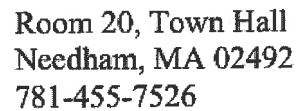


2022 SEP 22 PM 4:50



APPLICATION FOR SITE PLAN REVIEW

Major Project

NOTE: Reports on Minor Projects must be issues within 35 days of filing date.

ADDENDUM A
TO
APPLICATION FOR SITE PLAN REVIEW
OF
BTE Development, LLC
40 & 50 Central Avenue
Needham, Massachusetts

The following relief is or may be required, and is hereby requested:

1. Pursuant to the criteria of Section 7.4.2 of the By-Law, the proposed redevelopment of the Premises constitutes a “major project” and therefore requires Major Project Site Plan Review and the issuance of a special permit pursuant thereto.

2. In addition, the following relief is, or may be required:

- a. Issuance of a Special Permit pursuant to Section 1.4.6 for the change and extension of a lawful, pre-existing, non-conforming use, and the alteration, enlargement and reconstruction of a lawful, pre-existing, non-conforming structure;
- b. Issuance of a Special Permit pursuant to Section 3.2.3.2(g) for retail sales of ice cream, frozen yogurt and similar products for consumption on or off the premises, in a space less than two thousand (2,000) square feet (for Panella’s Market);
- c. Issuance of a Special Permit pursuant to Section 3.2.3.2(h) for a take-out food counter as an accessory to a food retail or other non-consumptive retail establishment (for Panella’s Market);
- d. Issuance of a Special Permit pursuant to Section 3.2.3.2(j) for more than one non-residential use on a lot where such uses are not detrimental to each other and are in compliance with all other requirements of this By-Law;
- e. Issuance of a Special Permit pursuant to Section 3.2.3.2(q) for apartment or multi-family dwelling use above the first floor where the first floor is used for a nonresidential use allowed in Section 3.2.3.1 or Section 3.2.3.2;
- f. Issuance of a Special Permit pursuant to Section 4.4.12(a) to increase the maximum floor area ratio to 0.7 and the building height to three (3) stories and forty (40) feet;
- g. Issuance of a Special Permit pursuant to Section 4.4.12(b) to reduce the minimum side setback adjoining a residential district to twenty (20) feet;
- h. Issuance of a Special Permit pursuant to Section 5.1.1.5 waving strict adherence with the off-street parking requirements of Section 5.1.2 of the By-Law and the parking design requirements of Section 5.1.3 of the Zoning By-law;

i. Waiver of strict compliance with the following requirements of Section 7.4.4, to the extent necessary and applicable:

1. Requirement of subparagraph (b) concerning location of structures within 100 feet of property line;
2. Requirements of subparagraph (d) concerning cross and longitudinal views of the proposed structure(s) in relation to proposed site layout, together with an elevation line to show the relationship to the center of the street; and
3. Requirements of subparagraph (o) concerning projected traffic volume; and

j. Any and all additional relief required or appropriate for the redevelopment of the Premises for mixed use purposes in a new building, with retail on the first floor and residential above.

3. The Applicant requests that any and all relief granted by the Board in connection with the within application shall run with the land and that the movement, change and alteration of interior layout, including, without limitation, walls and interior fixtures, furniture and the like, not require any further review, provided the total useable square footage of the building and of the commercial space, the total parking demand and the total number of residential units remain fixed and unchanged.

GEORGE GIUNTA, JR.
ATTORNEY AT LAW*
281 Chestnut Street
Needham, MASSACHUSETTS 02492
*Also admitted in Maryland

TELEPHONE (781) 449-4520

FAX (781) 465-6059

September 19, 2022

Planning Department
Town of Needham
Public Services Administration Building
500 Dedham Avenue
Needham, MA 02492

Re: Application for Zoning Relief
BTE Development, LLC
40 & 50 Central Avenue, Needham, MA

Dear Lee,

Please be advised that I represent BTE Development, LLC (hereinafter, the “Applicant”) relative to the adjacent properties known and numbered 40 & 50 Central Avenue (together, the “Premises”). In connection therewith, submitted herewith, in electronic and hard copy format please find the following:

1. Complete Site Plan Review Application with Addendum;
2. Authorization letter;
3. Architectural Plan Set titled “Central Ave Development”, prepared by MGD+ LLC, 411 Lexington St., Newton, MA 02466, consisting of five sheets as follows: Sheet 1, SP.00, Cover Page, dated September 18, 2022, Sheet 2, SP.01, Architectural Site Plan, dated September 18, 2022, Sheet 3, SP.02, Floor Plans, dated September 18, 2022, Sheet 4, SP.03, Elevations, dated September 18, 2022, Sheet 5, SP.04, and 3D Views dated September 18, 2022;
4. Site Plan Set, prepared by Verne T. Porter, Jr., PLS, Land Surveyors – Civil Engineers, 354 Eliot Street, Newton, MA 02464, consisting of three sheets as follows: Sheet 1, Existing Conditions Site Plan, dated September 12, 2022, Sheet 2, Proposed Parking and Building Location, dated September 12, 2022, and Sheet 3, Proposed Conditions Site Plan dated September 12, 2022;
5. Drainage Summary, Proposed Mixed-Use Building, 40-50 Central Ave, Needham, Massachusetts, dated September 12, 2020; and
6. Check no. 19062 in the amount of \$2,007.20 for the applicable filing fee.

The Premises consists of two parcels of land identified as Parcel 9 and Parcel 10 on Town of Needham Assessor's Map No. 80. It is located within the Neighborhood Business District (the "NBD") and contains approximately 32,058 square feet of area, with approximately 139.98 feet of frontage on Central Avenue and approximately 196.78 of frontage on Reservoir Avenue. The Premises is currently fully developed, with one parcel occupied by a one-story commercial building and the other being occupied by a two-story commercial building, as well as associated parking and driveway areas. The one-story building at 40 Central Avenue is currently vacant, and the two-story building at 50 Central Avenue is currently occupied by Panella's Market on the first floor and office space on the second floor.

The Applicant desires to demolish both existing buildings and replace them with a single, new building, to be used for mixed use purposes. The new building will be three stories high and contain approximately 20,072 square feet of space, with retail on the first floor, and 15 residential units on the second and third floors. It is currently contemplated that one of the retail bays on the first floor will be occupied by Panella's Market and that three of the residential units will be affordable, as defined by the Zoning By-Law. The entire site will be redeveloped and in addition to the new building, landscaping and other site improvements will also be installed, as shown on the plans submitted herewith.

Analysis

I. Use

Whereas the existing buildings are proposed to be demolished, no comment or analysis is made relative to the use thereof. With respect to the proposed new building, same is to be used for mixed purposes, including retail and residential, with one of the retail spaces intended for use by the current tenant, Panella's Market. Pursuant to Section 3.2.3.1 of the Zoning By-Law, certain retail uses are allowed by right in the NBD, specifically including a retail shop for the sale of convenience goods and a grocery store. In addition, pursuant to Section 3.2.3.2, retail sales of ice cream, frozen yogurt and similar products for consumption on or off the premises, a take-out food counter as an accessory to a food retail or other non-consumptive retail establishment, and more than one non-residential use on a lot are all allowable by special permit.

Finally, pursuant to Section 3.2.3.2, apartment or multi-family dwelling use above the first floor is allowable by special permit, provided the first floor is used for a nonresidential use allowed in Section 3.2.3.1 or Section 3.2.3.2 and further provided that the proposed apartment or multi-family dwelling complies with the lot area per unit requirements for apartments in the A-1 district as detailed in Section 4.3, and as affected by the provisions of Section 6.12(b).¹

Therefore, provided the Board approves the requested special permits, the proposed use of the Premises for mixed purposes, including retail and residential will comply with the By-Law.

¹ The lot area per unit requirement for apartments in the A-1 district set forth in Section 4.3 is 18 units per acre. Whereas the Premises consists of 32,058 square feet, that equates to a maximum total of 13.25 units. However, Section 6.12(b) provides that "the minimum lot area per dwelling unit normally required in the A-1 zoning district (as applicable to the Neighborhood Business District), shall be reduced by that amount necessary to permit up to two additional units (one affordable unit and one market unit) on the lot over the number required in section 6.12(a) above. As a result, the maximum allowable number of units is 15, being 13 + 2.

II. Dimensional and Density Requirements

A. Lot Area and Frontage

As indicated above, the Premises contains approximately 32,058 square feet of area, with approximately 139.98 feet of frontage on Central Avenue and approximately 196.78 of frontage on Reservoir Avenue. Pursuant to Section 4.4.1 of the By-Law, lots in the NBD are currently required to contain a minimum of 10,000 square feet of area and to have a minimum of 80 feet of frontage. Therefore, the Premises exceeds both the minimum frontage and the minimum area requirements.

B. Building Related Dimensional and Density Requirements

Pursuant to Section 4.4.2(d) of the By-Law, the maximum floor area ratio ("FAR") applicable to the Premises is 0.5. However, pursuant to Section 4.4.12(a), the Planning Board may issue a special permit for mixed use buildings allowed by special permit under Subsection 3.2.3.2 (q) in the Neighborhood Business District to increase the FAR to .7. The FAR for the new building is .63.² Therefore, provided the requested special permit is granted, the proposed new building will comply with the applicable FAR requirement.

Pursuant to Section 4.4.3 of the By-Law, the maximum height allowed as of right in the NBD is two and one-half (2 ½) stories, not to exceed thirty-five feet. However, pursuant to Section 4.4.12(a), the Planning Board may issue a special permit for mixed use buildings allowed by special permit under Subsection 3.2.3.2 (q) in the Neighborhood Business District to increase the maximum height to three stories and 40 feet. The proposed building is three stories and 39 feet high to the top of the elevator penthouse. As a result, provided the requested special permit issues, the building will comply with the height limitations of the By-Law.

As applied to the Premises, Section 4.4.4 of the By-Law requires a front yard setback of 20 feet. Whereas the proposed new building is set back 22.5 feet from Central Avenue at its closest point, it complies with such requirement.

Pursuant to Section 4.4.5 of the By-Law, no more than two driveways are allowed for every 150 feet of frontage, and two-way driveways of the kind proposed for the Premises must be no less than 18 feet wide and no more than 25 feet wide. Whereas only two, two-way driveways are proposed, and whereas each driveway opening is 20 feet wide, same will comply with the applicable driveway opening conditions of Section 4.4.5.

Pursuant to Section 4.4.8.4 of the By-Law,

no building or structure for a use not allowed in a residential district shall be placed within fifty (50) feet of a residential district boundary, and the ten feet closest to such boundary shall be suitable landscaped as specified at Section 4.4.8.5. The remainder of the setback may be used for an accessory use not including a building or structure.

² The FAR of .63 does not include the open area, used for driveway and surface parking, located adjacent to the first floor and underneath the second floor. If such space were included, the FAR would increase to .69, and would still comply, provided the requested special permit issues.

However, pursuant to Section 4.4.12(b), the Planning Board may issue a special permit for mixed use buildings allowed by special permit under Subsection 3.2.3.2 (q) in the Neighborhood Business District to reduce the minimum side and/or rear setback adjoining a residential district to twenty (20) feet provided said strip is suitably landscaped in accordance with the specifications in Section 4.4.8.5.

The proposed side yard setback adjoining the Single Residential B District to the northeast is 27.2 feet, and the setback area is proposed to be landscaped as required. Therefore, provided the requested special permit is granted, the building will comply with the applicable side-yard setback requirement.

Pursuant to Section 4.4.9 of the By-Law, first-floor commercial spaces are required to have individual entrances accessed from the exterior of the building. In addition, building entrances providing access to first and second-floor space must be available from one or more streets on which the building fronts and the primary building entrance must be from Central Avenue or Reservoir Street. Whereas the three commercial bays all have separate entrances on either Central Avenue or Reservoir Street, and whereas the main entrance to the residential space on the second and third floors is on Central Avenue, the requirements of Section 4.4.9 are met.

II. Parking

A. Demand

Total parking demand for the Premises, as redeveloped and used for retail purposes on the first floor and 15 residential units on the second and third floor (with two, one bedroom affordable units) is 31 spaces, calculated as follows:

13 Residential Units @ 1.5 spaces / unit = 19.5 spaces = 20 spaces required
2 1-bedroom affordable unit @ 1 space / unit³ = 2 spaces required
2,542 SF Retail @ 1 space / 300 SF = 8.47 spaces = 9 spaces required
20 + 2 + 9 = 31 total spaces required

The foregoing is for the base building, and does not take into account the anticipated use of one of the retail spaces by the Panella's Market. When such use is taken into account, the overall parking demand increases to 41 total spaces, calculated as follows:

13 Residential Units @ 1.5 spaces / unit = 19.5 spaces = 20 spaces required
2 1-bedroom affordable unit @ 1 space / unit³ = 2 spaces required
2,542 SF Retail @ 1 space / 300 SF = 8.47 spaces = 9 spaces required
1 Take-Out Station @ 10 spaces = 10 spaces required
20 + 2 + 9 + 10 = 41 total spaces required

There are a total of 28 parking spaces provided on site. In addition, six new on-street parking spaces, immediately adjacent to the Premises, are being proposed. However, pursuant to the By-Law, on-street may not be included in the parking calculation to determine compliance.

³ See Section 6.12(h) of the By-Law, which provides that: "For affordable units with not more than one bedroom, the minimum number of parking spaces under Section 5.1 shall be reduced to one space per unit".

As a result, under both the base condition and with the Panella's market taken into account, there is a shortfall of parking spaces, and a parking waiver is required. The waiver for the base condition is three spaces (31 required – 28 provided = 3), and taking the Panella's Market use into account, the waiver is 13 spaces (41 required – 28 provided).

The Applicant asserts that, in this instance, the requested waiver is appropriate. Under the base condition, the waiver is only for three spaces, and the Applicant is proposing to add six on-street spaces; double the shortfall. So, while the on-street spaces may not be included in the compliance calculation, they will provide sufficient parking under the base condition.

Moreover, the additional parking demand for the Panella's Market use is solely due to the By-Law requirement of ten parking spaces for a take-out station. As the Board has recognized in connection with prior projects involving a take-out station, this requirement is arbitrary, and is not necessarily reflective of real world conditions. Moreover, the take-out station parking requirement is applied in addition to the parking requirement for the area of the space, essentially imposing a double parking requirement.

Finally, 22 of the required spaces are associated with the proposed residential use. While it is true that some workers have continued to work from home as the Covid-19 pandemic has eased, many have returned to their workplace. Moreover, over time, it is expected that an increasing number of people will shift back to the workplace. As a result, it is anticipated that at least several, if not most of the spaces required by the residential component will be vacant during the morning and mid-day periods when Panella's Market is expected to experience its peak demand.

B. Design

In addition to a waiver for the number of required spaces, limited parking design waivers are required as well, as follows:

A. Parking Lot Illumination – The By-Law requires that all parking areas shall provide an illumination level of an average of one foot candle. The illumination proposed for the Premises is limited to modest lights, primarily or exclusively mounted on the building, which are expected to produce an illumination level of less than one foot candle in portions of the parking area.

B. Parking Setbacks – As applicable to the Premises, the By-Law requires that parking spaces and maneuvering aisles shall be setback a minimum of twenty (20) feet from a front lot line or street right-of-way line. The first couple of parking spaces adjacent to the driveway off Reservoir Avenue, in the southwest corner of the parking lot, are less than 20 feet from Reservoir Street.

III. Site Plan Analysis

(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 Applicant asserts that the mixed use of the Premises for retail and residential purposes, as proposed, does not constitute a “seriously detrimental use” within the terms of the By-Law. Furthermore, the side of the Premises adjacent to the residential district will be landscaped with over 20 feet of landscaping. And considering that the Premises is bounded on the other side by a fully developed commercial property, the Applicant asserts that no additional sound and sight buffers are required, and that views, light and air are not materially affected.

(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 Applicant is of the opinion that it has provided for safe and convenient vehicular and pedestrian movement within the site and on adjacent streets. The driveways serving the parking area are of adequate width and in appropriate locations, and the building is accessed by a walkway.

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

Parking is arranged around the building and is readily accessible. The proposed mixed retail and residential use of the building is not expected to require any special or dedicated loading spaces. Therefore, based on the proposed use, the Applicant is of the opinion that the arrangement of parking and loading spaces is adequate.

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

The proposed mixed use of the Premises is not anticipated to generate any significant wastes or trash. Nevertheless, it will be a requirement for the occupants of the building that all trash, waste and debris be removed on a regular basis, as necessary and appropriate. Furthermore, an area, in the southeast corner of the parking area has been designated for a trash area and will be suitably enclosed. Therefore, the Applicant asserts that the methods of waste disposal are adequate for the Premises and its proposed use.

(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 the By-Law.

There is no significant natural landscape to speak of in the vicinity of the Premises. The property is bounded on one side by an existing residential dwelling and on the other side by a fully developed commercial property. As a result, the proposed redevelopment of the Premises for mixed use is not anticipated to have any significant negative effect on any community assets or any adjacent landscape, buildings and structures.

(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 significant impact to the Town's resources is proposed or anticipated. The use of the Premises for retail and residential purposes is consistent with both other current uses in the NBD and the uses allowed pursuant to the By-Law. As a result, the proposed redevelopment of the Premises and use thereof for mixed purposes is not anticipated to substantially or materially increase or alter the need for any Town resources

Conclusion

Based on all the foregoing, the Applicant asserts that the proposed redevelopment of the Premises, and use thereof for mixed, commercial and residential purposes, as set forth above and in the materials submitted herewith, is both proper and appropriate. The proposed use of the Premises is allowed by right, in part, and allowable by special permit, in part. Provided the requested special permits are granted, the proposed new building will comply with all applicable density and dimensional requirements, and, while parking waivers are required, same are appropriate considering the proposed redevelopment and use of the Premises, and the surrounding area and abutting properties.

Please schedule this matter for the next available hearing of the Board. In the meantime, if you have any questions, comments or concerns relative to the foregoing, please do not hesitate to contact me so that I may be of assistance.

Your courtesy and attention are appreciated.

Sincerely,

George Giunta, Jr.

September , 2022

Town of Needham
Planning Board
Needham, Massachusetts 02492

Attn: Lee Newman, Planning Director

Re: BTE Development, LLC
Application for Major Project Site Plan Review
40 & 50 Central Avenue

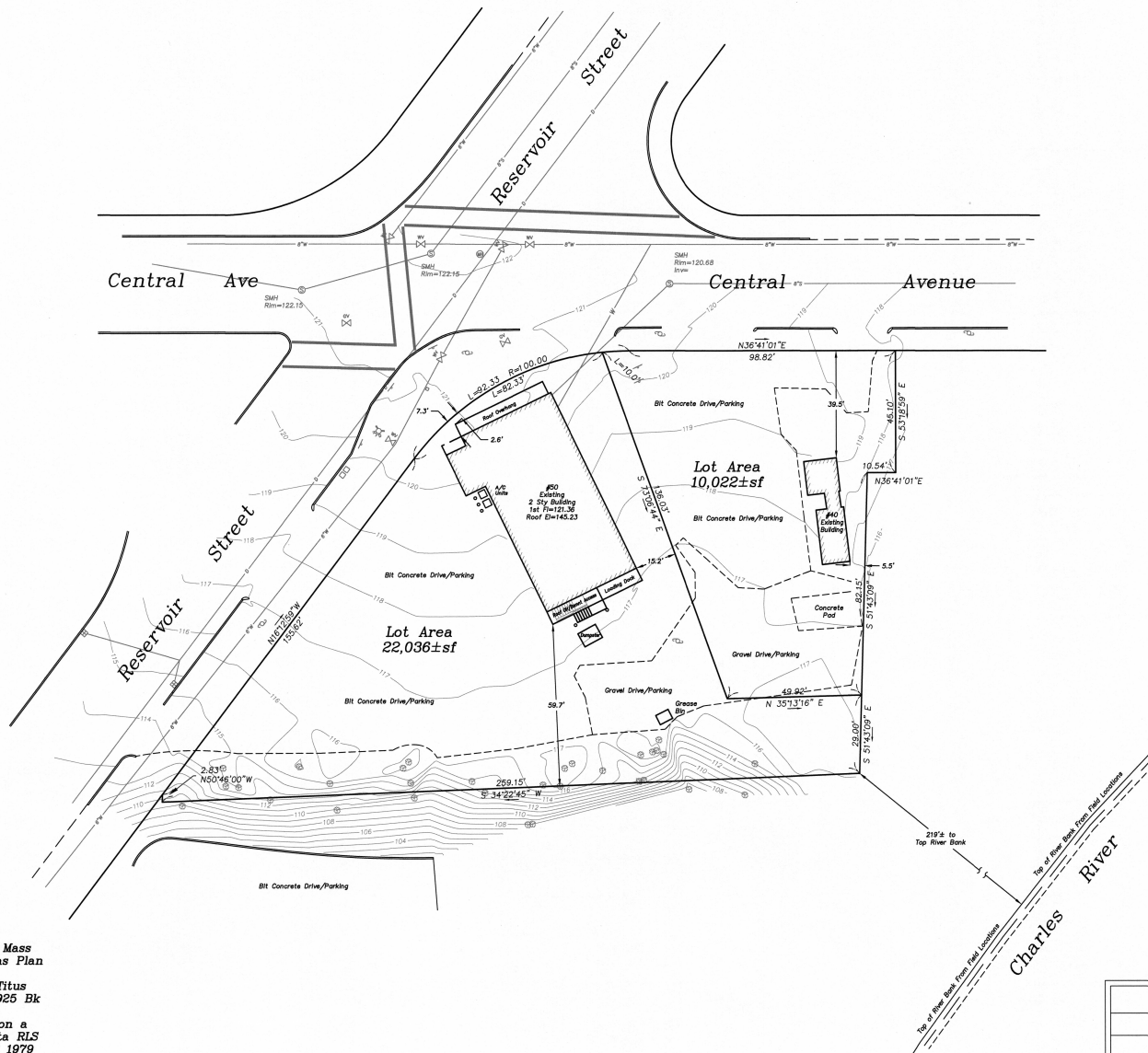
Dear Mrs. Newman,

Please accept this letter as confirmation that the Michael J. Panella 1992 Trust and the VP Realty Trust, current owners of the properties known and numbered 40 & 50 Central Avenue, Needham, MA, have authorized BTE Development, LLC, prospective purchaser, through their attorney George Giunta, Jr., Esquire, to make application to the Planning Board for major project site plan review and for all special permits and other zoning relief that may be required or appropriate in connection with the redevelopment of the aforesaid properties for multi-use development, in a new 3 story building, with commercial uses on the first floor and residential units above. In connection therewith, Attorney Giunta is specifically authorized to execute, sign, deliver and receive all necessary documentation related thereto, including, without limitation, Application for Site Plan Review.

Sincerely,


Jeanne Bolio - (9/17/2022)

Dig Safe
 Dig Safe System
 Before you dig contact the Dig Safe Center.
 To prevent damage to telephone, gas or electric underground facilities or other utilities, call toll free.
 Massachusetts state law requires contractors to call three business days before you start digging operations. In an emergency, call immediately.



Applicant:
 Bevilacqua Builders
 13 Eaton Court
 Wellesley, MA 02481
Owners:
 Michael J Panella 1992 Trust
 and the VP Realty Trust
Title Reference:
 Bk 10567 Pg 675 and Bk 11216 Page 659
 Parcels I and II

Plan References:
 Parcel I is shown on a Plan of Land in Needham Mass by UM Schiavone dated March 26, 1949 recorded as Plan No 541 of 1950 Bk 2913 Pg 350
 Parcel II is shown on a Plan of Land by John E Titus dated June 23, 1925 reorded as Plan No 772 of 1925 Bk 1659 Pg 306
 Parcel I and II are also shown as Lots 9 and 10 on a Plan of Land in Needham Mass by George N Giunta RLS dated March 24, 1979 recorded as Plan No 222 of 1979 Bk 5584 Pg 357

Zoning District:
 Neighborhood Business

Note: Existing zoning district information is based on information obtained from the Town of Needham on-line data base and property deeds and plans obtained from Norfolk County Registry of Deeds. Final zoning district and requirements to be determined by the Town of Needham Building Department.

Existing utilities shown are from field locations and available plans of record and may or may not be correct. Contact Dig Safe and field verify all locations prior to any excavation.

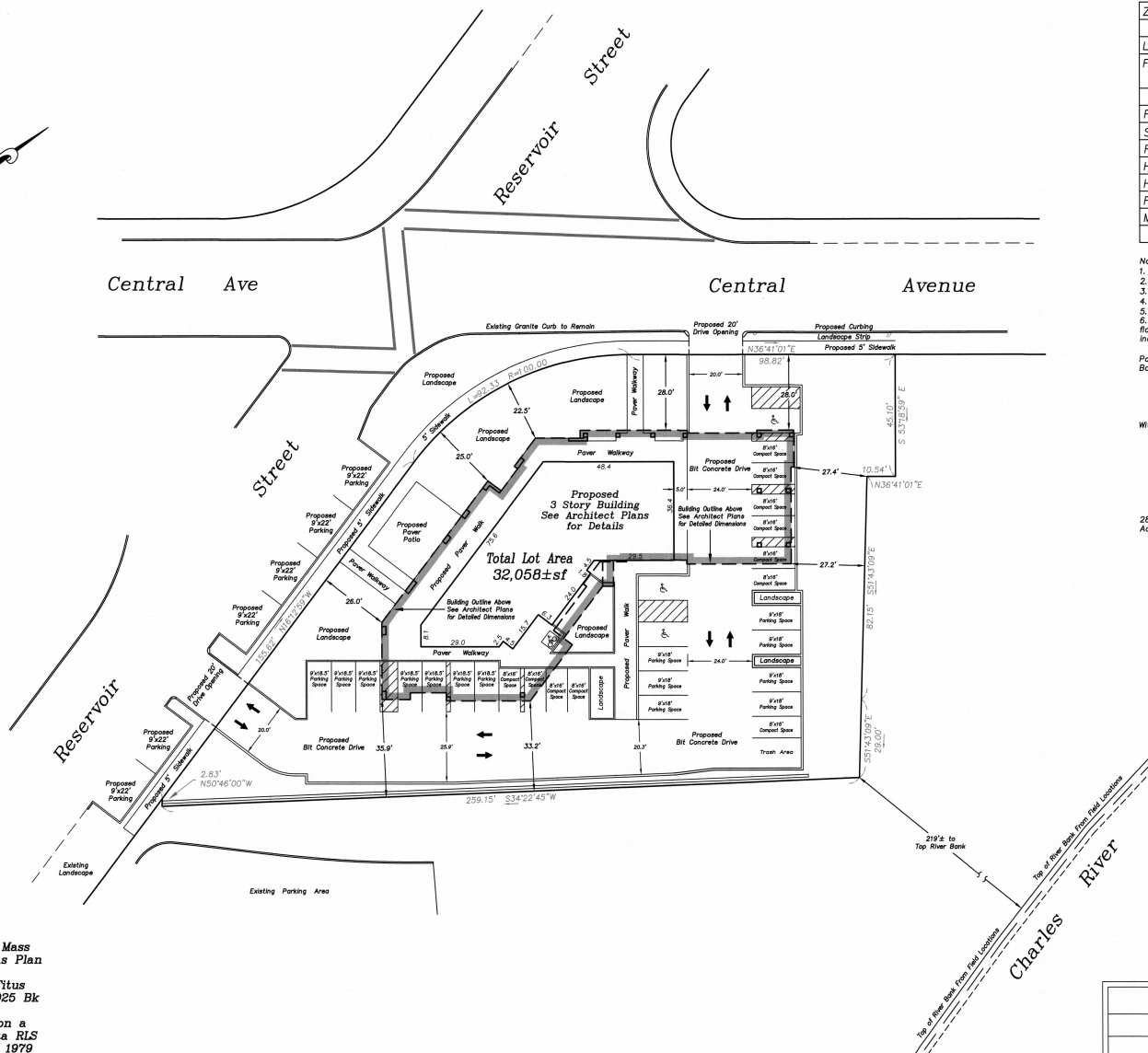
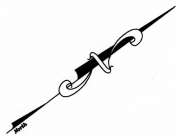
REVISIONS	
DATE	DESCRIPTION



40 & 50 Central Avenue	
Needham, Massachusetts	
Existing Conditions Site Plan	
Scale: 1"=20'	September 12, 2022
VERNE T. PORTER JR., PLS	
Land Surveyors - Civil Engineers	
354 Elliot Street Newton, Massachusetts 02464	
Project: 21037	
Checked By: V. Porter Jr.	
Drawn By: R. Jardine Jr.	

0 20 40 60 80

Sheet 1 of 3



Zoning	Required/Allowed	Existing	Proposed
Lot Area	10,000 sf	32,058 sf	32,058 sf
Frontage	80'	139.98 (Central) 196.78 (Reservoir)	139.98 (Central) 196.78 (Reservoir)
Front Setback	20'	2.6'	22.5'
Side Setback	50'/20' ¹	5.5'	27.2'
Rear Setback	N/A	59.7'	33.2'
Height—Stories	2.5/3 ²	2	3
Height—Feet	35'/40' ³	27.23'	39.0'
F.A.R.	.5/7/ ⁴	.26	.63 ⁶
Max Units	13/15 ⁵	N/A	15

- Notes:
1. Setback of 20' allowable by special permit-- Section 4.4.12(b).
2. Maximum height of 3 stories allowable by special permit-- Sections 4.4.12(a).
3. Maximum height of 40' allowable by special permit-- Section 4.4.12(a).
4. Maximum FAR of .7 allowable by special permit-- Section 4.4.12(a).
5. 15 Maximum units allowable pursuant to Section 6.12(b).
6. FAR of .63 does not include the surface parking area adjacent to the first floor and located underneath the second floor of the building. If such area were included, FAR would be .69.

Parking Analysis
Base Building: 31 Total Spaces Required

14 Residential Units @ 1.5 spaces/unit=21 spaces required
1 1-bedroom affordable unit @ 1 space/unit=1 space required
21+1=22 total spaces required

With Panella's Market: 41 Total Spaces Required

14 Residential Units @ 1.5 spaces/unit=21 spaces required
 1 1-bedroom affordable unit @ 1 space/unit=1 space required
 2,542 SF Retail @ 1 space/300 SF=8.47 spaces=9 spaces required
 1 Take-Out Station @ 10 spaces=10 spaces required
 21+1+9+10=41 total spaces required

*See By-Law Section 6.12(b)

28 On Site Spaces Provided
Additional 6 On Street Spaces Proposed

Applicant:
Bevilacqua Builders
13 Eaton Court
Wellesley, MA 02481
Owners:
Michael J Panella 1992 Trust
and the VP Realty Trust
Title Reference:
Bk 10567 Pg 675 and Bk 11216 Page 659
Parcels I and II

Plan References:
Parcel I is shown on a Plan of Land in Needham Mass by UM Schiavone dated March 26, 1949 recorded as Plan No 541 of 1950 Bk 2913 Pg 350
Parcel II is shown on a Plan of Land by John E Titus dated June 23, 1925 reorded as Plan No 772 of 1925 Bk 1659 Pg 306
Parcel I and II are also shown as Lots 9 and 10 on a Plan of Land in Needham Mass by George A Giunta RLS dated March 24, 1979 recorded as Plan No 222 of 1979 Bk 5594 Pg 357

Zoning District:
Neighborhood Business

Note: Existing zoning district information is based on information obtained from the Town of Needham on-line data base and property deeds and plans obtained from Norfolk County Registry of Deeds. Final zoning district and requirements to be determined by the Town of Needham Building Department.

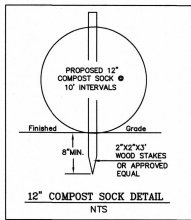
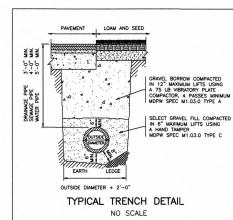
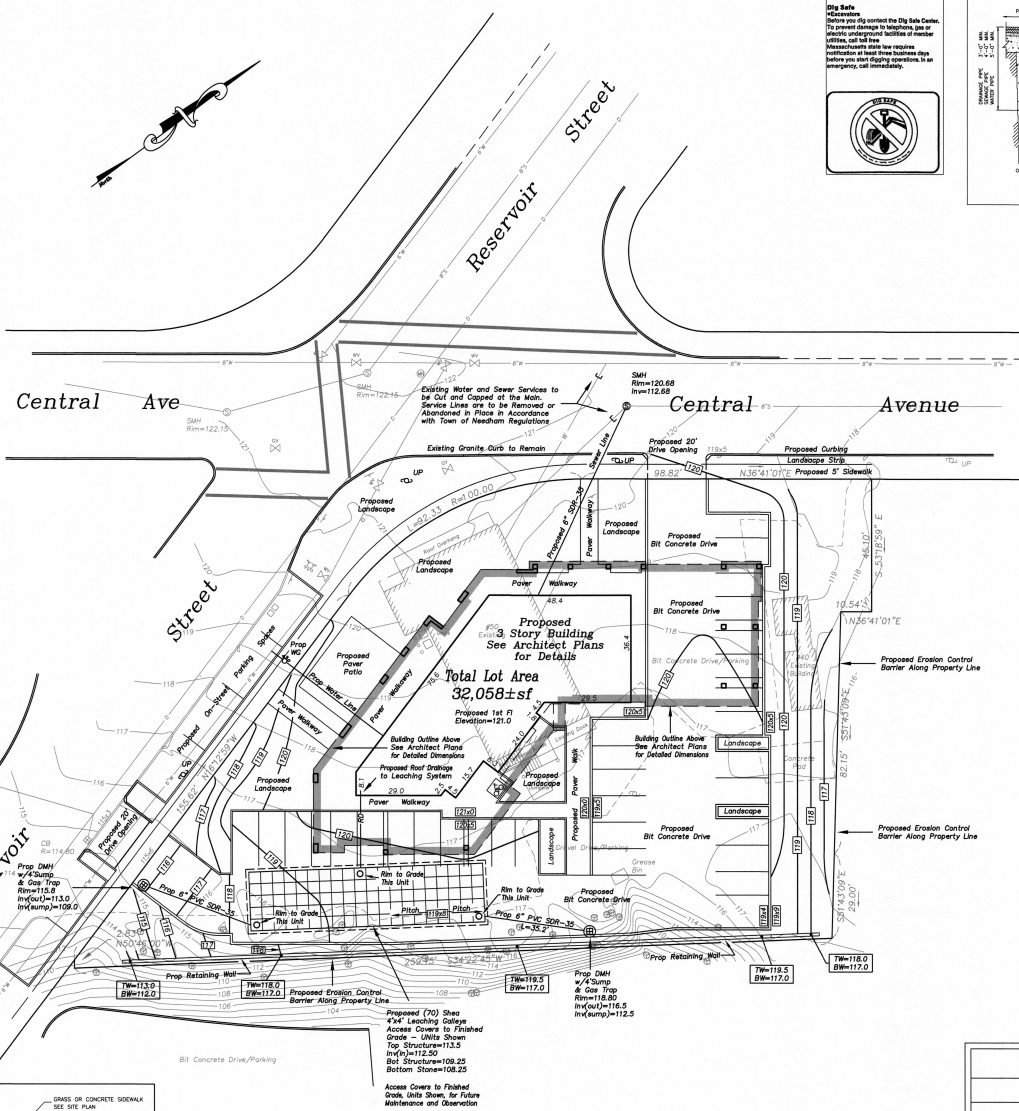
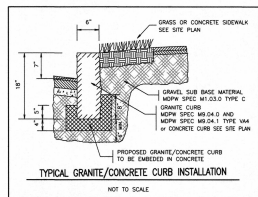
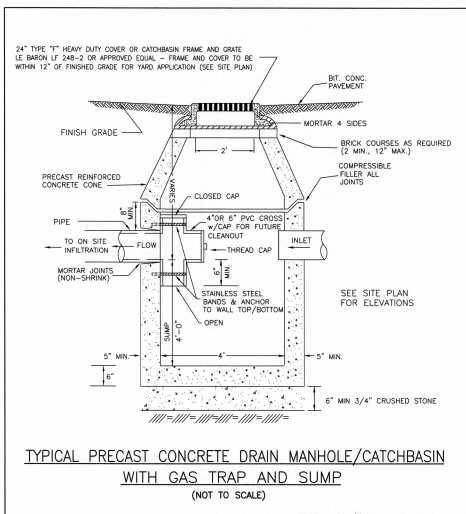
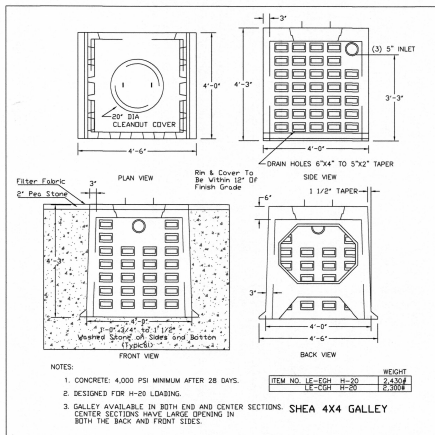
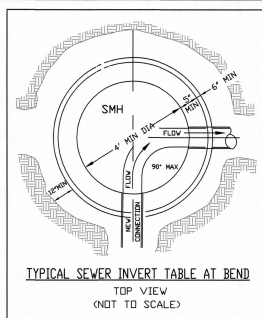
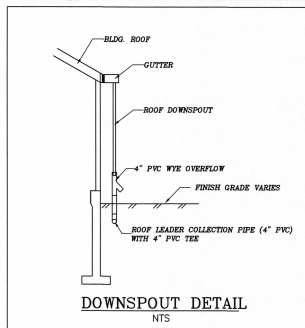
REVISIONS	
DATE	DESCRIPTION



40 & 50 Central Avenue	
Needham, Massachusetts	
Proposed Parking and Building Location	
Scale: 1"=20'	September 12, 2022
VERNE T. PORTER Jr., PLS	
Land Surveyors - Civil Engineers	
354 Elliot Street Newton, Massachusetts 02464	



Project: 21037
Checked By: V. Porter Jr.
Drawn By: R. Jardine Jr.



- Notes:
1. The utilities shown are from field locations and available plans of utility companies and may or may not be correct. Contractor is to contact Dig Safe, all local utility companies and field verify all locations as required prior to any excavation.
 2. All work shall be done in accordance with Town of Needham Specifications and shall be subject to inspection and approval by the Town of Needham Engineering Department.
 3. An erosion control barrier shall be in place around the existing property prior to any demolition/construction and all materials must be contained on site.
 4. The existing water and sewer services shall be cut and capped at the main. Service lines are to be removed or abandoned in place in accordance with Town of Needham regulations.
 5. The contractor shall be responsible for all proposed grading as shown on plan. Any variations to proposed grading shown and/or any changes to proposed structure may result in non compliance with zoning regulations.
 6. All roof drains are to be connected to proposed drainage system as shown on plan. Drainage design and accompanying drainage calculations meet the minimum requirements for drainage per Town of Needham Engineering Department.
 7. Soil conditions are to be determined at the time of excavation. Proposed drainage design and calculations may need to be revised based on soil testing results.

Impervious Surfaces	
EXISTING	
Buildings	3635 sf
Bit Conc Drive	17653 sf
Conc Pad	307 sf
Gravel Drive	3559 sf
PROPOSED	
Building	8930 sf
Drive	10048 sf
Walks/Patios	1574 sf

40 & 50 Central Avenue

Needham, Massachusetts

Proposed Conditions Site Plan

Scale: 1"=20' September 12, 2022

VERNE T. PORTER Jr., PLS
Land Surveyors - Civil Engineers
354 Elliot Street Newton, Massachusetts 02464

Project: 21037

Checked By: V. Porter Jr.

Drawn By: R. Jardine Jr.

Sheet 3 of 3

REVISIONS	
DATE	DESCRIPTION

SP.00

SPECIAL
PERMIT SET

[illegible]CENTRAL AVE
DEVELOPMENT

0-50 Central Ave, Needham, MA

ARCHITECTURAL SITE
PLAN

Project number	22-007
Date	9/18/22
Drawn by	TCO
Checked by	MGD

SP.01

$$3/32'' = 1'-0''$$


1 01 - Architectural Site Plan
3/32" = 1'-0"

PARKING ANALYSIS:

BASE BUILDING: 31 TOTAL SPACES REQUIRED

13 RESIDENTIAL UNITS @ 1.5 SPACES / UNIT = 20 SPACES REQUIRED
2 1-BEDROOM AFFORDABLE UNIT @ 1 SPACE / UNIT* = 2 SPACE REQUIRED
2,542 SF RETAIL @ 1 SPACE / 300 SF = 8.47 SPACES = 9 SPACES REQUIRED
20 + 2 + 9 = 31 TOTAL SPACES REQUIRED

WITH PANELLA'S MARKET: 41 TOTAL SPACES REQUIRED

13 RESIDENTIAL UNITS @ 1.5 SPACES / UNIT = 20 SPACES REQUIRED

1 1-BEDROOM AFFORDABLE UNIT @ 1 SPACE / UNIT* = 2 SPACE REQUIRED

2,542 SF RETAIL @ 1 SPACE / 300 SF = 8.47 SPACES = 9 SPACES REQUIRED

1 TAKE-OUT STATION @ 10 SPACES = 10 SPACES REQUIRED

20 + 2 + 9 + 10 = 41 TOTAL SPACES REQUIRED

*SEE BY-LAW SECTION 6.12(H)

28 ON SITE SPACES PROVIDED

11 COMPACT, 141 OLL SIZE, 3 ADA

ADDITIONAL 6 ON STREET SPACES PROPOSED (PARALLEL)

PARKING NOTES:
1. 50% COMPACT PARKING CAN BE USED (8' x 16') - 5.1.3(e)
2. 20 FT DRIVE LANE REQUIRED FOR 2 WAY TRAFFIC 5.1.3 (i)

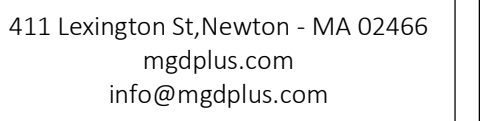
Parking Schedule		
Parking Type	Type	Qty

01 - First Floor

Parking Space	8' x 16' - 90 deg - Compact	11
Parking Space - ADA	9' x 18' (8' Aisle)	3
Parking Space	9' x 18.5' - 90 deg	14
Parking Space	9' x 22' - Parallel	6

(**NOTE - 6 SPACES ALONG PUBLIC WAY)

4



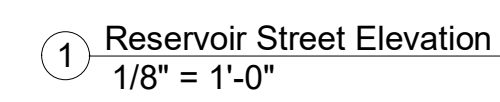
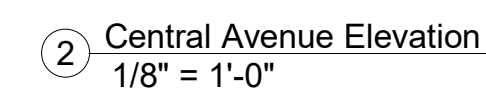
SPECIAL
PERMIT SET

[illegible]

0-50 Central Ave, Needham, MA

Project number	22-007
Date	9/18/22
Drawn by	TCO
Checked by	MGD

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





411 Lexington St, Newton - MA 02466
mgdplus.com
info@mgdplus.com

STAMP

SPECIAL
PERMIT SET

[illegible]CENTRAL AVE
DEVELOPMENT

40-50 Central Ave, Needham, MA

3D VIEWS

Project number	22-007
Date	9/18/22
Drawn by	TCO
Checked by	MGD

SP.04

Scale

DRAINAGE SUMMARY

PROPOSED MIXED-USE BUILDING
40-50 CENTRAL AVE
NEEDHAM, MASSACHUSETTS



September 12, 2020

VERNE T. PORTER JR., PLS
LAND SURVEYORS – CIVIL ENGINEERS
354 ELLIOT STREET
NEWTON, MA 02464

DRAINAGE SUMMARY
PROPOSED MIXED-USE BUILDING
40-50 CENTRAL AVE
NEEDHAM, MASSACHUSETTS

The proposed project consists of the demolition of an existing two-story commercial building and the construction of a new mixed-use building, which includes commercial space on the lower level and apartments on the upper floors. In addition, the project includes, including new bituminous concrete parking areas and drainage improvements, on two lots located at 40 & 50 Central Ave in Needham, MA, under the requirements of the City of Needham Stormwater By-Law.

The on-site soils in the area are shown as "104D – Hollis-rock outcrop-Charlton complex, 15 to 35 percent slopes" soils on the NRCS Soils Survey map of the area, which are areas that fall within the Hydrological Soil Groups A & D, as well as "602-Urban Land, 0 to 15 percent slopes" which are areas that have not soil group designation. For purposes of our design, we made a conservative assumption and assumed a D soil with an infiltration rate of 0.09 in/hr.

Ground cover on the site is an existing building and a mix of gravel and bituminous concrete parking/driveway areas. The existing drainage on the site flows overland from Central Ave, towards the rear of the property. Overall, the site will maintain the current flow pattern, however new collection systems for the proposed mixed-use building and proposed parking areas have been provided to collect the runoff and attenuate offsite flows.

The Charles River is located east of the subject parcel, however the site is more than 200-ft from the top of bank. There are no other wetlands Resource Areas within 100-feet of the lot. The proposed drainage controls are designed to capture & contain the runoff from the proposed building and proposed site improvements. This system will store the runoff from the addition and allow the stored water to slowly infiltrate after the storm event and overflow offsite.

Under the proposed conditions, with the new building and new driveway, the rate of site runoff from the re-developed lot area will be greater than the existing conditions for the 2, 10, 25 & 100-year storm events. The proposed controls have been designed to store this increase to maintain the pre and post runoff rates.

COMPLIANCE WITH STORMWATER STANDARDS

Untreated Stormwater (Standard 1)

The project is designed so that new stormwater conveyances (outfalls/discharges) do not discharge untreated stormwater into, or cause erosion to, existing wetlands.

Post-Development Peak Rates (Standard 2)

A hydrologic study was performed to determine the rate of runoff for the 2, 10, 25 and 100-year storm events under pre-development (existing) conditions. Unmitigated post-development rates were then computed in a similar manner. The study point where the peak rates were compared were taken at one (1) location at the existing offsite flow area. From these analyses, it was determined that the proposed project and its stormwater management system would not increase the peak runoff rates above existing levels. It is the intent of the stormwater management system to minimize impacts to drainage patterns, and downstream property prior to its release from the site or discharge to wetlands.

The *United States Department of Agriculture (U.S.D.A)*. Soil Conservation Service (SCS) Technical Release 55 (TR-55), 1986, was used as the procedure for estimating runoff. A SCS TR-20-based computer program was used for estimating peak discharges. TR-55 is a generally accepted model for use on small sites that begin with a rainfall amount uniformly imposed on the watershed over a specified time distribution. Mass rainfall is converted to mass runoff by using a runoff curve number (CN). CN is based on soils, plant cover, impervious areas, interception, and surface storage. Runoff is then transformed into a hydrograph that depends on runoff travel time through segments of the watershed.

Development in a watershed changes the watershed's response to precipitation. The most common effects are reduced infiltration and decreased travel time, which can result in significantly higher peak rates of runoff. The volume of runoff is determined primarily by the amount of precipitation and by infiltration characteristics related to soil type, antecedent rainfall, type of vegetal cover, impervious surfaces, and surface retention. Travel time is determined primarily by slope, flow length, depth of flow, and roughness of flow surfaces. Peak rates of discharge are based on the relationship of the above parameters, as well as the total drainage area of the watershed, the location of the development in relation to the total drainage area, and the effect of any flood control works or other manmade storage. Peak rates of discharge are also influenced by the distribution of rainfall within a given storm event.

Stormwater management computations for the full-build were performed using a SCS-based *HYDROCAD* for existing and proposed conditions, curve numbers, time of concentrations and unit hydrograph computations.

Existing Conditions

Table 1. Shows the curve numbers, areas and times of concentration used to develop the pre-development hydrologic model of the site.

Table 1. – Existing Conditions					
Sub-Areas	Surface Cover	Curve Number (CN)	Area (SF)	Tc (Mins.)	Remarks
Area #1				6.0	
	Exist Bldgs.	98	3,635		
	Exist. Bit.	98	17,653		
	Exist. Gravel	98	3,559		
	Exist. Conc. Pad	98	307		
	Lawn Areas	84	6,904		
		Total Area	32,058		
*CN based on Class D soils.					

Proposed Conditions

The proposed conditions will result in a new collection system that will collect the site run-off from the proposed building and proposed parking areas and direct it to underground leaching systems prior to overflowing off-site.

Table 2. Shows the curve numbers, areas and times of concentration used to develop the post-development hydrologic model of the site.

Table 2. – Proposed Conditions					
Sub-Areas	Surface Cover	Curve Number (CN)	Area (SF)	Tc (Mins.)	Remarks
Area #1				6.0	
	Lawn Area	84	11,506		
	Proposed Patio	98	1,574		Incls. Walks
Area #2				6.0	
	Prop. Building	98	8,930		
	Prop. Bit. Conc.	98	10,048		
		Total Area	32,058		
*CN based on Class D soils.					

Peak Rate Summary

Table 3. Shows the peak runoff for the existing, as well as for the developed site at 100-year design storms.

Areas	Design Storm	Existing Runoff* (CFS)	Existing Volume* (Ac-Ft)	Proposed Runoff* (CFS)	Proposed Volume* (Ac-Ft)
Offsite Flow					
	2-yr.	2.12	0.163	0.58	0.045
	10-yr.	3.32	0.262	1.03	0.081
	25-yr.	4.25	0.341	1.38	0.135
	100-yr.	6.15	0.502	2.29	0.291

Recharge to Groundwater (Standard 3)

The change in groundcover for the new development will change by increasing the impervious areas by approximately 4,602 sf. Groundwater infiltration will be achieved through the individual underground storage areas.

Required Recharge Volume for the entire site was calculated in accordance with the Massachusetts Stormwater Management Standards:

$$R_v = F * \text{impervious area (in acres)}$$

$$R_v = (0.10/12) * 0.471 = 0.004 \text{ Ac-ft.} = 171.27 \text{ CF}$$

R_v = Required Recharge Volume;

F = Target Depth Factor (0.10 in. for soils of Hydrologic Soil Group D);

Impervious area = building, pavement on site in post development condition (0.471 Ac).

The proposed onsite leaching systems will store and infiltrate over 171.27 cf in just the 2-year storm event.

In addition to MA Stormwater Standards for recharge, the Town of Needham has a requirement of 1" of the total proposed impervious area to be recharged.

The total SF of the impervious area in the proposed development is 20,552 sf (including the unit pavers). This results in 1,712.67 cf of runoff. The proposed leaching gallies provide 7,013 cf of available storage.

Removal of TSS (Standard 4)

To handle the TSS removal of the proposed parking areas, a 4' deep sump has been provided in the proposed catchbasins..

Land Uses with Higher Potential Pollutant Loads (Standard 5)

The use proposed does not differ from the current use of the space and has no higher potential for pollution.

Critical Areas (Standard 6 – Water Quality Treatments)

This site does not lie within a critical area. One-half inch (1/2") of runoff is the standard for treatment relative to water quality, but as stated prior, the proposed use will not create pollutants in excess of what exists today.

Redevelopment (Standard 7)

Redevelopment projects are those that involve development, rehabilitation or expansion on previously developed sites provided the redevelopment results in no net increase in impervious area. Furthermore, components of redevelopment project, which include development of previously undeveloped sites, do not fall under Standard 7. In addition, redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

The project, as proposed, is mixed-use building on an existing developed site, with a reduction in impervious areas. VTP has considered this project a re-development and we have met all the applicable standards of the Massachusetts Stormwater Policy to the maximum extent possible.

Erosion and Sedimentation Controls (Standard 8)

Erosion Control measures have been provided on the plans that accompany this application.

Operation and Maintenance Plan (Standard 9)

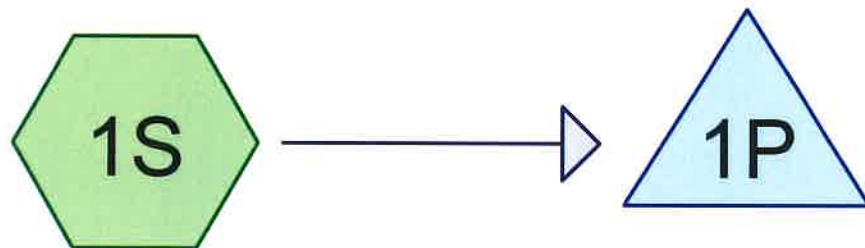
An Operation and Maintenance (O&M) Plan is provided as part of the application.

Prohibition of Illicit Discharges

The Owner and User of the facility, assures that there will not be illicit discharges to the nearby wetlands from the proposed facility.

Floodplain (310 CMR 10.57)

The project site does not fall with a floodplain district.



40-50 Central Ave

Offsite



Routing Diagram for Central Ave - Pre Development
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Central Ave - Pre Development

Prepared by HP

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Page 2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.158	84	50-75% Grass cover, Fair, HSG D (1S)
0.082	98	Exist. Gravel Drive (1S)
0.405	98	Existing Bit. Conc. (1S)
0.083	98	Existing Buildings (1S)
0.007	98	Existing Conc. Pad (1S)
0.736	95	TOTAL AREA

Central Ave - Pre Development

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40-50 Central Ave - Pre Development

Type III 24-hr 2-Year Rainfall=3.22"

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Page 3

Summary for Subcatchment 1S: 40-50 Central Ave

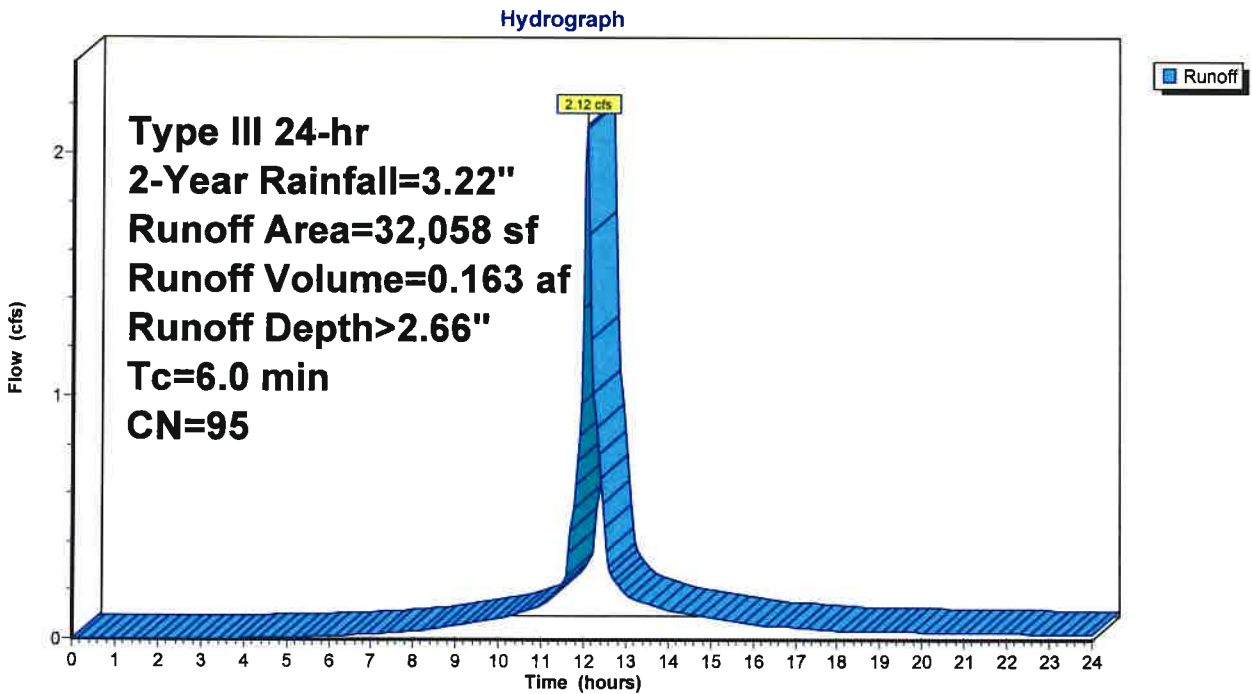
Runoff = 2.12 cfs @ 12.09 hrs, Volume= 0.163 af, Depth> 2.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
*	3,635	98	Existing Buildings
*	3,559	98	Exist. Gravel Drive
*	17,653	98	Existing Bit. Conc.
*	307	98	Existing Conc. Pad
	6,904	84	50-75% Grass cover, Fair, HSG D
	32,058	95	Weighted Average
	6,904		21.54% Pervious Area
	25,154		78.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: 40-50 Central Ave



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40-50 Central Ave - Pre Development

Type III 24-hr 2-Year Rainfall=3.22"

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Page 4

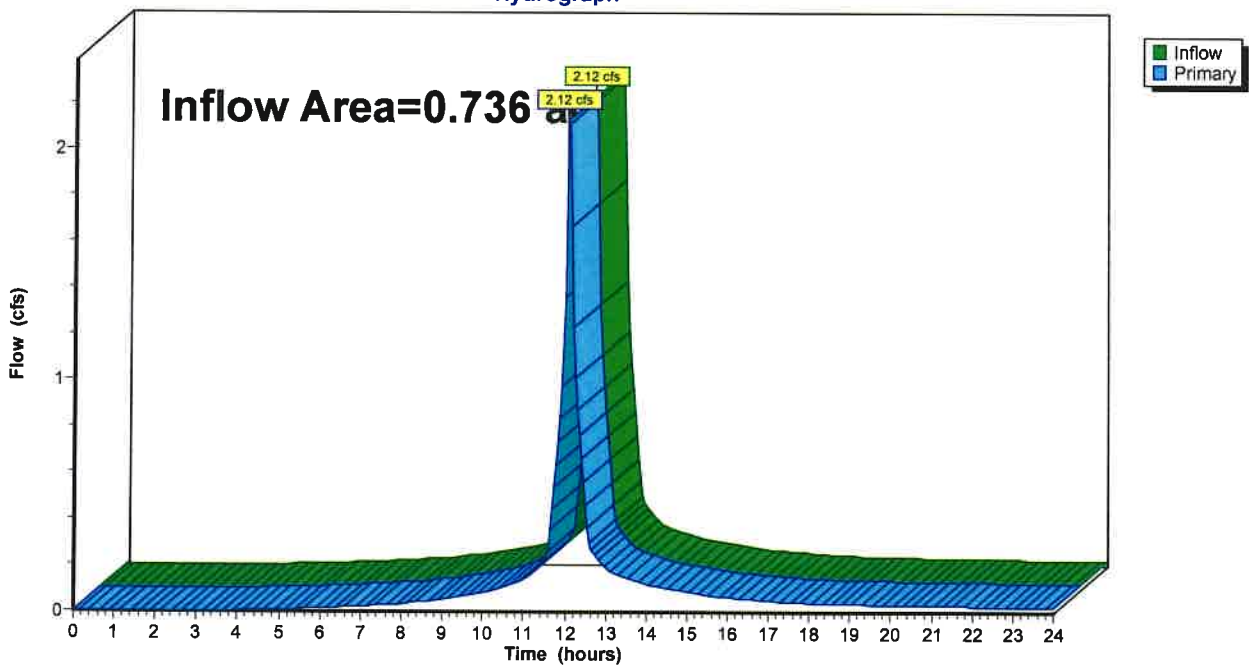
Summary for Pond 1P: Offsite

Inflow Area = 0.736 ac, 78.46% Impervious, Inflow Depth > 2.66" for 2-Year event
Inflow = 2.12 cfs @ 12.09 hrs, Volume= 0.163 af
Primary = 2.12 cfs @ 12.09 hrs, Volume= 0.163 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



Central Ave - Pre Development

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40-50 Central Ave - Pre Development

Type III 24-hr 10-Year Rainfall=4.86"

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Summary for Subcatchment 1S: 40-50 Central Ave

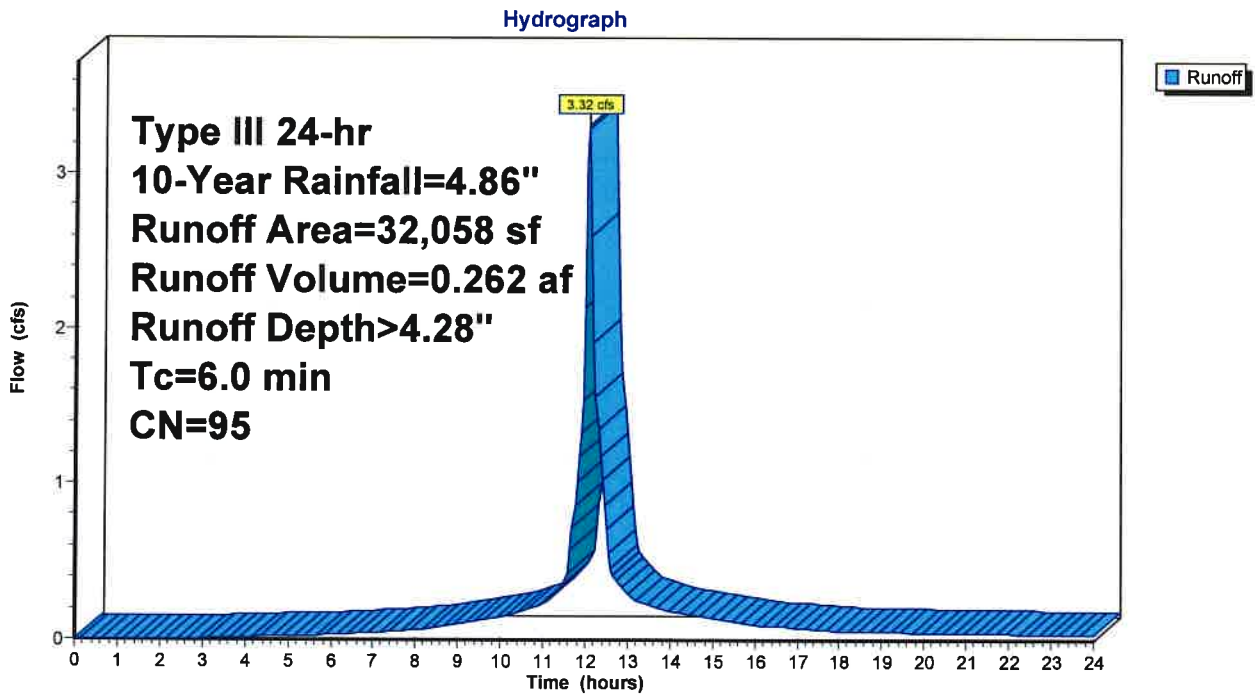
Runoff = 3.32 cfs @ 12.09 hrs, Volume= 0.262 af, Depth> 4.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

	Area (sf)	CN	Description
*	3,635	98	Existing Buildings
*	3,559	98	Exist. Gravel Drive
*	17,653	98	Existing Bit. Conc.
*	307	98	Existing Conc. Pad
	6,904	84	50-75% Grass cover, Fair, HSG D
	32,058	95	Weighted Average
	6,904		21.54% Pervious Area
	25,154		78.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: 40-50 Central Ave



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40-50 Central Ave - Pre Development

Type III 24-hr 10-Year Rainfall=4.86"

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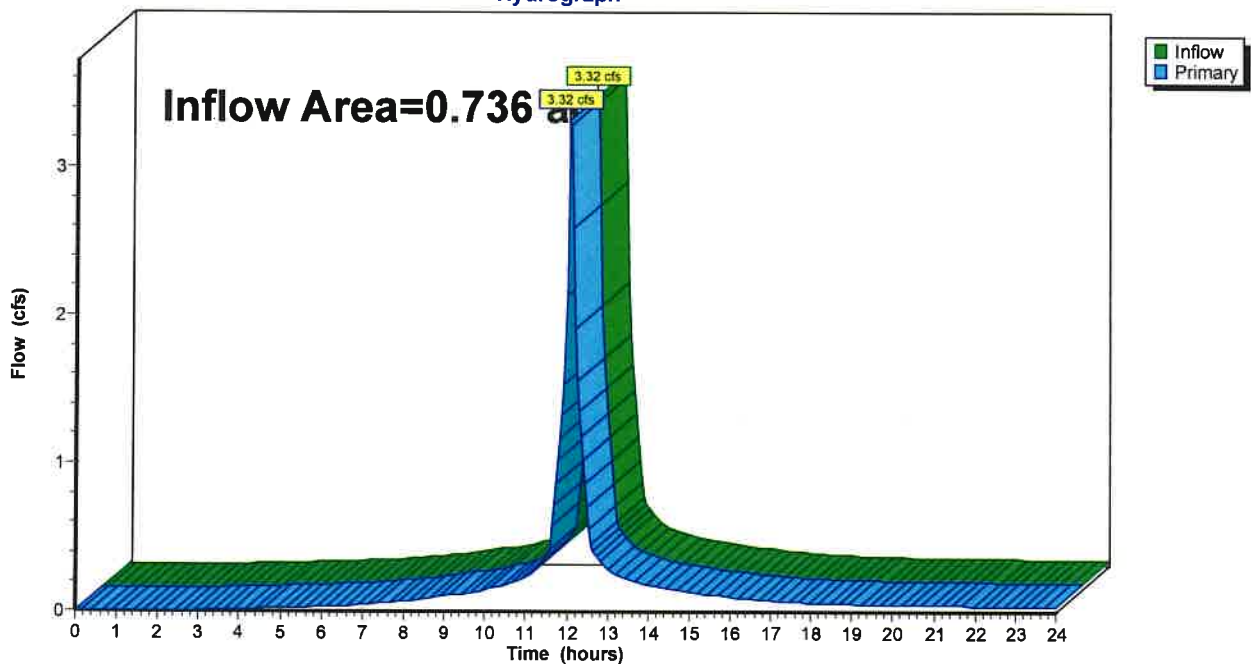
Summary for Pond 1P: Offsite

Inflow Area = 0.736 ac, 78.46% Impervious, Inflow Depth > 4.28" for 10-Year event
Inflow = 3.32 cfs @ 12.09 hrs, Volume= 0.262 af
Primary = 3.32 cfs @ 12.09 hrs, Volume= 0.262 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



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40-50 Central Ave - Pre Development

Type III 24-hr 25-Year Rainfall=6.15"

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Summary for Subcatchment 1S: 40-50 Central Ave

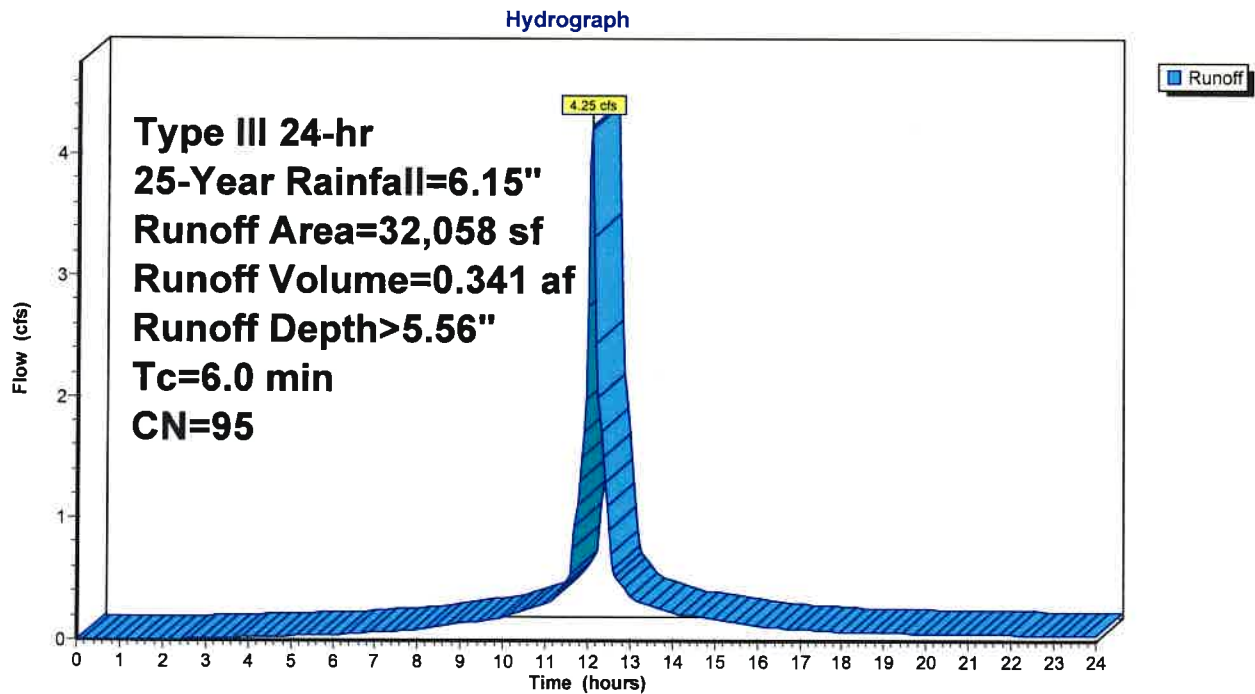
Runoff = 4.25 cfs @ 12.09 hrs, Volume= 0.341 af, Depth> 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

	Area (sf)	CN	Description
*	3,635	98	Existing Buildings
*	3,559	98	Exist. Gravel Drive
*	17,653	98	Existing Bit. Conc.
*	307	98	Existing Conc. Pad
	6,904	84	50-75% Grass cover, Fair, HSG D
	32,058	95	Weighted Average
	6,904		21.54% Pervious Area
	25,154		78.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: 40-50 Central Ave



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40-50 Central Ave - Pre Development

Type III 24-hr 25-Year Rainfall=6.15"

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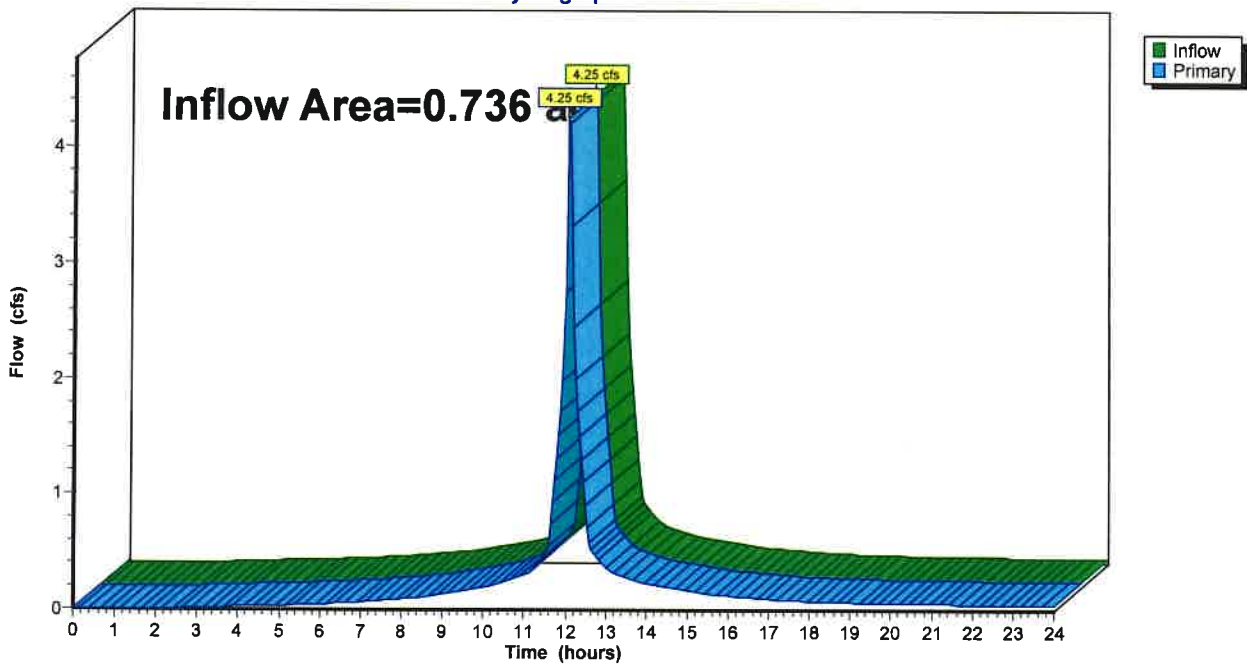
Summary for Pond 1P: Offsite

Inflow Area = 0.736 ac, 78.46% Impervious, Inflow Depth > 5.56" for 25-Year event
Inflow = 4.25 cfs @ 12.09 hrs, Volume= 0.341 af
Primary = 4.25 cfs @ 12.09 hrs, Volume= 0.341 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



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40-50 Central Ave - Pre Development

Type III 24-hr 100-Year Rainfall=8.80"

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Summary for Subcatchment 1S: 40-50 Central Ave

Runoff = 6.15 cfs @ 12.09 hrs, Volume= 0.502 af, Depth> 8.19"

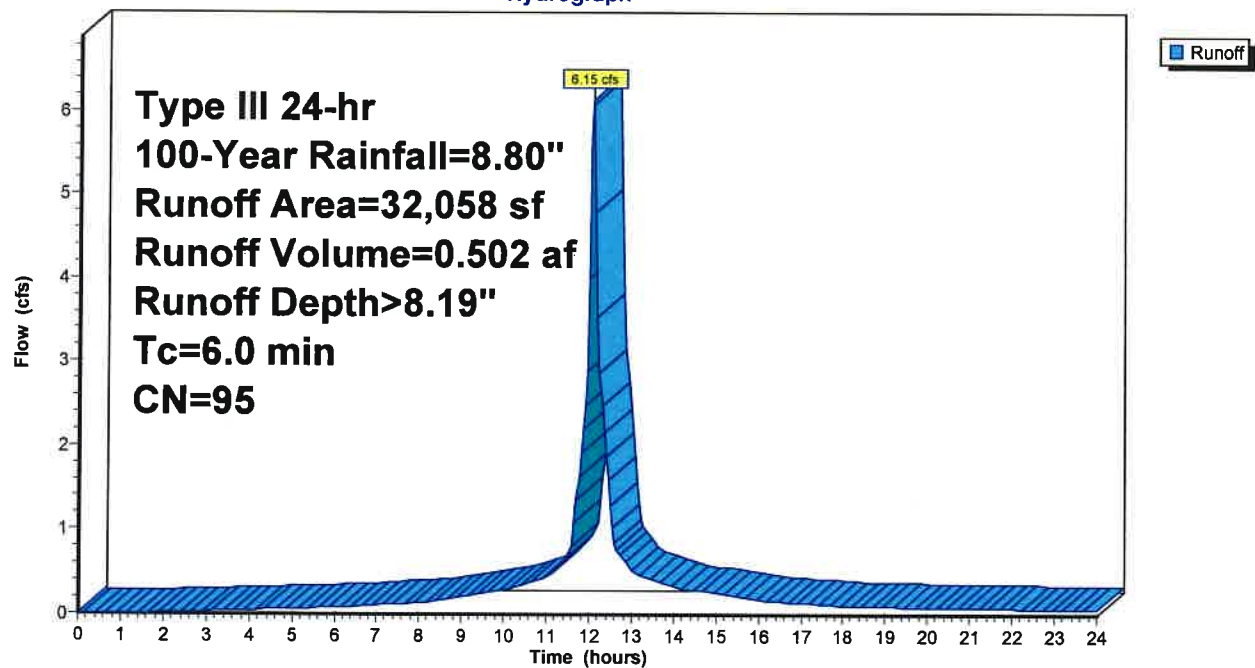
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

	Area (sf)	CN	Description
*	3,635	98	Existing Buildings
*	3,559	98	Exist. Gravel Drive
*	17,653	98	Existing Bit. Conc.
*	307	98	Existing Conc. Pad
	6,904	84	50-75% Grass cover, Fair, HSG D
	32,058	95	Weighted Average
	6,904		21.54% Pervious Area
	25,154		78.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: 40-50 Central Ave

Hydrograph



Central Ave - Pre Development

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40-50 Central Ave - Pre Development

Type III 24-hr 100-Year Rainfall=8.80"

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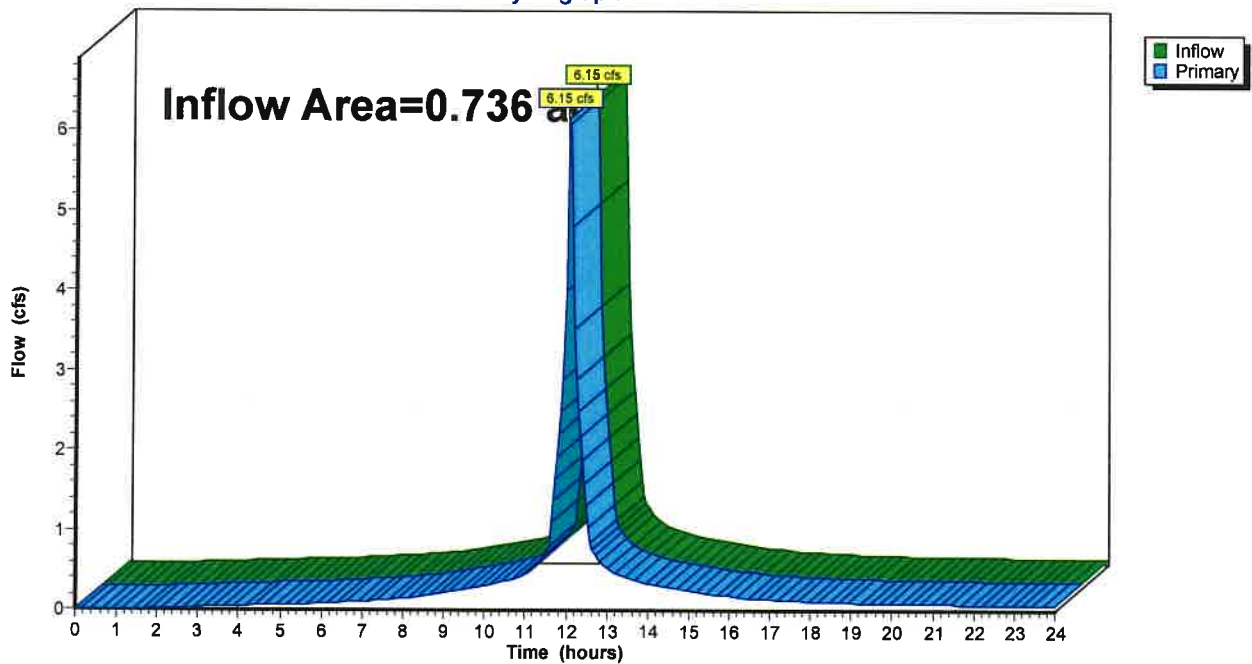
Summary for Pond 1P: Offsite

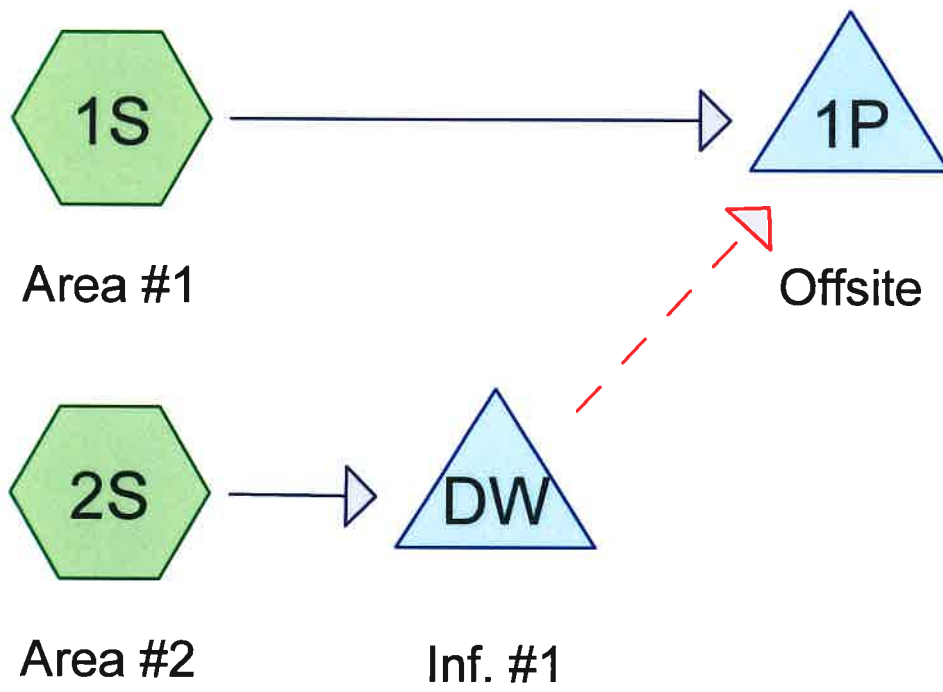
Inflow Area = 0.736 ac, 78.46% Impervious, Inflow Depth > 8.19" for 100-Year event
Inflow = 6.15 cfs @ 12.09 hrs, Volume= 0.502 af
Primary = 6.15 cfs @ 12.09 hrs, Volume= 0.502 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph





Routing Diagram for Central Ave - Post Development
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Central Ave - Post Development

Prepared by HP

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Page 2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.264	84	50-75% Grass cover, Fair, HSG D (1S)
0.205	98	Proposed Buildings (2S)
0.036	98	Proposed Walkways & Patio (1S)
0.231	98	Proposed parking (2S)
0.736	93	TOTAL AREA

Central Ave - Post Development

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40-50 Central Ave - Post Development

NRCC 24-hr D 2-Year Rainfall=3.16"

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Page 3

Summary for Subcatchment 1S: Area #1

Runoff = 0.58 cfs @ 12.13 hrs, Volume= 0.045 af, Depth> 1.80"

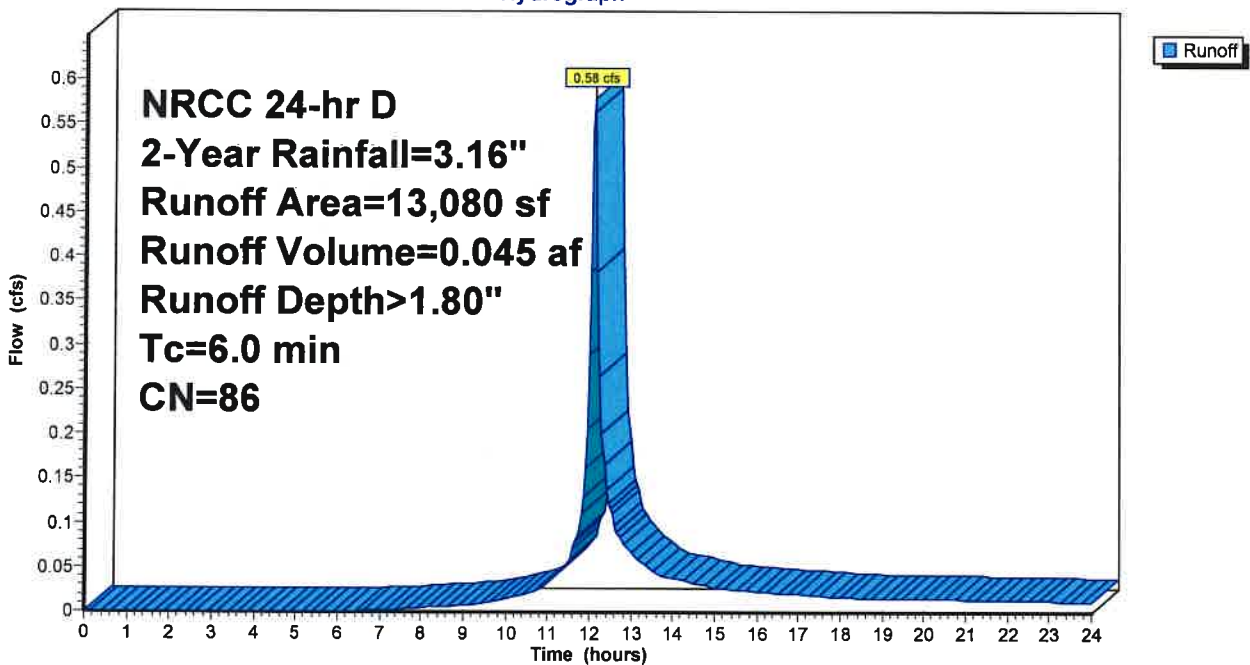
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.16"

Area (sf)	CN	Description
11,506	84	50-75% Grass cover, Fair, HSG D
* 1,574	98	Proposed Walkways & Patio
13,080	86	Weighted Average
11,506		87.97% Pervious Area
1,574		12.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: Area #1

Hydrograph



Central Ave - Post Development

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40-50 Central Ave - Post Development

NRCC 24-hr D 2-Year Rainfall=3.16"

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Summary for Subcatchment 2S: Area #2

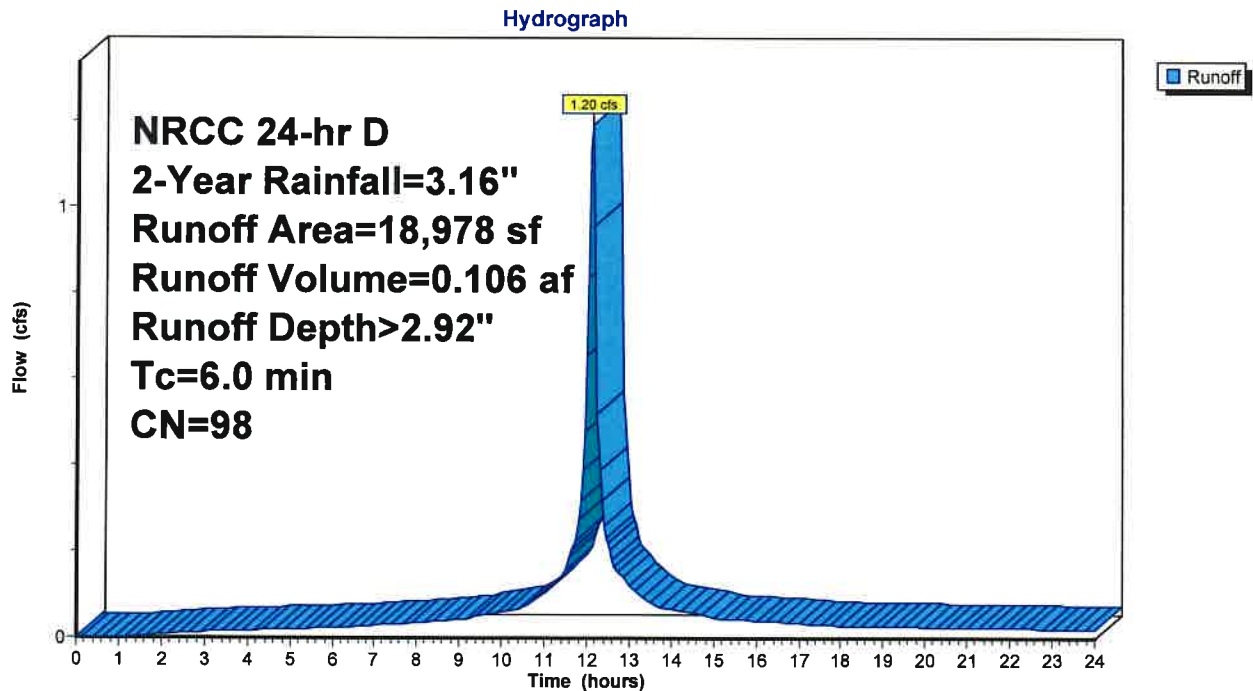
Runoff = 1.20 cfs @ 12.13 hrs, Volume= 0.106 af, Depth> 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.16"

	Area (sf)	CN	Description
*	8,930	98	Proposed Buildings
*	10,048	98	Proposed parking
	18,978	98	Weighted Average
	18,978		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Subcatchment 2S: Area #2



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40-50 Central Ave - Post Development

NRCC 24-hr D 2-Year Rainfall=3.16"

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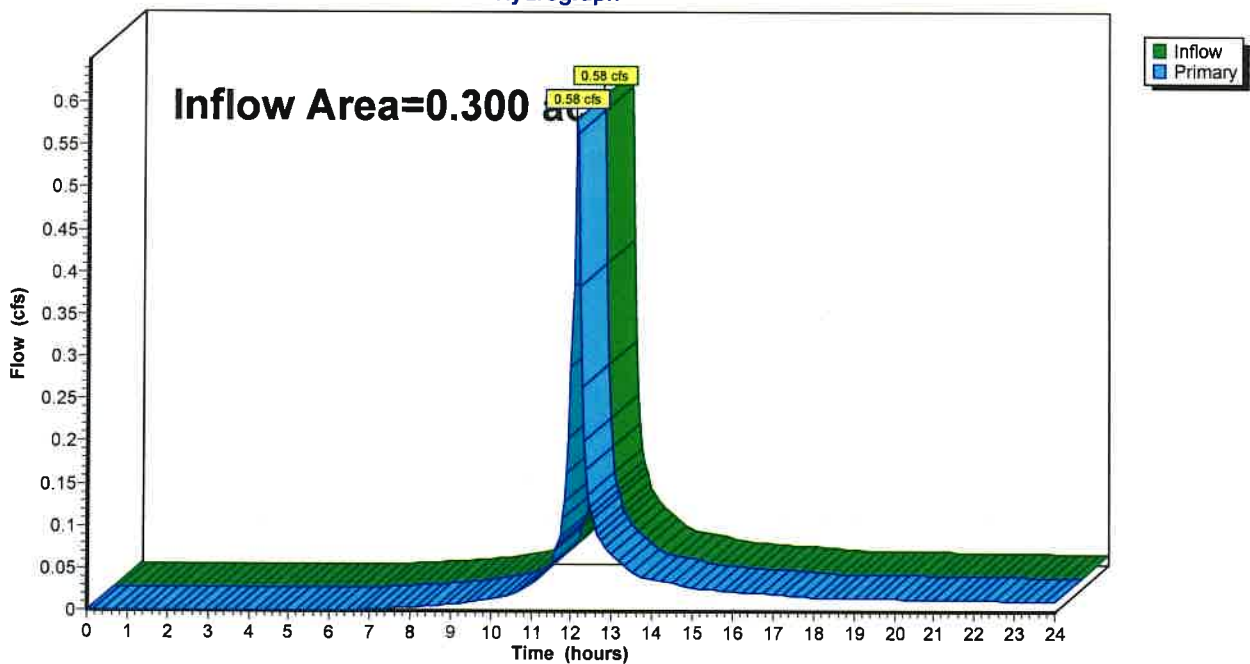
Summary for Pond 1P: Offsite

Inflow Area = 0.300 ac, 12.03% Impervious, Inflow Depth > 1.80" for 2-Year event
Inflow = 0.58 cfs @ 12.13 hrs, Volume= 0.045 af
Primary = 0.58 cfs @ 12.13 hrs, Volume= 0.045 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



Central Ave - Post Development

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NRCC 24-hr D 2-Year Rainfall=3.16"

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Summary for Pond DW: Inf. #1

Inflow Area = 0.436 ac, 100.00% Impervious, Inflow Depth > 2.92" for 2-Year event
Inflow = 1.20 cfs @ 12.13 hrs, Volume= 0.106 af
Outflow = 0.00 cfs @ 4.00 hrs, Volume= 0.008 af, Atten= 100%, Lag= 0.0 min
Discarded = 0.00 cfs @ 4.00 hrs, Volume= 0.008 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 111.36' @ 24.00 hrs Surf.Area= 0.049 ac Storage= 0.098 af

Plug-Flow detention time= 520.5 min calculated for 0.008 af (7% of inflow)
Center-of-Mass det. time= 45.0 min (805.0 - 760.0)

Volume	Invert	Avail.Storage	Storage Description
#1	108.25'	0.055 af	22.00'W x 98.00'L x 5.25'H Gravel 0.260 af Overall - 0.123 af Embedded = 0.137 af x 40.0% Voids
#2	109.25'	0.123 af	4.00'W x 4.50'L x 4.25'H Leaching Galley x 70 Inside #1
		0.178 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	108.25'	0.090 in/hr Exfiltration over Surface area
#2	Secondary	118.50'	24.0" x 24.0" Horiz. CB @ Driveway C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00 cfs @ 4.00 hrs HW=108.35' (Free Discharge)
↑ **1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=108.25' (Free Discharge)
↑ **2=CB @ Driveway** (Controls 0.00 cfs)

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40-50 Central Ave - Post Development

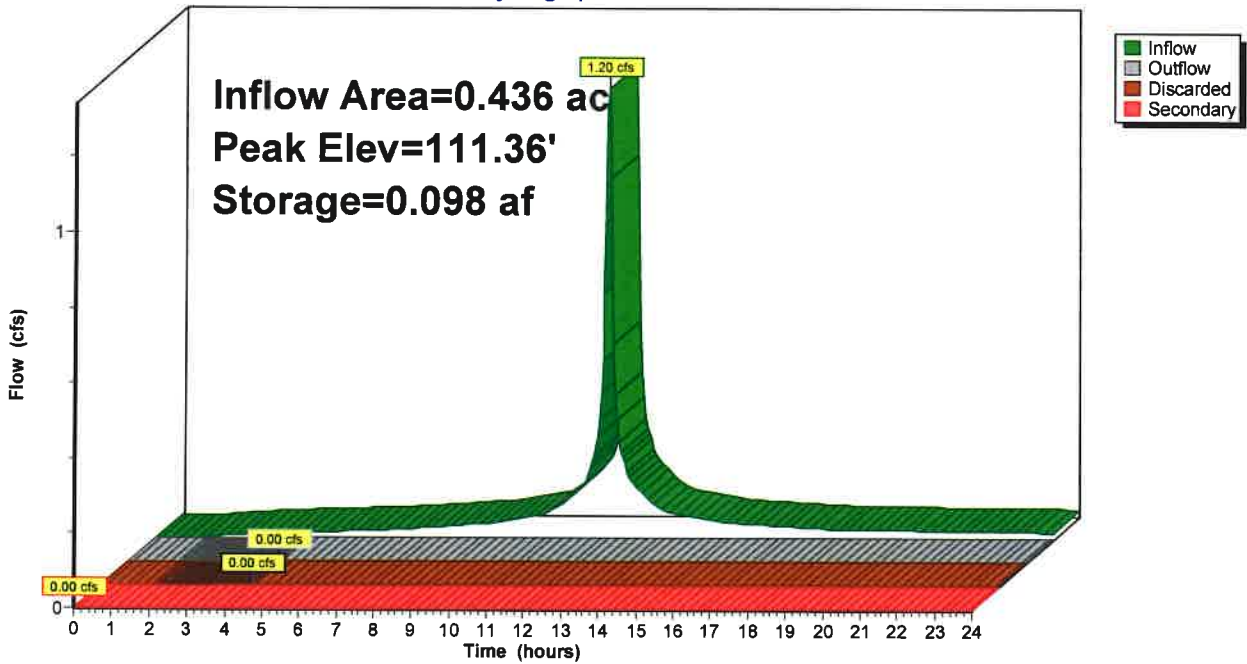
NRCC 24-hr D 2-Year Rainfall=3.16"

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Pond DW: Inf. #1

Hydrograph



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NRCC 24-hr D 10-Year Rainfall=4.77"

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Summary for Subcatchment 1S: Area #1

Runoff = 1.03 cfs @ 12.13 hrs, Volume= 0.081 af, Depth> 3.25"

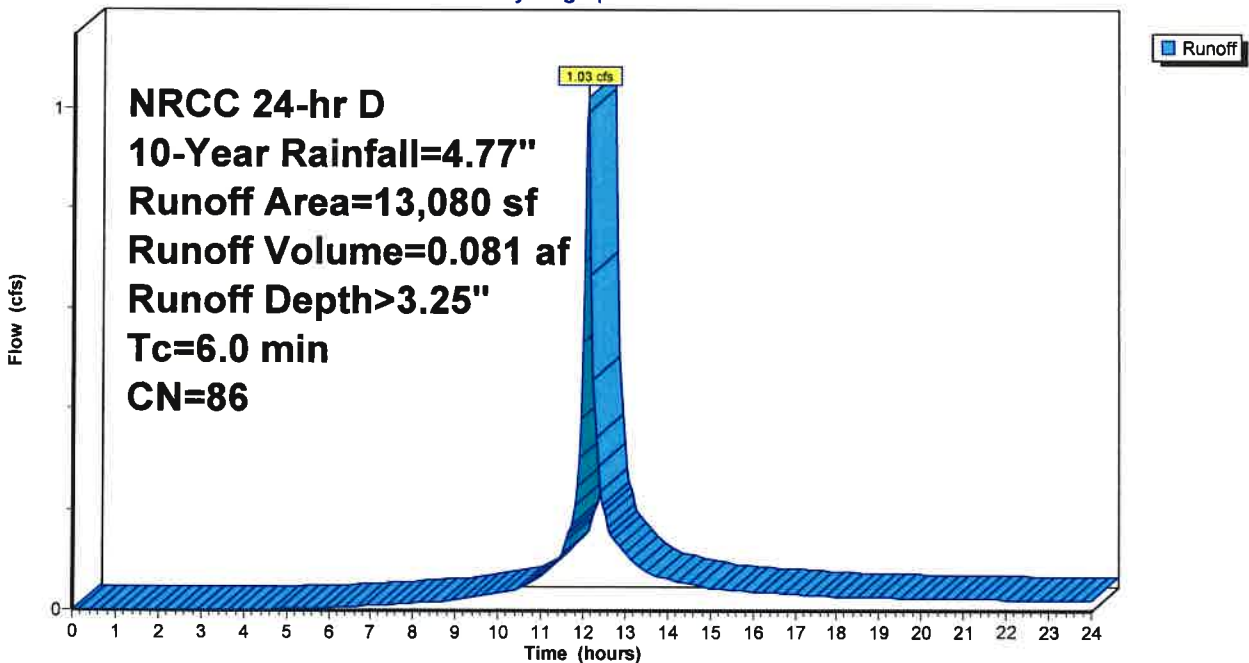
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.77"

Area (sf)	CN	Description
11,506	84	50-75% Grass cover, Fair, HSG D
* 1,574	98	Proposed Walkways & Patio
13,080	86	Weighted Average
11,506		87.97% Pervious Area
1,574		12.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: Area #1

Hydrograph



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NRCC 24-hr D 10-Year Rainfall=4.77"

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Summary for Subcatchment 2S: Area #2

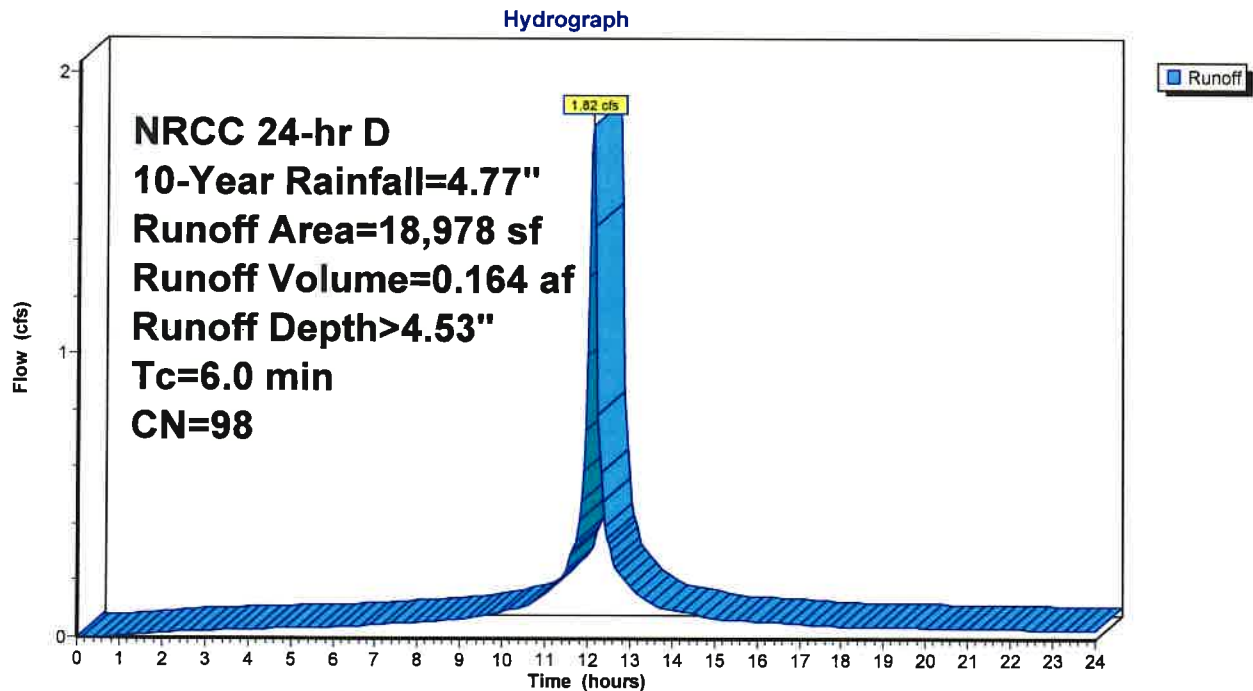
Runoff = 1.82 cfs @ 12.13 hrs, Volume= 0.164 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.77"

	Area (sf)	CN	Description
*	8,930	98	Proposed Buildings
*	10,048	98	Proposed parking
	18,978	98	Weighted Average
	18,978		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Subcatchment 2S: Area #2



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NRCC 24-hr D 10-Year Rainfall=4.77"

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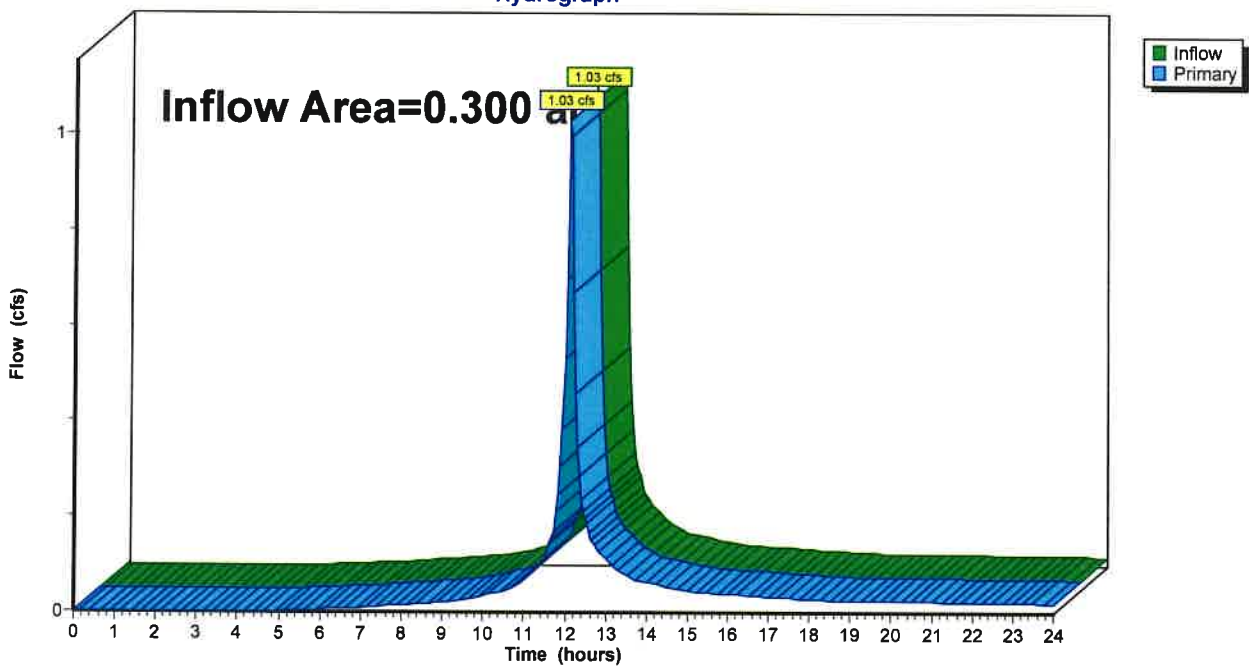
Summary for Pond 1P: Offsite

Inflow Area = 0.300 ac, 12.03% Impervious, Inflow Depth > 3.25" for 10-Year event
Inflow = 1.03 cfs @ 12.13 hrs, Volume= 0.081 af
Primary = 1.03 cfs @ 12.13 hrs, Volume= 0.081 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



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NRCC 24-hr D 10-Year Rainfall=4.77"

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Summary for Pond DW: Inf. #1

Inflow Area = 0.436 ac, 100.00% Impervious, Inflow Depth > 4.53" for 10-Year event
Inflow = 1.82 cfs @ 12.13 hrs, Volume= 0.164 af
Outflow = 0.00 cfs @ 2.70 hrs, Volume= 0.008 af, Atten= 100%, Lag= 0.0 min
Discarded = 0.00 cfs @ 2.70 hrs, Volume= 0.008 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 112.92' @ 24.00 hrs Surf.Area= 0.049 ac Storage= 0.156 af

Plug-Flow detention time= 574.3 min calculated for 0.008 af (5% of inflow)
Center-of-Mass det. time= 27.8 min (778.5 - 750.7)

Volume	Invert	Avail.Storage	Storage Description
#1	108.25'	0.055 af	22.00'W x 98.00'L x 5.25'H Gravel 0.260 af Overall - 0.123 af Embedded = 0.137 af x 40.0% Voids
#2	109.25'	0.123 af	4.00'W x 4.50'L x 4.25'H Leaching Galleyx 70 Inside #1
		0.178 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	108.25'	0.090 in/hr Exfiltration over Surface area
#2	Secondary	118.50'	24.0" x 24.0" Horiz. CB @ Driveway C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00 cfs @ 2.70 hrs HW=108.35' (Free Discharge)
↑1=Exfiltration (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=108.25' (Free Discharge)
↑2=CB @ Driveway (Controls 0.00 cfs)

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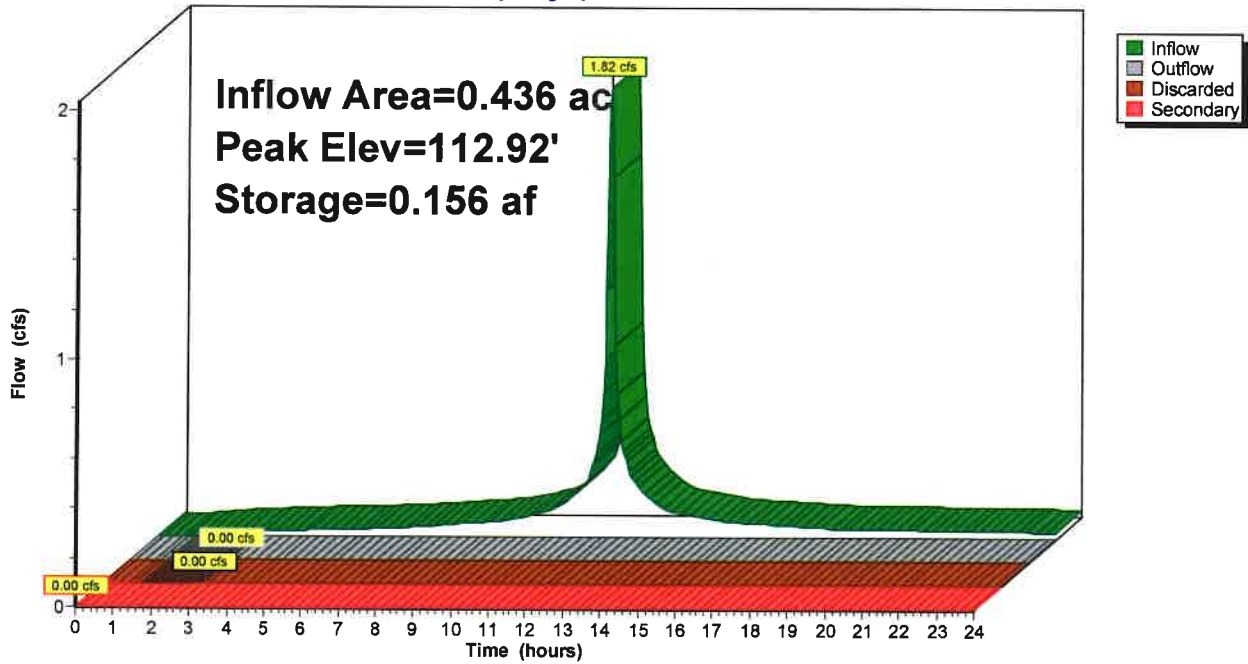
NRCC 24-hr D 10-Year Rainfall=4.77"

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Pond DW: Inf. #1

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NRCC 24-hr D 25-Year Rainfall=6.03"

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Summary for Subcatchment 1S: Area #1

Runoff = 1.38 cfs @ 12.13 hrs, Volume= 0.111 af, Depth> 4.43"

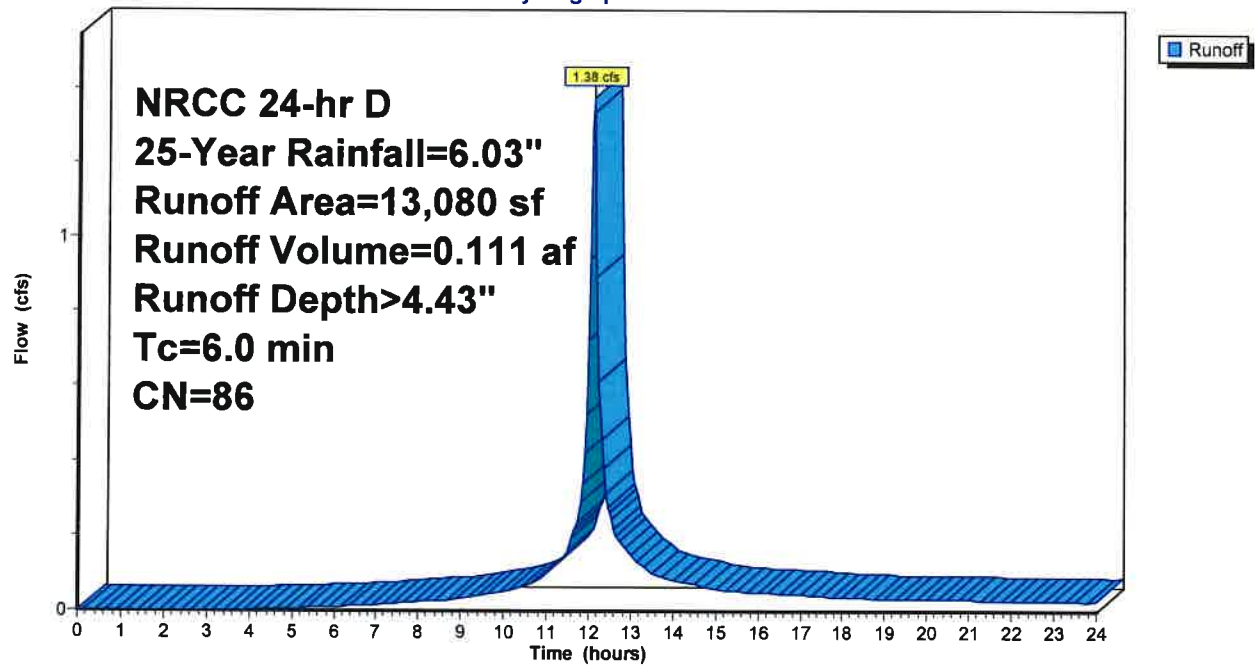
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=6.03"

Area (sf)	CN	Description
11,506	84	50-75% Grass cover, Fair, HSG D
* 1,574	98	Proposed Walkways & Patio
13,080	86	Weighted Average
11,506		87.97% Pervious Area
1,574		12.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: Area #1

Hydrograph



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Summary for Subcatchment 2S: Area #2

Runoff = 2.30 cfs @ 12.13 hrs, Volume= 0.210 af, Depth> 5.79"

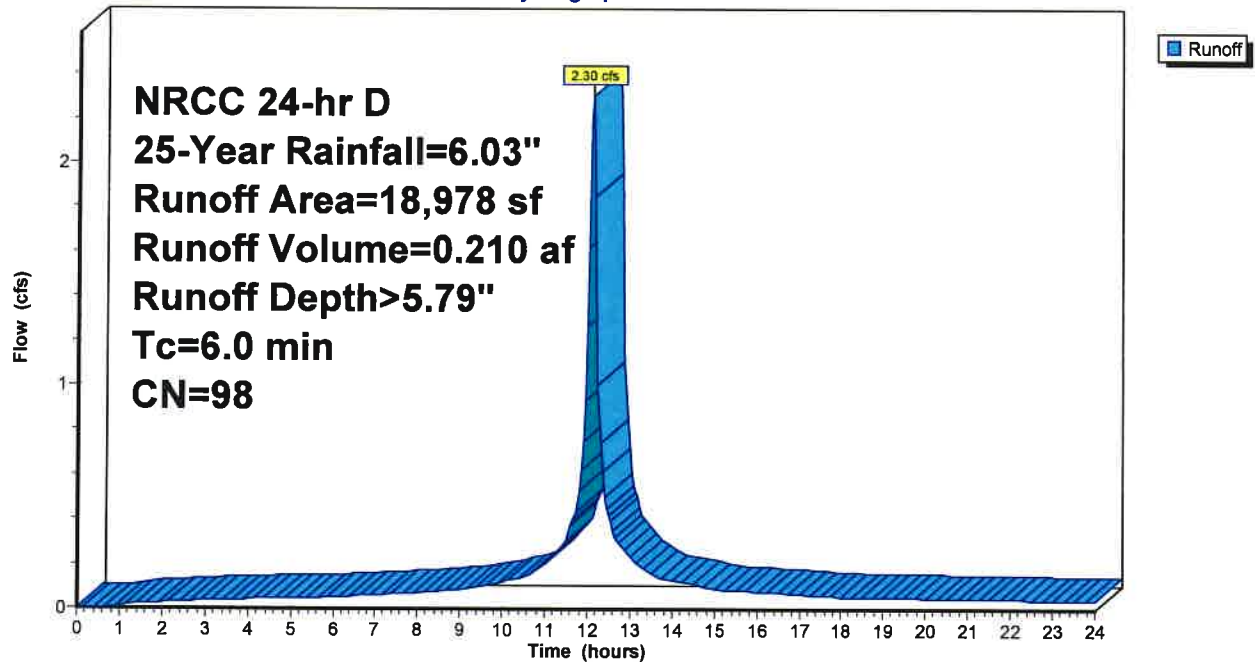
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=6.03"

	Area (sf)	CN	Description
*	8,930	98	Proposed Buildings
*	10,048	98	Proposed parking
	18,978	98	Weighted Average
	18,978		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Subcatchment 2S: Area #2

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NRCC 24-hr D 25-Year Rainfall=6.03"

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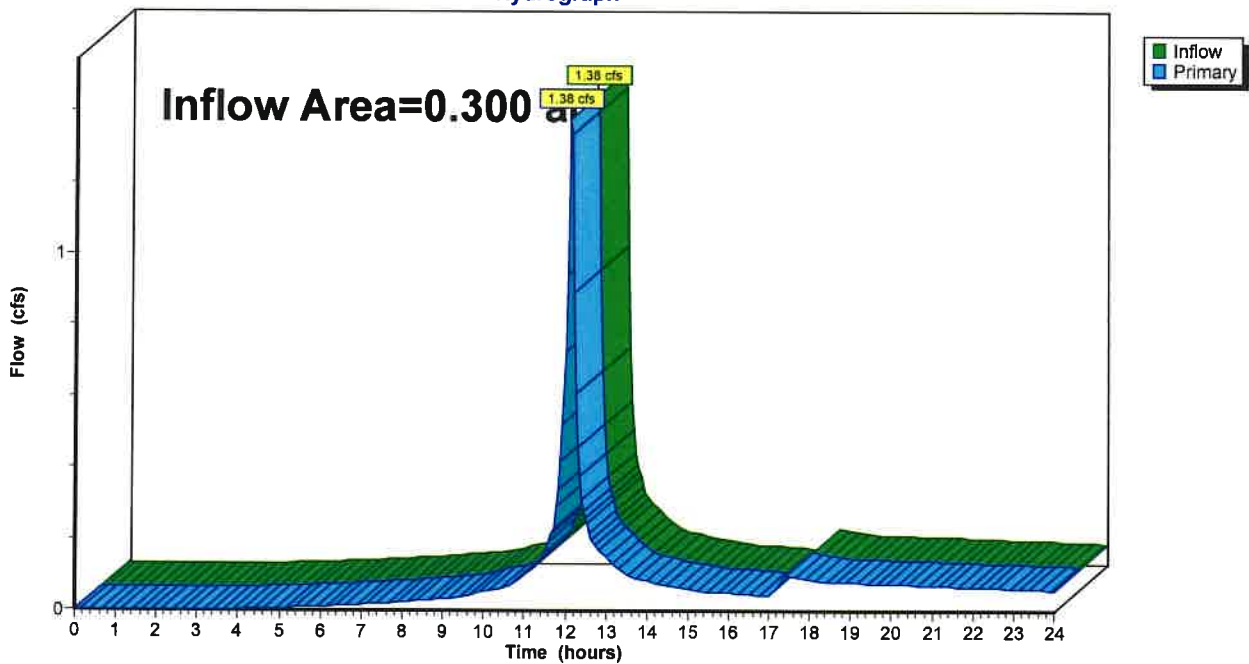
Summary for Pond 1P: Offsite

Inflow Area = 0.300 ac, 12.03% Impervious, Inflow Depth > 5.39" for 25-Year event
Inflow = 1.38 cfs @ 12.13 hrs, Volume= 0.135 af
Primary = 1.38 cfs @ 12.13 hrs, Volume= 0.135 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



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NRCC 24-hr D 25-Year Rainfall=6.03"

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Summary for Pond DW: Inf. #1

Inflow Area = 0.436 ac, 100.00% Impervious, Inflow Depth > 5.79" for 25-Year event
Inflow = 2.30 cfs @ 12.13 hrs, Volume= 0.210 af
Outflow = 0.07 cfs @ 17.25 hrs, Volume= 0.032 af, Atten= 97%, Lag= 307.4 min
Discarded = 0.00 cfs @ 2.20 hrs, Volume= 0.008 af
Secondary = 0.06 cfs @ 17.25 hrs, Volume= 0.024 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 118.51' @ 17.25 hrs Surf.Area= 0.049 ac Storage= 0.178 af

Plug-Flow detention time= 750.5 min calculated for 0.032 af (15% of inflow)
Center-of-Mass det. time= 357.0 min (1,103.4 - 746.4)

Volume	Invert	Avail.Storage	Storage Description
#1	108.25'	0.055 af	22.00'W x 98.00'L x 5.25'H Gravel 0.260 af Overall - 0.123 af Embedded = 0.137 af x 40.0% Voids
#2	109.25'	0.123 af	4.00'W x 4.50'L x 4.25'H Leaching Galleyx 70 Inside #1
		0.178 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	108.25'	0.090 in/hr Exfiltration over Surface area
#2	Secondary	118.50'	24.0" x 24.0" Horiz. CB @ Driveway C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00 cfs @ 2.20 hrs HW=108.36' (Free Discharge)
↑ **1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=0.02 cfs @ 17.25 hrs HW=118.51' (Free Discharge)
↑ **2=CB @ Driveway** (Weir Controls 0.02 cfs @ 0.28 fps)

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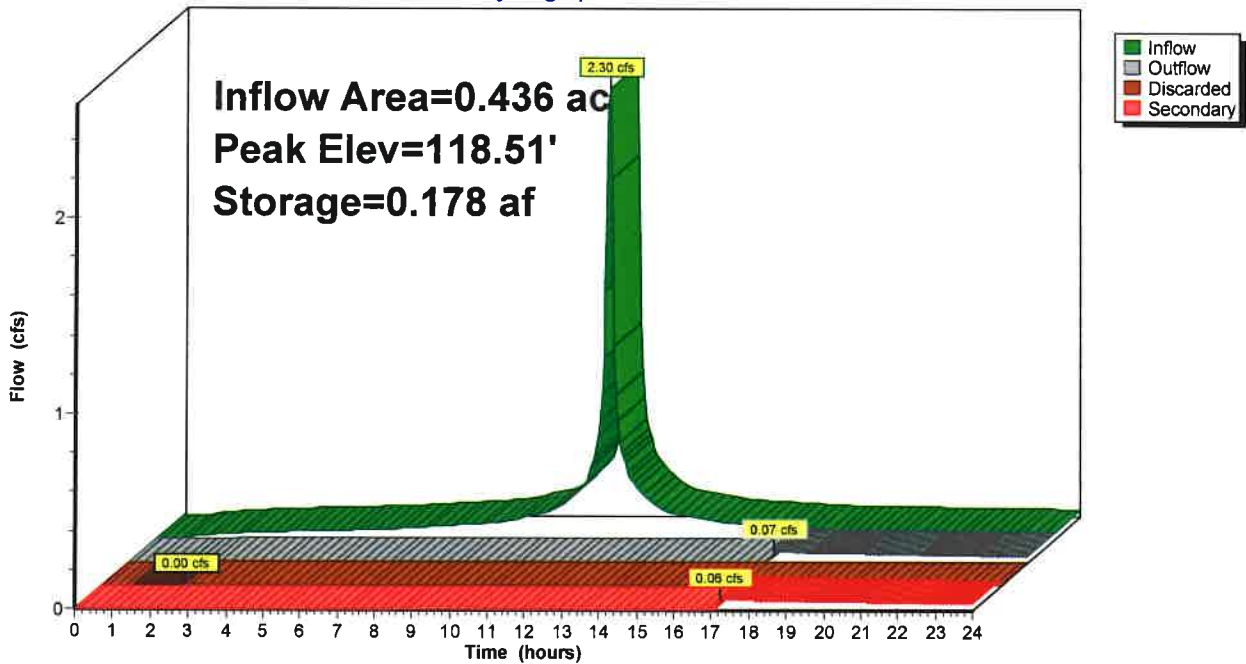
40-50 Central Ave - Post Development
NRCC 24-hr D 25-Year Rainfall=6.03"

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Pond DW: Inf. #1

Hydrograph



Central Ave - Post Development

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NRCC 24-hr D 100-Year Rainfall=8.62"

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Summary for Subcatchment 1S: Area #1

Runoff = 2.10 cfs @ 12.13 hrs, Volume= 0.173 af, Depth> 6.93"

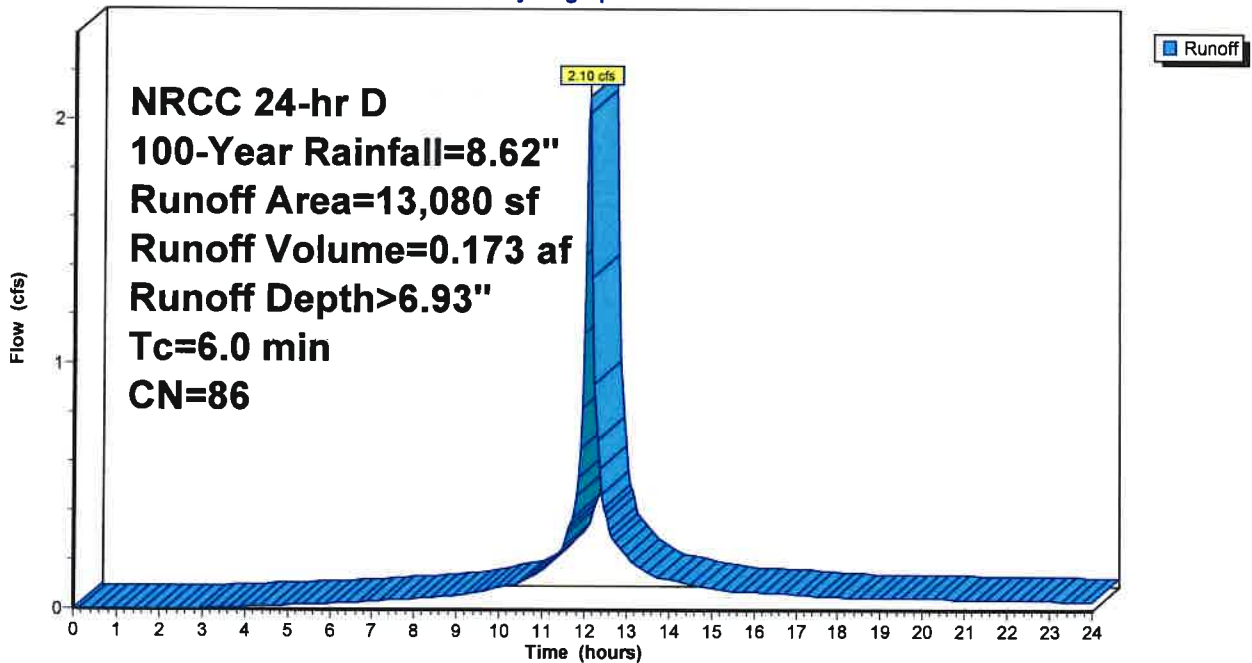
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.62"

Area (sf)	CN	Description
11,506	84	50-75% Grass cover, Fair, HSG D
* 1,574	98	Proposed Walkways & Patio
13,080	86	Weighted Average
11,506		87.97% Pervious Area
1,574		12.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Direct Entry

Subcatchment 1S: Area #1

Hydrograph



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NRCC 24-hr D 100-Year Rainfall=8.62"

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Summary for Subcatchment 2S: Area #2

Runoff = 3.30 cfs @ 12.13 hrs, Volume= 0.304 af, Depth> 8.37"

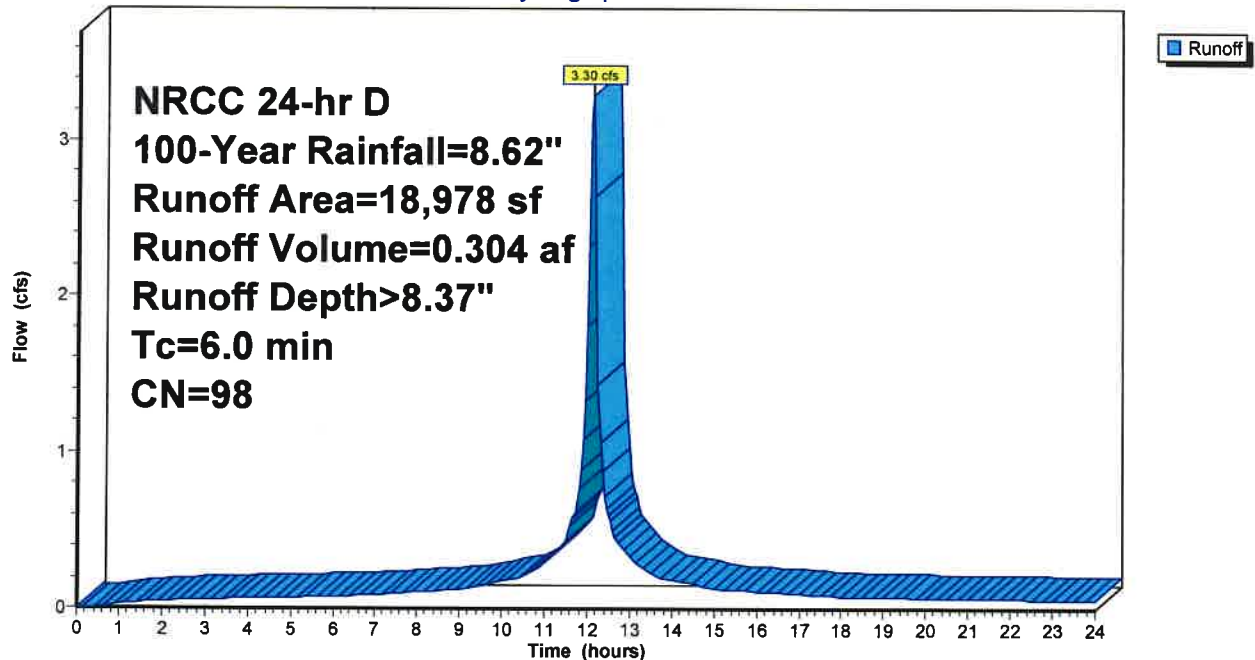
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.62"

	Area (sf)	CN	Description
*	8,930	98	Proposed Buildings
*	10,048	98	Proposed parking
	18,978	98	Weighted Average
	18,978		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Subcatchment 2S: Area #2

Hydrograph



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NRCC 24-hr D 100-Year Rainfall=8.62"

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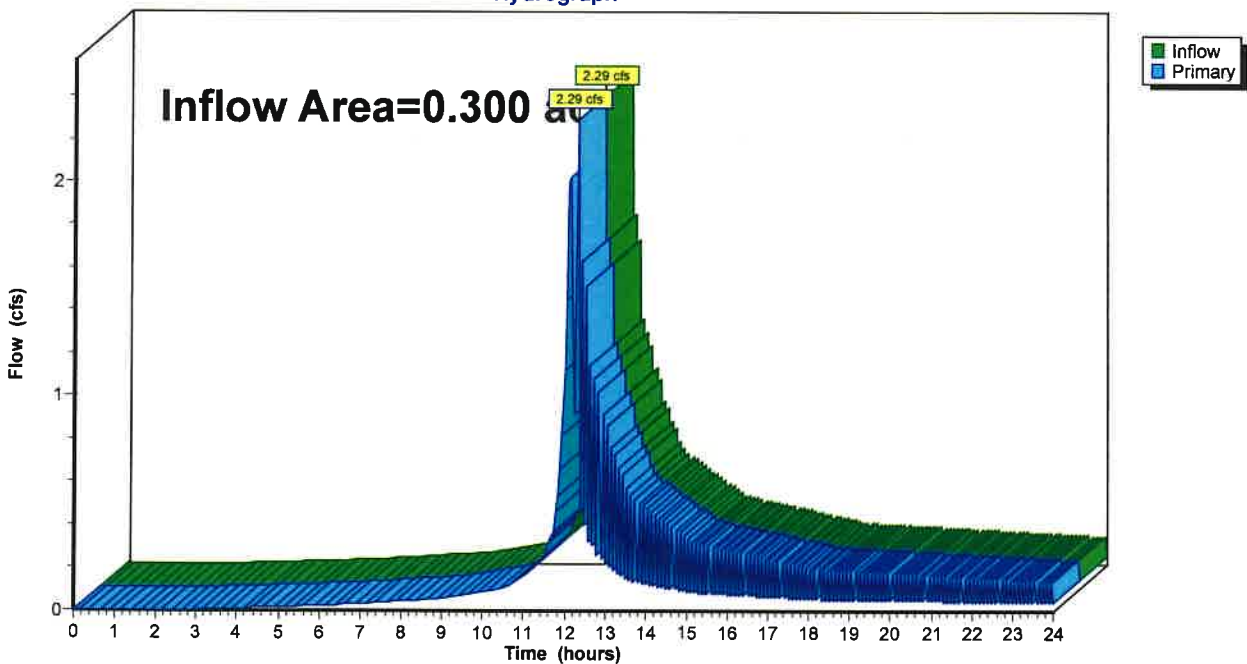
Summary for Pond 1P: Offsite

Inflow Area = 0.300 ac, 12.03% Impervious, Inflow Depth > 11.63" for 100-Year event
Inflow = 2.29 cfs @ 12.35 hrs, Volume= 0.291 af
Primary = 2.29 cfs @ 12.35 hrs, Volume= 0.291 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Pond 1P: Offsite

Hydrograph



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40-50 Central Ave - Post Development
NRCC 24-hr D 100-Year Rainfall=8.62"

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Summary for Pond DW: Inf. #1

Inflow Area = 0.436 ac, 100.00% Impervious, Inflow Depth > 8.37" for 100-Year event
Inflow = 3.30 cfs @ 12.13 hrs, Volume= 0.304 af
Outflow = 1.72 cfs @ 12.35 hrs, Volume= 0.126 af, Atten= 48%, Lag= 13.3 min
Discarded = 0.00 cfs @ 1.60 hrs, Volume= 0.009 af
Secondary = 1.72 cfs @ 12.35 hrs, Volume= 0.118 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 118.66' @ 12.35 hrs Surf.Area= 0.049 ac Storage= 0.178 af

Plug-Flow detention time= 396.4 min calculated for 0.126 af (41% of inflow)
Center-of-Mass det. time= 195.5 min (936.5 - 741.0)

Volume	Invert	Avail.Storage	Storage Description
#1	108.25'	0.055 af	22.00'W x 98.00'L x 5.25'H Gravel 0.260 af Overall - 0.123 af Embedded = 0.137 af x 40.0% Voids
#2	109.25'	0.123 af	4.00'W x 4.50'L x 4.25'H Leaching Galleyx 70 Inside #1
		0.178 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	108.25'	0.090 in/hr Exfiltration over Surface area
#2	Secondary	118.50'	24.0" x 24.0" Horiz. CB @ Driveway C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00 cfs @ 1.60 hrs HW=108.36' (Free Discharge)
↑1=Exfiltration (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=1.58 cfs @ 12.35 hrs HW=118.65' (Free Discharge)
↑2=CB @ Driveway (Weir Controls 1.58 cfs @ 1.28 fps)

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40-50 Central Ave - Post Development

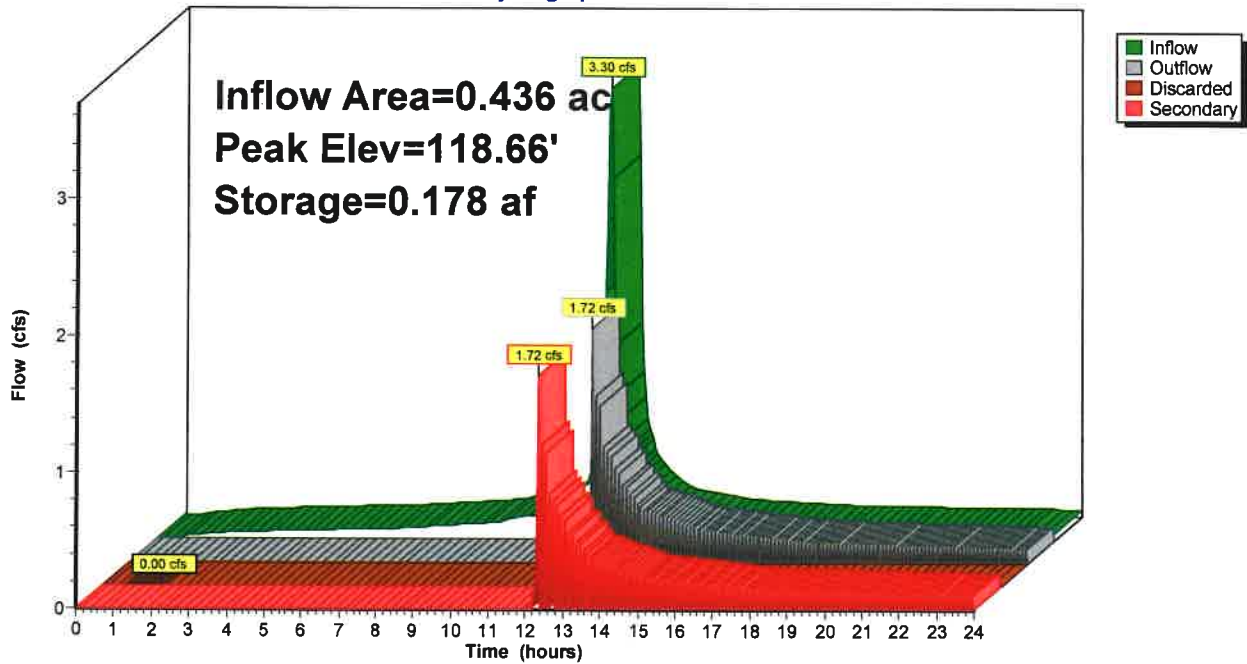
NRCC 24-hr D 100-Year Rainfall=8.62"

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Pond DW: Inf. #1

Hydrograph



Soil Map—Norfolk and Suffolk Counties, Massachusetts



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

9/12/2022
Page 1 of 3

Soil Map—Norfolk and Suffolk Counties, Massachusetts

MAP LEGEND

Area of Interest (AOI)		Area of Interest (AOI)		Spoil Area
Soils		Soil Map Unit Polygons		Stony Spot
		Soil Map Unit Lines		Very Stony Spot
		Soil Map Unit Points		Wet Spot
Special Point Features		Blowout		Other
		Borrow Pit		Special Line Features
		Clay Spot	Water Features	
		Closed Depression		Streams and Canals
		Gravel Pit	Transportation	
		Gravelly Spot		Rails
		Landfill		Interstate Highways
		Lava Flow		US Routes
		Marsh or swamp		Major Roads
		Mine or Quarry		Local Roads
		Miscellaneous Water	Background	
		Perennial Water		Aerial Photography
		Rock Outcrop		
		Saline Spot		
		Sandy Spot		
		Severely Eroded Spot		
		Sinkhole		
		Slide or Slip		
		Sodic Spot		

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 17, Sep 3, 2021

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
104D	Hollis-Rock outcrop-Charlton complex, 15 to 35 percent slopes	0.3	48.8%
602	Urban land, 0 to 15 percent slopes	0.3	51.2%
Totals for Area of Interest		0.6	100.0%

OPERATION & MAINTENANCE PLAN

STORMWATER MANAGEMENT FACILITIES

PROPOSED MIXED-USE BUILDING

40-50 CENTRAL AVE

NEEDHAM, MASSACHUSETTS

September 12, 2022

VERNE T. PORTER JR., PLS

LAND SURVEYORS – CIVIL ENGINEERS

354 ELLIOT STREET

NEWTON, MA 02464

**OPERATION & MAINTENANCE PLAN
STORMWATER MANAGEMENT FACILITIES
PROPOSED MIXED-USE BUILDING
40-50 CENTRAL AVE
NEEDHAM, MA**

The proposed project includes stormwater runoff controls associated with the construction of a new mixed-use building and associated site improvements. The major components associated with maintenance needs are the proposed leaching systems that will handle runoff from the proposed roof and parking areas. These will need to be cleaned periodically as noted below. Cleaning of these structures shall be done by the property owner or by a specialty contractor with hydraulic cleaning ability. The following outlines the major maintenance issues associated with the project:

Catchbasin Inspection/Cleaning:

Have all catchbasins cleaned out completely twice annually during April and October, if required.

Leaching Galley Cleaning:

The proposed leaching galleys should be inspected monthly during the first year, and then every third year following the 1-year inspection.

The leaching galleys are equipped with a frame and cover. After removal of the cover, a stadia rod should be used to measure the depth of sediment. If the depth of sediment is in excess of 3", then the sediment should be removed.

Street Sweeping

Have the driveway swept bi-annually in April and October.

MAINTENANCE RESPONSIBILITIES

The maintenance of the Drainage System is the responsibility of the Property Owners. The actual work can be accomplished by the Owner or can be subcontracted to a company that specializes in the cleaning of storm drainage facilities. Inspections should be performed by independent individual such as the design engineer or other experienced individual in the field.

The General Contract must take precautions during construction to protect all infiltration structures/systems during construction.

Construction period pollution control

Erosion and sedimentation control measures will be implemented prior to and during construction activities to minimize impacts from land disturbance activities. Erosion and sedimentation control measures implemented on the site will include, at a minimum, dust control measures, the installation of silt fence barriers on the up-gradient side of resource areas and catch basin inlet protection. Controls may also include temporary sedimentation basins and diversion swales and temporary seeding. The erosion and sedimentation controls will be inspected at the end of the day if precipitation is forecast, and after each rainfall event of 0.5 inches or more. Should construction occur during winter months, seasonally appropriate stabilization measure will be utilized.

Below is a summary of the minimum construction period pollution control requirements. These topics are presented as a means of demonstrating understanding of pollution control but are not meant to supplant preparation of the SWPPP. Please refer to the SWPPP for complete construction activity details.

a. Dust Control

Mitigation measures will be implemented to control fugitive dust during construction activities. Dust control measure may include seeding, wet suppression, application of soil stabilization agents, or other measures to control dust generated by construction activities. The Contractor shall confirm with state and local regulations to see if the use of calcium chloride for dust suppression is allowed.

b. Erosion Control Barriers

Prior to any ground disturbance, erosion control barriers will be installed at the limit of work at down-gradient positions on the site. The barriers will consist of silt fence and staked hay bales and will be entrenched in the soil to prevent underflow.

c. Catch Basin Inlet Protection

All existing and newly installed catch basin shall be protected during construction with a filter insert system. These sedimentation control measures will be regularly maintained until the drainage area tributary to the catch basin has been stabilized.

d. Temporary Sedimentation Basins and Diversion Swales

If necessary, temporary sedimentation basins will be constructed to prevent transport of fine-grained sediment into wetland resource areas and other off-site areas. These temporary basins will be located where appropriate, as determined by the contractor. Temporary diversion swales or berms may be used to convey runoff from construction areas to temporary or previously constructed basins.

e. Temporary Seeding

Temporary seeding will be used where vegetative cover is required for less than one year on disturbed soil areas. Such areas will be seeded if the soils will be exposed without construction activity for more than 30 days. Rapidly growing annual grasses, such as annual rye grass, oats, perennial rye grass or winter rye will be uniformly applied. Depending on the slope, the soil may be covered with a layer of straw mulch, an erosion control blanket, or a bonded fiber matrix.

f. Permanent Seeding

Upon completion of the final grading, any areas not covered by pavement, other forms of stabilization, including landscaping, will be seeded with rapidly growing annual rye grass/red fescue seed mix.

**STORMWATER MANAGEMENT REPORT
PROPOSED MIXED-USE BUILDING
40-50 CENTRAL AVE
NEEDHAM, MASSACHUSETTS**

INSPECTION REPORT:

Inspection Firm: _____

Inspectors Name: _____ Date: _____

Components Inspected: _____

Signed: _____

SYSTEM MAINTENANCE:

Maintenance Firm: _____ Date: _____

Catchbasin Inspected: Yes ____ No ____ Comments: _____

Catchbasin Cleaned: Yes ____ No ____ Comments: _____

Leaching Gallies Inspected: Yes ____ No ____ Comments: _____

Leaching Gallies Cleaned: Yes ____ No ____ Comments: _____

Estimate of Material Removed: _____

Other Comments: _____

Signed: _____

Norfolk and Suffolk Counties, Massachusetts

104D—Hollis-Rock outcrop-Charlton complex, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: vkvh
Elevation: 20 to 610 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis and similar soils: 35 percent
Rock outcrop: 30 percent
Charlton and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Shallow, friable loamy ablation till derived from igneous and metamorphic rock

Typical profile

H1 - 0 to 3 inches: fine sandy loam
H2 - 3 to 14 inches: gravelly fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 15 to 35 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s

Hydrologic Soil Group: D

Ecological site: F144AY033MA - Shallow Dry Till Uplands

Hydric soil rating: No

Description of Rock Outcrop

Setting

Parent material: Igneous and metamorphic rock

Properties and qualities

Slope: 15 to 35 percent

Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8s

Hydric soil rating: Unranked

Description of Charlton

Setting

Landform: Hills

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Convex

Parent material: Friable coarse-loamy ablation till derived from granite

Typical profile

H1 - 0 to 6 inches: fine sandy loam

H2 - 6 to 36 inches: fine sandy loam

H3 - 36 to 60 inches: fine sandy loam

Properties and qualities

Slope: 15 to 35 percent

Surface area covered with cobbles, stones or boulders: 1.6 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s

Hydrologic Soil Group: A

Ecological site: F144AY034CT - Well Drained Till Uplands

Hydric soil rating: No

Minor Components

Chatfield

Percent of map unit: 5 percent

Hydric soil rating: No

Canton

Percent of map unit: 5 percent

Hydric soil rating: No

Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts

Survey Area Data: Version 17, Sep 3, 2021

Norfolk and Suffolk Counties, Massachusetts

602—Urban land, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: vkyj

Mean annual precipitation: 32 to 50 inches

Mean annual air temperature: 45 to 50 degrees F

Frost-free period: 120 to 200 days

Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 99 percent

Minor components: 1 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Excavated and filled land

Minor Components

Rock outcrops

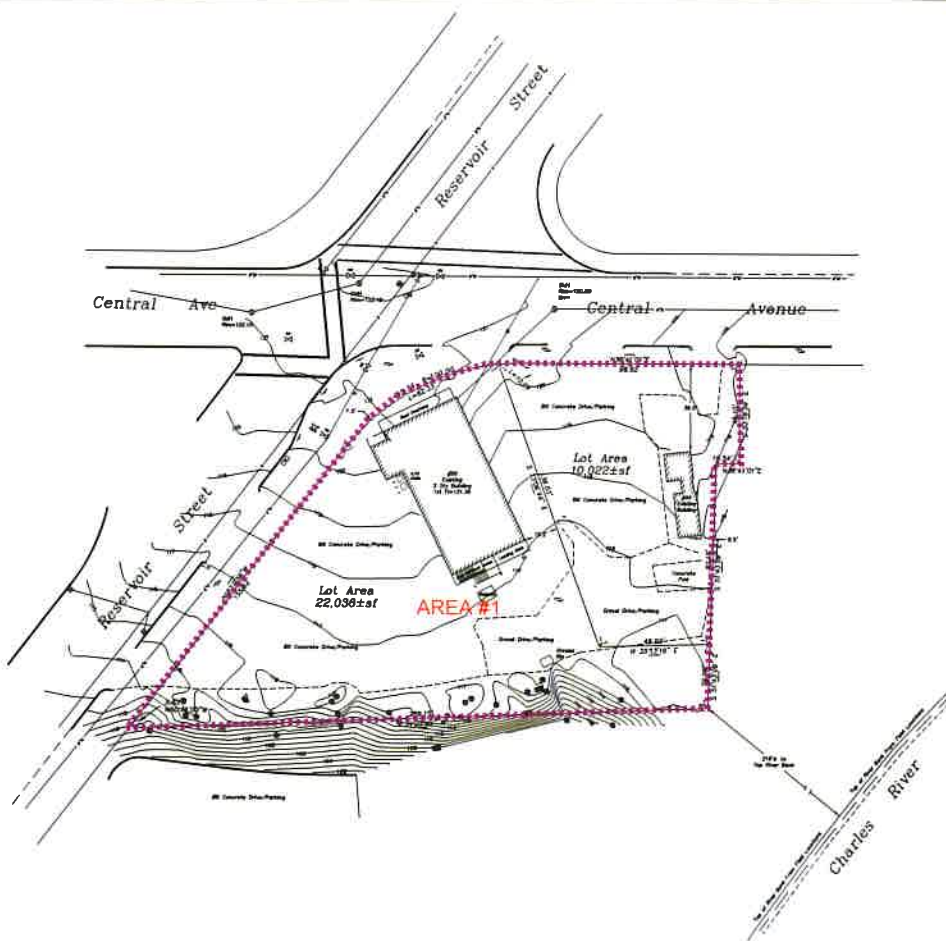
Percent of map unit: 1 percent

Hydric soil rating: Unranked

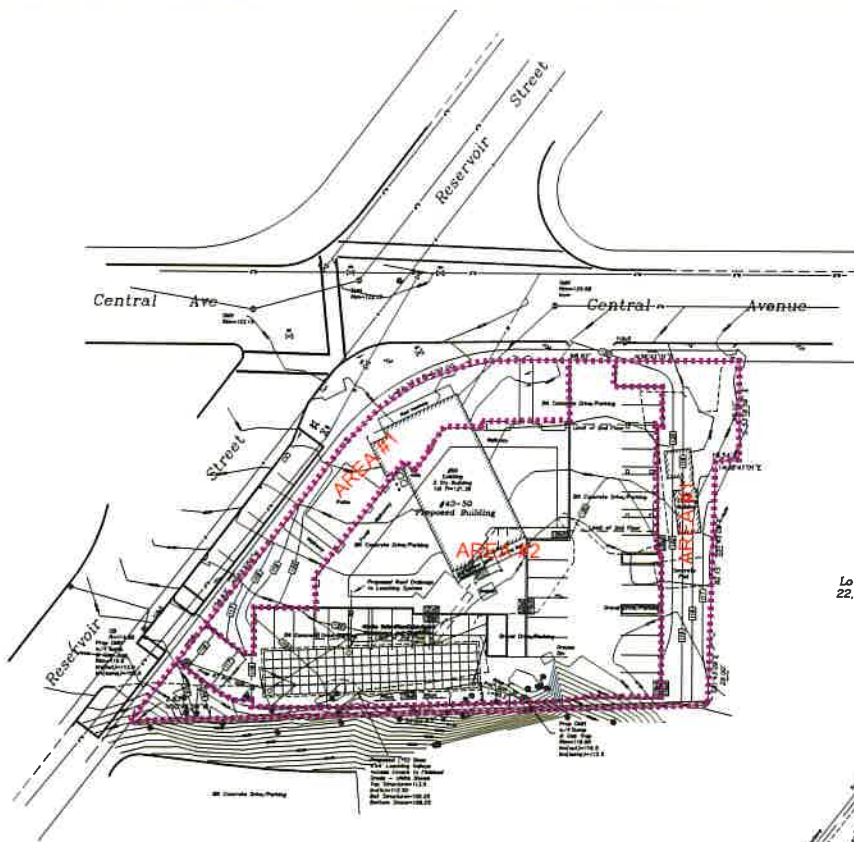
Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts

Survey Area Data: Version 17, Sep 3, 2021



40 & 50 Central Avenue	
Needham, Massachusetts	
Pre Development Catchment Area Plan	
Scale: n.i.s.	Sept. 12, 2022
VERNE T. PORTER Jr., PLS	
Land Surveyors - Civil Engineers	
354 Elliot Street Newton, Massachusetts 02464	
Project: 21007	
Checked: By V. Porter Jr.	
Drawn: By B. Jordano Jr.	
Sheet 1 of 2	



Lot Area Lot Area
22,036±sf 10,022±sf

Existing utilities shown are from field
locations and available plans of record
and may or may not be correct.
Contact Dig Safe and field verify all
locations prior to any excavation.

Charles River

40 & 50 Central Avenue	
Needham, Massachusetts	
Post Development Catchment Area Plans	
Scale: n.t.s.	Sept. 12, 2021
VERNE T. PORTER Jr., PLS	
Land Surveyors - Civil Engineers	
354 Elliot Street Newton, Massachusetts 02464	
Project: 21027	Checked By: V. Porter Jr.
Sheet: 2 of 2	Drawn By: E. Jordine Jr.

Transportation Impact Assessment

Received by
Needham Planning
Board
November 10, 2022

Proposed Residential Development
40-50 Central Avenue
Needham, Massachusetts

Prepared for:

BTE Development, LLC
Wellesley, Massachusetts

November 2022

Prepared by:

 **Vanasse &
Associates inc**
Transportation Engineers & Planners

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

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3	2022 Existing Peak-Hour Traffic Volumes
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No.	Title
1	2022 Existing Roadway Traffic-Volume Summary
2	Motor Vehicle Crash Data Summary
3	Trip Generation Summary
4	Trip-Distribution Summary
5	Peak Hour Traffic-Volume Increases
6	Level-of-Service Criteria for Unsignalized Intersections
7	Unsignalized Intersection Level-Of-Service Summary

EXECUTIVE SUMMARY

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to evaluate the potential traffic impacts associated with the proposed redevelopment of existing commercial properties located at 40-50 Central Avenue in Needham, Massachusetts, in order to accommodate a proposed 15-unit residential apartment development that will provide a total of 28 on-site parking spaces. 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.

As documented in this assessment:

- Project-related traffic increases are expected to amount to 11 new vehicle trips (4 entering and 7 exiting) during the weekday morning peak hour and 22 new vehicle trips (12 entering and 10 exiting) during the weekday evening peak hour;
- No notable safety deficiencies were identified within the study area, with all study area intersections exhibiting motor vehicle crash rates below the MassDOT state average, and available sight lines exceeding the minimum requirements to ensure safe access to and from the Project;
- In comparison to future No-Build traffic volumes, Project-related traffic increases amount to an increase in peak hour traffic volumes of approximately 0.7 to 1.0 percent;
- Project-related traffic conditions are expected to amount to only minor increases to delays as compared to future No-Build conditions.

The following recommendations are provided to ensure safe and efficient access to the Project.

RECOMMENDATIONS

Site Access

Access to the Project site is proposed via new curb cuts on the southern side of Central Avenue and eastern side of Reservoir Street. The proposed driveways will provide a single entering and exiting lane of travel. It is recommended that the proposed driveways be placed under STOP-sign control, with a painted STOP bar at the driveway approaches to Central Avenue and Reservoir Street. In order to ensure safe and efficient access to the Project and that adequate sightlines are provided in both directions, all signs and landscaping should be designed as to not impede lines of sight in both directions. Additionally, existing vegetation that currently limits sight lines to the south from the Reservoir Street driveway location should be removed and regularly maintained to ensure adequate sight lines are maintained to and from the south.

Transportation Demand Management

In order to minimize the number of single occupancy vehicles (SOVs) arriving and departing the Project, and to take advantage of transit, bicycle and pedestrian facilities that are available to residents of the Project, the proponent is committed to implementing a comprehensive Transportation Demand Management (TDM) Plan. Elements of the plan include the following measures:

- ***Orientation Packets:*** Prior to move in activities, the Proponent will provide orientation packets to new residents and tenants containing information on site access and circulation; and available transportation choices, including transit routes/schedules and nearby vehicle sharing locations and bicycle facilities.
- ***Bicycle Accommodation:*** The Proponent will provide interior and exterior bicycle storage in secure sheltered areas for residents and visitors of the Project.

CONCLUSION

In summary, the addition of Project-related traffic to study area roadways and intersections is not anticipated to significantly impact traffic operations within the study area over No-Build conditions. As documented in this report, Project-related traffic increases do not result in significant impact to area traffic operations, with only minimal increases to motorist delays projected along the Central Avenue and Reservoir Street corridors. With implementation of the above recommendations, the proposed Project can be built with minimal traffic impact on the surrounding roadway system.

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to evaluate the potential traffic impacts associated with the proposed redevelopment of existing commercial properties located at 40-50 Central Avenue in Needham, Massachusetts, in order to accommodate a proposed 15-unit residential apartment development that will provide a total of 28 on-site parking spaces. 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.

PROJECT DESCRIPTION

The Project site is situated on an approximate 0.7± acre parcel of land located in the southeast quadrant of the intersection of Central Avenue and Reservoir Street in Needham, Massachusetts. The Project site is generally bounded by private properties to the east, and south, and by Central Avenue and Reservoir Street to the north and west, respectively. The Project site currently houses a two story building that accommodates Panella's Market on the ground floor and office space on the second floor as well as a vacant building and parking lot on the eastern side of the site that previously housed a used car dealership. Under existing conditions, access to the Project site is provided via two unsignalized driveways onto the southern side of Central Avenue and two unsignalized driveways onto the eastern side of Reservoir Street.

The Project entails the razing of the existing buildings on site and the construction of a new 15-unit multi-family apartment building providing a total of 28 on-site parking spaces. An additional six on-street parking spaces are also proposed along the Reservoir Street site frontage. Additionally, the Project would provide approximately 2,542± sf of limited ground level commercial space, divided into three separate units. Access to the Project is proposed via reconstructed driveways onto both Central Avenue and Reservoir Street, that would provide direct access to the on-site ground level parking lot.

The location of the Project site relative to the surrounding roadway network is displayed in Figure 1.

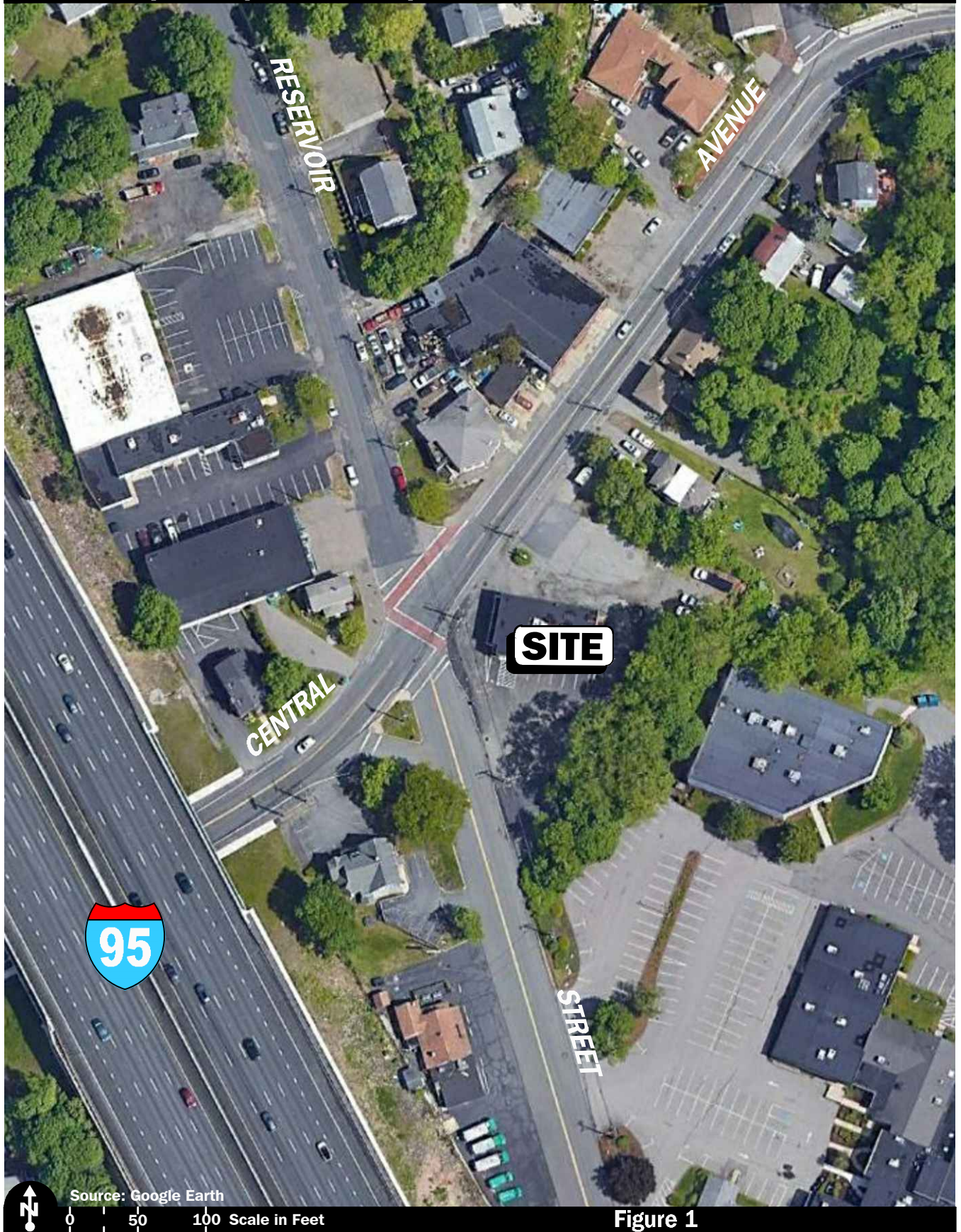


Figure 1

Site Location Map

STUDY METHODOLOGY

This study was prepared in consultation with the Town of Needham and in accordance with the Massachusetts Department of Transportation (MassDOT) Guidelines for traffic impact assessments 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 facilities; observations of traffic flow; review of safety characteristics along area roadways and collection of daily and peak period traffic 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 state guidelines for the preparation of TIAs. 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 October of 2022. The field investigation consisted of an inventory of existing roadway geometrics, pedestrian facilities, traffic volumes, and operating characteristics; as well as posted speed limits and land use information for the major roadways that provide access to the Project including Central Avenue and Reservoir Street, and the key intersections which are expected to accommodate the majority of Project-related traffic. The study area for the project and traffic count locations is listed below and graphically depicted in Figure 2.

1. Central Avenue at Reservoir Street
2. Central Avenue at site driveway
3. Reservoir Street at site driveway

The following describes the study area roadways and intersections:

GEOMETRY

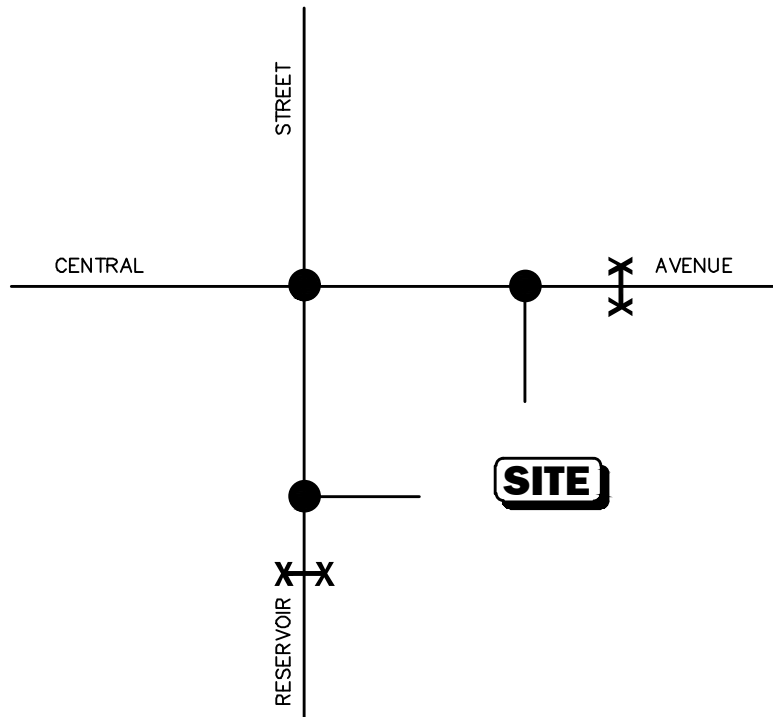
Roadways

Central Avenue

Central Avenue is a two-lane rural collector roadway under both Town of Needham and MassDOT jurisdiction that traverses the study area in a general east-west direction, providing connections to Elliot Street and Chestnut Street to the east and Centre Street to the west. In the vicinity of the Project site, Central Avenue provides a single approximately 12-foot lane of travel in each direction, separated by a painted double-yellow center line, with shoulders of variable width provided along both sides of the corridor. Sidewalk is provided continuously along both sides of the Central Avenue with the study area. The posted speed limit along the corridor, in the vicinity of the Project site is 25 miles per hour (mph). Land use in the vicinity of the Project consists primarily of commercial and residential uses. Street lighting is provided by way of overhead street lights mounted on utility poles.

Legend:

- Unsignalized Turning Movement Count Location
- X-X Automatic Traffic Recorder Count Location



Not To Scale

Figure 2

Study Area Intersections



Reservoir Street

Reservoir Street is a two-lane local roadway under Town of Needham jurisdiction that traverses the study area in a general north-south orientation, between its northern and southern dead end termini. Reservoir Street provides a single approximate 12-foot lane of travel in each direction, with on-street parking allowed along the site frontage. North of Central Avenue Reservoir Street provides access to a number of residential homes, while south of Central Avenue land use along the corridor is primarily commercial in nature. Sidewalk is provided along the site frontage, but does not extend further south. Street lighting is provided by way of overhead street lights mounted on utility poles. The speed limit on Reservoir Street is not posted.

Intersections

Central Avenue at Reservoir Street

Reservoir Street intersects Central Avenue from the north and south to form a four-way intersection that operates under STOP-sign control. The Central Avenue eastbound and westbound approaches provide a single lane of travel, with a channelized right-turn lane provided for eastbound traffic turning right onto Reservoir Street. The northbound and southbound Reservoir Street approaches provide an approximate 20-foot wide approach, allowing right-turn traffic to bypass vehicles waiting to turn left onto Central Street. Both Reservoir Street approaches operate under STOP-sign control. Crosswalks are provided along the westbound, northbound, and southbound approaches to this intersection, with sidewalk provided along both sides of Central Avenue and a limited stretch of Reservoir Street along the Project site frontage. Land use in the vicinity of this intersection consists of a mix of commercial and residential uses.

EXISTING TRAFFIC VOLUMES

In order to determine existing traffic-volume demands and flow patterns within the study area, traffic counts were conducted along Central Avenue and Reservoir Street by way of an automatic traffic recorder (ATR) count in October 2022. Additionally, peak period turning movement counts were conducted at all study area locations between the hours of 7:00 and 9:00 AM, and 4:00 and 6:00 PM. These time periods represent the peak period of roadway and residential traffic. Based on a review of the collected data, the peak hours of roadway traffic occurred between 8:00 and 9:00 AM during the weekday morning, and between 4:45 and 5:45 PM during the weekday evening.

Seasonal Variation

In order to identify whether traffic volumes collected in October are representative of typical traffic conditions, seasonal adjustment data published by MassDOT were reviewed. Based on this data, October traffic volumes are higher than average month conditions and therefore represent a conservative analysis scenario.

Central Avenue, in the vicinity of the Project, was found to accommodate approximately 10,052 vehicles on an average weekday (24-hour, two-way volume), with approximately 998 vehicles per hour (vph) during the weekday morning peak hour and 1,089 vph during the weekday evening peak hour.

Reservoir Street, in the vicinity of the Project, was found to accommodate approximately 2,174 vehicles on an average weekday, with approximately 181 vph during the weekday morning peak hour and 307 vph during the weekday evening peak hour.

The 2022 Existing traffic volumes are summarized in Table 1, with the weekday morning and evening peak-hour traffic volumes graphically depicted on Figures 3.

Table 1
EXISTING ROADWAY TRAFFIC-VOLUME SUMMARY

Location	Daily Volume (vpd) ^a	Weekday Morning Peak Hour (8:00 – 9:00 AM)			Weekday Evening Peak Hour (4:40 – 5:40 PM)		
		Volume (vph) ^b	Percent of Daily Traffic ^c	Predominant Flow	Volume (vph)	Percent of Daily Traffic	Predominant Flow
Central Avenue, east of Reservoir Street	10,052	998	9.9	69% EB	1,089	10.8	55% WB
Reservoir Street, south of Central Avenue	2,174	181	8.3	79% SB	307	14.1	63% NB

Source: Automatic traffic recorder counts and manual turning movement counts conducted in October 2022.

^aTwo-way daily traffic expressed in vehicles per day.

^bManual turning movement counts conducted in October 2022.

^cThe percent of daily traffic that occurs during the peak hour.

EB = eastbound, WB = westbound, NB = northbound, SB = southbound

PEDESTRIAN AND BICYCLE FACILITIES

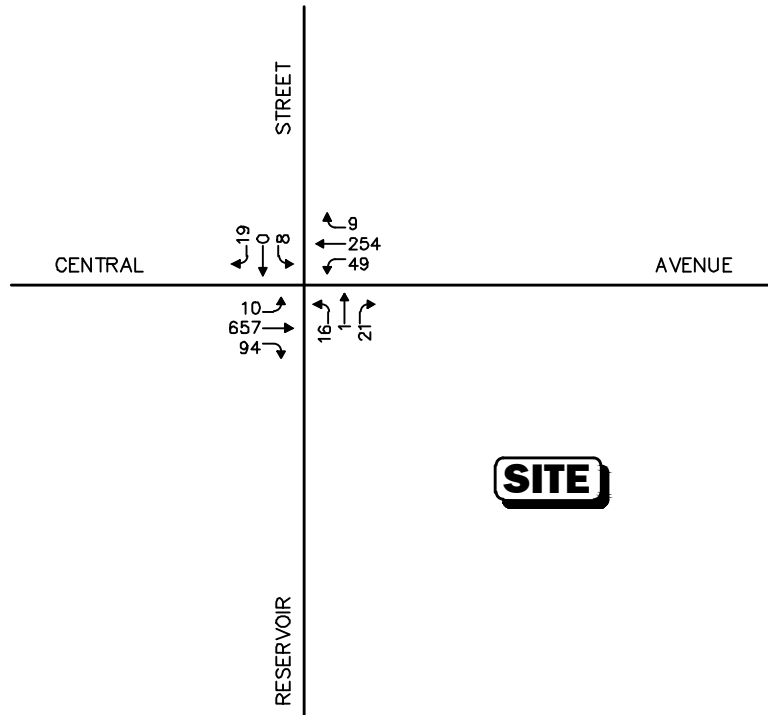
A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in October of 2022. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study area roadways and at the study area intersections. In general, sidewalk is currently provided continuously along Central Avenue, in the vicinity of the Project, with crosswalks provided at its intersection with Reservoir Street. Limited sidewalk is provided along the eastern side of Reservoir Street, south of Central Avenue along the site frontage. Formal bicycle accommodations are not currently provided within the study area.

PUBLIC TRANSPORTATION

The study area is served by public transportation services provide by the Massachusetts Bay Transit Authority (MBTA). Specifically, the study area is served by the following bus routes:

MBTA Bus Route 59 - Needham Junction via Needham Street – The MBTA Bus Route 59 travels between Watertown Square in Watertown and Needham Junction in Needham via Newton. The nearest stop to the Project Site is at the intersection of Central Avenue and Reservoir Street. Bus Route 59 runs seven days a week and during peak periods has a frequency of approximately 30-40 minutes. Bus Route 59 provides connections to the D Branch of the Green Line at Newton Highlands, to the Needham Line of the commuter rail at Needham Highlands, Needham Center, and Needham Junction, and to the Worcester Line of the MBTA Commuter Rail at Newtonville.

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR

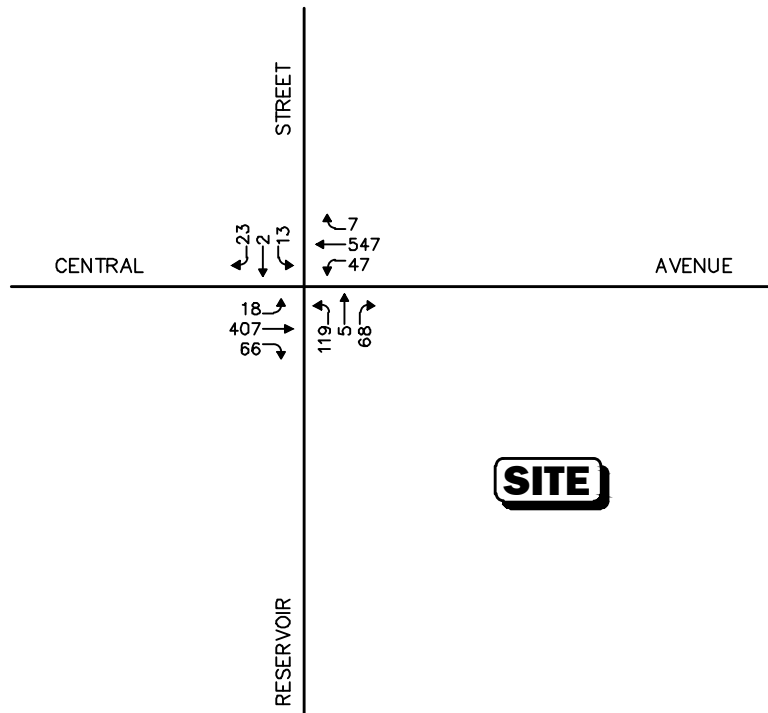


Figure 3

2022 Existing
Peak-Hour Traffic Volumes

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, and severity, and is presented in Table 2.

As summarized in Table 2, the intersection of Central Avenue with Reservoir Street experienced a total of seven (7) collisions over the five year review period, averaging 1.4 crashes per year. The majority of accidents involved property damage only, occurred on dry pavement, and involved angle collisions. Not fatalities were reported at this location. The motor vehicle crash rate for this location falls well below MassDOT's average crash rate for unsignalized intersections in this MassDOT District. No motor vehicle collisions were reported at the existing site driveway intersections with Central Avenue or Reservoir Street.

The Highway Safety Improvement Program (HSIP) database was also reviewed to identify whether any of the study area intersections are listed as HSIP-eligible clusters in the most recent (2017-2019) HSIP cluster listing. Based on this review, no study area intersections are identified as HSIP-eligible cluster locations.

SIGHT DISTANCE ANALYSIS

In order to ensure safe and efficient access will be provided to and from the Project site, a sight distance analysis was conducted for the proposed site driveways with Central Avenue and Reservoir Street. Specifically, available sight lines at the proposed driveway locations were compared to the sight distance requirements as defined by the American Association of State Highway and Transportation Officials (AASHTO).

As previously noted, the posted speed limit along Central Avenue is 25 miles per hour, with the speed limit on Reservoir Street unposted. In conjunction with the ATR data, vehicle speeds were recorded along both Central Avenue and Reservoir Street in order to identify prevailing travel speeds along the corridors. Specifically, the 85th percentile travel speeds, which are utilized for design purposes and are the basis for sight distance analyses were reviewed.

Based on the collected data, the 85th percentile travel speed on Central Avenue is 22 mph in the eastbound direction and 23 mph in the westbound direction. As these speeds are lower than the posted speed limit, the higher 25 mph travel speed was utilized. Along Reservoir Street the 85th percentile travel speeds were determined to be 27 mph in the northbound direction and 31 mph in the southbound direction, which were utilized for the sight distance analysis.

Based on these travel speeds, a minimum of 155 feet of sight distance is required to the east and west at the proposed Central Avenue driveway locations. Field measurements indicate that in excess of 450 feet of sight distance is available to and from the east, with in excess of 325 feet available to and from the west, well exceeding the AASHTO requirement.

At the proposed Reservoir Street site driveway location, a minimum of 210 feet of sight distance is required to and from the north, with a minimum of 175 feet of sight distance required to and from the south. Field measurements indicate that in excess of 275 feet of sight distance is provided to and from the north, exceeding the AASHTO design criteria. Sight lines to the south are currently obstructed due to overgrown vegetation at the southern end of the Project site. Following the removal of this vegetation in conjunction with the Project, in excess of 300 feet is available, exceeding the AASHTO requirements.

Table 2
MOTOR VEHICLE CRASH DATA SUMMARY^a

Scenario	Central Avenue at Reservoir Street
<i>Year:</i>	
2016	0
2017	2
2018	4
2019	1
<u>2020</u>	<u>0</u>
Total	7
Average ^b	1.4
Crash Rate ^c	0.31
Significant ^d	No
<i>Type:</i>	
Angle	5
Rear-End	1
Head-On	0
Sideswipe	0
Fixed Object	1
<u>Unknown/Other</u>	<u>0</u>
Total	7
<i>Day:</i>	
Weekday	5
Saturday	1
<u>Sunday</u>	<u>1</u>
Total	7
<i>Lighting Conditions:</i>	
Daylight	7
Dawn/Dusk	0
Dark (lit)	0
Dark (unlit)	0
<u>Unknown</u>	<u>0</u>
Total	7
<i>Pavement Conditions</i>	
Dry	7
Wet	0
Snow	0
Ice	0
<u>Unknown(Other)</u>	<u>0</u>
Total	7
<i>Severity:</i>	
Property Only	4
Injury Accident	1
Fatal Accident	0
<u>Unknown/Other</u>	<u>2</u>
Total	7

^aSource: MassDOT, 2016 through 2020

^bAverage crashes over five-year period.

^cCrash rate per million entering vehicles (mev).

^dUnsignalized intersections are significant if rate >0.57 crashes per million vehicles

^eSignalized intersections are significant if rate >0.73 crashes per million vehicles

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2029, which reflects a seven-year planning horizon consistent with State Traffic Study Guidelines. Independent of the Project, traffic volumes on the roadway network in the year 2029 under No-Build conditions include all existing traffic and new traffic resulting from background traffic growth. Anticipated Project-generated traffic volumes superimposed upon this 2029 No-Build traffic network reflect the 2029 Build 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, the drawback of this procedure is that the potential growth in population and development external to the study area would not be accounted for in the traffic projections.

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

Background Traffic Growth

In order to account for background growth in traffic, independent of any specific area development projects, a one percent annual compounded growth rate was applied to area traffic volumes over the seven year planning horizon. This growth rate is consistent with the background growth rate utilized for other recently conducted area traffic assessments.

Specific Developments by Others

In addition to the aforementioned background growth rate, traffic volumes associated with the following area development projects were identified based on consultation with the Town of Needham's Planning & Community Development Department, and have been incorporated into the analysis of future traffic conditions.

Highland Science Center - Needham, Massachusetts – The Highland Science Center redevelopment project entails the redevelopment of the former Muzi Ford and Chevrolet automobile dealership, service center and car wash, in order to accommodate approximately 496,694± sf of office, laboratory and research and development space, as well as limited retail and restaurant uses. Additional traffic associated with this project were determined based on a review of the traffic impact assessment¹ prepared for this project and have been included in the analysis of future traffic conditions.

No other developments were identified that are expected to result in an increase in traffic within the study area beyond the general background traffic growth rate.

ROADWAY IMPROVEMENT PROJECTS

The Town of Needham's Planning & Community Development Department was contacted to identify if any roadway or traffic signal improvement projects are proposed within the study area that would affect future traffic operations along the either the Central Avenue or Reservoir Street corridors. Based on these discussions, no improvements were identified outside of routing maintenance operations.

NO-BUILD TRAFFIC VOLUMES

The 2029 No-Build peak-hour traffic-volume networks were developed by applying the background growth rate to the 2022 Existing traffic volumes, as well as traffic associated with the aforementioned background development project. The resulting 2029 No-Build weekday morning and weekday evening peak-hour traffic volume networks are shown on Figure 4.

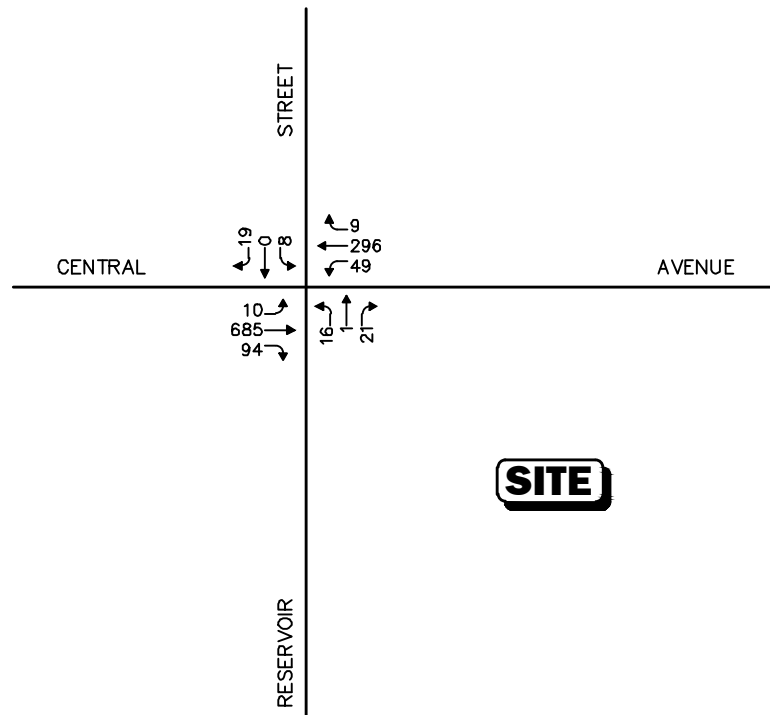
PROJECT-GENERATED TRAFFIC

The proposal entails the development of a multi-unit residential building that will provide a total of 15 apartment units, as well as approximately 2,542± sf of ground level commercial space. In order to develop the traffic characteristics of this proposal, trip-generation statistics published by the Institute of Transportation Engineers (ITE)² as part of the *Trip Generation* manual for LUC 220 – *Multifamily Housing (Low-Rise) Not Close to Rail Transit* were used. This land use code represent the most appropriate category for the proposed redevelopment of the site. Additionally, ITE data for LUC 822 – *Strip Retail Plaza* were utilized to develop the trip generation characteristics of the limited ancillary ground level commercial space. This land use code, which is new to the 11th edition of the manual, is intended for small commercial developments, and likely represents a conservative projection of trips

¹ *Transportation Impact and Access Study – Highland Innovation Center, 557 Highland Avenue, Needham, Massachusetts*; VHB, March 2022.

² *Trip Generation*, 11th Edition; Institute of Transportation Engineers; Washington, DC; September 2021.

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR

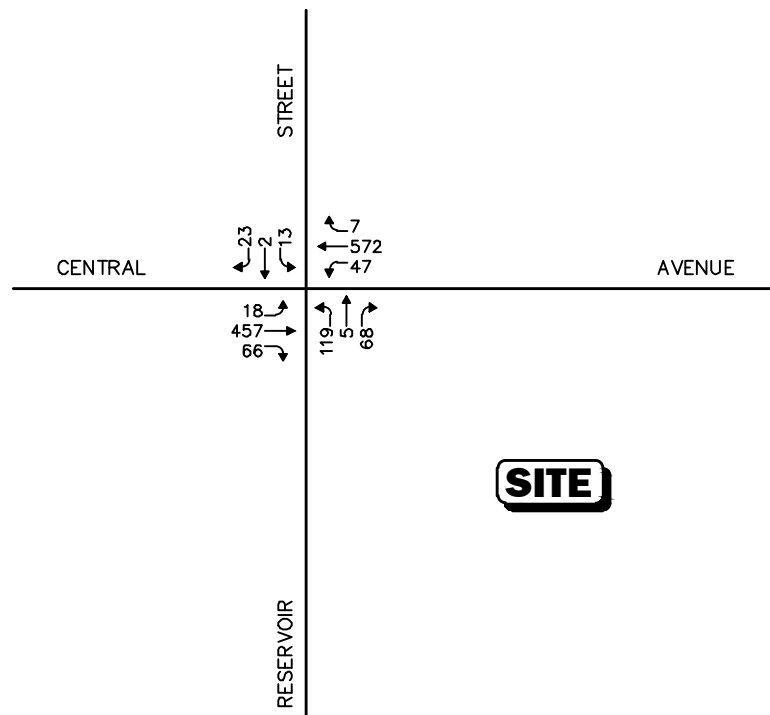


Figure 4

2029 No-Build
Peak-Hour Traffic Volumes

associated with the commercial space. Given the proximity of the Project site to surrounding residential and commercial uses, it is conservatively assumed that a modest 15 percent of traffic associated with this space will be non-auto in nature, including pedestrian, bicycle and public transit trips.

The trip generation projections are summarized in Table 3.

Table 3
TRIP GENERATION SUMMARY^a

Time Period/ Directional Distribution	Residential Trips	Commercial Trips	Total Trips
Weekday Daily	102	118	220
<i>Weekday Morning Peak Hour:</i>			
Entering	1	3	4
<u>Exiting</u>	<u>5</u>	<u>2</u>	<u>7</u>
Total	6	5	11
<i>Weekday Evening Peak Hour:</i>			
Entering	5	7	12
<u>Exiting</u>	<u>3</u>	<u>7</u>	<u>10</u>
Total	8	14	22

^aBased on ITE LUC 221 – Multifamily Housing (Mid-Rise) Not Close to Rail Transit, 15 units.

^bBased on ITE LUC 822 – Strip Retail Plaza, 2,542 sf, adjusted to reflect 15% non-auto trips.

As summarized in Table 3, the Project is expected to generate approximately 220 vehicle trips on a typical weekday (110 entering and 110 exiting), including 11 vehicle trips (4 entering and 7 exiting) during the weekday morning peak hour and 22 vehicle trips (12 entering and 10 exiting) during the weekday evening peak hour.

It is noted that these projections do not reflect the elimination of existing traffic activity arriving and departing the Project site under current conditions. The project currently houses Panella's Market and Deli, which based on field observations generates moderate traffic activity, particularly during lunch time hours. Additionally, approximately 5 employee vehicles were observed parked in the area that serves the second story office. It is also noted that the eastern portion of the Project site previously housed a use car sales lot. In total, these uses when operational, likely generated traffic that is similar to the proposed Project. However, in an effort to provide a conservative assessment of Project impacts, no reduction to area traffic was applied to account for the elimination of these existing and prior uses of the Project site.

TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution of the site-generated trips to and from the proposed development was determined based on a review of existing traffic patterns along the Central Avenue corridor and the anticipated arrival and distribution patterns for commuter traffic. In general, it is expected that 70 percent

of Project-related traffic will be oriented to and from Central Avenue, east of the site, with the remaining 30 percent oriented to and from Central Avenue, west of the site.

The general trip distribution for the project is summarized in Table 4. The weekday morning and weekday evening peak-hour traffic volumes expected to be generated by the Project were assigned on the study area roadway network based on these patterns, as shown on Figure 5.

Table 4
TRIP-DISTRIBUTION SUMMARY

Roadway	Direction (To/From)	Percentage (%)
Central Avenue	East	70%
Central Avenue	West	<u>30%</u>
TOTAL		100%

FUTURE TRAFFIC VOLUMES - BUILD CONDITION

The 2029 Build condition networks consist of the 2029 No-Build traffic volumes with the anticipated Project-generated traffic added to them. The 2029 Build weekday morning and weekday evening peak-hour traffic volume networks are graphically depicted on Figure 6.

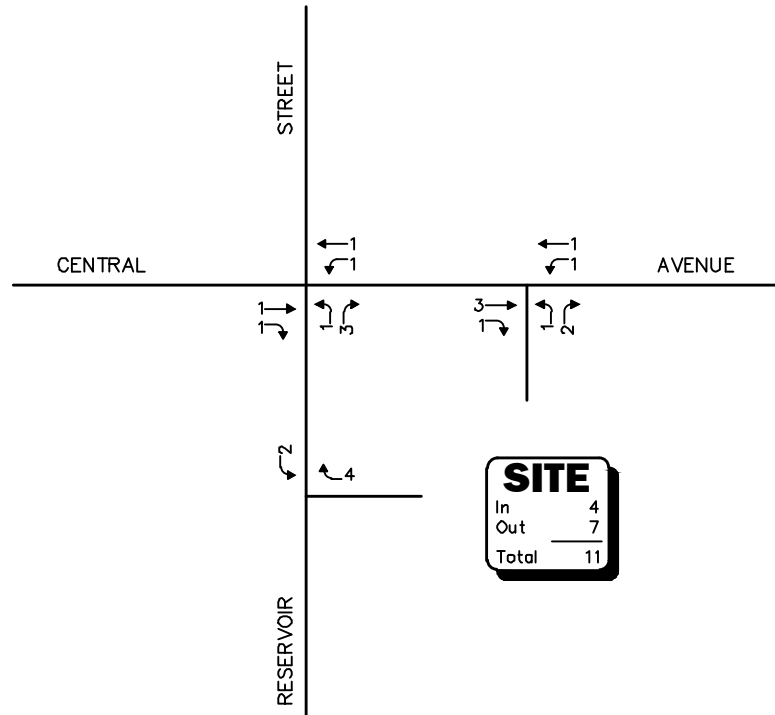
A summary of peak-hour projected traffic-volume increases external to the study area that is the subject of this assessment is shown in Table 5. These volumes are based on the expected increases from the Project.

Table 5
PEAK HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2029 No-Build	2029 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
<i>Central Avenue at Reservoir Street:</i>				
Weekday Morning	1,208	1,216	8	0.7
Weekday Evening	1,397	1,411	14	1.0

As summarized in Table 5, in comparison to future 2029 No-Build conditions, overall traffic volumes are expected to increase by approximately 0.7 to 1.0 percent at all off-site locations evaluated as part of this assessment, with overall volumes expected to increase by approximately 8 to 14 vehicles per hour, or approximately one new vehicle trip every 4 to 7 minutes. This level of traffic increase is unlikely to be notable to area motorists.

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR

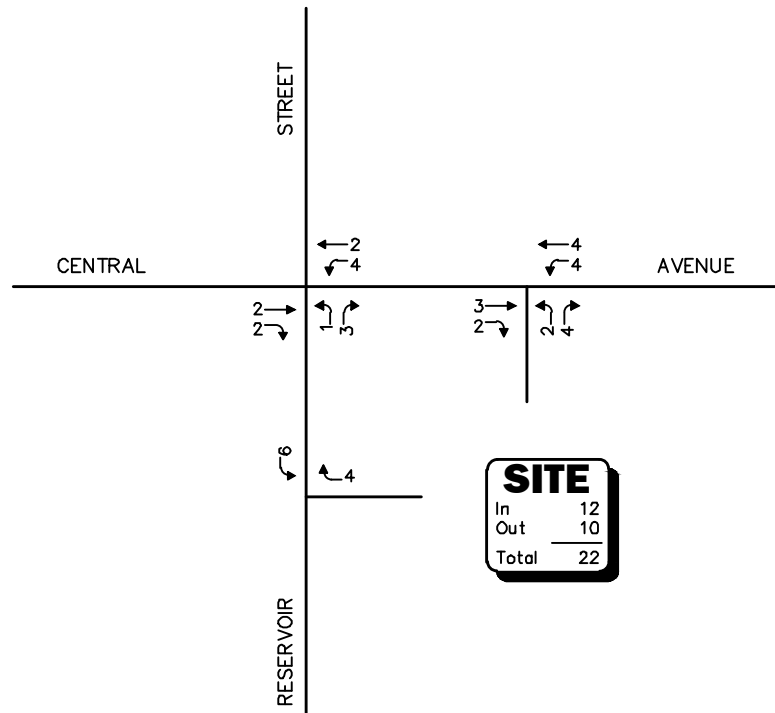
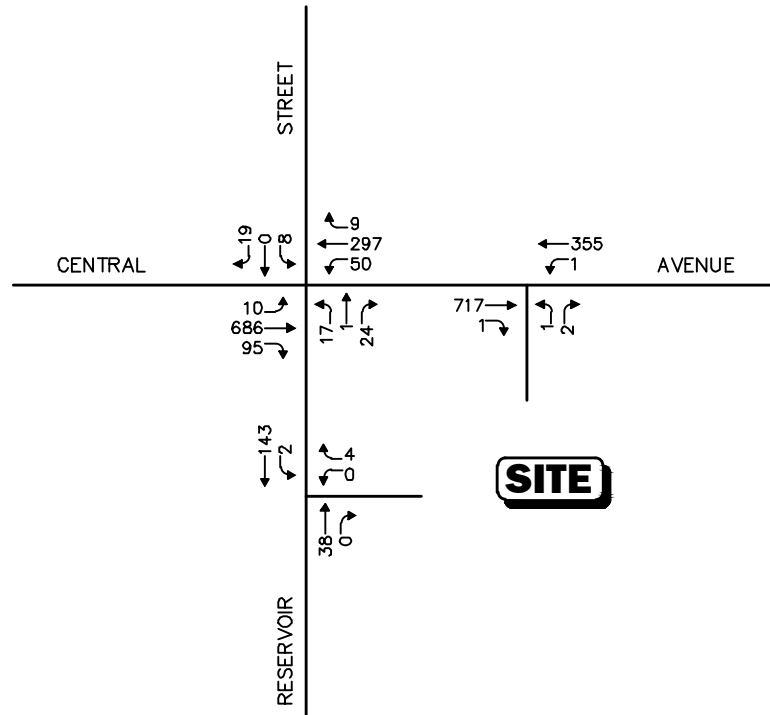


Figure 5

Project-Generated
Peak-Hour Traffic Volumes

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR

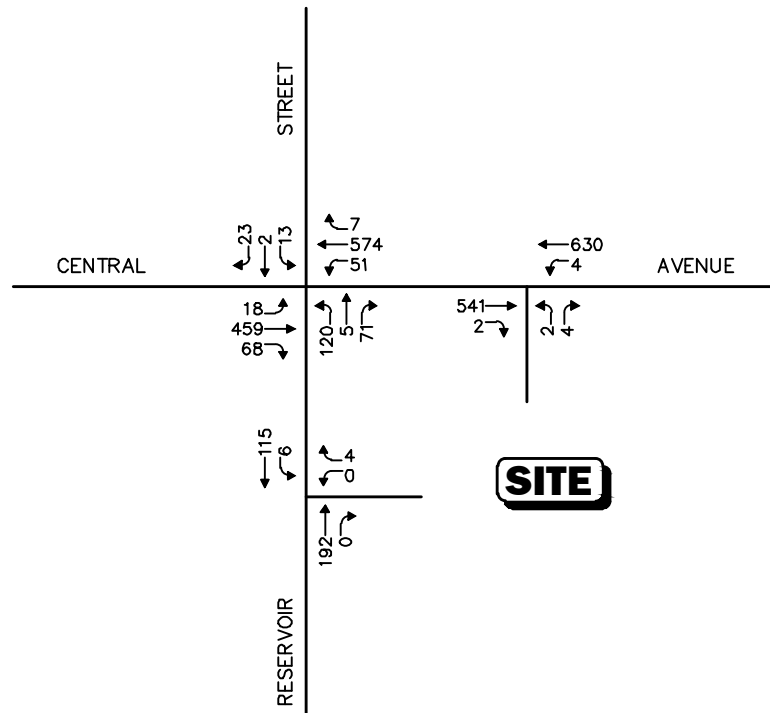


Figure 6

2029 Build
Peak-Hour Traffic Volumes

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.³ 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.

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.

³The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010.

- *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 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 2010 *Highway Capacity Manual*.⁴ 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 2010 *Highway Capacity Manual*. Table 6 summarizes the relationship between level of service and average control delay for two way stop controlled and all-way stop controlled intersections.

Table 6
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*; Transportation Research Board; Washington, DC; 2010; page 19-2.

ANALYSIS RESULTS

Level-of-service analyses were conducted for 2022 Existing, 2029 No-Build and 2029 Build conditions for the intersections within the study area. The results of the intersection capacity analyses for signalized and unsignalized intersections are summarized in Table 7, with detailed analysis results provided in the Appendix. The following is a summary of the level-of-service and delay analyses for the intersections within the study area:

⁴*Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010.

Table 7
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Location/Time Period/Movement	2022 Existing			2029 No-Build			2029 Build		
	V/C ^a	Delay ^b	LOS ^c	V/C	Delay	LOS	V/C	Delay	LOS
Central Avenue at Reservoir Street									
<i>Weekday Morning Peak Hour</i>									
Central Avenue EB	0.01	<5	A	0.01	<5	A	0.01	<5	A
Central Avenue WB	0.07	<5	A	0.07	<5	A	0.07	<5	A
Reservoir Street NB	0.13	21	C	0.14	23	C	0.15	23	C
Reservoir Street SB	0.07	17	C	0.08	18	C	0.09	18	C
<i>Weekday Evening Peak Hour</i>									
Central Avenue EB	0.02	<5	A	0.02	<5	A	0.02	<5	A
Central Avenue WB	0.05	<5	A	0.05	<5	A	0.06	<5	A
Reservoir Street NB	>1.2	>80	F	>1.2	>80	F	>1.2	>80	F
Reservoir Street SB	0.17	26	D	0.21	29	D	0.21	30	D
Central Avenue at Site Driveway									
<i>Weekday Morning Peak Hour</i>									
Central Avenue WB	--	--	--	--	--	--	0.00	<5	A
Site Driveway NB	--	--	--	--	--	--	0.01	17	C
<i>Weekday Evening Peak Hour</i>									
Central Avenue WB	--	--	--	--	--	--	0.00	<5	A
Site Driveway NB	--	--	--	--	--	--	0.02	17	C
Reservoir Street at Site Driveway									
<i>Weekday Morning Peak Hour</i>									
Site Driveway WB	--	--	--	--	--	--	0.00	9	A
Reservoir Street SB	--	--	--	--	--	--	0.04	<5	A
<i>Weekday Evening Peak Hour</i>									
Site Driveway WB	--	--	--	--	--	--	0.00	8	A
Reservoir Street SB	--	--	--	--	--	--	0.00	<5	A

^aVolume to capacity ratio.

^bDelay in seconds per vehicle.

^cLevel of service.

NB = northbound; SB = southbound; EB = eastbound; WB = westbound

Unsignalized Capacity Analysis Results

Central Avenue at Reservoir Street

Under 2022 Existing conditions, mainline traffic volumes along Central Avenue, at its intersection with Reservoir Street currently operate at LOS A conditions during both the weekday morning and weekday evening peak hours, with northbound movements from Reservoir Street operating at LOS C during the weekday morning peak hour and LOS F during the weekday evening peak hour. Under future 2029 No-Build conditions, mainline traffic volumes on Central Avenue are projected to continue to operate at LOS A, with northbound Reservoir Street continuing to operate at LOS C during the weekday morning and LOS F during the weekday evening peak hour. Under future 2029 Build conditions, mainline traffic volumes on Central Avenue are projected to continue to operate at LOS A, with northbound Reservoir Street continuing to operate at LOS C during the weekday morning peak hour and LOS F during the weekday evening peak hour.

It is noted that field observations indicate lower delays for northbound traffic than the capacity analysis model suggests. This is likely due to motorists exiting the commercial side of Reservoir Street being familiar with area traffic patterns and utilizing smaller gaps in traffic than the model assumes. It is noted that during periods where longer delays on Reservoir Street occur, exiting motorist may use the Central Avenue driveway as a means to exit the site.

Central Avenue at Site Driveway

Under 2029 Build conditions, mainline traffic volumes along Central Avenue, at the proposed site driveway location, are projected to operate at LOS A during both peak periods, with the site driveway operating at LOS C, with minimal vehicular queueing.

Reservoir Street at Site Driveway

Under 2029 Build conditions, mainline traffic volumes along Reservoir Street, at the proposed site driveway location, are projected to operate at LOS A during both peak periods, with the site driveway operating at LOS A, with minimal vehicular queueing.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

As documented in this assessment:

- Project-related traffic increases are expected to amount to 11 new vehicle trips (4 entering and 7 exiting) during the weekday morning peak hour and 22 new vehicle trips (12 entering and 10 exiting) during the weekday evening peak hour;
- No notable safety deficiencies were identified within the study area, with all study area intersections exhibiting motor vehicle crash rates below the MassDOT state average, and available sight lines exceeding the minimum requirements to ensure safe access to and from the Project;
- In comparison to future No-Build traffic volumes, Project-related traffic increases amount to an increase in peak hour traffic volumes of approximately 0.7 to 1.0 percent;
- Project-related traffic conditions are expected to amount to only minor increases to delays as compared to future No-Build conditions.

The following recommendations are provided to ensure safe and efficient access to the Project.

RECOMMENDATIONS

Site Access

Access to the Project site is proposed via new curb cuts on the southern side of Central Avenue and eastern side of Reservoir Street. The proposed driveways will provide a single entering and exiting lane of travel. It is recommended that the proposed driveways be placed under STOP-sign control, with a painted STOP bar at the driveway approaches to Central Avenue and Reservoir Street. In order to ensure safe and efficient access to the Project and that adequate sightlines are provided in both directions, all signs and landscaping should be designed as to not impede lines of sight in both directions. Additionally, existing vegetation that currently limits sight lines to the south from the Reservoir Street driveway location should be removed and regularly maintained to ensure adequate sight lines are maintained to and from the south.

Transportation Demand Management

In order to minimize the number of single occupancy vehicles (SOVs) arriving and departing the Project, and to take advantage of transit, bicycle and pedestrian facilities that are available to residents of the Project, the proponent is committed to implementing a comprehensive Transportation Demand Management (TDM) Plan. Elements of the plan include the following measures:

- ***Orientation Packets:*** Prior to move in activities, the Proponent will provide orientation packets to new residents and tenants containing information on site access and circulation; and available transportation choices, including transit routes/schedules and nearby vehicle sharing locations and bicycle facilities.
- ***Bicycle Accommodation:*** The Proponent will provide interior and exterior bicycle storage in secure sheltered areas for residents and visitors of the Project.

CONCLUSION

In summary, the addition of Project-related traffic to study area roadways and intersections is not anticipated to significantly impact traffic operations within the study area over No-Build conditions. As documented in this report, Project-related traffic increases do not result in significant impact to area traffic operations, with only minimal increases to motorist delays projected along the Central Avenue and Reservoir Street corridors. With implementation of the above recommendations, the proposed Project can be built with minimal traffic impact on the surrounding roadway system.

APPENDIX

TRAFFIC COUNT DATA
MOTOR VEHICLE CRASH DATA
BACKGROUND DEVELOPMENT PROJECTS
TRIP GENERATION DATA
CAPACITY ANALYSIS RESULTS

TRAFFIC COUNT DATA

Accurate Counts
978-664-2565

Location : Central Avenue
Location : East of Reservoir Street
City/State: Needham, MA
Direction: EB,

95140002

10/25/2022	0 - 3	> 3 - 6	> 6 - 9	> 9 - 12	> 12 - 15	> 15 - 18	> 18 - 21	> 21 - 24	> 24 - 27	> 27 - 30	> 30 - 33	> 33 - 36	> 36 - 39	> 39	Total
Time	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	
12:00 AM	0	0	0	0	2	3	4	5	0	0	0	0	0	0	14
1:00	0	0	0	0	1	0	4	1	1	0	0	0	0	0	7
2:00	0	0	0	0	1	1	1	0	1	0	0	0	0	0	4
3:00	0	0	0	0	2	0	0	3	0	0	0	0	0	0	5
4:00	0	0	0	0	3	1	3	7	1	1	1	0	0	0	17
5:00	0	0	0	0	0	12	27	17	5	0	0	0	0	0	61
6:00	0	0	0	6	35	53	83	52	15	1	1	0	0	0	246
7:00	0	0	5	21	139	145	119	42	8	4	0	0	0	1	484
8:00	0	0	66	84	107	90	120	19	15	2	1	0	0	0	504
9:00	0	0	4	17	102	123	111	32	10	1	2	0	0	0	402
10:00	0	0	2	10	55	79	63	13	8	7	4	0	0	0	241
11:00	0	0	3	9	55	72	84	15	11	6	3	1	1	0	260
12:00 PM	0	0	1	13	48	79	74	20	4	4	1	0	0	1	245
1:00	0	0	0	7	28	57	99	34	6	7	3	1	0	0	242
2:00	0	0	1	9	61	56	105	31	14	9	3	1	0	0	290
3:00	0	0	9	14	53	77	72	41	15	10	6	7	1	2	307
4:00	0	0	4	5	46	77	106	52	21	6	9	6	1	0	333
5:00	0	0	5	10	49	77	127	40	19	17	3	5	3	0	355
6:00	0	0	1	6	48	83	131	32	15	12	4	4	1	0	337
7:00	0	0	0	4	26	53	56	29	8	2	2	0	1	0	181
8:00	0	0	0	2	17	34	49	17	5	0	0	0	0	0	124
9:00	0	0	0	2	15	24	31	9	3	1	0	0	0	0	85
10:00	0	0	2	1	6	8	8	0	1	0	1	0	0	0	27
11:00	0	0	0	0	1	1	1	2	0	0	0	0	0	0	5
Total	0	0	103	220	900	1205	1478	513	186	90	44	25	8	4	4776
Percentile															
Speed				15th	50th	85th	95th								
				14	17	21	25								
Mean Speed (Average)				18.0											
10 MPH Pace Speed				12-21											
Number in Pace				3744											
Percent in Pace				78.4%											
Number > 21 MPH				870											
Percent > 21 MPH				18.2%											
Grand Total	0	0	103	220	900	1205	1478	513	186	90	44	25	8	4	4776
Stats															
Percentile				15th	50th	85th	95th								
Speed				14	18	22	26								
Mean Speed (Average)				18.4											
10 MPH Pace Speed				12-21											
Number in Pace				3744											
Percent in Pace				78.4%											
Number > 21 MPH				2450											
Percent > 21 MPH				24.5%											

Accurate Counts
978-664-2565

Location : Central Avenue
Location : East of Reservoir Street
City/State: Needham, MA
Direction: WB,

95140002

10/25/2022	0 - 3	> 3 - 6	> 6 - 9	> 9 - 12	> 12 - 15	> 15 - 18	> 18 - 21	> 21 - 24	> 24 - 27	> 27 - 30	> 30 - 33	> 33 - 36	> 36 - 39	> 39	Total
Time	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	
12:00 AM	0	0	0	0	2	2	3	2	3	0	1	1	0	0	14
1:00	0	0	0	0	0	0	2	3	1	0	0	0	0	0	6
2:00	0	0	0	0	0	1	1	0	1	0	0	0	0	0	3
3:00	0	0	0	0	0	0	1	1	3	0	0	0	0	0	5
4:00	0	0	0	0	0	2	3	0	4	0	0	0	0	0	9
5:00	0	0	0	1	2	2	3	4	2	3	0	0	1	0	18
6:00	0	0	4	3	19	24	23	24	10	1	1	0	0	0	109
7:00	0	0	6	10	32	42	60	33	15	3	1	1	0	0	203
8:00	0	0	12	11	42	44	65	40	19	6	2	2	0	0	243
9:00	0	0	7	24	46	55	79	42	27	3	1	0	0	0	284
10:00	0	0	3	2	43	60	61	39	16	6	3	0	0	0	233
11:00	0	0	5	12	56	78	84	50	20	13	2	1	0	0	321
12:00 PM	0	0	4	18	49	69	74	68	31	17	3	0	0	0	333
1:00	0	0	10	16	42	72	102	67	37	8	1	2	0	0	357
2:00	0	0	7	20	76	88	130	63	28	7	2	1	0	0	422
3:00	0	0	10	28	84	114	158	101	32	4	2	2	0	0	535
4:00	0	0	11	25	70	102	158	107	40	16	4	0	0	0	533
5:00	0	0	17	28	79	111	184	113	30	15	1	3	0	0	581
6:00	0	0	12	19	55	93	109	75	41	12	2	1	0	0	419
7:00	0	0	4	8	13	35	68	56	37	14	7	1	0	0	243
8:00	0	0	1	13	20	26	46	30	18	9	0	0	0	0	163
9:00	0	0	0	6	17	36	47	20	7	4	0	0	0	0	137
10:00	0	0	0	2	5	10	21	9	10	2	1	1	0	0	61
11:00	0	0	0	0	1	0	3	6	1	0	0	0	0	0	11
Total	0	0	113	246	753	1066	1485	953	433	143	34	16	1	0	5243
Percentile															
Speed				15th	50th	85th	95th								
Mean Speed (Average)				14	19	23	26								
10 MPH Pace Speed				18.8											
Number in Pace				14-23											
Percent in Pace				3748											
Number > 21 MPH				71.5%											
Percent > 21 MPH				1580											
				30.1%											
Grand Total	0	0	113	246	753	1066	1485	953	433	143	34	16	1	0	5243
Stats															
Percentile				15th	50th	85th	95th								
Speed				14	19	23	26								
Mean Speed (Average)				18.8											
10 MPH Pace Speed				14-23											
Number in Pace				3748											
Percent in Pace				71.5%											
Number > 21 MPH				1580											
Percent > 21 MPH				30.1%											

Accurate Counts
978-664-2565

Location : Central Avenue
Location : East of Reservoir Street
City/State: Needham, MA

95140002

10/25/2022		EB,		Hour Totals		WB,		Hour Totals		Combined Totals	
Time	Morning	Afternoon		Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00		1	59			5	75				
12:15		3	53			5	81				
12:30		5	51			2	85				
12:45		5	82	14	245	2	92	14	333	28	578
1:00		2	71			4	75				
1:15		0	50			1	92				
1:30		3	63			1	92				
1:45		2	58	7	242	0	98	6	357	13	599
2:00		2	71			1	96				
2:15		1	78			1	104				
2:30		0	60			0	124				
2:45		1	81	4	290	1	98	3	422	7	712
3:00		0	67			0	130				
3:15		0	87			0	126				
3:30		2	66			2	136				
3:45		3	87	5	307	3	143	5	535	10	842
4:00		2	72			1	127				
4:15		2	83			0	140				
4:30		8	79			3	128				
4:45		5	99	17	333	5	138	9	533	26	866
5:00		10	92			1	148				
5:15		7	91			6	154				
5:30		25	93			4	147				
5:45		19	79	61	355	7	132	18	581	79	936
6:00		32	99			10	115				
6:15		46	86			32	118				
6:30		71	76			25	91				
6:45		97	76	246	337	42	95	109	419	355	756
7:00		129	69			44	66				
7:15		141	40			52	56				
7:30		112	35			50	64				
7:45		102	37	484	181	57	57	203	243	687	424
8:00		132	42			51	47				
8:15		129	19			65	49				
8:30		120	33			49	37				
8:45		123	30	504	124	78	30	243	163	747	287
9:00		100	42			87	45				
9:15		119	19			61	34				
9:30		87	15			70	32				
9:45		96	9	402	85	66	26	284	137	686	222
10:00		69	12			52	11				
10:15		72	6			57	22				
10:30		54	4			58	20				
10:45		46	5	241	27	66	8	233	61	474	88
11:00		69	5			80	11				
11:15		62	1			85	13				
11:30		65	2			72	11				
11:45		64	3	260	11	84	3	321	38	581	49
Total	2245	2537				1448	3822			3693	6359
Percent	46.9%	53.1%				27.5%	72.5%			36.7%	63.3%
Grand Total	2245	2537				1448	3822			3693	6359
Percent	46.9%	53.1%				27.5%	72.5%			36.7%	63.3%

ADT

ADT: 10,052

AADT: 10,052

Accurate Counts
978-664-2565

Location : Central Avenue
Location : East of Reservoir Street
City/State: Needham, MA

95140002

10/25/2022	EB,	WB,	
Time			Total
12:00 AM	14	14	28
1:00	7	6	13
2:00	4	3	7
3:00	5	5	10
4:00	17	9	26
5:00	61	18	79
6:00	246	109	355
7:00	484	203	687
8:00	504	243	747
9:00	402	284	686
10:00	241	233	474
11:00	260	321	581
12:00 PM	245	333	578
1:00	242	357	599
2:00	290	422	712
3:00	307	535	842
4:00	333	533	866
5:00	355	581	936
6:00	337	419	756
7:00	181	243	424
8:00	124	163	287
9:00	85	137	222
10:00	27	61	88
11:00	5	11	16
Total	4776	5243	10019
Percent	47.7%	52.3%	
AM Peak	8:00	11:00	8:00
Volume	504	321	747
PM Peak	5:00	5:00	5:00
Volume	355	581	936
Grand Total	4776	5243	10019
Percent	47.7%	52.3%	
ADT		ADT: 10,052	AADT: 10,052

Accurate Counts
978-664-2565

Location : Reservoir Street
Location : South of Central Avenue
City/State: Needham, MA
Direction: NB,

95140001

10/18/2022	0 - 3	> 3 - 6	> 6 - 9	> 9 - 12	> 12 - 15	> 15 - 18	> 18 - 21	> 21 - 24	> 24 - 27	> 27 - 30	> 30 - 33	> 33 - 36	> 36 - 39	> 39	Total
Time	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	Total
12:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:00	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7
2:00	0	0	0	1	0	0	1	1	0	0	0	0	0	0	3
3:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
6:00	0	0	0	1	1	4	3	0	1	2	1	0	0	0	13
7:00	0	0	1	0	3	2	4	8	4	3	2	0	0	0	27
8:00	0	0	0	1	2	4	5	12	10	1	2	0	0	0	37
9:00	0	0	1	2	6	7	5	8	11	5	2	0	0	0	47
10:00	0	0	0	0	2	6	3	10	6	0	0	1	0	0	28
11:00	0	0	2	4	11	6	6	6	8	2	2	0	1	0	48
12:00 PM	0	0	6	14	8	19	15	14	13	4	1	1	0	1	96
1:00	0	0	2	8	9	10	8	11	10	5	1	0	0	0	64
2:00	0	0	1	4	11	13	10	14	8	9	3	1	0	0	74
3:00	0	0	1	4	8	15	11	29	15	11	8	0	0	0	102
4:00	0	0	1	4	15	17	13	26	23	9	1	1	0	0	110
5:00	0	0	3	6	23	25	26	21	31	6	1	1	0	0	143
6:00	0	0	2	6	8	11	9	16	12	4	3	0	0	0	71
7:00	0	0	1	0	6	4	9	25	19	6	2	0	0	0	72
8:00	0	0	1	0	0	3	1	9	2	3	1	4	0	0	24
9:00	0	0	0	0	2	7	14	14	11	3	0	1	0	0	52
10:00	0	0	0	0	0	0	1	0	1	2	0	0	0	0	4
11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	29	55	115	153	144	226	185	75	30	10	1	1	1024
Percentile				15th	50th	85th	95th								
Speed				14	22	27	30								
Mean Speed (Average)				20.6											
10 MPH Pace Speed				17-26											
Number in Pace				605											
Percent in Pace				59.1%											
Number > 24 MPH				302											
Percent > 24 MPH				29.5%											
Grand Total	0	0	29	55	115	153	144	226	185	75	30	10	1	1	1024
Stats				Percentile	15th	50th	85th	95th							
				Speed	14	22	27	30							
Mean Speed (Average)				20.6											
10 MPH Pace Speed				17-26											
Number in Pace				605											
Percent in Pace				59.1%											
Number > 24 MPH				302											
Percent > 24 MPH				29.5%											

Accurate Counts
978-664-2565

Location : Reservoir Street
Location : South of Central Avenue
City/State: Needham, MA
Direction: SB,

95140001

10/18/2022	0 - 3	> 3 - 6	> 6 - 9	> 9 - 12	> 12 - 15	> 15 - 18	> 18 - 21	> 21 - 24	> 24 - 27	> 27 - 30	> 30 - 33	> 33 - 36	> 36 - 39	> 39	Total
Time	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	Total
12:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2:00	0	0	0	0	0	0	0	1	3	0	0	0	0	0	4
3:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2
5:00	0	0	1	0	0	3	2	1	2	2	1	0	0	0	12
6:00	0	0	0	1	0	2	1	4	6	8	6	2	1	0	31
7:00	0	0	0	0	0	8	6	12	11	15	7	7	1	0	67
8:00	0	0	0	2	3	17	17	10	28	22	17	8	0	0	124
9:00	0	0	0	1	5	11	10	13	24	20	13	10	2	2	111
10:00	0	0	0	2	3	9	18	11	15	5	2	2	0	0	67
11:00	0	0	0	4	11	13	13	10	7	8	10	0	1	1	78
12:00 PM	0	0	0	2	16	15	19	7	9	13	3	0	0	0	84
1:00	0	0	1	3	10	9	8	9	13	8	7	2	0	0	70
2:00	0	0	0	2	9	10	12	9	12	10	8	3	0	0	75
3:00	0	0	1	1	12	13	14	17	16	13	16	6	2	0	111
4:00	0	0	0	2	7	9	13	13	11	10	9	3	2	0	79
5:00	0	0	0	0	9	9	5	17	17	20	14	8	2	1	102
6:00	0	0	0	1	3	1	3	6	15	20	11	4	0	0	64
7:00	0	0	0	0	0	1	1	2	5	10	6	2	1	0	28
8:00	0	0	0	0	0	0	2	1	9	9	3	1	0	0	25
9:00	0	0	0	0	0	0	1	0	6	4	2	0	0	0	13
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	3	21	88	130	145	143	210	197	135	58	13	4	1147
Percentile				15th	50th	85th	95th								
Speed				17	25	31	34								
Mean Speed (Average)				24.4											
10 MPH Pace Speed				20-29											
Number in Pace				597											
Percent in Pace				52.0%											
Number > 24 MPH				617											
Percent > 24 MPH				53.8%											
Grand Total	0	0	3	21	88	130	145	143	210	197	135	58	13	4	1147
Stats				Percentile	15th	50th	85th	95th							
				Speed	17	25	31	34							
Mean Speed (Average)				24.4											
10 MPH Pace Speed				20-29											
Number in Pace				597											
Percent in Pace				52.0%											
Number > 24 MPH				617											
Percent > 24 MPH				53.8%											

Accurate Counts
978-664-2565

Location : Reservoir Street
Location : South of Central Avenue
City/State: Needham, MA

95140001

10/18/2022		NB,		Hour Totals		SB,		Hour Totals		Combined Totals	
Time	Morning	Afternoon		Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00	0	24				0	19				
12:15	0	24				0	20				
12:30	0	16				0	26				
12:45	0	32	0	96	0	19	0	84	0	180	
1:00	7	14				0	12				
1:15	0	19				0	20				
1:30	0	16				0	22				
1:45	0	15	7	64	0	16	0	70	7	134	
2:00	0	18				3	16				
2:15	2	18				0	18				
2:30	0	20				0	17				
2:45	1	18	3	74	1	24	4	75	7	149	
3:00	0	23				0	20				
3:15	0	12				0	14				
3:30	0	20				0	26				
3:45	0	47	0	102	0	51	0	111	0	213	
4:00	0	38				0	21				
4:15	0	20				0	22				
4:30	0	28				0	10				
4:45	0	24	0	110	2	26	2	79	2	189	
5:00	0	48				1	20				
5:15	0	33				0	44				
5:30	2	43				6	23				
5:45	0	19	2	143	5	15	12	102	14	245	
6:00	1	19				4	12				
6:15	1	18				8	9				
6:30	4	14				9	9				
6:45	7	20	13	71	10	34	31	64	44	135	
7:00	11	45				17	16				
7:15	2	11				12	6				
7:30	4	7				17	2				
7:45	10	9	27	72	21	4	67	28	94	100	
8:00	9	4				29	1				
8:15	8	5				21	8				
8:30	10	12				27	5				
8:45	10	3	37	24	47	11	124	25	161	49	
9:00	23	39				43	9				
9:15	11	3				19	3				
9:30	3	9				27	0				
9:45	10	1	47	52	22	1	111	13	158	65	
10:00	10	3				18	0				
10:15	7	1				16	0				
10:30	5	0				17	0				
10:45	6	0	28	4	16	0	67	0	95	4	
11:00	20	0				20	0				
11:15	11	0				22	0				
11:30	14	2				20	1				
11:45	3	0	48	2	16	0	78	1	126	3	
Total	212	814				496	652			708	1466
Percent	20.7%	79.3%				43.2%	56.8%			32.6%	67.4%
Grand Total	212	814				496	652			708	1466
Percent	20.7%	79.3%				43.2%	56.8%			32.6%	67.4%
ADT		ADT: 2,174		AADT: 2,174							

Accurate Counts
978-664-2565

Location : Reservoir Street
Location : South of Central Avenue
City/State: Needham, MA

95140001

10/18/2022	NB,	SB,	
Time			Total
12:00 AM	0	0	0
1:00	7	0	7
2:00	3	4	7
3:00	0	0	0
4:00	0	2	2
5:00	2	12	14
6:00	13	31	44
7:00	27	67	94
8:00	37	124	161
9:00	47	111	158
10:00	28	67	95
11:00	48	78	126
12:00 PM	96	84	180
1:00	64	70	134
2:00	74	75	149
3:00	102	111	213
4:00	110	79	189
5:00	143	102	245
6:00	71	64	135
7:00	72	28	100
8:00	24	25	49
9:00	52	13	65
10:00	4	0	4
11:00	0	0	0
Total	1024	1147	2171
Percent	47.2%	52.8%	
AM Peak	11:00	8:00	8:00
Volume	48	124	161
PM Peak	5:00	3:00	5:00
Volume	143	111	245
Grand Total	1024	1147	2171
Percent	47.2%	52.8%	
ADT		ADT: 2,174	AADT: 2,174

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 1

Groups Printed- Cars - Trucks

	Reservoir St From North			Central Ave From East			Reservoir St From South			Central Ave From West			Int. Total
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
07:00 AM	3	0	5	10	39	1	4	0	7	2	150	7	228
07:15 AM	2	0	2	6	49	1	1	0	2	4	192	7	266
07:30 AM	4	0	4	5	40	1	1	0	2	5	186	14	262
07:45 AM	0	0	6	9	63	2	4	0	3	5	162	11	265
Total	9	0	17	30	191	5	10	0	14	16	690	39	1021
08:00 AM	1	0	4	9	63	3	4	0	6	3	145	24	262
08:15 AM	3	0	5	14	69	2	4	0	3	2	193	13	308
08:30 AM	1	0	4	9	69	3	4	0	5	2	159	21	277
08:45 AM	3	0	6	17	53	1	4	1	7	3	160	36	291
Total	8	0	19	49	254	9	16	1	21	10	657	94	1138
Grand Total	17	0	36	79	445	14	26	1	35	26	1347	133	2159
Apprch %	32.1	0	67.9	14.7	82.7	2.6	41.9	1.6	56.5	1.7	89.4	8.8	
Total %	0.8	0	1.7	3.7	20.6	0.6	1.2	0	1.6	1.2	62.4	6.2	
Cars	17	0	35	78	437	14	26	1	34	25	1332	132	2131
% Cars	100	0	97.2	98.7	98.2	100	100	100	97.1	96.2	98.9	99.2	98.7
Trucks	0	0	1	1	8	0	0	0	1	1	15	1	28
% Trucks	0	0	2.8	1.3	1.8	0	0	0	2.9	3.8	1.1	0.8	1.3

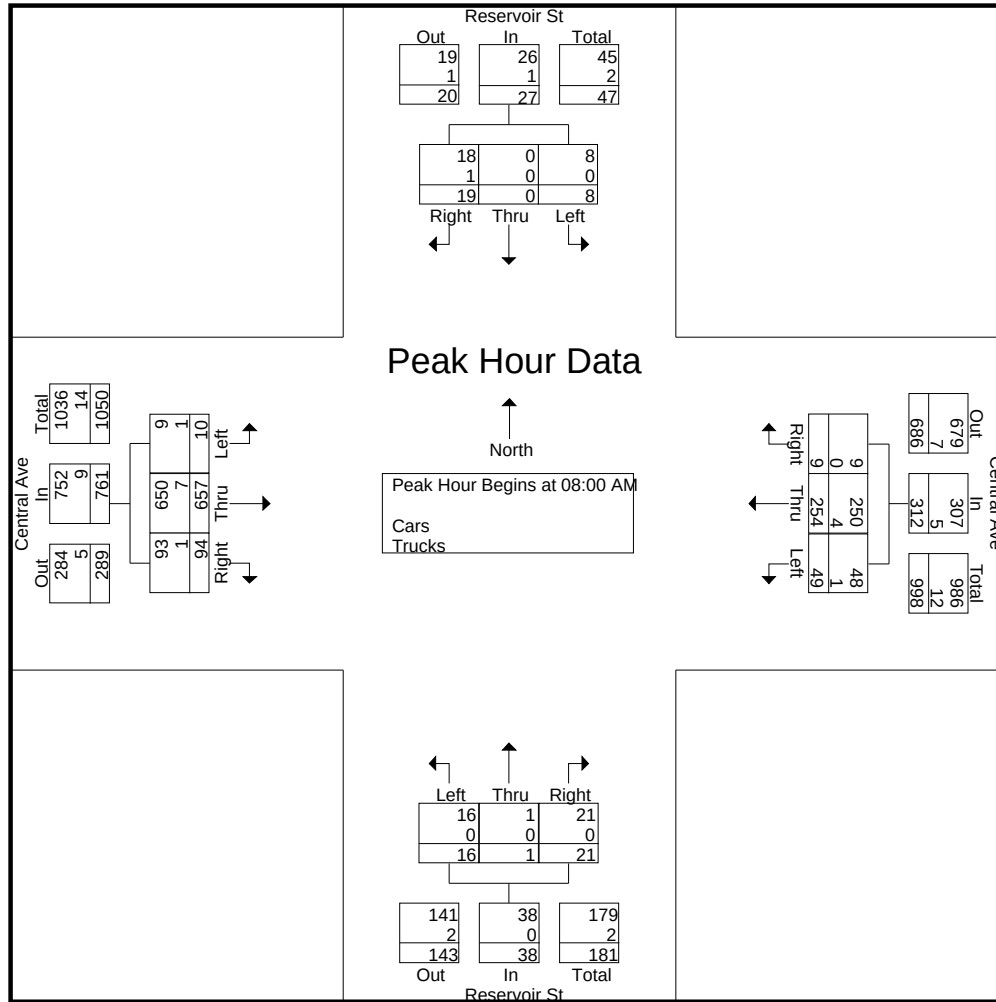
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 08:00 AM																	
08:00 AM	1	0	4	5	9	63	3	75	4	0	6	10	3	145	24	172	262
08:15 AM	3	0	5	8	14	69	2	85	4	0	3	7	2	193	13	208	308
08:30 AM	1	0	4	5	9	69	3	81	4	0	5	9	2	159	21	182	277
08:45 AM	3	0	6	9	17	53	1	71	4	1	7	12	3	160	36	199	291
Total Volume	8	0	19	27	49	254	9	312	16	1	21	38	10	657	94	761	1138
% App. Total	29.6	0	70.4		15.7	81.4	2.9		42.1	2.6	55.3		1.3	86.3	12.4		
PHF	.667	.000	.792	.750	.721	.920	.750	.918	1.00	.250	.750	.792	.833	.851	.653	.915	.924
Cars	8	0	18	26	48	250	9	307	16	1	21	38	9	650	93	752	1123
% Cars	100	0	94.7	96.3	98.0	98.4	100	98.4	100	100	100	100	90.0	98.9	98.9	98.8	98.7
Trucks	0	0	1	1	1	4	0	5	0	0	0	0	1	7	1	9	15
% Trucks	0	0	5.3	3.7	2.0	1.6	0	1.6	0	0	0	0	10.0	1.1	1.1	1.2	1.3

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 2

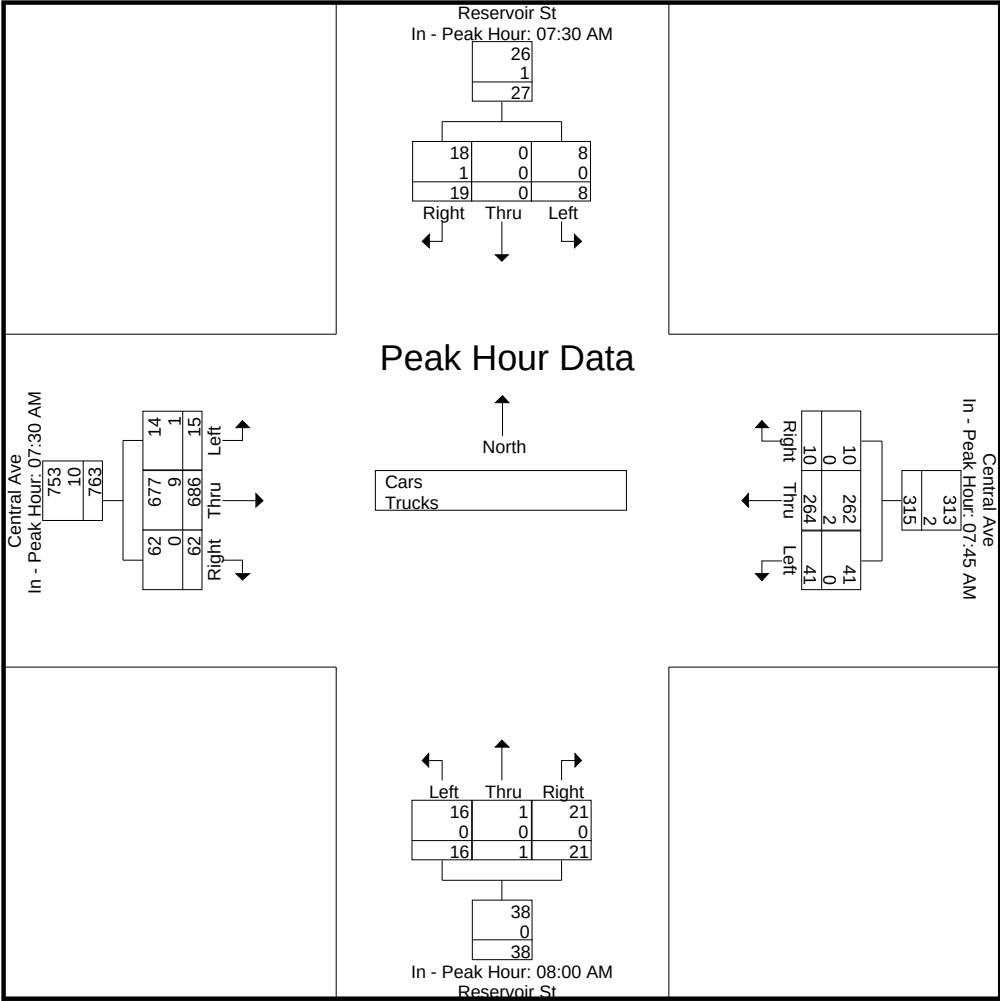


Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	07:30 AM				07:45 AM				08:00 AM				07:30 AM			
+0 mins.	4	0	4	8	9	63	2	74	4	0	6	10	5	186	14	205
+15 mins.	0	0	6	6	9	63	3	75	4	0	3	7	5	162	11	178
+30 mins.	1	0	4	5	14	69	2	85	4	0	5	9	3	145	24	172
+45 mins.	3	0	5	8	9	69	3	81	4	1	7	12	2	193	13	208
Total Volume	8	0	19	27	41	264	10	315	16	1	21	38	15	686	62	763
% App. Total	29.6	0	70.4		13	83.8	3.2		42.1	2.6	55.3		2	89.9	8.1	
PHF	.500	.000	.792	.844	.732	.957	.833	.926	1.000	.250	.750	.792	.750	.889	.646	.917
Cars	8	0	18	26	41	262	10	313	16	1	21	38	14	677	62	753
% Cars	100	0	94.7	96.3	100	99.2	100	99.4	100	100	100	100	93.3	98.7	100	98.7
Trucks	0	0	1	1	0	2	0	2	0	0	0	0	1	9	0	10
% Trucks	0	0	5.3	3.7	0	0.8	0	0.6	0	0	0	0	6.7	1.3	0	1.3

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 3



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 4

Groups Printed- Cars

	Reservoir St From North			Central Ave From East			Reservoir St From South			Central Ave From West			Int. Total
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
07:00 AM	3	0	5	10	38	1	4	0	7	2	149	7	226
07:15 AM	2	0	2	6	47	1	1	0	2	4	191	7	263
07:30 AM	4	0	4	5	40	1	1	0	2	5	184	14	260
07:45 AM	0	0	6	9	62	2	4	0	2	5	158	11	259
Total	9	0	17	30	187	5	10	0	13	16	682	39	1008
08:00 AM	1	0	3	9	62	3	4	0	6	2	143	24	257
08:15 AM	3	0	5	14	69	2	4	0	3	2	192	13	307
08:30 AM	1	0	4	9	69	3	4	0	5	2	157	20	274
08:45 AM	3	0	6	16	50	1	4	1	7	3	158	36	285
Total	8	0	18	48	250	9	16	1	21	9	650	93	1123
Grand Total	17	0	35	78	437	14	26	1	34	25	1332	132	2131
Apprch %	32.7	0	67.3	14.7	82.6	2.6	42.6	1.6	55.7	1.7	89.5	8.9	
Total %	0.8	0	1.6	3.7	20.5	0.7	1.2	0	1.6	1.2	62.5	6.2	

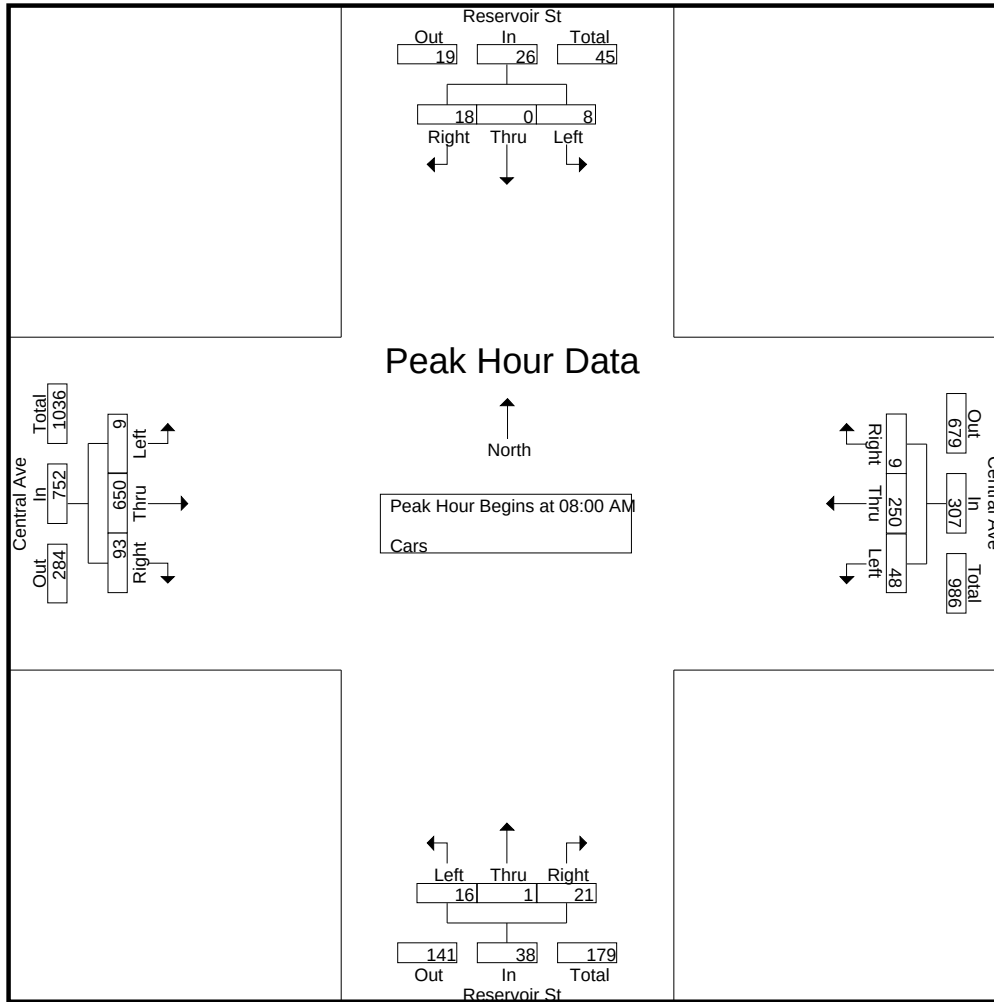
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				Int. Total
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 08:00 AM																	
08:00 AM	1	0	3	4	9	62	3	74	4	0	6	10	2	143	24	169	257
08:15 AM	3	0	5	8	14	69	2	85	4	0	3	7	2	192	13	207	307
08:30 AM	1	0	4	5	9	69	3	81	4	0	5	9	2	157	20	179	274
08:45 AM	3	0	6	9	16	50	1	67	4	1	7	12	3	158	36	197	285
Total Volume	8	0	18	26	48	250	9	307	16	1	21	38	9	650	93	752	1123
% App. Total	30.8	0	69.2		15.6	81.4	2.9		42.1	2.6	55.3		1.2	86.4	12.4		
PHF	.667	.000	.750	.722	.750	.906	.750	.903	1.00	.250	.750	.792	.750	.846	.646	.908	.914

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
 E/W Street : Central Avenue
 City/State : Needham, MA
 Weather : Rain / Clear

File Name : 95140001
 Site Code : 95140001
 Start Date : 10/18/2022
 Page No : 5

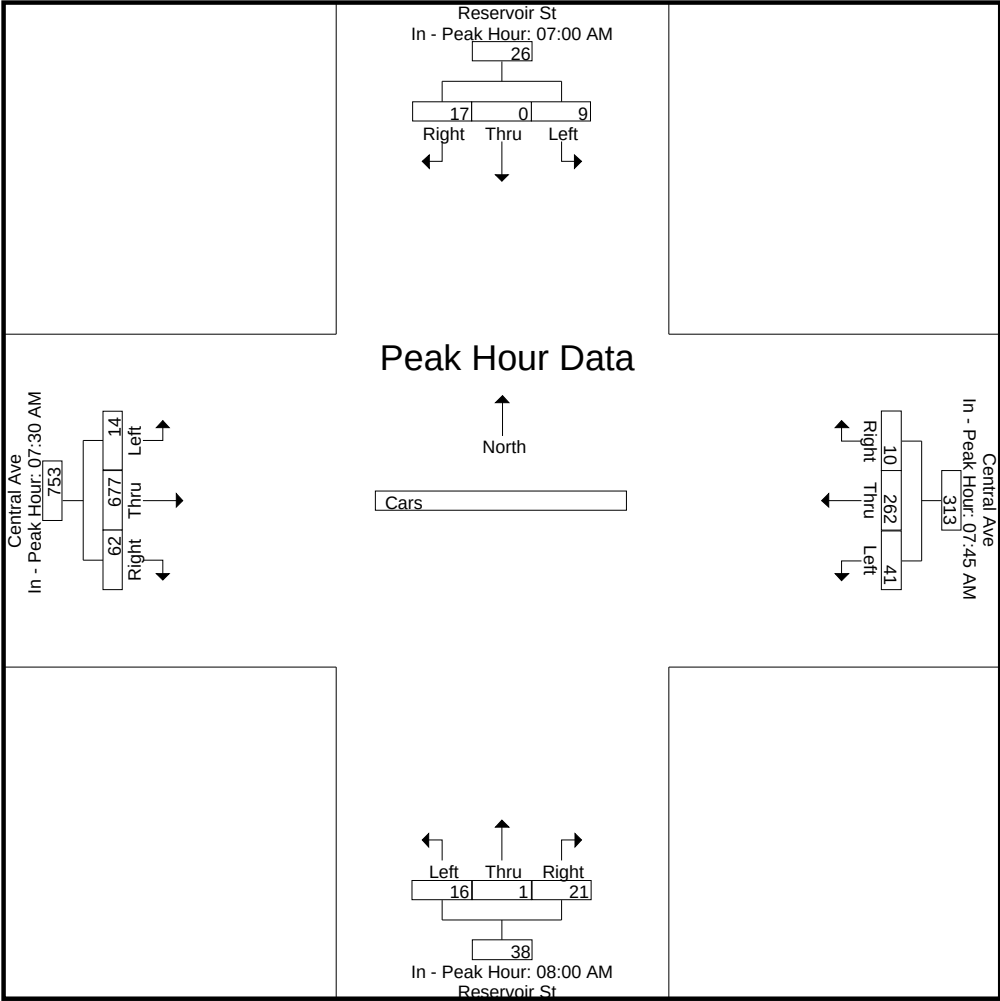


Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
 Peak Hour for Each Approach Begins at:

	07:00 AM				07:45 AM				08:00 AM				07:30 AM			
+0 mins.	3	0	5	8	9	62	2	73	4	0	6	10	5	184	14	203
+15 mins.	2	0	2	4	9	62	3	74	4	0	3	7	5	158	11	174
+30 mins.	4	0	4	8	14	69	2	85	4	0	5	9	2	143	24	169
+45 mins.	0	0	6	6	9	69	3	81	4	1	7	12	2	192	13	207
Total Volume	9	0	17	26	41	262	10	313	16	1	21	38	14	677	62	753
% App. Total	34.6	0	65.4		13.1	83.7	3.2		42.1	2.6	55.3		1.9	89.9	8.2	
PHF	.563	.000	.708	.813	.732	.949	.833	.921	1.000	.250	.750	.792	.700	.882	.646	.909

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 6



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 7

Groups Printed- Trucks

	Reservoir St From North			Central Ave From East			Reservoir St From South			Central Ave From West			Int. Total
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
07:00 AM	0	0	0	0	1	0	0	0	0	0	1	0	2
07:15 AM	0	0	0	0	2	0	0	0	0	0	1	0	3
07:30 AM	0	0	0	0	0	0	0	0	0	0	2	0	2
07:45 AM	0	0	0	0	1	0	0	0	1	0	4	0	6
Total	0	0	0	0	4	0	0	0	1	0	8	0	13
08:00 AM	0	0	1	0	1	0	0	0	0	1	2	0	5
08:15 AM	0	0	0	0	0	0	0	0	0	0	1	0	1
08:30 AM	0	0	0	0	0	0	0	0	0	0	2	1	3
08:45 AM	0	0	0	1	3	0	0	0	0	0	2	0	6
Total	0	0	1	1	4	0	0	0	0	1	7	1	15
Grand Total	0	0	1	1	8	0	0	0	1	1	15	1	28
Apprch %	0	0	100	11.1	88.9	0	0	0	100	5.9	88.2	5.9	
Total %	0	0	3.6	3.6	28.6	0	0	0	3.6	3.6	53.6	3.6	

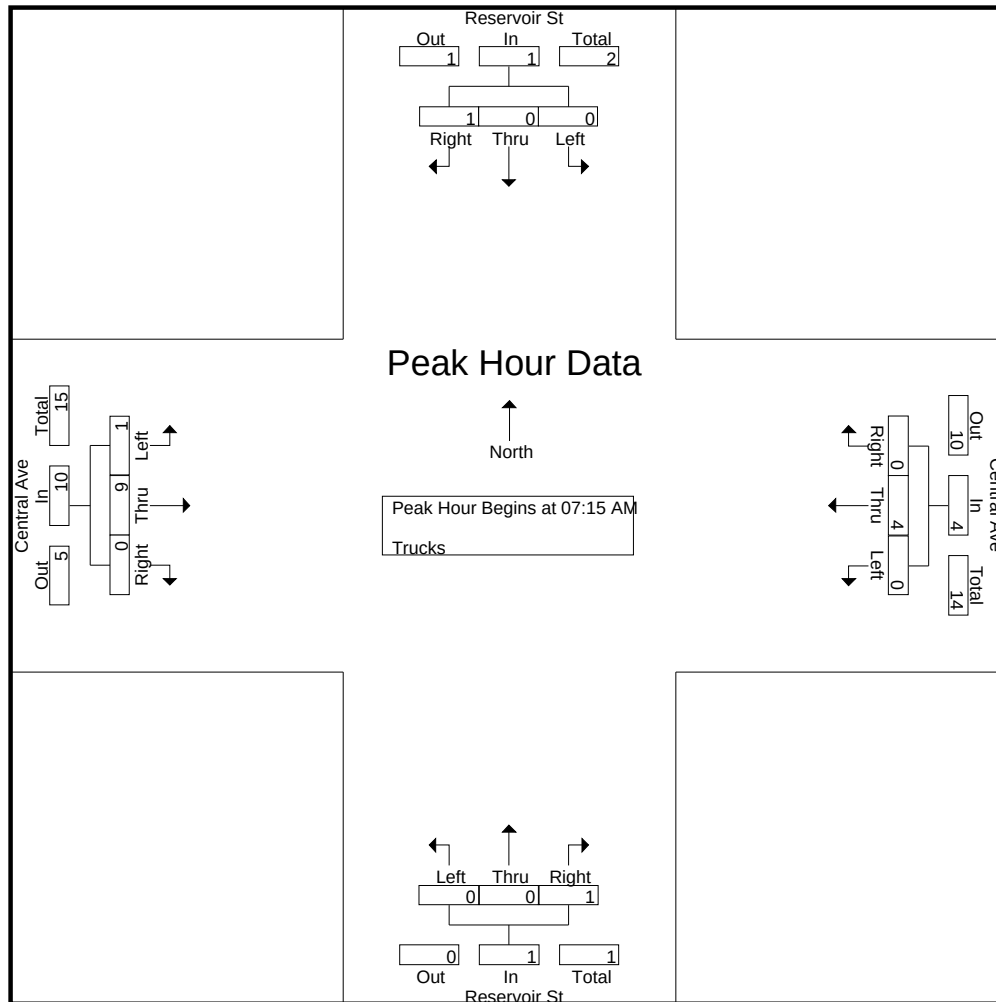
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				Int. Total
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	0	0	0	2	0	2	0	0	0	0	0	1	0	1	3
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
07:45 AM	0	0	0	0	0	1	0	1	0	0	1	1	0	4	0	4	6
08:00 AM	0	0	1	1	0	1	0	1	0	0	0	0	1	2	0	3	5
Total Volume	0	0	1	1	0	4	0	4	0	0	1	1	1	9	0	10	16
% App. Total	0	0	100		0	100	0		0	0	100		10	90	0		
PHF	.000	.000	.250	.250	.000	.500	.000	.500	.000	.000	.250	.250	.250	.563	.000	.625	.667

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
 E/W Street : Central Avenue
 City/State : Needham, MA
 Weather : Rain / Clear

File Name : 95140001
 Site Code : 95140001
 Start Date : 10/18/2022
 Page No : 8

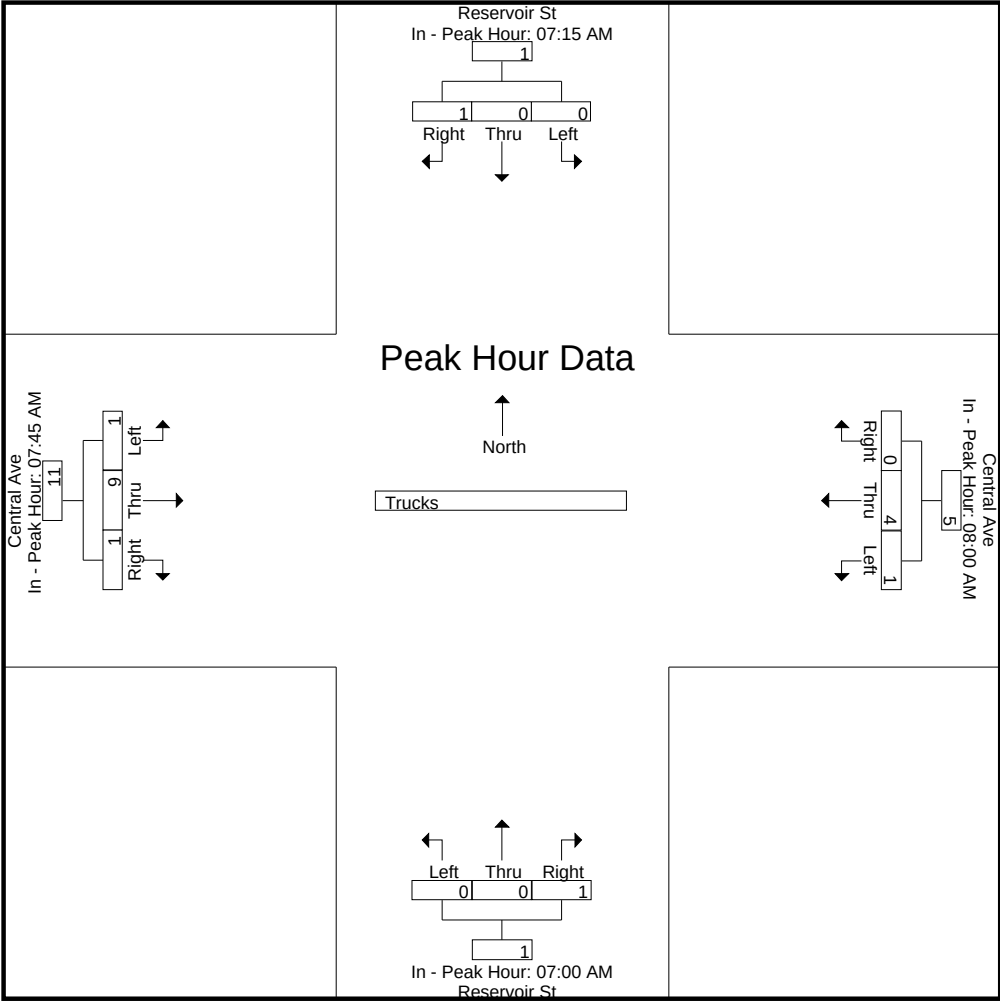


Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
 Peak Hour for Each Approach Begins at:

	07:15 AM				08:00 AM				07:00 AM				07:45 AM			
+0 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	4	0	4
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
+45 mins.	0	0	1	1	1	3	0	4	0	0	1	1	0	2	1	3
Total Volume	0	0	1	1	1	4	0	5	0	0	1	1	1	9	1	11
% App. Total	0	0	100		20	80	0		0	0	100		9.1	81.8	9.1	
PHF	.000	.000	.250	.250	.250	.333	.000	.313	.000	.000	.250	.250	.250	.563	.250	.688

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 9



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 10

Groups Printed- Bikes Peds

	Reservoir St From North				Central Ave From East				Reservoir St From South				Central 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	0	0	1	1	0	1
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	4	0	4
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	1	2	2	4
Total	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	5	7	3	10
08:00 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2	1	3
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	3
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	1	4
Total	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	10	10	2	12
Grand Total	0	0	0	0	0	1	0	0	0	0	0	2	0	4	0	15	17	5	22
Apprch %	0	0	0		0	100	0		0	0	0		0	100	0				
Total %	0	0	0		0	20	0		0	0	0		0	80	0		77.3	22.7	

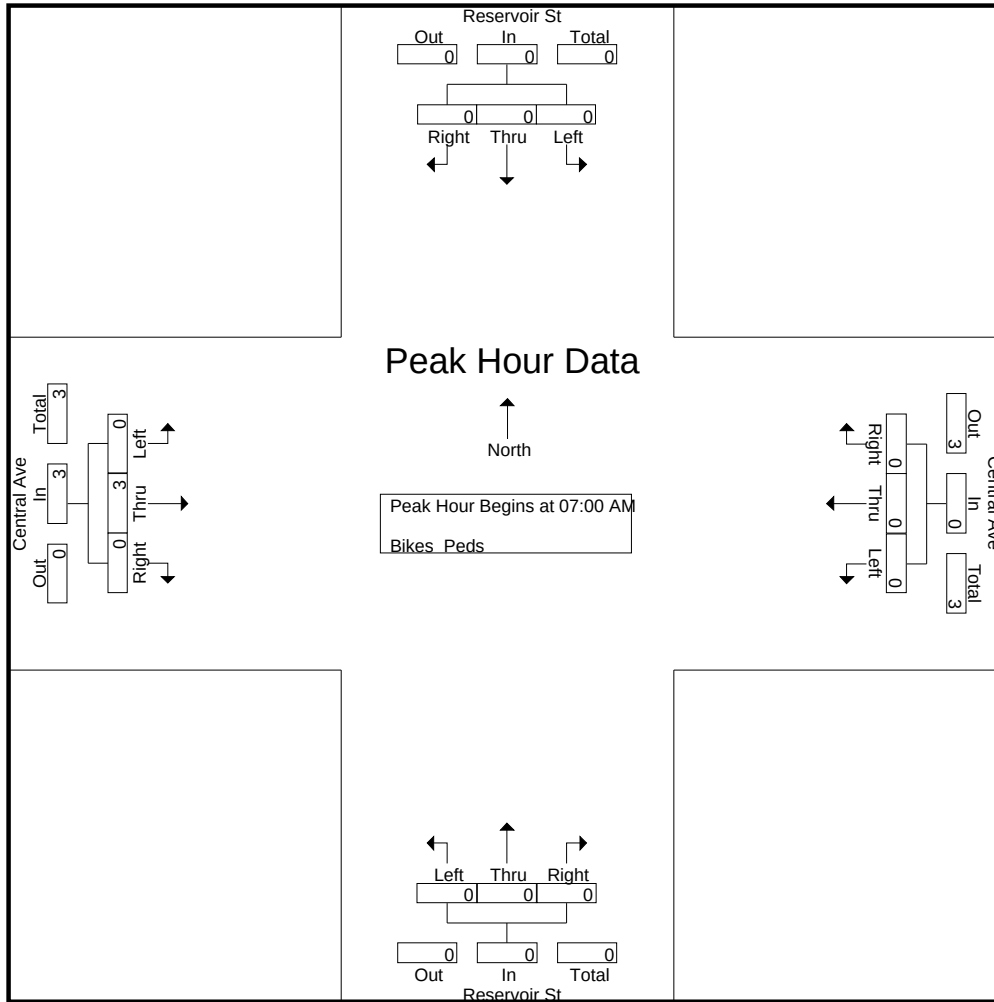
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:00 AM																	
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
% 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	.375	.000	.375	.375

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
 E/W Street : Central Avenue
 City/State : Needham, MA
 Weather : Rain / Clear

File Name : 95140001
 Site Code : 95140001
 Start Date : 10/18/2022
 Page No : 11

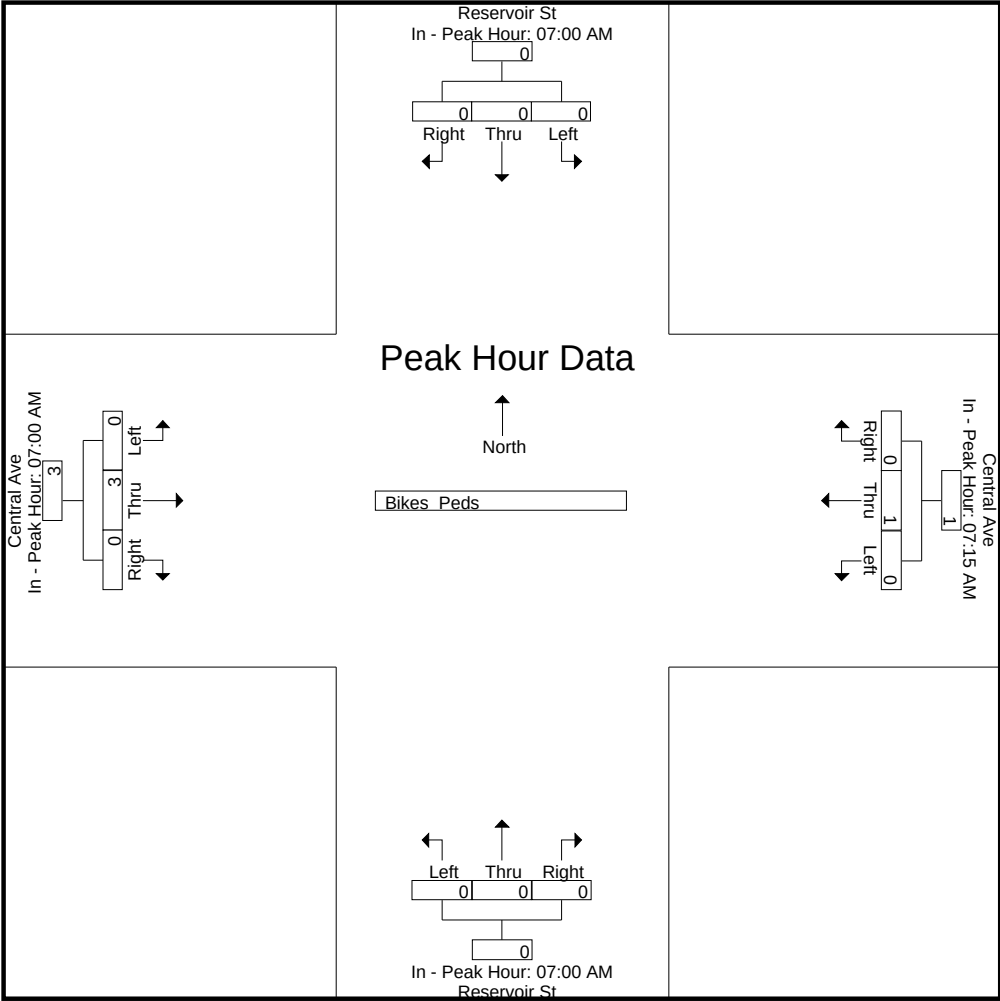


Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1
 Peak Hour for Each Approach Begins at:

	07:00 AM				07:15 AM				07:00 AM				07:00 AM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
+15 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+30 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+45 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	2
Total Volume	0	0	0	0	0	1	0	1	0	0	0	0	0	3	0	3
% App. Total	0	0	0	0	0	100	0		0	0	0	0	0	100	0	
PHF	.000	.000	.000	.000	.000	.250	.000	.250	.000	.000	.000	.000	.000	.375	.000	.375

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 12



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 1

Groups Printed- Cars - Trucks

	Reservoir St From North			Central Ave From East			Reservoir St From South			Central Ave From West			Int. Total
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
04:00 PM	2	0	6	11	144	5	24	0	21	4	82	11	310
04:15 PM	3	0	6	14	159	2	11	0	10	3	73	6	287
04:30 PM	0	0	9	6	127	4	22	0	16	5	93	3	285
04:45 PM	4	0	2	13	124	3	15	0	14	6	94	10	285
Total	9	0	23	44	554	14	72	0	61	18	342	30	1167
05:00 PM	3	0	5	8	132	0	37	0	21	4	117	12	339
05:15 PM	2	2	7	15	140	3	24	1	16	4	113	29	356
05:30 PM	4	0	9	11	151	1	43	4	17	4	83	15	342
05:45 PM	4	0	5	8	118	7	9	0	12	2	89	9	263
Total	13	2	26	42	541	11	113	5	66	14	402	65	1300
Grand Total	22	2	49	86	1095	25	185	5	127	32	744	95	2467
Apprch %	30.1	2.7	67.1	7.1	90.8	2.1	58.4	1.6	40.1	3.7	85.4	10.9	
Total %	0.9	0.1	2	3.5	44.4	1	7.5	0.2	5.1	1.3	30.2	3.9	
Cars	22	2	49	86	1089	25	185	5	126	32	738	94	2453
% Cars	100	100	100	100	99.5	100	100	100	99.2	100	99.2	98.9	99.4
Trucks	0	0	0	0	6	0	0	0	1	0	6	1	14
% Trucks	0	0	0	0	0.5	0	0	0	0.8	0	0.8	1.1	0.6

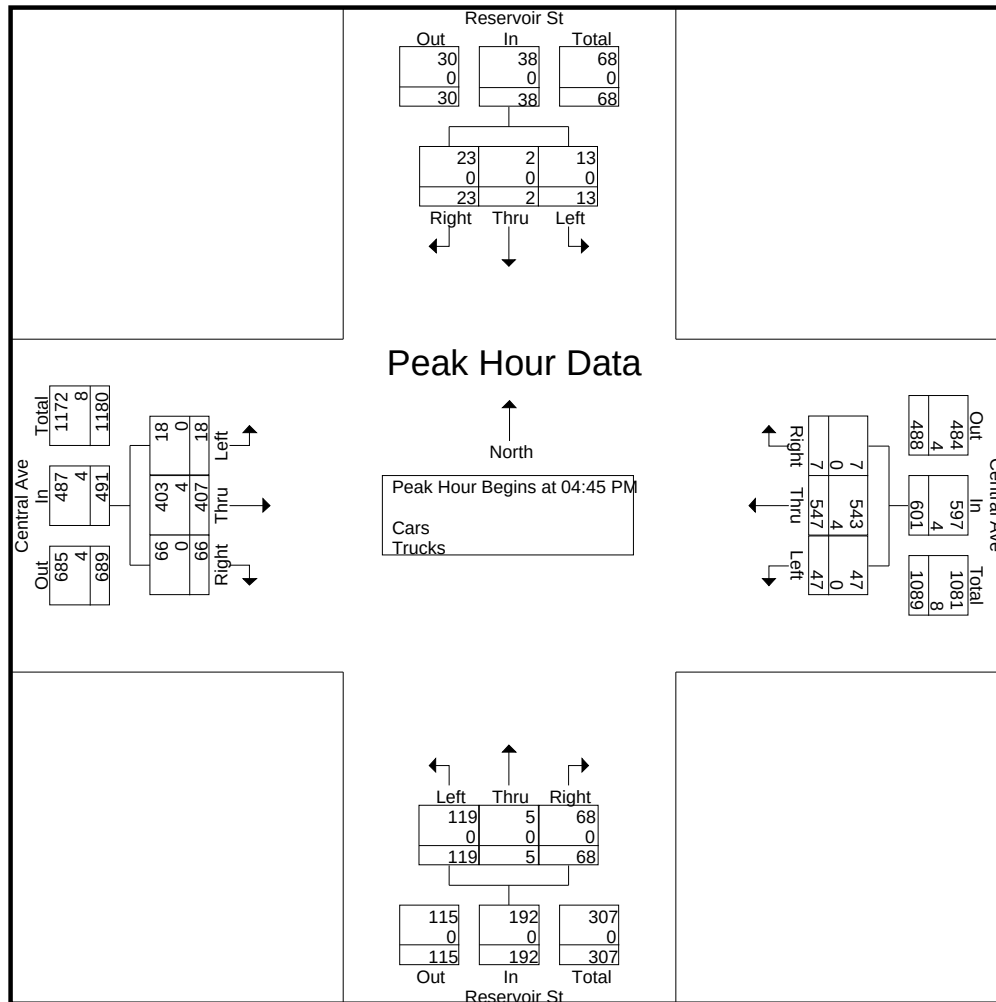
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	4	0	2	6	13	124	3	140	15	0	14	29	6	94	10	110	285
05:00 PM	3	0	5	8	8	132	0	140	37	0	21	58	4	117	12	133	339
05:15 PM	2	2	7	11	15	140	3	158	24	1	16	41	4	113	29	146	356
05:30 PM	4	0	9	13	11	151	1	163	43	4	17	64	4	83	15	102	342
Total Volume	13	2	23	38	47	547	7	601	119	5	68	192	18	407	66	491	1322
% App. Total	34.2	5.3	60.5		7.8	91	1.2		62	2.6	35.4		3.7	82.9	13.4		
PHF	.813	.250	.639	.731	.783	.906	.583	.922	.692	.313	.810	.750	.750	.870	.569	.841	.928
Cars	13	2	23	38	47	543	7	597	119	5	68	192	18	403	66	487	1314
% Cars	100	100	100	100	100	99.3	100	99.3	100	100	100	100	100	99.0	100	99.2	99.4
Trucks	0	0	0	0	0	4	0	4	0	0	0	0	0	4	0	4	8
% Trucks	0	0	0	0	0	0.7	0	0.7	0	0	0	0	0	1.0	0	0.8	0.6

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 2

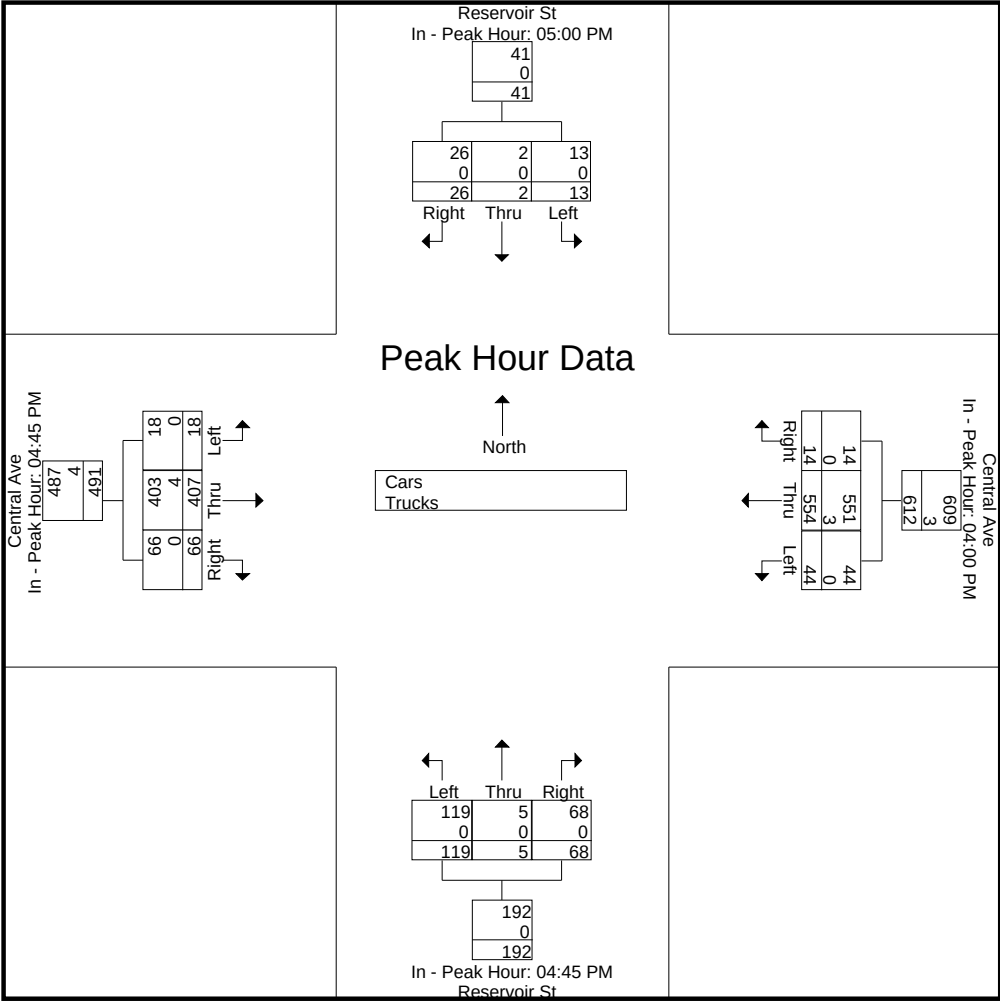


Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
Peak Hour for Each Approach Begins at:

	05:00 PM				04:00 PM				04:45 PM				04:45 PM			
+0 mins.	3	0	5	8	11	144	5	160	15	0	14	29	6	94	10	110
+15 mins.	2	2	7	11	14	159	2	175	37	0	21	58	4	117	12	133
+30 mins.	4	0	9	13	6	127	4	137	24	1	16	41	4	113	29	146
+45 mins.	4	0	5	9	13	124	3	140	43	4	17	64	4	83	15	102
Total Volume	13	2	26	41	44	554	14	612	119	5	68	192	18	403	66	487
% App. Total	31.7	4.9	63.4		7.2	90.5	2.3		62	2.6	35.4		3.7	82.9	13.4	
PHF	.813	.250	.722	.788	.786	.871	.700	.874	.692	.313	.810	.750	.750	.870	.569	.841
Cars	13	2	26	41	44	551	14	609	119	5	68	192	18	403	66	487
% Cars	100	100	100	100	100	99.5	100	99.5	100	100	100	100	100	99	100	99.2
Trucks	0	0	0	0	0	3	0	3	0	0	0	0	0	4	0	4
% Trucks	0	0	0	0	0	0.5	0	0.5	0	0	0	0	0	1	0	0.8

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 3



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 4

Groups Printed- Cars

	Reservoir St From North			Central Ave From East			Reservoir St From South			Central Ave From West			Int. Total
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
04:00 PM	2	0	6	11	143	5	24	0	20	4	81	10	306
04:15 PM	3	0	6	14	158	2	11	0	10	3	72	6	285
04:30 PM	0	0	9	6	127	4	22	0	16	5	93	3	285
04:45 PM	4	0	2	13	123	3	15	0	14	6	94	10	284
Total	9	0	23	44	551	14	72	0	60	18	340	29	1160
05:00 PM	3	0	5	8	131	0	37	0	21	4	115	12	336
05:15 PM	2	2	7	15	139	3	24	1	16	4	112	29	354
05:30 PM	4	0	9	11	150	1	43	4	17	4	82	15	340
05:45 PM	4	0	5	8	118	7	9	0	12	2	89	9	263
Total	13	2	26	42	538	11	113	5	66	14	398	65	1293
Grand Total	22	2	49	86	1089	25	185	5	126	32	738	94	2453
Apprch %	30.1	2.7	67.1	7.2	90.8	2.1	58.5	1.6	39.9	3.7	85.4	10.9	
Total %	0.9	0.1	2	3.5	44.4	1	7.5	0.2	5.1	1.3	30.1	3.8	

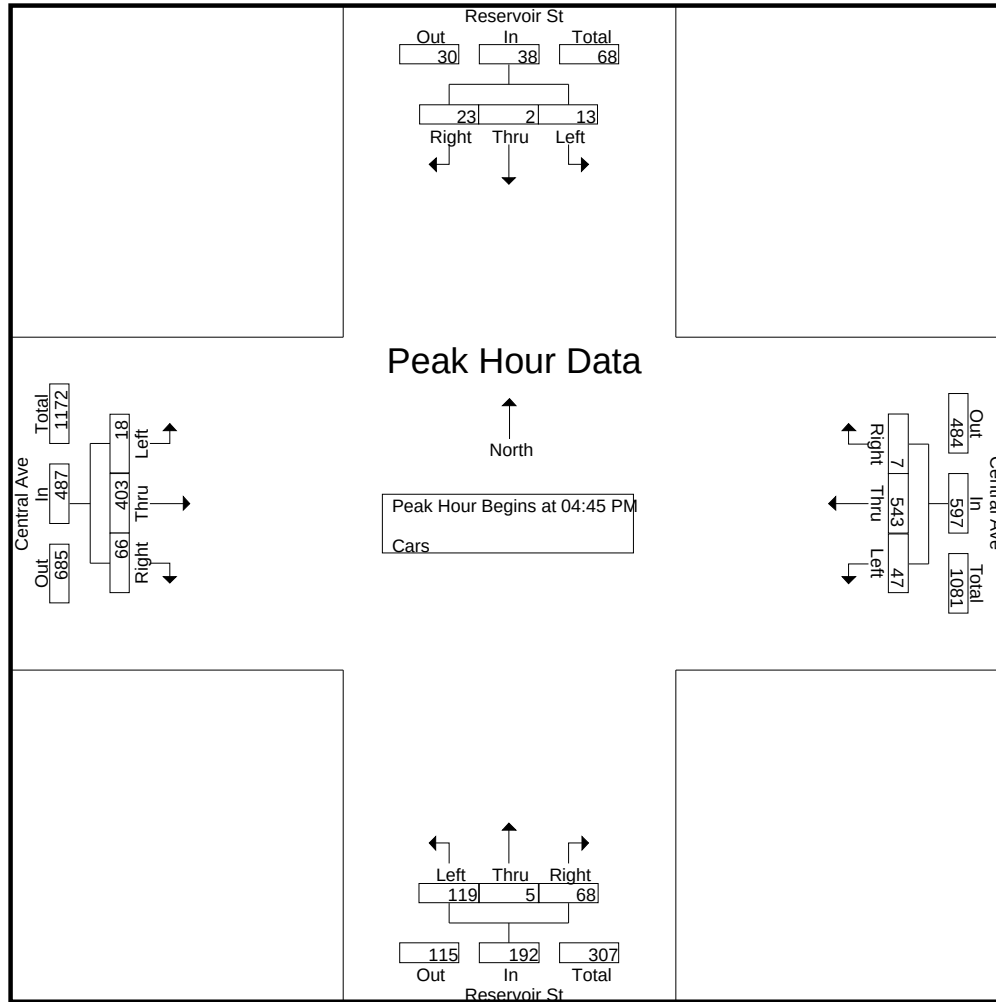
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				Int. Total
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	4	0	2	6	13	123	3	139	15	0	14	29	6	94	10	110	284
05:00 PM	3	0	5	8	8	131	0	139	37	0	21	58	4	115	12	131	336
05:15 PM	2	2	7	11	15	139	3	157	24	1	16	41	4	112	29	145	354
05:30 PM	4	0	9	13	11	150	1	162	43	4	17	64	4	82	15	101	340
Total Volume	13	2	23	38	47	543	7	597	119	5	68	192	18	403	66	487	1314
% App. Total	34.2	5.3	60.5		7.9	91	1.2		62	2.6	35.4		3.7	82.8	13.6		
PHF	.813	.250	.639	.731	.783	.905	.583	.921	.692	.313	.810	.750	.750	.876	.569	.840	.928

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
 E/W Street : Central Avenue
 City/State : Needham, MA
 Weather : Rain / Clear

File Name : 95140001
 Site Code : 95140001
 Start Date : 10/18/2022
 Page No : 5

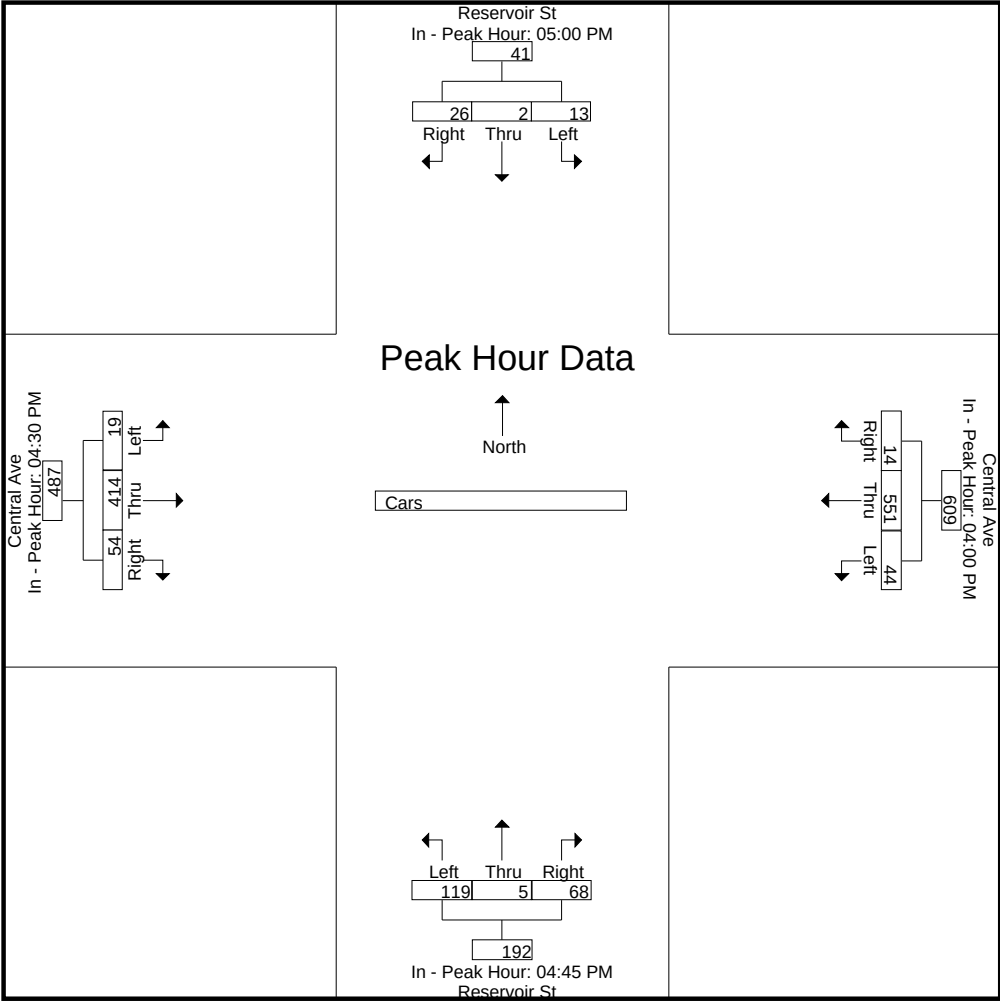


Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
 Peak Hour for Each Approach Begins at:

	05:00 PM				04:00 PM				04:45 PM				04:30 PM			
+0 mins.	3	0	5	8	11	143	5	159	15	0	14	29	5	93	3	101
+15 mins.	2	2	7	11	14	158	2	174	37	0	21	58	6	94	10	110
+30 mins.	4	0	9	13	6	127	4	137	24	1	16	41	4	115	12	131
+45 mins.	4	0	5	9	13	123	3	139	43	4	17	64	4	112	29	145
Total Volume	13	2	26	41	44	551	14	609	119	5	68	192	19	414	54	487
% App. Total	31.7	4.9	63.4		7.2	90.5	2.3		62	2.6	35.4		3.9	85	11.1	
PHF	.813	.250	.722	.788	.786	.872	.700	.875	.692	.313	.810	.750	.792	.900	.466	.840

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 6



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 7

Groups Printed- Trucks

	Reservoir St From North			Central Ave From East			Reservoir St From South			Central Ave From West			Int. Total
Start Time	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
04:00 PM	0	0	0	0	1	0	0	0	1	0	1	1	4
04:15 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	0	0	0	0	3	0	0	0	1	0	2	1	7
05:00 PM	0	0	0	0	1	0	0	0	0	0	2	0	3
05:15 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
05:30 PM	0	0	0	0	1	0	0	0	0	0	1	0	2
05:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	3	0	0	0	0	0	4	0	7
Grand Total	0	0	0	0	6	0	0	0	1	0	6	1	14
Apprch %	0	0	0	0	100	0	0	0	100	0	85.7	14.3	
Total %	0	0	0	0	42.9	0	0	0	7.1	0	42.9	7.1	

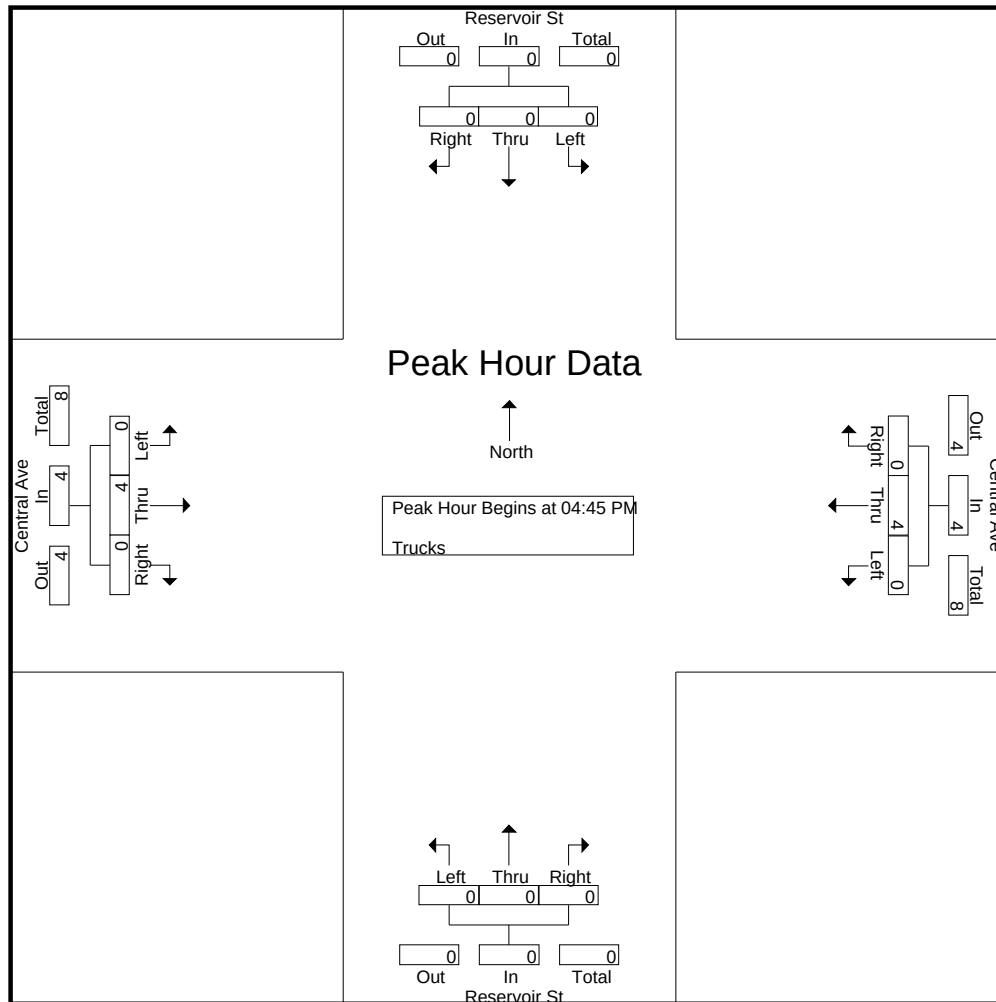
	Reservoir St From North				Central Ave From East				Reservoir St From South				Central Ave From West				Int. Total
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1
05:00 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	2	3
05:15 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	2
05:30 PM	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	2
Total Volume	0	0	0	0	0	4	0	4	0	0	0	0	0	4	0	4	8
% App. Total	0	0	0	0	0	100	0		0	0	0		0	100	0		
PHF	.000	.000	.000	.000	.000	1.00	.000	1.00	.000	.000	.000	.000	.000	.500	.000	.500	.667

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
 E/W Street : Central Avenue
 City/State : Needham, MA
 Weather : Rain / Clear

File Name : 95140001
 Site Code : 95140001
 Start Date : 10/18/2022
 Page No : 8

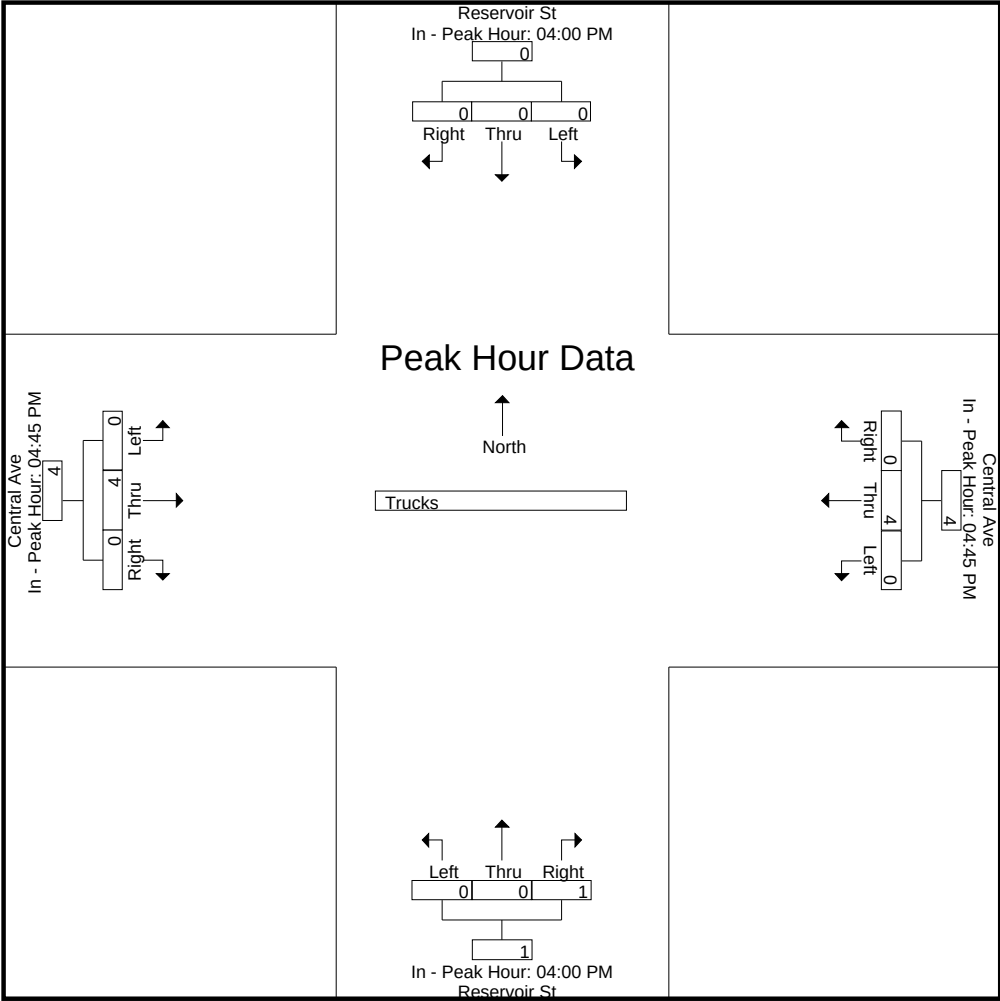


Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
 Peak Hour for Each Approach Begins at:

	04:00 PM				04:45 PM				04:00 PM				04:45 PM			
+0 mins.	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0
+15 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	2
+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	1	0	1	0	0	0	0	0	1	0	1
Total Volume	0	0	0	0	0	4	0	4	0	0	1	1	0	4	0	4
% App. Total	0	0	0	0	0	100	0	0	0	0	100	0	0	100	0	0
PHF	.000	.000	.000	.000	.000	1.000	.000	1.000	.000	.000	.250	.250	.000	.500	.000	.500

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 9



Accurate Counts

978-664-2565

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 10

Groups Printed- Bikes Peds

	Reservoir St From North				Central Ave From East					Reservoir St From South					Central 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				
04:00 PM	0	0	0	0	0	0	0	2		0	0	0	0		0	1	0	2		4	1	5
04:15 PM	0	0	0	0	0	2	0	1		0	0	0	0		0	0	0	0		1	2	3
04:30 PM	0	0	0	0	0	0	0	0		0	0	0	1		0	0	0	0		1	0	1
04:45 PM	0	0	0	0	0	1	0	0		0	0	0	0		0	0	0	2		2	1	3
Total	0	0	0	0	0	3	0	3		0	0	0	1		0	1	0	4		8	4	12
05:00 PM	0	0	0	0	0	0	0	0		0	0	0	0		0	2	0	1		1	2	3
05:15 PM	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0	2		2	0	2
05:30 PM	0	0	0	0	0	0	0	1		0	0	0	0		0	0	0	2		3	0	3
05:45 PM	0	0	0	0	0	1	0	0		0	0	0	0		0	1	0	0		0	2	2
Total	0	0	0	0	0	1	0	1		0	0	0	0		0	3	0	5		6	4	10
Grand Total	0	0	0	0	0	4	0	4		0	0	0	1		0	4	0	9		14	8	22
Apprch %	0	0	0		0	100	0			0	0	0			0	100	0					
Total %	0	0	0		0	50	0			0	0	0			0	50	0			63.6	36.4	

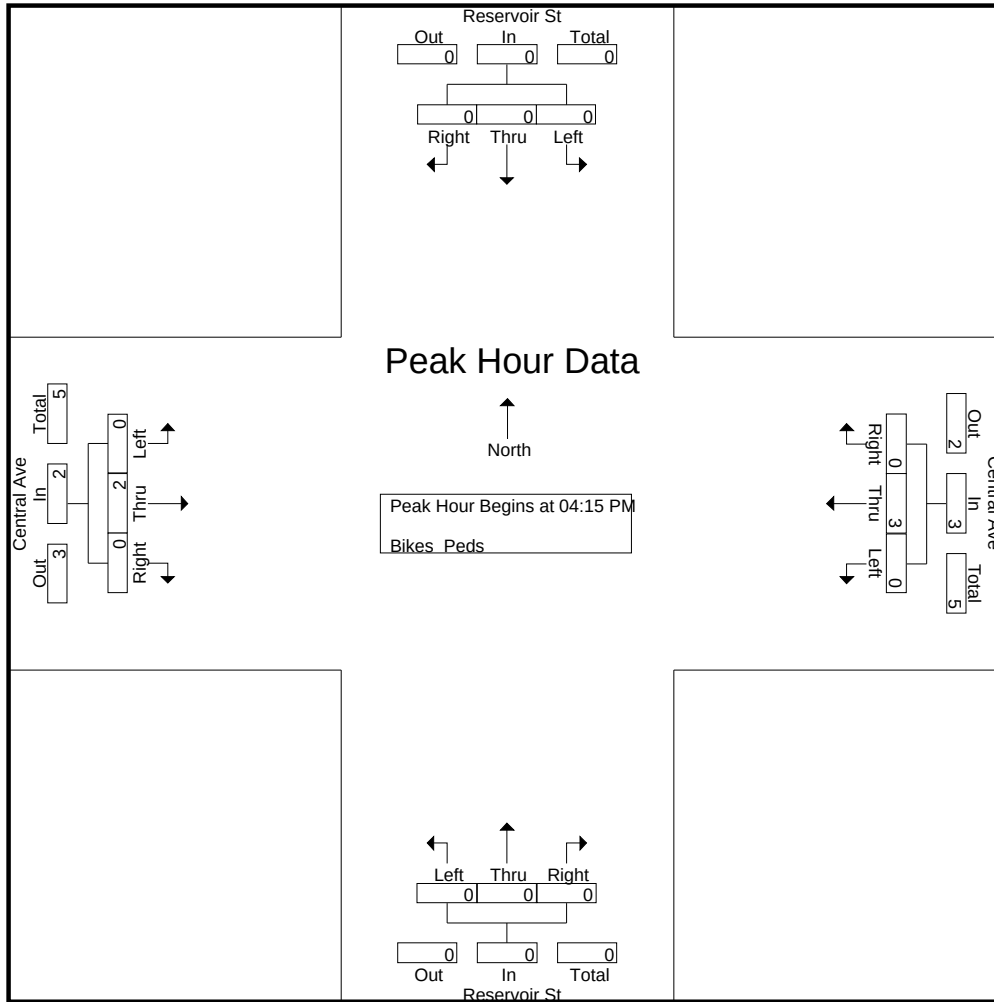
	Reservoir St From North				Central Ave From East					Reservoir St From South					Central Ave From West				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total		Left	Thru	Right	App. Total		Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																			
Peak Hour for Entire Intersection Begins at 04:15 PM																			
04:15 PM	0	0	0	0	0	2	0	2		0	0	0	0		0	0	0	0	2
04:30 PM	0	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0
04:45 PM	0	0	0	0	0	1	0	1		0	0	0	0		0	0	0	0	1
05:00 PM	0	0	0	0	0	0	0	0		0	0	0	0		0	2	0	2	2
Total Volume	0	0	0	0	0	3	0	3		0	0	0	0		0	2	0	2	5
% App. Total	0	0	0		0	100	0			0	0	0			0	100	0		
PHF	.000	.000	.000	.000	.000	.375	.000	.375		.000	.000	.000	.000		.000	.250	.000	.250	.625

Accurate Counts

978-664-2565

N/S Street : Reservoir Street
 E/W Street : Central Avenue
 City/State : Needham, MA
 Weather : Rain / Clear

File Name : 95140001
 Site Code : 95140001
 Start Date : 10/18/2022
 Page No : 11

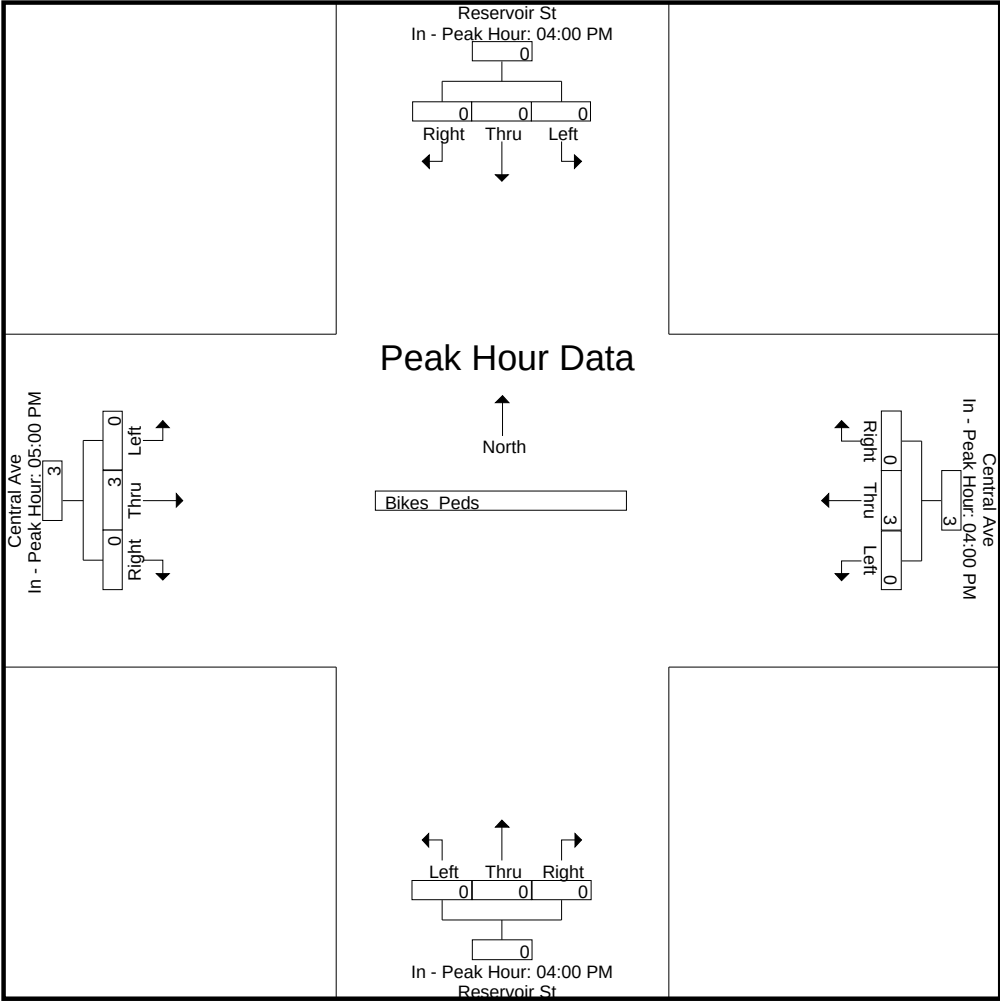


Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1
 Peak Hour for Each Approach Begins at:

	04:00 PM				04:00 PM				04:00 PM				05:00 PM			
+0 mins.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
+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	0	0	0
+45 mins.	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1
Total Volume	0	0	0	0	0	3	0	3	0	0	0	0	0	3	0	3
% App. Total	0	0	0	0	0	100	0	0	0	0	0	0	0	100	0	0
PHF	.000	.000	.000	.000	.000	.375	.000	.375	.000	.000	.000	.000	.000	.375	.000	.375

N/S Street : Reservoir Street
E/W Street : Central Avenue
City/State : Needham, MA
Weather : Rain / Clear

File Name : 95140001
Site Code : 95140001
Start Date : 10/18/2022
Page No : 12



MOTOR VEHICLE CRASH DATA

Crash Number	City Town Name	Crash Date	Crash Severity	Crash Time	Number of Vehicles	Light Conditions	Manner of Collision	Road Surface Condition	Weather Conditions	Street Number	Roadway
4400904	NEEDHAM	Sunday, April 16, 2017	Non-fatal injury	10:55 AM	1	Daylight	Single vehicle crash	Dry	Clear	39	CENTRAL AVE
4480042	NEEDHAM	Tuesday, November 7, 2017	Property damage only (none injured)	12:03 PM	2	Daylight	Angle	Dry	Cloudy		RESERVOIR ST / CENTRAL AVE
4536445	NEEDHAM	Thursday, February 8, 2018	Property damage only (none injured)	10:10 AM	3	Daylight	Angle	Dry	Clear		CENTRAL AVE / RESERVOIR ST
4592069	NEEDHAM	Wednesday, August 29, 2018	Unknown	10:46 AM	2	Daylight	Angle	Dry	Clear	189	RESERVOIR ST
4613319	NEEDHAM	Monday, September 3, 2018	Unknown	11:29 AM	2	Daylight	Angle	Dry	Clear	41	CENTRAL AVE
4613902	NEEDHAM	Monday, September 10, 2018	Property damage only (none injured)	8:53 AM	2	Daylight	Rear-end	Dry	Clear	189	RESERVOIR STREET
4787792	NEEDHAM	Saturday, October 19, 2019	Property damage only (none injured)	8:07 AM	2	Daylight	Angle	Dry	Clear	50	CENTRAL AVENUE / RESERVOIR STREET / CENTRAL AVENUE

MassHighway

CRASH RATE WORKSHEET

CITY/TOWN : NEEDHAM COUNT DATE : 2022

DISTRICT : 6 UNSIGNALIZED : ☒ SIGNALIZED : ☐

MHD USE ONLY

Source #

~ INTERSECTION DATA ~

MAJOR STREET : CENTRAL AVENUE

ST #

MINOR STREET(S) : RESERVOIR STREET

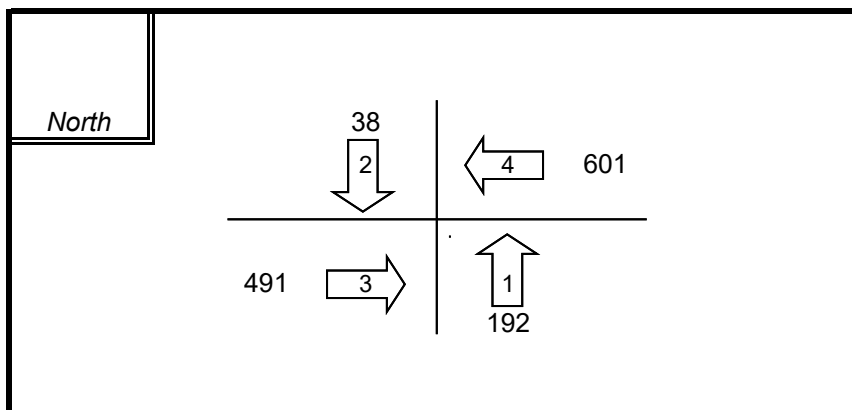
ST #

ST #

ST #

ST #

**INTERSECTION
DIAGRAM**
(Label Approaches)



INTERSECTION
REF #

Peak Hour Volumes

APPROACH :	1	2	3	4	5	Total Entering Vehicles
DIRECTION :	NB	SB	EB	WB		
VOLUMES (AM/PM) :	192	38	491	601		1,322

" K " FACTOR : **0.108** APPROACH ADT : **12,241** ADT = TOTAL VOL/"K" FACT.

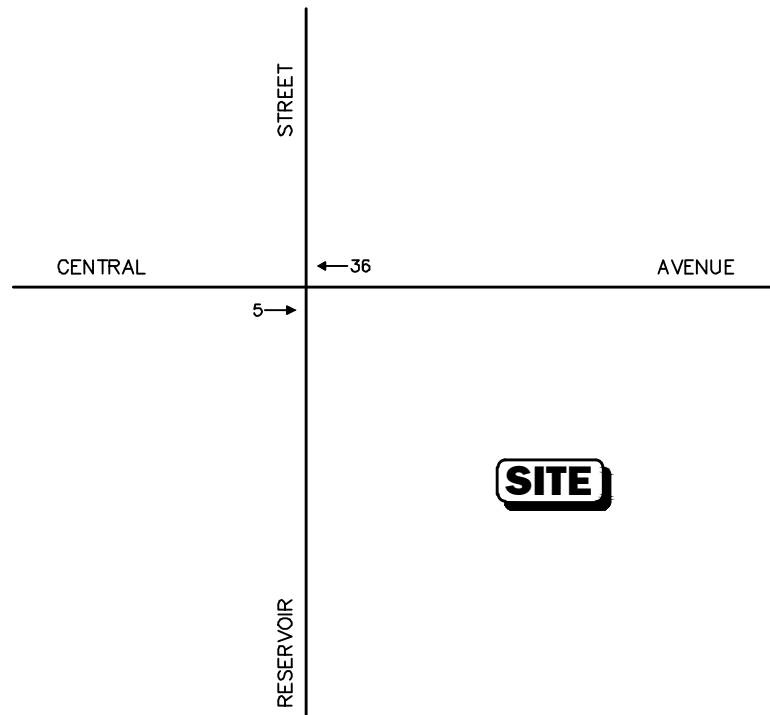
TOTAL # OF
ACCIDENTS : **7** # OF
YEARS : **5** AVERAGE # OF
ACCIDENTS (A) : **1.40**

CRASH RATE CALCULATION : **0.31** RATE = $\frac{(A * 1,000,000)}{(ADT * 365)}$

Comments : Accident Rate for District 6 signalized intersections = 0.71
Accident Rate for District 6 unsignalized intersections = 0.52

BACKGROUND DEVELOPMENT PROJECTS

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR

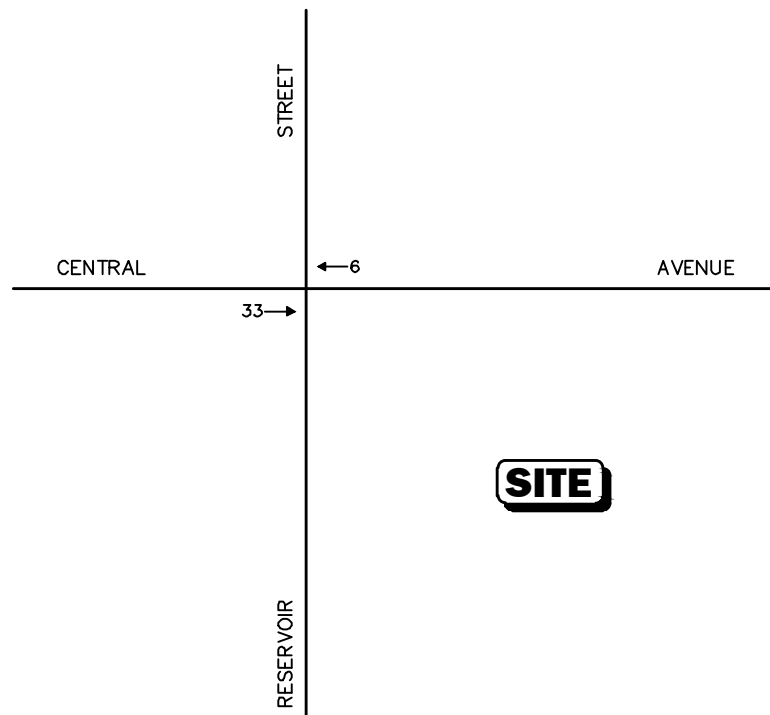


Figure A-1

Background Development Project
Highland Science Center
Project-Generated
Peak-Hour Traffic Volumes

TRIP GENERATION DATA

Institute of Transportation Engineers (ITE)

Trip Generation, 11th Edition

Land Use Code (LUC) 220 - Multifamily Housing (Low-Rise) Not Close to Rail Transit

Average Vehicle Trips Ends vs: Dwelling Units
Independent Variable (X): 15

AVERAGE WEEKDAY DAILY

$$T = 6.74$$

$$T = 6.74 * 15$$

$$T = 101.10$$

$$T = 102 \text{ vehicle trips}$$

with 50% (51 vpd) entering and 50% (51 vpd) exiting.

WEEKDAY MORNING PEAK HOUR OF ADJACENT STREET TRAFFIC

$$T = 0.40 * (X)$$

$$T = 0.40 * 15$$

$$T = 6.00$$

$$T = 6.00$$

$$T = 6 \text{ vehicle trips}$$

with 24% (1 vph) entering and 76% (5 vph) exiting.

WEEKDAY EVENING PEAK HOUR OF ADJACENT STREET TRAFFIC

$$T = 0.51 * (X)$$

$$T = 0.51 * 15$$

$$T = 7.65$$

$$T = 7.65$$

$$T = 8 \text{ vehicle trips}$$

with 63% (5 vph) entering and 37% (3 vph) exiting.

SATURDAY DAILY

$$T = 4.55 * (X)$$

$$T = 4.55 * 15$$

$$T = 19.55$$

$$T = 20 \text{ vehicle trips}$$

with 50% (10 vpd) entering and 50% (10 vpd) exiting.

SATURDAY MIDDAY PEAK HOUR OF GENERATOR

$$T = 0.41 * (X)$$

$$T = 0.41 * 15$$

$$T = 6.15$$

$$T = 6 \text{ vehicle trips}$$

with 50% (3 vph) entering and 50% (3 vph) exiting.

Directional Distribution unavailable assumed 50/50 split.

Institute of Transportation Engineers (ITE)
Trip Generation, 11th Edition
Land Use Code (LUC) 822 - Strip Retail Plaza (<40K)

Average Vehicle Trips Ends vs: 1,000 Square Feet Gross Leasable Area
Independent Variable (X): 2.542

AVERAGE WEEKDAY DAILY

$$T = 54.45 * X$$

$$T = 54.45 * 2.542$$

$$T = 138.41$$

$$T = 138 \text{ vehicle trips}$$

with 50% (69 vpd) entering and 50% (69 vpd) exiting.

WEEKDAY MORNING PEAK HOUR OF ADJACENT STREET TRAFFIC

$$T = 2.36 * (X)$$

$$T = 2.36 * 2.542$$

$$T = 6.00$$

$$T = 6 \text{ vehicle trips}$$

with 60% (4 vph) entering and 40% (2 vph) exiting.

WEEKDAY EVENING PEAK HOUR OF ADJACENT STREET TRAFFIC

$$T = 6.59 * X$$

$$T = 6.59 * 2.542$$

$$T = 16.75$$

$$T = 17 \text{ vehicle trips}$$

with 50% (9 vph) entering and 50% (8 vph) exiting.

Trip Generation Summary - Proposed Residential Development - Needham, MA

Land Use Size	Residential 15	Commercial 2542	Non-Auto --	Total --
Time Period				
<i>Weekday Morning Peak Hour</i>				
Entering	1	4	-1	4
Exiting	5	2	0	7
Total	6	6	-1	11
<i>Weekday Evening Peak Hour</i>				
Entering	5	9	-2	12
Exiting	3	8	-1	10
Total	8	17	-3	22
<i>Weekday Daily</i>	102	138	-20	220

CAPACITY ANALYSIS RESULTS

Intersection												
Int Delay, s/veh	1.8											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰	↱		↰		↰	↱		↰	↱	
Traffic Vol, veh/h	10	657	94	49	254	9	16	1	21	8	0	19
Future Vol, veh/h	10	657	94	49	254	9	16	1	21	8	0	19
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	-	-	0	-	-	-	0	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	79	79	79	75	75	75
Heavy Vehicles, %	10	1	1	2	2	0	0	0	0	0	0	5
Mvmt Flow	11	714	102	53	276	10	20	1	27	11	0	25
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	286	0	0	816	0	0	1136	1128	714	1188	1225	281
Stage 1	-	-	-	-	-	-	736	736	-	387	387	-
Stage 2	-	-	-	-	-	-	400	392	-	801	838	-
Critical Hdwy	4.2	-	-	4.12	-	-	7.1	6.5	6.2	7.1	6.5	6.25
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	2.29	-	-	2.218	-	-	3.5	4	3.3	3.5	4	3.345
Pot Cap-1 Maneuver	1232	-	-	812	-	-	181	206	435	167	180	751
Stage 1	-	-	-	-	-	-	414	428	-	641	613	-
Stage 2	-	-	-	-	-	-	630	610	-	381	384	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1232	-	-	812	-	-	162	187	435	145	163	751
Mov Cap-2 Maneuver	-	-	-	-	-	-	162	187	-	145	163	-
Stage 1	-	-	-	-	-	-	407	421	-	630	565	-
Stage 2	-	-	-	-	-	-	561	562	-	351	377	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.1			1.5			21.1			16.5		
HCM LOS							C			C		
Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2		
Capacity (veh/h)	162	410	1232	-	-	812	-	-	145	751		
HCM Lane V/C Ratio	0.125	0.068	0.009	-	-	0.066	-	-	0.074	0.034		
HCM Control Delay (s)	30.4	14.4	7.9	0	-	9.7	0	-	31.8	10		
HCM Lane LOS	D	B	A	A	-	A	A	-	D	B		
HCM 95th %tile Q(veh)	0.4	0.2	0	-	-	0.2	-	-	0.2	0.1		

Intersection												
Int Delay, s/veh	24.7											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕		↗	↖		↗	↖	
Traffic Vol, veh/h	18	407	66	47	547	7	119	5	68	13	2	23
Future Vol, veh/h	18	407	66	47	547	7	119	5	68	13	2	23
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	-	-	0	-	-	-	0	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	84	84	84	92	92	92	75	75	75	73	73	73
Heavy Vehicles, %	0	1	0	0	1	0	0	0	0	0	0	0
Mvmt Flow	21	485	79	51	595	8	159	7	91	18	3	32
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	603	0	0	564	0	0	1246	1232	485	1317	1307	599
Stage 1	-	-	-	-	-	-	527	527	-	701	701	-
Stage 2	-	-	-	-	-	-	719	705	-	616	606	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
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	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	984	-	-	1018	-	-	~ 152	179	586	136	161	505
Stage 1	-	-	-	-	-	-	538	532	-	433	444	-
Stage 2	-	-	-	-	-	-	423	442	-	481	490	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	984	-	-	1018	-	-	~ 129	160	586	103	144	505
Mov Cap-2 Maneuver	-	-	-	-	-	-	~ 129	160	-	103	144	-
Stage 1	-	-	-	-	-	-	521	516	-	420	411	-
Stage 2	-	-	-	-	-	-	364	409	-	389	475	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.3			0.7			141.2			25.5		
HCM LOS							F			D		
Minor Lane/Major Mvmt	NBLn1 NBLn2		EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2		
Capacity (veh/h)	129 496		984	-	-	1018	-	-	103	421		
HCM Lane V/C Ratio	1.23 0.196		0.022	-	-	0.05	-	-	0.173	0.081		
HCM Control Delay (s)	219.3		14	8.7	0	-	8.7	0	-	47.1	14.3	
HCM Lane LOS	F		B	A	A	-	A	A	-	E	B	
HCM 95th %tile Q(veh)	9.8		0.7	0.1	-	-	0.2	-	-	0.6	0.3	
Notes												
~: Volume exceeds capacity		\$: Delay exceeds 300s			+: Computation Not Defined				*: All major volume in platoon			

Intersection												
Int Delay, s/veh	1.8											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰	↱		↰	↱	↰	↱		↰	↱	
Traffic Vol, veh/h	10	685	94	49	296	9	16	1	21	8	0	19
Future Vol, veh/h	10	685	94	49	296	9	16	1	21	8	0	19
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	-	-	0	-	-	-	0	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	79	79	79	75	75	75
Heavy Vehicles, %	10	1	1	2	2	0	0	0	0	0	0	5
Mvmt Flow	11	745	102	53	322	10	20	1	27	11	0	25
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	332	0	0	847	0	0	1213	1205	745	1265	1302	327
Stage 1	-	-	-	-	-	-	767	767	-	433	433	-
Stage 2	-	-	-	-	-	-	446	438	-	832	869	-
Critical Hdwy	4.2	-	-	4.12	-	-	7.1	6.5	6.2	7.1	6.5	6.25
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	2.29	-	-	2.218	-	-	3.5	4	3.3	3.5	4	3.345
Pot Cap-1 Maneuver	1184	-	-	790	-	-	160	185	417	147	162	707
Stage 1	-	-	-	-	-	-	398	414	-	605	585	-
Stage 2	-	-	-	-	-	-	595	582	-	366	372	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1184	-	-	790	-	-	143	167	417	127	146	707
Mov Cap-2 Maneuver	-	-	-	-	-	-	143	167	-	127	146	-
Stage 1	-	-	-	-	-	-	391	407	-	594	537	-
Stage 2	-	-	-	-	-	-	527	534	-	335	365	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.1			1.4			23.1			17.9		
HCM LOS							C			C		
Minor Lane/Major Mvmt	NBLn1 NBLn2		EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2		
Capacity (veh/h)	143	390	1184	-	-	790	-	-	127	707		
HCM Lane V/C Ratio	0.142	0.071	0.009	-	-	0.067	-	-	0.084	0.036		
HCM Control Delay (s)	34.3	14.9	8.1	0	-	9.9	0	-	35.9	10.3		
HCM Lane LOS	D	B	A	A	-	A	A	-	E	B		
HCM 95th %tile Q(veh)	0.5	0.2	0	-	-	0.2	-	-	0.3	0.1		

Intersection												
Int Delay, s/veh	31.6											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕		↗	↕		↗	↕	
Traffic Vol, veh/h	18	457	66	47	572	7	119	5	68	13	2	23
Future Vol, veh/h	18	457	66	47	572	7	119	5	68	13	2	23
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	-	-	0	-	-	-	0	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	84	84	84	92	92	92	75	75	75	73	73	73
Heavy Vehicles, %	0	1	0	0	1	0	0	0	0	0	0	0
Mvmt Flow	21	544	79	51	622	8	159	7	91	18	3	32
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	630	0	0	623	0	0	1332	1318	544	1403	1393	626
Stage 1	-	-	-	-	-	-	586	586	-	728	728	-
Stage 2	-	-	-	-	-	-	746	732	-	675	665	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
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	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	962	-	-	968	-	-	~ 133	159	543	118	143	488
Stage 1	-	-	-	-	-	-	500	500	-	418	432	-
Stage 2	-	-	-	-	-	-	409	430	-	447	461	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	962	-	-	968	-	-	~ 112	141	543	87	127	488
Mov Cap-2 Maneuver	-	-	-	-	-	-	~ 112	141	-	87	127	-
Stage 1	-	-	-	-	-	-	483	483	-	404	397	-
Stage 2	-	-	-	-	-	-	349	395	-	355	445	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.3			0.7			192.9			29.2		
HCM LOS							F			D		
Minor Lane/Major Mvmt	NBLn1 NBLn2		EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2		
Capacity (veh/h)	112	454	962	-	-	968	-	-	87	398		
HCM Lane V/C Ratio	1.417	0.214	0.022	-	-	0.053	-	-	0.205	0.086		
HCM Control Delay (s)	\$ 302	15.1	8.8	0	-	8.9	0	-	56.7	14.9		
HCM Lane LOS	F	C	A	A	-	A	A	-	F	B		
HCM 95th %tile Q(veh)	11.2	0.8	0.1	-	-	0.2	-	-	0.7	0.3		
Notes												
~: Volume exceeds capacity		\$: Delay exceeds 300s			+: Computation Not Defined				*: All major volume in platoon			

Intersection												
Int Delay, s/veh	1.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰	↱		↰	↱	↰	↱		↰	↱	
Traffic Vol, veh/h	10	686	95	50	297	9	17	1	24	8	0	19
Future Vol, veh/h	10	686	95	50	297	9	17	1	24	8	0	19
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	-	-	0	-	-	-	0	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	79	79	79	75	75	75
Heavy Vehicles, %	10	1	1	2	2	0	0	0	0	0	0	5
Mvmt Flow	11	746	103	54	323	10	22	1	30	11	0	25
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	333	0	0	849	0	0	1217	1209	746	1271	1307	328
Stage 1	-	-	-	-	-	-	768	768	-	436	436	-
Stage 2	-	-	-	-	-	-	449	441	-	835	871	-
Critical Hdwy	4.2	-	-	4.12	-	-	7.1	6.5	6.2	7.1	6.5	6.25
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	2.29	-	-	2.218	-	-	3.5	4	3.3	3.5	4	3.345
Pot Cap-1 Maneuver	1183	-	-	789	-	-	159	184	417	146	161	706
Stage 1	-	-	-	-	-	-	397	414	-	603	583	-
Stage 2	-	-	-	-	-	-	593	580	-	365	371	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1183	-	-	789	-	-	142	166	417	124	145	706
Mov Cap-2 Maneuver	-	-	-	-	-	-	142	166	-	124	145	-
Stage 1	-	-	-	-	-	-	390	407	-	592	534	-
Stage 2	-	-	-	-	-	-	524	531	-	331	364	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.1			1.4			23			18.1		
HCM LOS							C			C		
Minor Lane/Major Mvmt	NBLn1 NBLn2		EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2		
Capacity (veh/h)	142	393	1183	-	-	789	-	-	124	706		
HCM Lane V/C Ratio	0.152	0.081	0.009	-	-	0.069	-	-	0.086	0.036		
HCM Control Delay (s)	34.8	15	8.1	0	-	9.9	0	-	36.7	10.3		
HCM Lane LOS	D	C	A	A	-	A	A	-	E	B		
HCM 95th %tile Q(veh)	0.5	0.3	0	-	-	0.2	-	-	0.3	0.1		

Intersection						
Int Delay, s/veh	0.3					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	4	38	0	2	143
Future Vol, veh/h	0	4	38	0	2	143
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	4	41	0	2	155

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	200	41	0
Stage 1	41	-	-
Stage 2	159	-	-
Critical Hdwy	6.42	6.22	-
Critical Hdwy Stg 1	5.42	-	-
Critical Hdwy Stg 2	5.42	-	-
Follow-up Hdwy	3.518	3.318	-
Pot Cap-1 Maneuver	789	1030	-
Stage 1	981	-	-
Stage 2	870	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	788	1030	-
Mov Cap-2 Maneuver	788	-	-
Stage 1	981	-	-
Stage 2	869	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.5	0	0.1
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	1030	1568
HCM Lane V/C Ratio	-	-	0.004	0.001
HCM Control Delay (s)	-	-	8.5	7.3
HCM Lane LOS	-	-	A	A
HCM 95th %tile Q(veh)	-	-	0	0

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	717	1	1	355	1	2
Future Vol, veh/h	717	1	1	355	1	2
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	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	779	1	1	386	1	2
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	780	0	1168	780
Stage 1	-	-	-	-	780	-
Stage 2	-	-	-	-	388	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	837	-	214	395
Stage 1	-	-	-	-	452	-
Stage 2	-	-	-	-	686	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	837	-	214	395
Mov Cap-2 Maneuver	-	-	-	-	214	-
Stage 1	-	-	-	-	452	-
Stage 2	-	-	-	-	685	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		16.8	
HCM LOS	C					
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	308	-	-	837	-	
HCM Lane V/C Ratio	0.011	-	-	0.001	-	
HCM Control Delay (s)	16.8	-	-	9.3	0	
HCM Lane LOS	C	-	-	A	A	
HCM 95th %tile Q(veh)	0	-	-	0	-	

Intersection												
Int Delay, s/veh	34.4											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	18	459	68	51	574	7	120	5	71	13	2	23
Future Vol, veh/h	18	459	68	51	574	7	120	5	71	13	2	23
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	-	-	0	-	-	-	0	-	-	0	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	84	84	84	92	92	92	75	75	75	73	73	73
Heavy Vehicles, %	10	1	1	2	2	0	0	0	0	0	0	5
Mvmt Flow	21	546	81	55	624	8	160	7	95	18	3	32
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	632	0	0	627	0	0	1344	1330	546	1418	1407	628
Stage 1	-	-	-	-	-	-	588	588	-	738	738	-
Stage 2	-	-	-	-	-	-	756	742	-	680	669	-
Critical Hdwy	4.2	-	-	4.12	-	-	7.1	6.5	6.2	7.1	6.5	6.25
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	2.29	-	-	2.218	-	-	3.5	4	3.3	3.5	4	3.345
Pot Cap-1 Maneuver	913	-	-	955	-	-	~ 130	156	541	116	140	477
Stage 1	-	-	-	-	-	-	499	499	-	413	427	-
Stage 2	-	-	-	-	-	-	403	425	-	444	459	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	913	-	-	955	-	-	~ 108	137	541	84	123	477
Mov Cap-2 Maneuver	-	-	-	-	-	-	~ 108	137	-	84	123	-
Stage 1	-	-	-	-	-	-	481	481	-	398	389	-
Stage 2	-	-	-	-	-	-	340	387	-	348	442	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.3			0.7			208.5			30.2		
HCM LOS							F			D		
Minor Lane/Major Mvmt	NBLn1 NBLn2		EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2		
Capacity (veh/h)	108	453	913	-	-	955	-	-	84	388		
HCM Lane V/C Ratio	1.481	0.224	0.023	-	-	0.058	-	-	0.212	0.088		
HCM Control Delay (s)	\$ 330.9	15.2	9	0	-	9	0	-	59	15.2		
HCM Lane LOS	F	C	A	A	-	A	A	-	F	C		
HCM 95th %tile Q(veh)	11.7	0.8	0.1	-	-	0.2	-	-	0.7	0.3		
Notes												
~: Volume exceeds capacity		\$: Delay exceeds 300s			+: Computation Not Defined				*: All major volume in platoon			

Intersection						
Int Delay, s/veh	0.6					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	4	12	0	6	115
Future Vol, veh/h	0	4	12	0	6	115
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	4	13	0	7	125

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	152	13	0
Stage 1	13	-	-
Stage 2	139	-	-
Critical Hdwy	6.42	6.22	-
Critical Hdwy Stg 1	5.42	-	-
Critical Hdwy Stg 2	5.42	-	-
Follow-up Hdwy	3.518	3.318	-
Pot Cap-1 Maneuver	840	1067	-
Stage 1	1010	-	-
Stage 2	888	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	836	1067	-
Mov Cap-2 Maneuver	836	-	-
Stage 1	1010	-	-
Stage 2	884	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.4	0	0.4
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	1067	1606
HCM Lane V/C Ratio	-	-	0.004	0.004
HCM Control Delay (s)	-	-	8.4	7.3
HCM Lane LOS	-	-	A	A
HCM 95th %tile Q(veh)	-	-	0	0

Intersection						
Int Delay, s/veh	0.1					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	541	2	4	630	2	4
Future Vol, veh/h	541	2	4	630	2	4
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	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	588	2	4	685	2	4
Major/Minor	Major1	Major2		Minor1		
Conflicting Flow All	0	0	590	0	1282	589
Stage 1	-	-	-	-	589	-
Stage 2	-	-	-	-	693	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	985	-	182	508
Stage 1	-	-	-	-	554	-
Stage 2	-	-	-	-	496	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	985	-	181	508
Mov Cap-2 Maneuver	-	-	-	-	181	-
Stage 1	-	-	-	-	554	-
Stage 2	-	-	-	-	493	-
Approach	EB	WB		NB		
HCM Control Delay, s	0	0.1		16.6		
HCM LOS	C					
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	317	-	-	985	-	
HCM Lane V/C Ratio	0.021	-	-	0.004	-	
HCM Control Delay (s)	16.6	-	-	8.7	0	
HCM Lane LOS	C	-	-	A	A	
HCM 95th %tile Q(veh)	0.1	-	-	0	-	