2

Existing Transportation Conditions

This chapter describes the existing transportation conditions within the study area. Sections of this chapter present an overview of the study area demographics, existing traffic demands and operations, safety and geometrics, and a summary of the deficiencies/needs of the corridor.

2.1 Study Area Demographics

The Housatonic Valley's population grew rapidly from 1970 to 1990, with an overall increase of 38 percent. The region is comprised of 10 municipalities with a total 1990 population of about 187,800 – approximately 6 percent of the entire state of Connecticut. Regional demographics and journey-to-work statistics for these municipalities are summarized in Table 2-1.

Table 2-1
Housatonic Valley Region Demographics/Trip Generation

Municipality	1990 Population	2020 Projected Population	% Change 1990 to 2020	1990 Journey To Work Daily Trip Origins	1990 Journey To Work Daily Trip Destinations
Bethel	17,500	19,700	12.6	9,500	6,200
Bridgewater	1,700	1,800	5.9	900	300
Brookfield	14,100	16,300	15.6	7,800	6,300
Danbury	65,600	71,200	8.5	34,800	44,600
New Fairfield	12,900	15,600	20.9	6,600	1,700
New Milford	23,600	31,300	32.6	12,700	10,200
Newtown	20,800	24,600	18.3	10,500	7,000
Redding	7,900	8,600	8.9	4,300	1,300
Ridgefield	20,900	23,700	13.4	11,400	7,200
Sherman	2,800	3,900	39.3	1,500	400
	187,800	216,700	15.4	100,000	85,200

Sources: 1998 – 2018 Regional Transportation Plan; Housatonic Valley Council of Elected Officials; Adopted on February 1998.
1998 Data Book; Housatonic Valley Council of Elected Officials; February 1998.

The population of the Housatonic Valley is projected to grow to 216,700 people by the year 2020. All municipalities are projected to experience population growth to the year 2020 and several are projected to grow in excess of 15 percent. The higher growth towns include Sherman, New Milford, Brookfield, New Fairfield, and Newtown.

According to 1990 census data, the region currently attracts approximately 85,000 daily work trips and is the source for approximately 100,000 daily work trips. Within the region, Danbury is the major employment center – attracting almost 45,000 daily work trips. Of Danbury's resident work trips, 11 percent are destined to New York. For the entire Housatonic Valley, about 12 percent of the region's workers commute to New York and approximately 5 percent of the region's workers commute from New York.

2.2 Existing Traffic Demand

Traffic volumes presented in this study are based on a combination of sources. The I-84 mainline and ramp traffic volumes are representative of 1998 conditions and were developed by ConnDOT through an ongoing statewide traffic counting program. This information was supplemented by counts conducted by ConnDOT for this project at additional interstate locations. Additional historic data were also available for mainline I-84 for 1987 and 1995 conditions from the 1998-2018 Regional Transportation Plan.[1] Detailed traffic volume networks are presented in the Appendix

2.2.1 Daily Volumes

Daily traffic volumes were collected by ConnDOT for the I-84 mainline and its interchanges within the study area during 1998. Average annual daily traffic (AADT) volumes for all mainline links are shown in Table 2-2.

Based on these data, traffic volumes along mainline I-84 range from 63,800 vehicles per day (vpd) between Exits 10 and 11, to 116,100 vpd between Exits 6 and 7. For reference, 1987 and 1995 historic traffic data are also presented in Table 2-2.

Traffic volumes from Exits 4 to 7 (defined as "the overlap area") are the most significant along the corridor, averaging 40 percent higher volume than other segments of I-84. Traffic, in general, on I-84 from Exit 1 to 11 has been steadily increasing. From 1987 to 1998, growth in traffic has ranged from 2 to 7 percent per year, with the most significant growth occurring in the western portion of the study area and in the vicinity of the Danbury Mall (Exits 3/4). Between 1995 and 1998, corridor traffic volumes have grown between 2.6 and 4.3 percent annually.

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1 1998-2018 Regional Transportation Plan; Housatonic Valley Council of Elected Officials; February 1998

Table 2-2
I-84 Average Annual Daily Traffic Volumes (AADT)

Segment	1987 ADT	1995 ADT	1998 ADT	% Change (1987 to 1998)	% Change (1995 to 1998)
Exit 1 to 2	40,700	60,400	67,300	65.4	11.4
Exit 2 to 3	48,000	65,800	74,300	54.8	12.9
Exit 3 to 4	44,600	87,700	95,700	114.6	9.1
Exit 4 to 5	73,000	99,900	108,600	48.8	8.7
Exit 5 to 6	67,700	87,900	96,400	42.4	9.7
Exit 6 to 7	85,900	105,500	116,100	35.2	10.0
Exit 7 to 8	59,700	77,000	84,400	41.4	9.6
Exit 8 to 9	53,500	63,100	68,200	27.5	8.1
Exit 9 to 10	53,200	60,100	64,800	21.8	7.8
Exit 10 to 11	52,400	57,500	63,800	21.8	11.0

Sources: 1998 – 2018 Regional Transportation Plan; Housatonic Valley Council of Elected Officials; February 1998.
ConnDOT; 1998

2.2.2 Peak Hour Volumes

While daily data provides an overview of the traffic conditions along I-84, one focus of this study is to evaluate how the mainline is able to accommodate the fluctuations in daily demands placed upon it. Identifying hourly fluctuations in daily volumes helps to identify the degree of commuting traffic and periods of peak usage of I-84. Figure 2-1 presents a daily traffic volume profile using counts collected by ConnDOT for a representative section of I-84 (in the vicinity of Exit 9 in Newtown).

As indicated, the "spikes" in the daily demand profile occur in the morning in the westbound direction from about 7:00 to 9:00 AM and in the eastbound direction in the evening from 3:00 to 7:00 PM. A sharp increase in demand in the morning occurs from about 6:00 to 7:00 AM and is followed by a gradual decrease, leveling off at about 10:00 AM. The opposite occurs in the evening, where a gradual increase in demand is observed beginning at about 3:00 PM and followed by a sharp decrease in demand after 6:00 PM. At midday, traffic demands are distributed evenly in both directions along I-84. In general, traffic demands are higher throughout the study corridor in the evening peak period.

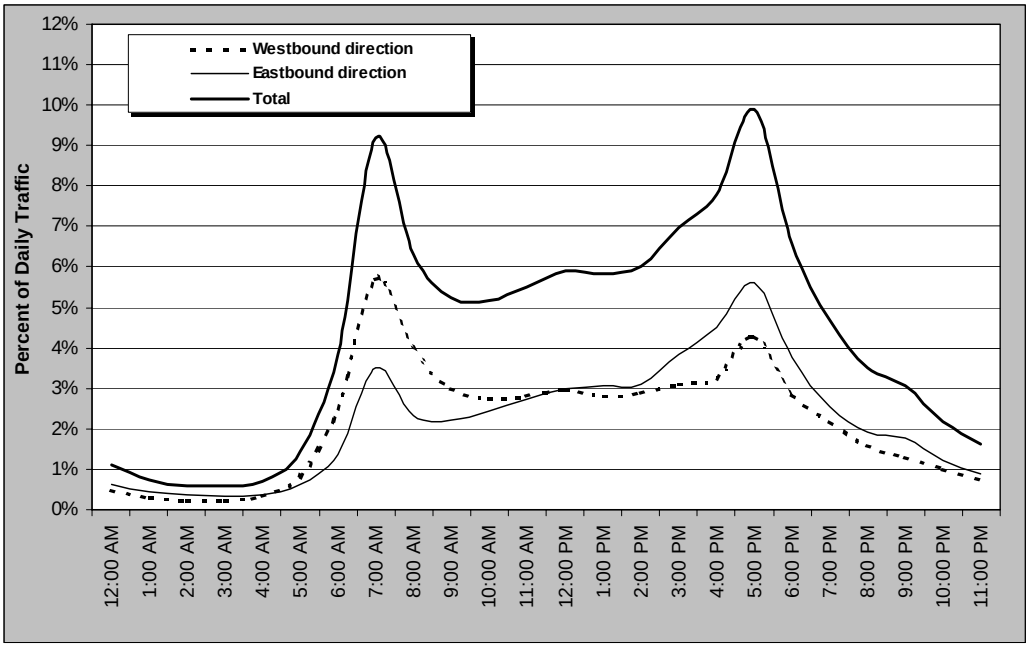


Figure 2-1
I-84 Mainline Hourly Traffic Demand Profile

As Table 2-3 and Figure 2-1 indicate, both morning and evening peak hour volumes generally represent between 8 and 10 percent of the daily volumes. Morning peak hour volumes are about 10 percent lower than evening peak hour volumes, ranging from 5,290 vehicles per hour (vph) (between Exits 1 and 2) to 9,800 vph (between Exits 6 and 7). Evening peak hour volumes range from 6,010 vph (between Exits 1 and 2) to 10,980 vph (between Exits 6 and 7).

The directional flow of traffic is heavier in the westbound direction in the morning for all segments. On average, 65 percent of the morning peak hour traffic is westbound. In the evening, the opposite occurs; traffic is heavier (58 percent of the total evening traffic) in the eastbound direction.

Traffic activity at interchange locations significantly influences I-84 corridor operations. The peak hour on and off-ramp volumes are presented in detail in the Appendix to this report. Due to the heavy directional flow of traffic along I-84, peak hour ramp demands vary from 4.7 percent (Exit 5 eastbound off-ramp) to 22.1 percent (Exit 2 westbound off-ramp) of the daily ramp traffic. In the morning peak travel direction (i.e., westbound), ramp demand varies from 150 vehicles per hour at the Exit 1 on-ramp to 2,500 vph at the Exit 7 on-ramp. In the evening, eastbound ramp demand varies from 100 vph at the Exit 1 off-ramp to 2,300 vph at the Exit 7 off-ramp.

Morning and evening peak hour traffic volumes for mainline segments were provided by ConnDOT and are compared to the daily volumes along the corridor in Table 2-3. These peak periods will be the focus of the capacity and level-of-service (LOS) analyses presented in subsequent sections of this report. These volumes, representing average annual weekday traffic volumes for 1998, are also shown graphically in the Appendix.

Table 2-3
I-84 Peak Hour Volumes- Mainline
1998 Existing Conditions

	Weekday Morning Peak Hour				Weekday Evening Peak Hour			
Segment	Volume (vph)	% of Daily Traffic	Directional Split (vph) EB/WB	Directional Distribution	Volume (vph)	% of Daily Traffic	Directional Split (vph) EB/WB	Directional Distribution
Exit 1 to 2	5,290	7.9	1,980 / 3,310	63% WB	6,010	8.9	3,310 / 2,700	55% EB
Exit 2 to 3	6,150	8.3	1,950 / 4,200	68% WB	7,120	9.6	4,430 / 2,690	62% EB
Exit 3 to 4	8,200	8.6	2,500 / 5,700	70% WB	9,140	9.6	5,680 / 3,460	62% EB
Exit 4 to 5	8,950	8.2	2,800 / 6,150	69% WB	10,060	9.3	6,050 / 4,010	60% EB
Exit 5 to 6	7,900	8.2	2,750 / 5,150	65% WB	9,140	9.5	5,160 / 3,980	56% EB
Exit 6 to 7	9,800	8.4	3,600 / 6,200	63% WB	10,980	9.5	6,030 / 4,950	55% EB
Exit 7 to 8	7,600	9.0	3,050 / 4,550	60% WB	7,650	9.1	4,100 / 3,550	54% EB
Exit 8 to 9	6,250	9.2	2,250 / 4,000	64% WB	6,600	9.7	3,850 / 2,750	58% EB
Exit 9 to 10	5,950	9.2	2,250 / 3,700	62% WB	6,420	9.9	3,650 / 2,770	57% EB
Exit 10 to 11	5,920	9.3	2,220 / 3,700	63% WB	6,140	9.6	3,520 / 2,620	57% EB

Source: ConnDOT

The degree of ramp usage also influences I-84 operations by creating "turbulence" in traffic flow on the mainline. Turbulence occurs when there is a mixture of through traffic with merging, diverging, or weaving traffic. The higher percent of merging, diverging, or weaving traffic as a portion of total traffic, the greater the turbulence. For an on-ramp, the proportion of downstream mainline traffic (including the on-ramp traffic) that just entered the mainline traffic stream indicates the degree of merging activity. The Appendix presents detailed ramp utilization data. This varies along I-84 from 4.5 percent (Exit 1 eastbound) to 45.5 percent (Exit 7 westbound). For an off-ramp, the proportion of upstream mainline traffic (including the off-ramp traffic) that exits the mainline indicates the degree of diverging activity. This varies along the corridor from 3.1 percent (Exit 1 eastbound) to 37.7 percent (Exit 8 eastbound). Field observations verified this level of turbulence in traffic flows in and around Exit 7.

2.2.3 Surface Street Traffic Volumes

Along with the traffic volumes collected on the I-84 mainline and its interchanges, ConnDOT collected morning and evening peak hour traffic volumes at 50 inter-sections throughout the study area. The locations are summarized in the Appendix to this report and were selected due to their proximity to the interstate, or their potential to influence future improvement alternatives. Later sections of this report address the operational characteristics at each of these locations.

2.2.4 Trucks

To quantify truck volumes on I-84, a vehicle classification study was conducted. Vehicle classification counts were taken during typical weekday morning (7:00 AM to 9:00 AM), midday (11:00 AM to 2:00 PM), and evening (4:00 PM to 6:00 PM) periods on the I-84 mainline. These counts were conducted in both directions at the following locations:

- between Exits 2 and 3 (at the Kenosia Avenue Overpass);
- between Exits 6 and 7; and
- between Exits 8 and 9.

Table 2-4 presents the observed data. The detailed classification data were aggregated into three broader vehicle types: cars, light trucks, and heavy trucks. Cars consisted of all passenger vehicles, motorcycles, and two-axle pick-up trucks (FHWA Classes 1, 2, and 3). Light trucks consisted of buses and two-axle trucks with more than four tires (FHWA Classes 4 and 5). Heavy trucks were all trucks with more than two axles (FHWA Class 6 and greater).

The percentage of trucks (light and heavy) in the total traffic stream varies from 4 to 14 percent. For the peak directional flow (i.e., westbound in the morning and eastbound in the evening), truck volumes comprise about 5 percent of the total demand. For off-peak directional flow, truck percentages are somewhat higher—up to 11 percent. During the midday, truck percentages are higher than either morning or evening peak periods, varying from 8 to 14 percent of the total midday traffic demand. Detailed, disaggregated data are provided in the Appendix to this report.

2.2.5 Mainline Speeds

Using the floating car method, a speed study was conducted along the mainline I-84 in the study area. The purpose of this study was to determine the prevailing vehicle speeds through different segments of I-84 during peak and off-peak weekday periods. These data were also collected to determine trends during specific periods. For each direction, three observations of the study area corridor were taken during three periods of the day (the morning, midday, and evening peak period). An observer recorded travel times between exits while maintaining the speed of the adjacent traffic stream.

Posted speed limits on I-84 in the study area vary from 50 to 65 mph. Between Exits 3 and 4 and Exits 7 and 8, speed limits are posted at 50 mph. Horizontal and vertical roadway curvature and the presence of closely spaced interchanges and ramps at these locations result in lower speed limits.

Table 2-4
Vehicle Classification Study Results

Count Location	Morning Peak Hour	Midday Peak Hour	Evening Peak Hour
Between Exits 2 and 3 EB			
Cars*	89%	86%	94%
Light Trucks**	3%	4%	2%
Heavy Trucks***	8%	10%	4%
Between Exits 2 and 3 WB			
Cars	95%	92%	89%
Light Trucks	2%	3%	2%
Heavy Trucks	3%	5%	9%
Between Exits 6 and 7 EB			
Cars	95%	90%	96%
Light Trucks	2%	4%	2%
Heavy Trucks	3%	6%	2%
Between Exits 6 and 7 WB			
Cars	95%	92%	93%
Light Trucks	2%	3%	2%
Heavy Trucks	3%	5%	5%
Between Exits 8 and 9 EB			
Cars	89%	86%	94%
Light Trucks	3%	4%	2%
Heavy Trucks	8%	10%	4%
Between Exits 8 and 9 WB			
Cars	93%	90%	89%
Light Trucks	3%	4%	2%
Heavy Trucks	4%	6%	9%

Source: Classification data collected by VN Engineers in February 1999.
* "Cars" include FHWA Classes 1, 2, and 3 (including motorcycles and light pick-up trucks).
** "Light Trucks" include FHWA Classes 4, and 5 (buses and two-axle trucks with more than 4 tires).
*** "Heavy Trucks" include FHWA Classes 6 or greater (trucks with more than two axles).

The data collected is presented in the Appendix, and indicates that average eastbound and westbound speeds were approximately 65 mph. Highest speeds were observed between Exits 5 and 6, with 71 mph in the westbound direction during the midday. Westbound speeds between Exits 3 and 4 dropped below 55 mph during both morning and evening peaks while midday speeds were above 65 mph, indicating constrained flow during both peak periods.

In the eastbound direction, low vehicle speeds were observed between Exits 7 and 8 for all three periods, dropping below 50 mph in the evening period. In the westbound direction, vehicle speeds were consistently lower than free flow speed between Exits 3 and 4, averaging below 55 mph in the morning and evening peak periods.

In general, midday speeds in the eastbound direction were similar to those in the westbound direction for all segments of I-84. In the morning and evening periods,

speeds were notably different in each direction for a specific segment, indicating congested flow in one direction only. This is especially true in the evening peak period when speeds dropped to about 50 mph on two segments, between Exits 3 and 4 westbound and between Exits 7 and 8 eastbound. At these segments, speeds in the opposite direction were consistently above 60 mph.

2.3 Geometrics

The study section of I-84 was originally constructed in 1958 and consisted of a two-lane cross-section from the Housatonic River to Exit 11, and a four-lane cross-section from Exit 11 to the New York state line, a total distance of approximately 18.5 miles. Since that time a number of improvements have been made to increase the capacity of the corridor. In 1973, the section of I-84 between the Housatonic River and Exit 11 was widened to a four-lane cross-section, and the Exit 11 interchange was relocated to the east to provide a high-speed/high-capacity connection to a proposed Route 25 expressway. In the early 1980's, a third westbound lane was added between Exit 1 and Exit 3, a third eastbound lane was added between Exit 2 and Exit 3, a new Exit 1 was constructed at Saw Mill Road, and the old Exit 1 interchange was reconstructed and renamed Exit 2. Most recently, in 1988, I-84 was widened from a four-lane cross-section to a six-lane cross-section between Exit 4 and Exit 7.

Since the highway was originally constructed, traffic volumes on I-84 and the adjacent highways have increased dramatically and, as such, interchanges that were designed to the standards of the time have developed capacity, geometry, and safety problems today. Capacity issues at the ramps have begun to affect mainline operating conditions. These heavy traffic demands coupled with geometric deficiencies increase the potential for safety problems. Accordingly, and as part of this study, each interchange was evaluated with regard to its conformance to current design standards. This includes the lengths of acceleration and deceleration lanes, design speeds of the ramps, and ramp capacities.

2.3.1 Methodology/Review of Geometrics

There are 43 ramps (22 on-ramps and 21 off-ramps) within the eleven interchanges located along I-84 within the project limits. These ramps provide access between I-84 and the local roadways and state highway system.

Each of the on-ramps was evaluated to determine if adequate acceleration length is provided based on the radius of the curve of the ramp. The radius of the curve dictates the ramp speed. Based on the speed differential between the ramp speed and the I-84 mainline, a minimum acceleration length can be determined.

The loop-type off-ramps were also evaluated with respect to the radius of the curve of the ramp. The minimum deceleration length required is based on the speed differential between the speed on the curve of the off-ramp and the mainline speed. Additionally, the ramp design speed was compared to the mainline design speed.

Based on AASHTO design standards, the design speed for a ramp should not be less than one-half the design speed of the highway.

The remaining off-ramps were analyzed in a similar fashion, with the addition of a closer examination of the ramp length at locations where a signal is located at the base of the ramp. A comparison of the total length required when the maximum queue length at the signal is added to the length required to decelerate from 65 mph to 0 mph was made to the total ramp length. This evaluation shows where inadequate storage lengths on the off-ramps affect deceleration lengths. The results of the analysis are summarized in Tables 2-5 and 2-6 and shown in Figure 2-2.

Table 2-5
I-84 On-Ramp Locations—Geometric Assessment

Location	Ramp Design Speed (mph)	AASHTO/ConnDOT Minimum Acceleration Length (Ft.) 65 mph Design Speed	AASHTO/ConnDOT Minimum Acceleration Length (Ft.) 70 mph Design Speed	Actual	Comments
Exit 1 Eastbound	50	375	NA	1015 Ft.	
Exit 1 Westbound	50	375	NA	1150 Ft.	
Exit 2 Eastbound	50	375	NA	A	
Exit 2 Eastbound	50	375	NA	500 Ft.	
Exit 2 Westbound	50	1380*	NA	1400 Ft.	
Exit 3 Eastbound	50	375	NA	A	
Exit 3 Westbound	50	375	NA	A	
Exit 4 Eastbound	35	1015	NA	550 Ft.	Acceleration length shorter than required
Exit 4 Westbound	45	615	NA	1000 Ft.	
Exit 5 Eastbound	50	1380*	NA	1300 Ft.	Acceleration length shorter than required
Exit 5 Westbound	45	615	NA	600 Ft.	Acceleration length shorter than required
Exit 6 Eastbound	45	615	NA	575 Ft.	Acceleration length shorter than required
Exit 7 Eastbound	45	615	NA	A	
Exit 7 Westbound	50	375	NA	A	
Exit 8 Eastbound	45	615	NA	575 Ft.	Acceleration length shorter than required
Exit 8 Westbound	45	615	NA	B	
Exit 9 Eastbound	45	NA	830	550 Ft.	Acceleration length shorter than required
Exit 9 Westbound	25	NA	1410	700 Ft.	Acceleration length shorter than required ramp; Design speed less than ½ mainline speed
Exit 10 Eastbound	35	NA	1230	C	
Exit 10 Westbound	35	NA	1230	730 Ft.	Acceleration length shorter than required
Exit 11 Eastbound	50	NA	580	1000 Ft.	
Exit 11 Westbound	45	NA	830	D	

Source: VHB and ConnDOT.
* Acceleration length based on acceleration from 0 mph to 65 mph as critical curve speed is greater than 50 mph
A Acceleration lane continues as third lane of mainline
B Acceleration lane continues as Auxiliary lane between Exit 8 and Exit 7
C Acceleration lane continues as Auxiliary lane between Exit 10 and Exit 11
D Acceleration lane continues as Auxiliary lane between Exit 11 and Exit 10
NA Not Applicable
Note: Segments in bold are deficient.

Table 2-6
I-84 Off-Ramp Locations—Geometric Assessment

Loop Ramps:

Location	Ramp Design Speed (mph)	One-half Mainline Speed (Y/N) [A]	AASHTO/ConnDOT Minimum Deceleration Length (Ft.)		Actual (Ft.)	Comments
			65 mph Design Speed	70 mph Design Speed		
Exit 2 Westbound	25	N[B]	280	NA	1050	Ramp design speed (25 mph) less than ½ mainline speed
Exit 4 Eastbound	25	N[B]	330	NA	150	Ramp design speed (25 mph) less than ½ mainline speed; Deceleration length shorter than required
Exit 10 Eastbound	25	N[B]	NA	510	760	Ramp design speed (25 mph) less than ½ mainline speed
Exit 10 Westbound	25	N[B]	NA	490	C	Ramp design speed (25 mph) less than ½ mainline speed

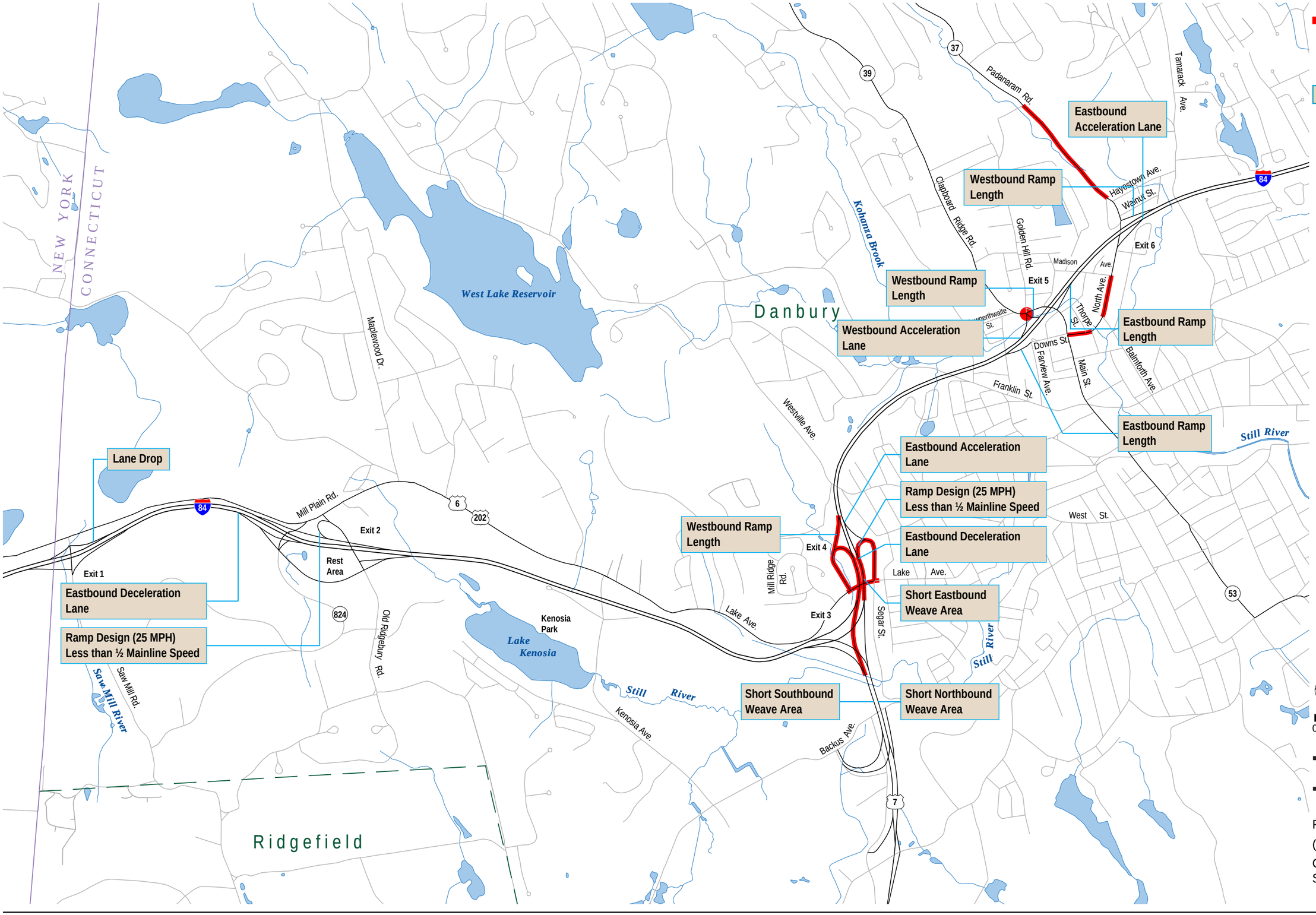
Slip Ramps:

Location	Ramp Design Speed (mph)	AASHTO/ConnDOT Minimum Deceleration Length (Ft.)		Actual (Ft.)	Total Ramp Length (Ft.)	Estimated Queue Length[D] (Ft.)	Comments
		65 mph to 0	70 mph to 0				
Exit 1 Eastbound	50	280[E]	NA	400	1400	25	
Exit 1 Westbound	50	280[E]	NA	H	1600	100	
Exit 2 Eastbound	50	280[E]	NA	200	1650	50	Deceleration length less than minimum
Exit 2 Westbound	50	280[E]	NA	2100	2100	125	
Exit 3 Eastbound	50	280[E]	NA	H	F	F	
Exit 3 Westbound	50	280[E]	NA	H	F	F	
Exit 4 Westbound	40	380[E]	NA	300	2050	550	Queue length + deceleration length greater than ramp length
Exit 5 Eastbound	45	570	NA	300	925	400	Queue length + deceleration length greater than ramp length
Exit 5 Westbound	45	570	NA	150	640	650	Queue length + deceleration length greater than ramp length
Exit 6 Westbound	45	570	NA	250	875	650	Queue length + deceleration length greater than ramp length
Exit 7 Eastbound	50	280[E]	NA	H	G	G	
Exit 7 Westbound	45	330[E]	NA	H	G	G	
Exit 8 Eastbound	45	570	NA	I	1000	675	Queue length + deceleration length greater than ramp length
Exit 8 Westbound	45	330[E]	NA	150	1250	200	Deceleration length less than desired
Exit 9 Eastbound	45	NA	615	150	750	175	Queue length + deceleration length greater than ramp length
Exit 9 Westbound	45	NA	615	150	1150	275	Deceleration length less than desired
Exit 11 Eastbound	50	NA	340[E]	J	>2000	680	
Exit 11 Westbound	50	NA	340[E]	390	>2000	680	

Source: VHB and ConnDOT.

A Design speed of ramp should not be less than one half the mainline speed
B Design speed of ramp is 25 mph
C Deceleration lane part of auxiliary lane from Exit 11 to Exit 10
D Based on results of the capacity analysis
E Length to decelerate from 65 mph to critical ramp speed
F Off-ramp is a direct connection to Route 7 southbound
G Off-ramp is a direct connection to Route 7 northbound
H Deceleration lane is an EXIT ONLY lane from mainline
I Deceleration lane part of auxiliary lane between Exit 7 and Exit 8
J Deceleration lane part of auxiliary lane between Exit 10 and Exit 11
NA Not Applicable

Note: Segments in bold are deficient.



I-84 Exits 1-11

Figure 2-2
(Sheet 1 of 3)
Corridor Geometric and Safety Review

High Accident Location

Location Does Not Meet Current AASHTO Standards

Brookfield

Danbury

Bethel

Newtown

Westbound Deceleration Lane

Westbound Acceleration Lane

Short Westbound Weave Area

Westbound Ramp Length

Eastbound Ramp Length

Eastbound Acceleration Lane

Short Eastbound Weave Area

Eastbound Ramp Length

Eastbound Acceleration Lane

Still River

Beaver Brook

Stony Hill Brook

Pogond Brook

Federal Rd.

White Turkey Rd Ext.

Vail Rd.

Stony Hill Rd.

Secor Rd.

Obtuse Rd.

Old Hawleyville Rd.

Mountain View Ter.

Pocono La.

Sky Edge

Old Sherman Trpk.

Payne Rd.

Eagle Rd.

Great Plain Rd.

Old Brookfield Rd.

Newtown Rd.

Mt. Pleasant Rd.

Exit 7

Exit 8

Exit 9

202

7

25

84

6

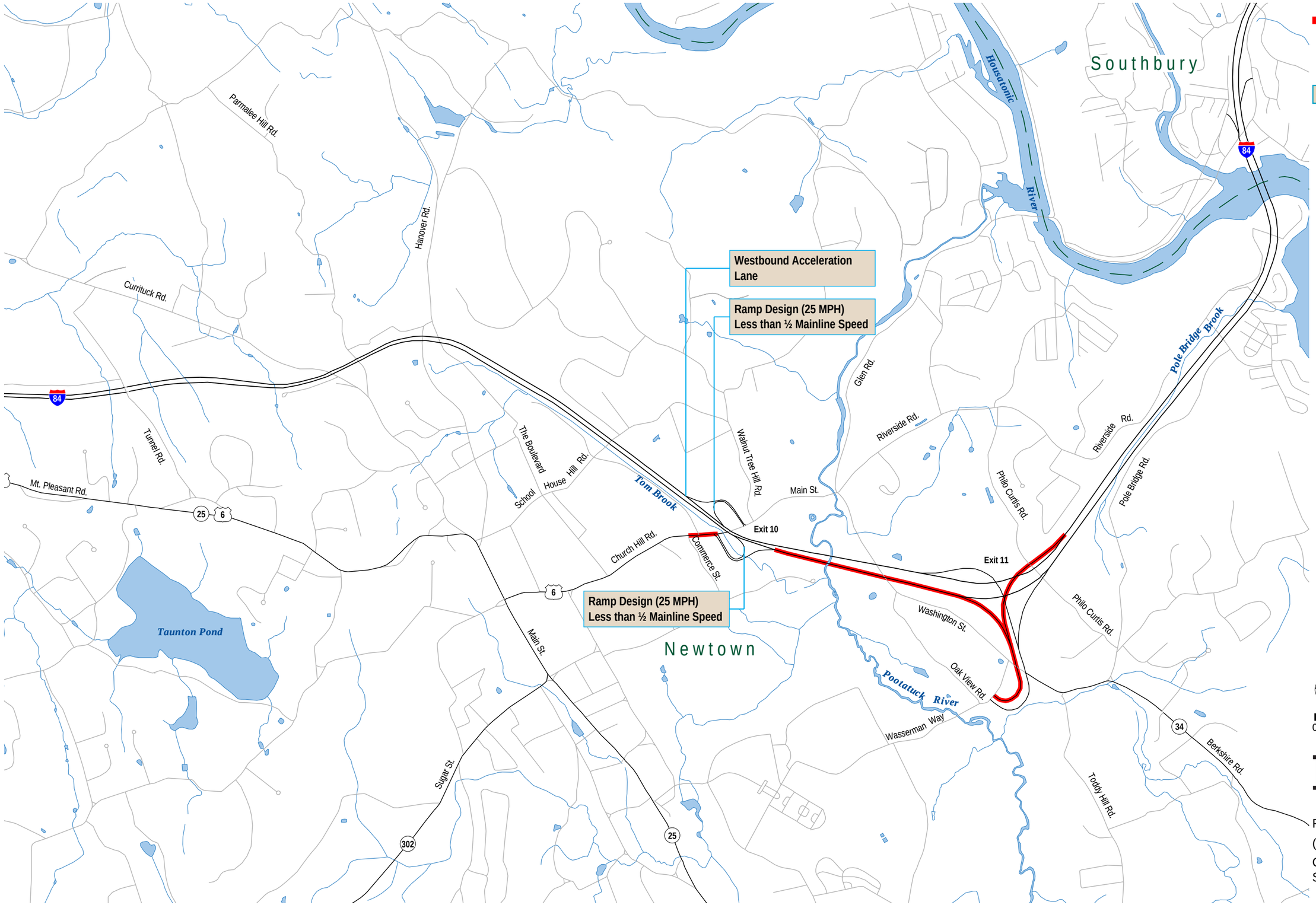
0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-2

(Sheet 2 of 3)

Corridor Geometric and Safety Review



High Accident Location

Location Does Not Meet Current AASHTO Standards

0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-2
(Sheet 3 of 3)
Corridor Geometric and Safety Review

Based on the analysis presented previously it is evident that a number of the ramps within the I-84 study area do not meet current design standards. Many of the on-ramps beyond Exit 2 have acceleration lanes that do not meet current design standards with the exception of the Exit 4 westbound ramp, the Exit 8 westbound ramp, the Exit 10 westbound ramp and both Exit 11 ramps. All of the loop-type off-ramps have a ramp design speed less then one-half the mainline speed, and the Exit 4 eastbound ramp has an insufficient deceleration length. Of the remaining off-ramps, the Exit 2 eastbound ramp, the Exit 4 westbound ramp, the Exit 8 westbound ramp, and the Exit 9 westbound ramp have deceleration lanes that are less than standard. Additionally, the Exit 5 ramps, the Exit 6 westbound ramp, the Exit 8 eastbound ramp, and the Exit 9 eastbound ramp are not long enough to accommodate the expected queue from the signal at the base of the ramp and still have enough remaining length to allow a vehicle to safely decelerate from 65 mph to a stop.

2.3.2 Interchange Spacing

In addition to the geometric review of the individual ramps, the spacing of the ramps between interchanges was evaluated. It is important to have adequate space between ramps to provide sufficient maneuvering length for vehicles to enter and exit from the main traffic stream and to provide adequate space for advance signing for the exits. The results of the ramp spacing analysis are shown in Table 2-7.

As the table indicates, there is only one location in both the eastbound and west-bound direction where the existing ramp spacing does not meet current design standards. In the eastbound direction, the distance between the Exit 3 on-ramp and the Exit 4 off-ramp is approximately 760 feet shorter than the current standard, and in the westbound direction, the distance between the Exit 4 on-ramp and the Exit 3 off-ramp is approximately 720 feet shorter than the current standard. It should be noted that although the distance between Exit 3 and 4 in the westbound direction is shorter than desired, the on-ramp traffic from Exit 4 is prevented from merging with the mainline traffic until the I-84 mainline is beyond Exit 3, thus preventing Exit 4 on-ramp traffic from exiting at Exit 3.

The table also indicates that there are a few additional locations in both the eastbound and westbound directions that are approaching the minimum recommended spacing guidelines. These locations include:

Eastbound

- The distance between the Exit 4 off-ramp and the Exit 4 on-ramp is approximately 150 feet greater than the minimum recommended distance.

- The distance between the Exit 10 off-ramp and the Exit 10 on-ramp is approximately 30 feet greater than the minimum recommended distance.

Table 2-7
I-84 Ramp Distances

Location	Upstream Distance (Feet)	Upstream Type	AASHTO Recommended (Feet)	Downstream Distance (Feet)	Downstream Type	AASHTO Recommended (Feet)
Eastbound						
Exit 1 Off Ramp	N/A	N/A	N/A	1380	On	500
Exit 1 On Ramp	1380	Off	500	3530	Off	1600
Exit 1 On Ramp	1380	Off	500	3530	Off	1600
Exit 2 Off Ramp	3530	On	1600	1990	On	500
Exit 2 On Ramp	1990	Off	500	1790	On	1000
Exit 2 On Ramp	1790	On	1000	9730	Off	1600
Exit 3 Off Ramp	9730	On	1600	1380	On	500
Exit 3 On Ramp	1380	Off	500	1240	Off	2000
Exit 4 Off Ramp	1240	On	2000	650	On	500
Exit 4 On Ramp	650	Off	500	6070	Off	1600
Exit 5 Off Ramp	6070	On	1600	2010	On	500
Exit 5 On Ramp	2010	Off	500	2160	On	1000
Exit 6 On Ramp	2160	On	1000	7770	Off	1600
Exit 7 Off Ramp	7770	On	1600	1600	On	500
Exit 7 On Ramp	1600	Off	500	2440	Off	2000
Exit 8 Off Ramp	2440	On	2000	1930	On	500
Exit 8 On Ramp	1930	Off	500	14690	Off	1600
Exit 9 Off Ramp	14690	On	1600	1660	On	500
Exit 9 On Ramp	1660	Off	500	17850	Off	1600
Exit 10 Off Ramp	17850	On	1600	530	On	500
Exit 10 On Ramp	530	Off	500	4450	Off	1600
Exit 11 Off Ramp	4450	On	1600	1760	On	500
Exit 11 On Ramp	1760	Off	500	N/A	N/A	N/A
Westbound						
Exit 1 Off Ramp	3450	On	1600	2060	On	500
Exit 1 On Ramp	2060	Off	500	N/A	N/A	N/A
Exit 2 Off Ramp	10320	On	2000	2490	On	500
Exit 2 On Ramp	2490	Off	500	3450	Off	1600
Exit 3 Off Ramp	1280	On	2000	1170	On	500
Exit 3 On Ramp	1170	Off	500	10320	Off	2000
Exit 4 Off Ramp	6450	On	1600	650	On	500
Exit 4 On Ramp	650	Off	500	1280	Off	2000
Exit 5 Off Ramp	3240	Off	1000	600	On	500
Exit 5 On Ramp	600	Off	500	6450	Off	1600
Exit 6 Off Ramp	7950	On	2000	3240	Off	1000
Exit 7 Off Ramp	2270	On	1600	1570	On	500
Exit 7 On Ramp	1570	Off	500	7950	Off	2000
Exit 8 Off Ramp	14700	On	1600	3120	On	500
Exit 8 On Ramp	3120	Off	500	2270	Off	1600
Exit 9 Off Ramp	16440	On	1600	650	On	500
Exit 9 On Ramp	650	Off	500	14700	Off	1600
Exit 10 Off Ramp	4600	On	1600	520	On	500
Exit 10 On Ramp	520	Off	500	16440	Off	1600
Exit 11 Off Ramp	N/A	N/A	N/A	3090	On	500
Exit 11 On Ramp	3090	Off	500	4600	Off	1600

Note: Boldface entries denote inadequate, or close to inadequate distances between ramps.

Westbound

- The distance between the Exit 4 off-ramp and the Exit 4 on-ramp is approximately 150 feet greater than the minimum recommended distance.
- The distance between the Exit 5 off-ramp and the Exit 5 on-ramp is approximately 100 feet greater than the minimum recommended distance.
- The distance between the Exit 9 off-ramp and the Exit 9 on-ramp is approximately 150 feet greater than the minimum recommended distance.
- The distance between the Exit 10 off-ramp and the Exit 10 on-ramp is approximately 20 feet greater than the minimum recommended distance.

2.3.3 Other Geometric Issues

The above analysis has indicated that there are a number of locations that do not meet current design standards. In addition to those areas identified previously, there are also other geometric issues that, while they meet current design standards, are causing operational difficulties along I-84. The first is the left-handed entrance and exit ramps at Exit 3 and Exit 7. Although AASHTO standards do not classify left-hand ramps as a design deficiency, the existence of left-handed entrance and exit ramps is contrary to driver expectancy, especially when the left-handed ramps are intermixed among a series of interchanges with conventional right-handed exits. The indecision that is created by the left-handed ramps produces driver confusion and creates hesitant operations on the highway.

A second issue is the truck climbing lane merges affecting mainline operations. There are three truck climbing lanes in both the eastbound and westbound direction between Exit 8 and Exit 11. In each location, the mainline consists of two lanes in each direction that are approaching capacity. Due to the inadequate capacity of the mainline, when the truck climbing lanes end and trucks attempt to merge back into the mainline traffic stream, additional turbulence is created within the mainline traffic stream and traffic operations and safety issues result.

2.4 Existing Traffic Operations

The next step in the study process was to evaluate the operations of the study area roadway system. This analysis provides a technical assessment of the operational qualities of the ramps, freeways, weaving sections, and intersections using the procedures documented in the *1994 Highway Capacity Manual* [2] and compares them with the hourly traffic demand volumes. The traffic analysis was conducted using the 1998 morning and evening peak hour traffic volumes, as previously discussed,

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2 Special Report 209 – Highway Capacity Manual, Third Edition; Transportation Research Board, National Research Council; Washington D.C. 1994

and the geometric design conditions as they currently exist along the study area roadways.

Understanding the relationship between the supply and demand on a roadway is a fundamental consideration in evaluating how well a transportation facility fulfills its objective to safely and efficiently accommodate the travelling public. The traffic operations analysis procedures used to evaluate the I-84 study area roadways assigns a level-of-service (LOS) rating for each specific segment, intersection, or area of roadway analyzed. LOS is a qualitative measurement of the operating conditions of a roadway facility or intersection taking into account a number of variables such as speed, vehicle maneuverability, driver comfort, and safety. Similar to a report card, LOS designations are letter based, ranging from A to F, with LOS A representing the best operating condition and LOS F representing the worst operating condition. LOS A represents free flow conditions and LOS E and F represent conditions where demands approach or are at the available capacity.

The Highway Capacity Manual does not present a recommended LOS for design purposes, rather it offers a description of the conditions associated with each level of service. For example, LOS C is described in the manual with key words and phrases such as "stable operations," "traffic stream is notably affected," "lane change requires additional care," and a noticeable increase in (driver) tension." As conditions deteriorate to LOS D, the HCM describes conditions with words such as "unstable flow," average travel speeds are noticeably reduced," freedom to maneuver is severely limited," and "drastically reduced physical and psychological (driver) comfort."

2.4.1 Methodology/Criteria

As stated, the criteria used to evaluate the I-84 roadway capacity were based on the methodology presented in the *1994 Highway Capacity Manual.* The HCM presents various methods for evaluating traffic operations for various types of roadway facilities. The criteria presented in the HCM is based on 44 years of research into traffic operations and traffic flow and is considered by the traffic engineering community as the tool of choice for analyzing traffic operations. The HCM is broken into a number of chapters that evaluate different transportation facilities. Specifically for the I-84 study, the following chapters were considered in the evaluation of the study area transportation facilities:

- Chapter 3 (Basic Freeway Sections),
- Chapter 4 (Weaving Areas),
- Chapter 5 (Ramps and Ramp Junctions),
- Chapter 6 (Freeway Systems),
- Chapter 9 (Signalized Intersections), and
- Chapter 10 (Unsignalized Intersections)

All of these chapters were used to define the operating conditions for the various traffic conditions and traffic volumes experienced along I-84 and the study area roadways. The following sections provide a summary of the existing conditions for each of the study area facilities.

2.4.2 Mainline Operations

The procedures for analyzing the operational conditions of the I-84 mainline are based on analysis procedures presented in Chapter 3 (Basic Freeway Sections) of the *Highway Capacity Manual.* The HCM procedure for analyzing freeway sections uses a number of factors including the traffic volumes on the analysis segment, the number of lanes in the analysis section, the width of those lanes, the percentage of trucks in the traffic stream, the lateral clearance to obstructions along side the road, the free-flow speed on the analysis segment, the terrain of the segment, and the driver population (primarily commuters, or some mix of recreational and commuter).

Levels of service for freeway sections are defined in terms of density and are measured in passenger cars per mile per lane (pc/mi/ln). LOS A would describe a freeway segment where vehicles are operating at free-flow speeds, vehicle maneuverability is relatively unimpeded, and densities are less than 10 pc/mi/ln. LOS C would describe a freeway where vehicles are operating close to or at free-flow speeds, maneuverability is becoming noticeably restricted but is possible with diligence, and densities are between 16 and 24 pc/mi/ln. At LOS E, the freeway segment is operating at capacity, maneuverability is severely restricted, and densities are highly variable due to potential volatility of the congestion but are greater than 37 pc/mi/ln. At LOS F, the traffic volume on the freeway segment exceeds the capacity of that segment.

The results of the freeway segment analysis under existing traffic conditions are summarized in Table 2-8 and illustrated on Figures 2-3 and 2-4. The tables show each segment of I-84 within the study area that was evaluated, the number of travel lanes in that segment, the general terrain type of each freeway segment, the existing peak AM and PM peak hour traffic volumes, and the corresponding levels of service.

Eastbound Freeway Segments

During the morning peak hour, the eastbound direction of I-84 is generally operating at acceptable levels from the New York State Line to the Housatonic River. All analyzed segments are operating at a LOS C or better except for the segment between Exit 7 and Exit 8, which is operating at a LOS E.

During the evening peak hour, there are eight segments of the twelve studied that are operating under congested conditions. The I-84 segments from Exit 5 to Exit 6, and from Exit 9 to the Housatonic River are operating at a LOS E. Additionally, the segments of I-84 from Exit 4 to Exit 5 and Exit 6 to Exit 9 are operating at a LOS F. Three of the remaining four segments are approaching capacity and are operating at a LOS D.

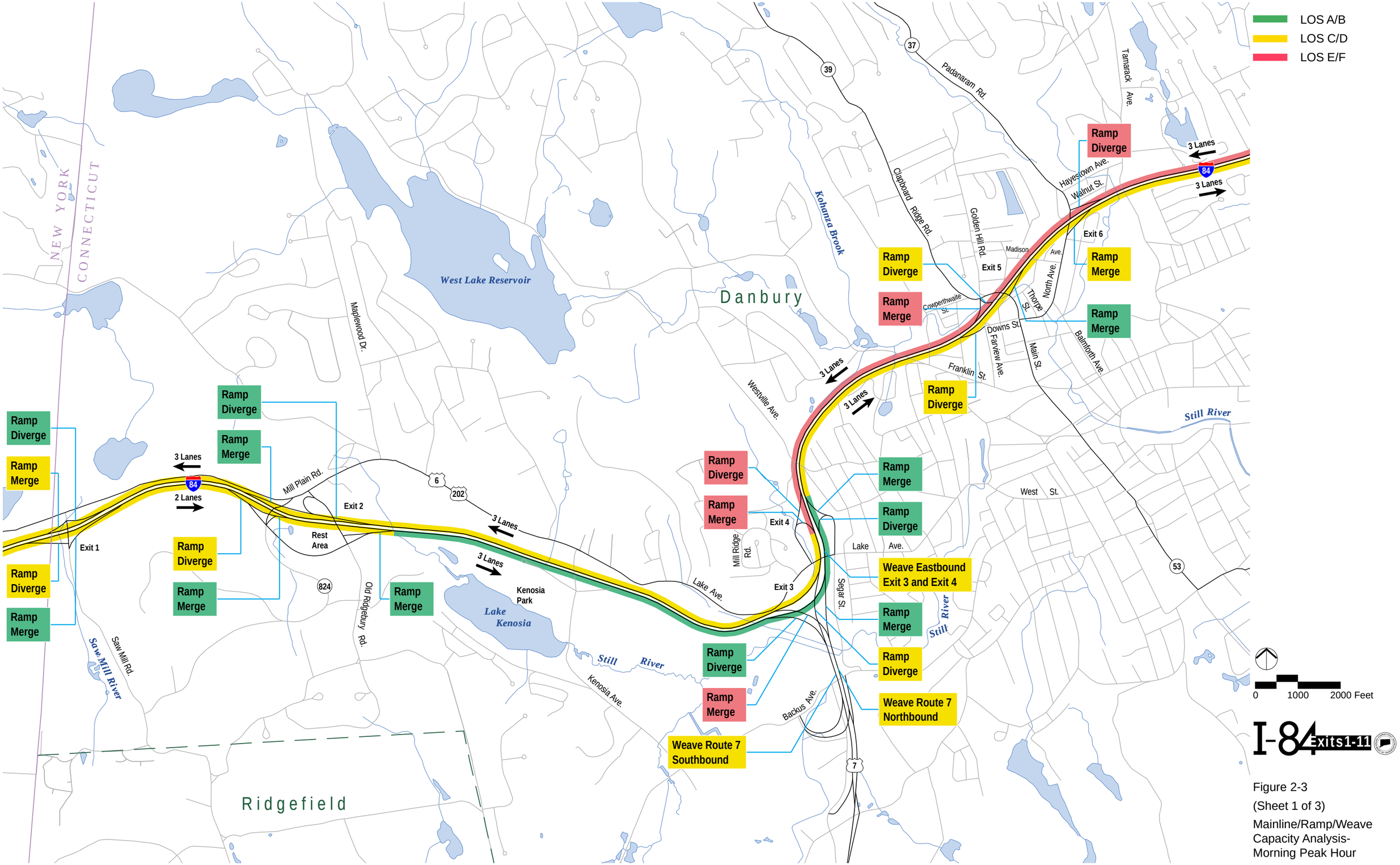

Figure 2-3

(Sheet 1 of 3)

Mainline/Ramp/Weave Capacity Analysis- Morning Peak Hour

Note: Number of mainline lanes referred to are general purpose lanes and do not include slow vehicle lanes at upgrades.

ts.40239.figures.40239i84.p65

LOS A/B
LOS C/D
LOS E/F

Brookfield
Danbury
Bethel
Newtown

Ramp Merge
Ramp Diverge
Ramp Merge
Ramp Diverge
Ramp Diverge
Ramp Merge
Ramp Merge
Weave Eastbound Exit 7 to Exit 8
Ramp Diverge
Weave Westbound Exit 8 to Exit 7
Ramp Merge
Ramp Diverge
Ramp Merge
Ramp Diverge
Ramp Merge

Exit 7
Exit 8
Exit 9

3 Lanes
2 Lanes
2 Lanes
3 Lanes
3 Lanes
3 Lanes
3 Lanes
2 Lanes
2 Lanes

Federal Rd.
Still River
White Turkey Rd. Ext.
Beaver Brook
Great Plain Rd.
Old Brookfield Rd.
Mountain View Ter.
Pocono La.
Vail Rd.
Stony Hill Rd.
Secor Rd.
Obtuse Rd.
Old Hawleyville Rd.
Pogond Brook
Mt. Pleasant Rd.
Eagle Rd.
Stony Hill Brook
Old Sherman Trpk.
Payne Rd.
Newtown Rd.
Still River

202
7
25
84
6

0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-3
(Sheet 2 of 3)
Mainline/Ramp/Weave Capacity Analysis-
Morning Peak Hour

Note: Number of mainline lanes referred to are general purpose lanes and do not include slow vehicle lanes at upgrades.

ts.40239.figures.40239i84.p65

LOS A/B
LOS C/D
LOS E/F

Southbury
Newtown
Housatonic River
Pole Bridge Brook
Tom Brook
Pootatuck River
Taunton Pond

Parmalee Hill Rd.
Hanover Rd.
Currituck Rd.
Tunnel Rd.
Mt. Pleasant Rd.
The Boulevard
School House Hill Rd.
Church Hill Rd.
Commerce St.
Main St.
Sugar St.
Walnut Tree Hill Rd.
Main St.
Glen Rd.
Riverside Rd.
Riverside Rd.
Philo Curtis Rd.
Pole Bridge Rd.
Philo Curtis Rd.
Washington St.
Oak View Rd.
Wasserman Way
Todd Hill Rd.
Berkshire Rd.

2 Lanes
2 Lanes
3 Lanes
2 Lanes
3 Lanes
3 Lanes

Ramp Merge
Ramp Diverge
Ramp Diverge
Ramp Merge
Ramp Diverge
Ramp Merge
Ramp Diverge
Ramp Merge
Ramp Merge

Exit 10
Exit 11

84
25
6
302
34

0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-3
(Sheet 3 of 3)
Mainline/Ramp/Weave Capacity Analysis-
Morning Peak Hour

Note: Number of mainline lanes referred to are general purpose lanes and do not include slow vehicle lanes at upgrades.

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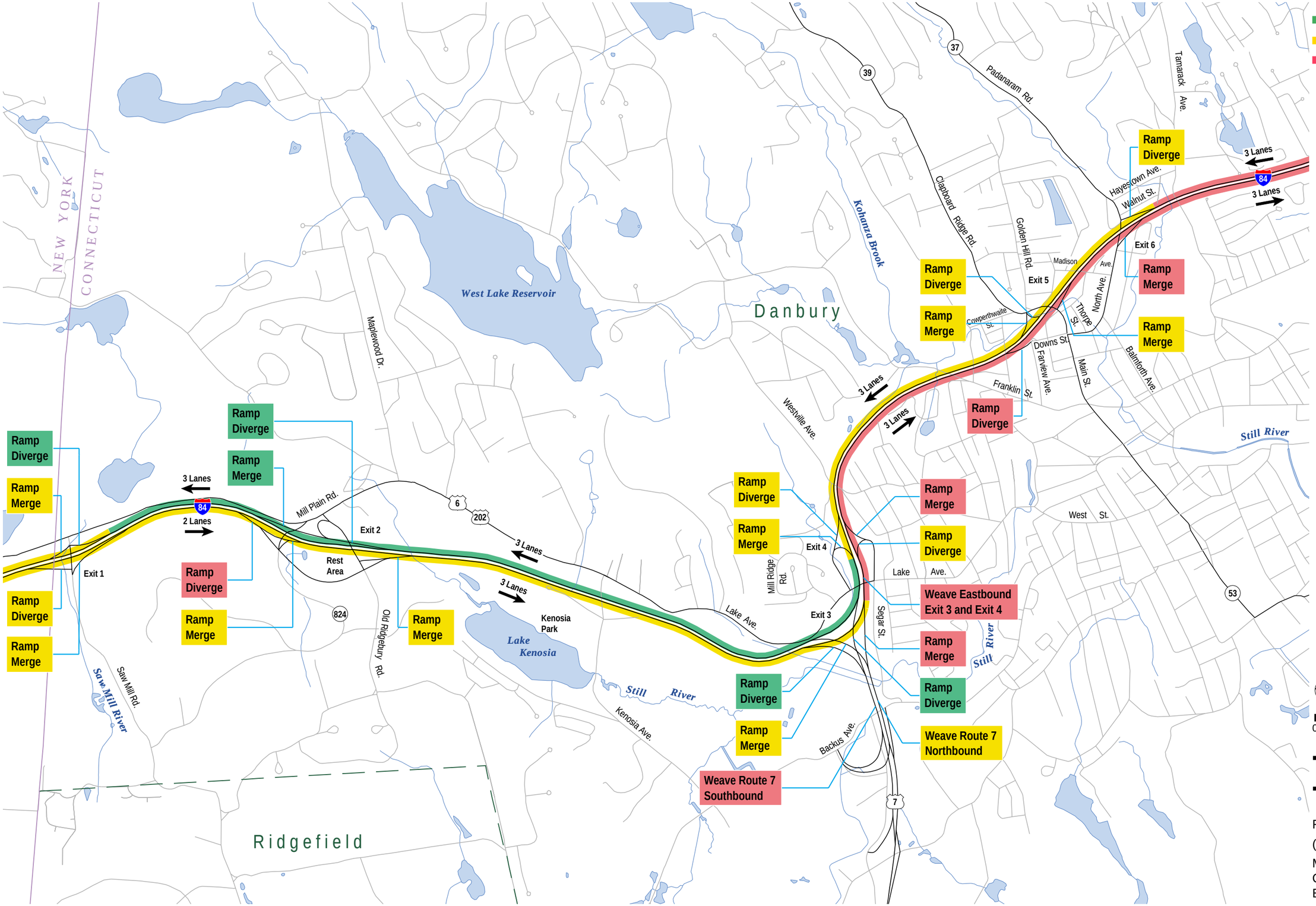


I-84 Exits 1-11

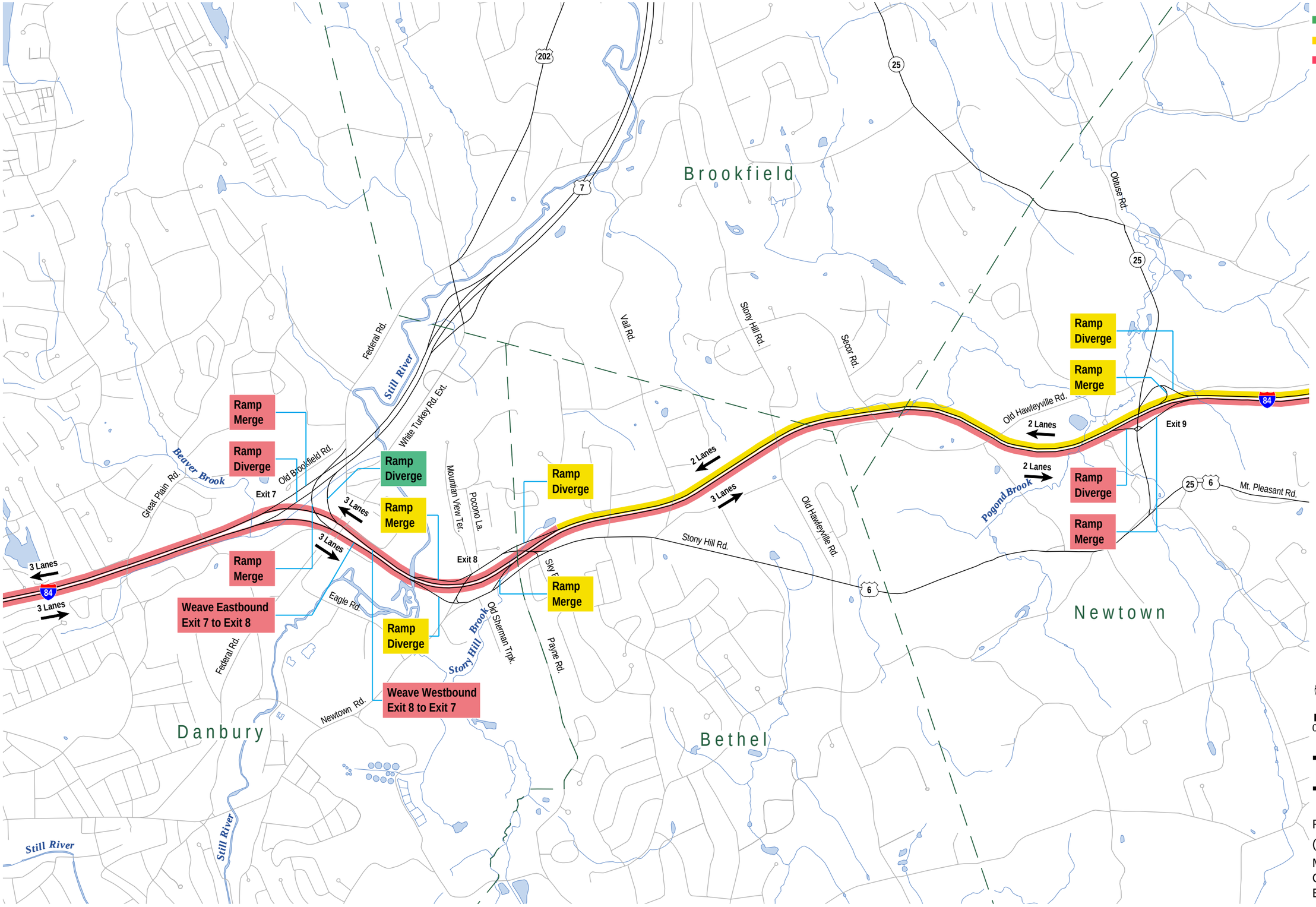
Figure 2-4

(Sheet 1 of 3)

Mainline/Ramp/Weave Capacity Analysis- Evening Peak Hour

Note: Number of mainline lanes referred to are general purpose lanes and do not include slow vehicle lanes at upgrades.

ts.40239.figures.40239i84.p65



I-84 Exits 1-11

Figure 2-4
(Sheet 2 of 3)
Mainline/Ramp/Weave Capacity Analysis-
Evening Peak Hour

Note: Number of mainline lanes referred to are general purpose lanes and do not include slow vehicle lanes at upgrades.

LOS A/B
LOS C/D
LOS E/F

Southbury
Newtown
Housatonic River
Pole Bridge Brook
Tom Brook
Pootatuck River
Taunton Pond
Parmalee Hill Rd.
Hanover Rd.
Currituck Rd.
Tunnel Rd.
Mt. Pleasant Rd
The Boulevard
School House Hill Rd.
Church Hill Rd.
Commerce St.
Main St.
Sugar St.
Walnut Tree Hill Rd.
Main St.
Glen Rd.
Riverside Rd.
Riverside Rd.
Philo Curtis Rd.
Pole Bridge Rd.
Philo Curtis Rd.
Washington St.
Oak View Rd.
Wasserman Way
Toddy Hill Rd.
Berkshire Rd.
2 Lanes
2 Lanes
3 Lanes
2 Lanes
3 Lanes
3 Lanes
Exit 10
Exit 11
Ramp Merge
Ramp Diverge
Ramp Diverge
Ramp Merge
Ramp Diverge
Ramp Merge
Ramp Diverge
Ramp Merge
84
25
6
302
34

0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-4
(Sheet 3 of 3)
Mainline/Ramp/Weave
Capacity Analysis-
Evening Peak Hour

Note: Number of mainline lanes referred to are general purpose lanes and do not include slow vehicle lanes at upgrades.

ts.40239.figures.40239i84.p65

Table 2-8
Summary of Freeway Segment Analysis
1998 Existing Conditions

Segment Description		Terrain	Number of Lanes*	Peak Hour	Level of Service	1998 Volumes (vph)
I-84 Eastbound						
From	To					
New York State Line	Exit 1	Level	2	AM	C	2030
				PM	D	3260
Exit 1	Exit 2	Level	2	AM	C	1980
				PM	D	3310
Exit 2	Exit 3	Level	3	AM	B	1950
				PM	C	4200
Exit 3	Exit 4	Rolling	4	AM	B**	2500
				PM	D**	5700
Exit 4	**Exit 5**	Rolling	3	AM	C	2800
				PM	F	6150
Exit 5	**Exit 6**	Rolling	3	AM	C	2750
				PM	E	5150
Exit 6	**Exit 7**	Rolling	3	AM	C	3600
				PM	F	6200
Exit 7	**Exit 8**	Rolling	2	AM	E	3050
				PM	F	4550
Exit 8	**Exit 9**	Rolling	2	AM	C	2250
				PM	F	4000
Exit 9	**Exit 10**	Rolling	2	AM	C	2250
				PM	E	3700
Exit 10	**Exit 11**	Rolling	2	AM	C	2220
				PM	E	3700
Exit 11	**Housatonic River**	Rolling	2	AM	C	2020
				PM	E	3450
I-84 Westbound						
New York State Line	Exit 1	Level	2	AM	D	3240
				PM	C	2730
Exit 1	Exit 2	Level	3	AM	C***	3310
				PM	B***	2700
Exit 2	Exit 3	Level	3	AM	D	4430
				PM	B	2690
Exit 3	Exit 4	Rolling	4	AM	C	5300
				PM	B	3260
Exit 4	**Exit 5**	Rolling	3	AM	F	6050
				PM	D	4010
Exit 5	**Exit 6**	Rolling	3	AM	E	5160
				PM	D	3980
Exit 6	**Exit 7**	Rolling	3	AM	F	6030
				PM	E	4950
Exit 7	**Exit 8**	Rolling	2	AM	F**	4100
				PM	F**	3550
Exit 8	**Exit 9**	Rolling	2	AM	F	3850
				PM	D	2750
Exit 9	**Exit 10**	Rolling	2	AM	E	3650
				PM	D	2770
Exit 10	**Exit 11**	Rolling	2	AM	E	3520
				PM	D	2620
Exit 11	Housatonic River	Rolling	2	AM	D	3190
				PM	C	2520

Source: VHB Inc. and ConnDOT
Note: Boldface segments indicate links currently operating at LOS E or F during one or both peak hours.
* The number of lanes indicated in the table are general purpose lanes and do not include slow vehicle lanes at steep upgrades.
** Capacity of this segment of I-84 is affected by the weaving condition that is present (see Table 2-10 and the related discussion).
*** Capacity of this segment of I-84 westbound is effected by the lane drop that occurs at Exit 1.
vph Vehicles per hour

Westbound Freeway Segments

During the morning peak hour, seven of the twelve westbound segments of I-84 are operating at congested levels. The segments from Exit 5 to Exit 6, Exit 9 to Exit 11 are operating at a LOS E. The segments from Exit 4 to Exit 5, and Exit 6 to Exit 9 are operating at a LOS F. Additionally, there are three segments that are approaching capacity and are operating at a LOS D

During the evening peak hour, the only two segments of I-84 westbound that are operating at a congested level are the Exit 6 to Exit 7 segment which is operating at a LOS E and the Exit 7 to Exit 8 segment which is operating at a LOS F. There are an additional five segments that are approaching capacity and are operating at a LOS D.

2.4.3 Ramp Operations

The procedures for analyzing the operational conditions of highway ramps is based on the analysis procedures outlined in Chapter 5 of the Highway Capacity Manual. The procedures focus on the interaction between freeway mainline through traffic and merging and diverging traffic to / from the ramps. These analyses consider a number of factors including the length and taper of acceleration/deceleration lanes, free-flow vehicle speeds along the freeway, and sight distances. In particular, the analysis for merging vehicles focuses on the areas where individual on-ramp vehicles attempt to find gaps in the adjacent mainline traffic stream. The action of this merging traffic creates turbulence along the mainline that can affect freeway operations. The converse of this is the diverge movement which forces exiting vehicles to shift in advance of the exit and occupy the right hand lane (in the case of a right-hand exit lane) in order to exit the freeway. This action causes some turbulence to the overall traffic stream as the vehicles shift lanes and slow their speed in preparation for the off-ramp.

Level of service for ramp operations is based on the density of the vehicles within the influence areas created by the merging or diverging vehicles. According to the HCM, the influence area for these movements is approximately 1,500 feet before the diverge area and 1,500 feet beyond the merge areas. LOS A represents a condition where merging and diverging vehicles create no disruption to the mainline through vehicles and there is virtually no turbulence within the ramp influence area. On the other hand, LOS E/F represent conditions where the turbulence created by the merging and diverging vehicles becomes intrusive to all drivers in the influence area. Under these conditions, any minor changes to the traffic conditions could result in the creation of unacceptable queues along the ramps and for the mainline through traffic.

While often confused, it is also important to note that ramp analyses do not evaluate the weaving conditions created by ramp operations along many freeway exits. For example, the ramp analysis does not take into account the factors involved where an on-ramp (such as I-84 eastbound at Exit 3) is immediately followed down stream by an off-ramp (such as I-84 eastbound Exit 4). This condition is evaluated as part of the

weaving analysis presented later in this report. All ramps analyzed were right-hand ramps, with the exception of Exit 3 westbound and Exit 7 eastbound, where both on- and off-ramps are left-hand. The results of the I-84 ramp analyses are shown in Table 2-9. The Appendix provides the actual worksheets and LOS criteria.

As Table 2-9 shows, most ramp sections are currently operating at LOS C or better in the off peak direction (i.e., eastbound in the morning and westbound in the evening). However, several ramps are currently operating at over capacity conditions (LOS E or F) in the peak flow direction. The only ramp experiencing LOS F during both the morning and evening peak hour is the Exit 7 on-ramp.

I-84 Eastbound Ramps

During the morning peak hour, the on and off-ramps along the eastbound direction of I-84 are generally operating at acceptable levels from the New York State Line to the Housatonic River. All 22 of the analyzed ramps are operating at a LOS C or better. As mentioned, traffic is not as significant in the eastbound direction in the morning as it is during the evening peak hour.

During the evening peak hour, 16 of the 22 ramp terminals analyzed are operating under congested conditions (LOS D, E or F). In particular, the on-ramps at Exits 3, 4, 6, and 7 and the off-ramps at Exits 5, 7 and 9 along eastbound I-84 are operating at a LOS F. Discussions with local officials confirm that the on-ramps at these locations are typically difficult merging conditions during the evening peak hours with occasional queuing occurring on the on-ramps during the peak periods. Additionally, the on-ramps at Exits 1, 2 (rest area), 9, 10,and 11 and the off-ramps at Exits 1, 2, 4 and 10 along eastbound I-84 are operating at LOS D or LOS E under evening peak conditions and occasional queuing conditions occur during these time periods.

I-84 Westbound Ramps

During the morning peak hour, 13 of the 21 ramp terminals analyzed are operating under congested conditions (LOS D, E, or F). The on-ramps at Exits 10 and 11 and the off-ramps at Exits 5 and 9 along westbound I-84 are operating at a LOS D or E. Additionally, the on-ramps at Exits 3, 4, 5, 7, 8, and 9 and the off-ramps at Exits 4, 6, and 8 along westbound I-84 are operating at a LOS F.

During the evening peak hour, 8 of the 21 ramps terminals analyzed are operating under congested conditions (LOS D, E, or F). The on-ramps at Exits 8 and 10 and the off-ramps at Exits 4, 5, 6, 8, and 9 along westbound I-84 are operating at a LOS D or E. Additionally, the on-ramp at Exit 7 is operating at a LOS F. No off-ramps operate below LOS D.

Table 2-9
Ramp Level-of-Service Analysis Summary
1998 Existing Conditions

	Eastbound Ramps								Westbound Ramps							
	Weekday Morning Peak Hour				Weekday Evening Peak Hour					Weekday Morning Peak Hour				Weekday Evening Peak Hour			
	Ramp Volume (vph)	Speed	Density	LOS	Ramp Volume (vph)	Speed	Density	LOS		Ramp Volume (vph)	Speed	Density	LOS	Ramp Volume (vph)	Speed	Density	LOS
Exit 1 on-ramp	120	59	19	B	150	56	29	D	Exit 1 on-ramp	150	56	27	C	150	57	25	C
Exit 1 off-ramp	170	52	23	C	100	52	34	D	Exit 1 off-ramp	220	52	13	B	120	52	11	B
Exit 2 on-ramp	90	60	11	B	160	58	24	C	Exit 2 on-ramp	250	60	16	B	340	60	14	B
Exit 2/Rest Area/Old Ridgebury Road on-ramp	480	58	15	B	1,110	56	29	D	Exit 2 off-ramp	1,370	50	16	B	330	53	6	A
Exit 2 off-ramp	600	54	24	C	380	54	36	E									
Exit 3 on-ramp	950	59	20	B	2,400	--	--	F	**Exit 3 on-ramp**	600	--	--	F	580	59	20	C
Exit 3 off-ramp	400	57	7	A	900	56	19	B	Exit 3 off-ramp	1,850	54	21	C	1,350	55	11	B
Exit 4 on-ramp	500	58	19	B	950	--	--	F	**Exit 4 on-ramp**	380	--	--	F	200	57	21	C
Exit 4 off-ramp	200	52	15	B	500	51	30	D	**Exit 4 off-ramp**	750	--	--	F	750	50	29	D
Exit 5 on-ramp	600	60	14	B	600	56	27	C	**Exit 5 on-ramp**	1,350	--	--	F	840	56	26	D
Exit 5 off-ramp	650	51	22	C	1,600	--	--	F	Exit 5 off-ramp	460	51	35	D	810	50	31	D
Exit 6 on-ramp	850	57	24	C	1,050	--	--	F	**Exit 6 off-ramp**	870	--	--	F	970	50	35	D
Exit 7 on-ramp	600	58	23	C	650	--	--	F	**Exit 7 on-ramp**	2,500	--	--	F	2,250	--	--	F
Exit 7 off-ramp	1,150	58	18	B	2,300	--	--	F	Exit 7 off-ramp	570	54	19	B	850	53	16	B
Exit 8 on-ramp	350	58	16	B	700	57	26	C	**Exit 8 on-ramp**	1,100	--	--	F	1,200	55	28	D
Exit 8 off-ramp	1,150	51	16	B	1,250	51	22	C	**Exit 8 off-ramp**	850	--	--	F	400	53	33	D
Exit 9 on-ramp	430	57	24	C	450	52	36	E	**Exit 9 on-ramp**	650	--	--	F	430	56	28	C
Exit 9 off-ramp	430	51	28	C	750	--	--	F	**Exit 9 off-ramp**	450	51	41	E	450	51	33	D
Exit 10 on-ramp	250	59	18	B	450	53	30	D	Exit 10 on-ramp	480	51	35	D	400	55	28	D
Exit 10 off-ramp	280	51	22	C	450	51	35	D	Exit 10 off-ramp	350	51	22	C	250	52	17	B
Exit 11 on-ramp	300	57	23	C	500	53	35	D	Exit 11 on-ramp	780	54	28	D	450	58	20	C
Exit 11 off-ramp	500	54	17	B	750	53	25	C	Exit 11 off-ramp	450	56	23	C	350	56	20	C

Note: Boldface ramps indicate locations where ramp is currently operating at LOS E or F during one or both peak hours.
a Speed is expressed in miles per hour
b Density is expressed in passenger vehicles/hour/lane
c LOS -- Level of service

2.4.4 Weaves

The procedure for analyzing the operational conditions of interchange ramps is based on analysis procedures presented in Chapter 4 (Weaving Areas) of the 1994 *Highway Capacity Manual*. A weaving movement is defined as the interaction between the crossing of two or more traffic streams traveling in the same direction without the aid of traffic control devices. There are a number of weaving areas along I-84 which require a significant amount of driver awareness as vehicles are simultaneously accelerating into the mainline freeway from the on-ramp or decelerating from the mainline freeway to the off-ramp.

The HCM procedure for analyzing freeway weaving areas uses the interaction between conflicting traffic streams to estimate vehicle speeds within a weaving section. More formally defined, weaving areas occur when a merge area is closely followed by a diverge area, or when an on-ramp is closely followed by an off-ramp. Thus, traffic within a weaving area is subject to turbulence above that which is normally present on basic freeway sections. This turbulence is in the form of forced lane changes within a restricted distance.

The traffic volumes in the weaving section (weaving and non weaving), the length and configuration of the section, and free-flow vehicle speeds are the critical inputs used to arrive at the LOS of the weaving section. LOS is determined separately for weaving vs. non-weaving vehicles, and is based on the average speeds of these vehicles in the weaving section.

The five study area locations where weaving conditions are experienced I-84 are discussed in detail below.

- ***I-84 Eastbound between Exit 3 on-ramp and the Exit 4 off-ramp*** – This weave is created when traffic destined for Exit 4 traveling eastbound on I-84 conflicts with the traffic entering I-84 from Route 7 (Exit 3). The traffic entering the I-84 mainline from Exit 3 does so in two lanes. This requires the exiting traffic already traveling along I-84 to cross these two lanes of traffic to reach the Exit 4 off-ramp. The short distance between the Exit 3 on-ramp and the Exit 4 off-ramp exacerbates this condition by limiting the distance for these vehicles to maneuver. Additionally, the high volume of traffic entering the I-84 mainline from Route 7, particularly during the evening peak period (approximately 2,400 evening peak hour vehicles) creates a difficult weaving condition for the Exit 4 traffic (500 vehicles during the evening peak hour).

- ***Route 7 Northbound and Southbound just after exiting I-84 at Exit 3*** – This weave is created when I-84 westbound traffic exiting at Exit 3 (Route 7) and I-84 eastbound traffic exiting at Exit 3 come into conflict with each other. I-84 westbound traffic heading to the Danbury Fair Mall must weave across the I-84

eastbound traffic that is heading south on Route 7 to Ridgefield. The high volume of traffic exiting from the westbound direction (1,850 morning and 1,350 evening peak hour vehicles) weaving into the eastbound exiting traffic (400 morning and 900 evening peak hour vehicles) in a short distance creates a weaving condition which is perceived to be difficult during peak conditions.

- ***I-84 Eastbound between Exit 7 and Exit 8*** – This weave is created when traffic originating from Route 7 southbound merges with mainline I-84 traffic from a left-hand on-ramp and weaves across mainline traffic to exit at a right-hand off-ramp at Exit 8. This traffic must weave across three lanes of traffic with peak period volumes ranging from 3,050 during the morning peak hour and 4,550 during the evening peak hour. The high design of the interchange, particularly the Route 7 southbound on-ramp to I-84, brings these vehicles into the mainline stream under higher than average speeds which limits the decision making distances of the drivers.

- ***I-84 Westbound between Exit 7 and Exit 8*** – This weave is created when Exit 8 on-ramp traffic (1,100 vehicles in the morning and 1,200 in the evening) from Route 6 westbound at the Exit 8 rotary merges with mainline I-84 traffic from a right-hand on-ramp and weaves across mainline traffic to avoid the right-hand Exit 7 off-ramp. Mainline traffic exiting at Exit 7 conflicts with this on-ramp movement, resulting in two weaving traffic streams over a short segment of roadway.

The results of these analyses are shown in Table 2-10 and Figures 2-3 and 2-4. The Appendix provides the detailed LOS criteria.

In the morning, all weaves analyzed operate at LOS D or better except the Exit 7/8 weave, where both directions operate at LOS E or F. In general, the operational problems at the weaving sections are more pronounced in the evening peak hour. In the evening, the weave sections between Exits 7 and 8 (both directions), on Route 7 southbound, and on I-84 eastbound between Exits 3 and 4 operate at LOS E or F. The Exit 7/8 weave operates poorly during both peak periods.

Table 2-10
Weaving Sections Level-of-Service Analysis Summary
1998 Existing Conditions

Weave Location	Number of Lane Changes for Weaving Traffic	Weekday Morning Peak Hour		Weekday Evening Peak Hour	
		Speed [a]	LOS [b]	Speed	LOS
I-84 EB Between Exits 3 and 4					
Weaving Vehicles	2	45	C	35	E
Non Weaving Vehicles		53	C	44	D
Route 7 SB at I-84 Exit 3					
Weaving Vehicles	2	42	D	39	E
Non Weaving Vehicles		50	C	44	D
Route 7 NB at I-84 Exit 3					
Weaving Vehicles	2	48	C	41	D
Non Weaving Vehicles		53	C	49	C
I-84 EB Between Exits 7 and 8					
Weaving Vehicles	3	28	F	25	F
Non Weaving Vehicles		26	F	22	F
I-84 WB Between Exits 7 and 8					
Weaving Vehicles	2	33	F	29	F
Non Weaving Vehicles		37	E	39	E

a Speed is expressed in miles per hour.
b LOS – Level-of-Service.

2.4.5 Intersections

The procedures for analyzing the operational conditions of signalized and unsignalized intersections are based on analysis procedures presented in Chapter 9 (Signalized Intersections) and Chapter 10 (Unsignalized Intersections) of the 1994 *Highway Capacity Manual.* Level of service designation is reported differently for signalized and unsignalized intersections.

For signalized intersections, level of service is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, level of service criteria are stated in terms of the average stopped delay per vehicle for a 15-minute analysis period.

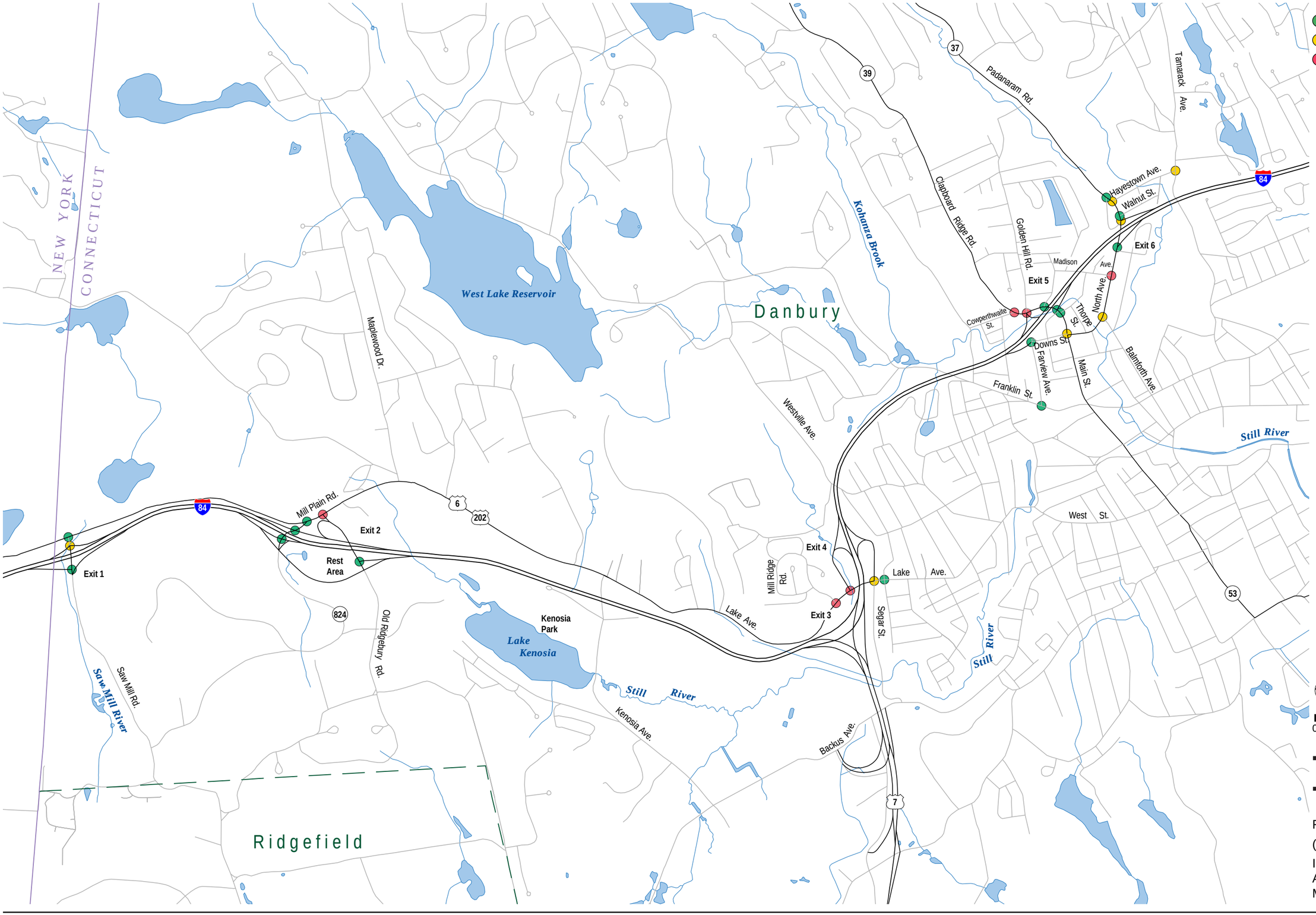
For unsignalized intersections, the analysis assumes that traffic on the local arterial is not affected by traffic on the side streets. That is, the through and right-turning movements on the mainline are unimpeded by side street traffic. The level of service is determined for left-turns from the main street onto the side street and for all movements from the side street. The level of service for each movement is calculated by determining the number of gaps that are available in the conflicting traffic stream. Based upon the number of gaps, the capacity of the movement can be calculated. The demand of the movement is then compared to the capacity and utilized to determine average delay for a particular movement.

Capacity analyses were conducted at all intersections of ramp termini with local streets within the study area. In addition, capacity analyses were conducted at several predefined intersections within the study area that are adjacent to the I-84 mainline and potentially impacted by traffic entering onto or exiting from I-84.

The results of the intersection analysis under existing traffic volume conditions are summarized in Table 2-11 for signalized intersections and Table 2-12 for unsignalized locations. Figures 2-5 and 2-6 present graphical representatives of these analyses. The table and figure show the intersections within the study area that were evaluated and the existing AM and PM peak hour levels of service. The following paragraphs summarize the locations that are operating at saturated (LOS E or LOS F) levels:

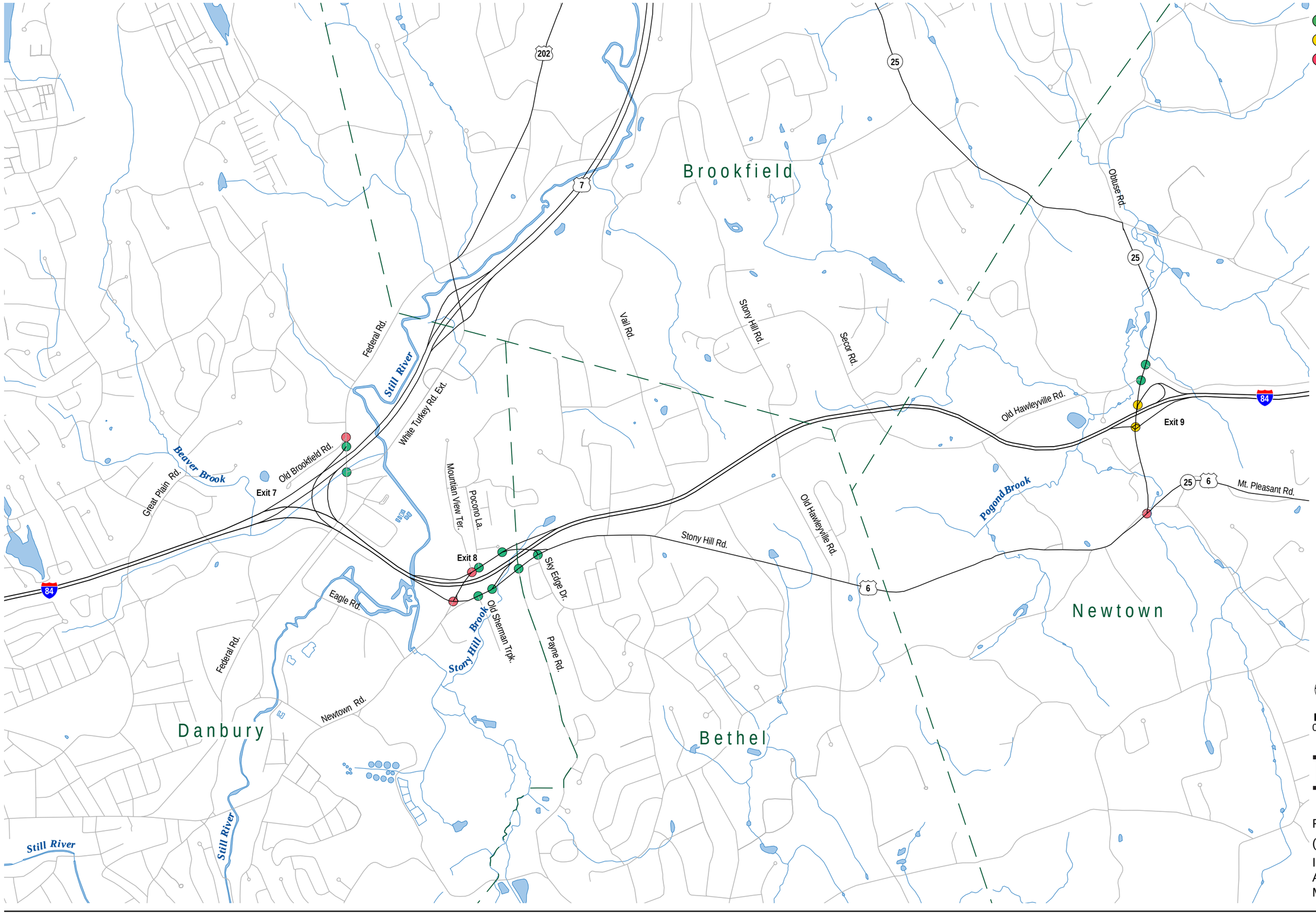
Signalized Intersections

- At Exit 2, the intersection of Route 6 with Old Ridgebury Road is operating at a LOS F during both peak hours.
- At Exit 4, the intersection of the westbound ramps and Lake Avenue is operating at a LOS F during the AM peak hour. The intersection of the eastbound ramps and Lake Avenue is operating at a LOS E during the PM peak hour, and the intersection of Lake Avenue and Mill Ridge Road is operating at a LOS F during both peak hours.
- At Exit 5, the intersection of the westbound off ramp with Route 39 and Golden Hill Road is operating at a LOS F during both peak hours and the intersection of Main Street with Downs Avenue is operating at a LOS F during the PM peak hour.
- At Exit 6, the intersection of Route 37 and Madison Avenue is operating at a LOS F during both peak hours and the intersection of Route 37 and Balmforth Avenue is operating at a LOS F during the PM peak hour. The intersection of Hayestown Road and Route 37 is also operating at a LOS F during the PM peak hour.
- At Exit 8, the intersection of westbound off-ramp with Route 6 and Mountainview Road is operating at a LOS F during the AM peak hour and a LOS E during the PM peak hour. The intersection of the eastbound off-ramp with Newtown Road is operating at a LOS F during the AM peak hour. The intersection of Route 6 and Old Sherman Turnpike is operating at a LOS F during the PM peak hour.
- At Exit 9, the intersection of Route 25 and Route 6 is operating at a LOS F during the AM and PM peak hours.
- At Exit 10, the intersection of the westbound ramps with Route 6 and the intersection of Route 6 and Commerce Road are operating at a LOS F during both peak hours.
- At Exit 11, the intersections of the ramps and Mile Hill Road, Route 34 and Mile Hill Road, and Route 34 and Toddy Hill Road are operating at a LOS F during both the AM and PM peak hours.



I-84 Exits 1-11

Figure 2-5
(Sheet 1 of 3)
Intersection Capacity Analysis-
Morning Peak Hour



I-84 Exits 1-11

Figure 2-5
(Sheet 2 of 3)
Intersection Capacity Analysis-
Morning Peak Hour

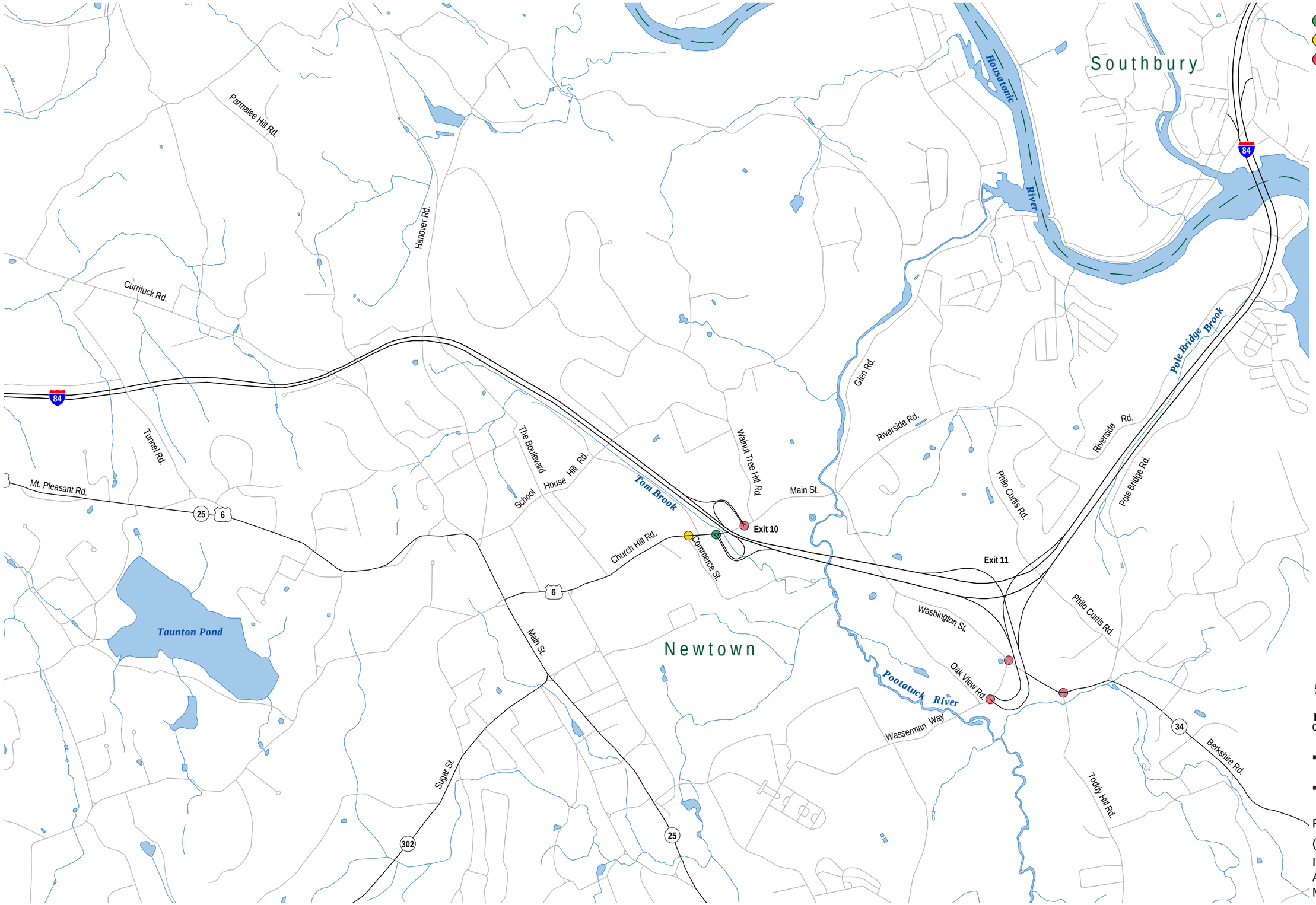
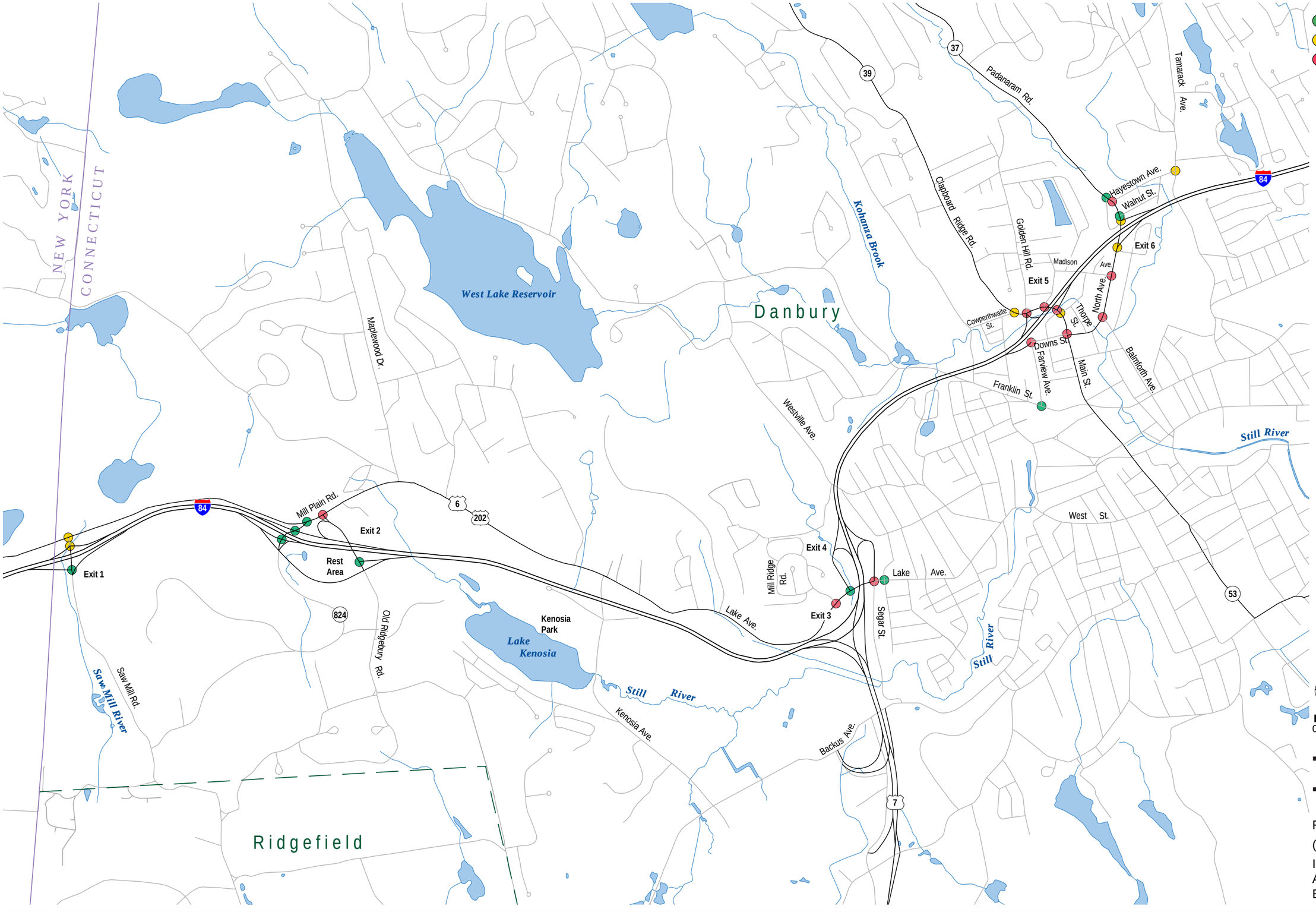


Figure 2-5
(Sheet 3 of 3)
Intersection Capacity Analysis-
Morning Peak Hour



I-84 Exits 1-11

Figure 2-6

(Sheet 1 of 3)

Intersection Capacity Analysis-
Evening Peak Hour

ts.40239.figures.40239i84.p65

LOS A/B
LOS C/D
LOS E/F

Brookfield
Danbury
Bethel
Newtown
Federal Rd.
Still River
White Turkey Rd. Ext.
Vail Rd.
Stony Hill Rd.
Secor Rd.
Obtuse Rd.
Old Hawleyville Rd.
Exit 9
Exit 7
Exit 8
Old Brookfield Rd.
Great Plain Rd.
Beaver Brook
Mountain View Ter.
Pocono La.
Sky Edge Dr.
Payne Rd.
Old Sherman Trpk.
Eagle Rd.
Stony Hill Brook
Newtown Rd.
Pogond Brook
Mt. Pleasant Rd.
202
7
25
84
6

0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-6
(Sheet 2 of 3)
Intersection Capacity Analysis-
Evening Peak Hour

LOS A/B
LOS C/D
LOS E/F

Southbury
Newtown
Parmalee Hill Rd.
Hanover Rd.
Currituck Rd.
Tunnel Rd.
Mt. Pleasant Rd.
Taunton Pond
Housatonic River
Pole Bridge Brook
Glen Rd.
Riverside Rd.
Riverside Rd.
Pole Bridge Rd.
Philo Curtis Rd.
Philo Curtis Rd.
The Boulevard
School House Hill Rd.
Tom Brook
Walnut Tree Hill Rd.
Main St.
Church Hill Rd.
Commerce St.
Exit 10
Exit 11
Washington St.
Main St.
Sugar St.
Pootatuck River
Oak View Rd.
Wasserman Way
Toddy Hill Rd.
Berkshire Rd.
84
25
6
302
34

0 1000 2000 Feet

I-84 Exits 1-11

Figure 2-6
(Sheet 3 of 3)
Intersection Capacity Analysis-
Evening Peak Hour

Table 2-11
Signalized Intersection Level-of-Service Summary
1998 Existing Conditions

Signalized Intersections	Time Period	1998 Existing Conditions LOS*	V/C**	Delay***
Exit 1 WB Ramps at Saw Mill Road	Morning Peak Hour	C	0.26	21
	Evening Peak Hour	C	0.20	17
Route 6 at Saw Mill Road	Morning Peak Hour	B	0.33	7
	Evening Peak Hour	D	0.30	27
Exit 2 EB Ramps to SR 824	Morning Peak Hour	B	0.17	6
	Evening Peak Hour	B	0.17	6
Exit 2 WB Ramps to SR 824	Morning Peak Hour	B	0.38	8
	Evening Peak Hour	B	0.24	6
Route 6 at SR 824	Morning Peak Hour	B	0.64	14
	Evening Peak Hour	B	0.61	8
Mile Hill Road at Route 34	Morning Peak Hour	F	1.09	nc
	Evening Peak Hour	E	0.98	nc
Old Ridgebury Road at Route 6	Morning Peak Hour	F	0.83	nc
	Evening Peak Hour	F	0.76	nc
Lake Avenue at Mill Ridge Road	Morning Peak Hour	F	0.94	nc
	Evening Peak Hour	F	0.95	nc
Exit 4 EB Ramps at Lake Avenue	Morning Peak Hour	C	0.60	20
	Evening Peak Hour	E	1.05	48
Exit 4 WB Ramps at Lake Avenue	Morning Peak Hour	F	0.97	nc
	Evening Peak Hour	B	0.82	15
Exit 5 WB Ramps at Rt. 39 and	Morning Peak Hour	F	1.47	nc
Golden Hill Rd.	Evening Peak Hour	F	1.21	nc
Main Street at Downs Avenue	Morning Peak Hour	D	0.62	33
(Routes 53, 37, and 39)	Evening Peak Hour	F	1.05	nc
Route 37 at Balmforth Avenue	Morning Peak Hour	D	0.77	31
	Evening Peak Hour	F	0.97	74
Route 37 at Madison Avenue	Morning Peak Hour	F	1.19	nc
	Evening Peak Hour	F	1.55	nc
Route 37 at Hayestown Avenue	Morning Peak Hour	D	1.02	30
	Evening Peak Hour	F	1.07	nc
Hayestown Avenue at Tamarack Avenue	Morning Peak Hour	D	0.94	30
	Evening Peak Hour	C	0.85	18
Exit 6 WB Off-Ramp at Route 37	Morning Peak Hour	C	0.92	20
	Evening Peak Hour	D	1.00	33

Table 2-11
Signalized Intersection Level-of-Service Summary
1998 Existing Conditions (Cont'd.)

Signalized Intersections	Time Period	1998 Existing Conditions LOS*	V/C**	Delay***
Federal Road at White Turkey Road Ext.	Morning Peak Hour	B	0.56	7
	Evening Peak Hour	D	1.08	32
Route 6 EB and Old Sherman Turnpike	Morning Peak Hour	B	0.54	6
	Evening Peak Hour	F	0.97	nc
Exit 8 EB Off-Ramp at Newtown Road	Morning Peak Hour	F	0.95	nc
	Evening Peak Hour	D	0.98	26
Exit 8 WB Off-Ramp at Mountainview	Morning Peak Hour	E	0.81	49
Terrace/Route 6	Evening Peak Hour	F	0.90	nc
Exit 8 WB Off-Ramp (Top of Ramp at	Morning Peak Hour	B	0.72	12
Route 6)	Evening Peak Hour	B	0.58	7
Route 25 at Route 6	Morning Peak Hour	F	1.02	nc
	Evening Peak Hour	F	0.98	nc
Exit 10 EB Ramps at Route 6	Morning Peak Hour	B	0.59	9
	Evening Peak Hour	B	0.71	12
Exit 10 WB Ramps at Route 6	Morning Peak Hour	F	1.07	nc
	Evening Peak Hour	F	1.06	nc
Route 6 at Commerce Road	Morning Peak Hour	F	1.52	nc
	Evening Peak Hour	F	1.26	nc
Exit 11 Ramps at Mile Hill Road	Morning Peak Hour	F	1.07	nc
	Evening Peak Hour	F	1.13	nc
Mile Hill Road at Route 34	Morning Peak Hour	F	1.09	nc
	Evening Peak Hour	F	0.98	nc
Route 34 at Toddy Hill Road	Morning Peak Hour	F	1.18	nc
	Evening Peak Hour	F	1.21	nc

Source: Vanasse Hangen Brustlin, Inc.
Note: Boldface intersections operate at LOS E or F during one or both peak periods.
* Level of Service
** Volume to Capacity Ratio
*** Delay = Average stopped delay to all vehicles entering the intersection in seconds / vehicle.
nc Not calculated.

Unsignalized Intersections

- At Exit 5, the intersection of the eastbound off-ramp with Downs Avenue and Fairview Avenue is operating at a LOS F during the PM peak hour and the intersection of the eastbound on-ramp with Route 39 and Water Street is operating at a LOS F during the PM peak hour. Additionally, the intersection of Hillside Avenue with Route 39 is operating at a LOS E during the PM peak hour and the intersection of Route 39 with Cowperthwaite Street is operating at a LOS F during the AM peak hour.

- At Exit 7, the intersection of Federal Road with the Route 7 westbound on-ramp is operating at a LOS F during the PM peak hour.

- At Exit 8, the intersection of the Route 6 and Sky Edge Drive is operating at a LOS F during the PM peak hour.

- At Exit 9, the intersection of the eastbound ramps with Route 25 is operating at a LOS F during the PM peak hour.

Table 2-12
Unsignalized Intersection Level of-Service Summary
1998 Existing Conditions

Unsignalized Intersections	Time Period	1998 Existing Conditions Demand*	Delay**	LOS***
Exit 1 EB Ramps at Saw Mill Road	Morning			
	-- Eastbound	170	5	A
	-- Southbound Left	80	3	A
	-- Overall		2	A
	Evening			
	-- Eastbound	100	5	B
	-- Southbound Left	70	3	A
	-- Overall		2	A
Exit 2 EB On-Ramp at Old Ridgebury Road	Morning			
	-- Southbound Left	170	3	A
	-- Overall		1	A
	Evening			
	-- Southbound Left	250	37	E
	-- Overall		6	B
Lake Avenue at Ridge Road and Shannon Ridge Road	Morning			
	-- Northbound	40	43	E
	-- Southbound	250	6	B
	-- Eastbound Left	80	6	B
	-- Westbound Left	0	4	A
	-- Overall		2	A
	Evening			
	-- Northbound	20	<100	F
	-- Southbound	150	5	A
	-- Eastbound Left	270	7	B
	-- Westbound Left	0	6	B
	-- Overall		5	A
Cowperthwaite Street and Route 39 (Main Street)	Morning			
	-- Northbound	390	<100	F
	-- Westbound Left	150	7	B
	-- Overall		82	F
	Evening			
	-- Northbound	290	93	F
	-- Westbound Left	300	5	B
	-- Overall		16	C

Table 2-12 (Cont'd.)
Unsignalized Intersection Level of-Service Summary
1998 Existing Conditions

Unsignalized Intersections	Time Period	1998 Existing Conditions Demand*	Delay**	LOS***
Hillside Avenue at Route 39	Morning			
	-- Southbound	150	30	E
	-- Eastbound Left	20	5	B
	-- Overall		3	A
	Evening			
	-- Southbound	170	<100	F
	-- Eastbound Left	50	14	C
	-- Overall		34	E
Exit 5 EB On-Ramp at Route 39 and Water Street	Morning			
	-- Northbound	20	4	A
	-- Eastbound Left	370	34	E
	-- Westbound Left	0	4	A
	-- Overall		7	B
	Evening			
	-- Northbound	20	nc	F
	-- Eastbound Left	260	264	F
	-- Westbound Left	0	4	A
	-- Overall		nc	F
Toomey Lane at Route 39	Morning			
	-- Southbound	70	44	E
	-- Eastbound Left	10	7	B
	-- Overall		2	A
	Evening			
	-- Southbound	100	<100	F
	-- Eastbound Left	60	25	D
	-- Overall		21	D
Fairview Avenue at Franklin Street	Morning			
	-- Southbound	150	7	B
	-- Eastbound Left	100	3	A
	-- Overall		2	A
	Evening			
	-- Southbound	350	24	D
	-- Eastbound Left	70	4	A
	-- Overall		8	B
Exit 5 EB Off-Ramp at Downs Street and Fairview Avenue	Morning			
	-- Northbound	650	7	B
	-- Eastbound	50	2	A
	-- Westbound	150	5	B
	-- Overall		6	B
	Evening			
	-- Northbound	1600	nc	F
	-- Eastbound	100	nc	F
	-- Westbound	100	nc	F
	-- Overall		nc	F

Table 2-12 (Cont'd.)
Unsignalized Intersection Level of-Service Summary
1998 Existing Conditions

Unsignalized Intersections	Time Period	1998 Existing Conditions		
		Demand*	Delay**	LOS***
Exit 6 EB On-Ramp at Route 37	Morning			
	-- Southbound Left	650	11	C
	-- Overall		3	A
	Evening			
	-- Southbound Left	700	91	F
	-- Overall		25	D
Padanaram Avenue at Route 37	Morning			
	-- Eastbound	30	48	F
	-- Northbound Left	10	12	C
	-- Overall		1	A
	Evening			
	-- Eastbound	40	<100	F
	-- Northbound Left	10	11	C
	-- Overall		3	A
Walnut Street at Route 37	Morning			
	-- Westbound	20	<100	F
	-- Southbound Left	0	8	B
	- Overall		2	A
	Evening			
	-- Westbound	20	<100	F
	-- Southbound Left	0	15	C
	-- Overall		5	B
Exit 7 EB On-Ramp at Federal Road	Morning			
	-- Northbound Left	200	37	E
	-- Overall		4	A
	Evening			
	-- Northbound Left	500	<100	F
	-- Overall		57	F
Federal Road at Old Brookfield Road	Morning			
	-- Eastbound	100	74	F
	-- Northbound Left	20	12	C
	- Overall		4	A
	Evening			
	-- Eastbound	60	<100	F
	-- Northbound Left	60	13	C
	-- Overall		11	C
Route 6 at Sky Edge Drive	Morning			
	-- Northbound Right	170	6	B
	-- Overall		12	B
	Evening			
	-- Northbound Right	300	17	C
	-- Overall		5	B

Table 2-12(Cont'd.)
Unsignalized Intersection Level of-Service Summary
1998 Existing Conditions

Unsignalized Intersections	Time Period	1998 Existing Conditions Demand*	Delay**	LOS***
Route 6 EB and Payne Road	Morning			
	-- Northbound Right	300	8	B
	-- Overall		2	A
	Evening			
	-- Northbound Right	250	26	D
	-- Overall		3	A
Exit 8 EB On-Ramp at Route 6	Morning			
	-- Eastbound Left	350	3	A
	-- Overall		1	A
	Evening			
	-- Eastbound Left	700	4	A
	-- Overall		1	A
Pocono Lane at Route 6	Morning			
	-- Southbound Right	100	9	B
	-- Overall		1	A
	Evening			
	-- Southbound Right	60	7	B
	-- Overall		1	A
Hawleyville Road at Route 25	Morning			
	-- Eastbound	80	17	C
	-- Northbound Left	30	5	A
	-- Overall		2	A
	Evening			
	-- Eastbound	80	19	C
	-- Northbound Left	30	4	A
	-- Overall		2	A
Barnabas Road at Route 25	Morning			
	-- Westbound Left	60	22	D
	-- Westbound Right	40	4	A
	-- Southbound Left	60	4	A
	-- Overall		2	A
	Evening			
	-- Westbound Left	80	33	E
	-- Westbound Right	50	7	B
	-- Southbound Left	50	6	B
	-- Overall		3	A
Exit 9 EB Ramps at Route 25	Morning			
	-- Eastbound Left	130	<100	F
	-- Eastbound Right	300	6	B
	-- Southbound Left	280	7	B
	-- Overall		19	C
	Evening			
	-- Eastbound Left	300	<100	F
	-- Eastbound Right	450	7	B
	-- Southbound Left	230	7	B
	-- Overall		<100	F

Table 2-12 (Cont'd.)
Unsignalized Intersection Level of-Service Summary
1998 Existing Conditions

Unsignalized Intersections	Time Period	1998 Existing Conditions Demand*	Delay**	LOS***
Exit 9 WB Ramps at Route 25	Morning			
	-- Westbound Left	200	71	F
	-- Westbound Right	250	4	A
	-- Southbound Left	250	3	A
	-- Overall		13	C
	Evening			
	-- Westbound Left	180	58	F
	-- Westbound Right	270	8	B
	-- Southbound Left	130	4	A
	-- Overall		10	B

Note: Boldface intersections operate at LOS E or F during one or both peak periods
* Demand in vehicles per hour.
** Delay = Average stopped delay in seconds per vehicle.
*** Level of Service.

2.5 Safety Analysis

A safety analysis was conducted for the I-84 corridor within the study area limits to determine if the traffic demands being placed on the roadway combined with the geometric conditions of the roadways or ramps have resulted in unsafe operating conditions.

2.5.1 Methodology

The safety analysis was based on an examination of accident rates on the roadway and a comparison to statewide averages for similar type facilities. The source of the data is the ConnDOT Traffic Accident Surveillance Report. The Traffic Accident Surveillance Report database compiles statewide accident data on a three-year basis. The database calculates actual accident rates for every roadway link and intersection on state numbered roadways. Also calculated is a critical accident rate for each location based upon the type of roadway or intersection, the traffic volume, and the vehicle miles of travel on the roadway. The ratio of the actual accident rate to the critical accident rate is then calculated. If this ratio is higher than one, then the rate of accident occurrence at that location is said to be "higher than expected." When a location has a rate "higher than expected" and more than 14 accidents have occurred at the location, the location meets the criteria to be placed on ConnDOT's Suggested List of Surveillance Study Sites (SLOSSS). Locations on the SLOSSS are given priority for funding of future safety improvement projects.

2.5.2 Qualitative Description

Traffic accident data for I-84 was supplied by ConnDOT for the period January 1993 through December 1995, which represents the most recent three-year period available. These data included all reported accidents with property damage greater than $1,000 or personal injury. A review of these data indicates that there are three locations along I-84 within the project limits which are exhibiting a "higher than expected" ratio of actual accident rate to the critical accident rate and appear on ConnDOT's SLOSSS list.

The first location is in the vicinity of Exits 3 and 4 where there were 201 accidents over the three-year study period and where the ratio of the actual accident rate to the critical accident rate is 1.03. The second location is the segment of I-84 from Exit 10 to Exit 11, where there were 22 accidents and the ratio of the actual accident rate to the critical accident rate is 1.05. The final location is at the Exit 11 interchange, where there were 43 accidents and the ratio of the actual accident rate to the critical accident rate is 1.02.

It should also be noted that along with the three areas on I-84 that appear on the SLOSSS list, there are six areas on state roadways adjacent to I-84 that also appear on the list. Those areas are Route 6 at the I-84 Exit 4 ramps, Route 6 between the Exit 10 ramps and Commerce Street, Route 37 between Route 37/Route 39 and Thorpe Street, Route 37 between Balmforth Avenue and Madison Avenue, Route 37 between Pandaram Avenue and Golden Hill Road, and Route 39 at the Golden Hill Road/I-84 Exit 5 ramp intersection. Although accident reports were not provided for these locations, each is in the vicinity of I-84 on and off ramps and it is likely that the traffic congestion in the areas surrounding the ramps may be contributing to the high accident rates.

In addition to reviewing those areas on the SLOSSS list, the accident reports for I-84 were broken down by tenth of a mile segments to evaluate any more localized areas that may be exhibiting an accident rate higher than the critical accident rate. Based on a more detailed review of the accident data, 27 additional locations (outside of those areas already shown on the SLOSSS list) have actual accident rates higher than the critical accident rate.

2.5.3 Quantitative Accident Data

For each of the locations that appear on the SLOSSS list, a more detailed analysis was undertaken to determine if the traffic demands placed on the roadway or the geometric conditions of the roadway or ramps have resulted in unsafe operating conditions. A summary is presented in Table 2-13 and Figure 2-2.

In the Exit 3/Exit 4 area, there were a total of 201 accidents over the three year study period. Of the 201 accidents, 96 (48%) occurred on the I-84 westbound mainline,

53 (26%) occurred on the I-84 eastbound mainline, and 52 (26%) occurred on the Exit 3 and Exit 4 ramps. As the table indicates, 40 (42%) of the 96 accidents on the westbound mainline were sideswipe type accidents. A closer examination of the 40 sideswipe accidents indicates that 27 accidents (68%) were attributed to the improper changing of lanes. This may be due to driver confusion created by the left-handed exit ramp to Route 7 southbound at Exit 3.

The data also reveals that there were a total of 32 rear-end accidents on I-84 in both the eastbound and westbound directions. Of the 32 rear-end accidents, 25 (78%) were caused by slowing or stopped traffic on I-84. The large volume of traffic that travels through this area of I-84, along with the closely spaced interchanges, the awkward left-hand entrance ramp, and the short weaving area eastbound between Exit 3 and Exit 4 likely contribute to the slowing and stopping of traffic on this portion of I-84.

The statistics also indicate that the Exit 4 westbound off-ramp had the most ramp accidents over the three-year study period. There were a total of 30 accidents on this ramp of which eighteen (60%) were fixed object accidents. A more detailed review of the fixed object accidents indicates that sixteen (89%) of the eighteen accidents were the caused by excessive speed and fifteen of the sixteen resulted in the vehicle running off the right side of the ramp. A contributing factor to the fixed object accidents may be the geometry of the Exit 4 off ramp. This ramp contains a curve to the left with a 25 mile per hour (mph) design speed. Vehicles are likely entering this curve at a speed that is too fast to negotiate the curve, and consequently run off the right side of the road.

Table 2-13
Summary of Accident History (SLOSSS* List)

Location	Rear End	Sideswipe	Fixed Object	Object in Road	Turn Into	Head On	Overturn
Exit 3/Exit 4							
Mainline Eastbound	13	15	23	2	0	0	0
Mainline Westbound	19	40	33	4	0	0	0
Exit 3 Westbound Off-Ramp	3	0	3	0	0	0	0
Exit 3 Eastbound Off-Ramp	3	0	0	0	0	0	0
Exit 4 Westbound On-Ramp	1	0	4	0	0	0	0
Exit 4 Westbound Off-Ramp	9	1	18	0	2	0	0
Exit 4 Eastbound Off-Ramp	3	0	0	0	1	4	0
Exit 10 to Exit 11							
Eastbound	3	2	5	9	0	0	0
Westbound	1	2	0	0	0	0	0
At Exit 11							
Mainline Eastbound	2	2	4	0	0	0	0
Mainline Westbound	2	3	5	0	0	0	0
Eastbound Ramps	0	1	4	1	0	0	0
Westbound Ramps	3	1	13	0	0	0	2

Source: VHB Inc. and ConnDOT
* The SLOSSS database includes accidents involving property damages greater than $1,000 or those resulting in a personal injury.

In the area from Exit 10 to 11, a total of 22 accidents occurred over the three-year study period. A majority (86%) of these accidents occurred in the eastbound direction. Of the 19 accidents that occurred in the eastbound direction, nine (47%) were the result of objects in the road. There were also four sideswipe accidents, two in the eastbound direction and two in the westbound direction. Of these four sideswipe accidents, two were the result of the improper changing of lanes. In this section of I-84, a third lane is introduced in both the eastbound and westbound directions that serves as an auxiliary lane between Exits 10 and 11. This third lane is introduced as a lane from the on-ramp and is dropped as an "exit only" lane at the next exit. It appears from a review of the accident reports that the two sideswipes occurred between vehicles that were moving out of the auxiliary lane and vehicles that were moving into the auxiliary lane.

In the Exit 11 interchange area, a total of 43 accidents occurred over the three year study period. Eighteen (42%) of the accidents occurred on the I-84 mainline, six (14%) occurred on the eastbound on and off ramps and nineteen (44%) occurred on the westbound on and off ramps. Of particular note is the large number of fixed object accidents on the ramps. Of the 25 accidents that occurred on the ramps, 17 (68%) of them were classified as fixed object accidents. A closer review of the fixed object accidents on the ramps reveals that a contributing cause of the accident was inappropriate speed on the ramps. Of the 17 fixed object accidents, fifteen (88%), were the result of driving too fast or losing control of the vehicle on the ramp. Additionally, the sideswipe accident, one of the overturn accidents and one of the rear end accidents on the westbound ramps was attributed to driving too fast. The large percentage of speed related accidents might indicate that drivers are not slowing down appropriately enough to negotiate the curves. This interchange was recently reconstructed to provide a direct connection from I-84 to Route 25 with high-speed ramps. However the Route 25 freeway was never constructed. Consequently the high-speed ramps end at an at-grade intersection. The large percentage of speed related accidents might be the result of the termination of high-speed ramps at an at-grade intersection.

For each of the tenth of a mile segment along I-84 that exhibited an accident rate higher than the critical accident rate, the accident reports were reviewed to determine if the traffic demands placed on the roadway or the geometric conditions of the roadway have resulted in unsafe operating conditions. A summary is presented in Table 2-14.

The table indicates there are 27 locations where the actual accident rate is greater than the critical accident rate. During the review of the accident reports it was evident that the traffic congestion between Exit 3 and Exit 8 (MP 3.00 to 8.80) was contributing to the large number of rear-end type accidents. After Exit 8, the number of rear end type accidents drops off substantially, with the only two other areas exhibiting a number of rear end accidents being located near Exit 9 (MP 11.30 to 11.39) and Exit 10 (MP 15.00 to 15.19). A number of rear-end type accidents also occurred on the ramps from I-84 to the local streets. This might be due to the congestion that is occurring on the ramps and the inadequate distances to decelerate to a stop, as outlined in the geometric deficiencies section of this report.

A review of areas that exhibited a large number of sideswipe type accidents indicated that the areas were generally in the vicinity of interchanges (MP 5.00 to 5.39 – Exit 5, MP 7.30 to 7.79 – Exit 7, MP 8.10 to 8.79 – Exit 8, MP 11.30 to 11.69 – Exit 9). A possible contributing factor to these accidents may the inadequate acceleration and deceleration lanes provided at each of these interchanges as noted in the geometrics section of this report. The inadequate acceleration and deceleration lanes along with the large volume of traffic restrict the driver's ability to maneuver safely into and out of the mainline traffic stream.

Table 2-14
Summary of Accident History (1/10 mile locations)*

Location	Number of Accidents	RA/RC**	Rear End	Sideswipe	Fixed Object	Object in Road	Turn Into	Overturn	Other
0.70 to 0.79 (at Exit 2)	16	1.04	2	3	6		4		1
1.90 to 1.99 (0.3 mi. east of Exit 2)	7	1.05	1	4	2				
3.00 to 3.09 (0.3 mi. west of Exit 3)	7	1.05	2		2	1		1	1
4.90 to 4.99 (0.9 mi west of Exit 4)	12	1.18	4	4	3			1	
5.30 to 5.39 (at Exit 5)	26	1.15	8	7	7		2		2
6.30 to 6.39 (0.3 mi. west of Exit 6)	16	1.55	8	6		1			1
6.80 to 6.89 (0.5 mi. east of Exit 7)	15	1.45	9	1	4	1			
7.00 to 7.09 (0.35 mi. east of Exit 7)	13	1.26	3	8	1				1
7.10 to 7.19 (0.25 mi. east of Exit 7)	15	1.45	8	2	3	2			
7.30 to 7.39 (at Exit 7)	25	1.16	10	10	5				
7.40 to 7.49 (at Exit 7)	24	1.11	9	3	11	1			
7.70 to 7.79 (at Exit 7)	31	1.44	8	11	7	1	2		2
8.10 to 8.19 (at Exit 8)	38	1.97	12	11	10	2		1	2
8.60 to 8.69 (at Exit 8)	20	1.18	3	10	5	1		1	
8.70 to 8.79 (at Exit 8)	32	1.88	13	6	10		1	1	1
9.00 to 9.09 (0.2 mi. west of Exit 8)	7	1.12	2	2	3				
10.70 to 10.79 (0.6 mi. east of Exit 9)	12	1.92	1		11				
10.80 to 10.89 (0.5 mi .east of Exit 9)	16	2.56	4	5	6	1			
11.30 to 11.39 (at Exit 9)	19	1.12	10		6	1	1		1
11.60 to 11.69 (at Exit 9)	26	1.53	2	9	5	2	7	1	
11.80 to 11.89 (0.1 mi. west of Exit 9)	19	1.11	8	5	5				1
12.60 to 12.69 (1 mi. west of Exit 9)	6	1.04		2	3	1			
14.10 to 14.19 (1 mi. east of Exit 10)	8	1.38		1	6	1			
14.20 to 14.29 (0.9 mi. east of Exit 10)	7	1.21	2	2	2				1
14.60 to 14.69 (0.5 mi. east of Exit 10)	9	1.55	2	5		1			1
15.00 to 15.09 (at Exit 10)	27	1.63	9	4	11	2		1	
15.10 to 15.19 (at Exit 10)	21	1.27	6	6	5	4			

Source: VHB Inc. and ConnDOT
*. Accident data includes accidents involving property damages greater than $1,000 or those resulting in a personal injury.
** - RA/RC = Actual Accident rate/Critical Accident Rate

2.6 Deficiencies/Needs Summary

The evaluation of existing traffic operations has provided an overview of the operational characteristics for the I-84 freeway mainline, ramps, and weaving movements along the mainline. Additionally, the analysis has provided an overview of a number of signalized and unsignalized intersections directly and indirectly impacting operations along I-84. The analysis has shown that there are specific locations where traffic operations do not meet current operational guidelines exclusive of any future traffic volume growth throughout the study area. The following findings were presented:

Traffic Demands

- Over the past decade or so (1987 to 1998), traffic volumes on I-84 from New York to the Housatonic River have increased by 46 percent, on average. This represents a rate of 4 percent per year. Between Exits 3 and 4, traffic volumes have increased by 115 percent – about 10 percent per year.
- In the past 3 years (1995 to 1998), traffic on this corridor has grown by 10 percent, on average – or 3 percent per year. Demands between Exits 3 and 4 stabilized from 1995 to 1998 – increasing at a rate of 3 percent per year.
- In 1998, average daily traffic demand on I-84 varied from 63,800 vehicles per day (vpd) between Exits 10 and 11 to 116,100 vpd between Exits 6 and 7.
- Traffic on I-84 is heavier in the westbound direction (toward New York) during the morning commute and in the eastbound direction during the evening commute. Evening demand exceeds morning demand by about 10 percent, on average. 1990 census data indicates that 12 percent of the workers residing in the Housatonic Valley work in New York.
- Heavy vehicles comprise 4 to 11 percent of the total peak period traffic demands.

Geometry

In the study area, there are 43 on and off-ramps (22 on-ramps and 21 off-ramps), all of which were evaluated for geometric deficiencies based on AASHTO design standards. Within the study area, 8 on-ramps and 13 off-ramps were identified as not meeting current design standards. At Exit 5, the on and off-ramps in both directions were deficient.

Traffic Operations

This study analyzed traffic operations on segments of I-84, on and off-ramps, weaving sections, and key intersections in the study area. Level-of-service (LOS) is used as the qualitative measurement denoting the different operating conditions that occur under various traffic volume loading. Similar to a report card, LOS designations are letter based, ranging from A to F, with LOS A representing the best operating condition

under relatively free flowing traffic conditions and LOS F representing the worst operating condition, or locations that are at or approaching capacity.

Mainline. There are 12 mainline segments from New York to the Housatonic River. In the morning peak hour, seven westbound and one eastbound segment operate at LOS E or F. In the evening peak hour, eight eastbound and two westbound segments operate at LOS E or F. The Exit 7/8 segment operates at LOS E or F in both directions during both morning and evening peak periods.

Ramps. A total of 43 ramps were analyzed – 22 in the eastbound direction and 21 in the westbound direction. In the morning peak hour, 10 westbound ramps operate at LOS E/F. All eastbound ramps operate at LOS C or better in the morning. In the evening, nine eastbound ramps and one westbound ramp operate at LOS E/F. The Exit 7 westbound on-ramp operates at LOS F during the morning and evening peak hour.

Weaves. Five segments with intense weaving maneuvers were analyzed – on I-84 between Exits 3/4 (eastbound) and Exits 7/8 (in both directions) and on Route 7 near I-84 Exit 3 (both directions). In the morning, two of the five operate at LOS E/F – both on I-84. In the evening, all three I-84 weaves and one of the Route 7 weaves operate at LOS E/F. The eastbound and westbound weaves on I-84 between Exits 7 and 8 operate at LOS E/F during both morning and evening peak periods.

Intersections. A total of 51 intersections were evaluated. These locations were at the base of ramps, or on key roadways in the vicinity of the I-84 corridor. Of these, 29 signalized and 22 unsignalized intersections were analyzed. For the signalized locations, 19 operate at LOS E or F during one or both peak hours. Eight of these locations occur where I-84 ramps intersect the local street system. For unsignalized intersections, six operate at LOS E or F during one or both peak periods- four of which are locations where I-84 ramps intersect the local street system.

Safety

Traffic accident data for I-84 for the most recent three-year period available indicates that there are three locations along I-84 within the project limits which are exhibiting a "higher than expected" accident rate. These include: the Exits 3 and 4 area (201 accidents over the three-year study period); the segment of I-84 from Exit 10 to Exit 11; and at the Exit 11 interchange. In looking at the I-84 mainline data at smaller increments, the data indicated 27 additional "spot segments" with high accident rates.

There are also several locations off I-84 in the study area exhibiting high accident rates. These include: Route 6 at the I-84 Exit 4 ramps; Route 6 between the Exit 10 ramps and Commerce Street; Route 37 between Route 37/Route 39 and Thorpe Street; Route 37 between Balmforth Avenue and Madison Avenue; Route 37 between Pandaram Avenue and Golden Hill Road; and Route 39 at the Golden Hill Road/I-84 Exit 5 ramp intersection. Additional data on these locations are provided in the Appendix to this report.