Interstate 84/Route 8 Interchange

Appendix E-1: Alternatives Screening Methodology

JULY 2025

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Connecticut Department of Transportation

Prepared by:

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The Connecticut Department of Transportation may adopt or incorporate Planning Products from this PEL Study into a federal or state environmental review process, pursuant to Title 23 U.S.C. § 168(d)(4).

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Report Version	Report Revision	Section Revision	Date	Description
1.0	--	--	November 2020	Initial draft release.
2.0	1	1.3; 4	April 2021	Refinement of the Preliminary purpose and Need Statement and evaluation criteria assumptions.
3.0	--	1.3; 1.4; 1.5; 3; 4	November 2024	Refinement of the Preliminary Purpose and Need Statement and evaluation criteria.
	--	--	July 2025	Report finalization.

1 Introduction

1.1 PLANNING CONTEXT

The Connecticut Department of Transportation (CTDOT) has initiated a Planning and Environmental Linkages (PEL) Study of the Interstate 84 (I-84)/State Route 8 (Route 8) Interchange, known as the "Mixmaster", in Waterbury. CTDOT desires to establish a vision, or master plan, for the interchange that addresses and balances the regional importance of the Mixmaster for commuter traffic and motor freight users, while also improving multi-modal services, local connections, and livability within the city of Waterbury to enhance and support social and economic vitality. The overarching goal of the PEL Study is to develop a clear and supported plan of action for addressing deficiencies of the Mixmaster.

The PEL Study Team (CTDOT and its consultants), with input from the City of Waterbury, engage stakeholders, the general public, regional, state and federal agencies, and tribal nations, to develop, screen, and evaluate alternatives. These alternatives are evaluated against design, cost, environmental, and community criteria, so that the alternative(s) that best meet the transportation needs of the corridor advance into further development and review under the National Environmental Policy Act (NEPA).

The purpose of this component of the PEL Study, the Alternative Screening Methodology (ASM), is to provide a decision-making tool for evaluating program alternatives in a sequential process, thereby narrowing the "Universe of Alternatives" to the "Range of Reasonable Alternatives." The evaluation methodology assesses alternatives based on the Preliminary Purpose and Need (which consists of structural and geometric condition and traffic operations, including congestion considerations.), local street and arterial mobility, multimodal travel, constructability, transportation-related goals and objectives, and costs. Potential impacts and benefits to the community and to the natural and human environments are also evaluated. Based on this ASM, recommendations of the PEL Study, the Range of Reasonable Alternatives, are advanced to subsequent stages of program development in accordance with planning guidelines established in state and federal law and regulation.

The first steps in the PEL Process are to identify the transportation problems (needs or deficiencies) that exist within the PEL Study Area (illustrated on Figure 1-1), or are forecast to exist in the future, and to develop the PEL Study Preliminary Purpose and Need. Then, the Universe of Alternative transportation concepts are identified, screened, and evaluated based on evaluation criteria that are established in the ASM.

1.2 PROGRAM NEEDS

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

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

The Mixmaster Needs are more thoroughly documented in the *Preliminary Purpose and Need Statement*, and the *Interstate 84/Route 8 "Mixmaster" Interchange Analysis, Needs and Deficiencies Report*.

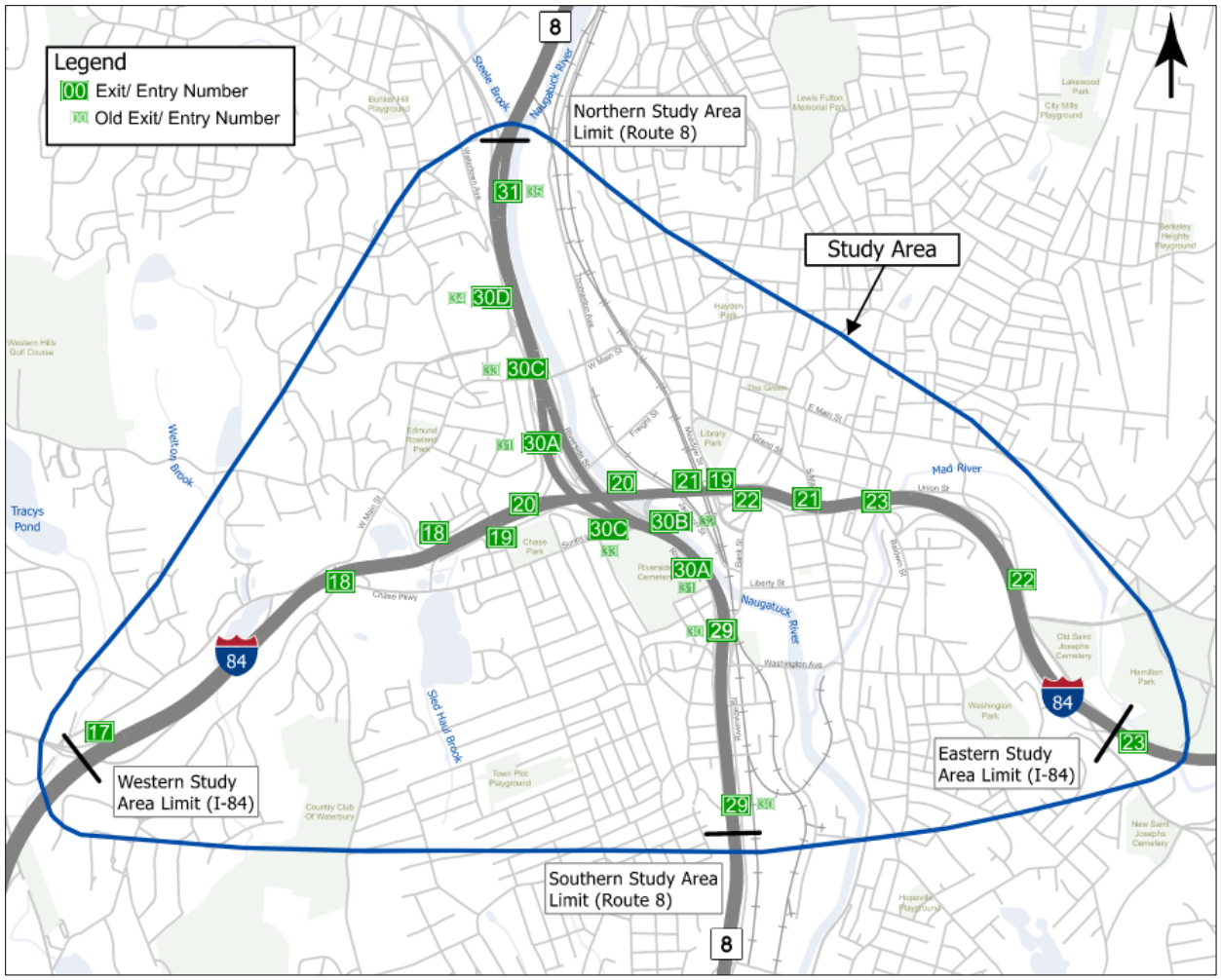

Figure 1-1 PEL Study Area

1.3 PRELIMINARY PURPOSE AND NEED STATEMENT

A Preliminary Purpose and Need Statement has been developed and is described below. This statement is the fundamental reason why the program is proposed.

The purpose of the I-84 / Route 8 Reconstruction Planning and Environmental Linkages Study is to correct the existing structural, geometric and operational deficiencies of the I-84 and Route 8 interchange to meet current and future traffic needs and enhance mobility within the associated transportation system.

These improvements are expected to **improve system performance**, improve air quality by **reducing congestion**, **reduce the crash rate**, **maintain critical system linkages** in Connecticut and the Northeast, and **facilitate connectivity and mobility** within Waterbury through the local road and multimodal network, thereby contributing to the economic vitality of the Greater Waterbury area.

1.3.1 Additional breakdown

- **Improve system performance** and **reduce congestion** thereby improving air quality by improving travel speeds and travel time through Waterbury by providing adequate capacity based on current traffic and future traffic forecasts on the mainlines, system ramps and service ramps;
- **Reduce crash rate** within and across the I-84 / Route 8 Interchange by eliminating and/or improving substandard structural, geometric, and operational design features to reduce the potential crash severity rate;
- **Maintain critical system linkages** in Connecticut and the Northeast by providing system ramp connections directly between I-84 and Route 8 for high-volume movements and indirectly for lower volume movements; and
- **Facilitate connectivity and mobility** through the local road and multimodal network, prioritizing the people of Waterbury by incorporating new or enhanced pedestrian and bicycle facilities to improve intermodal connections and facilities; incorporating resilient, green infrastructure; and incorporating safety countermeasures[1] to high crash / high traveled locations.

1.4 OTHER TRANSPORTATION-RELATED GOALS AND OBJECTIVES

The PEL Study Team identifies other transportation-related goals and objectives through outreach to stakeholders, the Project Advisory Committee (PAC), the general public, regional, state and federal agencies, and tribal nations. While these are not the primary purpose of the program and therefore, alone, are not reasons to advance or dismiss an alternative in the screening phase; achieving any of these other goals and objectives are a desirable outcome of the New Mix Program. These other transportation-related

[1] Safety countermeasures include incorporating new or improved crosswalks, warning signs, pedestrian crossing signals, and/or lighting, and more where feasible. Federal Highway Administration's (FHWA's) *Proven Safety Countermeasures* webpage provides a comprehensive list of strategies, https://highways.dot.gov/safety/proven-safety-countermeasures.

goals and objectives are considered as the alternatives are evaluated and are included at the forefront of the analysis for evaluation Levels 2 and 3.

Other transportation-related goals and objectives for the PEL Study (listed in no particular order) include:

- Enhance connectivity and mobility within Waterbury for motorized and non-motorized travel;
- Enhance modal interrelationships including non-motorized travel;
- Support economic development and revitalization opportunities within Waterbury;
- Improve or maintain the safety of all transportation users; and
- Avoid, minimize, or mitigate potential impacts to the human and natural environment, including historic and archaeological resources, to the extent practicable.

1.5 OTHER GUIDING PRINCIPLES

CTDOT's project development process supports a systematic decision-making process, where solutions to a transportation problem reflect technical and non-technical factors, in the approach to transportation decision-making and design. The following guiding principles helped influence the project but are not specifically transportation related goals and objectives. This means that Alternatives are not necessarily scored on the following principles but they are used to help navigate the overall project to a successful completion. Additional guidance for the PEL Study can be found within the *PEL Process Framework and Methodology* report:

- Accelerate Program Delivery;
- Maximize practicality in terms of cost and feasibility;
- Provide Context Sensitive Design/Solutions/aesthetically pleasing facility;
- Minimize the real, perceived, and visual barrier of the freeway;
- Integrate with the community and preserve environmental, scenic, aesthetic, historic, and natural resource values in the area;
- Incorporate design and construction provisions to minimize community disruption;
- Coordinate with local, state, tribal, and federal agencies, as applicable;
- Provide an open public participation process with early communication and coordination;
- Support Local, Regional, and Statewide Transportation Plans; and
- Develop a project(s) that is perceived as an enduring community enhancement;

2 Alternative Screening Framework

The PEL Study Team established a framework for this ASM to ensure that each alternative is evaluated and screened in a consistent and unbiased manner. Alternatives include both "Build" and "No-Build" alternatives. The Build alternatives are those alternatives which would include changes and improvements to the transportation system in the PEL Study Area beyond what would be expected for normal operation and maintenance activities. The No-Build Alternative represents a baseline condition where only normal operation and maintenance activities would occur. Typically, it describes the future transportation network with no improvements except those that are already programmed in the Statewide Transportation Improvement Plan (STIP), most recently updated for 2025-2028. Examples of STIP projects that are included in the No-Build Alternative are:

- State Project No. 151-273 – The (2018) widening project of I-84 to the east of the I-84/Route 8 Interchange;
- State Project Nos. 151-312, 151-313, and 151-326 – The recently completed (2024) projects to replace the bridge decks on Route 8 and rehabilitate the bridge decks on other bridges within the Mixmaster;
- State Project No. 151-340 – The ongoing project for the removal of the I-84 eastbound (EB) Exit 21 off-ramp (construction anticipated to commence in 2026); and
- State Project No. 151-341 – The project for the addition of auxiliary lanes between I-84 EB Exits 17 and 18 (construction anticipated to commence in 2027).

The Mixmaster PEL Study alternative screening and evaluation framework and process is similar to a funnel (Figure 2-1). During this process, the PEL Study Team engages, communicates with, and solicits feedback from the general public and various stakeholder groups throughout the PEL process, including screening and evaluating alternatives. Three evaluation and screening levels are used in the Mixmaster PEL Study. Through this multi-step filtering (funnel) process, the number of alternatives to be examined is anticipated to reduce while the evaluation detail will increase with each level of screening.

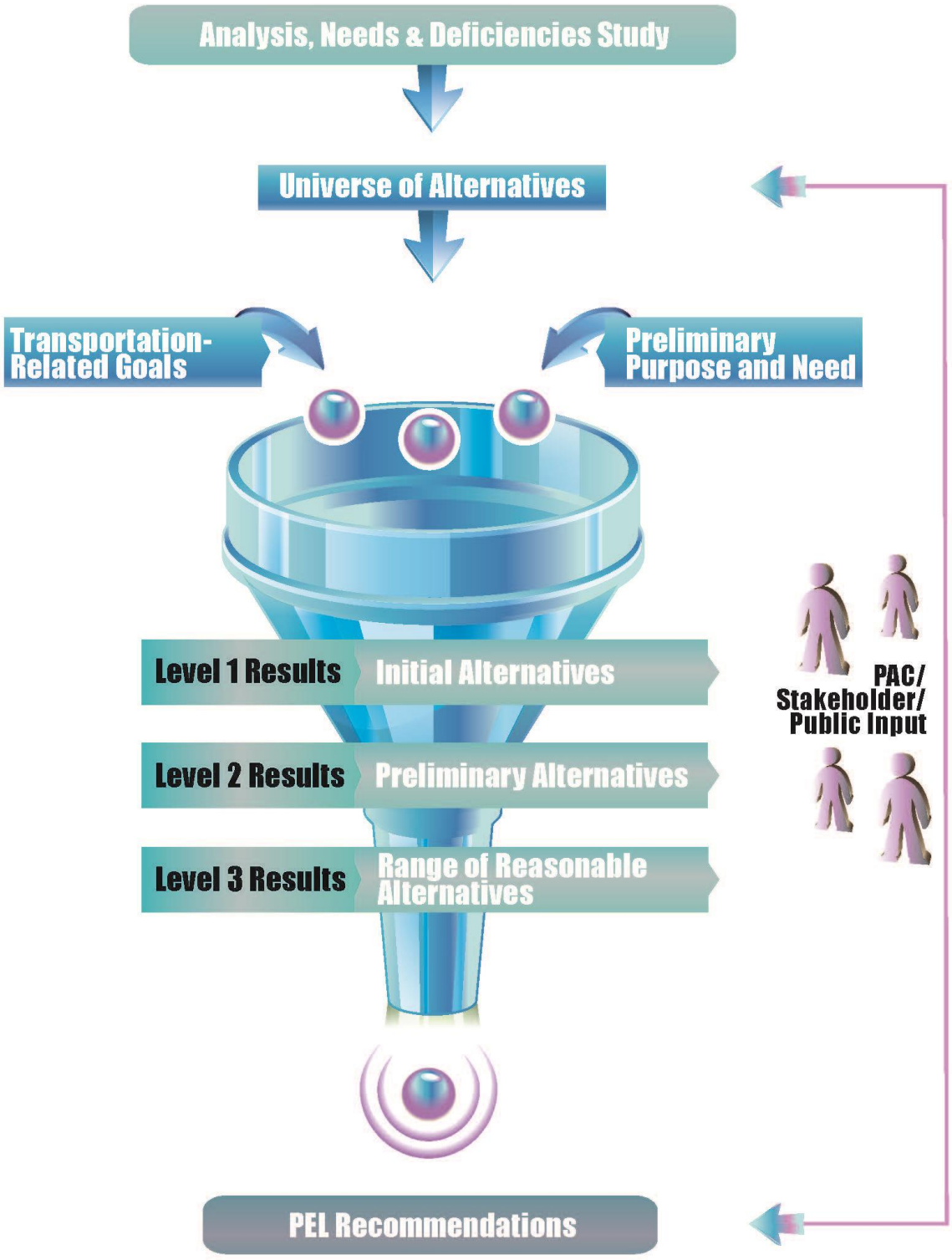

Figure 2-1 Alternatives Evaluation Process

2.1 LEVEL 1

Level 1 is an evaluation and screening of all potential solutions identified in the Universe of Alternatives. Level 1 assesses each alternative's ability to meet the Preliminary Purpose and Need in terms of the structural, geometric, and operational deficiencies and determine whether any of the alternatives contain fatal flaws. A 'pass' rating at Level 1 means that the alternative meets the criteria at this conceptual level of design to move beyond this initial screening. An alternative that receives a 'pass' rating in Level 1 may be eliminated from further study in subsequent evaluations based on advanced study and design. A "fail" rating at Level 1 means that the alternative clearly does not meet the criteria and therefore does not advance for further study.

The alternatives that pass the Level 1 screening are called ***Initial Alternatives*** and advance to Level 2.

2.2 LEVEL 2

The Initial Alternatives are developed to a higher level of conceptual design and undergo a more-detailed evaluation and screening in Level 2. As described in Chapter 3 - Alternative Screening & Evaluation Criteria, evaluations related to the Preliminary Purpose and Need: structural, geometric, and traffic operations are qualitative with some quantitative assessments. Potential impacts and benefits to the community and to the natural and human environments are primarily qualitative, while others are quantitative. The Initial Alternatives' multimodal characteristics related to transit, pedestrian, and bicycle accommodations and improvement are also assessed. The Level 2 evaluation also considers factors associated with other transportation-related goals and objectives introduced in Section 1.4 and described in more detail in Section 3.2.5.

The Initial Alternatives that pass the Level 2 screening are called ***Preliminary Alternatives*** and proceed to Level 3.

2.3 LEVEL 3

The Preliminary Alternatives are evaluated and screened in Level 3. The conceptual design of these alternatives are advanced and evaluated to a higher level of detail. Level 3 includes predominantly quantitative assessments. Evaluation criteria determined to be differentiators among alternatives during the Level 2 evaluation (e.g. specific transportation goals, rights-of-way (ROW), historical and cultural resources, etc.), are included in the Level 3 assessment. A comparative review of the Preliminary Alternatives based upon the differentiating criteria are paralleled with the comprehensive assessment of traffic operations, simulations, and evaluation of capital and life-cycle costs of the remaining Preliminary Alternatives for a comparative evaluation.

The Level 3 screening results in a ***Range of Reasonable Alternatives***, for further development during the NEPA process.

3 Alternative Screening & Evaluation Criteria

The screening and evaluation criteria for the PEL Study are based on the Preliminary Purpose and Need, the transportation-related goals and objectives for the Mixmaster, and other criteria that assess an alternative's practicability and degree of potential impacts on the community as well as natural and human environments. The following sections describe each of the screening and evaluation criteria for Level 1, Level 2, and Level 3, respectively.

3.1 LEVEL 1

Level 1 evaluation and screening of the alternatives is an engineering-based assessment of the Universe of Alternatives focusing on "fatal flaws." This review is predominantly qualitative with some quantitative assessments taken into consideration to provide a "Pass/Fail" rating. Each alternative is evaluated based on the alternative's demonstrated ability to:

1) Satisfy the ***Preliminary Purpose and Need*** in terms of ***structural***, ***geometric***, and ***operational*** (traffic) deficiencies and needs.

2) Meet the following criteria of ***practicability*** and therefore has no apparent "fatal flaws":

    a) ***Cost:*** financial resources can reasonably be made available for the alternative.

    b) ***Feasibility:*** the alternative is technically and logistically achievable.

3.1.1 Preliminary Purpose and Need

Structural

Ability to address the need to improve and/or replace deteriorating bridge structures that have outlived their original intended 50-year service lives.

Geometric

Ability to address and correct geometric deficiencies that do not meet current design standards (e.g. narrow lanes and shoulders) for the mainlines of I-84 and Route 8, system ramps, and service ramps. System ramps connect one limited access highway to another. Service ramps connect the local roadway network and a limited access highway.

Traffic Operations

Ability to provide system ramp connections directly between I-84 and Route 8 for high-volume movements and indirectly for lower volume movements. Additionally, the alternative must demonstrate the ability to provide adequate capacity based on current traffic and future traffic forecasts on the mainlines, system ramps and service ramps.

3.1.2 Practicability - Cost

Order of magnitude construction cost – Ability to be make financial resources available for the alternative. This will include capital construction costs and a contingency factor to account for engineering and mitigation. Right-of-way costs will not be included at Level 1.

3.1.3 Practicability - Feasibility

Ability to implement the alternative using proven technology, engineering, construction techniques, and general constructability – allowing mainlines and system ramps to continue to operate during construction.

3.2 LEVEL 2

The purpose of Level 2 is to further evaluate and screen the Initial Alternatives that remain from the Level 1 screening using design advanced to a higher level of conceptual design as compared to the design completion in Level 1. The distinction is made at this level of screening because additional engineering analysis and design (if it were to be performed) may determine that an Initial Alternative is ultimately not a viable solution. The Level 2 evaluation includes a re-evaluation of the advancing alternatives to identify potential fatal flaws with the additional information available. Alternatives determined to be fatally flawed are dismissed and do not receive a full analysis against the Level 2 goals and objectives due to their inability to meet the purpose of the PEL Study. The Level 2 screening assesses and screens the No-Build and Initial Alternatives' demonstrated ability to meet the goals and objectives identified by the PEL Study Team and informed by stakeholder / public input.

Level 2 considers the following general categories:

1) Confirmation that the Initial Alternatives continue to demonstrate the ability to satisfy the Level 1 ***fatal flaw*** criteria based on the more-advanced design and study.
2) An assessment of system performance, congestion reduction, potential crash severity, system linkages, connectivity, and mobility performance based on the ***Preliminary Purpose and Need***.
3) An assessment of the feasibility of project phasing and associated ***cost***.
4) An assessment of ***constructability*** including construction complexity and disruption to traffic.
5) An assessment of ***potential impacts and benefits to the community and to natural and human resources***.
6) An assessment of other ***transportation-related goals and objectives*** such as the ability to accommodate and enhance multimodal travel related to transit, pedestrian, and bicycle modes.

3.2.1 Preliminary Purpose and Need

The structural, geometric, and traffic operation components of the Initial Alternatives are quantitively and/or qualitatively assessed based on the more-advanced design of Level 2.

Structural

Confirmation that the Initial Alternatives continue to meet the structural component of the Preliminary Purpose and Need is performed. The alternative's ability to attain a National Bridge Inspection Standards (NBIS) condition rating greater than Fair (5) for PEL Study Area bridges will be assessed. NBIS bridge ratings range from Failure (0) to Excellent (9); a rating greater than Fair (5) exceeds the State of Good

Repair (SOGR) valuation as defined by CTDOT [2]. The ability of the alternative to have a minimum 40-year design service life projection is evaluated. Additionally, under this criterion, alternatives are assessed on their ability to replace the I-84 concrete bridge decks. The PEL Study Team assesses other desired structural improvements such as the ability to eliminate the existing fracture critical structures. Fracture critical structures are steel bridges with primary members whose individual failure could cause a portion of the bridge to fail. The ability to unstack the currently stacked structures which have high maintenance costs and potential safety concerns is assessed. A "stacked" structure is one where one direction of travel is on a structure over another direction of travel, which is also on structure. For example, I-84 eastbound is on structure over I-84 westbound.

Geometric

Initial Alternatives advanced to Level 2 are reviewed based on the progressed design to determine if the geometric component of the Preliminary Purpose and Need are still met. A comparative evaluation of the geometric features of the Initial Alternatives to determine their relative favorability is conducted. Additionally, each Initial Alternative is evaluated based on its ability to meet design considerations of CTDOT and AASHTO for the mainlines of I-84 and Route 8, system ramps, and service ramps. The Initial Alternatives are qualitatively assessed on geometric system performance by adhering to CTDOT and AASHTO design standards for safety including vertical/horizontal alignment standards, shoulder width, sight distance, exit and entrance lane lengths, and truck accommodations for out-of-direction travel and turning movements.

Operational

A review of the traffic operational component of the Preliminary Purpose and Need based on the advanced design of the Initial Alternatives is performed. The ability to provide adequate capacity on mainline and system and service interchanges to accommodate current and future travel demand, provide direct or indirect movements for high or low volume movements, respectively, and provide adequate access while improving operations and safety of the mainline highways is evaluated. An evaluation of conditions, such as demonstrated improvements to the operational system performance by either the reduction or the complete elimination of left-hand system ramps, as well as each Initial Alternative's multimodal characteristics related to transit, pedestrian, and bicycle accommodations and improvements is also performed.

3.2.2 Cost

Phasing Feasibility and Associated Cost

This includes an evaluation of the feasibility of phasing and associated cost implications of the Initial Alternatives based on the advanced design. The effects of project phasing opportunities on alternative fundability and the ability to be make financial resources available is assessed for the Initial Alternatives.

[2] "A Bridge for which the condition rating for each of the three major components for a span bridge (Substructure, Deck, and Superstructure) or the structural condition of a culvert is rated at least a 5 on a 0-9 condition scale is classified as being in a SOGR." *Connecticut Transportation Asset Management Plan Fact Sheet* (June 2024).

3.2.3 Constructability

Minimize Construction Impact

The PEL Study Team qualitatively and quantitatively assesses the constructability, or ease of construction, for each Initial Alternative using two criteria. Constructability is not only a measure of construction complexity; it is also an indicator of disruption to the traveling public. Highly constructible alternatives are desirable and generally less disruptive to the public. Highly constructible alternatives have shorter durations, more opportunities for off-line construction or phased work, and/or fewer detours when compared with a less constructible alternative. The qualitative criterion used to evaluate the Initial Alternative's constructability is the potential for offline construction.

3.2.4 Potential Impacts to the Community and Natural and Human Environments

Potential impacts to the community and to the natural and human environment are identified and assessed. Available desktop tools and file information such as Connecticut and City of Waterbury Geographic Information System (GIS) data, is used to establish baseline conditions in the PEL Study Area. Study areas may vary as they are tailored to the specific resources. The PEL Study Team assesses the potential adverse and beneficial impacts associated with each Initial Alternative. This high-level impact evaluation involves qualitative assessments and, where appropriate, a quantitative assessment of potential impacts to resources. These preliminary impacts are used to compare the potential impacts of each Initial Alternative. Alternatives should avoid or minimize impacts to these resources.

Community Resources

Community and Public Facilities – The City of Waterbury GIS records are reviewed to identify and map community and public facilities that might be affected by the alternative including schools, places of worship, cemeteries, public safety facilities, other municipal buildings and similar facilities.

Neighborhoods – Neighborhoods are identified and an assessment of the potential effects of each Initial Alternative on the nearby city of Waterbury neighborhoods is performed. This assessment considers potential effects on neighborhood cohesion, mobility, and access.

Land Use – Existing and proposed land uses, including zoning, using resources from the Naugatuck Valley Council of Governments (NVCOG) and the City of Waterbury are identified. Initial Alternatives are assessed relative to their consistency with existing land uses, zoning, and land use planning.

Socioeconomics - Socioeconomic data, including population, housing, and employment data generated for the PEL Study Area is used to establish baseline conditions and perform a preliminary evaluation of potential impacts upon the socioeconomic conditions of the PEL Study Area. Data sources include U.S. Census, Connecticut Department of Labor, NVCOG, and Connecticut Office of Policy and Management (OPM).

Title VI, Low Income, and Limited Proficiency in English–. Title VI is an anti-discrimination law applicable to federal-aid projects which includes limited proficiency in English populations. Through use of census data and American Community Survey (ACS) data, the Title VI, low income, and limited proficiency in English populations in the PEL Study Area are identified and the data is used for a comparative determination of the relative effects of each Initial Alternative on those populations.

Rights of Way – Rights-of-way (ROW) impacts including the potential number of anticipated takings, displacements, and relocations are identified through the use of available property maps and data to determine the potential impacts each Initial Alternative will have to non-CTDOT ROW land.

Natural Resources

Wetlands – Using National Wetland Inventory (NWI) maps and soil maps along with aerial photographs, potential impacts and location of impacts to wetlands are identified and an assessment of probable impact to wetlands is developed. This assessment of Initial Alternatives is made cognizant of guidance and future permit requirements from Connecticut Department of Energy and Environmental Protection (CTDEEP) and the U.S. Army Corps of Engineers (USACE).

Surface Waters and Ground Water – Using available United State Geologic Survey (USGS), GIS mapping, and aerial photography, the number of surface waters potentially impacted is quantified. Potential impacts to named perennial water courses and unnamed tributaries as well as potential impacts to ground water quality is qualitatively assessed. Potential impacts are assessed cognizant of CTDEEP and USACE guidance. Note that the PEL Study Area is not situated within nor in immediate proximity to a sole source aquifer.

Floodplain – Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) are used to identify floodplain and floodway areas within the PEL Study Area. Effects in floodway and/or floodplain is qualitatively assessed.

Farmland Soils – Farmland Soils including Prime Farmland Soils, Statewide Important Farmland Soils, and Locally Important Farmland Soils, are identified from available mapping, and potential location of impacts to these soils are also identified by the alternatives.

Biological Resources - The U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) tool and the most recent Natural Diversity Data Base (NDDB) maps maintained by CTDEEP are reviewed to identify federal and state listed species and critical habitats in the PEL Study Area.

Parks - Park lands and public recreation areas are identified through GIS mapping, City of Waterbury sources, and field reconnaissance, including the potential applicability of Section 4(f) of the U.S. Department of Transportation Act and Section 6(f) of the Land and Water Conservation Fund Act. Estimates of the number of publicly owned park land and recreation areas that may be affected by each Initial Alternative are made.

Human Resources

Historic and Cultural Resources - Mapping from the National Register of Historic Places' unrestricted database and inventories from Connecticut State Historic Preservation Office (CTSHPO) and local resources, along with mapping compiled by the CTDOT, is used to identify individual historic properties and historic districts in the PEL Study Area. Previously recorded archaeological sites are also identified for the quantification of potentially impacted sites for each Initial Alternative.

Hazardous and Contamination Conditions - The potential for existing hazardous and contaminated material and environmental risk sites in the PEL Study Area is assessed through a search of federal and state databases, and CTDEEP and municipal historical records. This preliminary screening identifies the potential for alternatives to encounter existing contamination and assesses and identifies sites that may negatively affect each Initial Alternative.

Noise-sensitive receptors – Noise-sensitive receptors, such as schools, residences, and parkland, are identified according to Federal Highway Administration (FHWA) criteria. The number of noise-sensitive receptors that exist within approximately 300 feet of an Initial Alternative is identified for comparison.

3.2.5 Other Transportation-Related Goals and Objectives

Enhance Connectivity and Mobility Within Waterbury

Each Initial Alternative is evaluated on its demonstrated ability to enhance the local transportation network for motorized and non-motorized travel without precluding access to major natural and built features such as the downtown Waterbury, and Naugatuck River. This is assessed through operational evaluation criteria which can be reviewed in Section 3.2.1

Enhance Modal Interrelationships

Each Initial Alternative is evaluated on its demonstrated ability to enhance and allow for opportunities to improve access to intermodal facilities in Waterbury such as the access to the bus facilities and railroad station. This is assessed through operational evaluation criteria which can be reviewed in Section 3.2.1.

Support Economic Development and Revitalization

Each Initial Alternative is evaluated on its demonstrated ability to support development and revitalization opportunities within the downtown area and surrounding neighborhoods as identified through ongoing funded projects and the City of Waterbury's 2015-2025 Plan of Conservation and Development. The severity of impact to the Central Business District including the Freight Street District is also included as part of this assessment. This is evaluated through the criteria discussed in Section 3.2.4.

Improve or Maintain the Safety of the Users and Those Affected by the Interchange

Each Initial Alternative is evaluated on its demonstrated ability to improve or maintain the safety of the users and those affected by the interchange. This is evaluated through the structural, operational, and geometric evaluation criteria which can be reviewed in Section 3.2.1.

Avoid, Minimize, or Mitigate Potential Impacts to the Human and Natural Environment

Each Initial Alternative is evaluated on its demonstrated ability to avoid potential impacts to the community and to the natural and human environment. This is evaluated through the criteria discussed in Section 3.2.4.

3.3 LEVEL 3

The purpose of Level 3 is to further evaluate and screen the Preliminary Alternatives using design progressed to a higher level of conceptual design completion. Level 3 considers four general categories, and their evaluation is predominantly quantitative:

1) A quantitative assessment of ***potential impacts and benefits to the community and to natural and human resources*** identified as differentiating among alternatives. Potential mitigation strategies are identified.

2) An assessment of other ***transportation-related goals and objectives***.

3) A detailed ***operational analysis*** of I-84, Route 8, and selected Waterbury streets and arterials using year 2045 travel demand forecasts.

4) An assessment of estimated costs – both ***capital costs and life-cycle costs***.

3.3.1 Potential Impacts to the Community, Natural, and Human Environments

To better distinguish the effects the Preliminary Alternatives may have on the community and the natural and human environments, potential impacts for criteria found to be differentiators and therefore will likely influence the screening selection are assessed. These assessments are used to further compare the potential impacts of each Preliminary Alternative. Alternatives should avoid or minimize impacts to these resources. The potential resources to be included in this analysis are listed in Section 3.2.4.

3.3.2 Other Transportation Related Goals and Objectives

The other transportation related goals, listed in Section 3.2.5, that are determined to be differentiating among the Preliminary Alternatives are evaluated and measured quantitatively.

3.3.3 Operational Analysis

An assessment of detailed analyses using traffic models of the Preliminary Alternatives for traffic operations along I-84 and Route 8 is conducted using the following parameters:

Mainlines, System and Service Ramps

Highway mainline segments are evaluated using several parameters, including Level of Service, Travel Speed, Delay, and Density during the weekday morning and weekday afternoon commuter peaks.

- Level of service (LOS) is a qualitative performance measure of driver satisfaction and traffic operations factoring travel time/speed, traffic flow characteristics, traffic interruption, freedom of maneuverability, driver behavior, and delay. LOS is measured using the letters A through F, with LOS A representing the least congested condition and LOS F representing the most congested condition. LOS E, which represents unstable flow conditions with localized congestion, and LOS F, which represents forced or breakdown traffic flow, are typically considered deficient traffic operations.
- Travel Speed is the average travel speed (distance divided by travel time) of vehicles traversing a given section of roadway. Travel speed decreases as congestion increases. Travel speed is typically measured in miles per hour.
- Delay is the difference between travel time under free-flow conditions and travel time under congested conditions. Delay is typically measured in minutes or seconds.
- Density is a numeric measure of the spacing of vehicles equal to traffic flow divided by speed. The higher the density, the closer the vehicle spacing. Congestion increases at higher densities, and higher densities correspond to deteriorated LOS conditions. Density is typically measured in vehicles per mile per lane.

System Performance

System performance is measured by evaluating vehicle miles traveled (VMT) and vehicle hours traveled (VHT). VMT and VHT is evaluated for each Preliminary Alternative with the results compared.

Local Street and Arterial Mobility

Local streets and arterials are evaluated using intersection LOS, measured as the weighted average delay of all approaches. Connections between the highways and the city streets and arterials in the PEL Study Area are assessed and compared for the Preliminary Alternatives in terms of their number and location. In addition, the number and location of proposed local connections over the Naugatuck River are assessed for each Preliminary Alternative. This assessment measures how well each alternative reduces the amount of local traffic using I-84 for short distance, local travel, often from one interchange to another, within the PEL Study Area. Reduction in short-distance use of I-84 supports the fundamental purpose of an interstate highway, to accommodate long distance travel from state to state.

3.3.4 Cost

Capital costs and life-cycle costs

The capital cost of the Preliminary Alternatives is estimated and compared between remaining alternatives. Planning level capital costs include construction costs, rights-of-way, and engineering. Life-cycle costs consider future maintenance and rehabilitation over the anticipated design life.

3.3.5 Constructability

The constructability of each Preliminary Alternative is estimated and compared though an assessment of the impact to the traveling public and surrounding communities and businesses using estimated user costs. User cost is the additional cost carried by motorists and the community as a result of work zone activity during construction and roadway modifications for the final condition.

4 Evaluation and Screening Criteria

The methodology described in this document is used to evaluate the various alternatives and determine their comparative advantages and disadvantages. The alternative screening process depicted in Tables 4-1, 4-2 and 4-3 contain the primary evaluation categories as well as the individual criteria within those categories. Utilizing this screening process and decision-making framework results in the selection of the Range of Reasonable Alternatives for continued development during the NEPA process.

Table 4-1 Level 1 Evaluation and Screening Criteria

Screening Criteria	Measure	Alternative Rating
Practicality – Satisfying the Preliminary Purpose and Need		
Structural	Does the alternative address the need to improve and/or replace deteriorating bridge structures that have outlived their original intended 50-year service lives?	Pass/Fail
Geometric	Does the alternative demonstrate the ability to address and correct geometric deficiencies that do not meet current design standards? (e.g. narrow lanes and shoulders)	Pass/Fail
Operations	Does the alternative provide connections between I-84, Route 8, and the city of Waterbury and provide adequate capacity based on current traffic and future traffic forecasts on mainlines and system and service interchanges?	Pass/Fail
Practicability – Costs	Does the cost of the alternative demonstrate viability, and can the financial resources reasonably be made available? (e.g. is the anticipated cost of the alternative feasible or insurmountable?)	Pass/Fail
Practicability – Feasibility	Does the alternative demonstrate the ability to be implemented using proven technology, engineering, construction techniques, and general constructability – allowing mainlines and system ramps to continue to operate? Is the alternative feasible? (e.g. are factors present that make the alternative impracticable?)	Pass/Fail

Table 4-2 Level 2 Evaluation and Screening Criteria

Evaluation Criteria	Measure	Analysis Type
Purpose and Need		
Structural	Continues to pass the Level 1 structural screening measure upon further design.	Qualitative & Quantitative
	Assessment of ability to attain a NBIS rating greater than Fair (5).	
	Assessment of ability to achieve minimum 40-year design service life projection.	
	Assessment of ability to replace the I-84 concrete bridge decks.	
	Assessment of ability to unstack existing I-84 and Route 8 structures.	
	Assessment of ability to eliminate fracture critical structures.	
Geometric	Continues to pass the Level 1 geometric screening measure upon further design.	Qualitative & Quantitative
	Assessment of ability to satisfy CTDOT and AASHTO geometric guidelines (e.g., vertical/horizontal alignment standards, shoulder width, sight distance, exit and entrance lane lengths, and truck accommodations for out-of-direction travel and turning movements).	
Operations	Continues to pass the Level 1 traffic screening measure upon further design.	Qualitative & Quantitative
	Assessment of ability to improve operational system performance by providing adequate capacity such as provides direct or semi-direct movements for high and low volume movements, respectively.	
	Assessment of access to mainlines while improving operations and safety.	
	Assessment of intermodal connectivity and mobility through an assessment of access across the I-84 and Route 8 mainlines, the local road network, and transit, bicycle, and pedestrian facilities.	

Evaluation Criteria	Measure	Analysis Type
Phasing Feasibility and Associated Cost	Assessment of the feasibility of phasing and associated cost implications. Assessment of the effects of phasing opportunities on alternative fundability and the ability to be make financial resources available.	Qualitative
Constructability	Assessment of construction complexity and disruption to traffic and feasibility of traffic mitigation measures.	Qualitative & Quantitative
Potential impacts to the community, natural, and human environments*		
Community and Public Facilities	Assessment of community and public facilities directly affected and/or whose access is affected.	Qualitative & Quantitative
Neighborhoods	Assessment of effect on identified neighborhoods considering neighborhood cohesion, mobility, and access.	Qualitative & Quantitative
Land Use	Assessment of consistency with existing land uses, zoning, land use planning through review of available planning reports.	Qualitative
Socioeconomic Conditions	Assessment of potential impacts upon the socioeconomic conditions.	Qualitative
Title VI, Low Income, and Limited Proficiency in English	Assessment and comparative evaluation of direct impacts and effects on low income, people of color, and limited English proficient populations.	Qualitative & Quantitative
Rights-of-Way (ROW)	Assessment of ROW impacts including potential number of anticipated takings, displacements, and relocations.	Quantitative
Wetlands	The number of wetland systems and assessment of probable impacts to wetland systems.	Qualitative & Quantitative
Surface waters and ground water	The number of surface waters potentially impacted and assessment of probable impact to surface waters and ground water is developed.	Qualitative & Quantitative
Floodplain	Floodplain (e.g. Zone A or Zone AE) and floodway areas potentially impacted and assessment of probable impact to floodplains.	Qualitative & Quantitative
Farmland Soils	The presence of farmland soils and assessment of potential areas affected by soil type.	Qualitative & Quantitative

Evaluation Criteria	Measure	Analysis Type
Biological resources	Number of state and federally listed threatened and endangered species potentially affected.	Quantitative
Parks	Number of parks potentially affected.	Quantitative
Historic and cultural resources	Number of known sites potentially affected and cultural/archaeological sensitivity.	Qualitative & Quantitative
Hazardous and Contamination Conditions	Identification of potentially hazardous and contaminated parcels (e.g. brownfield sites and landfills) through search of federal and state databases, and CTDEEP and municipal historical records. Assessment of the sites that may negatively affect construction of each alternative	Qualitative & Quantitative
Noise-sensitive receptors	Number of noise-sensitive receptors potentially impacted by traffic noise.	Quantitative
Other transportation-related goals and objectives*	These other transportation related goal measures are captured within the evaluation measures presented.	Quantitative & Qualitative

* Evaluation Criteria under these headers determined to be differentiators among alternatives will be carried forward for an additional assessment in the Level 3 screening.

Table 4-3 Level 3 Evaluation and Screening Criteria

Evaluation Criteria	Measure	Analysis Type
Potential impacts to the community, natural, and human environments	Select community, natural, and human environmental impact measures identified as differentiators among Preliminary Alternatives at the completion of the Level 2 analysis are carried forward. An evaluation of potential direct impacts is assessed for a comparative analysis.	Quantitative
Other transportation related goals and objectives	Select transportation related goal measures identified as differentiators among Preliminary Alternatives at the completion of the Level 2 analysis are carried forward for a comparative analysis.	Quantitative
Operational		
Mainlines, System and Service Ramps	LOS, travel speed, delay, and density.	Quantitative
System performance	VMT and VHT.	Quantitative
Local streets and arterials	Intersection LOS. Local connectivity. Reduction in use of interstate by short-distance, local traffic as measured by traffic volume.	Quantitative
Cost		
Capital costs and life-cycle costs	Estimated costs for the initial capital cost of construction, right of way, and engineering. Conceptual phasing will be further developed. Also, the annualized cost of maintaining the alternative based on the anticipated design life.	Qualitative & Quantitative
Constructability	Estimated user costs to the traveling public and surrounding communities and businesses during construction and roadway modifications for the final condition.	Quantitative

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