Route 113 Transportation Study: Existing Conditions Report

Prepared by:

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Prepared for the
Town of Dracut

January 2017

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INTRODUCTION

Broadway Road (Route 113) is classified as an urban minor arterial extending in an east-west direction from the Willard / Arlington Streets intersection to the Methuen town line, a distance of approximately 3.6 miles. Broadway Road serves as important economic function as it is one of two major roadways connecting Dracut to Interstate 93. Many of the Town's commercial and industrial enterprises are located along this roadway, and these businesses depend on acceptable operating conditions to accommodate the shipping and receiving of goods, and to access needed services.

Existing traffic data was collected to examine existing operating conditions along the corridor, and to establish a baseline for evaluating the impact of the future growth and development. Avenue. The data collection program included manual turning movement counts, automatic twenty-four hour (24) traffic recorders, travel time runs, pedestrian/bicycle facility assessment, and a crash analysis.

The Existing Conditions analysis is intended to identify the nature and location of existing transportation needs along the Corridor. An assessment of existing pedestrian and bicycle facilities consisted of identifying the location of such facilities, including sidewalks, crosswalks, pedestrian signal heads, and other pedestrian pathways, and providing a visual assessment of their condition.

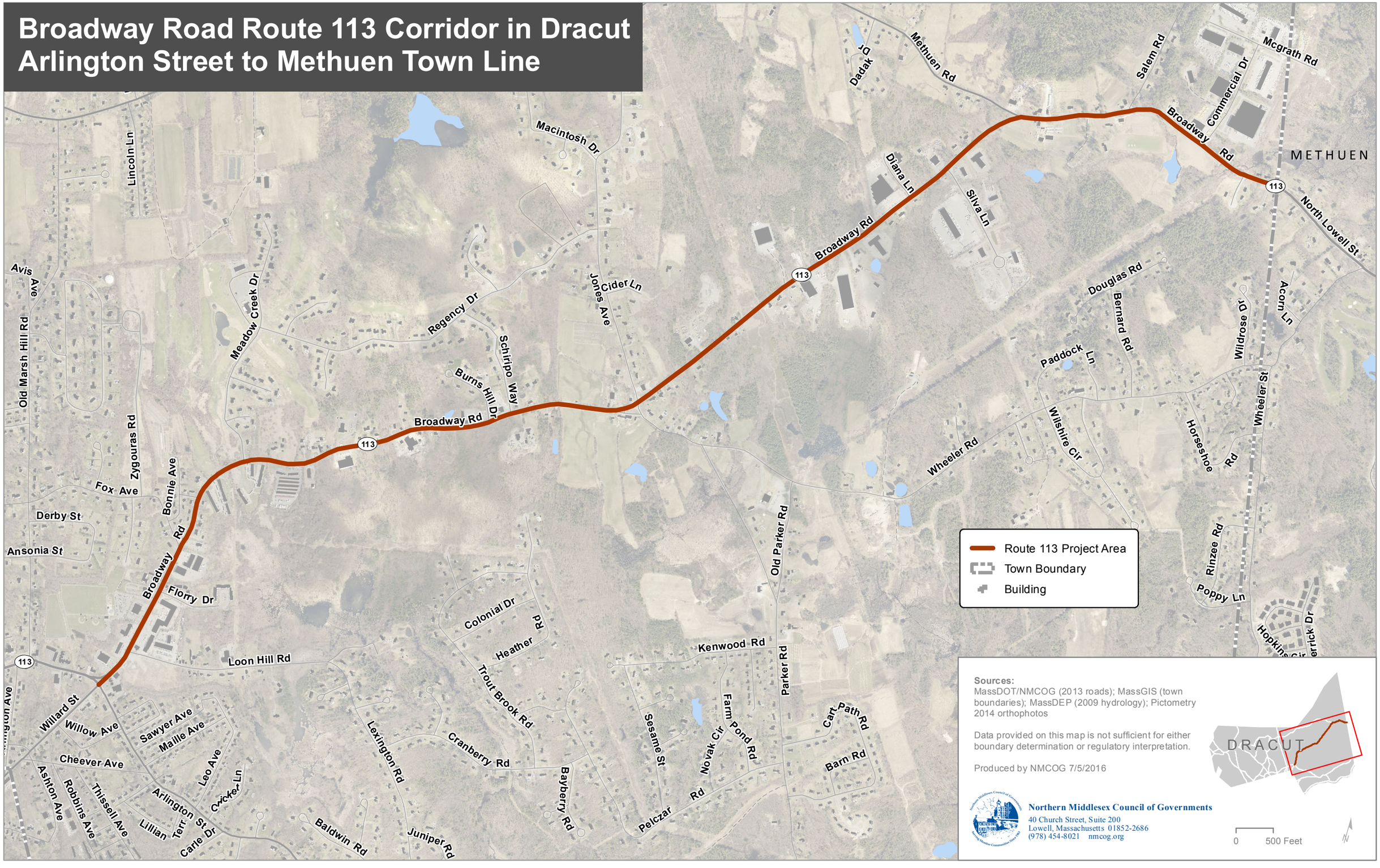
STUDY AREA CHARACTERISTICS

The study area extends from Broadway Road's intersection with Arlington Street and Willard Street to the Methuen town line, as shown on Map 1. The corridor is approximately 3.6 miles in length with 7 major intersections, 2 of which are signalized. The following major intersections were analyzed as part of this study:

- Broadway Road at Arlington/ Willard Street;
- Broadway Road at Loon Hill Road;
- Broadway Road at Fox Avenue;
- Broadway Road at Methuen Road;
- Broadway Road at Jones Avenue/ Wheeler Road; and
- Broadway Road at Salem Road.

In addition, there are numerous driveways and curb cuts to residential and commercial establishments.

Broadway Road Route 113 Corridor in Dracut
Arlington Street to Methuen Town Line



Sources:
MassDOT/NMCOG (2013 roads); MassGIS (town boundaries); MassDEP (2009 hydrology); Pictometry 2014 orthophotos

Data provided on this map is not sufficient for either boundary determination or regulatory interpretation.

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0 500 Feet

BROADWAY ROAD (ROUTE 113)

The width of Broadway Road varies from 24 feet to 32 feet along various segments of the corridor. Broadway Road consists of two travel lanes, with additional turning lanes to accommodate turning movements at major intersections. Land use along the roadway consists of a mix of commercial, residential and light industrial uses. The posted speed limit varies along the corridor, ranging from 25 mph between Arlington Street and Loon Hill Road, to 45 mph for the eastbound travel lane just east of Jones Avenue. According to the Manual of Uniform Traffic Control Devices (MUTCD) maximum speed limit signs should be installed at or near places where speed limits change. Table 1 below shows the location of posted speed limit signs by direction of travel on Broadway Road.

Table 1: Broadway Road (Route 113), Speed limits along the corridor

Direction	Posted Speed Limit (mph)	Sign Location
Eastbound	35	Across from Veteran Memorial Park Entrance
Eastbound	30	401 Broadway Road
Eastbound	35	West of Jones Ave
Eastbound	45	Mile marker 23.2
Eastbound	45	Mile marker 23.6
Eastbound	35	Mile marker 24.2
Westbound	40	Methuen Town Line
Westbound	35	At Commercial Dr
Westbound	45	960 Broadway Road
Westbound	35	Mile marker 23.2
Westbound	25	45 Broadway Rd

Five- foot wide sidewalks run along the westbound travel lane, from the Arlington Street / Broadway Road intersection to just east of the entrance to Veteran's Memorial Park, for a total distance of approximately 0.24 miles. The sidewalk continues along the eastbound travel lane, from directly east of the entrance to Veteran's Memorial Park to the entrance of Dunkin Donuts, which is located across from the Broadway Road/ Fox Avenue intersection. The length of this section of sidewalk is approximately 0.14 miles.

Traffic counts were collected along Broadway Road using automatic traffic recorders. The traffic count locations, as well as the AADT, truck percentages and A.M. and P.M. peak hour volumes can be found in Table 2 on the following page. The AADT averages around 12,500

vehicles per day throughout the corridor, with the Jones Avenue section of Broadway Road carrying slightly less traffic volume than other portions of the corridor, with an AADT of 9,900 vehicles per day.

Broadway Road at the Methuen town line carries the highest percentage of trucks, at 11.8 percent of total traffic. This is due a number of factors, including the businesses located on Commercial Drive that generate significant truck traffic, the presence of the school bus lot nearby, and the location of I-93 to the east. The remaining sections of Broadway Road carry between 3.7% (west of Jones Avenue) to 6.8% (at the Broadway Road/ Arlington Street intersection) truck traffic.

LOON HILL ROAD

Loon Hill Road runs easterly from Broadway Road for a distance of 0.71 miles before dead-ending east of Lexington Road. The roadway has an average width of thirty feet with a posted speed limit of 30 mph. The western end contains a mix of commercial buildings, including the Dracut Village Square and Loon Hill Plaza, while the easterly portion of the roadway contains single-family residences, with the exception of the Dracut Police station.

There is only one six- to eight-foot section of sidewalk on the Loon Hill Road approach to the intersection with Broadway Road, where the crosswalk is located. The truncated domes and the sidewalks are ADA complaint, but the sidewalks do not connect to any existing sidewalk network at this time.

Loon Hill Road has an AADT of 2,100 vehicles per day and approximately 1.2% of the traffic is comprised of trucks.

FOX AVENUE

Fox Avenue is functionally classified as a local roadway. Land uses consist of single-family residences and the road is used to travel between Broadway Road and Bridge Street, thereby avoiding the traffic signals at the Broadway/ Arlington Street intersection and bypassing Dracut Center. Fox Avenue has an average roadway width of twenty-six feet, with a posted speed limit of 25 mph.

Fox Avenue does not have any crosswalks, sidewalks or other pedestrian amenities. The AADT is 2,400 vehicles per day with trucks comprising 1.8% of the total volume.

JONES AVENUE

Jones Avenue is classified as a local roadway and extends in a northerly direction from the Broadway/ Wheeler Road intersection, eventually ending at Marsh Hill Road and Methuen Road. With the exception of a small farm stand and the fire station, land uses along the roadway are comprised of single-family homes.

Jones Avenue has an AADT of 1,600 vehicles per day and trucks make up 2.4 % of the total traffic volume and the posted speed limit is 30 mph. There are four-foot wide shoulders on both sides of the roadway but there are no other bicycle or pedestrian amenities present.

WHEELER ROAD

Classified as a local roadway, Wheeler Road extends in a south-west direction away from the Jones Avenue/ Broadway Road intersection, before turning and heading directly west and ending at the Methuen town line. Land uses along the roadway are residential. Wheeler Road has an AADT of 2,200 vehicles per day with 3.6% of the traffic comprised of trucks and buses. Wheeler Road does not have any sidewalks or bike lanes at this time, the posted speed limit is 30 mph.

METHUEN ROAD

Methuen Road is classified as an urban collector and connects Broadway Road to Marsh Hill Road. The road allows access from the eastern end of Route 113 to Route 38. The AADT on Methuen Road is 3,700 vehicles per day and 2.0 % of that volume is comprised of truck traffic. Sidewalks and bicycle lanes are non-existent along Methuen Road. The posted speed limit for Methuen Road is 30 mph.

SALEM ROAD

Salem Road is the mirror image of Methuen Road; it travels in a northeasterly direction from Broadway Road and ends at the Methuen town line. Salem Road has an AADT of 3,700 vehicles per day and a truck traffic percentage of 2.1% with a 30 mph posted speed limit.

COMMERCIAL DRIVE

Commercial Drive is classified as a local roadway, like many of the secondary streets along the corridor. Commercial Drive contains a mix of commercial and light industrial uses. Commercial Drive carries 2,100 vehicles per day but 31.9% of the traffic is comprised of trucks or buses.

A four-foot wide sidewalk runs along the southbound travel lane and a four-foot shoulder is present as well. The sidewalk is limited to Commercial Drive and does not connect to a larger sidewalk network.

INTERSECTION CHARACTERISTICS

Existing traffic flow patterns, geometrics and bicycle and pedestrian movements were examined at the following seven study area intersections:

- Broadway Road at Arlington/ Willard Street;
- Broadway Road at Loon Hill Road;
- Broadway Road at Fox Avenue;
- Broadway Road at Methuen Road;
- Broadway Road at Jones Avenue/ Wheeler Road; and
- Broadway Road at Salem Road.

A description of each intersection is provided in the following sections.

BROADWAY ROAD AT ARLINGTON/ WILLARD STREET

Arlington Street, Willard Street and Broadway Road form a four- legged intersection with a short bypass lane connecting the westbound lane of Broadway Road to the Arlington Street section of Route 113. A slip lane has been painted on the section of Arlington Street that travels eastbound into the intersection so that traffic turning left can continue heading eastbound on Broadway Road. Sight distances in both the east and west directions of Rte. 113 are over 500 feet. The bypass lane coming off Broadway Road eastbound is bisected by a crosswalk that links the end of the sidewalk on the eastbound travel lane of Broadway Road to a sidewalk located in the median, between Broadway Road and the bypass lane. Pedestrian-activated crossing signals are located at the bypass lane crosswalk and on both sides of the Broadway Road crosswalk, at the time of the April 2016 site visit both signals were working. The crosswalk traverses Broadway Road in front of the stop line and connects to the sidewalk that continues along Arlington Street.

Table 2: Directional Distribution for Broadway Rd at Arlington/ Willard St.

Intersection	A.M. Peak Period					P.M. Peak Period				
	Number of vehicles processed through the inter-section	Percent Directional Distribution				Number of vehicles processed through the inter-section	Percent Directional Distribution			
		Rte. 113 WB	Jones Ave	Rte. 113 EB	Wheeler Rd		Rte. 113 WB	Jones Ave	Rte. 113 EB	Wheeler Rd
Broadway at Arlington/ Willard St	1,753	36%	16%	37%	11%	2,320	41%	15%	29%	16%

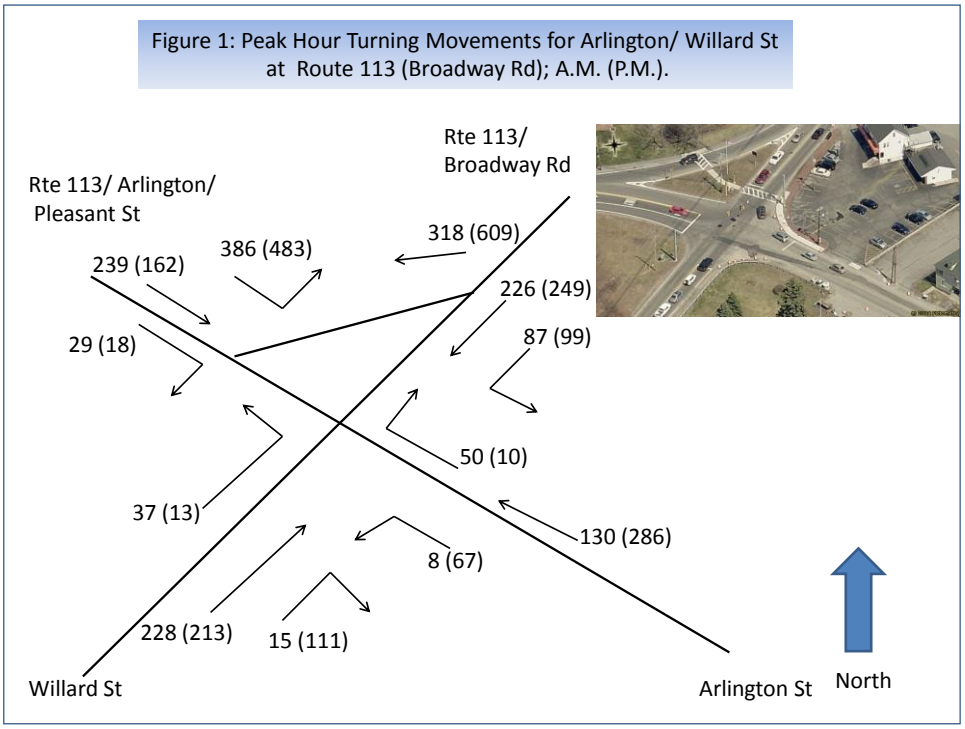


Figure 1: Peak Hour Turning Movements for Arlington/ Willard St at Route 113 (Broadway Rd); A.M. (P.M.).

BROADWAY ROAD AT LOON HILL ROAD

Broadway Road and Loon Hill Road form a T-intersection with stop sign control on Loon Hill Road. Loon Hill Road is thirty feet wide with one travel lane in each direction and one lane for all turns on to Broadway Road. Sight distances for the east and west direction are in excess of 500 feet. Shoulders are only defined at the Loon Hill Road approach to Broadway Road and no-where else along the roadway. Recent construction projects have upgraded pedestrian accessibility at and around the intersection with new sidewalks and improvements to the existing sidewalk network. Additional crosswalks were added across Route 113 and Loon Hill Road, and ADA compliant pedestrian features such as truncated domes where crosswalks meet sidewalks were also provided.

Table 3: Directional Distribution for Broadway Rd at Loon Hill Rd.

Intersection	A.M. Peak Period				P.M. Peak Period			
	Number of vehicles processed through the intersection	Percent Directional Distribution			Number of vehicles processed through the intersection	Percent Directional Distribution		
		Rte. 113 WB	Loon Hill Rd	Rte. 113 EB		Rte. 113 WB	Loon Hill Rd	Rte. 113 EB
Broadway Road at Loon Hill Road	1,167	41%	13%	47%	1,709	45%	8%	48%

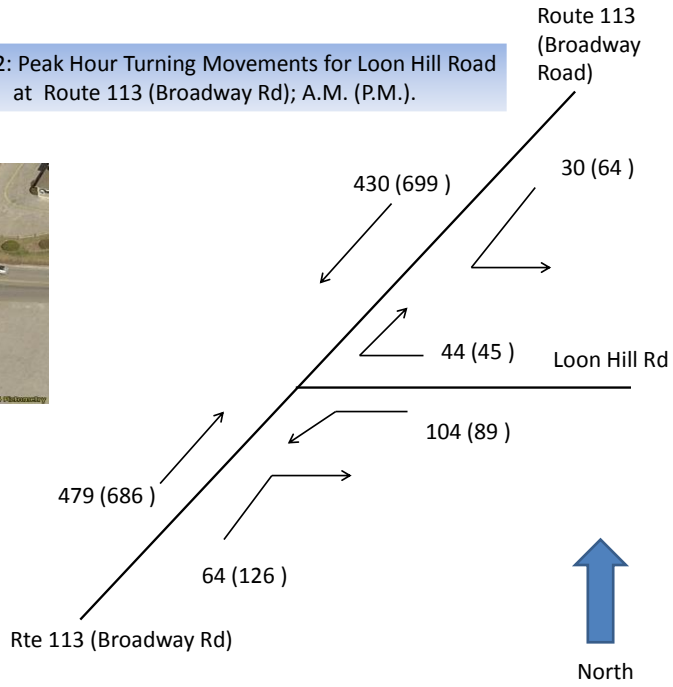


Figure 2: Peak Hour Turning Movements for Loon Hill Road at Route 113 (Broadway Rd); A.M. (P.M.).

BROADWAY ROAD AT FOX AVENUE

Fox Avenue intersects Broadway Road east of Toupin Plaza to form a spilt T-intersection, with stop signs located on both approaches of Fox Avenue as it intersects with Broadway Road. At the intersection, Fox Avenue splits into two lanes: one for vehicles traveling eastbound on Broadway Road and one for vehicles traveling westbound. Both legs are controlled by a stop sign and are separated by a small grassy traffic island. Sight distance for vehicles traveling eastbound along Rte. 113 from Fox Ave is approximately 370 feet due to the slight drop in elevation as Rte. 113 travels eastbound and the winding layout of the roadway east of Dunkin Donuts. Sight distance looking westbound is over 500 feet at this intersection. An entrance to Dunkin Donuts is directly across from the lane of Fox Avenue that allows vehicles to travel east on Broadway Road. A flashing yellow traffic signal warns motorists of the intersection and traffic movements.

Table 4: Directional Distribution for Broadway Rd at Fox Ave.

Intersection	A.M. Peak Period					P.M. Peak Period				
	Number of vehicles processed through the inter-section	Percent Directional Distribution				Number of vehicles processed through the inter-section	Percent Directional Distribution			
		Rte. 113 WB	Jones Ave	Rte. 113 EB	Wheeler Rd		Rte. 113 WB	Jones Ave	Rte. 113 EB	Wheeler Rd
Broadway Rd at Fox Ave	1,204	41%	9%	39%	11%	1,346	46%	11%	36%	8%

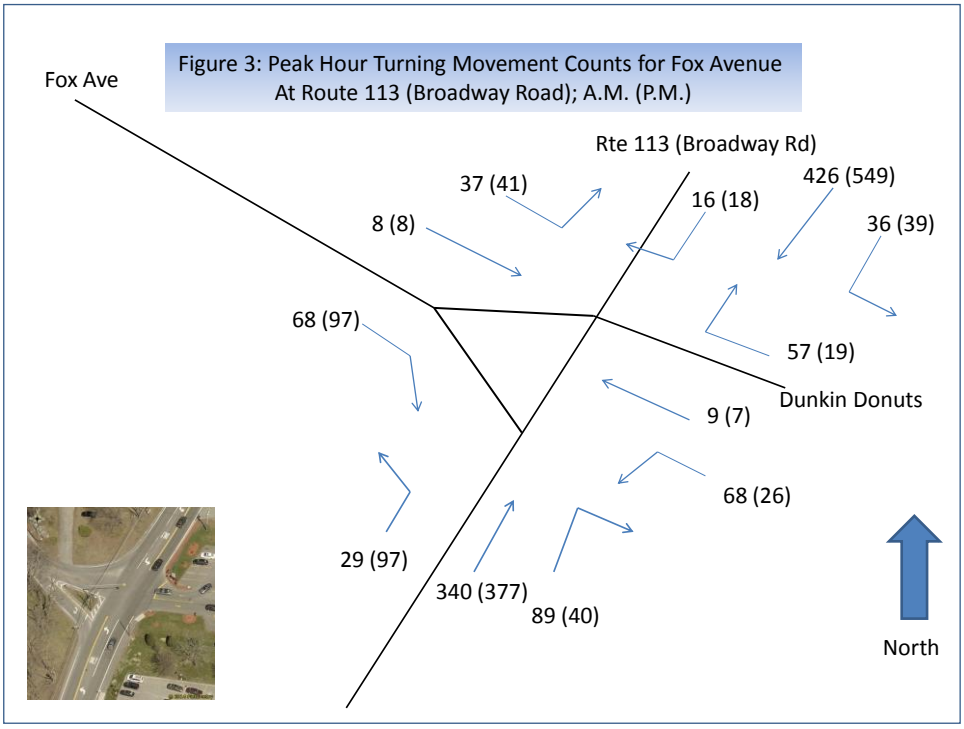


Figure 3: Peak Hour Turning Movement Counts for Fox Avenue At Route 113 (Broadway Road); A.M. (P.M.)

BROADWAY ROAD AT JONES AVENUE/ WHEELER ROAD

Jones Avenue, Broadway and Wheeler Road form a four-way intersection, with a slip lane for Jones Avenue on the eastbound direction of Broadway Road, and another slip lane that allows traffic to access Wheeler Road from the westbound travel lane. A traffic signal with emergency vehicle preemption controls the flow of traffic through the intersection, which is crucial given

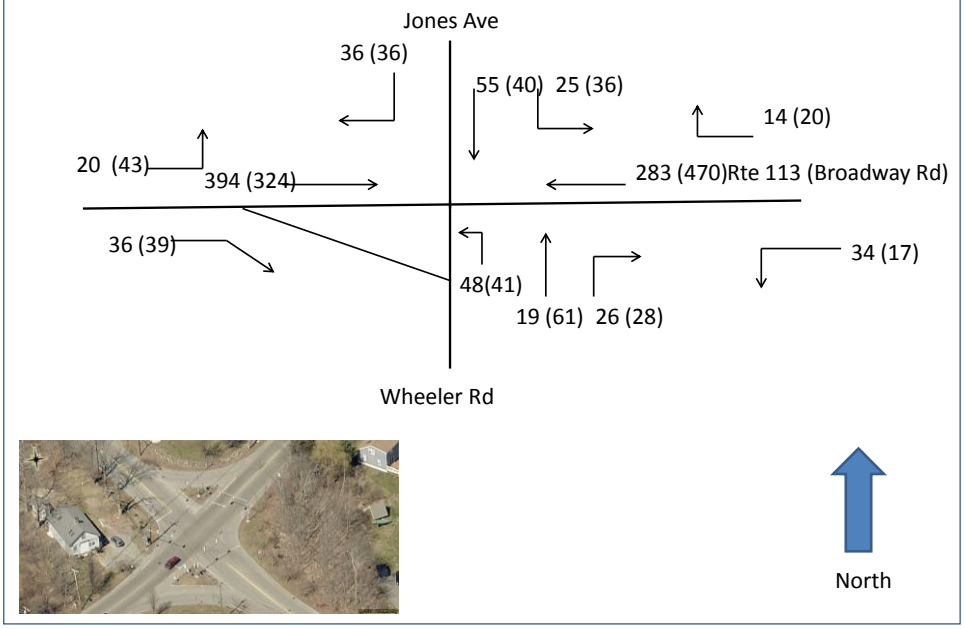
that a fire station is located on Jones Avenue. Sight distances are over 500 feet looking eastbound and approximately 437 feet westbound. Sight distances could be less during the growing season if roadside vegetation is not maintained.

Sidewalks, crosswalks and other pedestrian accommodations are absent from this intersection. Signs instructing bicyclists to "stop on line for green" are found on the Broadway Road eastbound and westbound lanes.

Table 5: Directional Distribution for Broadway Rd at Jones Ave/ Wheeler Rd.

Intersection	A.M. Peak Period					P.M. Peak Period				
	Number of vehicles processed through the inter-section	Percent Directional Distribution				Number of vehicles processed through the inter-section	Percent Directional Distribution			
		Rte. 113 WB	Jones Ave	Rte. 113 EB	Wheeler Rd		Rte. 113 WB	Jones Ave	Rte. 113 EB	Wheeler Rd
Broadway Rd at Jones Ave/ Wheeler Rd	988	34%	12%	45%	9%	1,131	45%	8%	36%	11%

Figure 4: Peak Hour Turning Movements for Jones Ave/ Wheeler Rd at Route 113 (Broadway Rd); A.M. (P.M.).



BROADWAY ROAD AT METHUEN ROAD

Broadway and Methuen Road form a "Y" intersection with a small slip lane for traffic coming off of Methuen Road merging onto the Broadway Road westbound travel lane. Broadway Road has no traffic controls at this intersection and the configuration of the intersection allows traffic to leave the westbound travel lane of Broadway Road to continue on Methuen Road without impediment. The traffic leaving Methuen Road is controlled by a stop sign that is placed on a small island in the middle of the mouth of Methuen Road. Sight distances along Rte. 113 are in excess of 500 feet for both the east and westbound travel lanes. Sight distances could be less during the growing season if roadside vegetation is not maintained. This intersection, like much of the corridor along the eastern part of the study area is devoid of any bicycle or pedestrian amenities.

Table 6: Directional Distribution for Broadway Rd at Methuen Rd.

Intersection	A.M. Peak Period				P.M. Peak Period			
	Number of vehicles processed through the intersection	Percent Directional Distribution			Number of vehicles processed through the intersection	Percent Directional Distribution		
		Rte. 113 WB	Methuen Rd	Rte. 113 EB		Rte. 113 WB	Methuen Rd	Rte. 113 EB
Broadway Rd at Methuen Rd	935	36%	23%	42%	1,079	44%	13%	43%

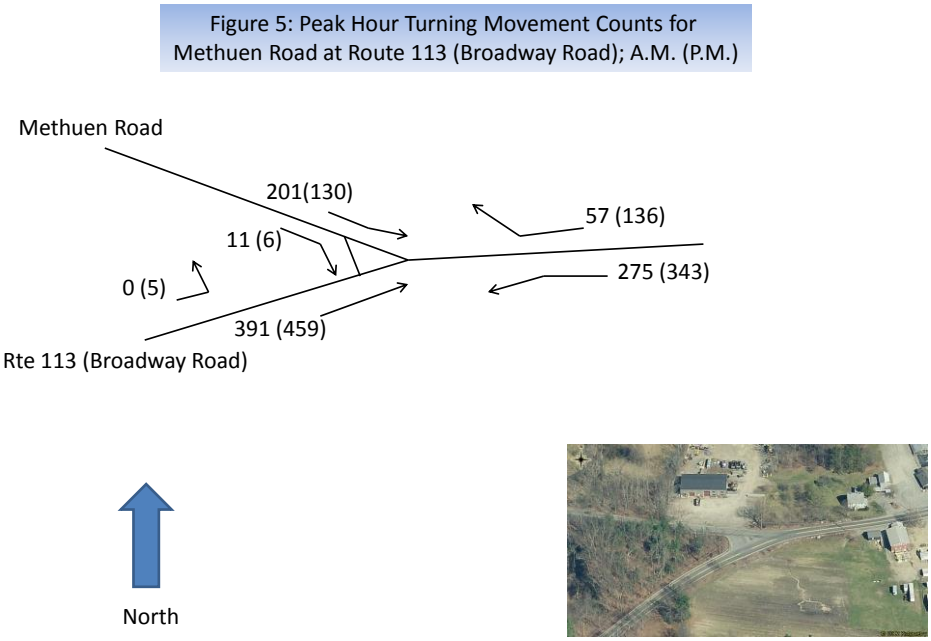


Figure 5: Peak Hour Turning Movement Counts for Methuen Road at Route 113 (Broadway Road); A.M. (P.M.)

BROADWAY ROAD AT SALEM ROAD

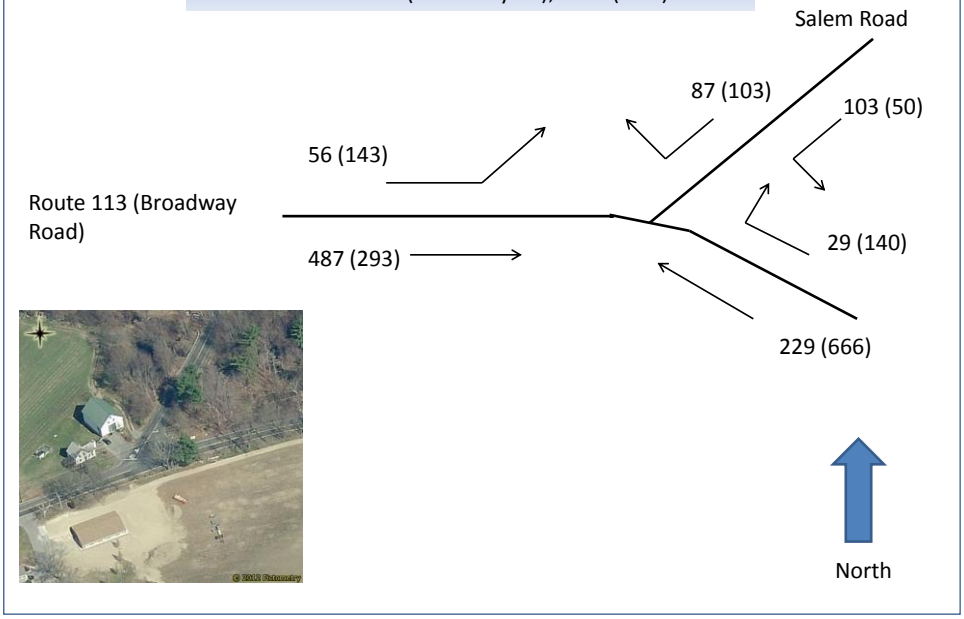
The intersection of Broadway Road and Salem Road is very similar to the intersection of Broadway and Methuen Roads. The intersection forms a "Y" with a stop sign traffic control for Salem Road. A small traffic island with a utility pole at its center splits the lanes at the mouth of Salem Road. Lane and stop lines have recently been repainted at both the Salem and Methuen

Road intersections with Broadway Road. Sight distance on Rte. 113 looking eastbound is approximately 465 feet and in excess of 500 feet in the westbound direction. Sight distances could be less during the growing season if roadside vegetation is not maintained. At the time of this report no bicycle or pedestrian amenities were found at the Broadway and Salem Road intersection.

Table 7: Directional Distribution for Broadway Rd at Salem Rd.

Intersection	A.M. Peak Period				P.M. Peak Period			
	Number of vehicles processed through the intersection	Percent Directional Distribution			Number of vehicles processed through the intersection	Percent Directional Distribution		
		Rte. 113 WB	Salem Rd	Rte. 113 EB		Rte. 113 WB	Salem Rd	Rte. 113 EB
Broadway Rd at Salem Rd	991	26%	19%	55%	1,395	58%	11%	31%

Figure 6: Peak Hour Turning Movements for Salem Road at Route 113 (Broadway Rd); A.M. (P.M.).



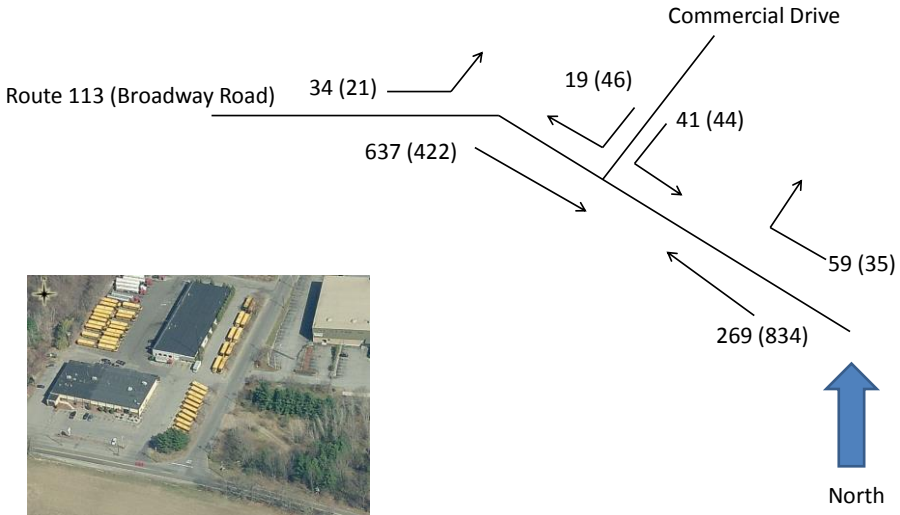
BROADWAY ROAD AT COMMERCIAL DRIVE

Broadway Road at Commercial Drive forms a "T" intersection, with a stop sign on Commercial Drive serving as the only traffic control device. Commercial Drive is comprised of various commercial enterprises, as the name implies, and many businesses employ tractor trailers to move products. A transportation company that provides busing for local public schools is also housed on Commercial Drive. The presence of these businesses contributes to the high truck traffic volumes entering and exiting Commercial Drive. As stated previously, 31.9% of all traffic on Commercial Drive is comprised of large trucks or buses. Commercial Drive at Rte. 113 has sight distances over 500 feet in both the east and westbound direction. Sight distances could be less during the growing season if roadside vegetation is not maintained.

Table 8: Directional Distribution for Broadway Rd at Commercial Dr.

Intersection	A.M. Peak Period				P.M. Peak Period			
	Number of vehicles processed through the intersection	Percent Directional Distribution			Number of vehicles processed through the intersection	Percent Directional Distribution		
		Rte. 113 WB	Commercial Dr	Rte. 113 EB		Rte. 113 WB	Commercial Dr	Rte. 113 EB
Broadway Rd at Commercial Dr	1,059	31%	6%	63%	1,402	62%	6%	32%

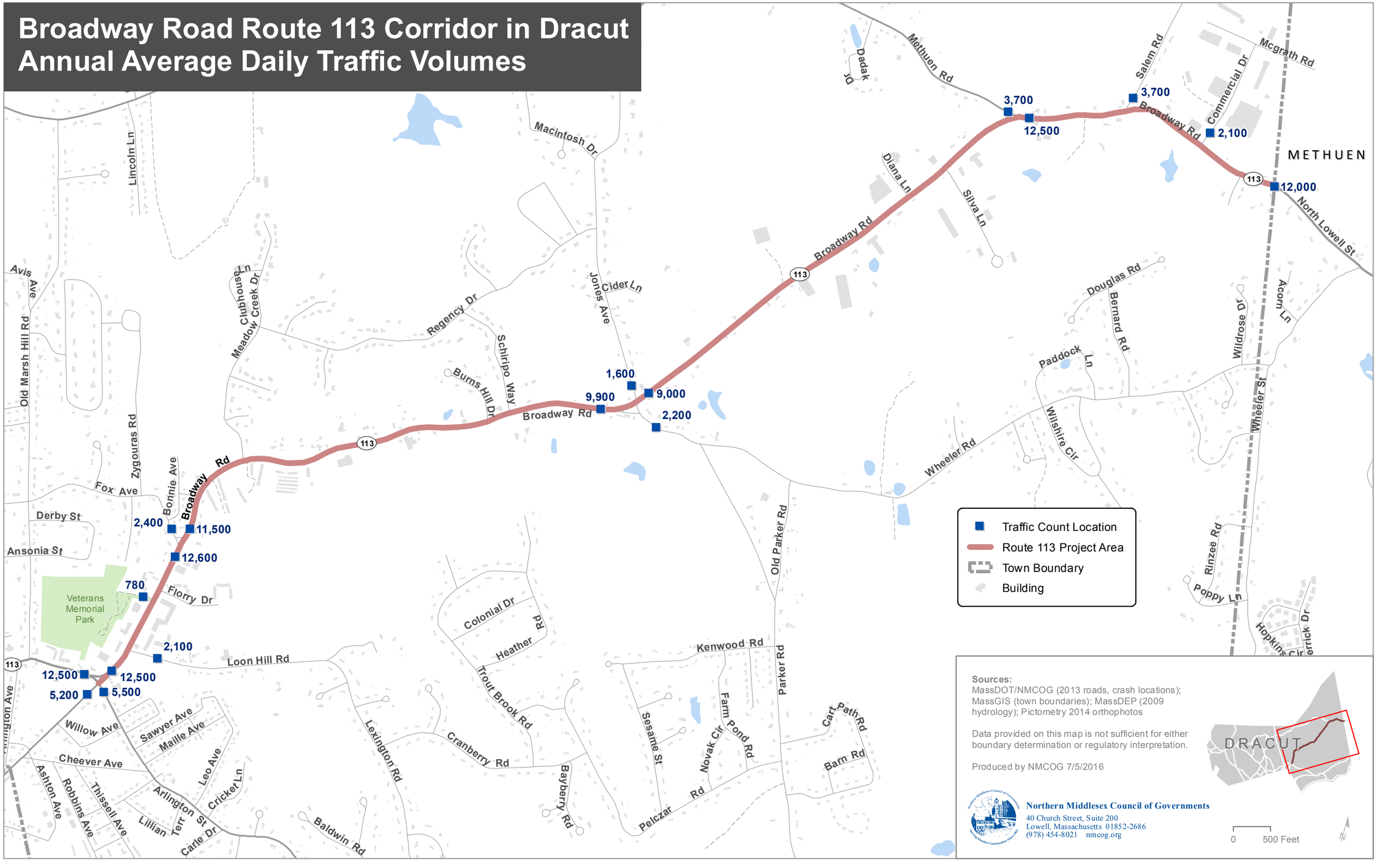
Figure 7: Peak Hour Turning Movement Counts for Commercial Drive At Route 113 (Broadway Road); A.M. (P.M.)



TRAFFIC VOLUMES

Automatic traffic recorder (ATR) counts were collected along key roadway segments on Route 113, and on selected secondary streets along the corridor. The counts quantify the volume of traffic on an average day over a 24-hour period and at peak travel times. Table 2 shows the Annual Average Daily Traffic (AADT) volumes within the study area and Map 2 shows the location of each count.

Broadway Road Route 113 Corridor in Dracut
Annual Average Daily Traffic Volumes



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Broadway Road experiences the highest traffic volume within the study area, with an AADT of 12,500 at three of the six locations counted. Broadway Road east and west of Jones Avenue had the lowest AADTs, at 9,900 vehicles per day respectively. Commercial Drive had the highest percentage of truck and bus traffic of the sixteen locations counted, with a truck percentage of 31.9%. This is due to the heavy commercial and light industrial uses found on Commercial Drive and on the roads to which it connects, such as I-93 to the east.

Table 9: Route 113 (Broadway Road) Average Daily Traffic Volumes: 2015 and 2016

Location	Annual Average Daily Traffic (vpd)	PM Peak Hour Volume	AM Peak Hour Volume	Percent Trucks
Arlington St East of Rte. 113	5,500	482	444	4.1
Jones Ave North of Rte. 113	1,600	164	149	2.4
Methuen Rd West of Rte. 113 (Broadway Rd)	3,700	410	367	2.0
Rte. 113 (Broadway Rd) at Methuen T.L.	12,000	1,094	996	11.8
Rte. 113 (Broadway Rd) North of Arlington St	12,500	1,085	840	4.6
Rte. 113 (Broadway Rd) East of Jones Ave	9,000	851	619	4.6
Rte. 113 (Broadway Rd) West of Jones Ave	9,900	939	590	3.7
Rte. 113 (Arlington St) West of Broadway Rd	12,500	1,018	957	6.8
Rte. 113 (Broadway Rd) North of Methuen Rd	12,500	1,229	894	5.6
Salem Rd North of Rte. 113 (Broadway Rd)	3,700	380	268	2.1
Loon Hill Rd East of Rte. 113 (Broadway Rd)	2,100	207	162	1.2
Wheeler Rd East of Rte. 113 (Broadway Rd)	2,200	240	186	3.6
Fox Ave North of Rte. 113 (Broadway Rd)	2,400	267	170	1.8
Willard St South of Rte. 113 (Broadway Rd)	5,200	515	322	2.7

Commercial Dr North of Rte. 113 (Broadway Rd)	2,100	178	277	31.9
Veterans Memorial Park	780	279	293	3.7

Source: NMCOG Traffic Counting Program

PAVEMENT MANAGEMENT

All roads need a certain level of maintenance to be able to withstand the daily demands of modern traffic and to extend their life for as long as possible. Timely and appropriate maintenance is even more important today as construction costs rise and government agencies fiercely compete for funds. In addition, overused, poorly maintained, inadequately lit and badly signed and striped roads pose a safety hazard. Many accidents could be prevented if road safety features were installed and upgraded.

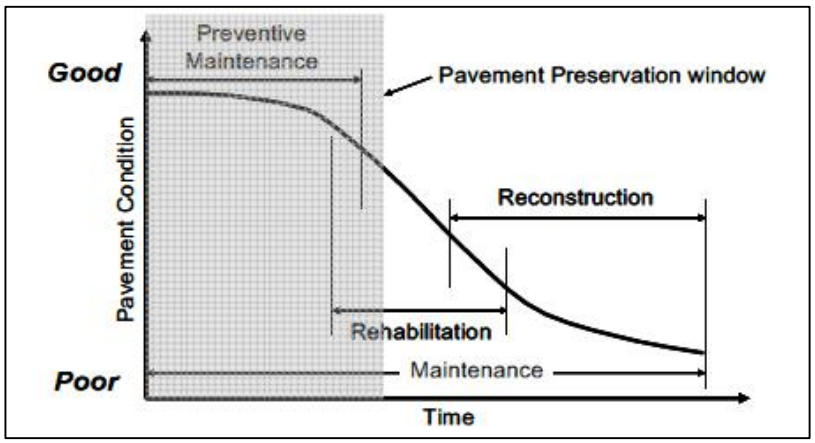
Poor maintenance has social and economic costs. Road maintenance ensures the longevity and long-term sustainability of road infrastructure. Such maintenance activities include:

- Winter maintenance
- Preservation (resurfacing, which can be carried out in the context of a preventive maintenance strategy, and crack filling)
- Pavement markings, signs, safety barriers, etc.
- Pavement rehabilitation (restructuring without upgrading nominal load capacity)
- Pavement upgrading (increasing load capacity, widening, environmental features, and applying low cost measures)
- Structural maintenance (bridges, tunnels, etc.)
- Peripheral maintenance (embankments, drainage, shoulders, etc.)

PAVEMENT MANAGEMENT AND PRESERVATION

Paved roadways represent one of the largest capital investments in any modern highway system. Maintaining the paved surface of a large highway system typically involves complex decision-making about how and when to apply surface treatments to keep the highway performing and operating with the funding available.

Figure 8: Pavement Maintenance Life Cycle



As Figure 8 depicts, pavement management is a key component to the development of a successful preservation, maintenance and rehabilitation program. A pavement management system consists of the collection and analysis of pavement condition data for use in identifying and implementing the most cost-effective treatments. The development of a pavement management system allows a jurisdiction to maximize the funding available for pavement maintenance and preservation. MassDOT uses such a system to manage roadways on the federal-aid system under their jurisdiction. Roadways under local jurisdiction are the responsibility of the municipalities. Locally controlled arterials and collectors are eligible for federal-aid funding providing that the communities fund design, permitting and any rights-of-way necessary.

The cost of pavement repairs increases dramatically if not completed at the appropriate time. While it is less expensive to properly maintain a sound roadway system, municipalities have not had the resources to keep up with the normal deterioration of pavement. If that could be accomplished, fewer tax dollars would be needed to maintain the road network over the long term. However, this has been fiscally and physically impossible under the current funding constraints.

Pavement preservation is a program aimed at preserving investments in the highway system, enhancing pavement performance, extending pavement life, and meeting the motorists' needs. Analysis from the pavement management systems is used to identify pavement preservation opportunities. Preservation is the sum of all activities undertaken to provide and maintain serviceable roadways; this includes corrective and preventive maintenance, as well as minor and

major rehabilitation. It excludes capacity improvements and new or reconstructed pavement. An effective pavement preservation program encompasses a full range of maintenance strategies, as well as rehabilitation treatments, with the goal of enhancing pavement performance (ride quality, safety, service life, etc.) in a cost-effective and efficient manner.

The communities in the Northern Middlesex region use a variety of methods to manage the pavement on the roadways under their jurisdictions. NMCOG performs its own pavement condition data collection and analysis for the Town of Dracut utilizing the *IWORQ* pavement management software.

For each roadway segment evaluated by NMCOG staff, the severity and extent of pavement distress was rated for the following:

- Fatigue Cracking (Alligator Cracking)
- Longitudinal Cracking
- Transverse Cracking
- Edge Cracking
- Patching and Potholes
- Roughness

The above defects were assigned one of three levels for severity and extent – resulting in a rating of one to nine (with zero indicating no defects). A value for remaining service life (RSL) was determined based on the type and severity of defects observed for each roadway segment. The pavement remaining service life rating is a common method of gauging pavement condition in the transportation industry and is generally defined as the anticipated number of years that pavement will be functionally and structurally acceptable with only routine maintenance. This method assumes that a properly constructed paved road will have a service life of twenty years, without any preventative measures or maintenance, before the pavement reaches an unacceptable condition and requires construction intervention. Regular maintenance will significantly increase a pavement's lifespan beyond twenty years, but the RSL rating, an integer number of years from zero to twenty, is estimated based on the current condition assuming no preventative measures. Categories of "Poor", "Fair", "Good", and "Excellent" were established as listed in Table 10 below:

Table 10: *IWORQ* Pavement Condition Categories

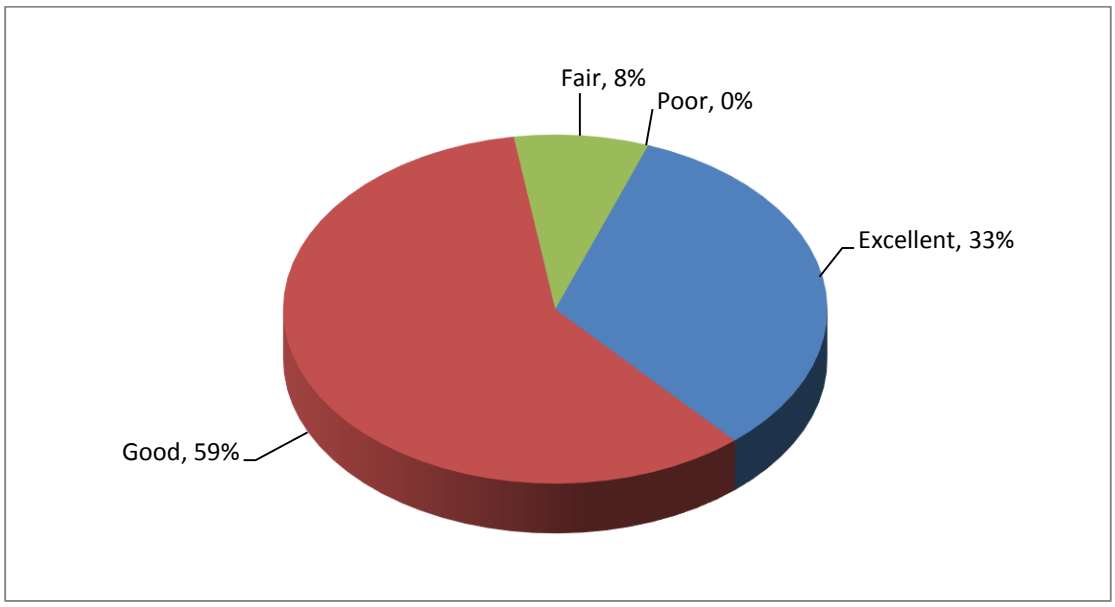
Pavement Condition Category	Remaining Service Life (RSL) Range
Poor	0 to 4 Years
Fair	5 to 7 Years
Good	8 to 10 Years
Excellent	11 to 20 Years

Source: IWORQ Pavement Management Software

Roads in excellent condition require very little maintenance. Roads in the good category require functional treatments, such as crack sealing and patching, a relatively inexpensive treatment. Fair condition roadways need some rehabilitation, such as leveling and overlays to improve pavement condition. Poor condition roadways are generally in need of reconstruction.

NMCOG staff evaluated 26.67 federal aid eligible centerline miles of roadway within Dracut. As of 2016, 33% of the Federal Aid eligible roadways monitored were found to be in excellent condition, 59% in good condition, 8% in fair condition, and 0% were in poor condition, as shown in Figure 9 on the following page.

Figure 9: Existing Pavement Condition for Monitored Federal Aid Eligible Roads



Source: NMCOG Pavement Monitoring Program and MassDOT Road Inventory File 2016

The overall estimated cost for improving the monitored roadways in Dracut is estimated at $318,324.21 as shown in Table 11 below.

Table 11: Estimated Cost to Rehabilitate Federal-Aid Eligible Roadways

Pavement Condition	Monitored Federal Aid Eligible Roadway Miles	Estimated Cost for Improving Monitored Roadway*
Excellent	8.73	$2,082.08
Good	15.78	$174,793.04
Fair	2.16	$141,449.09
Poor	0.00	$0.00
Total	26.67	$318,324.21

*Cost based on NMCOG monitored roadways

Source: NMCOG staff & IWORQ Pavement Management Software

While it is unrealistic to expect such high levels of funding for the town's pavement system, maintaining a pavement management system and utilizing pavement preservation techniques on roadways that are in acceptable condition will minimize the resources that need to be spent in the future to reconstruct and rebuild the highway network. As the town continues to expand its

pavement management program, opportunities for lower cost preservation projects will be identified.

FUNDING SOURCES FOR ROADWAY MAINTENANCE

In order to efficiently utilize limited transportation resources, the existing transportation system must be maintained and preserved. Pavement preservation/rehabilitation type projects are initiated by the communities or MassDOT, in a similar fashion to all other federal aid projects. Roadway reconstruction and maintenance projects follow the same procedures for project initiation and approval as other projects programmed on the TIP. The funding programs that can be utilized for such projects are outlined in the following section and are intended to ensure sound maintenance and management of the existing transportation infrastructure and facilities.

CHAPTER 90 PROGRAM

The Chapter 90 Program is funded through the State Transportation Bond Bill and administered by MassDOT. The program supports local roadway and construction projects implemented by municipalities. The funds are apportioned by formula based on local roadway mileage, employment and population. The Chapter 90 FY 2017 allocations for the Town of Dracut are outlined in Table 12 below.

Table 12: FY 2017 Chapter 90 Apportionments

Municipality	MassDOT District	Roadway miles	2010 Population	2015 Employment	FY 2017 Apportionment
Dracut	4	138	29,457	5,882	$805,654

Source: MassDOT March 31, 2016

Chapter 90 funds must be allocated to roadway projects, such as resurfacing and related work, and other incidental work, such as preliminary engineering, State Aid/Consultant Design Agreements, right-of-way acquisition, shoulders, side road approaches, landscaping and tree planting, roadside drainage, structures (including bridges), sidewalks, traffic control, service facilities, and street lighting (excluding operating costs).

Table 13: DRACUT - ROUTE 113 (BROADWAY ROAD)

Pavement Condition	GOOD	Total Miles

Road Service Life Remaining Recommended Treatment	8 to 10 Yrs. Chip Seal	
Mileage	3.72	3.72
Percent	100%	100%
Treatment Cost	$43,212.68	$43,212.68

***METHUEN TOWN LINE TO ARLINGTON STREET**

As shown in Table XX, the pavement along Broadway Road from the Willard/ Arlington intersection to the Methuen town line is in good condition with a projected road service life of eight (8) to ten (10) years with periodic maintenance. The treatment cost of $43,212.68 is a current estimate on what it would cost to bring the length of the roadway into excellent condition from its current status of good.

CRASH DATA ANALYSIS

Crash data for intersections within the study area was analyzed. The data is derived from MassDOT's statewide crash database, and includes traffic crashes that occurred over a three-year period between 2012 and 2014. Table 5 summarizes the crash rate for each intersection and provides a comparison to other similar intersections in MassDOT District 4 area. Information regarding the type of crash, severity, time of day and surface conditions is also provided.

With the exception of the Broadway and Salem Road intersection, all other intersections within the study area have a lower than expected crash rate, when compared with the MassDOT District 4 averages. The majority of the crashes within the study area involved property damage only. Although some crashes resulted in personal injury, there were no fatal crashes along the corridor. Broadway Road at Salem Road had the highest number of crashes of the key intersections studied, with ten (10) crashes, half of which occurred in 2014. The calculated crash rate for this location is three one hundredths of a point higher than the MassDOT District 4 crash rate for a similar intersection. Most of the crashes were rear-end type and occurred during off-peak hours. Seven (7) out of the ten (10) crashes involved property damage and two (2) crashes involved personal injury.

Two (2) of the seven (7) key intersections studied experienced only one (1) crash during the 2012-2014 study period for crashes. Broadway Road at Commercial Drive and Broadway Road at Jones Avenue both experienced their only crash during the study period in 2014. The Broadway Rd/ Commercial Drive crash resulted in property damage only, happened during non-peak traffic hours and was classified as a rear-end type of crash. The Broadway Rd/ Jones Ave

crash severity was classified as other/ unknown, also occurred during non-peak traffic hours and was classified as a side-swipe type of crash. Broadway Rd at Jones Ave is a signalized intersection and Broadway Rd at Commercial Drive is a non-signalized intersection with a stop sign control on Commercial Drive.

The intersection of Broadway Road at Methuen Road had a fraction of the crashes as Broadway Road at Salem Road had during the same study period, even though the configurations of the intersections are similar. Within the study period, the Methuen Road at Broadway Road intersection experienced two (2) crashes which resulted in property damage only. The crashes were of the rear-end type, and occurred during A.M. peak and non-peak traffic hours during dry road conditions. Broadway at Methuen Road intersection had ten (10) crashes during the years of 2012-2014, five (5) of those crashes occurred in 2014, two (2) in 2013 and three (3) in 2012. The majority of these crashes were identified as rear-end type crashes (5), followed by angle crashes (2), side-swipe crashes (2) and other (1). Half of the crashes occurred during P.M. peak traffic hours followed by three (3) crashes occurring during A.M. peak hours, road conditions were dry for seven (7) out of the ten (10) crashes.

Broadway Road at Loon Hill Road experienced four (4) crashes over the three-year study period, with three (3) of the crashes occurring in 2013 and the remaining one (1) happening in 2014. The crashes were split between angle (1), rear-end (2) and other (1) crash types. Three (3) crashes occurred during the P.M. peak and the other occurred during the A.M. peak. The majority of the crashes happened under dry pavement conditions, and the severity of the crashes was split between property damage (3) and personal injury (1).

Broadway Road at Arlington/ Willard Street experienced seven (7) crashes during the three-year period. Four (4) of the crashes were categorized as rear-end and two were side-swipe crashes, while one crash was categorized as other. Crashes happened in even numbers (2 each) during A.M. and P.M. peak hours and the remaining three (3) crashes occurred during non-peak traffic hours. Pavement conditions were dry for four (4) out of seven (7) crashes, the other three (3) crashes happened during wet (1), snow/ice (1) and other road conditions. The intersection of Broadway/ Arlington and Willard was the only intersection that had higher number of personal injury than property damage crashes, out of the seven intersections studied.

Broadway Road (Rte. 113), from Arlington Street to the Methuen town line saw 34 crashes during the years 2012-2014. 2014 saw thirteen (13) crashes, 2012 had ten (10) crashes and

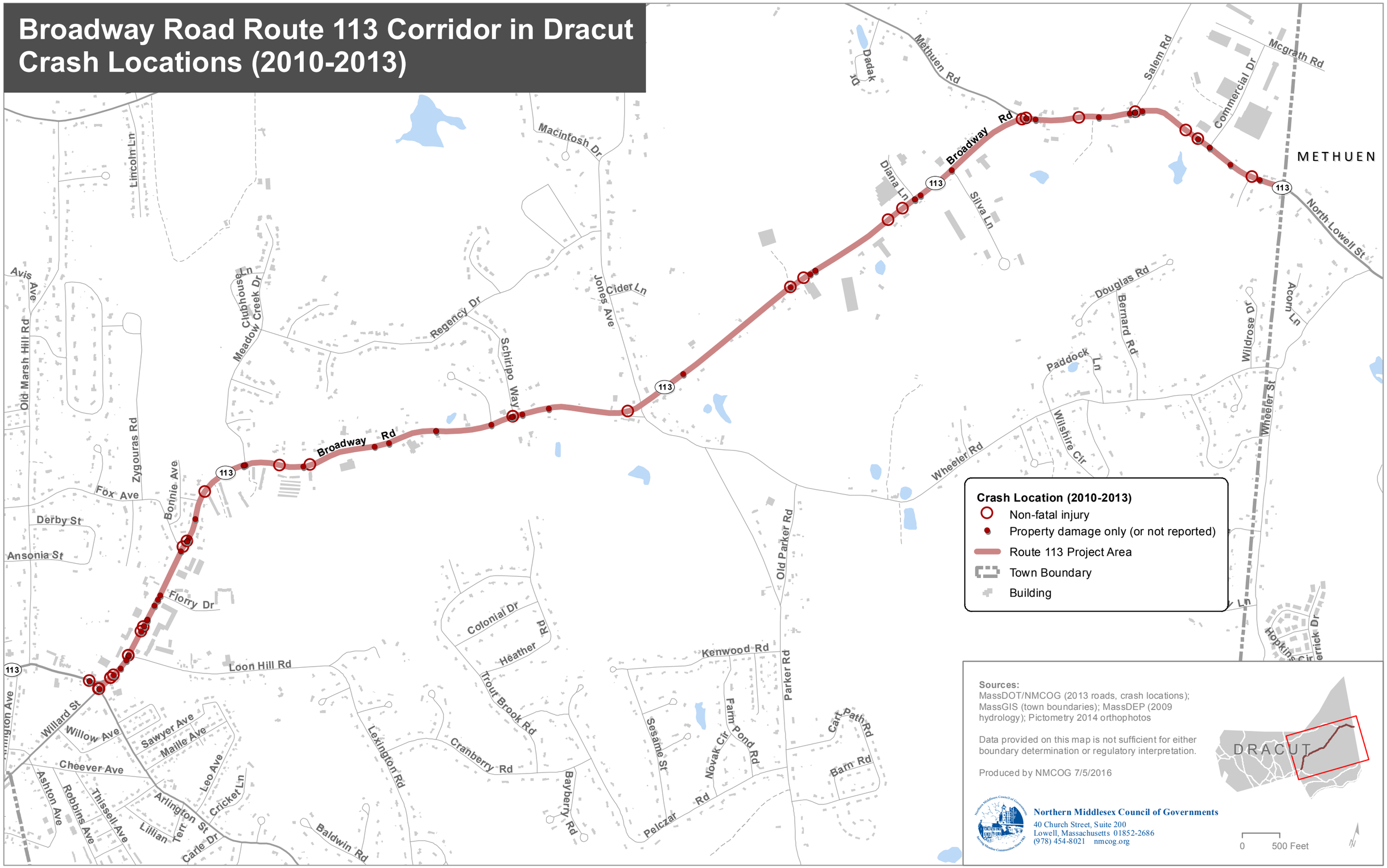
2012 had eleven (11) crashes. The majority of the crashes (18), were categorized as rear-end type of crashes, angle crashes (7), side-swipe crashes (3) and other crashes (6) were also reported. Four (4) crashes occurred during A.M. peak traffic hours, nine (9) during P.M. peak hours and twenty-one (21) occurred during non-peak traffic hours. Dry road conditions were reported for twenty-two (22) of the crashes while wet conditions were present during eight (8) crashes, snow/ice were noted during three (3) crashes and one (1) crash classified the road condition as other.

Table 14: Route 113/ Broadway Road Crash Data Analysis Summary

Major Street	Broadway Road (Rte. 113)	Broadway Road (Rte. 113)	Broadway Road (Rte. 113)	Broadway Road (Rte. 113)	Broadway Road (Rte. 113)	Broadway Road (Rte. 113)	Broadway Road (Rte. 113)
Minor Street	**Commercial Drive**	**Salem Road**	**Methuen Road**	**Jones Ave**	**Loon Hill Rd**	**Arlington St**	**Fox Ave**
Year							
2012		3				2	5
2013		2	2		3	3	1
2014	1	5		1	1	2	2
Total	1	10	2	1	4	7	8
MassDOT District 4 Crash Rate	0.56	0.56	0.56	0.73	0.56	0.73	0.56
Calculated Crash Rate	0.05	0.59	0.15	0.08	0.19	0.36	0.49
Higher than expected?	no	yes	no	no	no	no	no
EPDO Rating	1	12	2	0	8	27	20
Number of Crashes by Type:							
Angle		2			1		6
Rear-End	1	5	2		2	4	
Side Swipe		2		1		2	
Run off Rd							
Other		1			1	1	2
Total	1	10	2	1	4	7	8
Time of Day							
AM Peak		3	1		1	2	3
PM Peak		5			3	2	2
Non Peak	1	2	1	1		3	3
Total	1	10	2	1	4	7	8
Pavement Conditions							
Dry		7	2	1	3	4	4
Wet	1	2			1	1	3
Snow/Ice		1				1	1
Other						1	
Severity							
Property Damage Only	1	7	2		3	2	5
Personal Injury		2			1	5	3
Fatal							
Other/unknown		1		1			

Source: MassDOT Crash Data (2012-2014)

Broadway Road Route 113 Corridor in Dracut
Crash Locations (2010-2013)



Sources:
MassDOT/NMCOG (2013 roads, crash locations); MassGIS (town boundaries); MassDEP (2009 hydrology); Pictometry 2014 orthophotos

Data provided on this map is not sufficient for either boundary determination or regulatory interpretation.

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EXISTING CONDITIONS TRAFFIC OPERATIONS

Traffic operations within the Route 113 corridor study area are assessed from the study of key intersections, both signalized and stop controlled. Level of Service (LOS), as defined within in the *Highway Capacity Manual (HCM 2010 Edition),* is used as a performance measure describing traffic operating conditions based on average delay at each of the intersections within the roadway network. For purposes of this analysis, Synchro 9.0 was used to perform the LOS analysis for both signalized and stop controlled intersections, consistent with procedures outlined in the HCM.

Level of service (LOS) is a qualitative measure of traffic conditions ranging from free flow to major congestion. There are six levels of service ranging from A (free flow conditions) to F (highly delayed conditions). LOS accounts for various factors, including traffic volume, roadway capacity, speed, roadway grade, traffic control devices, roadway types and geometry, and roadway delays. LOS A through D is considered acceptable in an urbanized area, while LOS E and F indicate delays and congestion that warrant mitigation.

LEVEL OF SERVICE FOR Signalized Intersections

As described in the 2010 Highway Capacity Manual, Level of Service (LOS) criteria for automobile-modes are based on performance measures that are field measurable and perceivable by travelers. LOS can be characterized for the entire intersection, each intersection approach, and each lane group. Control delay is used to characterize LOS for an entire intersection or an approach. Control delay and volume to capacity ratio are used to characterize LOS for a lane group. Delay quantifies the increase in travel time due to traffic signal control. It is also a measure of driver discomfort and fuel consumption. The following criteria describe each LOS (see Table 6):

- LOS A – Operations with a control delay of 10 seconds/vehicle or less and a volume to capacity ratio no greater than 1.0. This level is typically assigned when the volume to capacity ratio is low and either progression is exceptionally favorable or the cycle length is very short. If it is due to favorable progression, most vehicles arrive during the green indication and travel through the intersection without stopping.
- LOS B – Operations with a control delay between 10 and 20 seconds/vehicle and a volume-to-capacity ratio no greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is low and either progression is highly favorable or the cycle length is short. More vehicles stop than with LOS A.

- LOS C – Operations with control delay between 20 and 35 seconds/vehicle and volume-to-capacity ratio no greater than 1.0. This level is assigned when progression is favorable or the cycle length is moderate. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant, although many vehicles still pass through the intersection without stopping.
- LOS D – Operations with control delay between 35 and 55 seconds/vehicle and volume-to-capacity ratio no greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is high and either progression is ineffective or cycle length is long. Many vehicles stop and individual cycle failures are noticeable.
- LOS E – Operations with control delay between 55 and 80 seconds/vehicle and a volume-to-capacity ratio greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is high, progression is unfavorable, and the cycle length is long. Most cycles fail to clear the queue.
- LOS F – Operations with control delay exceeding 80 seconds/vehicle or a volume-to-capacity ratio greater than 1.0. This level is typically assigned when the volume-to-capacity ratio is very high, progression is very poor, and the cycle length is long. Most cycles fail to clear the queue.

Table 15: LOS Thresholds for Signalized Intersections

CONTROL DELAY (SEC/VEH)	LOS BY VOLUME/CAPACITY RATIO[a]	
	≤ 1.0	> 1.0
≤ 10	A	F
> 10-20	B	F
> 20-35	C	F
> 35-55	D	F
> 55-80	E	F
> 80	F	F

Note: [a] For approach based and intersection-wide assessments, LOS is defined solely by control delay.

HCM 2010 Exhibit 18-4 pg 18-6.

TWO-WAY STOP CONTROLLED INTERSECTIONS

Level of Service (LOS) for a two-way stop controlled intersection is determined by the computed or measured control delay. For motor vehicles, LOS is determined for each minor street movement, as well as major street left turns, by using criteria described in Table 7. LOS is

not defined for the major street approaches or for the overall intersection for three primary reasons: (1) major street through vehicles are assumed to experience zero delay; (2) the disproportionate number of major street through vehicles at a typical two-way stop controlled intersection skews the weighted average of all movements, resulting in a very low overall average delay for all vehicles, and (3) the resulting low delay can mask important LOS deficiencies for minor movements. LOS criteria tend to have lower control delay thresholds than at signalized intersections, due to the expectation that there are lower volumes of traffic and less predictable delays. The following criteria describe each LOS:

- LOS A – Operations with a control delay of 10 seconds/vehicle or less and a volume to capacity ratio no greater than 1.0.
- LOS B – Operations with a control delay between 10 and 15 seconds/vehicle and a volume-to-capacity ratio no greater than 1.0.
- LOS C – Operations with control delay between 15 and 25 seconds/vehicle and volume-to-capacity ratio no greater than 1.0.
- LOS D – Operations with control delay between 25 and 35 seconds/vehicle and volume-to-capacity ratio no greater than 1.0.
- LOS E – Operations with control delay between 35 and 50 seconds/vehicle and a volume-to-capacity ratio greater than 1.0.
- LOS F – Operations with control delay exceeding 50 seconds/vehicle or a volume-to-capacity ratio greater than 1.0.

Table 16: Two-Way Stop Controlled Intersection LOS Criteria

CONTROL DELAY (SEC/VEH)	LOS BY VOLUME/CAPACITY RATIO[a]	
	≤ 1.0	> 1.0
≤ 10	A	F
> 10-15	B	F
> 15-25	C	F
> 25-35	D	F
> 35-50	E	F
> 50	F	F

Note: [a] For approach based and intersection wide assessments, LOS is defined solely by control delay.

HCM 2010 Exhibit 19-1, pg 19-2.

LEVEL OF SERVICE ANALYSIS RESULTS

The results of the Level of Service analysis are summarized in Table 8. Observations from the LOS analysis for existing conditions are as follows:

- The signalized intersection at Broadway, Arlington Street and Willard Street performs at acceptable levels of service during both peak commuting periods.
- Left turning movements from Loon Hill Road on to Broadway experience poor levels of service during peak hours due to the large traffic volumes along Route 113. Delays for the minor street movement are a reported 217 seconds per vehicle (LOS F).
- The intersection of Fox Avenue at Route 113 operates at acceptable levels of service overall. However, delays during both the AM peak (36.7 seconds/vehicle) and PM peak (48.7 seconds/vehicle) are considered unacceptable for minor street movements, due to traffic generated from the adjacent Dunkin Donuts interacting with high volumes of through traffic along Broadway.
- Salem Road vehicles experience delays while making movements during the evening peak period (57.6 sec/veh). This is mainly due to large volumes of traffic traveling along Route 113 westbound, as well as a higher number of left turning vehicles from Route 113 eastbound onto Salem Road.
- Although the entire intersection operates well during the peak periods, Broadway Road at Commercial Drive movements experience unacceptable delays during the evening peak period (40.6 seconds/vehicle). This is mainly due to the lack of acceptable gaps for the high percentage of heavy vehicles turning left onto Route 113.

Table 17: Route 113 Corridor Existing Conditions Operational Analysis Results

LOCATION	TYPE OF INTERSECTION/ CONTROL	PEAK PERIOD	INTERSECTION DELAY	MAX V/C RATIO	LOS	LOS E OR F MOVEMENTS
Route 113 at Arlington Street/Willard Street	Four legged actuated signal, not coordinated	AM	19.2	0.76	B	
		PM	37.6	0.95	D	
Route 113 at Loon Hill Road	T-intersection with stop control for Loon Hill Road	AM	5.0	0.59	A	Loon Hill
		PM	18.1	1.21	C	Loon Hill

Route 113 at Fox Avenue/Dunkin Donuts Driveway	Four legged intersection with stop control for Fox/DD	AM	6.9	0.57	A	Dunkin Donuts movements
		PM	7.3	0.58	A	Dunkin Donuts movements
Route 113 at Jones Avenue/Willard Street	Four legged actuated signal, not coordinated	AM	15.1	0.72	B	
		PM	15.6	0.77	B	
Route 113 at Methuen Road	T-intersection with stop control for Methuen Road	AM	5.7	0.57	A	
		PM	3.2	0.45	A	
Route 113 at Salem Road	T-intersection with stop control for Salem Road	AM	5.1	0.51	A	
		PM	8.0	0.75	A	Salem Rd
Route 113 at Commercial Drive	T-intersection with stop control for Commercial Drive	AM	2.2	0.32	A	
		PM	2.9	0.56	A	Commercial Dr

During the peak hour each intersection within the study area operates at acceptable conditions overall. There are individual movements within several intersections that experience longer delays, as shown in the table above. Because of this, traffic signal warrant analysis was conducted to determine if addition of signal control at the intersection would be warranted or needed to improve operations.

GUIDELINES FOR INSTALLATION OF A TRAFFIC CONTROL SIGNAL

To consider a traffic control signal installation, certain traffic signal warrants must be met. Outlined in the Manual of Uniform Traffic Control Devices (MUTCD), these warrants justify the need for a traffic control signal at a particular location. The 2009 edition of the MUTCD states:

"The investigation of the need for a traffic control signal shall include an analysis of factors related to existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:

- Warrant 1: Eight-Hour Vehicular Volume

- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection near a Railroad Grade Crossing."

In this study, Warrants 1, 2, 3 and 7 were analyzed in the justification for installation of a traffic signal at four un-signalized intersections, including Broadway at Loon Hill Road, Broadway at Fox Avenue/Dunkin Donuts entrance, Broadway at Salem Road, and Broadway at Commercial Drive. The analysis for each intersection is included in the appendix to this report.

WARRANT 1: EIGHT-HOUR VEHICULAR VOLUME

The eight-hour vehicular volume warrant considers the traffic volumes throughout the day. Table 9 provides the minimum standards for an intersection to justify the need for a traffic signal. The bolded sections are the minimum standards that are applicable to the intersection of Broadway and Loon Hill Road, with single-lane approaches on both roadways.

Table 18: Warrant 1, 8 - Hour Vehicular Volume

Condition A – Minimum Vehicular Volume							
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approach (one direction only)		
Major Street	**Minor Street**	**100%**	**80%**	**70%**	**100%**	**80%**	**70%**
1	1	**500**	400	350	**150**	120	105
2 or more	1	600	480	420	150	120	105
2 or more	2 or more	600	480	420	200	160	140
1	2 or more	500	400	350	200	160	140

ANALYSIS RESULTS:

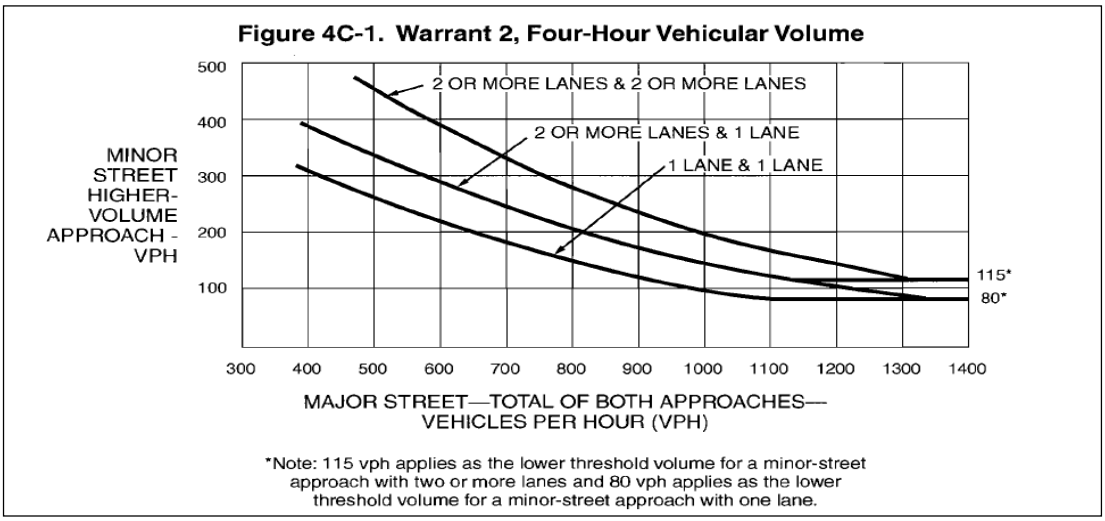
- *Broadway at Loon Hill Road:* Warrant 1 is not satisfied in that for eight hours of a typical weekday, major street approaches are greater than 500 vehicles per day but the minor street approach does not reach 150 vehicles per hour at any time.
- *Broadway at Fox Avenue/Dunkin Donuts driveway:* Warrant 1 is not satisfied in that for eight hours of a typical weekday, major street approaches are greater than 500 vehicles per day but the minor street approach does not reach 150 vehicles per hour at any time.
- *Broadway at Salem Road:* Warrant 1 is not satisfied in that for eight hours of a typical weekday, major street approaches are greater than 500 vehicles per day but the minor street approach totals over 150 vehicles per hour for only three hours.
- *Broadway at Commercial Drive:* Warrant 1 is not satisfied in that for eight hours of a typical weekday, major street approaches are greater than 500 vehicles per day but the minor street approach does not reach 150 vehicles per hour at any time.

WARRANT 2: FOUR-HOUR VEHICULAR VOLUME

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

"Standard: The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the minor street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 of the HCM for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours."

FIGURE 10: WARRANT 2, 4-HOUR VEHICULAR VOLUME



ANALYSIS RESULTS:

- *Broadway at Loon Hill Road:* Warrant 2 is not satisfied in that the traffic volumes do not fall above the approach threshold curve for at least four hours of the day.
- *Broadway at Fox Avenue/Dunkin Donuts driveway:* Warrant 2 is not satisfied in that traffic volumes do not fall above the approach threshold curve for at least four hours of the day.
- *Broadway at Salem Road:* Warrant 2 is not satisfied in that only three hours are listed above the threshold for a 1 lane minor and major street approach.
- *Broadway at Commercial Drive:* Warrant 2 is not satisfied in that Commercial Drive approach volumes do not meet minimum thresholds.

WARRANT 3: PEAK HOUR

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street. The MUTCD standard is stated below.

"02 - This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

03 - The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

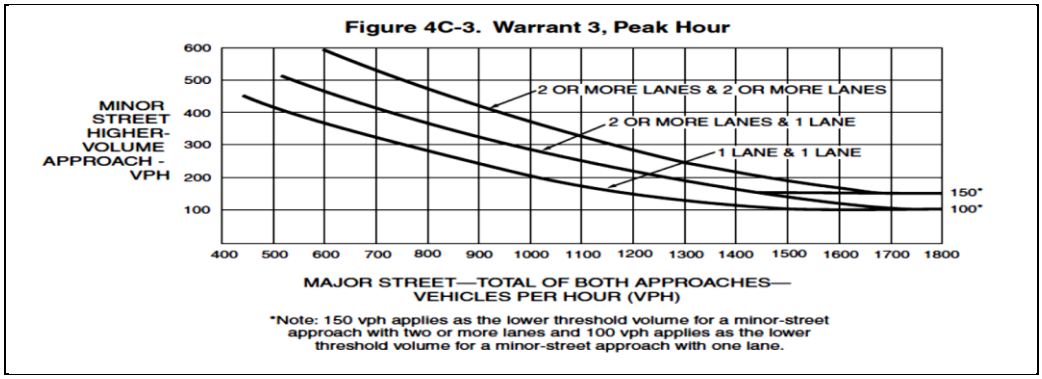
1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and

2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and

3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 of the HCM (see below) for the existing combination of approach lanes."

Figure 11: Warrant 3 Standard B, Peak Hour



RESULTS:

This warrant is intended for use in locations where high volumes of traffic are discharged over a short period of time. The Route 113 corridor generally does not have locations that trigger

satisfaction of this warrant. The study area intersections do not meet the standard for total stopped time delay and thus do not meet this warrant.

WARRANT 7: CRASH EXPERIENCE

The crash experience signal warrant is used where frequency and severity of crashes are the principal reasons for installing a traffic signal. An excerpt from the MUTCD explaining the crash experience standard is listed below:

"The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

- *Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and*
- *Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and*
- *For each on any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 14 exists on the major street and the higher-volume minor-street approach, respectively, to the intersection. These major-street and minor-street volumes shall be for the same eight hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours."*

RESULTS:

- *Broadway at Loon Hill Road:* Warrant 7 is not satisfied in that less than 5 crashes per year have been reported at this intersection.
- *Broadway at Fox Avenue/Dunkin Donuts driveway:* Warrant 7 is not satisfied in that less than 5 crashes per year have been reported at this intersection.
- *Broadway at Salem Road:* Warrant 7 is not satisfied in that only 4 of the reported 10 crashes in the three-year period are susceptible to correction by a traffic control signal. The threshold is 5 crashes during a 12-month period.
- *Broadway at Commercial Drive:* Warrant 7 is not satisfied in that there are only 2 reported crashes during the three-year study period.

Based on existing conditions warrant analysis results, additional traffic signals are not recommended along the Route 113 corridor at this time.