Section 1 – Introduction

The Town of Danvers retained BETA Group, Inc. to provide a comprehensive transportation study aimed at identifying problem areas and providing recommendations to remedy these problems. This report will detail existing traffic conditions, provide a build-out analysis based on future, residential, commercial and industrial development, conduct intersection capacity analysis utilizing traffic modeling software, complete pavement management analysis, and provide improvement alternatives and an action plan. Previously the town fulfilled a "Townwide Traffic Master Plan" in 1988. This report provides a historical prospective from which any progress can be measured in the future.

The Town of Danvers is located 17 miles north of Boston along the Massachusetts coast. The town has an area of 14.1 sq miles and a population of 25,212 based upon the 2000 US census. The road network contains limited access highways, principle arterials, collectors, and local roads. Within the town there are three limited access highways: Interstate 95, U.S. Route 1, and Route 128. Major state highway routes include Route 62, Route 114, and Route 35 (**Figure 1-1**).

Located within the greater Boston metropolitan area the Town of Danvers is well integrated into this highly developed economic region. To sustain this prosperous economic environment and expand business opportunities for others the town must maintain a transportation system capable of handling the large volumes of traffic that are produced from urbanized areas. Developing such a system requires extensive knowledge of the area, adequate infrastructure, and an eye towards trends and developments that may impact traffic patterns within the community. A transportation system of this type is never completely developed, as time goes on the system must continuously be re-evaluated and updated.

Danvers is a member of the Massachusetts Bay Transportation Authority (MBTA) which provides fixed bus routes to surrounding communities. The MBTA commuter rail also has stops in the neighboring towns of Salem and Beverly offering public transportation throughout the greater Boston metropolitan area.

Section 2 – Danvers Road Network

The Town of Danvers experiences high traffic volumes on many of its limited access roadways, state highways, and collector streets. It is understood that Danvers does not control or maintain these limited access highways or highway interchanges, but they are described here because of their importance to overall townwide circulation. Danvers has a large number of arterials, collectors, and local streets that serve a densely populated downtown area and growing external residential development.

Danvers contains 8 highway interchanges, and a ninth located in Peabody, near the town line. These highway interchanges increase traffic to the town and provide access to interstate and intercity travel. Because of Danvers location in close proximity to Metro-Boston, Danvers most likely experiences significant amounts of cut through traffic on local streets to avoid the peak hour traffic congestion on the arterial road network.

This section describes the Danvers road network and major streets including the major limited access highways and arterial road network (**Figure 2-1**). Some major collector roadways are included and described as connections to the local road network.

Limited Access Highways

Interstate 95
Interstate 95 within the Danvers town boundary is a multilane limited access highway with breakdown lanes in each direction. Interstate 95 provides access egress to the town at four highway interchanges in Danvers: at Route 1, Route 114, Centre Street, and Maple Street. Traffic volumes were very high at 56,000 vehicles per day in 1998.

Route 128
Route 128 within the town boundary is also a multilane limited access highway with breakdown lanes in each direction. Route 128 provides access egress to the town at three highway interchanges: a partial cloverleaf interchange at Endicott Street near the Liberty Tree Mall, a partial interchange at High Street (Route 35), and a partial interchange at Elliott Street (Route 62). Traffic volumes were very high at 79,500 vehicles per day in 2001.

Route 1
Route 1 is a limited access commercial highway. This roadway has four access egress points in Danvers: at Andover Street (Route 114), Centre Street, Maple Street (Route 62), and Interstate 95. Traffic volume on this roadway was over 38,000 vehicles per day at the Peabody line in 1998.

State Highways

Route 114 (Andover Street)
Route 114 is an east-west arterial road serving primarily commercial land use. The roadway is located in the southern portion of town and bisects the town from the Middleton town line to the Peabody city line. The roadway provides access to limited access highway interchanges for Route 1 and Interstate 95. The Route 1 interchange provides access to Route 1 north and south. Interstate 95 northbound can be accessed via a partial highway interchange, but Interstate 95 southbound is not accessible at this interchange. Route 128 north or south is accessible directly over the town line at a highway interchange in the City of Peabody.

Route 62 (Maple Street / Elliot Street)(Town Maintained)
Route 62 is a two lane east-west arterial road that bisects the entire town in the center from the Middleton town line to Beverly City line. The road has additional turn lanes provided at major intersections. Route 62 provides access to two limited access highways along its east-west path through town. Route 128 northbound can be accessed at a partial highway interchange to the west of Liberty Street. Route 1 north or south can be accessed at a full access highway interchange located to the west of Hill Drive.

Route 35 (Water Street / High Street / Locust Street)(Town Maintained)
Route 35 is a two lane north south arterial that bisects the entire town from the Peabody City line to the Town of Wenham on the north. Route 35 provides access to a partial highway interchange with Route 128 to the east of Purchase Street. Route 128 north or south can be accessed via this interchange.

Major Collectors

Endicott Street
This is a multi-lane east-west collector road that serves primarily commercial land use including the Liberty Tree Mall. The road provides a connection to a partial cloverleaf interchange with Route 128. The road extends from Route 114 to Route 35.

Centre Street
This road is a two-way two lane east-west collector road with no shoulder. The lanes are striped on portions of the street, but not the entire length. The road serves primarily residential property. The road extends from Collins Street to Armory Road.

Collins Street
This road is a two-way two lane east-west collector road that extends from Centre Street in the north to Sylvan Street to the south. The road is one lane in each direction with no shoulders. Collins Street connects to Centre Street to the west which provides a direct connection to the Route 1 interchange at Centre Street.

North Street
This road is a two-way two lane east-west striped collector road with narrow two foot shoulders. North Street extends from Route 35 west to the Topsfield / Middleton town line and travels to Route 1 at a signalized intersection near the Topsfield / Middleton town line.

Summer Street
This road is a two-way two lane north-south collector road with no shoulders. The road primarily serves local neighborhood streets and two schools, St. Johns Preparatory School and the Smith School. The road extends from Route 62 north to North Street.

Sylvan Street
This road is a two-way two-lane north-south collector road that provides additional turn lanes at key intersections. The road provides access to the downtown area and to the busy Route 114 commercial corridor. In a northerly direction, the road ends at the intersection of Elm Street / Holten Street / Ash Street, adjacent to the Town Hall.

Pine Street
This road is a two-way two lane north-south collector road that extends from Maple Street (Route 62) to Sylvan Street. Pine Street, from Route 62 to Sylvan Street was recently reconstructed by MassHighway. The road provides access to the Great Oak School. There are sidewalks on each side of the road throughout the length of the road.

Liberty Street
This road is a two-way two lane north south collector road that extends from Elliott Street (Route 62) to Water Street (Route 35). The road crosses the Porter River approximately a quarter mile north of High Street. The road provides access to the Riverside School and indirectly to the Williams School via Route 62. There are sidewalks and narrow shoulders on each side of the road.

Burley Street
This road is a two-way two lane north south collector road in the northeast corner of town. The road serves primarily residential homes in this rural section of Danvers. The road extends from Conant Street to Wenham Street.

Section 3 – Data Collection

Overview

In order to develop a baseline of intersection operations within the town, existing traffic flow characteristics for the project roadways were developed from a manual turning movement count (TMC) and an automatic traffic recorder (ATR) count program. **Figure 1** included with this memorandum provides the location of each TMC and ATR within the Town of Danvers.

Manual Turning Movement Counts

Based on an understanding of the Townwide roadway network through meetings with town officials, a number of key intersections were identified. Manual turning movement counts were completed in June of 2001 at these locations which are indicated below. Counts were taken at the intersections specified between the hours of 7:00 AM – 9:00 AM, and 4:00 PM – 6:00 PM, on weekdays excluding Monday AM and Friday PM and recorded in 15-minute intervals. **Figures 3-1** and **3-2** included depict the AM and PM peak hour turning movement count data for the locations referenced below.

A. Maple Street/Hobart Street
B. Locust Street/North Street
C. Locust Street/Wenham Street
D. Sylvan Street/Endicott Street
E. Centre Street/Hobart Street
F. North Street/Summer Street/Rodgers Road
G. Locust Street/Valley Street
H. Water Street/South Liberty Street
I. Liberty Street/Water Street/High Street
J. Water Street/Endicott Street
K. Pine Street/Holten Street
L. Collins Street/Holten Street/Centre Street
M. Sylvan Street/Collins Street/Federal Street
N. Sylvan Street/Ash Street
O. Conant Street/Burley Street/State Street
P. High Street/Purchase Street/Route 128
Q. Conant Street/Poplar Road/Elliot Street
R. Elm Street/Holten Street/Essex Street

In addition to the counts conducted in June, turning movement data was collected from a number of recent traffic studies prepared for locations within the town. Intersections for which turning movement count data was available are listed on the next page.

1. Maple Street/Forest Street
2. Maple Street/Vineyard Street
3. Maple Street/Summer Street
4. Maple Street/Poplar Street

5. **Poplar Street/Locust Street/Hobart Street**
6. **Rosewood Drive/Watson Parkway/Andover Street (Route 114)**
7. **Centre Street/Watson Parkway**
8. **Centre Street/Rowell Road**
9. **Centre Street/Armory Way**
10. **Centre Street/Armory Way**
11. **Dayton Street/Armory Way**
12. **Route 1/Dayton Street**

Automatic Traffic Recorder Counts

A series of 48-hour automatic traffic recorder (ATR) counts were conducted as part of the traffic counting program. This allows for a comparison of daily and hourly directional traffic on critical study area roadways. Counts were conducted at stations listed below. The average weekday volumes are listed in **Tables 3-1** and **3-2** and illustrated in **Figure 3-3**.

1. **State Road north of Route 128 SB Ramp**
2. **Liberty Street north of Route 62**
3. **Route 62 north of Preston Street**
4. **Route 62 east of Foster Street**
5. **Route 62 north of Bayberry Road**
6. **Conant Street east of Route 62**
7. **Sylvan Street north of Walcott Road**
8. **Sylvan Street (Elm Street) north of Adams Street**
9. **Purchase Street east of Ash Street**
10. **Pine Street north of Postgate Road**
11. **Holten Street west of Burroughs Street**
12. **Hobart Street east of Wadsworth Street**
13. **Wenham Street east of Princeton Street**
14. **Summer Street north of Spring Street**
15. **North Street west of Calumet Street**

Table 3-1
Automatic Traffic Recorder Data

Location	Weekday Average	Saturday Total
State Road North of Route 128 SB Ramp	6,992	
Liberty Street North of Route 62	11,738	
Route 62 North of Preston Street	13,698	
Route 62 East of Foster Street	30,961	28,860
Route 62 North of Bayberry Road	25,581	
Conant Street East of Route 62	10,917	
Sylvan Street North of Walcott Road	15,051	
Sylvan St (Elm St) North of Adams Street	7,504	
Purchase Street East of Ash Street	10,059	
Pine Street North of Postgate Road	3,256	3,281
Holten Street West of Burroughs Street	9,219	
Hobart Street East of Wadsworth Street	6,619	
Wenham Street East of Princeton Street	3,707	
Summer Street North of Sring Street	2,750	
North Street West of Calumet Street	5,714	

Table 3-2
Traffic Data for Danvers

(1998 volumes obtained from MHD counting stations)	
Location	**Weekday Average**
Centre Street west of Hobart Street	14,500
Dayton Street at Middleton Town Line	2,700
Garden Street north of Route 114	4,600
North Street west of Summer Street	6,000
Route 1 at Peabody City Line *	38,408
Route 1 at Topsfield Town Line	16,600
Route 1 south of Route 62 interchange	29,700
Route 62 west of Forest Street	23,400
Route 114 at Middleton Town Line	28,900
Route 114 east of Route 1 *	34,700
Route 114 west of Macarthur Boulevard	39,300
Route I-95 north of Route 1	55,500
Route I-95 north of Route 62 **	60,800
Route I-95 south of Route 62	56,000
State Road south of Conant Street	6,700

** 1999 data ** 1996 data*

ATR data was also obtained for a number of MassHighway counting stations that currently exist on major roadways within the town limits of Danvers. These locations are listed below.

1. **Centre Street west of Hobart Street**
2. **Dayton Street at Middleton Town Line**
3. **Garden Street north of Route 114**
4. **North Street west of Summer Street**
5. **Route 1 at Peabody City Line**
6. **Route 1 at Topsfield Town Line**
7. **Route 1 south of Route 62 interchange**
8. **Route 62 west of Forest Street**
9. **Route 114 at Middleton Town Line**
10. **Route 114 east of Route 1**
11. **Route 114 west of Macarthur Boulevard**
12. **Route I-95 north of Route 1**
13. **Route I-95 north of Route 62**
14. **Route I-95 south of Route 62**
15. **State Road south of Conant Street**

Traffic growth rates in Danvers vary depending on the functional classification of the roadway. The following table is a sample of traffic growth rates from available MHD data. These five streets are growing at 2% per year or less depending on the roadway.

Table 3-3 Average Daily Traffic (ADT) Growth Rates (MHD Volumes)

Street	Historic Count (1988)	New Count (1998-2001)	Annual Growth Rate %
Andover Street (114)	33530	39300 (1998)	1.6
Elliott Street (62)	28600	30961	.61
Sylvan Street	14400	15051	.34
North Street	4500	5714	1.85
Centre Street	11800	14500 (1998)	2.08

For comparison to traffic volumes, regional population growth is available to correlate with regional traffic volumes. Six neighboring communities were identified for comparison to Danvers. The following table indicates the average annual percent population growth for two periods. The first period is 10 years from 1990 to 2000, and the second period is 20 years from 2000 to 2020. This 2020 projection is taken from the Metropolitan Area Planning Council (MAPC). **Table 3-4** depicts the changes that occur in population totals at the six neighboring communities and Danvers.

Table 3-4	Population Totals*			Average Annual Percent Change	
	1990	2000	2020 Projected	1990-2000 (10yrs.)	2000-2020 (20yrs.)
Danvers	24174	25212	27424	.42	.42
Beverly	38195	39862	37944	.43	-.25
Middleton	4921	7744	10262	4.63	1.42
Peabody	47039	48129	42187	.23	-.65
Salem	38091	40407	41394	.59	.12
Topsfield	5754	6141	6795	.65	.51
Wenham	4212	4440	4960	.53	.56

*MAPC Community Population Forecasts, 2010-2025

As indicated in **Table 3-4**, population growth is under 1% annual growth at the six neighboring communities with the exception of the Town of Middleton. Middleton has experienced significant growth since 1990 and is projected to grow at a faster rate than any other community in the region in the next 20 years. Peabody and Beverly are projected to lose population over the next 20 years.

Intersection Inspection

Each intersection was inspected for operational characteristics, lane configurations, geometric conditions, pedestrian issues, sight distance problems, striping and signing and existing signal timings. A sketch of each intersection was also completed to assist with developing improvement alternatives. Although these sketches are schematic in nature they are provided in the appendix with the Final Report.

Journey to Work

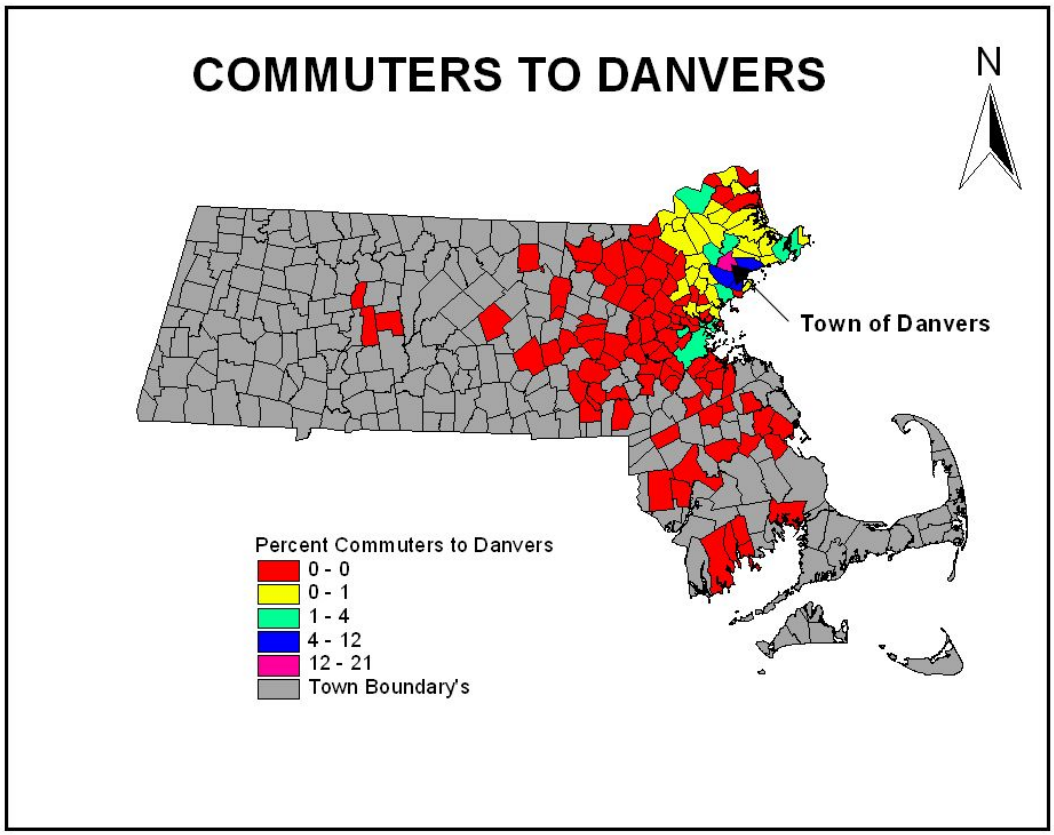
The Town of Danvers workforce is dispersed throughout the Commonwealth, but a majority of the workforce is from within Danvers and adjacent communities. 2000 Census Journey to Work data is not yet available. Therefore, based on the 1990 Census Journey to Work data, the following table indicates the breakdown of employees commuting to Danvers.

Table 10-1 Top Ten Commuters to Danvers

Community	Percent of Workforce
Danvers	21
Peabody	12
Beverly	10
Salem	7
Lynn	4
Gloucester	2
Middleton	2
Topsfield	2
Haverhill	2
Boston	2
All Others*	36

*171 communities contribute less than 2% per community

This distribution indicates a significant regional impact of the workforce commuting to Danvers. Although Danvers draws from all over the state and beyond, the predominant attraction is from within the town and communities adjacent to Danvers. The figure below graphically depicts this distribution.



Danvers residents commute primarily to 5 other communities other than Danvers. These communities include the following:

Table 10-2 Top Ten Danvers Commuting Residents

Community	Percent of Workforce
Danvers	34
Peabody	9
Boston	9
Beverly	7
Salem	6
Lynn	5
All Others*	30

*None of these 95 other communities contribute more than 2% to other communities' workforce totals.

As shown in **Table 10-2** above, Danvers residents primarily commute within the town boundaries. Other adjacent communities receive a majority of the remaining commuters. The remaining 30 percent are dispersed throughout the state with no community receiving more than 2% of Danvers residents as employees.

Section 4- Parking Inventory

The Town of Danvers maintains six municipal lots. Five of these lots are located in the downtown business district; the sixth is located at John L. George Park. As part of this comprehensive transportation study each of these lots was assessed to determine what, if any deficiencies they may have. The six lots are listed at the locations below.

- **John L. George Park**
- **Intersection of Page Street & Elm Street**
- **Intersection of High Street & Park Street**
- **Between Central Avenue & Cottage Avenue ~100' NE of High Street**
- **High Street ~150' NW of Cherry Street**
- **School Street ~150' NE of High Street**
- **Town Hall Municipal – Between Cherry Street and Elm Street**

John L George Park Municipal Parking Lot

This is the only municipal lot not located in the downtown business area. It is also the only municipal lot that does not have a time restriction on parking. The primary purpose of this lot is to provide parking for visitors to the park. At the time of the inspections the park was snow covered, leading the inspector to determine that the parking lot would not be at peak utilization until the warmer months. This lot has 50 regular spaces and 4 handicap spaces. Occupancy was low for both the weekend and weekday peak hour. More information can be found on **Figure 4-1**.

High Street Municipal Parking Lot

This lot located at the intersection of High Street and Park Street contains 43 regular spaces and 2 handicap spaces. All spaces have a 2 hour limit between the hours of 9 am and 9 pm Monday thru Friday. At the time of these inspections there were 3 snow covered spaces that were not included in the analysis of the lot. This lot is meant to serve primarily the Danvers Atrium which contains among other businesses a Movieworks, Danvers Savings Bank and Kumon Math and Reading Center. Vehicles entering the lot must do so through the High Street entrance and exit onto Park Street. There is a no parking zone immediately in front of the Danvers Atrium which was not strictly adhered to by patrons entering the movie works, presumably to return movies. The lot was at least three quarters full during both the weekend and weekday peak. For more information see **Figure 4-2**.

Elm Street Municipal Parking Lot

Located at the intersection of Elm Street and Page Street this lot also serves the downtown business area. Spaces here are 2 hour parking between the hours of 9 am and 9 pm. Page Street is one way going away from Elm Street, thus there is no right turn available to vehicles exiting onto Page Street. During both the weekend and weekday peak there are 10 spaces left un-occupied. There are 28 regular spaces, 2 handicap spaces and 7 permit only spaces as illustrated in **Figure 4-3**.

Central Avenue Municipal Parking Lot

This lot is located between Central Avenue and Cottage Avenue about 100' northeast of High Street. Central Avenue is one-way away from High Street and Cottage Avenue is one-way towards High Street. This lot contains 39 regular spaces, 4 handicap spaces and 3 permit only spaces. Again these spaces are 2 hour parking between the hours of 9 am and 9 pm Monday through Friday. In addition to these spaces, there are 16 spaces directly behind New Brother's Restaurant and Deli that are restricted to customer parking. These spaces may be confused with the municipal parking lot but are not included in the analysis of the lot. In addition four cars were seen parked illegally during the Saturday peak hour. All four of these cars were not parked in designated spaces, but along the rear fence of the lot. There is at least a 75% occupancy rate for both the weekend and weekday peak hours. More information can be seen on **Figure 4-4**.

School Street Municipal Parking Lot

This is a small lot with only 13 regular spaces, 1 handicap space and 2 permit only spaces all 2 hour parking between 9 am and 9 pm. It is another business district lot located about 150' northeast of High Street. Occupancy rates are high for both peak hours as can be seen in **Figure 4-5**.

Cherry Street Municipal Parking Lot

Located about 150' northwest of Cherry Street off of High Street set back behind the businesses this lot contains 24 regular spaces, 3 handicap spaces and 7 permit only spaces. Once again the lot serves the downtown business district and is 2 hour parking between 9 am and 9 pm Monday thru Friday. In addition to these spaces there is room for a few more vehicles close to the businesses that are filled with employee parking. The occupancy rate here is low compared to the other downtown lots as can be seen in the figure below. For more information see **Figure 4-6**.

Town Hall Municipal – Between Cherry Street and Elm Street

This parking lot is a long narrow lot located between Cherry Street and Elm Street. The lot extends in an east / west direction and contains 73 parking spaces: 69 unrestricted spaces, and 4 handicapped spaces. The parking lot access road functions in two ways. A short portion contains two rows of parking spaces and allows for two way traffic operations. This portion contains 20 unrestricted spaces and 2 handicapped. The remaining long narrow parking area contains angle parking and is one way westbound to Cherry Street. This portion contains 49 unrestricted parking spaces and 2 handicapped parking spaces. During a normal weekday, the parking lot was approximately half full. For more information see **Figure 4-7**.

In summary the Town of Danvers has 197 regular, 16 handicap and 19 permit only spaces within their municipal lots. Taking away the John L. George lot which lies far away from the downtown business district, the total number of spaces is reduced to 147 regular, 12 handicap and 19 permit only spaces.

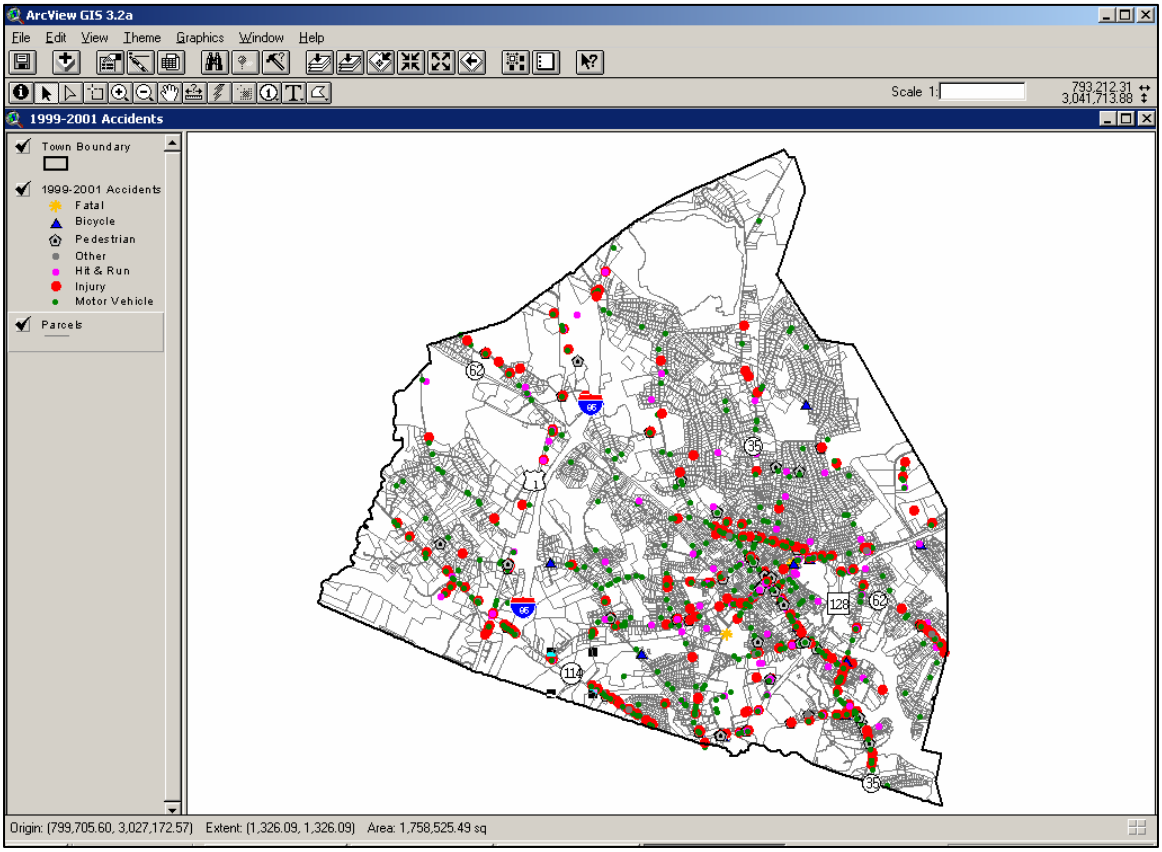
Parking Occupancy Survey

Each of the lots listed above were inspected to determine the total number of spaces, any parking restrictions on the spaces and occupancy rates for the lots during a weekday and weekend peak hour. Any other pertinent information such as signage, no-parking zones or direction of travel was also documented. These inspections were done on Saturday March 8, 2003 between 11:00 am and 1:00 pm and Wednesday March 12, 2003 between 9:00 am and 11:00 am. Weekend and weekday occupancy data for each lot can be found in the following table. The overall occupancy rates for the weekend and weekday peak hours respectively in the downtown lots are 74% for weekday and 75% for weekend.

Table 4-1 Lot Identification	Total Spaces	Number Spaces Occupied Wkday	Number Spaces Occupied Wkend	Percent Occupied Wkday	Percent Occupied Wkend
John L. George Municipal	54	2	1	4%	2%
High Street Municipal	45	36	34	80%	75%
Elm Street Municipal	37	20	24	54%	65%
Central Avenue Municipal	46	37	41	80%	89%
School Street Municipal	16	14	14	87%	87%
Town Hall Municipal	73	40	0	55%	0%
Cherry Street Municipal	34	23	19	68%	56%
TOTAL	305	172	133	-	-

Section 5- Safety Analysis

Crash data was obtained from the Town of Danvers Police Department for the 3 year period of 1999 to 2001. The information was provided in database format to allow for spatial analysis (GIS) to be performed as illustrated in the graphic below. Tables 3 and 4 on the following pages provide a summary of the results. Landmarks, as identified in **Table 5-2**, were locations which experienced more than 5 crashes per year within the study period.



The incidence of motor vehicle crashes has increased during this three year period as indicated on **Table 5-1**. High hazard locations should be identified and analyzed to determine the cause of crashes at these locations.

TABLE 5-1 Type	**1999**	**2000**	**2001**	**Total**
Motor Vehicle	870	973	1056	**2899**
Bicycle	5	7	7	**19**
Fatal	1	2	0	**3**
Hit & Run	65	85	109	**259**
Injury	199	215	197	**611**
Other	49	34	41	**124**
Pedestrian	32	17	18	**67**
Total	**1221**	**1333**	**1428**	**3982**
From MHD Crash Data / Traffic Operations, 2001				

The Massachusetts Highway Department is currently working on highway interchange improvements at several highway interchanges in town that should address some safety concerns in town.

The pie chart at right indicates the percent of crashes under each crash type. Motor vehicle crashes are the most frequent type of crash occurring in town. Bicycle crashes are the next most likely crashes to occur in town, and so forth.

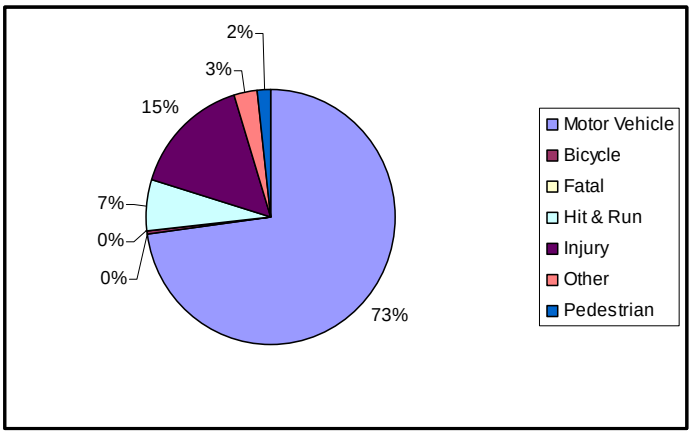


Table 5-2 below indicates total crashes in town by street name and landmark. Andover Street (Route 114) and the Liberty Tree Mall are the highest street and landmark locations for crashes in town. The next top four landmark locations for crashes are located at Route 128 highway interchanges.

Table 5-2 DANVERS - Accident Data Summary by Street and Landmark 1999-2001

Street	Total Accidents	Landmark	Total Accidents
ANDOVER ST	687	LIBERTY TREE MALL	85
ENDICOTT ST	390	128S AT 35	69
MAPLE ST	334	128S AT 62	64
NEWBURY ST	308	128N AT 35	50
HIGH ST	241	128S AT ENDICOTT ST	47
RTE 128 SOUTH	235	DUNKIN DONUTS	46
ELLIOTT ST	171	128N AT 62	42
WATER ST	171	ENDICOTT/128N	42
RTE 128 NORTH	168	128N AT ENDICOTT ST	41
INDEPENDENCE WAY	167	ANDOVER/NEWBURY	38
SYLVAN ST	119	DEERSKIN TRADING PO	38
CONANT ST	95	ANDOVER/GARDEN	36
LOCUST ST	94	ELLIOTT/LIBERTY	35
POPLAR ST	86	MAPLE/NEWBURY	34
LIBERTY ST	75	LIBERTY/ELLIOTT	32
RTE 1 SOUTH	59	ANDOVER/ROSEWOOD	29
HOBART ST	58	ANN & HOPE	28
CENTRE ST	53	ENDICOTT/128S	26
RTE 1 NORTH	49	HERB CHAMBERS DODGE	25
ELM ST	42	HOME DEPOT	24
HOLTEN ST	40	LOCUST/POPLAR	24
RTE 95 NORTH	38	SYLVAN/ADAMS	24
STATE RD	31	1N AT RTE 114	23
PURCHASE ST	30	MVP SPORTS	23
COLLINS ST	29	1S AT RTE 114	22
RTE 95 SOUTH	28	STATE/128S	22
CABOT RD	27	SYLVAN/ENDICOTT	21
PINE ST	27	1S AT RTE 62	20
FERNCROFT RD	25	MAPLE/SUMMER	20
SUMMER ST	22	WATER/ENDICOTT ST	20
DAYTON ST	21	114W/RTE 1 NORTH	18
CHERRY HILL DR	20	ELLIOTT/RTE 128	18
NORTH ST	20	DANVERS PLAZA	17
FEDERAL ST	17	ENDICOTT/WATER	17
BROOKSBY VILLAGE	16	114E/RTE 95 NORTH	16
COMMONWEALTH AV	16	IRA TOYOTA	16
PARK ST	16	K MART	16
TRASK LN	15	MAPLE/FOREST	16
BRIDGE ST	14	MCDONALDS	16
ROSEWOOD DR	13	SUNOCO ANDOVER	16
ASH ST	12	WALMART	16
NICHOLS ST	12	114E/RTE 1 NORTH	15
PICKERING ST	12	ENDICOTT PLAZA	15
ADAMS ST	11	MIDAS MUFFLER SHOPS	15
LINDALL ST	11	NEWBURY/ANDOVER	15
NEEDHAM RD	11	SUNLINE POOLS	15
GARDEN ST	10		
RIVER ST	10		

Data Source: Danvers Police Dept. (GIS)

For comparison to other communities, average annual crash growth rates were compared between six neighboring communities near Danvers. Crash totals are heavily impacted by population totals, highway design, driver error, and the location of major developments among other factors.

Table 5-3 Crash Totals*					Average Annual Percent Change	
	1990	1995	2000	TOTALS	1990-1995	1995-2000
Danvers	1223	1358	1520	4101	2.12	2.27
Beverly	1036	894	1092	3022	-2.90	4.08
Middleton	213	252	272	737	3.42	1.54
Peabody	1798	1849	2086	5733	.56	2.44
Salem	2049	1963	2004	6016	-.85	.41
Topsfield	174	140	173	487	-4.25	4.32
Wenham	88	98	80	266	2.17	-3.97

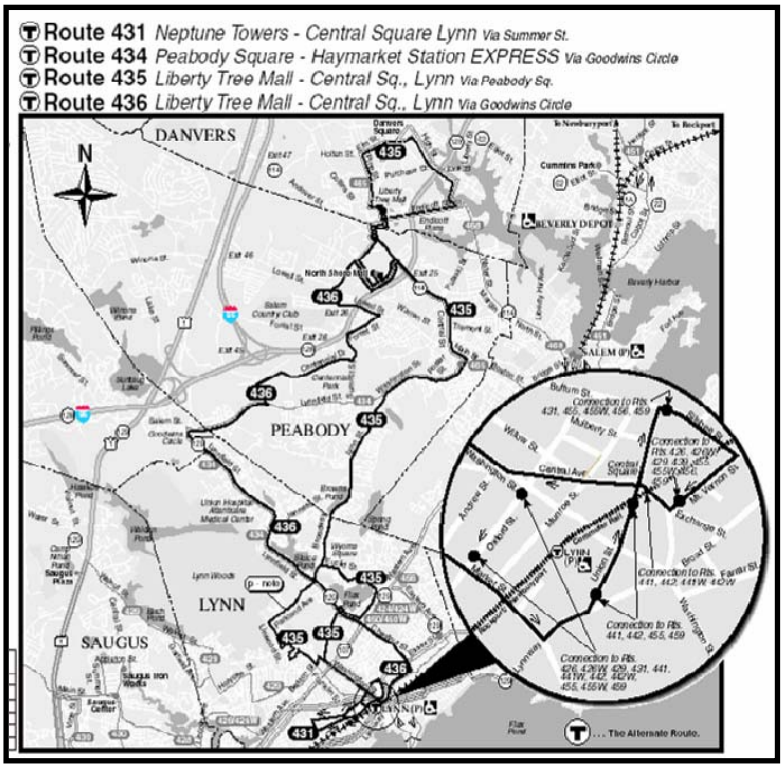
*MHD Traffic Operations, 2001

As indicated, Danvers crash totals are averaging an annual increase of slightly more than 2% since 1990. Other towns have had varying changes over the same time period. Beverly and Topsfield had a reduction in crashes for the first five years of the decade, but for the last five years, crashes have increased slightly over 4% per year. Wenham has experienced a significant reduction in crashes over the last five years with a 4% annual decrease in crashes since 1995.

Section 6 – Public Transportation Services

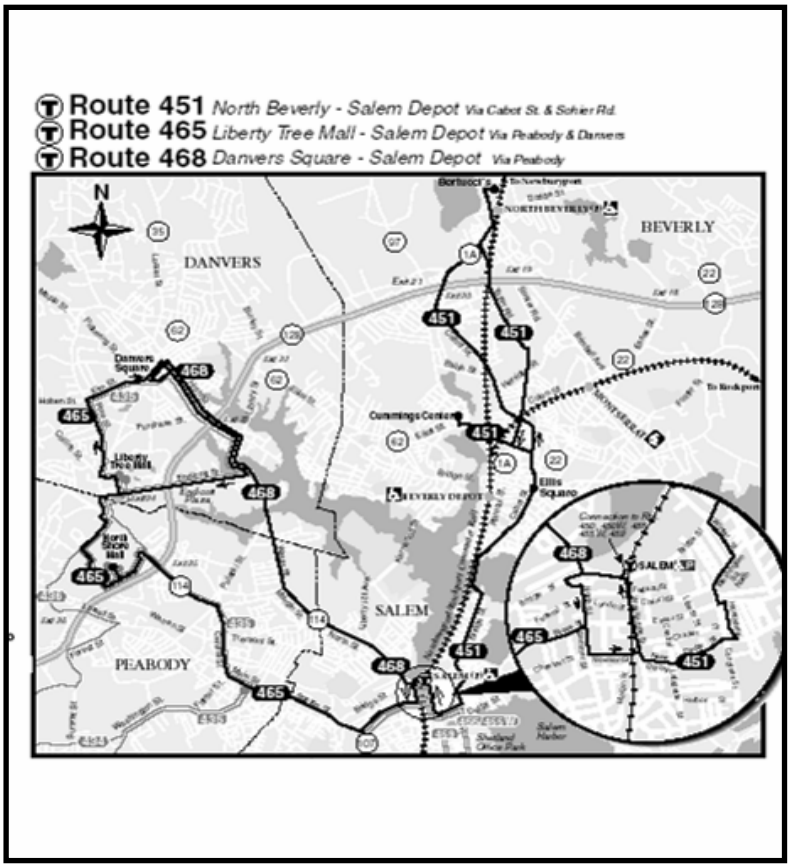
Overview

Being part of the Greater Boston Metropolitan Area the Town of Danvers is serviced by the Massachusetts Bay Transportation Authority (MBTA). The MBTA interconnects 175 cities and towns throughout metro Boston and the outlying suburbs. In all there are 181 routes and 252 stations, not including individual bus stops. The different modes of transportation include rapid transit, bus, trolley, commuter rail and water ferry.



Service Area

The MBTA services the Town of Danvers with three different bus routes (**see adjacent MBTA route maps**). Route number 435 connects Danvers to the City of Lynn. It makes 7 stops between and including the Liberty Street Mall in Danvers and the Neptune Towers in Lynn. This route has dedicated lift-busses for disabled patrons. Route numbers 465 and 468 provide service between the Liberty Street Mall in Danvers and North Beverly making 7 additional stops along the way. These routes provide call-a-lift for disabled patrons. Call-a-lift allows for a patron to call requesting a lift-bus be provided for a route on a given day. The following two



pages show maps of these two bus routes along with some other pertinent information. The MBTA also offers THE RIDE in the Town of Danvers. THE RIDE, developed in compliance with the Americans with Disability Act, offers transportation to those who cannot use public transportation because of a physical, cognitive or mental disability. While the MBTA does not offer a commuter rail stop in the Danvers it does offer stops in near by Salem and Beverly. The commuter rail is designed to be a park and ride service, meaning that these stops still should be effective for Danvers residents willing to drive to the commuter rail station and park their car during the course of their trip.

In addition to the MBTA services the Danvers Senior Center run by the Danvers Council on Aging provides a variety of services to the elderly for shopping and medical purposes.

MBTA Planning Improvements

The North Shore Transit Improvement Project has included options to improve transit service to the Town of Danvers. The project includes completion of a Major Investment Study (MIS) and Draft Environmental Impact Statement (DEIS). The Major Investment Study includes Danvers and other towns outside the area studied by the DEIS.

The conceptual project would include a new commuter rail route to Danvers via a rail spur off the existing Salem station using abandoned rail bed. The new rail line would be approximately 4 miles in length and pass primarily through the City of Peabody, terminating in the Town of Danvers. Complete reconstruction of the line would be required to activate the rail line.

This project is one of many alternatives being reviewed under the DEIS and MIS process. Commitment to this project is still undetermined at this time. However, it remains under review by the MBTA for potential funding in future years.

Section 7 - Bicycle Facilities

The Town of Danvers recognizes the potential transportation and safety benefits of providing bicycle routes through town. In 1997 the town was to receive MassHighway funds for construction of bicycle trails, but instead the town and MassHighway agreed to complete a Bicycle Facilities Master Plan. That same year, the town hired consultants to provide a Bicycle Facilities Master Plan. The project was lead by an active citizen group with the aid of the town planning department and consultants.

The town identified 10 locations that have potential for future bicycle paths or designations that will improve bicycle circulation and safety around the town.

- Route 35 – From Route 62 to Wenham (On road shoulder striping)
- Route 62 – From Town of Middleton to City of Beverly (On road shoulder striping)
- Route 114 - From Town of Middleton to City of Beverly (not recommended at this time)
- Collins / Centre Streets to Dayton and Green Streets (On road shoulder striping)
- Summer Street and North Street (not recommended at this time)
- Burley Street and Wenham Street – Designation of bicycle lanes, signing, and pavement markings
- Convert railroad bed from old train station to Town of Wenham (requires bridge crossing and wetlands permitting. Railroad tracks must be removed.)
- Electric Department Easement from Old Train Station to Endicott Park. (Requires bridge crossing and wetlands permitting. Railroad tracks must be removed).
- Convert railroad bed from old train station to Tapley Playground.
- Convert railroad bed from old train station to City of Peabody. (Not recommended at this time).

Section 8 – Buildout Analysis/Traffic Projections

Overview

In order to determine future traffic impacts to the Town's roadway network, estimates of anticipated traffic to be generated by future development must be calculated. These volumes were generated by completing a town-wide build-out analysis. This evaluation includes residential, commercial and industrial expansion opportunities. The projected development was then converted to vehicle trips and distributed accordingly to the area roadway network.

Build-out Assessment

Build-out projections are crucial for a town that is in the process of making long-term planning decisions. The build-out analysis can be used to predict the effect that growth will have on existing infrastructure and the need for expanded facilities such as roadway improvements. The probability of Danvers reaching total build-out is quite unlikely due to the amount of buildable land remaining as open space/conservation, agricultural or other recreational uses.

The build-out analysis conducted for this project was used to determine the amount of residential and commercial/industrial development that can be anticipated in the future within the Town. The parcel information utilized for both the residential and commercial/industrial build-out was provided by the Danvers Planning Department. This list also included properties which are currently underutilized. The underutilized lots were those that contained a single dwelling unit on a significant parcel.

Methodology

The source information utilized for this effort was the MassGIS environmental data layers, 5,000-scale Digital Orthophotos, and digital tax maps provided by the Town of Danvers. The build-out analysis was completed based on environmental constraints, development trends and current zoning. Zoning district descriptions, as adopted May 10, 1999, are provided in the Appendix. Build-out calculations were completed based upon the assigned zoning classifications for each respective zone, for all lots determined to be buildable or underdeveloped. Calculations were based on the assumption that each lot would be reduced accordingly to account for environmental issues and infrastructure (i.e. roads).

Build-out Results

Residential

The key goal of this analysis was to understand the Town's growth patterns in terms of housing units and overall population. The location of future housing units and population will affect the need for additional road improvements, schools, and fire and police service. Available land was derived from the data described under Methodology. For mixed use zones, available land includes only those parcels identified by the Town for

residential use. The following table provides a summary of the data utilized in generating traffic projections. The figures **(8-1, 8-2, and 8-3**) at the end of this section present this information in graphic form.

Table 8-1
Unit Projections by Zoning - Residential

Zoning District	Vacant Undeveloped Acres	Potential New Dwelling Units	% Total (Units)	Estimated Trip Ends / day
Residence I *	14.6	52	3%	500
Residence IA **	18.9	116	6%	769
Residence II	222.7	334	17%	3198
Residence IIA	51.9	132	7%	876
Residence III	441.7	393	20%	3764
Residence IIIA	11.8	13	1%	124
Highway Corridor ***	13.6	258	13%	1512
Route 114 Corridor Zone A	46.2	595	30%	3927
Route 114 Corridor Zone B	32.9	72	4%	422
Total	**854.3**	**1965**		**15092**

* Estimated trips for zoning district Residence I,II,III obtained from ITE LUC 210 (Single family detached housing)
** Estimated trips for zoning district Residence IA,IIA,IIIA obtained from ITE LUC 220 (Apartment)
*** Estimated trips for zoning district Highway Corridor and Route 114 Zones A and B obtained from ITE LUC 230

Residential Unit Projections

Total numbers of new housing units within each zone are based on full development within the dimensional requirements set forth in the Town zoning by-laws. As previously mentioned, calculations were based on a maximum build-out of the assumed developable area. In the zones which allow for single or multi-family dwellings, a maximum build out was calculated for both scenarios and the greater number of potential dwelling units was used for build-out analysis and included in the table above.

It is difficult to assess the number of units that will be built in a given year due to the volatile nature of the real estate market. For the purposes of this analysis an annual average of 75 units was applied to determine when full build-out would be reached. Based on this number of units, it is projected that the total build-out will occur between 2025 and 2030.

Commercial/Industrial

The location and quantity of available land for commercial and industrial development will impact job and revenue growth, as well as requiring public improvements to roads, water and sewer delivery systems and public safety services. Available land by commercial and industrial zoning districts is as follows:

Table 8-2
Commercial/Industrial Build-out Results

Zoning District	Vacant Undeveloped Acres	Planned Square Footage	% Total (SF)	Estimated Trip Ends / day
Commercial III	31.7	280,221	33%	11898
Highway Corridor	45.6	242,209	28%	4825
Route 114 Corridor Zone A	102.4	335,750	39%	9726
Route 114 Corridor Zone B	0.0	0	0%	0
Total	179.7	858,180		26449
Industrial I	9.3	63,000	15%	1993
Industrial II	36.9	371,000	85%	3754
Total	46.2	434,000		5747

Commercial/Industrial Square Footage Projections

In an effort to quantify potential commercial and industrial growth, specific vacant or underutilized properties were identified and targeted for build-out. Due to the complex nature of commercial and industrial zoning regulations, it is difficult to predict a land use and total square footage built on each lot. Parcels were identified by the Town which are either currently under development or which have known development planned. The remaining parcels was assumed to have a maximum build-out based on zoning classifications for maximum lot coverage and maximum building coverage for a one-story building. The total numbers of trips in each commercial and industrial zone are based on a combination of trip rates for the different land uses within each zone.

Institutional Projections

In addition to the zoning districts defined above, there are some specific institutional uses that have been identified by the Town for development. The North Shore Community College is currently building a 105,000 SF addition. The Essex Aggie Merger will add 100,000 SF of new buildings, as well as 1,500 high school students and 200 faculty members. The State Hospital Re-Use will result in 422 new townhouse units and 100 new senior living units, as well as 100,000 SF of new office space. Trips generated by these defined uses are summarized in the table below.

Table 8-3
Institutional Build-out Results

Site	Land Use	New Trips
Essex Aggie	1,500 student high school	2685
State Hospital Re-Use	422 Townhouse units	2473
	100 Senior housing units	348
	100,000 SF office	1101

Although a significant number of new trips have been calculated per ITE, it is understood that additional busing will be provided (45 new bus routes) that would most likely yield a lower number of new trips.

Summary

The build-out assessment for the Town indicates where development could occur and, based on existing zoning, the intensity of potential development can be evaluated. Due to changes in real estate absorption rates, a time line for this development can only be estimated. However, the build-out is a useful tool in assessing the Town's capital needs and aids in long term planning. The build-out assessment coupled with the ability to project fiscal impacts of new development provide the Town with valuable tools to make planning and financial decisions in a timely, proactive and efficient manner. The graphic on the following page depicts the results of the buildout and associated traffic volume projections by Traffic Analysis Zone and ITE Trip Generation Land Use Code.

Section 9 – Traffic Modeling (TRAFFIX)

Overview

A traffic model is a tool used to estimate the future travel patterns for a specified area and is typically used to forecast future traffic volumes on a street system and through intersections. For the purposes of this study, the Traffix modeling software was utilized. The software relies on existing traffic turning movement count data to represent existing baseline conditions. Traffic generated from the build-out analysis, as previously discussed, is assigned to the roadway network, based on trip distribution and added to existing traffic volumes to create a future condition. Simply, the future condition increment is estimated and is added to existing traffic conditions.

Traffic is assigned to the roadway network based on existing travel patterns and traffic volume data. Therefore, the model relies on manually assigning traffic based on recent traffic data. This eliminates the need to calibrate to an existing condition. The Danvers Model was developed to evaluate existing AM and PM peak hour conditions as well as future build-out conditions.

Model Development

The performance of any model depends on the how well it is built and the quality of data used. The five major steps taken to build the Model include:

- **Define the study area and roadway network**
- **Inventory intersection geometry and control**
- **Collect and summarize intersection turning movement volume count**
- **Establish traffic analysis zones (TAZs)**
- **Determine external gateway locations**

These steps are described below separately.

Roadway Network

The street system for an area in the traffic model is defined as the roadway network. The roadway network is created to represent the actual street system of an area. All highways and arterials, and major collector and local roadways are typically included in the roadway network. It is generally not necessary to include all minor roadways in the area. The network consists of links (streets) and nodes (intersections).

Intersection Attributes

After developing the roadway network into the model, the next step is to define attributes for the study intersections. Attributes such as lane widths and usage, control, on-street parking, and bus stops are considered for the purposes of evaluating intersection capacity. These data were entered into the model for each study intersection. Additional intersections (without geometrics) were included as part of the model for the purposes of

providing a more comprehensive study network and to allow analysis of these intersections if required in the future. It is noted that because these intersections have been included in the model network, project-generated traffic volumes through these locations can be measured. Study intersection geometrics are provided within the level of service calculation sheets

Intersection Volume Count Data

Morning and afternoon peak hour volumes obtained from the traffic data collection phase of the project, and peak hour factors were summarized for each intersection and entered in the model to represent existing year 2001 conditions.

Traffic Analysis Zones

A traffic analysis zone (TAZ) is designated to include all the land uses in that area. Unlike a TAZ for a gravity model, a TAZ in Traffix does not define a specific area. Instead, it represents a catchment area and serves as a loading point to the roadway network for the land uses in that zone. Land use, trip generation rates, and trip distribution rates information are contained within the TAZ. The number and locations of TAZ's was based on build out possibilities and roadway layouts within the town. A total of 17 TAZ's have been defined and are shown in **Figure 9-1** with a breakdown by ITE trip generation land use code in **Figure 9-2**. It should be noted that these analysis zones boundaries are based solely on the build-out results.

External Gateways

External gateways are similar to TAZ's except they do not have land use associated with them. They generate traffic and attract traffic from the outer boundary of the study area. Gateways are typically located around the perimeter of the roadway network creating a cordon line (although there can be internal gateways). The distribution percents for project traffic are tied to the gateways.

Level of Service Results

As stated in the previous section, all available existing traffic volumes, intersection geometry and lane configurations and signal timings were entered into the Traffix modeling program to create a traffic network that would represent existing conditions. The existing network does not include any possible build-out or distributions.

At this stage the traffic model has calculated an existing Level of Service (LOS) for the study intersections. Level of Service is a qualitative measure of traffic flow efficiency based on anticipated vehicle delays. For unsignalized intersections, LOS is measured only for the minor movements (major street left turns and all minor street movements). For signalized intersections, LOS is measured for all movements as well as the intersection as a whole. Many factors are taken into account in LOS analyses including vehicle volumes, heavy vehicle percentages, lane configurations and geometry, grades, parking, and pedestrian activity. For both signalized and unsignalized intersections, LOS is reported on a scale of A through F. LOS A represents the best conditions with little or no delay while LOS F indicates that the roadway/intersection is at full capacity resulting

in high vehicle delays and potential queuing problems. Levels of Service criteria for signalized and unsignalized intersections are defined in **Table 9-1**.

Table 9-1
Level of Service Criteria for Unsignalized and Signalized Intersections*

LOS	*Control Delay (sec/veh)*		*General Description*
	Unsignalized	*Signalized*	
A	0-10.0	0-10.0	Free flow
B	10.1-15.0	10.1-20.0	Stable flow (slight delays)
C	15.1-25.0	20.1-35.0	Stable flow (acceptable delays)
D	25.1-35.0	35.1-55.0	Approaching unstable flow (tolerable delay)
E	35.1-50.0	55.1-80.0	Unstable flow (intolerable delay)
F	50.1+	80.1+	Forced flow (jammed)

* Highway Capacity Manual, 2000

Level of service analysis results for existing and full build AM and PM peak hour conditions are listed in **Tables 9-2 and 9-3** and illustrated in **Figures 9-3 and 9-4** included with this memorandum.

The results of the analysis indicate that several intersections will experience large drops in LOS if the full buildout projection is reached at some future period, and no mitigation plans are implemented in the mean time.

The following section describes the reasons why the intersections experience LOS F conditions. It also lists which Traffic Analysis Zone is creating the impact to the intersection.

Table 9-2
Existing & Full Build AM Peak Hour
Impact Analysis Report (Level of Service)

Location	TRAFFIX Number	Intersection	Existing LOS	Existing Delay	Full Build LOS	Full Build Delay
1	12	Maple Street/Forest Street	F	OVRFL	F	OVRFL
2	13	Maple Street/Vineyard Street	F	88.8	F	OVRFL
3	14	Maple Street/Summer Street/State Street	F	193.5	F	846.3
4	15	Maple Street/Poplar Street	F	494.8	F	OVRFL
5	1	Poplar Street/Locust Street/Hobart Street	B	10.7	C	30.0
6	119	Andover Street/Watson Pkwy/Rosewood Street	B	15.3	C	31.8
7	27	Centre Street/Watson Pkwy	A	9.7	B	11.3
8	28	Centre Street/Rowell Road	B	11.5	C	16.0
9	29	Centre Street/Armory Road	B	10.1	F	290.0
10	30	Centre Street/Armory Road	C	16.1	F	595.2
11	31	Dayton Street/Armory Road	B	10.8	B	14.6
12	25	Route 1/Dayton Street	C	16.6	C	20.8
A	17	Maple Street/Hobart Street/Collins Street	F	OVRFL	F	OVRFL
B	10	Locust Street/North Street	B	10.6	C	20.0
C	11	Locust Street/Wenham Street	C	17.0	E	35.1
D	22	Sylvan Street/Endicott Street	B	18.7	C	22.7
E	18	Centre Street/Hobart Street	F	212.2	F	OVRFL
F	9	North Street/Summer Street/Rogers Street	B	13.7	F	254.2
G	8	Locust Street/Valley Street	A	9.2	B	10.2
H	24	Water Street/South Liberty Street	A	7.8	B	10.4
I	4	Liberty Street/Water Street/High Street	C	25.4	D	43.1
J	23	Water Street/Endicott Street	D	36.9	D	49.8
K	7	Pine Street/Holten Street	A	9.5	B	10.5
L	19	Collins Street/Holten Street/Centre Street	C	23.0	F	297.6
M	21	Sylvan Street/Collins Street	C	25.1	C	29.7
N	118	Sylvan Street/Ash Street	F	OVRFL	F	OVRFL
O	16	Conant Street/Burley Street	F	OVRFL	F	OVRFL
P	5	High Street/Route 128	B	13.9 **	B	16.6 **
Q	121	Conant Street/Poplar Road	F	OVRFL	F	OVRFL
Q	2	Conant Street/Poplar Road/Elliot Street	C	32.0	F	126.6
R	6	Elm Street/Holten Street	C	16.6	F	52.5
R	123	Elm Street/Holten Street/Essex Street	A	8.7	B	12.5

** LOS calculated using SYNCHRO Software

Table 9-3
Existing & Full Build PM Peak Hour
Impact Analysis Report (Level of Service)

Location	TRAFFIX Number	Intersection	Existing LOS	Existing Delay	Full Build LOS	Full Build Delay
1	12	Maple Street/Forest Street	F	77.7	F	OVRFL
2	13	Maple Street/Vineyard Street	F	90.5	F	OVRFL
3	14	Maple Street/Summer Street/State Street	C	16.6	F	83.3
4	15	Maple Street/Poplar Street	F	681.2	F	OVRFL
5	1	Poplar Street/Locust Street/Hobart Street	C	28.5	F	106.8
6	119	Andover Street/Watson Pkwy/Rosewood Street	B	12.6	C	21.1
7	27	Centre Street/Watson Pkwy	B	11.0	C	19.7
8	28	Centre Street/Rowell Road	B	11.6	C	17.6
9	29	Centre Street/Armory Road	B	12.3	F	852.3
10	30	Centre Street/Armory Road	D	32.4	F	OVRFL
11	31	Dayton Street/Armory Road	C	20.6	D	31.5
12	25	Route 1/Dayton Street	C	18.6	C	22.9
A	17	Maple Street/Hobart Street/Collins Street	F	OVRFL	F	OVRFL
B	10	Locust Street/North Street	B	12.4	E	42.4
C	11	Locust Street/Wenham Street	F	66.1	F	522.5
D	22	Sylvan Street/Endicott Street	C	25.3	D	51.7
E	18	Centre Street/Hobart Street	F	641.9	F	OVRFL
F	9	North Street/Summer Street/Rogers Street	C	15.4	F	342.0
G	8	Locust Street/Valley Street	A	9.7	B	11.2
H	24	Water Street/South Liberty Street	B	10.4	B	12.7
I	4	Liberty Street/Water Street/High Street	C	29.7	E	58.6
J	23	Water Street/Endicott Street	D	52.5	F	87.9
K	7	Pine Street/Holten Street	B	11.2	F	131.7
L	19	Collins Street/Holten Street/Centre Street	F	OVRFL	F	OVRFL
M	21	Sylvan Street/Collins Street	D	41.3	F	155.5
N	118	Sylvan Street/Ash Street	F	OVRFL	F	OVRFL
O	16	Conant Street/Burley Street	F	330.9	F	OVRFL
P	5	High Street/Route 128	C	26.6 **	C	28.3 **
Q	121	Conant Street/Poplar Road	F	OVRFL	F	OVRFL
Q	2	Conant Street/Poplar Road/Elliot Street	F	389.2		
R	6	Elm Street/Holten Street	F	64.4	F	219.0
R	122	Elm Street/Holten Street/Essex Street	B	10.5	D	32.1

** LOS calculated using SYNCHRO Software

For comparison, 2001 existing traffic operations were compared with the 1990 Transportation Master Plan to determine the change in level of service. The following table compares the two reports to see operational changes between the two time periods at select intersections that were analyzed during both periods:

Location	**Table 9-4 Intersection Level of Service**	1990 LOS AM / PM	2002 LOS AM / PM
J	Endicott Street at Water Street	C / B	D / D
D	Endicott Street at Prospect Street / Sylvan Street	C / C	B / C
M	Sylvan Street at Collins Street	D / E	C / D
N	Elm Street / Ash Street / Holton Street / Sylvan Street	D / F	F / F
I	Liberty Street at River Street	F / F	C / D
4	Maple Street at Poplar Street	F / F	F / F
A	Maple Street at Hobart Street	D / E	F / F
3	Summer Street at Maple Street	E / E	F / F
L	Collins Street at Holten Street at Centre Street	C / F	C / F
6	Andover Street at Watson Parkway at Rosewood Drive	E / F	B / C
5	Poplar Street at Locust Street at Hobart Street	B / C	C /D

As indicated in **Table 9-4**, significant LOS improvements occurred at Liberty Street at River Street and Andover Street at Watson Parkway. Traffic operations improved from failing operations to good or acceptable operations at both locations. The primary reasons for these improvements are due to changes in land use or roadway improvements. Other intersections that indicate a decrease in one grade are likely related to normal 2% annual traffic growth in the town. Locations that improve slightly may be related to road or intersection improvements in the area, or a diversion of traffic from the area.

Summary of intersections with deteriorating Levels of Service

The following provides a description of intersection that experience significant operational deficiencies under existing and future buildout conditions. The increasing volumes at intersections are based solely on the build-out and traffic projections discussed in Section 8 of this study. Our methodology and assumptions are based on the requirements of the TRAFFIX model. Refer to **Figure 9-2** and the traffic analysis output reports provided in the appendix for detailed information.

Poplar Street/Locust Street
(Location 5)

This is a signalized intersection that experiences a significant decrease in LOS for the AM peak hour.

Existing LOS/Delay
AM: C 28.5
PM: B 10.7

Future LOS/Delay
AM: F 106.8
PM: C 30.0

Locust Street Northbound

Factors leading to deterioration in future level of service:

- Significant residential development in TAZ 3, 5 and 17, along with commercial development in TAZ 5.
- Poplar Street (Route 62) will be the main carrier of newly generated trips to and from TAZ 5 from eastern Danvers and other points east.
- Poplar Street is also the main route to/from and through TAZ 3.

Poplar Street Westbound

Centre Street/Armory Road (Location 9)
Centre Street/Armory Road (Location 10)

This is an unsignalized intersection, within a primarily residential area, with significant decrease in level of service for the AM and PM peak hours.

Centre Street Westbound

Existing LOS/Delay

Location 9		Location 10	
AM:	B 10.1	AM:	C 16.1
PM:	B 12.3	PM:	D 32.4

Future LOS/Delay

Location 9		Location 10	
AM:	F 290.0	AM:	F 595.2
PM:	F 852.3	PM:	F *

Poplar Street Westbound

Factors leading to deterioration in future level of service:

- Significant residential development in TAZ 9.
- Both intersections link the residential neighborhoods in the southwest portion of Danvers with the highway system including Route 1 and Route 95.

North Street/Summer Street/Rogers Street (Location F)

This is an unsignalized intersection, within a primarily residential area, with significant decrease in level of service for the AM and PM peak hours.

Existing LOS/Delay	AM:	B	13.7
	PM:	C	15.4
Future LOS/Delay	AM:	F	254.2
	PM:	F	342.0

Factors leading to deterioration in future level of service:

- Significant residential development in TAZ 2 and 3.
- North Street and Summer Street are main (non-highway) links from northern Danvers to southern Danvers, thereby being included as a potential path for trips generated in most parts of the Town to either enter or exit the transportation system.

North Street Westbound

Collins Street/Holten Street/Centre Street (Location L)

Unsignalized intersection located in the southern section of town just west of the downtown area. There is a significant decrease in level of service for the AM peak hour, while the PM peak hour is currently operating with a very poor level of service.

Collins Street Southbound

Existing LOS/Delay

AM: C 23.0
PM: F *

Future LOS/Delay

AM: F 297.6
PM: F *

Factors leading to deterioration in future level of service:

- Significant residential development in TAZ 12, 13 and 14, along with commercial development in TAZ 12.
- Collins Street is a link between the southern portion of Town and the Route 95 and Route 1 highway system.

Conant Street/Poplar Road/Elliot Street(Location Q)

The intersection operates as a combination of two intersections, one signalized and one unsignalized. The unsignalized intersection of Conant and Poplar Street currently operates at level of service F for both peak periods. The signalized intersection of Elliot, Conant and Burley Street currently operates at a poor level of service in the PM peak hour and experiences a significant decrease in LOS for the AM peak hour.

Conant Street Eastbound

It should be noted that the Middle School expansion project is currently in preliminary design. Phasing could also have and effect on current operations. Additional modeling was completed as part of that project utilizing Synchro software. The analysis also yielded an unacceptable LOS. Road widening has to be kept to a minimum due to the bridge abutment thus minimizing additional capacity with improved geometry.

Poplar Street Eastbound

Existing LOS/Delay	AM:	C	32.0
	PM:	F	389.2
Future LOS/Delay	AM:	F	126.6
	PM:	F	*

Factors leading to deterioration in future level of service:

- Additional residential and commercial development in TAZ 17.
- Conant Street is one of the main links from Route 128 to downtown Danvers as well as points west of Route 128. It will be one of the main carriers of new trips generated by additional development in TAZs 3, 7, 8, and 13.

Other Affected Intersections (Less Severe)

Pine Street/Holten Street
(Location K)

Signalized intersection located in the southern section of town just west of the downtown area. There is a significant decrease in level of service for the PM peak hour.

Existing LOS/Delay
AM: A 9.5
PM: B 11.2

Future LOS/Delay
AM: B 10.5
PM: F 131.7

Pine Street Southbound

Factors leading to deterioration in future PM level of service:

- Significant residential development in TAZ 12, 13 and 14, along with commercial development in TAZ 12.
- Holten Street is one of the key links between the commercial area just east of Route 95 and the eastern part of the town It is also a main link from TAZ 12 to points north and east via town roads or Route 128. Development in these areas as well will likely cause increased traffic at the intersection.

Sylvan Street/Collins Street/Federal Street (Location M)

This signalized intersection is located in the southern section of town. There is a significant decrease in LOS during the PM peak hour.

Existing LOS/Delay
AM: C 25.1
PM: D 41.3

Future LOS/Delay
AM: C 29.7
PM: F 155.5

Collins Street Eastbound

Factors leading to deterioration in future PM level of service:

- Significant residential development in TAZ 12, 13, 14 and 15, along with commercial development in TAZ 12.
- Collins Street is a link between the southern portion of Town and the Route 95 and Route 1 highway system. Sylvan Street is a key link from the town boundary to the downtown area and points north. Trips assigned to TAZ 15 heading south will pass through this intersection, as will trips heading to TAZs in northern Danvers from points south.

Locust Street/North Street (Location B)

Unsignalized intersection located in the north central section of town. There is a significant decrease in level of service for the PM peak hour.

Existing LOS/Delay
AM: B 10.6
PM: B 12.4

Future LOS/Delay
AM: C 20.0
PM: E 42.4

Locust Street Southbound

Factors leading to deterioration in future PM level of service:

- Significant residential development in TAZ 1, and 3. Nearly all trips generated in these TAZs need to pass through this intersection.
- Locust Street (Route 35) is on of the main (non-highway) links from northern Danvers to southern Danvers, thereby being included as a potential path for trips generated in most parts of the Town to either enter or exit the transportation system

Pavement Deterioration Curve

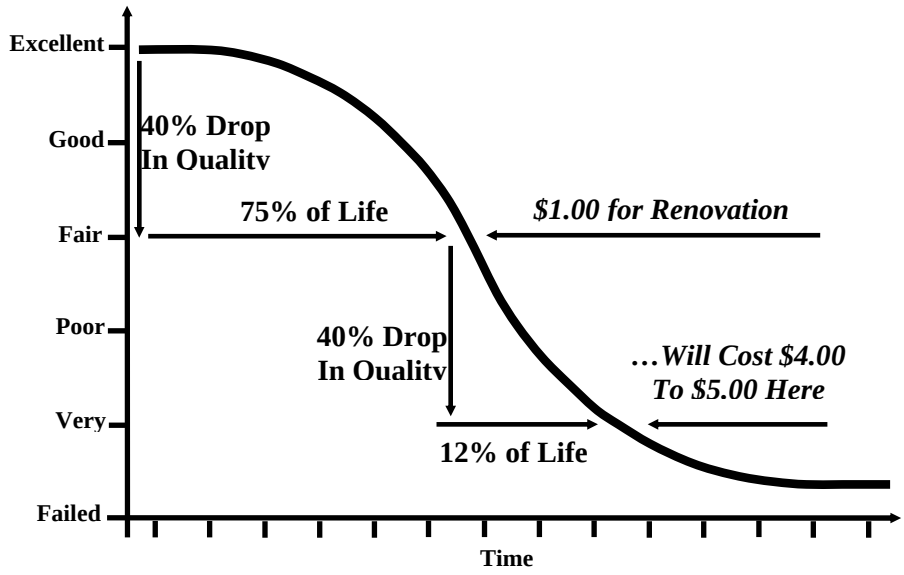
Section 10 – Pavement Management Summary

Overview

Danvers' Department of Public Works has implemented a roadway management system for its Towns roadways. This comprehensive road study was undertaken in order to develop an extensive roadway database describing and evaluating actual roadway infrastructure conditions in Danvers and to better understand current and future roadway conditions at various funding levels. Before describing the pavement management study scope and findings, an introduction to pavement management concepts and theory is offered. The product Danvers selected for developing their system is called the Road Surface Management System (RSMS) developed by the University of New Hampshire Technology Transfer Center. The RSMS is directed toward achieving the best value for public funds. It is expected to provide and generate smooth, safe, economical road surfaces. In addition, the town is utilizing a customized Microsoft Access Analysis/Reporting tool developed by BETA. The data has also been integrated with the town's GIS (centerline file) for mapping purposes.

The development of a roadway management system is formalized approach roads officials use to cost effectively allocate road budgets. The theory of pavement management is based on predicting roadway deterioration. The following figure dramatically illustrates the key concept of making timely maintenance repairs, thereby averting the need for far more expensive and extensive structural repairs. The goal is to save money is both the short and long run by developing a road repair program that maximizes expenditures while meeting the overall road program goals set by community decision makers.

Pavement Deterioration Curve



The procedure is to collect, organize, and maintain a complete roadway database which describes a particular road system. The RSMS builds on the basic system by adding data on drainage, sidewalks, traffic and other roadway elements.

In either case the resultant RSMS database is used as a repository of historical and descriptive data on a community's road network. Data generated by the roadway database provides useful input for reporting on and evaluating current roadway conditions, forecasting costs for different maintenance and repair treatments, and developing annual and long range budgets and repair plans.

The system provides Danvers with an opportunity to synthesize pavement inventory and condition data with other descriptive information on a host of related roadway elements such as drainage, and sidewalks.

The ongoing effort to establish a roadway management program is Danvers' recognition that the Town has a major investment in its **105 mile** town/public road network. New construction and repairs to existing infrastructure are very costly, and prudent fiscal management suggests that is makes economic sense for a community to protect that investment over time for current and future residents.

Data Collection

Starting in July, 2002 BETA collected two primary categories of data in Danvers: roadway network inventory data describing roadway lengths, widths, segment start and end points, etc. (items that seldom change), and pavement condition data, providing a snapshot description of roadway conditions on the day of the survey – the severity and extent of such specific pavement distresses as potholing, alligator cracking, rutting and longitudinal/transverse cracking. The inventory also included collecting data on drainage and sidewalks. The majority of the pavement distress elements mentioned above are caused by inadequate drainage (including facilities), traffic volume, or weak sub-grade. Some distresses, such as rutting are a result of inadequate compaction during construction or by sub-grade consolidation. Longitudinal/transverse cracking is typically caused by insufficient pavement thickness, overloads, shrinkage or weak subgrade.

The foundation of the pavement inventory was the MassHighway Road Inventory File (Centerline Coverage). The GIS database enabled BETA to extract precise data during the inventory process. Each roadway was divided into segments, each with a beginning and an end node. Each segment was assigned a unique identification number (SEGMENT ID) in addition to STREET NAME and CLASSIFICATION. The nodes typically correspond to intersections with side streets, dead ends, crossroads, water bodies and town boundaries. This results in an extremely accurate method of isolating pavement conditions on a map, and a straightforward way to rate sections of roads and organize the ratings in a meaningful way. Any information gathered in the field can be stored along with other geographic information linked to each roadway segment via its unique identification number.

Database components and structure were developed in a cooperative effort with the Town of Danvers. A series of meetings were held with the Department of Public Works,

Engineering Department, GIS Staff and BETA to target desired attribute data and system architecture for roadways and sidewalks.

The primary purpose of the condition survey is to determine the state of each roadway and/or sidewalk segment by visually observing the surface distress. The condition survey is crucial to the overall CIP considering its impact on the Pavement Condition Index (PCI). Considering repair/maintenance alternatives are generally based on the worst distress presented, an overall condition rating was assigned to each roadway segment. The following presents a description of the condition rating contributing factors:

NO DEFECT:		The road section has no visible distress or the total area figuring distress comprises less than 1% of the entire section.
SEVERITY:	LOW	Distress patterns are just beginning to appear. Deficiencies have no measurable *width* and no actual pavement separation is found.
	MODERATE	Easily discernible cracking with measurable crack *widths* up to 1/8" and some breakup. Pavement pieces, while loose, are still interconnected.
	HIGH	Wide cracking (1/8") has resulted in major pavement breakup with loose pieces actually displaced.
EXTENT:	LOW <10%	The total area figuring encompasses more than 1% and less than 10% of the roadway section.
	MOD. 10-30%	The total area figuring pavement distress encompasses between 10% and 30% of the roadway section.
	HIGH > 30%	The total *area* figuring distress encompasses greater than 30% of the roadway section.

Additional descriptions are provided in the Appendix. BETA also collected information relative to drainage and roadside features. Drainage conditions were rated on a scale of Good-Fair-Poor. These severities were judged by the ability of runoff to flow from the paved area to a location that does not influence roadway conditions.

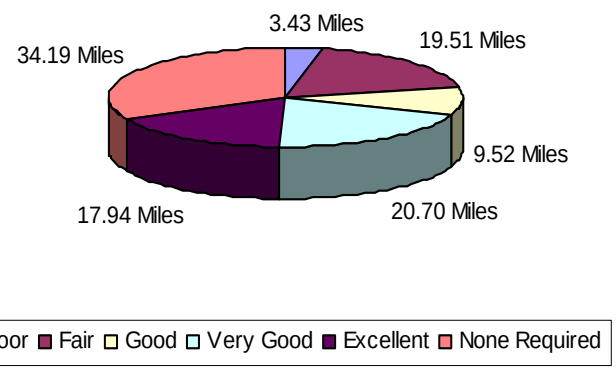
Analysis

Following data collection, entry, and verification, future pavement conditions were projected assuming varying maintenance/repair alterations and cost levels. The Town can refine these projections annually by reviewing repair type unit costs and by updating the roadway database as improvements are made. Since each road project will differ as to its specific improvement elements, major drainage improvements or the construction of new sidewalks would have to be specifically budgeted during project level pavement management evaluation and cost estimating.

The town's RSMS uses road inventory and roadway distress observations to develop an extensive database used for subsequent analysis and report generation. A rating system is built into the software that is derived from actual field conditions for a variety of roadway elements; pavement surface, rideability, drainage, traffic etc. Ultimately a Pavement Condition Index (PCI) value is established for determining pavement repair priorities for each roadway segment. Sidewalks were rated in a more general fashion – Good, Fair, Poor, Replace. The majority of the sidewalks fell into the good to poor category indicating a need to replace or improve the structural condition of the sidewalk.

The PCI was generated for each public roadway segment in Danvers using the distress data collected by BETA. PCI is measured on a scale of one hundred to zero, with one hundred representing a pavement in excellent condition and zero describing a road in extremely poor condition. The chart (**Figure 10-1**) below provides a summary of the pavement conditions in the Town of Danvers. Detailed pavement data for each segment is available at the Department of Public Works.

Figure 10-1
Pavement Condition Summary



The roadways that are in poor condition will require significant capital investment to accommodate future improvements. Conversely, the roadways with high PCI's or excellent conditions are considered at peak serviceability to the public.

Repair Alternatives

Broad treatment category ranges were utilized to assist in assigning repair alternatives. These "Repair Bands" are nationally accepted methods used to group the calculated values into improvement bands that can be related to a specific repair method. The goal is to budget sufficient funds for each road repair category for a particular roadway. The database structure provides the Town with the flexibility to revise repair strategies accordingly for a single segment or a multitude of roadways.

Broad Treatment Categories

Category	Description
Do Nothing	Segments in need of no maintenance
Routine Maintenance	Segments in need of routine maintenance maintenance (Crack Sealing/localized repair)
Preventive Maintenance	Segments in need of preventive maintenance (surface sealing/patching/crack sealing)
Structural Improvements	Segments in need of surface structural improvement/rehabilitation
Reconstruction	Segments in need of base improvement/reconstruction

Repair alternatives utilized for this project, in relation to the above table, includes the following.

- **Defer Maintenance (Do Nothing)**
- **Crack Seal (Routine Maintenance)**
- **Micro Seal (Preventive Maintenance)**
- **Grind&Overlay (Preventive Maintenance/Rehabilitation)**
- **Reclamation (Rehabilitation)**
- **Reconstruction**

These repair items were generated in cooperation with the Town and BETA. As the pie chart on the following page indicates, the majority of the roadways fall into the, preventive maintenance, rehabilitation and drainage categories. The roadways that fall within the preventive maintenance category indicate that they are at or beyond the critical point on the pavement deterioration curve. Unless repairs are made to these roadways in the near future, they will be in need of far more expensive capital repairs. RSMS did calculate values that indicate the need for structural improvements or reconstruction. These roadways were assigned a specific repair alternative, as outlined above, based upon the condition inventory completed and the Town's knowledge of the roadway itself. These type of roadways should be further evaluated by the Town prior to establishing a long-term budget. These improvement alternatives should also be reviewed periodically to determine if they represent the most cost-effective procedures. **Table 10-2** and the **Figure 10-2** above provide a breakdown of repair methods in terms of percentage of overall road network.

Figure 10-2
Proposed Pavement Repair Methods

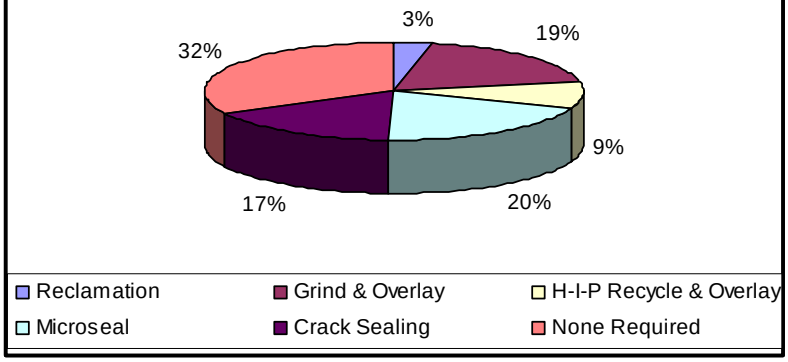


Table 10-2 Proposed Pavement Repair Methods

Repair Method	Approximate Length [miles]	% Total	Average PCI	RSMS Predicted Life Improvements (months)
Reclamation	3.43	3.3%	32.2	240
Grind & Overlay	19.51	18.5%	53.3	96
Hot In-Place Recycle & Overlay 1.5"	9.52	9.0%	66.7	96
Microseal	20.70	19.7%	74.2	48
Crack Sealing	17.94	17.0%	85.0	36
No Current Maintenance Required	34.19	32.5%	94.9	0
Grand Totals	105.29	100%	79.8	

A categorization of the surveyed roadway segments show that less than 30% of the roadways fall into the "Do Nothing" option. Approximately 18% of the roadways fall into the "Routine Maintenance" category (Crack Seal). Almost 50% of the roads fall within the Preventive Maintenance category (Microseal/Overlay). This indicates that these roadways are at or beyond the critical point on the pavement deterioration curve. Unless repairs are made to these roads in the near future, they will be in need of far more expensive capital repairs. The balance of the roadways, 3%, falls within the "Structural/Reconstruction" categories. It should be noted that whenever feasible and cost-effective, roadway improvement projects should include provisions to allow safe bicycling along the facility.

System Maintenance

To best manage and update the Danvers roadway database, the following practices are suggested:

- **Post all annual road improvements into the RSMS. Both the pavement condition ratings and the repair history information should be entered.**
- **Add any new roadway network descriptions to the database as soon as the Town accepts the roadways. Pavement and related data can be added as it becomes available.**
- **Update repair type unit costs annually to provide accurate work plan reports.**
- **Assign one or more individuals with the responsibility of overseeing system upkeep. This individual should be responsible for requesting annual pavement condition survey updates.**
- **Undertake annual street surveys on at least 25% of the system. Roadways that have been repaired within the last season, or roadways that fell into the reconstruct category and have not been repaired, can be screened from the update mileage total.**
- **Review developments in pavement technology that might offer a more cost effective alternative to pavement maintenance or rehabilitation over the pavement's life cycle.**
- **Implement a sound Department quality control/assurance program with particular focus on major pay items.**

Summary

The Town now has access to a roadway information database, which is based on road condition data and descriptive information collected in 2002. The Town is urged to fully utilize the considerable volume of data that exists. The Danvers roadway database gives Town decision makers a picture of existing roadway infrastructure conditions, a dollar estimate to protect those pavements already in good condition, and a recommended capital improvement plan strategy to meet the Town's goals.

The roadway database should serve as a valuable tool to the Town and to community decision makers in their progressive approach to managing the Danvers roadway infrastructure. Although maintenance/repair alternatives are provided, this information is a planning level tool and is intended to provide the foundation for managing the Town's

roadway resources by combining local knowledge with professional engineering input. Budget related data is available through the Department of Public Works and Town Engineer.

Section 11 – Local Traffic Calming Plan

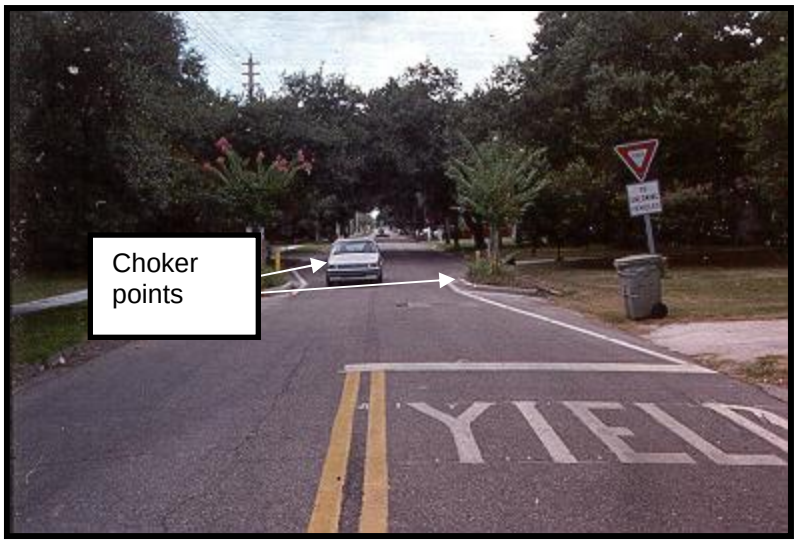
The Town of Danvers understands that increasing traffic sometimes reduces the quality of life for a community and plans to address specific issues to reduce these impacts. The town is interested in providing traffic calming options for local neighborhoods that are experiencing traffic impacts due to: high speeds, traffic congestion, high truck traffic, excessive cut through traffic and other transportation related safety or operational problems. The town will address these neighborhood concerns through an action plan that would work in conjunction with the capital improvement plan and assign priorities to projects based on individual impacts to the community. The traffic issues that many communities face include those listed above and others including the following:

- Improper stop sign installation
- Speed zoning enforcement
- Turn prohibition signs, enforcement
- Truck restrictions, enforcement

These issues are typical of local neighborhood concern. Enforcement of speed limits, stop sign violations, turn prohibitions, and truck restrictions requires significant police presence to detect infractions. Many communities do not have the resources to provide enforcement at all these locations in a large urbanized area.

Therefore, in order to address these issues, in many cases the physical design of the road can be changed to address traffic issues. Individual traffic studies will be conducted to verify the existence of the traffic problem, and appropriate action will be identified to improve the condition; including traffic calming options that can be tested initially, and installed permanently later if field testing is a success. Certain roadway geometric features for neighborhood traffic control can be added as a means to improve the traffic related problem. These traffic calming road treatments include the following among others:

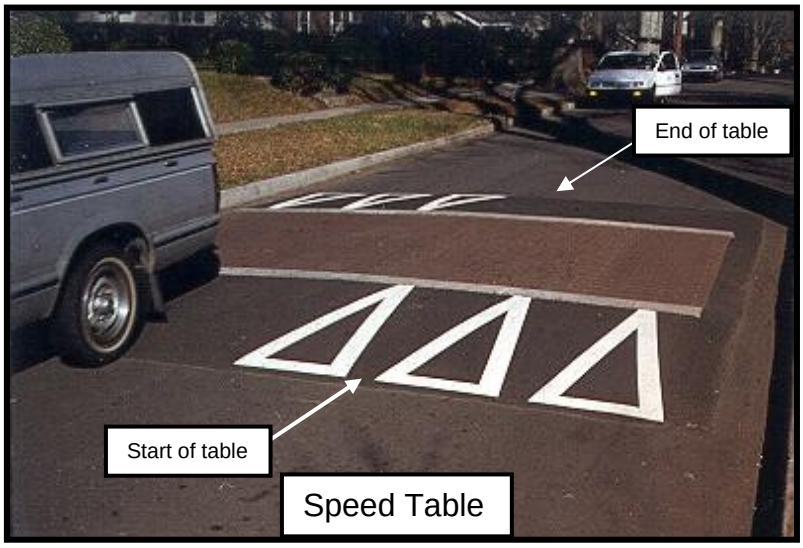
- Chokers or curb bulbs (see right) – These features reduce the physical width of a roadway and increase pedestrian safety by reducing the pedestrian crossing distance. This treatment also allows the drivers and pedestrians greater visibility between each other which in turn increases safety.



- Traffic Circles – Small circles (10 feet) are mainly installed in groups at intersections along local streets to control speed (see right). These devices are viewed as obstructions to traffic and discourages through traffic on streets with these circles. Some disadvantages to these circles are left turn problems and traffic turning in close proximity to pedestrians.

- Median Barriers – This treatment is used at major and minor street intersections. The barrier is placed on the minor street preventing left turn entry and through movements from the major street. This benefits the major street flow and minor street traffic, by essentially creating a cul-de-sac neighborhood, and cutting out the major turning traffic.

- Speed Tables / Speed Bumps / Speed Humps – These treatments are used to slow traffic and prevent unnecessary speeding. A speed table is used at the intersection of two roads, by increasing the pavement height, traffic is forced to slow down, or they will jump the street. Speed bumps are often times used in shopping centers to reduce speed and increase pedestrian safety. There application on local roads is minimal due to the frequency of bumps needed and the driver discomfort related to their abrupt vertical deflection. Speed humps are similar to speed bumps, but with less deflection, with a more gradual vertical deflection over a larger area. These devices slow traffic due to this vertical deflection design in the road (see above).



- Diagonal Diverters- This treatment is a barrier placed diagonally across an intersection to, in effect, convert the intersection into two unconnected streets, each making a sharp 90 degree turn. The treatment must allow for the traffic to reconnect to the destination via a nearby street connection. These treatments can be designed to allow emergency vehicles to cross the curbs, with mountable curbs, maintaining the safe access and egress that emergency personnel can use is a critical component of any roadway traffic calming design treatment.

- Traffic Control Gates – These treatments help reduce traffic volume on heavily traveled cut through roads. These are generally in place during peak hours, close traffic in one direction of the street, or constitute a full time closure.

These are just a few of the many traffic calming road treatments available to reduce travel speeds, discourage through traffic, and increase the quality of life for small neighborhoods that experience traffic related issues.

The Town of Danvers will undertake the potential traffic calming projects on a case-by-case basis and heed the advice of the Danvers Transportation Advisory Committee (DTAC). This committee meets regularly to discuss transportation projects and issues in town. This forum is the ideal group to discuss traffic calming opportunities for the Town of Danvers.

Section 12 – Action Plan / Improvement Alternatives

The Town of Danvers must determine which projects in town require traffic mitigation prior to others and develop a priority project list which the town can use to help develop annual projects. This action plan would work in conjunction with the pavement management recommendations. This comprehensive transportation master plan has revealed many traffic issues that the town can now prioritize into a list that the town can improve as funds become available. Federal and state grants can be pursued from this list of projects.

Massachusetts Highway Department (MHD) Plans

The Massachusetts Highway Department (MHD) is already in the process of addressing some of the highway interchange design limitations. All three highway interchanges with Route 128 are under redesign to improve access and safety. The highway interchanges were studied in the 1980's and are known to be inadequate to handle current traffic volumes. Route 128 at Endicott Street, Route 128 at Route 35, and Route 128 at Route 62 are all under redesign by MHD and are at the 25% design stage. The estimated construction cost of these three projects is 15 million dollars. The MHD is also addressing a redesign at Route 1 and Route 114. MHD plans are at 50% design and will improve overall traffic circulation and safety at this interchange.

The projects are expected to be programmed in the Regional Transportation Improvement Program (TIP) in the next two years. Endicott Street is projected for fiscal year 2004 and Route 35 and Route 62 are projected to be programmed for fiscal year 2005. Funding for these projects has not yet been identified, but will likely require special appropriations from federal or state government.

Other projects listed for the town include the replacement of the Route 35 and Water Street Bridge. This project is listed in the TIP for fiscal year 2005.

Action Plan / Alternatives

This comprehensive plan has revealed significant opportunities for the town to pursue other transportation improvements throughout the town. These are many opportunities for the town to pursue including the following:

- The pavement management program provides a PCI (pavement condition index) of all roads in town and gives the town an effective tool to prioritize road improvements.
- The MHD has plans to improve 4 of the 8 highway interchanges in town. These interchanges are already at 25 to 50 % design status. These highway interchanges are not full diamond interchanges or full cloverleaf designs that control traffic more efficiently than partial or quadrant interchanges. The existing partial interchanges require more stopping and turning and increase motor vehicle conflicts. MHD has addressed many of these concerns in the redesign plans.

- Along with potential interchange improvements, the development of access management plan for the town to control curb cut locations is an important part of reducing vehicle conflicts and improving overall roadway safety. Andover Street (Route 114) would be an ideal roadway corridor to implement a consolidation of curb cuts and minimize driveway openings onto the busy arterial road.
- The high incidence of crashes in town is a result of many factors. The MHD planned improvements at 4 highway interchanges should improve safety significantly at these locations. In order to determine the exact causes of the crashes at other locations further study is needed. The town may want to choose from the landmark high crash locations list, and conduct safety studies on these locations to determine the cause of the crashes and develop appropriate mitigation.
- Convene a neighborhood traffic calming committee to address local neighborhood traffic issues including truck traffic, cut through traffic, speeding, and safety.
- Implement some bicycle path projects both on road and off road. Funding for the projects could be pursued through several federal programs including Surface Transportation Program Transportation Enhancement Funds, Congestion Management and Air Quality Improvement Program Funds, and Section 402 Funding. These options were outlined in the 1997 Bicycle Master Plan.
- Implement key intersection improvements as identified by the DTAC and the traffic analysis results. These include improvements to the following intersections among others: Conant Street at Poplar Street, Elm Street at Park Street at Holton Street at Sylvan Street at Ash Street, High Street at Purchase Street at Milton Street, Centre Street at Armory Street, North Street at Summer Street at Rodgers Street, and Elliott Street at Liberty Street. A preliminary recommendations matrix has been developed to assist the town with targeting specific locations that require further discussion and conceptual plan development.