Chapter 2
EXISTING TRANSPORTATION

2.1 Study Area Demographics

There has been overall growth in both population and employment in the Study Area communities over the past 20 years. Tables 2.1 and 2.2 illustrate the changes. Population and employment levels were derived from the plans of conservation and development for each community, the *Central Naugatuck Valley Regional Plan* (CNV Regional Plan)(COGCNV, 1998), *A Profile of the COGCNVR: 1999* (COGCNV, 1999), projections provided by ConnDOT, and data provided through the state Office of Policy and Management.

Table 2.1
Population Change

Area	1980 Population	1990 Population	2000 Projected	% Change 1980-2000	2025 Projected	% Change 2000-2025
Southbury	14,156	15,818	18,200	29	21,200	16
Middlebury	5,995	6,145	6,499	8	6,600	2
Oxford	6,634	8,685	10,300	55	12,600	22
Waterbury	103,266	108,961	109,700	6	106,500	- 3
CNV Region	237,835	261,081	279,100	17	293,650	5
State of Connecticut	3,107,576	3,287,116	3,316,120	7	3,593,860	8

Source: U.S. Census, ConnDOT

Of the towns that make up the study area, Waterbury has the greatest population followed by Southbury, Oxford, and Middlebury. The greatest growth on a strict percentage basis occurs in Southbury and Oxford. In contrast, much of Waterbury experienced a decline in population. For 2025, Waterbury is projected to decrease in population from 109,700 to 106,500 people. Southbury and Oxford are expected grow significantly in population while Middlebury is projected to remain stable or increase slightly in size.

Employment is also expected to grow substantially in Oxford over the next 25 years. The First Selectman in Oxford anticipates that much of this growth will occur in the industrial area that surrounds the Waterbury-Oxford Airport. Levels of employment growth in the other three corridor communities are expected to be similar to that throughout the CNV Region. While much of Waterbury and Middlebury are expected to grow about 20% in employment, areas of Southbury and Oxford could see a very strong growth in excess of 50%. While this growth seems extraordinarily high, it should be noted that these towns have very low base numbers to begin with.

Table 2.2
Non-Agricultural Employment (persons employed) Change

Area	**1980**	**1990**	**2000 Projected**	**% Change 1980-2000**	**2025 Projected**	**% Change 2000-2025**
Southbury	4,250	6,440	9,130	115	10,530	15
Middlebury	4,170	3,660	3,600	-12	3,970	10
Oxford	850	1,320	1,780	101	3,090	74
Waterbury	49,230	48,510	46,530	5.5	52,180	12
CNV Region	89,980	99,600	106,340	18	122,320	15

Source: Connecticut Dept. of Labor, ConnDOT

The CNV Regional Plan estimates that there were 57,620 jobs in Study Area communities in 1995. This compares with 63,625 employed residents. This means that a great many of the Study Area residents traveled outside the Central Naugatuck Valley region to work. The towns of Middlebury, Oxford, and Southbury are anticipated to continue to have population growth, and will continue to serve as bedroom communities for employees commuting outside the Study Area. These trends suggest that the expected future growth of population and employment in the Study Area in general will result in increases in traffic volumes within the corridor, on local roads, and along I-84 for commuters traveling to and from the Study Area for work.

Trip Distribution. An analysis was performed to determine the origins and destinations of trips of vehicles on Interstate 84. To do this, a segment of I-84 in Waterbury was selected to determine which towns generated traffic that passed through this particular roadway link. From this analysis, a map was developed that illustrated the concentrations of origins and destination for each town in the state.

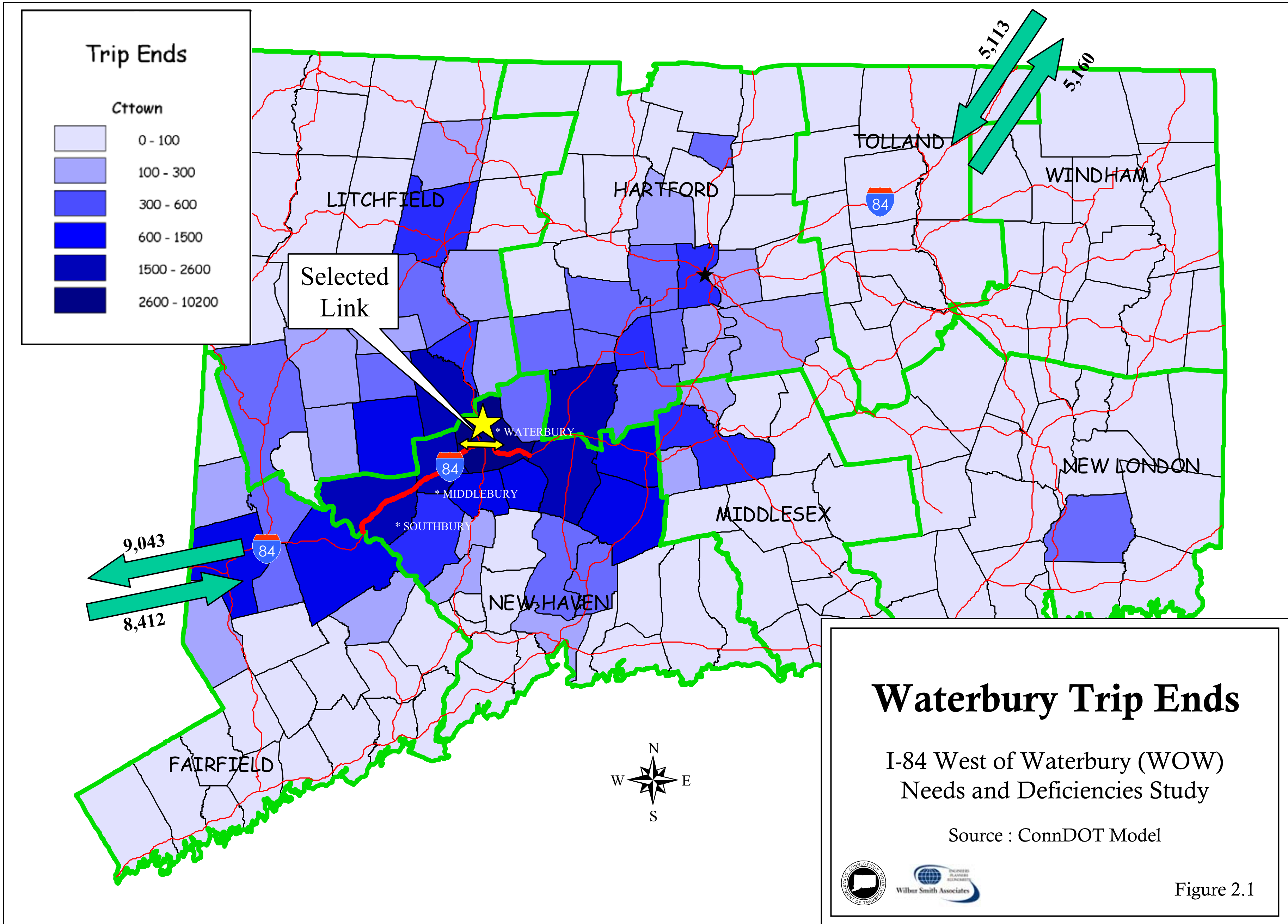
Figure 2.1 illustrates the distribution of trip ends throughout the state using the I-84 segment in Waterbury. A strong distribution of traffic along the entire WOW corridor and in downtown Waterbury is illustrated. There is also a heavy commuting pattern both north and south of Waterbury, along the Route 8 corridor south to New Haven and north to Litchfield County.

Over 10,000 trips traverse I-84 each day without an origin or destination in Connecticut. This reinforces the fact that I-84 carries a heavy proportion of long distance trips and is a vital economic link to the New England states.

2.2 Existing Land Use

The link between transportation access and land use is a critical relationship for any transportation system. Not only does transportation support the land use function by providing access and mobility, but the land use function also supports the transportation service by providing appropriate population and employment densities.

Land use within the I-84 corridor is mixed. In addition to developed land uses, there is a substantial amount of undeveloped land as well as preserved open space scattered throughout the corridor. The CNV Regional Plan estimates that there were 57,620 jobs in Study Area communities in 1995. This compares with 63,625 employed residents. This means that a great many of the Study Area residents traveled outside the Central Naugatuck Valley region to work.


Trip Ends
Cttown
0 - 100
100 - 300
300 - 600
600 - 1500
1500 - 2600
2600 - 10200
Selected Link
* WATERBURY
* MIDDLEBURY
* SOUTHBURY
84
LITCHFIELD
HARTFORD
TOLLAND
WINDHAM
NEW LONDON
MIDDLESEX
NEW HAVEN
FAIRFIELD
5,113
5,160
9,043
8,412
N
W
E
S
Waterbury Trip Ends
I-84 West of Waterbury (WOW)
Needs and Deficiencies Study
Source : ConnDOT Model
Wilbur Smith Associates
Figure 2.1

The towns of Middlebury, Oxford, and Southbury are anticipated to continue to have population growth, and will continue to serve as bedroom communities for employees commuting outside the Study Area. These trends suggest that the expected future growth of population and employment in the Study Area in general will result in increases in traffic volumes within the corridor, on local roads, and along I-84 for commuters traveling to and from the Study Area for work.

Waterbury - Within Waterbury, land use is a mix of industrial and commercial activity from Interchange 19 east to Interchange 23. There is a concentration of residential neighborhoods west of Interchange 19 in Waterbury, on the south side of I-84, with pockets of commercial uses on lands immediately adjacent to the interstate. There are two small concentrations of institutional uses in Waterbury, including municipal offices located in downtown and two colleges (Naugatuck Valley Community Technical College, Teikyo Post College) located in the vicinity of Interchange 17. Land use west of Interchange 17 to Interchange 18 is commercial with several medical office buildings along Chase Parkway and Middlebury Rd. (Route 64).

For the City of Waterbury, the key transportation concerns are reducing congestion and improving safety on the interstate and local arterial roads, while improving local downtown circulation and economic development.

Middlebury - Land use in Middlebury within the I-84 corridor is generally low-density residential with concentrations of commercial uses along Routes 188, 63, and 64. There are also concentrations of commercial uses in the vicinity of Interchange 16 and along the Straits Turnpike/Route 63 corridor.

The key transportation issue for Middlebury is the congestion and reduced quality of life caused by through movement of traffic on local commercial and residential streets.

Southbury - A concentration of commercial uses in the vicinity of Interchanges 16 and 15 and along Route 6 and Main Street in Southbury exists. Another small commercial center in Southbury is located at the southwestern edge of the corridor around the intersection of Routes 172 and Main Street South.

The key transportation issue for Southbury is alleviating traffic congestion on I-84 and along Main Street South. The future development plans of neighboring communities has led local officials to believe that Interchange 16 will become overburdened by the year 2020.

Oxford - The Waterbury-Oxford Airport vicinity is the center of industrial land use in Oxford. Industrial land use in Southbury in the corridor is concentrated in the vicinity of Interchange 14 and along Route 172. The bulk of the industrial land in Middlebury is located in the southwestern portion of town along Route 188 and Benson Road.

The key transportation issue for the Town of Oxford is creating improved access from I-84 to the town's development parcels. Town officials would like to see a new interchange constructed in Middlebury to serve the airport and surrounding industrial uses.

2.3 Bicycle Facilities

Designated bicycle routes for the state have been developed by ConnDOT and published in their statewide bicycle map. Bicycle accommodation within Waterbury is limited, but several recommended routes exist in Southbury, Middlebury and Oxford.

Route 6 to Route 67 in Southbury and Oxford is part of a cross state route that heads south to the shoreline and north to the Massachusetts border. Southbury also has Route 172 and a portion of Route 67 as a recommended bike route. Middlebury has portions of Routes 188 and 63 as recommended routes, as well as South Road. Oxford has Routes 63 and 188 as recommended routes.

The COGCNV has proposed a regional bikeway network in their Plan of Conservation and Development. It includes provisions for bicycle facilities in the planning stages of projects. It is also meant to be a foundation upon which local projects can be built.

In addition to the on road bicycle routes, the Larkin State Bridle Trail is an off-road alternative for bicyclists. The trail is a multi-use path, allowing access to bicyclists, pedestrians, and equestrians. Additionally, the conversion of an abandoned trolley line adjacent to route 64 in Middlebury to a multi-use path has recently been completed. The trail is approximately 4.3 miles from end to end, and runs from just south of Lake Quassapaug to just west of route 63. It is a popular recreational facility for bicyclists and pedestrians. The COGCNV is currently working with municipalities along the Naugatuck River to create a bicycle path adjacent to the river.

2.4 Pedestrian Facilities

National travel surveys indicate that most pedestrian trips do not exceed two miles, however, a great deal of travel within urban centers such as Waterbury is actually made over much shorter distances. For these trips, walking is an efficient alternative to the automobile. It has been estimated that approximately 12% of all walking trips involve a journey to work, while 32% walk for other personal business purposes. While the remaining walkers typically do it for recreation or to get to school, it is the previous 44% that most likely have abandoned the car in favor of walking.

As development continues to grow in the suburban towns of Southbury, Middlebury, and Oxford, walking becomes less practical as the activity centers become more spread out. Still, amenities such as street lighting and safe sidewalks are important in encouraging walking. Many of the town centers provide good walking facilities that connect local shopping and commercial centers.

In Southbury, the major arterial routes within the town were inventoried for the availability of sidewalks. Main Street South, extending from Route 172 to Route 6, is the town's commercial center and has continuous, well-maintained sidewalks with wide green-space and street furniture (i.e. benches, lighting, gazebo).

It should be noted that river crossings are typically an impediment to pedestrian activity. This is not the case on the bridge spanning the Housatonic River. Sufficient walking space is provided on both sides of the structure.

Middlebury has few sidewalks, as much of the town is rural and development is not concentrated in any one area. While Middlebury has and requires minimal sidewalks throughout the town, it does have excellent pedestrian facilities in the form of multi-use paths. The Middlebury Multi-Use Trail and the Larkin State Bridle Trail are both heavily utilized by pedestrians. The Middlebury Multi-Use Path runs from Lake Quassapaug and parallels Route 64 to just east of Route 188. The Larkin State Bridle Trail runs through Southbury, Oxford, and Middlebury, but does not provide good access to local activity centers

In Waterbury, sidewalks exist throughout much of the city, though as in most urban centers, security and safety can act as a deterrent to pedestrian travel. Pedestrian amenities such as sidewalks, lighting, emergency phones, ped-signals, crosswalks, signage, benches, and planters provide a safe and comforting atmosphere for the pedestrian. There are currently several streetscape projects being designed in Waterbury. Improvements along Meadow Street, South Main Street, and Bank Street will include new sidewalks, landscaping, decorative lighting and signing.

2.5 Park and Ride Lots

Park and Ride Lots are designed to encourage carpooling and reduce the number of vehicles on the road during peak hours. The eight park and ride lots found within the study area are listed in Table 2.3.

Table 2.3
I-84 Park and Ride Lots

Park and Ride Lot	Features	Spaces	Usage
Southbury			
Route 172 @ Main Street South (Interchange 14)	P, L	84	60%
I-84 @ Route 67 (Interchange 15)	P, L	25	72%
I-84 @ Route 188 (Interchange 16)	P, L	43	72%
Middlebury			
Route 63 @ Maggie McFly's	P	44	10%
I-84 @ Route 63 (Interchange 17)	P, L, T	61	100%
Waterbury			
I-84 @ Chase Parkway (Interchange 17)	P, L, T, B	123	46%
Meadow & Grand Sts. @ Railroad Station	P, L, T, S, R	101	24%
I-84 @ Route 69 (Interchange 23)	P, L, T	178	60%

Source: ConnDOT
Features: P = paved, L = lighted, T = telephone, S = shelter, B = local bus service, R = rail service

The number of spaces being used for each park and ride lot was counted in May 2000 on a midweek morning. Two of the park and ride lots were not clearly designated as park and ride, including Route 63 at Maggie McFly’s and Meadow and Grand St at the Railroad Station. The data also suggests the need to expand the park and ride lot at I-84 and Route 63, which is at capacity. Two other locations, I-84 at Route 67 and Route 188, could also benefit from the addition of parking spaces to accommodate future growth.

2.6 Public Transit

Public Transportation in the study area is focused on the greater Waterbury area. The Bonanza Bus Company operates routes through Waterbury and Southbury; the Northeast Transportation Company runs local fixed route service and provides American with Disabilities Act (ADA) paratransit service throughout greater Waterbury, as of July 1, 2000.

The Bonanza Bus Company operates 10 buses a day from Hartford to New York City and 10 buses a day from New York City to Hartford. The buses stop in Farmington, Waterbury, Southbury, Danbury and sometimes White Plains and Yonkers. Beyond the Hartford stop, four buses a day in each direction continue from Hartford to Manchester, Willimantic, Danielson and Providence. The service is provided every day of the week including Saturdays and Sundays. Buses leave Waterbury from 5:45 am to 9:15 pm and arrive in Waterbury from 8:15 am to 11:35 pm to make the 2 hour 20 minute journey into New York. The trip to Hartford is 45 minutes. The travel center, or bus terminal, is located on Bank Street where it meets Grand Street.

The Northeast Transportation Company (NET) provides fixed-route bus and paratransit service in Waterbury, Watertown, Naugatuck, Middlebury, Wallingford and Meriden with a fleet of 54 buses. Forty-six of these buses are owned by the state and NET leases eight.

In July 2000, ConnDOT produced a Statewide Bus System Study, in which recommended improvements were made for bus service throughout the state. Major changes were not recommended to the NET service, because the Waterbury system is well developed and has excellent coverage of the area. However, several NET routes were recommended for alteration in the route and one route, 31, was recommended for elimination. In addition, it was recommended that Saturday early morning service be discontinued and replaced with Sunday service from 9:00 am to 5:00 pm.

Metro North is a commuter rail system, which runs between New York City and points north in Connecticut and New York. The Metro North trains have five lines: Port Jervis, Pascack Valley, Hudson, Harlem and New Haven. The New Haven line has three branches, New Canaan, Danbury and Waterbury.

The New Haven line runs from Grand Central Terminal in New York City through the Bronx and into Connecticut along the coast of Long Island Sound. Once the line reaches Bridgeport, the Waterbury train branches off. The train stops in Derby-Shelton, Ansonia, Seymour, Beacon Falls and Naugatuck before heading into the downtown Waterbury station.

The Metro North Waterbury Station is located on Meadow Street in downtown Waterbury. The station is easily accessible from both I-84 and Route 8 using the downtown exits. Parking and connecting bus service is available.

2.7 Waterbury-Oxford Airport

The inclusion of the Waterbury-Oxford Airport into the study area was necessary due to its regional impact on traffic over the study period. The planned growth of the facility, along with projected industrial growth in the immediate vicinity, required a close look at the effect it would have on local trip generation. As it currently operates, airport traffic uses Christian Road to access the airport service road. This provides adequate service at today's traffic level, but could create congestion if trips were to significantly increase over the next twenty-five years. The Town of Oxford, as well as the airport, could also benefit economically from a direct connection to the interstate. For these reasons, the airport and surrounding property was included in the analysis.

The Waterbury - Oxford Airport is a General Utility Airport with a designated service level of General Aviation. It is located on Christian Road, about 3 miles north of Oxford Center on Route 188. The airport has already surpassed development estimates that were projected by the 1994 Master Plan. New hangers, aprons, and a control tower have been added to the facility to increase capacity and improve safety.

Current Airport Operational Statistics include:

- Aircraft based on the field: 203
- Single engine airplanes: 160
- Multi engine airplanes: 29
- Jet airplanes: 13
- Helicopters: 1

- Aircraft operations: average 404/day
- 68% is local general aviation
- 30% is transient general aviation
- 1% is air taxi
- <1% is military

2.8 Goods Movement

The heavy use of I-84 by commercial vehicles requires the availability of rest areas and service stations that can accommodate the trucks and their operators over night. While a number of private truck stops exist throughout the state, they are not desirable by all truckers since they must leave the interstate and navigate local streets. Since commercial vehicle operators can only drive for 10 consecutive hours before they must stop to rest (by law), the need for inexpensive and convenient rest areas is important.

Due to the infrequency of interstate rest areas along I-84, trucks are routinely parking along the shoulders between Interchanges 16 and 15 and along the ramp shoulders at Interchange 15. This contributes to a safety issue in the region, as trucks must accelerate from a dead stop onto the mainline of I-84, which carries vehicles traveling over 60 mph. The results of a preliminary inventory of truck parking indicate that over ten trucks occupy the shoulder area near Interchange 16 in the westbound direction and over five in the eastbound direction in the later hours of the night.

2.9 Current and Projected Transportation System Performance

Twenty-four (24) hour count data indicated that the morning peak hour with the highest volume is between 7:00 and 8:00 A.M. In the afternoon, the highest volume peak hour is between 5:00 and 6:00 P.M. Figure 2.2 illustrates the morning and afternoon peak volumes for both 1999 and

2025 conditions. The truck percentage on the interstate fluctuates between 8% in Southbury and 5% in Waterbury of the peak volume at each of these areas. The truck percentage decreases as the interstate approaches Waterbury due to the fact that the overall volume of traffic increases, with a higher mix of automobiles.

The 2025 traffic volume is 'demand' volume. That is, it is the traffic that will utilize the interstate provided enough capacity exists. This is an important distinction because approximately 2100 vehicles could be accommodated by a single lane of traffic per hour. If a future peak hour volume is projected at 15,000 vehicles, and the highway is three-lanes in each direction, the theoretical capacity of the road would only be 12,600. Of course, at this volume of traffic the interstate would already be operating at a very poor level of service and would not likely be able to accommodate the additional 2,400 vehicles that are projected to use it. In this case traffic may leave the interstate and use local arterial roads to complete their trip. When the local arterials fill with traffic, vehicles may use local neighborhood roads.

I-84 westbound is the overall peak direction in the morning and eastbound is the overall peak direction in the afternoon. The split for each of these periods is roughly 55/45 and varies only slightly depending on the location along the corridor. This directional split is attributed to the high through traffic volume that uses this corridor. Destinations in New York, western and central Connecticut, and Massachusetts attract traffic that relies on this corridor for east-west connectivity.

In order to determine the existing and future transportation performance of I-84 and other local arterial roads, the CORSIM computer-based transportation simulation model was used in conjunction with traditional Highway Capacity Manual methodologies to quantify the level of congestion. In addition, ConnDOT's statewide travel demand model was used to relate current and future population and employment and projected future travel demand.

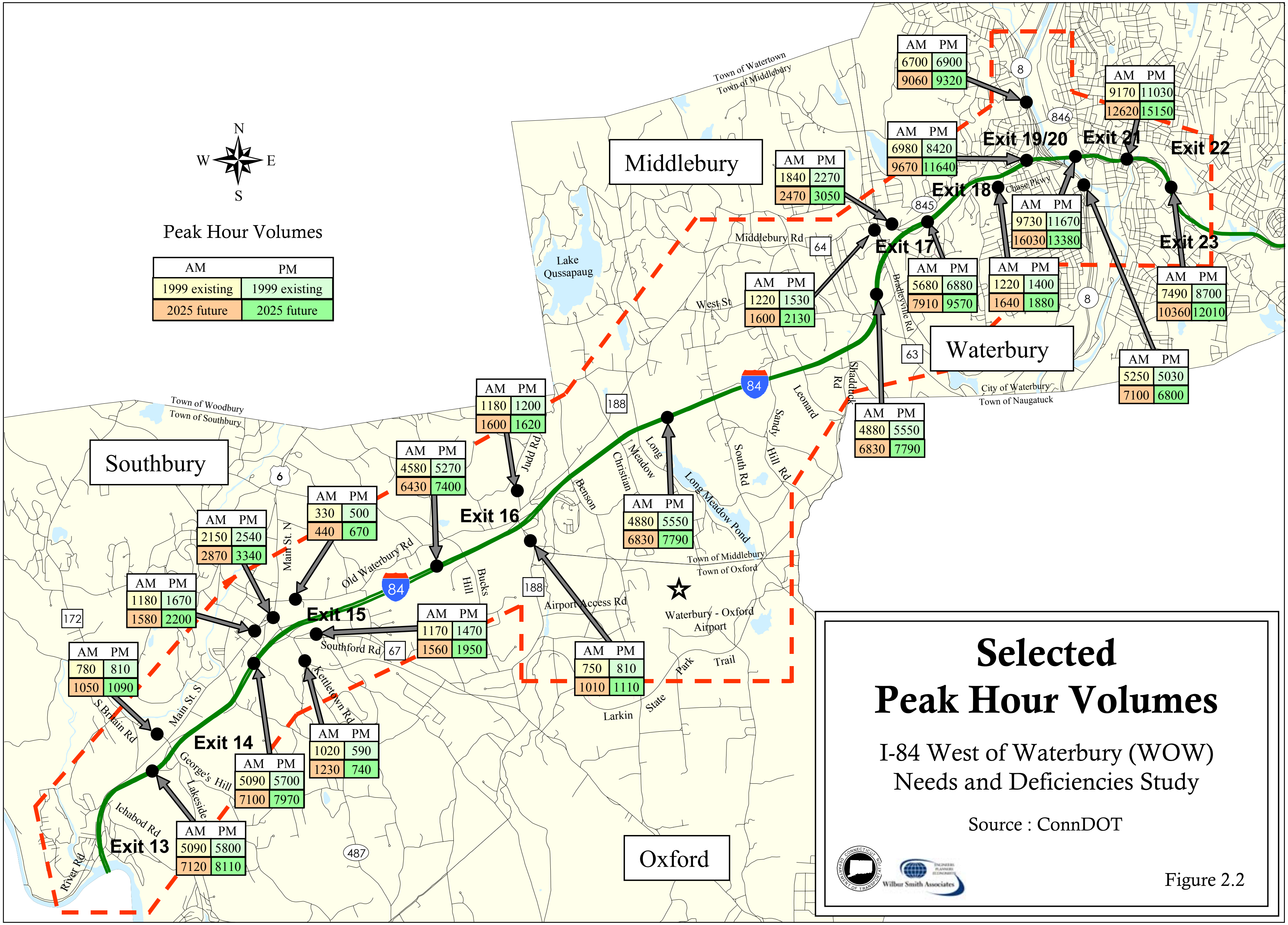
The results of the analyses for the existing and projected traffic volumes indicate the following:

Interstate 84

The future 2025 volumes were estimated to increase approximately 40% from their current level. On I-84, the future year Average Daily Traffic (ADT) on the Southbury end of the corridor is estimated to be about 40,500 in the eastbound direction and 42,000 in the westbound. In Middlebury between Interchanges 16 and 17, the eastbound ADT is 40,500 and the westbound is 42,300. In Waterbury, east of Interchange 23, the eastbound ADT is 62,400 while the westbound is 63,500.

I-84 in the westbound direction operates at poor Levels Of Service (LOS F) throughout much of the corridor in the year 2025 during the weekday morning peak hour condition. This is due to increase in traffic volumes within the corridor and the operation of left hand ramps to and from Route 8 and other interchanges. Figure 2.3 illustrates the comparison of LOS between year 2000 and 2025 for the westbound interstate during the A.M. peak hour.

In the afternoon peak hour, I-84 in the eastbound direction operates at poor levels of service (LOS F) in the year 2025 throughout the entire corridor. Similarly, I-84 in the westbound direction in the year 2025 operates at LOS F east of Interchange 18 in Waterbury during the



Selected Peak Hour Volumes

I-84 West of Waterbury (WOW) Needs and Deficiencies Study

Source : ConnDOT

Figure 2.2

weekday evening peak hour. Figure 2.4 illustrates the comparison of LOS between year 2000 and 2025 for the eastbound interstate during the P.M. peak hour.

The results of the capacity analysis also indicated that I-84 would show poor levels of service throughout much of the corridor in the year 2025, and may require improvements to enhance traffic operations. The analysis demonstrated that some of the congestion is created by localized choke points – such as when a lane drop occurs or a truck-climbing lane ends.

Based on both sets of analysis it was determined that overall continuity in the number of lanes on the Interstate could potentially provide improved operations over the base condition.

Arterial Roadways

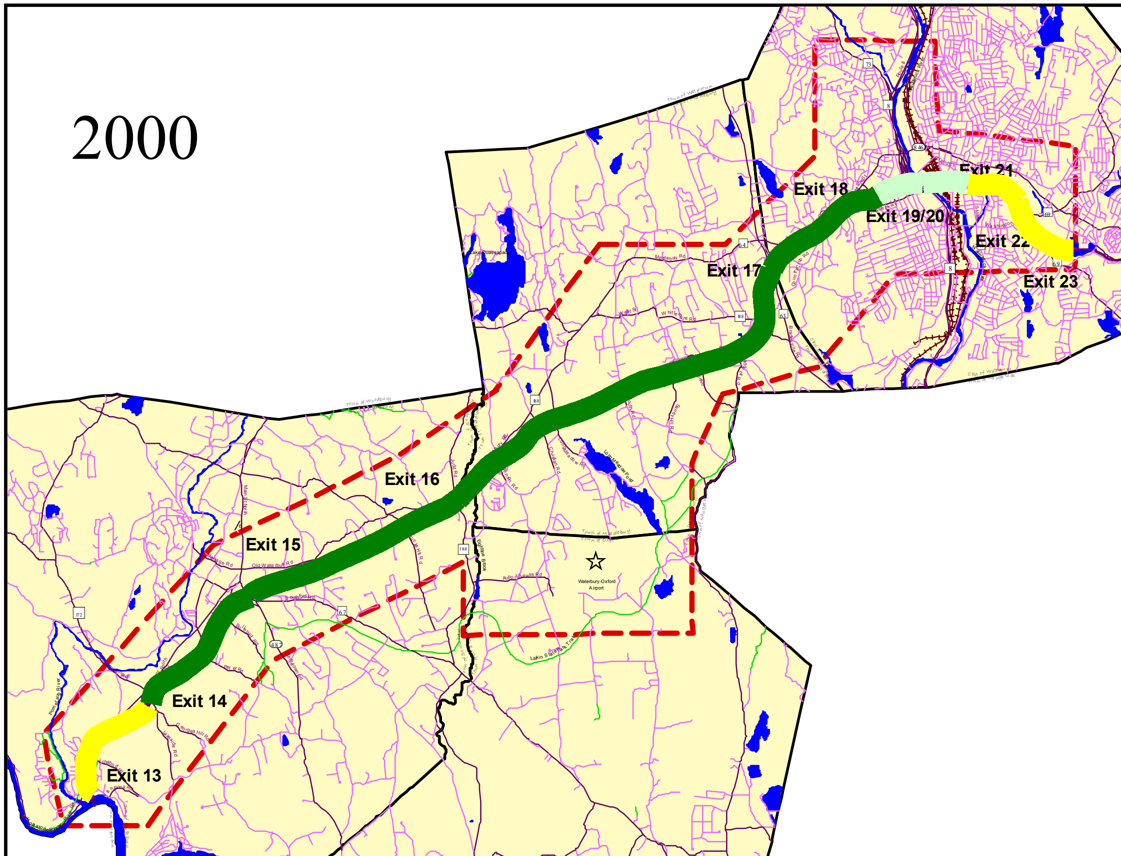
In summary, if no additional transportation improvements were to be implemented with the I-84 WOW corridor, during the next 25 years, I-84 WOW travelers would face:

- Significantly decreased travel speeds;
- Increased vehicle density (i.e., more vehicles per mile of highway);
- Decreased levels of service;
- Constrained capacity;
- Increased vehicle delays; and,
- Increased fuel consumption.

2.10 Safety Analysis

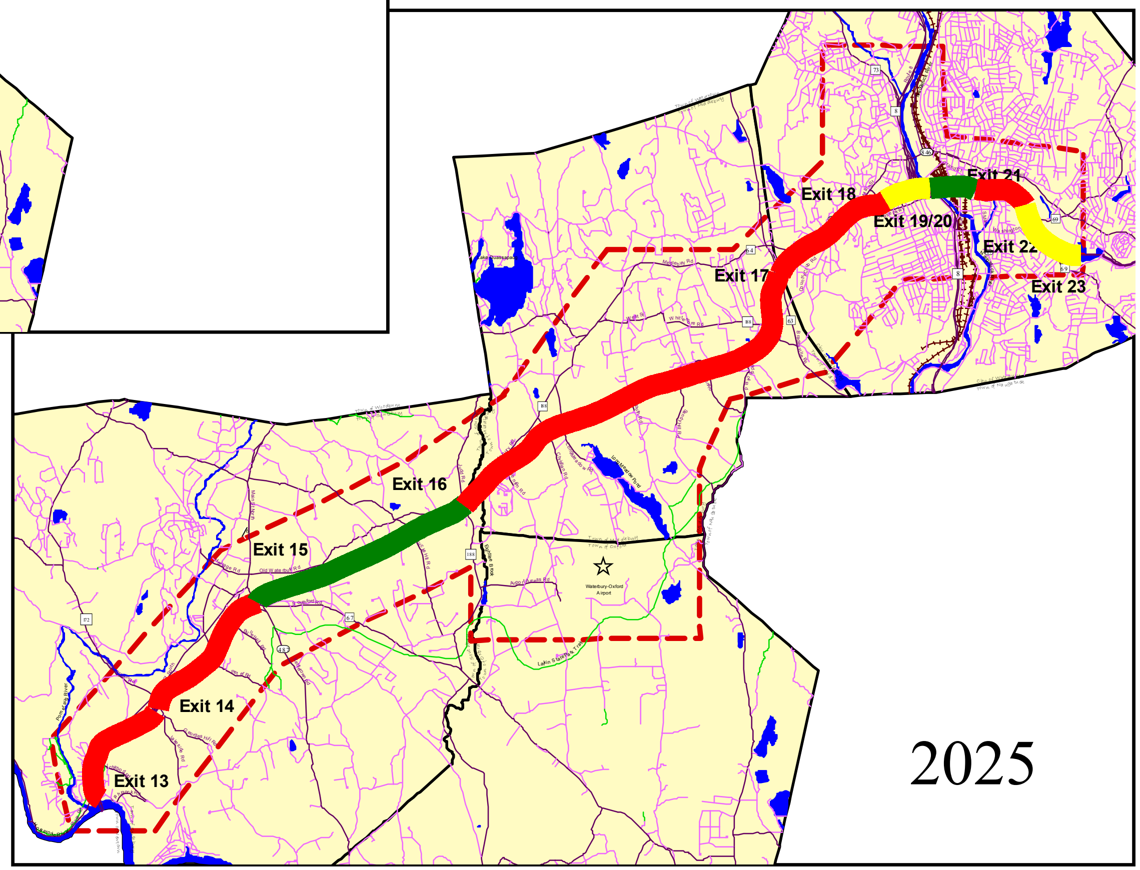
Accident records for I-84 from the most recent three-year period, 1996-1998, were collected from ConnDOT and analyzed. Accident record data is listed by date and includes information about the location, accident type, light, pavement and weather conditions, vehicles involved, direction of travel, severity of injuries and reason for the collision.

Five segments had accident rates high enough to be listed on ConnDOT's 1995-1997 SLOSS (Suggested List of Surveillance Sites). The SLOSS is a list of high accident sites, for which improvements may be appropriate. Locations are listed on the SLOSS when the ratio of the actual accident rate to the critical accident rate is greater than 1.0 and the number of accidents is greater than 15. The critical accident rate based on average accident rates for similar facilities statewide. The categories for which averages are prepared are defined in terms of the number of lanes, rural or urban characteristics, and whether the intersection is signalized or un-signalized. The accident rate is in terms of accidents per million vehicle miles. The segments of I-84 within the study area appearing on the SLOSS are shown in Table 2.4. Since the most recent SLOSS data is compiled a year behind the available accident data the number of accidents may not be comparable.



Level Of Service (LOS)

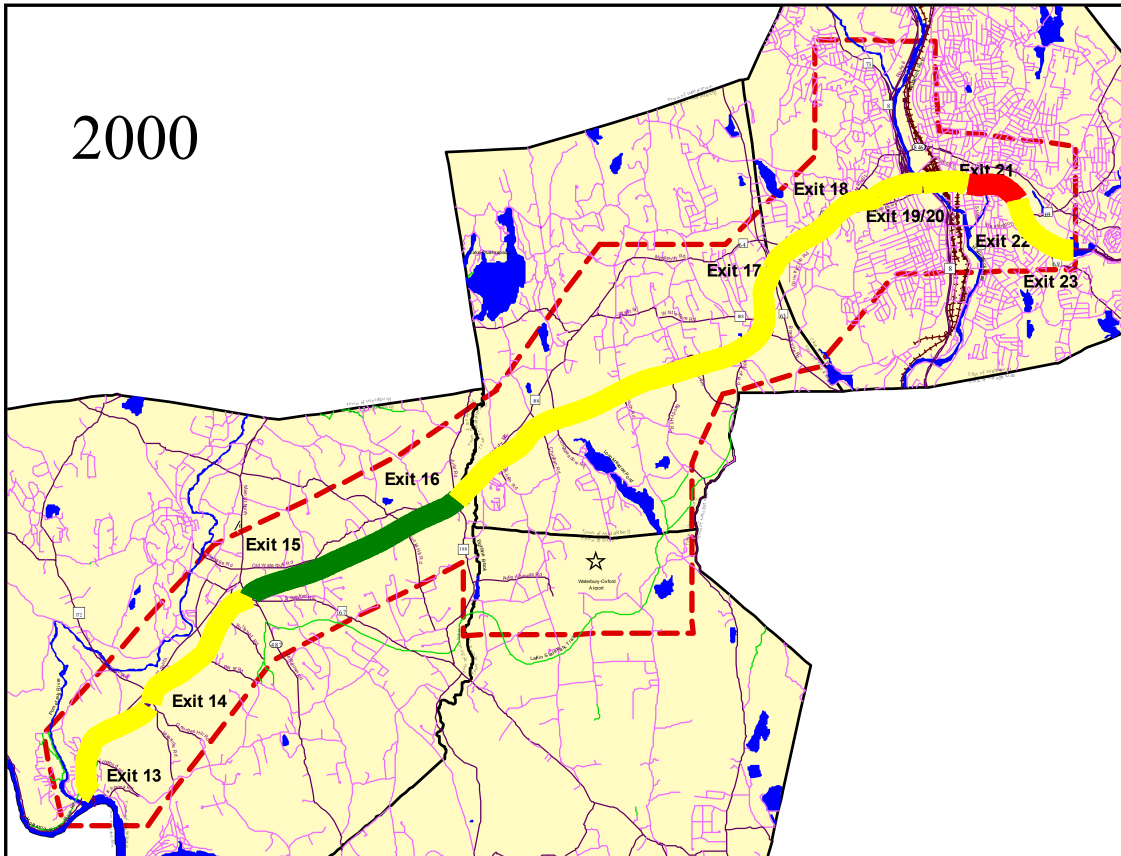
- A-C
- D
- E
- F



I-84 LOS Westbound AM Peak Period

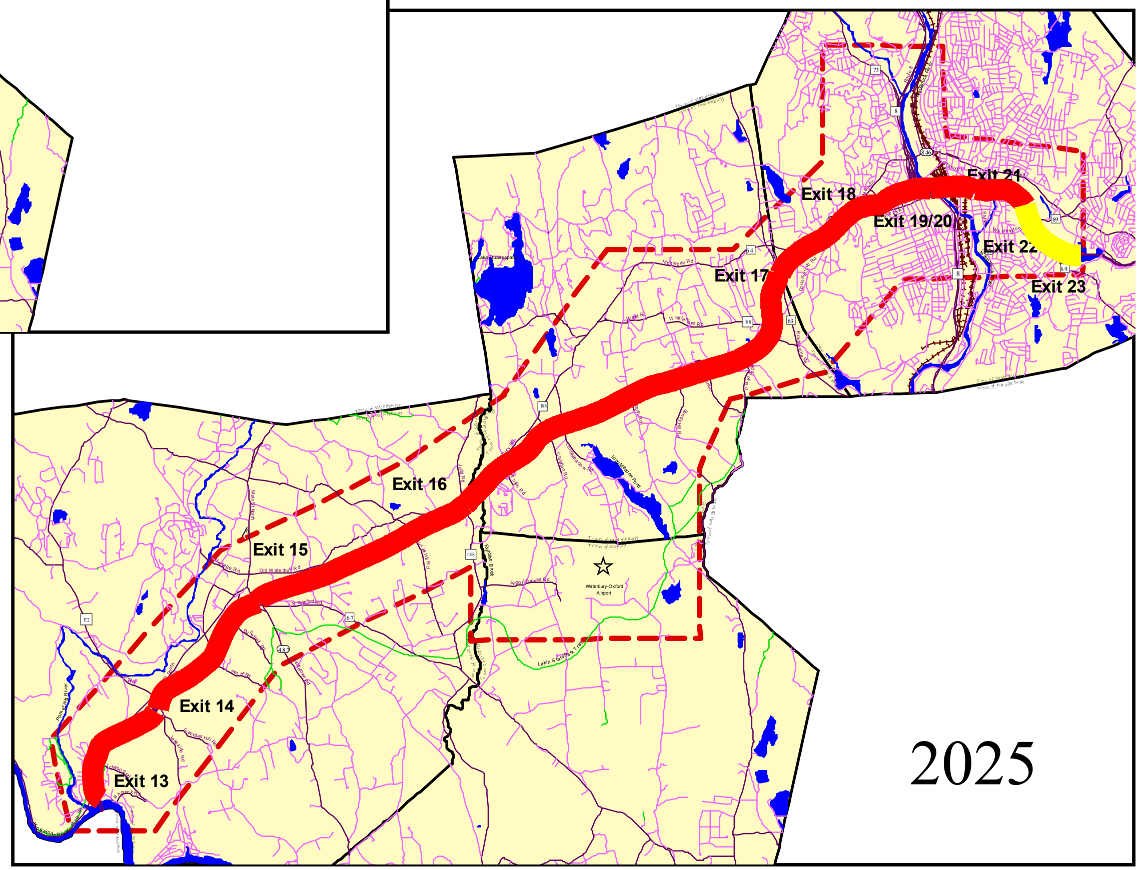
I-84 West of Waterbury (WOW)
Needs and Deficiencies Study

Figure 2.3



Level Of Service (LOS)

- A-C
- D
- E
- F



I-84 LOS Eastbound PM Peak Period

I-84 West of Waterbury (WOW) Needs and Deficiencies Study

Figure 2.4

Table 2.4
1995-1997 SLOSS Locations on I-84

Location	From Milepoint	To Milepoint	Number of Accidents	Actual Accident Rate (RA)	Critical Accident Rate (RC)	RA/RC
I-84 between Route 188 & Route 63 (rural portion)	25.30	27.94	125	0.79	0.784	1.01
I-84 at Route 63 Interchange (Interchange 17)	29.66	30.04	66	3.01	2.970	1.01
I-84 at Chase Pkwy & Highland Avenue Interchange (Interchange 18)	30.87	31.76	171	2.66	2.646	1.01
I-84 at Route 8, Meadow Street Interchange (Interchange 21)	31.77	32.91	360	3.24	2.536	1.28
I-84 at Washington and Hamilton Interchange (Interchange 23)	32.92	33.71	225	3.00	2.613	1.15

Source: ConnDOT

To better understand contributing factors, traffic incidents were compiled by year, light conditions, pavement conditions, accident severity, and accident type. Observations from these analyses are reported in this section.

Light Conditions. The number of accidents that occurred in daylight conditions for the WOW corridor was 64%. The segment of I-84 between River Road and Route 172 shows a large percentage of accidents occurring under dark, dusk or dawn conditions. More accidents occurred at night (50%) than during daylight hours (39%). Almost twice as many accidents occurred during partially dark conditions or dark conditions (61%) than in daylight (39%). The portion of I-84 between Route 188 and Route 63 experienced almost as large a percentage of accidents occurring in dark (46%) as the percentage of accidents occurring in daylight (51%).

Pavement Surface Conditions. Interchange 13 (River Road), Interchange 14 (Route 172) and Interchange 18 (Route 845) all had about 20% of accidents occurring in snowy or icy conditions.

Accident Severity. The percentage of injury accidents for the corridor as a whole was 20%. Most segments along the corridor were close to 20% injury accidents. Three segments of I-84 had particularly high percentages of injury accidents, including the interchange area of Interchange 13 (40% injury), the segment between Route 172 and Route 6 (29% injury) and the interchange area of Interchange 17 (28% injury). From analysis of the accident records, most of these accidents resulted in only minor injuries.

Four fatal accidents occurred within the corridor. Each one is described in detail below:

- The first fatality, occurring on September 15, 1997 in the rural portion of the segment between Route 188 and Route 63 (mile 27.01), was a rear end accident. Under daylight dry conditions, a westbound automobile struck a westbound truck stopped on the shoulder. Two people were killed.

- The second fatality, occurring on April 3, 1997 in the rural portion of the segment between Route 188 and Route 63 (mile 27.83), was a fixed object accident. Under dark dry conditions, an eastbound automobile struck an eastbound truck. The cause of the accident was an improper lane change. One person was killed.

- The third fatality, occurring on October 30, 1997 in the area of Interchange 21 (mile 32.62) was a sideswipe accident. Under daylight dry conditions, an eastbound automobile struck another eastbound automobile. The cause of the accident was loss of driver control. One person was killed.

- The fourth fatality, occurring on March 15, 1998 in the segment of I-84 between Route 830 (Hamilton Avenue) and Route 69 (mile 34.01), was a head-on collision. Under dark dry conditions, an eastbound automobile struck a westbound automobile. The cause of the accident was that the driver was under the influence of drugs or alcohol and went in the wrong direction on the highway. Two people were killed and one was injured.

Accident Type. Several segments if I-84 had unusually high percentages of a particular type of accident:

- Seven segments had significantly higher than average number of fixed object accidents, including I-84 from River Road to Route 172 (72%), near Interchange 14 (49%), Route 172 to Route 6 (50%), near Interchange 15 (53%), Route 6 to Route 188 (65%), Route 188 to Route 63 rural portion (47%), and near Interchange 17 (49%).

- Two segments at the eastern more congested half of the corridor, had a significantly higher than average number of rear end accidents. Interchange 22 had 45% rear end accidents and Route 830 (Hamilton Avenue) to Route 69 had 35% rear end accidents. The congestion in this area contributes to the high number of accidents, with vehicles stopping or slowing.

- The two segments at either end of the corridor, I-84 near Interchange 13 (60%) and near Interchange 23 (33%) had a significantly higher than average percentage of sideswipe accidents.

- Other segments had a slightly higher than average percentage of jack knife, overturn or moving object accidents.

Truck Related Accidents. The percentage of accidents involving trucks on I-84 is 27% for the corridor as a whole. This is significantly higher than the percentage of trucks (approximately 8%) compared to total vehicles. When compared with the average of 27%, all of the segments deviate within ± 9%. A few segments have slightly higher percentages, including the area near Interchange 16 (32% trucks) and the segments east of that (33% and 31% trucks). From observations in the field, trucks park on the shoulder in this area. In addition to this segment, the area west of Interchange 18 (36% trucks) and the Interchange 18 interchange area (36% trucks) both have a relatively high percentage of accidents involving trucks.

Other Contributing Factors. The top five typical contributing factors or causes for the accidents included:

- Driver following too close (23%)
- Driver changed lanes improperly (20%)

- Driving too fast for conditions (19%)
- Driver unable to cope with conditions and lost control (12%)
- Foreign object in road (7%)

Other factors such as driver falling asleep, slippery conditions, driver under the influence of alcohol or drugs, vehicle mechanical failure, and improper passing maneuver all contributed to less than 5% of the accidents.

2.11 Geometric Deficiencies

From the time of construction of I-84 in the early to mid-sixties, the traffic volume has increased dramatically. The highway was designed to carry approximately 35,000 vehicles daily, and has since exceeded 100,000 vehicles in some locations. This increase in traffic places a burden on the existing infrastructure and contributes to safety issues. The insufficient capacity at interchange ramps creates excessive queuing of vehicles that in some cases, affects the operation of the interstate mainline. Additionally, the changes in the practice of highway design have caused several interchanges to become sub-standard by today's criteria.

The purpose of this analysis was to identify any geometric deficiency at the interchanges within the study corridor. This included an assessment of acceleration and deceleration distances, queuing on interchange ramps, spacing between interchanges, and shoulder width.

Interchange Ramp Spacing

An analysis was performed to verify that the minimum distance between successive ramp terminals was satisfied, based on AASHTO spacing criteria. Successive ramp terminals are defined as the presence of two or more ramps (on or off) in close succession either upstream or downstream an urban freeway. A reasonable distance between successive terminals is required to provide adequate maneuvering and adequate spacing for signing. Based on this analysis, only the eastbound direction of I-84 demonstrated spacing deficiencies based on the AASHTO criteria. The locations are as follows:

- **Interchange 18** – This I-84 on ramp enters on the left hand side of the highway and has approximately 1690 feet of space to the left-hand Interchange 19 off ramp. The AASHTO minimum recommended spacing is 2000 feet.
- **Interchange 19** – The close succession of the off and on ramps to and from Route 8 have a distance of 445 feet. The requirement is that they should be at least 500 feet.
- **Interchange 19** – The on ramp from Route 8 is approximately 595 feet from the Interchange 20 on ramp. AASHTO recommends 1000 feet.
- **Interchange 20** – This interchange consists of two on ramps from downtown in close succession. They are spaced approximately 790 feet apart and the recommendation is for 1000 feet.
- **Interchange 20** – The on ramp from downtown is space 1415 feet from the off ramp at interchange 21. The recommendation is for 2000 feet.
- **Interchange 21** – The off ramp at this interchange is approximately 415 feet from the on ramp. AASHTO recommends a minimum of 500 feet.
- **Interchange 21** – The on ramp is spaced 740 feet from the off ramp at interchange 22. The recommendation is for 2000 feet.

Acceleration / Deceleration Length

Each of the 20 off ramps and 21 on ramps were evaluated to determine if the distance required to decelerate or to accelerate was available based on their current configuration. These ramps provide access to and from I-84 and local roadways and state highway systems.

To determine the acceleration distance of I-84 entrance ramps, the ramp design speed was first calculated. This was accomplished by measuring the radius of curvature of the ramp and applying methodology from A Policy on Geometric Design of Highways and Streets by the American Association of State Highway and Transportation Officials (AASHTO) – 1994 Edition, to determine design speed. Once the design speed of the ramp was determined, the distance required to accelerate from the ramp design speed to the interstate mainline speed was calculated. This distance was then compared to the actual distance that exists on the ramp today. If the calculated distance was greater than the actual ramp distance, the ramp was listed as geometrically deficient. Of the 21 on-ramps in the study corridor, 9 were determined to be geometrically deficient. Table 2.5 lists the results of the on-ramp analysis.

Similarly, the off-ramps were evaluated to verify whether existing deceleration length met current AASHTO requirements. Again, the radius of curvature of the ramp dictated the design speed. Once calculated, the speed was used to determine the length of deceleration distance that was required to decelerate from the mainline design speed. A secondary analysis was performed to determine the effect of queue lengths at signalized intersections at the ramp termini. If a vehicle queue was long enough to encroach on the minimum deceleration distance, then the ramp was noted to be deficient. Of the 20 off-ramps evaluated, 8 were determined to be geometrically deficient and one ramp was deficient based on the existence of vehicle queue. Table 2.6 lists the results of the off-ramp analysis.

Shoulder Width Analysis

A cursory examination of shoulder width was performed to gauge the existence of minimum shoulder requirements on the interstate mainline and its ramps. Aerial photographs were consulted and locations that appeared to violate AASHTO standards were noted. AASHTO criteria indicates that a 12-foot right hand shoulder (9 foot minimum) is desired on highway mainlines that are heavily traveled. The widths of shoulders on ramps vary; however, single lane ramps usually require a 10 to 12 foot breakdown lane to exist. The results of the analysis indicated that sufficient shoulders existed on all interchange ramps. Shoulder inventories for the mainline were separated by direction.

- **Eastbound -** The existing right shoulder width on I-84 eastbound measures approximately 12’ from Interchange 13 to the vicinity of the Peter Road overpass. The shoulder width then narrows from 12’ at Interchange 15 (east of the I.B.M. exit) to approximately 3’ wide. The full right shoulder reappears east of Exist 15 and maintains a 12’ width until it reaches a point approximately 350’east of Bucks Hill Road and drops back to 3’. East of Route 188, the right shoulder measures approximately 12’and then drops to approximately 3’ at a location 200’ east of South Road. The shoulder widens to 12’ on the east side of Shadduck Road and continues east to Interchange 18, where the right shoulder measures 3’ wide for the remainder of the corridor.

Table 2.5
On Ramp Assesment
I-84 West of Waterbury Needs and Deficiencies Study

Location	Direction	Curve Radius (m)	Curve Radius *(ft)*	Curve Design Speed[2] *(mph)*	Half Mainline Speed?[1] (Y/N)	Mainline Design Speed *(mph)*	Acceleration Length (m)	Acceleration Length *(ft)*	AASHTO Min. Acceleration Length[1,3] (m)	AASHTO Min. Acceleration Length[1,3] *(ft)*	Comments
Interchange 13											
	WB	125	*410*	*40*	Yes	*70*	135	*430*	400	*1315*	inadequate acceleration length
Interchange 14											
	EB	80	*260*	*30*	No	*70*	140	*445*	445	*1460*	inadequate acceleration length
	WB	385	*1260*	*50*	Yes	*70*	140	*455*	245	*805*	inadequate acceleration length
Interchange 15											
	EB	820	*2690*	*50*	Yes	*70*	235	*760*	245	*805*	inadequate acceleration length
	WB	105	*340*	*40*	Yes	*70*	465	*1515*	445	*1460*	
Interchange 16											
	EB	80	*260*	*30*	No	*70*	165	*535*	445	*1460*	inadequate acceleration length
	WB	7330	*24050*	*50*	Yes	*70*	160	*520*	245	*805*	inadequate acceleration length
Interchange 17											
	EB	260	*850*	*50*	Yes	*70*	305	*990*	245	*805*	
	WB	740	*2430*	*50*	Yes	*70*	170	*550*	245	*805*	inadequate acceleration length
Interchange 18											
	EB	215	*710*	*50*	Yes	*65*	125	*410*	145	*480*	inadequate acceleration length
	WB	325	*1070*	*50*	Yes	*65*	195	*625*	55	*185*	
Interchange 19											
	EB	29725	*97520*	*50*	Yes	*65*	75	*235*	55	*185*	
	WB	665	*2180*	*50*	Yes	*65*	165	*530*	55	*185*	
Interchange 20											
	EB	75	*250*	*30*	No	*65*	115	*375*	265	*870*	inadequate acceleration length
	EB (Rte. 8)	235	*770*	*50*	Yes	*65*	55	*175*	55	*185*	
	WB	3340	*10960*	*50*	Yes	*65*	100	*325*	55	*185*	
Interchange 21											
	EB	400	*1310*	*50*	Yes	*65*	175	*570*	55	*185*	
	WB Left	290	*950*	*50*	Yes	*65*	90	*280*	55	*185*	
	WB Right	360	*1180*	*50*	Yes	*65*	125	*410*	55	*185*	
Interchange 22											
	WB	4730	*15520*	*50*	Yes	*65*	70	*220*	55	*185*	
Interchange 23											
	EB	565	*1850*	*50*	Yes	*65*	90	*280*	55	*185*	

(1) Assumed highway design speed of 70 mph Interchange 17 & west; 65 mph Interchange 18 & east
(2) AASHTO 1994, Fig. III-20, p 197
(3) AASHTO 1994, Table X-4, p 945

Table 2.6

Off Ramp Assesment

I-84 West of Waterbury Needs and Deficiencies Study

Location	Direction	Curve Radius (m)	Curve Radius (ft)	Curve Design Speed[2] (mph)	Half Mainline Speed?[1] (Y/N)	Mainline Design Speed (mph)	Deceleration Length (m)	Deceleration Length (ft)	AASHTO Min. Deceleration Length[1, 4] (m)	AASHTO Min. Deceleration Length[1, 4] (ft)	Signalized Intersection (Y/N)	Total Ramp Length (ft)	Est. Queue Length (ft)	Comments
Interchange 13														
	EB	210	*690*	*50*	Yes	*70*	125	*395*	140	*460*	No	*N/A*	*N/A*	inadequate deceleration length
Interchange 14														
	EB	135	*440*	*40*	Yes	*70*	90	*290*	155	*510*	No	*N/A*	*N/A*	inadequate deceleration length
	WB	2670	*8760*	*50*	Yes	*70*	450	*1460*	120	*395*	No	*N/A*	*N/A*	
Interchange 15														
	EB	155	*510*	*45*	Yes	*70*	315	*1030*	155	*510*	Yes	*1030*	*385*	inadequate deceleration length
	WB	1270	*4170*	*50*	Yes	*70*	340	*1100*	120	*395*	Yes	*1100*	*1420*	with existence of queue
Interchange 16														
	EB	75	*250*	*30*	No	*70*	90	*285*	175	*575*	No	*N/A*	*N/A*	inadequate deceleration length
	WB	13060	*42850*	*65*	Yes	*70*	355	*1160*	120	*395*	Yes	*1190*	*490*	
Interchange 17														
	EB	275	*900*	*50*	Yes	*70*	165	*525*	120	*395*	Yes	*610*	*205*	
	WB	605	*1980*	*50*	Yes	*70*	340	*1115*	120	*395*	No	*N/A*	*N/A*	
Interchange 18														
	EB	75	*250*	*30*	No	*65*	120	*380*	145	*480*	Yes	*780*	*240*	inadequate deceleration length
	WB	65	*210*	*30*	No	*65*	120	*390*	145	*480*	Yes	*1790*	*175*	inadequate deceleration length
Interchange 19														
	EB	200	*660*	*50*	Yes	*65*	65	*210*	100	*330*	No	*N/A*	*N/A*	inadequate deceleration length
Interchange 20														
	EB	255	*840*	*50*	Yes	*65*	100	*325*	85	*280*	No	*N/A*	*N/A*	
	WB-A	780	*2560*	*50*	Yes	*65*	100	*325*	85	*280*	No	*N/A*	*N/A*	
	WB-B	265	*870*	*50*	Yes	*65*	55	*175*	85	*280*	No	*N/A*	*N/A*	inadequate deceleration length
Interchange 21														
	EB Meadow	170	*560*	*45*	Yes	*65*	65	*200*	120	*395*	Yes	*990*	*235*	inadequate deceleration length
	EB Market Sq	1905	*6250*	*50*	Yes	*65*	385	*1250*	85	*280*	Yes	*1390*	*440*	
	WB	400	*1310*	*50*	Yes	*65*	130	*415*	85	*280*	No	*N/A*	*N/A*	
Interchange 22														
	WB	325	*1070*	*50*	Yes	*65*	80	*250*	85	*280*	Yes	*1300*	*250*	
Interchange 23														
	WB	3055	*10020*	*50*	Yes	*65*	245	*800*	85	*280*	Yes	*885*	*195*	

(1) Assumed highway design speed of 70 mph Interchange 17 & west; 65 mph Interchange 18 & east
(2) AASHTO 1994, Fig. III-20, p 197
(4) AASHTO 1994, Table X-6, p 949

- **Westbound -** The existing right shoulder width on I-84 westbound measures approximately 12' at Interchange 13 to the vicinity of Peter Road and then narrows down to 3' for approximately 100'. The shoulder regains its full 12' width just east of Interchange 15 and then tapers down to approximately 3' at a location approximately 800' east of Rt.67 (Southford Road). The full 12' shoulder reappears at a location approximately 900' east of Bucks Hill Road until it reaches a point approximately 650' west of Long Meadow Road and narrows to 3'. The shoulder measures 12' wide again at a point 100' west of South Road and then tapers down to approximately 6-8' at a point about 600' west of Sandy Hill Road. Just east of Sandy Hill Road the shoulder drops to 3' wide to a point approximately 650' east of Route 63. The 12' shoulder reappears at the location 1000' east of Route 64 and continues west until it drops to about 6-8' between Interchanges 19 & 20. The shoulder remains at that width until it reaches Interchange 23.

2.12 Signage Deficiencies

The study team examined the current state of signage on and around I-84 and inventoried those that were missing, poorly located, or otherwise deficient. The task included field verification, photo documentation, and sign classification that was based on the following categories:

- Sign missing;
- Location;
- Legibility/Condition; and,
- Understanding.

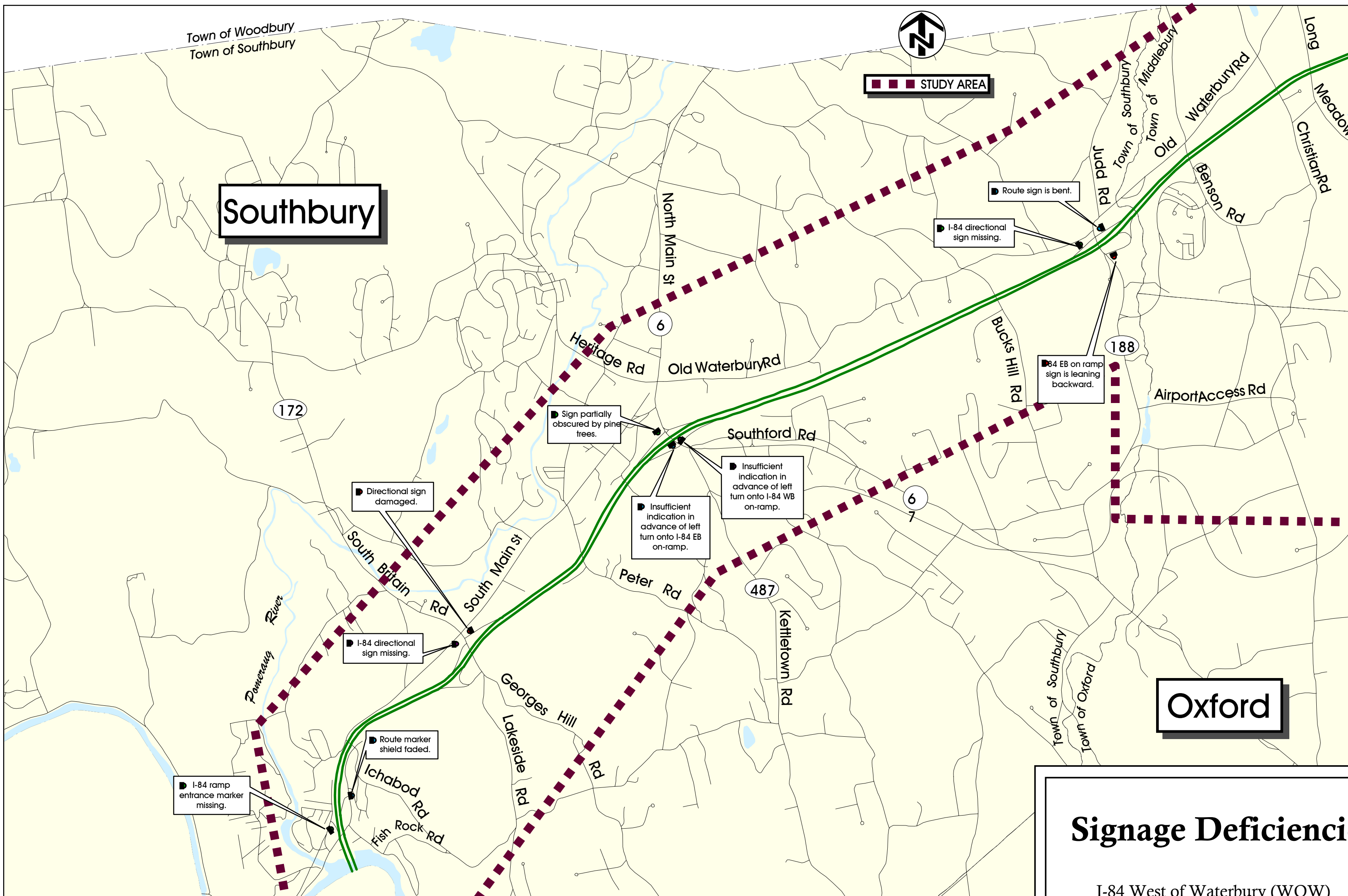
Each sign in the corridor was evaluated against these basic criteria. Many of the signs encountered only require minor maintenance to correct their deficiency, while others involve full replacement. In all, 44 signs and locations to be signed were examined.

Figures 2.5 and 2.6 illustrate the locations of the signs that failed under the above conditions. Missing signs and poor signage condition were the predominant deficiencies in this analysis. Several fell into the category of improper or poor location while a few caused driver confusion. In many instances, signs were bent, falling over, or seriously damaged. In the vicinity of Interchange 19-20 in Waterbury, the overhead interstate signs in the eastbound direction have become faded due to exposure. In the westbound direction, the signs have become covered in road soot and require cleaning.

Signage deficiencies that pose a challenge to drivers are the missing or improperly located signs. Interchanges 17 and 18 in Waterbury, due to their complex configurations, are in need of clear directional signage to the Interstate. Downtown Waterbury, in general, is poorly signed to the Interstate ramps. Locations such as the City Green, Municipal Parking Garage, and St. Mary's Hospital offer no clearly defined routes to return to I-84. In some instances where signs do exist, the route is often circuitous and confusing.

2.13 Structural Evaluation

The I-84/Route 8 Interchange viaduct and other bridge structures were constructed in the mid-sixties, and have undergone a series of retrofits over the years. These bridges are mainly composed of steel girders and concrete deck slab supported on concrete substructure.

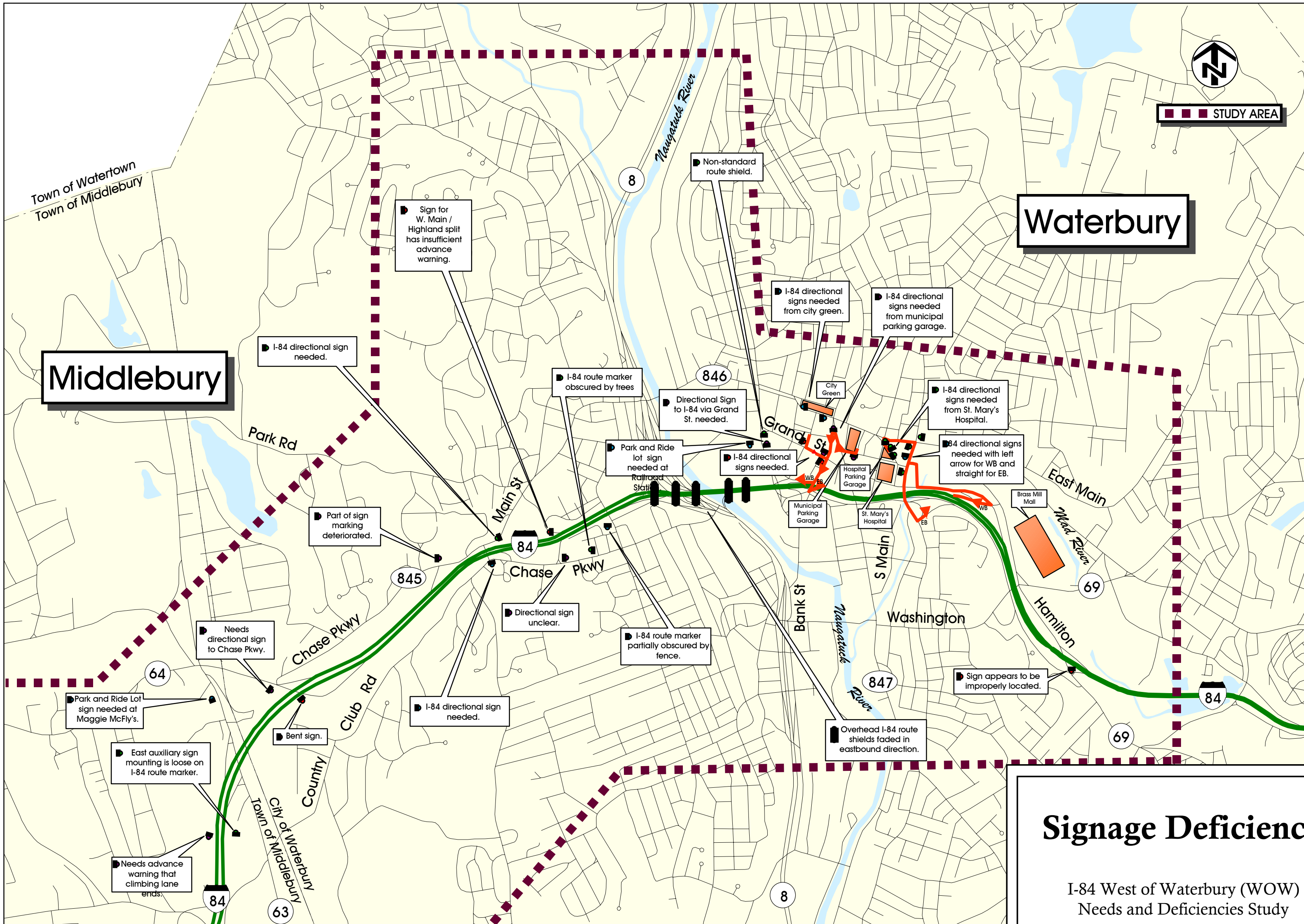


Signage Deficiencies

I-84 West of Waterbury (WOW)
Needs and Deficiencies Study

Source : Wilbur Smith Associates

Figure 2.5



Signage Deficiencies

I-84 West of Waterbury (WOW)
Needs and Deficiencies Study

Source : Wilbur Smith Associates

Figure 2.6

ConnDOT routinely inspects all structures every two years. The information contained in the latest inspection reports indicates that most of the bridges are in fair to satisfactory condition. On a scale of 1 to 10, the majority of the bridges are rated 5 and 6, indicating rehabilitation work will be needed in order to maintain their structural integrity to year 2025.

As part of this study, extra consideration is being given to the viaduct for several reasons. The poor operation of this interchange with respect to traffic and the safety issues that are associated with it constitute one set of deficiencies, while the overall condition of the structure represents another. It is important to identify each deficiency accordingly, and build a case for the need for a transportation improvement in this area. Certainly the capital investment that would have to be made would be substantial, but from an engineering standpoint, this interchange represents the most severe (and challenging) deficiency in the corridor. This study will begin to identify the needs and potential alternatives for this area. Because of the extreme complexity of the issues surrounding this interchange, a more detailed analysis will almost certainly be required as part of a subsequent study.

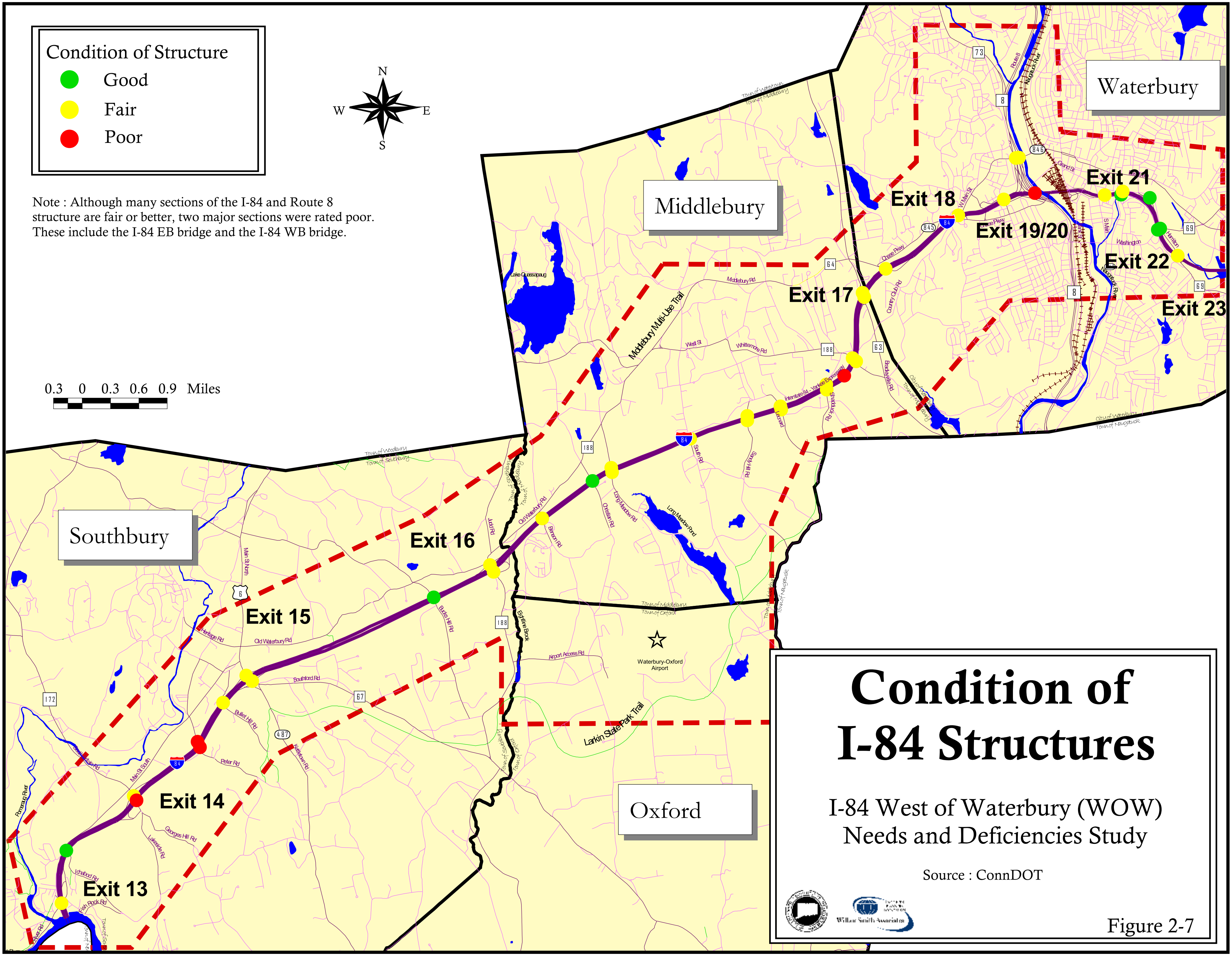
Many of bridge structures that make up Interchange 19/20 have geometric, structural, or operational deficiencies that do not meet the present ConnDOT standards. The structures evaluated have undergone a partial seismic retrofitting by ConnDOT, but they would need to be re-evaluated to determine if they comply with the present AASHTO Specifications. A fire suppression system has also been installed, but there is no clear indication as to which entity maintains and periodically tests the standpipes.

Based on the review, all of the bridges included in this interchange will require major rehabilitation consisting of:

- Concrete deck replacement;
- Construction of ‘sloped curb’ parapets;
- Elimination of numerous deck joints by making the deck slab continuous;
- Placing new membrane waterproofing and bituminous overlay;
- Cleaning and painting of structural steel;
- Rehabilitation or replacement of bridge bearings; and,
- Rehabilitation of concrete substructure.

Maintenance of traffic (MOT) on the existing bridges will be the major concern during replacement of the deck slab. Many of the turning roadways are one-lane facilities with narrow shoulders and a 6.71m (22’) bridge width. Staging of construction on these bridges to maintain traffic will be difficult.

In addition to the evaluation of the Route 8 Interchange with I-84, bridge inspection reports were reviewed for each of the remaining structures in the I-84 corridor. The purpose of this task was to inventory the current condition of these structures and identify any relevant geometric information that could indicate whether or not the structure could accommodate an additional travel lane on I-84. Figure 2.7 illustrates the location of the I-84 structures on the base map, and gives their most recent condition rating.



Condition of I-84 Structures

I-84 West of Waterbury (WOW)
Needs and Deficiencies Study

Figure 2-7

2.14 Highway Capacity Analysis

A study of capacity is important in determining the ability of a specific roadway, intersection, or freeway to accommodate traffic under various levels of service. Level of service (LOS) is a qualitative measure describing driver satisfaction with a number of factors that influence the degree of traffic congestion. These factors include speed and travel time, traffic interruption, freedom of maneuverability, safety, driving comfort and convenience, and delay.

In general there are six levels of service describing flow conditions. The highest, Level of Service A, describes a condition of free flow, with low volumes and high speeds. Level of Service B represents a stable traffic flow with operating speeds beginning to be restricted somewhat by traffic conditions. Level of Service C, which is normally utilized for design purposes, describes a stable condition of traffic operation. It entails moderately restricted movements due to higher traffic volumes, but traffic conditions are not objectionable to motorists. Level of Service D reflects a condition of more restrictive movements for motorists and influence of congestion becomes more noticeable. Level of Service E is representative of the actual capacity of the roadway or intersection and involves delay to all motorists due to congestion. The lowest, Level of Service F, is described as force flow and is characterized by volumes greater than the theoretical roadway capacity. Complete congestion occurs, and in extreme cases, the volume passing a given point drops to zero. This is considered as an unacceptable traffic operating condition.

For this study, level of service was performed for mainline freeway segments, freeway ramp junctions, freeway weaving conditions, and intersections (both signalized and un-signalized). Traffic analyses for this study was based on the 1997 Highway Capacity Manual and conducted using the Highway Capacity Software (HCS).

Mainline Capacity Analysis

In order to assess the capacity along I-84, a freeway analysis was performed during the existing and future years for the weekday morning and evening peak hour conditions. The input to the freeway analysis was the freeway geometry, free-flow speed, number of lanes, and volumes during the weekday morning and evening peak hour conditions. The results of the analysis are listed in Table 2.7.

Table 2.7
Freeway Analysis Summary

SECTION ALONG I-84	Eastbound			Westbound		
	1999	2025	Need Additional Lane?	1999	2025	Need Additional Lane?
Between Int. 13 and Int. 14	C(E)	D(F)	Yes	E(D)	F(E)	Yes
Between Int. 14 and Int. 15	C(E)	D(F)	Yes	D(D)	F(F)	Yes
Between Int. 15 and Int. 16	C(D)	D(F)	Yes	D(D)	E(E)	Yes
Between Int. 16 and Int. 17	C(E)	D(F)	Yes	D(D)	F(E)	Yes
Between Int. 17 and Int. 17	C(D)	D(E)	Yes	D(C)	E(E)	Yes
Between Int. 17 and Int. 18	D(E)	E(F)	Yes	D(E)	F(F)	Yes
Between Int. 18 and Int. 19	D(E)	F(F)	Yes	C(D)	E(E)	Yes
Between Int. 19 and Int. 20	D(E)	E(F)	Yes	D(F)	F(F)	Yes
Between Int. 20 and Int. 21	E(E)	F(F)	Yes	C(D)	D(E)	Yes
Between Int. 21 and Int. 22	E(E)	F(F)	Yes	D(E)	F(F)	Yes
Between Int. 22 and Int. 23	E(F)	E(E)*	No	E(F)	E(E)*	No

X(X) Represents LOS for AM peak hour. PM Peak LOS shown in parenthesis.
* Assumes that an additional lane will be added by 2025.

Ramp Operations

Existing Year (1999) Analysis - A freeway-ramp junction analysis is performed along I-84 in both directions during the weekday morning and evening peak hour conditions to evaluate traffic operations along I-84 and connecting ramps. The inputs to the analysis are freeway and ramp geometry, speed, and traffic volumes. The results of the freeway-ramp analyses are presented in Table 2.8.

Table 2.8
Freeway Ramp Analysis Summary

INTERCHANGE	Eastbound		Westbound	
	1999	2025	1999	2025
Interchange 13				
Off Ramp to Fish Rock Road	B(D)	C(F)	-	-
On Ramp from Oakdale Road	-	-	D(C)	F(D)
Interchange 14				
Off Ramp to Lakeside Road	B(D)	C(F)	-	-
On Ramp from Georges Hill Road	C(D)	D(F)	-	-
Off Ramp to South Britain Road	-	-	D(C)	F(F)
On Ramp From South Britain Road	-	-	D(C)	F(D)
Interchange 15				
Off Ramp to Route 67	C(D)	D(F)	C(C)	F(D)
On Ramp from Route 67/I.B.M Drive	B(D)	C(F)	D(C)	F(D)
Interchange 16				
Off Ramp to Route 188	B(D)	C(F)	C(C)	F(D)
On Ramp from Route 188	C(D)	D(F)	C(C)	E(D)
Interchange 17				
Off Ramp to Route 63	C(D)	D(F)	-	-
On Ramp from Route 64	C(D)	D(F)	-	-
Off Ramp to Route 64	-	-	D(D)	F(F)
On Ramp from Route 63	-	-	C(C)	F(D)
Interchange 18				
Off Ramp to Chase Parkway	C(D)	E(F)	-	-
On Ramp from Chase Parkway	D(E)	F(F)	-	-
Off Ramp to Main St./Highland Ave.	-	-	C(D)	E(F)
On Ramp from Chase Parkway	-	-	D(D)	F(F)
Interchange 19				
Off Ramp to Sunnyside Ave./Route 8 SB	C(C)	C(D)	-	-
Off Ramp to Route 8 NB	C(D)	D(F)	-	-
On Ramp from Highland Ave.	C(D)	D(F)	-	-
On Ramp from Route 8 SB	-	-	C(D)	E(F)
Interchange 20				
Off Ramp to Route 8 SB	-	-	D(E)	F(F)
Off Ramp to Route 8 NB	-	-	C(D)	D(F)
On Ramp from Route 8 SB	F(F)	F(F)	-	-
On Ramp from Route 8 NB	D(E)	F(F)	C(F)	F(F)
Interchange 21				
Off Ramp to Meadow St.	D(E)	F(F)	D(D)	F(F)
Off Ramp to South Main St.	D(D)	F(F)	-	-
On Ramp from Meadow St.	C(D)	F(F)	-	-
On Ramp from Bank St. (Left)	-	-	C(D)	E(F)
On Ramp from Bank St. (Right)	-	-	C(D)	F(F)
Interchange 22				
Off Ramp to Frontage Road	D(D)	F(F)	-	-
Off Ramp to Union St.	-	-	C(C)	D(F)
On Ramp from Union St.	-	-	D(E)	F(F)
Interchange 23				
Off Ramp to Hamilton Ave.	-	-	F(F)	F(F)
On Ramp from Hamilton Ave.	F(F)	F(F)	-	-

Weaves

In order to evaluate traffic operations along the freeway, a weaving analysis is necessary where the freeway consists of on-ramps followed by off-ramps at close proximity to each other. In this study area, weaving analysis was performed in the Waterbury area where a number of such operations take place along I-84 in the eastbound and westbound directions. The following weaves were identified for evaluation:

- Route 8 NB On-Ramp to Meadow Street Off-Ramp (Eastbound Direction)
- Meadow Street On-Ramp to Route 8 NB (Westbound Direction)
- Meadow Street On-Ramp to Route 8 SB (Westbound Direction)
- Route 8 Southbound to Highland Avenue Interchange 18 Off-Ramp (Westbound Direction)

Additionally, peak hour surveillance of the Route 8/I-84 interchange was performed to assess the number of vehicles that attempt the weave from Route 8 southbound to the downtown Waterbury exit ramps at Interchanges 21 and 22. While this movement is prohibited, and signed as such, it was noted that only a couple vehicles actually performed this weave during each of the morning and afternoon peak periods. More vehicles may violate this maneuver during off-peak hours when the traffic volumes are not as high. This is a serious safety issue because the off-peak traffic is also traveling at a higher rate of speed, and a higher probability of serious accidents exists.

In order to evaluate weaving operations along I-84, freeway and ramp geometry, freeway and ramp speeds, and length of weaving section (distance between on and off ramps) were used as inputs. The results of the weaving analyses are summarized in Table 2.9.

Table 2.9
Weaving Analysis Summary

SECTION ALONG I-84	**1999**		**2025**	
	AM	**PM**	**AM**	**PM**
Eastbound Direction				
Route 8 NB to Meadow Street	E	E	F	F
Westbound Direction				
Meadow Street to Route 8 NB	C	E	E	F
Meadow Street to Route 8 SB	D	E	F	F
Route 8 Southbound to Highland Avenue	D	D	F	F

Signalized Intersection Analysis

Signalized intersection analyses were performed at study area intersections during the weekday morning and evening peak hour conditions for existing year conditions. The signal plans used for traffic analyses were provided by ConnDOT as well as the City of Waterbury. The results of the LOS analysis for existing and future conditions are shown in Table 2.10.

Table 2.10
Capacity Analysis Summary - Signalized Intersections

INTERSECTION	1999		2025	
	AM	PM	AM	PM
Interchange 14				
South Main St. and South Britain Rd.	C	D	E	F
Interchange 15				
I-84 EB Ramps and Route 6/Route 67	B	C	B	C
I-84 WB Ramps and Route 6/Route 67	D	C	E	D
N. Main St. and Heritage/Old Waterbury	C	C	F	E
Main Street and Southford/Shopping Plaza	F	F	F	F
Route 487/67 and Community House Rd.	C	C	C	D
Interchange 16				
I-84 WB Ramps and Route 188	C	C	D	D
Old Waterbury Road and Route 188	D	C	F	F
Interchange 17				
I-84 EB Off Ramp and Route 63	B	B	B	B
Route 63 and Route 188	B	E	E	F
Route 63 and Country Club Road	E	E	F	F
Route 63 and Route 64	F	F	F	F
Interchange 18				
I-84 EB Off Ramp and Chase Parkway	B	B	B	C
I-84 WB Off Ramp and W. Main St.	F	F	F	F
Chase Parkway and W. Main St.	B	C	F	F
Chase Parkway and Sunnyside/Highland	D	D	E	F
Chase Parkway and Country Club Road	C	C	F	E
Interchange 19-20				
Sunnyside Ave. and Riverside St.	C	B	F	C
Freight St. and Riverside NB	C	C	C	D
Freight St. and Riverside SB	E	C	F	C
W. Main St. and Riverside NB	C	C	D	F
W. Main St. and Riverside SB	E	E	F	F
Interchange 21				
I-84 EB On Ramp and Meadow St.	B	C	C	C
I-84 EB Off Ramp and Meadow St.	B	C	C	C
Willow Street and W. Main Street	C/E^	E/F^	F/F^	F/F^
Willow Street and Freight Street	D/D^	D/D^	F	E
Meadow Street and Grand Street	E	C	F	D
Grand Street and Bank Street	C/C^	C/D^	C/D^	D/F^
Grand Street and S. Main Street	C/D^	C/F^	C/F^	D/F^
Union Street and S. Elm Street	C/E^	D/F^	E/F^	F/F^
Meadow Street and Bank Street	C	C	C	C
Market Square/I-84 EB Off and Main St.	C	C	C	C
Meadow Street and Field Street	B	C	B	C
Interchange 22				
I-84 EB On Ramp and Baldwin St.	B	B	B	B
I-84 WB Off Ramp and Hamilton/Union	C	C	E	D
Union Street and Brass Mill Mall	A	B	A	B
Union Street and Mill Street	B	B	C	C
Mill Street and Baldwin Street	C	C	C	D
Interchange 23				
I-84 WB On Ramp and Hamilton Ave.	B	C	D	D
I-84 WB Off Ramp and Hamilton Ave.	B	C	B	C
I-84 EB On Ramp and Hamilton Ave.	C	C	C	F
Washington Street and Silver/Hamilton	E	F	F	F

^ With pedestrian phase

Un-signalized Intersections

Un-signalized intersection analysis was performed at stop sign controlled intersections in the study area. Roadway geometry and traffic volumes were used as input for the analysis. Table 2.11 summarizes the results of the LOS analyses for un-signalized intersections:

Table 2.11
Capacity Analysis Summary - Un-signalized Intersections

INTERSECTION	1999		2025	
	AM	PM	AM	PM
Interchange 13				
I-84 EB Off Ramp and Fish Rock Rd.	B	B	B	C
Fish Rock Rd. and Ichabod Rd.	A	A	A	B
Ichabod Rd. and Russian Village Rd.	B	B	B	B
Interchange 14				
I-84 WB Off Ramp and South Britain Rd.	C	D	D	F
I-84 EB Off Ramp and South Britain Rd.	A	C	B	F
Interchange 16				
I-84 EB Off Ramp and Route 188	C	B	E	C
Interchange 17				
I-84 WB Off Ramp and Chase Parkway	F	F	F	F
Interchange 18				
I-84 WB Off Ramp and Highland Avenue	C	F	F	F
Country Club Road and Oronoke Road	F	F	F	F
Interchange 19-20				
I-84 EB Off Ramp and Sunnyside Avenue	B	B	B	B
Interchange 21				
I-84 WB Off Ramp and Field Street	F	C	F	D

Source: Wilbur Smith Associates