6.0 Transportation Analysis

6.1 Introduction

While hurricanes are relatively unusual for Connecticut, tropical cyclones pushing north can impact the state bringing dangerous weather conditions to its residents and visitors. These storm systems can bring flooding along the coast from storm surge and inland flooding from excessive rainfall, as well as tornadoes and associated wind damage. During these events, state and local emergency management officials may be required to call for evacuations of the Connecticut coast. These protective action decisions could result in the local and regional road network having to process a significant number of vehicles in a relatively short period of time. Congestion, especially during the summer, can be quite heavy. Frequent daily backups occur from just normal daily traffic demands; therefore, massive traffic congestion in the event of an evacuation could be a realistic possibility.

Based on the results of this transportation model, Connecticut enjoys very reasonable clearance times; that is to say most communities can successfully evacuate in the alert time created by a Hurricane Warning from the National Hurricane Center (NHC). In fact, most clearance times, except in the cases of Stamford, Old Saybrook and the western-most communities along the I-95 corridor during a simultaneous evacuation of New York City, do not exceed the mobilization times which are used to load the evacuation roadway network. Evacuating households in most communities, notwithstanding accidents or other incidents that negatively impact traffic flow, will not encounter significantly worse traffic queues than normal as a result of evacuation orders. Nonetheless, Connecticut's shoreline is densely populated with sizeable cities dotted along its entire extent; therefore, daily rush hours will surely complicate an evacuation, especially if it has to be initiated in the middle of a normal weekday or during the beginning or end of a normal business day. Another complicating factor is a simultaneous evacuation in New York City, but even those impacts will not cause the clearance times for the western-most communities along the coast to exceed the response period created by the issuance of a Hurricane Warning from the NHC.

In 2012, the Federal Emergency Management Agency (FEMA) and the United States Army Corps of Engineers (USACE), New England District, funded the Southern New England Hurricane Evacuation Study (HES). That same year, Atkins was retained to complete the HES transportation analysis and then the Technical Data Report (TDR). The HES develops technical data concerning hurricane hazards, the vulnerability of the resident and tourist populations; public response to evacuation advisories; evacuation timing; and sheltering needs for various hurricane threat situations. A critical component in the HES is the transportation analysis to determine how many people and vehicles would be involved if a hurricane forced an evacuation of Connecticut's coastal jurisdictions.

6.0 Transportation Analysis

The principal purpose of the transportation analysis is to: 1) determine the time required to evacuate the vulnerable population (clearance times), and 2) evaluate general traffic control measures that could improve the flow of evacuating traffic. This chapter documents the basic inputs and findings of the study analysis. The list of the jurisdictions involved in the Connecticut HES TDR is displayed in Table 6-1, and a map of the study area is located in Figure 6-1.

Table 6-1: Connecticut HES TDR Study Area

County	Community
Fairfield County	Bridgeport
	Darien
	Fairfield
	Greenwich
	Norwalk
	Stamford
	Stratford
	Westport
Middlesex County	Chester
	Clinton
	Deep River
	Essex
	Old Saybrook
	Westbrook
New Haven County	Branford
	East Haven
	Guilford
	Hamden
	Madison
	Milford
	New Haven
	North Haven
	West Haven
New London County	East Lyme
	Groton
	Ledyard
	Lyme
	Montville
	New London
	Old Lyme
	Preston
	Stonington
	Waterford

6.0 Transportation Analysis

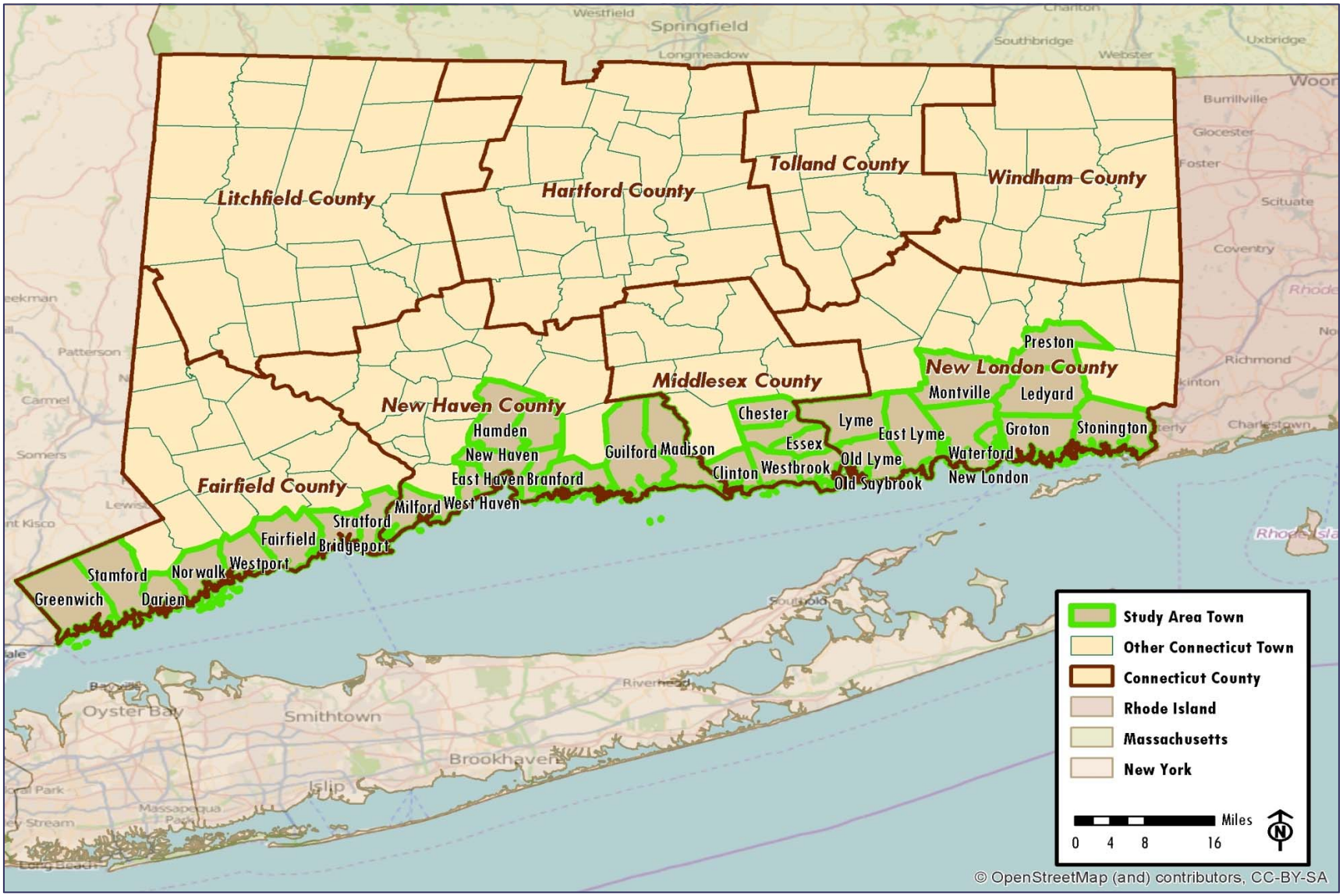

Figure 6-1: Connecticut HES TDR Study Area

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6.2 Analysis Objectives

During a hurricane evacuation, a large number of vehicles will have to travel through the local and regional road network. The number of evacuating vehicles will vary depending upon the intensity of the hurricane, publicity and warnings given about the storm, and certain behavioral response characteristics of the vulnerable population. During a typical evacuation, vehicles enter the road network at different times depending on the evacuees' response relative to an evacuation order or storm advisory. Conversely, vehicles leave the roadway system depending on both the planned destinations of evacuees and the availability of acceptable destinations, such as public shelters, hotel/motel units, churches, and friend's or relative's homes in non-surge prone areas. Vehicles move across the road network from trip origin to destination at a speed dependent on the rate of traffic flowing on various roadway segments, and the number of vehicles per hour those segments can handle. Clearance times must be calculated and evacuation advisories issued so that evacuees can reach a relatively safe destination prior to the arrival of sustained tropical storm force winds.

The main objective of the transportation analysis performed for the Connecticut HES TDR was to estimate evacuation clearance times. A clearance time is defined as the time it takes to clear the roadway of all evacuating vehicles. To make these estimates, the evacuation road network had to be defined and general traffic control issues had to be examined. Clearance time is a value resulting from transportation engineering analysis performed under a specific set of assumptions. During an actual tropical cyclone event, it must be considered in conjunction with a pre-landfall hazards time to determine the optimal timeframe for issuing an evacuation order. The pre-landfall hazards time is the period before the forecast arrival of tropical storm force winds and/or the onset of roadway flooding prior to landfall of a hurricane.

The transportation analysis task initially identified traffic movements associated with a hurricane evacuation. Basic assumptions for the transportation analysis were related to storm scenarios, vulnerable population, behavioral and socioeconomic characteristics, as well as the roadway system and traffic control. A transportation model and the evacuation roadway system were developed for the Connecticut study area to facilitate model application and development of clearance times. The major components involved in the transportation analysis were as follows:

1. Establish evacuation zones with the cooperation of Connecticut's state and local emergency management agencies;
2. Quantify the potential evacuation population for each storm scenario using socioeconomic and behavioral data;

3. Identify the existing evacuation roadway network, recognizing any recent or future infrastructure improvements, as well as state and local traffic control measures;
4. Using the evacuation road network develop:
   - Directional service volume per roadway segment;
   - Evacuation traffic congestion by roadway segment by storm scenario;
5. Identify local and regional bottlenecks/critical roadway segments;
6. Determine regional evacuation traffic that is expected to cross state and local lines and move inland;
7. Use evacuation zones and traffic management plans to complete transportation modeling and clearance time calculations;
8. Develop hurricane evacuation clearance times.

6.3 Transportation Analysis and Input Assumptions

Since all hurricanes differ from one another, it is necessary to establish clear assumptions about storm characteristics and evacuees' expected responses before transportation modeling can begin. Not only does a storm vary in its track, intensity, and size, but also in the way the populations in vulnerable areas perceive it. Even the time of day that a storm makes landfall influences the time parameters of an evacuation. All these factors can have a major impact on evacuation response timing and hence the clearance times ultimately developed by this analysis.

Given that a real tropical cyclone’s characteristics may well differ from the simulated storms used to develop the clearance times provided in this analysis, a sensitivity analysis was performed during the transportation modeling. Since many of the factors that influence an evacuation can change dramatically prior to a storm making landfall, the sensitivity analysis determines which model variables will have the most impact on the transportation analysis results. Therefore, those characteristics (storm intensity, level of background traffic, tourist occupancy, traffic loading rate, etc.) having the greatest influence on clearance times were identified and then varied to establish the logical range within which the input values may fall. Key assumptions guiding the transportation analysis include the following:

- Traffic evacuation zones;
- Housing Unit and Population Data;
- Behavioral Assumptions of the Evacuating Population;
- Roadway Network and Traffic Control Assumptions.

6.4 Traffic Analysis Zones

The foundational geographical unit of this transportation analysis is a system of hurricane evacuation zones established by USACE, FEMA, state and local emergency management officials for every surge vulnerable community in the state. The hurricane evacuation zones used in this study are based on vulnerability data provided by the USACE, New England District in the form of the storm tide limits delineated in the storm surge maps. The storm surge maps were developed from the results of the National Oceanic and Atmospheric Administration's (NOAA) Sea, Lake and Overland Surges from Hurricanes (SLOSH) model for the New York 3 and Providence/Boston 2 Basins.

The primary purpose of the hurricane evacuation zones is to specify which locales and populations will be directed to evacuate by local emergency management in response to Category 1 through 4 storms. Where possible, the evacuation zone boundaries depicted in Chapter 3 of this study are tied to identifiable landmarks, such as roads, and other features like community boundaries. These evacuation zones can also be combined to encompass more than one hurricane evacuation scenario. In the case of this study, category 1 and 2 evacuation scenarios, and category 3 and 4 scenarios were combined to form evacuation zones A and B respectively. These evacuation zones are the basis for the traffic analysis zones used in this transportation study described in this chapter. Therefore, the traffic analysis zones in this chapter exactly mimic the hurricane evacuation zones depicted in Chapter 3 of the TDR.

It is important to note that state and local officials are responsible for ensuring that the hurricane evacuation zones encompass all surge, and where applicable wind vulnerable residents and that evacuation advisories during a hurricane threat will adequately direct those living in evacuation zones to take action. Maps of the traffic analysis zones for each individual jurisdiction are provided in Figures 6-2 through 6-25 as listed below, and are also available in the File Bank section as interactive maps:

- Figure 6-2: Traffic Analysis Zones – Fairfield County / Bridgeport
- Figure 6-3: Traffic Analysis Zones – Fairfield County / Darien
- Figure 6-4: Traffic Analysis Zones – Fairfield County / Fairfield
- Figure 6-5: Traffic Analysis Zones – Fairfield County / Greenwich
- Figure 6-6: Traffic Analysis Zones – Fairfield County / Norwalk
- Figure 6-7: Traffic Analysis Zones – Fairfield County / Stamford
- Figure 6-8: Traffic Analysis Zones – Fairfield County / Stratford
- Figure 6-9: Traffic Analysis Zones – Fairfield County / Westport
- Figure 6-10: Traffic Analysis Zones – Middlesex County / Clinton

- Figure 6-11: Traffic Analysis Zones – Middlesex County / Old Saybrook
- Figure 6-12: Traffic Analysis Zones – Middlesex County / Westbrook
- Figure 6-13: Traffic Analysis Zones – New Haven County / Branford
- Figure 6-14: Traffic Analysis Zones – New Haven County / East Haven
- Figure 6-15: Traffic Analysis Zones – New Haven County / Guilford
- Figure 6-16: Traffic Analysis Zones – New Haven County / Madison
- Figure 6-17: Traffic Analysis Zones – New Haven County / Milford
- Figure 6-18: Traffic Analysis Zones – New Haven County / New Haven
- Figure 6-19: Traffic Analysis Zones – New Haven County / West Haven
- Figure 6-20: Traffic Analysis Zones – New London County / East Lyme
- Figure 6-21: Traffic Analysis Zones – New London County / Groton
- Figure 6-22: Traffic Analysis Zones – New London County / New London
- Figure 6-23: Traffic Analysis Zones – New London County / Old Lyme
- Figure 6-24: Traffic Analysis Zones – New London County / Stonington
- Figure 6-25: Traffic Analysis Zones – New London County / Waterford

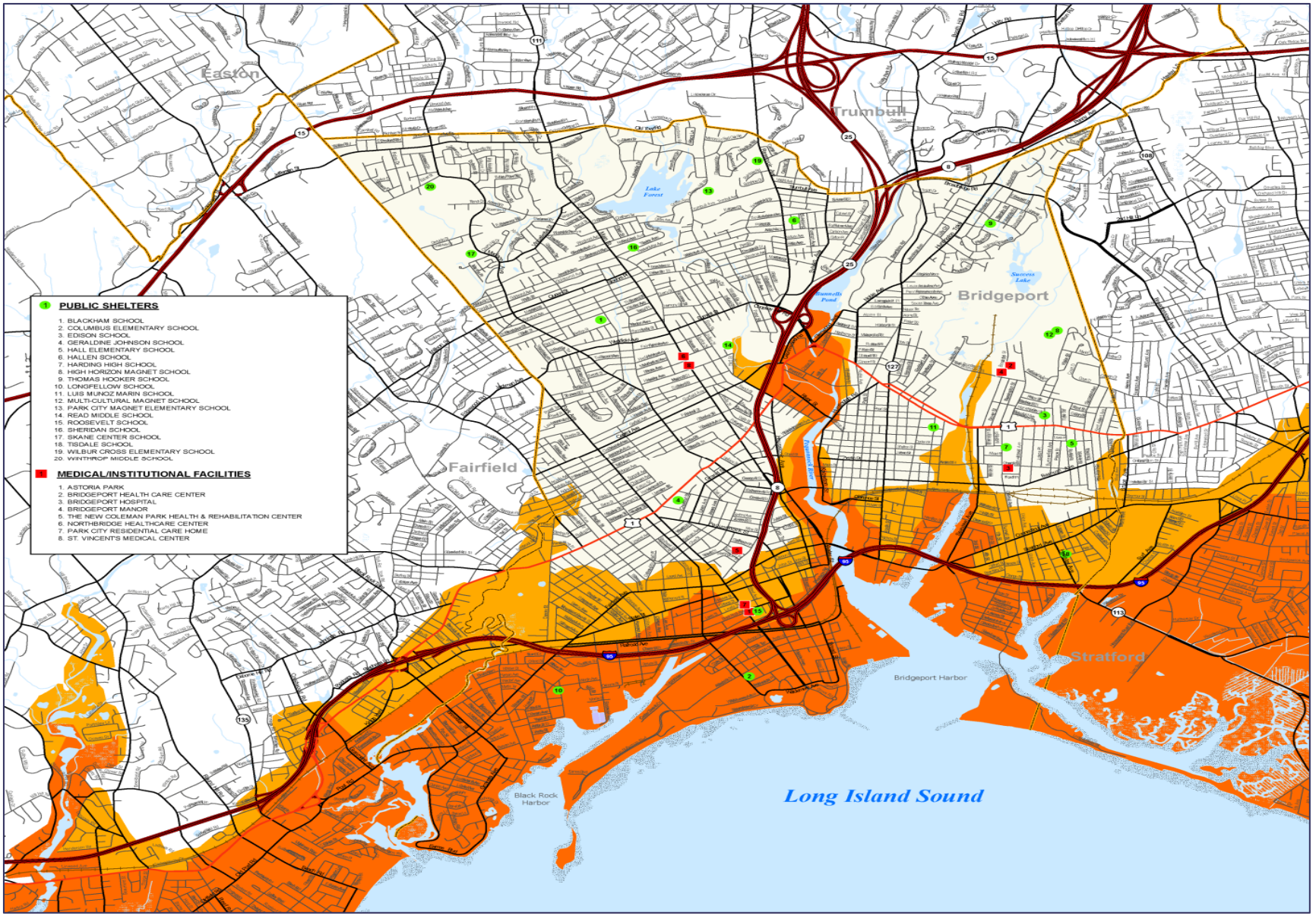

Figure 6-2: Traffic Analysis Zones – Fairfield County / Bridgeport

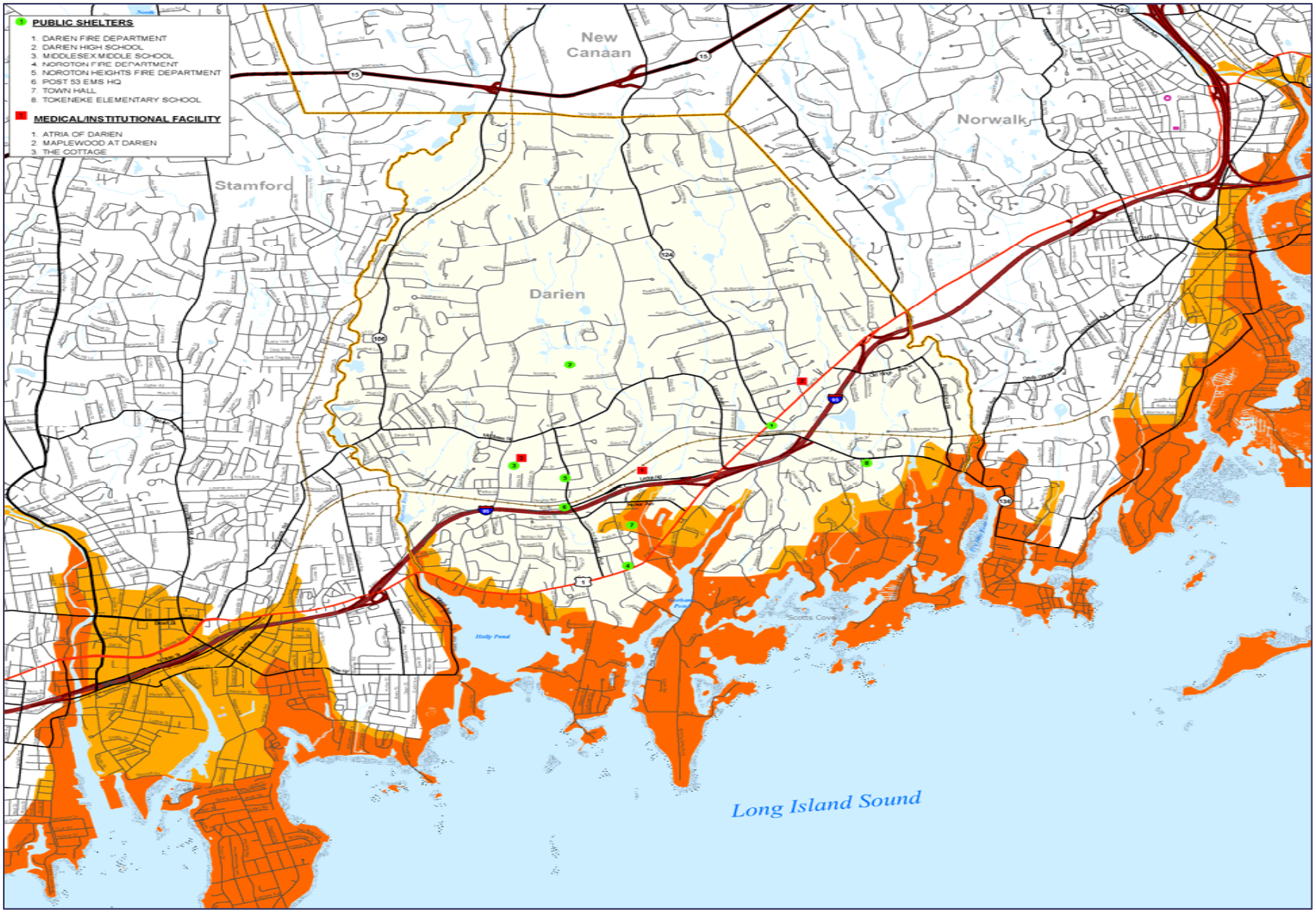

Figure 6-3: Traffic Analysis Zones – Fairfield County / Darien

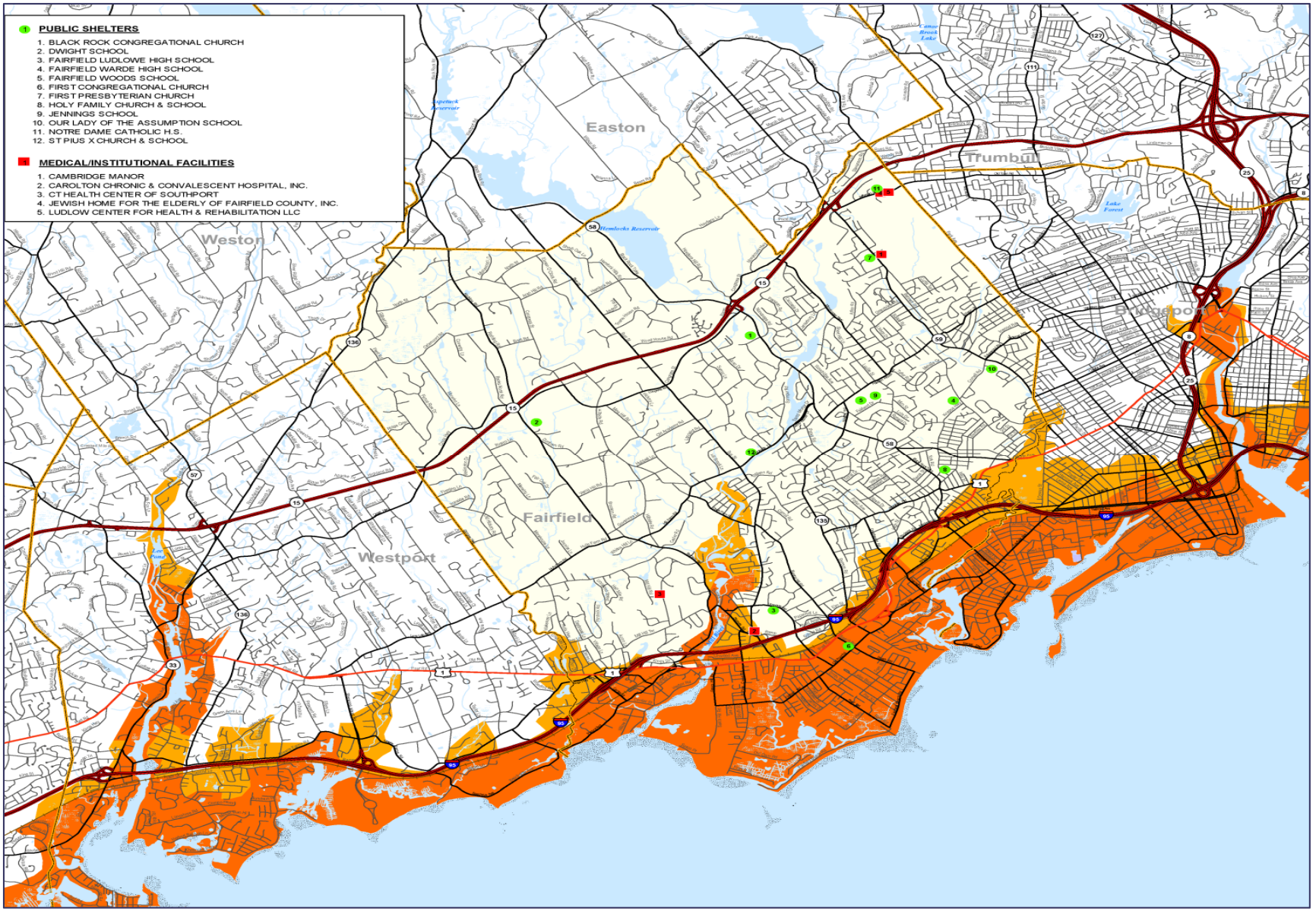

Figure 6-4: Traffic Analysis Zones – Fairfield County / Fairfield

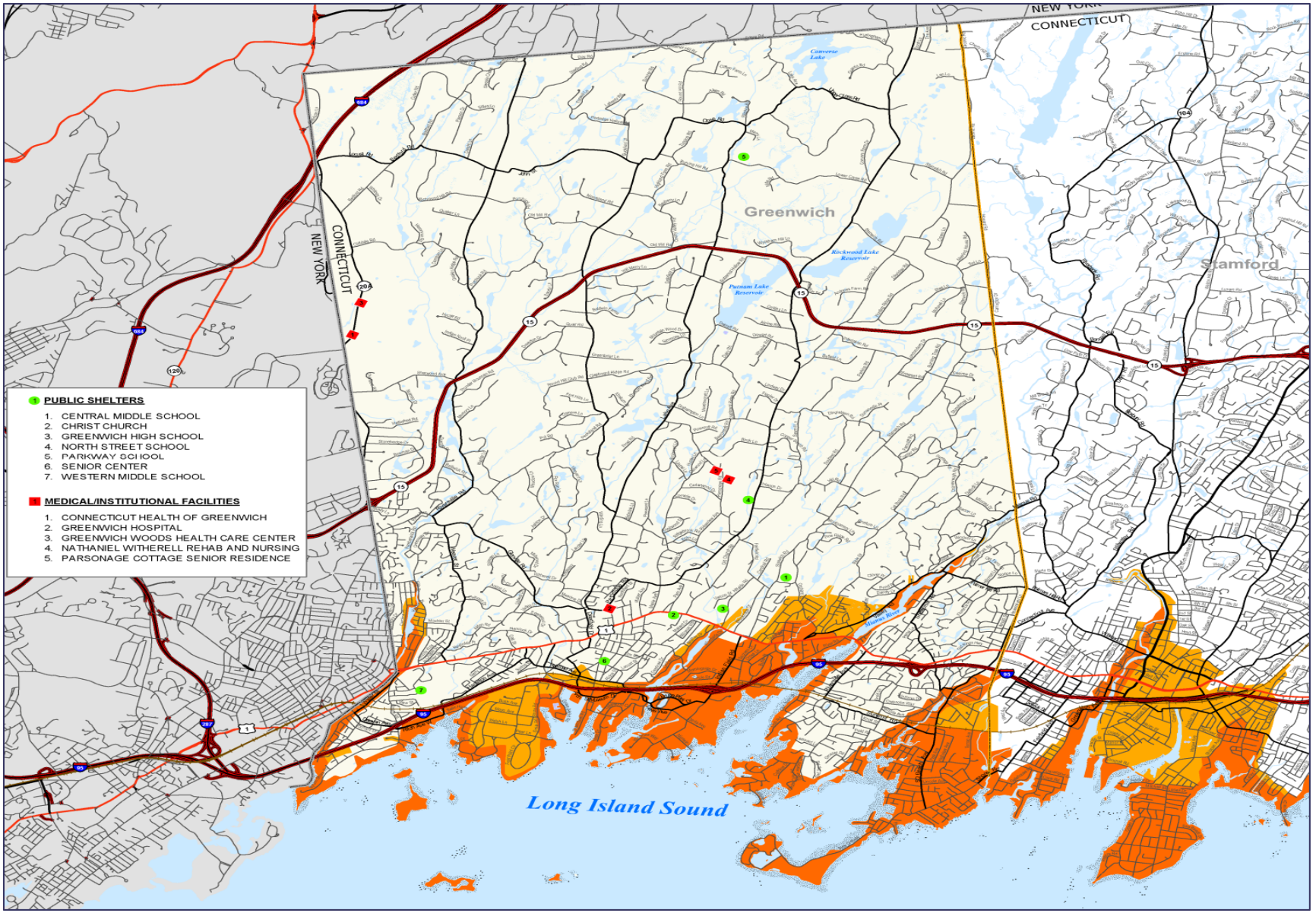

Figure 6-5: Traffic Analysis Zones – Fairfield County / Greenwich

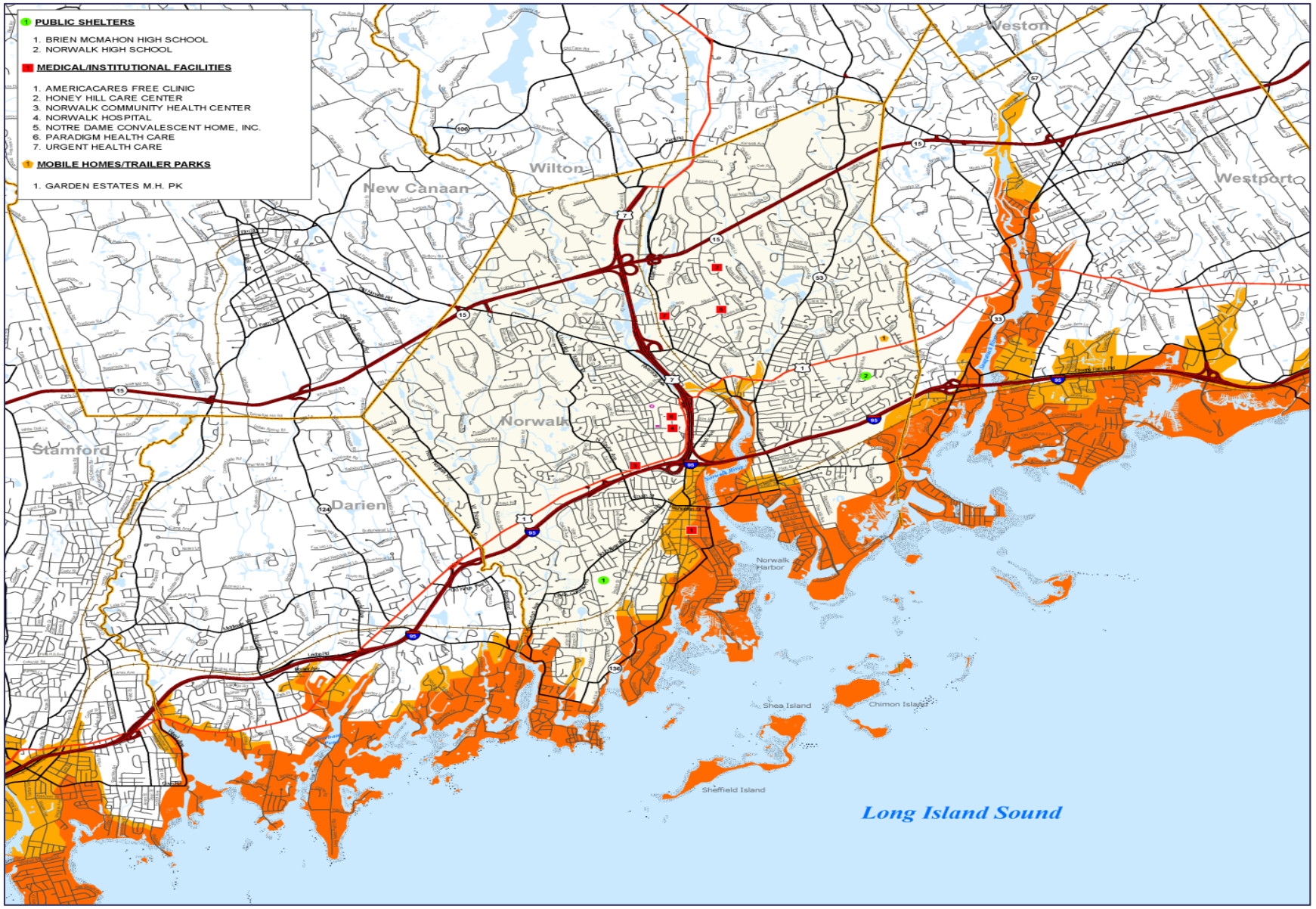

Figure 6-6: Traffic Analysis Zones – Fairfield County / Norwalk

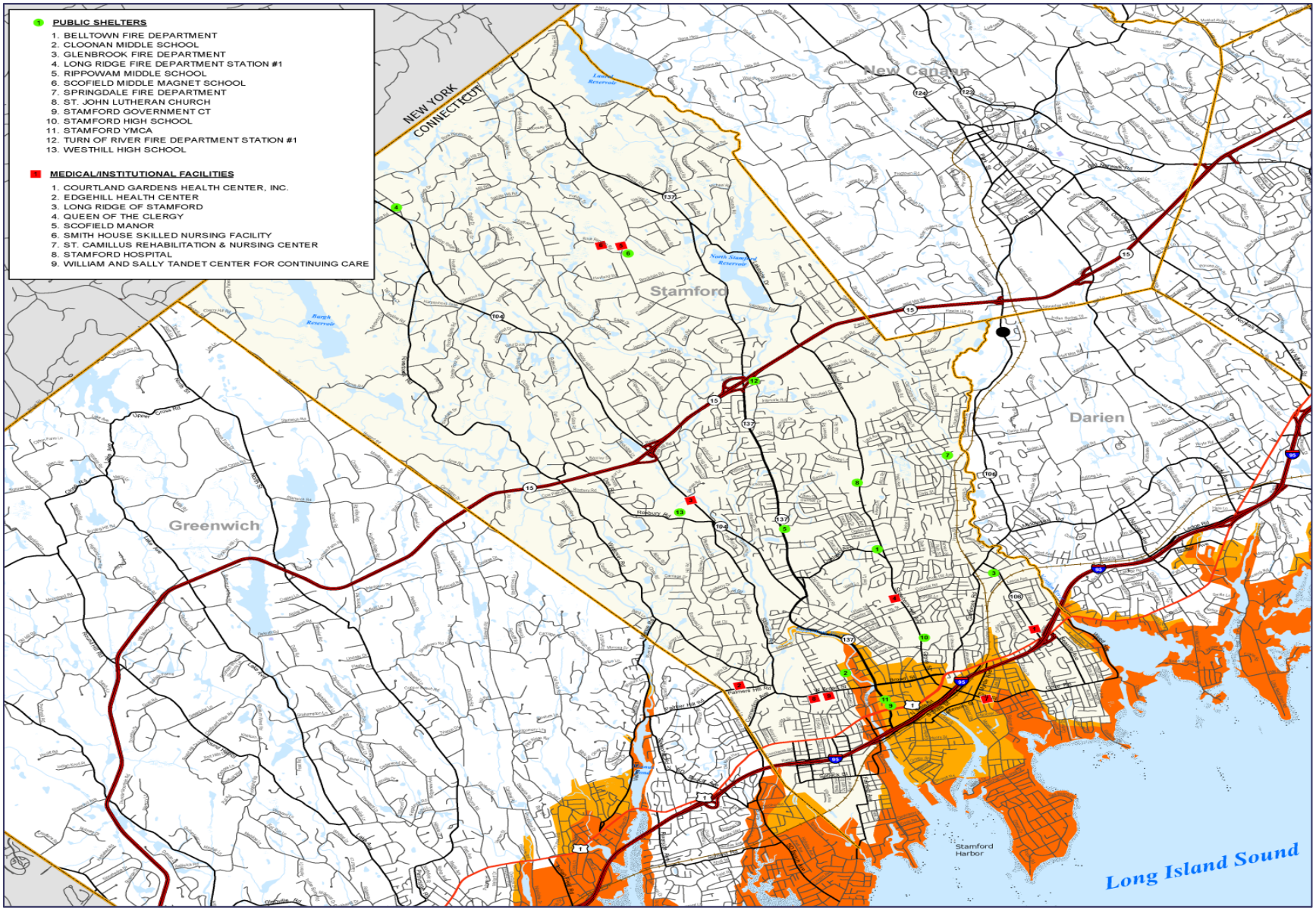

Figure 6-7: Traffic Analysis Zones – Fairfield County / Stamford

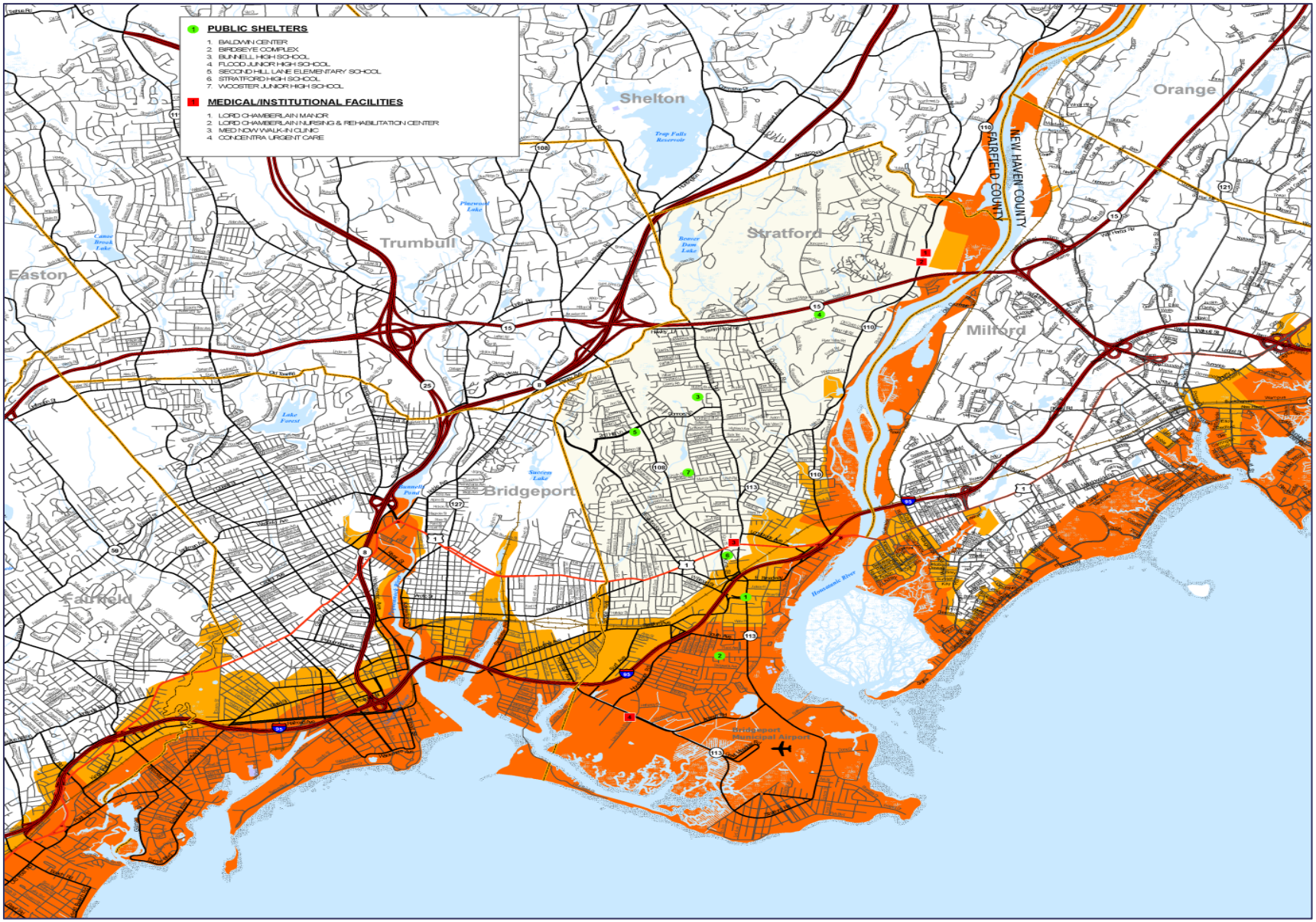

Figure 6-8: Traffic Analysis Zones – Fairfield County / Stratford

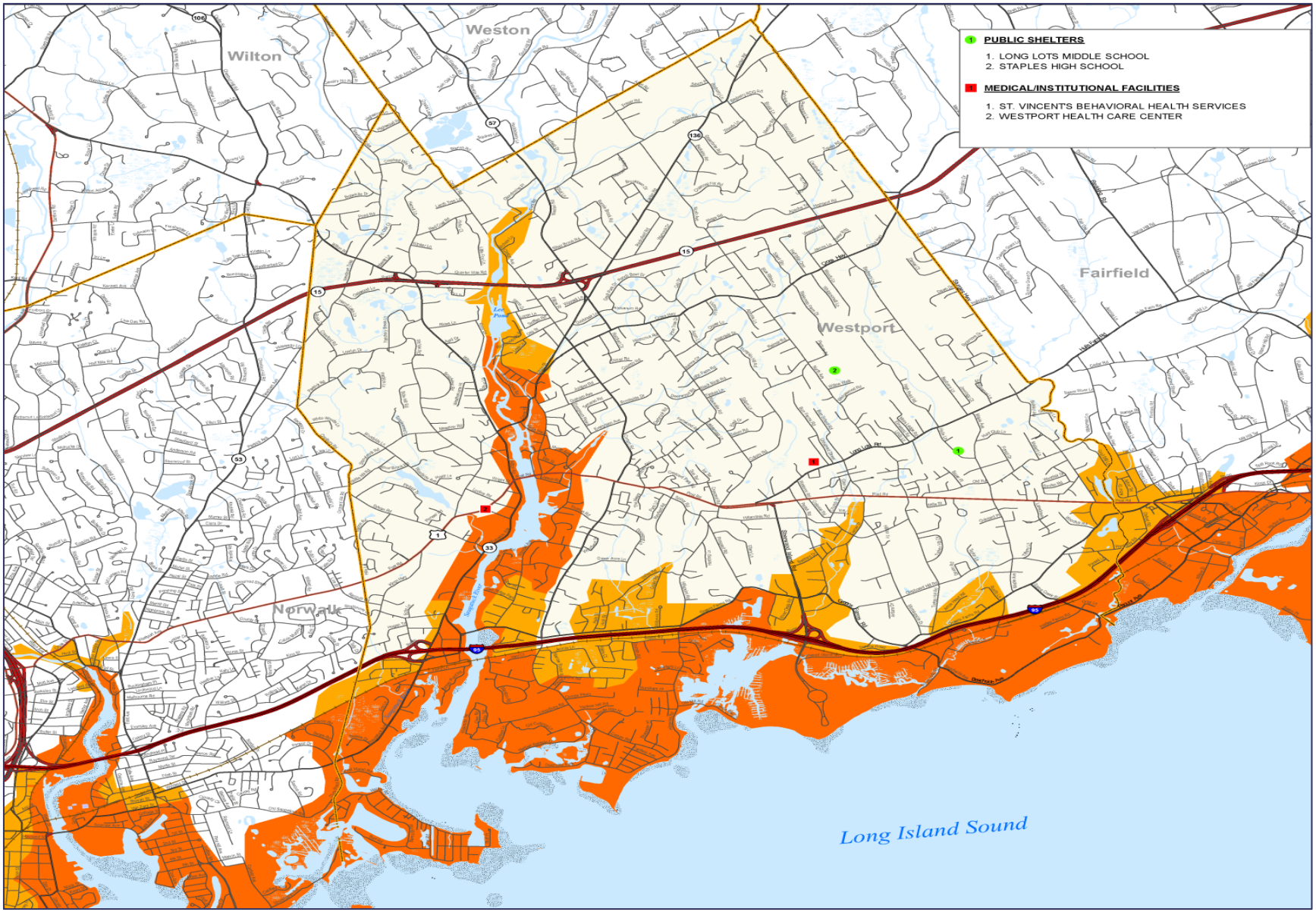

Figure 6-9: Traffic Analysis Zones – Fairfield County / Westport

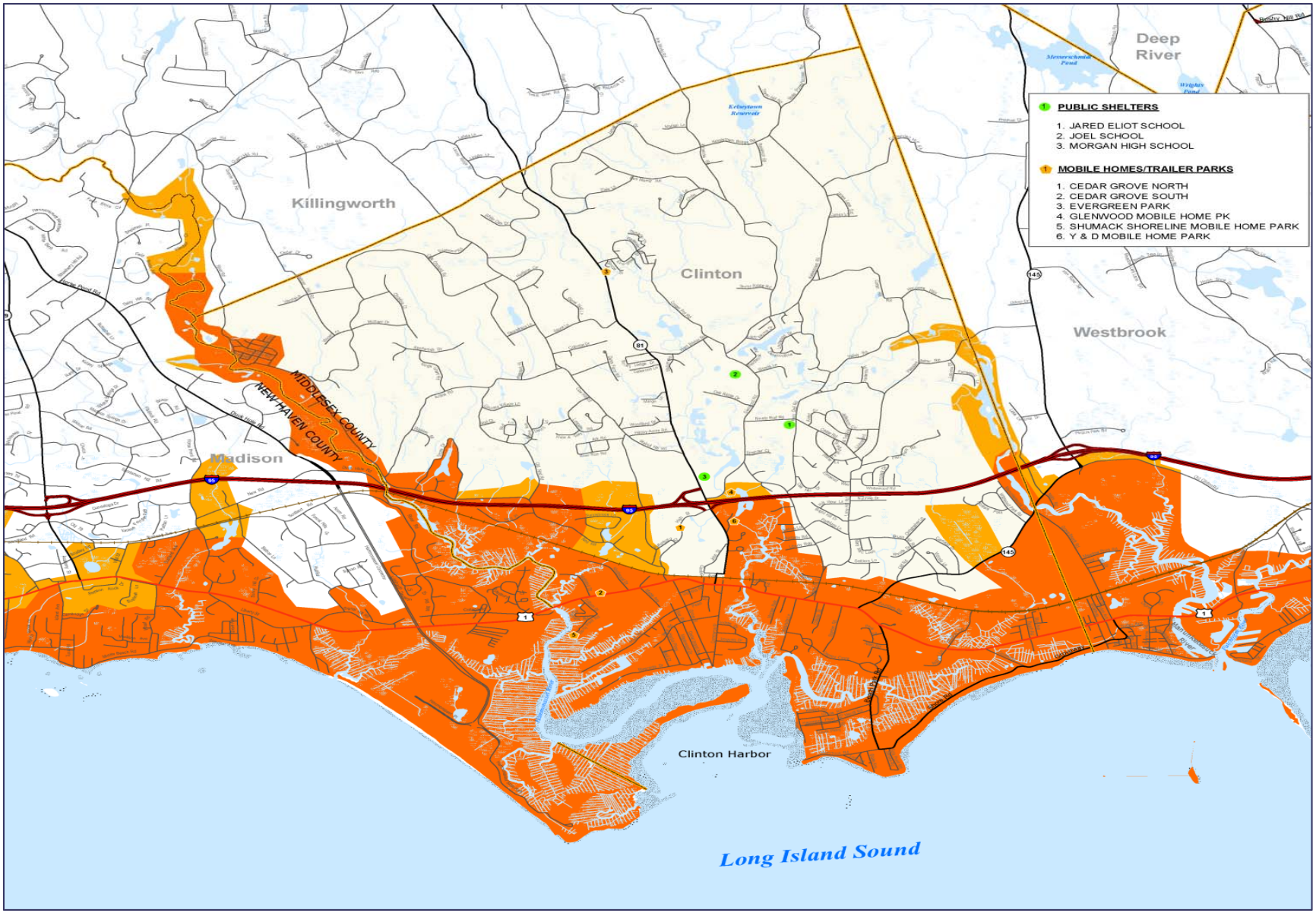

Figure 6-10: Traffic Analysis Zones – Middlesex County / Clinton

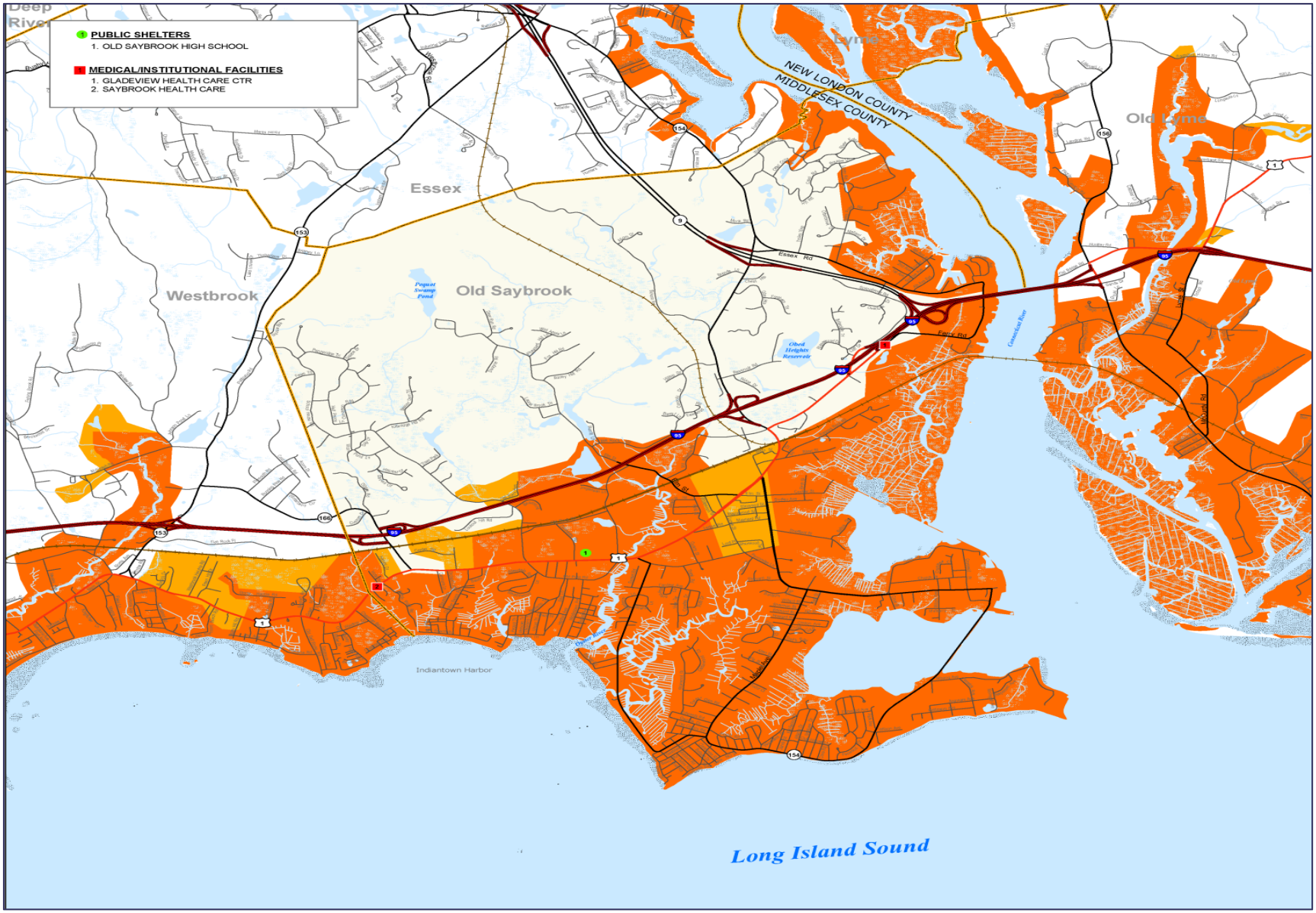

Figure 6-11: Traffic Analysis Zones – Middlesex County / Old Saybrook

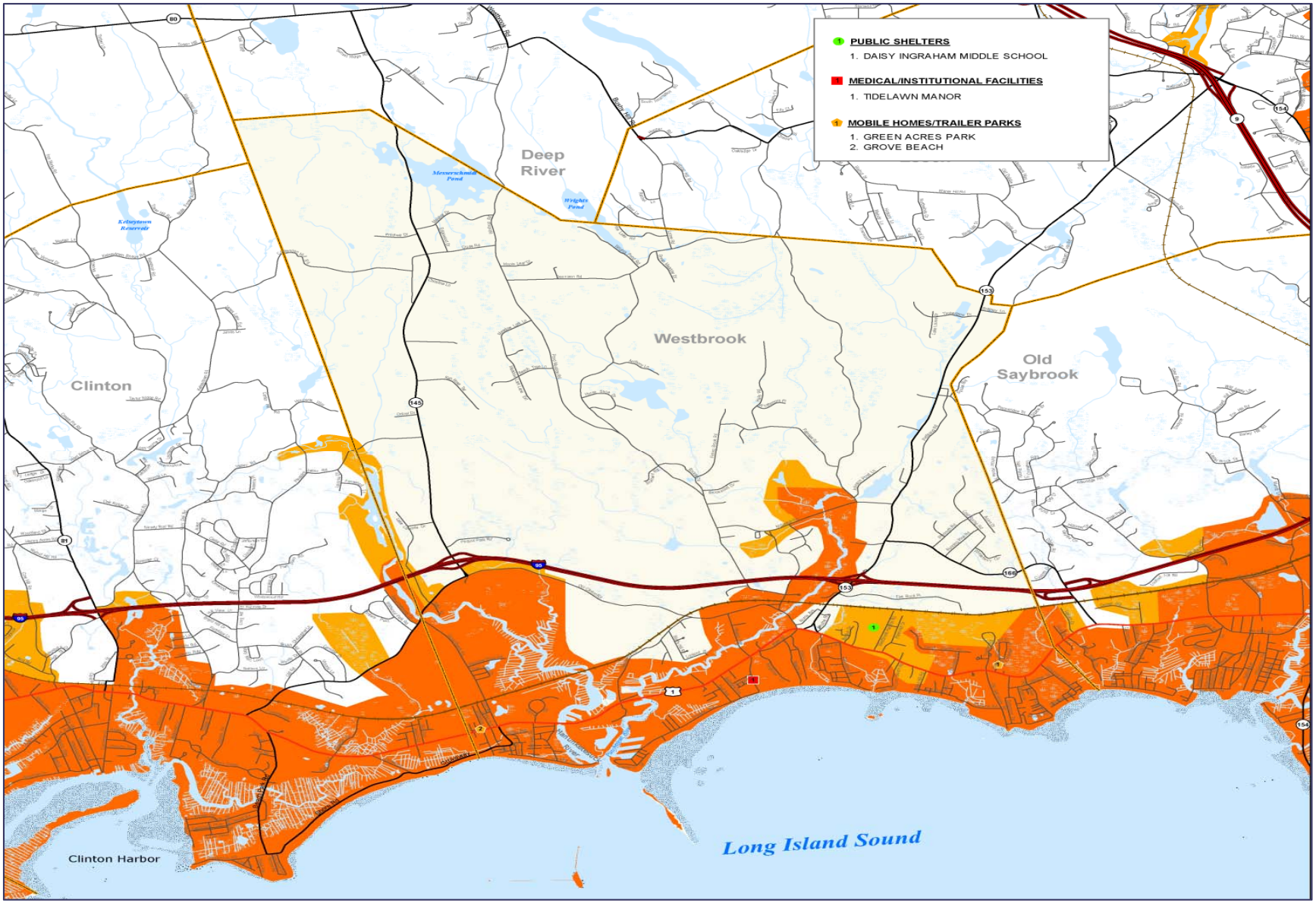

Figure 6-12: Traffic Analysis Zones – Middlesex County / Westbrook

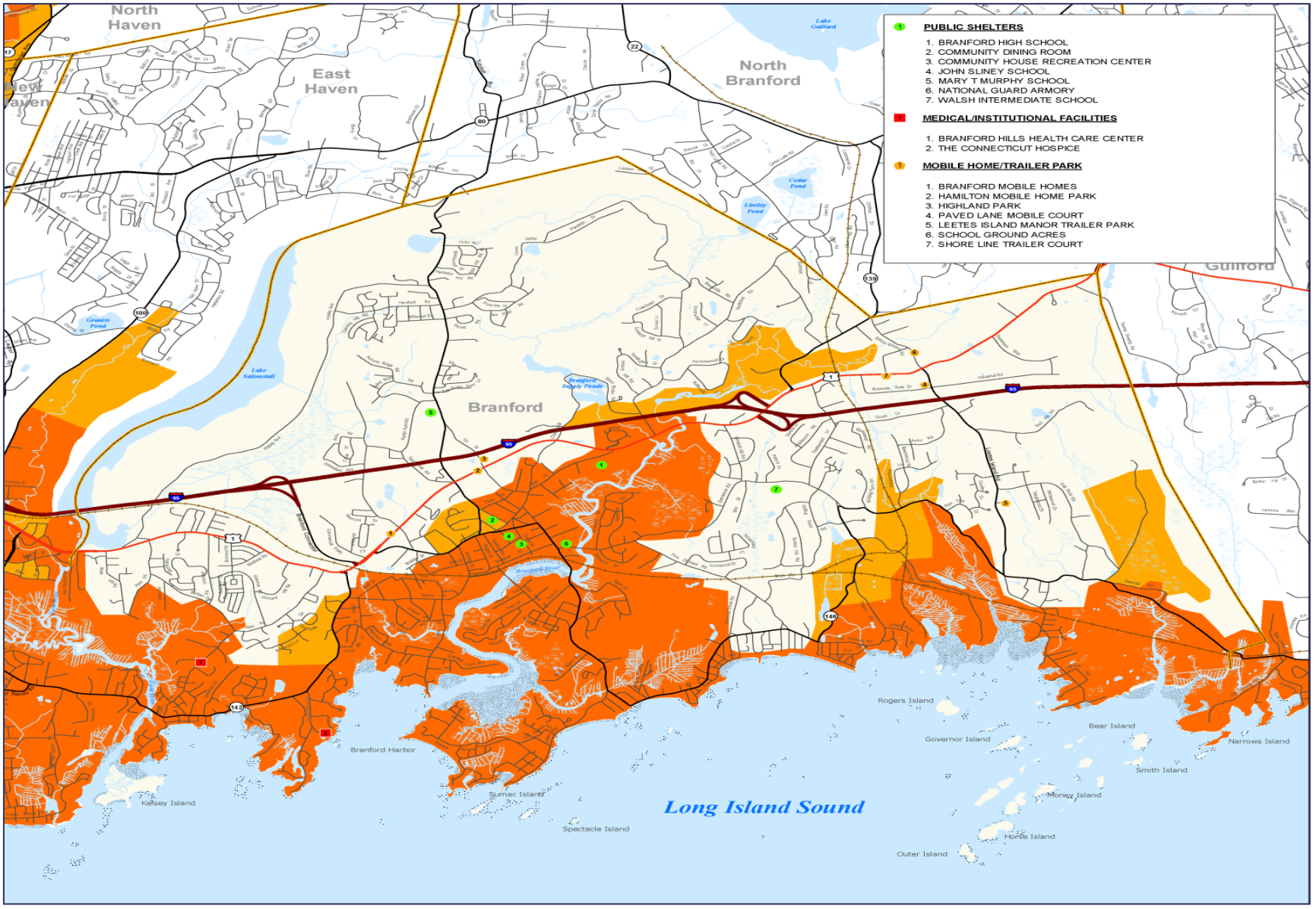

Figure 6-13: Traffic Analysis Zones – New Haven County / Branford

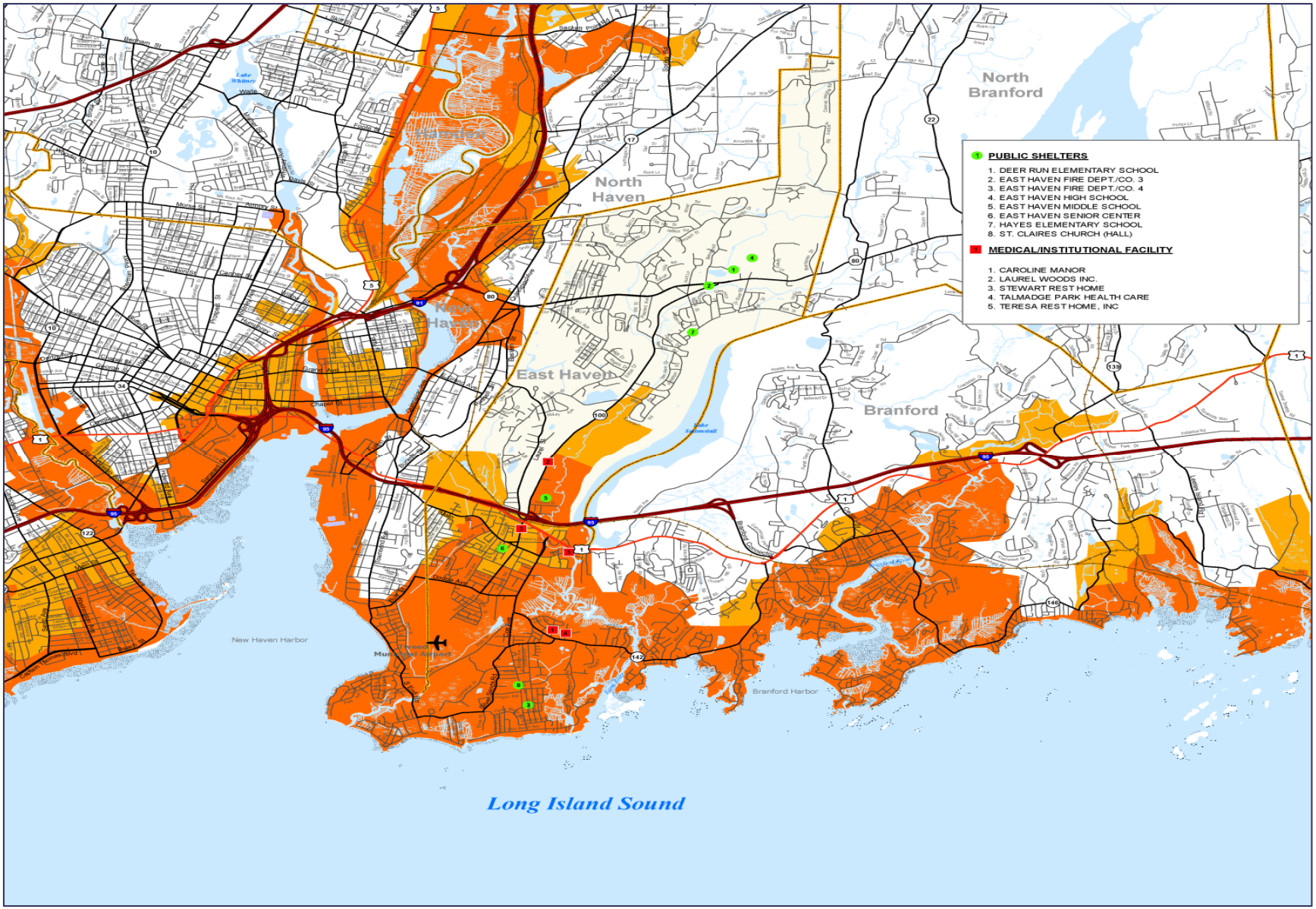

Figure 6-14: Traffic Analysis Zones – New Haven County / East Haven

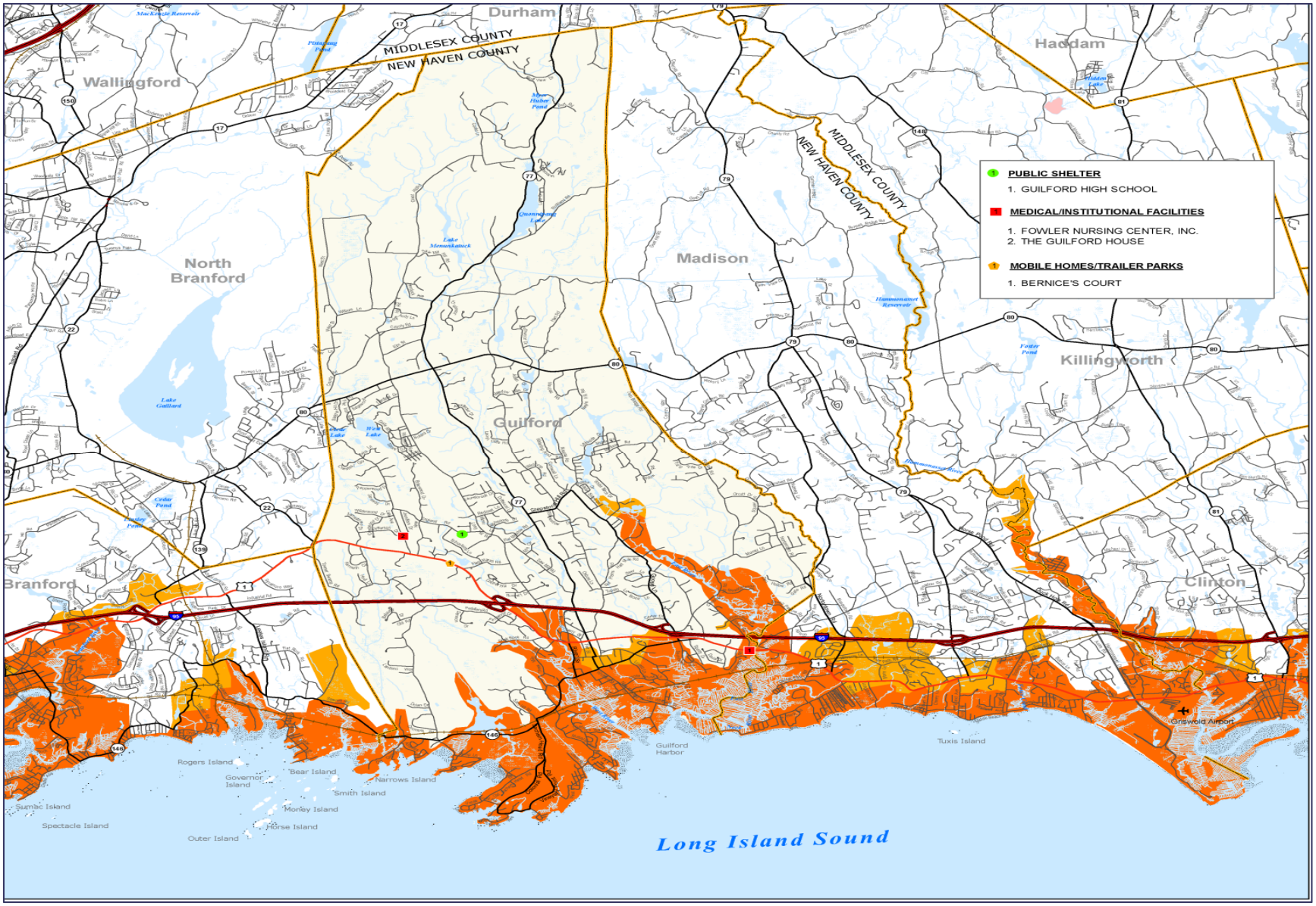

Figure 6-15: Traffic Analysis Zones – New Haven County / Guilford

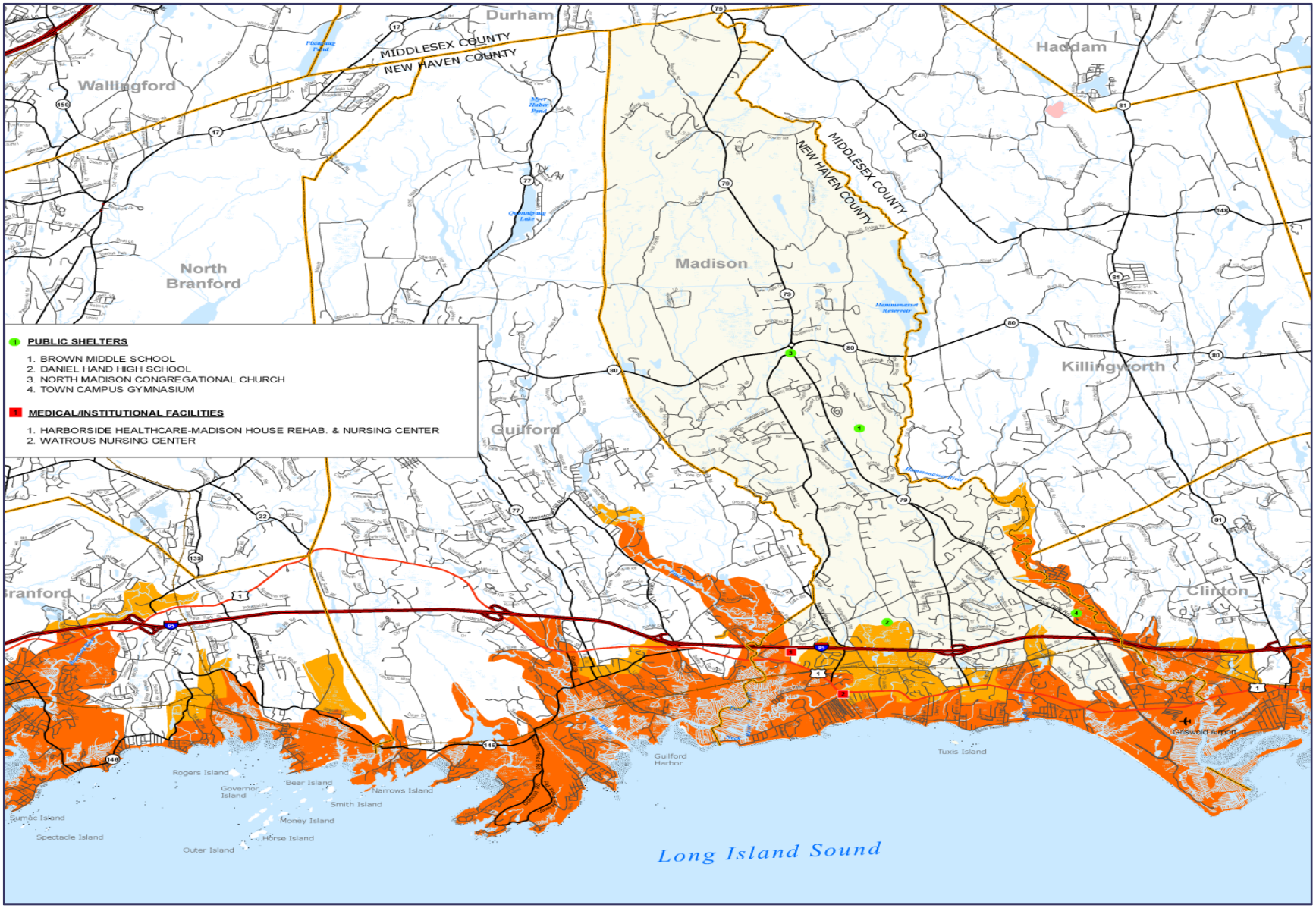

Figure 6-16: Traffic Analysis Zones – New Haven County / Madison

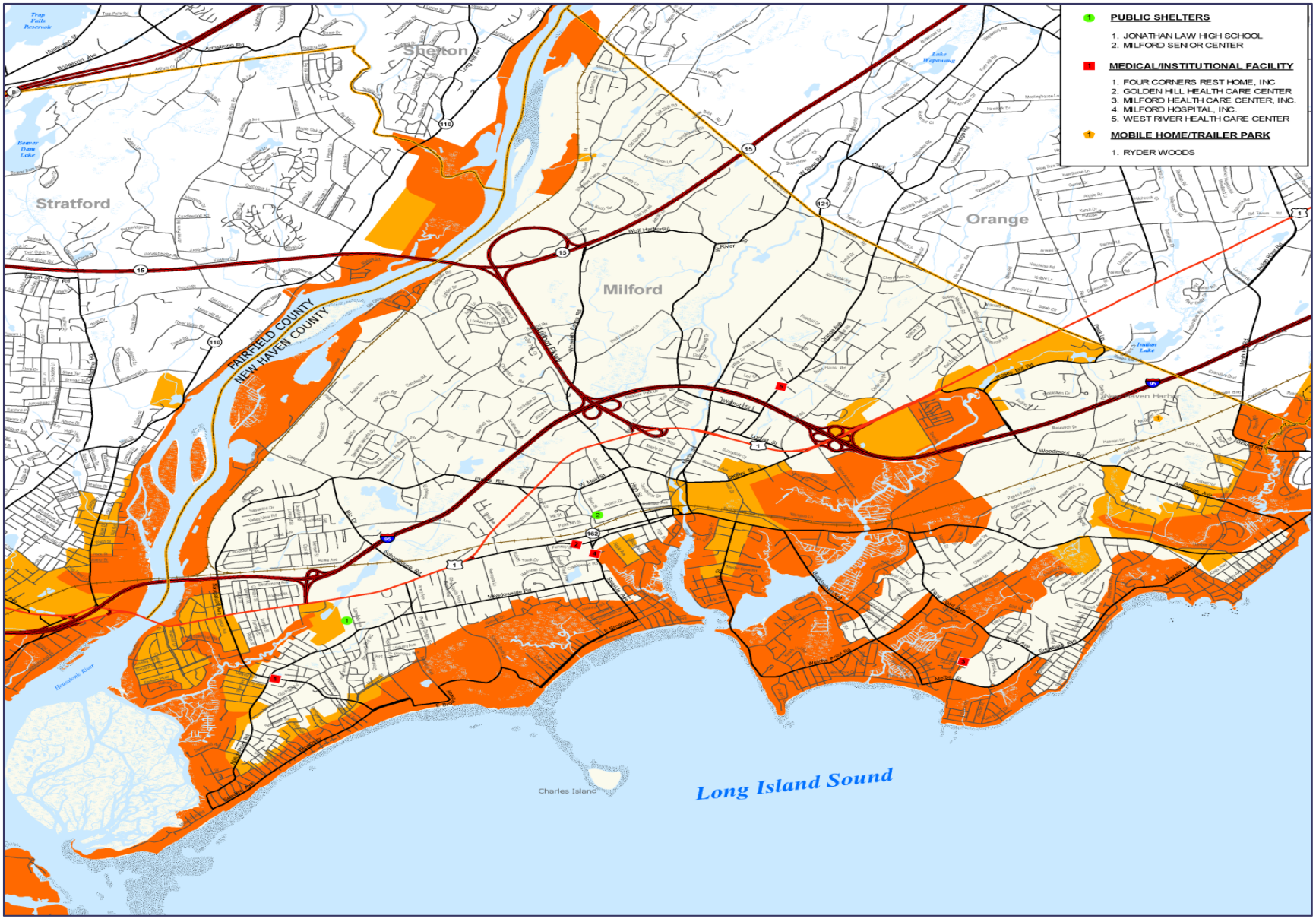

Figure 6-17: Traffic Analysis Zones – New Haven County / Milford

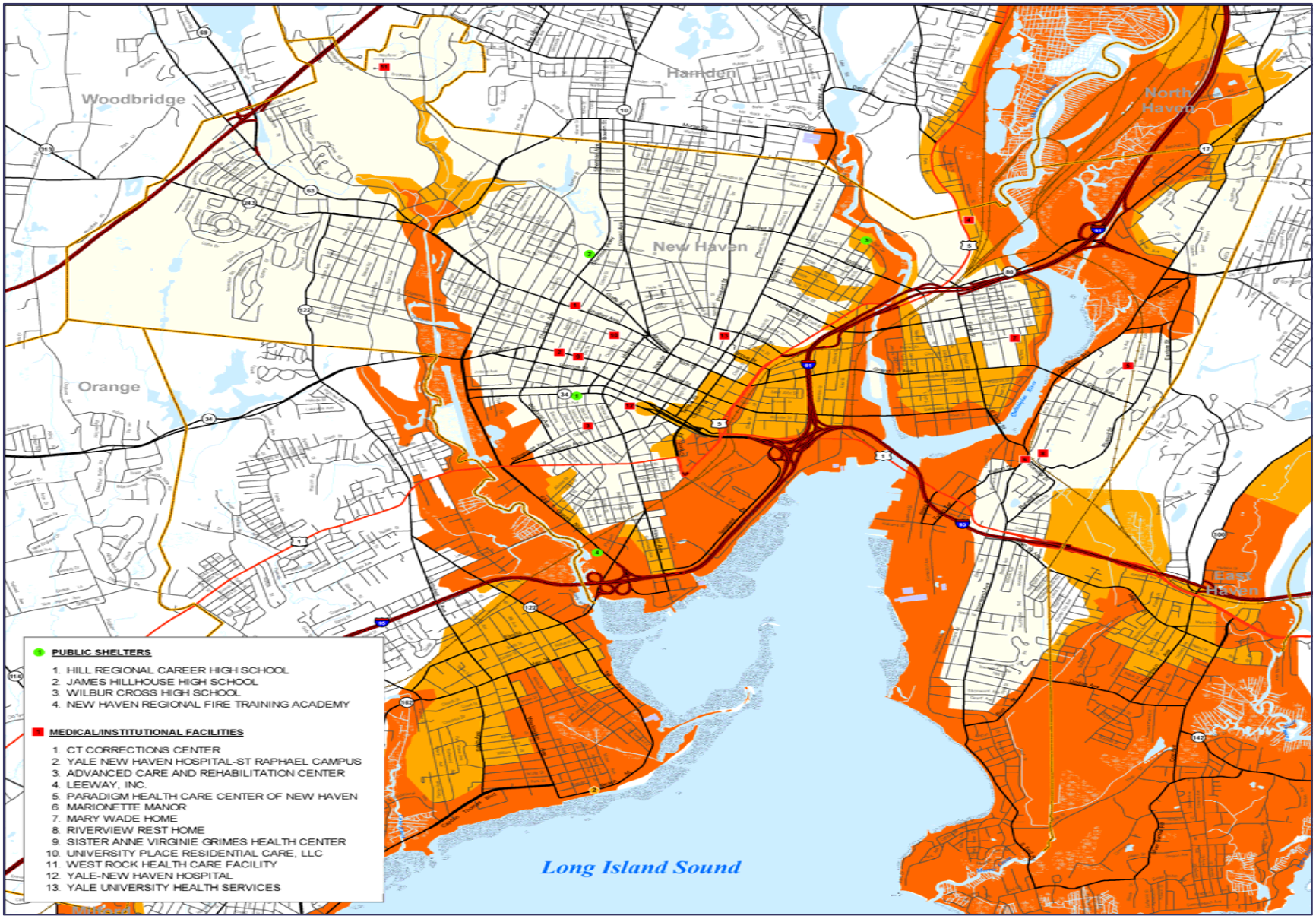

Figure 6-18: Traffic Analysis Zones – New Haven County / New Haven

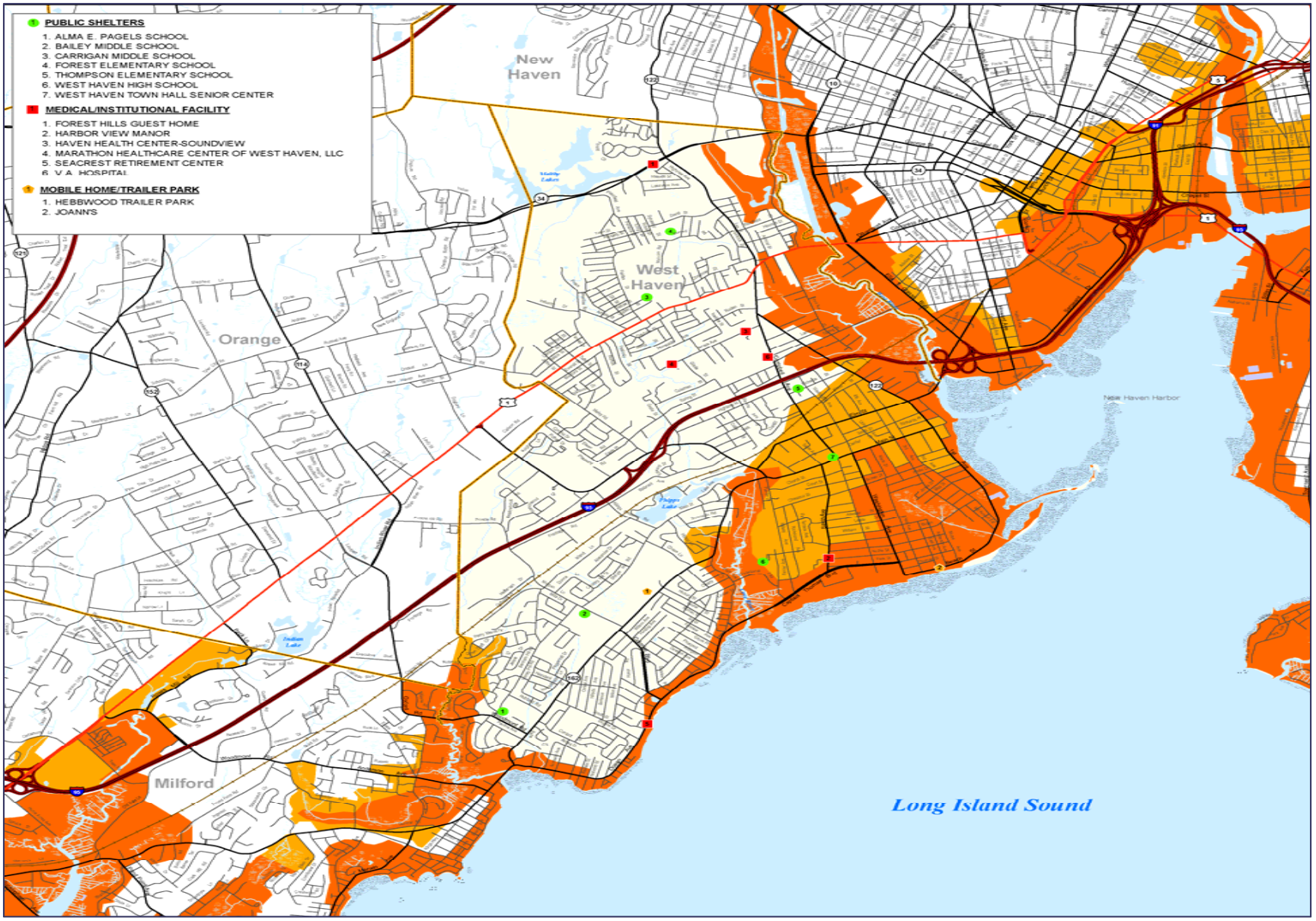

Figure 6-19: Traffic Analysis Zones – New Haven County / West Haven

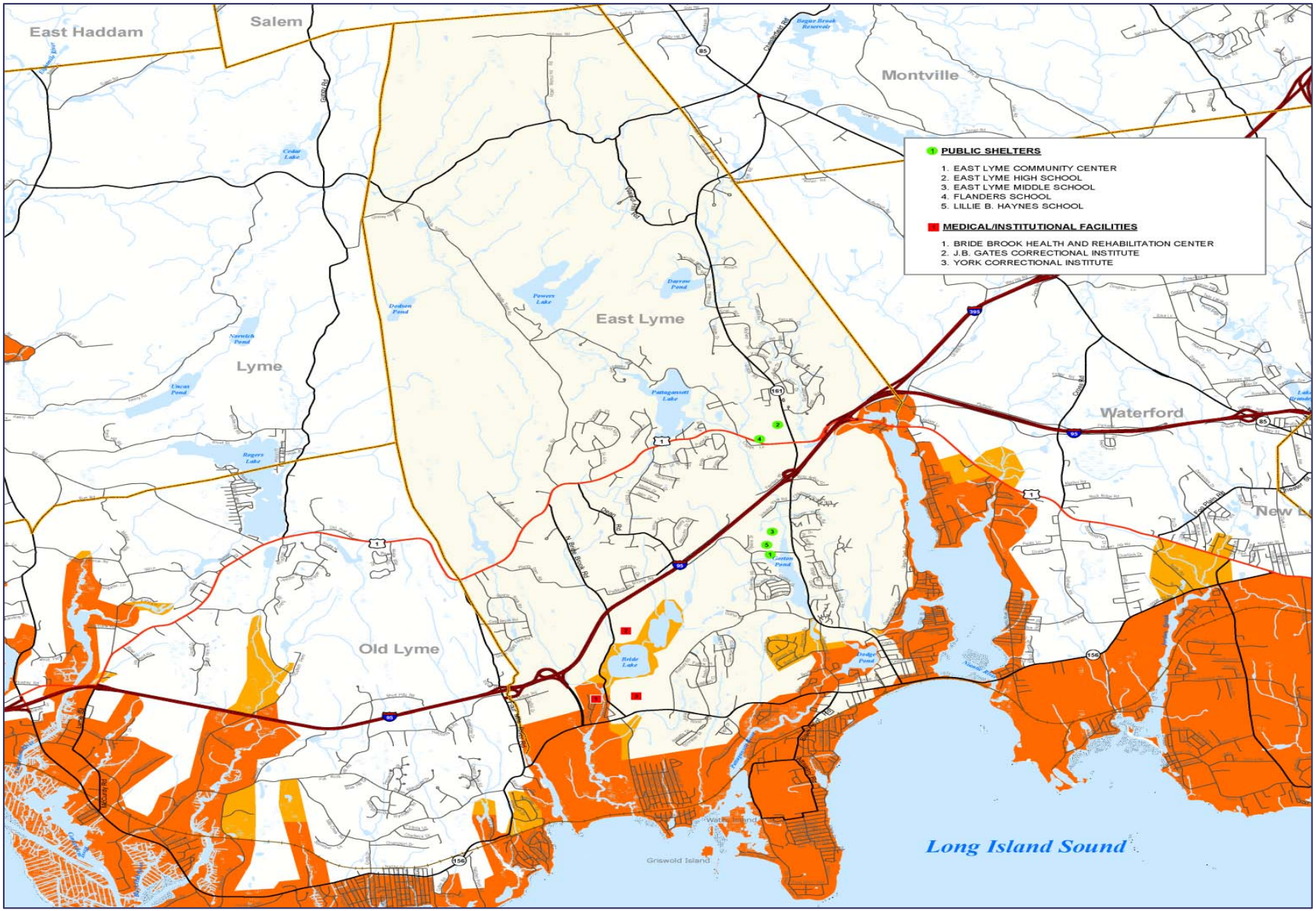

Figure 6-20: Traffic Analysis Zones – New London County / East Lyme

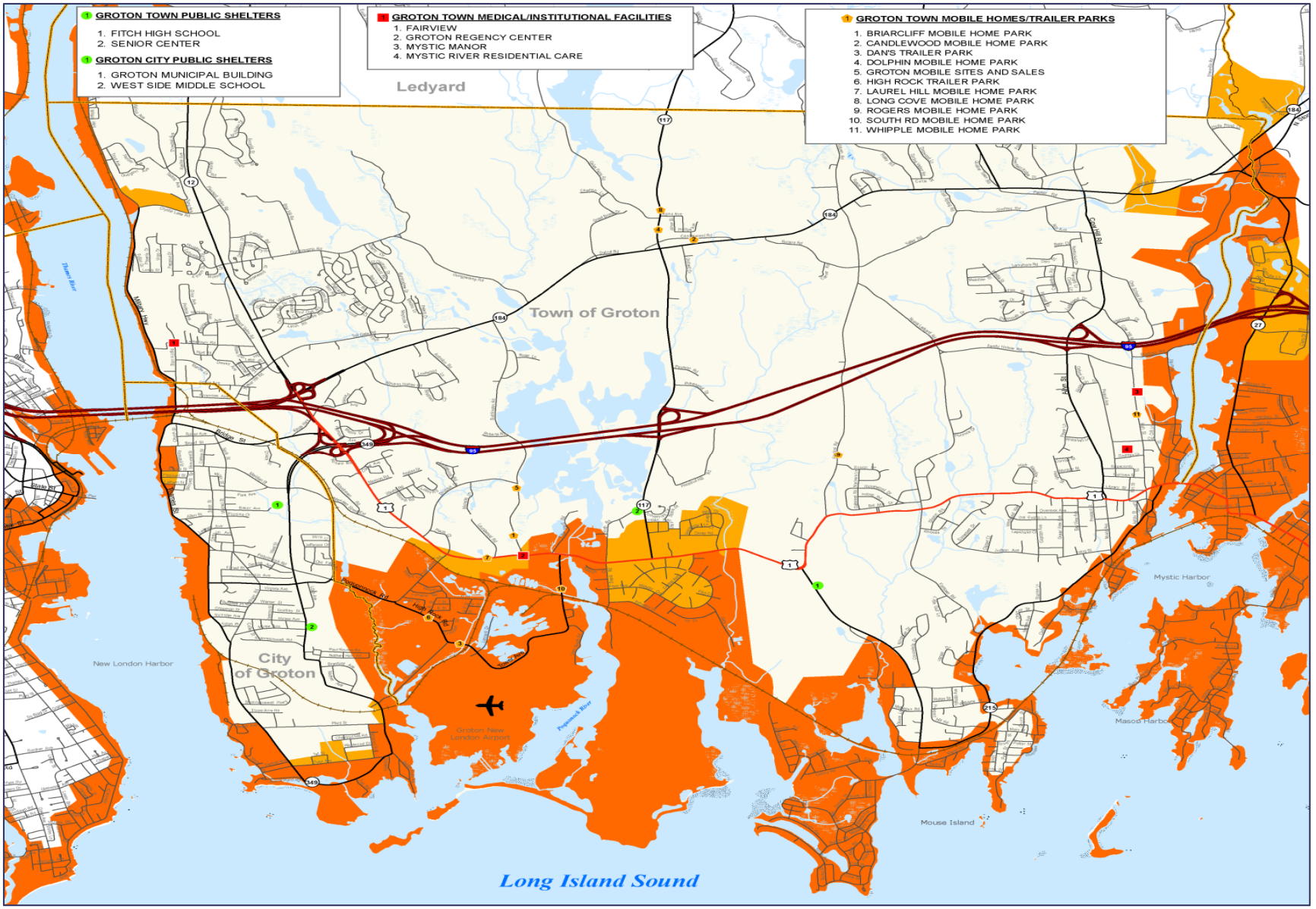

Figure 6-21: Traffic Analysis Zones – New London County / Groton

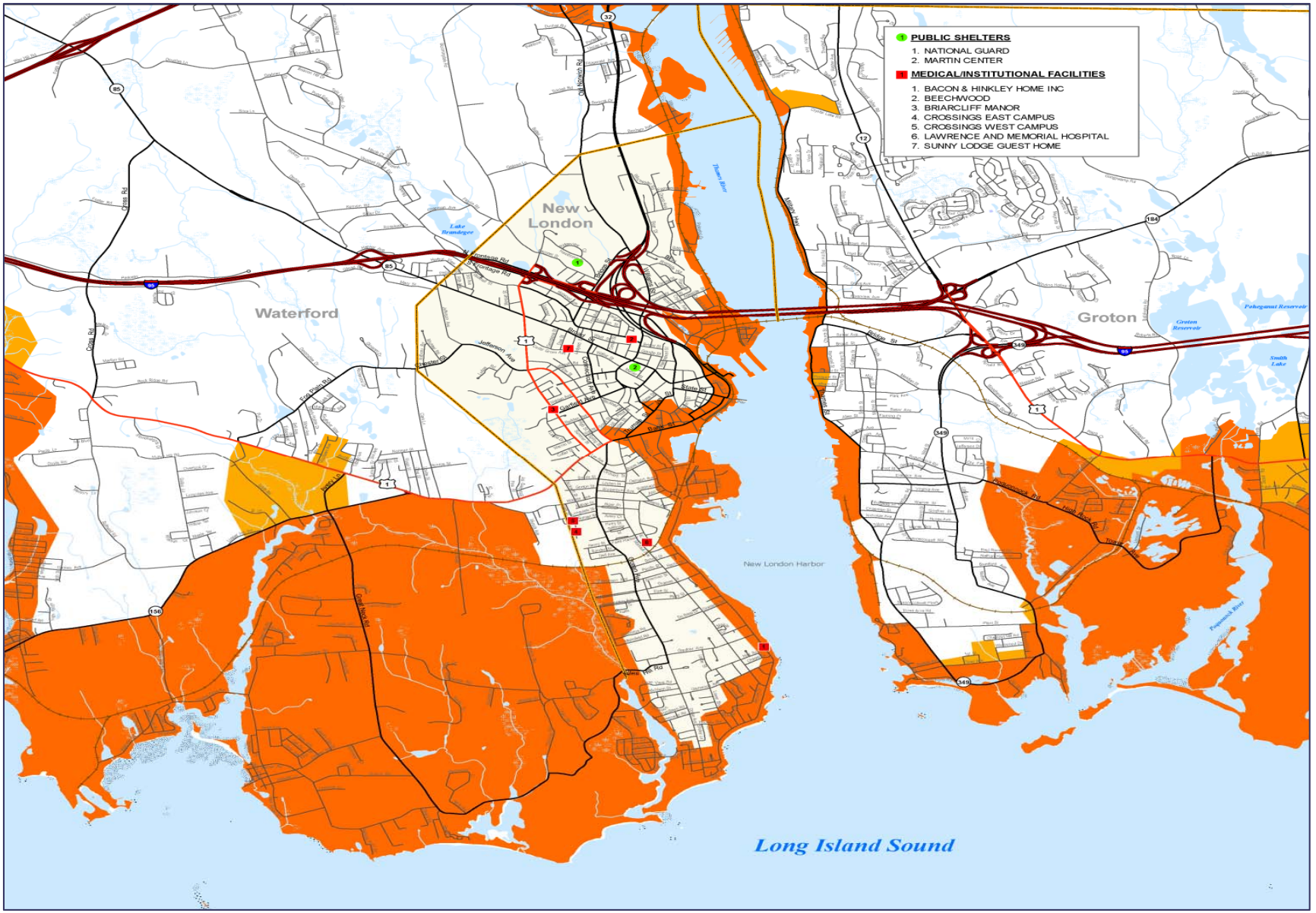

Figure 6-22: Traffic Analysis Zones – New London County / New London

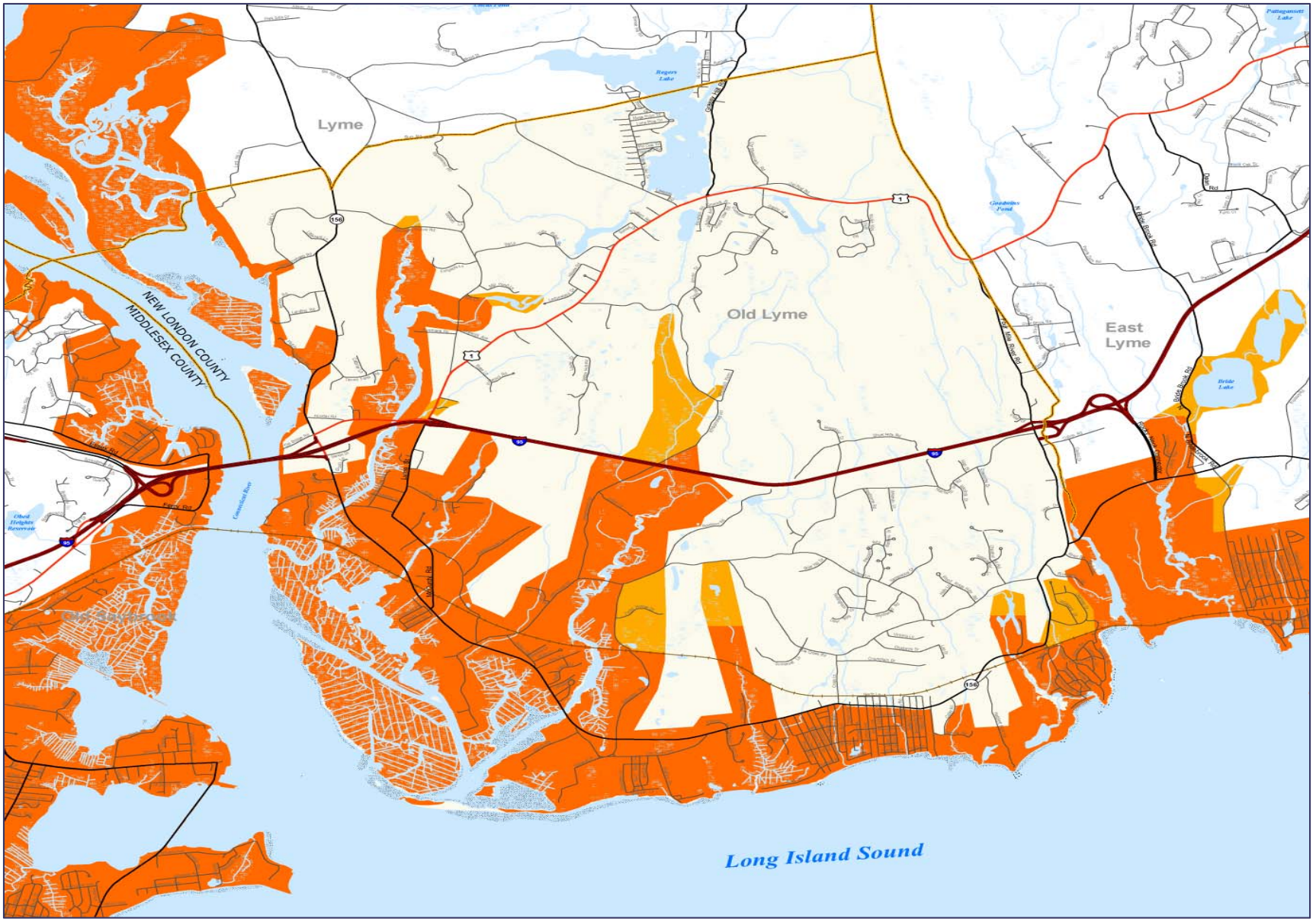

Figure 6-23: Traffic Analysis Zones – New London County / Old Lyme

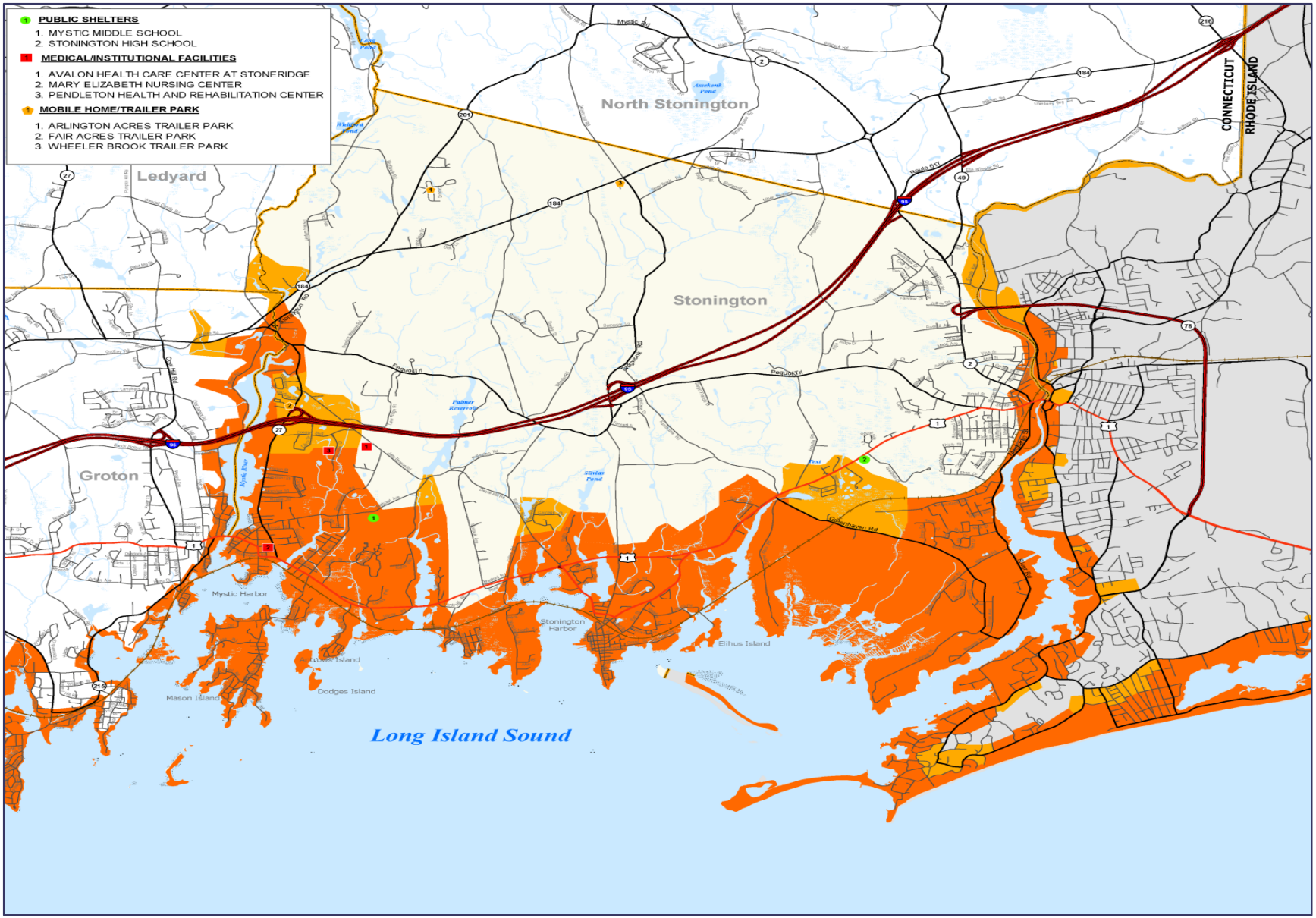

Figure 6-24: Traffic Analysis Zones – New London County / Stonington

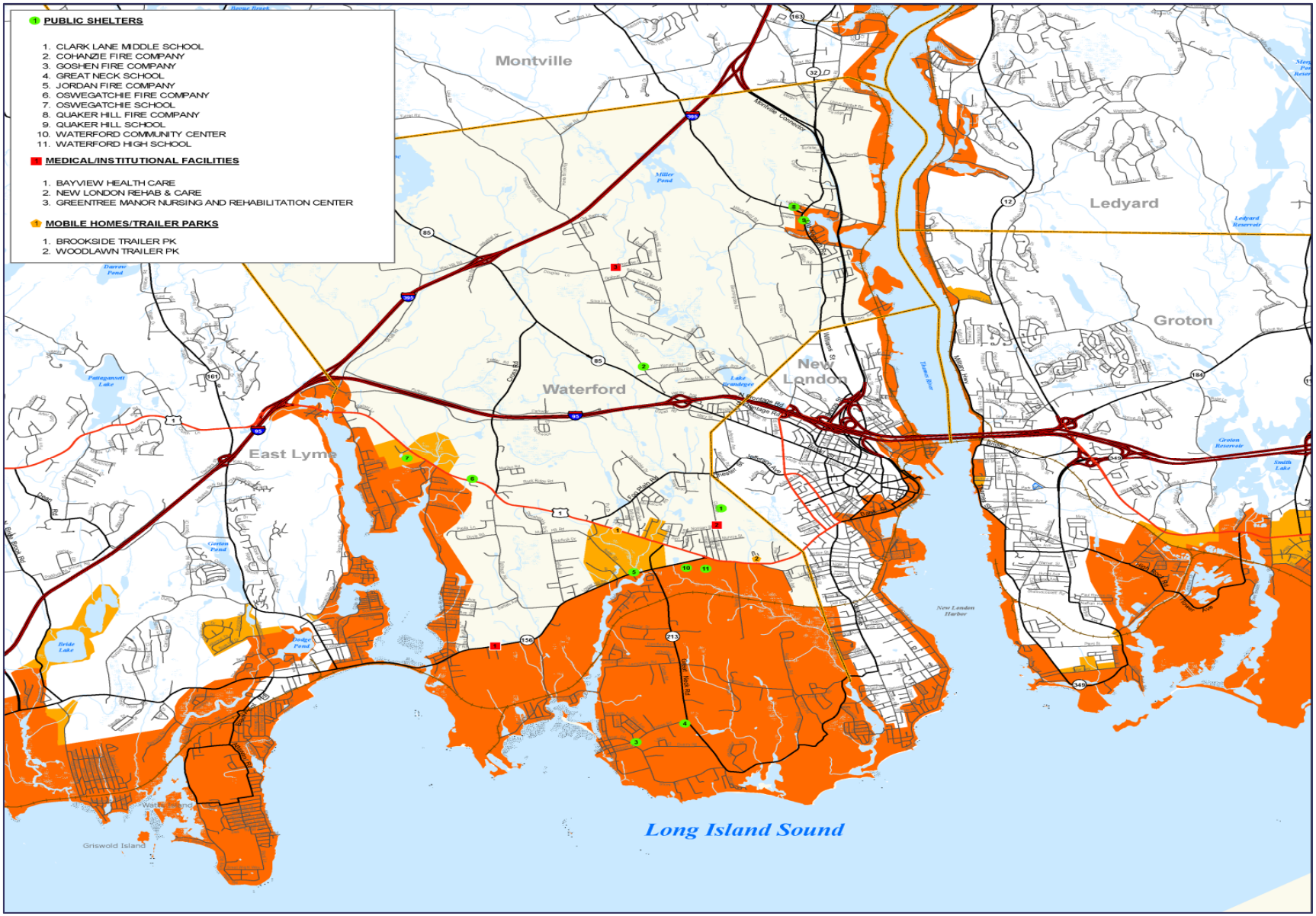

Figure 6-25: Hurricane Evacuation Zones – New London County / Waterford

6.5 Housing Unit and Population Data

All housing unit and other socioeconomic data were developed for each traffic evacuation zone based on data prepared by the U.S. Census Bureau for the 2010 decennial census, as well as 5-year projections from the 2013 American Community Survey. Geographic Information Systems (GIS) were used to further reconfigure the census data to conform to the evacuation/traffic analysis zones that formed the basic unit for this study. In addition, the U.S. Census also provided the data for the seasonal/vacation units in each traffic evacuation zone. The number of hotel and motel units, on the other hand, were obtained by a thorough investigation of various tourist information sites on the internet. Table 6-2 summarizes the key socioeconomic data used for the Connecticut HES TDR locations, as well as jurisdiction-wide averages for people and vehicles per unit, people per unit and vehicle ownership numbers for every evacuation zone in the study area.

Table 6-3 shows the socioeconomic data for the Connecticut HES TDR locations by vulnerability zone. This table represents the total aggregate number located in each vulnerability zone within a county and not the specific population and units that would be directed to evacuate from each sector. Tables 6-4 through 6-7 provide further detail on a community basis for each county as follows:

- Table 6-4: Key Socioeconomic Data – Fairfield County
- Table 6-5: Key Socioeconomic Data – Middlesex County
- Table 6-6: Key Socioeconomic Data – New Haven County
- Table 6-7: Key Socioeconomic Data – New London County

The socioeconomic data used in the transportation model focuses on three types of housing units to determine the vulnerability data included in the evacuation statistics. The most important housing category is occupied residential; these are the full time inhabitants most likely to be impacted by evacuation decisions throughout the hurricane season, especially if located in storm surge areas. The model also factors in occupied mobile homes residences because of their vulnerability to hurricane winds, regardless of distance from the storm tide limits or proximity to the coast. The third housing type used in the model is seasonal/vacation and tourist units; people in these units, although their numbers may vary from day to day during the hurricane season, are more likely to evacuate and will usually travel further to do so.

In the transportation model, each housing type described above will have specific socioeconomic and behavioral variables assigned to it to ensure that the inherent differences in the responses of their inhabitants during a hurricane event are factored into the vulnerability data. For instance, the number of vehicles and people per unit will vary, in some cases

dramatically, between occupied residential and seasonal/tourist units. Furthermore, this degree of specificity allows the model to factor in variations in occupancy levels, especially with respect to visitor units.

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Table 6-2: Key Socioeconomic Data

County	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
Fairfield County	577,326	213,840	456	2,606	5,545	2.68	1.71
Middlesex County	45,179	18,735	609	2,694	963	2.10	1.82
New Haven County	415,989	162,957	780	3,159	4,230	2.45	1.73
New London County	173,640	67,865	1,512	4,674	5,310	2.15	1.70
Totals / Averages	**1,212,136**	**463,397**	**3,357**	**13,136**	**16,048**	**2.35**	**1.74**

1. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
2. Obtained from http://www.ctvisit.com, accessed 1/27/15.

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Table 6-3: Housing Unit and Population Data by Evacuation Zone

Evacuation Areas[1]	Population[2]	Permanent Occupied Units[2]	Mobile Home Units[2]	Seasonal Vacation Units[2]	Tourist Motel / B&B Units[3]	Average People per Occupied Housing Unit[2]	Average Vehicle per Occupied Housing Unit[2]
Fairfield County	84,814	32,997	75	762	624	2.60	1.68
	59,623	23,283	56	217	1,387	2.64	1.63
	432,889	157,560	324	1,627	3,534	2.80	1.84
Middlesex County	15,932	7,293	448	2,391	673	2.15	2.05
	1,596	677	0	22	170	1.56	1.31
	27,654	10,764	161	281	120	2.59	2.11
New Haven County	74,521	32,864	239	2,169	1,220	2.29	1.68
	44,016	18,027	20	121	210	2.42	1.68
	297,453	112,066	521	869	2,800	2.64	1.84
New London County	35,017	15,471	318	3,719	509	2.26	1.99
	4,399	1,717	0	20	1,378	1.59	1.15
	134,225	50,679	1,194	935	3,423	2.60	1.97
Totals / Averages	210,284	88,625	1,080	9,041	3,026	2.33	1.85
	109,634	43,704	76	380	3,145	2.05	1.44
	892,221	331,069	2,200	3,712	9,877	2.66	1.94
Overall Totals / Averages	**1,212,139**	**463,398**	**3,356**	**13,133**	**16,048**	**2.35**	**1.74**

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-4: Key Socioeconomic Data – Fairfield County

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
Bridgeport	21,237	8,071	0	42	0	2.63	1.02
	19,916	7,160	31	15	210	2.78	1.12
	104,451	36,502	110	107	0	2.86	1.36
Darien	2,663	893	0	36	0	2.98	2.07
	882	288	0	2	0	3.07	1.94
	17,378	5,579	9	61	0	3.11	2.09
Fairfield	11,401	4,464	59	158	139	2.55	1.85
	4,538	1,768	0	21	60	2.57	1.87
	44,178	14,471	72	178	40	3.05	1.98
Greenwich	11,535	4,223	16	152	119	2.73	1.87
	3,974	1,548	0	41	18	2.57	1.88
	46,219	17,515	15	582	394	2.64	1.86
Norwalk	11,104	4,687	0	119	0	2.37	1.48
	4,707	1,776	0	8	0	2.65	1.26
	70,679	27,098	72	161	1,121	2.61	1.84
Stamford	10,105	3,920	0	51	99	2.58	1.50
	18,950	8,126	0	96	1,099	2.33	1.19
	94,954	35,827	23	283	1,406	2.65	1.61

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-4: Key Socioeconomic Data – Fairfield County (continued)

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
Stratford	11,890	4,794	0	75	255	2.48	1.67
	3,832	1,543	0	14	0	2.48	1.74
	35,970	13,879	0	83	458	2.59	1.87
Westport	4,879	1,945	0	129	12	2.51	1.95
	2,824	1,074	25	20	0	2.63	2.00
	19,060	6,689	23	172	115	2.85	2.10
Totals / Averages	**84,814**	**32,997**	**75**	**762**	**624**	**2.60**	**1.68**
	59,623	**23,283**	**56**	**217**	**1,387**	**2.64**	**1.63**
	432,889	**157,560**	**324**	**1,627**	**3,534**	**2.80**	**1.84**
Overall Totals / Averages	**577,326**	**213,840**	**455**	**2,606**	**5,545**	**2.68**	**1.71**

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-5: Key Socioeconomic Data – Middlesex County

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
Chester	429	196	0	8	0	2.19	2.47
	0	0	0	0	0	0.00	0.00
	3,048	1,206	0	29	0	2.53	2.45
Clinton	4,462	2,072	164	476	297	2.15	1.81
	567	214	0	0	0	2.65	1.93
	8,210	3,009	161	41	0	2.73	2.07
Deep River	283	123	0	7	0	2.31	2.14
	0	0	0	0	0	0.00	0.00
	4,332	1,811	0	49	8	2.39	2.14
Essex	609	320	0	48	33	1.90	1.93
	74	33	0	3	0	2.24	1.94
	5,986	2,556	0	100	22	2.34	1.94
Old Saybrook	6,933	3,052	0	1,097	313	2.27	1.92
	422	181	0	3	0	2.33	1.91
	2,904	1,021	0	21	90	2.84	2.01
Westbrook	3,216	1,530	284	755	30	2.10	2.03
	533	249	0	16	170	2.14	2.07
	3,174	1,161	0	41	0	2.73	2.02
Totals / Averages	15,932	7,293	448	2,391	673	2.15	2.05
	1,596	677	0	22	170	1.56	1.31
	27,654	10,764	161	281	120	2.59	2.11
Overall Totals / Averages	**45,182**	**18,734**	**609**	**2,694**	**963**	**2.10**	**1.82**

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-6: Key Socioeconomic Data – New Haven County

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
Branford	12,041	5,807	51	420	3	2.07	1.63
	1,436	591	0	9	0	2.43	1.65
	14,548	6,341	222	162	532	2.29	1.72
East Haven	11,148	4,679	58	238	0	2.38	1.63
	3,627	1,568	0	3	80	2.31	1.53
	14,391	5,473	0	15	58	2.63	1.94
Guilford	4,149	1,845	59	352	0	2.25	1.87
	589	260	0	5	0	2.27	1.79
	16,623	6,182	0	108	120	2.69	2.26
Hamden	633	244	0	1	0	2.60	1.80
	1,063	409	0	2	0	2.60	1.86
	56,705	22,195	0	140	0	2.55	1.64
Madison	3,862	1,728	46	686	630	2.24	1.72
	1,720	766	0	42	12	2.25	2.01
	10,865	3,886	0	83	0	2.80	2.41
Milford	16,401	7,315	3	379	323	2.24	1.75
	5,236	2,086	0	9	26	2.51	1.76
	31,257	12,362	179	80	949	2.53	1.87

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-6: Key Socioeconomic Data – New Haven County (continued)

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
New Haven	14,299	6,019	0	36	264	2.38	1.15
	19,637	7,838	20	37	92	2.51	1.09
	96,400	35,229	33	181	721	2.74	1.11
North Haven	589	278	0	2	0	2.12	2.02
	941	371	0	3	0	2.54	2.02
	22,481	8,455	12	55	143	2.66	2.00
West Haven	11,399	4,949	22	55	0	2.30	1.55
	9,767	4,138	0	11	0	2.36	1.41
	34,183	11,943	75	45	277	2.86	1.60
Totals / Averages	74,521	32,864	239	2,169	1,220	2.29	1.68
	44,016	18,027	20	121	210	2.42	1.68
	297,453	112,066	521	869	2,800	2.64	1.84
Overall Totals / Averages	**415,990**	**162,957**	**780**	**3,159**	**4,230**	**2.45**	**1.73**

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-7: Key Socioeconomic Data – New London County

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
East Lyme	5,153	2,361	0	847	175	2.18	1.80
	536	137	0	3	160	3.92	1.89
	13,430	4,679	5	100	532	2.87	1.96
Groton	6,402	2,656	187	490	85	2.41	1.65
	2,056	800	0	3	0	2.57	1.67
	31,669	12,357	270	195	1,176	2.56	1.66
Ledyard	624	261	0	12	0	2.39	2.15
	29	13	0	0	0	2.23	2.15
	14,398	5,360	191	60	302	2.69	2.15
Lyme	348	162	0	44	0	2.15	2.18
	0	0	0	0	0	0.00	0.00
	2,069	876	20	117	0	2.36	2.16
Montville	531	225	53	18	0	2.37	2.26
	0	0	0	0	0	0.00	0.00
	19,090	6,735	378	83	825	2.83	1.98
New London	3,875	1,810	29	111	0	2.14	1.31
	0	0	0	0	0	0.00	0.00
	23,713	8,551	0	59	389	2.77	1.35

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

Table 6-7: Key Socioeconomic Data – New London County (continued)

Evacuation Areas	Population[1]	Permanent Occupied Units[1]	Mobile Home Units[1]	Seasonal Vacation Units[1]	Tourist Motel / B&B Units[2]	Average People per Occupied Housing Unit[1]	Average Vehicle per Occupied Housing Unit[1]
Old Lyme	2,438	1,144	0	1,440	0	2.13	2.08
	236	92	0	2	13	2.57	2.16
	4,924	1,934	0	169	20	2.55	2.09
Preston	256	114	0	1	0	2.26	2.55
	0	0	0	0	0	0.00	0.00
	3,829	1,491	23	38	12	2.57	2.55
Stonington	8,523	3,860	0	586	237	2.21	1.87
	1,011	444	0	11	1,205	2.28	1.92
	8,993	3,803	252	70	27	2.36	1.80
Waterford	6,867	2,878	49	170	12	2.39	2.03
	531	231	0	1	0	2.30	1.75
	12,110	4,893	55	44	140	2.48	1.96
Totals / Averages	35,017	15,471	318	3,719	509	2.26	1.99
	4,399	1,717	0	20	1,378	1.59	1.15
	134,225	50,679	1,194	935	3,423	2.60	1.97
Overall Totals / Averages	**173,641**	**67,867**	**1,512**	**4,674**	**5,310**	**2.15**	**1.70**

1. Key: Zone A (Category 1 & 2) Zone B (Category 3 & 4) Inland Area (Non-Surge)
2. Data represented in this table reflects data obtained and/or calculated from the 2009-2013 American Community Survey 5-Year Estimates.
3. Obtained from http://www.ctvisit.com, accessed 1/27/15.

6.6 Behavioral Assumptions of the Evacuating Population

An evacuation of the Connecticut coast will involve decision making by thousands of individuals and households. In order to develop meaningful behavioral assumptions that account for these variations in decision making, the model incorporates data from the *Connecticut Hurricane Evacuation Study Behavioral Analysis Survey Data Report* (August 25, 2013) conducted by Dr. Jay Baker of Hazards Management Group (HMG). Chapter 4 of the TDR contains the analysis of the behavioral report. Other behavioral trends from around the coastal United States were also considered in developing behavioral assumptions for the transportation analysis.

The contractor used this data source and nationwide experience to focus the transportation analysis on the following behavioral aspects:

- Participation rates - what percent of the population in different areas will evacuate their dwelling units for hurricane threats?
- Response rates (timing) - how quickly will evacuees respond to what local officials are telling them to do?
- Destination percentages - what percent of the population by evacuation zone, will evacuate to local destinations (public shelters, hotel/motels, churches, friends' and relatives' homes) or out of the area entirely?
- Vehicle usage - of the vehicles available to the households, what percent of those vehicles will be used in an evacuation?

6.6.1 Participation Rates

One of the biggest challenges in developing the evacuation model for this area is choosing the appropriate participation rates that should be used for each storm intensity scenario. Where possible, this report and the evacuation transportation model incorporate the participation rates provided in the August 2013 behavioral survey cited above. Nonetheless, in the interests of public safety, this transportation analysis assumes a 100 percent participation rate for all residential and tourist units in each storm surge evacuation zone for the corresponding intensity scenario. For example, in the transportation model, all permanent residents and visitors in the Scenario A evacuation zone are considered evacuees, regardless of what percentages were provided in the behavioral analysis. Clearly, it is understood that not all households will evacuate their residences, regardless of the intensity, during an actual tropical cyclone event; nonetheless this assumption results in clearance times that provide the opportunity for all evacuees to leave regardless of their propensity to do so. This ensures that local lead times used in decision making will not result in potential evacuees stranded in their vehicles waiting to leave the vulnerable zones as hazardous conditions begin. Nonetheless, it

should be noted that even in coastal regions of the United States that have a lot of hurricane experience, participation rates among surge vulnerable residents have been no more than approximately 90 percent. In some of the noteworthy hurricanes in urban areas, the surge zone participation rates have been as low as 70 percent.

Although it generally can be said people living close to the coastline are more likely to evacuate than those living further inland, proximity to water is not always a good indicator of how severe hurricane hazards will be, or predicting peoples' propensity to evacuate. Consequently, some residents outside surge vulnerable areas, fearing for their safety, may elect to evacuate, even in the absence of a directive from local officials to do so. Post event behavioral survey results show that in past evacuations, a percentage of households not under a specific order from local officials will decide to leave their residences anyway. In areas with a lot of hurricane evacuation experience, these "shadow" participation rates can typically run from 10 to 30 percent of the populations not directed to evacuate during a particular scenario. For instance, in Hurricane Floyd (Southeast U.S. coast) and Hurricane Rita (Houston), inland participation rates were higher due to mixed messages that residents were receiving through various media releases and from local statements that abandoned the surge area risk concept.

For the Connecticut HES TDR, based on the behavioral hypothetical responses provided in the 2013 study cited above, the average shadow participation rate was 70 percent. Clearly, based on a hypothetical scenario, especially in the inland areas, there is a tendency for households to over-evacuate. Nonetheless, these shadow evacuation figures were judged to be too extreme for use in the latest evacuation model, and figures more consistent with locally established norms were used. Therefore, based on planning guidance from Hazards Management Group regarding the shadow evacuation percentages, figures of 10 to 20 percent were used depending on intensity scenario and evacuation zone.

Tables 6-8 through 6-11 below detail the participation rates used in the transportation model and not those from the behavioral surveys discussed above. These tables are arranged alphabetically by each town and by county. The figures are further segregated by evacuation zones and response scenarios.

Table 6-8: Assumed Participation Rates by Evacuation Zone – Fairfield County

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
Bridgeport	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Darien	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Fairfield	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Greenwich	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Norwalk	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Stamford	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-8: Assumed Participation Rates by Evacuation Zone – Fairfield County

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
Stratford	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Westport	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-9: Assumed Participation Rates by Evacuation Zone – Middlesex County

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
Chester	100%	100%	50%	50%	100%	100%	100%	100%
	10%	70%	40%	40%	60%	100%	100%	100%
	5%	50%	25%	25%	20%	70%	35%	35%
Clinton	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Deep River	100%	100%	50%	50%	100%	100%	100%	100%
	10%	70%	40%	40%	60%	100%	100%	100%
	5%	50%	25%	25%	20%	70%	35%	35%
Essex	100%	100%	50%	50%	100%	100%	100%	100%
	10%	70%	40%	40%	60%	100%	100%	100%
	5%	50%	25%	25%	20%	70%	35%	35%
Old Saybrook	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Westbrook	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-10: Assumed Participation Rates by Evacuation Zone – New Haven County

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
Branford	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
East Haven	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Guilford	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Hamden	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Madison	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Milford	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-10: Assumed Participation Rates by Evacuation Zone – New Haven County (continued)

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
New Haven	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
North Haven	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
West Haven	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-11: Assumed Participation Rates by Evacuation Zone – New London County

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
East Lyme	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Groton	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Ledyard	100%	100%	50%	50%	100%	100%	100%	100%
	10%	70%	40%	40%	60%	100%	100%	100%
	5%	50%	25%	25%	20%	70%	35%	35%
Lyme	100%	100%	50%	50%	100%	100%	100%	100%
	10%	70%	40%	40%	60%	100%	100%	100%
	5%	50%	25%	25%	20%	70%	35%	35%
Montville	100%	100%	50%	50%	100%	100%	100%	100%
	10%	70%	40%	40%	60%	100%	100%	100%
	5%	50%	25%	25%	20%	70%	35%	35%
New London	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-11: Assumed Participation Rates by Evacuation Zone – New London County (continued)

Evacuation Areas	Scenario A				Scenario B			
	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units	Permanent Units	Mobile Home Units	Seasonal Units	Tourist Units
Old Lyme	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Preston	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Stonington	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%
Waterford	100%	100%	100%	100%	100%	100%	100%	100%
	20%	70%	90%	90%	60%	100%	100%	100%
	10%	50%	50%	50%	20%	70%	70%	70%

1. Key: Zone A Zone B Inland Area (Non-Surge)

6.6.2 Response Rates

A critical behavioral assumption used in the transportation analysis is to establish how quickly after an evacuation order is issued will the vulnerable population in a community begin their evacuation trips, referred to as response time. Behavioral data from past hurricane evacuation research demonstrates wide variations in this evacuation response time ranging from a few hours to days, depending on the circumstances. To account for this disparity, clearance times were tested for three evacuation response rates represented by different behavioral response curves.

The resulting behavioral response curves describing mobilization by the vulnerable population define the rate at which evacuating vehicles will load onto the evacuation roadway network for each hourly interval relative to an evacuation order or advisory. These curves depict slow, medium and rapid responses by the public to an evacuation order. Typically, a small percentage of households will start evacuating before an order is issued. Upon receiving the evacuation order, some percentage of households will leave within an hour, others within two hours, some within three, etc. A curve can be drawn to show the cumulative percentage of households that have entered the evacuation network over a number of hours. A rapid loading of the network produces a steep curve; a medium loading scenario produces a flatter curve, etc. The response curves in Figure 6-26 reflect rapid, medium and long responses and are designed to include a range of mobilization times that may be experienced in a hurricane evacuation situation. For this analysis, the mobilization / traffic loading time varied between 3 and 9 hours. These mobilization times are generally based on the behavioral response curves discussed in Chapter 4 and shown below in Figure 6-26. From a traffic perspective, a more gradual loading of the network is preferred as the rapid loading of vehicles onto a transportation system results in heavier congestion and roadways reaching saturation levels very early on in an evacuation event.

The response curves depicted in the figure directly below relate to the following real-world examples regarding their use during an actual tropical cyclone response. A long response would be an appropriate clearance time assumption during nighttime hours, or during the middle of a normal weekday when most families are scattered to work, school and other routine activities away from home. A medium response curve would be appropriately applied during weekend days and any evening hours when most families have been rejoined at their residences and can be informed and mobilized in relatively short order. A rapid response relates to periods when most families are together and can be alerted and motivated to respond quickly, such as in the morning before most families have left from normal daytime activities and before schools and businesses are opened.

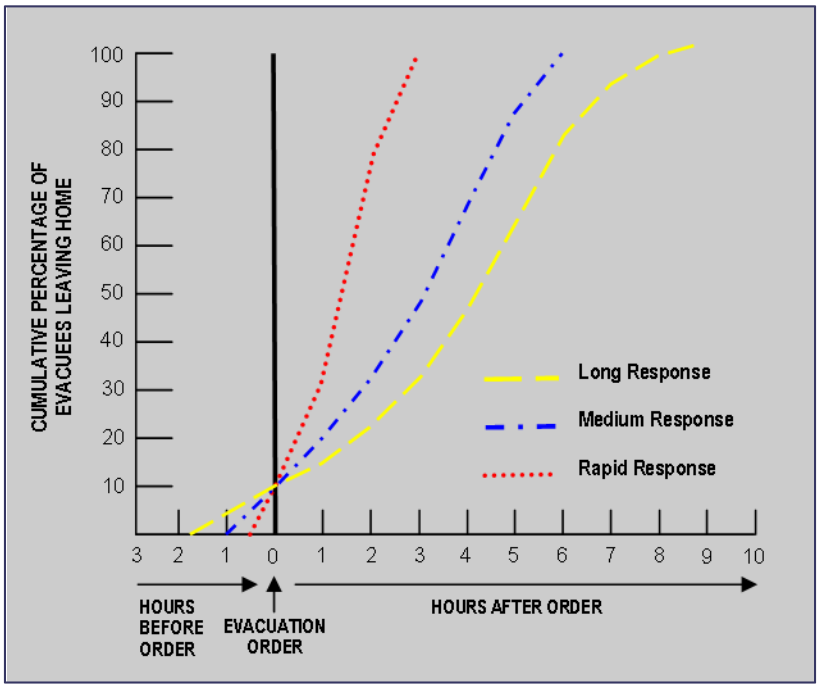

Figure 6-26: Behavioral Response Curve

6.6.3 Destination Percentages

Another essential input into the transportation analysis involves the destination percentages of evacuees. Generally, the traffic movements associated with hurricane evacuation have been identified by five general travel patterns as follows:

1. Internal Trips (In-Jurisdiction Origins to In-Jurisdiction Destinations)

   Vehicles primarily traveling from storm surge vulnerable areas and all mobile home units to destinations within the same community, such as public shelters, hotel and motel units, churches, and friends or relatives outside the storm surge vulnerable areas. An example of this pattern is a family leaving a home in Bridgeport and evacuating to a relative's home in Trumbull.

2. External Trips (In-Jurisdiction Origins to Out-Of-Jurisdiction Destinations)

   Evacuation travel that originates in an individual community and ends in other jurisdictions within the study area or outside the region entirely. Generally, the more intense the storm scenario, the larger the percent assumed to be exiting the jurisdiction. These trips are the most common for tourists, such as a couple vacating a hotel room in Groton, and evacuating to their home in Hartford.

3. Entering Trips (Out-Of-Jurisdiction Origins to In-Jurisdiction Destinations)

   Vehicles entering a jurisdiction after having evacuated from another community within or outside the study area. Evacuees traveling westbound from Cape Cod, Massachusetts, to return to their home in New Haven are an example of these kinds of trips.

4. Pass Through Trips (Out-of-Jurisdiction Origins to Out-of-Jurisdiction Destinations)

   These trips pass through an individual jurisdiction while traveling from one jurisdiction in the study area to another or outside the study area entirely; such as a family vacating their weekly vacation unit in Hyannis, Massachusetts, and returning to their home in New York City.

5. Background Traffic

   Trips made by persons preparing for the arrival of hurricane conditions; these trips are primarily shopping trips to gather supplies. Background traffic can also include transit vehicles (vans/ buses) used to pick up evacuees without personal transportation.

Destinations are related to evacuees' proximity to the coast and socio-economic conditions. The more affluent evacuees do not utilize public shelters as much as the remainder of the population. Persons of lower income generally utilize public shelters more because of the problems they may have with transportation and their inability to find affordable hotel/motel destinations.

For the Connecticut HES TDR study area destination options focused on: local public shelters, "other" local destinations, and out of the county destinations. Based on responses received during the behavioral analysis for the Connecticut coastal areas, destination percentages were varied for each traffic evacuation zone in the study area depending on the category of risk (distance from the coastline and water bodies). Assumptions were also varied for permanent residents versus tourist/seasonal populations. With each increase in storm intensity, a larger percentage of evacuees were assumed to go out of community, which is consistent with what has been learned in actual evacuations. The percent of permanent residents and mobile home evacuees going out of community varied between 20 and 50 percent depending on storm category and unit type. The percent of permanent residents and mobile home evacuees going to local public shelter ranged between 5 and 10 percent depending on type of unit and location. For modeling purposes, the remaining residents would then be seeking other safe locations, such as friends and relatives, within their own local jurisdictions. Table 6-12 below provides details on the percentages of evacuating vehicles going to each of those destinations.

Although the model uses behavioral characteristics to calculate the first three types of destinations described above, pass-through and background traffic trips are determined by the routing tables and the service-volume-to-capacity formulas applied later on in the transportation modeling process.

The destinations of the visitor populations were also factored into the transportation model since they are another important component of the evacuating people and vehicles figures. Visitor populations also have an impact on public shelter use, albeit smaller than the permanent residents in those communities. The basic assumptions regarding all visitor populations is that regardless of whether they are in seasonal/vacation units, or hotel rooms they are more likely to leave the community and become exiting evacuees. Only a very small percentage of visitors, only 1 percent, are assumed to remain in community, usually seeking public shelters space.

Table 6-12: Behavioral Assumptions for Permanent Resident Destinations

Evacuation Areas[1]	Permanent Resident/Mobile Home Destination Percentages					
	Percent to In-County Locations		Percent to Public Shelters		Percent to Out of Community Locations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Fairfield County	45%	35%	5%	5%	55%	65%
	40%	30%	5%	5%	60%	70%
	50%	45%	10%	10%	50%	55%
Middlesex County	45%	35%	5%	5%	55%	65%
	40%	30%	5%	5%	60%	70%
	50%	45%	10%	10%	50%	55%
New Haven County	45%	35%	5%	5%	55%	65%
	40%	30%	5%	5%	60%	70%
	50%	45%	10%	10%	50%	55%
New London County	45%	35%	5%	5%	55%	65%
	40%	30%	5%	5%	60%	70%
	50%	45%	10%	10%	50%	55%

1. Key: Zone A Zone B Inland Area (Non-Surge)

6.6.4 Vehicle Usage

The final set of behavioral assumptions concerns vehicle usage rates during an evacuation. Vehicle usage rates pertain to the percentage of vehicles available at the home origin, assumed to be used in the evacuation. Some households will not evacuate using all of the vehicles at their disposal, choosing instead to consolidate their trips for fear of becoming separated along the route. Others will take all vehicles fearing damage to their automobiles. Vehicle usage percentages have been measured during actual evacuations and are consistently in the 60 to 80 percent range in all parts of the coastal United States. In this analysis, the percentage ranged from 60 to 70 percent for permanent residents and 100 percent for tourist/seasonal populations.

The key behavioral concepts and assumptions used for the study are summarized in Table 6-12. These evacuating destination figures were developed from the behavioral characteristics provided in the most recent behavioral survey in Connecticut.

6.7 Transportation Modeling Methodology

6.7.1 Introduction

The general philosophy supporting all hurricane evacuation clearance time work around the country is that the analysis must be technically complex enough to produce reliable estimates of hurricane evacuation clearance times, yet clear enough for the emergency management community to be able to review key modeling assumptions and products. A brief overview of the steps in the modeling process and a description of the modeling framework are discussed in this section.

It is important to understand while applying the information in this section that the transportation analysis is predicated on the following important assumptions concerning traffic operations and other conditions:

- The evacuation of all vehicles will occur prior to the arrival of sustained tropical storm force winds (39 mph) and storm inundation of evacuation routes.
- Provisions will be made for the removal of vehicles in distress on the network through aggressive incident management and agreements worked out with tow truck operators.
- Traffic signal adjustments will be implemented to provide the most “green time” for movements away from the coast.
- Suspension and high altitude bridges will close when the wind speed exceeds that which is safe for the throughput of vehicles.

6.8 The Transportation Model

The model used for the Connecticut HES TDR transportation analysis is a series of spreadsheets that consolidate all of the data collected during the study, as well as hazards information, the socioeconomic data, behavioral assumptions combined with the public shelter information, and the roadway network attributes. This transportation model is based on the same model used for Hurricane Evacuation Studies throughout the United States. The minor difference between the model developed for this region and other studies was required to account for the specific variations and circumstances related to the Connecticut coastal communities. Nonetheless, the model process and methodology used in this study are essentially the same as those employed in other areas.

The primary results from the transportation analysis are clearance time calculations and an abbreviated version of the model. The model clearance times provide guidance to emergency managers and other local officials regarding the lead time needed to allow all evacuating vehicles the opportunity to reach their intended safe objective before the arrival of tropical storm force winds. This model has been updated over the past several years and enhanced for greater accuracy. Furthermore, an abbreviated version of the transportation model is provided as a customary component of the study results which allows greater transparency for the study users. With this abbreviated model, the assumptions, data sources and basic processes used to calculate the figures provided in this report are much more readily apparent and can be updated to account for annual developments and variations. The major inputs and outputs of the overall process are illustrated in Figure 6-27.

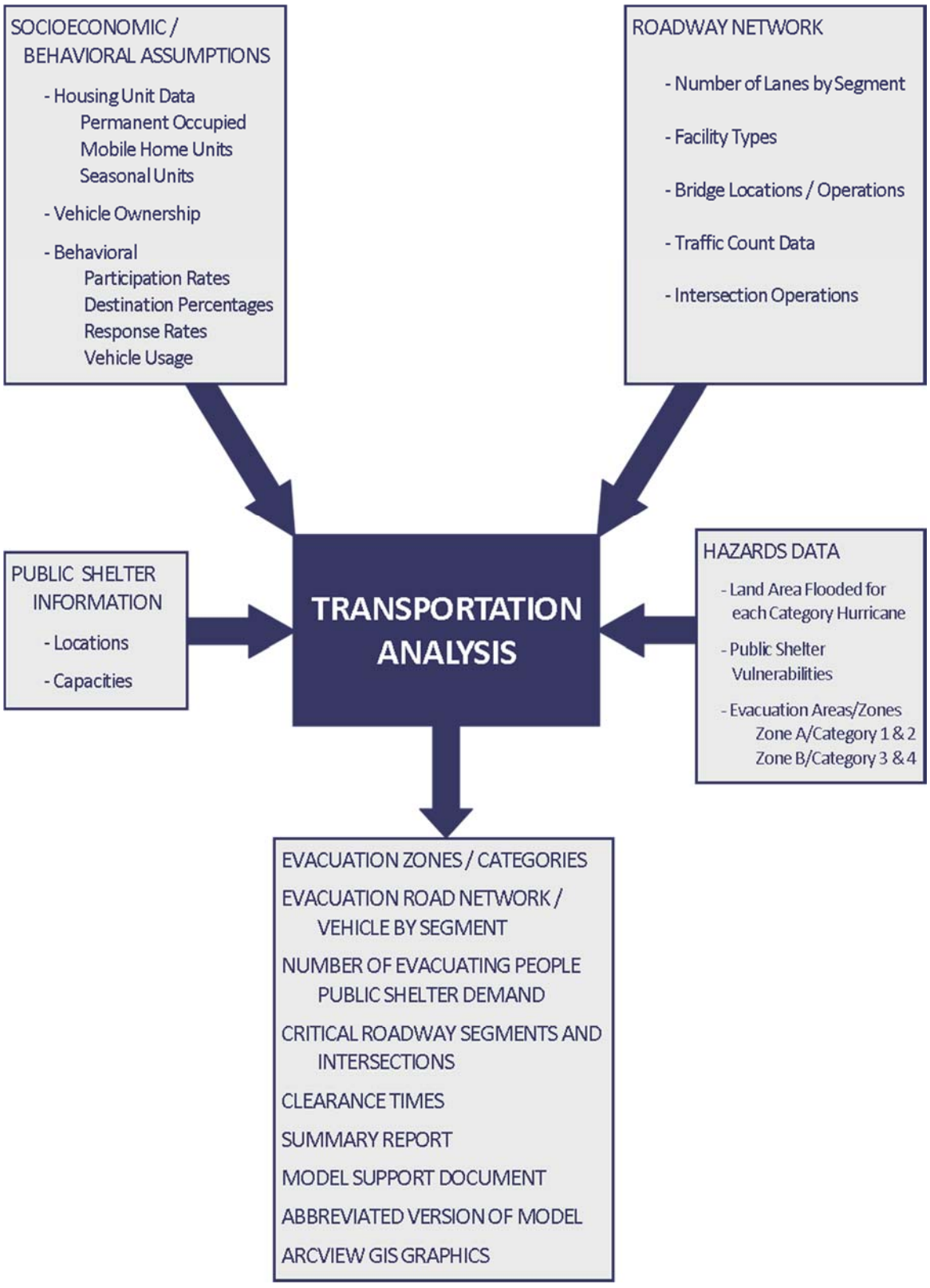

Figure 6-27: Clearance Time Model Process

6.0 Transportation Analysis

The basic key modeling steps used in this analysis for the Connecticut jurisdictions are as follows:

- Development of Evacuation Zones and Data - Identifies who is vulnerable and who is evacuating; socioeconomic data is stratified by evacuation zones; data includes numbers of permanent residential dwelling units, mobile homes, and seasonal units compiled by zone.
- Trip Generation - Calculates how many people and vehicles will move for a particular hurricane category originating from each evacuation zone.
- Trip Distribution - Determines where evacuees will go (to destinations within the originating jurisdiction or out of area).
- Development of Evacuation Road Network – This step identifies which roads can be used for evacuation and includes the assignment of reasonable vehicle carrying capacities during an evacuation.
- Trip Assignment - Determines what route(s) evacuees will take to get from their point of origin to their destination based on shortest travel time. Additionally, terminating trips entering the jurisdiction of interest from other locations and pass-through vehicles are accounted for in this step of the modeling process.
- Calculation of Clearance Time – Determines how much time it will take for all evacuees to clear evacuation network bottlenecks including time for the "last vehicle" to reach assumed safety point. This modeling step also factors in the impacts of background traffic (those vehicles on the roadway that are not expressly evacuating, but instead traveling on local evacuation routes to prepare for the storm or to conduct other daily activities). The end product of this major step is the development of clearance times for each storm scenario for the Connecticut jurisdictions.

At the conclusion of the study, the USACE, New England District; FEMA; and the Connecticut Division of Emergency Management and Homeland Security (DEMHS), as well as each community in the study area received a simplified spreadsheet tool that allows officials to make changes to critical socioeconomic, behavioral, and roadway assumptions. This dynamic transportation model (DTM) was developed in order to facilitate the ability of the emergency management and other local officials to update clearance times in an efficient manner.

6.9 Transportation Modeling Process

The first step in developing the hurricane evacuation transportation model for the region was to assess the myriad roads in the region to determine which should be included as primary evacuation routes. Fortunately, the Connecticut Department of Transportation and DEMHS staff, as well as local officials, had already designated official road corridors throughout the region to be used for hurricane evacuation. In addition, roadways that would logically be used by the surrounding populace were considered for inclusion in the model. Once the all roadways were identified, the network was mapped using GIS and incorporated into the model. A "link-node" system was used to characterize the selected roadway sections and create a reasonable representation of the evacuation roadway system for the Connecticut communities. Nodes are used to identify the intersection of two roadways or changes in roadway characteristics. Links are the roadway segments between nodes with each link identified by a letter designation. Figures were developed illustrating the coded evacuation network with link designations and zone centroid labels (loading points) shown by open circles and dashed lines. These are displayed in Figures 6-28 through 6-60 as follows:

- Figure 6-28: Evacuation Roadway Network – Fairfield County / Bridgeport
- Figure 6-29: Evacuation Roadway Network – Fairfield County / Darien
- Figure 6-30: Evacuation Roadway Network – Fairfield County / Fairfield
- Figure 6-31: Evacuation Roadway Network – Fairfield County / Greenwich
- Figure 6-32: Evacuation Roadway Network – Fairfield County / Norwalk
- Figure 6-33: Evacuation Roadway Network – Fairfield County / Stamford
- Figure 6-34: Evacuation Roadway Network – Fairfield County / Stratford
- Figure 6-35: Evacuation Roadway Network – Fairfield County / Westport
- Figure 6-36: Evacuation Roadway Network – Middlesex County / Chester
- Figure 6-37: Evacuation Roadway Network – Middlesex County / Clinton
- Figure 6-38: Evacuation Roadway Network – Middlesex County / Deep River
- Figure 6-39: Evacuation Roadway Network – Middlesex County / Essex
- Figure 6-40: Evacuation Roadway Network – Middlesex County / Old Saybrook
- Figure 6-41: Evacuation Roadway Network – Middlesex County / Westbrook
- Figure 6-42: Evacuation Roadway Network – New Haven County / Branford
- Figure 6-43: Evacuation Roadway Network – New Haven County / East Haven
- Figure 6-44: Evacuation Roadway Network – New Haven County / Guilford
- Figure 6-45: Evacuation Roadway Network – New Haven County / Hamden
- Figure 6-46: Evacuation Roadway Network – New Haven County / Madison
- Figure 6-47: Evacuation Roadway Network – New Haven County / Milford

- Figure 6-48: Evacuation Roadway Network – New Haven County / New Haven
- Figure 6-49: Evacuation Roadway Network – New Haven County / North Haven
- Figure 6-50: Evacuation Roadway Network – New Haven County / West Haven
- Figure 6-51: Evacuation Roadway Network – New London County / East Lyme
- Figure 6-52: Evacuation Roadway Network – New London County / Groton
- Figure 6-53: Evacuation Roadway Network – New London County / Ledyard
- Figure 6-54: Evacuation Roadway Network – New London County / Lyme
- Figure 6-55: Evacuation Roadway Network – New London County / Montville
- Figure 6-56: Evacuation Roadway Network – New London County / New London
- Figure 6-57: Evacuation Roadway Network – New London County / Old Lyme
- Figure 6-58: Evacuation Roadway Network – New London County / Preston
- Figure 6-59: Evacuation Roadway Network – New London County / Stonington
- Figure 6-60: Evacuation Roadway Network – New London County / Waterford

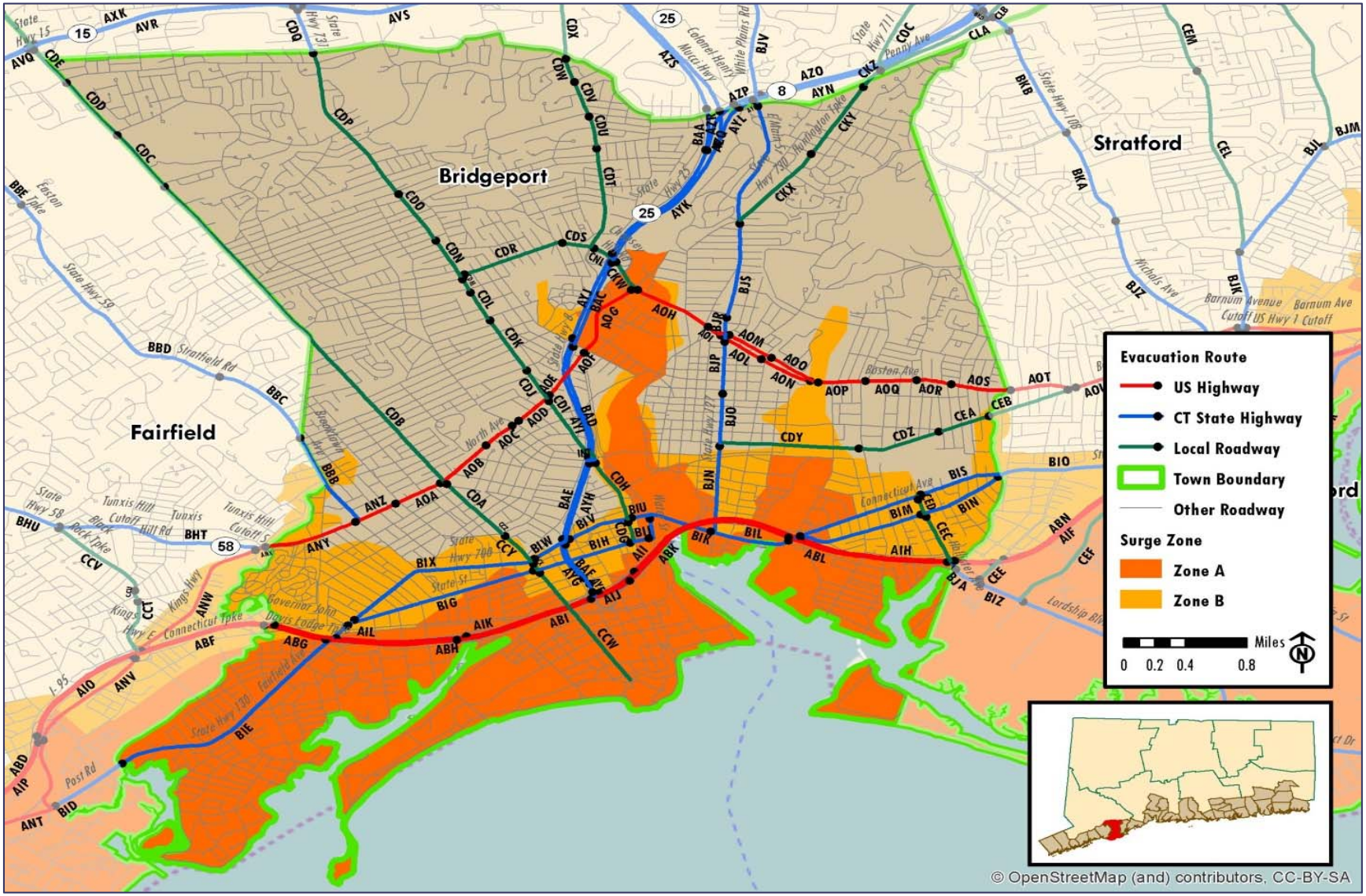

Figure 6-28: Evacuation Roadway Network – Fairfield County / Bridgeport

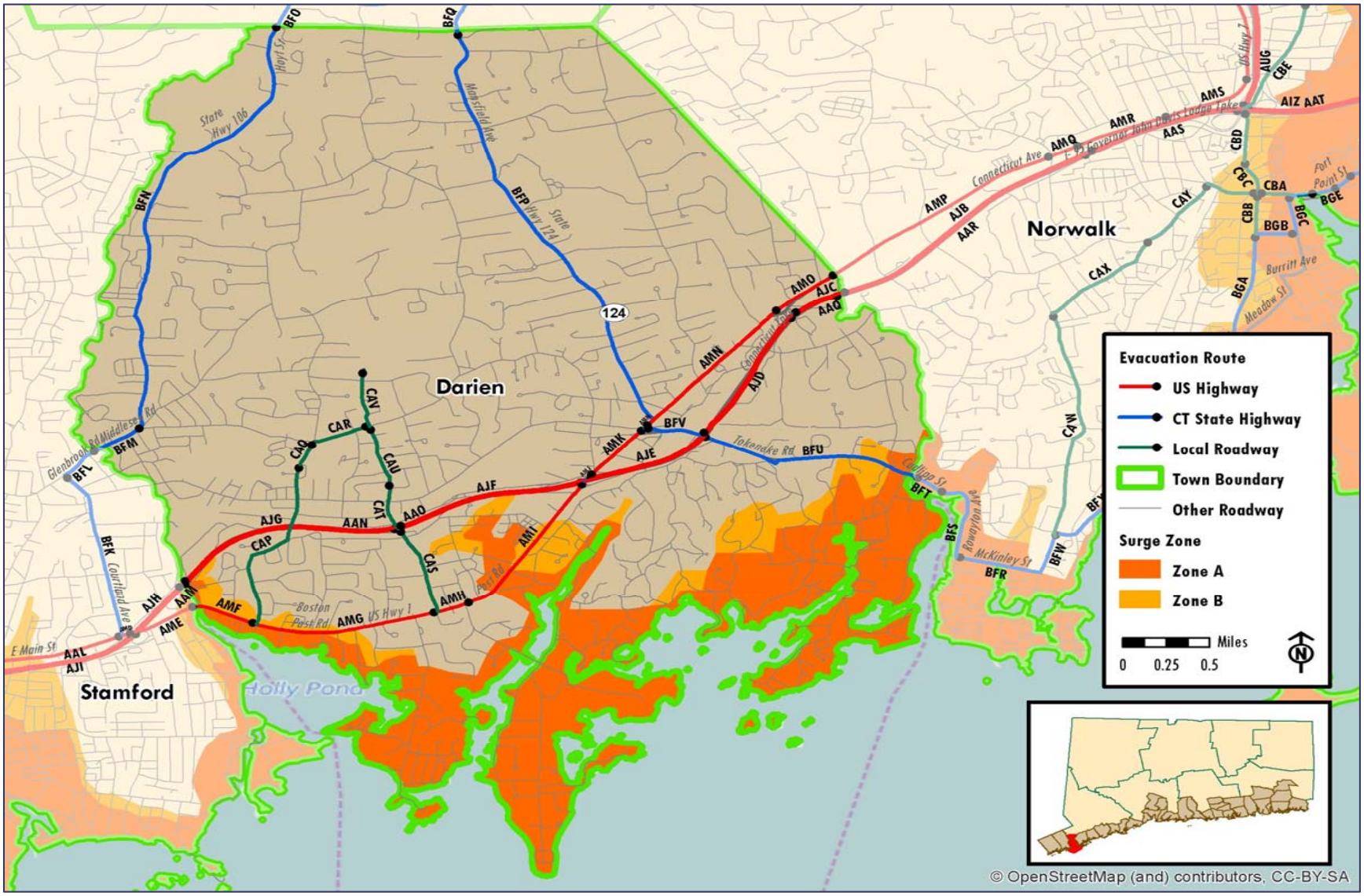

Figure 6-29: Evacuation Roadway Network – Fairfield County / Darien

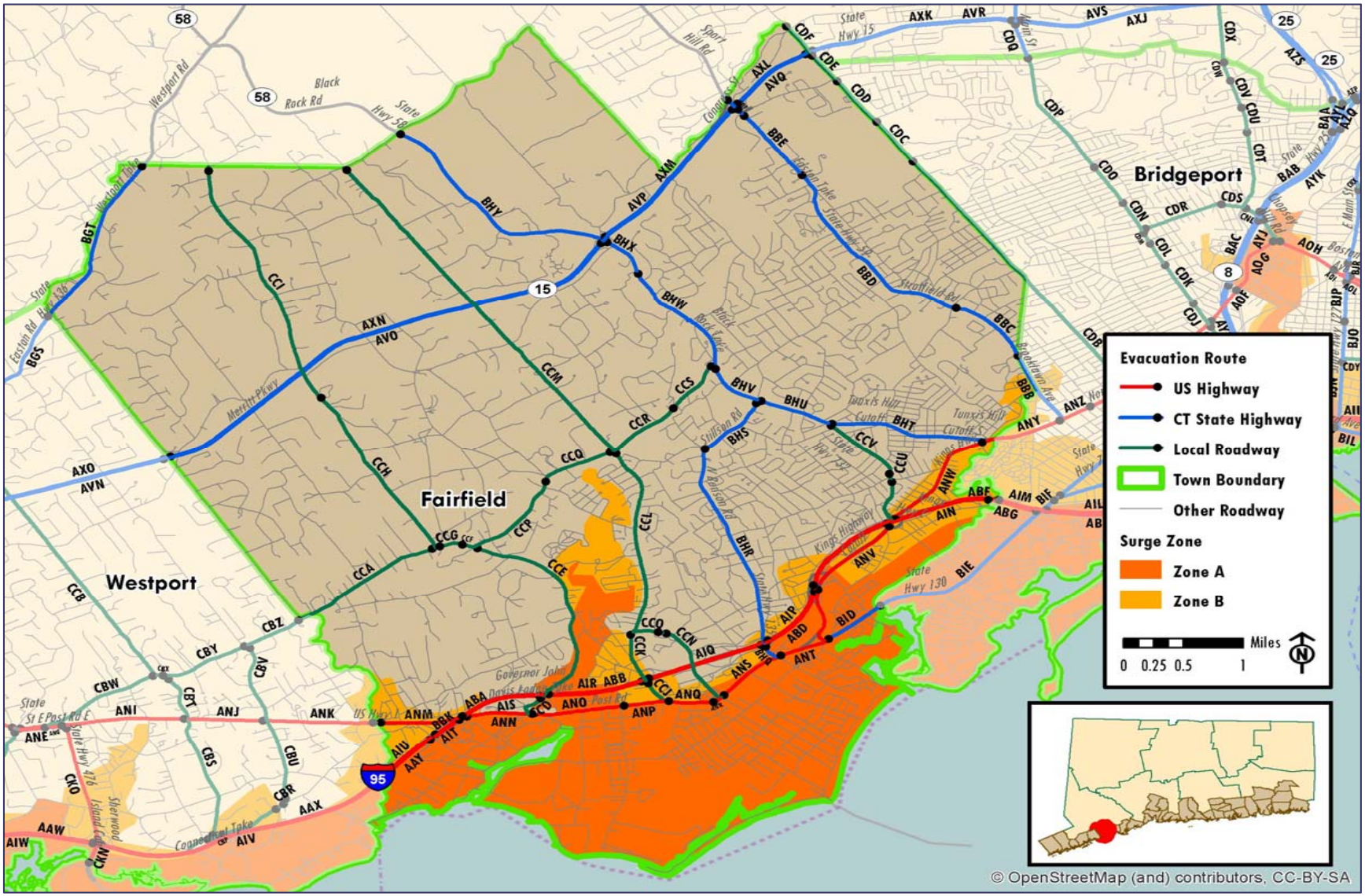

Figure 6-30: Evacuation Roadway Network – Fairfield County / Fairfield

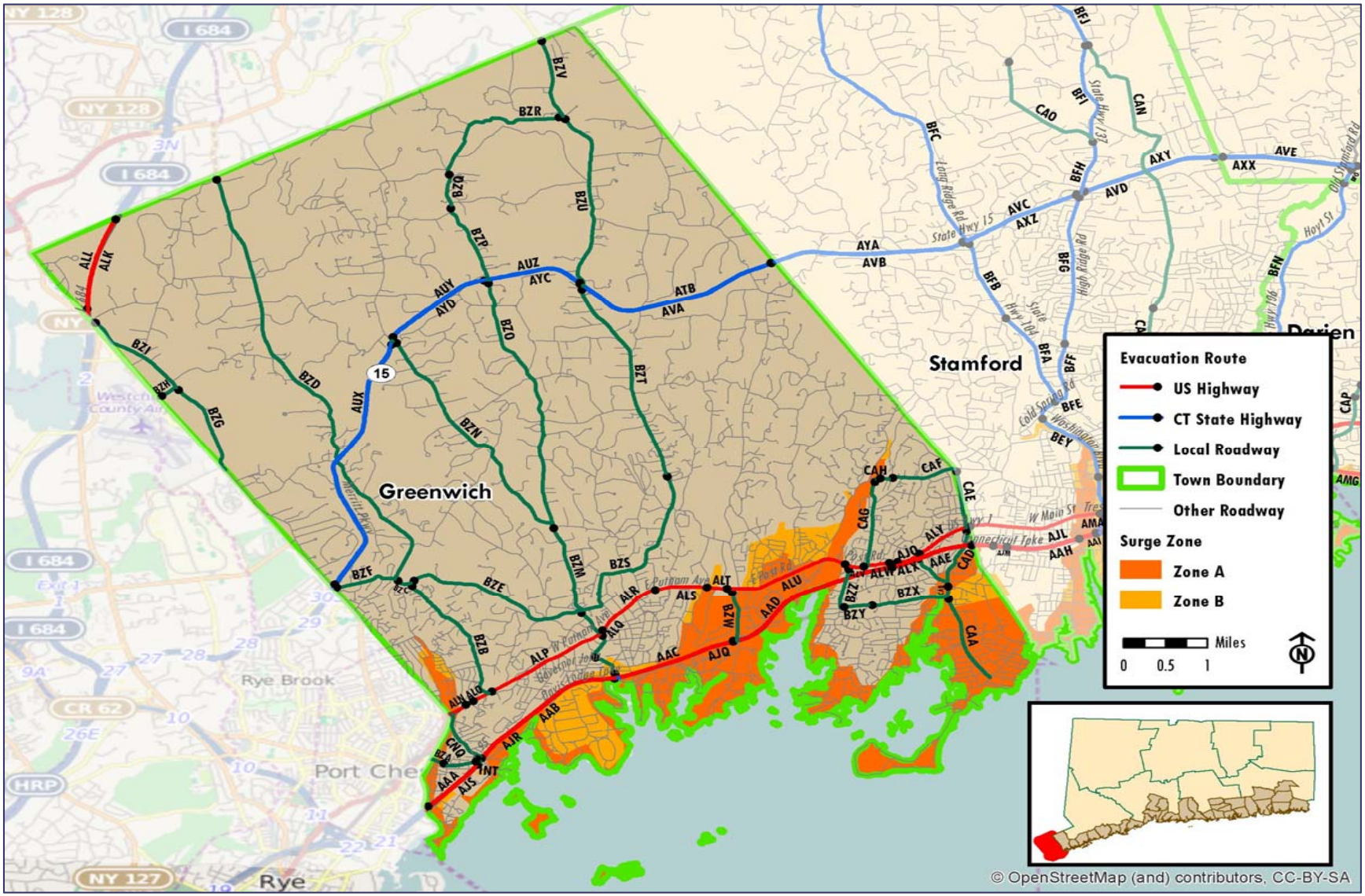

Figure 6-31: Evacuation Roadway Network – Fairfield County / Greenwich

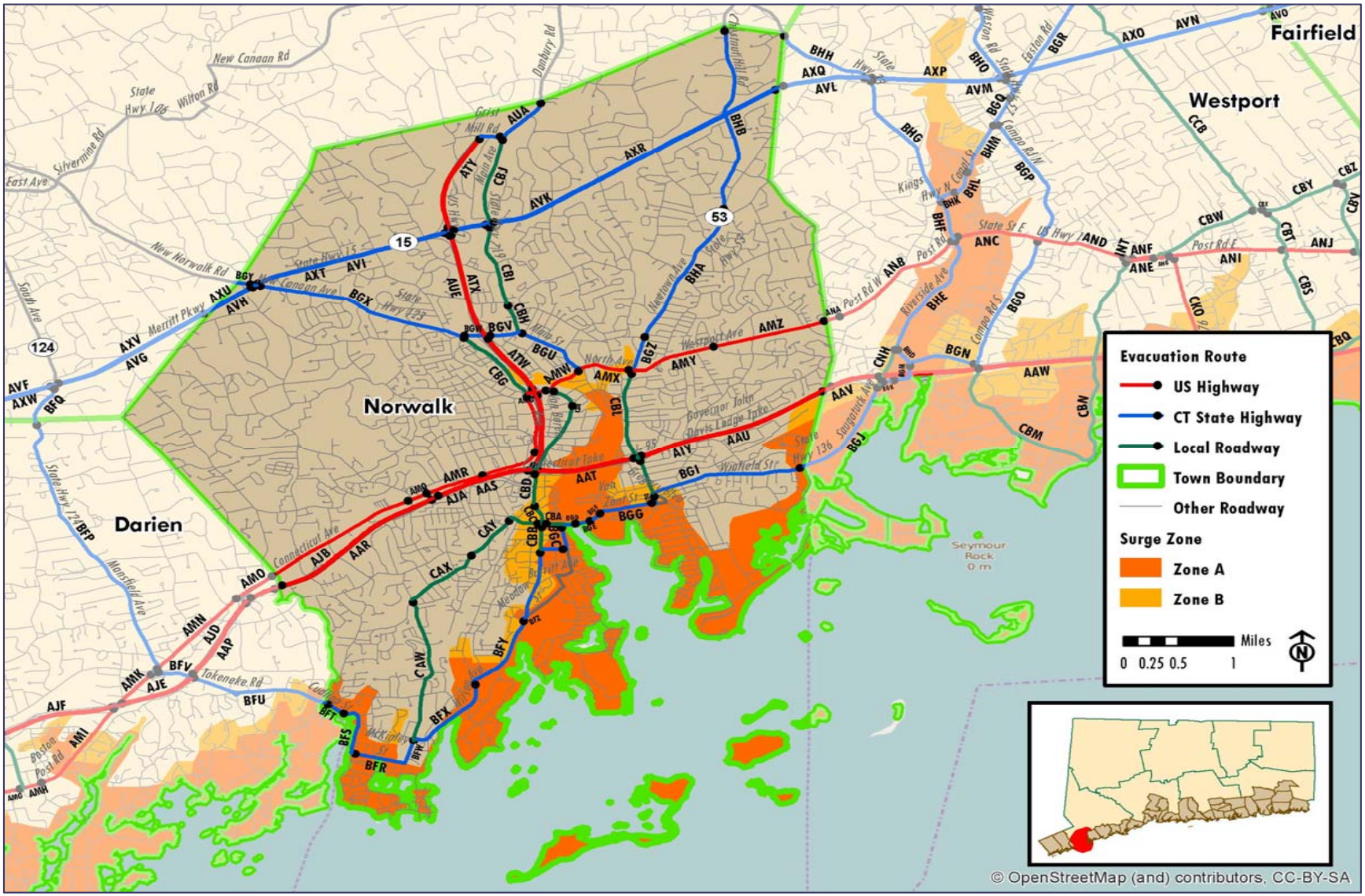

Figure 6-32: Evacuation Roadway Network – Fairfield County / Norwalk

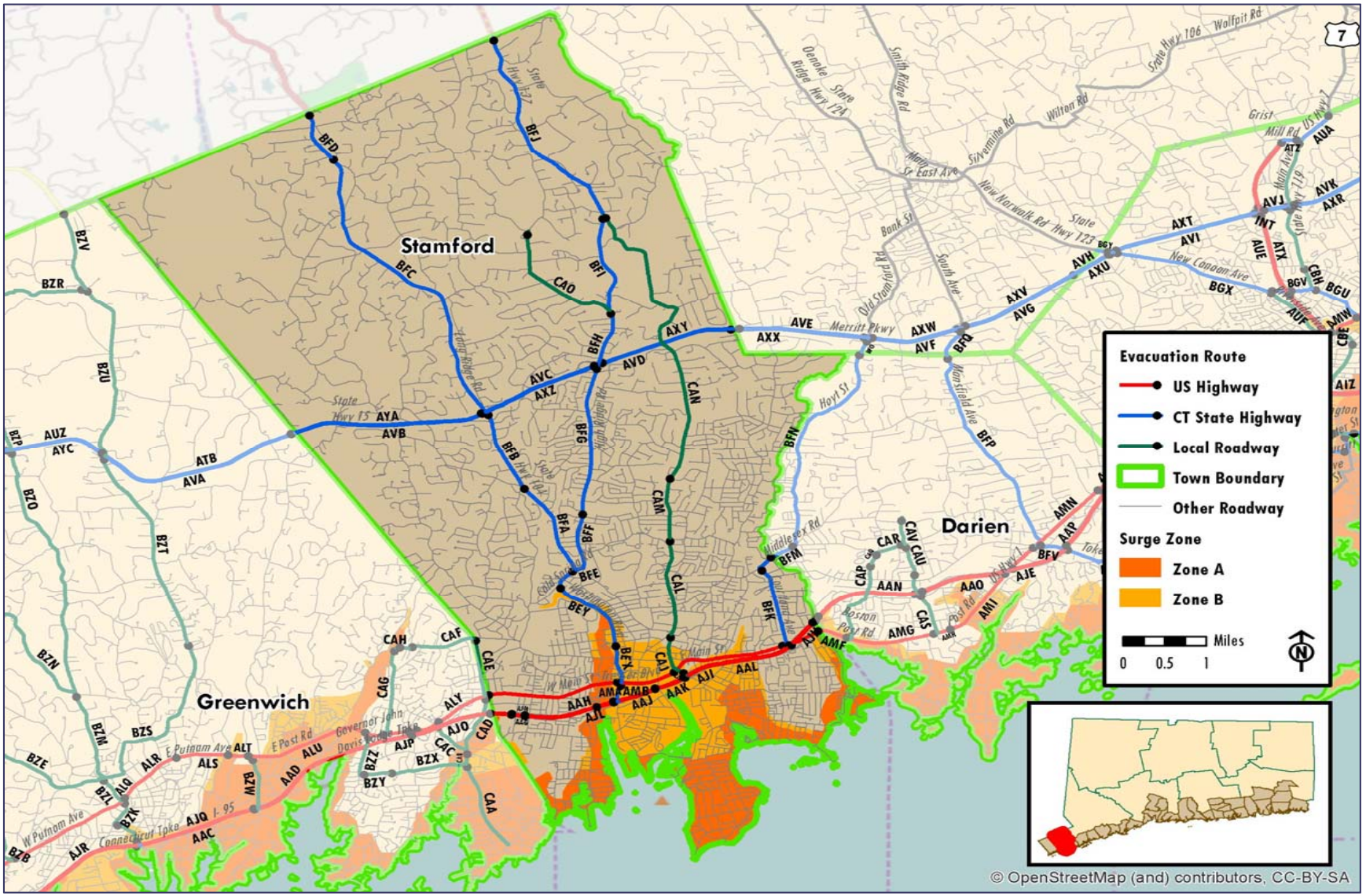

Figure 6-33: Evacuation Roadway Network – Fairfield County / Stamford

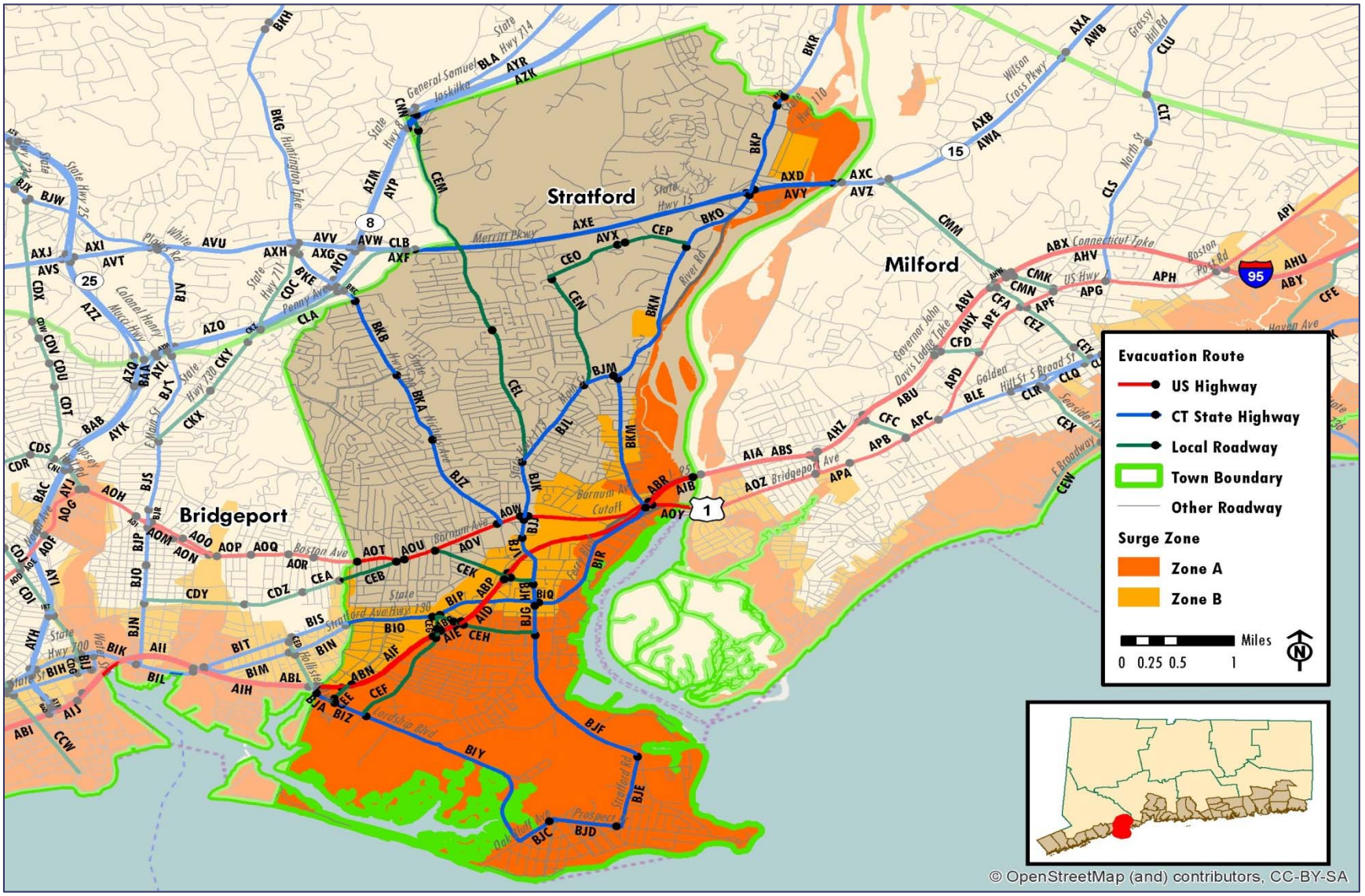

Figure 6-34: Evacuation Roadway Network – Fairfield County / Stratford

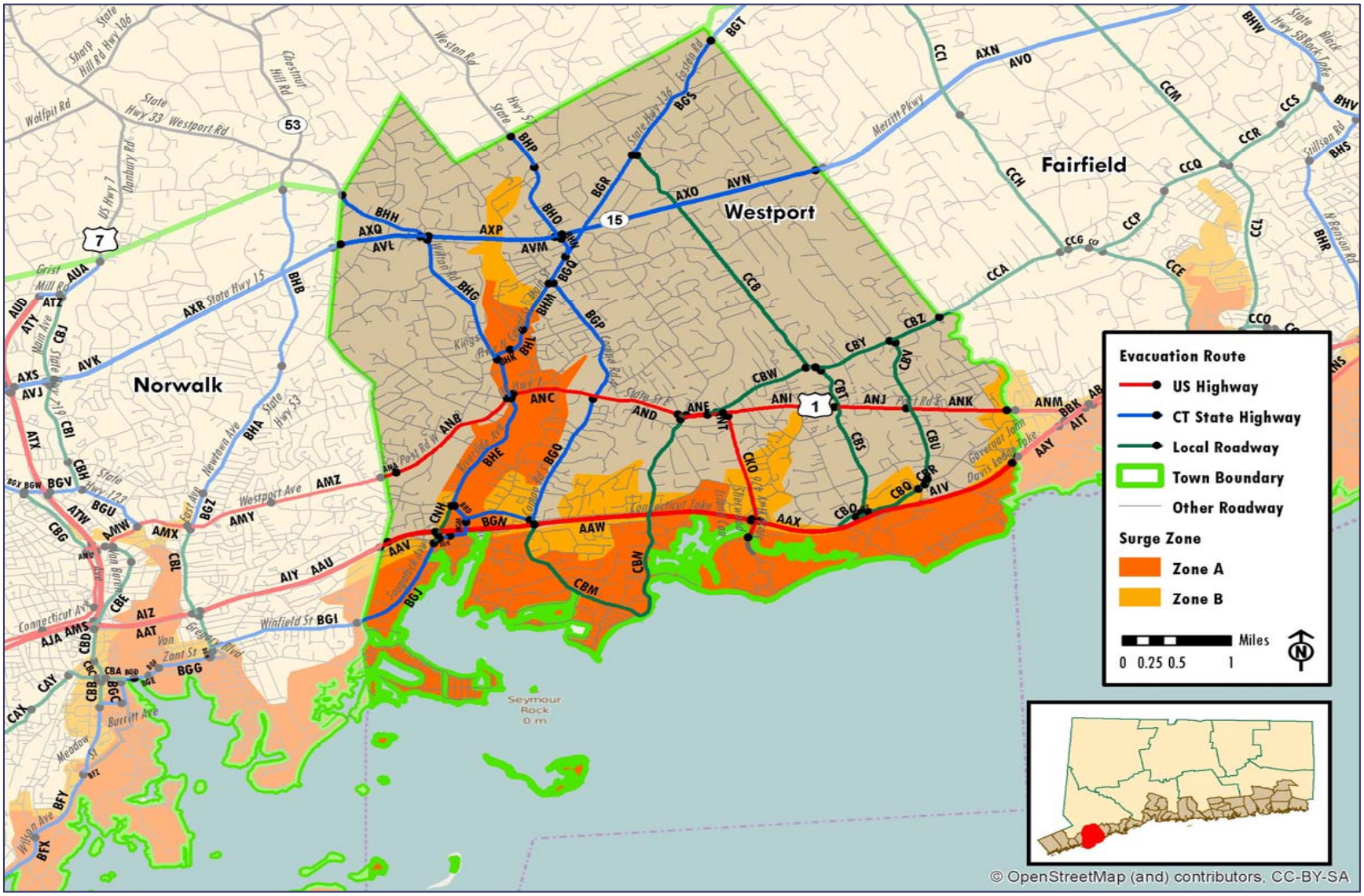

Figure 6-35: Evacuation Roadway Network – Fairfield County / Westport

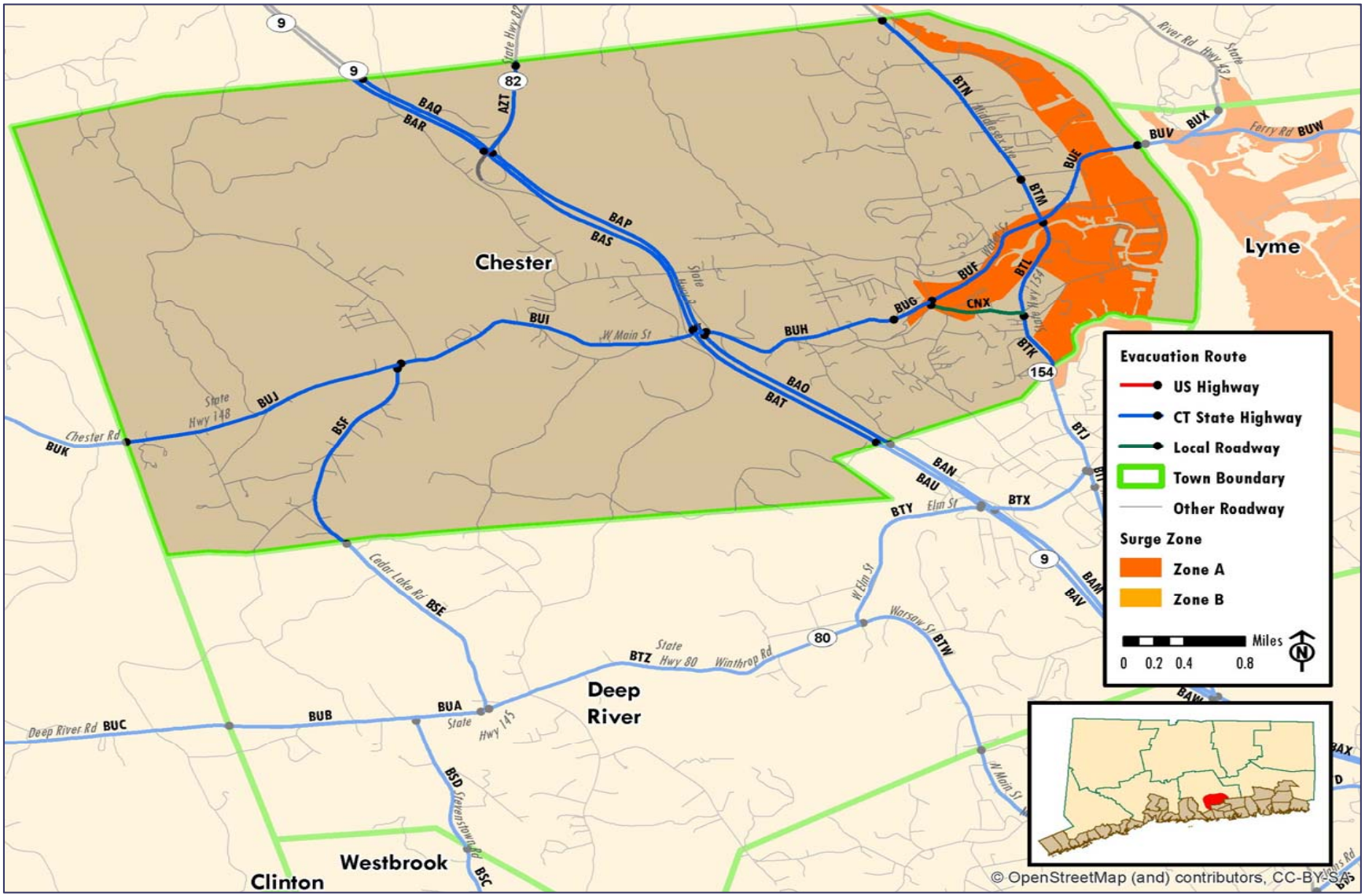

Figure 6-36: Evacuation Roadway Network – Middlesex County / Chester

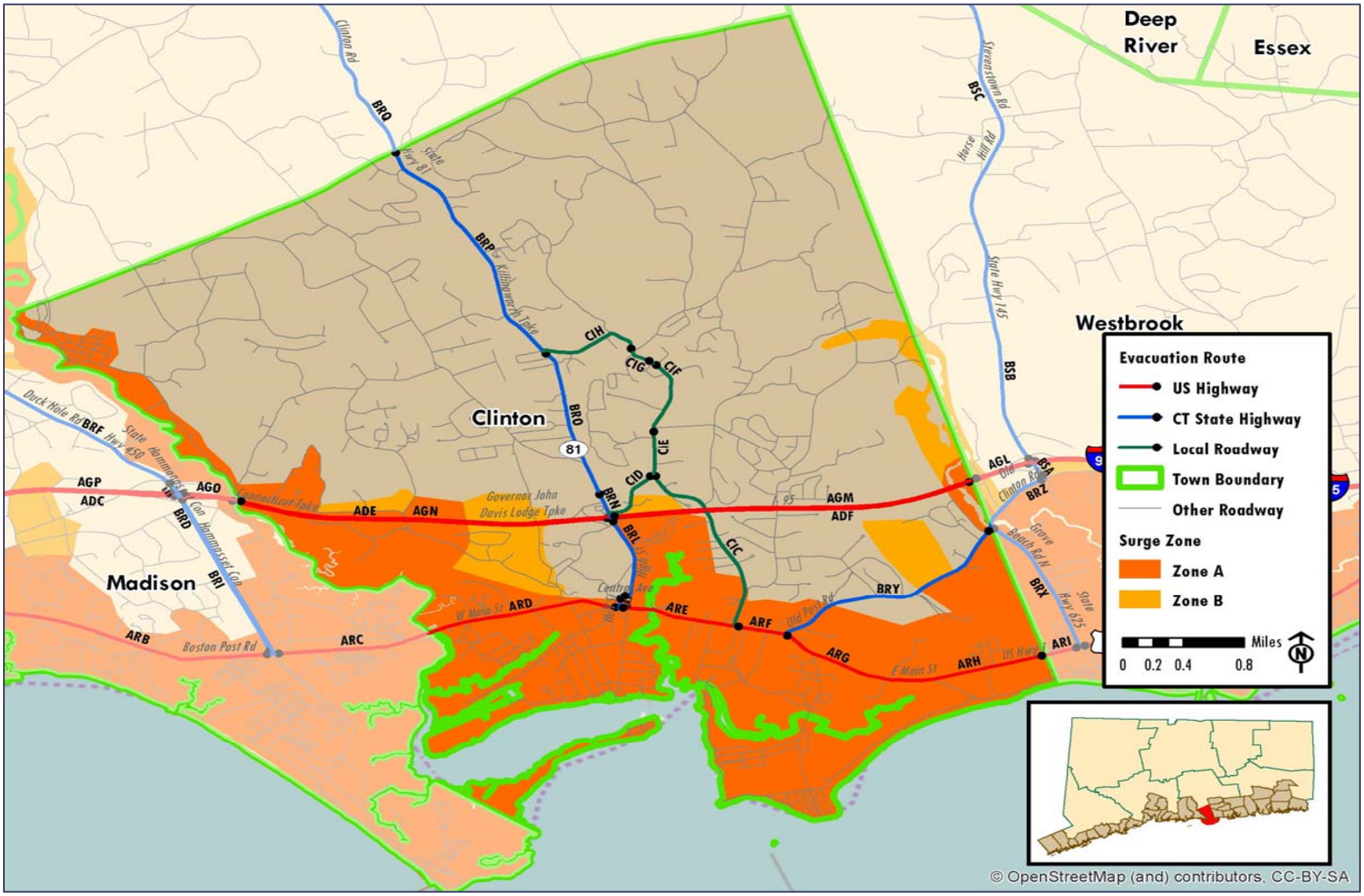

Figure 6-37: Evacuation Roadway Network – Middlesex County / Clinton

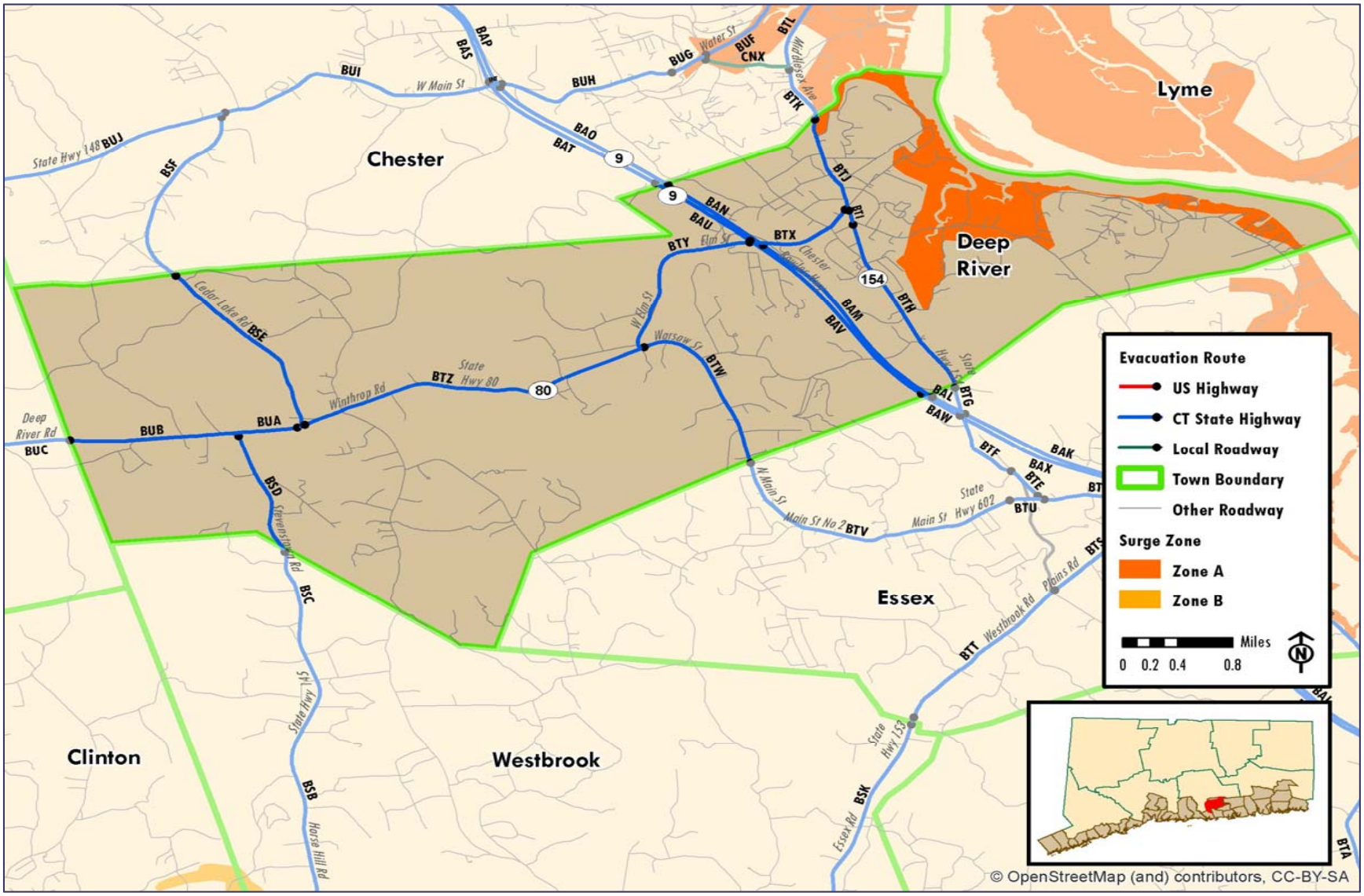

Figure 6-38: Evacuation Roadway Network – Middlesex County / Deep River

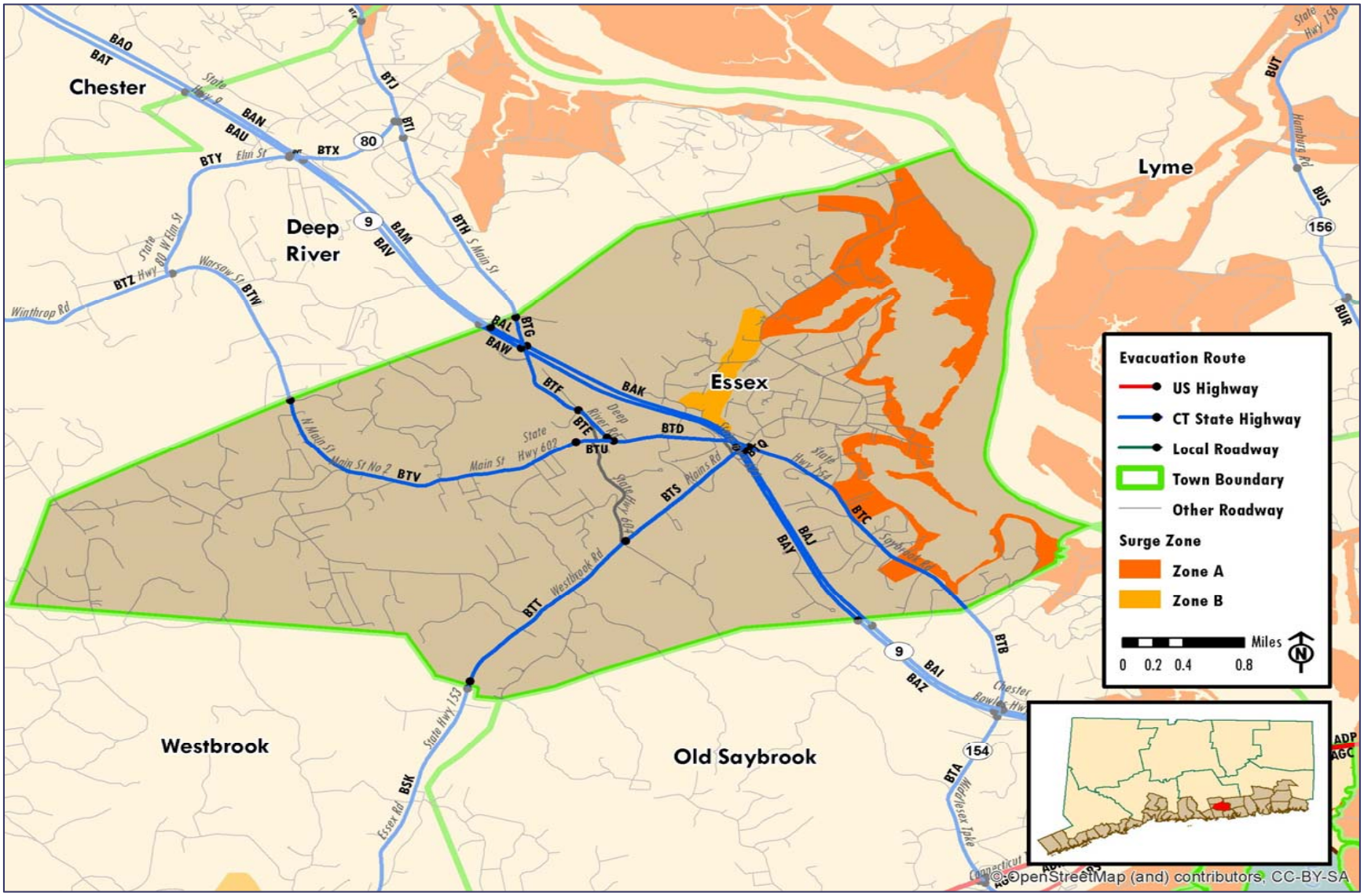

Figure 6-39: Evacuation Roadway Network – Middlesex County / Essex

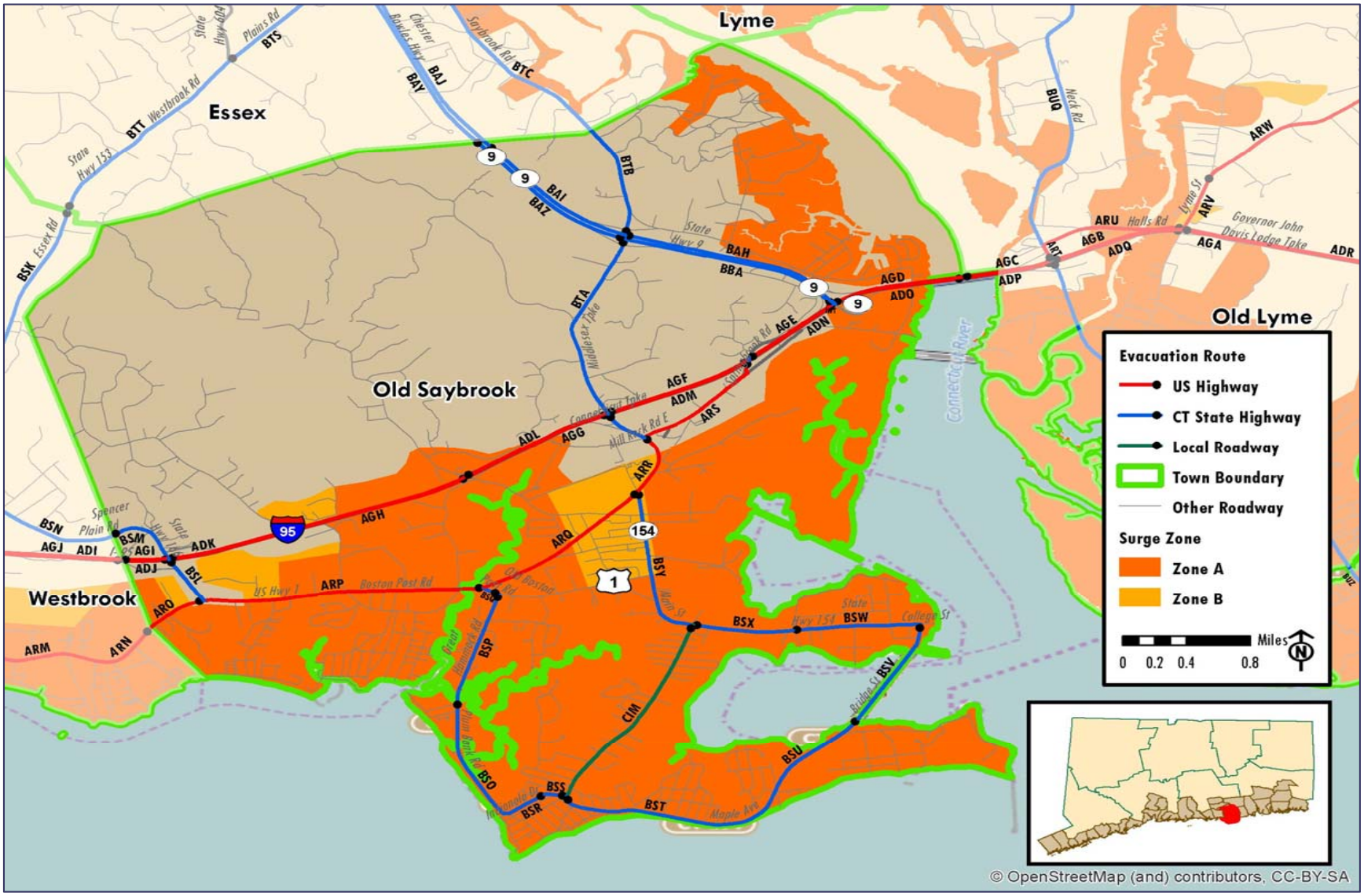

Figure 6-40: Evacuation Roadway Network – Middlesex County / Old Saybrook

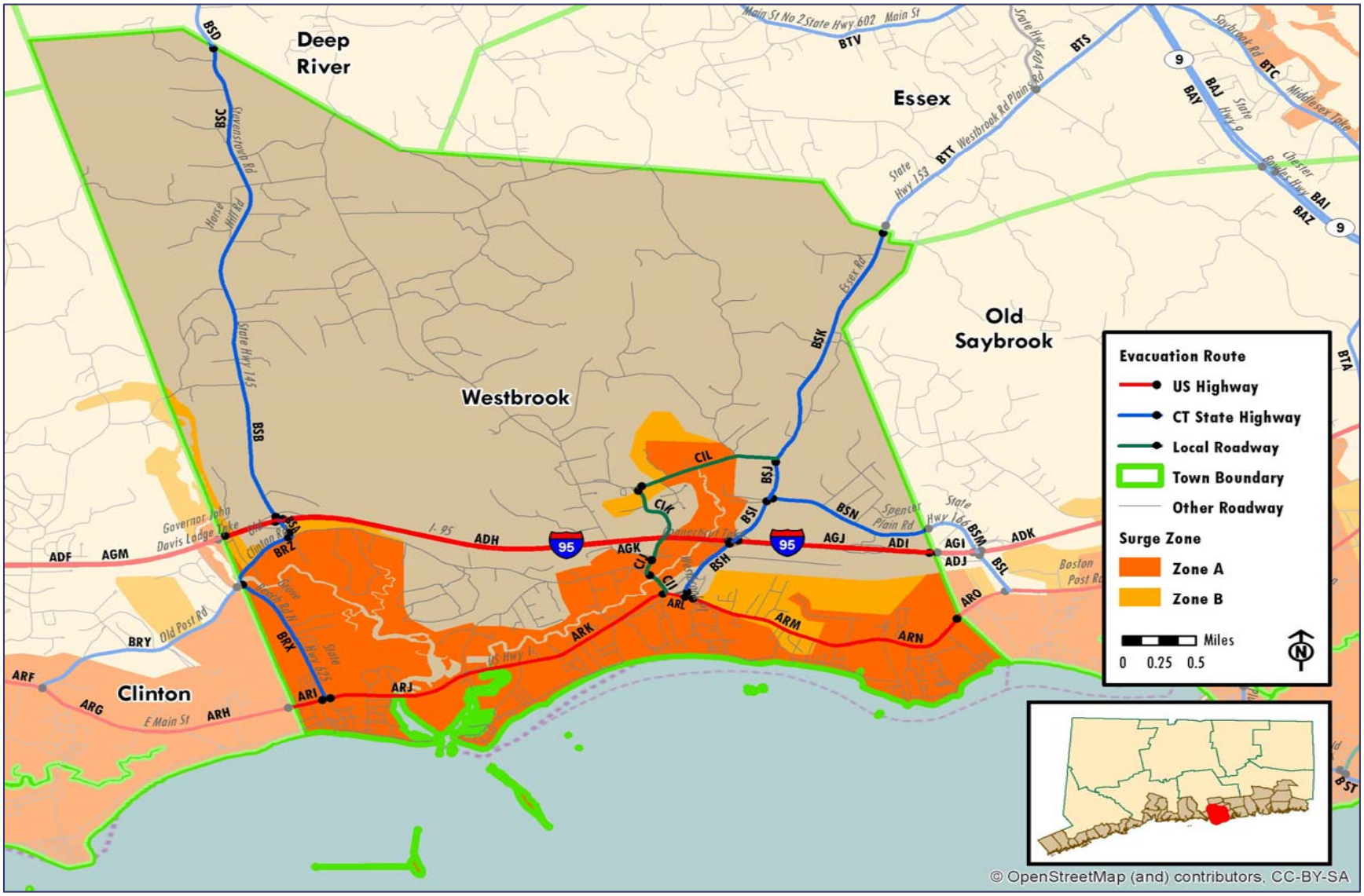

Figure 6-41: Evacuation Roadway Network – Middlesex County / Westbrook

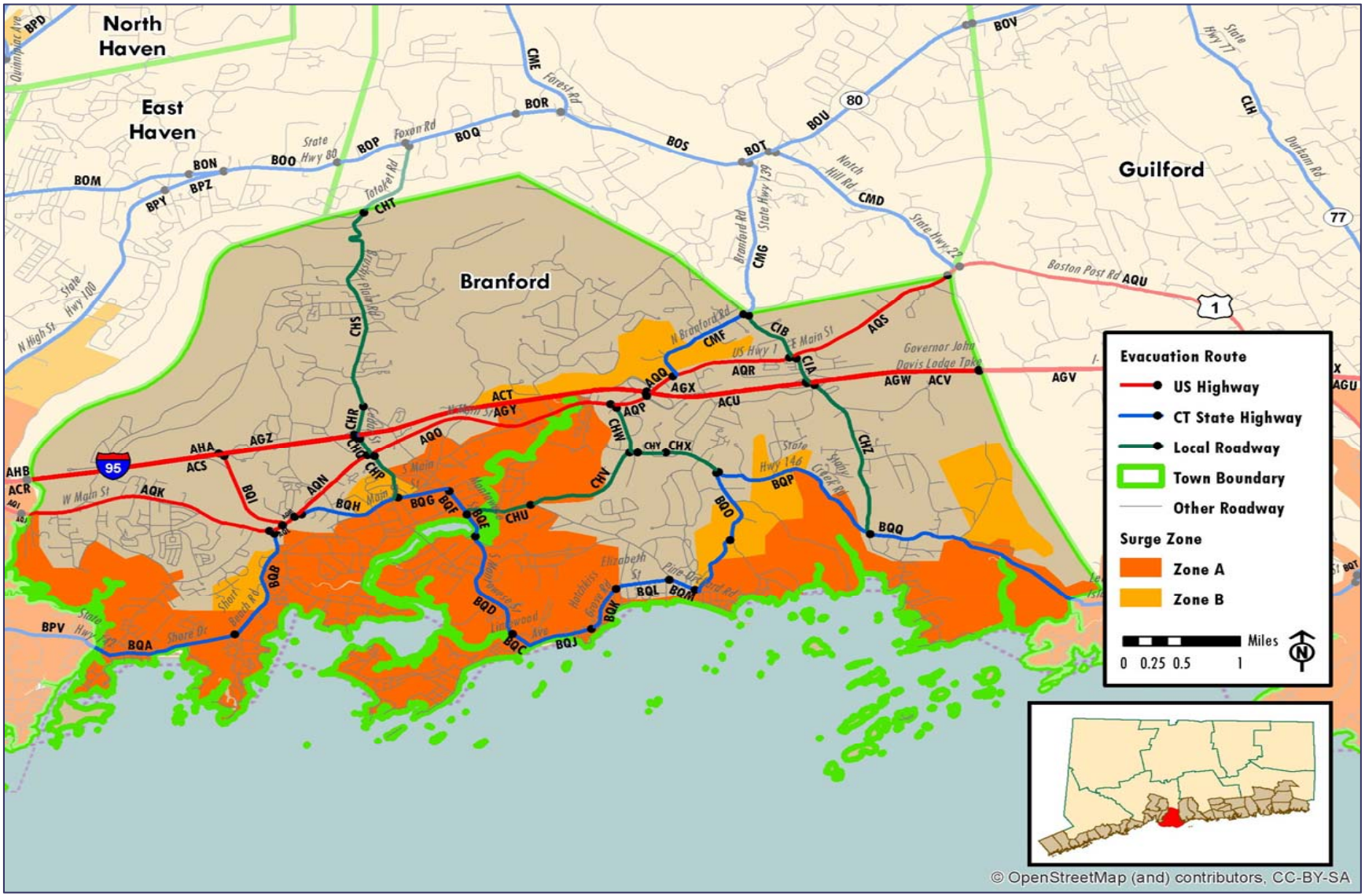

Figure 6-42: Evacuation Roadway Network – New Haven County / Branford

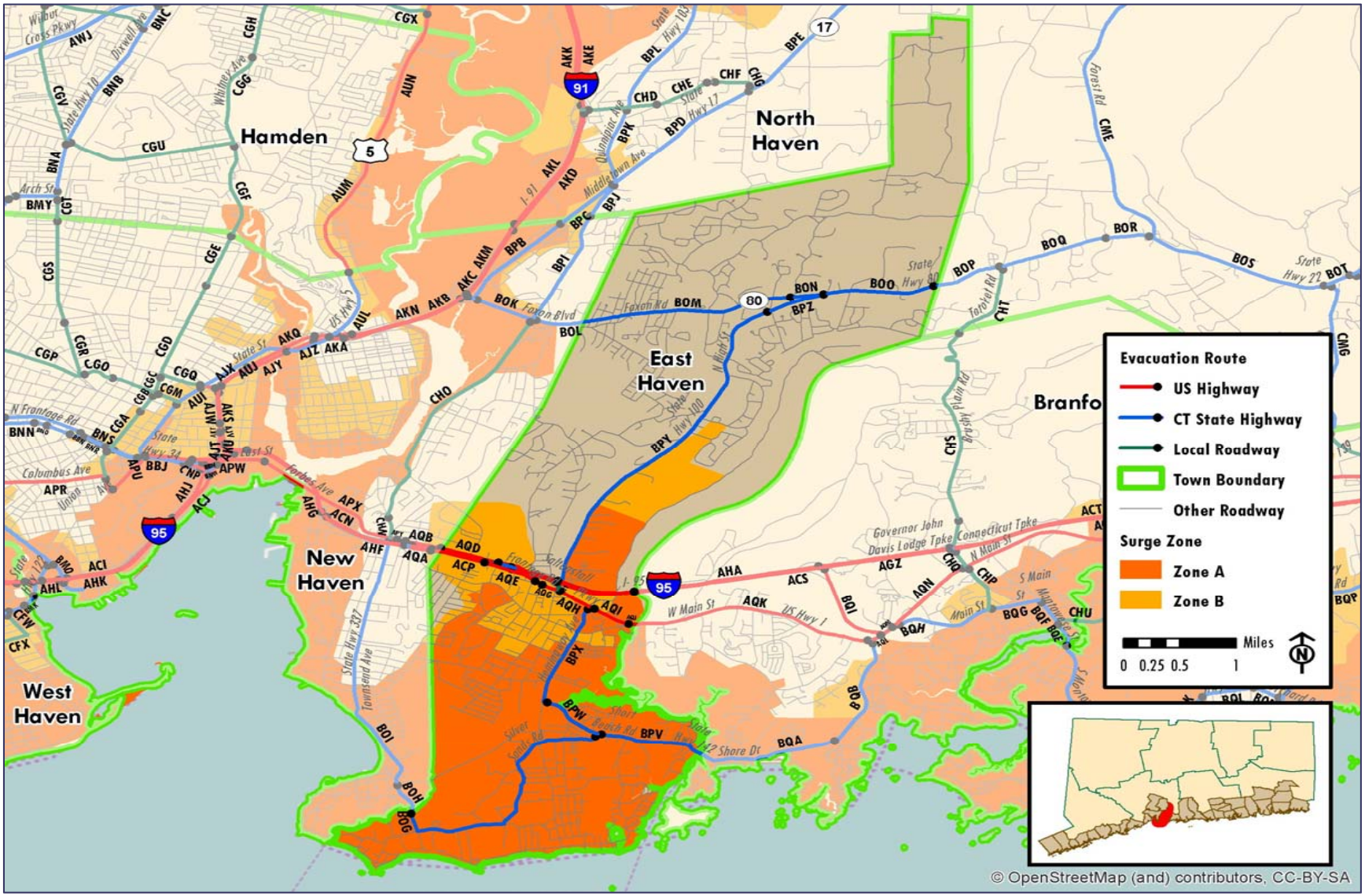

Figure 6-43: Evacuation Roadway Network – New Haven County / East Haven

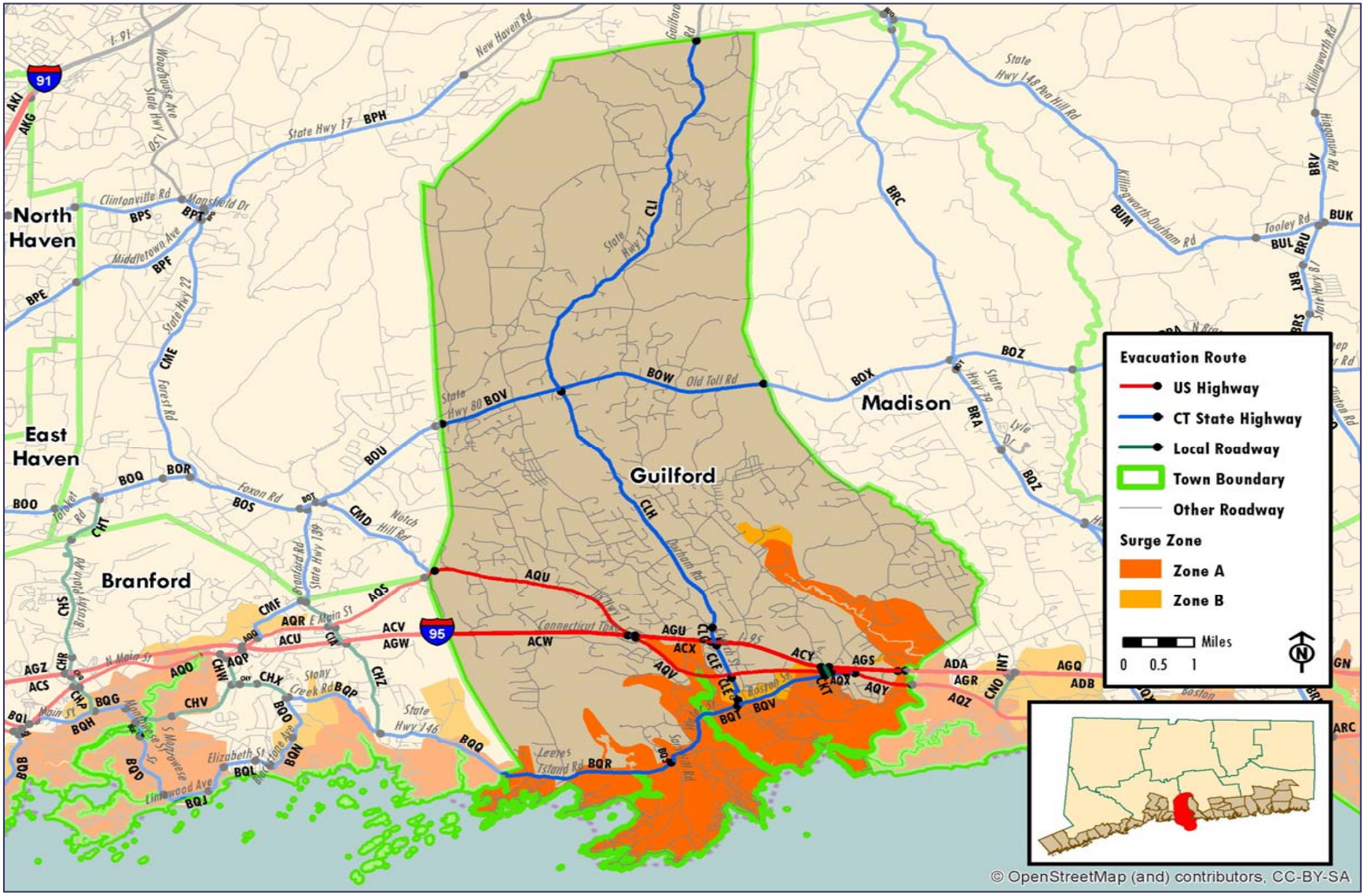

Figure 6-44: Evacuation Roadway Network – New Haven County / Guilford

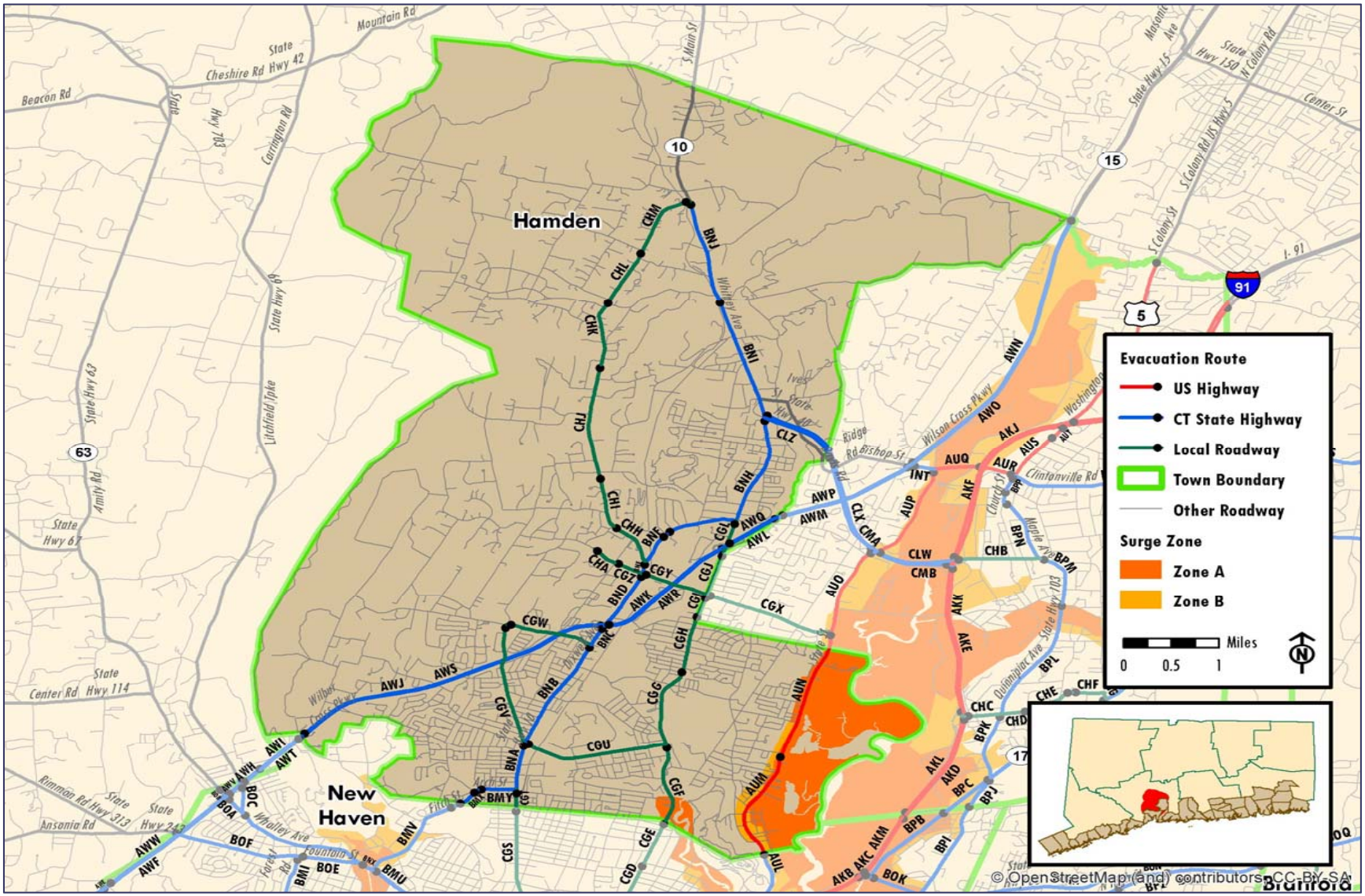

Figure 6-45: Evacuation Roadway Network – New Haven County / Hamden

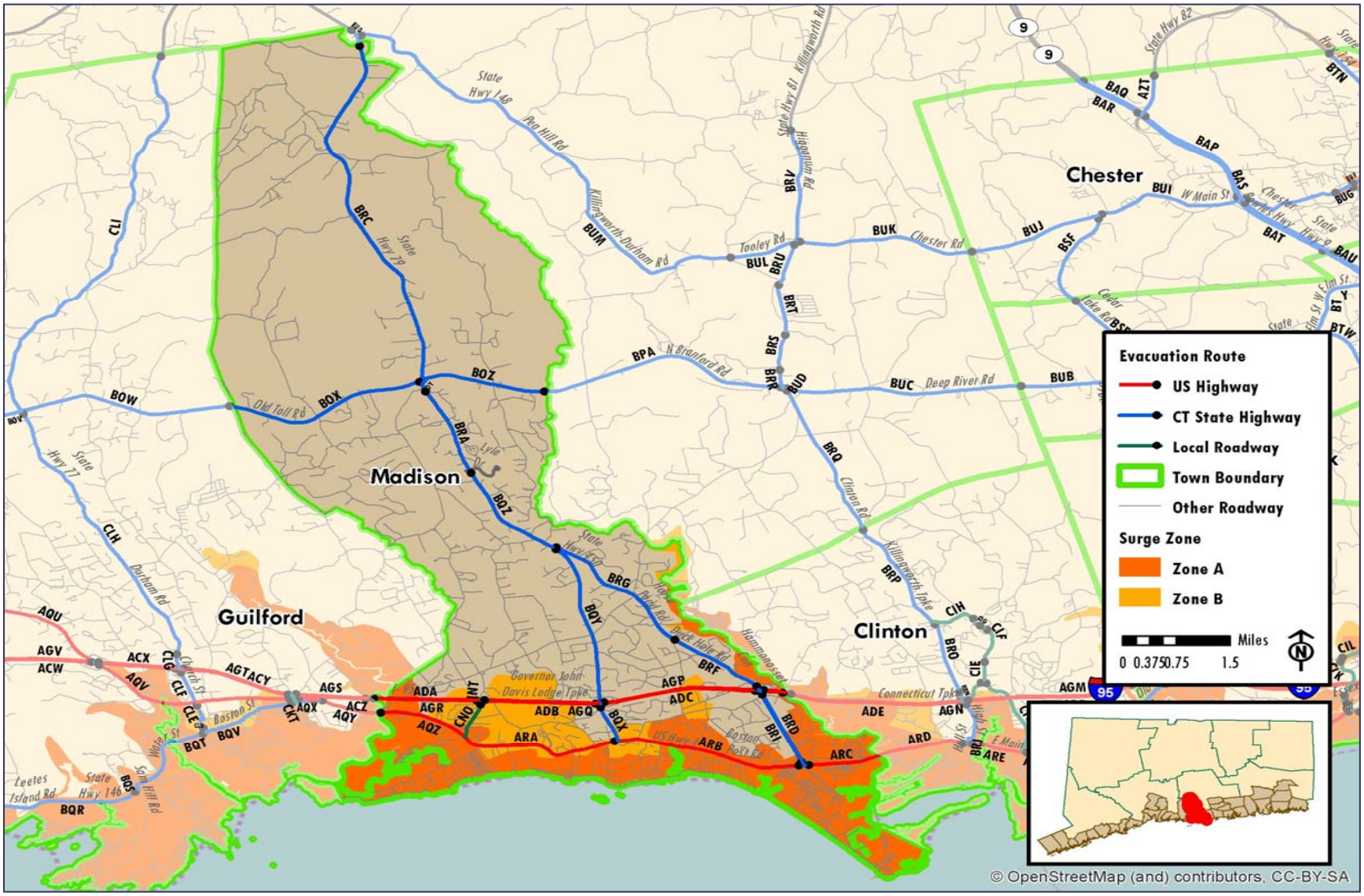

Figure 6-46: Evacuation Roadway Network – New Haven County / Madison

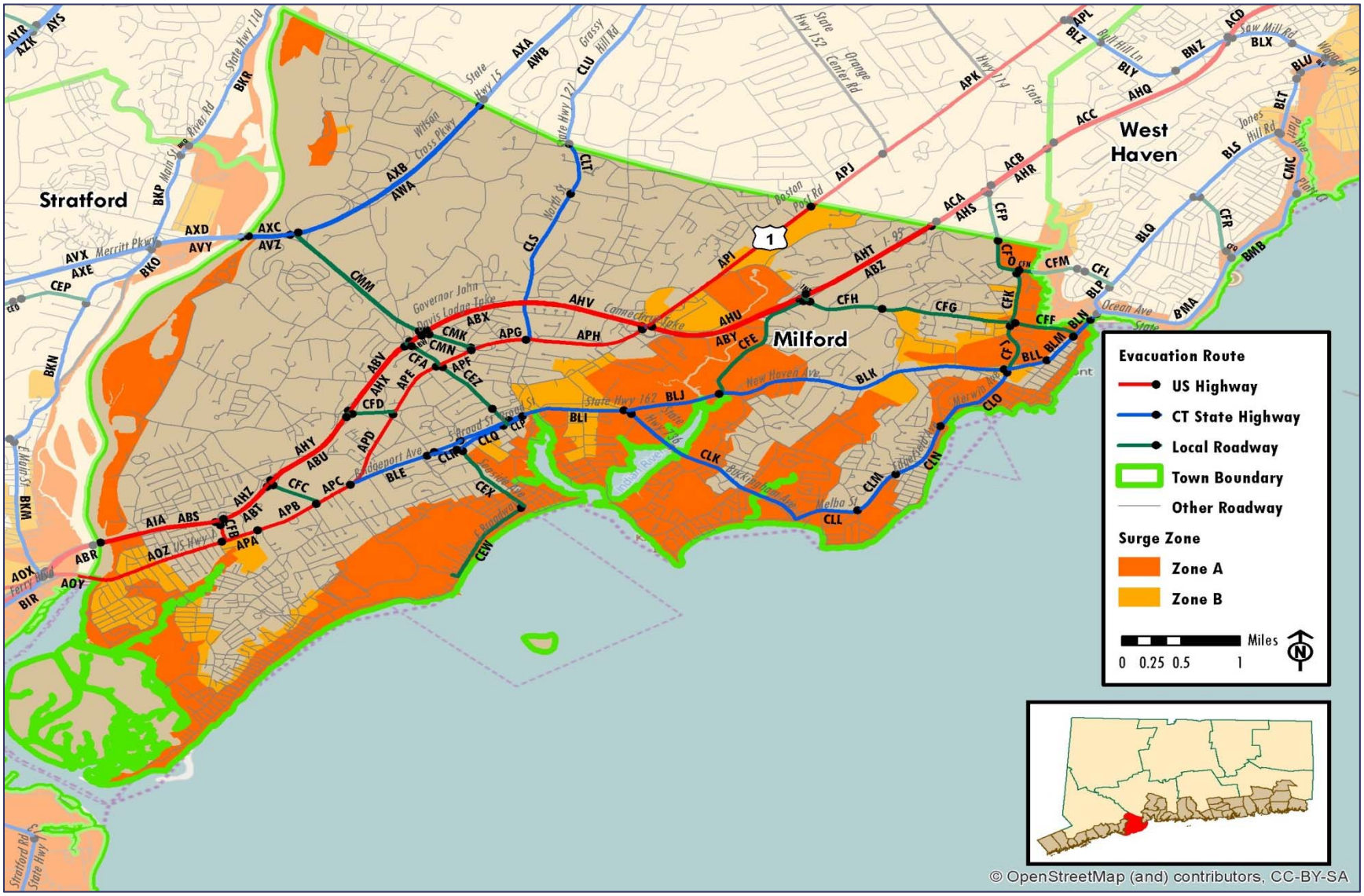

Figure 6-47: Evacuation Roadway Network – New Haven County / Milford

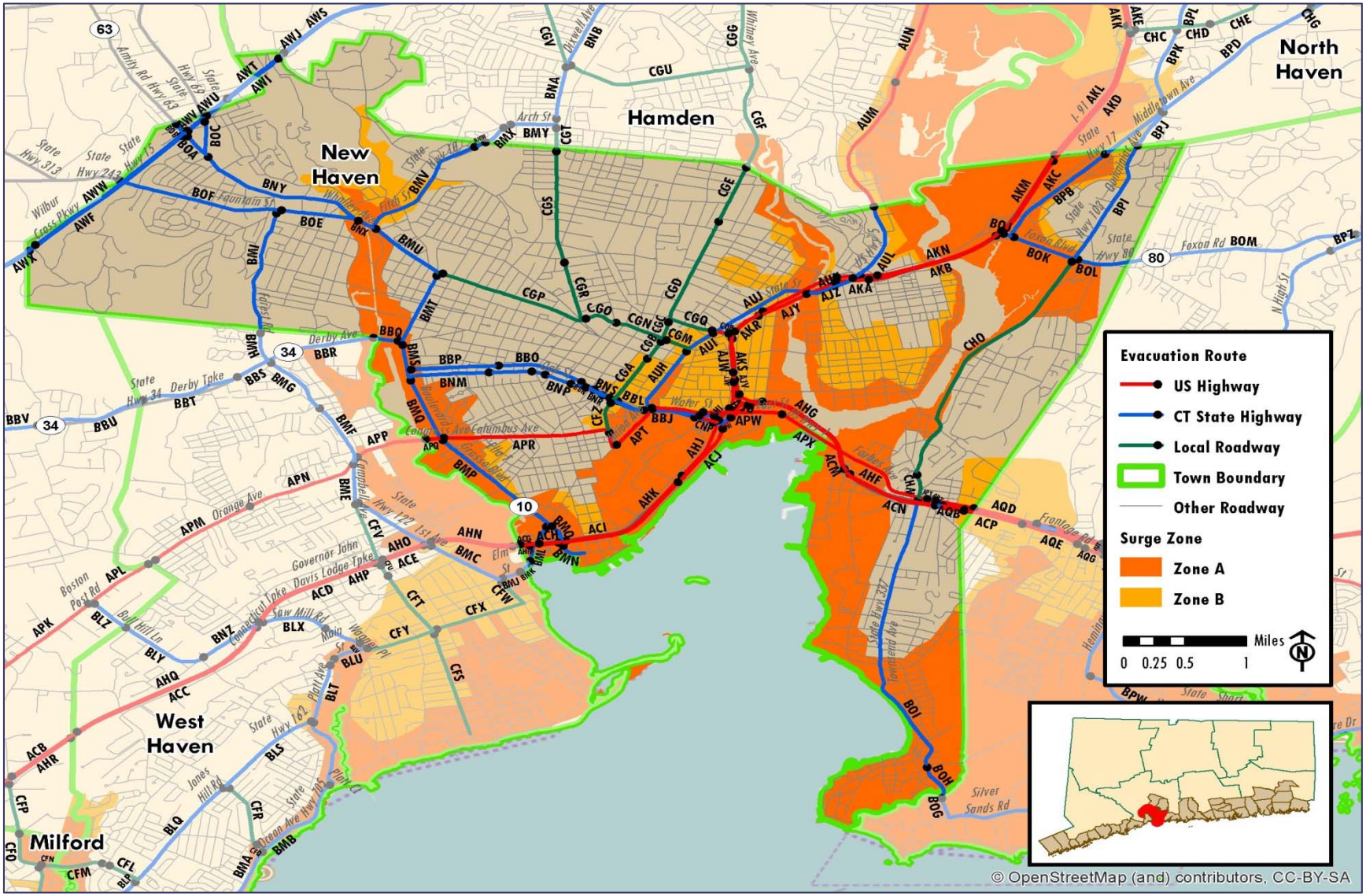

Figure 6-48: Evacuation Roadway Network – New Haven County / New Haven

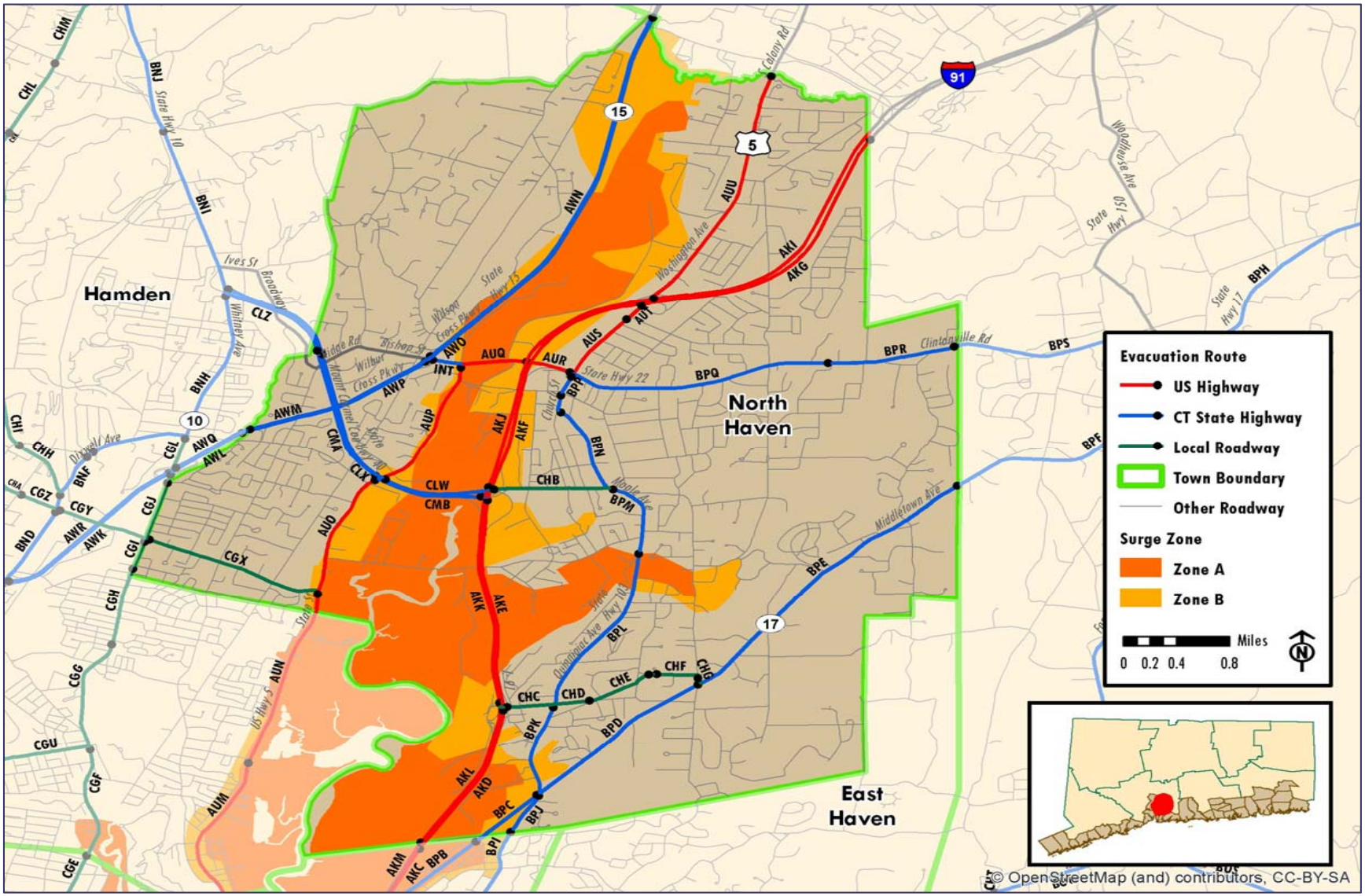

Figure 6-49: Evacuation Roadway Network – New Haven County / North Haven

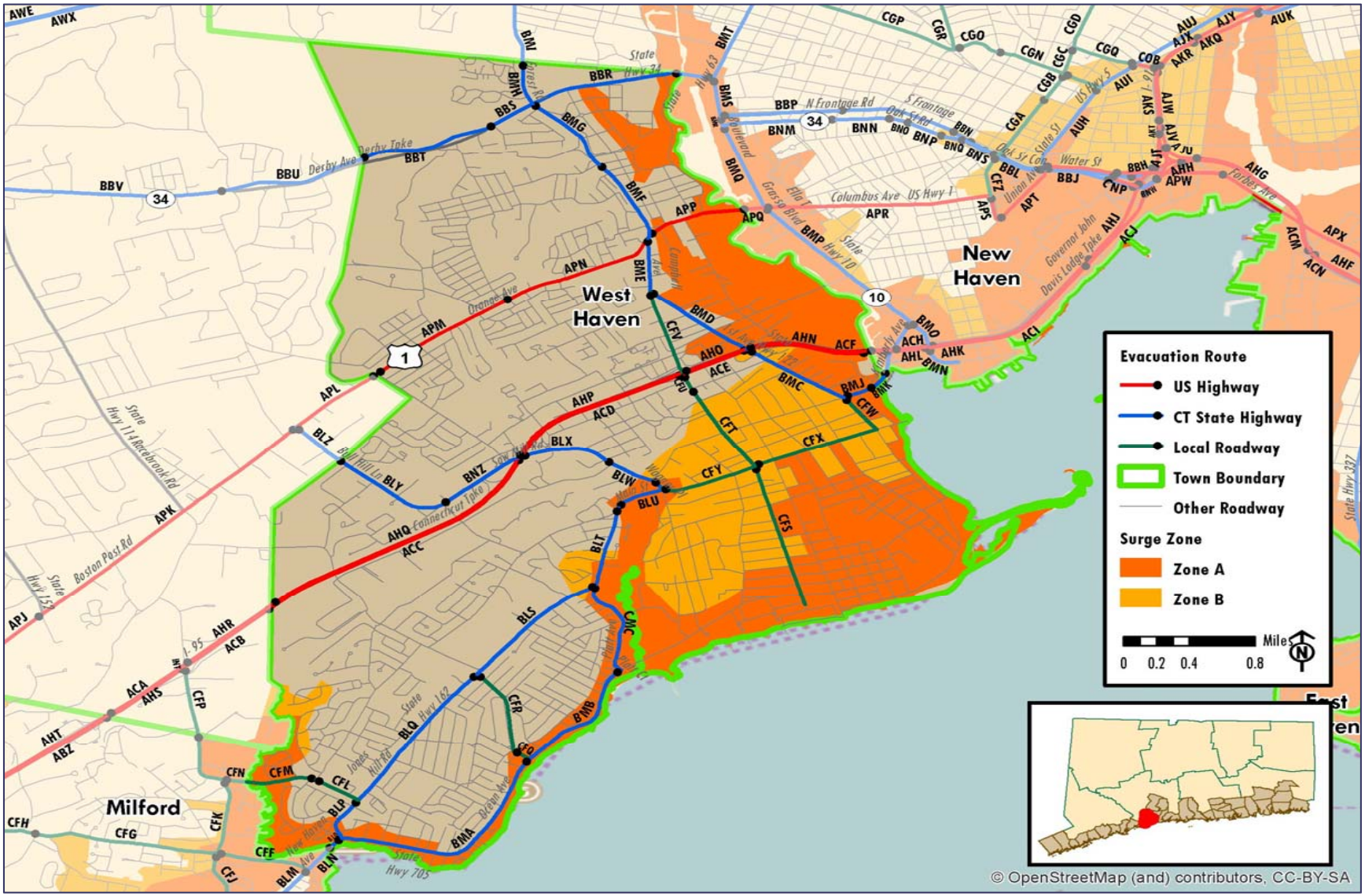

Figure 6-50: Evacuation Roadway Network – New Haven County / West Haven

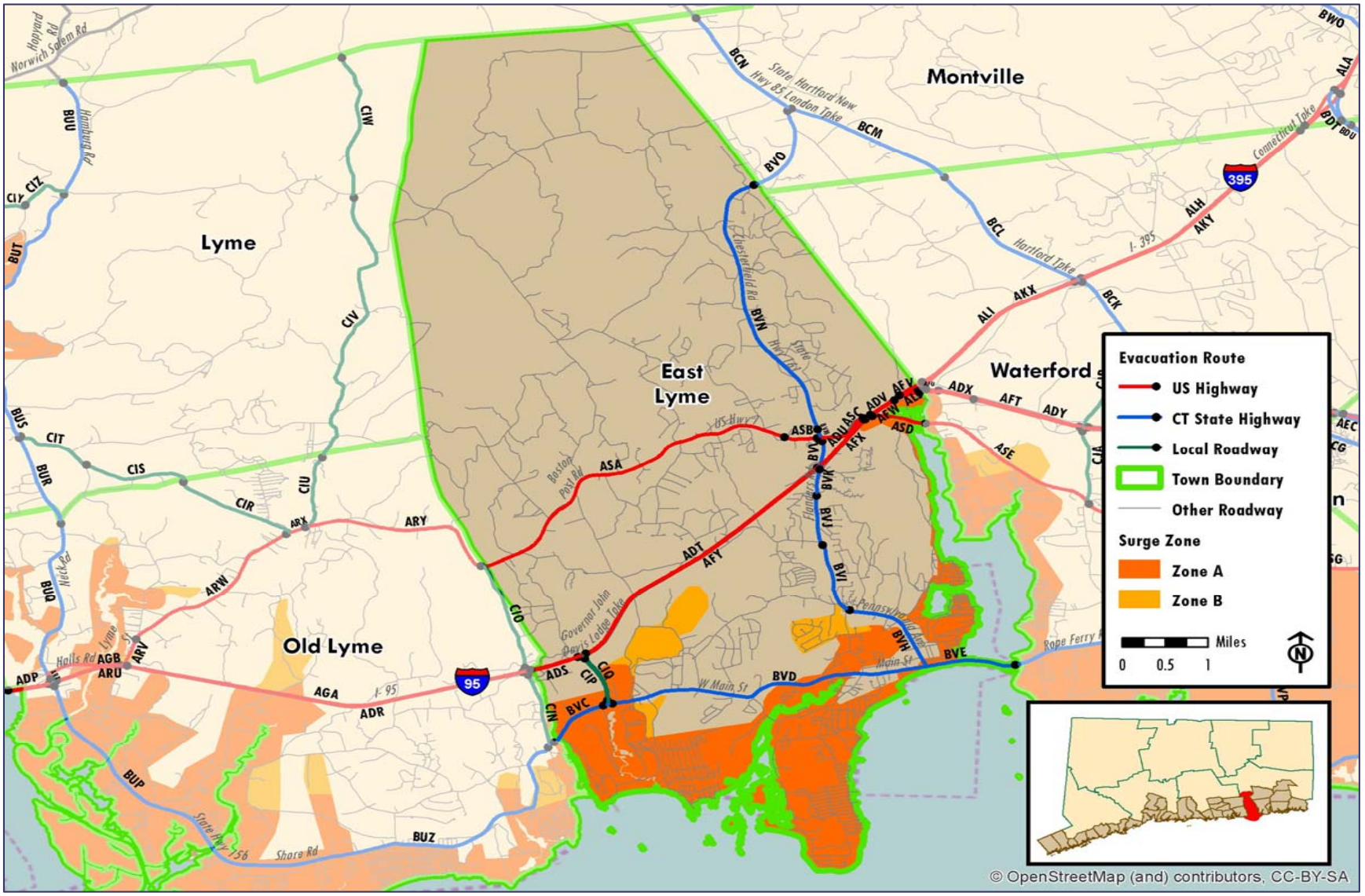

Figure 6-51: Evacuation Roadway Network – New London County / East Lyme

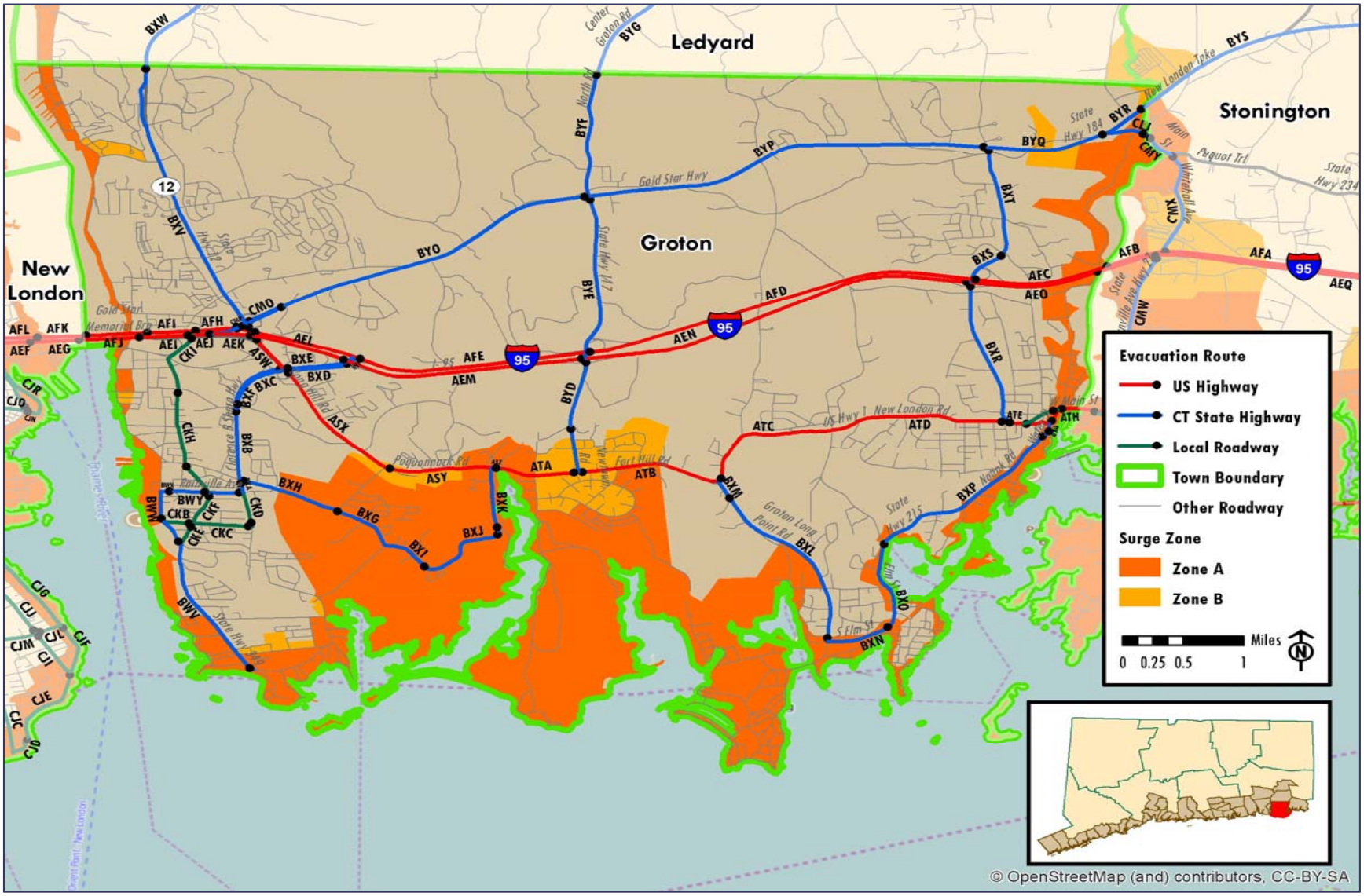

Figure 6-52: Evacuation Roadway Network – New London County / Groton

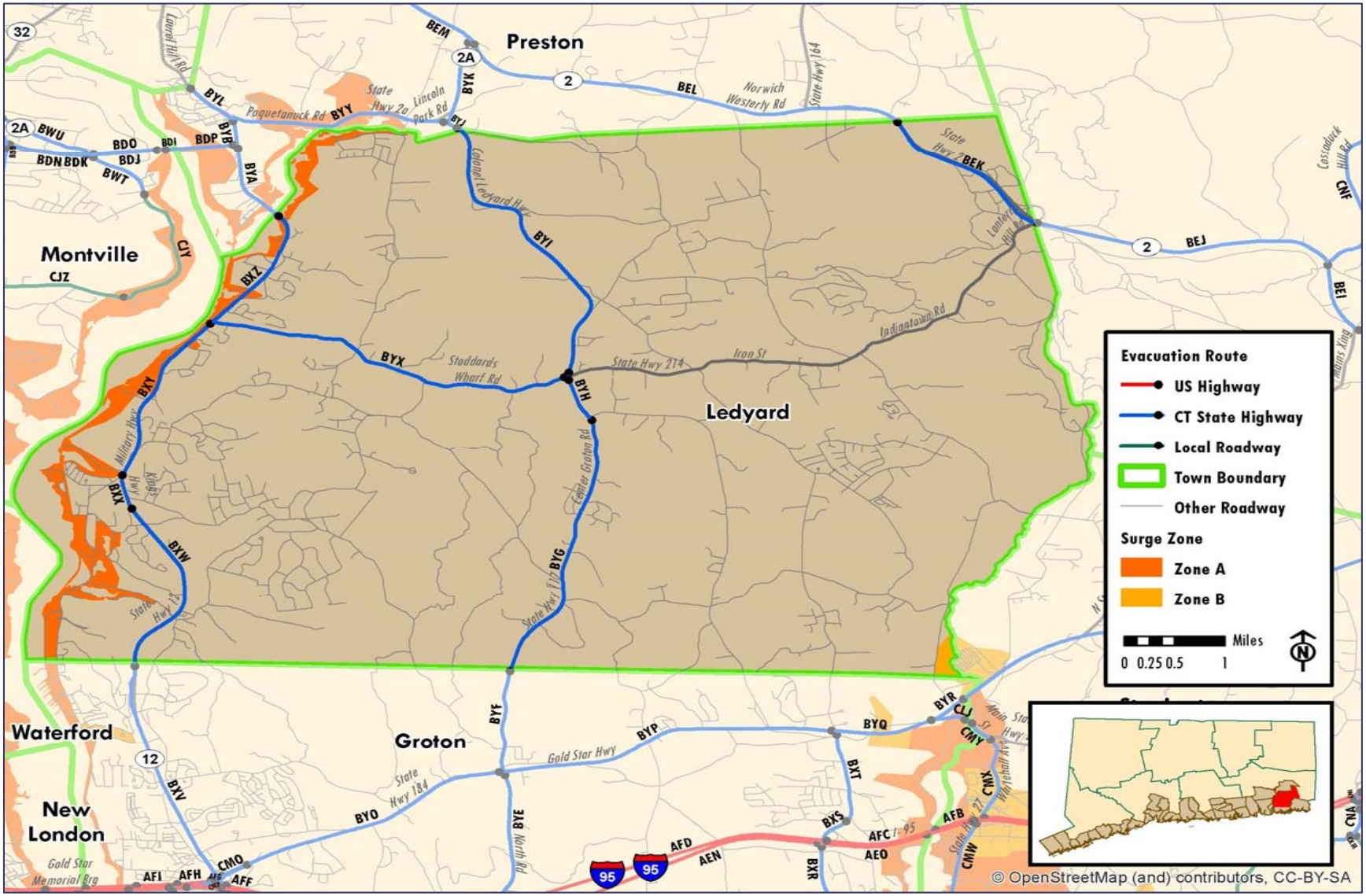

Figure 6-53: Evacuation Roadway Network – New London County / Ledyard

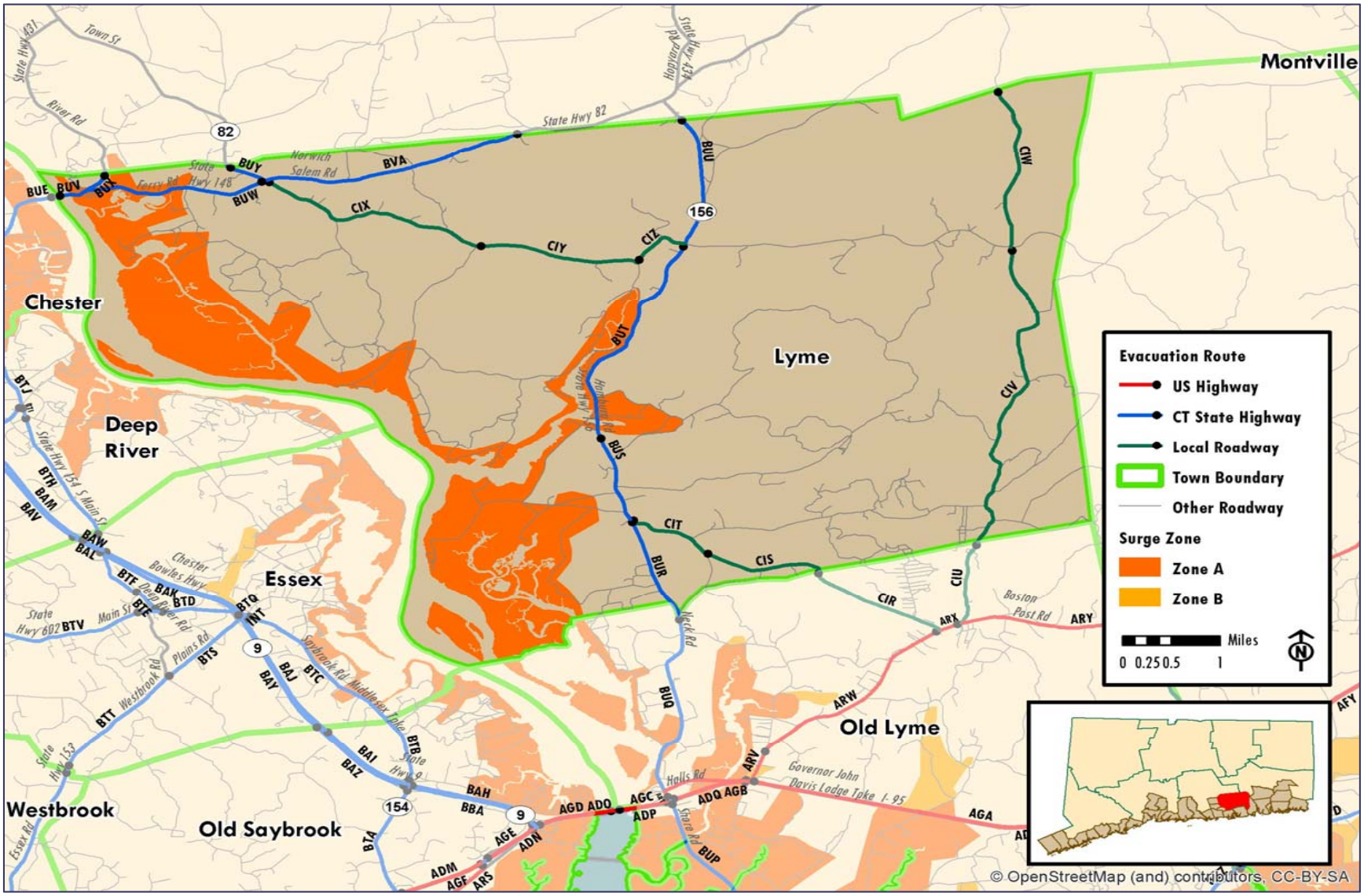

Figure 6-54: Evacuation Roadway Network – New London County / Lyme

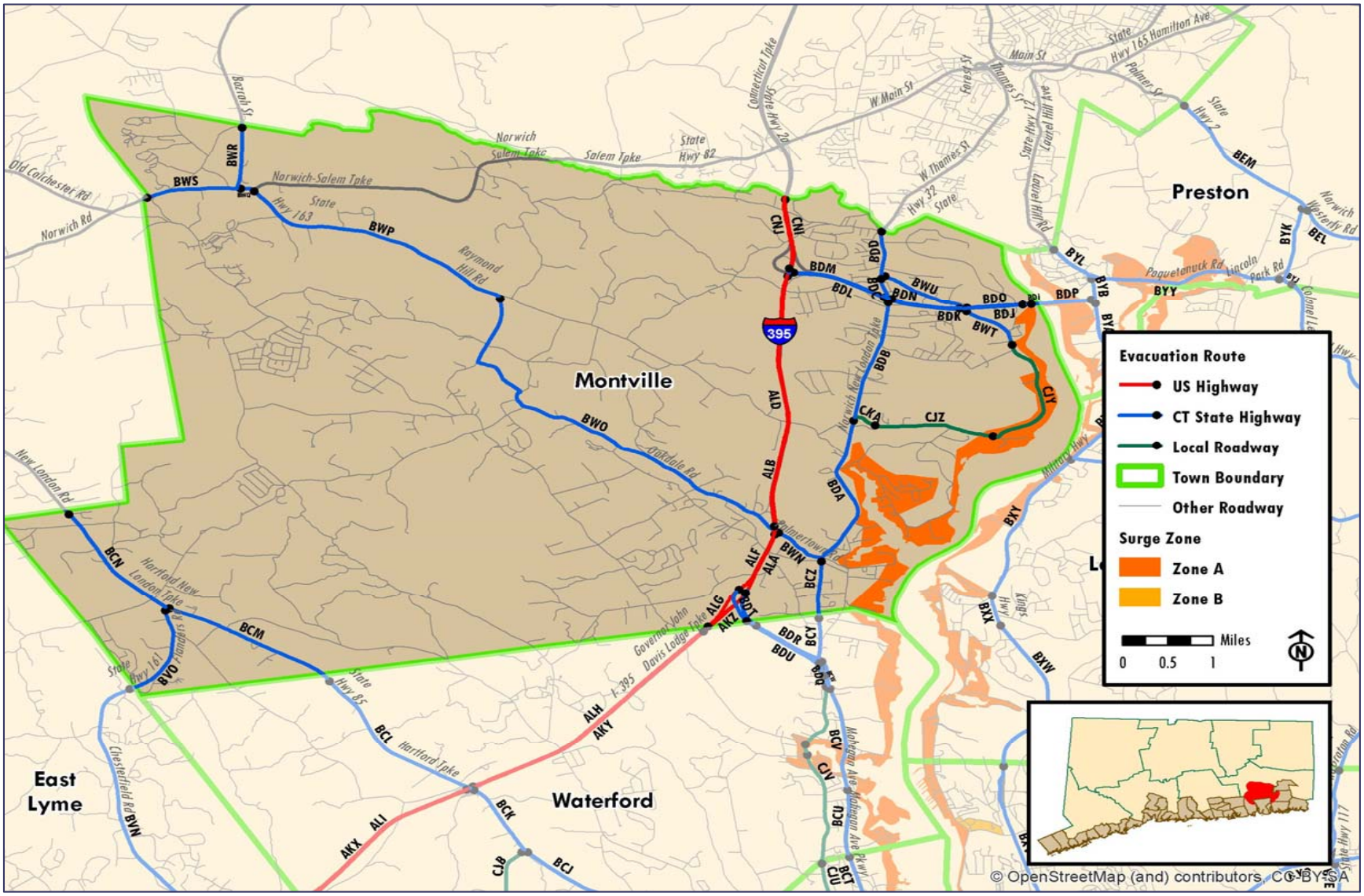

Figure 6-55: Evacuation Roadway Network – New London County / Montville

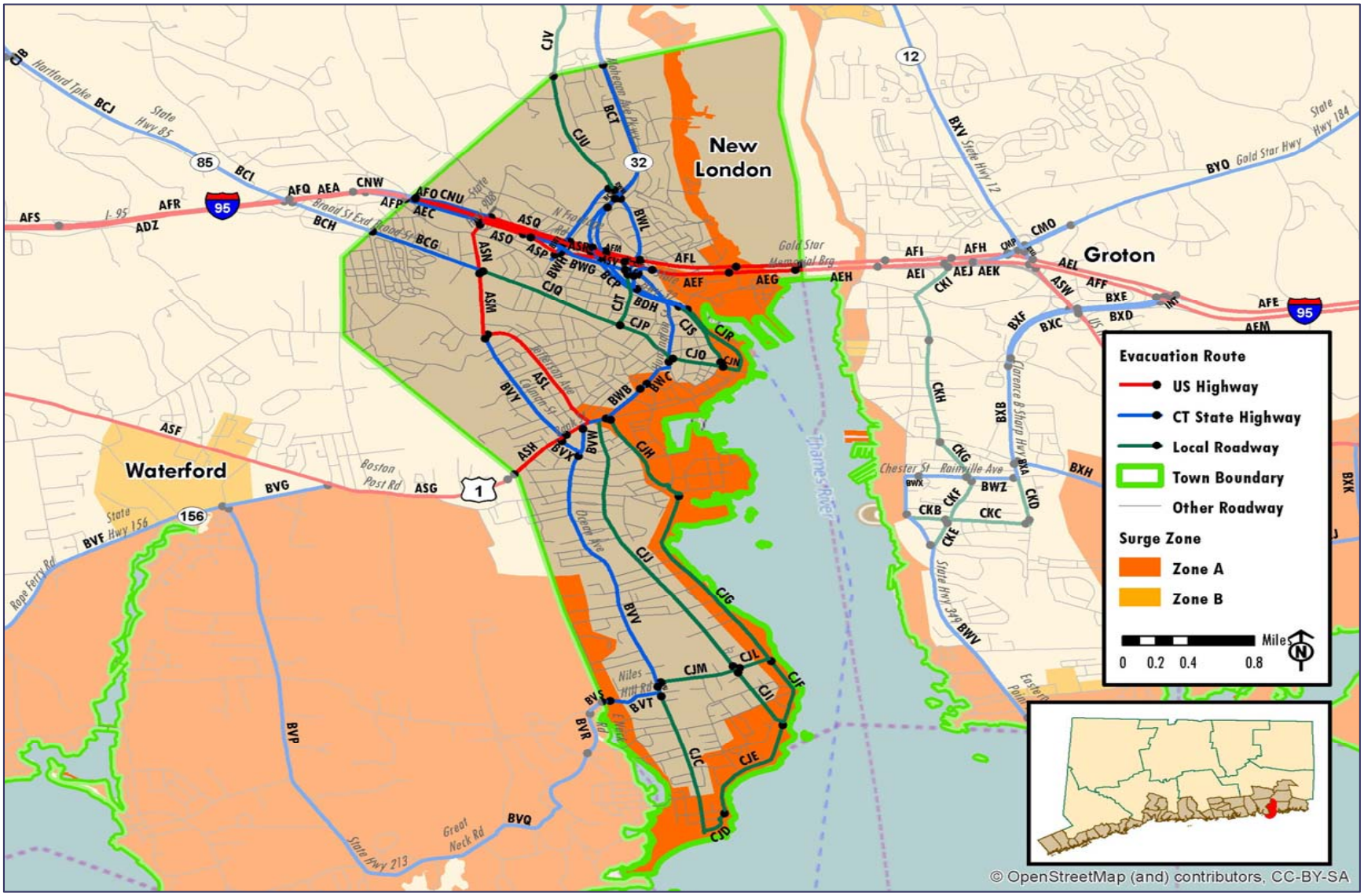

Figure 6-56: Evacuation Roadway Network – New London County / New London

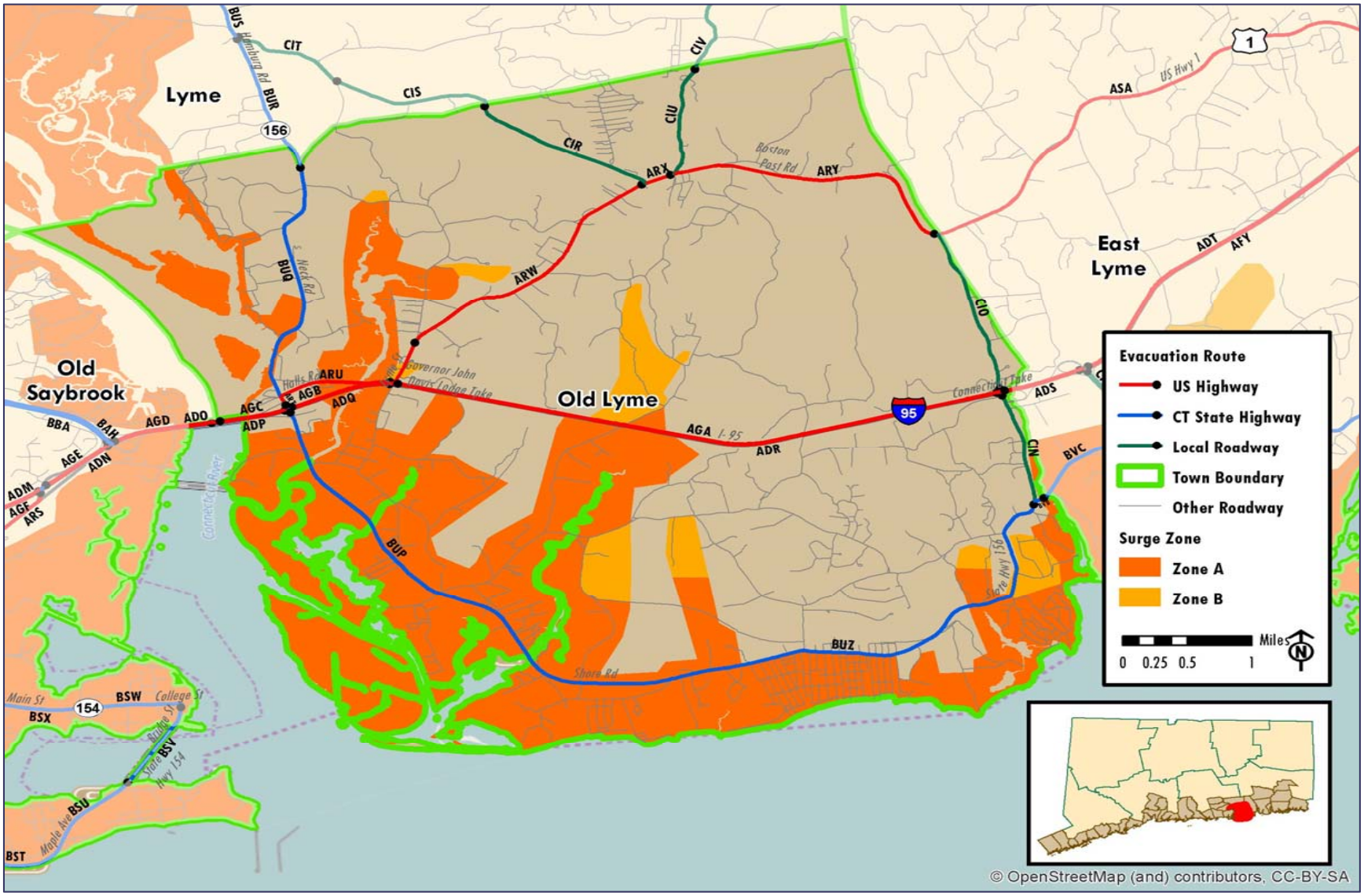

Figure 6-57: Evacuation Roadway Network – New London County / Old Lyme

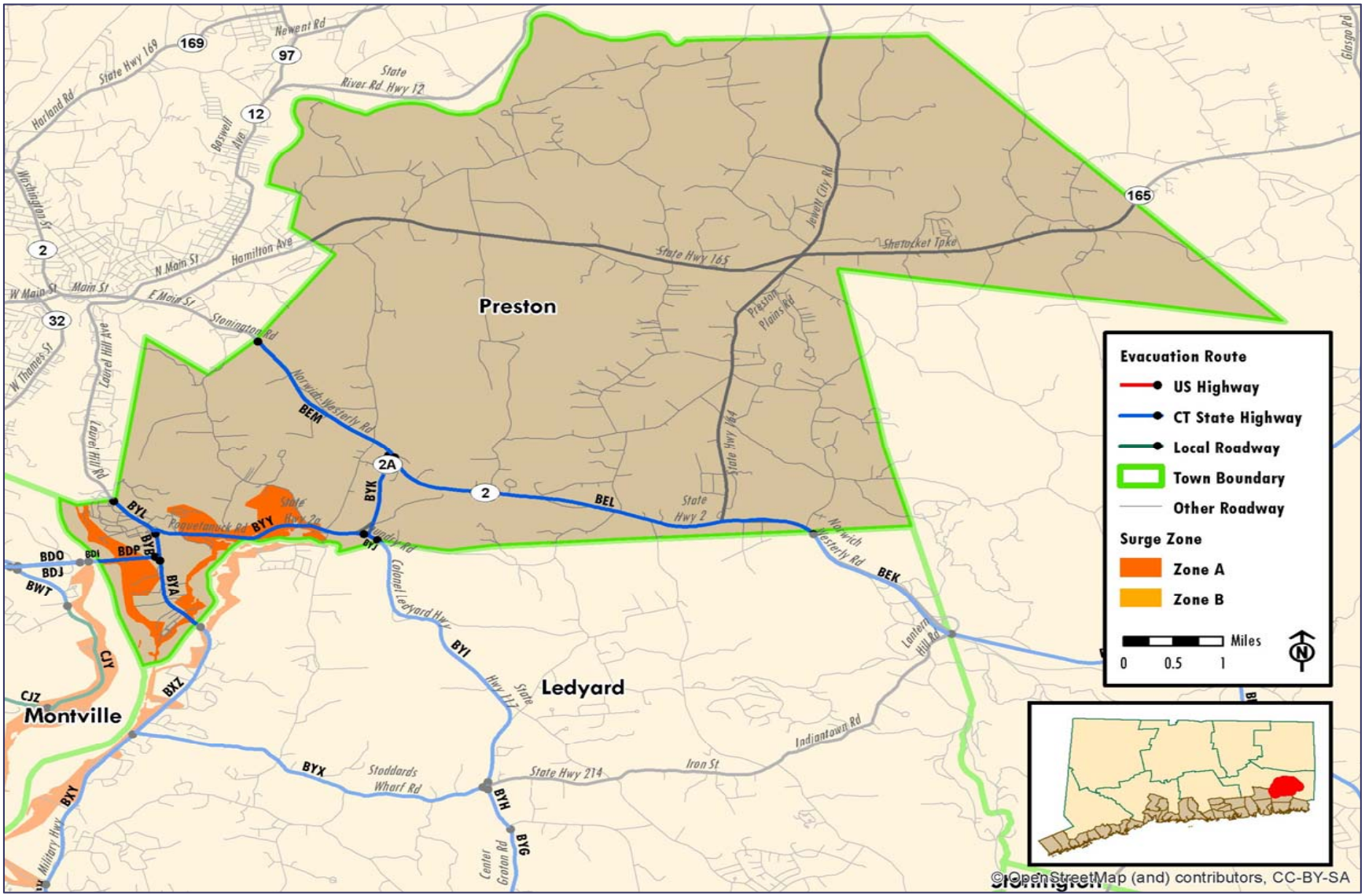

Figure 6-58: Evacuation Roadway Network – New London County / Preston

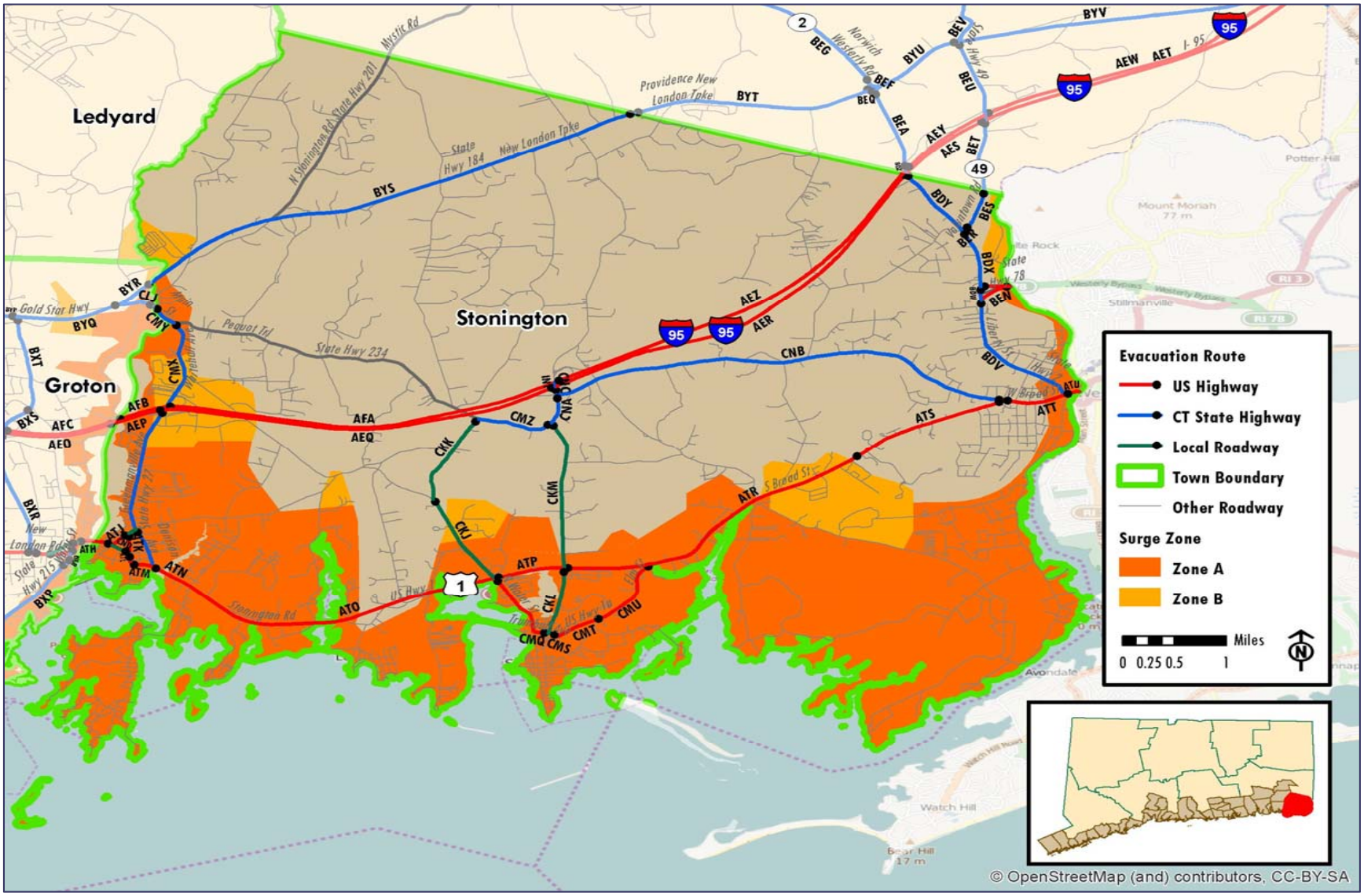

Figure 6-59: Evacuation Roadway Network – New London County / Stonington

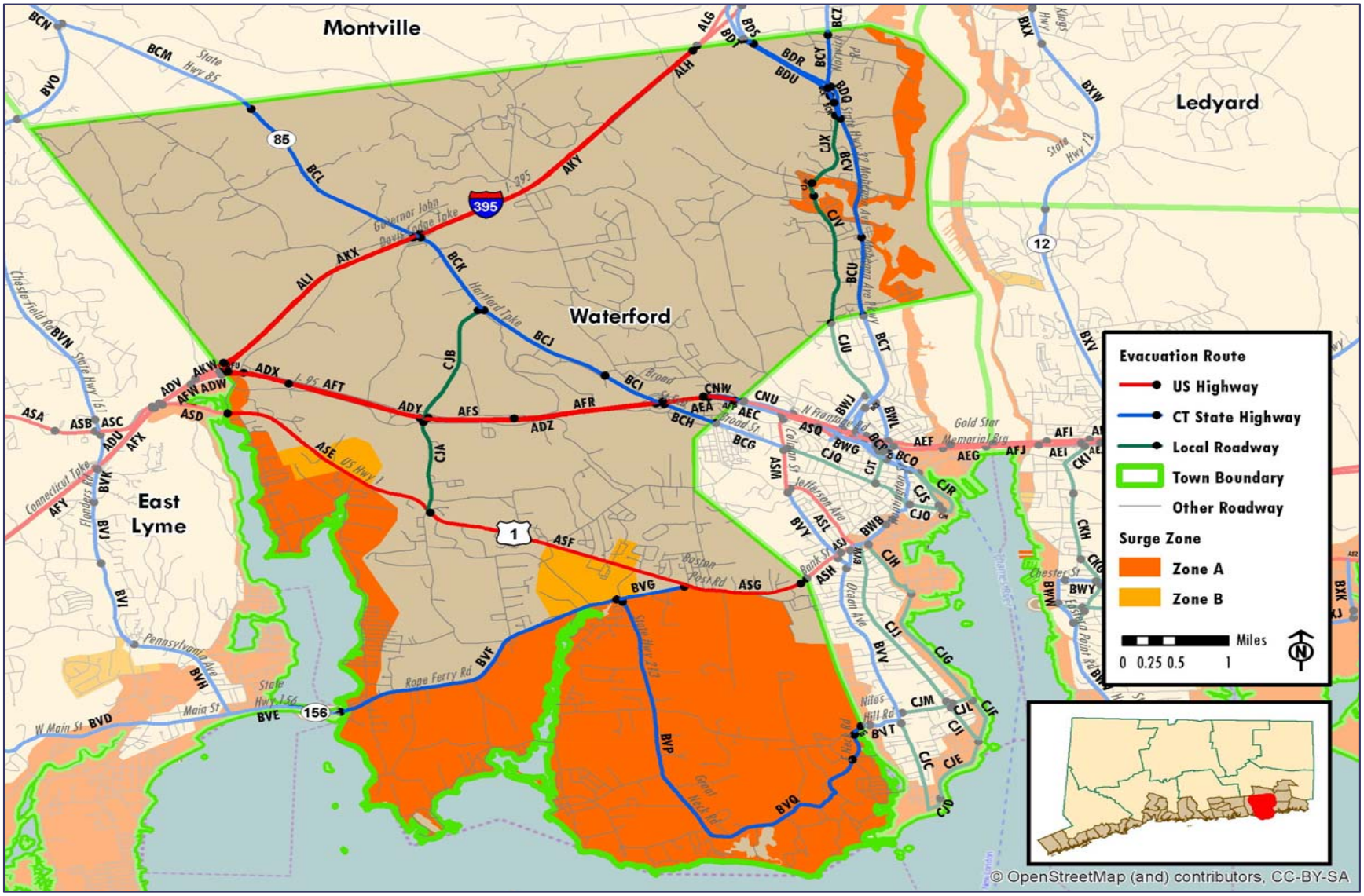

Figure 6-60: Evacuation Roadway Network – New London County / Waterford

6.0 Transportation Analysis

With the roadway network broken down into its component parts, the next key step in the process was to quantify the performance of the roadway system (i.e., defining the capability of the roadway network to convey traffic) under hurricane evacuation conditions. Such characteristics as number of lanes, type of roadbed, surrounding land uses, number and spacing of traffic signals are important determinants in assessing a roadway's ability to convey traffic. Using aerial imagery, derivations of level of service tables and peak hour traffic counter data, a specific value which represents an hourly directional peak service volume was assigned to each of the roadway segments identified above.

The assigned service volume for each roadway segment is an approximation of how many vehicles can flow through a roadway segment in one direction in one hour. With the roadway characteristic information described above, these capacity estimates can be derived from commonly used and widely recognized transportation planning guidance called Level of Service (LOS) tables from the Highway Capacity Manual. Using a LOS D figure, which is the category just below "free flow" conditions, each segment is associated with a number that represents its capacity to process vehicles under the less than optimal circumstances that normally will exist during a hurricane evacuation.

Another important variable in assessing roadway capacities is to investigate any traffic operations or other infrastructure related measures that may help or hinder the flow of vehicles during an evacuation. Contra flow, roadway barriers and diversions, toll operations as well as other traffic management schemes, especially if implemented to specifically control the flow of evacuating vehicles, can also have a significant impact on the service volume figures assigned to each roadway segment in the model.

Once the characteristics of the roadway system have been established, the travel demand (number of evacuating vehicles) is loaded by the model at the node assigned to each traffic evacuation zone. Those vehicles are then manually routed link by link through the entire evacuation roadway network from their originating node to their assumed safe destination points. Where the evacuation streams from traffic evacuation zones converge and/or overlap will determine those critical links requiring specialized attention over the course of an event. The application of this specialized transportation model allows the cumulative impacts of the multiple evacuation paths from competing vulnerability zones to be quantified and expressed as a period of time. Ultimately, the clearance time for a locale, jurisdiction, or region will be determined by the most congested roadway segment between the point of origin and the most distant destination node.

6.0 Transportation Analysis

Those key roadway segments, once they are established as the most critical by virtue of their relative congestion, are subjected to additional, more detailed traffic analysis for clearance time development. The listing of the critical roadway network segments and their directional service volume is provided in Table 6-13. The selection of these network focal points is not meant to be a complete listing of every traffic control point or problem spot during an evacuation. It is meant to capture the controlling bottlenecks and provide enough coverage and complexity so that clearance times can be calculated adequately and officials can make informed decisions from an evacuation timing standpoint.

Table 6-13: Critical Roadway Segments

Bottleneck Location	Critical Roadway Segments	Directional Service Volume
Greenwich	Sound Beach Ave @ Laddins Rock Rd (CAB)	760
Stamford	Elm St @ I-95 interchange (COG)	760
Darien	Tokeneke Rd/CT 136 @ US Hwy 1 (BFU)	860
Norwalk	West Ave @ I-95 interchange (CBD)	2,040
Norwalk	East Ave @ I-95 interchange (CBK)	1,620
Norwalk	Merritt Pkwy/CT 15 @ Main Ave interchange (AVK)	3,230
Westport	I-95 N/Connecticut Tpk @ Saugatuck Ave interchange (AAW)	4,840
Westport	Compo Rd S @ Bridge St/CT 136 (CBM)	760
Bridgeport	I-95 N/Connecticut Tpke @ State Hwy 8 /25 interchange (ABI)	4,840
Bridgeport	CT 8/25 @ CT 8 & CT 25 split (AYK)	6,450
Bridgeport	Park Ave @ State St/CT 130 (CCW)	760
Trumbull	Merritt Pkwy/CT 15 @ CT 8 interchange (AVW)	3,230
Stratford	Main St/CT 113 @ W Broad St (BJH)	860
Milford	High St @ Jepson Dr (CEY)	760
Milford	Milford Pkwy @ Merritt Pkwy/CT 15 (CMM)	3,230
West Haven	I-95 N/Connecticut Tpke @ West River bridge (ACF)	4,840
New Haven	I-95 N/Connecticut Tpke @ CT 34 interchange (ACJ)	4,840
New Haven	I-91 N @ CT 80 interchange (AKC)	6,450
New Haven	I-95 S/Connecticut Tpke @ I-91 interchange (AHG)	4,840
New Haven	Townsend Ave/CT 337 @ Main St (BOI)	860
Hamden	State St/US Hwy 5 @ Skiff St (AUN)	950
North Haven	I-91 N @ Wharton Brook Connector (AKG)	4,840
East Haven	Hemingway Ave/CT 142 @ Main St (BPX)	1,860
Branford	Cedar St @ US 1 (CHP)	720

Table 6-13: Critical Roadway Segments

Bottleneck Location	Critical Roadway Segments	Directional Service Volume
Guilford	Church St/CT 77 @ Boston Post Rd/US Hwy 1 (CLE)	720
Madison	Durham Rd/CT 79 @ I-95 intercahnge (BQX)	820
Clinton	High St/CT 81 @ I-95 interchange (BRL)	820
Westbrook	Essex Rd/CT 153 @ I-95 interchange (BSH)	820
Old Saybrook	Middlesex Tpke/CT 154 @ I-95 interchange (BSZ)	820
Essex	West Ave/CT 153 @ CT 9 interchange (BTQ)	820
Essex	Chester Bowles Hwy/CT 9 @ Middlesex Tpk/ CT 154 interchange (BAL)	3,230
Deep River	Chester Bowles Hwy/CT 9 @ Elm St/CT 80 interchange (BAN)	3,230
Chester	Chester Bowles Hwy/CT 9 @ W Main St interchange (BAP)	3,230
Old Lyme	I- 95 S/Connecticut Tpke/US Hwy 1 bridge over Connecticut River (AGC)	4,470
Old Lyme	Shore Rd/CT 156 @ Four Mile River Rd (BUZ)	820
East Lyme	Flanders Rd/CT 161 @ Society Rd (BVI)	820
Montville	I-395 N @ CT 2 Alt interchange (CNI)	2,980
Waterford	Boston Post Rd/US Hwy 1 @ Cross Rd (ASF)	820
New London	Colman St/US Hwy 1 @ Broad St/CT 85 (ASM)	950
Groton	Gold Star Memorial Bridge/I- 95/US Hwy 1 westbound (AFK)	6,450
Groton	North Rd/CT 117 @ I-95 interchange (BYD)	820
Stonington	CT 234 Interchange to I-95 (CNB)	820
Stonington	I-95 N @ Liberty St/CT 2 interchange (AER)	3,240

6.10 Model Results

The transportation modeling completed for Connecticut resulted in the items listed below. These are the most critical outputs for planning for shelter needs, anticipating bottlenecks and defining the timing requirements of an evacuation.

- Evacuating people and vehicle statistics by evacuation zone by storm category for each community;
- Shelter demand and capacity considerations by storm category for each community;
- Traffic volumes and critical roadway segments by storm category for each community;
- Estimated clearance times by response scenario for each community in Connecticut.

6.10.1 Evacuating People and Vehicles

The transportation model distributes the evacuating vehicles and people generated by each evacuation scenario to three destinations. The destination types in the model are: to in-community public shelters; to other refuges (internal hotels/motels, friends and family) within the originating community; and those leaving the community altogether. The evacuation statistics include scenarios for each level of storm intensity (Zone A and Zone B) as well as high and low tourist occupancy levels. Low tourist occupancy was assumed to be 30 percent and high was set at 90 percent.

Tables 6-14 through 6-23 shows how many residents and tourists are estimated to leave the vulnerability areas by response scenario and low or high tourist occupancy level, as well as the number of evacuating vehicles. It must be noted however that these figures may be higher than the actual number of people and vehicles that may evacuate during a real storm event. The assumed 100 percent participation rate used for the residents and visitors in the Zone A vulnerability zone, regardless of storm intensity, cause the bias in these evacuation statistics to favor a higher, rather than a lower, estimate. For the residents and visitors in each of the other storm tide vulnerability areas (Zones A and B), the model also assumes a 100 percent participation rate for the corresponding scenario, again to assure that sufficient time is provided for everyone to safely leave the zone. Consequently, by design, these figures actually err on the side of public safety since it is usually better to have the planning expectations and the response measures exceed the actual impacts of an event, especially when lives are at stake.

Table 6-14: Evacuating People and Vehicles – Low Occupancy – Fairfield County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Bridgeport	21,275	21,275	6,579	6,579	2,955	2,298	3,624	4,281
	4,226	12,239	1,361	3,932	519	1,159	841	2,773
	10,651	21,178	3,557	7,071	1,770	3,172	1,787	3,900
Darien	2,696	2,696	1,488	1,488	665	517	824	971
	178	531	90	269	36	81	54	188
	1,779	3,534	831	1,652	411	738	420	914
Fairfield	11,818	11,818	6,794	6,794	3,016	2,346	3,778	4,448
	973	2,796	551	1,609	211	475	340	1,134
	4,626	9,127	2,085	4,120	1,026	1,833	1,059	2,287
Greenwich	11,823	11,823	6,430	6,430	2,856	2,222	3,574	4,209
	843	2,438	482	1,415	186	419	296	996
	5,081	9,887	2,448	4,799	1,149	2,065	1,300	2,734
Norwalk	11,211	11,211	5,578	5,578	2,494	1,940	3,085	3,639
	948	2,832	360	1,075	143	322	217	753
	7,738	15,074	3,737	7,324	1,769	3,172	1,967	4,153
Stamford	10,240	10,240	4,741	4,741	2,113	1,643	2,628	3,097
	4,758	12,446	1,880	5,000	620	1,391	1,260	3,609
	10,286	20,098	4,320	8,472	2,029	3,648	2,290	4,823
Stratford	12,187	12,187	6,514	6,514	2,885	2,244	3,628	4,269
	778	2,312	434	1,295	172	387	262	908
	3,841	7,535	1,902	3,753	909	1,636	993	2,117
Westport	5,006	5,006	3,075	3,075	1,364	1,061	1,711	2,014
	628	1,780	378	1,077	149	321	229	756
	2,069	4,040	1,047	2,056	501	897	545	1,158
Totals	**145,659**	**214,103**	**66,662**	**96,118**	**29,948**	**35,987**	**36,712**	**60,131**

1. Key: Zone A | Zone B | Inland Area (Non-Surge)

Table 6-15: Evacuating People and Vehicles – High Occupancy – Fairfield County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Bridgeport	21,352	21,352	6,606	6,606	2,955	2,298	3,651	4,307
	4,591	12,645	1,489	4,073	521	1,160	968	2,913
	10,747	21,313	3,590	7,119	1,770	3,172	1,820	3,946
Darien	2,761	2,761	1,511	1,511	665	517	846	994
	181	535	91	270	36	81	55	190
	1,834	3,610	850	1,679	411	738	439	941
Fairfield	12,353	12,353	6,981	6,981	3,018	2,348	3,963	4,633
	1,105	2,942	597	1,660	212	476	385	1,184
	4,822	9,401	2,154	4,216	1,026	1,834	1,127	2,382
Greenwich	12,312	12,312	6,601	6,601	2,858	2,223	3,744	4,378
	939	2,545	516	1,452	187	419	329	1,033
	5,960	11,117	2,756	5,229	1,152	2,069	1,604	3,160
Norwalk	11,426	11,426	5,653	5,653	2,494	1,940	3,159	3,713
	961	2,846	364	1,080	143	322	221	759
	8,892	16,689	4,140	7,889	1,773	3,177	2,367	4,712
Stamford	10,509	10,509	4,835	4,835	2,114	1,644	2,721	3,191
	6,694	14,597	2,558	5,753	627	1,398	1,931	4,355
	11,806	22,226	4,852	9,217	2,035	3,656	2,817	5,561
Stratford	12,782	12,782	6,722	6,722	2,887	2,246	3,834	4,475
	801	2,337	442	1,304	172	387	270	916
	4,328	8,218	2,073	3,992	911	1,639	1,162	2,353
Westport	5,259	5,259	3,163	3,163	1,365	1,062	1,798	2,101
	661	1,816	389	1,090	149	322	240	769
	2,327	4,402	1,137	2,182	502	898	635	1,284
Totals	**155,403**	**225,993**	**70,070**	**100,277**	**29,983**	**36,026**	**40,086**	**64,250**

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-16: Evacuating People and Vehicles – Low Occupancy – Middlesex County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Chester	433	436	389	390	174	136	214	254
	0	0	0	0	0	0	0	0
	159	619	106	417	52	186	54	231
Clinton	5,510	5,510	3,483	3,483	1,460	1,136	2,023	2,347
	113	340	66	198	26	59	40	139
	1,059	1,975	558	1,042	276	465	282	577
Deep River	286	289	211	212	94	73	116	138
	0	0	0	0	0	0	0	0
	168	648	86	334	41	148	44	185
Essex	645	681	508	521	223	174	285	347
	8	47	5	32	2	9	3	22
	327	1,235	183	706	87	312	96	394
Old Saybrook	8,202	8,202	5,140	5,140	2,118	1,648	3,022	3,492
	87	256	56	167	22	50	34	117
	340	651	161	312	72	130	89	182
Westbrook	4,520	4,520	3,193	3,193	1,328	1,033	1,865	2,159
	257	487	135	306	34	75	102	231
	336	660	171	338	82	148	89	190
Totals	**22,450**	**26,556**	**14,451**	**16,791**	**6,091**	**5,782**	**8,358**	**11,005**

1. Key: Zone A | Zone B | Inland Area (Non-Surge)

Table 6-17: Evacuating People and Vehicles – High Occupancy – Middlesex County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Chester	440	451	391	395	174	136	217	259
	0	0	0	0	0	0	0	0
	172	637	110	424	52	186	59	237
Clinton	6,902	6,902	3,970	3,970	1,465	1,141	2,505	2,829
	113	340	66	198	26	59	40	139
	1,096	2,026	571	1,060	276	465	295	595
Deep River	293	302	213	216	94	73	119	143
	0	0	0	0	0	0	0	0
	186	673	92	343	41	148	51	194
Essex	718	827	533	572	223	174	310	398
	11	52	6	34	2	9	4	24
	381	1,312	202	733	87	312	115	421
Old Saybrook	10,739	10,739	6,028	6,028	2,127	1,657	3,902	4,371
	92	261	58	169	22	50	36	119
	440	791	196	361	72	130	124	231
Westbrook	5,933	5,933	3,688	3,688	1,333	1,038	2,355	2,649
	558	822	241	423	35	76	206	347
	373	712	184	356	82	148	101	208
Totals	**28,447**	**32,780**	**16,549**	**18,970**	**6,111**	**5,802**	**10,439**	**13,164**

1. Key: Zone A | Zone B | Inland Area (Non-Surge)

Table 6-18: Evacuating People and Vehicles – Low Occupancy – New Haven County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Branford	12,527	12,527	7,763	7,763	3,435	2,672	4,328	5,091
	294	870	159	471	62	140	96	330
	2,022	3,703	1,008	1,870	450	774	557	1,096
East Haven	11,501	11,501	6,254	6,254	2,781	2,163	3,473	4,090
	793	2,251	406	1,175	153	345	253	830
	1,472	2,924	754	1,502	371	669	383	833
Guilford	4,599	4,599	2,956	2,956	1,281	997	1,675	1,959
	122	358	76	225	30	67	46	158
	1,765	3,468	1,013	2,005	489	880	524	1,125
Hamden	634	634	352	352	158	123	194	229
	214	639	122	365	49	109	74	256
	5,734	11,429	2,565	5,116	1,272	2,289	1,293	2,828
Madison	5,149	5,149	2,860	2,860	1,105	860	1,756	2,000
	388	1,081	261	754	98	221	163	533
	1,124	2,225	669	1,331	328	591	341	740
Milford	17,039	17,039	10,449	10,449	4,605	3,582	5,844	6,867
	1,076	3,173	599	1,777	236	530	363	1,247
	3,816	7,217	1,893	3,619	867	1,529	1,026	2,090
New Haven	14,569	14,569	5,655	5,655	2,503	1,947	3,152	3,708
	4,067	11,949	1,422	4,177	554	1,241	867	2,935
	10,091	19,912	2,903	5,713	1,382	2,483	1,521	3,230
North Haven	591	591	450	450	202	157	248	293
	191	567	121	360	48	108	73	252
	2,353	4,643	1,224	2,425	597	1,072	627	1,353

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-18: Evacuating People and Vehicles – Low Occupancy – New Haven County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
West Haven	11,498	11,498	6,192	6,192	2,779	2,162	3,413	4,031
	1,962	5,870	939	2,811	374	842	565	1,969
	3,670	7,189	1,428	2,801	689	1,229	739	1,572
Totals	**119,261**	**167,575**	**60,493**	**81,428**	**26,898**	**29,782**	**33,594**	**51,645**

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-19: Evacuating People and Vehicles – High Occupancy – New Haven County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Branford	13,288	13,288	8,029	8,029	3,437	2,674	4,592	5,355
	309	886	164	477	62	140	101	336
	2,646	4,578	1,226	2,176	453	777	774	1,399
East Haven	11,930	11,930	6,404	6,404	2,783	2,165	3,621	4,239
	927	2,400	453	1,227	154	345	300	882
	1,538	3,016	777	1,534	372	669	406	865
Guilford	5,233	5,233	3,178	3,178	1,284	999	1,894	2,179
	130	367	79	228	30	67	49	161
	1,970	3,755	1,085	2,106	490	881	595	1,224
Hamden	636	636	353	353	158	123	195	230
	217	643	123	367	49	109	75	257
	5,860	11,606	2,609	5,178	1,272	2,289	1,337	2,889
Madison	7,518	7,518	3,689	3,689	1,113	868	2,576	2,821
	475	1,178	292	788	99	222	193	567
	1,199	2,330	696	1,367	329	591	367	776
Milford	18,303	18,303	10,891	10,891	4,609	3,586	6,282	7,305
	1,132	3,236	618	1,799	236	530	383	1,269
	4,742	8,514	2,217	4,073	870	1,533	1,347	2,540
New Haven	15,109	15,109	5,844	5,844	2,505	1,949	3,339	3,895
	4,276	12,181	1,495	4,258	555	1,242	940	3,016
	10,903	21,048	3,187	6,111	1,385	2,487	1,802	3,623
North Haven	594	594	451	451	202	157	249	294
	195	573	122	362	48	108	74	254
	2,531	4,892	1,287	2,512	597	1,073	689	1,439

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-19: Evacuating People and Vehicles – High Occupancy – New Haven County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
West Haven	11,597	11,597	6,227	6,227	2,779	2,162	3,448	4,065
	1,980	5,890	945	2,818	374	842	571	1,976
	3,960	7,594	1,530	2,943	690	1,231	839	1,712
Totals	**129,198**	**178,895**	**63,971**	**85,390**	**26,935**	**29,819**	**37,038**	**55,568**

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-20: Evacuating People and Vehicles – Low Occupancy – New London County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
East Lyme	6,073	6,073	3,731	3,731	1,537	1,196	2,194	2,535
	239	468	87	175	17	38	71	138
	1,634	3,094	743	1,425	323	580	420	845
Groton	7,370	7,370	3,923	3,923	1,686	1,312	2,238	2,612
	414	1,236	215	644	86	193	129	451
	4,130	7,682	1,805	3,387	797	1,391	1,008	1,996
Ledyard	629	635	451	453	202	157	249	296
	3	17	2	13	1	4	1	9
	1,058	3,353	577	1,858	274	818	302	1,039
Lyme	367	387	289	296	127	99	162	197
	0	0	0	0	0	0	0	0
	153	484	91	300	41	129	50	170
Montville	665	673	504	507	226	176	279	332
	0	0	0	0	0	0	0	0
	1,694	4,854	799	2,331	365	1,005	435	1,326
New London	4,036	4,036	1,961	1,961	867	675	1,094	1,287
	0	0	0	0	0	0	0	0
	2,573	5,025	877	1,712	404	727	473	985
Old Lyme	3,734	3,734	2,358	2,358	862	671	1,497	1,687
	59	155	36	100	13	29	23	72
	577	1,104	313	609	142	256	171	353
Preston	257	257	232	232	104	81	128	151
	0	0	0	0	0	0	0	0
	435	839	295	573	144	253	151	320

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-20: Evacuating People and Vehicles – Low Occupancy – New London County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Stonington	9,264	9,264	6,037	6,037	2,603	2,025	3,434	4,012
	1,187	1,701	481	792	58	126	423	665
	1,241	2,276	653	1,201	319	531	334	670
Waterford	7,147	7,147	4,807	4,807	2,138	1,663	2,669	3,144
	107	319	65	195	26	58	39	136
	1,362	2,633	737	1,434	354	627	383	806
Totals	**56,408**	**74,816**	**32,069**	**41,054**	**13,716**	**14,820**	**18,357**	**26,234**

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-21: Evacuating People and Vehicles – High Occupancy – New London County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
East Lyme	7,913	7,913	4,375	4,375	1,544	1,203	2,831	3,172
	503	762	180	278	18	39	162	239
	2,203	3,890	942	1,704	325	583	617	1,121
Groton	8,406	8,406	4,286	4,286	1,689	1,315	2,596	2,971
	418	1,241	217	646	86	193	131	453
	5,364	9,410	2,237	3,991	801	1,397	1,436	2,594
Ledyard	640	656	455	461	202	157	253	303
	3	17	2	13	1	4	1	9
	1,221	3,581	634	1,937	275	819	359	1,118
Lyme	407	467	302	323	127	99	176	224
	0	0	0	0	0	0	0	0
	206	557	109	325	41	129	68	196
Montville	681	706	510	519	226	176	284	343
	0	0	0	0	0	0	0	0
	2,103	5,426	942	2,531	366	1,007	576	1,524
New London	4,236	4,236	2,031	2,031	868	675	1,163	1,356
	0	0	0	0	0	0	0	0
	2,976	5,589	1,018	1,910	405	729	613	1,181
Old Lyme	6,327	6,327	3,266	3,266	871	680	2,395	2,585
	84	182	45	110	13	29	32	81
	747	1,342	373	692	143	256	230	435
Preston	259	259	233	233	104	81	129	152
	0	0	0	0	0	0	0	0
	480	902	311	595	144	253	167	342

1. Key: Zone A | Zone B | Inland Area (Non-Surge)

Table 6-21: Evacuating People and Vehicles – High Occupancy – New London County

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Stonington	10,746	10,746	6,556	6,556	2,608	2,030	3,948	4,526
	3,157	3,890	1,170	1,558	65	134	1,106	1,424
	1,328	2,399	683	1,244	319	531	364	712
Waterford	7,475	7,475	4,922	4,922	2,139	1,664	2,783	3,258
	109	321	66	195	26	58	40	137
	1,527	2,865	795	1,515	355	628	440	887
Totals	**69,519**	**89,565**	**36,660**	**46,216**	**13,761**	**14,869**	**22,900**	**31,343**

1. Key: Zone A Zone B Inland Area (Non-Surge)

Table 6-22: Summary of Evacuating People and Vehicles – Low Occupancy

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Fairfield County	86,256	86,256	41,199	41,199	18,348	14,271	22,852	26,928
	13,332	37,374	5,536	15,672	2,036	4,555	3,499	11,117
	46,071	90,473	19,927	39,247	9,564	17,161	10,361	22,086
Middlesex County	19,596	19,638	12,924	12,939	5,397	4,200	7,525	8,737
	465	1,130	262	703	84	193	179	509
	2,389	5,788	1,265	3,149	610	1,389	654	1,759
New Haven County	78,107	78,107	42,931	42,931	18,849	14,663	24,083	28,268
	9,107	26,758	4,105	12,115	1,604	3,603	2,500	8,510
	32,047	62,710	13,457	26,382	6,445	11,516	7,011	14,867
New London County	39,542	39,576	24,293	24,305	10,352	8,055	13,944	16,253
	2,009	3,896	886	1,919	201	448	686	1,471
	14,857	31,344	6,890	14,830	3,163	6,317	3,727	8,510
Totals	**223,501**	**223,577**	**121,347**	**121,374**	**52,946**	**41,189**	**68,404**	**80,186**
	24,913	**69,158**	**10,789**	**30,409**	**3,925**	**8,799**	**6,864**	**21,607**
	95,364	**190,315**	**41,539**	**83,608**	**19,782**	**36,383**	**21,753**	**47,222**
Overall Totals	**343,778**	**483,050**	**173,675**	**235,391**	**76,653**	**86,371**	**97,021**	**149,015**

1. Key: Zone A; Zone B; Inland Area (Non-Surge)

Table 6-23: Summary of Evacuating People and Vehicles – High Occupancy

Evacuation Areas[1]	Evacuating People		Evacuating Vehicles		Evacuating Vehicles to In-County Destinations		Evacuating Vehicles to Out of County Destinations	
	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Fairfield County	88,754	88,754	42,072	42,072	18,356	14,278	23,716	27,792
	15,933	40,263	6,446	16,682	2,047	4,565	4,399	12,119
	50,716	96,976	21,552	41,523	9,580	17,183	11,971	24,339
Middlesex County	25,025	25,154	14,823	14,869	5,416	4,219	9,408	10,649
	774	1,475	371	824	85	194	286	629
	2,648	6,151	1,355	3,277	610	1,389	745	1,886
New Haven County	84,208	84,208	45,066	45,066	18,870	14,683	26,196	30,383
	9,641	27,354	4,291	12,324	1,607	3,605	2,686	8,718
	35,349	67,333	14,614	28,000	6,458	11,531	8,156	16,467
New London County	47,090	47,191	26,936	26,972	10,378	8,080	16,558	18,890
	4,274	6,413	1,680	2,800	209	457	1,472	2,343
	18,155	35,961	8,044	16,444	3,174	6,332	4,870	10,110
Totals	**245,077**	**245,307**	**128,897**	**128,979**	**53,020**	**41,260**	**75,878**	**87,714**
	30,622	**75,505**	**12,788**	**32,630**	**3,948**	**8,821**	**8,843**	**23,809**
	106,868	**206,421**	**45,565**	**89,244**	**19,822**	**36,435**	**25,742**	**52,802**
Overall Totals	**382,567**	**527,233**	**187,250**	**250,853**	**76,790**	**86,516**	**110,463**	**164,325**

1. Key: Zone A | Zone B | Inland Area (Non-Surge)

6.10.2 Shelter Demand and Capacity Considerations

The potential public shelter lists provided in Chapter 5 in the TDR include the locations and capacities of those facilities. The opening and management of public shelters is an integral part of any evacuation operation, especially since mobile home residents typically have the highest propensity to use those facilities as their refuge location. For the Connecticut study, shelter demand was determined using assumptions derived from data in the behavioral analysis. Tables in Chapter 5 compares for A and B response scenarios the estimated public shelter demand with the available spaces in each jurisdiction to determine whether it has a surplus or deficit of spaces. The shelter locations and capacities provided in Chapter 5 were compiled by the USACE, New England District, from data provided by the state and the American Red Cross from their National Shelter System (NSS) database.

6.10.3 Traffic Volumes and Critical Roadway Segments

Once the evacuation statistics for each vulnerability area and evacuation zone have been developed and the departing vehicles distributed to the three major destinations mentioned above, the transportation model apportions the external trips to the routes that exit the jurisdiction. This allocation is particularly important because the vehicles leaving the community altogether will usually have to travel the furthest, over more segments than local trips, thereby increasing the likelihood that they will have to pass through one of the most congested segments identified in the model. These external trips will also spend more time traveling to their ultimate safe destination. In recognition of the relative difficulties associated with these out of jurisdiction vehicles, each evacuation sector is assigned a specific set of percentages that represent the proportion of those evacuating vehicles using each of the exiting routes. Although it is understood that a small number of evacuees will also take less obvious local roadways (those not specifically identified as evacuation routes) out of their communities, those number are very small and not significant in determining clearance times or any of the other transportation model results.

Table 6-24 displays the assumed percentage of all exiting vehicles on evacuation roadways leaving each community within the study region. The out route assumptions provided in Table 6-24 were derived from the behavioral data provided in the 2013 Behavioral Analysis. The specific per zone assignments can also be found in the Connecticut ATM which was developed to facilitate the ability of the emergency management and other local officials to update clearance times in an efficient manner.

Once the vehicle trips from each evacuation sector have been distributed according to the three destination categories, the model actually routes those vehicles from the start point of

each evacuation sector to the three assumed safe objective points. The two types of internal trips and one external for every evacuation zone are assigned to the critical links, if warranted, and cumulated to provide a total number of evacuating vehicles for that key segment. Table 6-24 displays those figures for the most critical roadway segments by county and community. The volumes of traffic include both local and out of county movements for each response scenario and tourist occupancy scenario. The volumes shown also include vehicles that may be passing through coastal Connecticut on their way out of the area, such as the evacuees leaving nearby communities in New York State traveling to Hartford or Boston.

The transportation model also factors in background traffic, namely those vehicles using the evacuation routes for purposes other than evacuating. These trips include travel associated with households procuring last minute supplies, individuals returning home to begin the evacuation process and other activities not at all related to the approaching storm. These background traffic figures were developed from peak hour, directional traffic counter data provided by Connecticut Department of Transportation; and in that respect factor in the highest average number of vehicles observed on each modeled roadway regardless of circumstances. Depending on the time and day the evacuation order is issued (such as morning or afternoon rush hour), background congestion could prove to be a significant hindrance for those vehicles using the same road network to escape the impacts of a tropical cyclone threat.

The predicted traffic volume is based upon the specific behavioral assumptions employed in the transportation analysis. Assumptions regarding participation rates and tourist occupancy are the most critical. Since the Connecticut area has very limited evacuation experience and since this analysis assumes full participation by the areas that should evacuate, actual volumes could be lower than the data presented in these tables. Many who should evacuate in lesser categories of hurricanes will underestimate the impact of a storm and will choose not to evacuate. However, clearance times calculated for this transportation analysis should allow for people to evacuate whether they choose to or not.

Table 6-24: Out Route Assignment Assumptions

County	Community	Critical Roadway Segment	Initial % Assignment
Fairfield County	Bridgeport	I-95 southbound	10%
		US 1 southbound	2%
		CT 59 northbound	1%
		Park Ave northbound	7%
		Reservoir Ave northbound	8%
		CT 25 northbound	22%
		CT 8 eastbound	25%
		CT 127 eastbound	1%
		Huntington Tpk northbound	1%
		Barnum Ave eastbound	1%
		CT 130 eastbound	1%
		I-95 northbound	21%
	Darien	US 1 southbound	10%
		I-95 southbound	15%
		CT 106 eastbound	15%
		CT 124 westbound	15%
		US 1 northbound	10%
		I-95 northbound	35%
	Fairfield	I-95 southbound	13%
		US 1 southbound	7%
		CT 15 southbound	12%
		CT 136 eastbound	1%
		Redding Rd northbound	1%
		Burr St northbound	1%
		CT 58 westbound	5%
		CT 15 northbound	25%
		US 1 northbound	12%
		I-95 northbound	20%
		CT 130 eastbound	3%
	Greenwich	I-95 southbound	10%
		Mill St westbound	1%
		US 1 southbound	4%
		CT 15 southbound	6%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
Fairfield (continued)	Greenwich (continued)	I-684 westbound	2%
		I-684 eastbound	3%
		Riversville Rd northbound	1%
		North St northbound	11%
		CT 15 northbound	17%
		US 1 northbound	10%
		I-95 northbound	35%
	Norwalk	CT 136 westbound	2%
		I-95 southbound	15%
		US 1 southbound	5%
		CT 15 southbound	15%
		CT 123 northbound	1%
		Main Ave northbound	1%
		CT 53 northbound	2%
		CT 15 northbound	25%
		US 1 northbound	5%
		I-95 northbound	27%
		CT 136 eastbound	2%
	Stamford	I-95 southbound	12%
		US 1 southbound	5%
		CT 15 southbound	7%
		CT 104 westbound	1%
		CT 137 northbound	1%
		CT 15 northbound	25%
		CT 106 eastbound	15%
		I-95 northbound	25%
		US 1 northbound	9%
	Stratford	CT 113 northbound	1%
		I-95 southbound	15%
		Barnum Ave westbound	1%
		US 1 southbound	8%
		CT 108 westbound	15%
		CT 15 southbound	5%
		Huntington Rd northbound	1%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
Fairfield (continued)	Stratford (continued)	CT 110 eastbound	5%
		CT 15 northbound	24%
		I-95 northbound	22%
		US 1 northbound	3%
	Westport	I-95 southbound	17%
		CT 15 southbound	17%
		CT 33 westbound	2%
		CT 57 eastbound	2%
		CT 136 eastbound	3%
		CT 15 northbound	27%
		Long Lots Rd eastbound	1%
		I-95 northbound	31%
		CT 110 eastbound	5%
		CT 15 northbound	24%
		I-95 northbound	22%
		US 1 northbound	3%
Middlesex County	Chester	CT 148 westbound	10%
		CT 9 northbound	75%
		CT 82 eastbound	5%
		CT 154 eastbound	5%
		CT 148 eastbound	5%
	Clinton	US 1 southbound	5%
		I-95 southbound	5%
		CT 81 northbound	30%
		I-95 northbound	55%
		CT 145 northbound	5%
		US 1 northbound	0%
	Deep River	CT 80 westbound	12%
		CT 145 northbound	2%
		CT 9 northbound	85%
		CT 154 eastbound	1%
	Essex	CT 602 westbound	8%
		CT 9 northbound	90%
		CT 154 eastbound	2%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
Middlesex County (continued)	Old Saybrook	US 1 southbound	0%
		I-95 southbound	10%
		CT 166 westbound	7%
		CT 9 northbound	55%
		CT 154 westbound	3%
		I-95/US 1 northbound	25%
	Westbrook	US 1 southbound	0%
		I-95 southbound	5%
		CT 145 northbound	10%
		CT 153 northbound	40%
		I-95 northbound	45%
		US 1 northbound	0%
New Haven County	Branford	CT 142 westbound	3%
		US 1 southbound	15%
		I-95 southbound	60%
		Brushy Plain Rd northbound	2%
		CT 139 northbound	2%
		School Ground Rd northbound	1%
		US 1 northbound	5%
		I-95 northbound	11%
		CT 146 eastbound	1%
	East Haven	CT 377 northbound	2%
		I-95 southbound	55%
		US 1 southbound	17%
		CT 80 westbound	13%
		CT 80 eastbound	2%
		I-95 northbound	8%
		US 1 northbound	2%
		CT 142 eastbound	1%
	Guilford	I-95 southbound	65%
		US 1 southbound	5%
		CT 80 westbound	5%
		CT 77 northbound	5%
		CT 80 eastbound	5%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
New Haven County (continued)	Guilford (continued)	I-95 northbound	5%
		US 1 northbound	5%
	Hamden	CT 10 eastbound	20%
		CT 15 northbound	8%
		Skiff St eastbound	2%
		Whitney Ave northbound	10%
		US 5 northbound	60%
	Madison	US 1 southbound	67%
		I-95 southbound	5%
		CT 80 westbound	5%
		CT 79 northbound	10%
		CT 80 eastbound	5%
		I-95 northbound	5%
		US 1 northbound	3%
	Milford	US 1 southbound	5%
		I-95 southbound	15%
		CT 15 southbound	10%
		CT 15 northbound	25%
		CT 121 northbound	5%
		US 1 northbound	5%
		I-95 northbound	30%
		Oxford Rd northbound	1%
		CT 162 eastbound	4%
	New Haven	I-95 southbound	5%
		US 1 southbound	3%
		CT 34 westbound	2%
		CT 15 southbound	5%
		CT 63 northbound	2%
		CT 69 northbound	2%
		CT 15 northbound	15%
		CT 10 eastbound	1%
		Dixwell Ave northbound	1%
		Whitney Ave northbound	1%
		US 5 northbound	15%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
New Haven County (continued)	New Haven (continued)	I-91 northbound	40%
		US 1 northbound	2%
		I-95 northbound	6%
	North Haven	Skiff St eastbound	2%
		SR 40 westbound	15%
		CT 15 northbound	18%
		US 5 northbound	15%
		I-91 northbound	45%
		CT 22 eastbound	2%
		CT 17 northbound	3%
	West Haven	Woodmont Rd westbound	1%
		I-95 southbound	12%
		CT 162 westbound	2%
		US 1 southbound	5%
		CT 34 westbound	5%
		CT 122 westbound	15%
		CT 34 eastbound	5%
		US 1 northbound	25%
		I-95 northbound	29%
		CT 122 eastbound	1%
New London County	East Lyme	CT 156 westbound	25%
		I-95 southbound	8%
		US 1 southbound	5%
		CT 161 northbound	2%
		I-395 northbound	55%
		I-95 northbound	2%
		US 1 northbound	1%
		CT 156 eastbound	2%
	Groton	I-95 southbound	55%
		CT 12 westbound	10%
		CT 117 northbound	10%
		CT 184 eastbound	3%
		I-95 northbound	20%
		US 1 northbound	2%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
New London County (continued)	Ledyard	CT 12 westbound	95%
		CT 117 northbound	5%
	Lyme	CT 148 westbound	3%
		CT 82 westbound	10%
		CT 82 eastbound	5%
		CT 156 westbound	80%
		Gungy Rd northbound	2%
	Montville	CT 85 northbound	35%
		CT 82 westbound	5%
		CT 163 northbound	5%
		I-395 northbound	45%
		CT 32 westbound	8%
		CT 2 Alt eastbound	2%
	New London	CT 213 southbound	0%
		US 1 southbound	5%
		CT 85 northbound	53%
		I-95 southbound	6%
		Williams St northbound	1%
		CT 32 westbound	15%
		I-95/US 1 northbound	20%
	Old Lyme	I-95/US 1 southbound	40%
		CT 156 westbound	5%
		Town Woods Rd northbound	2%
		Coach Dr northbound	3%
		US 1 northbound	5%
		I-95 eastbound	40%
		CT 156 eastbound	5%
	Preston	CT 2 Alt westbound	2%
		CT 12 westbound	80%
		CT 2 westbound	18%
	Stonington	US 1 southbound	3%
		I-95 southbound	40%
		CT 27 northbound	2%
		CT 184 westbound	1%

Table 6-24: Out Route Assignment Assumptions (continued)

County	Community	Critical Roadway Segment	Initial % Assignment
New London County (continued)	Stonington (continued)	CT 184 eastbound	4%
		I-95 northbound	30%
		CT 2 westbound	7%
		CT 49 northbound	3%
		CT 78 eastbound	5%
		US 1 northbound	5%
	Waterford	CT 156 westbound	1%
		US 1 southbound	1%
		I-95 southbound	3%
		CT 85 northbound	5%
		I-395 northbound	30%
		Montville Conn northbound	5%
		CT 32 westbound	5%
		I-95 northbound	10%
		US 1 northbound	20%
		CT 213 northbound	20%

Once the vehicle trips generated within each evacuation zone in each town have been aggregated and distributed according to the above assumptions, critical roadway segments can be determined and the number of evacuating vehicles calculated. This step in the development of the transportation model is called trip assignment and involves the routing of evacuating vehicles onto specific roadways. Table 6-25 below details the number of vehicles assigned to each critical roadway segment from all evacuating towns, by scenario and tourist occupancy. The bottleneck locations in this table relate to the town in which the critical roadway segment is physically situated rather than for which community the segment determines the clearance time. Bear in mind that in many cases the critical link that determines a town's clearance time will be located outside its jurisdiction. The table that relates the below listed critical bottlenecks to the specific towns they impact can be found in Table 6-24.

Table 6-25: Evacuating Vehicle Volume (Total Volume of Vehicles)

Bottleneck Location	Critical Roadway Segments[1]	Evacuating Vehicles			
		Scenario A		Scenario B	
		Scenario A	Scenario B	Scenario A	Scenario B
Greenwich	Sound Beach Ave @ Laddins Rock Rd (CAB)	2,434	3,288	2,567	3,453
Stamford	Elm St @ I-95 interchange (COG)	3,266	5,459	3,636	5,911
Darien	Tokeneke Rd/CT 136 @ US Hwy 1 (BFU)	1,087	1,539	1,111	1,568
Norwalk	West Ave @ I-95 interchange (CBD)	5,473	7,960	5,732	8,306
	East Ave @ I-95 interchange (CBK)	2,614	3,785	2,736	3,947
	Merritt Pkwy/CT 15 @ Main Ave interchange (AVK)	3,693	6,262	4,182	6,874
Westport	I-95 N/Connecticut Tpke @ Saugatuck Ave interchange (AAW)	5,059	8,411	5,678	9,187
	Compo Rd S @ Bridge St/CT 136 (CBM)	954	1,323	993	1,370
Bridgeport	I-95 N/Connecticut Tpke @ State Hwy 8 /25 interchange (ABI)	8,658	13,891	9,350	14,744
	CT 8/25 @ CT 8 & CT 25 split (AYK)	5,058	8,472	5,303	8,761
	Park Ave @ State St/CT 130 (CCW)	1,470	2,257	1,492	2,283
Trumbull	Merritt Pkwy/CT 15 @ CT 8 interchange (AVW)	4,003	6,841	4,437	7,380
Stratford	Main St/CT 113 @ W Broad St (BJH)	2,812	3,395	2,869	3,462
Milford	High St @ Jepson Dr (CEY)	3,539	4,741	3,849	5,103
	Milford Pkwy @ Merritt Pkwy/CT 15 (CMM)	3,397	4,961	3,739	5,364
West Haven	I-95 N/Connecticut Tpke @ West River bridge (ACF)	7,082	11,364	7,580	11,979
New Haven	I-95 N/Connecticut Tpke @ CT 34 interchange (ACJ)	6,685	10,735	7,153	11,314
	I-91 N @ CT 80 interchange (AKC)	15,438	23,382	16,874	25,046
	I-95 S/Connecticut Tpke @ I-91 interchange (AHG)	8,402	11,603	9,297	12,597
	Townsend Ave/CT 337 @ Main St (BOI)	636	995	670	1,036
Hamden	State St/US Hwy 5 @ Skiff St (AUN)	1,833	3,705	1,874	3,761
North Haven	I-91 N @ Wharton Brook Connector (AKG)	14,784	22,599	16,148	24,187

[1]The letters in parentheses pertain to the road segment designators from the maps contained in Figures 6-28 to 6-60.

Table 6-25: Evacuating Vehicle Volume (Total Volume of Vehicles) (continued)

Bottleneck Location	Critical Roadway Segments[1]	Evacuating Vehicles			
		Low Occupancy		High Occupancy	
		Scenario A	Scenario B	Scenario A	Scenario B
East Haven	Hemingway Ave/CT 142 @ Main St (BPX)	3,518	4,251	3,620	4,358
Branford	Cedar St @ US 1 (CHP)	2,188	2,530	2,312	2,677
Guilford	Church St/CT 77 @ Boston Post Rd/US Hwy 1 (CLE)	2,118	2,728	2,266	2,890
Madison	Durham Rd/CT 79 @ I-95 interchange (BQX)	1,433	1,747	1,598	1,914
Clinton	High St/CT 81 @ I-95 interchange (BRL)	2,014	2,398	2,233	2,621
Westbrook	Essex Rd/CT 153 @ I-95 interchange (BSH)	1,660	1,668	1,954	1,955
Old Saybrook	Middlesex Tpke/CT 154 @ I-95 interchange (BSZ)	3,989	4,188	4,657	4,866
Essex	West Ave/CT 153 @ CT 9 interchange (BTQ)	739	1,355	784	1,437
	Chester Bowles Hwy/CT 9 @ Middlesex Tpke/CT 154 interchange (BAL)	4,249	5,705	5,522	7,079
Deep River	Chester Bowles Hwy/CT 9 @ Elm St/CT 80 interchange (BAN)	4,300	5,865	5,556	7,224
Chester	Chester Bowles Hwy/CT 9 @ W Main St interchange (BAP)	4,444	6,173	5,682	7,514
Old Lyme	I- 95 S/Connecticut Tpke/US Hwy 1 bridge over Connecticut River (AGC)	2,718	3,666	3,627	4,655
	Shore Rd/CT 156 @ Four Mile River Rd (BUZ)	1,326	1,541	1,832	2,059
East Lyme	Flanders Rd/CT 161 @ Society Rd (BVI)	2,599	2,979	3,012	3,432
Montville	I-395 N @ CT 2 Alt interchange (CNI)	7,283	11,440	8,719	13,083
Waterford	Boston Post Rd/US Hwy 1 @ Cross Rd (ASF)	1,903	2,029	1,937	2,068
New London	Colman St/US Hwy 1 @ Broad St/CT 85 (ASM)	2,555	3,376	2,718	3,574
Groton	Gold Star Memorial Bridge/I- 95/US Hwy 1 westbound (AFK)	3,482	4,857	4,392	5,895
	North Rd/CT 117 @ I-95 interchange (BYD)	1,335	1,829	1,540	2,079
Stonington	CT 234 Interchange to I-95 (CNB)	4,087	4,577	4,794	5,333
	I-95 N @ Liberty St/CT 2 interchange (AER)	3,353	4,625	4,141	5,493

[1]The letters in parentheses pertain to the road segment designators from the maps contained in Figures 6-28 to 6-60.

6.10.4 Estimated Evacuation Clearance Times

The most important product of the transportation analysis is the clearance times developed by storm scenario and by behavioral characteristics for each group of counties. Clearance time is one of two major considerations involved in issuing an evacuation or storm advisory. Clearance time must be weighed with the forecast arrival of sustained tropical storm winds to make a prudent evacuation decision. Figure 6-61 illustrates these two timing issues of evacuation and their relationship to each other.

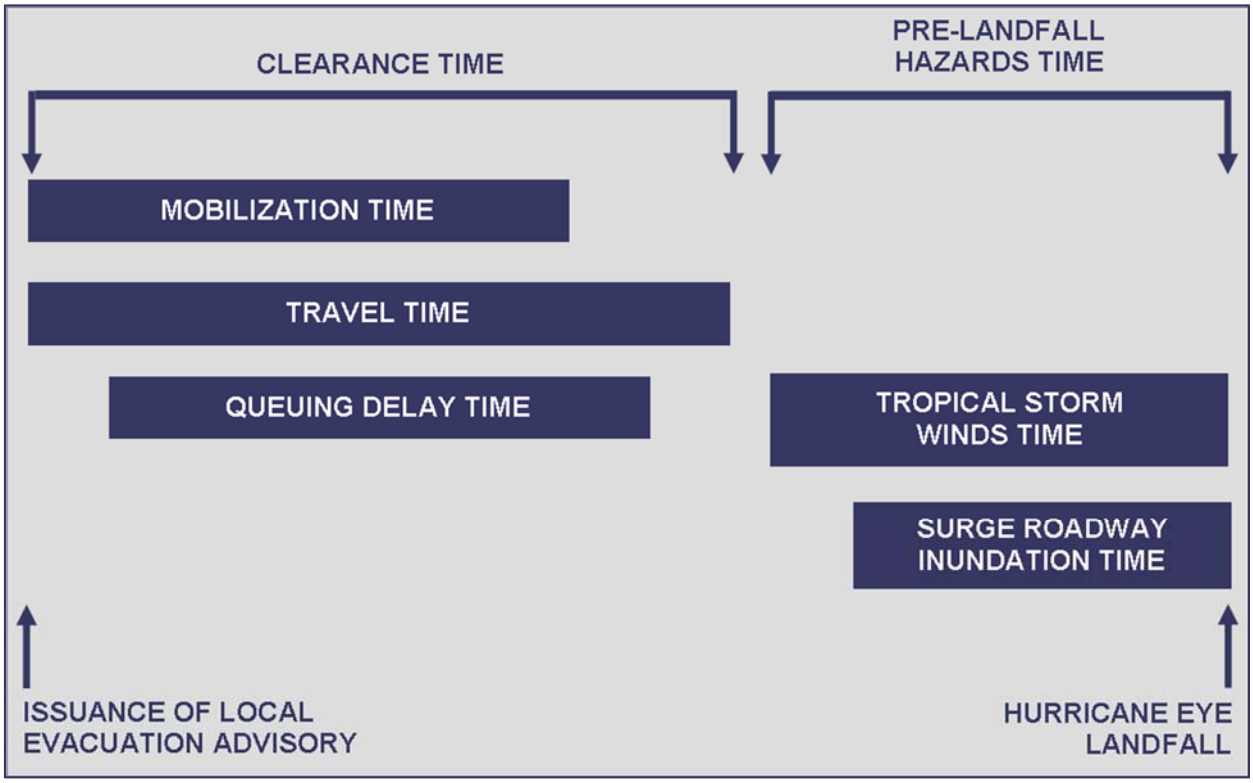

Figure 6-61: Components of Evacuation Timing

Clearance time is the time required to clear the roadway of all vehicles evacuating in response to a hurricane situation. Clearance time begins when the first evacuating vehicle enters the road network and ends when the last evacuating vehicle reaches an assumed point of safety. Clearance time includes the time required by evacuees to secure their homes and prepare to leave (referred to as mobilization time). Clearance time also encompasses the time spent by evacuees traveling along the road network (referred to as travel time), and the time spent by evacuees waiting along the road network due to traffic congestion (referred to as queuing delay time). Clearance time does not relate to the time any one vehicle spends traveling on the road

network and does not include time needed for local officials to assemble and make a decision to evacuate.

Clearance times for Connecticut were calculated by metering expected traffic through each regional and local route focal point location for every response and tourist occupancy scenario. A critical assumption for making these calculations is the hourly vehicular flow rate assumed at each focal point. Evacuation traffic flow assumptions are based on traffic counter data collected over time in other states after actual hurricane evacuations that show typical traffic movement is near maximum capacity at the beginning of the evacuation. Then for each quarter of the evacuation thereafter, the service volume is reduced. In the last quarter of the evacuation, the flow rate "recovers" to near capacity. This approach does an excellent job of mirroring what actually happens in most evacuations where the public responds to evacuation advisories and loads the roadway gradually over an approximate eight hour time period (medium response rate). Another important element to recognize in the calculations is the presence of a certain amount of background traffic (non-evacuee) that may be on the road network at the start of the evacuation. These movements may include residents going to stores for supplies or even a work to home movement. Depending on the normal daily congestion in an area, this can add up to a significant increase in time in an area like Connecticut.

The single largest factor influencing clearance times is the response scenario (A or B). Even in the most intense hurricanes, times are comfortably below the 24 hour time frame for both tourist occupancy scenarios. Even with the addition of evacuees from other regions and states, these clearance times do not escalate significantly and do not exceed the normal amount of response time allowed by a hurricane warning from the NHC. Table 6-26 shows the regional clearance times for Connecticut and Table 6-27 lists the critical links that determine those clearance times for each community.

Table 6-26: Evacuation Clearance Times (in hours)

County	Community	SLOW Response				MEDIUM Response				RAPID Response			
		Scenario A		Scenario B		Scenario A		Scenario B		Scenario A		Scenario B	
		Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.
Fairfield County	Bridgeport	8.6	8.8	9.8	10.0	7.1	7.2	8.3	8.5	5.4	5.6	6.7	6.9
	Darien	8.6	8.8	9.8	10.0	7.1	7.2	8.3	8.5	5.4	5.6	6.7	6.9
	Fairfield	8.6	8.8	9.8	10.0	7.1	7.2	8.3	8.5	5.4	5.6	6.7	6.9
	Greenwich	8.6	8.8	9.8	10.0	7.1	7.2	8.3	8.5	5.4	5.6	6.7	6.9
	Norwalk	8.6	8.8	9.8	10.0	7.1	7.2	8.3	8.5	5.4	5.6	6.7	6.9
	Stamford	12.7	13.3	16.1	16.8	11.0	11.5	14.3	14.9	9.2	9.7	12.6	13.3
	Stratford	8.2	8.4	9.2	9.4	6.6	6.8	7.6	7.8	4.8	5.0	5.9	6.1
	Westport	8.6	8.8	9.8	10.0	7.1	7.2	8.3	8.5	5.4	5.6	6.7	6.9
Middlesex County	Chester	3.9	4.4	4.5	5.0	3.4	3.9	4.0	4.5	3.0	3.4	3.6	4.1
	Clinton	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0
	Deep River	4.0	4.4	4.5	5.0	3.5	3.9	4.0	4.5	2.9	3.4	3.5	4.0
	Essex	4.0	4.5	4.6	5.1	3.5	4.0	4.0	4.5	3.0	3.4	3.5	4.0
	Old Saybrook	12.5	13.4	12.8	13.7	10.8	11.7	11.1	12.0	9.2	10.1	9.5	10.4
	Westbrook	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0

Table 6-26: Evacuation Clearance Times (in hours) (continued)

County	Community	SLOW Response				MEDIUM Response				RAPID Response			
		Scenario A		Scenario B		Scenario A		Scenario B		Scenario A		Scenario B	
		Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.
New Haven County	Branford	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0
	East Haven	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0
	Guilford	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0
	Hamden	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0
	Madison	8.0	8.2	8.7	9.0	6.5	6.7	7.3	7.5	5.0	5.2	5.8	6.0
	Milford	7.3	7.7	9.1	9.7	6.9	7.4	8.7	9.3	6.8	7.3	8.7	9.3
	New Haven	8.0	8.2	9.7	10.1	6.8	7.2	8.7	9.1	5.8	6.2	7.8	8.1
	North Haven	7.9	8.2	9.7	10.1	6.8	7.2	8.7	9.1	5.8	6.2	7.8	8.1
	West Haven	8.1	8.2	9.1	9.4	6.5	6.8	7.9	8.2	5.3	5.6	6.8	7.1
New London County	East Lyme	9.2	9.8	9.7	10.4	7.9	8.5	8.4	9.0	6.6	7.2	7.1	7.8
	Groton	6.1	6.4	6.8	7.2	5.2	5.5	5.9	6.2	4.2	4.5	4.9	5.3
	Ledyard	7.6	8.2	9.2	9.9	6.5	7.0	8.1	8.7	5.3	5.9	7.0	7.7
	Lyme	3.9	4.4	4.5	5.0	3.4	3.9	4.0	4.5	3.0	3.4	3.6	4.1
	Montville	7.6	8.2	9.2	9.9	6.5	7.0	8.1	8.7	5.3	5.9	7.0	7.7
	New London	7.0	7.2	8.0	8.2	6.1	6.3	7.1	7.3	5.2	5.5	6.3	6.5
	Old Lyme	5.0	5.3	5.3	5.5	4.0	4.3	4.3	4.5	2.9	3.2	3.2	3.5
	Preston	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Stonington	8.8	9.8	9.5	10.5	8.1	9.1	8.8	9.9	7.7	8.8	8.5	9.6
	Waterford	6.9	6.9	7.1	7.1	5.9	6.0	6.1	6.1	4.9	5.0	5.1	5.2

Table 6-27: Clearance Time Determining Critical Links

County	Physical Location	Name of Link	Impacted Communities
Fairfield County	Bridgeport	I-95 N/Connecticut Tpk @ State Hwy 8 /25 interchange (ABI)	Bridgeport Darien Fairfield Greenwich Norwalk Westport
	Stamford	Elm St @ I-95 interchange (COG)	Stamford
	Stratford	Merritt Pkwy/CT 15 @ CT 8 interchange (AVW)	Stratford
Middlesex County	Old Saybrook	Middlesex Tpk/CT 154 @ I-95 interchange (BSZ)	Old Saybrook
	Chester	Chester Bowles Hwy/CT 9 @ W Main St interchange (BAP)	Chester
	New Haven	I-95 S/Connecticut Tpke @ I-91 interchange (AHG)	Clinton Westbrook
	Essex	Chester Bowles Hwy/CT 9 @ Middlesex Tpk/ CT 154 interchange (BAL)	Essex
	Deep River	Chester Bowles Hwy/CT 9 @ Elm St/CT 80 interchange (BAN)	Deep River
New Haven County	New Haven	I-95 S/Connecticut Tpke @ I-91 interchange (AHG)	Branford East Haven Guilford Hamden Madison New Haven
	North Haven	I-91 N @ Wharton Brook Connector (AKG)	North Haven
	West Haven	I-95 N/Connecticut Tpk @ West River bridge (ACF)	West Haven
	Milford	High St @ Jepson Dr (CEY)	Milford
New London County	East Lyme	Flanders Rd/CT 161 @ Society Rd (BVI)	East Lyme
	Groton	North Rd/CT 117 @ I-95 interchange (BYD)	Groton
	Montville	I-395 N @ CT 2 Alt interchange (CNI)	Ledyard Montville

Table 6-27: Clearance Time Determining Critical Links (continued)

County	Physical Location	Name of Link	Impacted Communities
New London County	Chester	Chester Bowles Hwy/CT 9 @ W Main St interchange (BAP)	Lyme
	New London	Colman St/US Hwy 1 @ Broad St/CT 85 (ASM)	New London
	Old Lyme	I- 95 S/Connecticut Tpke/US Hwy 1 bridge over Connecticut River (AGC)	Old Lyme
	Stonington	CT 234 Interchange to I-95 (CNB)	Stonington
	Waterford	Boston Post Rd/US Hwy 1 @ Cross Rd (ASF)	Waterford

6.0 Transportation Analysis

The presentation of multiple clearance times can be confusing; the highest clearance time is the time to be used for decision making. Other times are shown so that local and state officials realize that once a roadway's congestion problem is "solved", the next most congested segment or corridor must be addressed. None of these clearance times factor in the effect of accidents, breakdowns or other exigent circumstances that may occur during an evacuation event. Although slow, medium and rapid scenarios have been included in the clearance time results, none of the figures take into account the adverse impacts of construction on the listed roadways, time of day considerations (middle of the workday or at night) or the additional travel demand created by short duration events (i.e., a well-attended special event in the area).

Additionally, the clearance times provided in both of the above tables are for an evacuation of the general population and not special needs evacuees. The evacuation of assisted or group living facilities and hospitals is driven more by operational constraints associated with the availability of adequate transportation and the time needed to prepare the evacuees, rather than any congestion or limitations to the roadway network. Therefore, no determination was made for the time required to evacuate nursing homes and other population groups with special needs.

Evacuations in this area will be problematic both for decision makers and the public given that in this part of the Atlantic coast, the forward speed of tropical cyclones is usually relatively fast and accelerating due to their proximity to the jet stream. Consequently, depending on the clearance time, the decision to evacuate may have to occur when the storm is still far from the forecast landfall point, well before the need to leave becomes evident to at-risk populations.

For evacuations to be successful, the public will have to start their movements in earnest, well before the threat is imminent, and at least a portion of the evacuees must be moving at the beginning of the clearance time period. Individual household evacuation commutes will be longer for those leaving in the middle of the evacuation for a major storm event. Evacuations must be started early enough so that movements are complete before the arrival of sustained tropical storm winds. Given the public's relative dearth of hurricane evacuation experience in the Connecticut coastal area, it is likely that many evacuees may attempt to leave very late in the process. All of these factors can have a significant impact on the actual time it takes to clear the roadways in any of the jurisdictions within the region.

6.10.5 Evacuation Impacts from New York City

As mentioned earlier, a simultaneous evacuation of New York City and its eastern environs will have an impact on clearance times in the adjacent communities along the coast in Connecticut. These impacts will be felt mostly along the I-95 and the Merritt Parkway corridors, with the former roadway being the more problematic with respect to increases in clearance times. Nonetheless, the impacted clearance times still do not exceed the optimal amount (36 hours or less) of alert and response time provided by a Hurricane Warning from the NHC.

Tables 6-28 and 6-29 document the increases in clearance times caused by simultaneous evacuations in New York City and surrounding communities. Table 6-28 provides the amount of additional time needed to accommodate the extra traffic, while 6-29 lists the new clearance time totals for those impacted communities.

Table 6-28: Change to Evacuation Clearance Times (in additional hours)

County	Town	SLOW Response				MEDIUM Response				RAPID Response			
		Scenario A		Scenario B		Scenario A		Scenario B		Scenario A		Scenario B	
		Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.
Fairfield County	Bridgeport	**1.8**	**2.1**	**5.2**	**5.7**	**1.8**	**2.2**	**5.1**	**5.6**	**1.9**	**2.2**	**5.4**	**5.8**
	Darien	**1.8**	**2.1**	**5.2**	**5.7**	**1.8**	**2.2**	**5.1**	**5.6**	**1.9**	**2.2**	**5.4**	**5.8**
	Fairfield	**1.8**	**2.1**	**5.2**	**5.7**	**1.8**	**2.2**	**5.1**	**5.6**	**1.9**	**2.2**	**5.4**	**5.8**
	Greenwich	**1.8**	**2.1**	**5.2**	**5.7**	**1.8**	**2.2**	**5.1**	**5.6**	**1.9**	**2.2**	**5.4**	**5.8**
	Norwalk	**1.8**	**2.1**	**5.2**	**5.7**	**1.8**	**2.2**	**5.1**	**5.6**	**1.9**	**2.2**	**5.4**	**5.8**
	Stamford	0	0	0	0	0	0	0	0	0	0	0	0
	Stratford	**0.6**	**0.8**	**2.8**	**3.2**	**0.6**	**0.8**	**2.8**	**3.1**	**0.7**	**0.9**	**2.9**	**3.3**
	Westport	**1.8**	**2.1**	**5.2**	**5.7**	**1.8**	**2.2**	**5.1**	**5.6**	**1.9**	**2.2**	**5.4**	**5.8**
Middlesex County	Chester	0	0	0	0	0	0	0	0	0	0	0	0
	Clinton	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**
	Deep River	0	0	0	0	0	0	0	0	0	0	0	0
	Essex	0	0	0	0	0	0	0	0	0	0	0	0
	Old Saybrook	0	0	0	0	0	0	0	0	0	0	0	0
	Westbrook	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**

Table 6-28: Evacuation Clearance Times (in hours) (continued)

County	Town	SLOW Response				MEDIUM Response				RAPID Response			
		Scenario A		Scenario B		Scenario A		Scenario B		Scenario A		Scenario B	
		Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.
New Haven County	Branford	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**
	East Haven	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**
	Guilford	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**
	Hamden	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**
	Madison	**0.9**	**1**	**2.6**	**2.7**	**0.9**	**1.1**	**2.5**	**2.7**	**0.9**	**1.1**	**2.6**	**2.9**
	Milford	0	0	0	0	0	0	0	0	0	0	0	0
	New Haven	**0.9**	**1**	**1.8**	**2**	**0.7**	**0.7**	**1.8**	**1.9**	**0.7**	**0.7**	**1.8**	**2.1**
	North Haven	**0.6**	**0.7**	**1.8**	**2**	**0.7**	**0.7**	**1.8**	**1.9**	**0.7**	**0.7**	**1.8**	**2.1**
	West Haven	**1.5**	**1.8**	**4.2**	**1.6**	**0.5**	**0.6**	**1.5**	**1.6**	**0.6**	**0.6**	**1.6**	**1.7**
New London County	East Lyme	0	0	0	0	0	0	0	0	0	0	0	0
	Groton	0	0	0	0	0	0	0	0	0	0	0	0
	Ledyard	**0.2**	**0.2**	**0.6**	**0.6**	**0.2**	**0.3**	**0.6**	**0.6**	**0.2**	**0.3**	**0.6**	**0.6**
	Lyme	0	0	0	0	0	0	0	0	0	0	0	0
	Montville	**0.2**	**0.2**	**0.6**	**0.6**	**0.2**	**0.3**	**0.6**	**0.6**	**0.2**	**0.3**	**0.6**	**0.6**
	New London	0	0	0	0	0	0	0	0	0	0	0	0
	Old Lyme	**0.3**	**0.2**	**0.6**	**0.7**	**0.3**	**0.2**	**0.6**	**0.7**	**0.3**	**0.3**	**0.6**	**0.7**
	Preston	0	0	0	0	0	0	0	0	0	0	0	0
	Stonington	0	0	0	0	0	0	0	0	0	0	0	0
	Waterford	0	0	0	0	0	0	0	0	0	0	0	0

Table 6-29: Multi-State Evacuation Clearance Times (in hours)

County	Town	SLOW Response				MEDIUM Response				RAPID Response			
		Scenario A		Scenario B		Scenario A		Scenario B		Scenario A		Scenario B	
		Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.
Fairfield County	Bridgeport *	10.4	10.9	15	15.7	8.9	9.4	13.4	14.1	7.3	7.8	12.1	12.7
	Darien *	10.4	10.9	15	15.7	8.9	9.4	13.4	14.1	7.3	7.8	12.1	12.7
	Fairfield *	10.4	10.9	15	15.7	8.9	9.4	13.4	14.1	7.3	7.8	12.1	12.7
	Greenwich *	10.4	10.9	15	15.7	8.9	9.4	13.4	14.1	7.3	7.8	12.1	12.7
	Norwalk *	10.4	10.9	15	15.7	8.9	9.4	13.4	14.1	7.3	7.8	12.1	12.7
	Stamford	12.7	13.3	16.1	16.8	11	11.5	14.3	14.9	9.2	9.7	12.6	13.3
	Stratford *	8.8	9.2	12	12.6	7.2	7.6	10.4	10.9	5.5	5.9	8.8	9.4
	Westport *	10.4	10.9	15	15.7	8.9	9.4	13.4	14.1	7.3	7.8	12.1	12.7
Middlesex County	Chester	3.9	4.4	4.5	5	3.4	3.9	4	4.5	3	3.4	3.6	4.1
	Clinton *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9
	Deep River	4	4.4	4.5	5	3.5	3.9	4	4.5	2.9	3.4	3.5	4
	Essex	4	4.5	4.6	5.1	3.5	4	4	4.5	3	3.4	3.5	4
	Old Saybrook	12.5	13.4	12.8	13.7	10.8	11.7	11.1	12	9.2	10.1	9.5	10.4
	Westbrook *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9

Table 6-29: Multi-State Evacuation Clearance Times (in hours) (continued)

County	Town	SLOW Response				MEDIUM Response				RAPID Response			
		Scenario A		Scenario B		Scenario A		Scenario B		Scenario A		Scenario B	
		Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.	Low Tour Occ.	High Tour Occ.
New Haven County	Branford *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9
	East Haven *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9
	Guilford *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9
	Hamden *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9
	Madison *	8.9	9.2	11.3	11.7	7.4	7.8	9.8	10.2	5.9	6.3	8.4	8.9
	Milford	7.3	7.7	9.1	9.7	6.9	7.4	8.7	9.3	6.8	7.3	8.7	9.3
	New Haven *	8.9	9.2	11.5	12.1	7.5	7.9	10.5	11	6.5	6.9	9.6	10.2
	North Haven *	8.5	8.9	11.5	12.1	7.5	7.9	10.5	11	6.5	6.9	9.6	10.2
	West Haven *	9.6	10	13.3	11	7	7.4	9.4	9.8	5.9	6.2	8.4	8.8
New London County	East Lyme	9.2	9.8	9.7	10.4	7.9	8.5	8.4	9	6.6	7.2	7.1	7.8
	Groton	6.1	6.4	6.8	7.2	5.2	5.5	5.9	6.2	4.2	4.5	4.9	5.3
	Ledyard *	7.8	8.4	9.8	10.5	6.7	7.3	8.7	9.3	5.5	6.2	7.6	8.3
	Lyme	3.9	4.4	4.5	5	3.4	3.9	4	4.5	3	3.4	3.6	4.1
	Montville *	7.8	8.4	9.8	10.5	6.7	7.3	8.7	9.3	5.5	6.2	7.6	8.3
	New London	7	7.2	8	8.2	6.1	6.3	7.1	7.3	5.2	5.5	6.3	6.5
	Old Lyme *	5.3	5.5	5.9	6.2	4.3	4.5	4.9	5.2	3.2	3.5	3.8	4.2
	Preston	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Stonington	8.8	9.8	9.5	10.5	8.1	9.1	8.8	9.9	7.7	8.8	8.5	9.6
	Waterford	6.9	6.9	7.1	7.1	5.9	6	6.1	6.1	4.9	5	5.1	5.2

* When evacuating with simultaneous evacuations in New York.

6.11 Traffic Control Measures

6.11.1 General Recommendations

Most residents in the vicinity of urbanized areas like Stamford, Bridgeport and Hew Haven are aware of the traffic jams that occur during every day commutes. Officials from local jurisdictions must manage traffic flow along major routes, especially I-95, US 1, I-91, State Route 9 and State Route 15/Merritt Parkway. The Connecticut Highway Assistance Motor Patrol (CHAMPS) vehicles should be in position to remove broken down vehicles blocking travel, especially at the critical evacuation roadway segments identified in this report. Roadway maintenance and minor construction blockages must be cleared to allow for evacuee traffic. To lessen the amount of background traffic, officials at the highest levels must discourage home to work and school related movements on the day of an evacuation.

Connecticut is fortunate to have an extensive transportation network that is further enhanced by a robust Intelligent Transportation System (ITS) framework. Real time traveler information systems such as the relatively dense network of web-based traffic cameras, variable message boards and other programs are not only useful for the users of the roadway network, but also the traffic managers and emergency management officials, especially during hurricane evacuation operations. As mentioned earlier, since these clearance times do not factor in the impacts of any incidents, it is of paramount importance that any temporary impediments to traffic flow are resolved quickly and efficiently, especially at those locations specified in Table 6-27. All measures should be undertaken to be able to continuously monitor the flow of traffic at these locations and ensure that CHAMP vehicles are pre-positioned nearby to handle any exigent circumstances. Although many of the locations in Table 6-23 have traffic cameras as traffic monitoring devices, at least on major interstate highways and thoroughfares, they should all have continuous real-time coverage with that information provided into the state Emergency Operation Center (EOC). If the installation of remote sensing equipment is not feasible, those locations should have assigned law enforcement assets during hurricane evacuation events.

Below are some general observations and recommendations concerning evacuations:

- Given the very high percentages of non-mobile homes and inland residents who indicated that they would evacuate in the 2013 Behavioral Analysis commissioned by the USACE, it is imperative that public information before and during the disaster specifically address who should not evacuate, as well as who should. These inland residents who are electing to leave their homes could be the largest component of the evacuating population in most jurisdictions, regardless of storm intensity. As an

example, during Hurricane Floyd in 1999, many of the southeastern states learned from experience that it is as important for local officials to clearly specify who is not ordered to evacuate, rather than concentrating solely on who should.

- Where the state and local jurisdictions have sufficient personnel resources, officers should be stationed at critical intersections to facilitate traffic flow, especially at those locations listed in Table 6-27. Where intersections will continue to have signalized control, signal patterns should provide the most "green time" in the directions leading out of the evacuation zones.
- If possible, arrangements should be made with tow truck operators and CHAMP assets so that they are prepositioned along key travel corridors and critical roadway facilities such as bridges.
- The state, counties, and cities should jointly work on a statewide evacuation and shelter monitoring system which would monitor travel flow at key locations and report traffic tie ups/ shelter availability to the general public as they evacuate. This should include the installation of strategically placed permanent traffic counters that could detect speed and volumes.
- High level bridges need to be monitored for the early arrival of sustained tropical storm winds. High profile vehicles such as recreational vehicles (RVs), trucks and buses could be adversely affected before the evacuation at ground level is completed or terminated.

6.11.2 Specific Recommendations

Except in the case of a simultaneous evacuation from New York City, a considerable burden on the regional evacuation roadway network in Connecticut is caused by vehicles evacuating within the local area. Those vehicles relocating to friends and family, as well as to public shelters in-county, impact the critical links identified in the report as much, and in some instances more, than the exiting trips. To accommodate all the evacuation movements in the Connecticut coastal region the following specific recommendations are provided for consideration by federal, state and local officials:

- All draw/swing bridges needed for evacuation should be locked in the "down" position during a hurricane warning, if possible. The following bridges have the potential to exacerbate traffic congestion on all adjacent evacuation routes if allowed to open while an evacuation is underway:
  - US 1/Main St bridge over the Mystic R. (ATH and ATI);
  - CT 156/W. Main/Rope Ferry Rd bridge over the Niantic R. (BE and BVF);
  - US 1/Forbes Ave bridge in New Haven (APX);
  - US 1/Burnham Ave Cutoff/Bridgeport Ave in Milford/Stamford (AOY and AOZ);

  - CT 130/Stratford Ave bridge in Bridgeport (BIL);
  - Other CT 130/Stratford Ave bridge in Bridgeport (BIK); and
  - Washington St Bridge in Norwalk (BGD).

  Boat owners must be made aware of flotilla plans and time requirements beforehand so that they prepare their vessels for departure, or secure them at the marinas and docks.
- Some railroad crossings directly cross evacuation roadways and could complicate evacuations if long trains cause major delays on evacuation routes. Coordinate with Connecticut Department of Transportation to establish when train schedules may interfere with crossing traffic during evacuation periods. The following evacuation route segments which are all included in the transportation model have railroad crossings that could be an impediment to evacuation traffic:
  - US 1/Cross St (AMW) in Norwalk (Danbury Branch);
  - New Canaan Ave (BGV) in Norwalk (Danbury Branch);
  - CT 113 Lordship Blvd (BIY) in Stratford (Stratford Industrial Spur);
  - CT 130/Stratford Ave (BIP) in Stratford (Stratford Industrial Spur);
  - CT 146/Stony Creek Rd (BQP) in Branford (Branford Steam RR Line);
  - CT 153/Plains Rd (BTS) in Essex (Valley Line); and
  - CT 154/CT 602/Main St (BTD) in Essex (Valley Line).
- The implementation of more robust ITS measures in more states and urban jurisdictions makes effective coordinated communication among all response agencies responsible for evacuations all the more important. The Department of Transportation Traffic Operations Centers (e.g., Newington, Bridgeport and New London, etc.), Emergency Management EOCs, Law Enforcement Command Posts (CPs) and American Red Cross (ARC) Chapters should all be communicating and sharing data to ensure that all aspects of implementing evacuation operations from decision making to traffic management to sheltering are coordinated. Furthermore, it will be imperative for inland communities to know what level of evacuation may be coming their way and when it will start.

6.12 Report Summary

Connecticut fortunately enjoys a very well developed transportation network that lends itself well to relatively rapid evacuations away from the coast. Limited access highways such as Connecticut Route 8, the Merritt Parkway/CT 15, I-91, Connecticut Route 9 and I-395 are all generally oriented away from the coast to inland locations. These major corridors are supplemented by many other state and local routes that also can convey traffic perpendicularly away from the coast. The end result is that Connecticut has very reasonable clearance times, regardless of scenario, even with the addition of vehicles from the New York City metropolitan area. The word ‘reasonable’ aptly describes the clearance times for the state because in all

cases an evacuation away from the coast can be conducted well within the alert and execution window accorded by a Hurricane Warning from the NHC.

Of paramount importance, though, is to minimize and manage the traffic on I-95 and US 1. Both of these roadways, which have been identified in this study's behavioral survey as primary evacuation routes by potential evacuees in the state, closely parallel the coast; meaning that no point along these corridors can be considered safe from hurricane hazards. In essence, I-95 and US 1 are just collector routes for the more perpendicularly oriented thoroughfares referenced earlier. Although much of I-95 along the coast is a robust evacuation corridor with a great deal of capacity, it links three major urban areas, Bridgeport, New haven and New London, on the coast, each of which can impede vehicle flow during rush hours and during other periods of high traffic congestion. Consequently, any vehicles trapped on these two roadways during an evacuation cannot be considered safe once hurricane hazards become apparent. Therefore, all operational efforts must be undertaken to ensure that traffic flow remains smooth on I-95 and US 1 during the course of an evacuation, and that the transition to those routes leading away from the coast is maximized as much as possible.