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Interstate 84/Route 8
Interchange Reconstruction

Preliminary Purpose and Need Statement (draft)

MARCH 2022

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1 Introduction

The Connecticut Department of Transportation (CTDOT) is initiating a Planning and Environmental Linkages (PEL) Study of the Interstate 84 (I-84) and Route 8 Interchange, informally known as the Mixmaster. CTDOT desires to establish a vision, or master plan, for the interchange that is articulated in a prioritized plan for implementation of improvements. The overarching purpose of the PEL Study is to develop a clear and supported plan of action for addressing deficiencies at the I-84/Route 8 Interchange, while considering phasing and constructability of potential solutions for this complex interchange. This plan of action is called the Mixmaster Reconstruction Project.

CTDOT is utilizing the PEL process for the Mixmaster Reconstruction Project to link project master planning with the National Environmental Policy Act (NEPA) review process. Through the PEL process, CTDOT will work with partners to discern the transportation need, develop a preliminary alternatives analysis process, incorporate early stakeholder involvement, and evaluate those alternatives relative to transportation needs and key environmental and community resources. The Mixmaster Reconstruction Project's PEL Study will be a resource for future NEPA documentation; it will avoid duplication of effort, streamline the environmental review process, and reduce delays in project implementation. An initial key step of the PEL Study is to develop a Preliminary Purpose and Need Statement, which will connect this master plan with, and form the basis of, the subsequent refined NEPA Purpose and Need Statement.

NEPA requires that projects develop a Purpose and Need Statement: a concise and well-defined statement of why the project is proposed and what underlying transportation problems and deficiencies need to be addressed. The Purpose and Need Statement comprises three parts: 1) the Project Purpose, which is a concise statement of why the project is proposed and the primary goals and objectives that are intended to be met; 2) the Project Need, which identifies the major transportation deficiencies including factual and quantifiable data to substantiate the deficiencies; 3) other transportation-related goals and objectives that the Project intends to meet. The Project Purpose and Need is essential to establish a basis for the development of the range of reasonable alternatives required for a NEPA evaluation and assists with the identification and eventual selection of a preferred alternative.

2 Background

The City of Waterbury is a major employment center in Connecticut and the governmental, institutional, and cultural center of the Naugatuck River Valley. The City of Waterbury today is home to about 65,000 jobs and is currently implementing a comprehensive strategic plan to reclaim its position as a regional employment center and commercial hub. Within Connecticut, I-84 serves as a critical east-west transportation link between Massachusetts and I-90 to the east, and New York and beyond to the west. In Waterbury, I-84 runs through the greater downtown area and is located just south of the City's Central Business District (CBD). Connecticut Route 8 (Route 8) extends from Bridgeport and the I-95 corridor on

the south coast, north to the Massachusetts state line. In Waterbury, Route 8 parallels the Naugatuck River. Figure 2-1 shows the location of the Mixmaster Reconstruction Project.

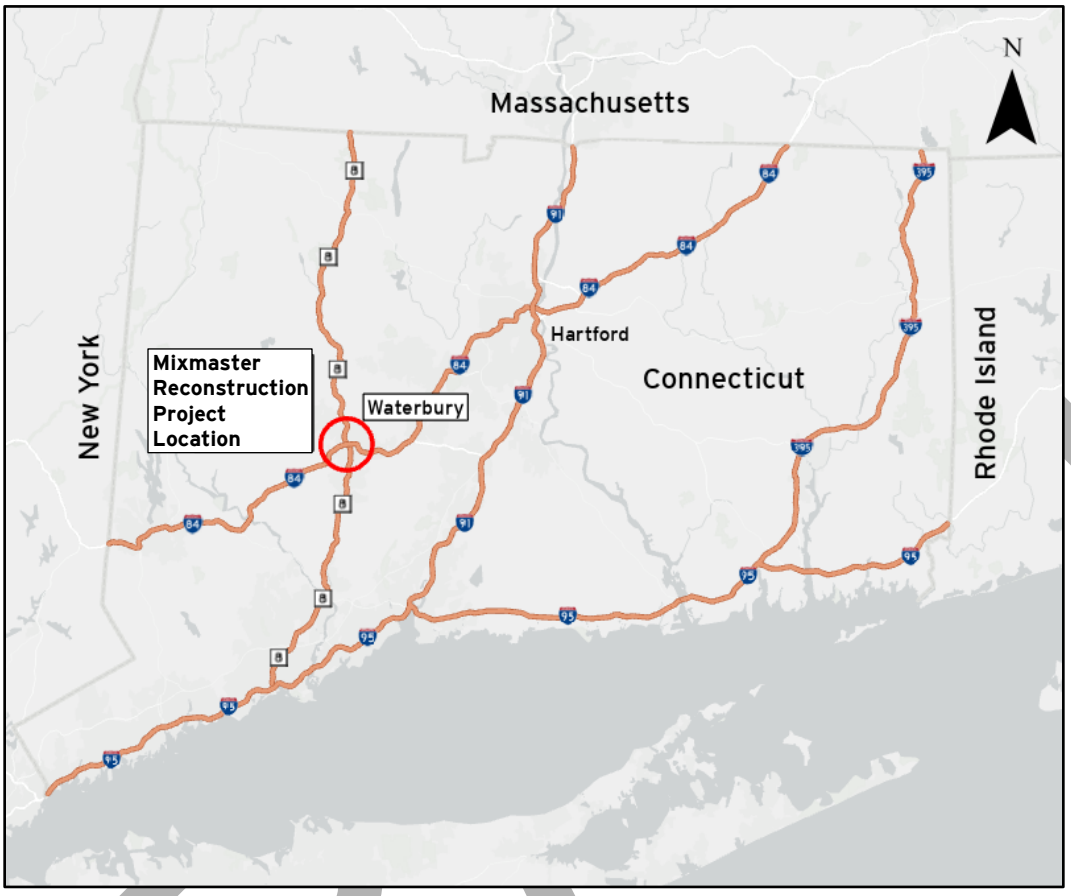


Figure 2-1. Mixmaster Reconstruction Project Location

I-84 carries approximately 135,000 vehicles daily in the immediate vicinity of the Mixmaster Interchange. Outside of the interchange area, at the Exit 17 west project extent, I-84 carries approximately 66,000 vehicles daily, while carrying approximately 101,000 vehicles daily at the Exit 23 east project extent. Route 8 carries approximately 94,000 and 68,000 vehicles daily to the north and south of the Mixmaster Interchange, respectively. Over the course of an average day, approximately 86,000 vehicles travel along the ramps between I-84 and Route 8. Approximately 121,000 vehicles daily use the I-84 ramps within the project limits to enter or exit the city. Approximately 63,000 vehicles daily use the Route 8 ramps to enter or exit the city.

I-84 is the principal freight corridor within the Naugatuck Valley region, important to local shippers and those across New England and New York. While I-84 services statewide east-west freight traffic, Route 8 is the regional north-south freight corridor. Trucks carry 93.7% of the tonnage and 92.4% of the value of freight moving throughout the state (2014), and truck freight volume is forecast to grow substantially over

the next 20 years.[1] Both I-84 and Route 8 are expected to accommodate a substantial amount of this growth in freight traffic.

The Mixmaster Interchange limits are roughly defined by numbered exits on the highways. On I-84, the corridor limits run from Exit 17 to 23; on Route 8 they extend just outside Exits 30 and 35. Figure 2-2 presents the PEL Study Area. At the junction of I-84 and Route 8, the Mixmaster interchange is an elevated, full system interchange. Designed and constructed to fit within challenging topographical and site constraints, the Interchange has four vertical levels and contains two stacked structures, with many left-hand on- and off- ramps. The stacked I-84 viaduct structure exists as the top two levels (Level 3, I-84 Westbound; and Level 4, I-84 Eastbound) and crosses over Route 8, a railyard, local roads, and the Naugatuck River. Route 8 is located at Level 2, and the local road network is defined as Level 1. The railroad is located vertically between Levels 1 and 2, and the Naugatuck River is located below Level 1. South of I-84, Route 8 is an elevated, stacked structure. The upper level is Route 8 Northbound while the lower level is Route 8 Southbound. These structures span local roadway networks. Figure 2-3 shows a representative photograph of the Mixmaster Interchange.

[1] Naugatuck Valley Council of Governments, *Metropolitan Transportation Plan: 2019-2045 for the Naugatuck Valley Planning Regional & Central Naugatuck Valley Metropolitan Planning Area* (Draft).

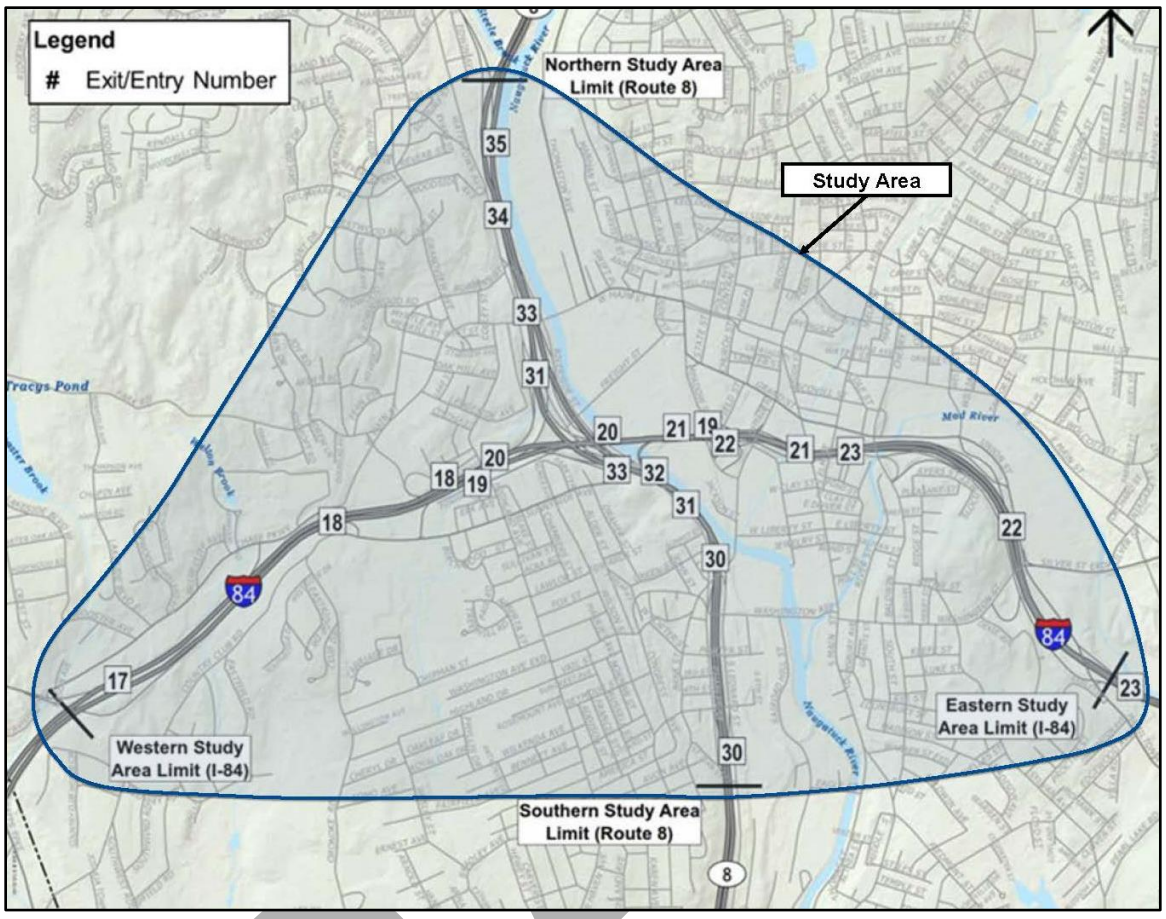


Figure 2-2. PEL Study Area

Figure 2-3. Stacked Mixmaster Interchange Structure with Four Levels

The PEL Study Area includes more than 5-miles of highway, 65 studied intersections, 62 bridges (including culverts) with a combined deck area exceeding 1,000,000 square feet (the equivalent of 23 acres), and over 100,000 square feet of retaining walls. In addition to the Naugatuck River, the PEL Study Area includes the Mad River, several brooks and unnamed tributaries, most of the Waterbury CBD, ten neighborhoods, five parks, three historic districts, many historic places/properties (including Riverside Cemetery), the Metro-North Railroad Waterbury Branch Line, CT*transit* and CT*fastrak* fixed routes, intercity bus service routes, the Naugatuck River Greenway, ten major employers, and the proposed (future) Freight Street District. The Freight Street District is a 60-acre area of low-cost developable or under-developed commercial property located on the western edge of the City of Waterbury's downtown CBD. The Waterbury Travel Center (intercity bus station) and the Waterbury Train Station are located in the CBD.

CTDOT, the City of Waterbury, and the Naugatuck Valley Council of Governments (NVCOG) [and its predecessor, the Council of Governments of the Central Naugatuck Valley (COGCNV)] have worked extensively to address the long-term transportation needs of the I-84 and Route 8 corridors through Waterbury. Since 2010, state, local, and regional governments have generated eleven transportation-related studies that either include the PEL Study Area or address a major transportation issue of the PEL Study Area, such as aging infrastructure, recurring congestion and delay, and high crash rates. High priorities for the PEL Study Area include addressing structural deficiencies, maintaining and enhancing the highway system while alleviating congestion, reducing travel delay, reducing the crash rate, preserving and enhancing multi-modal services, and improving local connections with downtown Waterbury. Projects to

improve existing infrastructure include State Project #151-273, completed in 2018, which widened I-84 to three lanes in each direction from Washington Street within the eastern Mixmaster PEL Study Area to Pierpont Road approximately 2.7 miles to the east.

3 Preliminary Purpose and Need Statement

3.1 PROJECT PURPOSE

The purpose of the Mixmaster Reconstruction Project is to improve the existing structural, geometric and operational deficiencies of the I-84 and Route 8 interchange to meet current and future traffic needs. These improvements are expected to improve system performance, reduce congestion, reduce the crash rate, maintain critical system linkages in Connecticut and the northeast, and facilitate connectivity within Waterbury through the local road network, including multimodal travel.

3.2 PROJECT NEEDS

The needs of the Mixmaster Interchange, expressed as existing deficiencies, have been identified as follows:

- Structural deficiencies;
- Geometric deficiencies; and
- Operational deficiencies (including congestion).

High crash rates at the Mixmaster Interchange are attributed to geometric and operational deficiencies

The following sections summarize the Mixmaster Interchange Needs, which are more thoroughly documented in the *Interstate 84/Route 8 "Mixmaster" Interchange Analysis, Needs and Deficiencies Report*, August 2020. The geometric and operational deficiencies contribute to a high crash rate at this interchange. The crash rate on I-84 is 4.5 crashes per million daily vehicle miles traveled (DVMT), which is substantially higher than the average State crash rate for all roads of 3.5 crashes per million DVMT (refer to Section 3.3).

3.2.1 Structural Deficiencies

Sixty-two bridges[2] in the PEL Study Area are identified as being pertinent to the existing (and future) needs of I-84, Route 8, or the Project's constructability. These bridges have a combined deck area of over 1,000,000 square feet. Most of the studied bridges carry I-84 and Route 8 mainlines or ramps; others are overpasses which carry local roads over the highways. Many of the bridges were built in the 1960s as part of the original interchange construction.

[2] The sixty-two bridges include eight culverts.

Bridge inspection reports, load ratings, and record plans for the 62 studied bridges were reviewed to assess their existing structural conditions. The deficiencies in the bridges' existing and future structural conditions were then identified through a series of evaluations of the physical condition, load carrying capacity, functional adequacy, sufficiency, fracture critical bridges and fatigue cracking, and pile corrosion (where applicable). Section 3.2.1 identifies major structural findings.

Four large mainline structures (two on I-84 and two on Route 8) account for about 50 percent of the 62 studied bridges when measured by deck area (over 500,000 square feet). Because of their relative size, the structural conditions of these four bridges strongly influence overall observations about the studied bridges.

Current (2020) Structural Evaluation

Physical condition (condition rating)

CTDOT continually assesses the physical condition of the state- owned bridge inventory by performing inspections in accordance with Federal Highway Administration (FHWA) National Bridge Inspection Standards (NBIS). Condition ratings are assigned during regular inspections to track each components' physical deterioration over time using a scale from 9 (excellent) to 0 (failed). For a typical bridge, there are three major components that are assigned condition ratings: deck, superstructure, and substructure. The lowest of the three component ratings determines the overall condition rating of the bridge. Three ranges of NBIS condition ratings are defined that broadly classify a bridge (and its components) as being in good, fair, or poor condition.

Classifying a bridge as structurally deficient does not mean the bridge is unsafe, but that deficiencies require maintenance, rehabilitation, or replacement

A bridge that is in poor condition is also considered "structurally deficient." Thus, if any major component is classified as being in poor condition, the overall bridge will be considered structurally deficient. Over 60 percent of the studied bridges (weighted by total deck area) are in overall poor condition and are therefore structurally deficient (about 700,000 square feet). [3] The poor condition of the decks on the stacked I-84 mainline bridges is a notable deficiency: deterioration of the upper bridge decks' concrete is an ongoing maintenance issue and potential safety concern.

[3] Project Numbers 151-312, 151-313, and 151-326, which are currently ongoing at this writing, will replace or rehabilitate bridge decks of the four large mainline structures in the PEL Study Area to extend their service life by approximately 25 years.

Functional adequacy (appraisal rating)

CTDOT uses appraisal ratings defined by the NBIS to establish a bridge's relative level of service by comparing details of its construction to current standards for new construction. The functionality of a bridge is appraised via the following: traffic safety features, structural evaluation, deck geometry, under clearance, bridge posting, waterway adequacy, and approach roadway alignment. Functionally obsolete bridges in the Mixmaster Interchange are defined as those bridges that do not have adequate lane widths, shoulder widths, or vertical clearances. Over 40 percent of the studied bridges (weighted by total deck area) qualify as deficient due to their functional obsolescence (about 470,000 square feet).

Fracture critical bridges and fatigue cracking

Most steel bridges are designed to be redundant, meaning that the bridge's structural system can carry loads after localized damage or the failure of one or more of its members. Some bridges lack redundancy because one or more of their primary load carrying members are considered "fracture critical." Fracture critical bridges per the NBIS definition are steel bridges with primary members whose individual failure would probably cause a portion of, or the entire bridge, to collapse. Bridges with these types of members must receive special attention during regular inspections because of their fracture critical nature, which can be exacerbated by extreme events such as earthquakes.

Of the project's 62 studied bridges:

- **60% are structurally deficient**
- **Over 40% are functionally obsolete**
- **19% are fracture critical**

When weighted by deck area, about 19 percent of the studied bridges (43 spans with over 220,000 square feet of combined deck area) currently contain members or details that classify them as fracture critical. The existing condition of these fracture critical spans is a notable deficiency among the studied bridges. Many of these spans have also experienced active fatigue-related cracking for decades. CTDOT implements regular rehabilitation projects to stop the propagation of cracks in fracture critical members. However, it is anticipated that crack formation and propagation will continue at many of the studied bridges until their complete replacement.

Future (2045 No Build) Structural Evaluation

Structural conditions have been forecasted for the year 2045 and analyzed to identify future needs and deficiencies in the PEL Study Area. The results of these forecasts present a future "No Build" scenario for the Mixmaster Reconstruction Project. The ongoing projects to achieve a "state of good repair" (SOGR) by replacing the bridge decks on Route 8 and rehabilitating the bridge decks on other bridges within the I-84/Route 8 Interchange are examples of improvements that are included in the No-Build Alternative.

CTDOT administers a series of preventative rehabilitation projects to maintain its bridges in a SOGR throughout their life. Weighted by deck area, more than 60 percent of the studied bridges are scheduled for rehabilitation before the year 2045. Given the age of the bridges and trends described in Section 3.2.1, however, CTDOT concludes that programmed SOGR rehabilitation projects will only be effective at

maintaining the PEL Study Area bridges in an overall fair condition through 2045. Three additional concerns apply in the 2045 No Build scenario:

- It is expected that all the original concrete decks on the I-84 mainline will be in fair/poor condition and will need replacement. Currently (2020), bridge decks on Route 8 mainline structures are being replaced. Unlike the Route 8 mainline structures, bridge decks on I-84 mainline structures cannot feasibly be replaced due to lack of a suitable detour route off the interstate and onto local roads. Programmed rehabilitation (deck patching) of I-84 mainline structures will only be effective at maintaining these decks in a fair/poor condition; as previously cited, a bridge that is rated in poor condition is considered to be structurally deficient Further, results of a 2015 sampling of bridge decks indicate that acceptable chloride (salt) concentrations are exceeded at about half of the sampled locations, indicating that deterioration of the I-84 bridge decks is anticipated to accelerate through 2045.
- Mainline structures will remain stacked, contributing to increased maintenance requirements and costs, as well as safety concerns.
- Non-redundant, fracture critical spans will remain on the Route 8 and I-84 mainline bridges. These fracture critical spans have fatigue prone connections that continue to crack and deteriorate.

In summary, in the 2045 No Build scenario, most of the concrete decks on I-84, as well as steel members and the substructures, will be 80 years old and past their originally intended design life of 50-years. To maintain these bridges in SOGR, the demand for preservation or rehabilitation projects will become increasingly more frequent. However, these preservation/rehabilitation efforts will become less effective and more costly as the bridges continue to age; these projects will not improve the studied bridge's functional adequacy or eliminate fatigue prone connections. Therefore, existing structural and functional deficiencies and fracture critical spans would remain unchanged under the 2045 No-Build scenario.

3.2.2 Geometric Deficiencies

The original Mixmaster Interchange, which opened to traffic in 1968, was designed in accordance with guidance and standards in effect at the time. An assessment of the interchange relative to controlling design criteria and operational factors, as established in CTDOT's *Highway Design Manual* (2003 Edition including revisions to February 2013) and AASHTO's guidance, A *Policy on Geometric Design of Highways and Streets* (7th Edition, 2018), indicates that geometric deficiencies exist throughout the interchange, including the mainlines, system ramps, and service ramps.

I-84 and Route 8 Mainline Geometric Deficiencies

I-84 is classified as Urban Interstate Principal arterial; Route 8 is classified as Urban Expressway Principal Arterial. Due to the presence of heavy truck volumes through the I-84 corridor and on a segment of Route 8 north of the interchange, additional criteria apply. Geometric deficiencies on I-84 and Route 8 include, but are not limited to the following indices, which impact rideability and safety:

CTDOT's Highway Design Manual and AASHTO's policies were used to evaluate geometric deficiencies

Insufficient Speeds and Deficient Horizontal Curves.

The current CTDOT standard for a roadway classified as an Urban Freeway in a Suburban/Intermediate type area requires a 65-70 mile-per-hour (mph) design speed. The current CTDOT standard for a roadway classified as an Urban Expressway Principal Arterial (Urban Freeway) requires a 50-55 mph design speed through the core of the Mixmaster. Posted speeds generally are lower than design speeds by approximately 5-10 mph. The posted speed limits for I-84 vary between 45 mph and 50 mph through the PEL Study Area based on the horizontal alignment. I-84 through the PEL Study Area has three existing deficient horizontal curves, where the existing radii do not meet the required minimum for the design speed, resulting in reduced speeds.

Substandard Shoulder Widths

The design criteria for I-84 and Route 8 require lane widths to be 12 feet wide, with a right shoulder width of 10 feet and a left shoulder width of 8 feet. Due to the heavy truck volumes through the I-84 corridor and along a segment of Route 8 north of the interchange, both the left and right shoulders on both mainlines require 12-foot shoulders to meet design standards. All existing through lanes and auxiliary lanes through the corridor meet the minimum design standard of 12-foot widths. The shoulder widths, however, are substandard in all locations through the I-84 corridor and the Route 8 corridor. Further, on Route 8, the structures are stacked due to site constraints with the steep topography and historic cemetery on the west and the Naugatuck River to the east, resulting in shoulders (left and right) less than 4 feet wide.

Inadequate Stopping Sight Distance

CTDOT's Highway Design Manual has established a minimum stopping sight distance (SSD) for roadways. There are seven vertical curves on I-84 Eastbound and nine vertical curves on I-84 Westbound that do not meet the minimum SSD standard. There is one vertical curve on Route 8 Northbound and one vertical curve on Route 8 Southbound that do not meet the minimum SSD standard.

Minimum Stopping Sight Distance (SSD) is the sum of the distance traveled during a driver's brake reaction and the distance traveled while decelerating to a complete stop

System Ramp Geometric Deficiencies

A system ramp is a roadway that connects one limited access highway to another. The system ramps within the Mixmaster include Exit 19 and Exit 20 along on I-84 and Exit 31 and Exit 33 along Route 8. Existing geometric deficiencies of the system ramps include but are not limited to inadequate design speeds, which are a function of the mainline design speeds; insufficient travel lane and shoulder width; deficient SSD; and insufficient vertical grade to provide proper drainage of the roadway.

System ramps connect one limited access highway to another

Service Ramp Geometric Deficiencies

A service ramp is a ramp that has a terminus on the limited access highway and another terminus at a local roadway network. Service ramps within the Mixmaster consist of I-84 Exits 17, 18, 21, 22 and 23; and Route 8 Exits 30, 32, 34 and 35. Existing geometric deficiencies of the service ramps include but are not limited to insufficient travel lane and shoulder width; deficient SSD; insufficient vertical grade; inadequate intersection sight distance (ISD); and insufficient acceleration and deceleration lane lengths.

Service ramps connect the local roadway network to a limited access highway

3.2.3 Operational Deficiencies

The Mixmaster Interchange and surrounding Waterbury street network function as a highly complex transportation system. I-84 and Route 8 serve as the primary regional transportation access. The following sections identify the major operational deficiencies on I-84 and Route 8.

Left-Hand Exits and Entrances and Inadequate Merging

According to the CTDOT Highway Design Manual, it is desirable to avoid left-hand exits and entrances to the freeway. Left-hand exits and entrances become a safety issue as drivers attempt to merge from or exit to a low-speed ramp onto or off the high-speed lane of a freeway.

I-84 has two left-hand ramps in the eastbound direction and three left-hand ramps in the westbound direction. Route 8 has four left-hand ramps in the northbound direction and four left-hand ramps in the southbound direction. The location of these ramps in conjunction with other ramps creates complicated, confusing, and potentially unsafe maneuvers. For example, some of the movements required to travel from an on-ramp to an off-ramp require traveling across two and three through lanes and entering merging traffic within relatively short distances.

Inadequate Interchange Spacing

Interchange spacing is defined as the distance measured between the respective centerlines of freeway cross streets that include ramps to or from that freeway. The National Cooperative Highway Research Program (NCHRP) Report 687 *"Guidelines for Ramp and Interchange Spacing"* indicates that interstate highway planning has historically provided a one-mile spacing recommendation for urban areas. AASHTO suggests that in urban areas, alternatives should be developed to address spacing of less than one mile.

There are four major components of interchange spacing:

- **traffic operations**
- **signing**
- **safety**
- **geometric design**

The Mixmaster Interchange is a full system interchange with eight system ramps and 32 service ramps within the PEL Study Area, all located within close proximity to each other, providing access to greater Waterbury. Eight ramps on I-84 Eastbound and six ramps on I-84 Westbound do not meet the spacing guideline. Five ramps on Route 8 northbound and six ramps on Route 8 southbound do not meet the spacing guideline. Inadequate interchange spacing adversely impacts traffic operations and safety.

Freeway Level of Service and Recurrent Congestion

Congestion is reported as a primary contributing factor in a substantial number of crashes in the PEL Study Area. Congestion may be defined as the travel time or delay in excess of that which normally occurs under light or free-flow travel conditions. FHWA defines recurrent congestion as congestion that occurs when demand increases beyond the available capacity. It is usually associated with the weekday morning (AM) and afternoon (PM) peak hour work commutes, when demand reaches such a level that the freeway is overwhelmed, and traffic flow deteriorates to unstable stop-and-go conditions.

Congestion is measured and tracked through a Level of Service (LOS) mobility measure. LOS is a qualitative measure of driver satisfaction factoring speed, travel time, traffic interruption, freedom of maneuverability, safety, driving comfort and convenience, and delay. LOS is measured using the letters A through F, with A being the best or optimal condition and F being the worst condition. LOS E, unstable flow conditions, and LOS F, forced or breakdown traffic flow, are typically considered deficient traffic operations.

A	**Free Flow Traffic** No Delays
B	**Light/Moderate Traffic** No Delays
C	**Steady Traffic** Minimal Delays
D	**Speeds Begin to Decline** Minimal Delays
E	**Traffic at Capacity** Significant Delays
F	**Heaviest Congestion** Forced Flow

Existing (Year 2017) Analysis

Traffic analyses performed for the Mixmaster Interchange mainline segments identified two locations on I-84 as operationally deficient under AM and/or PM peak hour conditions.

Traffic analyses performed for the Mixmaster Interchange in the PEL Study Area weave, merge and diverge segments, and system ramps to/from one highway to another highway identified three system ramps on I-84 as operationally deficient under AM and/or PM peak hour conditions. Under Existing Conditions, no facilities along Route 8 within the PEL Study Area were identified as operationally deficient.

Future (Year 2045) Analysis

Year 2045 traffic analyses performed for the Mixmaster Interchange mainline segments identified two locations on I-84 and one location on Route 8 as operationally deficient under AM and/or PM peak hour conditions.[4]

Traffic analyses performed for the Mixmaster Interchange PEL Study Area weave, merge and diverge segments, and system ramps to/from one highway to another highway identified multiple locations on I-84 and Route 8 as operationally deficient under AM and/or PM peak hour conditions. Figures 3-1 through 3-4 illustrate the anticipated future LOS along these interchange segments.

[4] Year 2045 analysis includes the completion of Project #151-273 which entails the widening of I-84 to three lanes in each direction from the eastern limit of the Mixmaster Project heading easterly.

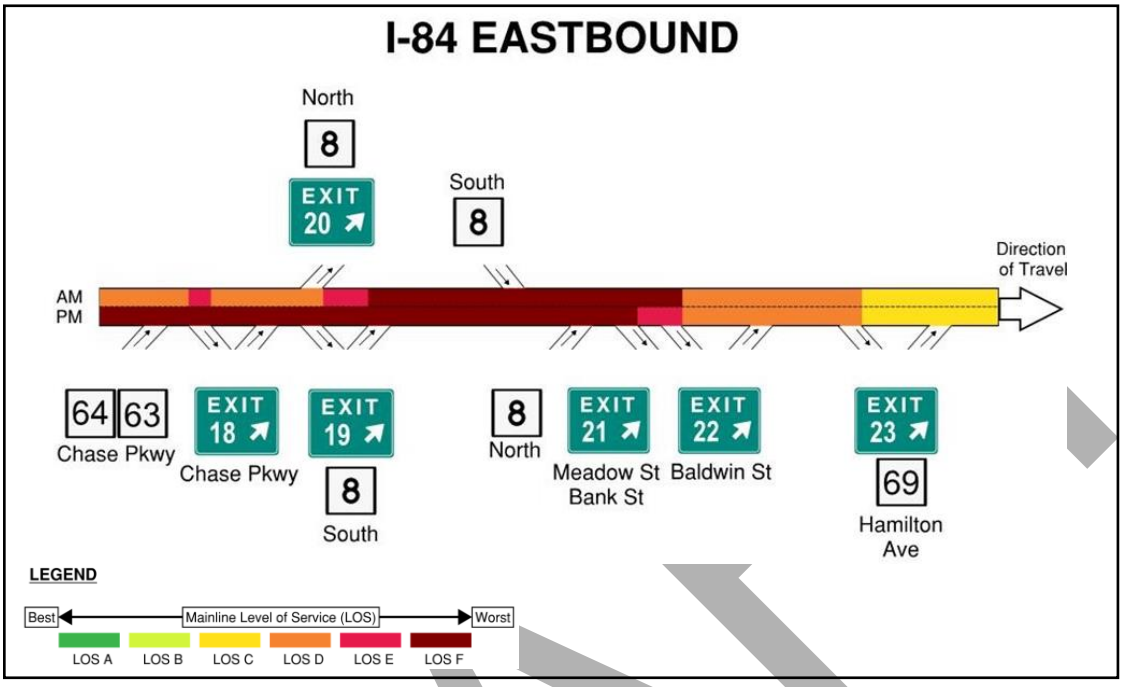


Figure 3-1. I-84 Eastbound Year 2045 Levels of Service, AM and PM Peak Hours, No-Build

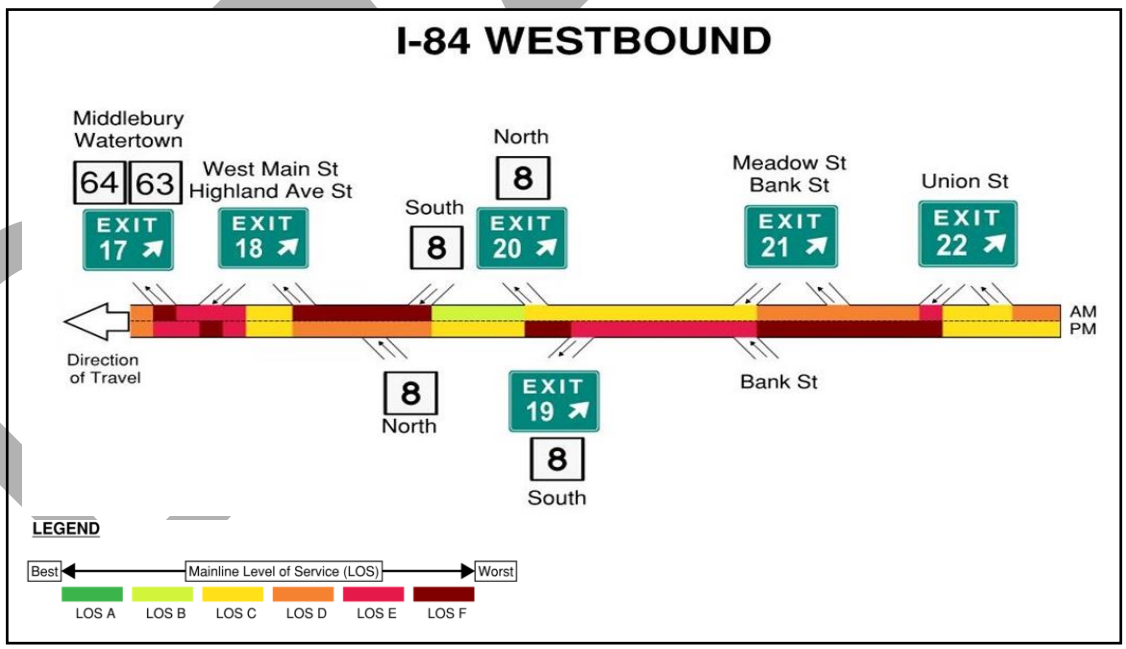


Figure 3-2. I-84 Westbound Year 2045 Levels of Service, AM and PM Peak Hours, No-Build

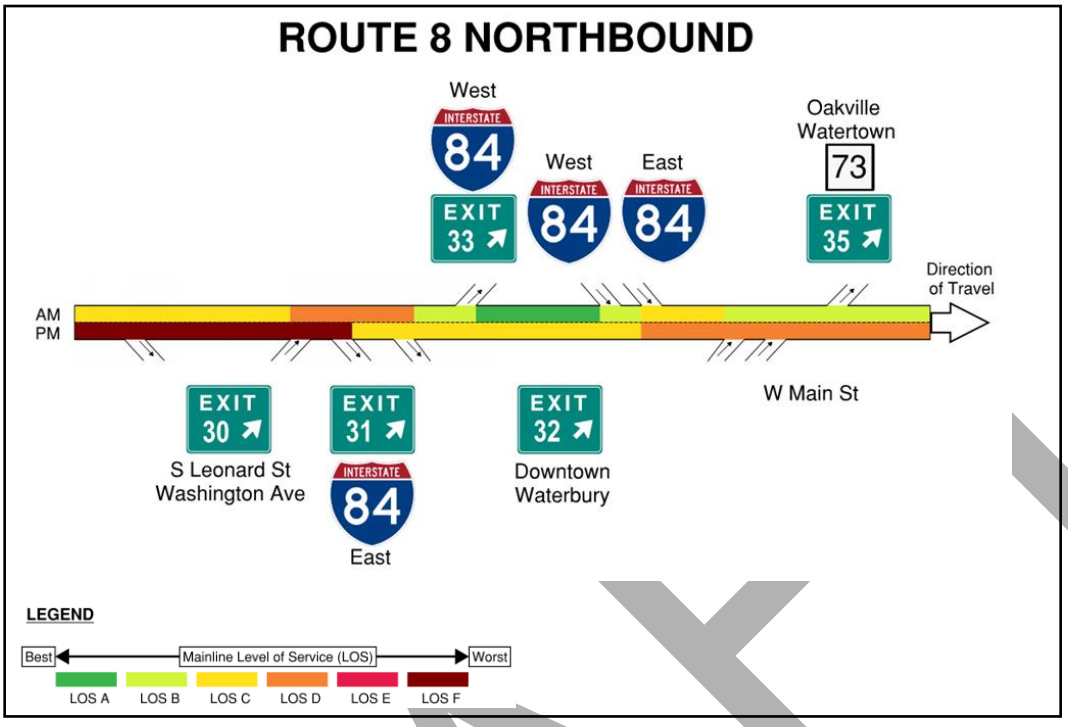


Figure 3-3. Route 8 Northbound Year 2045 Levels of Service, AM and PM Peak Hours, No-Build

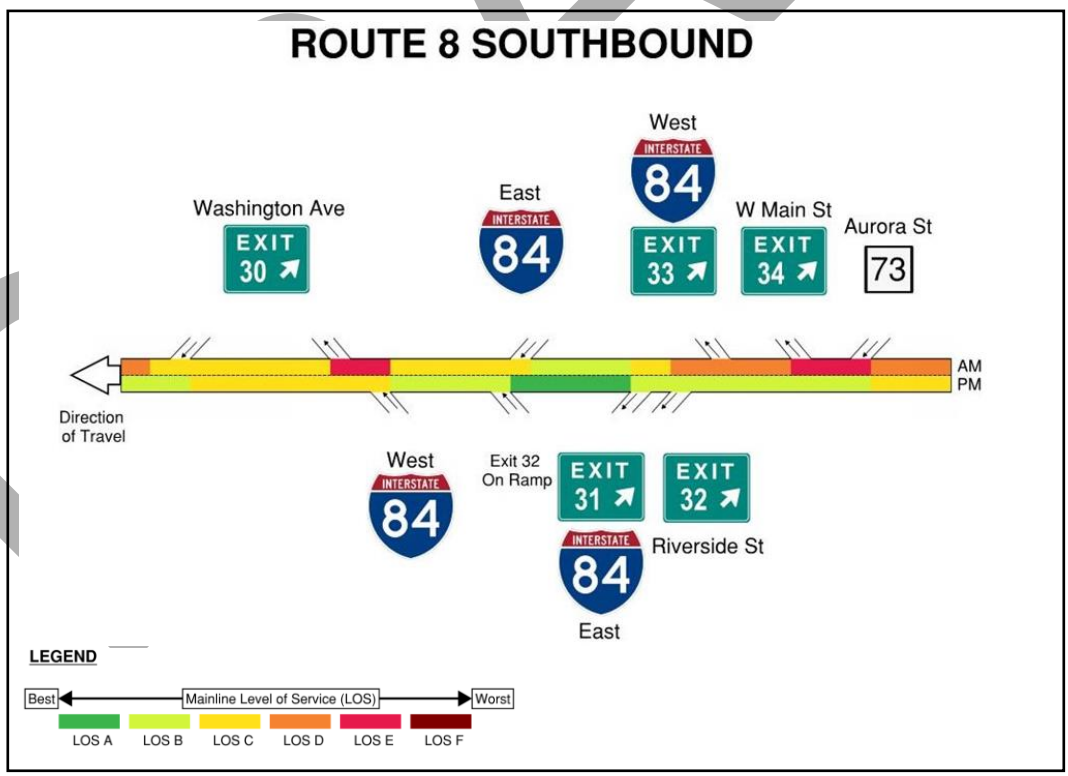


Figure 3-4. Route 8 Southbound Year 2045 Levels of Service, AM and PM Peak Hours, No-Build

Operationally Deficient Intersections with Local Roadways

The local roadway network in the PEL Study Area includes all nearby roads that are critical to travel in downtown Waterbury (defined as arterials). The City of Waterbury does not have an extensive roadway network near the core of the interchange, which limits options for detours from the mainlines. Starting north and moving south, Waterbury has four local street crossings of the Naugatuck River: West Main Street, Freight Street, Bank Street, and Washington Avenue. There are two major local north-south roadways through Waterbury on both the east and west sides of the Naugatuck River: Baldwin Street and South Main Street to the east of the river, and Riverside Street and Highland Avenue to the west of the river. Charles Street/South Leonard Street, Riverside Street, and Watertown Avenue are the local streets that run along and under the Route 8 viaduct through the PEL Study Area.

Sixty intersections were analyzed which represent the PEL Study Area street network. In Existing Conditions (year 2017), during the AM and Saturday midday peak hours, all intersections are estimated to operate at acceptable LOS (defined as LOS A through LOS D). Eight intersections (approximately 13 percent) are estimated to operate at unacceptable LOS E or LOS F during the PM peak hour and are considered operationally deficient. In the 2045 No-Build scenario, during the Saturday midday peak hour, all intersections analyzed are estimated to operate at acceptable LOS. During the AM peak hour and PM peak hour, respectively, six intersections (10 percent) and 16 intersections (approximately 27 percent) are estimated to operate at unacceptable LOS and are considered operationally deficient. Figure 3-5 and Figure 3-6 show anticipated intersection operations for the AM and PM peak hours in the 2045 No Build scenario.

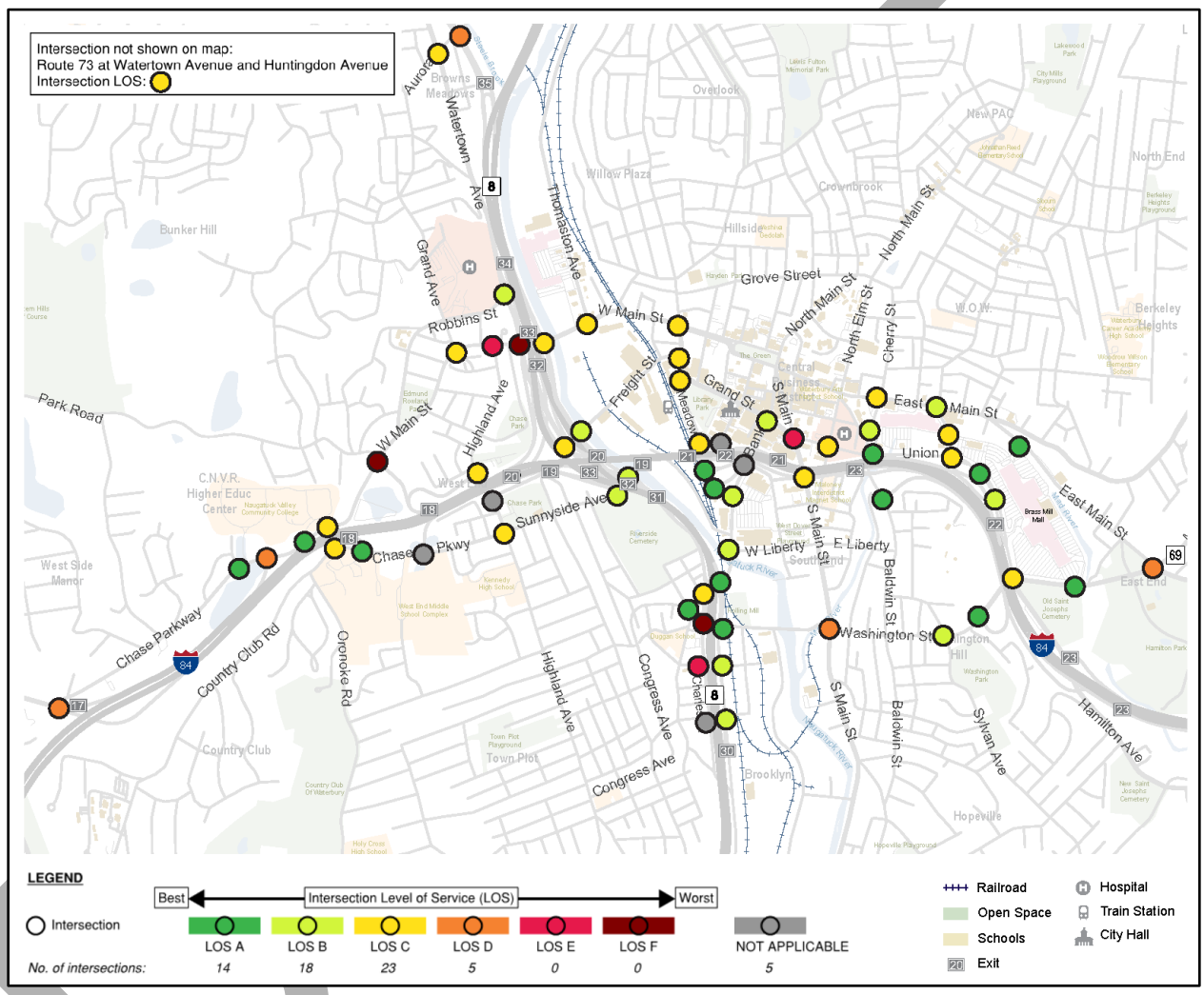


Figure 3-5. Intersection Operations Year 2045 Levels of Service, AM Peak Hour, No-Build

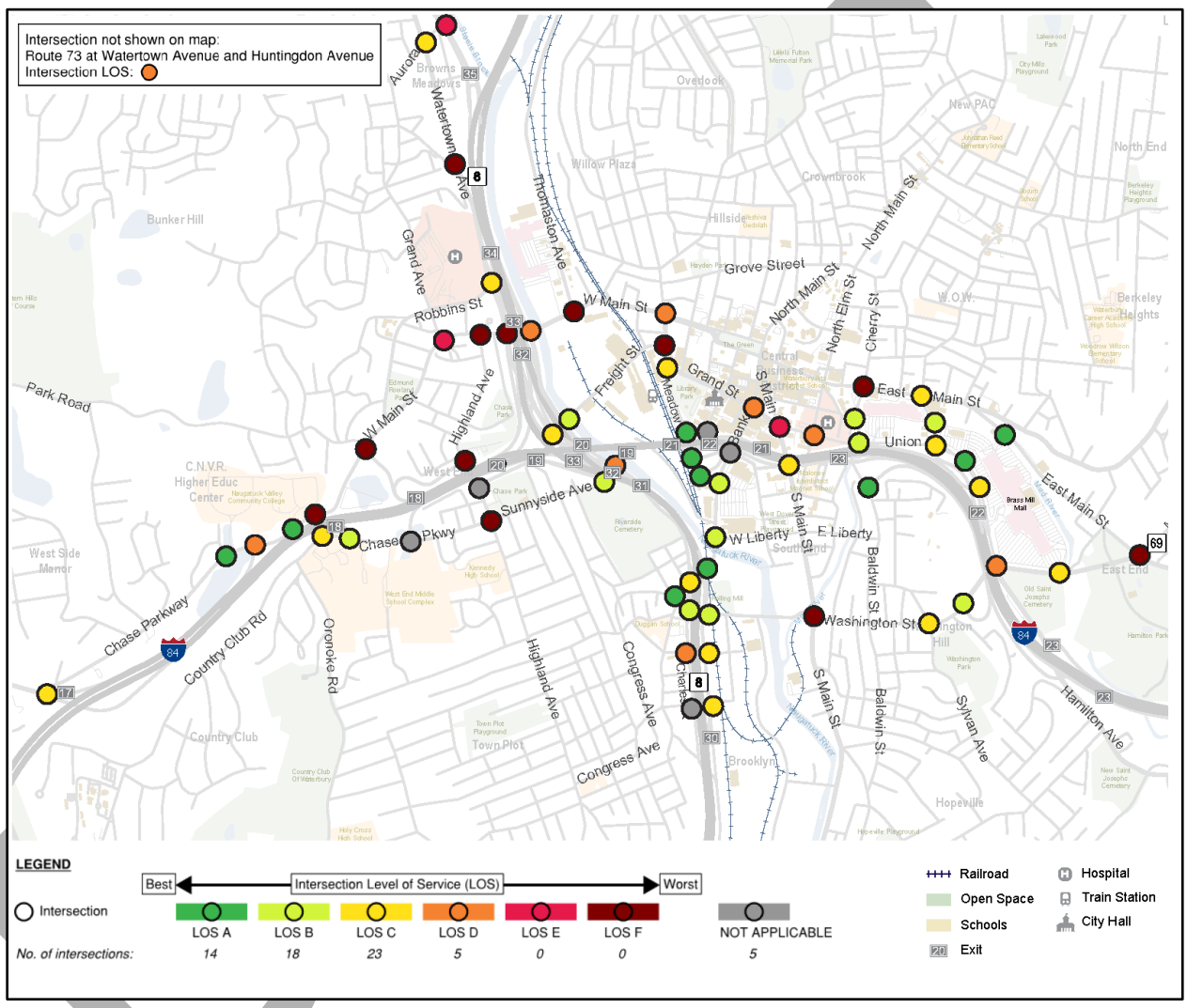


Figure 3-6. Intersection Operations Year 2045 Levels of Service, PM Peak Hour, No-Build

3.3 HIGH CRASH RATES

According to the Connecticut Crash Data Repository (CTCDR), a total of 1,365 crashes along I-84 and Route 8 were reported in the PEL Study Area from January 1, 2015 to December 31, 2017, averaging one crash per day in the three-year study period. A total of 861 crashes (63 percent) occurred on I-84, 189 crashes (14 percent) occurred on Route 8, and 315 crashes (23 percent) occurred on interchange ramps. [5]

The crash rate on Interstate 84 is 4.5 crashes per million daily vehicles miles traveled (DVMT), which is substantially higher than the average statewide crash rate for all roads of 3.5 crashes per million DVMT. This is significant since crash rates for freeways are typically expected to be lower than the average rate for all roads.

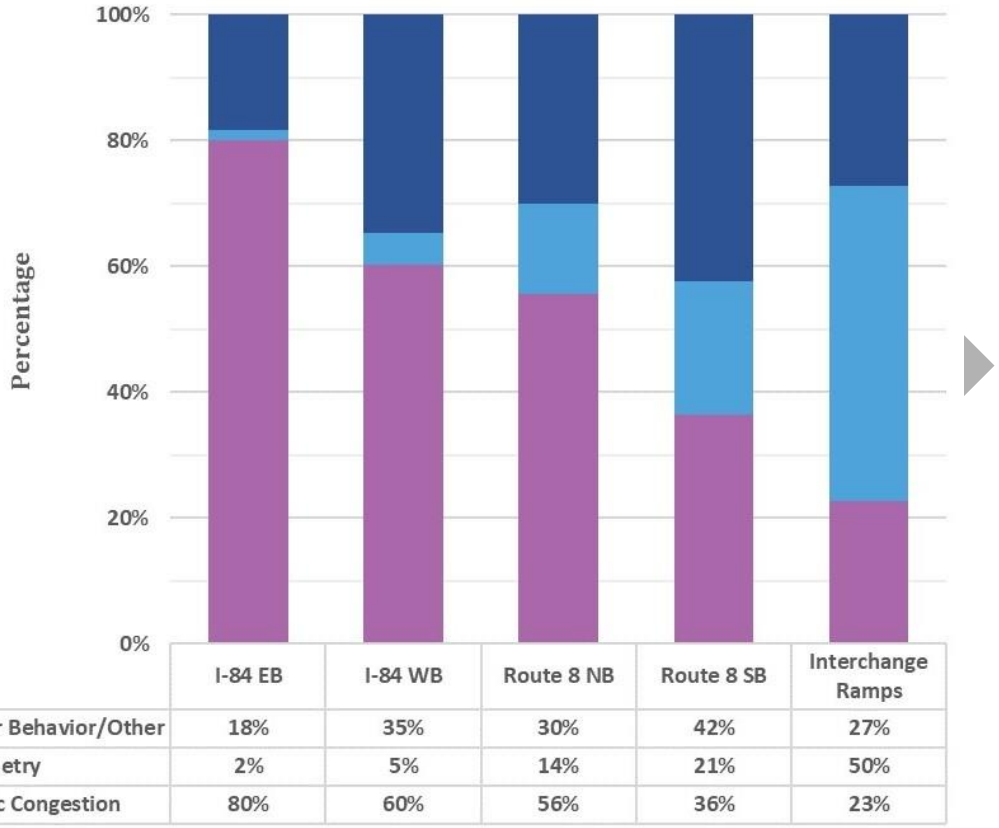
The high crash rate contributes to non-recurring traffic delays on I-84 in the PEL Study Area. The frequency of crashes on Route 8 was computed to be 3.0 crashes per million DVMT.

Incident reports from the crash data set indicates the following, illustrated in Figure 3-7:

- The primary contributing factors to crashes on I-84 Eastbound were road geometry (2 percent), traffic congestion (80 percent), and driver behavior and other factors (18 percent). Congestion was generally attributed to the steep grades at the interchange approach and queuing conditions east of the interchange. Geometry and driving behavior related crashes were observed more frequently near the core of the Mixmaster interchange where service ramps are closely spaced.
- The primary contributing factors to crashes on I-84 Westbound are road geometry (5 percent), traffic congestion (60 percent), and driver behavior and other factors (35 percent). Congestion appeared to be influenced by the presence of a work-zone during the analyzed period. Geometry and driver behavior related crashes became more prevalent as travel speeds increased through and after the interchange.
- The primary contributing factors to crashes on Route 8 southbound were congestion (56 percent), geometry (14 percent) and driver behavior (30 percent). Geometry and driver behavior influenced crashes were generally explained by observed merging and diverging traffic, lane drops, and weaving conditions.
- The primary contributing factors to crashes on Route 8 northbound were congestion (36 percent), geometry (21 percent) and driver behavior (42 percent). Geometry and driver behavior influenced crashes can be attributed to merging and diverging traffic, lane drops, and weaving conditions at higher speeds.

[5] Crash incidents and characteristics from the three-year period appear to capture the effects from ongoing I-84 construction at the eastern limit of the PEL Study Area. About 60 percent of I-84 eastbound crashes were rear-end type collisions, corresponding to congested flow conditions, higher vehicle density, and decreased levels of service associated with construction at the eastern study limit.

- The primary contributing factors to crashes on the Mixmaster interchange ramps were geometry (50 percent) and driver behavior (27 percent) that was generally attributed to the presence of left hand exits and sharp roadway curvature. Congestion related crashes made up the remainder (23 percent).



	I-84 EB	I-84 WB	Route 8 NB	Route 8 SB	Interchange Ramps
Driver Behavior/Other	18%	35%	30%	42%	27%
Geometry	2%	5%	14%	21%	50%
Traffic Congestion	80%	60%	56%	36%	23%

Figure 3-7. Mixmaster Interchange Crash Contributing Factors, 2015-2017

A total of 249 crashes (approximately 18 percent of all crashes) resulted in injury during the study period. A total of five fatalities (less than 1 percent of all crashes) occurred during the study period. Crashes attributed to congestion also typically occur at lower speeds and the high percentage (81 percent) of crashes with no apparent injuries supports this finding. A total of 1,111 crashes resulted in property damage only. Figure 3-8 shows the existing crash density for the I-84 and Route 8 mainlines.

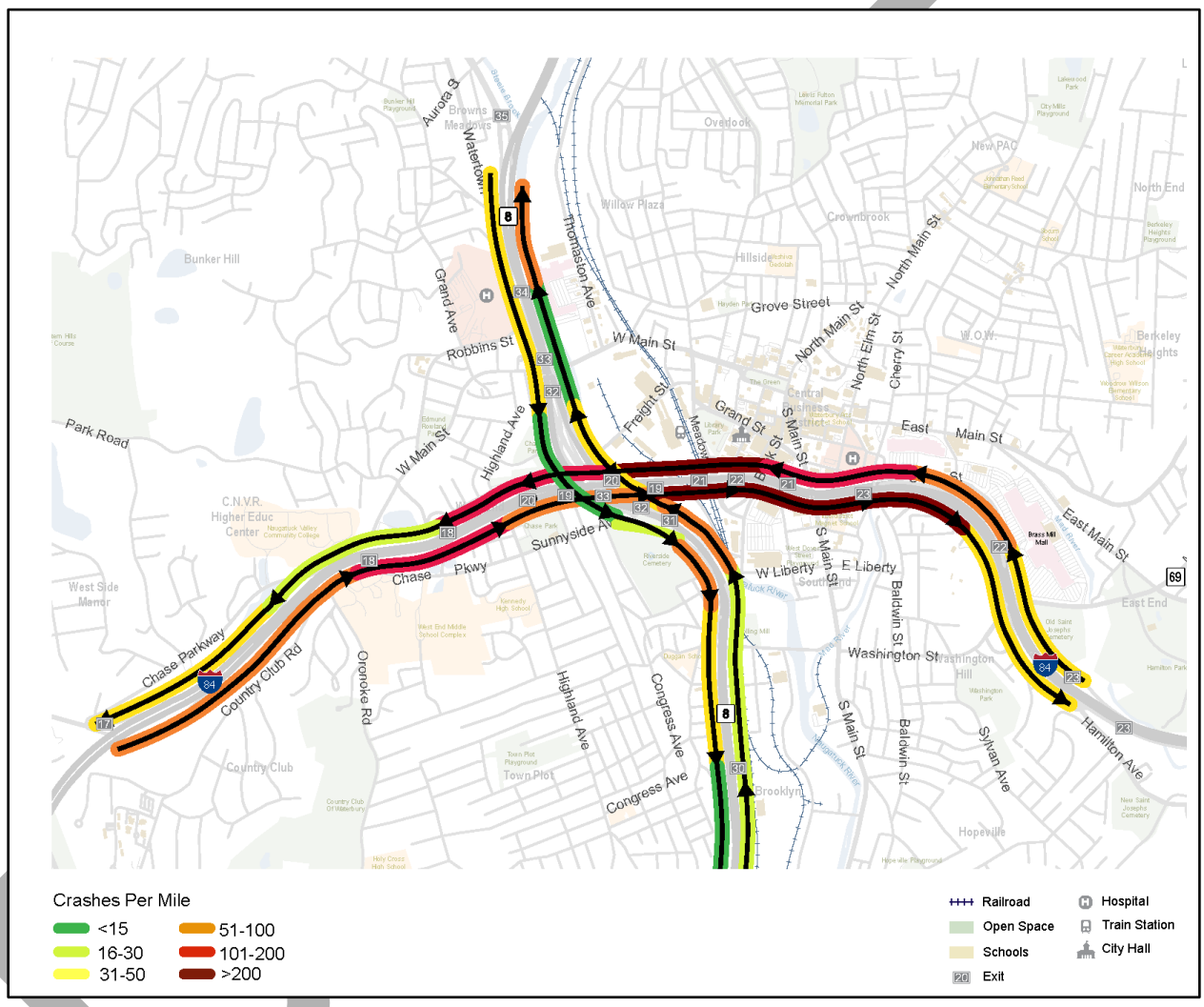


Figure 3-8. I-84 and Route 8 Mainline Crash Density, 2015-2017

3.4 OTHER TRANSPORTATION-RELATED GOALS AND OBJECTIVES

The Mixmaster Reconstruction Preliminary Purpose and Need Statement includes other transportation-related goals and objectives identified through outreach to stakeholders; the Project Advisory Committee (PAC); the general public; regional, state, and federal agencies; and Native nations. These transportation-related goals and objectives identify other outcomes that the Project intends to achieve beyond the transportation issues identified in the Purpose Statement.

The following transportation-related goals and objectives (listed in no particular order) for the Mixmaster Reconstruction Project have been identified by the Project Team and informed by the PEL Study's PAC members and stakeholder/public input. These other goals and objectives focus on transportation improvements and opportunities in the city of Waterbury. Additionally, these other transportation-related goals and objectives will continue to be refined as community and agency outreach progresses during the PEL Study. Figure 3-9 shows the location of the Mixmaster Interchange relative to key community resources and neighborhoods in Waterbury.

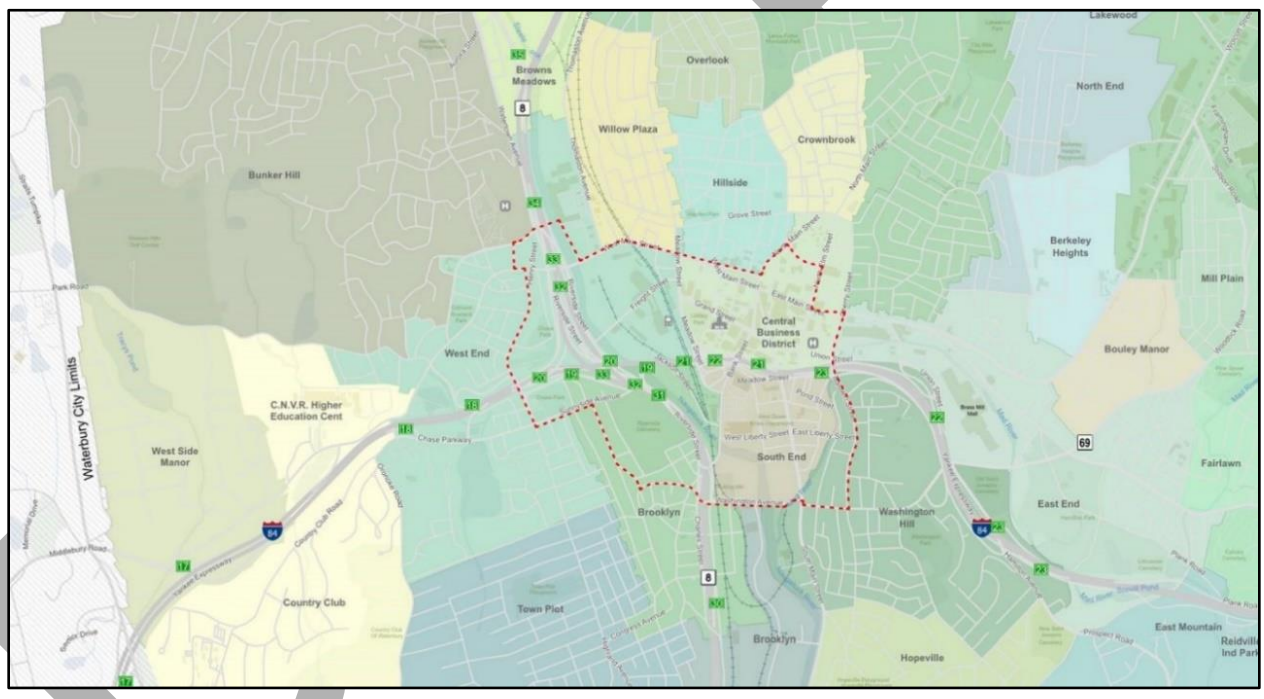


Figure 3-9. Mixmaster Interchange Project Location in the City Setting

3.4.1 Enhance connectivity within Waterbury

The City of Waterbury street network is effectively split into quadrants due to the topography, Naugatuck River, and the alignment of Route 8 in the north-south direction and I-84 in the east-west direction. Few roadways provide local access across these major features, which encourages intracity trip access via I-84 and Route 8 mainlines and the interchange. One of Waterbury's most prominent natural resources is the

Naugatuck River; however, Route 8 currently serves as a barrier between the river and the City, leaving no access to the river's edge on the city's west side.[6] The following presents goals for the Mixmaster Reconstruction Project relative to enhancing connectivity within Waterbury:

- Provide connections to, along, and over the Naugatuck River and the Naugatuck River Greenway.
- Improve the local roadway network associated with the Mixmaster for intra-city trips.
- Enhance mobility equity for bicyclists and pedestrians and improve bicyclist and pedestrian safety.
- Integrate the Project with ongoing City of Waterbury projects, such as the Waterbury Active Transportation and Economic Resurgence (W.A.T.E.R.) Complete Streets Project, including projects associated with the Freight Street Business District.
- Improve access to downtown Waterbury and key destinations.[7]
- Reduce interchange complexity.

3.4.2 Support Modal Interrelationships

I-84 and Route 8 are important routes to access the bus facilities and railroad station in downtown Waterbury. The bus facilities serve both intercity travel and transit for the greater Waterbury area. At least one bus transit route uses Route 8 in the PEL Study Area. The railroad station serves Metro-North commuter rail. Addressing the deficiencies in the Mixmaster Interchange will provide opportunities to improve equitable access to these intermodal facilities in Waterbury, as stated in the following goal:

- Support opportunities to improve equitable access to intermodal facilities in Waterbury.

3.4.3 Support development opportunities in Waterbury

The underpasses and overpasses that connect downtown Waterbury with surrounding neighborhoods are important gateways to the CBD, as well as to city parks and historic districts. Connections among neighborhoods, the CBD, and the Naugatuck River Greenway will complement on-going downtown revitalization efforts. The following presents goals for the Mixmaster Reconstruction Project relative to supporting development opportunities in Waterbury:

- Strengthen the role of surrounding neighborhoods as gateways to the CBD.
- Support the City of Waterbury's goal of revitalizing the CBD through mixed use development, such as the Freight Street District Redevelopment.

[6] On the city's east side, access to the Naugatuck River is restricted by industrial or former industrial properties.

[7] Key destinations identified by the Program Team in the *Analysis Needs and Deficiencies Report* and informed by public involvement are further outlined in the PEL Study's *Context Sensitive Features Report*.

3.4.4 Avoid, Minimize, or Mitigate Potential Project Consequences to the Human and Natural Environment, Including Historic and Archaeological Resources, to the Extent Practicable

The PEL Study Area takes place within the city of Waterbury which is an historically underserved and Environmental Justice (EJ) community.[8] Additionally, the city of Waterbury is host to various natural resources including watercourses, wetlands, and protected species, as well as an abundance of historical resources. As the Mixmaster Interchange traverses, provides access to, and directly and indirectly affects many of these sensitive populations and resources, is it important that the Mixmaster Reconstruction Project considers potential Project outcomes outside of the transportation realm. The Mixmaster Reconstruction must consider and examine the needs and any impacts to this community and resources as well as ensure that no disproportionate adverse impacts to Environmental Justice populations occur. The following presents a goal of the Mixmaster Reconstruction Project relative to the human and natural environment in Waterbury:

- Avoid, minimize, or mitigate potential Project consequences to the human and natural environment, including historic and archaeological resources, to the extent practicable.

[8] Demographic data provided by the US Census Bureau American Community Survey indicate that the city of Waterbury is considered an "Environmental Justice" community due to the racial composition and low-income populations. Additionally, according to the Connecticut Department of Economic and Community Development (DECD), the city of Waterbury is on the Connecticut Distressed Municipalities List. The list is determined annually based on indicators that measure the fiscal capacity of each municipality based on its tax base. As both the EJ findings and Distressed Municipalities list indicate, the needs of the local community will be an important consideration in the development of highway alternative. Environmental Justice communities and demographic information are presented in the PEL Study's *Analysis Needs and Deficiencies Report.*