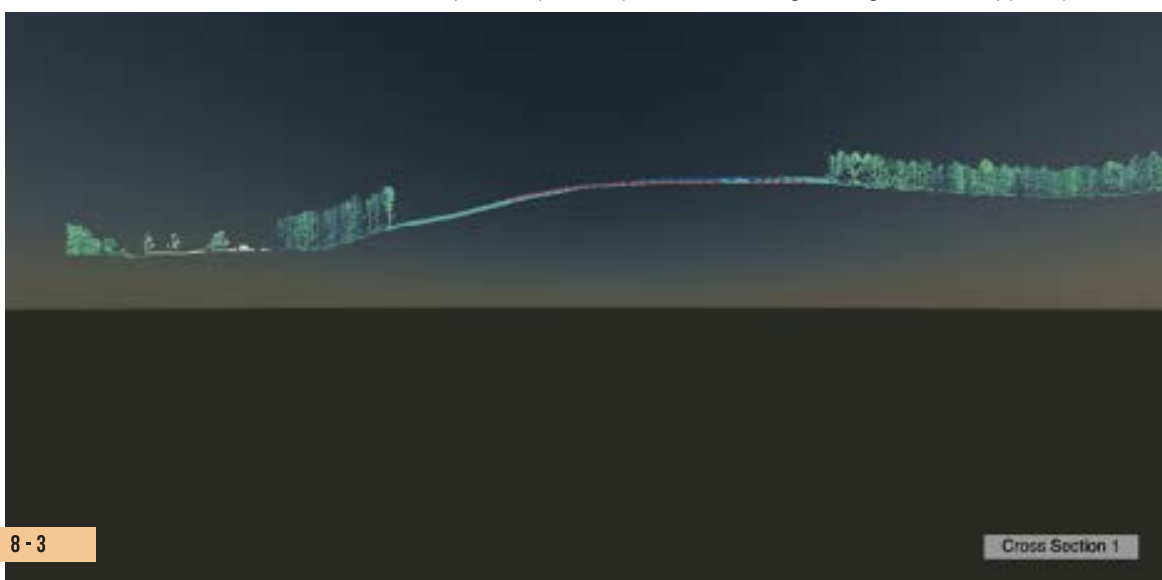


FIG. 8-3

Cross Section (Courtesy of Williamsburg Zoning Board of Appeals)

Further recommended Site Plan Approval language continues, as follows:

3. Operation & Maintenance Plan. This plan shall include measures to maintain safe access to the installation, stormwater controls, and general procedures for operational maintenance of the installation. The Operation & Maintenance Plan should include a training component and schedule for emergency services staff along with any designees the Site Plan Approval Authority deems necessary.

4. Waiver Requests. The Site Plan Approval Authority may waive documentation requirements as it deems appropriate upon written request of the applicant submitted with an application for approval.

The language below is one way to ensure coordination among all necessary boards, commissions, and departments, and avoid discrepancies in the approval process across separate municipal entities.

5. Consultation with Other Departments and Entities. No building permit shall be issued and no application for such permits shall be accepted for construction, exterior alteration, relocation, or change in use except where noted in Section X, unless a site plan has been endorsed by the Site Plan Approval Authority, after consultation with other boards, including but not limited to the following: Building Inspector, Board of Health, Select Board or Town/City Council, Historical Commission, Conservation Commission, Highway Department or DPW, Fire Department and Police Department. The Site Plan Approval Authority may waive any or all requirements of site plan review for external enlargements of less than 10% of the existing occupied area.

Further example language continues, as follows:

B. Utility Notification. No solar photovoltaic installation shall be constructed until evidence has been given to the Site Plan Approval Authority that the utility company operating the electric grid the installation is to be connected to has been informed of the solar photovoltaic installation owner or operator's intent to install an interconnected customer-owned generator. Off-grid systems shall be exempt from this requirement.

OPTIONAL - Pollinator Friendly Certification

Municipalities may wish to consider a requirement for pollinator-friendly certification of CSPIs. This ensures the CSPI is planted and maintained as a native wildflower meadow, without requiring additional, continued oversight by the Site Plan Approval Authority. The Pollinator-Friendly Certification Program for Solar PV Arrays, administered by UMass Clean Energy Extension, is a program that promotes the planting of native vegetation under and around solar arrays, and maintenance of vegetation, fencing, nesting habitat, and other features to support continued use of land under and around solar arrays by native pollinators and other wildlife. The criteria for each level of certification are available on the UMass Clean Energy Extension website at (<https://ag.umass.edu/clean-energy/services/pollinator-friendly-solar-pv-for-massachusetts>). These criteria are updated periodically as new information and scientific research become available.

Example language:

C. Pollinator-Friendly Certification. No Commercial-Scale Solar Photovoltaic Installation shall be constructed until proof has been given to the Site Plan Approval Authority that the project proponent has obtained Pollinator-Friendly Certification for the solar photovoltaic installation through the UMass Clean Energy Extension Pollinator-Friendly Certification Program at a minimum of the [choose Certified, Silver, or Gold] Certification Level, or other equivalent certification as determined by the Site Plan Approval Authority. This certification must be maintained throughout the life of the installation.



PROTECT THE WATER SUPPLY!

Municipalities should protect the water supply through requirements and standards that should be addressed during the site plan review process. Some of the suggestions to protect the water supply are covered elsewhere in this document through standards of development and decommissioning.

Additional considerations to protect the water supply in your zoning regulations:

- Require planting of low growing grasses or regular mowing of other types of grasses to ensure minimal fuel for wildfires in areas around panels.
- Ensure that there is no oil, hazardous materials or other potential contaminants stored on-site
- Require only non-toxic materials to be used in transformers.

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9 SITE PLAN REVIEW STANDARDS

Many zoning bylaws already include general language regarding dimensional requirements (such as height or setbacks), as well as lighting and signage standards. The standards identified in this section of the guide may be used in addition to existing special use permit and site plan review standards, or they may be used to create a stand-alone set of review standards specific to solar photovoltaic installations. These standards are often included under sections identified as Local Site Requirements, Dimensional Regulations, or Site Plan Review Design and Operations Standards. Standards may be written so as to differ across projects based on size, type, or permitting pathway (as-of-right vs. special permit).





SAMPLE BYLAW/ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE *SITE PLAN REVIEW STANDARDS* SECTION AND SAMPLE LANGUAGE

Municipalities may want to identify specific standards or criteria for the site plan approval of solar photovoltaic installations and its related application requirements. Suggestions below may or may not be appropriate for your community.

The following language addresses large-scale PV installations.

All commercial-scale solar photovoltaic installations requiring Site Plan Review shall adhere to the following Design and Operation Standards.

Height

In general, height standards should be consistent with requirement for other types of structures. Separate height requirements may be imposed if there is a compelling reason to do so. For example:

A. Height. The height of any structure associated with a Commercial-Scale Ground Mounted Solar Photovoltaic Installation shall not exceed 35 feet.

Building Height Standards

Standards within the zoning bylaw may need to be adjusted to include an exemption for the small increase in height created by roof-mounted solar PV installations. For example:

B. Building Height Regulations Exemptions. Mechanical equipment and appurtenances necessary to the operation or maintenance of the building or structure itself, including chimneys, ventilators, plumbing vent stacks, cooling towers, water tanks, broadcasting and television antennae and roof-mounted solar energy systems.

Setbacks

Minimum setbacks can be established to meet standards already required by the individual municipality, based on their desire to preserve viewsheds and character, as outlined in planning documents (e.g. Master Plan, Open Space and Recreation Plan), or along any designated scenic roads within municipal limits. Some municipalities require buffering from adjacent residential properties that exist at the time of permitting, along with larger setbacks from the right-of-way or other zoning district.

In general, these setbacks should be consistent with other use types. For example:

C. Setbacks. All Medium and Large Ground-Mounted Solar Photovoltaic Installations shall meet the front setback of 50 feet, side setbacks of 20 feet, and rear setback of 20 feet.

Smaller setbacks may be considered for small-scale, residential projects:

Small Ground-Mounted Solar Photovoltaic Installations accessory to principal use may be located no closer than [1/2 of the setback that would otherwise apply] from the front, side or rear lot line. All ground-mounted solar energy systems in residential districts shall be installed either in the side yard or rear yard to the extent practicable.

Larger setbacks may be considered for Commercial Solar Photovoltaic Installations, if there is a compelling reason to do so. For example:

For all Commercial-Scale Ground-Mounted Solar Photoelectric Installations, minimum setbacks shall be as follows:

FRONT SETBACK (feet) 100

REAR YARD (feet) 100

SIDE YARD (feet) 100

PERIMETER SETBACK (feet) 100

Acreage and generating capacity thresholds apply in the aggregate to new facilities and expansions of existing facilities. For expansions, the acreage and output generation of the existing facility would be added to those of the proposed expansion to determine the overall size and generating capacity. Required setback areas shall not be counted toward a facility's total acreage.

Appurtenant Structures

In general, all appurtenant structures should be subject to the same requirements as other types of structures. This can be specifically called out within the bylaw or ordinance language.

D. Appurtenant Structures. All appurtenant structures to a solar photovoltaic installation shall be subject to the requirements of the Zoning Guide concerning the bulk and height of structures, lot area, setbacks, open space, parking and building coverage requirements. All such appurtenant structures, including but not limited to, equipment shelters, storage facilities, transformers, and substations, shall be architecturally compatible with each other. Whenever reasonable, structures should be screened from view by vegetation.

Lighting

Dark Sky standards for lighting are often included and defined elsewhere in the zoning code, particularly as a consideration in Site Plan Review. The intent of the lighting/dark sky regulations is to manage and/or limit outdoor lighting in order to preserve and recover the visibility of the night sky; prevent light pollution, light trespass, and glare; to conserve energy and protect natural resources; and to facilitate safety and security of persons and property.

E. Lighting. Lighting shall be consistent with local, state and federal law. Lighting of all parts of the installation, such as appurtenant structures, shall be limited to that required for safety and operational purposes, and shall be reasonably shielded from abutting properties. Where feasible, lighting of the solar energy system shall be directed downward and shall incorporate full cutoff fixtures to reduce light pollution. Lighting of CSPI shall be limited to night-time maintenance and inspections by authorized personnel, and shall comply with Dark Sky standards. There should be no illumination when personnel are not on the site.

Signage

Sign standards are often defined elsewhere in the zoning code, and can be referenced here.

F. Signage. A sign shall be erected identifying the owner and providing a 24-hour emergency contact phone number of the CSPI owner or operator. CSPIs shall not display any advertising. Signs must comply with sign standards as identified in the community's sign regulations.

Day-time Visual Distraction

If restrictions on visual distractions are not included elsewhere in the bylaw or ordinance, they may be defined here. For example:

G. Day-time Visual Distraction. The Commercial-Scale Ground-Mounted Photovoltaic Installation shall be positioned to minimize glare on any residence or public way, and shall not create a visual obstruction on a public roadway, such as blocking intersections or creating blind curves. The applicant should submit a ratings and technical specifications for the solar panels to ensure minimal reflectivity.

Utility Connections

H. Utility Connections. All utility connections from the solar photovoltaic installation must be placed underground, unless it can be demonstrated to the Site Plan Approval Authority that soil conditions, shape, and topography of the site or requirements of the utility provider make it infeasible. Electrical transformers for utility interconnections may be above ground if required by the utility provider.

Fencing

I. Fencing. There shall be a fence built surrounding the solar array and ancillary equipment. The fence shall be knuckled selvage chain link fence unless determined otherwise by the Site Plan Approval Authority. The fence shall be at least six inches above the ground to allow for wildlife crossing under fence.

If Pollinator-Friendly Certification is required (see Section 7), that may be referenced in the bylaw language. For example:

I. Fencing. There shall be a fence built surrounding the solar array and ancillary equipment. The fence shall be knuckled selvage chain link fence unless determined otherwise by the Site Plan Approval Authority. There shall be a gap along the bottom of the fence that complies with UMass Clean Energy Extension Pollinator-Friendly Certification Program standards, in order to allow for wildlife crossing under fence.

Access Roads

J. Access Roads. Access roads shall be planned and constructed in consultation with the Department of Public Works in order to minimize grading, stormwater/run-off control, removal of stone walls or trees and to minimize impacts to environmental, wetlands, or historic resources.

Emergency Access

K. Emergency Access. The CSPI owner or operator shall provide a copy of the project summary, electrical schematic, and an approved site plan, to the local fire department and the Building Inspector. Upon request the owner or operator shall cooperate with local emergency services in developing an emergency response plan, which may include ensuring that emergency personnel have immediate, 24-hour access to the facility. All means of shutting down the CSPI shall be clearly marked. The owner or operator shall identify a responsible person for public inquiries throughout the life of the installation and shall provide a mailing address and 24-hour telephone number for such person(s). **These components shall be included in the Operation & Maintenance Plan.**

OTHER CONSIDERATIONS

ENERGY STORAGE

As battery technology improves, energy storage has recently made its way into solar PV site plans as an additional component of larger CSPIs. As of April 2020, energy storage will now be required for new solar projects larger than 500 kW seeking incentives under the SMART program. Because this is a relatively new technology, there are not yet clear standards and criteria for development of these systems. The DOER Model Solar Bylaw does not address them.

Current energy storage systems are most often composed of large banks of lithium ion batteries, although new technologies are being developed and beginning to enter the market. Energy storage systems are beneficial to the electricity grid, because they allow for a more regulated flow of electricity into the grid, and also allow intermittent renewable energy sources to provide electricity during times when it is not being directly generated, for example, allowing for the use of solar-generated electricity at night. Of course, energy storage systems add additional complexity to a proposed solar PV project, and additional considerations with regards to safety, environmental hazards, noise, aesthetics, operations and maintenance, and decommissioning must be addressed.

Local boards and planning departments are beginning to gain experience in reviewing battery storage systems, and examining the extent to which they fit into existing local zoning regulations. Unfortunately, because they are a relatively new technology, there are not yet clear standards and criteria for development of these

systems. This gap has been recognized at both the state and federal level. The U.S. Department of Energy (DOE) has established an Energy Storage Safety Collaborative, which is currently working on updates to the various safety codes, regulations, and standards (collectively known as CSR) applicable to energy storage systems. The Massachusetts Clean Energy Center reports it is supporting the development and implementation of appropriate CSRs, as well exploring outreach and education opportunities for emergency personnel and other relevant authorities. Because energy storage systems are evolving quickly, the guidance provided below is relatively general and preliminary. We encourage you to check the resources identified at the end of this guide for any updates on the regulation of energy storage systems.

Safety

Energy storage systems are regulated by a variety of safety codes, standards, and regulations – the “CSRs” noted above. The US DOE has identified over 40 codes and standards that may require updates to address energy storage systems - including building codes, electrical codes, and fire safety codes – but not all of these codes require enforcement by local officials.

Safety codes in a given municipality are enforced by Authorities Having Jurisdiction (AHJs), which is a collective term for the organizations, agencies, or individuals responsible for enforcing the requirements of a specific code or standard. The AHJ in a given community may vary, depending on the municipality and the code being enforced. According to the Massachusetts Department of Fire Services, *the phrase “authority having jurisdiction,” or its acronym AHJ, is used in ... a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the AHJ may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.*

Your municipal fire chief, building inspector, and electrical inspector should be able to identify areas in which they qualify as an AHJ, and which safety codes they are responsible for enforcing. When an energy storage project comes forward, it is important to ensure these officials are staying abreast of any new additions to national safety codes applicable to energy storage systems, and any modifications of these rules specific to Massachusetts. For example, the National Fire Prevention Association (NFPA) issued an updated *NFPA 1 Fire Code* in 2018, which addresses energy storage systems specifically. The State Fire Marshall announced Massachusetts amendments to that code in October 2019, including provisions relevant to energy storage systems.

In the absence of additional guidance regarding safety planning, the Safety Subgroup of the national Energy Storage Integration Council has the following recommendations regarding incident preparedness and training of emergency response personnel. These recommendations can inform the portion of the Operations and Maintenance Plan composed by the facility developer in consultation with emergency response personnel.

For those personnel called on during emergency situations an important consideration is appropriate training to recognize and respond to all reasonably foreseeable incidents that may occur at the site of an energy storage installation, whether the incident source is the system itself or something external (e.g. wildfire or flood). It is recommended that ... the energy storage supplier make available all necessary emergency action information related to their system. This information could also be included in the operations and maintenance manual. This emergency action information will contain salient information for preparing for incidents and could be used by the utility and other stakeholders, such as local responders, to prepare a site specific, emergency action plan.

The action plan could address possible incident scenarios starting during construction and commissioning and continuing through operation and decommissioning. This could include a call/email list for all those who need to be informed of a situation potentially including: emergency personnel, operators, owners, regulators, and many others. Actions for these parties may include urgent responses, such as responding to a medical emergency, or non-urgent responses, such as performing an incident investigation. This plan could account for all reasonable accidents that could occur at the project site possibly including but not limited to medical emergencies and incidents associated with fires, chemical spills, explosions, shocks and mishandling of the system or materials related to the installation.

The incident training manual could allow utility personnel and their contractors, as well as first and second responders, to understand the likely incident scenarios associated with the energy storage installation and appropriate actions to take to for each scenario. It could include, at a minimum, emergency shutdown procedures, a Materials Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) along with any first-aid requirements. Steps and actions listed in the incident training manual could be consistent with the Occupational Safety and Health Administration (OSHA) hazard communications standard (HCS).

Several technical recommendations regarding design for safety are included in Appendix D.

Responding to emergencies at a solar facility may require special training and equipment. Lithium ion battery fires, for example, cannot be treated like common fires; they have different burn characteristics and toxic byproducts. The relevant permitting authority for a commercial-scale solar PV facility – be it the Site Plan Review Authority in As-of-Right zones, or the Special Permit Approval Authority – should be prepared to include conditions on the permit necessary to ensure that emergency personnel have access to the appropriate training and equipment in order to respond to any emergencies that may occur on-site. It is not inappropriate for the municipality to request or require that the solar developer cover the costs of necessary training or equipment. NFPA currently has an on-line training available for fire personnel (see Resources).

In many cases, both the solar PV facility owner and local emergency personnel may prefer that specialized emergency response personnel employed by the facility owner respond to directly address certain kinds of incidents specific to solar sites, including electrical and chemical fires. Local emergency personnel may not have the expertise or equipment necessary to respond appropriately to these situations, nor a comfort level working in close proximity to high voltages.

Where this is the case, emergency personnel's main role may be to contain any fires to the facility property, while ensuring that appropriate personnel employed by the facility are alerted and responding to the scene. Solar PV arrays and energy storage systems typically include remote monitoring systems which alert the facility owner to any problems or unusual conditions occurring on-site.

However, ensuring that emergency contact information for the facility is readily accessible and up-to-date is imperative, especially since solar PV facilities often change hands multiple times over their operational life.

Environmental Considerations

Large battery systems are an evolving technology, but many batteries contain heavy metals, which could cause damage if leached into the environment. In addition, fire suppression systems may include release of a chemical agent to suppress the fire. Material Safety Data Sheets (MSDS) for fire suppression chemicals should be reviewed carefully, and the potential for any leaking, leaching, or chemical spills reviewed with the solar developer. The Site Plan Review Authority, and Conservation Commission where applicable, should take special care in reviewing plans for energy storage systems placed in environmentally-sensitive areas.

Environmental Considerations

Because batteries require climate-controlled conditions, these systems must be actively heated and cooled over the course of the year, to prevent freezing or

overheating. The fans associated with these units do produce noise, which in some conditions may be audible to nearby abutters. It is important to ensure that these systems meet any noise regulations or bylaws applicable in the municipality.

In addition to this long-term noise consideration, there are also noise issues to consider during construction. Depending on the order of workflow at the site, energy storage systems may be installed at the site before the solar PV facility is in full operation. These energy systems may sit idle for multiple weeks before the utility finishes its approval process and the facility goes into operation. During this time, battery systems need to be kept from freezing or overheating; in the absence of an operational solar array, the solar developer may expect to power climate control systems through a diesel generator, which can disturb abutters.

Don't forget to ask the solar developer about the timing of installation of the energy storage system, and their plans for keeping the batteries climate-controlled until the system is fully operational.

Aesthetics

Batteries for energy storage are often packaged into large metal shipping containers, installed over a concrete pad. These units are not always the most attractive, and some permitting authorities have requested that these units be painted such that they blend in with the surrounding scenery. However, these systems may need to be painted white or another light color, to reduce heat load on the unit. Vegetation screens, situated at a safe distance from the unit, may provide an alternative method to screen these systems from view, as well as offer cooling value. One innovative approach in more developed areas could be to have a mural painted on the side of the unit.

Operations and Maintenance

The municipality may wish to include requirements to ensure the energy storage component of the Operations and Maintenance Plan is complete. According to the Energy Storage Integration Committee Safety Subgroup, the plan the solar developer provides to the utility could be designed to include:

- Plans for inspecting, servicing, repair and renovation as well as any addition to the system (e.g. installation of additional storage capacity).
- A complete operation and maintenance manual. This manual could provide instructions for all required operating and maintenance activities, the timing for these activities, and who will perform them. Ideally the manual could be in electronic form and automatically prompt utility personnel and/or their agents

to initiate, perform, and document required actions after the system is commissioned and placed in operation. This manual could also include conditions under which the system will have met end of warranty, service life, and operational life.

A municipality may choose to require all or a subset of these components.

Decommissioning

Decommissioning costs and protocol for the energy storage system should also be considered. The Energy Storage Integration Committee Safety Subgroup provides the following guidance regarding decommissioning, which may be already addressed by the utility, but is worth noting here: *It is recommended that the energy storage supplier be required to develop a decommissioning and disposal plan for utility approval. This plan could explain the procedure for decommissioning, including any hazards this may present, as well as the steps to disconnect the system from external automated control systems. It could elaborate who is responsible for disposal and recycling, what costs this will incur, how articles could be packaged for disposal, and who is responsible for shipping the materials to the disposal or recycling site.*

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10 ENVIRONMENTAL STANDARDS

Municipal planners and Site Plan Approval Authorities (whether Planning Boards or Zoning Board of Appeals members) should carefully consider impacts of proposed projects on abutters and neighbors, safety concerns, and short- and long-term environmental impacts.

“While solar energy is a renewable, green resource, its generation is not without environmental impacts. Though solar facilities do not generate the air or water pollution typical of other large-scale fossil-fuel power production facilities, impacts on wildlife habitat and stormwater management can be significant due to the large scale of these uses and the resulting extent of land disturbance. The location of sites, the arrangement of panels within the site, and the ongoing management of the site are important in the mitigation of such impacts.”

- Darren K. Coffey, AICP

American Planning Association Planning Advisory Service, 2019





SAMPLE BYLAW/ORDINANCE LANGUAGE

ENVIRONMENTAL COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE *SITE PLAN REVIEW STANDARDS* SECTION AND SAMPLE LANGUAGE

Municipalities may choose to adopt specific environmental standards as part of Site Plan Review Design and Operation Standards, along with the basic standards addressed in *Section 9*. The examples provided below may be adapted for your community.

Vegetation Clearing

A. Vegetation Clearing. Clearing of natural vegetation shall be limited to what is necessary for the construction, operation, and maintenance of the Commercial Solar Photovoltaic Installation or otherwise prescribed by applicable laws, regulations, and guides. Existing root structures and topsoil shall be maintained to the maximum extent possible. Where removal of naturally occurring vegetation such as trees and shrubs is planned, the owner of the CSPI must demonstrate that the removal of this vegetation is necessary and its presence adversely affects the performance and operation of the solar installation.

Project Visibility

B. Project Visibility. The CSPI shall be designed to minimize its visibility, including preserving natural vegetation to the maximum extent possible, blending in equipment with the surroundings, adding vegetative buffers to provide an effective visual barrier from adjacent roads and driveways, and from abutting dwellings.

Topsoil is critical to supporting healthy vegetation and reducing stormwater flows post construction. Topsoil, the uppermost soil layer, also known as “A horizon,” is typically higher in organic matter and darker in color than underlying soils. It also often has a granular and more porous structure and has lower clay content. Permanent removal of topsoil often ends in poor vegetation growth and survival and greatly diminished capacity for soaking up and mitigating stormflows.

See page 48 for some suggestions on how to ensure preservation and management of topsoil.

Site Vegetation Planting and Vegetation Maintenance

As noted in Section 7, municipalities may wish to consider a requirement for pollinator-friendly certification of CSPIs. This ensures the CSPI is planted and maintained as a native wildflower meadow, without requiring additional, continued oversight by the Site Plan Approval Authority. The Pollinator-Friendly Certification Program for Solar PV Arrays, administered by UMass Clean Energy Extension, is a program which promotes the planting of native vegetation under and around solar arrays, and maintenance of vegetation, fencing, nesting habitat, and other features to support continued use of land under and around solar arrays by native pollinators and other wildlife.

For municipalities that wish to include this requirement, the following language can be used:

C*. Vegetation Planting and Maintenance. The project proponent must obtain Pollinator-Friendly Certification for the solar photovoltaic installation through the UMass Clean Energy Extension Pollinator-Friendly Certification Program at a minimum of the [choose Certified, Silver, or Gold] Certification Level, or other equivalent certification as determined by the Site Plan Approval Authority. This certification must be actively maintained throughout the lifetime of the installation. **A copy of the final Establishment and Maintenance plan approved by the UMass Clean Energy Extension Pollinator-Friendly Certification Program must be included in the final Operations & Maintenance Plan for the installation.**

Alternatively, or in addition, municipalities can choose to include the following language regarding vegetation plantings.

C. Vegetation Planting. A diversity of plant species native to New England shall be used for any visual screens and vegetative erosion controls. Use of invasive plants, as identified by the most recent version of the "Massachusetts Prohibited Plant List" maintained by the Massachusetts Department of Agricultural Resources, is prohibited. If deemed necessary by the Site Plan Approval Authority, the depth of the vegetative screen shall be 30 feet and will be composed of native trees and shrubs staggered for height and density that shall be properly maintained.

The following language may also be used to regulate vegetation management on-site.

D. Vegetation Management. The open area of the site shall be seeded with a pollinator mix and maintained as bird and insect habitat. Mowing may only be done to retain a natural functioning of the landscape. Plants shall be maintained and replaced as necessary by the owner of the CSPI for the life of the CSPI. **The plan for vegetation control, and if applicable, animal control, shall be included in the Operation & Maintenance Plan.**

E. Animal and Plant Management. Herbicides, rodenticides, or any other pesticides may not be used to control vegetation or animals at a CSPI, except where herbicide use has been approved by the Site Plan Approval Authority for control of invasive species. In a dual-use CSPI, the agricultural operator, but not the CSPI operator, is exempt from this restriction. **The plan for vegetation control, and if applicable, animal control, shall be included in the Operation & Maintenance Plan.**

STORMWATER MANAGEMENT, EROSION & SEDIMENT CONTROL

Site disturbance for large solar facilities can be significant due to the large area taken up by the solar PV panels themselves, as well as inter-row spacing, trim zones to limit shading of panels, and associated electrical infrastructure. Depending on the site orientation and the panels to be used, significant grading may be required for panel placement, roads, and other support infrastructure.

Solar PV installations that impact areas identified in Chapter 131, Section 40 are subject to the state Wetlands Protection Act 310 CMR, and the requirements within the Massachusetts Stormwater Handbook and Standards. Local wetlands and stormwater regulations may also apply to the installation.

The project proponent will need to submit a Stormwater Management Plan, detailing how the site will meet state and local regulations. Depending on the project siting relative to wetlands and other water bodies, the Stormwater Management Plan may need to be reviewed solely by the Site Plan Approval Authority, or by both the Authority and the Conservation Commission.

The Massachusetts Stormwater Handbook and Stormwater Standards can be found at: <https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards>

Considerations for phasing the construction could minimize sedimentation.

A municipality may have stormwater management and erosion and sediment control standards and requirements in a number of possible places within local municipal code.

- A community regulated by EPA's MS4 permit (Municipal Separate Storm Sewer System) will likely have these standards specifically in a general bylaw or ordinance and possibly accompanying regulations. Any part of the zoning relative to drainage and solar photovoltaic installations ought to reference specifically that stormwater management and erosion and sediment control part of the local municipal code.
- Non-MS4 permit communities may have drainage and erosion and sediment control standards in subdivision regulations and in the zoning bylaw. Given the scale of CSPI projects, all such development proposals should include provisions for erosion and sediment control and stormwater management. This is critical to avoiding impacts to properties and resources that are located downgradient from the solar field. Substandard development projects have the effect of often passing on costs to others. If no such section exists in the zoning bylaw, following is some example language:

F. Stormwater Management. A Stormwater Management Plan must be submitted with the stamp and signature of a Registered Professional Engineer (PE) who is licensed in the Commonwealth of Massachusetts. The Stormwater Management Plan shall fully describe the project in drawings, narrative, and calculations. It shall include:

- a. The site's existing and proposed topography;
- b. All areas of the site designated as open space;
- c. A description and delineation of existing stormwater conveyances, impoundments, environmental resources on or adjacent to the site into which stormwater flows;
- d. A delineation of 100-year flood plains, if applicable;
- e. Estimated seasonal high groundwater elevation in areas to be used for stormwater retention, detention, or infiltration;
- f. Existing and proposed vegetation and ground surfaces with runoff coefficients for each;
- g. A drainage area map showing pre- and post-construction watershed boundaries, drainage area and stormwater flow paths, including municipal drainage system flows, at a scale that enables verification of supporting calculations;
- h. A recharge analysis that calculates pre- and post-construction annual groundwater recharge rates on the parcel;
- i. A description and drawings of all components of the proposed stormwater management system;
- j. Soils information from test pits performed at the location of proposed Stormwater Management facilities, including soil descriptions, depth to seasonal high groundwater and depth to bedrock. Soils information will be based on site test pits logged by a Massachusetts Certified Soil Evaluator.

Preserve and Manage Topsoil and Soil Porosity

If there are not explicit and strong provisions for preservation of topsoil in the local Earth Removal bylaw/ordinance, it is important to consider adding requirements for project proposals to fully describe control measures that will be used to preserve the existing topsoil on the construction site.

At a minimum, site owners and operators must preserve existing topsoil on the construction site to the maximum extent feasible. For low-density developments, the common measure of topsoil stripping might be unnecessary and should be minimized, if not avoided. If it is determined that preserving native topsoil is infeasible, the reasons why this was determined must be addressed in the project proposal.

Further, proper management of the topsoil stockpile should include measures that minimize or eliminate the discharge of material from entering drainage systems or surface waters. For any stockpile or land clearing debris composed, in whole or in part, of sediment or soil, the following requirements apply:

- Locate the piles within the designated limits of disturbance.
- Protect from contact with stormwater (including run-on) using a temporary perimeter sediment barrier.
- Where practicable, provide cover or appropriate temporary vegetative or structural stabilization to avoid direct contact with precipitation or to minimize sediment discharge.
- Never hose down or sweep soil or sediment accumulated on pavement or other impervious surfaces into any stormwater conveyance, storm drain inlet, or surface water.
- To the maximum extent practicable, contain and securely protect from wind.
- For final stabilization, all areas within the limits of disturbance to be seeded or planted must be de-compacted and topsoiled, and then seeded or planted with perennial vegetative cover.
- Immediately after seeding or planting the area to be stabilized, select, design, and install non-vegetative erosion controls that provide cover (e.g., mulch, rolled erosion control products), to the extent necessary to prevent erosion while vegetation is becoming established.

Where construction activity does require grading and filling and where compaction of soil can be expected, this disturbance should be limited. Soil treatments/amendments should be considered for such disturbed areas to restore permeability. If the bulk density is not reduced following fill, these areas will be considered semi-impervious after development and runoff volumes should be calculated accordingly.

MITIGATION CONSIDERATIONS

MITIGATION COMPONENTS OF BYLAWS/ORDINANCES AND SAMPLE LANGUAGE

Tree clearing is a major concern when it comes to solar development. Solar developers require clearing of wooded areas within and surrounding the solar array to avoid shading of solar panels by surrounding vegetation. Meanwhile, local community residents and abutters may be concerned about the loss of forest, and associated habitat and ecosystem services. Communities can reduce potential conflicts between solar development and forest preservation by requiring mitigation for large-scale forest clearing.

Mitigation for Loss of Wildlife Habitat within the Installation

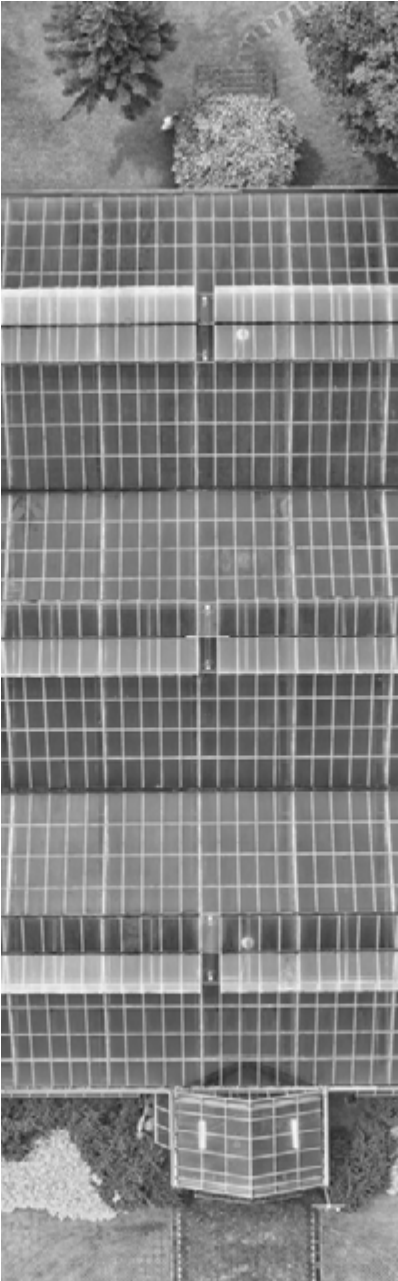
If natural forest, shrubland, or grassland is proposed to be converted to a CSPI, the municipality may require that the project proponent create a wildflower meadow habitat within and immediately around the CSPI, and a successional forest habitat in the surrounding areas managed to prevent shading until the installation is decommissioned and the site restored to forest. This can be accomplished through Pollinator-Friendly Certification, which requires establishment and maintenance of a native wildflower meadow. Alternatively, the Site Plan Approval Authority can provide direct oversight of the establishment and maintenance of such habitat. The special permit may be conditioned to effect and make enforceable this requirement. Keep in mind that replacement of a natural habitat with a managed wildflower meadow is likely to provide higher quality habitat than gravel or non-native turfgrass; however, such a substitution is unlikely to replace the wildlife habitat and other ecosystem services provided by the natural habitat.

G. Mitigation for Loss of Wildlife Habitat within the Installation. If undeveloped land is proposed to be converted to a CSPI, the plans shall show mitigation measures that create a wildflower meadow habitat within and immediately around the CSPI and a successional forest habitat in the surrounding areas managed to prevent shading until the installation is decommissioned and the site restored to forest.

The special permit may be conditioned to effect and make enforceable this requirement.

Mitigation for Loss of Carbon Sequestration and Forest Habitat

If forestland is proposed to be converted to a CSPI, the municipality may require that the developer designate an area of unprotected forestland (that is, land that could otherwise be developed under current zoning) within the municipality for permanent protection. The location of the designated forest may be limited to the parcel under development or contiguous parcels, or allowable anywhere within the municipality. The designated area may be required to be equal in size to the project footprint of the proposed for development, or of a size equal to multiple times the total area of such forest conversion (e.g two or four times). Such designated land shall remain in substantially its natural condition without alteration except for routine forestry practices until such time as the CSPI is decommissioned and the CSPI project footprint is restored to forest. The special permit may be conditioned to effect and make enforceable this requirement.



H. Mitigation for Loss of Carbon Sequestration and Forest Habitat. If undeveloped land is proposed to be converted to a CSPI, the plans shall designate an area of unprotected land (that is, land that could otherwise be developed under current zoning) contiguous parcels or nearby, or location within the municipality agreed upon by the the Site Plan Authority in consultation with the Conservation Commission, under common ownership that comprise the project site, and of a size equal to four times the total area of such forest conversion. Such designated land shall remain in substantially its natural condition without alteration except for routine forestry practices until such time as the CSPI is decommissioned and the site restored to forest. The special permit may be conditioned to effect and make enforceable this requirement.

As an alternative to forest protection, municipalities can also consider a tree replacement bylaw or ordinance for solar development that clears large acreages of trees. This can be applied to all types of development that are regulated by the zoning code. See Appendix E for example.



11

CONSTRUCTION, MAINTENANCE, MONITORING & MODIFICATIONS

The intent of this section is to provide assurance that the facility will be built and operated in accordance with the approved agreement and maintained within accepted standards for its lifespan of operation. This section covers **Construction, Maintenance, Annual Reporting and Modification** requirements. By signing an agreement with the municipality, the operator is assuming responsibility and assuring the municipality it will meet all of its short and long term obligations under the signed agreement.





SAMPLE BYLAW/ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE *CONSTRUCTION, MAINTENANCE, MONITORING & MODIFICATIONS* SECTION AND SAMPLE LANGUAGE

Municipalities may want to identify specific standards or criteria for the approval of solar photovoltaic installations and its related application requirements. Suggestions below may or may not be appropriate for your community.

Construction Monitoring

It is important that municipal boards are assured that the operator is constructing the solar array in accordance with the approved plan. Once the plan has been approved, the appropriate municipal board(s) or municipal staff will need to monitor construction to assure it is being done to in accordance with the approved plan, as overseen by the Building Inspector, the Site Plan Approval Authority, the Special Permit Granting Authority, and/or the Conservation Commission. The construction monitoring costs may be required to be covered by the developer as one of the conditions in the approved agreement. Alternatively, approval may be conditioned upon having an engineer provide weekly reports to the supervising authority, indicating the work completed and stamping it as being in substantial compliance with the approved plans.

A. Construction Monitoring. The Site Plan Approval Authority may require a third-party inspector, selected by and acting under the direction of the Building Commissioner, to be employed to monitor compliance with all approvals and conditions during the CSPI's construction at the applicant's expense.

Maintenance

It is important for safety, visual appearance, and environmental compliance that the operator perform agreed upon regular maintenance of the facility. If there is the need for additional maintenance need, the operator must address it in accordance with the conditions agreed to in the permit, and in accordance with state law and the municipal bylaw or ordinance.

B. Maintenance. The CSPI owner or operator shall maintain the facility in good condition. Maintenance shall include, but not be limited to, painting, structural repairs, and integrity of security measures. Site access shall be maintained to a level acceptable to the local emergency services. The owner or operator shall be responsible for the cost of maintaining the solar photovoltaic installation and all access roads that are not public ways.

Annual Reporting

The community should be kept up-to-date through the identified proper municipal authorities informed and in accordance with the signed agreement. The operator must complete and submit any required annual reports to appropriate Town or City authorities. These authorities can be established via the bylaw or ordinance or as a condition of approval. Appropriate authorities may include the Health Agent, Town/City Clerk, Fire Chief, Police Chief, Planning Department (and/or Planning Board or ZBA), Highway Superintendent or DPW Director, Town/City Engineer, Conservation Commission, or others.

C. Annual Reporting. The owner or operator of a CSPI shall submit an annual report demonstrating and certifying compliance with the Operation and Maintenance Plan, the requirements of this guide, and approvals granted hereunder, including but not limited to continued management and maintenance of vegetation, compliance with the approved plans and any permit conditions, continuation of liability insurance, and adequacy of road access. The annual report shall also provide information on the maintenance completed during the course of the year and the amount of electricity generated by the facility. The report shall be submitted to the Board of Selectmen or Town/City Council, Planning Board, Fire Chief, Building Commissioner, Board of Health, and Conservation Commission (if a wetlands permit was issued) no later than 45 days after the end of the calendar year.

If the municipality has required Pollinator Friendly Certification of the CSPI through the UMass Clean Energy Extension program, it may request a copy of the Annual Maintenance Log, which is submitted annually to UMass.

E. The owner or operator of a CSPI shall submit a copy of the Annual Maintenance Log submitted to UMass Clean Energy Extension as proof of continued participation in the Pollinator Friendly Certification Program. The log shall be submitted to the [list appropriate authorities] no later than 45 days after the end of the calendar year.

Modifications

There are two types of modifications municipal authorities commonly face. The first is a modification during construction based on the existing site conditions, forcing the developer to alter the installation and configuration of the site. The second are modifications put in place by the developer after site plan approval (additional panels, etc). The operator must inform the Site Plan Review Authority of any type of proposed modification to allow for proper review and approval.

D. Modifications. All modifications to a CSPI made after issuance of the required building permit shall require approval by the Site Plan Approval Authority before implementation.

Transfer of Ownership

In the current solar market, commercial-scale facilities change ownership frequently – in many cases, even before the project is fully constructed and operational. It is important to include language within the conditions set on a permit approval that detail the expectations associated with a transfer of ownership.

E. Transfer of Ownership. In the event that the solar facility is sold, all municipal permits, conditions, and associated documentation shall be provided in both digital and hard copy format to the new owner, including [add specific documents as needed]. The [Site Review Approval Authority/Special Permit Granting Authority] must be provided with updated contact information for the new owner, including name, address, telephone number, and e-mail address. Authorities Having Jurisdiction, including local emergency personnel, must be provided with updated emergency contact information, including an emergency contact number that is staffed 24 hours a day. The new owner must abide by all conditions as detailed in the final permit. Any proposed changes to the project shall require approval as described in the Modifications section of the municipality's solar zoning bylaw [list section of bylaw].

12 DISCONTINUANCE & REMOVAL

The intent of this section is to provide guidance on the discontinuation and removal of the Commercial Solar Photovoltaic Installations. All actions and requests in this section should be at the expense of the owner or operator, upon written request of the Building Inspector Select Board, Town or City Council. If in accordance with the existing agreement there is an indication of lack of operation, maintenance or the discontinuance of the operation of the array, the municipality must take enforceable action. The terms of the agreement must also be transferrable and transmissible to any assigned future owners of the array. The removal of the CSPI should include returning to the original conditions in accordance with the approved building permit and any other permits or conditions. The challenge with solar PV installations is that they will likely be in place for at least 20 years; agreements, permits, and conditions must therefore be accessible to future local officials, as well as future owners of the solar PV installation, should the project change hands. Therefore, all language and requirements must be in clear and enforceable terms.



SAMPLE BYLAW/ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE *DISCONTINUANCE AND REMOVAL* SECTION AND SAMPLE LANGUAGE

Municipalities may want to identify specific standards or criteria for approval of solar photovoltaic installations and its related application requirements. Suggestions below may or may not be appropriate for your community.

A. Removal Requirements. Any CSPI, or any substantial part thereof, not used for a period of one continuous year or more without written permission from the Site Plan Approval Authority, or that has reached the end of its useful life, shall be considered discontinued and shall be removed. Upon written request from the Building Inspector, addressed to the contact address provided and maintained by the owner or operator as required above, the owner or operator shall provide evidence to the Building Inspector demonstrating continued use of the CSPI. Failure to provide such evidence within thirty days of such written request shall be conclusive evidence that the installation has been discontinued. Anyone intending to decommission and/or remove such an installation shall notify the Site Plan Approval Authority and Building Inspector by certified mail of the proposed date of discontinued operations and plans for removal.

1. Physical removal of all parts of and appurtenances to the CSPI, including structures, equipment, security barriers and transmission lines;
2. Disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations;
3. Stabilization or re-vegetation of the site as necessary to minimize erosion. The Site Plan Approval Authority may allow the owner or operator to leave landscaping or designated below-grade foundations in order to minimize erosion and disruption to vegetation.
4. Any site that was deforested for the CSPI, per Section 5(B) or (C), shall be restored to encourage native tree growth, including the planting of seedlings, if necessary, to establish growth. The cost of plant replacement shall be incorporated into the financial surety stipulated in Section 13.

B. Right to Remove. If the owner or operator of the CSPI fails to remove the installation in accordance with the requirements of this section, the town shall have the right, to the extent it is otherwise duly authorized by law, to enter the property and physically remove the installation at the expense of the owner of the installation and the owner(s) of the site on which the facility is located. The Town/City may use the financial surety as stipulated in §13(D), below for this purpose.

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13 FINANCIAL SURETY

The intent of financial surety is to protect the municipality by making make sure that the funds identified for decommissioning and site stabilization are available throughout the lifetime of the project. In this section, we provide sample language to ensure a clear disposition of cash bonds or other financial surety, and annual confirmation of the existence of the financial surety for the lifetime of the project.



SAMPLE BYLAW/ ORDINANCE LANGUAGE

COMPONENTS OF BYLAW/ORDINANCE TYPICALLY IN THE *FINANCIAL SURETY* SECTION AND SAMPLE LANGUAGE

A. Financial Surety. Prior to commencing operation, the applicant shall provide a form of financial surety, through a cash deposit, in an amount determined to be adequate by the Site Plan Review Authority to cover cost of CSPI removal and site restoration.

B. Decommissioning Cost Estimation. The applicant shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include an escalator for calculating increased removal costs due to inflation. Salvage for solar panels may be included for other components of the installation at the discretion of the Site Plan Review Authority.

See *Appendix E* for an example of estimating decommissioning costs.

C. The financial surety shall be maintained by the developer for the lifespan of the facility, with annual certification notices from the surety company or bank for surety bonds submitted to the Site Plan Review Authority. Such surety is not required for municipal facilities.

D. A cash deposit [of a minimum amount of \$100,000 per MW (DC) of installed system capacity] shall be held by the Town Treasurer pursuant to M.G.L. Chapter 44, Section 53 ½.

SOME ADDITIONAL CONSIDERATIONS ON THE TRANSACTION OF FINANCIAL SURETY

1. Cash deposit amount shall be identified in the conditions of the Special Permit
2. Interest earned on cash deposit shall be deposited into the General Fund and shall be returned to the developer with cash deposit at time of decommissioning.
3. Performance required and standards for determining satisfactory completion or default: by-law, ordinance, rule, regulation or contract stating that Building Inspector/Zoning Enforcement Officer shall inspect the project and provide written documentation of completion or default to the applicant and the Town.
4. The procedures the applicant must follow to obtain a return of the monies or other security: by-law, ordinance, rule, regulation or contract stating the applicant shall request in writing to the Building Inspector/Zoning Enforcement Officer (BI/ZEO) who shall in turn inspect the project for full completion (regarding a construction bond) or full decommissioning at the time it is requested. BI/ZEO shall inspect and provide in writing to the applicant and the Town of the condition of the project and inform the Town/City Treasurer and/or Accountant to release the funds to the applicant or to be used to restore the site to its original condition.
5. The project shall be deemed in default if it has been abandoned (as previously described in this bylaw), if applicant has notified the Town of default, or if the project is inactive for 180 days and deemed in default after inspection by the BI/ZEO and notice of default is sent to the Town/City, Treasurer and/or Accountant in writing.

14 PAYMENT IN LIEU OF TAXES (PILOT) LOCAL TAX PAYMENTS

We strongly recommend that towns and cities utilize Payments in Lieu of Taxes (PILOTs), rather than traditional property taxes in assessing Commercial-Scale Solar Photovoltaic Installations. PILOT agreements are made between the project proponent and the municipality to modify the schedule for the payment of taxes; these agreements ideally result in better cash management for the operator and a greater total tax receipt for the municipality. PILOTs also avoid questions of legality surrounding municipal property tax payments on certain types of solar photovoltaic installations.

PILOT Agreements must be ratified by Town Meeting or Town/City Council, and submitted to the Department of Revenue for approval. (For more information, contact the Massachusetts Department of Revenue). The municipality will account for PILOT payment revenue under the "New Growth" section of its total tax levy.

The Legal Status of PILOTs

PILOT Tax payments. Under Massachusetts G.L. c. 59, §38H(b): "agreement for payment in lieu of taxes" (PILOT), municipalities are permitted to negotiate a fair value PILOT applicable to the developer and/or successor entities, which will be in place for the agreed upon lifespan of the proposed solar array.

Negotiating a PILOT Agreement

PILOT agreements should be negotiated between the project proponent and the municipality in an open, equitable fashion. PILOT agreements should be negotiated with the assistance and involvement of the assessors. Before negotiating a PILOT, the eligibility of the project for a PILOT should be reviewed by Town Counsel or the City Solicitor.

Exemptions to Property Taxes for Solar PV Arrays

Your community should be aware that in accordance with MGL Chapter 59 Section 5 (Clause 45), this MGL has negatively impacted the property taxes collected in other communities and provides for a tax exemption for solar and wind energy systems. It applies only to projects which are being utilized as primary or auxilliary source (i.e., if the energy is used on the site may be considered tax exempt).

15 THE PERMITTING PROCESS

TIPS TO REMEMBER

SITE PLAN REVIEW AUTHORITY/SPECIAL PERMIT GRANTING AUTHORITY

- **Follow Open Meeting Laws and Required Timelines** – This is ALWAYS legally required, but because development of CPSIs may be controversial, with a good deal of money wrapped up in their development, it is especially important to ‘dot every i and cross every t’ to avoid possible litigation.
- **As-of-Right vs. Special Permit Site Plan Review** – Recognize the difference between as-of-right non-discretionary site plan review, and special permit discretionary site plan review, and act accordingly.
- **Consult with other relevant municipal boards and departments.**
- **Third Party Consultation** – Third-party review of stormwater management plans is allowable under Massachusetts law, and should be paid for by the project proponent.
- **Negotiate PILOT payments in consultation with assessors and other relevant municipal representatives.**
- **Bonds for Decommissioning**
- **Consider site-specific aesthetic, environmental, and safety specifications, to be included in conditions set on the permit.**
- **Remember large solar PV facilities change ownership frequently.** Write permit conditions such that they are clear and enforceable. Require the transfer of all permitting documents to any new owners as a condition of the permit.

TIPS TO REMEMBER

CONSERVATION COMMISSION

- **MA DEP Guidance** – Review guidance on permitting of solar PV arrays provided by the Massachusetts Department of Environmental Protection: <https://www.mass.gov/guides/massdep-wetlands-program-policy-17-1-photovoltaic-system-solar-array-review#-siting-photovoltaic-systems->
- **Don't be afraid to contact your MassDEP circuit rider with questions.**
- **Follow Open Meeting Laws and Required Timelines** – This is ALWAYS legally required, but because development of CPSIs may be controversial, with a good deal of money wrapped up in their development, it is especially important to 'dot every i and cross every t' to avoid possible litigation.
- **Coordinate with the Site Plan Approval Authority and Special Permit Granting Authority** - (often the Planning Board of Zoning Board of Appeals)
- **Third Party Consultation** – Third-party review of wetland boundaries and stormwater management plans is allowable under Massachusetts law, and should be paid for by the project proponent.
- **The Commission can require regular site checks** during construction and following storm events– weekly, if necessary.
- **The Commission can use its discretion in the wetland buffer zone**, and apply appropriate Special Conditions in the Order of Conditions.
- **The Commission can require limited vegetation clearing in the trim zone**, and apply appropriate Special Conditions in the Order of Conditions.

Consultation with other Agencies and Municipal Boards

In cases where a Site Plan Review is required, the permitting process will be overseen by the Site Plan Review Authority, in consultation with other boards and departments as needed. For projects which require a Special Permit, this Special Permit Approval Authority will then need to determine whether a Special Permit can be granted, and to set appropriate conditions. The Site Plan Review Authority and Special Permit Approval Authority may or may not be the same entity, depending on the permitting structure laid out in the municipality's bylaws.

In most cases, the Conservation Commission only becomes directly involved in the permitting process if work activities associated with development of the solar array are to occur in jurisdictional areas defined under the Massachusetts Wetland Protection Act (WPA). These areas are defined in detail in the WPA, but typically include areas within 100 feet of a wetland or water body, or 200 feet of most rivers and streams.

Because commercial-scale solar projects often involve clearing of large tracts of land, they have the potential to affect wetlands and water bodies, even if those areas are greater than 100 feet away. However, the Conservation Commission has no authority outside its jurisdictional area based on the potential for a project to affect a wetland – it can only come in after the fact, if a jurisdictional area is negatively affected in a way that violates the WPA. For any project that has the potential for run-off or erosion into a wetland or water body, members of the Conservation Commission should be included in meetings of the Site Plan Approval Authority in an advisory role. Even in cases where the Conservation Commission has direct jurisdictional authority, it is important for town boards to coordinate closely, to ensure that the requirements laid out for permitting are consistent and do not work at cross-purposes.

Other entities that may be involved in environmental permitting relating to proposed solar PV projects include the Massachusetts Department of Environmental Protection (as above, under the Wetland Protection Act), the Massachusetts Natural Heritage and Endangered Species Program (within rare species habitat, under the Massachusetts Endangered Species Act), the Department of Conservation and Recreation (in public water supply zones, under the Watershed Protection Act), and the federal Army Corps of Engineers (under the Clean Water Act). The Massachusetts Department of Agricultural Resources (MDAR) may specifically be involved in projects related to agriculture.

Third-Party Review of Stormwater Management Plans

Due to the complexity of large, land-altering solar developments, it is recommended that an independent third party review all stormwater and erosion control and sedimentation controls and plans as part of the Site Plan Approval process. The applicant's engineering and site plans should be reviewed by a licensed third-party engineering review. Usually, municipalities have engineering firms on call who can perform this review in advance of a hearing by the boards on these applications. If the municipality has adopted MGL Chapter 44, Section 53G, the municipality may require that the third-party review be paid for by the applicant.

If approved, it will be important for the municipality to ensure successful implementation of the stormwater management plan and ongoing maintenance of mitigation measures. These measures can be addressed in an approval upon conditions, through sufficient performance security requirements and long-term maintenance provisions.

MGL Chapter 44, Section 53G authorizes the establishment of a special account by certain local boards including the Planning Board or Conservation Commission, for the employment of outside consultants (i.e., peer review of technical issues like peer civil engineering review or traffic peer review) using funds supplied by an applicant for a permit.

Pursuant to section 53G, a board must adopt regulations, through a simple vote of the board to adopt, in order to establish an account.

The account is established by the treasurer with funds segregated from other municipal accounts. The funds, plus interest earned, in such account can be expended by the board without appropriation. Usually, a contract is entered into with the consultant only upon receipt by the board of the funds necessary to pay the consultant. Upon completion of review of a project, any excess funds plus interest shall be repaid to the applicant. The treasurer of the municipality must submit annual reports on such special accounts to the Select Board, Town or City Council, Mayor, or City Manager. All contracts awarded under the provisions of section 53G must comply with the bidding laws of MGL Ch 30B.

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APPENDIX

- A - INSTRUCTIONS AND COMPLETE APPLICATION CHECKLIST
- B - RESOURCES REGARDING AGRICULTURAL EXEMPTION
- C - EXAMPLE SOLAR MORATORIUM BYLAW/ORDINANCE
- D - SAFETY IN ENERGY STORAGE
- E - EXAMPLE TREE REPLACEMENT BYLAW/ORDINANCE
- F - SAMPLE MUNICIPAL BYLAWS/ORDINANCES
- G - SAMPLE PILOT AGREEMENT
- H - ADDITIONAL RESOURCES

A

INSTRUCTIONS AND COMPLETE APPLICATION CHECKLIST

- Town of East Longmeadow



Town of East Longmeadow
Department of Planning and Community Development
60 Center Square
East Longmeadow, Massachusetts 01028
(413) 525-5400 - ext. 1700

INSTRUCTIONS FOR FILING
SPECIAL PERMIT, SITE PLAN REVIEW, and SUBDIVISION PLAN APPLICATIONS

COMPLETE APPLICATION PACKETS

For Special Permits, Site Plan Review, and Subdivision Plans, prior to filing application packets with the Planning Board, the applicant shall review the contents of the packet with Planning & Community Development staff for completeness. After the applicant receives approval from Planning & Community Development staff, the applicant shall bring the packets to the Town Clerk to have the submittals date/time stamped and certified by the Town Clerk. Submittals shall be returned to the Planning and Community Development Department on the same date as part of the COMPLETE APPLICATION PACKET.

The Planning and Community Development Department will only accept a COMPLETE APPLICATION PACKET. All submitted materials should be typed or legibly printed. Fillable forms are available on the Town's website at:

<https://www.eastlongmeadowma.gov/286/Planning>

A COMPLETE APPLICATION PACKET must include all of the following:

1. A ZONING DETERMINATION, with original signatures, signed by the Building Commissioner.
2. Eight (8) hard copies of the executed Zoning Determination (submit this request at least 10 days prior to your anticipated application submittal).
3. A fully completed APPLICATION FORM with original signatures and with the date and time of the filing certified by the Town Clerk.
4. Eight (8) hard copies of the executed APPLICATION FORM.
5. Eight (8) complete sets of all Supporting Materials, as applicable (Plan review application check list, Narrative, Deed of Ownership, Waiver Request Form, Photos, Drainage Report, Traffic Impact Study, Maps, Development Impact Statement).
6. Determination of Applicability submitted to the Conservation Commission (If applicable)
7. Five (5) Storm water Drainage Reports (if applicable)

8. Site Plans and Architectural Elevations (plans should bear the seal of an architect, landscape architect or professional engineer of appropriate discipline licensed in Massachusetts).
 - a. Two separate site plans showing: 1) Existing Conditions 2) Proposed Conditions
 - b. Three (3) sets of the plans shall be full sized (24"x36")
 - c. Six (6) sets shall be 11"x17"

PLEASE NOTE: If filing an Application Not Required (ANR) the following is required:

- Two (2) Mylar Plans
- One (1) full sized (24"x36")

9. Required Filing Fee.
10. **Two sets** of pre-stamped, BLANK envelopes for mailing out required "parties of interest" notifications.
11. Twelve (12) additional pre-stamped, blank envelopes for notice to surrounding municipalities.
12. A TAX COLLECTOR AFFIDAVIT signed by the East Longmeadow Tax Collector (or designee).
13. A CERTIFIED LIST OF ABUTTERS from the Assessor's Office (submit this request at least 10 days prior to your anticipated application submittal).
14. Digital PDF files on a USB device containing the items listed above.

STEPS:

1. Depending on the scale and complexity of the project, it is suggested that the Planning and Community Development Director be consulted early in the project planning process.
2. FILE A ZONING DETERMINATION APPLICATION WITH THE BUILDING DEPARTMENT (submit this request at least 10 days prior to your anticipated application submittal).

This will formally determine what zoning approvals are needed and, if so, by which permit granting authority (Planning Board, Board of Appeals, or Town Council).

3. COMPILE APPLICATION MATERIALS (see COMPLETE APPLICATION PACKET)

4. Before submitting the packet to the TOWN CLERK, submit the COMPLETE APPLICATION PACKET (see COMPLETE APPLICATION PACKET) to the Planning and Community Development Department staff for final review.
5. Submit application with original signatures and one application copy with the Town Clerk to be date/time stamped. This constitutes the official filing date of the application. Leave one date/time stamped packet with Town Clerk.
6. The Planning and Community Development Department will schedule the required meeting date for the application for which the applicant and “parties of Interest” will be mailed notifications.
7. For larger or complicated projects an informal project review/pre permitting meeting may be held with relevant departments to which the applicant will be invited to attend to informally present and discuss the project with various town departments and solicit input. This will likely be conducted prior to the Public Hearing meeting.
8. The Planning Board will conduct the Public Hearing at which the applicant will be given the opportunity to present the project. “Parties in interest” will also have the opportunity participate. The Public Hearing may be continued to a future meeting(s) by the Planning Board to request additional materials and information.
9. Once the Planning Board has determined that they have received all of the relevant information that they require to render a Decision, they will close the Public Hearing and render a Decision.
10. Within fourteen (14) days of the close of hearing, the Planning Board will file its Decision with the Town Clerk, which will be date/time stamped. This will constitute the date on which the Appeal period starts.

The Applicant and any “parties in interest” have 20 days from this date to file an appeal of the Planning Board’s Decision in Court.

11. The applicant will be mailed a copy of the Decision.
12. At the expiration of the 20 day Appeal period the applicant shall go to the Town Clerk’s Office and receive the Planning Board’s Decision endorsed by the Town Clerk that the 20 Day Appeal period has expired with no appeals being filed.
13. The Applicant must record the Special Permit Decision, Site Plan Approval and Plans, and/or Subdivision Certificate of Approval Decision at the Hampden County Registry of Deeds in order for it to become effective. A copy of the recorded document shall be returned to the Planning and Community Development Department.



Case Number:

Plan Review Application Checklist

In order for the town of East Longmeadow Planning Board to accurately review your project in a timely manner, plan sets submitted with applications must be complete and thorough. A comprehensive understanding of this handout and submittal of all required documents and plans ensures an efficient review of your project.

Unless otherwise noted or determined by Planning and Community Development Department Staff to not be required, the following information and drawings must be included in the submittal package for your application. For an application to be accepted, each and every item is required at the time of application submittal.

In certain instances, plans, or portions of plans, may be waived when not applicable for the review of a particular type of development, at the discretion of the Planning and Community Development Director. Requests for any such waiver(s) must be submitted, in writing, to the Planning and Community Development Department for consideration prior to application submittal.

All submitted materials must be legible, organized & bound (where appropriate) in a manner that allows for distribution of all proposal materials as one (1) package. Please utilize double-sided printing for submitted reports, studies and statements when possible.

Initials Indicate Items Submitted

Staff	Applicant
	1. Completed Application Form (with all required signatures; 8 Copies)
	2. Completed Plan Review Application Checklist (1 original & 7 copies)
	3. Plans
	☐ Three (3) stapled and folded sets of full-sized plans (24" x 36") and six (6) sets of reduced plans (11" x 17") are required for all applications. Staff reserves the right to require additional copies.
	☐ One (1) electronic copy (PDF) of all proposed activity plans (See Section 10 of checklist for requirements)
	☐ All plans oriented so that north arrow points to top of sheet
	☐ Plans shall be drawn at a minimum scale of 1"= 40' or less
	☐ All plans shall be stamped by Commonwealth of Massachusetts Registered Professional Engineer, Professional Land Surveyor, Professional Landscape Architect, and/or Architect, as appropriate
	☐ Plan sets shall be comprised of separate sheets as listed below unless otherwise approved by the Planning and Community Development Director
	☐ All plans shall have a title block comprised of the following: Project Title, Sheet Title, Sheet Number; Registrant Stamp (i.e., PE, PLS, LA, RA); Registrant's name and address; Street addresses of the project area parcels; Scale at which the plan is drawn; Plan Issue Date; and all plan revision dates (with corresponding revision descriptions).

3a. Cover Sheet, to include the following information:

☐ **Title Block**

- ☐ Project name/title
- ☐ Assessor's map and parcel number(s)
- ☐ Name and address of property owner(s)
- ☐ Name and address of developer
- ☐ Name and address of Engineer / Architect/ Landscape Architect
- ☐ Revision Date Block
- ☐ Street Number and/or Lot Number
- ☐ HCRD Registry Book and Page (to include previous land plans and recorded deed book and page numbers)

☐ **Zoning Requirements Table** (Indicate Required vs. Provided)

- ☐ Zoning District
- ☐ Lot Area
- ☐ Lot Frontage
- ☐ Front, Side & Rear Setbacks of Buildings and Parking Areas
- ☐ Building Height
- ☐ Lot Coverage Percentage
- ☐ Green Space
- ☐ Off-Street Parking Spaces
- ☐ Compact Parking Spaces
- ☐ Accessible Parking Spaces
- ☐ Van Accessible Parking Spaces
- ☐ Screening Buffers
- ☐ Percentage of Lot that is Upland
- ☐ Total Square Footage of Upland

☐ **Locus Map** (At a scale of 1 inch = 100 feet, showing the entire project and its relation to existing areas, buildings, and roads within a distance of 1,000 feet from the project boundaries, or such other distances as may be approved or required by the Planning Board.)

☐ **Plan Index** with latest revision date of each individual plan

☐ **Flood Insurance Rate Map (FIRM) with effective date**

☐ **Soils Map**

3b. Existing Conditions Plan

- ☐ Name of Surveyor or Surveyor Firm
- ☐ Date of survey
- ☐ Property lines with bearings and distances

Staff	Applicant
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| <ul style="list-style-type: none">☐ Monuments set/found at all lot corners☐ Easements with bearings and distances suitable for registry filing☐ Names of all abutters and zoning district☐ Street names☐ Benchmark locations (Based on USGS NGVD 88. Datum may not be assumed)☐ NHESP mapped areas (Areas of Estimated and Priority Habitats)☐ Existing 21E Contaminated Site Information☐ Existing Buildings and Structures<ul style="list-style-type: none">☐ Area of building☐ Number of stories | |
|---|--|

- ☐ Principal use
- ☐ Setbacks from property lines
- ☐ Floor elevations
- ☐ Existing Topography:
 - ☐ Contours at 2' intervals (1' contours or additional spot grades if site is flat)
 - ☐ Overhead and underground utilities including but not limited to water, sewer, drainage, electric, telephone, cable TV, gas, septic systems, detention structures, wells
 - ☐ Existing parking/paved areas including pavement type (parking, walkways, etc.)
 - ☐ All existing curbcuts
 - ☐ Listing of all existing utility owners and contact info located within the project limits
 - ☐ Adequate utility information outside the site to verify proposed utility connections
 - ☐ All utility pipe types, sizes, lengths, and slopes
 - ☐ All utility structure information including rim and invert elevations
 - ☐ All existing easements within 50 feet of property line-Identify any utility within the easement
 - ☐ All existing utility easements with bearings and distances
 - ☐ Existing pavement markings within site and on connecting roads
 - ☐ Existing features such as walls, curbing, landscaping, trees, walks, fences, trees 18 inches DBH (diameter at breast height), lighting, poles, guys, signs, loading areas, fire hydrants, dumpster locations, known buried slabs, etc.
 - ☐ Wetlands, floodplain, water protection district delineation including offsets and buffer zones
 - ☐ Streams, water courses, swales, and all flood hazard areas
 - ☐ Rock outcroppings
 - ☐ Test pit locations including groundwater depths when encountered
 - ☐ Historic buildings within 250 feet of the subject property
- ☐ Door locations with sill elevation

3c. Demolition Plan

- ☐ **Existing Conditions Plan plus:**
 - ☐ Existing Buildings and Structures to be removed/demolished

Staff	Applicant
Rev 04.08.2019.	☐ Existing parking/paved areas to be removed/demolished ☐ Existing utilities to be removed/demolished ☐ Existing hydrants to be removed ☐ Existing features to be removed/ demolished such as walls, curbing, landscaping trees, walks, fences, trees 18" DBH or greater, lighting, poles, guys, signs, etc. ☐ Dust Control Measures

- ☐ Proposed construction phase drainage infrastructure plan including (but not limited to) piping and natural watercourse profiles & cross-sections, retention/detention structures, drain manholes, catch basins, gutter inlets, headwalls, water quality BMPs, and erosion & sedimentation control features, etc.

3d. Construction/Layout Plan/Site Plan

- ☐ Proposed Buildings and Structures
 - ☐ Area of building or additions
 - ☐ Number of stories
 - ☐ Principal use of structure
 - ☐ Floor elevations
- ☐ Proposed Topography, including but not limited to:
 - ☐ Proposed contours at 2' intervals
 - ☐ Parking lot setbacks to property line
 - ☐ Parking lot grades (not to exceed 5% or be less than 0.5%)
 - ☐ Walls
 - ☐ Parking spaces (delineated and dimensioned)
 - ☐ Accessible parking spaces & aisles
 - ☐ Wheelchair ramps
 - ☐ Sidewalks
 - ☐ Pavement type(s)
 - ☐ Curb type(s) and limits
 - ☐ Lighting / Poles / Guys
- ☐ Door locations with sill elevations
- ☐ Setback dimensions from property lines
- ☐ Out-buildings, detached garages, temp. construction trailers, etc.
- ☐ Signs (include sign schedule)
- ☐ Pavement markings
- ☐ Loading areas / Loading Docks / Platforms
- ☐ Fences
- ☐ Landscape areas
- ☐ Dumpster(s), Compactor(s) & Pads
- ☐ Spot Grades at four (4) Building Corners
- ☐ Overall Plan Showing Areas of Cut & Fill

Staff	Applicant
	☐ Critical dimensions including aisle widths, parking stall dimensions, curb radius, driveway openings, etc.

- ☐ Grading at entrance-show spot grades, if required
- ☐ Emergency Vehicle Access
- ☐ Truck Access (WB-50 unless otherwise approved by Department of Public Works)
- ☐ Snow Storage Areas
- ☐ Construction notes (including the following notes):
 - ☐ Any minor modifications (as determined by the Department of Public Works and Planning and Community Development Director) to the information shown on the approved site plans shall be submitted to the Department of Public Works as a Minor Plan Revision for approval prior to the work being performed.
 - ☐ Any work and material within the Town right-of-way shall conform to the Town of East Longmeadow requirements
 - ☐ All handicap parking, ramps, and access shall conform to AAB & MAAB requirements
 - ☐ All erosion control measures shall be in place prior to construction. Erosion Control shall conform to the East Longmeadow Conservation Commission requirements as stated in the Order of Conditions. (Refer to Erosion Control Plan if part of submission)
 - ☐ All pavement markings and signs shall conform to MUTCD requirements

3e. Grading and Drainage Plan

- ☐ **Existing Conditions Plan and Construction/ Layout/ Site Plan plus:**
- ☐ Existing and proposed site grading/ topography-Contours at 2' intervals (1' contours or additional spot grades, if slight is flat)
- ☐ Proposed parking lots, sidewalks, islands, etc.
 - ☐ Parking lot grades shall not exceed 5% or be less than 0.5 %
- ☐ Floor elevations & door locations
- ☐ Proposed drainage infrastructure plan including but not limited to piping and natural watercourse profiles & cross-sections, infiltration/ retention / detention structures, drain manholes, headwalls, roof recharge systems, flow direction, water quality BMPs, etc.
- ☐ Adequate information off site to verify proposed drain connections
- ☐ Drainage system profiles including rim and invert elevations, material, types, sizes, lengths, utility crossings and slopes
- ☐ Utility easements with bearings and distances suitable for Hampden County Registry of Deeds filing
- ☐ Delineation of all stockpile areas
- ☐ Provide safety fencing around stockpiles over 10' in height or otherwise restrict site access
- ☐ For applications associated with residential or commercial/industrial subdivisions, include an overall development plan showing all construction activity and proposed grading for all project phases, and

Staff	Applicant

show the proposed building envelope within each house lot and the proposed grading, drainage, and storm water disposal for each lot.

- ☐ A design for the stormwater drainage systems prepared by a Registered Professional Engineer demonstrating that proposed development rates of runoff do not exceed pre-development rates, as required under Massachusetts Stormwater Management Standards.

3f. Utility and Grading Plan (Show appropriate info from Existing Conditions & Construction/Layout/Site Plans)

- ☐ Include all proposed utilities, including, but not limited to, Water, Sewer, Drainage, Electric, Telephone, Cable TV, Gas, Lighting, Title V Septic Systems & Detention and Retention Structures
 - ☐ Adequate utility information outside the site to verify proposed utility connections
 - ☐ All utility pipe types, sizes, lengths, and slopes
 - ☐ All utility structure information including rim and invert elevations
 - ☐ Any utility access vaults
 - ☐ All utility access handholes
 - ☐ All water services, hydrants, gates, shutoffs, tees
 - ☐ Utilities shall be underground
 - ☐ All transformer locations
 - ☐ Required utility easements with dimensional bearings and distances
- ☐ Force main, if required, conforming to Town of East Longmeadow requirements
- ☐ Water main loop
- ☐ Sewer profile showing all utility crossings
- ☐ Sections through detention basin(s)
- ☐ Detention basin, retention basin or other stormwater mechanisms (such as infiltration devices), if proposed (All storm water plans must adhere to the new NPDES MS4 permit which have taken effect July 1, 2018).
- ☐ Include the following notes:
 - ☐ The contractor shall obtain a letter of approval from DPW prior to any construction within the right-of-way
 - ☐ All water and sewer material and construction shall conform to the Town of East Longmeadow requirements
 - ☐ All water and sewer construction shall be inspected by the Town of East Longmeadow before being backfilled
 - ☐ The Town shall be notified at least 24 hours prior to the required inspections

3g. Landscape Plan

- ☐ Location, species, and size of all proposed plantings
- ☐ All existing landscaping to be removed or retained
- ☐ Plant and tree legend

Staff	Applicant
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| | <ul style="list-style-type: none">☐ Delineate & label all existing and proposed groundcovers, lawn areas, driveways, walkways, patios and other surface treatments☐ Snow storage areas☐ Proposed irrigation methods (on-site wells to be used unless otherwise approved)☐ Verify sight distances at entrances☐ Include the following notes:<ul style="list-style-type: none">• Planting period shall be noted as March 15 - May 15 and September 15 – November 15, weather permitting• Owner is responsible for maintaining live vegetation, and the maintenance, removal and replacing of all dead trees, shrubs, ground cover and plants |
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	3h. Erosion Control Plan (show appropriate information from Existing Conditions and Construction/Layout/Site Plans)
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- | | |
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| | <ul style="list-style-type: none">☐ Straw bales or straw bale/silt fence combination and compost filter tubes☐ Anti-tracking BMP area at all construction entrances☐ Dust Control (Methods of)☐ Protection of existing and proposed drainage structures with straw bales and/or silt sacks☐ Delineation of all temporary stockpile areas☐ Safety fencing around stockpiles over 10' in height or otherwise restricted site access☐ Straw bales or straw bale/silt fence combination around all stockpiles☐ Include the following notes:<ul style="list-style-type: none">• All BMP erosion control measures shall be in place prior to demolition or any site work.• Erosion Control BMPs shall conform to US EPA, NPDES, MA DEP and Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas.• Maintenance specifications for all proposed erosion and sedimentation controls. |
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	3i. Building Elevations
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| | <ul style="list-style-type: none">☐ Show all structural building elevations (front, sides and rear facades)☐ For additions/alterations: label existing and new construction, as well as items to be removed☐ Identify all existing and proposed exterior materials, treatments and colors - including roofing, roof eaves, eave brackets, siding, doors, trim, sills, windows, fences, and railings, etc.☐ Show details of proposed new exterior elements☐ Show any exterior mechanical, duct work, utility boxes, satellite dish, etc.☐ Include dimensions for building height and wall length and identify existing and proposed floor elevations☐ Provide Sample Boards of proposed finish materials☐ For alterations to any existing or new business/commercial/industrial uses, show a table containing the following: |
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- Maximum area of building to be used for retail/sales, office, business, industrial or other use
- Maximum number of employees, where applicable

Staff	Applicant
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- Maximum seating capacity, where applicable
- Hours of operation
- Number of parking spaces existing or required for the intended use

3j. Sign Plan

- ☐ Fully-dimensioned color elevations for all proposed signs
- ☐ Total square footage of existing signs and total square footage of proposed signs
- ☐ Existing and proposed sign locations on site plan, to include directional signs
- ☐ Existing and proposed materials and methods of lighting for all signs

3k. Lighting Plan

- ☐ Location and orientation of all existing and proposed exterior lighting, including building and ground lighting and emergency spot lighting (if any)
- ☐ Height and initial foot-candle readings on the ground and the types of fixtures to be used
- ☐ Plan must show illumination patterns on-site and areas off-site
- ☐ Provide Cut Sheet for all lighting fixtures

3l. Detail Sheets (Typical Details)

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| ☐ Pavement Section Detail | ☐ Sewer Manhole Detail (26" cover) |
| ☐ Sidewalk Detail | ☐ Detention/Retention Basin Sections (from plan) |
| ☐ Curb Detail | ☐ Detention Basin Outlet Structure Detail |
| ☐ Driveway Detail | ☐ Miscellaneous Detention/Retention Basin Details |
| ☐ Wheel Chair Ramp Detail | ☐ Infiltration Device Details |
| ☐ Concrete Pad Detail | ☐ Stormwater BMPs (Water Quality Structure Details, etc.) |
| ☐ Catch Basin Detail | ☐ Bollards |
| ☐ Drainage Manhole Detail | ☐ Tree/Shrub Planting Detail |
| ☐ Silt Sac Detail | ☐ Sign Detail |
| ☐ Water and Sewer Trench Sections | ☐ Fence Detail |
| ☐ Anti-Seepage Collar Detail | ☐ Flowable Fill Trench |
| ☐ Flared End Detail | ☐ Pavement Marking Details |
| ☐ Rip Rap Detail | ☐ Handicap Parking/Compact Parking Signs |
| ☐ Straw Bales/Silt Fence Detail | ☐ Hydrant Detail: American-Darling B-62-B Open Right) or Mueller Super Centurion Silt Sac Detail Hydrant (Open Right) |
| ☐ Compost Filter Tube Detail | ☐ Thrust Block Detail |
| ☐ Light Pole Foundation Detail | ☐ Retaining Wall Details |

4. Project Narrative (15 Copies), to include adequate summary & description of the proposed project and indicating, where appropriate:

Staff	Applicant
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| | ☐ The number of dwelling units to be built and the acreage in residential use
☐ Evidence of compliance with parking and off-street loading requirements
☐ The forms of ownership contemplated for the property and a summary of the provisions of any ownership or maintenance thereof
☐ Identification of all land that will become common or public land
☐ Any other evidence necessary to indicate compliance with the zoning ordinance
☐ A written statement indicating the estimated time required to complete the proposed project and any and all phases thereof
☐ A written estimate showing, in detail, the projected costs of all site improvements (and off-site improvement) planned
☐ Drainage calculations by a registered professional engineer, with storm drainage design conforming to Town of East Longmeadow stormwater regulations, as well as wetland delineations determined by a certified wetland scientist, if applicable, for 1, 10, 25 & 100 year storm events |
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5. Certified Abutters List (15 copies)

6. Proof of Ownership (Copy of Deed(s) for All Involved Parcels; 15 Copies)

7. Development Impact Statement (DIS) (15 Copies), if required by the Planning Board

8. Traffic Impact & Access Study (TIAS) (15 Copies), if required by the Planning Board

9. Stormwater Management Report (15 Copies), if required, comprised of the following:

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| | ☐ MADEP Stormwater Standards Compliance Checklist (signed & stamped)
☐ Overall Project Description
☐ Existing Conditions
☐ Proposed Improvements
☐ Proposed Conditions
☐ Hydrologic Analysis for Existing & Proposed Conditions for Milestone Storm Event Intensities
☐ Stormwater Management Regulations
☐ Summary
☐ Appendix - Existing/Proposed Conditions Plans showing the following: <ul style="list-style-type: none"> ▪ Overall Existing Subcatchment Area Table <ul style="list-style-type: none"> ▪ Subcatchment Labeled, Design Point, Area, Curve number, Tc (min.) ▪ Soil Classifications Table (Existing Soils) <ul style="list-style-type: none"> ▪ Map Unit Symbol, Map Unit Name, Hydrologic Soil Code ▪ Overall Proposed Subcatchment Area Table <ul style="list-style-type: none"> ▪ Subcatchment Labeled, Design Point, Area, Curve number, Tc (min.) ▪ Soil Classifications Table (Including Proposed Boron Soils, Etc., if applicable) |
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- Map Unit Symbol, Map Unit Name, Hydrologic Soil Code
- ☐ Appendix - Hydrologic Analyses

Staff	Applicant
	▪ HydroCAD Software Analyses (or equivalent software) Analyses (Existing & Proposed Conditions) ☐ Appendix - Illicit Discharge Certification (signed & dated)
	10. <u>Electronic PDF and AutoCAD Files</u> ☐ Shall consist of a CD with a printed CD Label in a CD case or USB Drive in PDF Format ☐ PDF files shall be created from within the AutoCAD environment and contain Layer information.
	11. <u>Application Fee</u> (All fees are due at time of application submission)

Official Use Only:

For the Planning Board, this application has been received by the Planning and Community Development Department on the date specified below:

Review date: _____ All materials submitted: Yes No

Signature: _____ Fee: _____

B

**RESOURCES REGARDING
AGRICULTURAL EXEMPTION**

Part I ADMINISTRATION OF THE GOVERNMENT**Title VII** CITIES, TOWNS AND DISTRICTS**Chapter 40A** ZONING**Section 3** SUBJECTS WHICH ZONING MAY NOT REGULATE;
EXEMPTIONS; PUBLIC HEARINGS; TEMPORARY
MANUFACTURED HOME RESIDENCES

Section 3. No zoning ordinance or by-law shall regulate or restrict the use of materials, or methods of construction of structures regulated by the state building code, nor shall any such ordinance or by-law prohibit, unreasonably regulate, or require a special permit for the use of land for the primary purpose of commercial agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture, nor prohibit, unreasonably regulate or require a special permit for the use, expansion, reconstruction or construction of structures thereon for the primary purpose of commercial agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture, including those facilities for the sale of produce, wine and dairy products, provided that either during the months of June, July, August and September of each year or during the harvest season of the primary crop raised on land of the owner or lessee, 25 per cent of such products for sale, based on either gross sales dollars or volume, have been produced by the owner or lessee of the land on which the facility is located, or at least 25 per cent of such products for sale,

based on either gross annual sales or annual volume, have been produced by the owner or lessee of the land on which the facility is located and at least an additional 50 per cent of such products for sale, based upon either gross annual sales or annual volume, have been produced in Massachusetts on land other than that on which the facility is located, used for the primary purpose of commercial agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture, whether by the owner or lessee of the land on which the facility is located or by another, except that all such activities may be limited to parcels of 5 acres or more or to parcels 2 acres or more if the sale of products produced from the agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture use on the parcel annually generates at least \$1,000 per acre based on gross sales dollars in area not zoned for agriculture, aquaculture, silviculture, horticulture, floriculture or viticulture. For such purposes, land divided by a public or private way or a waterway shall be construed as 1 parcel. No zoning ordinance or by-law shall exempt land or structures from flood plain or wetlands regulations established pursuant to the General Laws. For the purposes of this section, the term "agriculture" shall be as defined in section 1A of chapter 128, and the term horticulture shall include the growing and keeping of nursery stock and the sale thereof; provided, however, that the terms agriculture, aquaculture, floriculture and horticulture shall not include the growing, cultivation, distribution or dispensation of marijuana as defined in section 2 of chapter 369 of the acts of 2012, marihuana as defined in section 1 of chapter 94C or marijuana or marihuana as defined in section 1 of chapter 94G; and provided further, that nothing in this section shall preclude a municipality from establishing zoning by-laws or ordinances which allow commercial marijuana growing and cultivation on land used for

commercial agriculture, aquaculture, floriculture, or horticulture. Said nursery stock shall be considered to be produced by the owner or lessee of the land if it is nourished, maintained and managed while on the premises.

No zoning ordinance or by-law shall regulate or restrict the interior area of a single family residential building nor shall any such ordinance or by-law prohibit, regulate or restrict the use of land or structures for religious purposes or for educational purposes on land owned or leased by the commonwealth or any of its agencies, subdivisions or bodies politic or by a religious sect or denomination, or by a nonprofit educational corporation; provided, however, that such land or structures may be subject to reasonable regulations concerning the bulk and height of structures and determining yard sizes, lot area, setbacks, open space, parking and building coverage requirements. Lands or structures used, or to be used by a public service corporation may be exempted in particular respects from the operation of a zoning ordinance or by-law if, upon petition of the corporation, the department of telecommunications and cable or the department of public utilities shall, after notice given pursuant to section eleven and public hearing in the town or city, determine the exemptions required and find that the present or proposed use of the land or structure is reasonably necessary for the convenience or welfare of the public; provided however, that if lands or structures used or to be used by a public service corporation are located in more than one municipality such lands or structures may be exempted in particular respects from the operation of any zoning ordinance or by-law if, upon petition of the corporation, the department of telecommunications and cable or the department of public utilities shall after notice to all affected communities and public hearing in one of said municipalities, determine

the exemptions required and find that the present or proposed use of the land or structure is reasonably necessary for the convenience or welfare of the public. For the purpose of this section, the petition of a public service corporation relating to siting of a communications or cable television facility shall be filed with the department of telecommunications and cable. All other petitions shall be filed with the department of public utilities.

No zoning ordinance or bylaw in any city or town shall prohibit, or require a special permit for, the use of land or structures, or the expansion of existing structures, for the primary, accessory or incidental purpose of operating a child care facility; provided, however, that such land or structures may be subject to reasonable regulations concerning the bulk and height of structures and determining yard sizes, lot area, setbacks, open space, parking and building coverage requirements. As used in this paragraph, the term "child care facility" shall mean a child care center or a school-aged child care program, as defined in section 1A of chapter 15D.

Notwithstanding any general or special law to the contrary, local land use and health and safety laws, regulations, practices, ordinances, by-laws and decisions of a city or town shall not discriminate against a disabled person. Imposition of health and safety laws or land-use requirements on congregate living arrangements among non-related persons with disabilities that are not imposed on families and groups of similar size or other unrelated persons shall constitute discrimination. The provisions of this paragraph shall apply to every city or town, including, but not limited to the city of Boston and the city of Cambridge.

Family child care home and large family child care home, as defined in section 1A of chapter 15D, shall be an allowable use unless a city or town prohibits or specifically regulates such use in its zoning ordinances or by-laws.

No provision of a zoning ordinance or by-law shall be valid which sets apart districts by any boundary line which may be changed without adoption of an amendment to the zoning ordinance or by-law.

No zoning ordinance or by-law shall prohibit the owner and occupier of a residence which has been destroyed by fire or other natural holocaust from placing a manufactured home on the site of such residence and residing in such home for a period not to exceed twelve months while the residence is being rebuilt. Any such manufactured home shall be subject to the provisions of the state sanitary code.

No dimensional lot requirement of a zoning ordinance or by-law, including but not limited to, set back, front yard, side yard, rear yard and open space shall apply to handicapped access ramps on private property used solely for the purpose of facilitating ingress or egress of a physically handicapped person, as defined in section thirteen A of chapter twenty-two.

No zoning ordinance or by-law shall prohibit or unreasonably regulate the installation of solar energy systems or the building of structures that facilitate the collection of solar energy, except where necessary to protect the public health, safety or welfare.

No zoning ordinance or by-law shall prohibit the construction or use of an antenna structure by a federally licensed amateur radio operator.

Zoning ordinances and by-laws may reasonably regulate the location and height of such antenna structures for the purposes of health, safety, or

aesthetics; provided, however, that such ordinances and by-laws reasonably allow for sufficient height of such antenna structures so as to effectively accommodate amateur radio communications by federally licensed amateur radio operators and constitute the minimum practicable regulation necessary to accomplish the legitimate purposes of the city or town enacting such ordinance or by-law.

EMERGENCY ALERTS

Coronavirus Updates and Information

Get notified by text, email, or phone in your preferred language. Sign-up for COVID-19 alerts. *Nov. 29th, 2020, 5:00 pm*

[Read more](#) ♦

For the latest information on COVID-19 Cases, Travel, & Reopening. *Dec. 2nd, 2020, 5:00 pm* [Read more](#) ♦

HIDE ALERTS ▲

≡ Mass.gov

Smart Growth / Smart Energy Toolkit Modules - Agricultural Preservation

Learn about the Smart Growth/Smart Energy Agricultural Preservation module.

Overview

Preserving agricultural land and farming in Massachusetts has been a high priority of state and local officials for several decades. Through a variety of state and local initiatives, opportunities have emerged to help ensure a viable agricultural economy and farmland preservation. Many communities have successfully protected agricultural land using an array of financial and legal tools.

The Problem

We are losing agricultural lands and farming opportunities at an alarming rate. These losses create issues such as:

- dramatic alteration of the traditional New England landscape
- A growing dependence on imported food products, and
- A commitment to spending an ever-increasing portion of our food costs on transportation of these products.

Over 16,000 acres of open space is developed and lost in Massachusetts each year, much of it existing or retired farmland. These lands represent a tremendous cultural and historic resource for rural and suburban communities throughout the Commonwealth.

High real estate values in Massachusetts, along with the steady decrease in buildable areas, have increased pressure to develop what remains of agricultural open spaces in many communities. Lands that have been

used historically for farming or pasture, but lie in residential or commercial zones, are often considered "prime real estate" to the development community. These areas are generally clear of forest and have topography well-suited to a variety of land use developments.

High land values has made it very attractive for existing farmers, orchard owners or other agricultural enterprises to sell these lands to private developers. Most communities don't have the funds to "match" a developer's offer resulting in farmlands being converted into residential subdivisions at the expense of viewsheds, open space, local agricultural production and community character.



Pressure to develop residentially zoned agricultural land in Massachusetts is enormous. Despite the existence of several state programs designed to maintain or preserve existing farmland, thousands of acres of these lands are vulnerable to prospective sprawl development. Communities should use the Open Space and Recreation Plan process to identify existing agricultural lands that should be preserved and the tools that would be most effective toward that goal.

Image taken from *Above and Beyond, Visualizing Change in Small Towns and Rural Areas*. Campoli et, al. APA Planners Press, 2001

Introduction to Agricultural Preservation

The goals of agricultural preservation in Massachusetts vary depending on the unique situations of each community.

- In some rural communities, the goal of agricultural preservation is to enable existing farmlands to remain viable through the use of restrictions programs and marketing projects or tax breaks.
- Other more suburban communities may want to see existing agricultural lands developed in ways that decrease the impacts from conventional subdivision activity and preserve significant amounts of the open areas.
- In urban areas, the focus may be less on preservation and more on providing access to agricultural opportunities not often found in densely developed areas.

There are a variety of ways to protect or promote agricultural opportunities in Massachusetts. The tools that are used will depend on the opportunities faced by a community and their goals for preserving or creating agricultural spaces:

Chapter 61A - The Chapter 61 Program provides a tax break to owners of recreational, forest or agricultural lands as long as the land remains in the specified use. It is important to note that Chapter 61 is an incentive program not a permanent protection of open space or farmland. Local planners should assume that all of these lands in their community have development potential. [Changes were made to this law in 2006](https://malegislature.gov/Laws/SessionLaws/Acts/2006/Chapter394) (<https://malegislature.gov/Laws/SessionLaws/Acts/2006/Chapter394>).

Agricultural Commissions - These Commissions are formed by passing a local bylaw or ordinance and serve as advocates for local farms. Responsibilities can include protecting farmland, providing assistance for natural resource management, affording visibility to local farmers, and assisting local boards with community development decisions. [Ninety-one cities and towns have established Agricultural Commissions.](/files/documents/2017/11/13/Agricultural%20Preservation%20towns.pdf) (</files/documents/2017/11/13/Agricultural%20Preservation%20towns.pdf>)

Right to Farm - The Right to Farm is vested in all residents of the Commonwealth under Article 97 of the state Constitution. Communities interested in formally re-asserting that right within the community may pass a Right to Farm Bylaw that clearly states the priorities of the community relative to fostering agricultural activities and allowing farms to operate "with minimal conflict with abutters and Town agencies". The bylaw/ordinance also establishes the notification procedure for informing all residents of the Town of the community's status as a Right to Farm entity. You can [view a list of communities with a Right-to-Farm Bylaw](/files/documents/2017/11/13/Agricultural%20Preservation%20towns.pdf) (</files/documents/2017/11/13/Agricultural%20Preservation%20towns.pdf>).

Agricultural Preservation Restrictions (APRs) - This program is designed to protect the most productive agricultural lands in the Commonwealth and establishes permanent deed restrictions on agricultural lands, protecting them from any use that might diminish the area's agricultural potential. These deed restrictions are purchased with state funds that can be matched to some extent by municipal and in some cases federal funding as well.

Community Gardens - Community Garden programs have been successfully developed in cities such as Somerville and Lowell and provide residents with an opportunity to grow food or horticultural varieties in heavily urbanized settings. Gardens are often managed by community groups who allocate specific plots of land to citizens on an annual basis. These areas also provide community gathering for cultural and educational events.

Farm Viability Enhancement Program (FVEP) - The purpose of the FVEP is to improve the economic bottom line and environmental integrity of participating farms through the implementation of Farm Viability Plans. These farm plans, which are developed by teams comprised of farmers and other agricultural, economic and environmental consultants, suggest ways for farmers to increase their on-farm income through such methods as improved management practices, diversification, direct marketing, value-added initiatives and agritourism. In addition, Farm Viability Plans make recommendations concerning environmental and resource conservation concerns on participating farms

Zoning Protections - Communities concerned with the development potential of existing agricultural lands can adopt zoning bylaw amendments specifically designed to protect these open tracts of land. Perhaps the most straight forward approach is to implement true large lot zoning. Minimum lot sizes in these provisions generally range from 10 to 25 acres per unit and, as a result, are best suited to communities with vast areas of farmland. Densities should not go below these levels in order to achieve the desired end result of preserving wide open undeveloped areas. Other protections can include mandatory cluster or Open Space Residential

Design (OSRD) provisions for existing farmland. These provisions ensure that the protection of open space will be maximized as lands transition from farmland to residential development.

Transfer of Development Rights (TDR) - This technique is better suited to Massachusetts communities where individual farms are considerably smaller than in other areas of the country where true large lot zoning has been used to preserve open space in agricultural areas.

TDR provides an excellent opportunity to blend down-zoning with incentives for increased density. In agricultural communities, undeveloped agricultural lands can be designated as "sending areas" where the amount of development that would ordinarily be allowed on the parcel is transferred to a pre-designated "receiving area". In other words, the development potential of one area is added on to the development potential of another.



Existing Village vs. Conventional Development vs. Development with TDR

Characteristics that Support Agricultural Preservation

Communities that have success in preserving farmland and agricultural preservation will generally have the following characteristics:

- **Well Organized Parcel Information.** Having access to a well organized Assessor's database that identifies preservation and development opportunities is a critical first step to planning for agricultural preservation. Communities that have implemented a GIS Assessor's database have a clear advantage when prioritizing lands for preservation. Other local initiatives, such as Open Space and Recreation Plans, can serve as an excellent source of information relative to Chapter 61A lands and other farmlands in a community.
- **Committed Core Citizens Group.** Institutionalizing preservation efforts in the form of Agricultural Commissions, Agricultural Preservation Restrictions or Community Gardens often hinges on a reliable group of citizens with administrative skills and a solid understanding of the local tools and state-level programs that apply to these situations.
- **Open Lines of Communication.** Regular outreach efforts are a required component of a successful Right-to-Farm initiative and local Commissions must develop a consistent forum for individuals to raise issues, resolve conflicts and plan for the future of agricultural lands.

- **Local Commitment in the General Population.** Agricultural Preservation efforts often require community-wide support. It is therefore essential for communities involved in these efforts to continually reach beyond the primary stakeholders in the agricultural community and into the overall population to support local initiatives.

Benefits

Over ninety Agricultural Commissions have been created in Massachusetts to help preserve agricultural lands and farming operations in their community. In these communities and many others, local officials have leveraged funding to help finance more than 500 APRs statewide, which span thousands of acres of active or retired farmland. Targeted production efforts have also successfully decreased local commitments to imported products. The work of local Commissions, in collaboration with state agencies, has helped to maintain a \$6 billion revenue stream for an industry that pays \$77 million each year in wages.

These types of agricultural preservation measures directly or indirectly satisfy several of the Massachusetts Sustainable Development Principles including:

- **Plan Regionally:** Preserving farmland and agricultural opportunities has obvious economic significance to the state as a whole and is consistent with long standing Massachusetts policies.
- **Concentrate Development and Mix Uses:** Preservation techniques that mandate cluster development in agricultural areas concentrate development in a way that preserves land while expanding housing opportunities in a municipality.
- **Use Natural Resources Wisely:** The preservation of agricultural lands conserves existing natural resources by maintaining recharge to groundwater and maintaining open space.
- **Protect Land and Ecosystems:** Conservation restrictions that may be placed on existing agricultural lands can provide permanent protection for wildlife habitat and significant cultural or historic landscapes.
- **Increase Job and Business Opportunities:** Efforts to preserve and enhance the viability of existing agricultural operations foster local economies and strengthen sustainable resource-based businesses.

Financial Considerations

Agricultural preservation can provide several financial benefits to municipalities and to the development community:

- Limiting development in outlying agricultural areas will reduce municipal infrastructure and service costs that would result from large scale subdivision development.
- If development rights are transferred as part of a preservation technique, private developers can realize significant financial gains through an increase in the development potential in "receiving areas" such as village centers or established residential neighborhoods.

Other financial considerations include:

- the amount of money that may be needed by a community to purchase lands that are withdrawing from the Chapter 61A program.
- the likelihood of success of any proposed APR will be increased if a municipality can provide a portion of the funding required to purchase the deed restriction.

Another direct economic benefit of agricultural preservation comes from maintaining a viable local agricultural economy. Producing more local agricultural products reduces dependence on foreign and out-of-state operations, reduces shipping expenses and oil consumption, and strengthens local economies. Locally grown products employ Massachusetts farmers and substantially reduce the costs and impacts of large scale interstate transport.

RELATED

Case Studies - Agricultural Preservation (</service-details/case-studies-agricultural-preservation>)

C

EXAMPLE SOLAR MORATORIUM BYLAW / ORDINANCE

- Pioneer Valley Planning Commission

Example Language for a Temporary Moratorium on the Construction of Large-Scale Ground-Mounted Solar Photovoltaic Installations

Italic text highlighted in GRAY represents instructions, and not text to be included in the Moratorium. Text highlighted in YELLOW should be updated to match the circumstances of the Town.

Article I: Temporary Moratorium on the Construction of Large Ground Mounted Photovoltaic Installations

1.1 Authority and Purpose

The Town of _____ (“Town”) currently has _____ approved ground mounted photovoltaic installations, commonly referred to “solar farms”, completed or under construction and another _____ that have been approved and are in the permitting process. Many of these projects have involved large-scale clear cutting of trees and ground vegetation and several have been located in close proximity to abutting residential neighborhoods.

For towns with an existing solar zoning bylaw:

Although the Zoning Bylaw adopted pursuant to the vote on _____ and amended at a(n) _____ Town Meeting as Article # _____ on DATE addresses ground-mounted photovoltaic installations, the Town needs to adopt further changes to the Zoning Bylaw to protect environmental resources and provide more efficiency for those property owners who seek to develop solar facilities as an accessory use. It is crucial that the Town act to establish a temporary moratorium on the use of land and the construction related to large ground mount photovoltaic installations and the issuance of building permits in connection with the same.

For towns with no existing solar zoning bylaw:

The Town of _____ has yet to develop specific requirements with regard to large ground mounted solar photovoltaic installations. There is an immediate identified need to protect the interests of the Town and its citizens by establishing long term zoning bylaw standards and provisions to ensure that such uses and development will be consistent with the Town’s long term planning interests and Master Plan.

1.2 Temporary Moratorium

The purpose of this moratorium is to allow the Town sufficient time to engage in a planning process to address the effects of such structures and uses in the Town and to enact bylaws in a matter consistent with sound land use planning goals and objectives. Because the regulation of ground mounted photovoltaic installations raises novel legal, planning and public safety issues, the Town needs time to undertake a planning process to make appropriate amendments to the Zoning Bylaw regarding regulation of Ground Mounted Photovoltaic Installations. Accordingly, the Town intends to adopt a temporary moratorium on the use of land and structures in the Town

Comment [KC1]: Use defined term (in zoning bylaw) related to ground mounted solar. Use throughout bylaw text.

Comment [ZD2]: Provide local context regarding need for amendment.

Comment [ZD3]: Some dates/context as to the amendments to your ground mounted solar zoning bylaw could be helpful, if adopted per this process.

Comment [ZD4]: ...or other identifiable community planning document.

for Ground Mounted Photovoltaic Installations [provide size limitation – e.g. “over X kW DC in capacity” or “with a project footprint over X acres in size] until Future date to allow the sufficient time to address the effects of such structures and uses in the Town and to enact appropriate Zoning Bylaws in a consistent manner. Notwithstanding any other provision in the Town of _____ Zoning Bylaw to the contrary, no building permit may be issued for the construction of any Ground Mounted Photovoltaic Installation over X in size and to the extent legally permissible, the Planning Board shall not accept any further application for any Ground Mounted Photovoltaic Installation over X in size during the aforementioned moratorium period. This moratorium shall not apply to any Ground Mounted Photovoltaic Installation for which a Site Plan Review or Special Permit application was received by the Planning Board prior to 1st posting date of public notice for bylaw amendment. Any Ground Mounted Photovoltaic Installation proposed in an application submitted to the Planning Board prior to 1st posting date of public notice for bylaw amendment, shall be governed by the provisions of the _____ Town Zoning Bylaw in effect prior to the first publication of notice of the public hearing on this by-law required by MGL Chapter 40A, Section 5.

Comment [KC5]: Reasonable time frame to achieve a new solar bylaw – AG’s office approved 10 months for this example.

Comment [KC6]: Or ZBA – dependent on which authority permits solar

Comment [KC7]: Consider permitting for these types of developments and list applications required for approvals.

Comment [KC8]: Or ZBA – dependent on which authority permits solar

D

TECHNICAL RECOMMENDATIONS FOR SAFE ENERGY STORAGE SYSTEMS

The recommendations below are pulled directly from Energy Storage Safety Guidelines compiled by the Energy Storage Integration Council for Distribution-Connected Systems in 2016. These guidelines are directed towards energy storage system suppliers, but may serve as a starting point for electrical inspectors or other safety personnel making inquiries about the safety of the system. The complete report is available at: <https://www.epri.com/research/products/000000003002008308>

- While it is often beneficial to design a closed system for heating and cooling efficiency, pressure relief valves could be considered to prevent a hazardous buildup of pressure. Closed systems can lead to oxygen starvation which can cause a backdraft if sufficient heat builds up for a fire. In systems where an explosion hazard may exist, deflagration venting could be considered as well.
- Fire suppression systems may be an effective control for component fire potential. Claims on effectiveness could be supported with some combination of testing, analysis, and/or simulation. However, it is important to consider the material that may experience a fire when selecting the type of system to be used. In the case of lithium-ion batteries, sufficient heat can be generated internally to sustain or reignite a fire if extinguished by an oxygen starvation system. In these cases a water suppression system may be considered if properly designed to remove enough heat from the cells that the exothermic chemical reaction can be slowed or stopped.
- It is important to consider both normal and unexpected operating conditions in the design of the contactors. Inverter based systems often require large capacitive filters on their DC bus to reduce the magnitude of the AC current (noise) component. These capacitors draw significant current when first connected to a battery or other DC source; thus, all inverters come with a pre-charge circuit. This circuit allows the input capacitors to be resistively coupled to battery voltage thereby reducing the in-rush current. Abnormal conditions during pre-charge include voltage spikes, incorrect contactor switching, and battery short circuit. If the contactors in this circuit open unexpectedly while pre-charging the capacitors, they can fuse and cause an inverter fault requiring extensive repair or, in rare cases, an inverter fire.

Impressed current systems or sacrificial anodes may be used in environments where corrosion could affect system operation or safety. Essentially, they work by holding the system at a somewhat positive potential to slow the rate of chemical reaction with this environment. Impressed current systems accomplish this through the use of a DC power supply or rectifier. Sacrificial anodes accomplish this by providing an anode of an appropriate chemical to produce a negative potential as it reacts with the air or soil.

- When an energy storage system contains large volumes of liquid, it is important to consider secondary containment. Recommendations can be adapted from stationary battery standards for flooded lead acid batteries which stipulate that secondary containment be sufficient to contain and allow for the safe disposal of either 30% of the total volume or 100% of the largest single container, whichever is greater.
- Cyber security may be considered as a safety issue for internet connected systems, SCADA connected systems, and even stand-alone systems. This involves an analysis of what access to system information and system control could produce a hazard. For example, changing BMS parameters could lead to reduced system life or fire through the improper enforcement of safety constraints. The National Institute of Standards and Technology publishes a general cyber security framework which may be applied to energy storage systems and installations.
- Energy storage technologies that contain or produce hydrogen gas are subject to the appropriate controls for this hazard. Examples of these controls can be found in section 500 of the National Electrical Code (NEC), and NFPA 2: Hydrogen Technologies Code those other standards may be more appropriate for specific technologies.

E

EXAMPLE TREE REPLACEMENT BYLAW / ORDINANCE

- City of Northampton

§ 350-12.3. Significant trees.

- A. Legislative findings and intent. The City of Northampton finds that significant trees enhance air quality, reduce noise, reduce energy costs, create habitat, enhance aesthetics and property values, and benefit City neighborhoods. The intent of this section is to encourage the preservation and protection of significant trees during development and redevelopment projects that require a site plan approval, special permit, comprehensive permit, finding, or variance (collectively "zoning relief").
- B. No person shall remove any significant tree associated with any site plan approval or any other zoning relief without a site plan approval from the Planning Board (if a site plan approval is otherwise required), or an administrative site plan approval from the Office of Planning and Sustainability if no site plan is otherwise required.
- C. The removal of any significant tree after July 1, 2015, or within 12 months immediately prior to such a site plan or zoning relief, whichever is later, shall be subject to this section.
- D. The requirements of this section shall not apply to:
 - (1) Trees located on property under the jurisdiction of the Conservation Commission.
 - (2) City-owned public shade trees pursuant to MGL Chapter 87.
 - (3) Trees associated with emergency projects necessary for public safety, health and welfare as determined by the Building Commissioner, Director of Planning and Sustainability, or Director of Public Works.
 - (4) Trees that are hazardous due to disease, age, or shallow roots, as determined and confirmed in writing by a certified arborist and reviewed by the City's Tree Warden.
 - (5) Trees affected by work performed by a utility company in maintenance of its rights-of-way or in its maintenance, repair or replacement of infrastructure that is unrelated to a development project requiring zoning relief.
 - (6) Trees that are approved for removal through special permit by the Planning Board.
 - (a) The Board may grant a special permit if, after weighing the benefits of significant trees against other community benefits created as part of the project, it determines a

waiver of tree replacement to be appropriate and if at least the following standards have been met:

[1] Trees are removed in order to create net zero energy buildings (for electric and thermal use) of up to 10,000 square feet and/or to install 10,000 square feet of ground-mounted PV panels; in addition to providing one or more community benefits, which may include:

[a] Affordable housing units where 50% or more of the units are deed-restricted for affordable housing as defined in this Chapter 350.

[b] A project that results in permanently protected open space.

(b) Building square footage shall apply to a single building footprint or to the aggregate of two or more buildings. In order to exercise a special permit granted under this section, applicants must present a building permit that has been issued for specific plans showing compliance with the net-zero standard and must construct in accordance with the special permit within one year of the issuance of a building permit. Planning Board special permit to grant a waiver from replacement within this provision is allowed only for the trees necessary to be removed in order to provide the solar access to the building(s) and/or panel array.

E. Any person removing a significant tree that is subject to this section shall satisfy either of the following conditions:

(1) Provide for replacement trees according to the following standards:

(a) Replacement trees shall be noninvasive deciduous or coniferous trees (as defined by the City's Tree List and Planting Guidelines) planted on or off site, as approved as part of a site plan or administrative site plan, or on any City-owned property with approval by the Office of Planning and Sustainability, in consultation with the City Tree Warden, unless such trees are public shade trees as per MGL c. 87, § 1,. Replacements shall be calculated so that for each inch of diameter at breast height of the removed trees there shall be no less than 1/2 inch of caliper diameter of replacement trees.

- (b) Replacement trees shall have a minimum of one-inch caliper diameter.
- (c) Replacement trees shall be maintained in good health a minimum of 24 months after they are planted as confirmed by the City's Tree Warden. If replacement trees are not found to be in "good health" as determined by the Tree Warden, the trees shall be replaced as directed by the Warden.
- (d) Replacement trees shall either be approved street tree species as defined in the rules and regulations regarding subdivision of land or other trees that are hardy in all of the following USDA Plant Hardiness Zones: 6a, 6b, 7a, and 7b.
- (2) Pay funds to the City for a tree replacement fund account that, in the Planning Board's estimate, will allow the City to plant new public shade trees on City property in accordance with the above formula.

F. Protection of significant trees during construction.

- (1) Any significant trees to be retained and any replacement trees on property where demolition and/or construction activity is planned shall be protected in an area shown on the approved site plan and should follow American National Standards Institute (ANSI) A300 standards for tree care practices.
- (2) The protected area shall exceed both the critical root zone and drip-line of each significant tree unless the Planning Board approves an alternate maintenance and tree protection plan submitted by a certified arborist.
- (3) A certified arborist shall submit a written letter to the Building Commissioner, Tree Warden and Office of Planning and Sustainability certifying that such area has been so protected in accordance with the site plan.

G. Recordkeeping. The Department of Planning and Sustainability shall collect annual totals of the number and diameter at breast height measurements of significant trees preserved and replaced.

F

SAMPLE MUNICIPAL BYLAWS/ ORDINANCES

- Town of Belchertown
- City of Northampton
- Town of Shutesbury
- Town of Athol

Belchertown Solar Bylaw

§145-28. Commercial Solar Photovoltaic Installations

A. Purpose. This bylaw is to regulate the development of Commercial Solar Photovoltaic Installations by providing standards for their placement, design, construction, operation, monitoring, modifications, and removal; to protect public health, safety or welfare in accordance with M.G.L. c. 40A, § 3; to protect and preserve farmland, forests, and open space as promoted by the Commonwealth of Massachusetts; to protect the scenic, natural, and historic resources of Belchertown; and to provide adequate financial assurance for the eventual decommissioning of such installations.

A solar photovoltaic system that is for the exclusive purpose of providing electricity for a property that is primarily in agricultural use as defined under M.G.L. c. 40A, §3, and that produces electricity to be used solely for the benefit of the agricultural property is exempt.

B. Applicability. This bylaw applies to large-scale (minimum 250 kW rated nameplate capacity) solar photovoltaic installations constructed after the effective date of this bylaw. This bylaw also pertains to physical modifications that materially alter the type, configuration, or size of these installations or related equipment. The requirements of this bylaw shall apply to a commercial solar photovoltaic installation regardless of whether it is the primary use of property or an accessory use.

(1) As-of-Right: The following commercial solar photovoltaic installations, as defined herein, are allowed as of right with site plan approval in all zoning districts:

- (a) Any such installation over parking lots;
- (b) Any such installation on existing structures.

(2) Special Permit: Any CSPI not specified in (1) requires a special permit in all zoning districts from the Planning Board. For all special permit applications, site plan approval as described below is required, but shall not require a second public hearing, per §145-27D(3)(a).

(3) Not Permitted: No commercial solar photovoltaic installation may be permitted as follows:

- (a) Any CSPI of greater than 20 acres in fenced array area.
- (b) Any CSPI requiring forest clearing greater than ten acres.
- (c) Any CSPI on slopes of 8% or greater as averaged over 50 horizontal feet; the Planning Board may consider waiving this up to 12% based on site-specific parameters.
- (d) Any CSPI on a parcel with inadequate frontage as defined in §145-2.

C. Definitions.

Commercial Solar Photovoltaic Installation (CSPI): Any solar photovoltaic installation with 250 kW or greater rated nameplate capacity, even if its primary generation is not intended for supplying the grid.

Rated Nameplate Capacity: The maximum rated output of electric power production of the commercial solar photovoltaic installation in Direct Current (DC).

Site Plan Approval Authority: The site plan approval authority as designated by the Zoning Bylaw.

Solar Photovoltaic Array: an arrangement of solar photovoltaic panels.

D. Requirements.

(1) Site Plan Approval. The construction, installation or modification of a CSPI, whether as-of-right or by special permit, shall be subject to site plan approval in accordance with the Zoning Bylaw. Together with the requirements of §145-27, the Site Plan Approval Authority shall consider and apply the requirements set forth in this bylaw in reviewing and deciding an application for site plan approval.

(a) General. All plans and maps shall be prepared, stamped and signed by a Professional Engineer licensed to practice in Massachusetts.

(b) Required Documents. The project proponent shall provide the following documents:

[1] A site plan showing:

- i. An existing conditions plan with property lines and physical features, including topography and roads, for the project site;
- ii. Proposed changes to the landscape of the site, including grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures, driveways, snow storage, and storm water management systems;
- iii. Blueprints or drawings of the solar photovoltaic installation signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts showing the proposed layout of the system and any potential shading from nearby structures;
- iv. One or three line electrical diagram detailing the solar photovoltaic installation, associated components, and electrical interconnection methods, with all National Electrical Code compliant disconnects and overcurrent devices;
- v. Documentation of the major system components to be used, including the PV panels, mounting system, and inverter;
- vi. Name, address, and contact information for proposed system installer;
- vii. Name, address, phone number and signature of the project proponent, as well as all co-proponents or property owners, if any;

- viii. The name, contact information and signature of any agents representing the project proponent; and
- [2] Documentation of actual or prospective access and control of the project site (item (2) below);
- [3] An operation and maintenance plan (item (3) below);
- [4] Proof of liability insurance; and
- [5] Description of financial surety that satisfies Section 10(b);
- [6] There shall be a fence surrounding the solar array and ancillary equipment.

The Site Plan Approval Authority may waive documentary requirements as it deems appropriate upon the written request of the applicant submitted with an application for approval.

(2) Site Control. The project proponent shall submit documentation of actual or committed prospective access and control of the project site sufficient to allow for construction and operation of the proposed CSPI.

(3) Operation & Maintenance Plan. The project proponent shall submit a plan for the operation and maintenance of the CSPI. This plan shall include measures to maintain safe access to the installation, storm water controls, and general procedures for operational maintenance of the installation. The development is subject to the Belchertown Stormwater bylaw and regulations.

(4) Utility Notification. No CSPI shall be constructed until evidence has been given to the Site Plan Approval Authority that the utility company operating the electrical grid the installation is to be connected to has been informed of the CSPI owner or operator's intent to install an interconnected customer-owned generator. Off-grid systems shall be exempt from this requirement.

(5) Dimension and Density Requirements.

(a) Setbacks

For all CSPI, front, side and rear yard setbacks shall be as follows:

- [1] The front setback depth shall be at least 150 feet;
- [2] The side setback depth shall be at least 75 feet;
- [3] The rear setback depth shall be at least 75 feet;
- [4] The setback from any developed residential property shall be at least 200 feet.

(b) Appurtenant Structures. All appurtenant structures to a CSPI shall be subject to the requirements of the Zoning Bylaw concerning the bulk and height of structures, lot area, setbacks, open space, parking and building coverage requirements. All such appurtenant structures, including but not limited to, equipment shelters, storage

facilities, transformers, and substations, shall be architecturally compatible with each other. Whenever reasonable, structures should be shaded from view by vegetation.

(6) Design Standards.

(a) Lighting. Lighting of CSPI shall be limited to night-time maintenance and inspections by authorized personnel, and shall comply with Dark Sky standards. There shall be no illumination without personnel on the site.

(b) Signage. A sign shall be erected identifying the owner and providing a 24-hour emergency contact phone number of the CSPI owner or operator. CSPIs shall not display any advertising. Any sign must comply with §145-22.

(c) Day-time Visual Distraction. The panel array shall be positioned to minimize glare on any residence or public way, and shall not create a visual obstruction on a public roadway, such as blocking intersections or creating blind curves.

(d) Utility Connections. Reasonable efforts shall be made to place all utility connections from the CSPI underground, depending on appropriate soil conditions, shape, and topography of the site and any requirements of the utility provider. Electrical transformers for utility interconnections may be above ground if required by the utility provider.

(7) Safety and Environmental Standards.

(a) Emergency Services. The CSPI owner or operator shall provide a copy of the project summary, electrical schematic, and an approved site plan, to the local fire department and the Building Inspector. Upon request the owner or operator shall cooperate with local emergency services in developing an emergency response plan, which may include ensuring that emergency personnel have immediate, 24-hour access to the facility. All means of shutting down the CSPI shall be clearly marked. The owner or operator shall identify a responsible person for public inquiries throughout the life of the installation, and shall provide a mailing address and 24-hour telephone number for such person(s).

(b) Control of Vegetation and Animals, Including Insects. Herbicides, rodenticides, or any other pesticides may not be used to control vegetation or animals at a CSPI. In a dual-use CSPI, the agricultural operator, but not the CSPI operator, is exempt from this restriction.

(c) Project Visibility and Landscape Planting. A CSPI shall be designed to minimize its visibility, including preserving natural vegetation to the maximum extent possible, blending in equipment with the surroundings, adding vegetative buffers to provide an effective visual barrier from adjacent roads and driveways, and to screen abutting dwellings. The owner of the CSPI shall not remove any naturally occurring vegetation

such as trees and shrubs unless it adversely affects the performance and operation of the solar installation. A diversity of plant species native to New England shall be used for any screens and vegetative erosion controls. Use of exotic plants, as identified by the most recent version of the "Massachusetts Prohibited Plant List" maintained by the Massachusetts Department of Agricultural Resources, is prohibited. If deemed necessary by the Planning Board, the depth of the vegetative screen shall be 30 feet and will be composed of native trees and shrubs staggered for height and density that shall be properly maintained. Cultivars of native plants are acceptable. The open area of the site shall be seeded with a pollinator mix and maintained as bird and insect habitat. Mowing is to be done as little as possible to retain a natural functioning of the landscape. Plants shall be maintained and replaced as necessary by the owner of the CSPI for the life of the CSPI.

(d) Land Clearing, Soil Erosion, and Wildlife Habitat. Clearing of natural vegetation shall be limited to what is necessary for the construction, operation, and maintenance of the CSPI or otherwise prescribed by applicable laws, regulations, and bylaws. A CSPI may not be constructed on slopes exceeding 8% except as expressly authorized pursuant to §145-28B(3)(c), nor may cutting and filling be done to reduce natural slopes. Existing root structures and topsoil shall be maintained to the maximum extent practicable and provide for a minimum of 6" of topsoil on all exposed areas.

(8) Mitigation Measures.

(a) Mitigation for Loss of Carbon Sequestration and Forest Habitat. If forestland is proposed to be converted to a CSPI, the plans shall designate an area of unprotected land (that is, land that could otherwise be developed under current zoning) on the parcel or block of contiguous parcels under common ownership that comprise the project site, and of a size equal to four times the total area of such forest conversion. Such designated land shall remain in substantially its natural condition without alteration except for routine forestry practices until such time as the CSPI is decommissioned and the site restored to forest. The special permit may be conditioned to effect and make enforceable this requirement.

(b) Mitigation for Loss of Forest Habitat within the Installation. If forestland is proposed to be converted to a CSPI, the plans shall show mitigation measures that create a wildflower meadow habitat within and immediately around the CSPI and a successional forest habitat in the surrounding areas managed to prevent shading until the installation is decommissioned and the site restored to forest. The special permit may be conditioned to effect and make enforceable this requirement.

(9) Monitoring and Maintenance.

(a) Construction Monitoring. The Site Plan Approval Authority may require a third-party inspector, selected by and acting under the direction of the Building

Commissioner, to be employed to monitor compliance with all approvals and conditions during the CSPI's construction at the applicant's expense.

(b) Maintenance. The CSPI owner or operator shall maintain the facility in good condition. Maintenance shall include, but not be limited to, painting, structural repairs, and integrity of security measures. Site access shall be maintained to a level acceptable to the local emergency services. The owner or operator shall be responsible for the cost of maintaining the solar photovoltaic installation and all access roads that are not public ways.

(c) Annual Reporting. The owner or operator of a CSPI shall submit an annual report demonstrating and certifying compliance with the Operation and Maintenance Plan, the requirements of this bylaw, and approvals granted hereunder, including but not limited to continued management and maintenance of vegetation, compliance with the approved plans and any permit conditions, continuation of liability insurance, and adequacy of road access. The annual report shall also provide information on the maintenance completed during the course of the year and the amount of electricity generated by the facility. The report shall be submitted to the Board of Selectmen, Planning Board, Fire Chief, Building Commissioner, Board of Health, and Conservation Commission (if a wetlands permit was issued) no later than 45 days after the end of the calendar year.

(d) Modifications. All material modifications to a CSPI made after issuance of the required building permit shall require approval by the Site Plan Approval Authority.

(10) Discontinuance and Removal.

(a) Removal Requirements. Any CSPI, or any substantial part thereof, not used for a period of one continuous year or more without written permission from the Site Plan Approval Authority, or that has reached the end of its useful life, shall be considered discontinued and shall be removed. Upon written request from the Building Inspector, addressed to the contact address provided and maintained by the owner or operator as required above, the owner or operator shall provide evidence to the Building Inspector demonstrating continued use of the CSPI. Failure to provide such evidence within thirty days of such written request shall be conclusive evidence that the installation has been discontinued. Anyone intending to decommission and/or remove such an installation shall notify the Site Plan Approval Authority and Building Inspector by certified mail of the proposed date of discontinued operations and plans for removal.

The owner or operator shall physically remove the installation no more than 150 days after the date of discontinued operations. Removal shall consist of:

- [1] Physical removal of all parts of and appurtenances to the CSPI, including structures, equipment, security barriers and transmission lines;

[2] Disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations;

[3] Stabilization or re-vegetation of the site as necessary to minimize erosion. The Site Plan Approval Authority may allow the owner or operator to leave landscaping or designated below-grade foundations in order to minimize erosion and disruption to vegetation.

[4] Any site that was deforested for the CSPI, per §145-28B(3)(b), shall be restored to encourage native tree growth, including the planting of seedlings, if necessary, to establish growth. The cost of plant replacement shall be incorporated into the financial surety stipulated in §145-28D(10)(b) below.

If the owner or operator of the CSPI fails to remove the installation in accordance with the requirements of this section, the town shall have the right, to the extent it is otherwise duly authorized by law, to enter the property and physically remove the installation at the expense of the owner of the installation and the owner(s) of the site on which the facility is located. The Town may use the financial surety as stipulated in §145-28D(10) (b), below for this purpose.

(b) Financial Surety. Proponents seeking to construct and operate a CSPI shall provide to the Town, in a form determined by the Site Plan Approval Authority and prior to construction, a surety, through cash, an escrow account, bond or otherwise, to cover the cost of removal in the event the town must remove the CSPI and remediate the landscape, including reforestation. The amount and form of such surety shall be determined by the Site Plan Approval Authority. This surety will not be required for municipally- or state-owned facilities. The project proponent shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for calculating increased removal costs due to inflation.

NORTHAMPTON CODE

WATER SUPPLY PROTECTION (WSP)						
Uses Allowed: (by-right unless otherwise noted) any mix or their accessory uses/structures (home office, tag sales § 350-2.1, fences § 350-6.8, horses and animals § 350-5.3)	Site Plan Approval Required by Planning Board (if checked) Any nonresidential construction greater than 2,000 square feet triggers site plan	Use By Special Permit Approval Required by Designated Board (if checked)	Dimensions	Landscaping	Minimum Parking	Building Design
Solar photovoltaic of any size, ground-mounted: 1. Over any legal parking lot or driveway; 2. At any landfill site not separate from the site-assigned property by any road; and 3. At an airport not separated from the runways by any road.	√		Same setbacks as setbacks for other accessory buildings in the district	Sufficient landscaping within the setbacks to provide effective visual separation	0	None. Installations must be maintained in good condition with painting, structural repairs and security maintained and facilities no longer being used dismantled within 90 days.
Accessory solar photovoltaic ground-mounted on a parcel with any building or use, provided that the PV is sized to generate no more than 100% or 8 KW of the annual projected electric use of the non-PV building or use			Setbacks: Front = 15 feet Side = 4 feet Rear = 4 feet And such open space as applies to the principal building			
Accessory solar photovoltaic ground-mounted on a parcel with any building or use, between 8 KW or over 100% up to but no more than 200% of the annual projected electric use of the non-PV building or use	√	√ Planning Board	Setbacks: Front = 15 feet Side = 4 feet Rear = 4 feet And such open space as applies to the principal building			

ZONING

WATER SUPPLY PROTECTION (WSP)						
Uses Allowed: (by-right unless otherwise noted) any mix or their accessory uses/structures (home office, tag sales § 350-2.1, fences § 350-6.8, horses and animals § 350-5.3)	Site Plan Approval Required by Planning Board (if checked) Any nonresidential construction greater than 2,000 square feet triggers site plan	Use By Special Permit Approval Required by Designated Board (if checked)	Dimensions	Landscaping	Minimum Parking	Building Design
Solar photovoltaic (PV), large-scale ground-mounted with less than two acres of tree removal: Any other solar photovoltaic (PV), large-scale ground-mounted not listed above, where less than two acres of tree removal is planned. The removal of significant trees on the subject parcel(s) must be replaced in accordance with § 350-12. 3 and includes tree removal that occurs within 12 months immediately prior to an application for installation of such a system. ¹	√		Lot size = 0 Frontage/Width/Depth = 0 Setbacks: Front: 50 feet Side: 50 feet Rear: 50 feet Maximum height = 30 feet Open space = 20%	A planted buffer to abutting residential property shall be at least 15 feet in width along the property boundary. It shall contain a screen of plantings of vertical habit in the center of the strip not less than three feet in width and six feet in height at the time of occupancy of such lot. Individual shrubs shall be planted not more than five feet on center, and individual trees thereafter shall be maintained by the owner or occupants so as to maintain a dense screen year-round. At least 50% of the plantings shall be evenly spaced. Whenever possible, existing trees and ground cover should be preserved in this strip, reducing the need to plant additional trees. Trees may not be cut down in this strip without site plan approval.	0 See also §§ 350-8.2 through 350-8.11 for location, construction, layout requirements for parking lots	Installation must be maintained in good condition with painting, structural repairs and security maintained and facilities no longer being used dismantled within 90 days.

NORTHAMPTON CODE

WATER SUPPLY PROTECTION (WSP)						
Uses Allowed: (by-right unless otherwise noted) any mix or their accessory uses/structures (home office, tag sales § 350-2.1, fences § 350-6.8, horses and animals § 350-5.3)	Site Plan Approval Required by Planning Board (if checked) Any nonresidential construction greater than 2,000 square feet triggers site plan	Use By Special Permit Approval Required by Designated Board (if checked)	Dimensions	Landscaping	Minimum Parking	Building Design
Solar photovoltaic (PV), large-scale ground-mounted with more than two acres of tree removal ^{1,2}	√	√ Planning Board	Lot size = 0 Frontage/Width/Depth = 0 Setbacks: Front: 50 feet Side: 50 feet Rear: 50 feet Maximum height = 30 feet Open space = 20%	A planted buffer to abutting residential property shall be at least 15 feet in width along the property boundary. It shall contain a screen of plantings of vertical habit in the center of the strip not less than three feet in width and six feet in height at the time of occupancy of such lot. Individual shrubs shall be planted not more than five feet on center, and individual trees thereafter shall be maintained by the owner or occupants so as to maintain a dense screen year-round. At least 50% of the plantings shall be evenly spaced. Whenever possible, existing trees and ground cover should be preserved in this strip, reducing the need to plant additional trees. Trees may not be cut down in this strip without site plan approval.	0 See also §§ 350-8.2 through 350-8.11 for location, construction, layout requirements for parking lots	Installation must be maintained in good condition with painting, structural repairs and security maintained and facilities no longer being used dismantled within 90 days.

NORTHAMPTON CODE

WATER SUPPLY PROTECTION (WSP)						
Uses Allowed: (by-right unless otherwise noted) any mix or their accessory uses/structures (home office, tag sales § 350-2.1, fences § 350-6.8, horses and animals § 350-5.3)	Site Plan Approval Required by Planning Board (if checked) Any nonresidential construction greater than 2,000 square feet triggers site plan	Use By Special Permit Approval Required by Designated Board (if checked)	Dimensions	Landscaping	Minimum Parking	Building Design
Short-term rental: allowed only upon annual registration with the City. Use as a registered rental is only valid for the year in which registration is completed and expires December 31 each year.						

NOTES:

- ¹ The owner or operator shall remove the installation no more than 150 days after the date of discontinued operations. Removal shall consist of:
- Removal of all structures, equipment, security barriers, transmission lines, conduits, poles.
 - Disposal of all waste in accordance with local, state, and federal waste disposal regulations.
 - Stabilization or re-vegetation of the site as necessary to minimize erosion.

If the owner/operator fails to remove the installation in accordance with the requirements of this section, the City shall have the right, exercise or call the bond/performance guarantee in order to cover the cost of removal.

Performance guarantee: Applicants shall submit an itemized cost estimate for complete decommissioning of the array as specified above. Prior to beginning construction the applicant shall post a performance guarantee in the form of a bond or escrow or other guarantee approved by the Planning Board for the amount to cover decommissioning, including a 20% contingency and calculated with twenty-year inflation factor.

- ² The Board must find that the removal of trees will not negatively impact the health, safety and welfare of the residents of Northampton by maintaining a robust and diverse ecosystem for the residents while also creating renewable energy systems. In order for the Board to make such finding, the applicant shall submit an analysis of the proposed project's impact relative to the benefit of the solar installation as follows:
- Analysis showing that tree removal which occurs on more than one acre of slopes greater than 20% will not cause erosion of topsoil and will not increase siltation of any streams present on the site or within 200 feet of the property boundary.
 - Analysis of the forest type and relevant habitat that will be lost. This analysis must include the structure and diversity of the canopy, midstory and understory of the forested area to be cleared. Analysis must be performed by an individual with a master's degree in wildlife biology or ecological science from an accredited college/university or other competent professional with at least two years of experience in wildlife habitat evaluation.
 - Any forested area within which certifiable vernal pools are found must be identified and a permit from the Conservation Commission must be granted prior to review by the Planning Board.
 - Any forested area containing clusters of five or more healthy trees of 20 inches diameter breast height or greater that are not in decline shall be preserved in order to continue to provide high value ecological benefit to the community. Connection of these larger trees to surrounding stands of trees shall be maintained.
 - As part of the forest type analysis, the report shall contain information regarding the abundance and distribution of habitats within the region and of the specific site and any historical information on the extent and quality of these habitats and impact of clearing on these habitats. The applicant must show through analysis that habitat is not fragmented and that connectivity remains in the proposed conditions.
 - Analysis by a qualified third party showing that the project will be carbon-neutral over the first 10 years of operation. The applicant shall provide the following calculations:
 - The total volume of trees to be removed (provided by an independent certified forester) and the projected volume of trees over a ten-year period of additional growth.
 - Subtracting the estimated live-wood in replacement trees provided under the significant tree section of this zoning ordinance 10 years after planting.
 - Conversion of the net live-wood to be removed to short tons of carbon (using research from the Northern Institute of Applied Climate Science or other methodology after approval by the permit granting authority).
 - Subtraction of the carbon offsets (short tons of carbon) provided by the solar photovoltaic project over 10 years of operation, including the calculation of potential carbon stored had the trees continued to thrive in that same ten-year window.

ZONING

- e. If there is any net release of carbon with the above calculations, the applicant shall assign renewable energy credits (REC) to the City to match or exceed said release of carbon.
However, RECs may not be used to fund biomass projects.
- 4. At least 50% of the property shall be protected from tree clearing and future development for the duration of the operation of the solar array installation and until such time as the system is decommissioned and removed.
- 5. Within the area beyond the first two acres of canopy removed, stumps for removed trees must remain in place and no excavation/soil disturbance is allowed other than what would be required to bore support posts for the PV panels.
- 6. Electrical transformers for utility interconnections may be aboveground only if required by the utility provider. Power and telecommunications poles and equipment shall not be visible from the public way.

Town of Shutesbury



8.10-1 Purpose

The purpose of this bylaw is to facilitate and appropriately regulate the creation of Ground-Mounted Solar Electric Installations (a) by providing standards for the placement, design, construction, operation, monitoring, modification and removal of such installations that address public safety, minimize impacts on environmental, scenic, natural, and historic resources and (b) to provide adequate financial assurance for the eventual decommissioning of such installations.

8.10-2 Applicability

A.! This Section 8.10 applies to Large- Scale and Small-Scale Ground-Mounted Solar Electric Installations, as noted. Small-Scale Ground-Mounted Solar Electric Installations which are accessory to an existing residential or non-residential use which generate electricity principally used by such residential or non-residential use are permitted as of right, do not need to comply with this Section, but require a Site Plan Review from the Zoning Board of Appeals, as well as a building permit, and must comply with all other applicable

provisions of the Town of Shutesbury Zoning Bylaw.

- B. This Section 8.10 also pertains to physical modifications that materially alter the type, configuration, or size of Ground-Mounted Solar Electric Installations or related equipment.
- C. This Section 8.10 shall not apply to any special permit duly applied for and in process prior to its effective date.
- D. Upon written request by the applicant, the Planning Board may waive or reduce any requirement of this Section 8.10 by the same majority vote required for the permit itself upon written findings included in the permit of:
 - 1. special circumstances of the site, its surroundings, or the proposal that negate the need for imposition of the requirement; or the objectives of this section may be met in an alternative manner; and
 - 2. that such a waiver or reduction will not derogate from the public purposes and intent of this zoning bylaw.

In the case of a special permit, such requests must be made by the applicant no later than the close of the public hearing. An affirmative or negative vote under this paragraph shall not be construed as an approval or disapproval of the permit sought.

8.10-3 General Requirements

- A. Compliance with Laws, Bylaws, and Regulations
The construction and operation of all Ground-Mounted Solar Electric Installations shall be consistent with all applicable local, state and federal requirements, including but not limited to all applicable safety, construction, electrical, and communications requirements. All buildings and fixtures forming part thereof shall be constructed in accordance with the Massachusetts State Building Code.
- B. Mitigation for Loss of Carbon Sequestration and Forest Habitat
If forestland is proposed to be converted to a Ground-Mounted Solar Installation the plans shall designate thereon an area of unprotected (meaning, not subject to MGL. Ch. 184, §§ 31-33 at time of application) land on the same lot and of a size equal to four times (4X) the total area of such installation. Such designated land shall remain in substantially its natural condition without alteration, including unauthorized (by SPGA) forestry/tree cutting, until such time as the installation is decommissioned. The Special Permit may be conditioned to effectuate and make enforceable this requirement.
- C. Mitigation for Loss of Forest Habitat within the Installation
If forestland is proposed to be converted to a Ground-Mounted Solar Electric Installation the plans shall show mitigation measures that create a wildflower meadow habitat within and immediately around the Solar Electric System and a successional forest habitat in the surrounding areas managed to prevent shading until such time as the installation is decommissioned. The Special Permit may be conditioned to effectuate and make enforceable this requirement.
- D. Mitigation for Installation of Perimeter Fencing
Any perimeter fencing within winter sight of a public roadway, driveway, or dwelling existing at the time of the special permit application shall be entirely black in color. The Special Permit may be conditioned to effectuate and make enforceable this requirement.

E. Mitigation for Disruption of Trail Networks

If existing trail networks or woods roads are disrupted by the location of the Ground-Mounted Solar Electric Installation, the plans shall show alternative trail alignments to be constructed by the applicant. The Special Permit may be conditioned to effectuate and make enforceable this requirement, although no rights of public access may be established hereunder.

F. All plans and maps shall be prepared, stamped and signed by a Professional Civil Engineer licensed to practice in the Commonwealth of Massachusetts.

8.10-4 Required Documents

The project applicant shall provide the following documents in addition to or in coordination with those required under Article IX below.

A. Site Plan. A Site Plan additionally showing:

1. Locations of wetlands and Priority Habitat Areas as defined by the Natural Heritage & Endangered Species Program (NHESP).
2. Locations of local or National Historic Districts.
3. Locations of all known, mapped or suspected Native American archaeological sites or sites of Native American ceremonial activity. Identification of such sites shall be based on responses, if any, to written inquiries with a requirement to respond within 35 days, to the following parties: all federally or state recognized Tribal Historic Preservation Officers with any cultural or land affiliation to the Shutesbury area; the Massachusetts State Historical Preservation Officer; tribes or associations of tribes not recognized by the federal or state government with any cultural or land affiliation to the Shutesbury area; and the Shutesbury Historical Commission. Such inquiries shall serve as a notice to the aforesaid parties and shall contain a plan of the project, specific identification of the location of the project, and a statement that permitting for the project is forthcoming. Accompanying the site plan shall be a report documenting such inquiries, the responses from the parties, a description of the characteristics, including photographs, of any Native American sites located, and the outcomes of any additional inquiries made based on information obtained from or recommendations made by the aforesaid parties. A failure of parties to respond within 35 days shall allow the applicant to submit the site plans.
4. The project proponent must submit a full report of all materials to be used, including but not limited to the use of cleaning products, paints or coatings, hydro-seeding, fertilizers, and soil additives. When available, Material Safety Data Sheets will be provided.

B. Blueprints. Blueprints or drawings of the installation signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts, showing:

1. The proposed layout of the system and any potential shading from nearby structures.
2. One- or three-line electrical diagram detailing the Ground-Mounted Solar Electric Installation, associated components, and electrical interconnection methods, with all Massachusetts and National Electrical Code compliant disconnects and overcurrent devices.

C. General Documentation. The following information shall also be provided:

1. A list of any hazardous materials proposed to be located on the site in excess of

- household quantities and a plan to prevent their release to the environment as appropriate.
2. Name, address, and contact information for proposed system installer.
 3. The name, contact information and signature of any agents representing the project applicant.
- D. Site Control
- The project applicant shall submit documentation of actual or prospective access and control of the project site sufficient to allow for construction and operation of the proposed Ground-Mounted Solar Electric Installation.
- E. Operation and Maintenance Plan
- The project applicant shall submit a plan for the operation and maintenance of the Ground-Mounted Solar Electric Installation, which shall include measures for maintaining safe access to the installation, stormwater management (consistent with DEP's and, where appropriate, Shutesbury's stormwater regulations and vegetation controls), as well as general procedures for operational maintenance of the installation.
- F. Financial Surety
- Applicants for Ground-Mounted Solar Electric Installations shall provide a form of surety, either through an escrow account, bond or otherwise, accessible to the Town of Shutesbury, to cover the cost of removal in the event the Town must remove the installation and remediate the site to its natural preexisting condition, in an amount and form determined to be reasonable by the SPGA, but in no event to exceed more than 125 percent of the cost of removal and compliance with the additional requirements set forth herein. The project applicant shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for calculating increased removal costs due to inflation.
- G. Utility Notification
- No Ground-Mounted Solar Electric Installation shall be constructed until evidence has been provided to the Planning Board that the utility company that operates the electrical grid where the installation is to be located has approved the solar electric installation owner or operator's intent to install an interconnected customer-owned generator and that the utility can and will connect the proposed generator into their power grid. Off-grid systems shall be exempt from this requirement.
- H. Proof of Liability Insurance

8.10-5 Dimensional Requirements

- A. Minimum setbacks for all Large-Scale Ground-Mounted Solar Electric Installations:
- Front street setback: 500 feet (as required for Forest Conservation District)
 - Property line setback: 100 feet
- B. Minimum setbacks for all Small-Scale Ground-Mounted Solar Electric Installations:
- Front street setback: 100 feet
 - Property line setback: 50 feet
- C. Required setback areas shall not be counted toward a facility's total acreage.

8.10-6 Design and Performance Standards

- A. Lighting

Large- and Small-Scale Solar Electric Installations shall have no permanently-affixed exterior lighting.

B. Signage

1. Sufficient signage shall be provided to identify the owner of the facility and provide a 24-hour emergency contact phone number.
2. Signage at the perimeter warning pedestrians is allowable.
3. Ground-Mounted Solar Electric Installations shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of such installation.

C. Control of Vegetation

Herbicides or pesticides may not be used to control vegetation or animals at a Ground-Mounted Solar Electric Installation.

D. Visual Impacts

1. Ground-Mounted Solar Electric Installation shall be designed to minimize visual impacts including preserving natural vegetation to the maximum extent possible, blending in equipment with the surroundings, and adding vegetative buffers to provide an effective visual barrier from adjacent roads and driveways, and to screen abutting residential dwellings.
2. When possible, a diversity of plant species shall be used, with a preference for species native to New England.
3. Use of exotic plants, as identified by the most recent copy of the "Massachusetts Prohibited Plant List" maintained by the Massachusetts Department of Agricultural Resources, is prohibited.
4. If deemed necessary by the Planning Board, the depth of the vegetative screen shall be 30 feet and will be composed of native trees and shrubs staggered for height and density that shall be properly maintained.
5. The owner/operator shall not remove any naturally occurring vegetation such as trees and shrubs unless it adversely affects the performance and operation of the solar installation.
6. Landscaping shall be maintained and replaced as necessary by the owner/operator of the Ground-Mounted Solar Electric Installation.

E. Utility Connections.

Electrical transformers, wires, or other utility interconnections shall be constructed as required by the utility provider and may be above ground if necessary; provided, however, that every reasonable effort shall be made to place all utility connections underground, depending on appropriate soil conditions and topography of the site and any requirements of the utility provider.

F. All electric power generated at a Ground-Mounted Solar Electric Installation shall be from Solar Energy.

G. Access Driveways shall be constructed to minimize grading, removal of stone walls or roadside trees, and minimize impacts to environmental or historic resources.

8.10-7 Safety and Environmental Standards

A. Emergency Services

1. Ground-Mounted Solar Electric Installations owner or operator shall provide a copy of

- the project summary, electrical schematic, and site plan to the Shutesbury Fire Chief.
2. The owner or operator shall cooperate with local emergency services to develop an emergency response plan.
 3. All means of shutting down the solar electric installation shall be clearly marked.
 4. The owner or operator shall identify a responsible person for public inquiries throughout the life of the installation.
- B. Land Clearing, Soil Erosion and Land Impacts
1. The facility shall be designed to minimize impacts to open agricultural land and fields, even if not in production. Clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of the Ground-Mounted Solar Electric Installation. In no event shall tree stocking on the parcel to be developed for the installation be reduced to below Level-C as defined in 304 CMR 11.03 and as measured at the time of application. Grading that substantially disturbs the existing soil profile and structure is prohibited; sites shall be selected where construction may be accomplished without such earth work.
 2. Prior to any site disturbance and construction, the limits of the work shown on the approved site plan shall be surveyed and clearly marked by a Professional Land Surveyor. Upon completion of the survey, the Professional Land Surveyor shall verify to the Planning Board, in writing, that the limit of work, as shown on the approved site plans, has been established on site.
 3. The design shall minimize the use of concrete and other impervious materials to the maximum extent possible. Ground-Mounted Solar Electric Installation shall be installed on water permeable surfaces.
 4. Locating Ground-Mounted Solar Electric Installations, including access driveways and any associated drainage infrastructure on original grades in excess of 15% is prohibited.
- C. Habitat Impacts
- Large-Scale Ground-Mounted Solar Electric Installations shall not be located on permanently protected land subject to MGL. Ch. 184, §§ 31-33 Priority Habitat and Bio Map 2 Critical Natural Landscape Core Habitat mapped by the Natural Heritage and Endangered Species Program (NHESP) and "Important Wildlife Habitat" mapped by the DEP.
- D. Wetlands
1. Where wetland delineation is in doubt or dispute, the Planning Board may require the applicant to submit a request for determination of wetlands to the Conservation Commission.
 2. The Planning Board may impose conditions to contain and control stormwater runoff that might negatively impact identified wetlands or other hydrologic features even if the proposed work area is outside the jurisdiction of the Conservation Commission.

8.10-8 Monitoring, Maintenance and Reporting

A. Solar Electric Installation Conditions

1. The Ground-Mounted Solar Electric Installation owner or operator shall maintain the facility in good condition.
2. Maintenance shall include, but not be limited to, painting, structural repairs, and

- integrity of security measures.
- 3. Site access shall be maintained to a level acceptable to the Shutesbury Fire Chief and Emergency Management Director.
- 4. The owner or operator shall be responsible for the cost of maintaining the Solar Electric Installation and any access driveways.
- B. Annual Reporting
 - 1. The owner or operator of a Ground-Mounted Solar Electric Installation shall submit an annual report demonstrating and certifying compliance with the Operation and Maintenance Plan, the requirements of this Section 8.9 and the approved special permit, including but not limited to continued management and maintenance of vegetation, compliance with the approved plans and any special permit conditions, continuation of liability insurance, and adequacy of road access.
 - 2. The annual report shall also provide information on the maintenance completed during the course of the year and the amount of electricity generated by the facility.
 - 3. The report shall be submitted to the Select Board, Planning Board, Fire Chief, Emergency Management Director, Building Commissioner, Board of Health and Conservation Commission (if a wetlands permit was issued) no later than 45 days after the end of the calendar year.

8.10-9 Abandonment or Decommissioning

- A. Removal Requirements
 - 1. Any Ground-Mounted Solar Electric Installation which has reached the end of its useful life or has been abandoned shall be removed.
 - 2. The owner or operator shall physically remove the installation no later than 150 days after the date of discontinued operations.
 - 3. The owner or operator shall notify the Special Permit Granting Authority by certified mail, of the proposed date of discontinued operations and plans for removal.
- B. Decommissioning shall consist of:
 - 1. Physical removal of all components of the Ground-Mounted Solar Electric Installation, including but not limited to structures, foundations, equipment, security barriers, and on-site above-ground transmission lines. Associated off-site utility interconnections shall also be removed if no longer needed.
 - 2. Disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations.
 - 3. Restoration of the site to its natural preexisting condition, including stabilization or re-vegetation of the site as necessary to minimize erosion. The Special Permit Granting Authority may allow the owner or operator to leave landscaping or designated below-grade foundations and electric lines in order to minimize erosion and disruption to vegetation.
- C. Decommissioning by the Town

If the owner or operator of a Ground-Mounted Solar Electric Installation fails to remove such installation in accordance with the requirements of this Section 8.9 within 150 days of discontinued operations or abandonment, the Town may enter the property and physically remove the installation at the owner's expense, drawing from the escrow account or upon the bond or other financial surety provided by the applicant.

8.10-10 Lapse of Approval

Any special permit shall automatically lapse if the Large-or Small-Scale Ground-Mounted Solar Electric Installation is not installed and functioning within two (2) years of the grant of the special permit or if the installation shall be considered abandoned.

MAP: LARGE GROUND MOUNTED SOLAR ELECTRIC INSTALLATION DISTRICTS

As referenced in Shutesbury Zoning Bylaws, Section 8.10



Article ____ To see if the Town of Athol will vote to amend the Athol Zoning Bylaws, Article III, by deleting the existing Section 3.24, Ground-Mounted Solar Photovoltaic Installations, in its entirety and replacing with the following new text in its place.

The purpose and intent of this bylaw is to provide standards for the placement, design, construction, operation, monitoring, modification and removal of ground-mounted solar photovoltaic installations which address public safety, minimize impacts on scenic, natural and historic resources and to provide adequate financial assurance for the eventual decommissioning of such installations. The provisions set forth in this section shall apply to the placement, design, construction, operation, maintenance and/or repair, and environmental effects of ground-mounted solar photovoltaic installations.

3.24.2 Applicability

This bylaw applies to commercial and residential ground-mounted solar photovoltaic installations greater than 10,000 square feet proposed to be constructed after the effective date of this bylaw. This bylaw also pertains to physical modifications that materially alter the type, configuration or size of the installation. Square footage shall be calculated as follows:

- i. The area within the security fence if a fence is provided, or
- ii. All land area within a polygon (a plane shape-two dimensional-with straight sides) around the entire installation including all solar panels, all appurtenances including but not limited to buildings, storage areas, construction staging and lay-down areas, and transformers and poles, and parking along with a 15 foot perimeter area around all of the above or
- iii. All areas of disturbed land, whichever is greater.

As defined in 3.24.2:

- a) This bylaw does not pertain to ground-mounted solar photovoltaic installations installed on residential, commercial or industrial buildings. Those installations are subject to the State Building Code.
- b) Ground-mounted solar photovoltaic installations less than or equal to 10,000 square feet shall only need a building permit and meet property setback requirements.
- c) This bylaw does not pertain to solar carport canopies over existing rows of parking spaces. Such installations are considered Accessory Uses under Section 2.3 and are subject to the State Building Code.
- d) This bylaw shall not apply to any ground-mounted solar photovoltaic installation being developed with the direct involvement of the Town of Athol at the former municipal landfill on West Royalston Road in Athol, MA.

3.24.3 Special Permit Granting Authority

Subject to the requirements of this bylaw, ground-mounted solar photovoltaic installations may be permitted in the R-C Zoning District subject to a Special Permit from the Athol Board of Planning and Community Development, pursuant to meeting the Special Permit Criteria and Requirements below. The Board of Planning and Community Development shall be the Special Permit Granting Authority for ground-mounted solar photovoltaic installations. In addition to the findings required in Section 1.2.6.2, the Special Permit Granting Authority must also find that the proposal does not contravene the purposes of this section. Ground-mounted solar photovoltaic installation Special Permit applications shall be filed in accordance with the Board of Planning and Community Development Filing Requirements & Fees.

3.24.4 Requirements for Ground-Mounted Solar Photovoltaic installations

The following requirements shall apply to ground mounted solar photovoltaic installations greater than 10,000 square feet.

1. Compliance with Laws, Bylaws and Regulations

The construction and operation of ground-mounted solar photovoltaic installations shall comply with all applicable local, state and federal requirements, including but not limited to all applicable safety, construction, electrical, and communications requirements. All buildings, fixtures and other appurtenance structures forming part of a ground-mounted solar photovoltaic installation shall be constructed in accordance with the State Building Code.

2. Building Permit

No ground-mounted solar photovoltaic installation shall be constructed, installed or modified as provided in this section without first obtaining a building permit

3. Pre-application Conference and Public Outreach

The applicant shall participate in a pre-application conference with the Board of Planning and Community Development prior to the submittal of a formal application. A public outreach plan, including project development timeline, which indicates how the applicant will meet the required site plan review notification procedures and otherwise inform the abutters and the town residents, shall be provided as part of the pre-application conference process. The applicant shall be required to erect a 4-foot by 4-foot double-sided sign perpendicular to the road at the proposed entrance to the project site prior to the pre-application conference.

The sign shall be headed with the following: Notice: This property is the site of a proposed commercial ground-mounted solar photovoltaic installation in accordance with Section 3.24 of the Athol Zoning Bylaw. The sign shall also indicate the name of the applicant, the name of the owner of the installation, the size of the proposed facility in both acreage and MW, a contact person for additional information including phone and email address, and assessors plot number for the property.

4. Site Plan Review

Ground-mounted solar photovoltaic installations greater than 10,000 square feet shall undergo site plan review by the Board of Planning and Community Development (BPCD) prior to construction, installation or modification as provided in this section as well as section 3.18, Site Plan Review, as

applicable. The BPCD shall act as the Special Permit Granting Authority for such site plans with the entirety of the Town of Athol, including the Major Commercial Overlay District.

3.24.4.5 Professional Engineer

All plans and maps shall be prepared, stamped, and signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts.

3.24.4.6 Required Documents to be deemed a complete application.

Pursuant to the site plan review process, the applicant shall also provide the following documents:

(a) A site plan showing:

- i. Property lines and physical features, including both existing and proposed roads, for the project site at a scale of 1 inch equals 40 feet or such scale as may be approved by the Special Permit Granting Authority on standard 24" by 36" sheets and continuation on 8.5 " by 11" sheets as necessary for narrative;
- ii. Blueprints or drawings of the solar photovoltaic installation showing the proposed layout of the system;
- iii. One or three line electrical diagram detailing the solar photovoltaic installation, associated components, and electrical interconnection methods, with all National Electrical Code compliant disconnects and overcurrent devices;
- iv. Proposed wattage of the solar photovoltaic installation solar power generation indicated in both dc (direct current) and ac (alternating current); a notation shall be included explaining the difference, e.g. loss in conversion from dc to ac;
- v. Technical specification of the major system components to be used, including the PV panels, mounting system, and inverter and battery storage;
- vi. Name, address, and contact information for proposed system installer (owner);
- vii. Name, address, phone number and signature of the applicant, as well as all co-proponents or property owners;
- viii. Proposed changes to the landscape of the site, grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures;
- ix. All existing lot lines, with size of each existing lot in acres or square feet, abutting land uses and location of structures [REDACTED]
- x. Names and addresses of all record owners within 500 hundred feet of all property lines along with a map showing the same;
- xi. Locations and details of all security measures for the site;
- xii. [REDACTED] as identified on the United States Natural Resources Conservation Service soils survey, on all land involved with the project;
- xiii. [REDACTED]
- xiv. [REDACTED]
- xv. All storm water plans as required in Section 3.24.5.11;
- xvi. A [REDACTED]
- xvii. A buffer, screening and landscape plan as required in Section 3.24.3;
- xviii. [REDACTED] at the time of application filing.
- xix. [REDACTED] as well as documentation of Dark Sky Standards in accordance with Section 3.24.5.7;

xx. Location of equipment and construction staging area, and

- (b) The name, contact information and signature of any agents representing the applicant;
- (c) [REDACTED] and proposed mitigation, if any, to minimize the impact on affected properties and roads, as well as the Orange airport in regards to the proposed solar panels as required in Section 3.24.5.5;
- (d) [REDACTED]
- (e) Documentation by an acoustical engineer of the noise levels projected to be generated by both the installation and operation of the facilities as required in Section 3.24.5.13;
- (f) Documentation of all soils types, as identified on the United States Natural Resources Conservation Service soils survey, on all land involved with the project;
- (g) Documentation of actual or prospective access and control of the project site as required in Section 3.24.7;
- (h) Visual impact analysis as required in Section 3.24.5.5;
- (i) [REDACTED]
- (j) [REDACTED]
- (k) Mitigation Plan as required in Section 3.24.5.4;
- (l) A list identifying all off-site electrical system improvements necessary to the electrical grid to accommodate the power from the proposed installation and identification of what entity is paying for such improvements.

3.24.4.7 Waiver of Submittal Requirements: Upon the written request of the applicant with justification, the Special Permit Granting Authority may waive any of its submission requirements under unique site conditions. In addition, the Special Permit Granting Authority may request any additional data needed to render its decision.

3.24.5 Design Standards

1. Lot and Siting Requirements

- i. Ground-mounted commercial solar photovoltaic array installations shall be permitted on parcels larger than 10 acres located within the RC zoning district and shall have a minimum lot frontage of 160 feet.
- ii. Project generation size shall not exceed 5MW AC, nor shall the installation exceed 20 acres of fenced area, if fenced. If not fenced, the 20 acre area shall be calculated as the area within a polygon around the entire installation including all solar arrays, all appurtenances including but not limited to buildings, storage areas, construction staging and lay-down areas, transformers and poles along with a 15 foot perimeter area around all of the above

[REDACTED]

a. [REDACTED] (measured over 100-foot intervals.) Cutting and filling to reduce natural slopes shall be prohibited except on short hollows, depressions or high spots. A waiver to increase the slope from 10% to 12% may be requested.

b. Shall be located on any parcel that contains 50% of Priority Habitat, Core Habitat or Critical Natural Landscape as defined in 225 CMR 20.00 Solar Massachusetts Renewable Target (SMART) Program, nor shall any trees be removed, or construction of structures, access roads or transmission lines may be placed in these designated areas.

iv. [REDACTED]
[REDACTED]

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

[REDACTED]
[REDACTED]

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

[REDACTED]
[REDACTED]
[REDACTED]

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

v. Location of the entrance road and all utility poles shall be located within the lot's frontage taking into consideration site lines for vehicular traffic and to lessen any visual impacts on abutters.

2. [REDACTED]

i. For all zoning districts except for the Rural Single-Family Residential (RC) zoning district, ground-mounted solar photovoltaic installations must observe all yard requirements applicable to the principal structure as defined in Section 2.6, Intensity of Use Schedule. The Special Permit Granting Authority may increase these setbacks in these districts if they determine it to be appropriate.

ii. For the RC zone, setbacks shall be:

- 200 feet for front yard*
- 200 feet for side and rear yard*
- 200 feet from any perennial stream**
- 200 feet from any water body greater than 1 acre and less than 5 acres**
- 400 feet from the shoreline of any water body greater than 5 acres**

* The Special Permit Granting Authority may reduce the minimum setback distance for front, side and rear yards only in the RC District to a minimum of 75 feet as authorized per Section 3.24.17. In addition to the specifics of Section 3.24.17, the applicant shall also be required to submit written consent from all affected abutter(s) for any reduction in setbacks.

However, reduction of the setback on any frontage with a public road is not permitted whether the yard is a front, side or rear yard. The setback between properties of a single owner subdivided per Section 3.24.5.4.4 may be waived to no less than the minimum for existing setback requirements of the RC District per Section 2.6.

**The setbacks for perennial streams and water bodies between 1 and 5 acres are not subject to any waiver of distances under Section 3.24.13. Setbacks for water bodies greater than 5 acres are only allowed to be reduced through a waiver to a minimum distance of 300 feet as long as a natural wooded buffer is maintained, detailed stormwater plans show no further impact to abutting properties versus the 400-foot setback distance, water quality of runoff is not reduced and wildlife and fauna movement is not restricted with the reduced setback. No access roads or transmission lines may be constructed in the setbacks to any water body greater than 1 acre.

- All ground mounted photovoltaic panels in a residential zone shall be limited to a height of 10 feet. For any other zone, the height shall be limited to 15 feet. Other appurtenance structures shall be limited to a height of 15 feet in all zones.

- 1. Ground-mounted solar photovoltaic installations shall be effectively screened year-round:
 - i. from all abutting properties in all residential zones;
 - ii. from all abutting properties in residential use in all non-residential zones;
 - iii. and from public and private ways in all residential districts.

Except for vehicular and pedestrian passageways and permitted signs, setback areas shall be modified only for additional screening. Where existing vegetation in the setbacks is insufficient to achieve year-round screening, additional screening shall be provided including, but not limited to, planting of dense vegetative screening, fencing, berms, natural ground elevations, land contouring, and/or placement of the solar panels and appurtenant structures on the site, all depending on site specific conditions.

Tree cutting within the required setback area shall not be permitted if it would reduce to any degree the effectiveness of the year-round screening.

- 2. If additional plantings are required for screening, a planting plan shall be submitted:

- i. Showing the types, sizes and locations of material to be used which shall be subject to the approval of the Special Permit Granting Authority.
 - ii. Plantings shall be a minimum of six (6) feet in height at planting and staggered so as to fill the setback area and keep the arrays from view year round.
 - iii. Using a diversity of plant species native to New England for any screens and vegetative erosion controls. Use of exotic plants, as identified by the most recent version of the “Massachusetts Prohibited Plant List” maintained by the Massachusetts Department of Agricultural Resources, is prohibited. Cultivars of native plants are acceptable.
 - iv. At least 75% of the plantings shall consist of evergreens and shall be evenly spaced throughout the area of the setback area.
3. Planting of the vegetative screening shall be completed prior to connection of the installation. Plants shall be maintained and replaced if unhealthy by the owner/operator of the installation for the life of the installation.
4. The open area of the site shall be seeded with a pollinator mix and maintained as bird and insect habitat. Mowing is to be done as little as possible to retain a natural functioning of the landscape. Alternative vegetation or cover options may be proposed by the applicant in consideration of soil type and quality, subject to the approval of the Special Permit Granting Authority. Gravel areas that are well drained and stable do not require the addition of topsoil. Topsoil shall not be imported into any project sites unless there is a demonstrated engineering need and must be approved by the Special Permit Granting Authority prior to any introduction. The need to introduce topsoil may be grounds for permit denial.
5. Clearing of natural vegetation shall be limited to what is necessary for the construction, operation, and maintenance of the installation. Existing root structures, flat gravel areas, and topsoil shall be maintained to the maximum extent practicable.
6. Vegetation Management: Herbicides, pesticides, or chemical fertilizers shall not be used to manage vegetation at the ground mounted solar photovoltaic installation.
7. Ground surface areas beneath solar arrays and setback areas shall be pervious to maximize on-site infiltration of stormwater.
4. 
 1. The Special Permit Granting Authority shall discuss construction phasing with the designer of the installation as a means of mitigating erosion and sedimentation.
 2. Habitat Fragmentation. A ground-mounted solar photovoltaic installation shall, to the greatest extent practicable, be clustered and located in or adjacent to areas of the site where the land has already been cleared of vegetation to avoid habitat fragmentation.

3. Invasive Species. The introduction of invasive species shall be prevented to the greatest extent practicable, during any construction or removal of a solar photovoltaic installation, through the use of current best practices.

4. A ground-mounted solar photovoltaic installation shall be considered the principal use of the parcel. Any parcel with an existing residence or other building may be approved for a solar installation with the provision that the residence or building be subdivided from the larger parcel prior to any construction

of the solar installation. The parcel with the ground-mounted solar photovoltaic installation may not be subdivided for the purpose of development of the divided land until such time as the installation is decommissioned.

- 
1. The design of the ground-mounted solar photovoltaic installations shall prevent reflected solar radiation or glare from becoming a public nuisance or hazard to adjacent buildings, roadways, or properties. Design efforts may include, but not be limited to, deliberate placement and arrangement on the site, anti-reflective materials, solar glare modeling, and screening in addition to required landscaping.
 2. Any ground-mounted solar photovoltaic array installation proposed within a 5-mile radius of the Orange Airport shall be analyzed for glare utilizing any glare analysis compatible with FAA glare guidelines. [One such software package is Forge Solar, PV Planning and Glare Analysis.]
 3. Ground-mounted solar photovoltaic installations shall not be approved unless the system design provides screening and buffers to protect scenic vistas and view sheds from residential uses, public streets and any waterways or water bodies.
 4. A visual impact assessment shall be conducted that follows the protocols of the “Guidelines for Landscape and Visual Impact Assessment (Third Addition). Such assessment shall produce a map showing all areas within a 5-mile radius of the installation where the installation can be seen and where it cannot be seen.

With input from the Planning Director, the applicant shall utilize additional tools to assess the visual impacts in critical areas of concern such as renderings, line-of-sight studies and/or two or three dimensional visualizations i.e. Photomontage, video montage, animation produced through Spatial Information Systems (SIS) and Geographic Information Systems (GIS).

5. All results of the visual impact assessment shall be taken into account in the design of the installation. When reviewing for compliance with section 3.24.3 Vegetated Buffer, Screening and Landscaping and scenic vistas in Section 3.24.5.3, the Special Permit Authority shall make a definitive judgment that the intent has been achieved.

3.24.5.6 Appurtenant Structures:

All appurtenant structures to ground-mounted solar photovoltaic installations shall be subject to reasonable regulations concerning the bulk and height of structures, lot area, setbacks, and open space, parking and building coverage requirements.

All such appurtenant structures, including but not limited to, equipment shelters, storage facilities, transformers, and substations, shall be architecturally compatible with each other. Whenever reasonable, structures shall be shielded from view by vegetation approved by the Special Permit Granting Authority and/or joined or clustered to avoid adverse visual impacts.

3.24.5.7 Lighting:

Lighting of ground-mounted solar photovoltaic installations shall be consistent with local, state and federal law.

Lighting of other parts of the installation, such as appurtenant structures, shall be limited to that required for safety and operational purposes, and shall be reasonably shielded from abutting properties. All lighting shall comply with International Dark Sky Standards FSA Certification Requirements. There shall be no illumination without personnel on site.

3.24.5.8 Signs:

The following signs shall be required:

- i. one that identifies the owner, the street address, provides a 24-hour emergency contact phone
- ii. educational signs providing information about solar photovoltaic panels and the benefits of renewable energy.

Signs shall comply with Section 3.9, Sign Regulations.

Ground-mounted solar photovoltaic installations shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of the solar photovoltaic installation.

3.24.5.9 Utility Connections:

Utility connections, as determined by the Special Permit Granting Authority, shall be underground, depending on appropriate soil conditions, shape, and topography of the site and any requirements of the utility provider.

3.24.5.10

The need for fencing shall be determined by the applicant unless such fencing is needed to comply with Section 3.24.3 Vegetated Buffer, Screening and Landscaping, and/or as required per the National Electrical Code. If installed, all, shall be placed 6 inches off the ground to allow migration of wildlife, and shall have an Emergency Access System padlock or box at each gate.

3.24.5.11

1. Proposed stormwater management plans detailed below shall conform to the more stringent of any conditions or standards of this subsection and the Department of Environmental Protection's Massachusetts Stormwater Handbook, as amended.

2. All stormwater infrastructure shall be owned and maintained by the owner of the installation and shall be located on the same parcel as the solar installation.

3. All post-development stormwater, up to and including a 50-year return frequency 24-hour storm, shall be retained on the parcel site and infiltrated into the soil thru low impact development, retention and infiltration basins. At no time may stormwater be carried off site.

Emergency overflows for storms in excess of the 50-year return frequency may be permitted provided it is demonstrated that no flooding or damage would be caused by the overflow. Attenuation of the discharge may be required as needed as determined by the Special Permit Granting Authority.

4. All pipes, catch basins and other materials utilized in the stormwater facilities shall be approved by the Athol Superintendent of Public Works, or his designee.

5. Stormwater Management Plan

i. The Stormwater Management Plan (four paper copies and one electronic copy in PDF format required) with the permit application shall contain sufficient information for the Special Permitting Granting Authority to evaluate the environmental impact and effectiveness of the measures proposed for retaining stormwater on the parcel site.

ii. The Stormwater Management Plan shall fully describe the project in drawings, narrative and calculations. It shall include:

- a. The site's existing and proposed topography [REDACTED]
- b. A description and delineation of existing stormwater conveyances, impoundments, environmental resources on or adjacent to the site into which stormwater could flow;
- c. A delineation of 100-year flood plains, if applicable;
- d. Estimated seasonal high groundwater elevation in areas to be used for stormwater retention, detention, or infiltration;
- e. The existing and proposed vegetation and ground surfaces with areas and runoff coefficients for each;
- f. [REDACTED]
- g. [REDACTED]
- h. A drainage area map showing pre- and post-construction watershed boundaries, area and stormwater flow paths at a scale that enables verification of supporting calculations;
- i. A recharge area analysis that calculates pre-and post-project annual groundwater recharge rates on the parcel;
- j. A description and drawings of all components of the proposed stormwater management system;
- k. [REDACTED]
- l. Soils information from test pits performed at the location of proposed Stormwater Management facilities, including soil descriptions, depth to seasonal high groundwater and depth to bedrock. Soils information will be based on site test pits logged by a Massachusetts Certified Soil Evaluator.

6. To ensure proper containment and stabilization of the site during the construction phase, a [REDACTED] to control construction-related impacts, including erosion, sedimentation,

and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented. Such plan shall be developed to document compliance with Standard 8 of the Massachusetts Stormwater Handbook.

7. A Long -Term Stormwater Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed. Such plan shall be developed to document compliance with Standard 9 of the Massachusetts Stormwater Handbook.

- i. Stormwater management system(s) owners;
 - ii. The party or parties responsible for operation and maintenance of all aspects of the stormwater management system;
 - iii. The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks;
 - iv. A plan that is drawn to scale and shows the location of all stormwater BMPs;
 - v. A schedule for routine inspections as well as a description of storms that would trigger immediate inspections following the storm;
 - vi. An inspection and maintenance log form
 - vii. An estimated stormwater operations and maintenance budget.
 - viii. Permission from the operator to allow agents of the Town of Athol to enter and inspect the premises to evaluate and ensure that the responsibility party complies with the Long-Term Stormwater Operation and Maintenance Plan requirements for each BMP.
8. During times of construction and post-construction where stormwater generated from the project area may inadvertently enter the public way, the developer (owner) shall be responsible for direct costs incurred by the town, including but not limited to stormwater related clean up, sanding, salting, street sweeping or other necessary management when required for the protection of public health and safety.

12.

Hazardous materials stored, used, or generated on site shall not exceed the amount for a Very Small Quantity Generator of Hazardous Waste as defined by the DEP pursuant to Mass DEP regulations 310 CMR 30.000 and shall meet all requirements of the DEP including storage of hazardous materials in a building with an impervious floor that is not adjacent to any floor drains to prevent discharge to the outdoor environment.

If any hazardous materials, including, but not limited to, lithium ion (storage batteries) are used within the solar electric equipment, then impervious containment areas capable of controlling and containing any release of hazardous materials to the environment and to prevent potential contamination of groundwater are required. A list of any hazardous materials proposed to be located on the site and a plan to prevent their release shall be provided to the Special Permit Granting Authority and Fire Chief.

13.

Noise generated by ground-mounted solar photovoltaic installations, cooling fans, inverters, associated equipment and machinery shall conform at a minimum to applicable state and local noise regulations,

including the DEP's Division of Air Quality noise regulations, 310 CMR 7.10 and 3.8.1.1 of the Athol Zoning Bylaw. Noise reduction shall be considered and incorporated as needed during the design phase of the installation including the location of the noise generator, shielding, noise cancellation, filtering, and noise suppression.

1. The right of abutting and neighboring landowners to live without undue disturbance from noise, traffic, lighting, fumes, dust, odor, glare, or stormwater runoff;
2. The adequacy of methods to store, handle, or dispose of wastes, including hazardous materials, to protect air, groundwater, and surface water pollution;
3. The protection of historical and natural environmental features on the site under review and in adjacent areas;
4. The adequacy of stormwater management systems to address non-point-source pollution.
5. Minimization of erosion of soil both during and after construction.
6. In the case of a residential zone location, the visual impact of the installation on its immediate abutters and the nearby neighborhood have been effectively neutralized through its location on the lot, appropriate design, landscaping and effective screening.
7. The location of the site and the system design provides effective screening and buffers to protect scenic vistas and view sheds from residential uses, public streets, recreational areas and any waterways or water bodies, and
8. The rural character of the general location has been maintained.

3.24.7 Site Control: The applicant shall submit documentation of actual or committed prospective access and control of the project site to allow for construction and the operation of the proposed ground-mounted solar photovoltaic installation.

3.24.8 Operation and Maintenance Plan: The installation owner or operator shall maintain the facility in good condition. The applicant shall submit a plan for the operation and maintenance of the ground-mounted solar photovoltaic installation along with a signed agreement with a maintenance company. This plan shall include measures for maintaining year-round safe access for emergency vehicle, snow plowing, storm water controls, and general procedures and a yearly schedule for the operation and maintenance of the facilities including fencing, and maintenance of landscaping.

3.24.9 Utility Notification: The applicant shall submit evidence satisfactory to the Special Permit Granting Authority that the utility company operating the electrical grid has been informed in writing of the intent to install a ground-mounted solar photovoltaic installation and intends to file an Interconnect Agreement in the future and that the utility company has responded in writing acknowledging the plan. Any off-grid system shall be exempt from this requirement.

3.24.10 Emergency Services: The applicant shall provide a copy of the project summary, operation and maintenance plan, electrical schematic, and site plan to the Athol Fire and Police Departments. The applicant and the installation operator shall cooperate with local and regional emergency services in developing an emergency response plan, which will ensure that emergency personnel have immediate, 24-hour access to the facility.

All means of shutting down the solar installation shall be clearly marked on the plan. The operator of the installation shall identify an official representative for public inquiries throughout the life of the installation.

The operation and maintenance plan required in Section 3.24.8 shall be periodically jointly reviewed and updated as necessary by the operator of the installation and the Athol Fire and Police Departments at a frequency to be determined by the Athol Fire Department. Safety personnel may request at any time that the operator provide onsite training in accessing and shutting down the operation of the installation.

The operator shall identify a qualified contact person who will provide assistance to local officials during an emergency. The operator shall update the contact information whenever there is a change in the contact person.

3.24.11 Annual Reporting: The owner or operator of a solar installation shall submit an annual report demonstrating and certifying compliance with the Operation and Maintenance Plan, the requirements of this bylaw, and approvals granted hereunder, including but not limited to continued management and maintenance of vegetation, compliance with the approved plans and any permit conditions, continuation of liability insurance, and adequacy of road access and functionality of stormwater management system. The annual report shall also provide information on the maintenance completed during the course of the year and the amount of electricity generated by the facility. The report shall be submitted to the Board of Selectmen, Special Permit Granting Authority, Fire Chief, and Conservation Commission (if a wetlands permit was issued) no later than 45 days after the end of the calendar year.

3.24.12 Modifications: All material modifications to the installation to be made after the issuance of the initial required building permit shall require approval of the Special Permit Granting Authority through a permit modification.

3.24.13 Discontinuance and Removal: Absent notice of a proposed date of decommissioning or written notice of extenuating circumstances, any ground-mounted solar photovoltaic installation not used for a period of one continuous year or more without written permission from the Special Permit Granting Authority, [REDACTED] shall be considered to be discontinued and shall be removed by the owner.

Upon written request from the Building Inspector addressed to the contact address provided and maintained by the owner or operator as required, the owner or operator shall provide evidence to the Building Inspector demonstrating continued use of the installation. Failure to provide such evidence within thirty days of such written request shall be conclusive evidence that the installation has been discontinued.

The owner or operator or landowner shall physically remove the installation no more than 180 days after the date of discontinued operation. The owner or operator or landowner shall notify the Special Permit Granting Authority by certified mail of the proposed date of discontinued operations and submit plans for removal. Removal shall consist of:

1. Physical removal of all parts of and appurtenances of the installation including solar arrays, structures, equipment, security barriers and transmission lines.
2. [REDACTED] and disposal of remaining solid and hazardous wastes in accordance with state and federal waste disposal regulations applicable at the time of disposal.
3. Stabilization and revegetation of the site as necessary to minimize erosion and prevent impacts to wetlands, water courses or water bodies. The Special Permit Granting Authority may allow the owner or operator or landowner to leave landscaping or designated below grade foundations (provided they are filled in) in order to minimize erosion and disruption of existing vegetation. This requirement may be waived if the landowner submits a plan for re-use of the site.
4. Any portion of a site that was deforested for the installation shall be restored so as to encourage native tree growth, including the planting of seedlings, if necessary to establish growth.

As a condition of the Special Permit approval, the applicant and the landowner shall agree to allow entry to remove an abandoned or decommissioned installation. If the owner or operator or landowner fails to remove the installation in accordance with the requirements of this section, the Town of Athol shall have the right, to the extent it is otherwise duly authorized by law, to enter the property and physically remove the installation at a rate of 1.3 times the actual costs incurred. The Town of Athol shall use the financial surety as stipulated in the Financial Surety Section 3.24.14.

- 3.24.14 Financial Surety: The applicant of ground-mounted solar photovoltaic installations shall provide surety in the form of cash, certified bank check, escrow account or bond held by and for the Town of Athol to cover the cost of removal and stabilization of the site in the event the town must remove the installation and remediate the landscape, in an amount and form determined to be reasonable by the Special Permit Granting Authority, but in no event to exceed more than 130 percent of the cost of removal and stabilization costs as well as any compliance with the additional requirements set forth herein.

This surety will be due and payable at the issuance of the building permit. Proof of payment in the form of a receipt from the Town Treasurer will be shown to the Building Inspector before the permits are issued. Such surety will not be required for municipally- or state-owned facilities. The project applicant shall submit a fully inclusive estimate of the costs associated with removal and stabilization prepared by a licensed professional engineer. Such estimate shall be reviewed by the Town of Athol and adjusted as needed to reflect the opinion of the Town as to fair costs. The amount shall include a mechanism for calculating increased removal costs due to inflation.

As a condition of approval, an applicant shall bind itself to grant the necessary license or easement to the Town to allow entry to remove the structures and stabilize the site. The Town shall have the right but not the obligation to remove the facility.

- 3.24.15 Taxes or Payment in Lieu of Taxes: If the project would otherwise be exempt from the payment of personal or real property taxes, the applicant shall enter into a tax agreement or a payment in lieu of taxes (PILOT) agreement with the Town of Athol that provides an equivalent amount of tax revenue to the town as determined by the Board of Assessors. Any tax-related agreement or PILOT shall be approved by the Board of Assessors prior to the issuance of the Building Permit.

- 3.24.16 [REDACTED] The Special Permit Granting Authority may hire, at the expense of the applicant, consultants to review the plans submitted if it determines that independent expert review is appropriate for the interest of the neighborhood and/or the town. The applicant shall pay the

estimated cost of said expert(s), including all legal fees and publication fees, to the Town prior to any review being undertaken. No Building Permit shall be approved until the total costs of said review(s) have been paid by the applicant.

3.24.17

1. The Special Permit Granting Authority may waive or reduce strict compliance with any requirement of the Design Standards of this bylaw (unless noted otherwise in the bylaw), or any rules and regulations promulgated hereunder, where:
 - a. such action is allowed by federal, state or local statutes and/or regulations;
 - b. it is fully within the public interest;
 - c. it is not inconsistent with the purpose and intent of this bylaw and the purposes and intent of the bylaw can still be met with the waiver or reduction due to special circumstances of the site
 - d. and the full objectives of the bylaws can be met in an alternative manner.
2. The applicant shall submit a written request for any requested waiver at the time of the initial application. Such request shall be accompanied by an explanation or documentation supporting the waiver request and demonstrating that:
 - a. strict application of the bylaws does not further the purposes or objectives of this bylaw,
 - b. due to special circumstances of the site that the objectives of the bylaws can be met in an alternative manner and,
 - c. such a waiver or reduction of the requirements will not derogate from the intent or purpose of the bylaw.
3. All waiver requests shall be discussed during a required a public hearing duly noted in a public agenda and shall require a two-thirds vote in favor to be approved. If the Special Permit Granting Authority deems additional time or information is required in the review of the waiver request, the Special Permit Granting Authority may continue the request for the waiver to a subsequent BPCD meeting.

3.24.18

The Special Permit Granting Authority may adopt, and from time to time amend, Rules and Regulations consistent with the provisions of this bylaw and G.L. c. 40A and other provisions of the General Laws, including the Subdivision Rules and Regulations of Town of Athol, Massachusetts, and shall file a copy of said Rules and Regulations with the Town Clerk. Said Rules and Regulations may provide for an application fee schedule for ground-mounted solar photovoltaic installation application submittals and methods for calculating the financial surety required under Section 3.24.14.

3.24.19

If the owner of the ground-mounted solar photovoltaic installation changes or the owner of the property changes, the special permit shall remain in effect, provided that the successor owner or operator assumes in writing all of the obligations of the special permit, site plan approval, and decommissioning plan. A new owner or operator of the ground-mounted solar photovoltaic installation shall notify the Special Permit Granting Authority and the Building Inspector/Zoning Enforcement Officer of such change in ownership or operator within thirty (30) days of the ownership change.

The special permit and all other local approvals for the ground-mounted solar array installation system would be void if a new owner or operator fails to provide written notification to Special Permit Granting Authority and the Building Inspector/Zoning Enforcement Officer in the required timeframe. Reinstatement of a void special permit, site plan approval and any other local approvals will be subject to the same review and approval processes for new applications under the Town of Athol Bylaws and Regulations.

3.24.20 Severability

If any provision of this bylaw is held invalid by a court of competent jurisdiction, the remainder of the bylaw shall not be affected thereby.

or act in relation thereto.

G

SAMPLE PILOT AGREEMENT

AGREEMENT FOR PAYMENT IN LIEU OF TAXES
FOR REAL PROPERTY AND PERSONAL PROPERTY

between

VH WEST BROOKFIELD, LLC (Developer)

and

THE TOWN OF WARE, MASSACHUSETTS (Town)

dated as of November 29, 2016

AGREEMENT FOR PAYMENT IN LIEU OF TAXES FOR
REAL PROPERTY AND PERSONAL PROPERTY

THIS AGREEMENT FOR PAYMENT IN LIEU OF TAXES FOR REAL PROPERTY AND PERSONAL PROPERTY ("Agreement") is made and entered into as of November [], 2016, by and between VH West Brookfield, LLC, a Delaware limited liability company ("Developer") and the Town of Ware, a municipal corporation duly established by law and located in Hampshire County, Massachusetts (the "Town"). Developer and the Town are collectively referred to in this Agreement as the "Parties," and individually referred to as a "Party."

WHEREAS, Developer is a "generation company" engaged in the business of producing, manufacturing or generating electricity or related services or products, including but not limited to, renewable energy generation attributes for retail sale to the public, or a "wholesale generation company" engaged in the business of producing, manufacturing or generating electricity for sale at wholesale only, as such terms are defined or used in the Massachusetts General Laws Chapter 59, §38H(b), and Chapter 164, §1;

WHEREAS, Developer has leased from Peter E. and Mary M. Dudula ("Property Owner") approximately 18.11 acres of land located at 38 Gilbertville Road in Ware, Massachusetts, more particularly described on the attached Exhibit A (the "Property"), under the terms of a Solar Facility Land Lease, dated July 21, 2016 (the "Lease"), with an initial term of twenty-five (25) years, and Developer plans to build, own and operate a solar photovoltaic energy facility with an expected nameplate capacity (the "Capacity") of approximately 1.39 MW (DC) (the "Project"), on said Property, as such Project is more particularly described in Exhibit B, and has entered into a Special Permit and Decommissioning Cash Surety Agreement with the Town in connection with Developer's obligation to decommission the Project within six (6) months following termination of the Lease;

WHEREAS, it is the intention of the Parties that Developer make annual payments to the Town for the full term of this Agreement in lieu of all real and personal property taxes for the Project, in accordance with M.G.L. c.59, §38H(b) and other applicable laws and regulations, including the regulations of the Massachusetts Department of Revenue adopted in connection therewith;

WHEREAS, because Developer and the Town desire an accurate projection of their respective expenses and revenues with respect to the real and personal property that is taxable under law as a result of the Project, the Parties believe that it is in their mutual best interests to enter into this Agreement fixing the payments that will be made with respect to all taxable real and personal property for the Project for the term of the Agreement;

WHEREAS, the Parties intend that, during the term of the Agreement, except as otherwise provided herein, Developer will not be assessed for any statutory real and personal property taxes attributable to the Project to which it might otherwise be subjected under

Massachusetts General Law for the Project, and that this Agreement will provide for the exclusive payments in lieu of such real and personal property taxes that Developer (or any successor owner of the Project) will be obligated to make to the Town with respect to the Project during the term hereof, provided, however, that this Agreement does not affect any other taxes and payments that may be charged to and owed by the Developer or Property Owner to the Town except for the real and personal property taxes attributable to the Project; nor does this Agreement affect any other payments that may be legally owed by Developer or Property Owner to the Town, including, but not limited to, real property taxes for the Property, taxes for personal property other than the taxes attributable to the Project, and payments for services provided by the Town to the Project and the Property, including, but not limited to, water and sewer services, betterment assessments, and other payment obligations;

WHEREAS, notwithstanding the foregoing, it is not the intention of the Parties to remove any obligation of the Property Owner to pay the real property taxes on the Property, including the land upon which the Project is sited;

WHEREAS, it has been determined that the Project equipment, machinery and components described in Exhibit D constitute real and/or personal property for tax purposes, and are not part of the real property upon which they are installed;

WHEREAS, this Agreement does not apply to real property taxes for the Property, and this Agreement shall not impact the Town's ability to raise or lower real property taxes in the ordinary course of its tax assessment practices;

WHEREAS, the Town is authorized to enter into this Agreement with the Developer, provided the payments in lieu of real and personal property taxes over the life of the Agreement are expected at inception to approximate the real and personal property tax payments that would otherwise be determined under M.G.L. c.59 based upon the full and fair cash valuation of the real and personal property attributable to the Project; and Developer, throughout the term hereof, qualifies as a "generation company" or "wholesale generation company";

WHEREAS, this Agreement is subject to approval by the Town's Board of Selectmen and Town Meeting; and

WHEREAS, the Parties have reached this Agreement after good faith negotiations.

NOW THEREFORE, in exchange for the mutual commitments and other good and valuable consideration, the receipt and sufficiency of which are acknowledged, the parties agree as follows:

1. Payment in Lieu of Real and Personal Property Taxes. Developer agrees to make annual payments to the Town ("Annual Payments") in lieu of all real and personal property taxes attributable to the Project for the period commencing on the Completion Date (as defined below) and continuing for twenty (20) years from such date (the "Term"). The amount of each Annual

Payment shall be the amount arrived at by multiplying the number of megawatts of the Project's installed Capacity on the Completion Date by the Factor, defined below, subject to adjustment as set forth herein. The "Factor" shall be \$14,000 per megawatt of the Project's installed Capacity on the Completion Date for the first year of the Term and shall increase by 2.0% annually thereafter, as reflected on the schedule attached hereto as Exhibit C. The "Completion Date" shall be the first date on which the Developer has received from the local electric utility written authorization to interconnect the Project to the utility's system and acceptance of the Project from the utility (to the extent required) and the Project has commenced commercial operation or when the Project is completed as determined by the building inspector. Each Annual Payment will be paid to the Town in four (4) equal quarterly installments (prorated for the first and last quarters of the term of this Agreement) on or before August 1, November 1, February 1 and May 1 of each fiscal tax year during the term of this Agreement and the Annual Payment amount and payment dates will be noted on quarterly bills issued by the Town to the Developer. Developer agrees that the Annual Payments in lieu of taxes under this Agreement will not be reduced on account of a depreciation factor or reduction in the Town's tax rate, or increased on account of an appreciation factor or increase in the Town's tax rate, which factors have been anticipated and are reflected in Exhibit C. The failure of the Town to deliver such a bill shall not relieve the Developer of its obligation to timely make payments required hereunder.

2. Changes In Capacity. To the extent that the Capacity of the Project is increased by Developer after the Completion Date, the remaining Annual Payments in lieu of taxes for real and personal property attributable to the Project will be increased as described in Paragraph 3 of this Agreement. Developer shall notify the Town of the Completion Date in writing within 30 days after the Completion Date has been achieved, and in such notification shall confirm the installed Capacity of the Project as of the Completion Date, which the Town may verify by visiting the Property or otherwise in accordance with paragraph 4 of this Agreement. Notwithstanding anything to the contrary in this Agreement, there shall be no reductions in annual payments for any reductions in capacity.

3. Calculation of Adjustment. To the extent that the installed Capacity of the Project exceeds 1.39 MW (DC) on the Completion Date or is increased by the Developer after the Completion Date, the remaining Annual Payments in lieu of taxes under this Agreement shall be increased by an amount equal to \$14.00 (MW payment divided by 1,000) for each kW of any such excess or increase, as applicable. The Parties agree that this adjustment is designed to ensure that the annual payments in lieu of taxes approximate the full and fair cash valuation of the Project. Notwithstanding anything to the contrary in this Agreement, in the event Developer reduces the Capacity of the Project to less than .2 MW DC, the Town may terminate this Agreement and assess any and all real and personal property taxes in accordance with the Massachusetts General Laws. No increase in installed Capacity of the Project shall increase payments hereunder until the Project equipment, improvements or other property causing the increase in Capacity have been interconnected to the local utility and have begun generating electrical power.

4. Inspection and Verifications. The Town, its officers, employees, consultants and attorneys will have the right to periodically inspect the Project and meters used to measure the

energy generated by the Project on reasonable prior notice to Developer for the purpose of confirming and verifying the Capacity of the Project and compliance with this Agreement.

Attached to this Agreement as Exhibit D is a preliminary, itemized inventory prepared by Developer (the "Inventory") of the improvements, equipment and other property anticipated to be incorporated into the Project. Only property necessary or incidental to the production of electricity shall be included in the Inventory or Project. Notwithstanding anything to the contrary in this Agreement, the Project, and thus the Annual Payments hereunder, shall not include buildings (except for a single equipment storage shed for use in the Project, subject to advance approval of the Town).

Within sixty (60) days after the Completion Date, Developer shall provide the Town with an as-built description of the solar photovoltaic panels and inverters and other equipment in the Project, to the same level of detail as provided on Exhibit D, which shall be considered the "Inventory." Within thirty (30) days after the Town's receipt of such notification, the Parties will agree on an updated Inventory; in the event the Town does not respond during such period, it shall be deemed to have accepted the Inventory as provided by the Developer. In the event the Parties are unable so to agree in such 30-day period, the Town shall, at its sole election, reasonably determine the updated Inventory, or assess taxes for such portions of the Project that are not included in the Inventory in Exhibit D as if this Agreement did not exist. Developer will update the Inventory annually as of January 1 of each year, and an updated written Inventory, referred to as an Annual Inventory Update, will be provided to the Town on or before February 1 of each year. The Town, its officers, employees, consultants, agents and attorneys will have the right periodically, during normal business hours and upon reasonable advance notice to Developer, to inspect the Project and review documents in possession of Developer that relate to the Project and the Inventory to verify the Inventory and Developer's compliance with this Agreement.

The Developer shall promptly provide such information as may be reasonably requested by the Town from time to time to determine and verify the existence, condition, cost and valuation of any and all equipment or personal property constituting the Project and any additions, replacements, improvements and upgrades thereto. In addition to any other rights of inspection hereunder, the Town, its officers, employees, consultants and attorneys will have the right to periodically inspect the Project on reasonable advance notice to the Developer for any reasonable purpose, including verification of Capacity of the Project. During any such inspection the Town shall comply with the reasonable safety guidelines of the Developer. The Town, its officers, employees, consultants and attorneys shall also have the right to review and audit those documents in the possession of the Developer relating to equipment and/or personal property installed relevant to Exhibit D of this Agreement and capacity data to verify the Capacity of the Project.

5. Town Expenses. Developer shall contribute \$3,500.00 to the Town for the legal costs associated with this Agreement. Such payment shall be made ten (10) days after execution of this Agreement.

6. Payment Collection. In addition to such rights and remedies available in this Agreement, all statutory rights and remedies available to the Town for the collection of taxes shall apply to the Annual Payments in lieu of taxes hereunder, including but not limited to, all rights and remedies provided in G.L. c.59 and G.L. c.60, and all such rights and remedies are hereby reserved notwithstanding anything to the contrary herein. The provisions of the General Laws, including but not limited to G.L. c.59 and G.L. c.60, will govern the establishment of liens and the collection of any payments in lieu of taxes provided for in this Agreement as though said payments were real or personal property taxes due and payable to the Town. Accordingly, for example, if and to the extent deemed necessary by the Town for assessment or collection of Annual Payments, the Project may, at the Town's election, be deemed personal property unintentionally omitted from annual assessment under G.L. c. 59, § 75, or "Real Property," as defined in G.L. c. 59, § 2A(a). All payments more than thirty (30) days past due shall accrue interest at 14 percent per annum until paid. Additionally, Developer shall pay reasonable attorneys' fees, court and other costs incurred by the Town in the collection of any unpaid amounts due under this agreement.

7. Tax Status. The Town agrees that during the term of this Agreement, the Town will not assess Developer or Property Owner for any real and personal property taxes attributable to the Project to which they might otherwise be subject under Massachusetts law in the absence of this Agreement, and the Town agrees that this Agreement will exclusively govern the payments of such taxes; provided, however, that this Agreement does not affect, and will under no circumstances preclude, the Town from assessing any other taxes, fees, charges, rates or assessments which Developer or Property Owner may be obligated to pay (except for the real and personal property taxes attributable to the Project), including, but not limited to, real estate and personal property taxes excluding those attributable to the Project, excise taxes on vehicles due pursuant to G.L. c.60A, betterments, fees, or charges for services provided by the Town to the Project or Property, including, but not limited to, water and sewer services.

8. Binding Effect; Assignment; Termination. This Agreement will be binding upon and inure to the benefit of the successors and assigns of the Developer as owner of the Project and tenant under the Lease and the provisions of this Agreement will run with the Project and the Property during the Term. This Agreement may not be assigned without the advance written approval of the Town, which approval shall not be unreasonably withheld or delayed. Notwithstanding the foregoing, Developer may assign this Agreement, without approval of the Town, for collateral purposes or to a new owner in the event the Project is sold or transferred, or to an entity who is also an owner of the Project, provided that it shall provide the Town with written notice of such assignment within 30 days of any such assignment, provided that Developer shall not sell or transfer the Project to a tax exempt entity without the advance written consent of the Town. Notwithstanding the foregoing or any other provision contained herein to the contrary, the Developer or its successors and assigns may terminate this Agreement in the event that (i) the Lease is terminated at any time for any reason or (ii) the Project ceases commercial operation and is decommissioned. Upon termination of this Agreement for any reason, the Project will thereafter be assessed and taxed as though this Agreement does not exist.

9. Statement of Good Faith. The Parties agree that the payment obligations established by this Agreement were negotiated in good faith in recognition of and with due consideration of the full and fair cash value of the Project, to the extent that such value is reasonably determinable as

of the date of this Agreement in accordance with G.L. c.59, §38H. Each Party was represented by counsel in the negotiation and preparation of this Agreement and has entered into this Agreement after full and due consideration and with the advice of its counsel and its independent consultants. The Parties further acknowledge that this Agreement is fair and mutually beneficial to them because it reduces the likelihood of future disputes over real and personal property taxes attributable to the Project, establishes tax and economic stability at a time of continuing transition and economic uncertainty in the electric utility industry in Massachusetts and the region, and fixes and maintains mutually acceptable, reasonable and accurate payments in lieu of taxes for the Project that are appropriate and serve their respective interests. The Town acknowledges that this Agreement is beneficial to it because it will result in mutually acceptable, steady, predictable, accurate and reasonable payments in lieu of taxes to the Town. Developer acknowledges that this Agreement is beneficial to it because it ensures that there will be mutually acceptable, steady, predictable, accurate and reasonable payments in lieu of taxes for the Project.

10. Notices. All notices, consents, requests, or other communications provided for or permitted to be given hereunder by a Party must be in writing and will be deemed to have been properly given or served upon the personal delivery thereof, via courier delivery service or otherwise. Such notices shall be addressed or delivered to the Parties at their respective addresses shown below. Developer shall be solely responsible to provide copies of any notices to Property Owner.

To: Developer:

VH West Brookfield, LLC
c/o Nautilus Solar Energy, LLC
396 Springfield Avenue
Summit, NJ 07901
Attn: James M. Rice

To: Town:

Board of Selectmen
Town of Ware
126 Main St # C
Ware, MA 01082

Any such addresses for the giving of notices may be changed by giving written notice as provided above to the other Parties. Notice given by counsel to a Party shall be effective as notice from such Party.

11. Applicable Law. This Agreement will be made and interpreted in accordance with the laws and regulations of the Commonwealth of Massachusetts, which are incorporated herein by reference. The Parties each consent to the jurisdiction of the Massachusetts courts or other applicable agencies of the Commonwealth of Massachusetts regarding any and all matters, including interpretation or enforcement of this Agreement or any of its provisions. The Parties each agree that service of process may be affected by certified mail, return receipt requested at

the addresses indicated in Paragraph 10 of this Agreement (Notices) (or such other address a Party may provide from time to time pursuant to Paragraph 10). Venue for all court actions brought hereunder shall be the state courts located in Hampshire or Worcester County Massachusetts.

12. Good Faith. The Parties shall act in good faith to carry out and implement this Agreement and to resolve any disputes between them.

13. Force Majeure. The Parties recognize that there is the possibility during the term of this Agreement that all or a portion of the Property or Project may be damaged or destroyed or otherwise rendered unusable due to unforeseeable events beyond the reasonable control of the Parties. These events are referred to as "Force Majeure." As used herein, Force Majeure includes, without limitation, the following events:

- a. Acts of God, including floods, winds, storms, earthquake, fire or other natural calamity;
- b. Acts of War or other civil insurrection or terrorism; or
- c. Taking by eminent domain by any governmental entity of all or a portion of the Property or the Project.

If an event of Force Majeure occurs during the Term and as a result of such event of Force Majeure the Project is partially or wholly damaged or destroyed or otherwise rendered inoperable or unusable ("Damaged") but the Lease is not terminated, then for the period of time following the event of Force Majeure during which the Project is so Damaged, the Annual Payments hereunder will be eliminated or reduced accordingly. In addition and without limiting the foregoing, if an event of Force Majeure occurs during the term of this Agreement with respect to any portion of the Project that renders the Project unusable for the customary purpose of the production of electricity for a period of more than sixty (60) consecutive calendar days, then Developer may, at its election, notify the Town of the existence of this condition as well as of its decision whether or not to rebuild that portion of the Project so damaged or destroyed or taken. If Developer elects not to rebuild, then it may notify the Town in writing of its termination of this Agreement and the Project and Property will thereafter be assessed and taxed by the Town as though this Agreement does not exist.

14. Covenants/Warranties of Developer.

- a. During the term of the Agreement, Developer will not voluntarily do any of the following:
 - 1) Convey by sale, lease, or otherwise any interest in the leasehold premises or Property to any tax exempt entity or organization, including without limitation a charitable organization pursuant to G.L. c.59, §5, Clause Third or to any person or entity that is not a

"generation company" or "wholesale generation company" under G.L. c. 59, § 38H(b) or assign this Agreement to any person or entity that is not a "generation company" or "wholesale generation company" under G.L. c. 59, § 38H(b), or in a manner where such assignment would otherwise disqualify this Agreement under G.L. c. 59, § 38H (b);

- 2) Fail to pay the Town all amounts due hereunder when due in accordance with the terms of this Agreement;
- 3) Seek, for any reason, an abatement or reduction of any of the amounts assessed in accordance with the terms of this Agreement and Developer hereby waives during the full term of this Agreement any rights it may have otherwise had to seek such an abatement or reduction; or
- 4) Seek to amend or terminate this Agreement on account of the enactment of any new law or regulation or a change in any existing law or regulation the intent or effect of which is to fix the method for calculating PILOT payments for renewable energy facilities.

b. Developer represents and warrants:

- 1) It is a corporation or other business entity duly organized, validly existing and in good standing under the laws of the state in which it was formed, and if a foreign corporation, is registered with the Massachusetts Secretary of State, and has full power and authority to carry on its business as it is now being conducted.
- 2) This Agreement constitutes a legal, valid and binding obligation of Developer enforceable in accordance with its terms, except to the extent that the enforceability may be limited by applicable bankruptcy, insolvency or other laws affecting other enforcement of creditors' rights generally or by general equitable principles.
- 3) It has taken all necessary action to authorize and approve the execution and delivery of this Agreement.
- 4) None of the documents or information furnished by or on behalf of Developer to the Town in connection with negotiation and execution of this Agreement contains any untrue statement of a material fact or omits to state any material fact required to be stated therein, or necessary to ensure that the statements contained herein or therein, in the light of the circumstances in which they were made, are not misleading.

- 5) The person executing this Agreement on behalf of Developer has the full power and authority to bind it to each and every provision of this Agreement.
- 6) Developer is a "generation company" or "wholesale generation company" as those terms are used and defined in G.L. c.59, §38H(b) and G.L. c.164, §1.
- 7) Developer does not qualify for a manufacturing classification exemption pursuant to G.L. c. 59 §5 (16)(3).

15. Invalidity. The Parties understand and agree that this Agreement shall be void and that no portion of this Agreement shall be enforceable, if (a) this Agreement, or any material portion of this Agreement, is determined or declared by a court or agency of competent jurisdiction to be illegal, void, or unenforceable; (b) Developer is determined or declared to not be a "generation company" or "wholesale generation company" as those terms are used and/or defined in G.L. c.59 §38H (b), and G.L. c.164, §1; and/or (c) this Agreement has not been approved by Ware Town Meeting.

16. Termination by Town. Notwithstanding anything to the contrary in this Agreement, the Town may terminate this Agreement upon and effective after ten (10) days written notice to Developer if:

- a. The Developer fails to make payments required under this Agreement and such failure is not cured within thirty (30) days, unless the past due payment is received prior to the effective date of the termination, as set forth above;
- b. The Developer has filed, or has had filed against it, a petition in Bankruptcy, or is otherwise insolvent;
- c. The Project is permanently abandoned for six (6) consecutive months or more or the Capacity of the Project is reduced to .2 MW (DC) or less; and/or
- d. The Developer otherwise materially breaches this Agreement and fails to cure such breach within sixty (60) days following notice of such failure received by Developer from Town.

17. Miscellaneous.

- a. Subject to applicable laws and regulations, each Party will, from time to time hereafter, execute and deliver, or cause to be executed and delivered, such reasonable additional documents or instruments as the Party reasonably requests for the purpose of implementing or effectuating the provisions of this Agreement, including, without limitation, lender consent documents on customary terms and conditions requested by Developer and approved by the Town through its Board of Selectmen. The reasonable

costs of executing and delivering such documents or instruments shall be borne by the requesting Party.

b. This Agreement may be executed in several counterparts, each of which shall be an original, and all of which shall constitute but one and the same instrument.

c. The Parties agree that this is the entire, fully integrated Agreement between them with respect to payments in lieu of taxes for the Project, and that there are no third party beneficiaries to this Agreement.

18. Certification of Tax Compliance. Pursuant to G.L. c. 62C, § 49A, Developer by its duly authorized representative, certifies that it has have complied with all laws of the Commonwealth relating to taxes, reporting of employees and contractors, and withholding and remitting of child support.

19. Provisions Required by Law: Each and every provision of law and clause required by federal, state or local law to be inserted in this Agreement shall be deemed to be inserted herein and the Agreement shall be read and enforced as though it were included herein, and if through mistake or otherwise any such provision or clause is not inserted, or is not correctly inserted, then upon the request of any party the Agreement shall forthwith be amended to make such insertion or correction. In any event, this agreement shall be read and enforced as if it contains all provisions and clauses required by applicable federal, local and Massachusetts law.

20. Compliance with PILOT Statute. The Town and Developer shall timely comply with any recordkeeping, filing or other requirements mandated by the Massachusetts Department of Revenue in connection with the Department's implementation of the PILOT Statute.

21. Recording. This Agreement will be recorded by the Developer in the Hampshire County Registry of Deeds promptly following its execution.

[Signature Page to Follow]

Executed under seal by the undersigned as of the day and year first written above, each of whom represents that it is fully and duly authorized to act on behalf of and bind its principals.

TOWN OF WARE
BY ITS BOARD OF SELECTMEN:

John A. Desmond
Michael F. Fenton
Alan P. White
Nancy Tabat

DEVELOPER:

VH WEST BROOKFIELD, LLC

By:

James M. Rice
James M. Rice [Office, Certificate of Vote]
Authorized Signatory

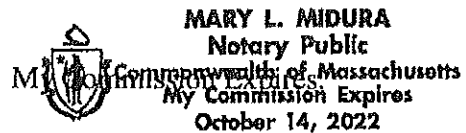
COMMONWEALTH OF MASSACHUSETTS

HAMPSHIRE, ss.

November 29, 2016

Then personally appeared the above-named [NANCY J. TALBOT], Selectman of the Town of Ware Board of Selectmen, who proved to me by satisfactory evidence of identification, being (check whichever applies): ☒ driver's license or other state or federal governmental document bearing a photographic image, ☐ oath or affirmation of a credible witness known to me who knows the above signatory, or ☐ my own personal knowledge of the identity of the signatory, to be the person whose name is signed above, and acknowledged the foregoing instrument to be his/her free act and deed for the purposes stated therein, before me.

Mary L. Midura
Notary Public



State of New Jersey
COMMONWEALTH OF MASSACHUSETTS ha

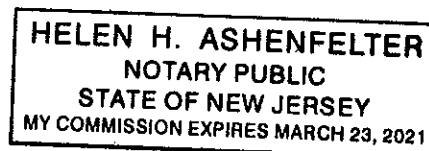
Morris, ss.

November 30, 2016

Then personally appeared the above-named [James M. Rice], Selectman of the Town of Ware Board of Selectmen, who proved to me by satisfactory evidence of identification, being (check whichever applies): ☐ driver's license or other state or federal governmental document bearing a photographic image, ☐ oath or affirmation of a credible witness known to me who knows the above signatory, or ☐ my own personal knowledge of the identity of the signatory, to be the person whose name is signed above, and acknowledged the foregoing instrument to be his/her free act and deed for the purposes stated therein, before me.

Helen H. Ashenfelter
Notary Public

My Commission Expires:



COMMONWEALTH OF MASSACHUSETTS

_____, ss.

November __, 2016

Then personally appeared the above-named [_____] , Selectman of the Town of Ware Board of Selectmen, who proved to me by satisfactory evidence of identification, being (check whichever applies): ☐ driver's license or other state or federal governmental document bearing a photographic image, ☐ oath or affirmation of a credible witness known to me who knows the above signatory, or ☐ my own personal knowledge of the identity of the signatory, to be the person whose name is signed above, and acknowledged the foregoing instrument to be his/her free act and deed for the purposes stated therein, before me.

Notary Public

MASSACHUSETTS
NOTARY PUBLIC
COMMISSION EXPIRES
09/01/2017

My Commission Expires:

STATE OF NEW JERSEY

_____, ss.

November __, 2016

Then personally appeared the above-named James M. Rice, Authorized Signatory for VH West Brookfield, LLC, who proved to me by satisfactory evidence of identification, being (check whichever applies): ☐ driver's license or other state or federal governmental document bearing a photographic image, ☐ oath or affirmation of a credible witness known to me who knows the above signatory, or ☐ my own personal knowledge of the identity of the signatory, to be the person whose name is signed above, and acknowledged the foregoing instrument to be his/her free act and deed for the purposes stated therein, before me.

Notary Public

My Commission Expires:

EXHIBIT A Description of

the Property

Approximately 18.11 acres of land shown on plan entitled "PLAN OF LAND Prepared For SEABOARD SOLAR HOLDINGS, LLC GILBERTVILLE ROAD WARE, MA.", prepared by Foresight Land Services, and filed in the Hampshire County Registry of Deeds in Plan Book 236, Page 84.

EXHIBIT B Description

of the Project

Solar Facility Size:	1.39 MW (DC)
Solar Facility Installation:	Ground mounted at a fixed tilt
Location:	Approximately 18.11 acres of land located at 38 Gilbertville Rd, Ware, MA 01082, which constitutes property owned by Landlord more particularly described on <u>Exhibit A</u> .
Solar Development Plan:	See map attached

EXHIBIT C

Schedule of Factors to Calculate Annual Payments in lieu of Taxes For Real and Personal Property Attributable to Project

<u>Contract Year</u>	<u>Factor</u>
1	\$ 14,000.00
2	\$ 14,280.00
3	\$ 14,565.60
4	\$ 14,856.91
5	\$ 15,154.05
6	\$ 15,457.13
7	\$ 15,766.27
8	\$ 16,081.60
9	\$ 16,403.23
10	\$ 16,731.30
11	\$ 17,065.92
12	\$ 15,542.18
13	\$ 17,407.24
14	\$ 18,110.49
15	\$ 18,472.70
16	\$ 18,842.16
17	\$ 19,219.00
18	\$ 19,603.38
19	\$ 19,995.45
20	\$ 20,395.36

EXHIBIT D

Preliminary Inventory

Item	Description	# Units
Photovoltaic Panels	Hanwha 330W	4,230
Inverters	Chint 1000V DC String Inverters for North America CPS-SC36-KTL	26
Transformers	1) 1MW Zig-Zag Grounding XFMR & 1) 1,000KVA Step Up XFMR	1 + 1
Racking	Magna Ground Mount Racking with Boysa.s Foundation	118 4x9 tables

H

ADDITIONAL RESOURCES

- SMART Regulation: <https://www.mass.gov/solar-massachusetts-renewable-target-smart>
- SMART Program Progress Updates: <http://masmartsolar.com/>
- Ineligible Lands under “SMART-ER” (for Category 2 & 3): <https://bit.ly/SMARTLanduse>
- Dual-Use Agriculture & Solar PV: Find more information on the UMass Clean Energy Extension website: <https://ag.umass.edu/clean-energy/current-initiatives/solar-pv-agriculture>
- Pollinator-Friendly Solar PV: Find more information about our certification program on our website: <https://ag.umass.edu/clean-energy/current-initiatives/pollinator-friendly-solar-pv-for-massachusetts>
- DOER Model Solar Zoning Bylaw: <https://www.mass.gov/files/documents/2016/08/nc/model-solar-zoning.pdf>
- MAPC Solar Permitting and Zoning Bylaw Guidance: <http://www.mapc.org/wp-content/uploads/2017/10/Solar-Permitting-and-Zoning-Bylaw-Guidance.pdf>
- Solar PV Information for Municipalities: UMass Clean Energy Extension is collecting links to resources for municipalities regarding solar PV siting and planning on its website: <https://ag.umass.edu/clean-energy/solar>
- Fire Safety Training for Battery Systems: <https://catalog.nfpa.org/Energy-Storage-and-Solar-Systems-Safety-Online-Training-P20882.aspx>

ENERGY STORAGE RESOURCES

National Fire Prevention Association - The 2018 NFPA 1 Fire Code is available for free viewing in read-only mode on the NFPA website. Unless already a NFPA member, you will need to create a free account and click on a URL received via e-mail to view the document. Energy storage systems are addressed in Chapter 52 of the code. <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1>

Fire Safety Training for Battery Systems - NFPA's self-paced online training teaches the fire service how to safely deal with emergency situations involving high voltage commercial and residential energy storage and solar PV systems. Students receive a certificate upon their successful completion of the program. <https://catalog.nfpa.org/Energy-Storage-and-Solar-Systems-Safety-Online-Training-P20882.aspx>

Massachusetts Comprehensive Fire Safety Code - State regulation 527 CMR 1.00 governs fire safety in Massachusetts, and addresses any state-specific modifications to the NFPA 1 Fire Code. <https://www.mass.gov/regulations/527-CMR-100-massachusetts-comprehensive-fire-safety-code>

Revisions to the Massachusetts Comprehensive Fire Safety Code - Revisions to 527 CMR 1.00 are posted on this website. An advisory from the State Fire Marshall details changes to the code effective October 18, 2019 which are relevant to energy storage systems. <https://www.mass.gov/service-details/massachusetts-fire-code>

Energy Storage Safety Collaborative - The website for the Energy Storage Safety Collaborative provides codes and standards, publications, and research updates regarding Department of Energy and National Laboratory work on energy storage safety. <https://www.sandia.gov/energystoragesafety-ssl>

Energy Storage Safety Guidelines - Guidelines developed in 2016 by the Energy Storage Integration Council for distribution-connected energy storage systems. Available from EPRI. <https://www.epri.com/research/products/000000003002008308>

Energy Storage System Guide for Compliance with Safety Codes and Standards - A report by two National Laboratories (Pacific Northwest and Sandia) providing a review of current gaps, and what should be included in energy storage system standards and safety codes. <https://www.sandia.gov/ess-ssl/publications/SAND2016-5977R.pdf>

Article ____ To see if the Town of Athol will vote to amend the Athol Zoning Bylaws, Article III, by deleting the existing Section 3.24, Ground-Mounted Solar Photovoltaic Installations, in its entirety and replacing with the following new text in its place.

3.24.1 Purpose

The purpose and intent of this bylaw is to provide standards for the placement, design, construction, operation, monitoring, modification and removal of ground-mounted solar photovoltaic installations which address public safety, minimize impacts on scenic, natural and historic resources and to provide adequate financial assurance for the eventual decommissioning of such installations. The provisions set forth in this section shall apply to the placement, design, construction, operation, maintenance and/or repair, and environmental effects of ground-mounted solar photovoltaic installations.

This bylaw aims to balance the rights of landowners to use their land with the corresponding right of abutting and neighboring landowners to live without undue disturbance from noise, traffic, lighting, signage, smoke, fumes, dust, odor, glare, or storm water runoff. To maintain the character of the Town of Athol as a small New England village, this bylaw aims to retain the natural beauty, aesthetic appeal, historic value and scenic attraction of the Town for both residents and tourists.

3.24.2 Applicability

This bylaw applies to commercial and residential ground-mounted solar photovoltaic installations greater than 10,000 square feet proposed to be constructed after the effective date of this bylaw. This bylaw also pertains to physical modifications that materially alter the type, configuration or size of the installation. Square footage shall be calculated as follows:

- i. The area within the security fence if a fence is provided, or
- ii. All land area within a polygon (a plane shape-two dimensional-with straight sides) around the entire installation including all solar panels, all appurtenances including but not limited to buildings, storage areas, construction staging and lay-down areas, and transformers and poles, and parking along with a 15 foot perimeter area around all of the above or
- iii. All areas of disturbed land, whichever is greater.

As defined in 3.24.2:

- a) This bylaw does not pertain to ground-mounted solar photovoltaic installations installed on residential, commercial or industrial buildings. Those installations are subject to the State Building Code.
- b) Ground-mounted solar photovoltaic installations less than or equal to 10,000 square feet shall only need a building permit and meet property setback requirements.
- c) This bylaw does not pertain to solar carport canopies over existing rows of parking spaces. Such installations are considered Accessory Uses under Section 2.3 and are subject to the State Building Code.
- d) This bylaw shall not apply to any ground-mounted solar photovoltaic installation being developed with the direct involvement of the Town of Athol at the former municipal landfill on West Royalston Road in Athol, MA.

3.24.3 Special Permit Granting Authority

applicable. The BPCD shall act as the Special Permit Granting Authority for such site plans with the entirety of the Town of Athol, including the Major Commercial Overlay District.

3.24.4.5 Professional Engineer

All plans and maps shall be prepared, stamped, and signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts.

3.24.4.6 Required Documents to be deemed a complete application.

Pursuant to the site plan review process, the applicant shall also provide the following documents:

(a) A site plan showing:

- i. Property lines and physical features, including both existing and proposed roads, for the project site at a scale of 1 inch equals 40 feet or such scale as may be approved by the Special Permit Granting Authority on standard 24" by 36" sheets and continuation on 8.5 " by 11" sheets as necessary for narrative;
- ii. Blueprints or drawings of the solar photovoltaic installation showing the proposed layout of the system;
- iii. One or three line electrical diagram detailing the solar photovoltaic installation, associated components, and electrical interconnection methods, with all National Electrical Code compliant disconnects and overcurrent devices;
- iv. Proposed wattage of the solar photovoltaic installation solar power generation indicated in both dc (direct current) and ac (alternating current); a notation shall be included explaining the difference, e.g. loss in conversion from dc to ac;
- v. Technical specification of the major system components to be used, including the PV panels, mounting system, and inverter and battery storage;
- vi. Name, address, and contact information for proposed system installer (owner);
- vii. Name, address, phone number and signature of the applicant, as well as all co-proponents or property owners;
- viii. Proposed changes to the landscape of the site, grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures;
- ix. All existing lot lines, with size of each existing lot in acres or square feet, abutting land uses and location of structures within 500 feet of the site;
- x. Names and addresses of all record owners within 500 hundred feet of all property lines along with a map showing the same;
- xi. Locations and details of all security measures for the site;
- xii. Documentation of all soils types, as identified on the United States Natural Resources Conservation Service soils survey, on all land involved with the project;
- xiii. Provision of water including that needed for fire protection;
- xiv. Location of all existing trail networks and woods roads, stonewalls, and historic features;
- xv. All storm water plans as required in Section 3.24.5.11;
- xvi. A calculation of slopes throughout the site as a percentage over consecutive 100-foot distances;
- xvii. A buffer, screening and landscape plan as required in Section 3.24.3;
- xviii. Location and approximate height of tree cover on the site at the time of application filing.
- xix. Location, type of fixture, and height of any proposed lighting as well as documentation of Dark Sky Standards in accordance with Section 3.24.5.7;

xx. Location of equipment and construction staging area, and

- (b) The name, contact information and signature of any agents representing the applicant;
- (c) A glare analysis and proposed mitigation, if any, to minimize the impact on affected properties and roads, as well as the Orange airport in regards to the proposed solar panels as required in Section 3.24.5.5;
- (d) Names and addresses of all record owners within 500 hundred feet of all property lines along with a map showing the same;
- (e) Documentation by an acoustical engineer of the noise levels projected to be generated by both the installation and operation of the facilities as required in Section 3.24.5.13;
- (f) Documentation of all soils types, as identified on the United States Natural Resources Conservation Service soils survey, on all land involved with the project;
- (g) Documentation of actual or prospective access and control of the project site as required in Section 3.24.7;
- (h) Visual impact analysis as required in Section 3.24.5.5;
- (i) A complete list of chemicals, fuels, and any other hazardous materials to be used in both the construction and operation phase;
- (j) A calculation of earthwork operations listing the amount of soil and rock to be imported or exported from the site. If any material is to be imported, such material shall clean and without contamination by hazardous substances or invasive species and must be obtained from a source(s) approved by the Athol DPW.
- (k) Mitigation Plan as required in Section 3.24.5.4;
- (l) A list identifying all off-site electrical system improvements necessary to the electrical grid to accommodate the power from the proposed installation and identification of what entity is paying for such improvements.

3.24.4.7 Waiver of Submittal Requirements: Upon the written request of the applicant with justification, the Special Permit Granting Authority may waive any of its submission requirements under unique site conditions. In addition, the Special Permit Granting Authority may request any additional data needed to render its decision.

3.24.5 Design Standards

1. Lot and Siting Requirements

- i. Ground-mounted commercial solar photovoltaic array installations shall be permitted on parcels larger than 10 acres located within the RC zoning district and shall have a minimum lot frontage of 160 feet.
- ii. Project generation size shall not exceed 5MW AC, nor shall the installation exceed 20 acres of fenced area, if fenced. If not fenced, the 20 acre area shall be calculated as the area within a polygon around the entire installation including all solar arrays, all appurtenances including but not limited to buildings, storage areas, construction staging and lay-down areas, transformers and poles along with a 15 foot perimeter area around all of the above
- iii. No portion of a ground-mounted commercial solar photovoltaic array installation:

- a. Shall be constructed on slopes greater than 10%, (measured over 100-foot intervals.) Cutting and filling to reduce natural slopes shall be prohibited except on short hollows, depressions or high spots. A waiver to increase the slope from 10% to 12% may be requested.
- b. Shall be located on any parcel that contains 50% of Priority Habitat, Core Habitat or Critical Natural Landscape as defined in 225 CMR 20.00 Solar Massachusetts Renewable Target (SMART) Program, nor shall any trees be removed, or construction of structures, access roads or transmission lines may be placed in these designated areas.
- iv. Ground-mounted solar photovoltaic installations shall be permitted only on previously disturbed areas* with an option of adding additional area through land clearing.

If less than 20 acres of contiguous or nearly contiguous previously disturbed area is not present on the lot, then land clearing of up to 5 acres of non-previously disturbed area is allowed for the installation. The acreage for clearing of non-previously disturbed area may be increased to a maximum of 10 acres with a proper waiver request from the developer and with the approval of the waiver request by the Board as authorized under Section 3.24.17. At least 50% of the area of any such installation, with or without a waiver, shall be located on previously disturbed areas.

*Previously disturbed areas shall mean land that meets any one of the following conditions at the time of adoption of these bylaws:

1. Land where the original grade and native material has been altered and/or removed for previous development.
2. Land where ALL existing vegetation has been removed for previous development.
3. Land utilized for sand, gravel or rock excavation.
4. Land that has been utilized for agricultural purposes.

Land that has been utilized for Silviculture*, whether under the Massachusetts Forest Cutting Practices Act (FCPA) or not, or for any of the activities exempt under the FCPA, shall not be considered previously disturbed areas.

*Definition from the UD Forest Service: Silviculture is the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society such as wildlife habitat, timber, water resources, restoration, and recreation on a sustainable basis

- v. Location of the entrance road and all utility poles shall be located within the lot's frontage taking into consideration site lines for vehicular traffic and to lessen any visual impacts on abutters.

2. Setbacks and Height

- i. For all zoning districts except for the Rural Single-Family Residential (RC) zoning district, ground-mounted solar photovoltaic installations must observe all yard requirements applicable to the principal structure as defined in Section 2.6, Intensity of Use Schedule. The Special Permit Granting Authority may increase these setbacks in these districts if they determine it to be appropriate.

- ii. For the RC zone, setbacks shall be:

- 200 feet for front yard*
- 200 feet for side and rear yard*
- 200 feet from any perennial stream**
- 200 feet from any water body greater than 1 acre and less than 5 acres**
- 400 feet from the shoreline of any water body greater than 5 acres**

* The Special Permit Granting Authority may reduce the minimum setback distance for front, side and rear yards only in the RC District to a minimum of 75 feet as authorized per Section 3.24.17. In addition to the specifics of Section 3.24.17, the applicant shall also be required to submit written consent from all affected abutter(s) for any reduction in setbacks.

However, reduction of the setback on any frontage with a public road is not permitted whether the yard is a front, side or rear yard. The setback between properties of a single owner subdivided per Section 3.24.5.4.4 may be waived to no less than the minimum for existing setback requirements of the RC District per Section 2.6.

**The setbacks for perennial streams and water bodies between 1 and 5 acres are not subject to any waiver of distances under Section 3.24.13. Setbacks for water bodies greater than 5 acres are only allowed to be reduced through a waiver to a minimum distance of 300 feet as long as a natural wooded buffer is maintained, detailed stormwater plans show no further impact to abutting properties versus the 400-foot setback distance, water quality of runoff is not reduced and wildlife and fauna movement is not restricted with the reduced setback. No access roads or transmission lines may be constructed in the setbacks to any water body greater than 1 acre.

- iii. All ground mounted photovoltaic panels in a residential zone shall be limited to a height of 10 feet. For any other zone, the height shall be limited to 15 feet. Other appurtenance structures shall be limited to a height of 15 feet in all zones.

3. Vegetated Buffer, Screening and Landscaping

- 1. Ground-mounted solar photovoltaic installations shall be effectively screened year-round:
 - i. from all abutting properties in all residential zones;
 - ii. from all abutting properties in residential use in all non-residential zones;
 - iii. and from public and private ways in all residential districts.

Except for vehicular and pedestrian passageways and permitted signs, setback areas shall be modified only for additional screening. Where existing vegetation in the setbacks is insufficient to achieve year-round screening, additional screening shall be provided including, but not limited to, planting of dense vegetative screening, fencing, berms, natural ground elevations, land contouring, and/or placement of the solar panels and appurtenant structures on the site, all depending on site specific conditions.

Tree cutting within the required setback area shall not be permitted if it would reduce to any degree the effectiveness of the year-round screening.

- 2. If additional plantings are required for screening, a planting plan shall be submitted:

- i. Showing the types, sizes and locations of material to be used which shall be subject to the approval of the Special Permit Granting Authority.
 - ii. Plantings shall be a minimum of six (6) feet in height at planting and staggered so as to fill the setback area and keep the arrays from view year round.
 - iii. Using a diversity of plant species native to New England for any screens and vegetative erosion controls. Use of exotic plants, as identified by the most recent version of the “Massachusetts Prohibited Plant List” maintained by the Massachusetts Department of Agricultural Resources, is prohibited. Cultivars of native plants are acceptable.
 - iv. At least 75% of the plantings shall consist of evergreens and shall be evenly spaced throughout the area of the setback area.
3. Planting of the vegetative screening shall be completed prior to connection of the installation. Plants shall be maintained and replaced if unhealthy by the owner/operator of the installation for the life of the installation.
4. The open area of the site shall be seeded with a pollinator mix and maintained as bird and insect habitat. Mowing is to be done as little as possible to retain a natural functioning of the landscape. Alternative vegetation or cover options may be proposed by the applicant in consideration of soil type and quality, subject to the approval of the Special Permit Granting Authority. Gravel areas that are well drained and stable do not require the addition of topsoil. Topsoil shall not be imported into any project sites unless there is a demonstrated engineering need and must be approved by the Special Permit Granting Authority prior to any introduction. The need to introduce topsoil may be grounds for permit denial.
5. Clearing of natural vegetation shall be limited to what is necessary for the construction, operation, and maintenance of the installation. Existing root structures, flat gravel areas, and topsoil shall be maintained to the maximum extent practicable.
6. Vegetation Management: Herbicides, pesticides, or chemical fertilizers shall not be used to manage vegetation at the ground mounted solar photovoltaic installation.
7. Ground surface areas beneath solar arrays and setback areas shall be pervious to maximize on-site infiltration of stormwater.
4. Mitigation
 1. The Special Permit Granting Authority shall discuss construction phasing with the designer of the installation as a means of mitigating erosion and sedimentation.
 2. Habitat Fragmentation. A ground-mounted solar photovoltaic installation shall, to the greatest extent practicable, be clustered and located in or adjacent to areas of the site where the land has already been cleared of vegetation to avoid habitat fragmentation.

3. Invasive Species. The introduction of invasive species shall be prevented to the greatest extent practicable, during any construction or removal of a solar photovoltaic installation, through the use of current best practices.

4. A ground-mounted solar photovoltaic installation shall be considered the principal use of the parcel. Any parcel with an existing residence or other building may be approved for a solar installation with the provision that the residence or building be subdivided from the larger parcel prior to any construction

of the solar installation. The parcel with the ground-mounted solar photovoltaic installation may not be subdivided for the purpose of development of the divided land until such time as the installation is decommissioned.

5. Visual Impacts and Glare

1. The design of the ground-mounted solar photovoltaic installations shall prevent reflected solar radiation or glare from becoming a public nuisance or hazard to adjacent buildings, roadways, or properties. Design efforts may include, but not be limited to, deliberate placement and arrangement on the site, anti-reflective materials, solar glare modeling, and screening in addition to required landscaping.

2. Any ground-mounted solar photovoltaic array installation proposed within a 5-mile radius of the Orange Airport shall be analyzed for glare utilizing any glare analysis compatible with FAA glare guidelines. [One such software package is Forge Solar, PV Planning and Glare Analysis.]

3. Ground-mounted solar photovoltaic installations shall not be approved unless the system design provides screening and buffers to protect scenic vistas and view sheds from residential uses, public streets and any waterways or water bodies.

4. A visual impact assessment shall be conducted that follows the protocols of the “Guidelines for Landscape and Visual Impact Assessment (Third Addition). Such assessment shall produce a map showing all areas within a 5-mile radius of the installation where the installation can be seen and where it cannot be seen.

With input from the Planning Director, the applicant shall utilize additional tools to assess the visual impacts in critical areas of concern such as renderings, line-of-sight studies and/or two or three dimensional visualizations i.e. Photomontage, video montage, animation produced through Spatial Information Systems (SIS) and Geographic Information Systems (GIS).

5. All results of the visual impact assessment shall be taken into account in the design of the installation. When reviewing for compliance with section 3.24.3 Vegetated Buffer, Screening and Landscaping and scenic vistas in Section 3.24.5.3, the Special Permit Authority shall make a definitive judgment that the intent has been achieved.

3.24.5.6 Appurtenant Structures:

All appurtenant structures to ground-mounted solar photovoltaic installations shall be subject to reasonable regulations concerning the bulk and height of structures, lot area, setbacks, and open space, parking and building coverage requirements.

All such appurtenant structures, including but not limited to, equipment shelters, storage facilities, transformers, and substations, shall be architecturally compatible with each other. Whenever reasonable, structures shall be shielded from view by vegetation approved by the Special Permit Granting Authority and/or joined or clustered to avoid adverse visual impacts.

3.24.5.7 Lighting:

Lighting of ground-mounted solar photovoltaic installations shall be consistent with local, state and federal law.

Lighting of other parts of the installation, such as appurtenant structures, shall be limited to that required for safety and operational purposes, and shall be reasonably shielded from abutting properties. All lighting shall comply with International Dark Sky Standards FSA Certification Requirements. There shall be no illumination without personnel on site.

3.24.5.8 Signs:

The following signs shall be required:

- i. one that identifies the owner, the street address, provides a 24-hour emergency contact phone
- ii. educational signs providing information about solar photovoltaic panels and the benefits of renewable energy.

Signs shall comply with Section 3.9, Sign Regulations.

Ground-mounted solar photovoltaic installations shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of the solar photovoltaic installation.

3.24.5.9 Utility Connections:

Utility connections, as determined by the Special Permit Granting Authority, shall be underground, depending on appropriate soil conditions, shape, and topography of the site and any requirements of the utility provider.

3.24.5.10 Fencing:

The need for fencing shall be determined by the applicant unless such fencing is needed to comply with Section 3.24.3 Vegetated Buffer, Screening and Landscaping, and/or as required per the National Electrical Code. If installed, such fencing shall be no more than 10 feet tall, shall be placed 6 inches off the ground to allow migration of wildlife, and shall have an Emergency Access System padlock or box at each gate.

3.24.5.11 Stormwater and Erosion Control

1. Proposed stormwater management plans detailed below shall conform to the more stringent of any conditions or standards of this subsection and the Department of Environmental Protection's Massachusetts Stormwater Handbook, as amended.

2. All stormwater infrastructure shall be owned and maintained by the owner of the installation and shall be located on the same parcel as the solar installation.
3. All post-development stormwater, up to and including a 50-year return frequency 24-hour storm, shall be retained on the parcel site and infiltrated into the soil thru low impact development, retention and infiltration basins. At no time may stormwater be carried off site.

Emergency overflows for storms in excess of the 50-year return frequency may be permitted provided it is demonstrated that no flooding or damage would be caused by the overflow. Attenuation of the discharge may be required as needed as determined by the Special Permit Granting Authority.

4. All pipes, catch basins and other materials utilized in the stormwater facilities shall be approved by the Athol Superintendent of Public Works, or his designee.

5. Stormwater Management Plan

- i. The Stormwater Management Plan (four paper copies and one electronic copy in PDF format required) with the permit application shall contain sufficient information for the Special Permitting Granting Authority to evaluate the environmental impact and effectiveness of the measures proposed for retaining stormwater on the parcel site.
- ii. The Stormwater Management Plan shall fully describe the project in drawings, narrative and calculations. It shall include:
 - a. The site's existing and proposed topography with contours at 2-foot intervals;
 - b. A description and delineation of existing stormwater conveyances, impoundments, environmental resources on or adjacent to the site into which stormwater could flow;
 - c. A delineation of 100-year flood plains, if applicable;
 - d. Estimated seasonal high groundwater elevation in areas to be used for stormwater retention, detention, or infiltration;
 - e. The existing and proposed vegetation and ground surfaces with areas and runoff coefficients for each;
 - f. Calculations for the 2-year, 10 year and 50 year return period utilizing NCRS TR 55 Handbook. Pipe sizes, depth of flow, capacities and velocities shall be included;
 - g. All pipes shall be a minimum 12-inch diameter.
 - h. A drainage area map showing pre- and post-construction watershed boundaries, area and stormwater flow paths at a scale that enables verification of supporting calculations;
 - i. A recharge area analysis that calculates pre-and post-project annual groundwater recharge rates on the parcel;
 - j. A description and drawings of all components of the proposed stormwater management system;
 - k. Hydrologic and hydraulic design calculations for the pre-development and post- development conditions for the design storms specified in the Massachusetts Stormwater Handbook;
 - l. Soils information from test pits performed at the location of proposed Stormwater Management facilities, including soil descriptions, depth to seasonal high groundwater and depth to bedrock. Soils information will be based on site test pits logged by a Massachusetts Certified Soil Evaluator.
6. To ensure proper containment and stabilization of the site during the construction phase, a Stormwater Pollution Plan to control construction-related impacts, including erosion, sedimentation,

and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented. Such plan shall be developed to document compliance with Standard 8 of the Massachusetts Stormwater Handbook.

7. A Long -Term Stormwater Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed. Such plan shall be developed to document compliance with Standard 9 of the Massachusetts Stormwater Handbook.

The Long-Term Stormwater Operation and Maintenance Plan shall at a minimum include:

- i. Stormwater management system(s) owners;
 - ii. The party or parties responsible for operation and maintenance of all aspects of the stormwater management system;
 - iii. The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks;
 - iv. A plan that is drawn to scale and shows the location of all stormwater BMPs;
 - v. A schedule for routine inspections as well as a description of storms that would trigger immediate inspections following the storm;
 - vi. An inspection and maintenance log form
 - vii. An estimated stormwater operations and maintenance budget.
 - viii. Permission from the operator to allow agents of the Town of Athol to enter and inspect the premises to evaluate and ensure that the responsibility party complies with the Long-Term Stormwater Operation and Maintenance Plan requirements for each BMP.
8. During times of construction and post-construction where stormwater generated from the project area may inadvertently enter the public way, the developer (owner) shall be responsible for direct costs incurred by the town, including but not limited to stormwater related clean up, sanding, salting, street sweeping or other necessary management when required for the protection of public health and safety.

12. Hazardous Materials:

Hazardous materials stored, used, or generated on site shall not exceed the amount for a Very Small Quantity Generator of Hazardous Waste as defined by the DEP pursuant to Mass DEP regulations 310 CMR 30.000 and shall meet all requirements of the DEP including storage of hazardous materials in a building with an impervious floor that is not adjacent to any floor drains to prevent discharge to the outdoor environment.

If any hazardous materials, including, but not limited to, lithium ion (storage batteries) are used within the solar electric equipment, then impervious containment areas capable of controlling and containing any release of hazardous materials to the environment and to prevent potential contamination of groundwater are required. A list of any hazardous materials proposed to be located on the site and a plan to prevent their release shall be provided to the Special Permit Granting Authority and Fire Chief.

13. Noise

Noise generated by ground-mounted solar photovoltaic installations, cooling fans, inverters, associated equipment and machinery shall conform at a minimum to applicable state and local noise regulations,

including the DEP's Division of Air Quality noise regulations, 310 CMR 7.10 and 3.8.1.1 of the Athol Zoning Bylaw. Noise reduction shall be considered and incorporated as needed during the design phase of the installation including the location of the noise generator, shielding, noise cancellation, filtering, and noise suppression.

3.24.6. Site Plan Review Criteria: In addition to the criteria under Section 3.18.8, the Special Permit Granting Authority shall consider the following matters during Site Plan Review and shall either approve or deny a special permit upon its determination that such matters have or have not been satisfactorily addressed:

1. The right of abutting and neighboring landowners to live without undue disturbance from noise, traffic, lighting, fumes, dust, odor, glare, or stormwater runoff;
2. The adequacy of methods to store, handle, or dispose of wastes, including hazardous materials, to protect air, groundwater, and surface water pollution;
3. The protection of historical and natural environmental features on the site under review and in adjacent areas;
4. The adequacy of stormwater management systems to address non-point-source pollution.
5. Minimization of erosion of soil both during and after construction.
6. In the case of a residential zone location, the visual impact of the installation on its immediate abutters and the nearby neighborhood have been effectively neutralized through its location on the lot, appropriate design, landscaping and effective screening.
7. The location of the site and the system design provides effective screening and buffers to protect scenic vistas and view sheds from residential uses, public streets, recreational areas and any waterways or water bodies, and
8. The rural character of the general location has been maintained.

3.24.7 Site Control: The applicant shall submit documentation of actual or committed prospective access and control of the project site to allow for construction and the operation of the proposed ground-mounted solar photovoltaic installation.

3.24.8 Operation and Maintenance Plan: The installation owner or operator shall maintain the facility in good condition. The applicant shall submit a plan for the operation and maintenance of the ground-mounted solar photovoltaic installation along with a signed agreement with a maintenance company. This plan shall include measures for maintaining year-round safe access for emergency vehicle, snow plowing, storm water controls, and general procedures and a yearly schedule for the operation and maintenance of the facilities including fencing, and maintenance of landscaping.

3.24.9 Utility Notification: The applicant shall submit evidence satisfactory to the Special Permit Granting Authority that the utility company operating the electrical grid has been informed in writing of the intent to install a ground-mounted solar photovoltaic installation and intends to file an Interconnect Agreement in the future and that the utility company has responded in writing acknowledging the plan. Any off-grid system shall be exempt from this requirement.

3.24.10 Emergency Services: The applicant shall provide a copy of the project summary, operation and maintenance plan, electrical schematic, and site plan to the Athol Fire and Police Departments. The applicant and the installation operator shall cooperate with local and regional emergency services in developing an emergency response plan, which will ensure that emergency personnel have immediate, 24-hour access to the facility.

All means of shutting down the solar installation shall be clearly marked on the plan. The operator of the installation shall identify an official representative for public inquiries throughout the life of the installation.

The operation and maintenance plan required in Section 3.24.8 shall be periodically jointly reviewed and updated as necessary by the operator of the installation and the Athol Fire and Police Departments at a frequency to be determined by the Athol Fire Department. Safety personnel may request at any time that the operator provide onsite training in accessing and shutting down the operation of the installation.

The operator shall identify a qualified contact person who will provide assistance to local officials during an emergency. The operator shall update the contact information whenever there is a change in the contact person.

3.24.11 Annual Reporting: The owner or operator of a solar installation shall submit an annual report demonstrating and certifying compliance with the Operation and Maintenance Plan, the requirements of this bylaw, and approvals granted hereunder, including but not limited to continued management and maintenance of vegetation, compliance with the approved plans and any permit conditions, continuation of liability insurance, and adequacy of road access and functionality of stormwater management system. The annual report shall also provide information on the maintenance completed during the course of the year and the amount of electricity generated by the facility. The report shall be submitted to the Board of Selectmen, Special Permit Granting Authority, Fire Chief, and Conservation Commission (if a wetlands permit was issued) no later than 45 days after the end of the calendar year.

3.24.12 Modifications: All material modifications to the installation to be made after the issuance of the initial required building permit shall require approval of the Special Permit Granting Authority through a permit modification.

3.24.13 Discontinuance and Removal: Absent notice of a proposed date of decommissioning or written notice of extenuating circumstances, any ground-mounted solar photovoltaic installation not used for a period of one continuous year or more without written permission from the Special Permit Granting Authority, or is operating at less than 25% of its nameplate capacity shall be considered to be discontinued and shall be removed by the owner.

Upon written request from the Building Inspector addressed to the contact address provided and maintained by the owner or operator as required, the owner or operator shall provide evidence to the Building Inspector demonstrating continued use of the installation. Failure to provide such evidence within thirty days of such written request shall be conclusive evidence that the installation has been discontinued.

The owner or operator or landowner shall physically remove the installation no more than 180 days after the date of discontinued operation. The owner or operator or landowner shall notify the Special Permit Granting Authority by certified mail of the proposed date of discontinued operations and submit plans for removal. Removal shall consist of:

1. Physical removal of all parts of and appurtenances of the installation including solar arrays, structures, equipment, security barriers and transmission lines.
2. Recycling of all possible materials and disposal of remaining solid and hazardous wastes in accordance with state and federal waste disposal regulations applicable at the time of disposal.
3. Stabilization and revegetation of the site as necessary to minimize erosion and prevent impacts to wetlands, water courses or water bodies. The Special Permit Granting Authority may allow the owner or operator or landowner to leave landscaping or designated below grade foundations (provided they are filled in) in order to minimize erosion and disruption of existing vegetation. This requirement may be waived if the landowner submits a plan for re-use of the site.
4. Any portion of a site that was deforested for the installation shall be restored so as to encourage native tree growth, including the planting of seedlings, if necessary to establish growth.

As a condition of the Special Permit approval, the applicant and the landowner shall agree to allow entry to remove an abandoned or decommissioned installation. If the owner or operator or landowner fails to remove the installation in accordance with the requirements of this section, the Town of Athol shall have the right, to the extent it is otherwise duly authorized by law, to enter the property and physically remove the installation at a rate of 1.3 times the actual costs incurred. The Town of Athol shall use the financial surety as stipulated in the Financial Surety Section 3.24.14.

3.24.14 Financial Surety: The applicant of ground-mounted solar photovoltaic installations shall provide surety in the form of cash, certified bank check, escrow account or bond held by and for the Town of Athol to cover the cost of removal and stabilization of the site in the event the town must remove the installation and remediate the landscape, in an amount and form determined to be reasonable by the Special Permit Granting Authority, but in no event to exceed more than 130 percent of the cost of removal and stabilization costs as well as any compliance with the additional requirements set forth herein.

This surety will be due and payable at the issuance of the building permit. Proof of payment in the form of a receipt from the Town Treasurer will be shown to the Building Inspector before the permits are issued. Such surety will not be required for municipally- or state-owned facilities. The project applicant shall submit a fully inclusive estimate of the costs associated with removal and stabilization prepared by a licensed professional engineer. Such estimate shall be reviewed by the Town of Athol and adjusted as needed to reflect the opinion of the Town as to fair costs. The amount shall include a mechanism for calculating increased removal costs due to inflation.

As a condition of approval, an applicant shall bind itself to grant the necessary license or easement to the Town to allow entry to remove the structures and stabilize the site. The Town shall have the right but not the obligation to remove the facility.

3.24.15 Taxes or Payment in Lieu of Taxes: If the project would otherwise be exempt from the payment of personal or real property taxes, the applicant shall enter into a tax agreement or a payment in lieu of taxes (PILOT) agreement with the Town of Athol that provides an equivalent amount of tax revenue to the town as determined by the Board of Assessors. Any tax-related agreement or PILOT shall be approved by the Board of Assessors prior to the issuance of the Building Permit.

3.24.16 Costs of Outside Expertise: The Special Permit Granting Authority may hire, at the expense of the applicant, consultants to review the plans submitted if it determines that independent expert review is appropriate for the interest of the neighborhood and/or the town. The applicant shall pay the

estimated cost of said expert(s), including all legal fees and publication fees, to the Town prior to any review being undertaken. No Building Permit shall be approved until the total costs of said review(s) have been paid by the applicant.

3.24.17 Waiver of Design Standards

1. The Special Permit Granting Authority may waive or reduce strict compliance with any requirement of the Design Standards of this bylaw (unless noted otherwise in the bylaw), or any rules and regulations promulgated hereunder, where:
 - a. such action is allowed by federal, state or local statutes and/or regulations;
 - b. it is fully within the public interest;
 - c. it is not inconsistent with the purpose and intent of this bylaw and the purposes and intent of the bylaw can still be met with the waiver or reduction due to special circumstances of the site
 - d. and the full objectives of the bylaws can be met in an alternative manner.
2. The applicant shall submit a written request for any requested waiver at the time of the initial application. Such request shall be accompanied by an explanation or documentation supporting the waiver request and demonstrating that:
 - a. strict application of the bylaws does not further the purposes or objectives of this bylaw,
 - b. due to special circumstances of the site that the objectives of the bylaws can be met in an alternative manner and,
 - c. such a waiver or reduction of the requirements will not derogate from the intent or purpose of the bylaw.
3. All waiver requests shall be discussed during a required a public hearing duly noted in a public agenda and shall require a two-thirds vote in favor to be approved. If the Special Permit Granting Authority deems additional time or information is required in the review of the waiver request, the Special Permit Granting Authority may continue the request for the waiver to a subsequent BPCD meeting.

3.24.18 Rules and Regulations

The Special Permit Granting Authority may adopt, and from time to time amend, Rules and Regulations consistent with the provisions of this bylaw and G.L. c. 40A and other provisions of the General Laws, including the Subdivision Rules and Regulations of Town of Athol, Massachusetts, and shall file a copy of said Rules and Regulations with the Town Clerk. Said Rules and Regulations may provide for an application fee schedule for ground-mounted solar photovoltaic installation application submittals and methods for calculating the financial surety required under Section 3.24.14.

3.24.19 Ownership Changes

If the owner of the ground-mounted solar photovoltaic installation changes or the owner of the property changes, the special permit shall remain in effect, provided that the successor owner or operator assumes in writing all of the obligations of the special permit, site plan approval, and decommissioning plan. A new owner or operator of the ground-mounted solar photovoltaic installation shall notify the Special Permit Granting Authority and the Building Inspector/Zoning Enforcement Officer of such change in ownership or operator within thirty (30) days of the ownership change.

Model Zoning for the Regulation of Solar Energy Systems¹
Department of Energy Resources
Massachusetts Executive Office of Energy and Environmental Affairs
December 2014

This model zoning and accompanying Guidance were prepared to assist Massachusetts cities and towns in establishing reasonable standards to facilitate development of solar energy systems. These systems include small-, medium- and large-scale as well as both ground-mounted and roof-mounted installations.² The model zoning language provided here is not intended for adoption precisely as it is written. Communities will need to carefully consider how this language may be modified to suit local conditions and where it should be inserted into an existing Zoning Bylaw/Ordinance. Further, it is highly recommended that any language adapted from this model be reviewed by municipal counsel prior to adoption.

As small-, medium-, and large-scale ground-mounted and roof-mounted solar energy systems become more prevalent in Massachusetts, many communities are attempting to regulate the installation of these systems through their Zoning Bylaw/Ordinance. Developing these regulations has been particularly challenging for a number of reasons. Most notably, the Massachusetts General Laws contains several provisions that specifically address the ability of local governments to regulate solar energy systems and/or to protect solar access from development or vegetation (shading) on adjacent properties. While the language within Chapter 40A Section 3 states that a local government may not prohibit these uses, it does say they cannot be “unreasonably regulated” without providing guidance on what that particular phrase means. The Solar Energy Systems Policy Guidance, which accompanies this model zoning and succeeding sections of this document provide more explanation regarding the implications of the statutes on this issue and its significance to local zoning.

Unlike model bylaws/ordinances typically developed by the Commonwealth, the regulatory language provided here is not packaged as a “stand-alone” section of a Zoning Bylaw/Ordinance. With ground-mounted and roof-mounted solar energy systems, the statutory framework and “accessory” nature of some of these installations lend themselves to a different approach. This model zoning therefore assumes that municipalities will have many “typical” sections within their Zoning Bylaw/Ordinance and that several of these sections would be amended to address this issue. For the purposes of this model zoning, the Bylaw/Ordinance sections that are amended include:

¹ This material is based upon work supported by the U.S. Department of Energy under Award Number DE-EE0005692. This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

² This material was prepared by the Horsley Witten Group.

*The Definitions Section;
Allowable Uses;
Dimensional Requirements; and
Site Plan Review.*

There is also further discussion intended to help communities regulate these systems in the context of a Local Historic District.

Definitions

Commentary: Within a Zoning Bylaw/Ordinance, the Definitions Section usually stands alone. Definitions are also sometimes included as a sub-section within other sections of the Zoning Bylaw/Ordinance. For example, terms related to the protection of water resources may be included in a water resource protection overlay district section. We recommend that the following terms be added to the general Definitions Section of the Zoning Bylaw/Ordinance.

Photovoltaic System (also referred to as Photovoltaic Installation): An active solar energy system that converts solar energy directly into electricity.

Rated Nameplate Capacity: The maximum rated output of electric power production of the photovoltaic system in watts of Direct Current (DC).

Solar Access: The access of a solar energy system to direct sunlight.

Solar Collector: A device, structure or a part of a device or structure for which the primary purpose is to transform solar radiant energy into thermal, mechanical, chemical, or electrical energy.

Solar Energy: Radiant energy received from the sun that can be collected in the form of heat or light by a solar collector.

Commentary: While it is anticipated that installed solar energy systems will most frequently be photovoltaic, this model zoning uses the statutory definition of a solar energy system, which is broader and permits the installation of solar thermal systems as well.

Solar Energy System: A device or structural design feature, a substantial purpose of which is to provide daylight for interior lighting or provide for the collection, storage and distribution of solar energy for space heating or cooling, electricity generation, or water heating.

Solar Energy System, Active: A solar energy system whose primary purpose is to harvest energy by transforming solar energy into another form of energy or transferring heat from a collector to another medium using mechanical, electrical, or chemical means.

Solar Energy System, Grid-Intertie: A photovoltaic system that is connected to an electric circuit served by an electric utility.

Solar Energy System, Ground-Mounted: An Active Solar Energy System that is structurally mounted to the ground and is not roof-mounted; may be of any size (small-, medium- or large-scale).

Solar Energy System, Large-Scale: An Active Solar Energy System that occupies more than 40,000 square feet of surface area (equivalent to a rated nameplate capacity of about 250kW DC or greater).

Solar Energy System, Medium-Scale: An Active Solar Energy System that occupies more than 1,750 but less than 40,000 square feet of surface area (equivalent to a rated nameplate capacity of about 10 - 250 kW DC).

Solar Energy System, Off-Grid: A photovoltaic solar energy system in which the circuits energized by the solar energy system are not electrically connected in any way to electric circuits that are served by an electric utility.

Solar Energy System, Passive: A solar energy system that captures solar light or heat without transforming it to another form of energy or transferring the energy via a heat exchanger.

Solar Energy System, Roof-Mounted: An Active Solar Energy System that is structurally mounted to the roof of a building or structure; may be of any size (small-, medium- or large-scale).

Solar Energy System, Small-Scale: An Active Solar Energy System that occupies 1,750 square feet of surface area or less (equivalent to a rated nameplate capacity of about 10 kW DC or less).

Solar Thermal System: An Active Solar Energy System that uses collectors to convert the sun's rays into useful forms of energy for water heating, space heating, or space cooling.

Use Regulations

Commentary: Within a Zoning Bylaw/Ordinance, the Use Regulations describe which land uses are allowed within different zoning districts of the community, and which permits are required. The Use Regulations typically include a Use Table and/or a narrative description of the principal and accessory uses that are allowed, prohibited and/or allowed only through a Special Permit within each zoning district.

Pursuant to Chapter 40A Section 3, a Massachusetts municipality may not prohibit or unreasonably regulate solar energy systems except where necessary to protect public health, safety or welfare. Therefore, although these systems must be allowed within the community, they may be regulated where necessary to protect public health, safety or welfare through other provisions of the Zoning Bylaw/Ordinance. For example, these systems will still need to meet dimensional regulations and other performance standards necessary to protect public health, safety or welfare. In addition, a Site Plan Review process may be used to collect information that will ensure compliance with the performance standards in the Zoning Bylaw/Ordinance. Where some communities include Design Review in their permit processes, these communities will need to balance their desire for certain design objectives with the Commonwealth's protection of solar energy systems. Finally, as drafted this model zoning requires a special permit for a large-scale ground-mounted facility in a residential district and prohibits such systems in another residential district. While a special permit is discretionary, and language expressing uncertainty and cautioning communities about the lack of case law regarding Chapter 40A Section 3 has been included, the Attorney General's Office has approved local

zoning using this permitting mechanism. While DOER cannot offer a definitive interpretation, limited use of special permits when applied to the largest of solar systems, especially when these systems are allowed elsewhere by right, may well be reasonable regulation. In DOER's view, given the plain language of the statute, it is prudent to allow opportunity to site all scales of solar energy systems somewhere in the community. These provisions are described in more detail in the following sections. A more detailed discussion of DOER's understanding of Chapter 40A Section 3 is provided in the Policy Guidance for Regulating Solar Energy Systems that serves as a companion piece to this regulatory guidance.

As a cautionary note, while regulating aesthetics can arguably be considered a matter of protecting public welfare, attempting to place restrictions on materials, setbacks or height, and other similar items, as related to aesthetics, can create roadblocks to actual installation. It is therefore not recommended that communities regulate aesthetics of solar energy systems, or that they do so very cautiously, due to the strong statutory protections in Chapter 40A Section 3.

Two examples are provided in this section for how roof-mounted, small-scale ground-mounted, medium-scale ground-mounted, and large-scale ground-mounted solar energy systems can be incorporated into a municipality's Use Regulations. In these examples, roof-mounted solar energy systems, regardless of size, are allowed as-of-right throughout the community. As-of-right siting means that development may proceed without the need for a Special Permit, variance, amendment, waiver, or other discretionary approval. These projects cannot be prohibited, and can be built once a building permit has been issued by the inspector of buildings, building commissioner or local inspector.

For ground-mounted systems, there is a distinction between how small-scale, medium-scale and large-scale systems are treated and where each are allowed as-of-right, via site plan review, or by special permit. The model zoning allows small-scale ground-mounted systems as-of-right throughout the community. These are of a size that would service a house, small businesses, or small municipal building.

The model zoning allows medium-scale ground-mounted systems as-of-right in all districts except residential zoning districts; in these districts Site Plan Review is required. This means that medium-scale ground-mounted systems cannot be prohibited, and that DOER considers Site Plan Review reasonable regulation. Site Plan Review is discussed in more detail later in this document, but in general it establishes criteria for the layout, scale, appearance, safety, and environmental impacts of certain types and/or scales of development. Typically, site plan approval must be obtained before the building permit is issued. Since medium-scale ground-mounted systems can reach up to approximately an acre in size, DOER believes it is reasonable and appropriate to provide more regulatory scrutiny via Site Plan Review for these projects in residential districts to protect public health, safety, or welfare.

As drafted, the model zoning requires Site Plan Review for large-scale ground-mounted systems within most zoning districts, a special permit in one residential district, and prohibits such systems in another residential district. However, communities should remember that the language of the zoning exemption for solar energy systems is imprecise. While some communities already require a Special Permit to install a large-scale ground mounted solar facility, and/or

restrict them to certain districts, it is not clear whether these regulations are consistent with the Chapter 40A Section 3 mandate that they be reasonable and necessary to protect public health, safety, or welfare.

Connection to the Massachusetts Green Communities Designation and Grant Program

Recognizing the uncertainty around how regulations may or may not be interpreted as reasonable, DOER allows communities to meet Green Communities Criterion One by zoning for the as-of-right installation of a solar facility of at least an acre in size in a designated location. For more information on the Green Communities Designation and Grant Program, please visit: <http://www.mass.gov/eea/energy-utilities-clean-tech/green-communities/>.

Siting Preferences

Where a solar facility is sited, as well as placement on the site once selected, is an important consideration, particularly in regard to large-scale ground mounted facilities. DOER strongly discourages locations that result in significant loss of land and natural resources, including farm and forest land, and encourages rooftop siting, as well as locations in industrial and commercial districts, or on vacant, disturbed land. Significant tree cutting is problematic because of the important water management, cooling, and climate benefits trees provide.

In regard to farm properties, rooftops are preferable. If roof space is inadequate non-productive, non-arable agricultural land is the second choice. Should this also prove infeasible or inadequate a dual use of land design concept could preserve productive farmland by continuing crop production underneath high-mounted and well spaced panels. Finally, if none of these are feasible or they are inadequate the least productive land should be used first to minimize the loss of productive food/crop land.

Overlay Zoning Districts

Overlay zoning districts are one zoning approach that could be used to permit solar energy systems, and in ways not allowed under the base zoning districts. For example, the model zoning as drafted requires Site Plan Review for medium-scale ground mounted solar energy systems in residential districts. An overlay district could be used to permit such facilities without Site Plan Review in a portion of these residential districts where Site Plan Review is deemed unnecessary, while retaining the review for the balance of the districts.

In addition, some communities may wish to conduct a feasibility analysis to determine where large-scale solar energy systems are most appropriate within the municipality and use an overlay zoning district approach to encourage the siting of facilities in the most feasible locations. Once an area has been established through a thoughtful and analytical process, the municipality could enact overlay zoning legislation to prioritize these areas for large-scale solar energy systems. Many Massachusetts communities have already taken this approach through adoption of a large-scale ground-mounted solar overlay district, often based on DOER's [Model As-of-Right Zoning Bylaw: Allowing Use of Large-Scale Ground-Mounted Solar Photovoltaic Installations](#).

Agricultural Exemption:

In addition to the exemption pertaining to solar energy systems Section 3 of Chapter 40A also exempts agricultural uses from zoning regulations that would otherwise apply. Thus, when the majority of the power from a solar energy system (or a wind turbine) is integral to farm production construction and operation of the system would covered by the exemption. Questions on the applicability of the agricultural exemption to solar energy systems should be directed to Gerry Palano at the Dept. of Agricultural Resources (Gerald.Palano@state.ma.us or 617-626-1706).

Example 1 (Use Tables):

	Residential-1 (R1)	Residential-2 (R2)	Residential-3 (R3)	Commercial (C)	Industrial (I)	Public (P)
<u>PRINCIPAL USE</u>						
Medium-Scale Ground-Mounted Solar Energy System	SPR	SPR	SPR	Y	Y	Y
Large-Scale Ground-Mounted Solar Energy System	SP	N	SPR	SPR	SPR	SPR

Y = Allowed

SP = Special Permit

N = Prohibited

SPR = Site Plan Review

	Residential-1 (R1)	Residential-2 (R2)	Residential-3 (R3)	Commercial (C)	Industrial (I)	Public (P)
<u>ACCESSORY USE</u>						
Roof-Mounted Solar Energy System	Y	Y	Y	Y	Y	Y
Small-Scale Ground-Mounted Solar Energy System	Y	Y	Y	Y	Y	Y
Medium-Scale Ground-Mounted Solar Energy System	SPR	SPR	SPR	Y	Y	Y

Y = Allowed

SP = Special Permit

N = Prohibited

SPR = Site Plan Review

Example 2 (Uses listed):

1.0 Residential District Uses

1.1 Uses Permitted

1.1.1 Roof-Mounted Solar Energy Systems

1.1.2 Small-Scale Ground-Mounted Solar Energy Systems

1.2 Uses Allowed through Site Plan Review

- 1.2.1 Medium-Scale Ground-Mounted Solar Energy Systems
- 1.2.2 Large-Scale Ground-Mounted Solar Energy Systems in the R3 District

1.3 Uses Allowed via Special Permit

- 1.3.1 Large-Scale Ground-Mounted Solar Energy Systems in the R1 District

2.0 Non-Residential District Uses

2.1 Uses Permitted

- 2.1.1 Roof-Mounted Solar Energy Systems
- 2.1.2 Small-Scale Ground-Mounted Solar Energy Systems
- 2.1.3 Medium-Scale Ground-Mounted Solar Energy Systems

2.2 Uses Allowed through Site Plan Review

- 2.2.1 Large-Scale Ground-Mounted Solar Energy Systems

Dimensional Regulations

Commentary: In most cases, the existing dimensional standards in a Zoning Bylaw/Ordinance will allow for the development of small-, medium-, and large-scale solar energy systems. However, if a municipality finds alternate dimensional standards are necessary to allow solar energy systems while protecting public health, safety, or welfare, it may impose them. As a reminder, while regulating aesthetics can arguably be considered a matter of protecting public welfare, attempting to place restrictions on dimensional standards, such as setbacks or height, as they relate to aesthetics can create roadblocks to actual installation. It is therefore not recommended that communities regulate aesthetics of solar energy systems due to the strong statutory protections in Chapter 40A Section 3, or that they do so very carefully.

With regard to more basic dimensional requirements such as setbacks from the property line, municipalities may also find that adjustments can be made to encourage broader use of solar energy systems. Below is a series of dimensional regulation amendments that a municipality could adopt to further encourage small-, medium-, and large-scale ground-mounted and roof-mounted solar energy systems, or simply clarify requirements pertaining to them.

Height

Commentary: It is recommended that for purposes of height, roof-mounted solar energy systems should be considered similar to chimneys, television antennae, roof-top mechanical equipment and other appurtenances that are usually either allowed a much higher maximum height (e.g., 100 feet instead of 35 feet) or are exempted altogether from building height requirements. Such

an exemption can be stated in the definition of “Building Height” or through language similar to that provided in the following example.

It is recommended that existing zoning district height limitations apply for all ground-mounted solar energy systems. If the ground-mounted solar energy system is accessory to a principal building or structure on a lot, then the height restriction for accessory structures would apply. If the ground-mounted solar energy system is the principal structure on a lot, then the height restriction for principal structures would apply.

Example:

1.0 Building Height Regulations

1.1 Exemptions

1.1.1 Mechanical equipment and appurtenances necessary to the operation or maintenance of the building or structure itself, including chimneys, ventilators, plumbing vent stacks, cooling towers, water tanks, broadcasting and television antennae and roof-mounted solar energy systems.

Setbacks

Commentary: It is recommended that small- and medium-scale ground-mounted solar energy systems that are accessory to a primary building or structure on a lot be provided with more flexible setback requirements than those that would typically apply to a primary structure. Many communities already provide some flexibility for “accessory structures” like sheds, allowing these to be closer to the lot line than the primary structure. For example, where a front/side/rear yard setback for the primary structure may be 50 feet, setbacks of 20 feet may be allowed for accessory structures. When ground-mounted solar energy systems are developed as accessory structures to a home, business or other building or structure, they should be afforded at least the same flexibility.

If a community does not have this type of reduced setback already built into the Zoning Bylaw/ Ordinance, a provision could be added that effectively reduces the setback distance just for this use. For example, if the community has a dimensional table, a special footnote could be added to the dimensional table as indicated in the following examples. It should be noted that often times there is a distinction between how accessory structures are regulated in a residential zoning district and how they are regulated in a commercial or industrial district. Therefore, communities should ensure that provisions for flexible setbacks for small- and medium-scale ground-mounted solar energy systems are incorporated wherever appropriate.

The first example applies a reduction of 50% to the otherwise required setbacks for accessory uses. The value of 20 feet is used in the second example; however, this may be altered based on local conditions. For example, in some communities, particularly urban communities, the required side- and rear-yard setback distances may be shorter than 20 feet. In these

circumstances, the existing shorter setback distances should remain for small- and medium-scale ground-mounted solar energy systems.

As opposed to small- and medium-scale ground-mounted solar energy systems, which are typically sited as accessory to a principal building or structure on a lot, large-scale ground-mounted solar energy systems are usually sited as principal structures. Whenever a solar energy system is sited as a principal structure on a lot, it is recommended that the setback requirements for principal structures in that zoning district apply. Regardless of the scale of the system or the minimum setback required solar energy system installers often allow a sufficient setback to avoid the issue of shading by vegetation on neighboring properties.

Placement of solar energy systems in front yards should be avoided if at all possible. However, in DOER's view the statutory protections for solar energy systems create a situation where a ground-mounted array could not be prohibited outright in a front yard, so the language provided in the following example includes a standard for the front yard setback. DOER recognizes the concerns this may raise in residential neighborhoods and acknowledges that communities should work with property owners to find appropriate locations for ground-mounted systems in side or rear yards.

Example Dimensional Table Footnotes for Accessory Installations:

- (1) Small- and medium-scale ground-mounted solar energy systems accessory to principal use may be located no closer than [1/2 of the setback that would otherwise apply] from the front, side or rear lot line. All ground-mounted solar energy systems in residential districts shall be installed either in the side yard or rear yard to the extent practicable
- (2) Small- and medium-scale ground-mounted solar energy systems accessory to a principal use may be located no closer than [twenty (20) feet] from the front, side or rear lot line. All ground-mounted solar energy systems in residential districts shall be installed either in the side yard or rear yard to the extent practicable.

Lot Coverage

Commentary: A number of communities use "maximum lot coverage" or "maximum impervious surface" as one of their dimensional standards. While it is clear that such features as driveways or buildings would be included in any calculation of lot coverage, many other features may be more ambiguous depending on how clearly the definition in the Zoning Bylaw/Ordinance is written. Awnings, porches, decks and similar features can often become a matter of dispute. Regardless of the definition, it is recommended that solar energy systems with grass or another pervious surface under them be exempted from lot coverage or impervious surface calculations. If the area is to be paved or otherwise rendered impervious then this land area should in fact count toward any coverage or impervious surface limit. It is also important to note that this recommended exemption is not intended to apply to municipal stormwater regulations, as the panels could have the effect of altering the volume, velocity, and discharge pattern of stormwater runoff. The following provision could be included as a footnote to the Dimensional Table related

to maximum lot coverage and impervious cover requirements, or as a separate provision within the dimensional regulations.

Example:

Solar energy systems shall not be included in calculations for lot coverage or impervious cover as defined in [INSERT SECTION REFERENCE FOR ‘DEFINITIONS’].

Site Plan Review Requirements and Performance Standards

Commentary: Although not specifically addressed under Chapter 40A, Site Plan Review is included within the local Zoning Bylaws/Ordinances of many Massachusetts communities. Site Plan Review is meant to enforce clear and fair design standards for different types of development. This is typically done through a coordinated review process that circulates development applications among, and invites input from, all local boards and commissions that might permit a project, including Local Historic District Commissions as applicable. Site Plan Review is usually triggered by either specific types of uses (e.g., commercial or industrial development), or certain scales of uses (e.g., non-residential buildings over 5,000 square feet).

Typically, Site Plan Review procedures and requirements are provided within a separate section of the Zoning Bylaw/Ordinance. However, there are instances when communities provide separate Site Plan Review provisions and procedures within a section pertaining to a particular use or development type (e.g., Planned Business Development, etc.). Consistent with the Legislature’s intent to facilitate the siting of solar energy, communities should shape the Site Plan Review provisions of their Zoning Bylaws/Ordinances to enable large-, medium- and small-scale solar energy system projects to proceed without undue delay.

Model language for Site Plan Review for medium-scale ground-mounted solar energy systems is provided in the following Example 1. As discussed earlier in this document, Site Plan Review may be appropriate when medium-scale ground-mounted systems are sited within residential districts. The model language provided in Example 1 below is based on, but is less stringent than, the provisions in the Massachusetts DOER [Model As-of-Right Zoning Bylaw: Allowing Use of Large-Scale Ground-Mounted Solar Photovoltaic Installations](#).

Example 2 provides model language for Site Plan Review for large-scale ground-mounted solar energy systems when they are permitted as of right. As discussed earlier in this document, Site Plan Review may be appropriate for large-scale ground-mounted systems when they are sited anywhere within the community. The model language provided in Example 2 below is based on the provisions in the Massachusetts DOER [Model As-of-Right Zoning Bylaw: Allowing Use of Large-Scale Ground-Mounted Solar Photovoltaic Installations](#). Example 2 is also intended for use in concert with the special permit language in the next section of this model zoning.

Example 3 provides model language for roof-mounted and small-scale ground-mounted systems when they are part of a larger project where Site Plan Review is triggered through another threshold (e.g., commercial development, non-residential buildings over 5,000 square feet, etc.). It is important to note that the installation of roof-mounted or small-scale ground-mounted solar

energy systems does not trigger Site Plan Review on its own. However, when such systems are included as part of a larger development proposal that requires Site Plan Review, the municipality has the opportunity to review the roof-mounted or small-scale ground-mounted solar energy systems as part of the larger proposal.

As discussed earlier in this document, while regulating aesthetics can arguably be considered a matter of protecting public welfare, attempting to place restrictions on solar energy systems as they relate to aesthetics can create roadblocks to actual installation. It is therefore not recommended that communities regulate aesthetics of solar energy systems, or that they do so very cautiously, due to the strong statutory protections in Chapter 40A Section 3. However, where communities already have Site Plan Review standards that relate to aesthetics, such as screening requirements, these standards should also apply to solar energy systems. In other words, solar energy systems should not be singled out and regulated more stringently than other uses that require Site Plan Review; however, they can be held to the same level of restrictions that are in place for other uses.

Example 1 (Site Plan Review provisions for medium-scale ground-mounted solar energy systems in residential zoning districts):

1.0 Site Plan Review

1.1 Applicability

1.1.1 Medium-scale ground-mounted solar energy systems proposed within residential zoning districts shall undergo Site Plan Review prior to construction, installation or modification as provided in this section.

1.2 Site Plan Document Requirements

Pursuant to the Site Plan Review process, the project proponent shall provide the following documents, as deemed applicable by the Site Plan Review Authority:

1.2.1 A site plan showing:

- (a) Property lines and physical features, including roads, for the project site;
- (b) Proposed changes to the landscape of the site, grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures;
- (c) Blueprints or drawings of the solar energy system showing the proposed layout of the system, any potential shading from nearby structures, the distance between the proposed solar collector and all property lines and existing on-site buildings and structures, and the tallest finished height of the solar collector;

- (d) Documentation of the major system components to be used, including the panels, mounting system, and inverter;
- (e) Name, address, and contact information for proposed system installer;
- (f) Name, address, phone number and signature of the project proponent, as well as all co-proponents or property owners, if any;
- (g) The name, contact information and signature of any agents representing the project proponent; and
- (h) Zoning district designation for the parcel(s) of land comprising the project site.

If the following are not addressed in existing site plan review regulations, then the community may wish to include them:

- (i) *Locations of active farmland and prime farmland soils, wetlands, permanently protected open space, Priority Habitat Areas and BioMap 2 Critical Natural Landscape Core Habitat mapped by the Natural Heritage & Endangered Species Program (NHESP) and “Important Wildlife Habitat” mapped by the DEP.*
- (j) *Locations of floodplains or inundation areas for moderate or high hazard dams;*
- (k) *Locations of local or National Historic Districts;*

- 1.2.2 Proof that the project proponent will meet the required Site Plan Review notification procedures.

Commentary: Provision 1.2.2 above should reference the municipality’s existing Site Plan Review public and/or abutter notification procedures if applicable. For example, a community may require projects that are subject to Site Plan Review to notify all property owners within 100 feet of the project site.

1.3 Site Plan Review Design Standards

- 1.3.1 Standards for medium-scale ground-mounted solar energy systems proposed within residential zoning districts

- 1.3.1.1 Utility Notification - No grid-intertie photovoltaic system shall be installed until evidence has been given to the Site Plan Review Authority that the owner has submitted notification to the utility company of the customer’s intent to install an interconnected customer-owned generator. Off-grid systems are exempt from this requirement.

1.3.1.2 Utility Connections - Reasonable efforts, as determined by the Site Plan Review Authority, shall be made to place all utility connections from the solar photovoltaic installation underground, depending on appropriate soil conditions, shape, and topography of the site and any requirements of the utility provider. Electrical transformers for utility interconnections may be above ground if required by the utility provider.

1.3.1.3 Safety - The medium-scale ground-mounted solar energy system owner or operator shall provide a copy of the Site Plan Review application to the local fire chief. All means of shutting down the solar installation shall be clearly marked.

Commentary: With regard to issues of access and safety, communities looking to adopt zoning for medium-scale solar energy systems should be aware of any unique local requirements that could apply. For example, if the fire department will want an Emergency Response Plan as part of approval, this should be folded into the review process as seamlessly as possible.

1.3.1.4 Visual Impact – Reasonable efforts, as determined by the Site Plan Review Authority, shall be made to minimize visual impacts by preserving natural vegetation, screening abutting properties, or other appropriate measures.

1.3.1.5 Land Clearing, Soil Erosion and Habitat Impacts - Clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of ground-mounted solar energy systems or as otherwise prescribed by applicable laws, regulations, and bylaws/ordinances.

Commentary: As drafted, this model zoning does not require medium-scale ground mounted solar energy systems to be fenced, but this is something communities will want to consider. Regardless, many project proponents will find fencing prudent.

Example 2 (Site Plan Review provisions for large-scale ground-mounted solar energy systems):

1.0 Site Plan Review

1.1 Applicability

1.1.1 Large-scale ground-mounted solar energy systems shall undergo Site Plan Review prior to construction, installation or modification as provided in this section.

1.2 Site Plan Document Requirements

Pursuant to the Site Plan Review process, the project proponent shall provide the following documents, as deemed applicable by the Site Plan Review Authority:

1.2.1 A site plan showing:

- (a) Property lines and physical features, including roads, for the project site;
- (b) Proposed changes to the landscape of the site, grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures;
- (c) Blueprints or drawings of the solar energy system signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts showing the proposed layout of the system, any potential shading from nearby structures, the distance between the proposed solar collector and all property lines and existing on-site buildings and structures, and the tallest finished height of the solar collector;
- (d) One or three line electrical diagram detailing the solar photovoltaic installation, associated components, and electrical interconnection methods, with all Massachusetts Electric Code (527 CMR 12.00) compliant disconnects and overcurrent devices;
- (e) Documentation of the major system components to be used, including the panels, mounting system, and inverter;
- (f) Name, address, and contact information for proposed system installer;
- (g) Name, address, phone number and signature of the project proponent, as well as all co-proponents or property owners, if any;
- (h) The name, contact information and signature of any agents representing the project proponent; and
- (i) Zoning district designation for the parcel(s) of land comprising the project site.

If the following are not addressed in existing site plan review regulations, then the community may wish to include them:

- (j) *Locations of active farmland and prime farmland soils, wetlands, permanently protected open space, Priority Habitat Areas and BioMap 2 Critical Natural Landscape Core Habitat mapped by the Natural Heritage & Endangered Species Program (NHESP) and “Important Wildlife Habitat” mapped by the DEP.*
- (k) *Locations of floodplains or inundation areas for moderate or high hazard dams;*
- (l) *Locations of local or National Historic Districts;*

- 1.2.2 Documentation of actual or prospective access and control of the project site (see also Section 1.3.1.1);
- 1.2.3 An operation and maintenance plan (see also Section 1.3.1.2);
- 1.2.4 Proof of liability insurance; and
- 1.2.5 A public outreach plan, including a project development timeline, which indicates how the project proponent will meet the required Site Plan Review notification procedures and otherwise inform abutters and the community.

Commentary: Provision 1.2.6 above should reference the municipality's existing Site Plan Review public and/or abutter notification procedures if applicable. For example, a community may require projects that are subject to Site Plan Review to notify all property owners within 100 feet of the project site.

1.3 Site Plan Review Design and Operation Standards

1.3.1 Standards for large-scale ground-mounted solar energy systems

- 1.3.1.1 Site Control - The project proponent shall submit documentation of actual or prospective access and control of the project site sufficient to allow for construction and operation of the proposed solar energy system.
- 1.3.1.2 Operation & Maintenance Plan - The project proponent shall submit a plan for the operation and maintenance of the large-scale ground-mounted solar energy system, which shall include measures for maintaining safe access to the installation, stormwater controls, as well as general procedures for operational maintenance of the installation.
- 1.3.1.3 Utility Notification - No grid-intertie photovoltaic system shall be installed until evidence has been given to the Site Plan Review Authority that the owner has submitted notification to the utility company of the customer's intent to install an interconnected customer-owned generator. Off-grid systems are exempt from this requirement.
- 1.3.1.4 Lighting - Lighting of large-scale ground-mounted solar energy systems shall be consistent with local, state and federal law. Lighting of other parts of the installation, such as appurtenant structures, shall be limited to that required for safety and operational purposes, and shall be reasonably shielded from abutting properties. Where feasible, lighting of the solar energy system shall be directed downward and shall incorporate full cut-off fixtures to reduce light pollution.

- 1.3.1.5 Signage - Signs on large-scale ground-mounted solar energy systems shall comply with a municipality's sign bylaw/ordinance. A sign consistent with a municipality's sign bylaw/ordinance shall be required to identify the owner and provide a 24-hour emergency contact phone number. Solar energy systems shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of the solar energy system.
- 1.3.1.6 Utility Connections - Reasonable efforts, as determined by the Site Plan Review Authority, shall be made to place all utility connections from the solar photovoltaic installation underground, depending on appropriate soil conditions, shape, and topography of the site and any requirements of the utility provider. Electrical transformers for utility interconnections may be above ground if required by the utility provider.
- 1.3.1.7 Emergency Services – The large-scale ground-mounted solar energy system owner or operator shall provide a copy of the project summary, electrical schematic, and site plan to the local fire chief. Upon request the owner or operator shall cooperate with local emergency services in developing an emergency response plan. All means of shutting down the solar energy system shall be clearly marked. The owner or operator shall identify a responsible person for public inquiries throughout the life of the installation.

Commentary: With regard to issues of access and safety, communities looking to adopt zoning for large-scale solar energy facilities should be aware of any unique local requirements that could apply.

- 1.3.1.8 Land Clearing, Soil Erosion and Habitat Impacts - Clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of solar energy system or otherwise prescribed by applicable laws, regulations, and bylaws/ordinances.

1.3.2 Monitoring and Maintenance

- 1.3.2.1 Solar Energy System Installation Conditions - The large-scale ground-mounted solar energy system owner or operator shall maintain the facility in good condition. Maintenance shall include, but not be limited to, painting, structural repairs, and integrity of security measures. Site access shall be maintained to a level acceptable to the local Fire Chief, Emergency Management Director, and Emergency Medical Services. The owner or operator

shall be responsible for the cost of maintaining the solar energy system and any access road(s), unless accepted as a public way.

1.3.2.2 Modifications - All material modifications to a large-scale ground-mounted solar energy system made after issuance of the required building permit shall require approval by the Site Plan Review Authority.

1.3.3 Abandonment or Decommissioning

1.3.3.1 Removal Requirements

Any large-scale ground-mounted solar energy system which has reached the end of its useful life or has been abandoned consistent with Section 1.3.3.2 of this bylaw/ordinance shall be removed. The owner or operator shall physically remove the installation no more than 150 days after the date of discontinued operations. The owner or operator shall notify the Site Plan Review Authority by certified mail of the proposed date of discontinued operations and plans for removal. Decommissioning shall consist of:

- (a) Physical removal of all solar energy systems, structures, equipment, security barriers and transmission lines from the site.
- (b) Disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations.
- (c) Stabilization or re-vegetation of the site as necessary to minimize erosion. The Site Plan Review Authority may allow the owner or operator to leave landscaping or designated below-grade foundations in order to minimize erosion and disruption to vegetation.

1.3.3.2 Abandonment

Absent notice of a proposed date of decommissioning or written notice of extenuating circumstances, the large-scale ground-mounted solar energy system shall be considered abandoned when it fails to operate for more than one year without the written consent of the Site Plan Review Authority. If the owner or operator of the solar energy system fails to remove the installation in accordance with the requirements of this section within 150 days of abandonment or the proposed date of decommissioning, the town retains the right, after the receipt of an appropriate court order, to enter and remove an abandoned, hazardous, or decommissioned large-scale ground-mounted solar energy system. As a condition of Site Plan approval, the applicant and landowner

shall agree to allow entry to remove an abandoned or decommissioned installation.

Commentary: Recognizing that other remedies, such as a tax lien, are available to communities in the event an abandoned facility is legitimately putting public safety at risk this model zoning does not require the provision of surety to cover the cost of removal in the event the municipality must remove the installation and remediate the landscape. Communities can, however, require surety in circumstances where a valid planning purpose for doing so exists.

Commentary: As drafted, this model zoning does not require large-scale ground mounted solar energy systems to be fenced, but this is something communities will want to consider. Regardless, many project proponents will find fencing prudent.

Example 3 (Site Plan Review provisions for roof-mounted and small-scale ground-mounted solar energy systems as part of a larger project that triggers Site Plan Review):

1.0 Site Plan Review

1.1 Site Plan Document Requirements

1.1.1 Requirements for Roof-Mounted and Small-Scale Ground-Mounted Solar Energy Systems - Where these solar energy systems may be accessory to a use allowed through Site Plan Review, the Site Plan Review shall include review of their adequacy, location, arrangement, size, design, and general site compatibility.

1.1.1.1 Roof-Mounted Solar Energy Systems – For all roof-mounted systems, the applicant shall provide:

- (a) The shortest distance between the solar collector and all edges of the roof.
- (b) The distance between the solar collector and any other existing rooftop features such as chimneys, spires, access points, etc.
- (c) The height of the solar collector both from finished grade and, where applicable, from the finished surface of the roof.

1.1.1.2 Small-Scale Ground-Mounted Solar Energy Systems – For all ground-mounted systems, the applicant shall provide:

- (a) The distance between the proposed solar collector and all property lines and existing on-site buildings and structures.
- (b) The tallest finished height of the solar collector.
- (c) Proposed changes to the landscape of the site, grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures.

1.1.1.3 System Components – The Plan must include documentation of the major system components to be used, for example the panels, mounting system, and inverter.

1.1.1.4 Installer Details – The Plan must include the name, address, and contact information for proposed system installer.

1.2 Site Plan Review Design Standards

1.2.1 Standards for roof-mounted and small-scale ground-mounted solar energy systems

1.2.1.1 Utility Notification - No grid-intertie photovoltaic system shall be installed until evidence has been given to the Site Plan Review Authority that the owner has submitted notification to the utility company of the customer's intent to install an interconnected customer-owned generator. Off-grid systems are exempt from this requirement.

1.2.1.2 Emergency Access - Solar energy systems shall be located in such a manner as to ensure emergency access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunities, and provide emergency egress from the roof.

(a) For buildings with pitched roofs, solar collectors shall be located in a manner that provides a minimum of one three-foot wide clear access pathway from the eave to the ridge on each roof slope where solar energy systems are located as well as one three-foot smoke ventilation buffer along the ridge.

(b) Residential rooftops that are flat shall have a minimum three-foot wide clear perimeter and commercial buildings that are flat shall have a minimum four-foot wide clear perimeter between a solar energy system and the roofline, as well as a three-foot wide clear perimeter around roof-mounted equipment such as HVAC units.

(c) To the extent practicable, the access pathway shall be located at a structurally strong location on the building (such as a bearing wall).

Commentary: Building and Fire Department personnel should be involved in the development of emergency access standards, and any zoning standards that are adopted should be consistent with local building and fire codes.

1.2.1.3 Safety – No roof-mounted solar energy system shall be located in a manner that would cause the shedding of ice or snow from the roof into a porch, stairwell or pedestrian travel area.

Special Permits

Commentary: Special Permits are addressed in Chapter 9 of the Zoning Act, and most Massachusetts communities have regulations pertaining to them within their zoning bylaw or ordinance. Below is model language for municipalities requiring special permits for large-scale ground-mounted solar energy systems. It is intended to be adopted and implemented alongside Site Plan Review language for large-scale ground-mounted systems included as Example 2 in this model zoning. Rather than include separate special permit standards applicable specifically to large-scale ground-mounted solar energy systems, this language simply directs that a permit be issued pursuant to the already established special permit bylaw/ordinance of the community.

Municipalities will, however, want to audit their special permit language, especially the approval standards, for compatibility with the siting of large-scale ground-mounted solar energy systems. Such systems should have far lower impacts than commercial or industrial uses that often require issuance of special permit, and communities should keep in mind the requirement in Chapter 40A Section 3 that any regulations pertaining to solar energy systems be reasonable.

1.0 Special Permit with Site Plan Review

1.1 Special Permit Requirements

- 1.1.1 Where required a special permit shall be issued prior to construction, installation or modification of any large-scale ground-mounted solar energy system. The special permit granting authority shall include as part of its special permit review and proceedings all the provisions and requirements of the Site Plan Review standards applicable to large-scale ground-mounted solar energy systems.

Pre-Existing Non-Conforming Uses and Structures

Commentary: Alterations, extensions and structural changes to pre-existing non-conforming uses and structures (e.g., existing buildings that do not meet the dimensional requirements of the Zoning Bylaw/Ordinance) that intensify non-conformities or result in additional non-conformities may not be allowed beyond a certain threshold or may require a Special Permit pursuant to the local Zoning Bylaw/Ordinance. It is recommended that the installation of roof-mounted or small-scale ground-mounted solar energy systems associated with pre-existing non-conforming uses or structures be exempt from this requirement. An example provision is provided below. Communities not comfortable with providing this exemption to small-scale ground mounted systems due to their potential to be located on very small lots may wish to apply Site Plan Review or continue to require a Special Permit where this can be justified to protect public health, safety, or welfare. As to roof mounted systems on non-conforming properties, given the exemption afforded solar energy systems, DOER believes it would be unreasonable to disallow them or require a Special Permit even when installation would exacerbate a pre-existing building height non-conformity.

Example:

1.0 Pre-Existing Non-Conforming Uses and Structures

1.1 Improvements that do not change the use or the basic exterior characteristics or appearance of the building or structure are allowed. Such improvements include but are not limited to the following:

1.1.1 Installation or replacement of solar energy systems.

Historic Districts

Commentary: Many communities in the Commonwealth have adopted Local Historic Districts to protect and preserve buildings, landscapes and neighborhoods of historic significance. In recent years, conflict has occasionally arisen about the installation of solar energy systems within these districts on historic buildings and structures, since some argue that they have adverse impacts on the visual appearance and integrity of the buildings and structures.

As described in the DOER Policy Guidance for Regulating Solar Energy Systems, Local Historic District Commissions must consider the policy of the Commonwealth to encourage the use of solar energy systems and to protect solar access when considering issuance of a certificate of appropriateness for a solar energy system. However, thoughtful design guidelines can help ensure that solar energy systems are sited while the goals of historic preservation continue to be achieved.

Design guidelines can require that solar energy systems not be visible from public areas, to the greatest extent practicable. When it is not feasible (either physically or economically) to locate solar energy systems out of the public eye, solar energy systems can be required to be designed to certain architectural standards (e.g., building-integrated, use of solar shingles) to the greatest extent practicable. However, these options may be infeasible as well due to the high cost and low performance of many of these technologies. To meet these challenges, Local Historic District Commissions are encouraged to write design guidelines that support the development of solar energy systems and are sensitive to the historic preservation goals of the Commission.



Climate-Smart Zoning and Permitting

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Contents

Introduction	1
Playbook Indicators & Terms	5
Action A: Allow by-right the installation and operation of net zero enabling technologies.	10
Action B: Include net zero enabling technologies and related terms in zoning definitions.	13
Action C: Exempt net zero enabling technologies from height and setback requirements.	17
Action D: Create a climate overlay that reduces greenhouse gas (GHG) emissions per building type.	21
Action E: Create a climate overlay for high performance building standards.	25
Action F: Enable and incentivize transit-oriented development (TOD).	29
Action G: Require all new construction and roof replacements to implement an eco-roof.	33
Action H: Adopt a Green Code with resiliency and mitigation incentives.	37
Action I: Require energy efficiency licensing for rental units.	40
Action J: Phase in clean heating and cooling technology requirements in the special permit process.	43
Action K: Offer expedited permitting and reduced permitting fees for net zero emissions buildings and net zero enabling technology.	47
Action L: Train reviewers and staff on net zero building standards and design.	50
End Notes	53

MAPC's Municipal Net Zero Playbook

MAPC's **Municipal Net Zero Playbook** ("the Playbook") provides guidance and tools to equip cities and towns with the resources to tackle their climate goals in an efficient and equitable manner. The Playbook is an interdisciplinary tool for municipal planners, energy/sustainability staff, and community members that seeks to empower cities and towns to implement net zero actions within their communities. These resources will help local net zero action implementers understand their role in advancing greenhouse gas (GHG) emissions reductions, adopting local policies, and accelerating state-level policy changes.

Explore all of MAPC's resources on Net Zero Planning: <https://www.mapc.org/net-zero/>

How to Use the Playbook

START HERE

MAPC developed two guiding frameworks to help communities navigate the Net Zero approach as they start on, or ramp up, their Net Zero journeys. Cities and towns can use these frameworks to inform community engagement, plan development, and strategy prioritization as they seek to customize their local Net Zero Action Plans.

Framework for Action

Learn how to navigate the Net Zero planning process and evaluate priority actions for a local net zero plan.

Framework for Equity

Learn how to develop Net Zero Plans that assess and acknowledge existing inequities and work to uplift and provide direct benefits to underserved communities.

Zero Emissions Mobility

Tackle GHG emissions reductions from how people get around a community.



Net Zero Buildings

Make buildings highly efficient and optimize clean energy for electricity, heating, and cooling.

Clean Energy Supply

Transition to 100 percent renewable sources of energy across a community.



Climate-Smart Zoning and Permitting

Take a strategic approach to local zoning and permitting updates.



WHAT'S NEXT?

As our work with communities expands, we plan to continue to add and update chapters to the Playbook that touch on emerging best practices.

CHOOSE YOUR OWN ADVENTURE

Drawing on our years of experience working with cities and towns on clean energy and climate, MAPC has compiled information on the best practices and actions municipalities can implement in their plans to advance toward Net Zero. You can start with the Chapter you are most interesting in tackling, or review each in depth.

The Playbook provides a starting point for each priority action, with links to resources, at MAPC and beyond, that offer more detailed guidance on implementation.

In order to guide our communities to net zero emissions by 2050, we must adjust zoning and permitting policies and practices to require and encourage the necessary changes to our building stock today and into the future.

This chapter outlines opportunities for municipalities to demonstrate leadership in zoning and permitting. The buildings sector comprises a large percentage of greenhouse gas emissions, and buildings constructed or renovated today will last for decades to come. Municipal zoning and permitting processes can help leverage a shift to low-carbon buildings and make a huge impact on current and future emissions. The recommendations in this chapter include best practices that have been utilized for some time, as well as emerging innovative practices.

The following strategies for **Climate-Smart Zoning and Permitting** provide your community with recommended actions that draw on best practices and innovations from across the Commonwealth of Massachusetts and country to:



Allow net zero enabling technologies by-right



Establish climate zoning overlays



Mandate energy efficiency and renewable energy as appropriate



Streamline and expedite permitting for net zero buildings

The Playbook provides a selection of priority actions to advance each of these strategies in your community. Each action's urgency factor of 2025, 2030, or 2050 provides a recommended timeframe by which to fully implement the action. For each action, the Playbook outlines the **action type, urgency, timeframe, local and national examples, scale of impact, type of expense, lead implementer and key partners,** and **performance indicators**. Where available, we have also identified funding opportunities and tools to measure action impacts.

Playbook Indicators

Timeframe to Implement

-  Short-term (Less than one year)
-  Intermediate (1 to 5 years)
-  Long-term (5 years or more)
-  Ongoing

Type of Expense

-  Staff
-  Capital
-  Operations

Benefits and Impacts

The listed benefits and impacts are in addition to reductions in greenhouse gas emissions.

- | | | | |
|---|----------|---|------------------|
|  | Equity |  | Environmental |
|  | Economic |  | Energy |
|  | Health |  | Calculating Tool |

Playbook Terms

Type Actions are sorted into the categories of advocacy, financing, plan, policy, program, or outreach.

Urgency Each action is assigned an urgency factor of 2025, 2030, or 2050, providing a recommended year by which to fully implement the action.

Feasibility A sampling of local, national, or international examples is provided to illustrate on-the-ground implementation. Some actions we have assessed to be impactful have not yet been demonstrated in other communities – these actions are identified as leadership opportunities.

Lead Implementer Each action includes a suggested municipal staff person or department responsible for leading the execution of the action and any decision-making involved. This will differ from community to community.

Key Partner(s) We identified partners within the municipality and the broader community who will be critical to successful implementation of the action.

Scale of Impact Actions have been identified as either an enabling action, hard to measure and high impact, or measurable and high impact. A high impact action is based on whether or not there is a direct connection with emissions reductions within a priority sector. Enabling actions may not have a direct connection to emissions reductions, but they are essential to put in place early on to support greater emissions reductions over time.

Performance Indicators Each action includes suggested metrics to track success and impact during implementation of the action.

How to use this chapter

Since developing, refining, and approving zoning language can take some time (at least a year or more), we recommend that municipalities consider pursuing multiple zoning actions at the same time, and begin as early as possible. It may make sense to plan for an initial round of zoning language changes, and then a second or third round as the community progresses onto other net zero targets.

For instance, a municipality may approve net zero definitions (**Action B**) and establish a climate overlay (**Action D or E**) in an initial article, and then later broaden some of the changes in the overlay to apply community-wide or adopt a Green Factor (**Action H**). Adopting multiple actions together into zoning allows for the city or town to carefully consider how each portion of the zoning code or the bylaws will interact with one another. A municipality may also consider adopting climate zoning changes as part of a larger zoning overhaul if the community has one planned in upcoming years.

Throughout these actions, it is beneficial to engage stakeholders within municipal government and across the community, including [equity stakeholders](#),¹ to create a holistic process for zoning and permitting. The process should be

clear to all departments involved in permitting and plan approval and should align with municipal goals. Once a municipality has successfully adopted net zero zoning language and streamlined permitting, consider developing a net zero zoning guide and permitting checklist to make it easy for developers to follow new policies and to create consistency.

Throughout this chapter, we highlight zoning actions that Massachusetts municipalities can take to advance net zero in their communities. Since zoning language legally cannot conflict with the [State Building Code](#),² Massachusetts municipalities may want to pair the adoption of these zoning and permitting actions with advocacy for a highly efficient building code to complement them. Communities can provide testimony and written comments on the State Building Code through the [Board of Building Regulations and Standards \(BBRS\)](#)³ or propose changes and vote on national codes through the [International Code Council \(ICC\)](#).⁴ Municipalities should consider pursuing Action H from the Net Zero Buildings Chapter to engage in this advocacy. MAPC's [Codes for Climate](#)⁵ webpage has more information on these actions and other ways municipalities can engage on building codes.



Strategy:

Allow net zero enabling technologies by-right

Action A

pg 10

Action B

pg 13

Action C

pg 17

Net Zero Enabling Technologies

In this chapter, **net zero enabling technologies** are defined as those technologies that either 1) significantly increase energy efficiency, 2) allow for a structure to avoid onsite combustion of fossil fuels or to source renewable energy, or 3) store energy generated from renewable sources onsite.

There is a lot of innovation within this field, as new technologies are being developed, tested, scaled up, and improved upon. Many of these technologies are decreasing in costs, as technology improves and supply chains grow, making them more financially attractive solutions for developers.

Category	Example Technologies
Energy Efficiency	• Triple-glazed windows • Ground-, air-, and water-source heat pumps • High R value insulation • Cool or green roof
Renewable Energy	• Solar photovoltaic (PV) • Solar hot water • Solar space heating • Ground-, air-, and water-source heat pumps • Onsite wind turbines
Energy Storage and Management	• Battery storage • Thermal energy storage • Electric vehicle (EV) charging infrastructure



Action A:

Allow by-right the installation and operation of net zero enabling technologies.

Type
Policy

Timeframe

Short-term

(Less than one year)

Urgency

By 2025



Type of Expense
Staff time

Scale of Impact
Hard to measure/
high impact

Performance Indicators

- Number of permits for enabling technology
- Number of clean energy systems installed

Feasibility

Leadership opportunity – look to DOER's [Massachusetts Model Solar Zoning](#)⁶

Key Partners

Planning Department, Energy Manager,
Zoning Board, Planning Board,
Inspectional Services Department

Lead Implementer

Select Board / City Council

Benefits and Impacts

Energy - Reduced energy load through use of energy efficient technologies. Reduced fossil fuel consumption

Environmental - Reduced indoor and outdoor air pollution

Economic - Lower electric and heating energy costs



Allow by-right the installation and operation of net zero enabling technologies.

Some net zero enabling technologies may require local zoning permits for installation. This typically includes solar PV, solar hot water, eco-roofs, and other mechanical equipment that is installed outside the building envelope (such as on the rooftop or within setbacks). This type of equipment will likely be subject to local zoning restrictions and may require additional permits or special permits to be installed.

- Streamline and expedite local permitting processes by allowing net zero enabling technologies to be installed by-right in the majority of zones, rather than requiring additional permits.
- Create a process by which the Inspectional Services Department, the Zoning Board, and developers have a shared understanding of what makes these technologies safe and suitable within the municipality.
- Provide additional training, checklists, and other process documentation to clearly outline what is allowed for which zones (see **Actions L** and **K**).





Equity Considerations

Municipalities should engage with populations identified in the community's Equity Assessment (see [MAPC's Framework for Equity](#)⁷) to plan for which technologies this action will include. Like other zoning actions, the locations in the municipality where this action is implemented will have an impact on equity. Municipalities implementing this action in phases or only in certain zones should consider choosing areas where the action will benefit renters, people of color, low-income residents, and other identified populations.



Immediate Next Step

Municipalities will need to determine which technologies to include and what language is appropriate for their local zoning code. The Massachusetts [Department of Energy Resources' \(DOER's\) Model Solar Zoning](#)⁸ is a good starting point for model language. DOER's model language establishes by-right zoning for solar energy, which could be adapted to define and include additional technologies.

Explore MAPC's resources on climate zoning:
<https://www.mapc.org/resource-library/climate-zoning/>



Action B:

Include net zero enabling technology and related terms in zoning definitions.

Type
Policy

Timeframe
Short-term
(Less than one year)

Urgency

By 2025

Feasibility

Local examples – [Natick Solar Zoning Definitions Section⁹](#); [Massachusetts Model Solar Zoning¹⁰](#)

Lead Implementer
Select Board /
City Council

Key Partners

Planning Department, Energy
Manager, Zoning Board,
Planning Board, Inspectional
Services Department

Benefits and Impacts

Energy – Reduced energy load
through use of energy efficient
technologies

Environmental – Reduced
indoor and outdoor air pollution

Economic – Lower electric and
heating energy costs



Type of Expense
Staff time



Scale of Impact
Enabling action

Performance Indicators

- Number of permits for net zero enabling technologies
- Number of clean energy systems installed



Include net zero enabling technology and related terms in zoning definitions.

Municipalities can take a foundational first step to adopting climate-smart zoning by defining net zero terms, such as “net zero” and “solar energy system”, in the Definitions section of the Zoning Ordinance. Defining terms provides clarity in the interpretation of the zoning ordinance, both for developers and building inspectors.

- Include definitions for any technology with a specified use in the zoning code, including those allowed by-right (**see Action A**) or by special permit.
- For some technologies, like solar or storage, it may be appropriate to designate different definitions based on size or capacity of the system, which could influence their impact on land use.
- Consider including definitions for technologies that the community may want to encourage in the future, such as microgrids, water-based district heating and cooling, or vehicle-to-grid technology.

Definitions can either be integrated into the zoning code in the current Definitions section, or as a separate net zero enabling technologies ordinance. As with any zoning change, zoning and planning staff should make sure to consult municipal counsel throughout the process.



Equity Considerations:

Municipalities should include definitions for community shared solar and other equity-focused clean energy structures that can ensure benefits for low-income residents and other vulnerable groups. The exercise of determining which technologies and actions should be included can be combined with an [Equity Assessment](#).¹¹

Immediate Next Step:

Municipalities should determine which zoning actions from this chapter align with the community's net zero target and other goals. From this list of zoning actions, the additions to the Definitions section should include any technologies or terms that will help to achieve these actions.

Explore MAPC's resources on climate zoning:

<https://www.mapc.org/resource-library/climate-zoning/>



Additional Zoning Ordinance Resources

[Green Zoning: Using Local Zoning to Achieve Community Energy Efficiency and Resiliency](#)¹²: This guide was developed by Northeast Energy Efficiency Partnerships (NEEP) to provide case studies on how green zoning measures can be applied in Massachusetts cities and towns.

[New York Battery Energy Storage System Guidebook for Local Governments](#)¹³: This resource was developed by the New York State Energy Research and Development Authority (NYSERDA) to support cities and towns in planning for and managing the deployment of energy storage in their communities. The guide includes model laws, permits, and electrical checklists.

[Renewable Energy Ordinance Framework – Geothermal](#)¹⁴: This guidance document was developed by the Delaware Valley Regional Planning Council's (DVRPC) Alternative Energy Ordinance Group. The document provides example ordinance language and guidance on how municipalities could approach incorporating the language locally.

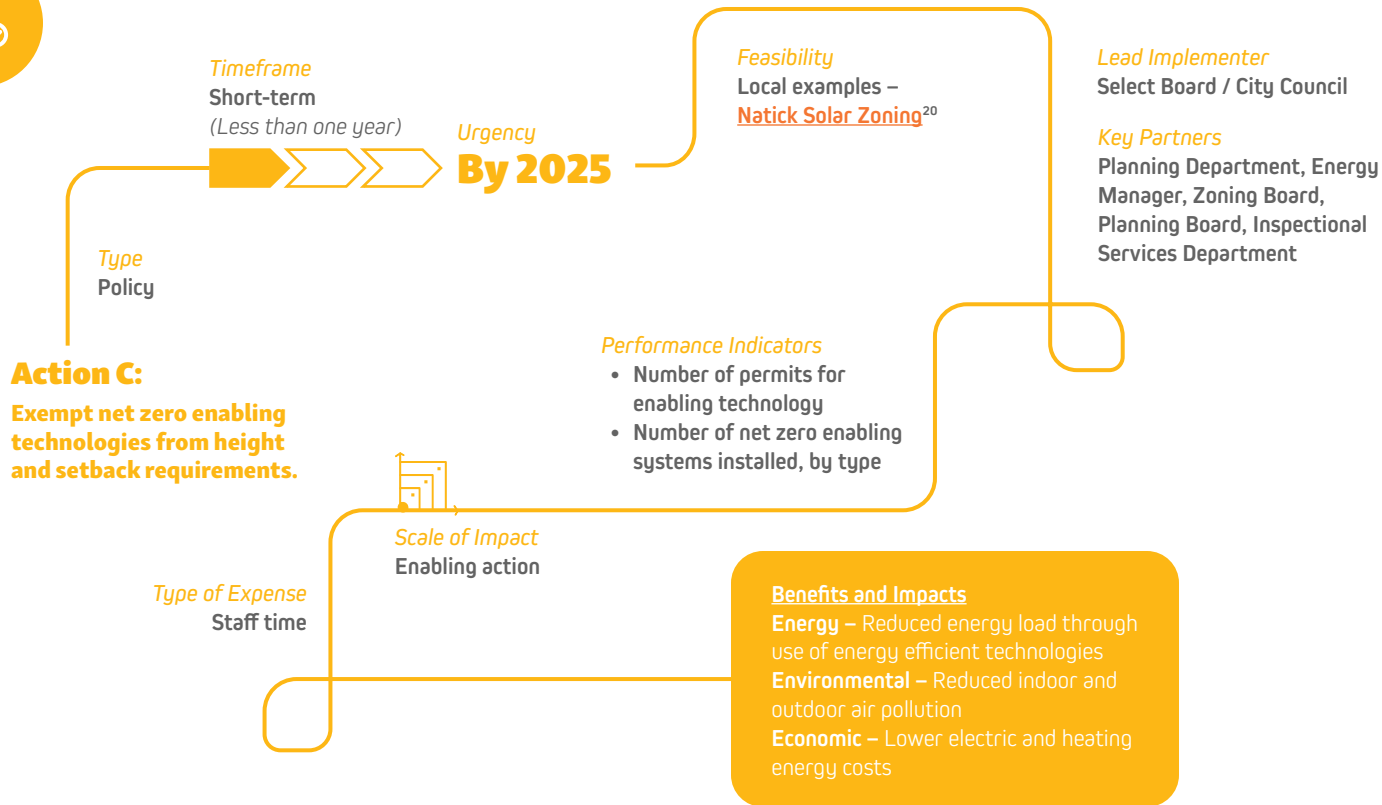
[Guide to Streamlining the Solar PV Permitting Process and Developing Supportive Zoning Bylaws](#)¹⁵: MAPC developed this solar permitting and zoning toolkit to support municipalities in increasing solar adoption across their community.

[Massachusetts Model Solar Zoning Ordinance](#)¹⁶: The Massachusetts Department of Energy Resources (DOER) developed model language for cities and towns to use to support the deployment of solar PV in their communities.

[Solar Energy Toolkit for Local Governments](#)¹⁷: SolSmart developed a toolkit for municipalities on supporting the growth of solar energy. This section of the toolkit focuses on how local governments can use planning, zoning, and development as tools to facilitate solar growth.

[How and Why to Permit for Small Scale Wind Systems](#)¹⁸: This report developed by the American Wind Energy Association covers the ins and outs of small-scale wind system deployment at the local level.

[Climate Resilient Land Use Strategies](#)¹⁹: This online resource compiles example regulatory language and policies that can be used to increase climate resilience in Massachusetts, including the impacts of flooding, drought, and heat.





Exempt net zero enabling technologies from height and setback requirements.

Height and setback requirements determine how tall and how close to the property lines structures can be within a particular zone. Some height and setback requirements can cause unintentional barriers to installing net zero enabling technologies or increase installation costs and timeline. For example, height requirements may make it more difficult for buildings to install rooftop solar PV if they are already built to the maximum height, and other mechanical equipment may need to get special permits if located within a setback. By exempting appropriate net zero enabling technologies, such as those that are accessory use by-right, the municipality can help reduce costs and approval timelines and encourage the integration of these technologies in designs and retrofits.

A municipality should consider exemptions for additional insulation to improve energy efficiency, rooftop solar PV, rooftop solar thermal, eco-roofs, accessory energy storage, and heat pump equipment, from height and setback requirements (where appropriate). For example, a rooftop solar PV system may require a few inches of space between the roof surface and the panels to function optimally, and for electrical boxes and a disconnect switch to be installed on the side of a building. Exemptions enable the addition of solar more easily into the building footprint without having to sacrifice height or setback space. Moreover, setback exemptions can obviate the need for a developer to have to choose between ample living space and the additional insulation and other weatherization measures needed to construct a better building envelope.

This is an enabling action that improves the impact of by-right zoning (**Action A**), as well as other net zero zoning actions.



Equity Considerations

The setback exemptions are particularly relevant in densely populated areas and areas with smaller lot sizes, as these lots will have competing needs that need to be met in a small space. Allowing smaller homes and apartments to expand their building envelope provides more opportunity for low-income residents and renters to benefit from the resiliency, comfort, and cost savings of more robust building shells, lower heating and cooling loads, and improved indoor air quality. Buildings in communities with the most need should be prioritized and supported to maximize these benefits.



Immediate Next Step

Municipalities can get started by reviewing their existing zoning and determining what unintentional barriers may already exist. They can also review current compliance by existing buildings with height restrictions and setback requirements. If most existing structures are out of compliance already, it may be worth including further exemptions or exempting net zero enabling technologies entirely so that efforts to enforce non-compliance do not trigger a zoning review or other additional burdens for prioritized projects.



Strategy: **Establish climate zoning overlays**

Action D

pg 21

Action E

pg 25

Action F

pg 29



Action D:

Create a climate overlay zone that reduces greenhouse gas (GHG) emissions per building type.

Type
Policy

Timeframe
Intermediate
(1 to 5 years)



Urgency

By 2030

Benefits and Impacts

Energy – Reduced fossil fuel energy use in building stock to comply with GHG caps, and associated energy demand reductions from increased energy efficiency

Economic – Reduced energy costs

Health – Improved indoor air quality

Scale of Impact
Measurable /
high impact

Type of Expense
Staff time and capital, including for emissions modeling and zoning enforcement

Key Partners

Planning Department, Energy Manager, Zoning Board, Planning Board, Inspectional Services Department, Building Owners

Lead Implementer
Select Board/City Council

Performance Indicators

- Percentage of buildings in compliance with GHG caps
- Number of new Net Zero buildings constructed

Feasibility

Leadership opportunity – look to [NYC Local Law 97](#)²¹ and [Institute for Market Transformation Building Performance Standards](#)²²



Create a climate overlay zone that reduces greenhouse gas (GHG) emissions per building type.

Similar to **Action A** in the [Net Zero Buildings Chapter](#)²³, this type of climate overlay zone is another mechanism that could be instituted to set a maximum annual GHG emissions cap per square foot for buildings located within a defined boundary.

Determine the initial maximum GHG emissions per square foot for different building types (i.e., commercial, single family, and multi-family) located within the overlay zone. For **form-based zoning**, the maximum can more easily be formatted by building type across different zones since these categories will likely already be established. For **traditional zoning**, the building types that are present within the specific overlay boundary will need to be categorized.

- Establish a stakeholder process to enable different building interests, occupants, and experts to participate in the cap determinations and timeline.
- Consider phasing in more challenging building types or functions and lowering the caps over time.

Continued on the next page.



Choose **compliance and enforcement mechanisms** best suited to your community.

- Two potential compliance pathways include requiring the building developer to either complete GHG emissions modeling at the time of construction or benchmark the building's operational emissions from a set year. Either pathway requires annual reporting for tracking compliance.
- Noncompliance could be addressed through fines or alternative compliance payments, both of which could be collected by the municipality to help support low- to moderate-income building owners and environmental justice communities to comply with the overlay.

This action is one of the most direct ways to drive GHG emissions reductions through zoning but will require robust and thoughtful planning to deploy successfully. Implementation can also be tied to a robust building energy use disclosure ordinance to support data collection and analysis and ensure compliance (see **Action B** of the [Net Zero Buildings Chapter](#)).



Equity Considerations

Municipalities should consider pairing this action with affordable housing requirements. One approach could be to encourage affordable net zero housing for the municipality's most vulnerable residents. Another approach to implementation could be to strengthen tenant rights while establishing the overlay in multi-family zones. Additionally, municipalities should consider dedicating the revenue raised through any noncompliance fees or alternative compliance payments to support for low- to moderate-income building owners and environmental justice communities.



Immediate Next Step

Communities should begin with a thorough greenhouse gas inventory to get an understanding of the emissions for which the building sector in the community is currently responsible. Further analysis will be needed to separate these emissions into different building categories (i.e., types of commercial properties), and enable the municipality to set appropriate GHG emissions reduction targets by building type.

Explore MAPC's Community Greenhouse Gas Inventory Tool

to establish a baseline of community-wide emissions: <https://www.mapc.org/resource-library/community-ghg-inventory-resources/>

Check out MAPC's resources on Climate Zoning:

<https://www.mapc.org/resource-library/climate-zoning/>



Action E:

Create a climate overlay
for high performance
building standards.

Type
Policy

Timeframe
Intermediate
(1 to 5 years)

Urgency

By 2030



Feasibility
Leadership
opportunity – look to
Boston, MA, [Green
Building Guidelines](#)²⁴;
Somerville, MA, [2019
Zoning Ordinance](#)²⁵



Scale of Impact
Hard to measure / high impact

Benefits and Impacts

Energy – Reduced energy use in building stock from
the development of more energy efficient buildings

Economic – Reduced energy costs and maintenance
costs for buildings

Health – Improved indoor air quality from
weatherization measures and elimination of on-site
combustion

Performance Indicators

- Compliance with climate overlay
- Modeled energy use reductions
- Modeled or reported GHG reductions

Key Partners

Planning Department, Energy
Manager, Zoning Board, Planning
Board, Inspectional Services
Department, Building Owners

Lead Implementer
Select Board /
City Council

Type of Expense
Staff time





Create a climate overlay for high performance building standards.

Within this type of climate overlay zone, buildings will be required to meet one of a menu of high-performance building standards, such as [Passive House](#),²⁶ [LEED Zero](#),²⁷ or [Living Building Challenge](#),²⁸ with multiple pathways for compliance.

This overlay accomplishes many of the same objectives as a GHG emissions cap climate overlay (**Action D**), while potentially being easier to track compliance. High performance building standards require developers to meet a certain number of points or choose certain energy efficiency, climate, resilience, and renewable energy measures to include in the building and landscape design. It is essential that the chosen building standard or standards have a variety of ways for a developer to comply to not unintentionally overlap with the building code. However, due to this flexibility, this action does not have as direct an impact on GHG emissions as the GHG emissions cap overlay.

The LEED standards have some precedent in municipal zoning code, such as in the City of Boston's zoning²⁹, City of Cambridge Section 22.000³⁰, and City of Somerville's Development Standards³¹ LEED certification can be met via measures in various sectors, ranging from energy to waste and water use in a building. While compliance with LEED silver, gold, or platinum standards may be less impactful on GHG emissions than other more rigorous standards such as Passive House, Living Building Challenge, and LEED Zero, by offering a menu of compliant standards, a community can offer choice within high-performance bounds. Communities may also want to consider combining this action with a Green Code to incentivize green infrastructure (**Action H**).



Equity Considerations

The location of the overlay will have a direct impact on where highly efficient buildings are located, and thus who will live, work, and spend time in them. It is worth thinking through where this overlay can best benefit residents who would not otherwise get the benefits of a high-performance building. Municipalities can also consider including healthy-living or landscape standards such as WELL³² or SITES³³ in collaboration with high-performance building standards in order to emphasize holistic goals of achieving co-benefits such as health, safety, and resiliency.



Immediate Next Step

Municipalities should explore different high-performance building standards to determine which may best fit the community's goals. Municipalities should look for building standards for which the options for compliance are weighted in alignment with municipal goals. For instance, a municipality that has not yet seen much high-performance construction may wish to include LEED gold or silver in the menu to provide developers a range of stringency in the standards available.

Check out MAPC's resources on Climate Zoning:

<https://www.mapc.org/resource-library/climate-zoning/>





High Performance Building Standards

LEED (Leadership in Energy and Environmental Design)³⁴ is one of the most widely used green building rating systems globally. LEED certification can be pursued for virtually all building types and provides a framework for healthy, highly efficiency, and cost-saving green buildings.

LEED Zero³⁵ complements LEED and verifies the achievement of net zero goals. LEED projects can achieve LEED Zero certification when they demonstrate any or one of the following: net zero carbon emissions, net zero energy use, net zero water use, or net zero waste.

The **Living Building Challenge**³⁶ is an international sustainable building certification program. Living Buildings are defined as regenerative buildings that connect occupants to light, air, food, nature, and community, and remain within the resource limits of their site. The Living Building Challenge is organized into seven performance areas: place, water, energy, health and happiness, materials, equity, and beauty.

Passive House³⁷ is a building performance standard that focuses on efficient building design with low energy consumption. This could be achieved through quality design paired with continuous insulation, high-performance windows, and heat recovery ventilation. In addition to energy efficiency, passive buildings offer long-term benefits such as minimal energy consumption, better indoor air quality, and increased building resiliency.

The **WELL Building Standard**³⁸ provides a framework for buildings and organizations to create spaces that enhance human health. WELL strategies advance health by setting performance standards for design interventions, operational protocols and policies, and commitment to foster health and wellness. Spanning ten concepts with specific health intents, WELL Certification offers a roadmap for improving the quality of air, water, and light with mindful design decisions.



Urgency

By 2025

Type
Policy

Action F:

Enable and incentivize transit-oriented development (TOD).

Timeframe

Short-term

(Less than one year)

Feasibility

Local examples – Growing Station Areas ETOD³⁹; South Salem Transit Oriented Development⁴⁰



Scale of Impact

Hard to measure
/ high impact

Lead Implementer

Select Board / City Council

Key Partners

Planning Department, Transportation Department, Energy Manager, Zoning Board, Planning Board, Inspectional Services Department

Performance Indicators

- Number of vehicle miles traveled within municipality
- Number of affordable units built within an overlay or district
- Number of parking spaces within an overlay or district



Type of Expense

Staff time and capital (if paired with infrastructure changes)

Benefits and Impacts

Economic – Reduced transportation and housing costs for multi-family units

Health - Improved physical and mental health outcomes from active mobility and shorter commute times

Environmental - Improved outdoor air quality



Enable and incentivize transit-oriented development (TOD).

Transit-oriented development encourages increased proximity and access to public transit and active modes of getting around. This can address the challenges for the first and last mile of a commute and provide a more connected and car-free commute through options such as walking and biking. TOD should benefit residents who utilize public transportation and are able to limit the use of single passenger vehicle trips.

- Allow for and incentivize high density and mixed-use buildings close to transit centers such as T-stops, commuter rail stops, bus stops, and bike infrastructure.
- Allow for lower parking minimums for development within walking distance of public transit.
- Discourage and/or re-locate parking away from transit centers in denser municipalities; in suburban and rural municipalities, co-locate parking and transit centers to encourage use of public transit.
- Demonstrate leadership by establishing a car-free block or neighborhood, re-locating parking to the perimeter of the block, and re-purposing roadways in the center for bikes, pedestrians, and green space.





Equity Considerations

In creating the transit-oriented development overlay or district, municipalities should take care to hear lived experiences of residents who rely on public transit, and those who walk and bike for transportation. An overlay or district can be designed to include additional requirements for affordability and community amenities. This recommendation should also be paired with strategies that preserve affordable housing, such as community land trusts, and protect against displacement.

Immediate Next Step

Refer to the [MAPC Growing Station Areas](#) resource through which municipalities can identify community goals and options that may be a good fit given the types of transportation that would be emphasized. Those communities serviced by the MBTA should refer to guidance from the Massachusetts Department of Transportation and the MBTA on the requirements enacted by the Housing Choice legislation in 2021.⁴¹ Through this legislation, all MBTA communities must have at least one multifamily district of reasonable size permitted by right.

Explore MAPC's work with communities on TOD:

<https://www.mapc.org/transportation/>



Strategy: **Mandate energy efficiency and renewable energy as appropriate**

Action G

pg 33

Action H

pg 37

Action I

pg 40

Action J

pg 43



Action G:

Require all new construction and roof replacements to implement an eco-roof.



Type
Policy

Timeframe to Implement

Short-term

(Less than one year)

Urgency

By 2025



Type of Expense
Staff time



Scale of Impact
Hard to measure/
high impact

Benefits and Impacts

Energy – Increased renewable energy through the development of new rooftop renewable systems. Lower building energy demand.

Economic – Reduced heating and cooling loads leads to savings on energy bills.

Environmental – Reduced urban heat island effect and mitigation of stormwater runoff. Improved outdoor air quality due to addition of green infrastructure, provision of food and habitat for pollinators.

Performance Indicators

- Square footage of eco-roofs implemented
- kW of solar installed
- Gallons of stormwater diverted

Key Partners

Planning Department, Energy Manager, Zoning Board, Planning Board, Inspectional Services Department

Feasibility

Local examples and national examples – [Watertown, MA - Solar Requirement](#)⁴², [Cambridge, MA – Green Roofs](#)⁴³, [Toronto, Ontario - Green Roof By-Law](#)⁴⁴, [NYC Cool Roofs Ordinance](#)⁴⁵, [Philadelphia, PA - Blue Roofs](#)⁴⁶



Lead Implementer

Select Board / City Council



Require all new construction and roof replacements to implement an eco-roof.

An “eco-roof” is a term used to describe a climate-smart roof that provides multiple benefits. Eco-roofs can generate renewable energy, manage stormwater, reduce heating loads in a building, and/or mitigate urban heat island effect, depending on the type of roof installed.

- Establish an eco-roof requirement for new construction and roof replacements to ensure developers make use of frequently underutilized rooftop space to advance net zero goals and co-benefits.
- Allow for flexibility within the requirement by allowing developers and building owners to select the best option for each building and location. For instance, the requirement could be fulfilled by either a roof with solar PV or solar thermal, a blue roof that helps to manage stormwater, a green or living roof that uses green infrastructure to store water, reduce heat, and improve air quality, or a white roof that has a finishing surface that reflects sunlight to reduce temperature.
- Consider limiting or prioritizing the types of eco-roof options to those most advantageous to the building types and goals within your community. Different roofs may be more applicable in different municipalities depending on the location of lots available for new construction, or the needs of the community. For example, a more densely populated area may have more need for measures that reduce heat.



Equity Considerations

Some of the options for eco-roofs provide multiple benefits to a greater area than their lot. For example, blue roofs can make an impact over an area larger than the rooftop by reducing stormwater runoff. Energy generation from solar PV could be offered as community shared solar. When planning for the particular eco-roof types available for compliance, municipalities should survey the populations most affected for feedback. Additionally, municipalities should consider providing financial incentives to support deployment in low- and moderate-income neighborhoods.



Immediate Next Step

Municipalities can get started by assessing the solar potential, stormwater mitigation needs, and impacts of urban heat island effect in different areas of the community to determine which eco-roof types may be more feasible and useful. Municipalities should consider supporting this action by adding prioritized rooftops to the Definitions section of their zoning code (see **Action B**); this can help encourage eco-roof deployment even before requirements are in place.





Types of Eco-Roofs

Type	Definitions	Benefits
Solar Roof	A solar roof could be a solar photovoltaic (PV) system for renewable energy generation or a solar thermal system to offset the heating load of the building by pre-heating the building's water with heat generated from solar collectors on the roof.	• Generates renewable energy - either electricity via solar PV or thermal energy in terms of solar hot water. • Reduces energy costs to occupants over time.
Green (or Living) Roof	A roof with living green infrastructure for the purpose of mitigating heat, storing water, and improving air quality; can also function as a location for urban farming, pollinators, and passive recreation.	• Provides many co-benefits including water filtration, improved air quality, localized cooling, and reduced heating and cooling loads. • Can serve as a public amenity, providing open space.
White (or Cool) Roof	A finishing or surface that reflects more light than it absorbs. This lowers the temperature of the air around it, helping to reduce urban heat island impacts by as much as a third globally if all roofs in major cities were treated. ⁴⁷	• Low-cost option that reduces energy load in the summer, thereby also decreasing need for mechanical cooling. • May be paired with other eco-roofs or solar roof.
Blue Roof	A roof system employed in stormwater management. This could encompass active or passive rainwater storage and drainage systems.	• Improves water quality by reducing strain on sewer system and overflow events. • Reduces flooding.



Action H:

Adopt a Green Code with resiliency and mitigation incentives. Set minimum requirements for compliance in each zone.

Type
Policy

Timeframe to Implement
Short-term
(Less than one year) Urgency

By 2025

Feasibility

Local and national examples – Somerville, MA – [2019 Zoning Ordinance](#)⁴⁸ ; Seattle, WA – [Green Factor Standard](#)⁴⁹

Lead Implementer

Select Board / City Council

Key Partners

Planning Department, Energy Manager, Zoning Board, Planning Board, Inspectional Services Department



Performance Indicators

- Number of permits meeting the Green Score criteria

Scale of Impact
Hard to measure/
high impact

Type of Expense
Staff time

Benefits and Impacts

Health – Improved management of urban heat island impacts
Environmental – Improved management of stormwater and outdoor air quality



Adopt a Green Code with resiliency and mitigation incentives.

A Green Code provides development incentives to encourage a variety of environmentally sustainable building and site measures. Many nature-based or green strategies also present opportunities for emissions reductions if implemented holistically. For example, a green roof improves air quality and localized cooling benefits, but it also has the mitigation benefit of reduced heating and cooling load in the building. A Green Code allows for multiple pathways of compliance, as applicants choose actions from a pre-set list (examples include native plants, de-paving, and percent lot coverage), and encourages the inclusion of green infrastructure within each lot on a points-based system. The Green Code builds off impervious surface requirements from low-impact development and adds guidance for green infrastructure.

- Assess whether a Green Code is a good fit for your community. Municipalities experiencing new development and redevelopment may want to incentivize green infrastructure that increases multiple co-benefits, including improvements to air quality, water quality, and natural cooling.
- Include incentives in the Green Code for climate mitigation measures that are implemented along with the climate resiliency measures. Such as shade trees that are planted intentionally to shade structures and reduce heating/cooling loads in nearby buildings.
- Ensure that the Green Code aligns with your community's values so that the actions worth the most points are those from which the community would most benefit, as opposed to just the most difficult to implement. This can include prioritizing trees near walking paths and sidewalks, and green infrastructure for stormwater management.



Equity Considerations

Depending on where the Green Code is implemented, there could be concern around “green gentrification,” such as in the potential for displacement of residents in neighborhoods experiencing increased investment in local amenities. A zoning ordinance could be paired with housing strategies, such as community land trusts and mechanisms for preserving and requiring affordability, to address this concern. Engage residents from at-risk communities in the planning and development of the Green Code to improve the likelihood for a more equitable and impactful outcome. The specific factors and multiplier should be determined based on local needs and priorities.



Immediate Next Step

Municipalities can start by reviewing the existing examples of Green Codes (see Somerville, MA, Green Score, and Seattle, WA, Green Factors, local zoning ordinances), and conducting stakeholder engagement sessions to determine which factors should be weighted most heavily for your community.



Action I:

Require energy efficiency licensing for rental units. Include requirements for ongoing compliance.

Type
Policy

Timeframe
Intermediate
(1 to 5 years)

Urgency

By 2040

Benefits and Impacts

Equity – Increased affordability, safety, and comfort of rental units
Economic – Reduced energy costs for renters

Health – Improved resiliency and indoor air quality

Scale of Impact

Hard to measure/high impact

Performance Indicators

- Percentage of rental units licensed
- Number of energy efficiency measures installed in licensed units

Type of Expense

Staff time and operations (could be offset by noncompliance fees)

Feasibility

Leadership opportunity – look to [Somerville, MA](#)⁵⁰; [Boulder, CO](#)⁵¹; [NYSERDA Energy Efficiency Retrofit Program](#)⁵²

Lead Implementer

Inspectional Services Department

Key Partners

Housing Department, Energy Manager, Renters, Property Owners, Advocacy and Consumer Protection Organizations, Board of Health



Require energy efficiency licensing for rental units.

One of the largest barriers to implementation of energy efficiency in rental units is that it requires those who own and manage the property, such as landlords and building managers, to invest in efficiency upgrades while those occupying the building units – assuming they are responsible for the utility payments – experience the benefits, including economic, quality of life, resilience, and health benefits. This is known as a “split incentive.” Rental licensing helps to address this challenge and promote energy efficiency in existing buildings by requiring that certain actions, such as energy audits and weatherization, be implemented in rental properties and pass a regular inspection during the point of leasing.

- Establish requirements within the rental licensing process for landlords and building managers to improve the health, safety, and welfare of renters. This could include requirements to provide a minimum level of energy efficiency for lighting, heating and cooling, and hot water their units.
- Formalize the timeline of energy efficiency measures so that landlords and building managers can implement appropriate measures strategically. Consider starting with a voluntary program with recognition for joining the program, and ramping up to required rental licensing over time.
- Provide landlords with flexibility in how to comply, such as the ability to choose which technology, from among a prioritized list or degree of efficiency, is most appropriate.
- Inspections of rental units should happen at minimum when the lease changes. However, municipalities could require more regular inspections at a standard interval of time. Results of the inspection should be publicly available for renters.
- Consider adopting commercial property assessed clean energy (PACE) financing in your community or other financing policies to help to defray the costs for licensees (see **Action I** of the [Net Zero Buildings Chapter](#)).



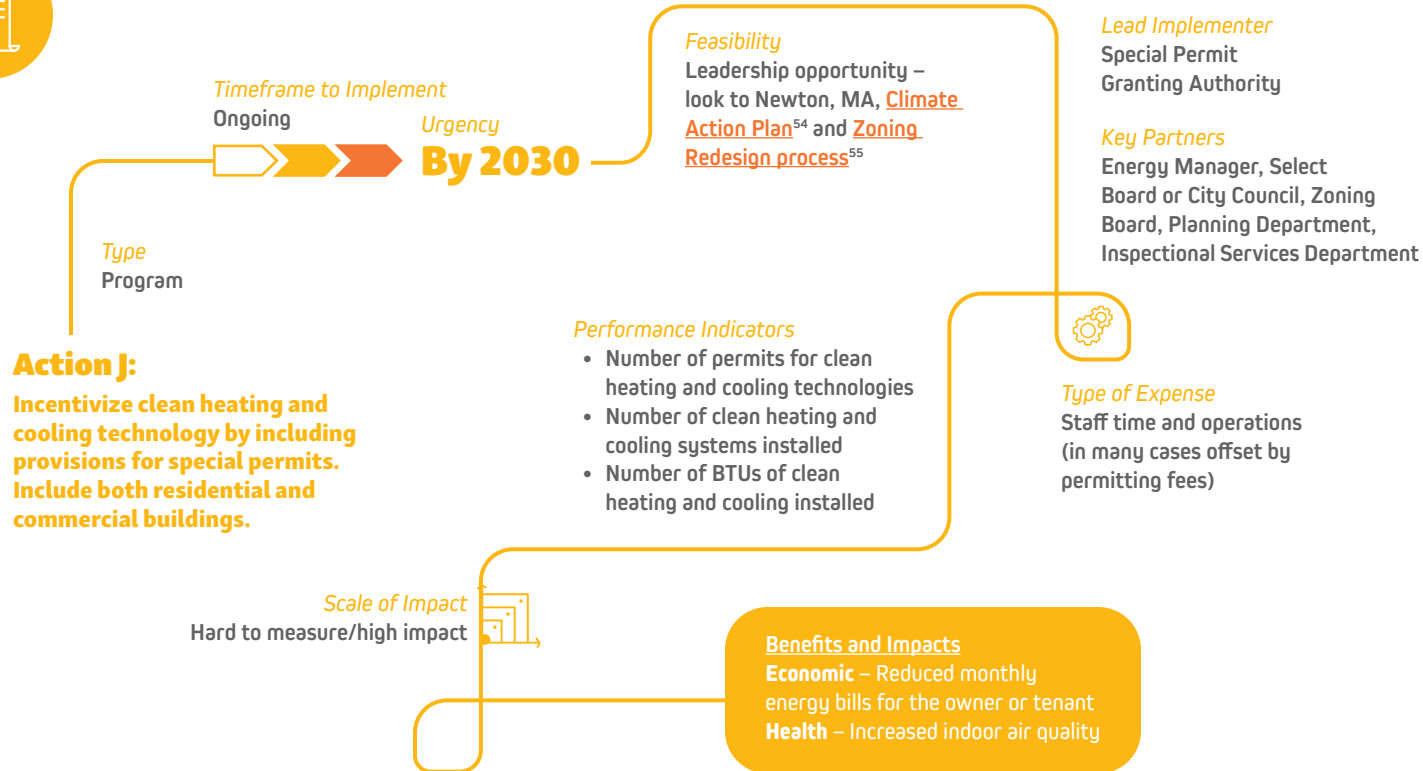
Equity Considerations

This action should be paired with protection for renters so that they are not displaced by resulting improvements to the property. Municipalities enacting this action should enact complementary policies and programs, such as renter protections, free renter legal aid, and renter support phone-lines. One of the primary goals of this policy should be to implement energy efficiency measures, such as clean heating and cooling technologies, and weatherization in units occupied by those often underserved by these benefits, including low- and moderate-income residents and small businesses, environmental justice communities, and those with limited English proficiency. Renters across these communities have long been a priority of the MA Energy Efficiency Advisory Council due to the challenges of the split incentive issue and significant intersection of renters with other prioritized groups.⁵³



Immediate Next Step

Municipalities can start by establishing a list of rental units and a contact list of landlords within the municipality for communication about the licensing policy under development. Municipalities should also survey renters and obtain feedback on beneficial protections.





Incentivize clean heating and cooling technology by including provisions for special permits.

Developers must seek special permits to build specific types of uses in specific zones, such as density bonus or allowing a mixed-use multifamily in a commercial district. Municipalities have the authority to incentivize the inclusion of additional amenities in order to be able to grant a special permit that align with their goals. Amenities such as solar energy systems or clean heating and cooling technologies (ground-source or air-source heat pumps or solar hot water), could be required for developers applying for a special permit.

- Create guidance for the Special Permit Granting Authority (SPGA)⁵⁶ on clean heating and cooling technologies amenities and ensure that information on the technologies is provided during special permit hearings. Once familiarity with the technology is increased, adoption of clean heating and cooling can be required as part of the special permitting process.
- Phase in the requirement of clean heating and cooling technology within the special permitting process by end use. For instance, a municipality could first require this technology to be used for space heating and cooling, and soon after include incentives for domestic hot water in single-family and then multi-family buildings.





Equity Considerations:

To ensure that low-income residents, communities of color, and other populations that are disproportionately affected by poor indoor and outdoor air quality are beneficiaries of this action, municipalities can consider equity indicators in the permitting process, prioritize permitting for multi-family buildings, or provide financial or technical assistance for those populations adopting clean heating and cooling technology.



Immediate Next Step:

Municipalities can start by reviewing their current special permit review process. The incentives for clean heating and cooling can be modeled after existing solar energy system incentives for special permits or density bonuses. Municipalities can also begin educating the select board, city council, zoning board, planning board, board of appeals, or other individuals that are a part of the SPGA on the pathway under development and the benefits and feasibility of clean heating and cooling.

Explore MAPC's resources on clean heating and cooling technologies:

<https://www.mapc.org/resource-library/clean-heating-and-cooling/>



Strategy: **Streamline and expedite permitting for net zero buildings.**

Action K

pg 47

Action L

pg 50



Action K:

Offer expedited permitting and reduced permitting fees for net zero emissions buildings and net zero enabling technologies.

Type
Policy

Timeframe to Implement
Ongoing

Urgency

By 2030

Type of Expense
Staff time and
operations

Benefits and Impacts

Energy – Reduced energy use in building stock from the development of energy efficient and net zero emissions buildings

Economic – Reduced energy costs for the owner or tenant, reduced soft costs for the developer (i.e., non-hardware costs)

Health – Improved indoor air quality

Performance Indicators

- Number of permits for net zero enabling technologies
- Number of permits for net zero emissions buildings
- Average length of permitting process for net zero emissions buildings and enabling technologies

Feasibility

Local and national examples – [Natick, MA – Solar Permitting Checklist](#)⁵⁸; [Seattle, WA - Priority Green Expedited](#)⁵⁹; [Salt Lake City, UT - Green Building Expedited](#)⁶⁰; [San Diego, CA - Green Building Program](#)⁶¹; [Palo Alto, CA – Net Zero Baseline Study](#)⁶²

Key Partners

Energy Manager, Planning Department, Zoning Board,

Lead Implementer

Inspectional Services Department

Scale of Impact

Hard to measure/high impact





Offer expedited permitting and reduced permitting fees for net zero buildings and technology.

The goal of this streamlined permitting pathway is to encourage net zero construction and technologies by providing a transparent, easier, and/or less expensive permitting process. Building developers will find a simple pathway easier to plan for and follow, and will be more likely to submit plans that meet the requirements of the pathway. Reduced or eliminated fees and more predictable timing can also be an enticement.

- Assess the existing permitting pathway for net zero buildings and enabling technologies and then implement measures to streamline the process. A checklist that outlines the permitting pathway is a beneficial starting place, as it improves communication among inspectional services, planning, and zoning staff as well as those pulling the permits. Other measures include electronic permitting, fast response times for pulled permits, automatic approvals for commonplace and prioritized technologies, brief and predictable inspection windows, and virtual inspection options.
- Provide additional substantive guidance to developers on permitting for net zero buildings. This guidance will help encourage developers to meet and exceed building standards for net zero.
- Consider combining with online plan reviews to increase the effectiveness of the process for developers.
- Offer expedited permitting and reduced permitting fees for other high-performance building types as well, perhaps with a sliding scale toward those that are more efficient and low-carbon. Include buildings meeting the requirements of Passive House and/or buildings meeting one of many high-performance building standards (see **Action E**).



Equity Considerations

In developing streamlined permitting processes, municipalities can start by prioritizing feedback from developers that are minority and women-led businesses. These steps will help to ensure that minority and women-led businesses will be able to effectively navigate the permitting pathways. Municipalities should consider increasing the available incentives for multi-family buildings and retrofits to encourage greater adoption of net zero enabling technologies and systems in hard-to-reach buildings. Moreover, they should consider implementing incentives for projects that serve environmental justice communities or share energy savings between renters and landlords in addition to these other permitting mechanisms.



Immediate Next Step

Municipalities should convene relevant staff, including Inspectional Services, Planning, and Zoning, to review the existing permitting pathways for high-performance buildings and net zero enabling building systems (such as clean heating and cooling equipment), and determine how the process can be improved for net zero-related permits. Municipalities can create a checklist of this improved process for clarity and simplicity.

Explore the resources available from MAPC and SolSmart on how to expedite permitting:

<https://www.mapc.org/planning101/best-practices-for-streamlining-solar-permitting-and-inspection-processes/>

<https://www.mapc.org/wp-content/uploads/2017/11/Solar-Permitting-and-Zoning-Bylaws.pdf>

<https://solsmart.org/permitting/>



Action L:

Train reviewers and staff on net zero building standards and design.

Type
Program

Timeframe to Implement
Ongoing

Urgency

By 2030

Feasibility

Local examples – [MAPC SolSmart Solar Permitting Trainings](#)⁶³; [MassCEC Solar Permitting and Inspection Trainings](#)⁶⁴; [Building Operator Certification trainings](#)⁶⁵

Benefits and Impacts

Energy – Reduced energy use in building stock from the development of new energy efficient and net zero buildings

Economic – Reduced operational energy costs

Health – Improved indoor air quality

Lead Implementer
Inspectional Services Department

Key Partners
Certified Trainers, Planning Department, Energy Manager

Type of Expense
Capital and staff time

Performance Indicators

- Participation by Inspectional Services staff in training
- Turnaround time for permits for net zero enabling technology and net zero buildings

Scale of Impact
Enabling action



Train reviewers and staff on net zero building standards and design.

Since the development of a net zero building utilizes different building standards, calculations, and codes than are typically used in construction, building inspectors and plan reviewers may not have a familiarity with best practices.

- Train planning board, building inspectors, and related staff in net zero building standards to familiarize them with high-performance building practices, to empower them to conduct relevant energy and performance calculations during plan review, and to enable inspectors to identify common construction mistakes and code violations so that they can conduct effective inspections.
- Provide a thorough curriculum that covers topics such as LEED, Net Zero, Passive House and other high-performance standards, HERS ratings, life safety benefits of high-performance buildings, and energy modeling.
- Provide continuing education units for the trainings to enhance professional development.



Equity Considerations

Training for plan reviewers and inspectors should include multi-family units, as appropriate depending on the community. There are some existing examples of net zero and net positive multi-family buildings primarily where housing is built by a state or municipality. However, significant barriers exist for renters due to the split incentive issue referenced in **Action I**. By focusing on multi-family buildings, a municipality can make this permitting pathway easier and more familiar for both the plan reviewer and the developer, which can reduce time and effort and increase the likelihood that multi-family net zero buildings will be developed.



Immediate Next Step

Municipalities should seek to establish goals for a net zero inspection and plan review training curriculum and identify project partners to conduct the trainings. Municipalities can look to MassCEC⁶⁶, Mass Save⁶⁷, and Built Environment Plus⁶⁸ for more resources on trainings.

End Notes

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- 2 Massachusetts RE16RC13: Zoning and Building Codes, <https://www.mass.gov/service-details/re16rc13-zoning-building-codes>
- 3 Massachusetts Board of Building Regulations and Standards (BBRS), <https://www.mass.gov/orgs/board-of-building-regulation-and-standards>
- 4 International Code Council (ICC), <https://www.iccsafe.org/>
- 5 MAPC Codes for Climate resources, <https://www.mapc.org/resource-library/building-codes-climate-2/#climatecodes>
- 6 “Model Zoning for the Regulation of Solar Energy Systems,” Massachusetts Department of Energy Resources, December 2014, <https://www.mass.gov/files/documents/2016/08/nc/model-solar-zoning.pdf>
- 7 “Net Zero Framework for Equity,” MAPC, March 2020, p.7, http://www.mapc.org/wp-content/uploads/2020/03/03052020-Playbook_Framework-for-Equity.pdf
- 8 “Model Zoning for the Regulation of Solar Energy Systems,” Massachusetts Department of Energy Resources, December 2014, <https://www.mass.gov/files/documents/2016/08/nc/model-solar-zoning.pdf>
- 9 Natick, MA, SolSmart and Solar Efforts, <https://www.natickma.gov/1233/Renewable-Energy>
- 10 Massachusetts Department of Energy Resources Model Zoning for the Regulation of Solar Energy Systems: <https://www.mass.gov/files/documents/2016/08/nc/model-solar-zoning.pdf>

- 11 MAPC Net Zero Playbook Framework For Equity p.7 Conducting an Equity Assessment: http://www.mapc.org/wp-content/uploads/2020/03/03052020-Playbook_Framework-for-Equity.pdf
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- 14 Renewable Energy Ordinance Framework, DVRPC, https://www.dvrpc.org/EnergyClimate/ModelOrdinance/Geothermal/pdf/2012-11-30_AEQWGGeothermalFrameworkFINAL.pdf
- 15 “Guide to Streamlining the Solar PV Permitting Process and Developing Supportive Zoning Bylaws,” MAPC, January 2015, <https://www.mapc.org/wp-content/uploads/2017/11/Solar-Permitting-and-Zoning-Bylaws.pdf>
- 16 Model Zoning for the Regulation of Solar Energy Systems, MA Department of Energy Resources, <https://www.mass.gov/doc/model-solar-zoning-0/download>
- 17 Solar Energy: SolSmart’s Toolkit for Local Governments, SolSmart, <https://solsmart.org/solar-energy-a-toolkit-for-local-governments/planning-zoning-development/>
- 18 In the Public Interest: How and Why to Permit for Small Scale Wind Systems, American Wind Energy Association, https://www.dvrpc.org/EnergyClimate/ModelOrdinance/Wind/pdf/AWEA_In_the_Public_Interest_2008.pdf
- 19 Climate Resilient Land Use Strategies <https://www.mapc.org/resource-library/climate-resilient-land-use-strategies/>
- 20 Natick, MA, SolSmart and Solar Efforts webpage, <https://www.natickma.gov/1233/Renewable-Energy>
- 21 “Local Laws of the City of New York for the Year of 2019: No. 97”, City of New York, 2019, https://www1.nyc.gov/assets/buildings/local_laws/ll97of2019.pdf

- 22 “The ABC’s of BPS: What You Should Know about Building Performance Standards,” Institute for Market Transformation, October 2019, <https://www.imt.org/the-abcs-of-bps-what-you-should-know-about-building-performance-standards/>
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- 44 Toronto, Ontario, Green Roof By-Law, <https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/green-roofs/green-roof-bylaw/>
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- 47 Pearce, Fred, "Urban Heat: Can White Roofs Help Cool World's Warming Cities?," YaleEnvironment360, March 7, 2018, <https://e360.gale.edu/features/urban-heat-can-white-roofs-help-cool-the-worlds-warming-cities#:~:text=Keith%20leson%20of%20the%20National,percent%20today%20to%2090%20percent>
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- 51 Boulder, CO, Rental Housing Licensing, <https://bouldercolorado.gov/plan-develop/rental-housing-licensing>
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- 63 MAPC Resources for Solar Permitting and Inspection Training, <https://www.mapc.org/planning101/best-practices-for-streamlining-solar-permitting-and-inspection-processes/>
- 64 MassCEC Solar Permitting and Inspection trainings, <https://www.masscec.com/events/masscec-solar-permitting-and-inspection-training-sponsored-masscec>
- 65 Building Operator Certification, <https://www.theboc.info/>
- 66 MassCEC Solar Permitting and Inspection trainings, <https://www.masscec.com/events/masscec-solar-permitting-and-inspection-training-sponsored-masscec>
- 67 Mass Save Energy Code Trainings, <https://www.masssave.com/learn/partners/energy-code-training-and-events>
- 68 Built Environment Plus Green Building Training Program, <https://builtenvironmentplus.org/green-building-training-program/>

FOR PB USE ONLY

**NEEDHAM
ZONING BOARD OF APPEALS
AGENDA
THURSDAY, September 21, 2023 - 7:30PM**

Charles River Room Public Service Administration Building 500 Dedham Avenue Needham, MA 02492	Also livestreamed on Zoom Meeting ID: 869-6475-7241 To join the meeting click this link: https://us02web.zoom.us/j/86964757241
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Minutes Review and approve Minutes from July 20, 2023 meeting.

Case #1 – 7:30PM **1458 Great Plain Avenue** –Tobin Beaudet Schools, Inc., has applied for a Special Permit Amendment under Sections 5.1.1.5, 5.1.4, 5.1.3 and any other applicable Sections of the By-Law to waive strict adherence to the number of parking spaces required and parking plan and design requirements. This request is associated with the increase of children at 1458 Great Plain Avenue who are temporarily relocated because of a six-to-nine-month construction project at 72 School Street. The property is located at 1458 Great Plain Avenue, Needham, MA in the Single Residence B (SR-B) District.

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ZBA Application For Hearing

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

Applicant Information

Applicant Name	Tobin Beaudet Schools, Inc.			Date:	08-28-23
Applicant Address	72 School Street, Needham, MA 02492				
Phone	781-444-5444	email	sbeaudet@tobinbeaudet.com		
Applicant is ☐ Owner; ☒ Tenant; ☐ Purchaser; ☐ Other _____					
If not the owner, a letter from the owner certifying authorization to apply must be included					
Representative Name	Evans Huber, Esq., Frieze Cramer Rosen & Huber LLP				
Address	62 Walnut Street, Suite 6				
Phone	781 943-4000	email	eh@128law.com		
Representative is ☒ Attorney; ☐ Contractor; ☐ Architect; ☐ Other _____					
Contact ☐ Me ☒ Representative in connection with this application.					

Subject Property Information

Property Address	1458 Great Plain Avenue, Needham		
Map/Parcel Number	Map 216 Parcel 1	Zone of Property	Single Residence B
Is property within 100 feet of wetlands, 200 feet of stream or in flood Plain? ☐ Yes ☒ No			
Is property ☐ Residential or ☒ Commercial			
If residential renovation, will renovation constitute "new construction"? ☐ Yes ☒ No			
If commercial, does the number of parking spaces meet the By-Law requirement? ☐ Yes ☒ No			
Do the spaces meet design requirements? ☐ Yes ☒ No			
Application Type (<i>select one</i>): ☐ Special Permit ☐ Variance ☐ Comprehensive Permit ☒ Amendment ☐ Appeal Building Inspector Decision			



ZBA Application For Hearing

Existing Conditions:

The applicant currently operates an afterschool program in the Church building

on the property, for up to 90 children and 10 staff. The applicant also has approval of this Board to operate a morning program for up to 40 children and 4 staff. However, Applicant is not currently operating the morning program at this location. See prior decision of this Board dated June 16, 2019, filed herewith.

There are seventeen (17) parking spaces in the Church lot. In addition, Applicant has permission from the Newman school to use the adjacent parking lot (with no cap on the number of spaces used) between 7:00 - 8:00 a.m. and after 3:30 p.m.

Statement of Relief Sought:

Because, as approved by this Board, the Applicant's location at 72 School Street will be undergoing construction for approximately six to nine months, applicant proposes, during that period of construction, to increase the number of children at this location during the afterschool program to a maximum of 120, with a maximum of 12 staff, and to increase the number of children during the morning to a maximum of fifty (50), with a maximum of eight (8) staff. Applicant seeks a temporary amendment to its existing special permit, waiving the requirement of compliance with the number of parking spaces required by section 5.1.2 of the Bylaw (as determined by the Building Commissioner), as well as certain design requirements in section 5.1.3 of the Bylaw. Applicant notes that this use is protected by the Dover Amendment.

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

Subject to the fact that the child care facility is

protected by the Dover Amendment, sections 5.1.1.5, 5.1.2, 5.1.3, 7.5.2, and any other applicable section of the Bylaw.

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

	Existing Conditions	Proposed Conditions
Use	N/A	N/A
# Dwelling Units	N/A	N/A
Lot Area (square feet)	N/A	N/A
Front Setback (feet)	N/A	N/A
Rear Setback (feet)	N/A	N/A
Left Setback (feet)	N/A	N/A
Right Setback (feet)	N/A	N/A
Frontage (feet)	N/A	N/A
Lot Coverage (%)	N/A	N/A
FAR (Floor area divided by the lot area)	N/A	N/A
Numbers must match those on the certified plot plan and supporting materials		



ZBA Application For Hearing

Date Structure Constructed including additions:

There is no issue regarding pre-existing non-conforming lot or structures

Date Lot was created:

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

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



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

I certify that I have consulted with the Building Inspector August 17, 2023
date of consult

Date: August 28, 2023

Applicant Signature

Stephenio Beedat

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

COMMONWEALTH OF MASSACHUSETTS

NORFOLK, ss

NEEDHAM ZONING
BOARD OF APPEALS

The Tobin Beaudet Schools, Inc.,
Applicant

Re: Amendment to Special Permit
For 1458 Great Plain Ave, Needham)

**APPLICANT'S MEMORANDUM IN SUPPORT OF
APPLICATION FOR AMENDMENT TO SPECIAL PERMIT**

INTRODUCTION

Applicant, The Tobin Beaudet Schools, Inc. ("TBS") is a tenant, and runs an afterschool program, at the property located at 1458 Great Plain Avenue, Needham, MA, owned by the Presbyterian Church of Needham (the "Property"). There are 17 parking spaces in the parking lot at the Property.

On June 16, 2019, this Board issued an Amendment to the previously issued and amended Special Permit for this location, pursuant to Section 5.1.1.5 of the Zoning By-Law, waiving strict adherence with the requirements of Sections 5.1.2 (Required Parking) and 5.1.3 (Parking Plan and Design Requirements). A copy of that decision is attached as **Exhibit 1**.

By virtue of the 2019 Amendment to Special Permit, TBS has been running its afterschool program at the Property, for up to 90 children and a maximum of 10 staff members at any one time (the actual number of children in the current afternoon program is currently approximately 70). The 2019 Amendment also allowed TBS to run a morning program for up to 40 children and a maximum of 4 staff. However, TBS has not been running the morning program at that location, so the only current use of the 1458 Great Plain Avenue location is the afternoon program.

As this Board will recall, TBS also runs a child care program at its facility located at 72 School Street in Needham. The Special Permit for that location allows up to 66 children; in reality, the actual number of children at that location is below 66, and TBS expects that the enrollment for that program for 2023-24 will be approximately 50 children. By Decision dated June 16, 2023, this Board approved an amendment to the Special Permit for that location, allowing the construction of a partial second floor on the existing building. Applicant intends to commence that construction project as soon as possible, but obviously cannot operate as a child care facility during construction.

TBS therefore proposes to run both programs at its 1458 Great Plain Avenue location during the period of construction at 72 School Street. The hours of operation for the program

currently run at 72 School Street will not change: 7:30 a.m. to 6:00 p.m., Monday through Friday. In addition, TBS will be continuing the afternoon program it has been running at the Property since 2011, with no change in the hours of operation, which are from 2:30 p.m. until 6:30 p.m. on days when school is in session. In addition to after-school hours, as is currently the case, the program will continue to be open during school vacations and on weekdays when school is not in session, such as teacher development days and snow days. On those days the program begins at 7:00 a.m. and end at 6:30 p.m. The program will not be open on Saturdays or Sundays.

Combining the two programs during the construction period would mean a maximum of 50 students and 8 staff members in the morning, and a maximum of 120 students and 12 staff members during the afternoon.

PROPERTY CHARACTERISTICS

The Property is located at the corner of Great Plain Avenue and Central Avenue and consists of approximately 55,494 square feet of land with approximately 250 feet of frontage on Great Plain Avenue and approximately 125 feet of frontage on Central Avenue. The Property is located in the Single Residence B Zoning District; and contains the Church and an attached one-story building with basement that was first constructed in 1958 and subsequently renovated in 1971.

There are seventeen parking spaces at the Property, which includes the Church sanctuary and related space; and slightly less than 1,000 square feet of first floor office and administrative space in addition to the space being leased by Tobin Afterschool. The parking spaces and layout of the parking area has not changed since the time of the 2019 Amendment to the Special Permit for this location.

The Property is adjacent to the Newman School and is separated from the Newman School parking lot by a short walkway.

CALCULATED PARKING REQUIREMENTS

The Applicant and counsel met with the new Building Commissioner on August 17. At that time, the Building Commissioner noted (i) the Needham zoning bylaw does not specify a particular parking requirement for child care facilities; and (ii) in the absence of a specified parking requirement, the Bylaw authorizes the Building Commissioner to determine the required parking. The formula that the Town has used in the past to calculate parking required for child care facilities with more than 45 children (1 space for each staff member, plus 8 spaces, plus 1 space for each 40 children) was discussed, and the Commissioner expressed some reservations that the formula might require too many spaces. No determination as to the parking requirement was made at that time.

Nevertheless, if one applies the formula that the Town has used in the past, the proposed temporary increase in children and staff will result in the following calculated parking requirements for the TBS programs during the period of construction at 72 School Street:

1. Morning (up to 50 children and 8 staff) : 8 staff + 8 spaces + 2 (1 space per 40 children or fraction thereof) = 18 spaces
2. Afternoon (up to 120 children and 12 staff): 12 staff + 8 spaces + 3 (1 space per 40 children or fraction thereof) = 23 spaces

At present there are no other uses of the Church Property during the hours of the TBS morning or afternoon programs. Nevertheless, as calculated in the original Memorandum submitted to this Board as part of the original 2011 application for a Special Permit, pursuant to section 5.1.2 (7) of the Bylaw, the approximately 1,000 square feet of office and administrative space in the portion of the building near the sanctuary requires four parking spaces.¹

In total, therefore, the calculated parking requirement for 1458 Great Plain Avenue (at least according to the formula used in the past), if the two programs are combined, would be 18 program spaces + 4 church-use space = 22 in the morning, and 23 program spaces + 4 church-use = 27 in the afternoon.

Consequently, TBS seeks a further amendment to its Special Permit, pursuant to Section 5.1.1.5 of the Zoning By-Law, again waiving (during the period of construction at 72 School Street) strict adherence with the requirements of Sections 5.1.2 and 5.1.3 of the Bylaw.

HOW TBS WILL MEET ACTUAL PARKING DEMAND

Children enrolled in the program that is currently run at the 72 School Street location are typically dropped off or picked up by a parent or caregiver. This is typically an all-day program.

Children arrive at the afternoon program currently run at the 1458 Great Plain Avenue location in one of two ways. Children coming from the adjacent Newman School simply walk to the afternoon program via the walkway connecting the Property to the Newman School parking lot. Children coming from other schools arrive via a bus provided by TBS. Thus, at the start of the afternoon program each day (at 2:30 p.m.), the actual demand for parking resulting from children arriving for the afternoon program is far less than the 27 spaces that the formula described above would require.

As noted above, the Newman School parking lot is adjacent to the Property and is connected to the Property via a short walkway. As was true at the time of the original application, and the 2019 Amendment, the Newman School has granted permission for TBS parents to use the Newman School parking lot between 7:00 - 8:00 a.m., and after 3:30 p.m. See email exchange between Jessica Peterson, Principal of the Newman School, and Stephanie Beaudet, attached as Exhibit 2.

¹ The original Application for the Special Permit did not address the parking requirements for the sanctuary of the Church, which, under Section 5.1.2 (1) would be one parking space per three seats of total seating capacity. Presumably, this was because parking for Church services would only be required on Sundays, and Tobin Afterschool's operation would therefore have no impact on the Church's parking requirements for those attending its services. Tobin Afterschool is applying the same assumption to the present analysis.

TBS proposes that in terms of pickup and drop-off, the two programs will be segregated as follows: parents and caregivers dropping off and picking up children from the 72 School street program will be instructed to use the 1458 Great Plain Avenue lot; and parents and caregivers picking up children from the afternoon program currently run at the 1458 Great Plain Avenue location will be instructed to utilize the Newman School lot. TBS anticipates that these parents will have no difficulty complying with this directive, as many of them are already choosing to use the Newman School lot for this purpose.

Attached hereto as **Exhibit 3** are three charts showing the actual drop-off and pick-up data for the School Street program, for three representative weeks in October 2022, February 2023, and May 2023. The drop-off and pick-up numbers are divided into 30-minute increments. These three charts show that the peak drop-off period is between 8:00 and 8:30 a.m. and there are never more than 24 children being dropped off during that 30-minute period. If this program is moved to the 1458 Great Plain Avenue location, the 17 parking spots will be more than adequate to meet this demand, as virtually all parents do not park and get out of their vehicles; instead, they drive to the entrance, where they are met by a TBS staff member, drop off their child, and leave.

The pick-up data for the 72 School Street program shown on the charts attached as Exhibit 3 lead to the same conclusion. Those charts show that the peak pick-up period for that program is between 5:00 p.m. and 5:30 p.m., and the largest number of children being picked up during that block is 19. Again, the 17 parking spots will be more than adequate to meet this demand: as with drop-offs, virtually all parents do not park and get out of their vehicles; instead, they drive to the entrance, where they are met by a TBS staff member, pick up their child, and leave.

Under TBS's proposal, the parents and caregivers picking up the children from the afternoon program will be instructed that they must use the Newman School lot to pick up their children. The pick-up data for the afternoon program currently being run at the 1458 location, set forth in the charts in Exhibit 3, show that during the representative sample weeks there have never been more than 28 children being picked up from the afternoon program during a 30-minute increment, and the number of pick-ups during any given 30-minute increment is typically much lower than that. Once again, the parking at the Newman school lot is clearly adequate to handle this demand.

This proposal also has the benefit of diverting traffic on Central Avenue away from the Church parking lot entrance, as the entrance to the Newman School lot is much further away from the Great Plain/Central Avenue intersection. (also note that, as stated above, afternoon "drop-offs" are a non-issue, because children in the afternoon program arrive either by bus or on foot.

ARGUMENT

Pursuant to Section 5.1.1.5 of the By-Law, the Board may grant a special permit waiving strict adherence to such requirements if the Board finds that the number of parking spaces required by Section 5.1.2 and/or the application of the design requirements of Section 5.1.3 are not warranted due to special circumstances relating to the particular use of the Property, the

structure or the lot. Such special permit waiving strict adherence to the minimum number of required parking spaces may be granted if either:

- (i) Special circumstances relating to a particular use of the structure do not warrant insistence upon the minimum number of spaces required under Section 5.1.2; or
- (ii) The extent of existing building coverage on a particular lot is such that in laying out parking spaces in accordance with the design requirements of Subsection 5.1.3, the requirement for minimum number of spaces under Section 5.1.2 cannot be met.

Furthermore, when considering a request for a special permit under Section 5.1.1.5, the Board is to consider and/or incorporate the following into its decision:

- (a) The issuance of a special permit will not be detrimental to the Town or to the general character and visual appearance of the surrounding neighborhood and abutting uses, and is consistent with the intent of this Zoning By-Law;
- (b) In the case of waiving strict adherence to the requirements of Section 5.1.2, the special permit shall define the conditions of the use of structure so as to preclude changes that would alter the special circumstances contributing to the reduced parking need or demand;
- (c) [omitted as not relevant]
- (d) Provisions to demonstrate the ability to provide for additional parking consistent with Section 5.1.2 and/or parking designed in accordance with the particular requirements of Section 5.1.3; and
- (e) The granting of a special permit under this Section shall not exempt a structure, use or lot from future compliance with the provisions of Section 5.1.2 and/or 5.1.3.

TBS submits that in this case, special circumstances exist that justify waiving strict compliance with the parking requirements of Section 5.1.2. and the design requirements of Section 5.1.3. Specifically:

1. Although the *calculated* combined parking requirements for the proposed combine TBS programs and the Church pursuant to the Zoning Bylaw exceed available parking (by five spaces in the morning and 10 spaces in the afternoon), as a practical matter, the proposal outlined above would “split” the two programs so that only the program currently being run at 72 School Street would use the Church lot, and the current afternoon program would use the Newman School lot. For the reasons discussed above, if drop-offs and pick-ups are split in this way, there will be plenty of parking for both programs.

2. As was the case at the time the Board approved the original Special Permit, the existing parking spaces do not meet all of the design requirements of Section 5.1.3. A waiver of

strict compliance is requested with respect to certain subparagraphs of Sections 5.1.3, including but not limited to subparagraph (a)(existing illumination does not meet the requirement of an average of one foot-candle); subparagraph (f)(some of the parking spaces are slightly less than the required dimensions); subparagraph (i)(the maneuvering aisle is not the required width in some locations); subparagraph (j)(parking spaces in a few cases are slightly less than 5 feet from the building); subparagraphs (k) and (l)(setback spaces are not all landscaped in the manner called for in the bylaw); and subparagraph (m)(location of additional parking – the Newman School lot -- is not under the same ownership as the principal use).

However, as noted in the Board's original 2011 decision (**Exhibit 4**, page 4, paragraph 7), "compliance with the design requirements [of Section 5.1.3] would be burdensome and would reduce the number of spaces which is already very limited." This is still true today. Requiring strict compliance with the design requirements of Section 5.1.3 would place a significant financial burden on the Tobin Beaudet Schools and/or the Church, and would not contribute to improving the overall parking situation at the Property.

3. The factors that the Board is supposed to consider under Section 5.1.1.5 of the Bylaw are met or can be adequately addressed:

a. The approval of the requested amendment to the existing Special Permit will not be detrimental to the Town or to the general character and visual appearance of the surrounding neighborhood and abutting uses, and is consistent with the intent of the Zoning By-Law. The expanded program will help meet a need of Needham residents and their children. There will be no physical change to the Property, and thus no negative impact on the character and visual appearance of the neighborhood.

b. As was done with the initial Special Permit, approval of the requested amendment can include a definition of "the conditions of the use of structure so as to preclude changes that would alter the special circumstances contributing to the reduced parking need or demand." Those conditions were "(a) the Applicant shall not terminate its current practice of delivering most students ([for the afternoon program] by bus; (b) the Applicant shall not change its current hours of operation in a manner that would cause a conflict with the pick-up of students from other after-school programs at the site; and (c) the Applicant shall not be prohibited from using 30 spaces in the Newman parking lot for the pick-up of students." These conditions can continue to apply to the Special Permit, as further amended.

c. TBS has "demonstrate[d] the ability to provide for additional parking consistent with Section 5.1.2." As set forth in Exhibit 2 hereto, the Needham Public Schools have granted permission for TBS parents to use the Newman School lot between 7:00 and 8:00 a.m. and after 3:30 p.m. (with no stated restriction on the number of spaces to be used).

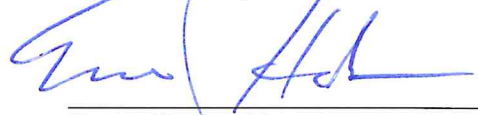
d. Granting the requested amendment to the Special Permit "will not exempt a structure, use or lot from future compliance with the provisions of Section 5.1.2 and/or 5.1.3. This can be made explicit in the Board's approval of the requested amendment.

CONCLUSION

For the reasons set forth above, TBS submits that special circumstances exist sufficient to justify waiving strict compliance with the number and design requirements for parking spaces at the Property, set forth in sections 5.1.2 and 5.1.3 of the Bylaw, and that this can be done while taking into account all of the factors that the Board is to consider under Section 5.1.1.5 of the Bylaw. Consequently, TBS requests that its proposed amendment to its previously-issued, and twice-amended, Special Permit be approved.

TBS would also point out that this use is protected by the Dover Amendment, M.G.L. c. 40A, Section 3 *et seq.* Under that statute, this Board cannot require a special permit for this proposed use (meaning that it cannot deny this proposed increase in enrollment), although it can impose “reasonable regulations” regarding, among other things, parking. TBS submits that the conditions and limitations described above, including the “split” of the two programs so that one program uses the Church lot and the other program uses the Newman School lot, constitute reasonable regulation, and will satisfy actual parking demands, while allowing the proposed increase in enrollment, as required by the Dover Amendment.

Respectfully Submitted
The Tobin Beaudet Schools, Inc.,
By its attorneys,



Evans Huber, Esq.
BBO # 542133
Frieze Cramer Rosen & Huber LLP
62 Walnut Street, Suite 6
Wellesley, MA 02481
(781) 943-4000

Date: August 25, 2023

EXHIBIT 1



2019 JUN 16 10 30 AM
TOWN OF NEEDHAM
CLERK

**TOWN OF NEEDHAM
MASSACHUSETTS
BOARD OF APPEALS
SPECIAL PERMIT AMENDMENT**

*Tobin Beaudet Schools, Inc., applicant
1458 Great Plain Avenue
Map 216, Parcel 1*

June 16, 2019

The Tobin Beaudet Schools, Inc. made application to the Board of Appeals for a Special Permit Amendment under Sections 5.1.1.5, 5.1.2, 5.1.3, 7.5.2 and any other applicable Sections of the Zoning By-Law (i) to increase the number of children enrolled in the after-school program to a maximum of 90 students, and to increase the maximum number of staff at any given time to ten, and waiving the requirement of compliance with the number of parking spaces, as well as certain parking design requirements, of the Zoning By-Law, and (ii) to operate a before-school program at the property for a maximum of 40 students and four staff employees at any given time. The property is located at **1458 Great Plain Avenue, Needham, MA** in the Single Residence B District. A public hearing was held on Thursday, June 20, 2019 at 7:30 p.m. in the Charles River Room, Public Services Administration Building, 500 Dedham Avenue, Needham, MA, pursuant to notices thereof published in a local newspaper and mailed to all parties of interest.

Documents of Record:

- Application for Hearing, Clerk stamped May 23, 2019.
- Applicant's Memorandum in Support of Application for Amendment to Special Permit, prepared by Evans Huber, Esq., dated May 23, 2019.
- 1458 Great Plain Avenue, ZBA Special Permit, filed with the Town Clerk on November 9, 2011 (the "2011 Special Permit").
- 1458 Great Plain Avenue, ZBA Special Permit, dated April 27, 2017 (the "2017 Special Permit Amendment").
- Letter from David A. Roche, Building Commissioner, to Evans Huber, dated May 21, 2019.
- E-mail titled "Amendment to the special permit" from Donald Dick to Evans Huber, dated April 22, 2019,
- E-mail titled "Parking" from Donald Dick to Evans Huber, dated April 22, 2019.

- Existing Conditions Plan, C1; prepared by Horsley Witten Group, Inc., stamped by Michael S. Laduc, Professional Land Surveyor, March 31, 2019.
- Letter from Thomas A. Ryder, Assistant Town Engineer, dated June 12, 2019.
- Email from Tara Gurge, Assistant Public Health Director, dated June 11, 2019.
- Email from Chief Dennis Condon, Fire Department, dated June 13, 2019.
- Letter from Needham Planning Board, prepared by Lee Newman, Director of Planning and Community Development, dated June 6, 2019.

June 20, 2019

The Board included Jon D. Schneider, Chairman; Jonathan D. Tamkin, Member; Howard S. Goldman, Member; Kathy Lind Berardi, Associate Member and Peter Friedenberg, Associate Member. Mr. Schneider opened the hearing at 7:34 p.m. by reading the public notice.

Evans Huber, representing the applicant, informed that the applicant's name as it appears in the application was incorrect and that the correct name is ***Tobin Beaudet Schools, Inc.***

Mr. Huber reported that the applicant is seeking an amendment to the 2011 Special Permit, as previously amended by the 2017 Special Permit Amendment, to expand the after-school program from 65 students and 7 staff to a maximum of 90 students and 10 staff. The Building Inspector has reviewed the program expansion and made a determination that the number of parking spaces required by the Zoning By-Law for the after-school program would increase from 17 spaces to 21 spaces. With the Presbyterian Church staff parking requirement of four spaces remaining unchanged, the new total parking requirement for the property would be 25 spaces.

The program has permission from the Newman School to use up to 30 spaces in their parking lot for after-school pick-up. The demand for parking is only for pick-up, as the children arrive to the school by walking from the Newman School or are bused from other schools.

Other than the requested increase in the maximum number of students and staff, the after-school program will remain as described in the 2011 Special Permit and the 2017 Special Permit Amendment.

The applicant also seeks to add a new before-school program for up to 40 children and 4 staff, which will run from 7:00 a.m. to 8:15 a.m., before the opening of the Newman School. All of the participating children will be students at the Newman School and will be walked to the Newman School at 8:15 a.m. by staff.

The before-school children will be dropped off by their parents. The drop-off times will likely range from 7:00 a.m. to 8:00 a.m. The grades served will be kindergarten to fifth grade. Mr. Huber stated that the before-school program will not create additional parking usage and based on the Building Inspector's determination that the before-school program would require 12 parking spaces, the 17 spaces in the existing Church parking lot on the property will be sufficient.

Mr. Huber stated that, unlike in the past, there are now no other before- or after-school

programs at the Church nor any overlapping church activities competing for parking spaces during the school's proposed hours of operation.

Comments received:

- Planning Board had no comment.
- Engineering Department had no comment.
- The Health Department noted that if there are any food/snacks provided on site a food establishment permit and copy of the menu was required. The applicant is in the process of submitting an application for this permit.

No comments were received from the public.

Mr. Goldman stated that the corner of Great Plain Avenue and Central Avenue is very congested during peak commuting hours and asked about the impact of the proposed before-school program on the traffic. Stephanie Beaudet, President of Tobin Beaudet School, Inc., responded that students would not all arrive at the same time and that drop-offs would be staggered. Parents of children in the morning program tend to drop off early to take advantage of the program. The drop-off time would generally be an hour before the Newman School begins.

Mr. Tamkin and Mr. Goldman were concerned about the morning drop-off backing up onto Central Avenue and adding to the congestion of the area. Mr. Tamkin asked if the school had contacted the Newman School for permission to park during the morning drop-off. The applicant has not. Mr. Tamkin requested that the applicant ask the Newman School for the right to use a portion of its parking lot for morning drop-off parking. He was particularly concerned about the morning drop-off that occurs between 8:15 a.m. and 8:30 a.m., when the intersection is at its most congested. The traffic will be worse when the Sunita Williams Elementary School comes on line on Central Avenue. In the afternoon he had less of an issue about the pick-up. Mr. Huber informed him that 30 spaces at the Newman School parking lot are available for use by the school for pick-up parking after 3:00 p.m.

Mr. Huber suggested that a condition could be added to any decision requiring that the pick-up between 3:30 p.m. and 4:30 p.m. be limited from the Newman School parking lot. Mr. Tamkin suggested that the morning drop-off be done from the Newman School as well. Mr. Schneider questioned whether there would be less congestion turning into the Newman School entrance versus the Church parking lot driveway. Mr. Tamkin thought the Newman School entrance would be preferable with its wide driveway and assigned crossing guard.

Mr. Huber reported that the Church driveway is long and there is ample access to drive into the lot to park or turn around after dropping off a child. There are three parallel spaces along the side of the school from the driveway entrance to the front door of the school. Cars using the Church parking lot enter and exit through the same driveway.

After discussion, the Board was unanimously supportive of the proposed expansion of the after-school program. The Board discussed possibly approving the new before-school program with the following conditions:

- the applicant obtain parking permission from the Newman School;
- the morning traffic exiting the driveway be limited to right turns only;
- the Special Permit be subject to revocation if the Church adds another program; and

- the morning drop-offs be limited to 7:00 a.m. to 8:00 a.m.

The applicant suggested continuing the meeting to allow them to explore options with the Newman School. Mr. Schneider suggested that the applicant think about other measures to address the traffic issue.

Mr. Goldman moved to continue the Public Hearing to July 11, 2019. Mr. Tamkin seconded the motion. The motion was unanimously approved.

The meeting adjourned at 8:13 p.m.

July 11, 2019

The Board included Jon D. Schneider, Chairman; Howard S. Goldman, Member; and Peter Friedenberg, Associate Member. Mr. Schneider opened the hearing at 7:37 p.m. by reading the public notice. The meeting was held in the Select Board Chambers, Needham Town Hall, 1471 Highland Avenue, Needham, MA

Mr. Huber presented proposed alternative conditions to address the concerns raised by Board members at the previous meeting, which would be publicized and included in the contract to be signed by parents using the before-school program:

Parents will be instructed that between 7:00 a.m. – 8:30 a.m.:

- no parking is allowed in the first four parallel spaces closest to Central Avenue along the building by the Tobin school, which are to be used only for drop-off;
- the parents must drive down to the widest point of the lot to turn around to exit the parking lot;
- if a parent wants to walk the child into the building, they will be required to park in the parking spaces in the back of the lot; and
- when exiting the lot, cars will only be permitted to turn right onto Central Avenue.

Mr. Goldman stated that the area is a very busy intersection until 9:00 a.m. He was concerned about the width of the driveway accommodating two-way traffic. Mr. Huber noted that the morning program ends at 8:15 a.m. when the children are walked to the Newman School, so drop-off will occur at an earlier hour. The driveway is 21 feet wide and can accommodate two-way traffic if no cars are allowed in the parking spaces along the entrance of driveway.

Mr. Goldman inquired if directional arrows would be painted. Mr. Huber agreed they could do this if required. Mr. Huber thought that a no parking/drop-off only sign and the contract would be sufficient to manage the parking.

Ms. Beaudet said that parents of older students (3rd – 5th grade) tend to park, allowing their children to walk rather than simply stop and drop off their children by the door.

Mr. Goldman was concerned about the creation of back-up. Mr. Huber said that there would be approximately 3-4 car lengths of no parking from the driveway entrance to the door of the school. If there are cars live-parked by the door of the school, parents will be instructed to drive past those cars, park in the back, and walk their child to the door. There will be a

maximum of 40 children who will be dropped off staggered over the course of approximately 45 minutes.

Ms. Beaudet noted that the school's operating hours during the holidays are from 7:00 a.m. to 6:30 p.m.

There were no comments from the public.

Mr. Friedenbergr moved to amend the Special Permit to accommodate the following:

- Permit an increase in the after-school program from 65 students to 90, and 6 staff to 10, with no change to the operating hours and no changes to the conditions set forth in the 2011 Special Permit and the 2017 Special Permit Amendment other than the permitted increase in the maximum number of students and staff;
- Permit the addition of a before-school program from 7:00 a.m. to 8:30 a.m. for a maximum of 40 students and 4 staff, subject to the following:
 - when exiting the driveway to Central Avenue cars will be required to make a right turn only;
 - the two parking spaces nearest to Central Avenue will not be used for parking or drop-off;
 - the next four parking spaces adjacent to the Tobin School door will be limited to drop-off only;
 - the applicant will be responsible for managing the parking plan and will make adjustments accordingly to insure there will be no back-up onto Central Avenue;
 - if there is any violation of the terms of this Special Permit Amendment, the Special Permit shall be subject to revocation or amendment after a hearing before the Board.

Mr. Goldman seconded the motion. The motion was unanimously approved.

The meeting adjourned at 8:00 p.m.

Findings:

On the basis of the evidence presented at the hearing, the Board makes the following findings:

1. The applicant, Tobin Beaudet Schools, Inc. is a tenant that runs an after-school program at the property located at 1458 Great Plain Avenue, Needham, MA ("the Property"). The Presbyterian Church of Needham owns the Property.
2. The Property consists of approximately 55,494 square feet of land and is located in the Single Residence B Zoning District. The Property contains the Church and an attached one-story building.
3. This Board issued the 2011 Special Permit pursuant to Section 5.1.1.5 of the Zoning By-Law to the applicant waiving strict compliance with the required number of parking spaces under Section 5.1.2 and the design requirements of Section 5.1.3, subject to three conditions. The 2011 Special Permit limited the applicant to an after-school program with a maximum of 39 children and a maximum of 5 staff members.
4. The 2017 Special Permit Amendment permitted an increase in the number of children

- enrolled in the after-school program to 65 and in increase in the maximum number of staff at any given time to 7, with no change in the program's hours of operation.
5. On April 22, 2019, the property manager of the Church confirmed via e-mail that there are no other groups that use the Property during the after-school or proposed pre-school program hours of operation.
 6. The Property has 17 parking spaces. The proposed increase in the size of the after-school program will result in an increase of the number of required number of parking spaces to serve that use. The Needham Building Commissioner's letter dated May 21, 2019 determined that the applicant's proposed increase in students and staff would require 4 additional parking spaces, for a total requirement of 21 parking spaces for the after-school program. In the same letter, the Needham Building Commission determined that the Applicant's proposed before-school program, would require 12 parking spaces.
 7. The requirement of 21 parking spaces for the after-school program, plus the additional 4 spaces required for the 1,000 sf of space in the Church used for the Church's office and administrative purposes, results in a total combined calculated requirement of 25 parking spaces for the Property. Accordingly, there is a shortfall of 8 required parking spaces at the Property. The before-school program, together with the additional 4 spaces required for the Church's office and administrative space, does not create a shortfall in required parking at the Property.
 8. The applicant submitted an e-mail dated April 22, 2019 from Jessica Peterson, Principal of Newman Elementary School, confirming that the applicant is still authorized to use the adjacent Newman School parking lot after 3:30pm.
 9. The Applicant seeks an amendment to the 2011 Special Permit, as previously amended by the 2017 Special Permit Amendment, pursuant to Section 5.1.1.5 of the Zoning By-Law waiving strict adherence with the required number of parking spaces under Section 5.1.2 and the design requirements of Section 5.1.3, with respect to the expanded after-school program.
 10. Section 5.1.1.5 of the By-Law grants authority to the Board to issue a special permit to waive strict adherence to the requirements of Section 5.1.2 and/or 5.1.3 where the Applicant can demonstrate that a particular use, structure or lot, owing to special circumstances does not warrant the number of parking spaces required by Section 5.1.2 and/or the application of certain design requirements contacted in Section 5.1.3.
 11. Due to the Applicant's confirmation that only the Applicant's after-school program will be using the Property during its hours of operation, and the confirmed continued authorization to use the parking spaces in the Newman Elementary School lot, the Board finds that there are special circumstances that that do not warrant insistence upon the minimum number of required parking spaces.
 12. The Applicant also confirmed that the existing 17 parking spaces do not meet all of the design requirements of Section 5.1.3 (a), (f), (i), (j), (k), (l) and (m), as was the case at the time of the 2011 Special Permit. There will be no expansion of the building. The Board finds that circumstances have not changed since the 2011 Special Permit as to design and that compliance with the design requirements would be burdensome and

would reduce the number of parking spaces.

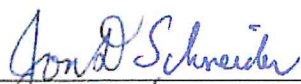
13. In addition, the Applicant's proposed before-school program requires a Special Permit to permit such use under Section 3.2.1 of the Zoning By-Law.
14. Although there is substantial traffic congestion on Central Avenue during the morning rush hour, the Applicant has agreed to a number of conditions on its operation of this program which the Board finds will mitigate the impact of this program on that traffic.
15. The requested amendments to the 2011 Special Permit, as previously amended by the 2017 Special Permit Amendment, will not be detrimental to the Town or to the general character and visual appearance of the surrounding neighborhood and abutting uses, and is consistent with the intent of the By-Law.

Decision:

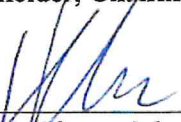
On the basis of the foregoing findings, following due and open deliberation, upon motion duly made and seconded, the Board by unanimous vote, amends the 2011 Special Permit, as previously amended by the 2017 Special Permit Amendment, by:

1. waiving strict adherence to the requirements of Section 5.1.2 (number of parking spaces) and 5.1.3 (parking lot design requirements), subject to the following conditions applicable to its after-school program:
 - a. conditions (a) and (b) set forth in the 2017 Special Permit Amendment shall remain in effect;
 - b. the number of children enrolled in the after-school program shall be a maximum of 90 students and the maximum number of staff at any given time shall be 10 staff members; and
 - c. no changes shall be made in the hours of operation of the program as set forth in the 2017 Special Permit Amendment.
2. permitting the operation by the Applicant of a before-school program at the Property, subject to the following conditions:
 - a. hours of operation shall be from 7:00 a.m. to 8:30 a.m.;
 - b. the number of children enrolled in the program shall not exceed 40 and the maximum number of staff at any given time shall be 4 staff members;
 - c. the two parking spaces nearest to Central Avenue will not be used for parking or drop-off so that the width of the driveway at that location for entering and exiting the Property shall not be narrowed;
 - d. the next four parking spaces adjacent to the Tobin School door will be limited to drop-off only, no parking in those spaces will be allowed;
 - e. when exiting the driveway to Central Avenue cars will be required to make a right turn only and the applicant will install such signage to that effect as may be necessary to enforce this restriction;
 - f. the Applicant will be responsible for managing the parking plan and will make adjustments accordingly to insure there will be no back-up of cars onto Central Avenue; and

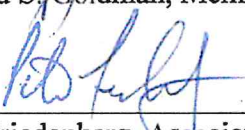
- g. if there is any violation of any of these conditions, this Special Permit Amendment shall be subject to revocation or amendment after a hearing before the Board.



Jon D. Schneider, Chairman



Howard S. Goldman, Member



Peter Friedenber, Associate Member

EXHIBIT 2

From: [Stephanie Beaudet](#)
To: [Evans Huber](#)
Subject: Fwd: Tobin Parking
Date: Wednesday, August 9, 2023 10:57:14 AM

Stephanie Beaudet
Executive Director
Tobin Beaudet Schools
917-733-0974 (cell)

Sent from my iPhone

Begin forwarded message:

From: Jessica Peterson <jessica_peterson@needham.k12.ma.us>
Date: August 9, 2023 at 10:55:52 AM EDT
To: Stephanie Beaudet <sbeaudet@tobinbeaudet.com>
Cc: "Shane Marchand (DIS)" <shane_marchand@needham.k12.ma.us>, Andrea Vargas <andrea_vargas@needham.k12.ma.us>
Subject: Re: Tobin Parking

Hi Stephanie--certainly your families can have access to our lot from 7-8 and after 3:30--good luck with the project!
Jessica

On Tue, Aug 8, 2023 at 1:59 PM Stephanie Beaudet
<sbeaudet@tobinbeaudet.com> wrote:

Hi Shane,

Thanks for your quick response! Yes, of course we will remind families not to park in bus or van designated parking.

Thank you,
Stephanie

On Tue, Aug 8, 2023 at 1:53 PM Shane Marchand (DIS)
<shane_marchand@needham.k12.ma.us> wrote:

Good afternoon, Jessica Peterson will need to provide you with the permission to access the lot. All I ask, that the families do not park in the spots where the buses park (at the very bottom of the lot in line with the tennis courts towards Central Ave) in as well as our vans spots (noted by signs)

Thank you
Shane

On Tue, Aug 8, 2023 at 1:49 PM Stephanie Beaudet

<sbeaudet@tobinbeaudet.com> wrote:

Hi Andrea, Jessica and Shane,

We hope you are having a relaxing and enjoyable summer. We are so grateful that you have provided permission for our families at Tobin Beaudet Schools to use the Newman parking lot in the mornings (between 7-8am) and in the afternoons, after 3:30pm.

We are starting a construction project at our Early Childhood location (72 School Street) this fall to add an indoor gross motor space for our children as well as teacher office space. We expect the project will take 6-8months and start late fall. We are applying to the Needham Zoning Board of Appeals to temporarily move those children (Preschool, Pre-K and Junior K) to the Presbyterian Church during the project.

We have a note from the Newman administration from 2019 and we think the ZBA will likely request a more recent note that our program still has the same access to the parking lot we have had in the past. Is this something you would be able to provide to us?

I am available by phone or in person if you prefer, please let me know and thank you as always!

Thank you,
Stephanie

On Thu, Jul 4, 2019 at 10:26 AM Stephanie Beaudet

<sbeaudet@tobinbeaudet.com> wrote:

Hi Andrea, Shane and Jessica,

Thank you for your email and agreement to allow our families to use the parking lot during drop off between 7am-8am. We will communicate with the parents in our program to be sure the lot is not accessed before 7am and after 8am. This allowance is very much appreciated.

Many thanks and happy 4th,
Stephanie

Stephanie Beaudet
Executive Director
Tobin Beaudet Schools
781-444-5444
sbeaudet@tobinbeaudet.com

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<http://www.facebook.com/tobinbeaudet>

Connect with me on LinkedIn

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COA Accredited Program

On Jul 3, 2019, at 12:34 PM, Andrea Vargas
<andrea_vargas@needham.k12.ma.us> wrote:

Hello Stephanie,
Shane Marchand and I spoke this morning regarding Tobin parking in the Newman lot. We are in agreement that this arrangement should work as long as parents arrive after 7:00 and before 8:00 so as not to interfere with buses and Newman arrival procedures.
Many thanks,
Andrea

*Andrea Vargas
Assistant Principal
Newman Elementary School
781-455-0416*

--



Stephanie Beaudet
Executive Director
Tobin Beaudet Schools
781-444-5444
www.tobinbeaudet.com
sbeaudet@tobinbeaudet.com

[Schedule a visit at Tobin Beaudet Schools - Click here!](#)

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You can make a difference! Our Afterschool program is hiring, [click here](#) to apply!

--

Shane Marchand
Transportation Director
Needham Public Schools
781-455-0400 X11234

Please subscribe to our Transportation
listserv <https://lists.needham.k12.ma.us/mailman/listinfo/transportation>

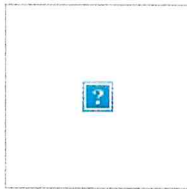
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--



Stephanie Beaudet
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Click below and give us a follow or leave us a review on Google!



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--



Jessica Peterson
Principal

Newman Elementary School
781-455-0416

Pronouns: she, her, hers

ATTENTION: If you speak a language other than English, language assistance services are available to you free of charge. Contact your child's school for assistance.

ATANSYON: Si ou pale yon lòt lang ke lang Anglè, sèvis asistans lang yo disponib pou ou gratis. Kontakte lekòl timoun ou an pou kapab jwenn asistans.

请注意：如果您的母语不是英语，我们将免费提供您语言辅助服务。如需协助，请与您孩子的学校联系。

ATENCION: Si usted habla un idioma que no sea el inglés, hay servicios de asistencia lingüística disponibles gratis. Contacte la escuela de su hijo para asistencia.

ВНИМАНИЕ: Если вы не говорите на английском языке, для вас доступны бесплатные языковые сервисы на вашем языке. Обратитесь за помощью в школу, в которой учится ваш ребенок.

Spanish: ATENCION: Si usted habla un idioma que no sea el inglés, hay servicios de asistencia lingüística disponibles gratis. Contacte la escuela de su hijo para asistencia.

EXHIBIT 3

TOBIN BEAUDET SCHOOLS, INC.
ACTUAL DROP-OFF AND PICK-UP DATA DURING PEAK TIMES

Week of October 17 – 21, 2022

SCHOOL STREET DROP OFF DATA

	M	T	W	TH	F
7:30 – 8am	7	6	6	6	8
8- 8:30AM	16	18	17	15	14
8:30AM -9AM	13	11	9	11	11
9-9:30AM	2	3	3	4	4
9:30-10AM	1	2	1	1	1

SCHOOL STREET PICK UP DATA

	M	T	W	TH	F
3-3:30PM	4	4	1	3	7
3:30-4PM	3	3	1	4	1
4- 4:30PM	3	7	1	4	8
4:30-5PM	10	8	7	4	5
5- 5:30 PM	7	8	14	14	9
5:30-6PM	8	6	9	6	1

1458 GREAT PLAIN AVE PICK UP DATA

	M	T	W	TH	F
3-3:30PM	0	0	0	1	0
3:30-4PM	1	2	5	2	0
4- 4:30PM	2	4	6	4	4
4:30-5PM	11	9	6	10	10
5- 5:30 PM	24	16	19	21	9
5:30-6PM	19	23	16	22	8

TOBIN BEAUDET SCHOOLS, INC.
ACTUAL DROP-OFF AND PICK-UP DATA DURING PEAK TIMES

Week of February 13 – 17th, 2023

SCHOOL STREET DROP OFF DATA

	M	T	W	TH	F
7:30 – 8am	6	8	5	9	10
8-8:30AM	18	13	24	18	14
8:30AM -9AM	10	18	8	15	15
9-9:30AM	6	6	6	1	1
9:30-10AM	2	1	0	2	1

SCHOOL STREET PICK UP DATA

	M	T	W	TH	F
3-3:30PM	7	3	5	5	6
3:30-4PM	3	1	0	2	2
4- 4:30PM	5	2	2	1	6
4:30-5PM	9	16	9	10	9
5- 5:30 PM	8	12	19	17	10
5:30-6PM	8	7	7	6	4

1458 GREAT PLAIN AVE PICK UP DATA

	M	T	W	TH	F
3-3:30PM	0	0	0	1	3
3:30-4PM	2	1	3	2	3
4- 4:30PM	6	6	2	2	4
4:30-5PM	9	8	12	12	5
5- 5:30 PM	23	18	13	23	2
5:30-6PM	23	20	19	23	3

TOBIN BEAUDET SCHOOLS, INC.
ACTUAL DROP-OFF AND PICK-UP DATA DURING PEAK TIMES

Week of MAY 22 – 26TH, 2023

SCHOOL STREET DROP OFF DATA

	M	T	W	TH	F
7:30 – 8am	9	6	8	5	7
6-8:30AM	15	22	23	24	18
8:30AM -9AM	11	10	10	9	13
9-9:30AM	5	5	5	9	7
9:30-10AM	2	2	1	0	0

SCHOOL STREET PICK UP DATA

	M	T	W	TH	F
3-3:30PM	6	9	7	10	6
3:30-4PM	3	2	1	3	3
4- 4:30PM	2	5	7	3	6
4:30-5PM	10	9	3	7	7
5- 5:30 PM	11	8	17	11	11
5:30-6PM	8	11	7	10	3

1458 GREAT PLAIN AVE PICK UP DATA

	M	T	W	TH	F
3-3:30PM	0	0	1	0	0
3:30-4PM	1	2	0	0	5
4- 4:30PM	6	7	9	3	4
4:30-5PM	7	12	6	12	4
5- 5:30 PM	14	20	17	14	7
5:30-6PM	28	14	16	24	0

EXHIBIT 4

RECEIVED AND RECORDED
NORFOLK COUNTY
REGISTRY OF DEEDS
DEDHAM, MA

N O T
A N
F I C I A L
C O P Y



N O T
A N
F I C I A L
C O P Y

RECEIVED TOWN CLERK
NEEDHAM, MA 02492

2011 NOV -9 PM 1:16

CERTIFY

William P. O'Donnell
WILLIAM P. O'DONNELL, REGISTER

**TOWN OF NEEDHAM
MASSACHUSETTS
BOARD OF APPEALS**

Tobin School

Record owner: Needham Presbyterian Church
1458 Great Plain Avenue, Map 216, Parcel 01

Upon the application of The Tobin School, Inc. d/b/a Tobin Afterschool, 1458 Great Plain Avenue, Needham, MA, owner ("Applicant"), to the Board of Appeals for a Special Permit under Sections 5.1.1.5, 5.1.2, 5.1.3, 7.5.2 and any other applicable Sections of the By-Law to waive strict adherence with the off-street parking requirements, and any and all other relief as may be necessary and appropriate to permit the use of a portion of the church building for an after-school child care facility at 1458 Great Plain Ave., Needham, MA, in the Single Residence B, a public hearing was held at the Public Service Administration Building, 500 Dedham Ave., Needham, MA on October 20, 2011 at 7:45 PM pursuant to notice thereof, published in a local newspaper and mailed to all parties of interest.

Documents of Record:

- Application Packet, received September 26, 2011 containing:
 1. Application form dated September 26, 2011;
 2. Cover letter to Marita Klements dated September 26, 2011 signed and submitted by George Giunta, Jr., attorney for the applicant.
- Received prior to the October 20, 2011 hearing:
 1. Certified abutters' list;
 2. Plans of the Tobin Afterschool dated September 2, 2011, signed and stamped by George W. Schnee, A.I.A., three pages;
 3. Memorandum from the Planning Board to Daniel Walsh, Building Inspector, regarding parking for the Tobin Afterschool, dated October 20, 2011;
 4. Email from Dan Gutekanst, superintendent of the Needham Public Schools, to Donald Dick, Property Manager of the Presbyterian Church, granting permission for the use of 25-30 spots in the Newman School parking lot for use after school hours.
- Received at the October 20, 2011 hearing:
 1. Memorandum in support of the application dated October 19, 2011, signed and submitted by George Giunta, Jr., attorney for the applicant;

October 20, 2011

N O T

N O T

Mr. Schneider opened the hearing at 8:50 by reading the notice of hearing. The Board included Jon D. Schneider, Chairman; Jonathan D. Tamkin, Member; and Howard S. Goldman, Member. Appearing before the Board were George Giunta Jr., attorney for the applicant; Mary Beth Tobin, principal for the applicant; and Stephanie Beaudet, the director of Tobin Afterschool.

Mr. Giunta presented his case. The Tobin Afterschool is proposing to occupy approximately 800 square feet in the basement of the Needham Presbyterian Church, formerly occupied by the Salt Box School. The Salt Box School will still operate out of the Church, but no longer has need of the space proposed to be used by the Applicant. . The Planning Board determined, based upon the maximum enrollment of 39 students and a maximum staff of 5, that Tobin has a requirement of 13 parking spaces. Tobin Afterschool runs from 2:30 PM to 6:30 PM.

Mr. Schneider read the Planning Board's comments which indicated that they were unable to comment because the application did not contain sufficient information.

Saltbox runs its basic program from 8:30 AM to Noon. They also have a maximum licensed capacity of 39 students, although they currently have no more than 25 students. They have extended hours from 12 to 3, but during the extended hours there are typically no more than 5 children. Their parking demand is also 13 spaces. Their licensing is not being reduced, although the space they occupy is being reduced. Parents park at the church lot and the Newman School while they drop or pick up their children.

The children attending the Tobin Afterschool arrive by bus hired by the school. Parents pick up their children between 5:15 and 6:45. Most parents use the parking lot at the Newman School and walk down a sidewalk to the church to pick up their children.

There are other activities that occur during the same time as the Tobin Afterschool operates. The Freelance Players is an afterschool theatrical program that meets on Fridays from 3:30 to 5:30. The children attending this program walk to the church from the Newman School. The program has under 40 students and less than 5 staff. The Ease Program is a language program that runs on Wednesdays with approximately 23 students. They too walk over from the Newman school. Parents use the Newman lot to pick them up at 4:15. There may be two smaller programs on Tuesdays and Thursdays starting on November 15th. The pick up for all of these programs will be through the Newman School Parking lot.

There are 17 parking spaces on site. The church has made application to build an additional 10 spaces, but requires a design waiver. The Board held a hearing on the church's application immediately before this matter. While the Board indicated that it was favorably inclined to grant the waiver, but the Board continued the church's application so that they could submit a landscaping plan and consult with the Town Engineer regarding drainage. The Tobin Afterschool and Salt Box School taken together require 36 spaces. The theater and language programs would require additional parking. However, the demand for parking is staggered.

There was a suggestion that the matter be continued until the church's application for new spaces is approved, but the Applicant indicated that they were anxious to begin operations. Mr.

Schneider stated that everything works fine so long as they have access to the Newman School lot.

O F F I C I A L O F F I C I A L

Mr. Tamkin expressed concern that there is no long term lease for the parking spaces at the Newman School and perhaps it should perhaps be disregarded. Mr. Schneider noted that there is permission to use 25-30 spaces in the Newman lot after school hours and suggested that the special permit could be conditioned on the Newman School not denying access to the parking.

Mr. Schneider invited the public to come forward and be heard. None did so.

At 9:11 Mr. Goldman moved to grant a special permit to the Tobin Afterschool subject to the requirement that the Town not prohibit their use of 30 spaces in the Newman School parking lot. The hours of operation of the program will be 2 PM to 7 PM. Mr. Tamkin seconded the motion. The vote was unanimously in favor.

Decision:

On the basis of the evidence presented at the hearing, the Board makes the following findings:

1. The Applicant, The Tobin School, Inc. d/b/a Tobin Afterschool, is licensed to provide day care for up to 39 children. The proposed program will operate from 2:30 pm to 6:30pm on days when school is in session and from 7:00am to 6:30pm on days when school is not in session. On school days students will be bused to the site on a bus hired by the Applicant, except for students from Newman School who may walk. Students are picked up by parents or other caretakers generally between 5:15pm and 6:15pm. The maximum number of staff is 5 at any one time.
2. The Applicant proposes to lease approximately 1423 square feet of space spread over several rooms in the basement of the Needham Presbyterian Church at the corner of Great Plain Avenue and Central Avenue. The church currently has 17 parking spaces in a paved lot entered from Central Avenue. The church is in close proximity to a large parking lot at the Newman School that is separated by a short walkway. The Applicant has permission to use the Newman parking lot after school hours and children are typically picked up by parties parking in the Newman lot. In addition, the church has plans to build an additional 10 spaces upon issuance of necessary permits.
3. The Planning Board has recommended that the Applicant should be required to have 13 parking spaces. Since the Applicant's use requires more parking than the church use, Section 5.1.1.1 of the By-Law requires that the premises comply with the number and design of parking spaces contained in the By- law unless the Board issues a special permit waiving such compliance.
4. The church currently leases additional space in the basement to the Salt Box School which is licensed to provide day care to up to 39 children, but the current enrollment is less than 25 students. The Salt Box School generally operates from 8:30am until Noon,

but has extended hours until 3:00pm. The enrollment in the extended program is currently 5 children. The majority of pick ups from the Salt Box School are completed before the Tobin Afterschool begins operations and all are completed before the time of pick ups from the Tobin Afterschool. While the Board has not received a recommendation from the Planning Board for the parking requirement of the Salt Box School, it presumes that the requirement is 13 spaces.

5. The church has other student activities that potentially conflict with the Applicants operations including an after school theatrical program for approximately 40 students on Fridays from 3:30pm to 5:30 pm and a language program on Wednesdays for approximately 23 students from the end of school until 4:15 pm. The church is also considering additional language programs for Tuesdays and Thursday that would have a similar number of students and hours of operation. The students participating in these activities walk from Newman School and are picked up in the Newman parking lot, typically before parents are picking up students from the Applicant's program.

6. The church conducts other activities during the week including employment counseling, meetings for Boy Scouts, meetings for a chapter of Alcoholic Anonymous, bible study, rehearsal and meeting space for the Needham Community Theater and, on occasions, assemblies for groups from the Newman School and Town Flu Clinics. These activities are generally timed so they do not conflict with parking activities associated with the Applicant's operations. At the present time, the Town Flu Clinics have been moved to another location because the Newman School is under construction and the Newman parking lot is not available during school hours.

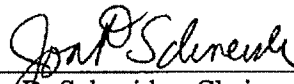
7. It is unclear whether the existing church parking spaces comply with size, maneuvering aisle and illumination requirements of the By-Law, but they clearly do not comply with other design requirements such as landscaping. There is no expansion of the building. Compliance with the design requirements would be burdensome and would reduce the number of spaces (which is already very limited). Moreover, the Board expects to review the design of the current parking in the separate application of the church to build 10 additional spaces.

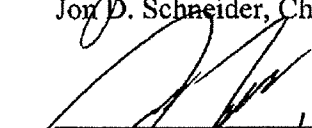
8. Special circumstances exist including the staggered time of parking need and the availability of parking at the Newman parking lot that warrants a waiver of the required number of parking spaces.

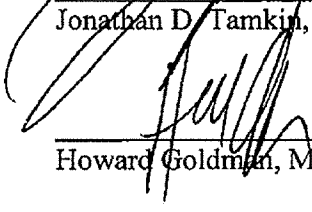
9. The issuance of a special permit will not be detrimental to the Town or to the general character and visual appearance of the surrounding neighborhood and abutting uses and is consistent with the intent of the Zoning By-Law.

On the basis of the foregoing findings, following motion duly made and seconded, after due and open deliberation, the Board by unanimous vote grants the applicant a special permit under Section 5.1.1.5 of the Zoning By-law waiving compliance with the required number of spaces under Section 5.1.2 and the design requirements of Section 5.1.3 subject to the condition that a)the Applicant shall not terminate its current practice of delivering most students by bus,

b) the Applicant shall not ^{N O T} change its current hours of operation ^{N O T} in a manner that would cause a conflict with the pick up of students from other after school programs at the site, and c) the Applicant shall not be prohibited from using 30 spaces in the Newman parking lot for the pick up of students. ^{O F F I C I A L} ^{C O P Y} ^{O F F I C I A L} ^{C O P Y}

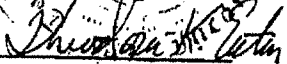

Jon D. Schneider, Chairman


Jonathan D. Tamkin, Member

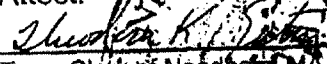

Howard Goldman, Member

This is to certify that no appeal has been filed within the 20 day statutory appeal period.

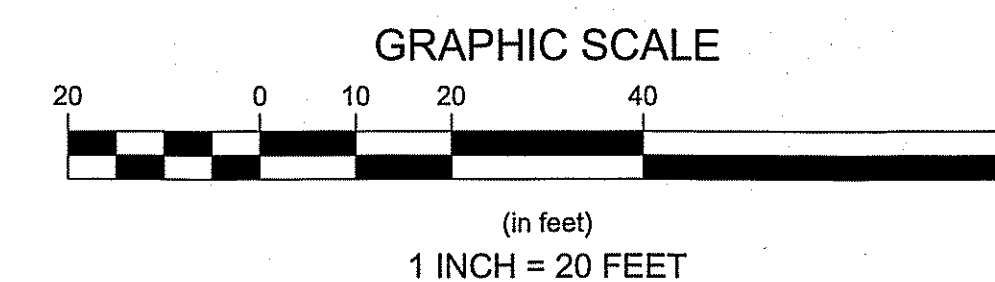
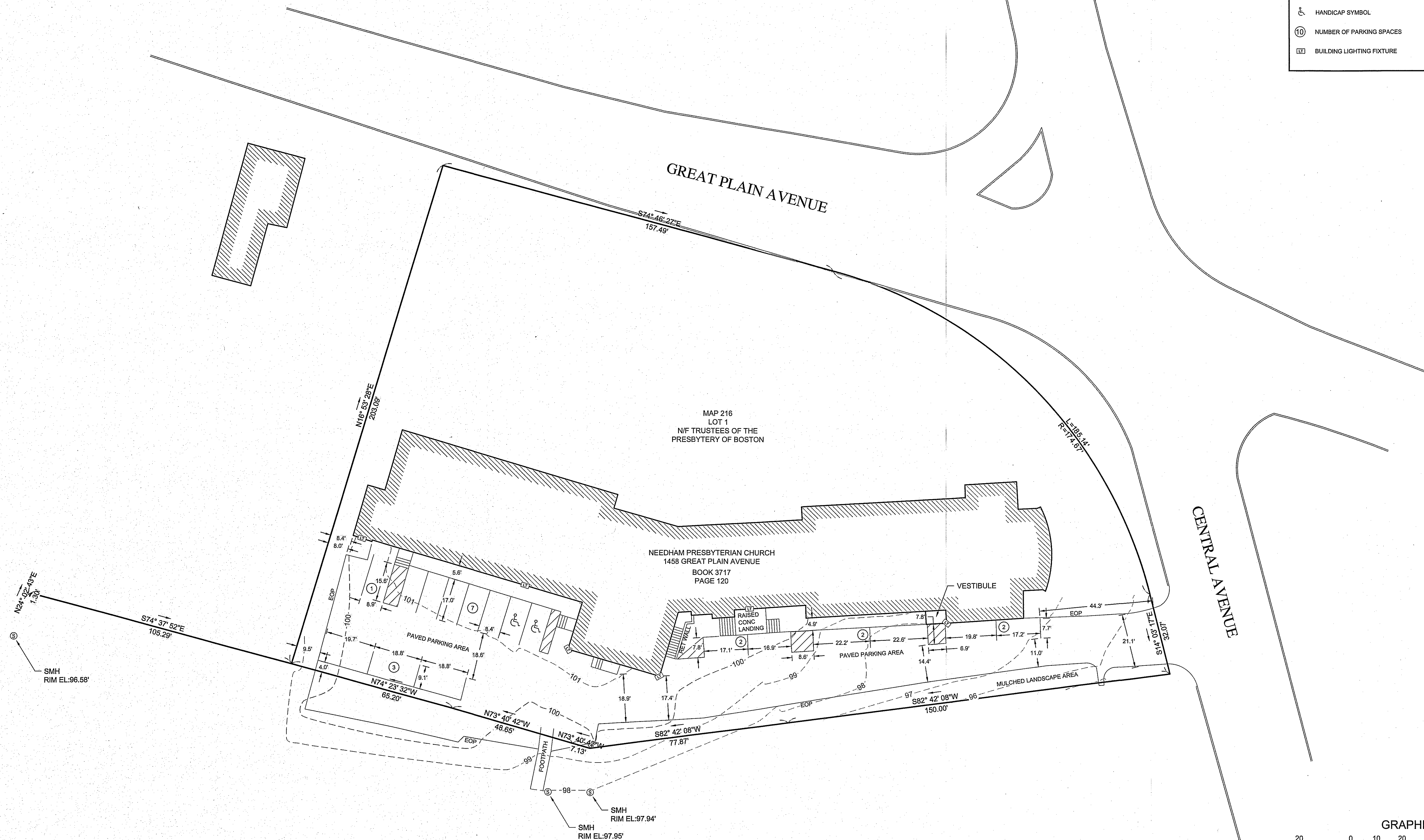
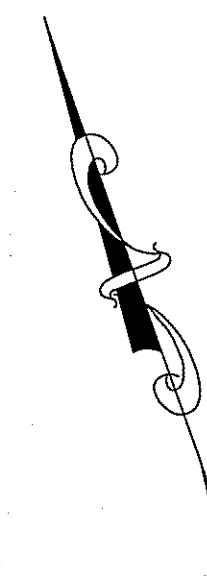
Date Dec. 5, 2011


Town Clerk

A True Copy
Attest:


Town Clerk of Needham, MA

GENERAL	
	BUILDING
	CONTOUR - MINOR
	CONTOUR - MAJOR
	EDGE OF PAVEMENT
	PARKING LINES; HATCHING
	CURB
	WALL - RETAINING
PROPERTY INFORMATION	
	PROPERTY, LOT, OR ROW
SYMBOLS	
	SEWER MANHOLE
	HANDICAP SYMBOL
	NUMBER OF PARKING SPACES
	BUILDING LIGHTING FIXTURE

[illegible]

NEEDHAM PLANNING BOARD MINUTES

June 20, 2023

The Needham Planning Board meeting, held in the Charles River Room of the Public Services Administration Building and virtually using Zoom, was called to order by Adam Block, Chairman, on Tuesday, June 20, 2023, at 7:00 p. m. with Messrs. Crocker and Alpert and Mmes. McKnight and Espada, Planner, Ms. Newman and Assistant Planner, Ms. Clee.

Appointments:

7:00 p.m. – Needham Housing Authority Linden/Chambers Redevelopment Project Update.

Mr. Block noted the applicants came before the Board at the 2/28/23 meeting and different options were looked at. The applicant was considering a “friendly” 40B but is now looking at a By-Law change to be led by the Planning Board. Reginald Foster, of the Needham Housing Authority, stated a friendly 40B was the best route but the Planning Board felt ~~they~~ the NHA should engage Counsel. Attorney Robert Smart did a deep dive to see how the housing originally came about. It is highly advisable to go the Town Meeting route rather than the 40B route. There are notes from Mr. Smart in the packet. They are in the conceptual design process. After considering multiple options for the site, he feels they have agreed on how to go forward. He thinks they have a good approach right now.

Attorney Smart noted in his 6/15/23 letter, there are 3 Zoning Articles – 1) to establish a zoning district for Linden/Chambers which is just over 11 acres; 2) the Zoning Map Article and 3) non-zoning authority for the Select Board to correct deeds or issues to clear titles. He noted it was done that way back in the 1960s. He has not spoken with the Select Board or Town Counsel to see how they want to do it. ~~Some things in prior deeds and votes~~ appear to be incompatible ~~with current plans~~ and may need to be cleaned up. Ms. McKnight noted she has reviewed the documents. The documents could be characterized as restrictions ~~held~~ by the Town. The restrictions may not be able to be released without a Town Meeting vote. Mr. Alpert asked if the applicant was looking for a May Town Meeting. Mr. Foster stated yes, October is not a realistic time frame.

Mr. Block feels the question of title should be flagged. He knows it will be pursued diligently but he would expect a shared resolution. Mr. Smart noted the key zoning issues with the project include density, dimensional requirements and parking ~~[appearance? – requirements?]~~, the review procedure and identifying the proponent of the warrant article. Will it be an overlay or new apartment district? He noted the units per acre ~~for the Apartment A-1 District~~ is a maximum of 18 but the Housing Authority would like 25 units per acre to construct 250 units for an increase of 100 ~~units~~. He noted 70% of the site is wetlands. There will be sloped roofs rather than flat roofs so greater heights are needed. ~~With sloped roofs, the~~ buildings would be 52 feet and 3 stories or 62 feet and 4 stories. With a flat roof it would be 36 feet for 3 stories or 48 feet for 4 stories. The applicant would like a 20-foot front setback rather than the 25 feet in the Apartment ~~A-1 District~~. They want to keep it as far away from the wetlands as possible. For parking, ~~Apartment A-1 requires should have~~ 1.5 spaces/unit. The Housing Authority has data usage suggesting .5 is more than enough.

Mr. Alpert noted the Select Board has ~~commissioned~~ conditioned a parking study. The first draft has been done and it shows the Planning Board regulations are out of line. Mr. Block noted the study focused on the Center and the Heights and not the whole of the municipality. That has to be worked on. Mr. Alpert noted his point is that even 1.5 spaces is way too much. Mr. Smart added a lot of residents who live ~~at Linden/Chambers there~~ do not own cars. Mr. Foster noted there is transportation to appointments. Ms. McKnight stated there was a supplement to the recent parking study. Traffic counts were done at several multi-tenant locations and it was found one space was more than enough per unit. She went late at night and counted the cars and spaces ~~at one such development~~. There were many unused spaces. Mr. Foster stated parking permits are given ~~to NHA tenants~~. He has several years of data regarding how many spaces are needed. The average is less than .5. Ms. Espada noted there are 200 units and 144 spaces.

Mr. Crocker noted the setbacks. He stated a building at this height with a 20-foot setback is too close to the street. Mr. Foster noted his second point is the review procedure. They would prefer the proposed use be as-of-right and site issues be handled through the site plan review process. If additional criteria are needed, they could be incorporated into zoning. He hopes the Planning Board would be the proponent for the Article, rather than the Housing Authority, and present at Town Meeting. He discussed what type of district would be appropriate. An Elderly housing overlay district makes more sense than apartment zoning without age restriction. He provided a draft with an overlay that is like what the Town created for the hospital in 1998. The hospital is in 2 districts like Linden/Chambers. Mr. Crocker commented that it is incredibly close to the street. He wants to do as much as they can but this is too close to the street. Visually, this makes the staircase bumpout worse. Mr. Smart noted there are no houses across the street. There is a big field and a school behind that. The closest neighbors are on Maple Street. Mr. Crocker reiterated looking at it down the road there is too much massing. It takes away from the residential look and is more institutional.

Mr. Foster stated they need to stay out of the 50-foot wetland setback line in the back. The Linden Street existing condition has one-story buildings and not 3-story. They are trying to optimize the open space with courtyards. The point is well taken but there is a tradeoff. Mr. Block asked why the stairs are in front and not somewhere else. Dan Chen, of Bargmann Hendrie + Archetype, Inc. (BHA), noted the architectural preference is to break up the façade. This is the conceptual design phase. They can look at 26 feet from the curb to the building and one wing of the building is slightly shorter than the others. Mr. Block does not see the zoning chart with the dimensional regulations he was looking for and compared to the existing conditions. Mr. Chen stated the current setback is 20 feet. Mr. Crocker feels there is a way to accommodate this better.

Ms. McKnight stated the General Residence District's setback is 20 feet. A strip of this is now in General Residence A. She feels the eventual plan is to make it all General Residence. It seems 20 feet would work so the focus should be on the look of the building. The courtyard is lovely but there should be a more residential look. Mr. Crocker stated the Board needs to be realistic. There is much more massing that should be taken into account. This is not the same as a normal residential setback and should be further setback. Mr. Alpert agreed with Mr. Crocker. Three stories, or maybe even 3.5 stories right on Linden Street, is massive. It does not matter that it is across the street from a field. It should be set back. Having the building be 25 to 50 feet from the wetlands should not be an issue. He feels it could be set back and still be out of the wetland and would look better driving down the street. He likes the courtyards. It breaks it up nicely but should be set back.

Mr. Foster stated he had input from the Maple Street abutters. He is planning to meet with the Conservation Commission shortly. A meeting was scheduled but it was postponed. He will get on the Commission's calendar as soon as possible. He noted the map in the packet is accurate. Mr. Alpert prefers a special permit to an as of right use. He does not want to see a private developer in here if it is as of right. If they could legally limit this to government agencies or quasi government agencies rather than for profit he would be inclined to go as-of-right, but ~~He~~ does not want to do that if it is a private developer. Ms. McKnight stated the ownership has to be private in order to get tax breaks. Mr. Foster noted the Housing Authority will retain ownership of the underlying land and [unencumbered ownership?] would come back to the Housing Authority but the entities who finance would need an iron clad agreement.

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Ms. McKnight commented on the process of the meeting. The Board members have been able to review the materials but not the public. Mr. Block agreed. Mr. Foster stated that they have met with abutters. They need to embark on comprehensive public engagement if the Planning Board is going to take over. They need to have review and language complete if going to Town Meeting. Hearings would need to be in January but there are substantive changes. This requires more than one hearing and at least 2 community engagements. The Planning Board will create several more opportunities for the community. Margaret Moran, Leader of the Cambridge Housing Authority Team, stated they had a Chair [meeting with the NHA Chair?]. The thought was to have the Housing Authority develop this to the terms required.

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Mr. Block stated Mr. Smart did an excellent job in the base zoning. There needs to be robust community engagement. The Planning Board should take the lead on arranging the community participation. The Board can

discuss this later. Mr. Crocker agreed. He does not feel these plans are ready for the Planning Board to take over. Ms. Espada disagrees with the statement that there are no houses around there. There is a fabric around, setbacks and a landscape as you go down Linden Street. It is at a conceptual stage now, but shows an abrupt scale and landscape change. She needs to see more context and wants to see how it looks in the neighborhood conceptually.

Mr. Foster noted the intention was this is only an informal discussion. He envisioned this round of check-ins now, check-ins with the Conservation Commission and then wrap up the schematic design. If they stay on track the schematics should be done by December. They do not want public hearings in the summer. He wanted to check in to see if they were going in the right direction. He is asking for zoning by right subject to site plan review, noting that the—but it is a funding process requires zoning to be in place by right.

Ms. McKnight noted, with regard to height, in front along Linden Street the maximum is 52 feet. She asked if that is to the top of the half story above the third story. That is the same as the Mixed Use on Dedham Avenue. At the rear of the site it was proposed one big angled building would be 62 feet. She wants to make sure, when drafting the decision, it is clear the higher height limit can only be used in the area that is at least 150 feet back from Linden Street. For the process, she wants to see this site as an opportunity for the Town to add these 11 acres to the zone that complies with the MBTA Communities Actlaw Guidelines supply. She wants to get this zoning in place for this development. It would allow seniors, handicap and low income population. The Housing Authority wants zoning in place for the 2024 Annual Town Meeting. The Board should get this zoning secured for the NHA development, then, moveing forward with the MBTA Communities Actlaw, then go to the site and change the underlying zoning. The underlying zoning can be Apartment A-1 by right. The developer would go forward with this zoning. That is what she envisions. The underlying zoning will need to have no age limits.

Mr. Alpert would have a backup to see if they could meet the MBTA Communities zoning without that. Ms. Espada would like to see how the height relates to the High Rock School across the street. She feels it would be helpful for context. She feels understanding the relationship is critical. Mr. Foster put up an artist's rendering. They have 25 acres where housing is. It is a beautiful neighborhood with mature trees. It is incumbent upon them to preserve the area. They have had 2 neighbor meetings. They will take those comments and tonight's comments to see the best way to move forward. Mr. Block stated the Board is unresolved as to by right or by special permit. They are also unresolved on the dimensional regulations. Some or all members feel the front setback on Linden may need to be greater. There is also a question on how far you can go in the back and a question on the staircase. Those will not be resolved tonight. He asked how a density of 250 units or 25 units per acre was arrived at.

Mr. Chen stated it came to 252, which was not a definitive number. He wanted to understand the density for what the site can support, the ability to phase and the financial ability to support in the future. The minimum was to replace 150 units – 72 in phase 1A, 72 in phase 1B – and add 100+ units in phase 2. With parking, traffic and impact to the neighborhood that seems to be the right number. Currently Linden has 18 buildings with 4 studio units in each, which is 72. The current design is able to maintain the 72 units in phase 1. Mr. Foster stated the temporary tenant relocation is the number 1 priority. There will be an individual relocation plan for each tenant. Once through the first phase 1A everyone can move back and they will have their own swing space.

Mr. Block asked if the Town has engaged a consultant to assist with financing. Mr. Foster stated an RFP is out for a housing consultant for financing and the [Home Committee?] will also be receiving some financing. He will send the RFP to Board members. Mr. Block noted an email from a number of Sylvan Street residents commenting on a number of elements. Mr. Foster thanked the Board and stated he would continue to work with staff throughout the summer. Mr. Block would like to see the first community meeting in September. He would like conceptual drawings, a dimensional comparison of current versus proposed and would like, by late September, to have had the first 2 meetings/hearings. Mr. Smart asked to clarify the dimensional comparison. Is it what is currently on the ground or dimensional of the underlying zoning. Mr. Block stated the underlying zoning but also the current conditions with the existing housing and new proposed zoning.

Ms. McKnight discussed the timing. Ms. Moran noted there should be the Town Meeting vote to approve the zoning during the Attorney General review period. The Housing Authority would apply for a site plan application and it seems the Board would issue a conditional approval. Ms. Newman feels they should get an opinion from the

new Town Counsel. Mr. Foster stated it is the second time he has done a project like this. He would welcome opinions from the Fire, Police, DPW and all stakeholders this summer.

The Board took a 5-minute break.

Decision: Major Project Site Plan Special Permit No. 2023-02: Shallots Needham, Inc., dba Sweet Boba, Kakada Ly, President, Petitioner (Property located at 1032 Great Plain Avenue, Needham, Massachusetts). Regarding request to renovate approximately 644 SF of first floor space for use as a retail bakery with an accessory eat in/take out counter and 6 seats.

Mr. Block noted they have received comments and a modified decision. Ms. McKnight noted in [Section 3.12](#) regarding solid waste [collection](#), it says weekdays 7:00 a.m. to 6:00 p.m. There are not residential uses nearby [now](#), ~~but~~ [With](#) the current zoning the hope is to develop mixed use. In [Section 3.12](#) it has Saturday, Sunday and holiday hours as 7:00 a.m. to 1:00 p.m. She asked why not 11:00 a.m. to 6:00 p.m. Ms. Newman used the same [hours](#) as French Press. Ms. McKnight asked why not make the noisy trucks come later if the hours are being abbreviated. Ms. Clee clarified [that](#) French Press has hours of 9:00 a.m. to 1:00 p.m. Ms. McKnight is ok with those hours.

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

VOTED: to GRANT: (1) the requested Major Project Site Plan Review Special Permit under Section 7.4 of the Needham Zoning By-Law (hereinafter the By-Law); (2) the requested Special Permit under Section 3.2.2 of the By-Law for an eat in/take out establishment accessory to a food retail operation in the Center Business District; (3) the requested Special Permit under Section 3.2.2 of the By-Law for more than one non-residential uses on a lot where such uses are not detrimental to each other and are in compliance with all other requirements of the By-Law; and (4) the requested Special Permit under Section 5.1.1.6 of the By-Law to waive strict adherence with the requirements of Section 5.1.2 (Required Parking) and Section 5.1.3 (Off-Street Parking Requirements), subject to and with the benefit of the following Plan modifications, conditions and limitations.

Upon a motion made by Mr. Alpert, and seconded by Mr. Crocker, it was by a vote of the five members present unanimously:

VOTED: to approve the decision as modified tonight and as red-lined.

Discussion of Planning Board Goals & Priorities

Mr. Block stated he has prepared a list of priorities based on ongoing discussions. He has an inventory of priorities and a schedule for goals for this year, what needs to be worked on and by when. He noted there are several categories. The first is a Planning Board retreat for additional training and information. The retreat will be with Town Counsel, staff and members. He will work with Ms. Espada, Ms. Newman and Ms. Clee to devise modules to work on. Training will be an ongoing effort. The work product will have some kind of manual or guideline. He will identify the process, how to deal with zoning and some other elements. They will identify modules, lay out a schedule and then come back to the full Board with a proposal of when they can begin work. The Board will determine zoning best practices.

Mr. Block noted residential zoning amendments. He commented on the Housing Authority Linden/Chambers and stated affordable housing in 6.12 has a minimum standard of 12.5%. Ms. McKnight wants to expand the [12.5%](#) standard townwide. Ms. McKnight noted she wants it expanded in all districts where multi-family housing is allowed. The goal is to always use 12.5% or 1 per 8 units. They usually round up if there are 6 units. She feels the Board should look at [conditioning buildings with](#) 3 to 7 units. Applicants should supply one unit or pay into the Affordable Housing Trust Fund. She would like to explore this concept. Mr. Block stated that would be an action item to discuss.

Mr. Block asked if the Board should reconsider detached ADUs and, if so, when? The MBTA Communities Compliance effort will start this year, with a view to pass MBTA compliance in October 2024. There is also a concern from residents with the replacement of tear downs and the FAR. An email from Joe Matthews, dated 6/18/23, is included in the packet.

As to tear downs and FAR, Mr. Crocker feels there is a loophole in there to letting these houses get this large. There is could be an unfinished upper floor that is then immediately finished. Mr. Alpert noted he went to the By-Law after reading Mr. Matthews letter. There is FAR for 2 floors, but the house can have a finished basement and attic and still meet also have the lot area coverage. He would like to get a list of houses Mr. Matthews is complaining about to see what they really look like. Mr. Block asked the staff to reach out to Mr. Matthews to come in to discuss. He should bring examples. Ms. McKnight stated she began a study back in 2019 as she was on the Large House Study Committee. A list of teardowns was created and building permits for a year before and after all in effect. Then Covid hit and she gave it up. She asked if there is the ability to do a study like that. Ms. Newman asked what the priorities are for the next year. The MBTA Communities will take a lot of time. There will be Climate Action and also the Linden/Chambers.

Mr. Crocker stated a whole other floor with living space increased the height of the house. Mr. Alpert noted the mass of the house does not change. There are height limitations. Ms. Newman stated the half story does not count or the basement. The height constraint is 35 feet. The Board has relaxed on how dormers could be used. Mr. Crocker stated people have third floor living space. The loophole in FAR is not supposed to allow that to occur. Mr. Alpert noted the third floor does not change the nature of the house or the neighborhood. Mr. Crocker noted the question is what is counted toward FAR. If living space is expanded, it should be counted toward FAR. Mr. Block will get specific information from Joe Matthews for the Board to look at. Then the Board will look to see if it should be taken on.

Ms. Espada stated it appears from what has been said that the Planning Staff can only do the MBTA Communities, Climate Action and Linden/Chambers in the next 2 years. She asked what they can do as Board members, within the list, that does not require Ms. Newman or Ms. Clee, as they would not have the capacity. She feels the Board needs to prioritize but there is only the capacity for so much. The MBTA Communities will take over once that gets started. Getting into zoning amendments will be tough to do. A discussion ensued.

Mr. Block noted 888 Great Plain Avenue will come in front of them. It would be an opportunity to talk about broader zoning or extending the overlay. Ms. Newman feels it could possibly be rolled into the MBTA Communities through the public process. Ms. McKnight feels 888 Great Plain Avenue zoning a more comprehensive study should be on the list but on the list for a change in the Fall of 2024. It should be kept as a priority on the list but extended until the Spring 2025 Town Meeting. Mr. Block noted his list includes a commercial zoning amendment, 888 Great Plain Avenue, the parking By-Law, unlocking the Charles from Staples through Highland Avenue and Mixed Use 128 and Highland Commercial 128 Districts. Mr. Alpert noted that area was recently rezoned and asked why revisit it. Mr. Block is looking at the broader picture to get revenue for the Town. Ms. Newman commented she would be interested in understanding what the developer's issues are with the Charles. She does not think it is regulatory based. They need to understand what the issue is. Ms. McKnight noted the Board should not forget the Highland Avenue strip from Rosemary Street to May Street. Ms. Clee stated that could be under the MBTA Communities Act law compliance effort.

Ms. Espada wants to see what can be looked at at the same time. Some can be integrated into studies but not be individual studies. Mr. Block noted Customary Home Occupation has been brought up by the Building Commissioner. He would like it updated. Ms. Newman feels it makes sense to update and has a draft she will share. Ms. McKnight feels the site plan approval process needs to be looked at, part of the By-Law needs to be revisited, and should be on the list.

Mr. Alpert asked if Mr. Block has spoken with Town Counsel about a retreat meeting with him. Can they have a retreat without violating the open meeting law? Mr. Block has spoken with Town Counsel and Assistant Town Manager Katie King and is on top of it. Mr. Block noted there are a number of changes including solar canopies and solar panels. Large size ground mounted solar panels are in the By-Law already. Does the Board want to

modify for smaller or geothermal? He wants more realistic sustainability goals for the town. He wants to modify the administrative practices that relate to sustainability goals and he wants to ensure zoning is meeting best practices for inclusion, equity and diversity. Ms. Espada asked what information is being collected. Mr. Block noted the Board needs to have a session to talk that through. Zoning needs to be made more inclusive and equitable and facilitate the underrepresented in the process. He noted other Building Commissioner questions include rear lots and corners lots and the site plan review process and procedures. Ms. Newman stated there is a current court case on ~~this~~ site plan review so it should be on hold until the case is resolved.

Mr. Block noted he has already planted anchors in the schedule for these identified training and other category headings. He will add the site plan review process to the next draft. The Planning Board representatives for the MBTA Communities advisory committee will be resolved at the next meeting. He feels there should be 3 community meetings maybe in November, January and April but that is not set in stone. The language would need to be finalized in September. They would want the zoning almost complete but need to be mindful of the process and schedule.

Ms. Espada stated detached ADUs is not a priority. The Board should focus on things that would create the most change and the most opportunity. All agreed. Ms. McKnight noted it is not realistic to have a community meeting in July on affordable housing for the October Town Meeting. She would like to address that for the May 2024 Town Meeting. Mr. Block will move detached ADUs to 2025. Ms. Espada stated sustainability should be a priority. She feels, knowing the priorities, the members should look at them offline then share and review at the next meeting. Mr. Block would like to look at the schedule for Climate Action and sustainability. Ms. Newman noted, realistically, it would be for the May Town Meeting. A discussion ensued.

Ms. Newman asked if the members agree with the draft language from Stephen Frail. Mr. Alpert noted they have not discussed what he says. It needs to be reviewed, have an open meeting to discuss, make changes and see what the public thinks. It would be a multi month product. Mr. Block feels it should be put on the schedule for the May Town Meeting. Ms. Espada noted everyone wants it done quickly but it needs to be done right. Ms. McKnight commented that the spreadsheet is really good and the Board should have it for years. Mixed Use zoning is on the planning list but not on this chart. It should be under commercial. The Tree By-Law is not on the list. The Select Board's goals do not ~~say~~ list Tree By-Law. Mr. Block stated the lead on that will come from the Select Board

Mr. Alpert feels this was a very productive discussion. There are a lot of changes for May. The information should be put together in a chart for May. Then the Board can look at the chart and prioritize the big 3 to bring to Town Meeting. Linden/Chambers is number 1. Then 2 or maybe 3 more could be added.

Minutes

This will be deferred.

Report from Planning Director and Board members.

Ms. Newman is putting together an RFP to get a consultant for the Home Group.

Correspondence

Mr. Block noted a notice from Newton regarding a new village center overlay district hearing and an email from Joe Matthews dated 6/18.

Upon a motion made by Mr. Crocker, and seconded by Ms. Espada, it was by a vote of the five members present unanimously:

VOTED: to adjourn the meeting at 10:32 p.m.

Respectfully submitted,
Donna J. Kalinowski, Notetaker

Jeanne S. McKnight, Vice-Chairman and Clerk

DRAFT

From: [Anica Law](#)
To: [Planning](#); [Selectboard](#)
Subject: Zoning against firearm vendors
Date: Thursday, August 17, 2023 9:35:16 AM
Attachments: [As Littleton gun vendors seek new home, towns erect barriers - The Boston Globe.pdf](#)

Dear Select Board -

Thank you for your services to our Town.

To continue to keep our town as safe from gun violence as possible, has the Select Board considered erecting zoning barriers, joining our neighbors Newton, Wellesley, Brookline, Westwood, and Dedham? Needham is currently a gaping hole in the map of towns with zoning to limit gun businesses in our local area, and we should certainly not be the vulnerable weak link. With respect to the idea that we don't want to enact too many zoning restrictions for the sake of local economic/business health, I think the vast majority of families in Needham would gladly sacrifice any revenue from gun vendors for the safety of our community.

Link to Boston Globe article (with map of towns), from August 15, 2023:

<https://www.bostonglobe.com/2023/08/14/metro/after-uproar-littleton-gun-vendors-seek-new-home-nearby-towns-are-wary-them/>

PDF of the article also attached.

Thank you,
Anica Law,
65 Kingsbury St

As Littleton gun vendors seek new home, towns erect barriers

Zoning becomes go-to defense against new weapons hubs.

By [Sarah L. Ryley](#) Globe Staff, Updated August 15, 2023, 11:30 a.m.



The Gleasondale Mill houses wood workers and artisans, but if the landlord gets his way, 10 gun makers will move in. SUZANNE KREITER/GLOBE STAFF

STOW — It's postcard-perfect: a historic brick Greek Revival mill with a towering smokestack, nestled on the banks of the Assabet River, with apple orchards and rolling golf courses in the distance. Once a textile hub, the Gleasondale Industrial Park now

houses woodworkers and artisans — and soon, if the owner gets his way, a crew of 10 gun vendors.

The owner, Chris Franklin, said the vendors are seeking to relocate there from another old mill building, in Littleton, which the Globe [revealed last fall](#) was home to more than 80 federally licensed gun manufacturers, the largest cluster at a single address in the nation. Many were openly selling firearms and parts that exploited loopholes in the state's notoriously strict gun laws.

Littleton officials acted swiftly in response to the [uproar](#). By February, they had recruited a developer to buy the building, which will eventually be razed to make way for apartments, and to enact zoning restrictions that effectively bar new gun tenants from moving into the mill in the meantime, or clustering elsewhere in town.



The ATF did a sweep of inspections of every gun vendor at the Littleton Mill in February. JOHN TLUMACKI/GLOBE STAFF

Concerned they may soon get an influx of weapons purveyors, the neighboring towns of [Acton](#), [Sudbury](#), [Westford](#), and [Maynard](#) began considering similar zoning restrictions on where and how many firearms businesses could operate. Acton's bylaw was the first to pass, in May, and caps the number allowed within town limits at two.

Stow hasn't taken any such measure so far. Town Planning Director Valerie Oorthuys said she raised the issue with the Planning Board [in June](#), but some members were hesitant because the process of locating where gun stores potentially could operate could stir up controversy.

"It might be frustrating for residents if we say, 'Gun dealers are allowed in your backyard,'" Oorthuys told the Globe.

Two weeks later, Franklin [submitted his application](#) to add the 10 gun vendors, along with 20 new artisan tenants, to his 5-acre complex. The [hearing](#) is Tuesday. Since the mill's zoning already allows for gun shops, Oorthuys said, the board likely has no choice but to approve the plans, though it can add conditions.

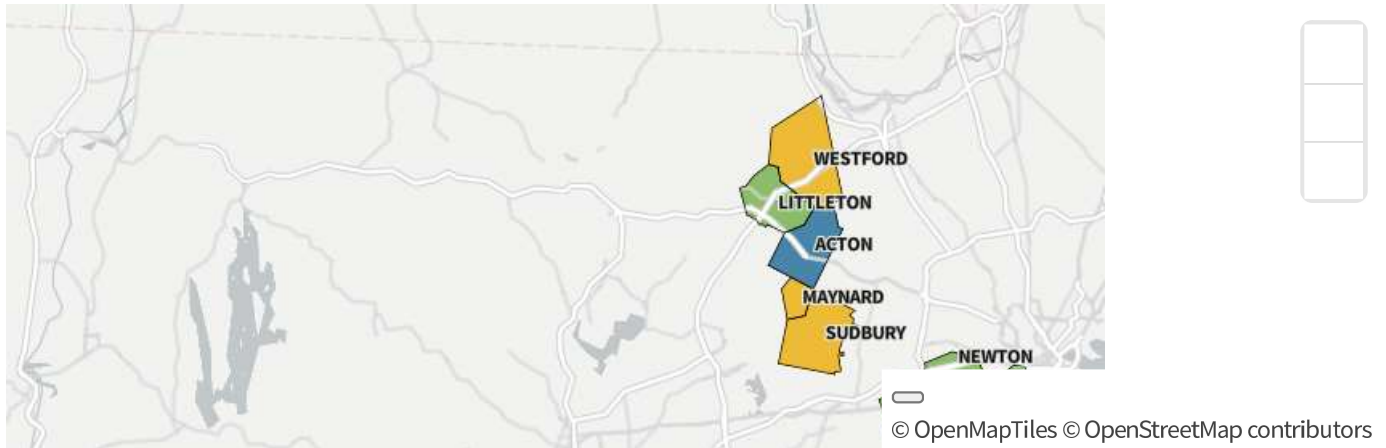
The fraught considerations in Stow, 20 miles west of Boston, reflect the suburban tension that has arisen in recent years between a small but growing contingency of Second Amendment enthusiasts and the majority of locals, who favor strict gun control.

The Globe found at least six other municipalities, all in Middlesex or Norfolk counties, that enacted zoning restrictions on firearms businesses in the years before the Littleton controversy, either in response to a proposed gun shop or to preempt a proposal.

Cities and towns turn to zoning to limit gun businesses

At least eight municipalities in Massachusetts passed zoning bylaws between 2020 and 2023 to limit where firearms businesses can operate. Some also cap the total number that can exist at one time and bar them from clustering in the same building. At least three other towns are eying similar measures.

Status Pending AG approval Pending town approval Enacted



Source: Globe reporting and the Office of Massachusetts Attorney General • GLOBE STAFF

✶ A Flourish map

The share of Massachusetts residents 15 and older with permits to use firearms doubled from 2010 to 2020, to 13 percent of males and 4 percent of females, while the state’s overall population in that age group increased by 10 percent, according to a Globe analysis of US Census Bureau and state gun licensing data.

Stow has a slightly larger prevalence of firearms license-holders: 22 percent of males and 6 percent of females. But they are still a clear minority.

“If you took a vote, it would not pass,” a longtime Stow resident said of Franklin’s efforts to bring the Littleton gun vendors to her town. “We know what kind of people and activity they brought,” she said. “We don’t want them here.”

The resident, like many who spoke to the Globe, asked not to be identified because of safety concerns.

Gun shop owners were also wary about voicing their beliefs. One Littleton shop owner eyeing a move to New Hampshire said he's experienced far more discrimination in Massachusetts for his Second Amendment beliefs than he ever has as a brown, Muslim immigrant.

Another vendor pleaded with the Globe not to print his name because his neighbors have already harassed his family after he expressed support for gun rights on Facebook.

Jim Wallace, executive director of Gun Owners' Action League, a prominent state gun rights group, called the local opposition to gun dealers "pure bigotry."

"There is absolutely nothing wrong with having a licensed firearm retailer in your town," he said.

The Littleton mill has shed about 30 gun vendors since last fall, said a spokesperson for the building's new owner, Lupoli Companies.

Several vendors lost or relinquished their licenses following [mill-wide inspections](#) by the US Bureau of Alcohol, Tobacco, Firearms and Explosives in February, the Globe found in response to records requests to the ATF and Littleton Police Department.

Others settled into new digs in other towns or faced intense push-back when attempting to relocate.



Former Littleton gun dealer Jeffrey Steinbrecher told Westford's Planning Board in February that his shop, Legal Arms Co., doesn't manufacture guns in the classic sense. "We collect high end parts from around the country and assemble them into high end dream purchases for our clients," he said. The shop often displayed these weapons on its Instagram page, which is now private. LEGAL ARMS CO/INSTAGRAM

When Jeffrey Steinbrecher sought to move his gun shop, Legal Arms Co., from Littleton to Westford, a [Planning Board hearing](#) on his application in February stretched more than two hours as residents took turns expressing alarm about the military-style weapons he sold.

Westford Select Board chair, Tom Clay, said the Planning Board had little choice but to approve Steinbrecher's application since the zoning allowed it. But it spurred the town to draft a [zoning bylaw](#) that, if enacted, would limit where gun businesses could locate in the future, cap the number at four, and prohibit them from operating in the same building.

Steinbrecher, who did not respond to a request for comment, still hasn't moved to Westford. The ATF said in response to the Globe's records request that Steinbrecher and two other Littleton vendors are undergoing license revocation proceedings, but could not share further details.

Federal authorities arrested another Littleton vendor, Cory Daigle, [in January](#) for knowingly selling three pistols to a straw buyer, which were later recovered during the investigation of a Boston shooting. But that didn't stop Daigle from trying to open a new shop in Lynn, where he, too, faced local opposition. Daigle eventually withdrew his application and the ATF revoked his license to manufacture guns.



For now, the Littleton mill still houses the nation's largest group of gun businesses at a single address, with roughly 50. Massachusetts also claims the second- and fourth-largest hubs — a shopping center in Bridgewater, with 15 vendors, and another old mill building in Rockland, with nine — according to an analysis of ATF data.

If plans by Franklin, the Stow mill landlord, come to fruition, his building would be tied with a shooting complex in San Antonio as the nation's third-largest gun hub.

All of the vendors in the Massachusetts hubs hold licenses to manufacture firearms, a product of the state's strict gun laws that are also filled with loopholes.

The laws prohibit dealers from selling civilians many popular guns, such as Glock pistols and AR-15-style rifles, but don't regulate the sale of gun parts. The state's assault weapons ban has also been widely interpreted as allowing for their sale with cosmetic modifications. Dealers need the manufacturing license to modify guns or break them down to sell as parts.

A [140-page gun bill](#) pending on Beacon Hill would close some of the loopholes used by many vendors. But House Speaker Ronald J. Mariano recently [put the bill on hold](#) for the summer.

Franklin said some of the artists in the Stow mill objected to his plan. But he assured them that they wouldn't be sharing the same entrance with the gun businesses.

The gun vendors, he said, are "just people running a small business, but the stereotypical — people might call them rednecks or rubes or whatever — they're far from it."

A painter and a woodworker in the building told the Globe that while they prefer not to share space with weapons purveyors, they recognize their right to operate.

But Colleen Pearce, a retired elementary school art teacher in Harvard who had planned to move her painting studio to the Stow mill, said she wouldn't go there if guns were being built or sold out of the same building. The mass shooting drills she did with her young students were traumatizing, and she has had nightmares about failing to get them all to safety.

"I don't want to go into a studio where I'm trying to create beautiful things and have a gun manufacturer that's all about destroying, not just things, but humans," Pearce said.



Colleen Pearce, a painter, said she won't move her studio to the Gleasondale Industrial Park if guns are being built and sold in the same building. SUZANNE KREITER/GLOBE STAFF

Sarah Ryley can be reached at sarah.ryley@globe.com. Follow her [@MissRyley](https://twitter.com/MissRyley).

[Show 158 comments](#)

From: [Keller, Stanley](#)
To: [Planning](#); [Selectboard](#); [Kate Fitzpatrick](#)
Subject: Daycare Development at 1688 Central Avenue
Date: Monday, August 28, 2023 12:03:11 PM

We are longtime residents at 325 Country Way and have a direct interest in the proposed development, initially of a daycare facility, at 1688 Central Avenue. After extensive hearings and with careful consideration, the Needham Planning Board issued a well-reasoned decision that permitted construction of the proposed daycare facility but with conditions designed to protect the interests of the Town and the immediately affected properties consistent with the character of the neighborhood, all with due deference to the rights of the developer and proposed operator under the Dover Amendment. The Land Court Judge who heard the developer's appeal of the Planning Board decision was hostile to the Town's interests from the outset of the proceeding and issued a decision that gave excessive weight to the Dover Amendment and effectively stripped the Town of authority to impose reasonable regulations on the development in accordance with its zoning bylaws while the Town permitted this development to proceed.

We feel it is extremely important for the Planning Board to appeal the Land Court's decision to the Massachusetts Appeals Court. The Planning Board held hearings and issued a decision that permitted the development to proceed as contemplated by the Dover Amendment but at the same time protected the interests of the Town through reasonable conditions. The Planning Board sought to keep the residential character of this neighborhood, mitigate traffic impacts, mitigate impacts on the safety of pedestrians, mitigate visual and auditory impacts on the neighboring properties, mitigate environmental and health impacts on families, children and residents. The Planning Board should continue to protect its authority and the interests of Needham by appealing this decision. Without an appeal, all of these protections will be lost and its authority emasculated, contrary to the protections recognized by the Dover Amendment.

Also, an appeal is important not just for the sake of this project but for the sake of being able to protect Needham's legitimate municipal interests with regard to all schools, churches, childcare centers and other Dover Amendment uses. If the decision is left as it is, it will open the door for all past and future Dover Amendment projects to argue that their projects likewise do not need to submit to site plan review/special permit or abide by any reasonable conditions established to protect the Town.

If the Planning Board does not appeal the Land Court's adverse decision and defend its authority, it will be signaling all other project proponents that bringing suit, or even just threatening to bring suit, is a fruitful method to overcome the Town's interest. Moreover, it is appropriate to have in mind the sensitivity of this particular project because of the developer's, Mr. Borrelli's, conflict of interest as Chair of the

Select Board at the time of the Planning Board's actions.

As Needham taxpayers, we support the expenditure of Town funds to appeal the Land Court decision because it is essential to protect the right of the Planning Board and the Town to reasonably regulate these types of projects, and specifically Mr. Borrelli's project, with appropriate site plan and special permit review. It would be short sighted for the Town to save on litigation expenses today only to suffer the consequences and future litigation expenses that this Land Court decision will invite on other projects in the future.

We appreciate your consideration of these views.

Stanley Keller
Sandra F. Keller
325 Country Way
Needham, MA 02492



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From: macleod41@aol.com
To: [Kate Fitzpatrick](#); [Planning](#); [Selectboard](#)
Subject: 1688 Central Ave
Date: Tuesday, August 29, 2023 9:51:56 PM

To: Needham Planning Board
Needham Select Board
Kate Fitzpatrick - Town Manager

I write this email to strongly urge The Town of Needham to appeal the judge's recent decision ruled in favor of Needham Enterprises for the proposed development of the 1688 Central Avenue property as a day care center.

I believe the conditions set forth by the Planning Board, subsequently appealed by Needham Enterprises, were more than fair to Needham Enterprises. The proposed development of this site with a daycare facility, with or without the Planning Board restrictions, will change the nature of this residential neighborhood forever.

The Town should appropriate the necessary funds to appeal the judge's current decision and interpretation of the Dover Amendment to prevent this type of development from impacting this and other neighborhoods in Needham and likely other communities.

The money spent now is an investment in the future character of Needham and its neighborhoods.

Matt Borrelli, while sitting on the Needham Select Board, clearly did not have the Town's best interests in mind when he proposed the building of the daycare and later sued the Town when some restrictions/conditions were placed on his proposed development.

His actions do not project a good impression of our Town government and its ability govern effectively preventing any conflict of interests from our elected Town officials. It is an embarrassment to our community.

The alternative development of this parcel at 1688 Central with one, two or even three residential homes would be most appropriate and in keeping with the neighborhood as it currently exists.

I urge the Town to appropriate the necessary funds and appeal the judge's decision.

Respectfully,

Norman MacLeod
41 Pine Street
Needham, MA
Email: macleod41@aol.com
Cell: 617-877-5100

From: [Gregg J. Darish](#)
To: [Kate Fitzpatrick](#); [Planning](#); [Selectboard](#)
Subject: 1688 Central
Date: Tuesday, August 29, 2023 11:24:50 AM

To Whom it May Concern,

Can you please let me know what your process is for contemplating filing an appeal on this matter? My understanding is that the Town believes that the Judge got this wrong and that there is a strong likelihood of success on appeal. Much appreciated.

Gregg Darish
34 Country Way

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Gregg J. Darish
617-306-4011
gjdarish@gmail.com

From: [Lois Sockol](#)
To: [Planning](#); [Selectboard](#); [Kate Fitzpatrick](#)
Subject: Land Court Decision
Date: Tuesday, August 29, 2023 2:13:38 PM

I trust that each member of the Select Board and the Planning Board endeavors to protect our citizens. In that I have faith. For what is Needham but its citizens? Recently, the Land Court issued a judgment in Needham Enterprises' favor, annulling the precautions and guidelines of the Needham Planning board which had worked resolutely to frame a just compromise that enabled the protection of Needham's municipal interests. The judge in the Land Court case also denied the request by the citizens impacted by the project to have their voices heard. I believe such a decision by the Land Court undermines the authority of our Planning Board and the rights of our citizens. Therefore, I believe the Needham Planning Board has just cause to appeal the land court decision. I think it essential to protect its authority and our Town. I believe it would be short sighted and injurious not to do so. I fervently hope you will support an appeal.

Lois Sockol

Precinct I

From: [Robert Onofrey](#)
To: [Planning](#)
Subject: 1688 Central Avenue
Date: Wednesday, August 30, 2023 10:07:33 AM

30 August 2023

Re: 1688 Central Avenue

I recently learned that a judge has ruled in favor of the Plaintiff (the Developer) and against the Town of Needham relative to the proposed Daycare Center at 1688 Central Avenue. I'm disappointed in this decision and I'm asking that the town appeal this to a higher court. Failure to appeal this decision will undercut any authority that the various boards would have in reviewing future projects proposed in Needham and open the floodgates for other developers to challenge any reviews done by the Town.

While I've only seen a summary of the judges ruling - giving the developer the right to apply for a building permit - without conditions. Surprising that no conditions were placed on the testing and removal of potential contaminants. Ample evidence was provided indicating that the site was long used as a junk yard - with the leaking of fluids associated with junked vehicles.

While the "Dover Amendment" is cited as allowing this project to be constructed on this site - this amendment never considered a project of this scale to be constructed in this residential setting. It doesn't seem logical that this 10,000 SF single story building would have the same setback requirements as a residence with a 1,500 - 2,000 SF footprint. The bulk and scale of this facility will be overwhelming in comparison with adjacent residences.

Don't know the origins of the Dover Amendment - but The Dover Amendment needs "amending".

I've been against this project from the very beginning. The expected increase in traffic on Central Avenue will be crippling. Morning and evening traffic is difficult as it is without the added burden of parents dropping off children in the morning and picking them up in the evening. While additional childcare facilities are much needed - this is not the right location.

This project was ill conceived and poorly planned from a Site Plan perspective, siting this facility to allow the retention of the existing barn for uses not associated with the daycare facility.

This parcel of land at 1688 Central Avenue is best suited for residential development.

Thank you.

Robert & Joan Onofrey
49 Pine Street
Needham, MA 02492

PUBLIC MEETING NOTICE - LARGE HOUSE REVIEW
LHR 23-03, 52 WESTGATE ROAD, WELLESLEY, MA
MIKE AND ELIZABETH FISH, APPLICANT
MONDAY, AUGUST 21, 2023, 6:30 PM

REMOTE MEETING

If you would like to participate on this topic, an agenda will be posted prior to the meeting with the remote information

At the Wellesley Planning Board Public Meeting on Monday, August 21, 2023, the Board will consider the request to construct an addition to the house at 52 Westgate Road pursuant to Section 16 D, Large House Review of the Wellesley Zoning Bylaw.

Residents seeking to participate in Citizen Speak or any other agenda item should email planning@wellesleyma.gov prior to the meeting indicating the item they wish to speak on.

The submission and plans may be viewed on the Planning Department webpage at:
<http://wellesleyma.gov/1479/Planning-Board-Applications-Under-Review>