APPENDIX D

A REVIEW OF EXISTING TRANSPORTATION CONDITIONS

A REVIEW OF EXISTING TRANSPORTATION CONDITIONS

INTRODUCTION[1]

Subsequent to the 19 January, 2005, Advisory Group meeting, CTPS distributed two draft memoranda to all Group representatives. The Task 2 memorandum, dated 14 February, 2005, inventoried general transportation concerns in the Mid–North Shore Subregional Transportation Study area.[2] That memorandum also included those concerns in the three-town study area which CTPS was specifically asked to study in greater detail. The Task 3 memorandum, dated 14 April, 2005, inventoried existing and planned transportation improvements and economic development projects throughout the study area.[3]

The focus of this memorandum (Task 4) is a review of existing transportation conditions in the study area—Lynn, Swampscott, and Salem—and how they relate to the transportation concerns included for further study in the Task 2 memorandum mentioned above. The various components of the study area's transportation system are described below for existing travel modes. Included are data and information pertaining to motor vehicles, public transportation, and bicycles and pedestrians, respectively. The categories of data and information presented include:

- Traffic counts, travel-time data, vehicle crash data, intersection level-of-service (LOS) analysis, park-and-ride facilities (motor vehicles)
- Extent and performance of service, ridership data (rail and bus public transportation services)
- Crosswalks, signals, dedicated paths (pedestrians and bicycles)

The transportation concerns in Lynn, Swampscott, and Salem, respectively, which CTPS was asked to study in detail include (as described in the aforementioned Task 2 memorandum):

- Lynn officials explicitly asked CTPS to analyze concerns A and B described below. CTPS will also look into concern C to see whether recommendations can be made to increase the usage of the Lynn station parking garage. In addition, this study will evaluate the impacts of changes in North Shore MBTA bus operations which were implemented as a result of the North Shore Bus Improvement Project, completed in 2001.

    A. "There is congestion in the Broad Street/Lewis Street corridor. This may affect access to downtown Lynn, and thereby discourage commuter rail riders from neighboring towns from using the Lynn Station parking garage."
    B. "There is congestion in the Route 129 (Broadway/Lynnfield Street) corridor between Boston Street and Parkland Avenue."

[1] [Appendices D and D-1 through D-5 together were originally a CTPS memorandum, distributed on 1 April, 2006, to the Mid–North Shore Subregional Transportation Study Advisory Group, entitled "Task 4: A Review of Existing Transportation Conditions." The contents have been revised or updated where appropriate.]

[2] R. Sievert, "Task 2: An Inventory of Study Area Transportation Concerns," CTPS memorandum, 14 February, 2005. [See Appendix B of this final report.]

[3] R. Sievert, "Task 3: An Inventory of Existing and Planned Transportation Improvements and Economic Development Projects," CTPS memorandum, 14 April, 2005. [See Appendix C of this final report.]

C. "There are perceived dangers and poor aesthetics in the Lynn Station parking garage. This discourages spillover commuter rail riders/parkers from neighboring towns from using the underutilized garage." Current capacity is 952 parking spaces, with an average daily utilization rate of 38%.

- Swampscott town officials asked CTPS to analyze concerns D, E, and F below. CTPS will also look into concern G to see whether recommendations can be made to relieve current parking pressures in the station area.

D. "Traffic backs up on Lynn Shore Drive in Lynn onto Humphrey Street in Swampscott." According to Swampscott officials, "the cause may be traffic operations at the signal at Lynn Shore Drive at Nahant Street in Lynn."
E. "There is substantial congestion and excessive truck traffic on Essex Street. Essex Street is the only officially designated truck route in Swampscott." According to town officials, "most of the trucks travel to/from the Aggregate Industries quarry on Danvers Road/Swampscott Road on the Swampscott/Salem border."
F. "There appears to be high levels of cut-through traffic between Route 1A (Paradise Road) and Route 129 (Humphrey Street). The affected residential neighborhoods are along Walker Road and Farragut Road."
G. "There are not enough parking spaces at the Swampscott commuter rail station." Current capacity is 153 parking spaces and the daily utilization rate is 100%.

- Salem city officials asked CTPS to analyze concerns H, I, and J below. CTPS will also analyze concern K, since a Vanasse Hangen Brustlin, Inc. (VHB) traffic study scheduled for that location may not take place.

H. "Changes/improvements may be needed at Vinnin Square. This location underwent major geometric and signal improvements in 2002." Some problems may still remain in terms of queuing, congestion, crashes, signal timing, and pedestrian operations.
I. "There is congestion at the Route 1A (Loring Avenue)/Route 114 (Lafayette Street) intersection." This location is at the northern end of the Salem State College campus.
J. "Congestion as well as problematic traffic operations exist at the Jefferson Avenue/Willson Street intersection. This intersection is located in the vicinity of Salem High School and Salem Hospital."
K. "There are safety concerns at the Route 1A (Loring Avenue)/Canal Street/Jefferson Avenue intersection." A traffic study of this intersection by VHB of Watertown has been put on hold indefinitely since a new CVS drug store planned for this location may not be built.

The final step in the study, Task 5, has begun. It will consist of recommended transportation improvements for the concerns which CTPS was asked to analyze in detail (in Task 2). These recommended improvements will be multi-modal, and will be based on the review of existing conditions as stated in this memorandum, as well as on subsequent feedback received from the Advisory Group.

MOTOR VEHICLES

Introduction

Data were collected and analyzed for numerous elements of traffic in the study area. This section of the memorandum discusses such elements as existing traffic counts, corridor travel time data, vehicle crash data, and intersection level of service. A discussion of park-and-ride facilities in the study area is presented in the public transportation section below.

Traffic Counts

Traffic counts were obtained from numerous sources, including existing traffic studies, the Massachusetts Highway Department (MassHighway), and the Central Transportation Planning Staff (CTPS). The majority of the counts used in this analysis were collected in 2004, and for the purposes of this study, the base year for the existing counts is identified as 2004.

Figures D-1, D-2, and D-3 show daily as well as AM and PM peak hour traffic volumes in Lynn, Swampscott, and Salem, respectively. These include high arterial volumes of 43,400 vehicles per day (two-way) on Route 1A at the Lynn/Revere line and 27,500 vehicles on Route 1A south of Canal Street in Salem. Low arterial volumes range from 15,100 vehicles on Route 1A south of Burrill Street in Swampscott, 13,400 vehicles on Eastern Avenue west of Lynn Shore Drive in Lynn, and 11,500 daily vehicles on Summer Street east of Boston Street in Lynn.

Manual Turning Movement Counts (MTMCs) at key signalized and unsignalized intersections include high total volumes of 3,630 vehicles (PM peak hour) at Route 129 (Broadway) at Parkland Avenue in Lynn; 2,610 vehicles (PM peak hour) at Essex Street at Danvers Road in Swampscott; and 3,500 vehicles (PM peak hour) at Route 107 (Highland Avenue) at Marlborough Road/Traders Way in Salem. Observed low intersection volumes include 1,320 vehicles (PM peak hour) at Route 129 (Lewis Street) at Chestnut Street/Atlantic Street in Lynn; 960 vehicles (PM peak hour) at Essex Street at The Greenway in Swampscott; and 1,280 vehicles (AM peak hour) at Vinnin Street at Loring Avenue in Salem.

Tables D-1-1, D-1-2, and D-1-3 in Appendix D-1 describe all of the pertinent traffic count data for the three study area towns, respectively.

Travel Time Data

As a key ingredient of its ongoing Congestion Management System (CMS) functions, CTPS performs travel time runs on major highways and arterials in the Boston metropolitan region. The runs yield average vehicle speeds for segments of a roadway, as well as for the entire facility. From the average speeds, a relative measure of congestion is obtained on a particular roadway, as well as on its individual segments. Figures D-4 and D-5 show average AM and PM peak period speeds, respectively, for all or parts of five arterials in the study area: Routes 1A, 107, 114, 129, and 129A.

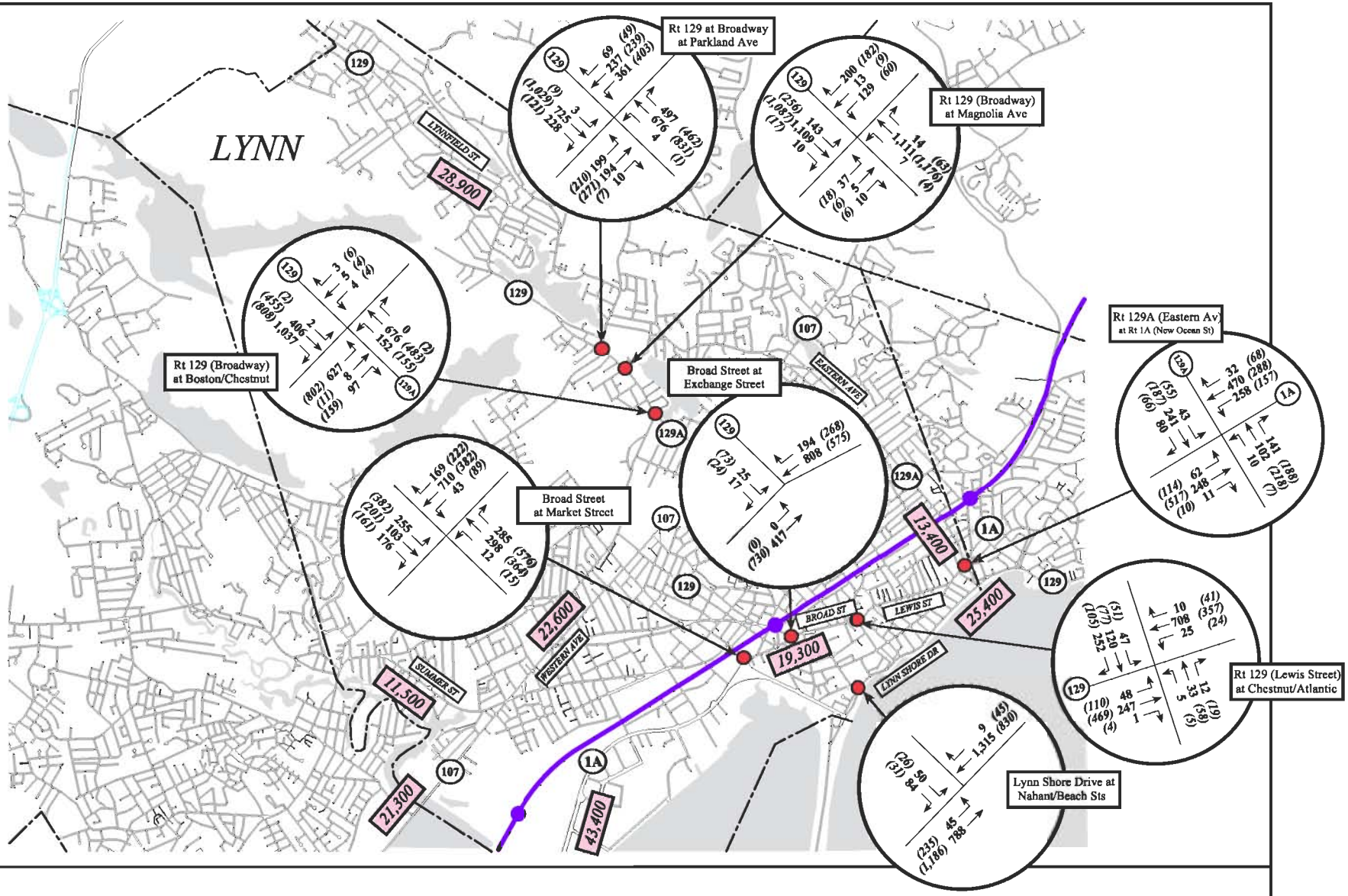

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FIGURE D-1
Lynn: Existing (2004) 24-Hour Arterial Volumes and AM and PM Peak Hour Intersection Turning Movement Counts

00,000 = 24-Hour Volumes (two-way)

xxx AM Peak Hour Volumes

(xxx) PM Peak Hour Volumes

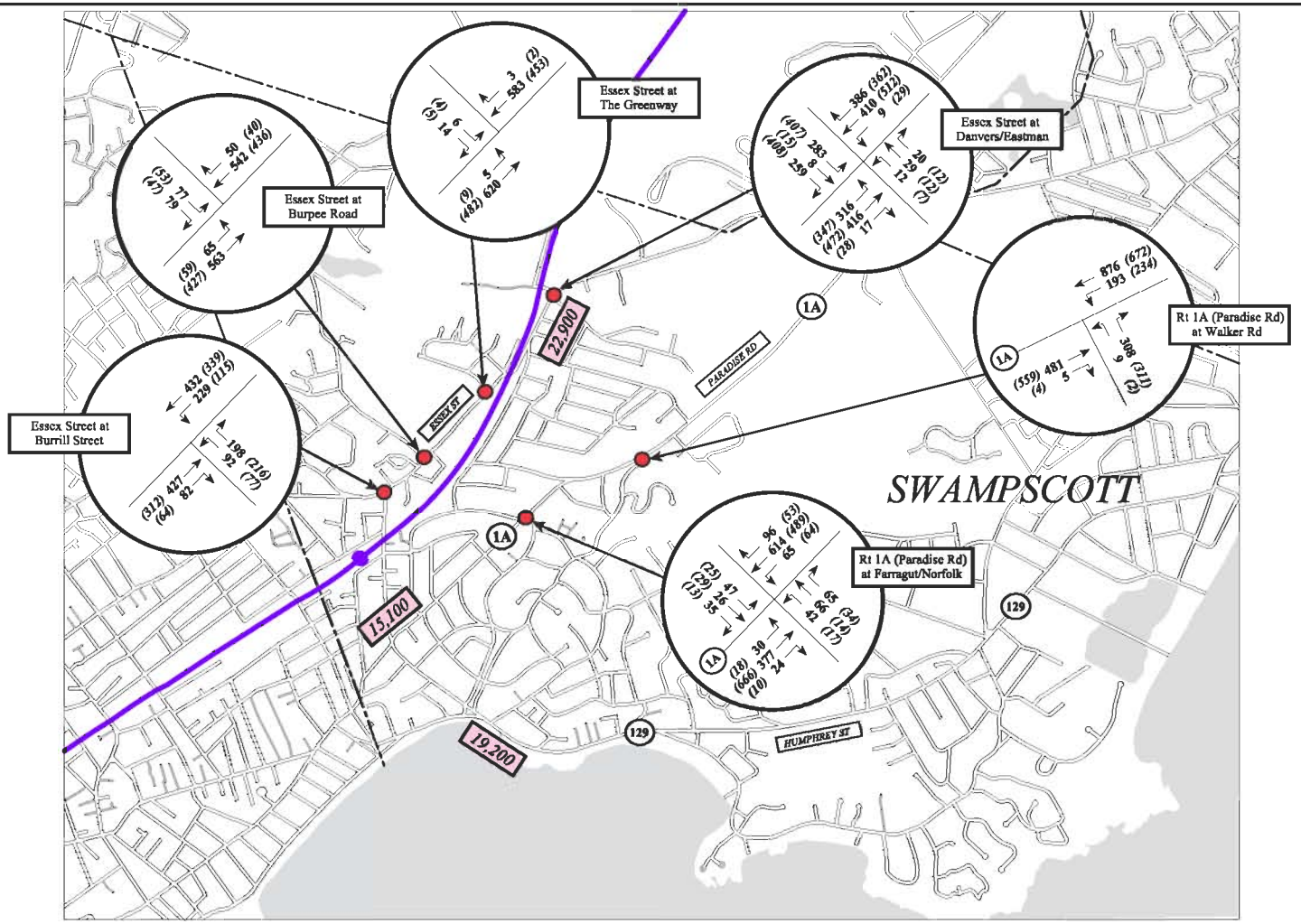

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FIGURE D-2
Swampscott: Existing (2004) 24-Hour Arterial Volumes and AM and PM Peak Hour Intersection Turning Movement Counts

00,000 = 24-Hour Volumes (two-way)

xxx AM Peak Hour Volumes
(xxx) PM Peak Hour Volumes

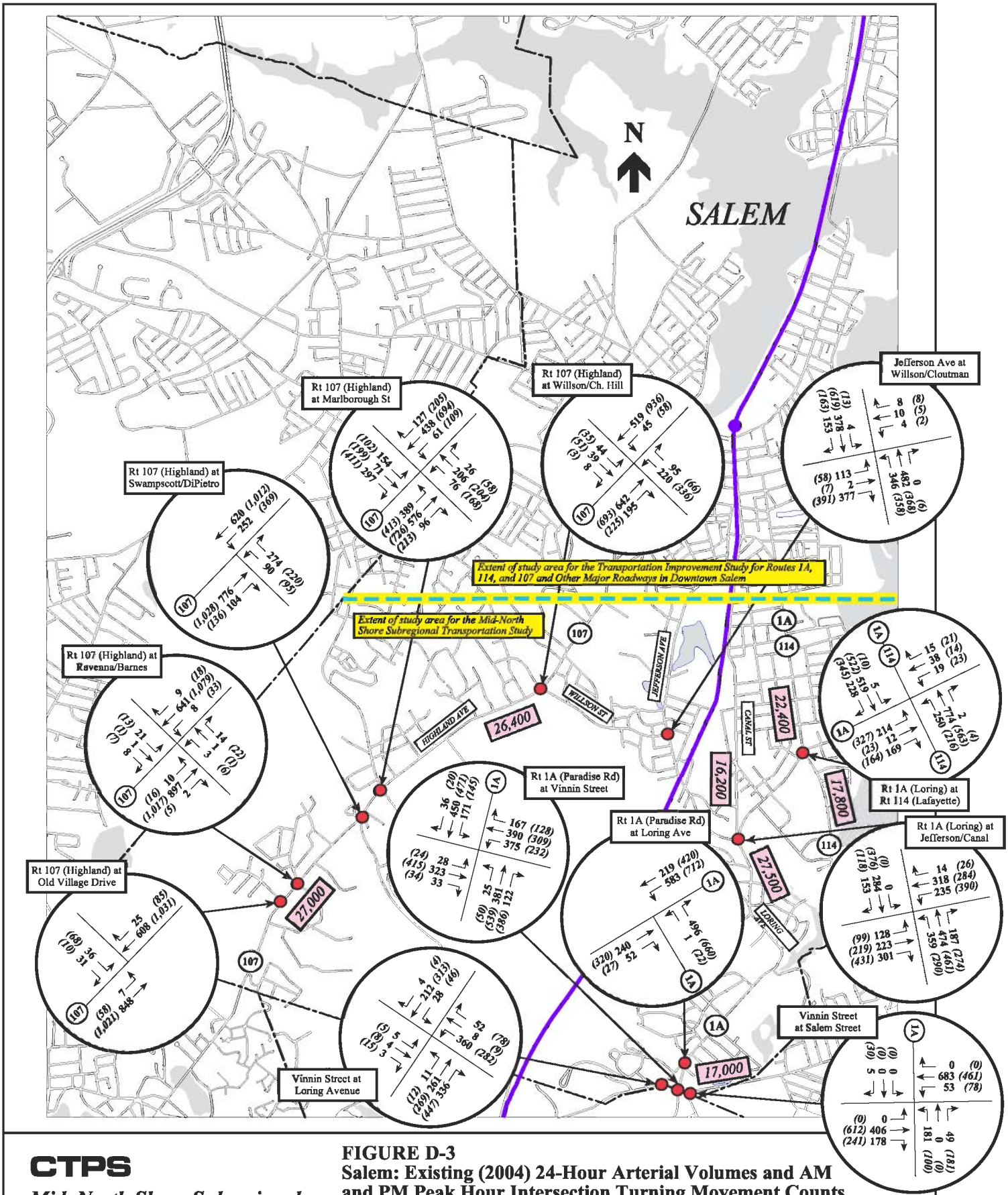

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FIGURE D-3
Salem: Existing (2004) 24-Hour Arterial Volumes and AM and PM Peak Hour Intersection Turning Movement Counts

00,000 = 24-Hour Volumes (two-way)

xxx AM Peak Hour Volumes

(xxx) PM Peak Hour Volumes

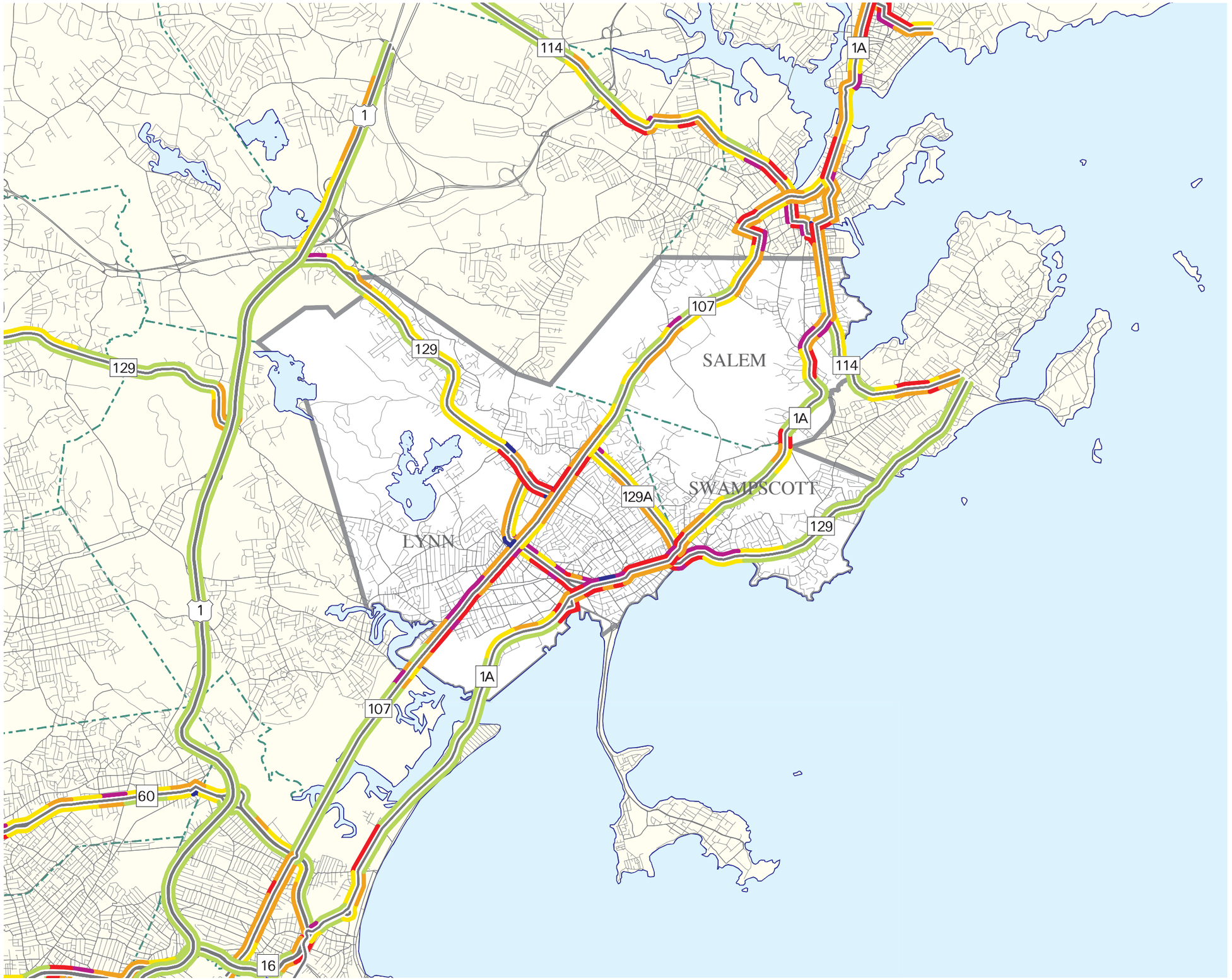

FIGURE D-4

AM Peak Period Average Speeds

Mid-North Shore
Subregional Transportation Study

Urban Arterial Class I & II

Routes Monitored	Year
Route 1	1999-2000

Average Speed (mph)

- 1 – 16
- 17 – 21
- 22 – 27
- 28 – 34
- 35 – 42
- 43+

Urban Arterial Class III

Routes Monitored	Year
Route 1A	2001
Route 16	2001-2002
Route 60	2001
Route 107	2001
Route 114	2002
Route 129	2001
Route 129A	2001

Average Speed (mph)

- 1 – 10
- 11 – 14
- 15 – 18
- 19 – 24
- 25 – 30
- 31+

FIGURE D–5

PM Peak Period Average Speeds

Mid–North Shore
Subregional Transportation Study

Urban Arterial Class I & II

Routes Monitored	Year
Route 1	1999–2000

Average Speed (mph)

- 1 –16
- 17 –21
- 22 –27
- 28 –34
- 35 –42
- 43+

Urban Arterial Class III

Routes Monitored	Year
Route 1A	2001
Route 16	2001–2002
Route 60	2001
Route 107	2001
Route 114	2002
Route 129	2001
Route 129A	2001

Average Speed (mph)

- 1 –10
- 11 –14
- 15 –18
- 19 –24
- 25 –30
- 31+

The most congested segments and intersections in the study area are, according to the CMS data (see the dark blue segments in Figures D-4 and D-5: Urban Arterial Class III, average speed, 1–10 mph):

- Route 1A (Broad Street) southbound, north of Route 129 (Exchange Street) in Lynn (AM peak period, Figure D-4)
- The intersection of Routes 1A/129 (New Ocean Street) and 129A (Eastern Avenue) in Lynn (PM peak period; Figure D-5)
- Route 1A (Loring Avenue) southbound, north of Canal Street in Salem (PM peak period; Figure D-5)
- The intersection of Routes 107 (Western Avenue) and 129 (Washington Street) in Lynn (AM and PM peak periods; Figures D-4 and D-5)
- Route 107 (Western Avenue) northbound, north of the Saugus River in Lynn (PM peak period; Figure D-5)
- Route 129 (Broadway) westbound, south of Lynnfield Street and Parkland Avenue in Lynn (AM and PM peak periods; Figures D-4 and D-5)
- Route 129 (Washington Street) eastbound, between Essex Street and Liberty Street in Lynn (PM peak period; Figure D-5)

A cross-reference to Table D-1 below shows that a number of the heavy congestion points displayed in Figures D-4 and D-5 correspond to most of the intersections analyzed for crashes and operational LOS in this study.

Vehicle Crash Data

Vehicle crash data from the Massachusetts Registry of Motor Vehicles were gathered for the years 1999–2001 for a number of key study area intersections. Actual police accident reports were obtained for a limited number of the intersections identified by local officials as being in need of further study. In these cases, police reports for the most recent three-year period were obtained, usually for 2002 through 2004 (see Table D-1).

The local police department accident report data enabled CTPS to construct collision diagrams of some of the intersections identified by local officials. The diagrams help to identify probable causes for crashes occurring at the intersections, and will contribute to the development of recommended transportation improvements in Task 5. It should be noted that police accident reports for the intersections analyzed in Lynn were unavailable from the Lynn police department. For Swampscott, police accident reports were not warranted, while for Salem, police accident reports for the three key intersections analyzed were available from the Salem police department.

Table D-1 lists the intersections in the study area for which vehicle crash data were summarized in tabular format and for which a limited number of collision diagrams were created. Also shown are the intersection crash rates, expressed as crashes per million entering vehicles (MEV), and, for comparative purposes, the applicable 2005 MassHighway District 4 crash-rate averages. Table D-1 also displays intersection level of service (LOS) data. Tables D-3-1 through D-3-23 in Appendix D-3 describe crash data summaries for the study area intersections analyzed.

TABLE D-1

(ReS, 060827, Crashes&LOS.xls)

MID-NORTH SHORE SUBREGIONAL TRANSPORTATION STUDY

Intersections Analyzed for Vehicle Crashes and Operational Level of Service

(Crash Rate=number of crashes per million entering vehicles; based on 2004 PM peak hour volumes) **Town, Intersection**	**Source, Years of Crash Data**	**Existing Vehicle Crash Rate (based on PM peak hour)**	**Average 2005 MassHighway District 4 Crash Rates**	**Signalized (S) or Unsignalized (U)**	**Existing AM / PM Level of Service**
Lynn					
1. Route 129 (Lynnfield St) at Broadway/Parkland Ave	Mass Registry, '99-'01	1.54	0.88	S	D / D
2. Route 129 (Broadway) at Magnolia Ave/Springvale Ave	Mass Registry, '99-'01	0.60	0.88	S	C / E
3. Route 129 (Broadway) at Boston St/Chestnut St/Carter Rd	Mass Registry, '99-'01	1.20	0.88	S	C / C
4. Route 1A (Broad St) at Market St	Mass Registry, '99-'01	0.72	0.88	S	E / D
5. Route 1A (Broad St) at Washington St/Spring St	Mass Registry, '99-'01	0.79	0.88	S	D / D
6. Route 1A (Broad St) at Route 129 (Exchange St)	Mass Registry, '99-'01	0.20	0.88	S	B / B
7. Routes 1A/129 (Broad St) at Silsbee St/Newhall St	Mass Registry, '99-'01	0.77	0.88	S	C / C
8. Routes 1A/129 (Broad St/Lewis St) at Chestnut St/Atlantic St	Mass Registry, '99-'01	1.68	0.88	S	D / C
9. Routes 1A/129 (Lewis St) at Chatham St/Aubrey Ter	Mass Registry, '99-'01	0.13	0.63	(Flashing Beacon) U	N.A.
10. Routes 1A/129 (Lewis St) at Ocean St/Ocean Cir	Mass Registry, '99-'01	0.55	0.88	S	B / B
11. Routes 1A/129 (New Ocean St) at Route 129A (Eastern Ave)	Mass Registry, '99-'01	1.36	0.88	S	F / E
12. Lynn Shore Dr at Nahant St/Beach Rd	Mass Registry, '99-'01	0.45	0.88	S	F / F
Swampscott					
13. Route 1A (Paradise Rd) at Farragut Rd/Norfolk Ave	Mass Registry, '99-'01	0.46	0.63	U	N.A.
14. Route 1A (Paradise Rd) at Walker Rd	Mass Registry, '99-'01	0.37	0.63	U	N.A.
15. Essex St at Danvers Rd/Eastman Ave	Mass Registry, '99-'01	0.59	0.88	S	E / F
Salem					
16. Route 1A (Loring Ave) at Route 114 (Lafayette St)/West Ave)	Salem Police, '02-'04	0.99	0.88	S	F / D
17. Jefferson Ave at Willson St/Cloutman St	Salem Police, '02-'04	0.86	0.63	(Flashing Beacon) U	N.A.
18. Swampscott Rd at Aggregate Industries driveway	Mass Registry, '99-'01	0.59 (AM)	0.63	U	N.A.
19. Route 1A (Paradise Rd) at Vinnin St (Vinnin Square)	Mass Registry, '99-'01	1.16	0.88	S	F / D
20. Vinnin St at Salem St/plaza driveway (Vinnin Square)	Mass Registry, '99-'01	0.29	0.88	S	B / D
21. Vinnin St at Loring Ave (Vinnin Square)	Mass Registry, '99-'01	1.49	0.88	S	C / B
22. Route 1A (Paradise Rd) at Loring Ave (Vinnin Square)	Mass Registry, '99-'01	1.17	0.88	S	B / C
23. Route 1A (Loring Ave) at Canal St/Jefferson Ave	Salem Police, '02-'04	1.91	0.88	S	F / F

Intersection Level of Service

Intersection level-of-service (LOS) analyses were performed for selected intersections in the study area. The analyses were limited to those intersections which were identified by local officials as in particular need of further study. The twenty-three intersections listed in Table D-1 above were selected both for crash data analysis as well as for operational analysis.

The LOS results are summarized below by study area town. The results, discussed in terms of congestion and operational safety, are one set of factors which will be taken into account when developing recommended transportation improvements for study area intersections in Task 5. The intersections were analyzed using either of the software programs HCS2000 (Highway Capacity Software)[4] or Synchro 6.[5]

Lynn

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1. Route 129 (Lynnfield Street) at Broadway/Parkland Avenue Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	D	49	127	D	52	133

- Number of vehicle crashes, 1999–2001 (Mass Registry): 68 (22.7 per year)
- Crash rate: 1.54 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 29 of the 68 crashes were rear end crashes (43%). This type of crash is typically associated with heavy congestion and stop-and-go traffic. A possible contributing factor is a lack of sufficient green time on one or more approaches. In addition, 26 of the 68 crashes were angle crashes (38%). This type of crash is most often associated with left turns. The intersection's vehicle crash rate is 1.54, far exceeding MassHighway's 2005 District 4 average rate for signalized intersections of 0.88.[6]

[4] HCS2000 Signalized and Unsignalized Intersections Version 4.1f, McTrans Center, University of Florida, 1994–2003.

[5] Synchro 6, Traffic Signal Coordination Software, Trafficware, 1993–2005.

[6] The vehicle crash rate is the number of crashes per million vehicles entering an intersection (normally based on PM peak hour volumes). The MassHighway average rates exist for both signalized and unsignalized intersections, and are based on average crash rates for intersections in cities and towns throughout Massachusetts. District 4 encompasses the northeast portion of Massachusetts (including Boston) from Weymouth in the south, Concord in the west, Tyngsborough in the northwest, and Salisbury in the northeast. The entire North Shore area is included in District 4.

Level of service (LOS) analyses show that the intersection operates at LOS D in both the AM and PM peak hours. Within the intersection, the northbound (Parkland Avenue) and southbound (Broadway) approaches both operate at LOS F in the AM and PM peak hours, with significant queuing existing on both approaches. The westbound and eastbound approaches (Route 129) operate at LOS B and C, respectively, in both the AM and PM peak hours.

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2. Route 129 (Broadway) at Magnolia Avenue/Springvale Avenue Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	28	57	E	63	66

- Number of vehicle crashes, 1999–2001 (Mass Registry): 21 (7.0 per year)
- Crash rate: 0.60 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 10 of the 21 crashes were angle crashes (48%). The crash rate for this location is 0.60, well below the 2005 District 4 average rate for signalized intersections of 0.88.

The intersection operates at LOS C in the AM peak hour and at LOS E in the PM peak hour. The eastbound (Broadway) approach operates at LOS F in the PM peak hour.

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3. Route 129 (Broadway) at Boston Street/Chestnut Street/Carter Road Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	30	44	C	30	64

- Number of vehicle crashes, 1999–2001 (Mass Registry): 42 (14.0 per year)
- Crash rate: 1.20 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 18 of the 42 crashes were rear end crashes (43%). Ten of the 42 recorded crashes were angle (24%). The crash rate at this intersection is 1.20, exceeding the 2005 District 4 average rate for signalized intersections of 0.88.

This intersection functions relatively well, operating at LOS C in both the AM and PM peak hours. Moderate queues exist on the northbound (Boston Street) approach during both peak hours, and on the eastbound (Broadway) approach in the PM peak hour.

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4. Route 1A (Broad Street) at Market Street Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	E	65	46	D	35	61

- Number of vehicle crashes, 1999–2001 (Mass Registry): 21 (7.0 per year)
- Crash rate: 0.72 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 12 of the 21 crashes were angle crashes (57%). These crashes could possibly be related to the numerous left turns from the eastbound (Market Street) approach conflicting with the throughs and heavy right turns from the westbound (Market Street) approach. The eastbound and westbound approaches currently operate during the same signal phase. The crash rate at this location is 0.72, below the 2005 District 4 average rate for signalized intersections of 0.88.

LOS analyses show that the intersection operates at LOS E during the AM peak hour, with the southbound (Broad Street) approach at LOS F. During the PM peak hour, the intersection operates at LOS D, with the southbound approach at LOS E. Queuing is not an issue at this location.

5. Route 1A (Broad Street) at Washington Street/Spring Street Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	D	38	41	D	38	54

- Number of vehicle crashes, 1999–2001 (Mass Registry): 18 (6.0 per year)
- Crash rate: 0.79 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 6 of the 18 crashes were angle crashes (33%). Five of the crashes were rear end (28%). The crash rate at this location is 0.79, below the 2005 District 4 average rate for signalized intersections of 0.88.

Congestion at this intersection is moderate. The overall LOS is D for both the AM and the PM peak hours, with no individual approach operating worse than LOS E.

6. Route 1A (Broad Street) at Route 129 (Exchange Street) Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	16	26	B	13	29

- Number of vehicle crashes, 1999–2001 (Mass Registry): 4 (1.3 per year)
- Crash rate: 0.20 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 1 of the 4 crashes was an angle crash (25%), and one was head on (25%). The crash rate at this location is 0.20, well below the 2005 District 4 average rate for signalized intersections of 0.88.

There is no significant congestion problem at this intersection. The overall LOS is B for both the AM and the PM peak hours, with no individual approach operating worse than LOS C.

7. Routes 1A/129 (Broad Street) at Silsbee Street/Newhall Street Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	21	18	C	24	25

- Number of vehicle crashes, 1999–2001 (Mass Registry): 14 (4.7 per year)
- Crash rate: 0.77 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 4 of the 14 crashes were rear end (29%) and 4 were angle (29%). The crash rate at this location is 0.77, below the 2005 District 4 average rate for signalized intersections of 0.88.

There is not a significant congestion problem at this intersection. The overall LOS is C for both the AM and the PM peak hours, with no individual approach operating worse than LOS C.

8. Routes 1A/129 (Broad Street/Lewis Street) at Chestnut St/Atlantic St Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	D	37	42	C	24	28

- Number of vehicle crashes, 1999–2001 (Mass Registry): 27 (9.0 per year)
- Crash rate: 1.68 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 11 of the 27 crashes were angle (41%) and 10 were rear end (37%). The crash rate at this intersection is 1.68, well above the 2005 District 4 average rate for signalized intersections of 0.88.

There is no significant congestion problem at this intersection. The overall LOS is D for the AM peak hour and C for the PM peak hour. Queuing is not an issue.

9. Routes 1A/129 (Lewis Street) at Chatham Street/Aubrey Terrace Summary:

- Intersection LOS data: Unsignalized

Scenario	AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
	EB, all turns	WB, all turns	EB, all turns	WB, all turns
2004 Existing	C / 23	C / 20	F / *	N.A.

- Number of vehicle crashes, 1999–2001 (Mass Registry): 2 (0.7 per year)
- Crash rate: 0.13 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

Based on available Mass Registry data for 1999–2001, only two crashes were recorded at this intersection. The crash rate at this intersection is 0.13, well below the 2005 District 4 average rate for unsignalized intersections of 0.63.

This is an unsignalized intersection, with a flashing beacon controlling traffic. The beacon flashes yellow for the major roadway, Routes 1A/129 (Lewis Street), northbound/southbound, and flashes red for the minor approaches, Chatham Street and Aubrey Terrace, eastbound and westbound, respectively. There are no pedestrian-activated controls at this location. LOS analyses show that the two minor approaches both operate at LOS C in the AM peak hour. In the PM peak hour, the Chatham Street approach operates at LOS F; there was no traffic on Aubrey Terrace during the PM peak hour.

10. Routes 1A/129 (Lewis Street) at Ocean Street/Ocean Circle Summary:

- Intersection LOS data: Signalized

Scenario	AM Peak Hour			PM Peak Hour		
	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	10	13	B	16	15

- Number of vehicle crashes, 1999–2001 (Mass Registry): 8 (2.7 per year)
- Crash rate: 0.55 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 4 of the 8 crashes were rear end crashes (50%). Three of the crashes were angle (17%). The crash rate at this location is 0.55, below the 2005 District 4 average rate for signalized intersections of 0.88.

There is not a significant congestion problem at this intersection. The overall LOS is B for both the AM and the PM peak hours, with no individual approach operating worse than LOS D (Ocean Street westbound, PM peak hour).

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11. Routes 1A/129 (New Ocean Street) at Route 129A (Eastern Avenue) Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	71	E	67	72

- Number of vehicle crashes, 1999–2001 (Mass Registry): 31 (10.3 per year)
- Crash rate: 1.36 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 24 of the 31 crashes were angle (77%). The heavy southbound left turns (from New Ocean Street to Eastern Avenue) may be a contributor to this crash total. The crash rate at this intersection is 1.36, well over the 2005 District 4 average rate for signalized intersections of 0.88.

This is a congested intersection, with an overall LOS of F in the AM peak hour and E in the PM peak hour. Queuing is moderate, particularly on the southbound approach during the AM peak hour, and on both the northbound and southbound approaches during the PM peak hour.

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12. Lynn Shore Drive at Nahant Street/Beach Road Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	166	F	*	153

- Number of vehicle crashes, 1999–2001 (Mass Registry): 13 (4.3 per year)
- Crash rate: 0.45 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 6 of the 13 crashes were angle (46%) while 4 were rear end (31%). The crash rate at this location is 0.45, well below the 2005 District 4 average rate for signalized intersections of 0.88.

This is a very congested intersection, with an overall LOS of F in both the AM and PM peak hours. Queuing is severe, especially on Lynn Shore Drive southbound in the AM peak hour, but also northbound and southbound in the PM peak hour. Field observations substantiate anecdotal evidence that the southbound AM queue at times stretches three-quarters of a mile or more into Swampscott.

Swampscott

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13. Route 1A (Paradise Road) at Farragut Road/Norfolk Avenue Summary:

- Intersection LOS data: Unsignalized

		AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
Scenario		EB, all turns	WB, all turns	EB, all turns	WB, all turns
2004	Existing	F / *	F / *	F / *	F / *

- Number of vehicle crashes, 1999–2001 (Mass Registry): 8 (2.7 per year)
- Crash rate: 0.46 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

Based on available Mass Registry data from 1999–2001, 4 of the 8 crashes were angle (50%) while 2 were rear end (25%). The crash rate at this location is 0.46, well below the 2005 District 4 average rate for unsignalized intersections of 0.63.

This is a busy, unsignalized intersection. The minor approaches (Farragut Road, westbound; Norfolk Avenue, eastbound) operate at LOS F in both the AM and PM peak hours. Total combined left turn movements from the minor approaches are more numerous (89 versus 42), and therefore more difficult, during the AM peak hour than in the PM peak hour.

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14. Route 1A (Paradise Road) at Walker Road Summary:

- Intersection LOS data: Unsignalized

		AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
Scenario		SB, left turns/throughs	WB, left/right turns	SB, left turns/throughs	WB, left/right turns
2004	Existing	A / 10	E / 37	B / 10	D / 30

- Number of vehicle crashes, 1999–2001 (Mass Registry): 8 (2.7 per year)
- Crash rate: 0.37 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

Based on available Mass Registry data from 1999–2001, 3 of the 8 crashes were rear end crashes (38%). The crash rate at this location is 0.37, below the 2005 District 4 average rate for unsignalized intersections of 0.63.

There is no significant congestion problem at this unsignalized intersection. The minor approach (Walker Road, westbound) operates at LOS E during the AM peak hour (with only 9 westbound left turns), and at LOS D during the PM peak hour (only 2 westbound left turns).

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15. Essex Street at Danvers Road/Eastman Avenue Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	E	66	88	F	*	104

- Number of vehicle crashes, 1999–2001 (Mass Registry): 19 (6.3 per year)
- Crash rate: 0.59 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 8 of the 19 crashes were angle (42%) and 6 were rear end (32%). The crash rate at this location is 0.59, below the 2005 District 4 average rate for signalized intersections of 0.88.

This is a congested, signalized intersection. The overall LOS is E in the AM peak hour and F in the PM peak hour. Two of the approaches operate at LOS F during both peak hours: eastbound (Danvers Road) and northbound (Essex Street).

Salem

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16. Route 1A (Loring Ave) at Route 114 (Lafayette St) and West Ave Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	101	D	54	84

- Number of vehicle crashes, 2002–2004 (Salem Police Department): 27 (9.0 per year)
- Crash rate: 0.99 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

The vehicle crash data for this signalized intersection are based on actual accident reports for the years 2002 through 2004, and were provided by the Salem Police Department.

Based on the data provided, 10 of the 27 crashes were rear end (37%), 7 were angle (26%), and 7 were sideswipes in the same direction (26%). It is not surprising that there is a variety of crash types at this location, since there is prevailing congestion, numerous left turns, and a generally tight geometric layout, including grade differences between approaches. Figure D-6 depicts a collision diagram of the combined three-year intersection data. The crash rate at this location is 0.99, more than the 2005 District 4 average rate for signalized intersections of 0.88.

LOS analyses reveal that the overall AM peak hour operates at LOS F, with the southbound (Lafayette Street) approach at LOS F and the northbound (Lafayette Street) approach at LOS E. During the PM peak hour, overall LOS is D with the eastbound (Loring Avenue) approach and the southbound approach both operating at LOS E. Queuing is moderate.

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17. Jefferson Avenue at Willson Street/Cloutman Street Summary:

- Intersection LOS data: Unsignalized

	AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
Scenario	EB, all turns	WB, all turns	EB, all turns	WB, all turns
2004 Existing	F / *	F / *	F / *	F / *

- Number of vehicle crashes, 2002–2004 (Salem Police Department): 21 (7.0 per year)
- Crash rate: 0.86 crashes per million entering vehicles (2005 District 4 average: 0.63)

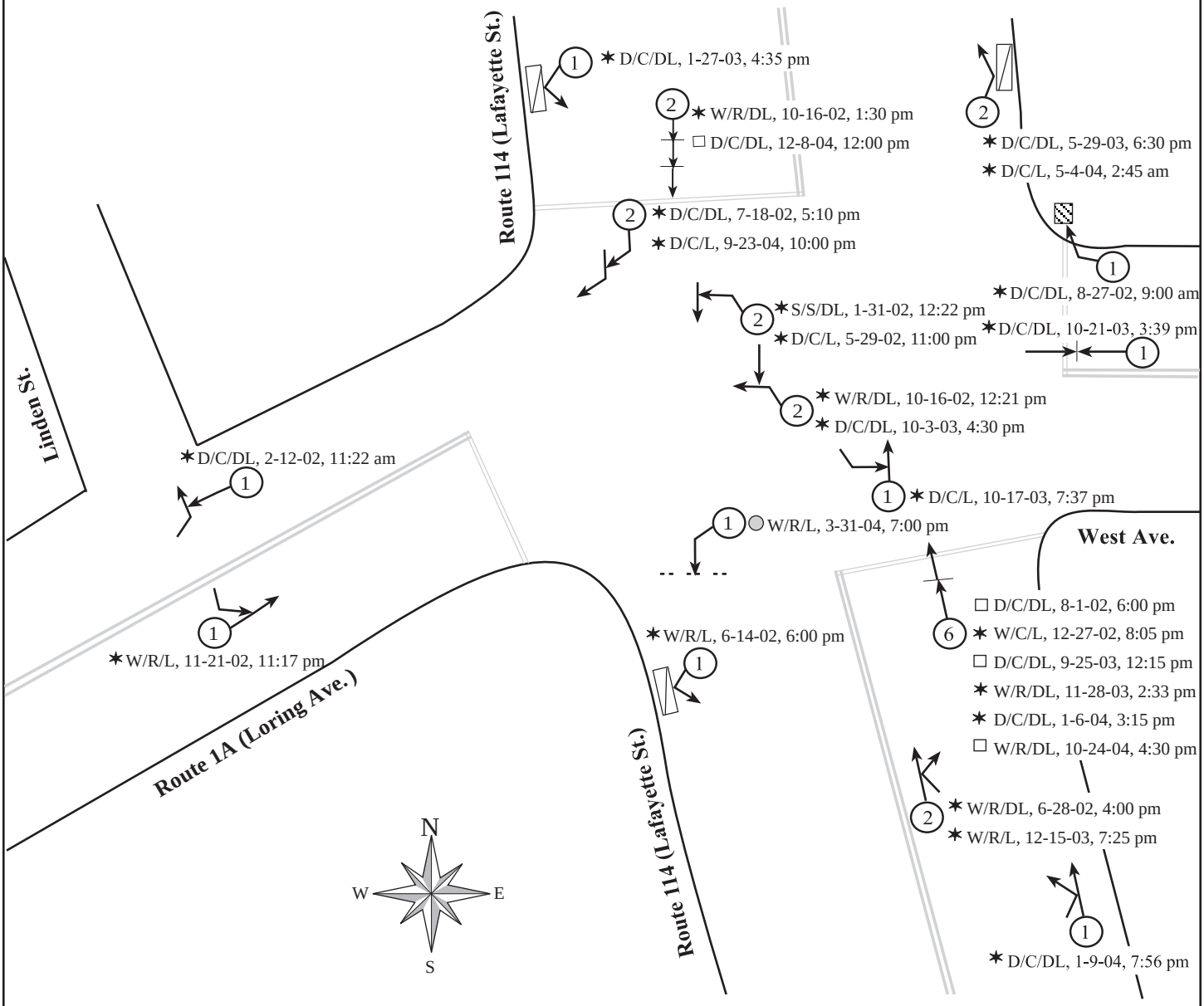
* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

The vehicle crash data for this intersection are based on actual accident reports for the years 2002 through 2004, and were provided by the Salem Police Department.

Based on the data provided, 11 of the 21 crashes were angle (52%), 6 were rear end (29%), and 3 were sideswipes in the same direction (14%). Most of the conflicts involved left turns to and from Willson Street, as seen in the collision diagram in Figure D-7. The crash rate at this location is 0.86, exceeding the 2005 District 4 average rate for unsignalized intersections of 0.63.

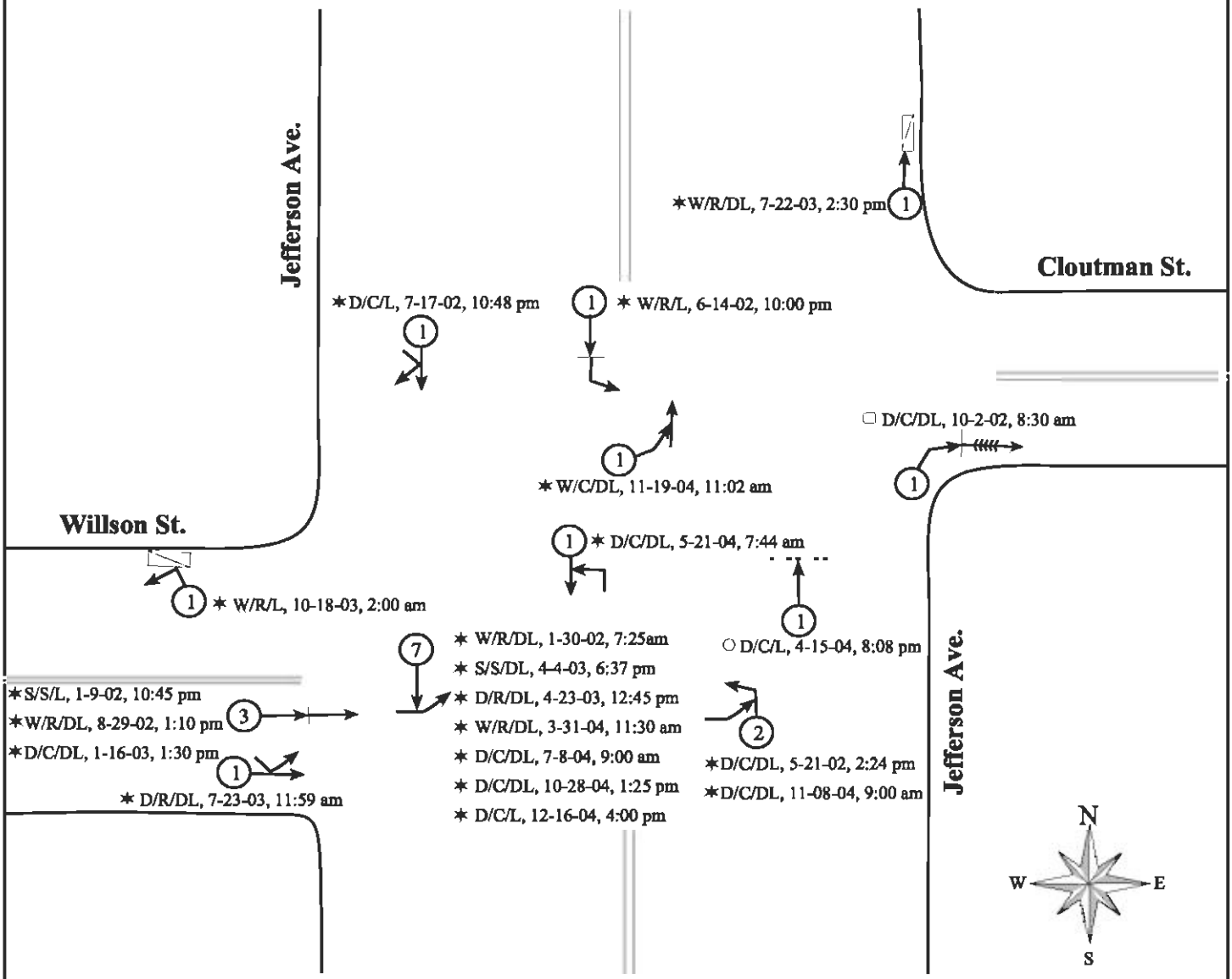
The intersection is controlled by a flashing beacon, with flashing green on the northbound/southbound approaches (Jefferson Avenue), and flashing red on the eastbound (Willson Street) and westbound (Cloutman Street) approaches. In essence, the flashing beacon becomes a pedestrian signal since pedestrian activation buttons exist. The pedestrian phase is 15 seconds in duration. LOS analyses show that as an unsignalized intersection, the two minor approaches—eastbound and westbound—operate at LOS F in both the AM and PM peak hours.

FIGURE D-6
(pertains to Location 16 – see above, pp. D-21 and D-22)
Collision Diagram
Crashes from 1/1/2002 to 12/31/2004
Rt 1A (Loring Ave) at Rt 114 (Lafayette St)/West Ave, Salem



SYMBOLS		PAVEMENT/WEATHER/LIGHTING		TYPES OF COLLISIONS	
←	Moving Vehicle	D	Dry	→ ←	Head On
←≈	Backing Vehicle	W	Wet	↙	Angle
-- -- --	Pedestrian/Bicycle	S	Snowy, Icy	← ←	Rear End
▱	Parked Vehicle	C	Clear	↙ ←	Sideswipe
▨	Fixed Object	R	Rainy/Foggy/Cloudy	↓ ←	Broadside
✶	Property Damage Only	S	Snow/Sleet		
○	Injury	O	Other		
●	Fatality	DL	Daylight		
□	No Damage/Injury	L	Dark – Lights		CTPS
(#)	Number of Accidents	N	Dark – No Lights		

FIGURE D-7
(pertains to Location 17 – see above, p. D-22)
Collision Diagram
Crashes from 1/1/2002 to 12/31/2004
Jefferson Ave at Willson St/Cloutman St, Salem



SYMBOLS		PAVEMENT/WEATHER/LIGHTING		TYPES OF COLLISIONS	
←	Moving Vehicle	D	Dry	→ ←	Head On
←≈	Backing Vehicle	W	Wet	↙	Angle
- - -	Pedestrian/Bicycle	S	Snowy, Icy	← ←	Rear End
▱	Parked Vehicle	C	Clear	↙	Sideswipe
▨	Fixed Object	R	Rainy/Foggy/Cloudy	↓	Broadside
✶	Property Damage Only	S	Snow/Sleet		
○	Injury	O	Other		
●	Fatality	DL	Daylight		
□	No Damage/Injury	L	Dark – Lights		CTPS
(#)	Number of Accidents	N	Dark – No Lights		

18. Swampscott Road at Aggregate Industries driveway Summary:

- Intersection LOS data: Unsignalized

Scenario	AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
	WB, l. turns/throughs	NB, left/right turns	WB, l. turns/throughs	NB, left/right turns
2004 Existing	B / 11	C / 19	N.A.	N.A.

- Number of vehicle crashes, 1999–2001 (Mass Registry): 11 (3.7 per year)
- Crash rate: 0.59 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

Based on available Mass Registry data from 1999–2001, 4 of the 11 crashes were rear end (36%) while 2 were head on (18%). The crash rate at this location is 0.59, just below the 2005 District 4 average rate for unsignalized intersections of 0.63.

There is no significant congestion problem at the intersection of Swampscott Road and the Aggregate Industries driveway. CTPS was asked to analyze the prevalence of trucks on nearby Essex Street in Swampscott, and it was suggested that many of these travel through town on Essex Street to and from this location. LOS on the driveway approach is seen to be C for the AM peak hour; the PM peak hour was not analyzed.

19. Route 1A (Paradise Rd) at Vinnin Street (Vinnin Square) Summary:

- Intersection LOS data: Signalized

Scenario	AM Peak Hour			PM Peak Hour		
	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	120	D	48	109

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- Number of vehicle crashes, 1999–2001 (Mass Registry): 39 (13.0 per year)
- Crash rate: 1.16 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 20 of the 39 crashes were angle (51%) and 15 were rear end (38%). The crash rate at this location is 1.16, exceeding the 2005 District 4 average rate for signalized intersections of 0.88.

This is a congested, signalized intersection with numerous approaches with heavy left and right turns during both the morning and afternoon peak hours. Queuing is significant. LOS analyses show that the AM peak hour operates at LOS F and the PM peak hour operates at LOS D. During the AM, the westbound (Vinnin Street) approach is at LOS F while the eastbound

(Vinnin Street) approach is at LOS E. During the PM peak hour, the eastbound approach is at LOS F. Field observations revealed that southbound left turns from Route 1A (Paradise Road) sometimes do not clear the intersection due to the nearby downstream signal at Vinnin Street at Salem Street.

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20. Vinnin Street at Salem Street/plaza driveway (Vinnin Square) Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	19	30	D	39	36

- Number of vehicle crashes, 1999–2001 (Mass Registry): 6 (2.0 per year)
- Crash rate: 0.29 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 5 of the 6 crashes were angle (83%). The crash rate at this location is 0.29, well below the 2005 District 4 average rate for signalized intersections of 0.88.

LOS analyses at this signalized intersection show that the AM peak hour operates at LOS B while the PM peak hour operates at LOS D. One approach, northbound (Salem Street), is at LOS E during the AM peak hour, while the eastbound (Vinnin Street) approach is at LOS E during the PM peak hour. Queuing is insignificant, except for eastbound through movements which sometimes back up into the nearby upstream intersection at Route 1A (Paradise Road) at Vinnin Street.

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21. Vinnin Street at Loring Avenue (Vinnin Square) Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	24	37	B	18	43

- Number of vehicle crashes, 1999–2001 (Mass Registry): 27 (9.0 per year)
- Crash rate: 1.49 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 19 of the 27 crashes were angle (70%) while 4 were rear end (15%). The crash rate at this location is 1.49, well above the 2005 District 4 average rate for signalized intersections of 0.88.

LOS analyses at this signalized intersection show that the AM peak hour operates at LOS C and the PM peak hour operates at LOS B. No approaches operate at LOS E or F. Queuing is moderate.

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22. Route 1A (Paradise Rd) at Loring Avenue (Vinnin Square) Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	19	42	C	25	62

- Number of vehicle crashes, 1999–2001 (Mass Registry): 31 (10.3 per year)
- Crash rate: 1.17 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

Based on available Mass Registry data from 1999–2001, 12 of the 31 crashes were rear end (39%), 11 were angle (35%), and 3 were head on (10%). The crash rate at this location is 1.17, above the 2005 District 4 average rate for signalized intersections of 0.88.

LOS analyses at this signalized intersection show that the AM peak hour operates at LOS B and the PM peak hour operates at LOS C. The eastbound (Loring Avenue) approach is at LOS E during the AM peak hour and at LOS F during the PM peak hour. Queuing is moderate.

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23. Route 1A (Loring Avenue) at Canal Street/Jefferson Avenue Summary:

- Intersection LOS data: Signalized

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	127	F	*	154

- Number of vehicle crashes, 2002–2004 (Salem Police Department): 69 (23.0 per year)
- Crash rate: 1.91 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total Average Queue is the average number of queued vehicles at the intersection during a given signal cycle.

The vehicle crash data for this signalized intersection are based on actual accident reports for the years 2002 through 2004, and were provided by the Salem Police Department.

Based on the data provided, 38 of the 69 crashes were rear end (55%), 18 were angle (26%), and 7 were sideswipes in the same direction (10%). Most of the rear end crashes occurred on the southbound (Canal Street) and eastbound (Jefferson Avenue) approaches. Of the angle crashes, there was an even distribution with 9 crashes involving left turns or broadsides within the intersection, and 9 crashes involving vehicles entering or exiting driveways and then conflicting with through traffic. See Figure D-8 for a collision diagram of the combined three-year data. The crash rate at this location is 1.91, more than twice the 2005 District 4 average rate for signalized intersections of 0.88.

LOS analyses reveal that the overall intersection operates at LOS F during both the AM and PM peak hours. Most of the individual approaches operate at either LOS E or F. Queuing is severe.

PUBLIC TRANSPORTATION[7]

Introduction

While the share of commuter trips from the greater Mid–North Shore area made by public transportation grew by just 1% between 1990 and 2000, there are several reasons to suggest that the demand for such services will grow, both for commuting and for other trip purposes. Lynn and Salem are the fastest growing towns in the region in terms of population. They also have the highest values, and greatest growth, of many other variables that are traditionally linked to transit usage. For example, they have two of the highest population densities in the area, as well as substantial growth in the number of employed residents. Also, moderately high poverty rates, and large numbers of immigrants and younger residents, are factors which are traditionally correlated with high transit usage. This high transit usage is also related to the lack of disposable income and access to private vehicles. As the local economy grows, however, a general increase in commuting can be expected, including increased demand for local public transportation services.

Growing job opportunities in Boston also suggest that the demand for public transportation will continue to remain strong for commuters from throughout the Mid-North Shore area. The speed and comfort of existing public transportation modes, as compared to the private automobile, will likely determine to what extent transit is used. In fact, between 1990 and 2000 many commuters switched to commuter rail, presumably partly as a result of the improvements made to the commuter rail system in the late 1980s and early 1990s.

Certain variables and trends, however, suggest the continuing difficulty that public transportation in general may have in the Mid-North Shore area. As more and more residents work outside the study area and in dispersed locations throughout the Boston metropolitan

[7] This section is based on three Draft technical memoranda by CTPS Transit Service Planning staff: T. Humphrey, "Mid–North Shore Transit Service Connectivity," 27 July, 2005; R. Guptill, "Task 4: Mid–North Shore Subregional Transportation Study: Public Transportation," 3 February, 2006; and, R. Guptill, "Task 4: Mid–North Shore Subregional Transportation Study: Bus Service Demand," 7 February, 2006.