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MEMORANDUM

TO: Ms. Amanda Cavaliere
Tata and Howard, Inc.
67 Forest Street
Marlborough, Massachusetts 01752

DATE: March 22, 2013

FROM: Kevin R. Dandrade, PE, PTOE, Principal
Rebecca L. Brown, P.E., Senior Traffic Engineer
Samuel W. Gregorio, E.I.T., Project Engineer

PROJECT NO.: T0469

RE: Proposed River's Edge Residential Development, 484-490 Boston Post Road, Wayland, MA
Traffic Impact Assessment

INTRODUCTION

TEC has been retained by the Town of Wayland Economic Development Committee, through its contract with Tata and Howard, Inc., to prepare a Traffic Impact Assessment for the proposed River's Edge 216-unit residential development to be located on an existing Town of Wayland parcel at 484-490 Boston Post Road (US Route 20) in Wayland, Massachusetts. The site is currently vacant; however, it is being utilized for soil storage by the Town of Wayland Department of Public Works. The residential development will be separated into 151-units of age-restricted housing and 65-units of general apartment housing. Access to the site is proposed via a shared full-access/egress driveway with the Town Dump, the former Wayland Wastewater Treatment Facility, and the proposed Department of Public Works facility, which provides adjacent access/egress to Boston Post Road (US Route 20).

TEC evaluated the traffic operations for the shared site driveway and the intersections immediately to the east within the center of Wayland under existing and future conditions. The future year planning horizon examines traffic operations under existing conditions (2013), as well as a 5-year design horizon (2018) for traffic-volume projections, which includes an evaluation of the no-build conditions (without the proposed project) and build conditions (with site traffic added). These conditions are compared to determine what, if any, off-site mitigation is necessary to provide reasonable traffic operations in the area after the project is complete.

EXISTING CONDITIONS

Traffic Study Area

The study area was selected to contain the major roadways providing local access to the project site. The following intersections were included in the study area:

1. Boston Post Road (US Route 20) / Town Dump Driveway (River's Edge Site Driveway)
2. Boston Post Road (US Route 20) / Pelham Island Road [North]
3. Boston Post Road (US Route 20) / Cochituate Road (Route 27 / Route 126)
4. Cochituate Road (Route 27 / Route 126) / Millbrook Road / Pelham Island Road [East]

The study area intersections are shown graphically in Figure 1.

River's Edge Residential Development - Wayland, Massachusetts

Figure 1

Project Location Map & Study Area Intersections

TEC

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Geometry

A comprehensive field inventory of existing traffic conditions at the study area intersections was conducted by TEC staff in February and March 2013 to obtain information related to intersection geometry and lane usage. The field investigation consisted of an inventory of existing roadway geometrics, operating characteristics, and safety characteristics. A description of the existing roadway and intersection inventory is provided below.

Roadways

Boston Post Road (US Route 20)

Boston Post Road, signed as US Route 20, is a two-lane, east-west urban principal arterial roadway maintained by the Massachusetts Department of Transportation (MassDOT). The roadway provides connection from Marlborough and Sudbury to the west and Weston, Waltham, and Interstate 95 / Route 128 to the east. Boston Post Road (US Route 20) is approximately 30-wide (approximately 45-foot right-of-way) and provides one travel lane in each direction with auxiliary turning lanes at intersections. In the vicinity of the study area, directional flow along Boston Post Road (US Route 20) is separated by a marked centerline. The posted speed limit along Boston Post Road (US Route 20) at the Town Dump Driveway (Site Driveway) is 45 miles per hour (mph). Land uses along Boston Post Road (US Route 20) include retail, commercial, industrial, and residential uses.

Intersections

Boston Post Road (US Route 20) / Wayland – Town Dump Driveway

The Town of Wayland – Town Dump Driveway intersects Boston Post Road (US Route 20) to form a three-way, unsignalized intersection. The Town Dump Driveway southbound approach operates under STOP control while both Boston Post Road approaches are free-flowing. Both Boston Post Road approaches consist of a single 12-foot general-purpose travel lane with 3-foot shoulders. Directional flow along Boston Post Road is separated by a marked centerline. The Town Dump Driveway southbound approach consists of an unmarked 35-foot wide approach. The driveway also currently services the Town of Wayland Wastewater Treatment Facility.

Boston Post Road (US Route 20) / Pelham Island Road [North]

Pelham Island Road intersects Boston Post Road (US Route 20) from the north to form a three-way, unsignalized intersection. The Pelham Island Road southbound approach operates under STOP control while both Boston Post Road approaches are free-flowing. Both Boston Post Road approaches consist of a single general-purpose travel lane. Directional flow along Boston Post Road is separated by a marked centerline. The Pelham Island Road southbound approach consists of a single general-purpose travel lane with adjacent on-street parking stalls. Traffic flow on Pelham Island Road is one-way southbound only.

Boston Post Road (US Route 20) / Cochituate Road (Route 27 / Route 126)

Cochituate Road (Route 27 / Route 126) intersects Boston Post Road (US Route 20) to form a four-way, fully-actuated signalized intersection. Both the Cochituate Road northbound and southbound approaches consist of an exclusive left-turn lane and a shared through/right-turn lane, while the Boston Post Road eastbound and westbound approaches consist of an exclusive left-turn lane, a through lane, and a shared through/right-turn lane. Directional flow along Cochituate Road and Boston Post Road is separated by a marked centerline. There are currently

"NO TURN ON RED" restrictions posted for both the Boston Post Road eastbound and westbound approaches. Sidewalks are provided on both sides of Cochituate Road and along the southerly edge of Boston Post Road at the intersection. Crosswalks are striped across each approach and the signal phasing includes an exclusive pedestrian phase. This intersection is currently being upgraded as part of the transportation mitigation for the Wayland Town Center project.

Cochituate Road (Route 27 / Route 126) / Millbrook Road / Pelham Island Road [North]

Millbrook Road and Pelham Island Road intersect Cochituate Road (Route 27 / Route 126) to form a four-way, unsignalized intersection. The Millbrook Road westbound approach is under STOP control while the Cochituate Road northbound and southbound approaches are free-flowing. Pelham Island Road is one-way flow exiting the intersection. The Millbrook Road westbound approach consists of a single general-purpose travel lane with directional flow separated by a marked centerline. The Cochituate Road northbound approach consists of a single general purpose travel lane, while the Cochituate Road southbound approach consists of a shared left-turn/through lane and a shared through/right-turn lane. Directional flow along Cochituate Road is separated by a marked centerline. Sidewalks are present along both sides of Cochituate Road, along the northerly side of Pelham Island Road, and along the southerly side of Millbrook Road. Crosswalks are striped across all approaches except the southerly Cochituate Road leg of the intersection.

Existing Traffic Volumes

In order to establish existing traffic-volume conditions at the study area intersections, manual Turning Movement Counts (TMCs) were conducted during the weekday morning (7:00 AM – 9:00 AM) and weekday evening (4:00 PM – 6:00 PM) peak periods at the study area intersections on Wednesday, February 13 and Thursday, February 14, 2013. TMCs were not conducted at the proposed site driveway (Town Dump Driveway) during the weekday evening peak period as the Town Dump is closed at this time. Automatic Traffic Recorder (ATR) count data collected on Boston Post Road near the Town Dump Driveway was utilized to determine through traffic volumes in either direction along Boston Post Road (US Route 20) at this location. A detailed summary of the turning movement counts, partitioned into 15-minute intervals, is provided within Attachment A.

In addition, Automatic Traffic Recorder (ATR) counts were conducted along Boston Post Road (US Route 20) east of the proposed site driveway concurrently with the TMCs on Wednesday, February 13 to Thursday, February 14, 2013 to gather daily traffic-volume and speed data during a continuous 48-hour time period. A summary of the Weekday ATR traffic data is presented in Table 1. A detailed summary of the ATR data, partitioned into 15-minute intervals, is provided within Attachment B.

Table 1 - Existing Weekday Traffic Volume Summary[a]

Location	Weekday Traffic Volume[b]	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		Traffic Volume[c]	K Factor[d]	Directional Distribution[e]	Traffic Volume	K Factor	Directional Distribution
Boston Post Road (east of driveway)	17,390	1,185	6.8	61.9% EB	1,366	7.9	53.1% WB

[a]Two-way traffic volume
[b]Daily traffic expressed in vehicles per day.
[c]Expressed in vehicles per hour.
[d]Percent of daily traffic volumes which occurs during the peak hour.
[e]Percent of peak-hour volume in the predominant direction of travel.
EB = eastbound; WB = westbound

Boston Post Road (US Route 20), east of the Town Dump Driveway (proposed site driveway), carries approximately 17,390 vehicles per day (vpd) on an average weekday. The majority of vehicles along Boston Post Road are travelling eastbound during the weekday morning peak period and westbound during the weekday evening peak period. This is consistent with commuter flows travelling to/from Interstate 95 to the east. Speed data collected as part of the ATR counts show that the 85th percentile speeds along Boston Post Road are approximately 50 mph.

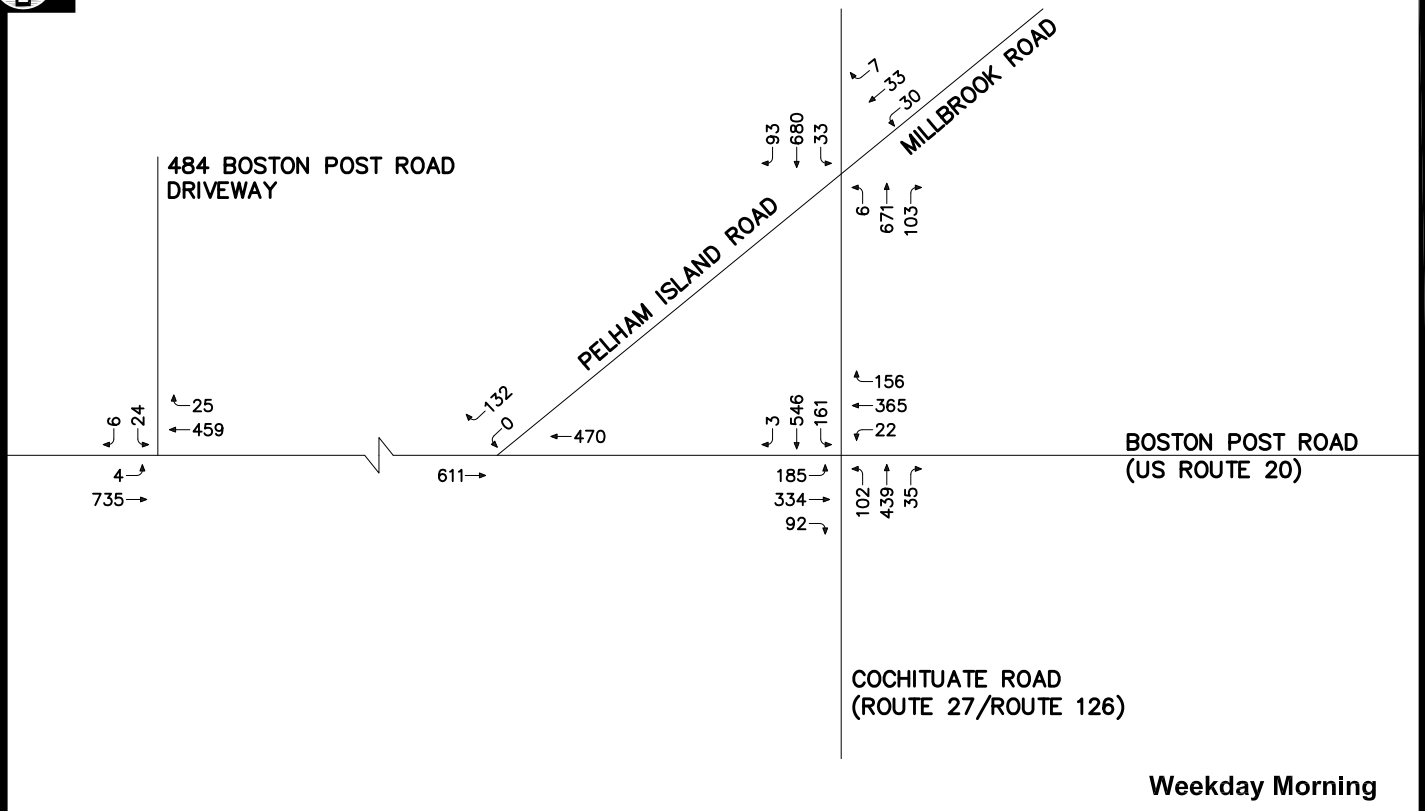
Seasonal Adjustment

In accordance with MassDOT standards, traffic volumes are typically adjusted to average-month conditions. Based on a review of historic traffic-volume counts collected by MassDOT at permanent count stations along Interstate 95 / Route 128 in Lexington[1], and along Route 2 in Concord[2], traffic volumes in February are 3.8 percent lower than average-month conditions. Therefore, the February 2013 traffic counts were increased by 3.8 percent to reflect average-month conditions. These two count station locations represent the closest MassDOT Permanent Count Station locations to the project site that serve Boston commuter flows similar to Boston Post Road (US Route 20) traffic volumes near the project site. The compiled seasonal adjustment data is provided in Attachment C. The resulting 2013 Existing weekday morning and weekday evening peak-hour traffic-volume networks are illustrated in Figure 2.

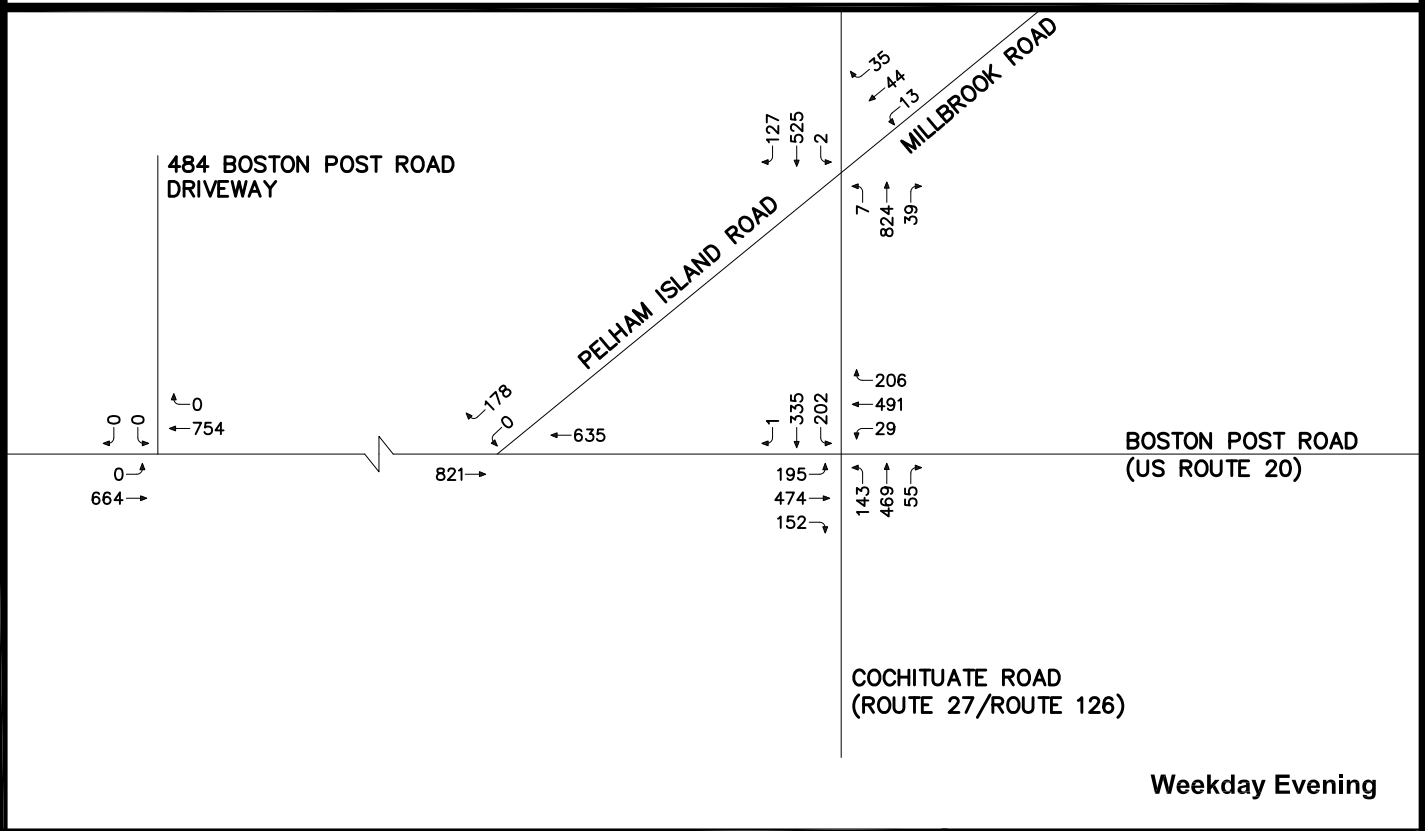
[1] MassDOT Permanent Count Station 4118 – Lexington – Interstate 95 / Route 128 – North of Route 2A
[2] MassDOT Permanent Count Station 403 – Concord – Route 2 – East of Concord Rotary

Not to Scale

River's Edge Residential Development - Wayland, Massachusetts



Weekday Morning



Weekday Evening

Figure 2

**2013 Existing Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes**

Crash History Analysis

Collision data for the study area intersections was compiled and analyzed for the most recent consecutive three year period (2008-2010) on file from MassDOT. The motor vehicle crash data was reviewed to determine if any collision trends exist within the study area. A summary of the vehicle collision data and intersection crash rates are provided in Table 2.

This study area does not include any intersections from MassDOT's Top 200 Crash Locations. The intersection of Boston Post Road (US Route 20) / Cochituate Road (Route 27 / Route 126) is considered Highway Safety Improvement Program (HSIP) eligible. However, the crash data utilized to determine HSIP eligibility may not represent existing conditions at the intersection based on recent and future improvements being implemented as mitigation for the Wayland Town Center development.

Crash Rate Worksheets

In addition to examining the number of collisions at the study area intersections, a crash rate was calculated to compare occurrence of collisions to the volume of traffic passing through the intersection. The crash rate per million entering vehicles (MEV) was calculated using the evening peak hour volumes from the TMCs and a calculated K-factor obtained from ATR counts. The crash rates at each of the study area intersections were compared to the statewide and district-wide averages published by MassDOT in January 2013 to determine the significance of the collision occurrence. The statewide average for signalized intersections is 0.80 and the District 3 average for signalized intersections is 0.89. The statewide average for unsignalized intersections is 0.60 and the District 3 average for unsignalized intersections is 0.66. A compilation of the MEV rate calculation worksheets and detailed crash data are provided in Attachment D.

Collision Data Summary

The intersection of Boston Post Road (US Route 20) / Cochituate Road (Route 27 / Route 126) experienced an average of approximately 6 collisions per year over the three-year study period. The crash rate for this intersection is significantly lower than the statewide and district-wide averages for signalized intersections. Approximately half (9 of 19) of the collisions were rear-end collisions, which are typical of signalized intersections. In addition, approximately 37 percent (7 of 19) of the collisions occurred during the weekday evening commuter period, which may be a result of heavy traffic congestion and long vehicle queues along the Boston Post Road corridor.

All other intersections within the study area experienced an average of fewer than three crashes per year over the three-year study period and crash rates significantly lower than statewide and district-wide averages, indicating that no noticeable trend exists. A compilation of the MEV rate calculation worksheets and crash data can be found in the Attachment D.

Table 2 - Crash Data Summary

		Rt. 20 / Town Dump Driveway	Rt. 20 / Pelham Island Road	Rt. 20 / Cochituate Road	Cochituate Road / Millbrook Road
Crash Year:	2008	1	0	6	3
	2009	0	1	8	3
	2010	1	1	5	2
	TOTAL	**2**	**2**	**19**	**8**
Annual Average		*0.67*	*0.67*	*6.33*	*2.67*
Crash Rate (MEV):		*0.10*	*0.09*	*0.50*	*0.52*
Significant:		NO	NO	NO	NO
Type:	Angle	1	1	5	5
	Rear-end	0	1	9	1
	Sideswipe	1	0	2	1
	Head-on	0	0	1	0
	Single Vehicle	0	0	1	0
	Not Reported	0	0	1	1
	TOTAL	**2**	**2**	**19**	**8**
Surface Conditions:	Dry	2	2	16	7
	Wet	0	0	3	1
	Snow/Slush/Ice	0	0	0	0
	Other / Unknown	0	0	0	0
	TOTAL	**2**	**2**	**19**	**8**
Severity:	PDO	1	2	13	5
	Non-Fatal Injury	1	0	3	2
	Fatal Injury	0	0	0	0
	Not Reported	0	2	3	1
	TOTAL	**2**	**20**	**19**	**8**
Day of Week:	Monday-Friday	2	2	12	7
	Saturday-Sunday	0	0	7	1
	TOTAL	**2**	**2**	**19**	**8**
Time of Day:	6:00AM-9:00AM	0	0	2	0
	9:00AM-3:00PM	1	0	6	1
	3:00PM-6:00PM	1	2	7	4
	6:00PM-6:00AM	0	0	4	3
	TOTAL	**2**	**2**	**19**	**8**

Sight Distance Measurements

TEC, Inc. visited the site on Thursday, February 28, 2013 to measure the available sight distances at the location of the existing Town Dump Driveway, which will serve as the proposed development's access to Boston Post Road (US Route 20). The available sight distances were compared to minimum requirements established by the American Association of State Highway and Transportation Officials (AASHTO).

Sight distance represents the length of roadway that is visible to a driver traveling within the roadway. Two types of sight distance are typically evaluated for driveways and intersections: stopping sight distance (SSD) and intersection sight distance (ISD). SSD is the minimum distance required for a driver traveling along a roadway to perceive an object in the roadway and stop safely in advance of the object when traveling on a wet pavement surface. SSD is measured from an eye height of 3.5 feet to an object height of 2 feet above the ground, which is equivalent to a driver viewing the taillight of a vehicle ahead. SSD is measured along the centerline of the travel lane approaching the driveway or intersection.

ISD represents the length of the roadway visible to a driver waiting to exit a driveway or minor street. Minimum ISD requirements are based on the distance required for a driver to exit a minor street onto a major street without requiring an approaching vehicle to reduce its speed from the design speed to less than 70 percent of the design speed. ISD is measured from an eye height of 3.5 feet to an object height of 3.5 feet, and is measured from a distance 15 feet off the edge of the travel-way of the major roadway to represent a driver waiting to exit a driveway or minor roadway.

SSD is typically considered the critical sight distance, as it represents the minimum distance required for safe stopping, while ISD represents an acceptable speed reduction for approaching vehicles. The ISD, however, must be at least equal to the minimum required SSD in order to prevent a driver from entering the roadway when an approaching vehicle is too close to safely stop. The guidance provided by AASHTO states:

> *"If the available sight distance for an entering or crossing vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to anticipate and avoid collisions. However, in some cases, this may require a major-road vehicle to stop or slow to accommodate the maneuver by a minor-road vehicle. To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road."*

The available SSD and ISD at the existing Town Dump Driveway intersection was measured and compared to AASHTO's minimum requirements based on a 85th percentile speed of approximately 50 miles per hour (mph) along Boston Post Road (US Route 20). Table 3 provides a summary of the available sight distances at the study intersections.

Table 3 - Sight Distance Measurements

Approach/Direction	Stopping Site Distance Minimum Required	Stopping Site Distance Measured	Intersection Site Distance Minimum Required	Intersection Site Distance Measured
Boston Post Road at Town Dump Driveway:				
East of Site Driveway	425 FT	+700 FT	555 FT	+700 FT
West of Site Driveway	425 FT	+700 FT	555 FT	+700 FT

As shown in Table 3, the SSD and ISD at the existing Town Dump Driveway exceeds AASHTO's minimum recommendations for safe operations.

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2018, which reflects a five-year planning horizon in accordance with MassDOT standards. The traffic conditions for the year 2018, under No-Build conditions, were developed to document the operating conditions independent of the proposed project, including all existing traffic, new traffic resulting from background growth, and traffic from specific development projects expected to be completed by 2018. Anticipated site-generated traffic volumes for the proposed residential development were superimposed upon the No-Build traffic networks to reflect the Build conditions with the proposed project.

Background Traffic Growth

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. Traffic engineers frequently employ an annual percentage increase in traffic growth, which is applied 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 considered.

General Background Growth

Traffic-volume data compiled by MassDOT from permanent count stations and historic traffic counts in Concord, Framingham, Natick, Newton, Waltham, and Weston along arterial commuter roadways in the vicinity of the Town of Wayland were reviewed in order to determine traffic growth trends. Based on the MassDOT traffic volume data, traffic volumes in the area have been decreasing at a rate of 0.7 percent per year since 2000.

TEC also reviewed turning movement counts conducted at the intersection of Boston Post Road (US Route 20) / Cochituate Road (Route 27 / Route 126) that were conducted as part of the Wayland Town Center development project in May 2007. The May 2007 counts were compared to the seasonally adjusted February 2013 traffic volumes, which indicated that traffic volumes during the weekday morning increased by approximately 1 percent over the six year period, while

the weekday evening counts indicated a negligible growth in traffic volumes over the six year period.

In order to provide a conservative (worse case) analysis scenario, a 1.0 percent per year compounded annual background traffic growth rate was used to account for potential future traffic growth external to the study area and presently unforeseen development. Count station data and the May 2007 traffic counts have been included in Attachment E.

Specific Development by Others

TEC coordinated with the Town of Wayland and Town of Sudbury Planning Departments to identify nearby private / public development projects in the vicinity of the study area that are either in the planning process or were recently approved but not yet occupied. After discussions with Town officials and review of recently approved projects, six (6) projects were identified within the Town of Wayland and Sudbury that would contribute significant traffic volumes to the study area. These projects are described in detail below:

- *Wayland Town Center* – The Wayland Town Center project consists of the development of an approximately 56.5-acre parcel of land situated north of Boston Post Road (US Route 20) and west of Route 27. The development consists of a maximum of 167,000 square feet (SF) of residential uses, 155,000 SF of retail/commercial uses, 10,000 SF of office space, and a deeded parcel to contain a potential 40,000 SF municipal building. As of the date of the traffic counts in February 2013, a 40,000 SF Stop & Shop Supermarket and a 5,000 SF Bertucci's Restaurant were open while many additional retail structures were constructed with identified tenants, but unoccupied. Several other components of the development are still under construction. According to Town officials, the residential component of the project was recently reduced from 100 to 44 units. Traffic-volumes expected to be generated by the remaining unopened development were estimated based on the revised trip generation information presented in the Master Special Permit Traffic Impact and Access Study[3,4] prepared for the project and have been included as part of this study.
- *Sudbury Village* – The Sudbury Village development consists of constructing a 73-unit Section 40B apartment complex along Boston Post Road in Sudbury, MA. The project was recently approved by the Town's Planning Board. Traffic-volumes expected to be generated by the development were estimated based on the combined trip generation model for specific known residential developments in Sudbury west of the site. The projected trip distribution for the River's Edge Residential Development based on US Census Journey to Work data was used to determine the number of trips that will traverse Boston Post Road (US Route 20) in front of the site.
- *Landham Crossing* – The Landham Crossing development consists of constructing a 31-unit Chapter 40B apartment complex at 192 Boston Post Road in Sudbury, MA. The project is currently under construction. Traffic-volumes expected to be generated by the development were estimated based on the combined trip generation model for specific known residential developments in Sudbury west of the site. The projected trip distribution for the River's Edge Residential

[3] *Master Special Permit Traffic Impact and Access Study*; Wayland Town Center – Wayland, Massachusetts; Vanasse & Associates, Inc.; May 2007

[4] *Traffic Engineering Peer Review – Response to Comments*; Wayland Town Center – Wayland, Massachusetts; Vanasse & Associates, Inc.; August 6, 2007

Development was used to determine the number of trips that will traverse Boston Post Road (US Route 20) in front of the site.

- *The Coolidge* – The Coolidge development consists of constructing a 64-unit Section 40B apartment complex at 189 Boston Post Road in Sudbury, MA. The project was recently approved by the Town's Planning Board. Traffic-volumes expected to be generated by the development were estimated based on the combined trip generation model for specific known residential developments in Sudbury west of the site. The projected trip distribution for the River's Edge Residential Development was used to determine the number of trips that will traverse Boston Post Road (US Route 20) in front of the site.
- *Johnson Farm* – The Johnson Farm development consists of constructing a 56-unit Section 40B apartment complex at 189 Landham Road in Sudbury, MA. The project was recently approved by the Town's Planning Board. Traffic-volumes expected to be generated by the development were estimated based on the combined trip generation model for specific known residential developments in Sudbury west of the site. The projected trip distribution for the River's Edge Residential Development was used to determine the number of trips that will traverse Boston Post Road (US Route 20) in front of the site.
- *Town of Wayland DPW Facility* – The Town of Wayland has recently approved the construction of a 40,000 SF DPW facility which will share a driveway with the proposed River's Edge Apartments. It is expected that only 20 to 40 vehicle trips per day will enter and exit the facility. Traffic-volumes expected to be generated during the peak hours was estimated at 20 vehicles during the weekday morning peak period and 10 vehicles during the weekday evening peak period.

Several additional residential developments are proposed within the Town of Wayland and the Town of Sudbury; however; based on the overall size and location of these developments, there is not expected to be any substantial increase to traffic volumes along Boston Post Road (US Route 20) within the study area. Trips that will be generated by these developments are assumed to be included as part of the 1-percent annual background growth rate.

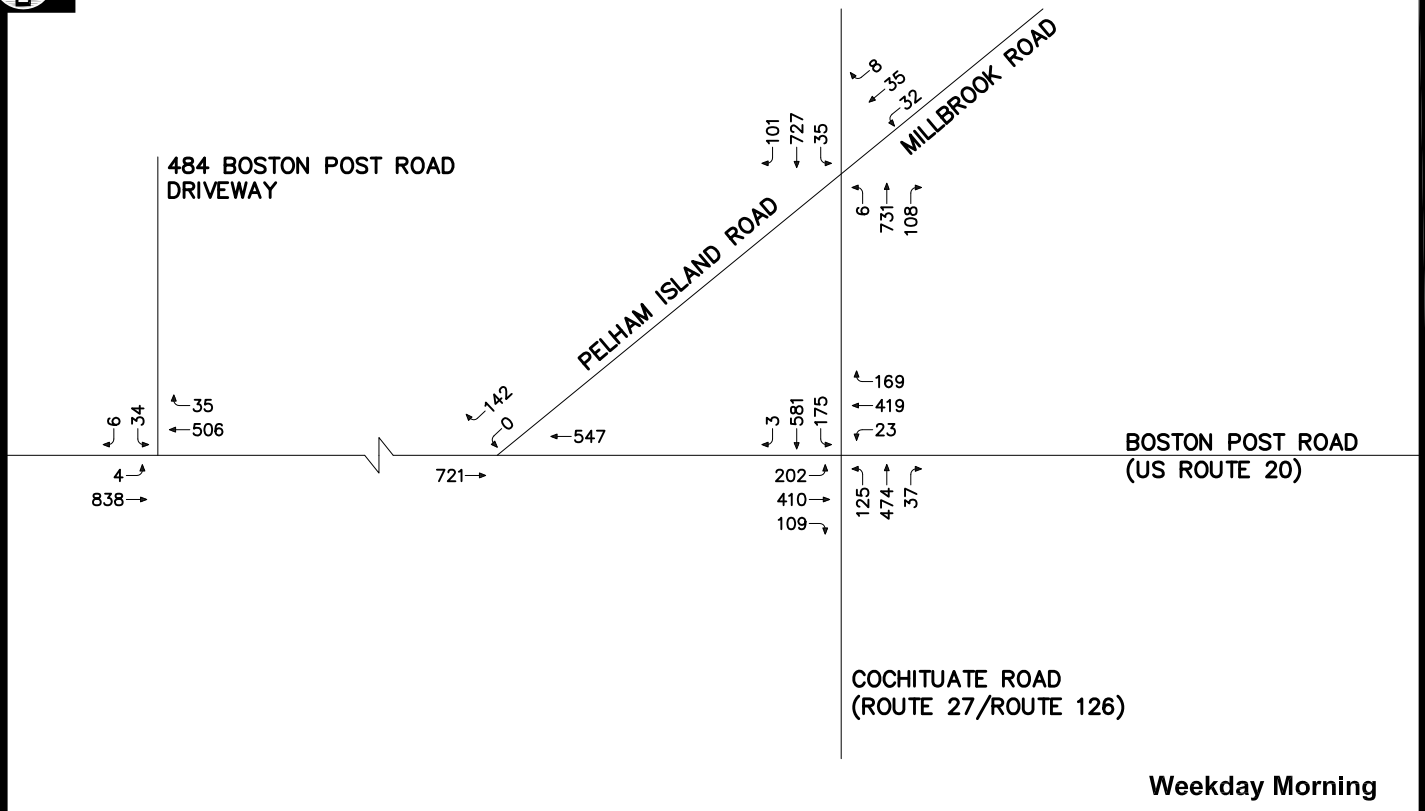
The resulting "Other Development" traffic-volumes are illustrated in Figure F-1 for the weekday morning and weekday evening peak hours. Detailed trip generation worksheets for each development have been provided in Attachment F.

No-Build Traffic Volumes

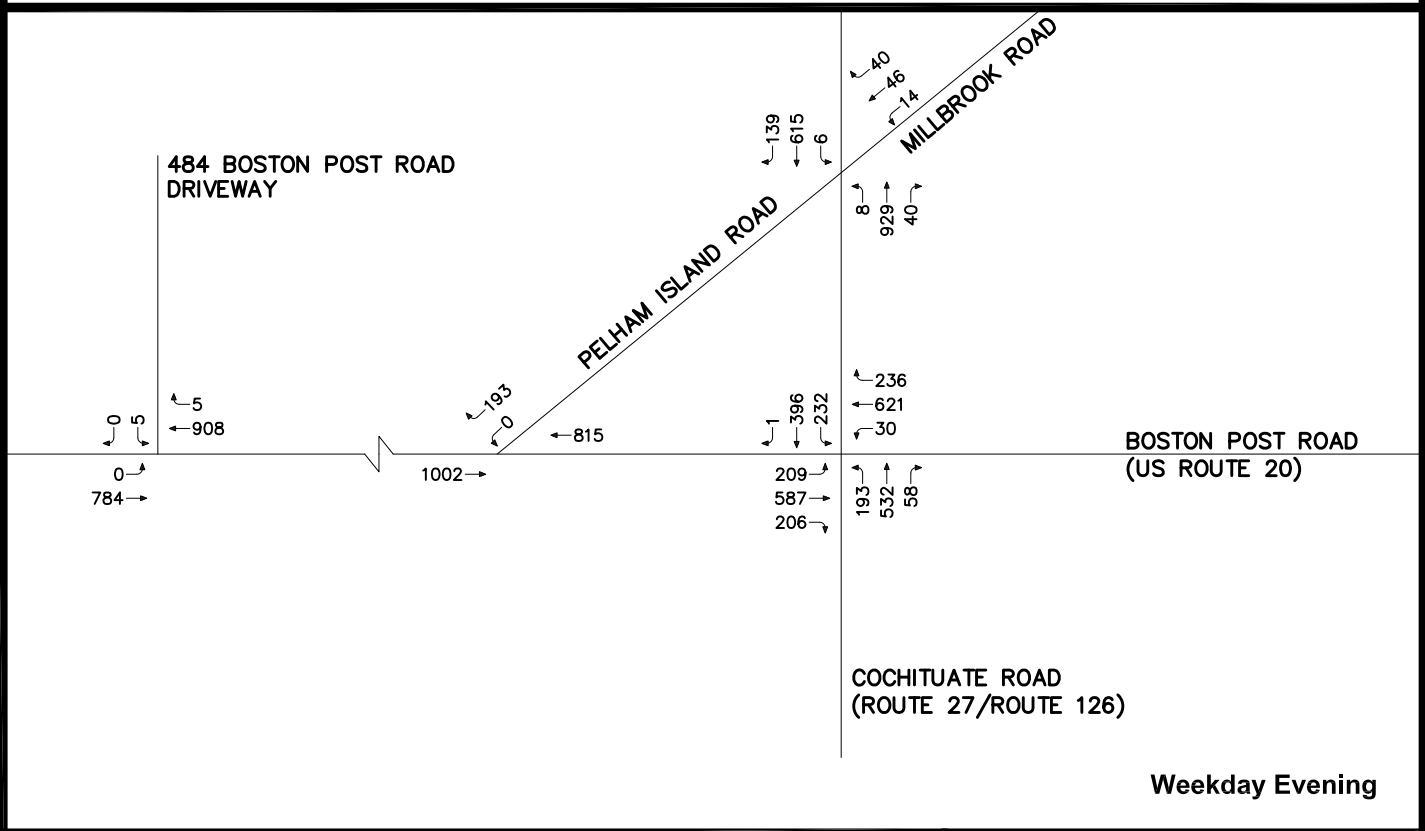
The 2018 No-Build weekday morning and weekday evening peak-hour traffic-volume networks were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2013 Existing peak-hour traffic-volumes over the 5-year design horizon and adding traffic volumes to be generated by specific developments by others. The resulting 2018 No-Build weekday morning and weekday evening peak-hour traffic-volume networks are illustrated in Figure 3.

Not to Scale

River's Edge Residential Development - Wayland, Massachusetts



Weekday Morning



Weekday Evening

Figure 3

2018 No-Build Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

Site-Generated Traffic

The project consists of constructing a 216-unit residential development (151-unit age-restricted housing and 65-unit non-restricted housing). The site-generated traffic-volumes for the project were estimated based on standard trip rates published in the Institute of Transportation Engineers (ITE) publication *Trip Generation, 9th Edition* for Land Use Codes (LUC) 220 – Apartments and LUC 252 – Senior Adult Attached Housing. Table 4 provides a summary of the projected site trip generation.

Table 4 - Trip Generation Summary – 216 Units (w/ 151 age-restricted)

	LUC 220		LUC 252		TOTAL	
Time Period	IN	OUT	IN	OUT	IN	OUT
Weekday Daily	259	258	235	236	494	494
Morning Peak Hour	7	29	10	20	17	49
Evening Peak Hour	34	19	21	17	55	36
Saturday Daily	208	207	171	171	379	378
Saturday Midday Peak Hour	23	23	27	20	50	43

The proposed housing development is anticipated to generate approximately 988 vehicle trips on an average weekday, approximately 66 vehicle trips (17 entering and 49 exiting) during the weekday morning peak hour, and approximately 91 vehicle trips (55 entering and 36 exiting) during the weekday evening peak hour. On an average Saturday, the proposed age-restricted housing development is anticipated to generate approximately 757 vehicle trips daily with approximately 93 vehicle trips (50 entering and 43 exiting) during the Saturday midday peak hour.

The proposed residential development is expected to increase traffic along Boston Post Road (US Route 20) by only 3 percent during the weekday morning and evening peak periods. Trip generation calculations are provided in Attachment G.

In the event that the project changes to consider only traditional market housing (non-age-restricted), it will generate slightly more vehicle trips during each interval. Table 5 provides a summary of the associated trips.

Table 5 - Trip Generation Summary – 216 Units (w/ no age-restricted units)

	LUC 220	
Time Period	IN	OUT
Weekday Daily	717	717
Morning Peak Hour	22	88
Evening Peak Hour	88	48
Saturday Daily	690	690
Saturday Midday Peak Hour	54	54

Although this increase in trips will result in a need to file an Environmental Notification Form (ENF) through the Massachusetts Environmental Policy Act (MEPA) office, it will not result in a noticeable increase in traffic on the area roadways. It will result in approximately one additional vehicle trip per minute for all entering and exiting movements during the peak hour at the site driveway; the impacts are significantly less at the other study area intersections as traffic disperses.

Trip Distribution

The distribution of residential site-generated traffic volumes was based upon a gravity model using 2000 U.S. Census Bureau Journey to Work data for the Town of Wayland residents working in municipalities surrounding the site. The resulting primary trip distribution is shown in Table 6 and the gravity model is included in Attachment H.

Table 6 - Trip Distribution Summary

Direction	Distribution Percentage
Route 20 to/from West	13%
Route 20 to/from East	55%
Route 27/126 to/from North	10%
Route 27/126 to/from South	20%
Millbrook Road to/from East	2%
Total	100%

The resulting site-generated traffic-volume networks for the weekday morning and weekday evening peak hours are presented in Figure 4.

Build Traffic Volumes

The 2018 Build condition traffic-volume networks consist of the 2018 No-Build traffic-volumes with the addition of the anticipated site-generated traffic. The resulting 2018 Build weekday morning and weekday evening peak-hour traffic-volume networks are presented in Figure 5.

LEFT-TURN LANE WARRANT ANALYSIS

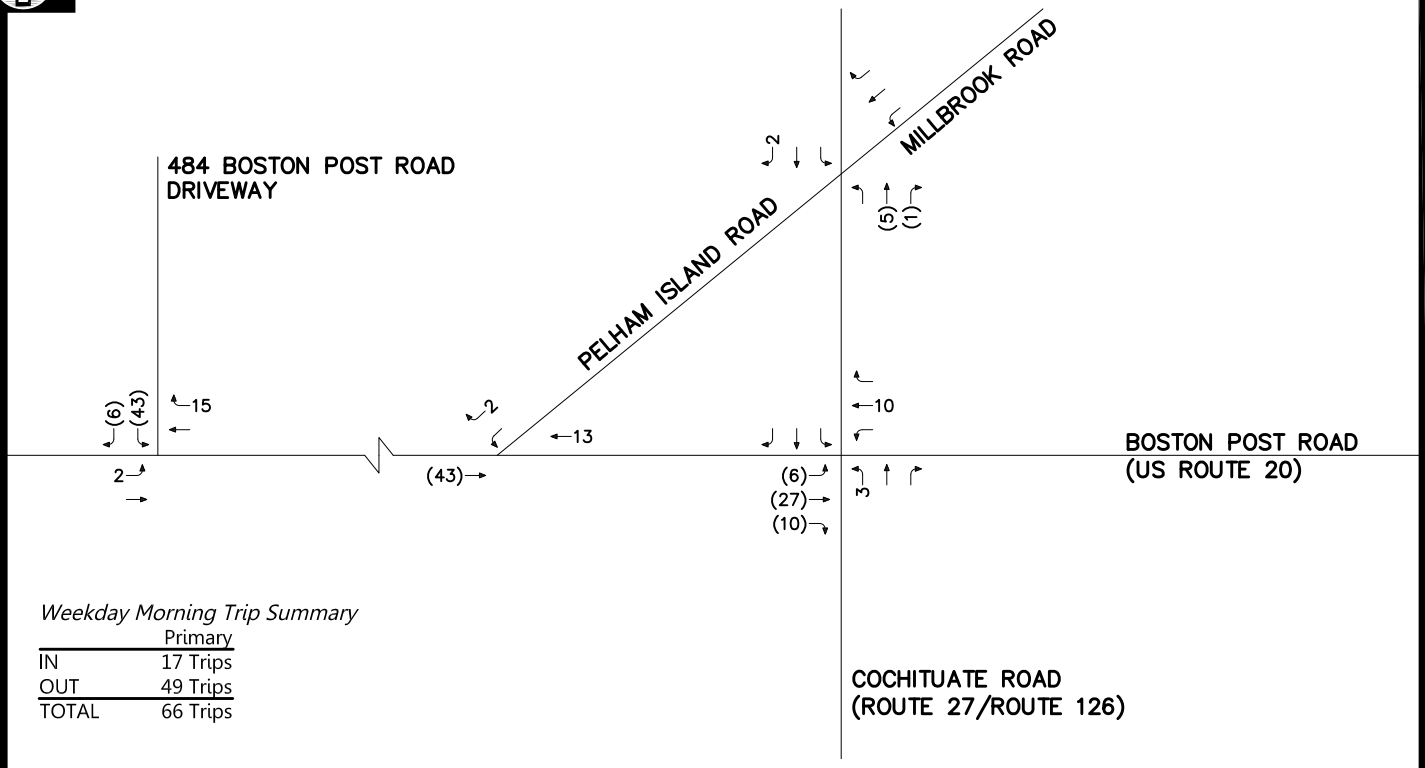
A left-turn lane warrant analysis was conducted for the eastbound approach of the intersection of Boston Post Road (US Route 20) / Town Dump Driveway. The left-turn lane warrant analysis was conducted using hourly traffic volumes based on ATRs conducted in February 2013, the weekday morning TMCs, and the site-generated trip estimates utilizing LUC 220 – Apartments and LUC 252 – Senior Adult Attached Housing. The potential left-turn lane was analyzed under unsignalized intersection conditions.

MassDOT defines left-turn lane warrants at unsignalized intersections based on the Highway Capacity Manual (HCM), 2000 Exhibit 6-23. The criteria are based on the design speed of the roadway, the opposing volume, and the percent of left-turning vehicles for the advancing vehicle volume. The unsignalized operating conditions at the Town Dump Driveway with the site-generated traffic volumes do not warrant the construction of a left-turn lane on Boston Post Road (US Route 20) westbound. An excerpt from the MassDOT Project Design Guide[5] noting the criteria for the introduction of a left-turn lane is provided in Attachment I.

[5] Project Development and Design Guide – Massachusetts Highway Department – 2006 Edition

Not to Scale

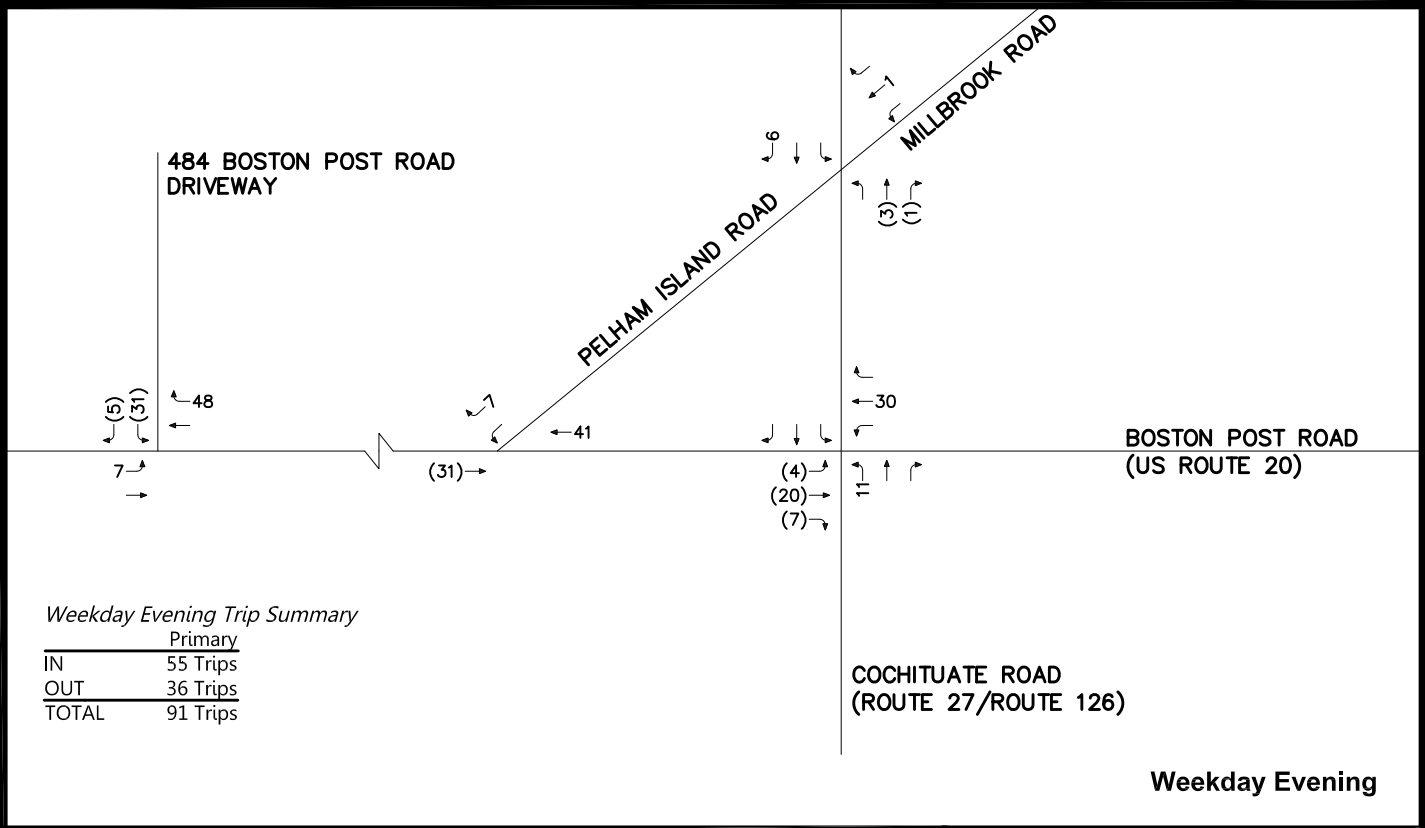
River's Edge Residential Development - Wayland, Massachusetts



Weekday Morning Trip Summary

	Primary
IN	17 Trips
OUT	49 Trips
TOTAL	66 Trips

Weekday Morning



Weekday Evening Trip Summary

	Primary
IN	55 Trips
OUT	36 Trips
TOTAL	91 Trips

Weekday Evening

Figure 4

Site Generated Trip Assignment
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

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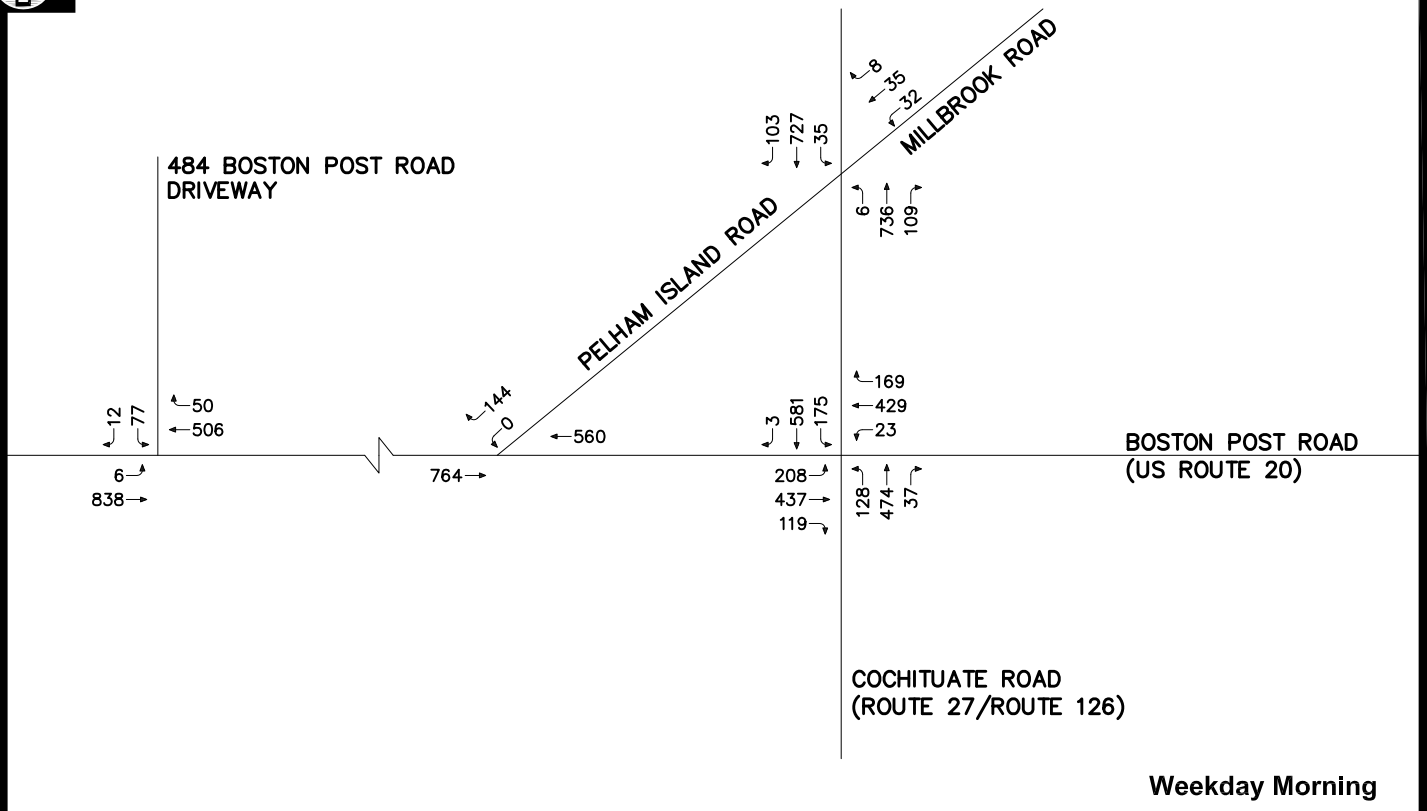
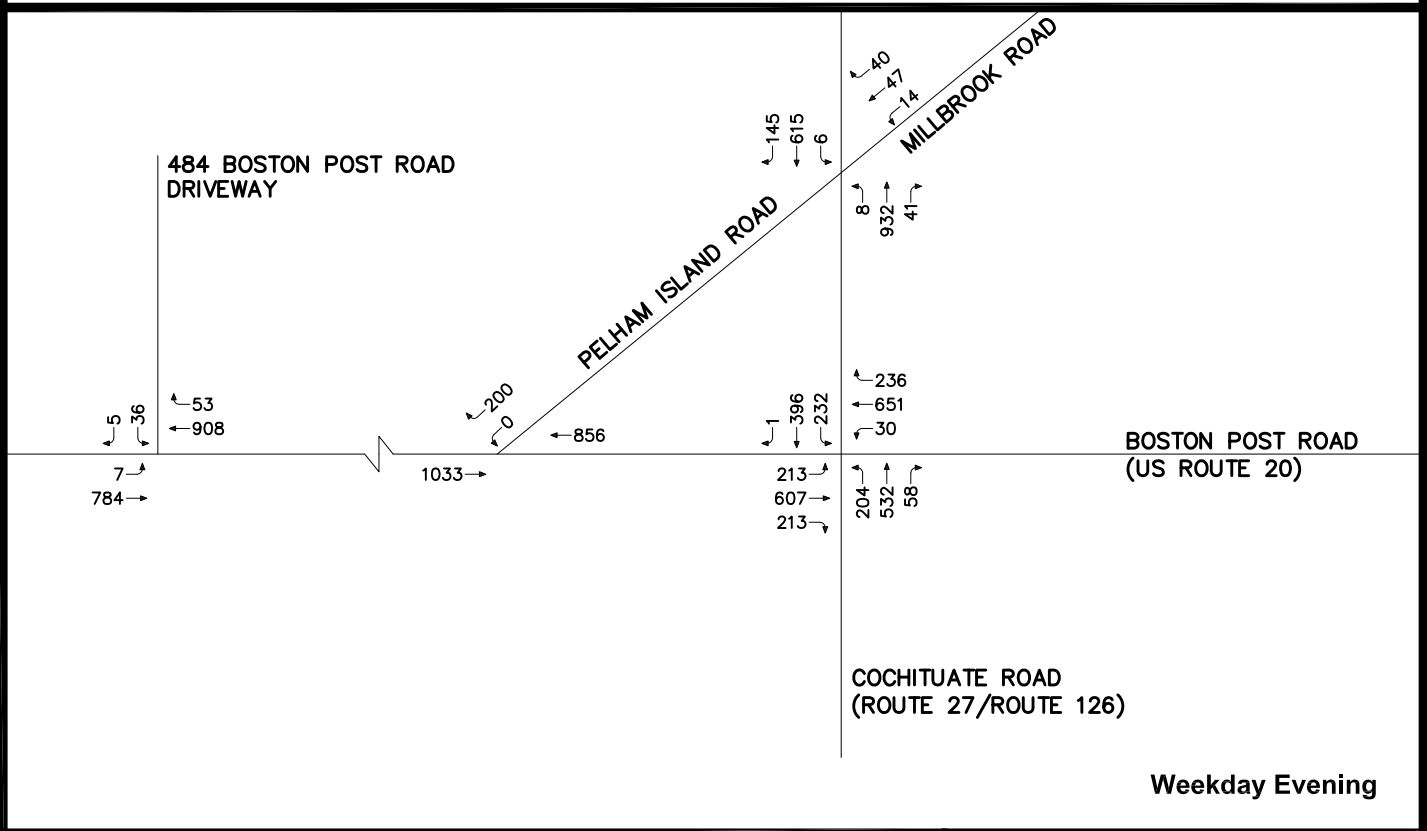
Not to Scale

River's Edge Residential Development - Wayland, Massachusetts



Weekday Morning



Weekday Evening

Figure 5

2018 Build Conditions
Weekday Morning and
Weekday Evening
Peak Hour Traffic Volumes

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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.[6] 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 the worst. 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.

Queue Length Analysis

Vehicle queue analyses are a direct measurement of an intersections ability to process vehicles under various traffic control and volume scenarios and lane use arrangements.

The vehicle queue analysis was performed using the Synchro 8.0 intersection capacity analysis software which is also based upon the methodology and procedures presented in the 2010 HCM. Synchro reports the 95th percentile queues for unsignalized intersections and both the 50th (average) and 95th percentile vehicle queues for signalized intersections, which are based on the number of vehicles that experience a delay of six seconds or more at an intersection and is a function of the traffic signal timing; vehicle arrival patterns during the analysis period; and the saturation flow rate. The 50th percentile or average vehicle queue is the average number of vehicles that are projected to be delayed by six seconds or more at the intersection under study during the analysis period. The 95th percentile vehicle queue is the vehicle queue length that will be exceeded only 5 percent of the time; or approximately three minutes out of sixty minutes during the peak one hour of the day. During the remaining fifty-seven minutes, the vehicle queue length will be less than the 95th percentile queue length.

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

Unsignalized Intersections

The six levels of service for two-way STOP-controlled unsignalized intersections may be described as follows:

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

The levels of service of unsignalized intersections are determined by application of a procedure described in the *2010 Highway Capacity Manual.* 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 7 summarizes the relationship between level of service and average control delay.

Table 7 - Level-of-Service Criteria for Two-Way STOP-controlled Unsignalized Intersections[a]

Level of Service with V/C ≤ 1.0	Level of Service with V/C > 1.0	Average Control Delay (seconds per vehicle)
A	F	≤ 10.0
B	F	10.1 to 15.0
C	F	15.1 to 25.0
D	F	25.1 to 35.0
E	F	35.1 to 50.0
F	F	>50.0

[a]Source: *Highway Capacity Manual 2010*; Transportation Research Board; Washington, DC; 2010; page 19-2.

Unsignalized Intersection Capacity and Queue Analysis Results

Level-of-service and queue analyses were conducted for 2013 Existing, 2018 No-Build, and 2018 Build conditions for the unsignalized intersections within the study area. The results of the unsignalized intersection capacity and queue analysis are summarized in Table 8. The capacity analysis worksheets are provided in Attachment J.

Boston Post Road (US Route 20) / Town Dump Driveway

Vehicles exiting the River's Edge Apartment / Town Dump Driveway will experience delay during the weekday morning and weekday evening peak periods for both the No-Build and Build conditions. The Boston Post Road (US Route 20) eastbound and westbound approaches are expected to continue operating at acceptable levels of service (LOS B or better) during both the weekday morning and weekday evening peak periods.

Boston Post Road (US Route 20) / Pelham Island Road

Although traffic exiting Pelham Island Road will experience delay during the weekday evening peak hour, the volume-to-capacity (V/C) ratio will be well below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes. The additional traffic generated by the proposed residential development is not expected to increase delay by more than 7 seconds per vehicle on any approach or increase queues by more than two vehicles in any lane.

Cochituate Road (Route 27/126) / Pelham Island Road / Millbrook Road

Although traffic exiting the Millbrook Road westbound approach will experience delay during the weekday morning peak hour, the V/C ratio will be below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes. All other movements at this intersection are anticipated to operate at acceptable levels of service (LOS D or better) with queues not exceeding one vehicle under Build conditions. The additional traffic generated by the proposed residential development is not expected to increase delays on any movement by more than 6 seconds per vehicle or increase queues by more than one vehicle.

Table 8 - Unsignalized Intersection Capacity and Queue Analysis Summary

	2013 Existing				2018 No-Build				2018 Build			
Intersection / Lane Group	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Boston Post Road / Town Dump Driveway (Site Driveway)												
Weekday Morning Peak Period												
Boston Post Road EB approach	0.01	8.5	A	<25	0.01	8.7	A	<25	0.01	8.8	A	<25
Site Driveway SB approach	0.26	31.8	D	<25	0.46	52.2	F	53	1.08	166.9	F	198
Weekday Evening Peak Period												
Boston Post Road EB approach	-	-	-	-	-	-	-	-	0.01	10.3	B	<25
Site Driveway SB approach	-	-	-	-	0.06	48.1	E	<25	0.49	79.1	F	53
Boston Post Road / Pelham Island Road												
Weekday Morning Peak Period												
Pelham Island Road SB RT	0.38	17.7	C	43	0.47	22.1	C	60	0.49	23.1	C	65
Weekday Evening Peak Period												
Pelham Island Road SB RT	0.46	19.7	C	60	0.64	32.4	D	105	0.71	38.9	E	128
Cochituate Road / Millbrook Road / Pelham Island Road												
Weekday Morning Peak Period												
Millbrook Road WB approach	0.71	65.0	F	108	0.88	104.3	F	150	0.90	109.9	F	155
Cochituate Road NB approach	0.01	10.1	B	<25	0.01	10.3	B	<25	0.01	10.3	B	<25
Cochituate Road SB approach	0.04	9.9	A	<25	0.05	10.2	B	<25	0.05	10.3	B	<25
Weekday Evening Peak Period												
Millbrook Road WB approach	0.36	24.9	C	40	0.48	33.8	D	60	0.49	34.3	D	60
Cochituate Road NB approach	0.01	9.2	A	<25	0.01	9.7	A	<25	0.01	9.7	A	<25
Cochituate Road SB approach	0.00	9.7	A	<25	0.01	10.2	B	<25	0.01	10.3	B	<25

[a] Volume-to-capacity ratio
[b] Delay expressed in seconds per vehicle (average)
[c] Level of service
[d] 95th Percentile Queue

Signalized Intersections

The six Levels of Service (LOS) for signalized intersections may be described as follows:

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

LOS for signalized intersections is calculated using the operational analysis methodology of the 2010 Highway Capacity Manual. This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. LOS designations are based on the criterion of control or signal delay per vehicle. Control or signal delay can be related to driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. Table 9 summarizes the relationship between LOS and control delay. The tabulated control delay criterion may be applied in assigning LOS designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table 9 – Level-of-Service Criteria for Signalized Intersections[a]

Level of Service with V/C ≤ 1.0	Level of Service with V/C > 1.0	Average Control (Signal) Delay (Seconds per Vehicle)
A	F	<10.0
B	F	10.1 to 20.0
C	F	20.1 to 35.0
D	F	35.1 to 55.0
E	F	55.1 to 80.0
F	F	>80.0

[a]Source: *Highway Capacity Manual 2010*; Transportation Research Board Washington, DC; 2010; page 18-6.

Signalized Intersection Capacity and Queue Analysis Results

Table 10 provides a summary of the intersection capacity analysis for the signalized intersections within the study area during each peak period. The analysis includes a summary under 2013 Existing conditions, as well as the 2018 No-Build and 2018 Build scenarios. The intersection capacity analysis worksheets from the Synchro 8.0 program are provided in Attachment J.

Boston Post Road (US Route 20) / Cochituate Road (Route 27/126)

The intersection of Boston Post Road (US Route 20) / Cochituate Road (Route 27/126) is anticipated to operate at overall LOS E or better under all analysis scenarios. Although some movements at this intersection will experience delay during the weekday morning and evening peak hours under No-Build and Build conditions, the additional traffic generated by the proposed residential development is not anticipated to increase overall intersection delay by more than four seconds per vehicle or increase queues in any given lane by more than two vehicles. In some cases, the minor increase in delays migrates into the next level of service category as the No-Build condition was just below the threshold.

Table 10 – Signalized Intersection Capacity and Queue Analysis Summary

Intersection / Lane Group	2013 Existing				2018 No-Build				2018 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Boston Post Road / Cochituate Road												
Weekday Morning Peak Period												
Boston Post Road EB LT	0.84	46.0	D	114/182	0.99	75.4	E	91/202	1.03	86.9	F	99/210
Boston Post Road EB TH	0.53	23.6	C	234/276	-	-	-	-	-	-	-	-
Boston Post Road EB RT	0.15	15.5	B	42/59	-	-	-	-	-	-	-	-
Boston Post Road EB TH/RT	-	-	-	-	0.68	33.5	C	119/183	0.73	35.8	D	130/198
Boston Post Road WB LT	0.09	31.1	C	<25/34	0.12	23.1	C	<25/<25	0.13	23.3	C	<25/<25
Boston Post Road WB TH	0.84	44.3	D	319/385	-	-	-	-	-	-	-	-
Boston Post Road WB RT	0.33	25.5	C	93/130	-	-	-	-	-	-	-	-
Boston Post Road WB TH/RT	-	-	-	-	0.95	65.0	E	169/212	0.96	68.2	E	174/228
Cochituate Road NB LT	0.50	26.7	C	47/87	0.58	23.1	C	41/72	0.59	23.3	C	41/74
Cochituate Road NB TH/RT	0.88	47.3	D	373/581	1.06	82.1	F	324/494	1.06	82.1	F	324/494
Cochituate Road SB LT	0.66	29.6	C	69/187	0.73	30.4	C	52/132	0.73	30.4	C	52/132
Cochituate Road SB TH/RT	0.85	42.9	D	377/647	1.02	69.7	F	355/530	1.02	70.9	F	335/530
Overall Intersection	**0.57**	**37.5**	**D**	-	**0.82**	**58.9**	**E**	-	**0.84**	**60.9**	**E**	-
Weekday Evening Peak Period												
Boston Post Road EB LT	0.93	70.4	E	123/288	1.14	136.5	F	130/284	1.17	145.4	F	137/292
Boston Post Road EB TH	0.63	27.4	C	313/432	-	-	-	-	-	-	-	-
Boston Post Road EB RT	0.20	15.7	B	60/97	-	-	-	-	-	-	-	-
Boston Post Road EB TH/RT	-	-	-	-	0.83	47.9	D	267/390	0.86	50.8	D	280/412
Boston Post Road WB LT	0.14	38.0	D	<25/44	0.19	27.8	C	<25/33	0.20	28.1	C	<25/33
Boston Post Road WB TH	0.92	58.8	E	423/607	-	-	-	-	-	-	-	-
Boston Post Road WB RT	0.36	25.9	C	116/174	-	-	-	-	-	-	-	-
Boston Post Road WB TH/RT	-	-	-	-	1.02	84.0	F	297/438	1.05	93.7	F	335/465
Cochituate Road NB LT	0.47	26.6	C	75/120	0.67	28.9	C	78/155	0.71	31.8	C	83/173
Cochituate Road NB TH/RT	0.96	68.0	E	456/679	0.99	63.4	E	410/639	0.99	63.4	E	410/639
Cochituate Road SB LT	1.13	130.8	F	196/308	1.34	209.0	F	204/315	1.34	209.0	F	204/315
Cochituate Road SB TH/RT	0.65	36.8	D	282/346	0.72	31.2	C	266/331	0.72	31.2	C	266/331
Overall Intersection	**0.61**	**52.2**	**D**	-	**0.88**	**73.9**	**E**	-	**0.90**	**77.6**	**E**	-

[a] Volume-to-capacity ratio;
[b] Delay expressed in seconds per vehicle (average)
[c] Level of service;
[d] 50th/95th Percentile Queue

CONCLUSIONS AND RECOMMENDATIONS

TEC has examined the potential traffic impacts of the proposed residential development on the study area roadways. The following is a summary of the results and conclusions of this effort.

- The site is currently vacant; however, it is being utilized as soil storage by the Town of Wayland. As proposed, the project consists of the construction of 151-units of age-restricted housing units and 65-units of general apartment housing units.
- Access to the site is proposed via a shared driveway with the Town of Wayland Town Dump Driveway on Boston Post Road (US Route 20).
- The intersection of Boston Post Road (US Route 20) / Cochituate Road (Route 27 / Route 126) experienced an average of approximately 6 collisions per year over the three-year study period. The crash rate for this intersection is significantly lower than the statewide and district-wide averages for signalized intersections. Approximately half (9 of 19) of the collisions were rear-end collisions, which are typical of signalized intersections. All other intersections within the study area experienced fewer than three crashes per year and crash rates lower than the statewide and district-wide averages, indicating that no identifiable safety trends that require immediate attention.
- Sight distances at the Town Dump Driveway intersection with Boston Post Road (US Route 20) exceed AASHTO recommendations for safe operations. All signage and vegetation near the intersection should be kept low to the ground or sufficiently set back so as not to impede sight distances.
- The proposed housing development is anticipated to generate approximately 988 vehicle trips on an average weekday, approximately 66 vehicle trips (17 entering and 49 exiting) during the weekday morning peak hour, and approximately 91 vehicle trips (55 entering and 36 exiting) during the weekday evening peak hour. On an average Saturday, the proposed age-restricted housing development is anticipated to generate approximately 757 vehicle trips daily with approximately 93 vehicle trips (50 entering and 43 exiting) during the Saturday midday peak hour.
- Vehicles exiting the River's Edge Apartment / Town Dump Driveway will experience delay during the weekday morning and weekday evening peak periods for both the No-Build and Build conditions due to the high volume of traffic on Route 20. The Route 20 eastbound and westbound approaches are expected to continue operating at acceptable levels of service (LOS B or better) during both the weekday morning and weekday evening peak periods. A left-turn lane warrant analysis indicates that a left-turn lane is not warranted on Route 20 eastbound at the Town Dump Driveway.
- Although traffic exiting Pelham Island Road onto Boston Post Road (US Route 20) will experience delay during the weekday evening peak hour, the volume-to-capacity (V/C) ratio will be well below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes. The additional traffic generated by the proposed residential development is not expected to increase delay by more than 7 seconds per vehicle on any approach or increase queues by more than two vehicles in any lane at this intersection.
- Although traffic exiting the Millbrook Road westbound approach to Cochituate Road (Route 27/126) will experience delay during the weekday morning peak hour, the V/C ratio will be below 1.00, indicating there will be adequate capacity to accommodate the anticipated traffic volumes. All other movements at this intersection are anticipated to operate at acceptable levels of service (LOS D or

better) with queues not exceeding one vehicle under Build conditions. The additional traffic generated by the proposed residential development is not expected to increase delays on any movement by more than 6 seconds per vehicle or increase queues by more than one vehicle.

- The intersection of Boston Post Road (US Route 20) / Cochituate Road (Route 27/126) is anticipated to operate at overall LOS E or better under all analysis scenarios. Although some movements at this intersection will experience delay during the weekday morning and evening peak hours under No-Build and Build conditions, the additional traffic generated by the proposed residential development is not anticipated to increase overall intersection delay by more than four seconds per vehicle or increase queues in any given lane by more than two vehicles.

In conclusion, the traffic generated by the proposed residential development can be reasonably accommodated along the existing street system. The minor increase in delay at the study area intersections resulting from the project does not warrant project-specific mitigation.