

## 5.1 Discussion of Conceptual Costs Estimates

### 5.1.1 Civil Highway Costing Assumptions and Justification

For each of the three Conceptual Alternatives, construction costs were developed for the following civil highway construction items as applicable:

- Earthwork and Embankment Items;
- Drainage and Hydraulics Items;
- Pavement and Subgrade Items;
- Traffic Signals and Traffic Safety Related Items;
- Roadside Safety Items;
- Buses & Bus Shelters;
- Stage Construction and Work Zone Safety Items; and
- Impact Mitigation.

Unit costs for each of the various civil highway items are based on several sources, namely, the Connecticut Department of Transportation Preliminary Cost Estimating Guidelines dated January 2005, ConnDOT Weighted Unit Pricing documents, past experience, and professional judgment.

Quantities for earthwork and embankment items were developed from the measurement of overall lengths of roadway on embankment, the width of various roadway types based on standard cross sectional dimensions (a.k.a. 12 foot travel lanes, inside and outside shoulders up to 10 feet wide and inside and outside berms up to 4 feet), and assumed heights of embankment. The Conceptual Alternatives depict various roadways crossing over or under other roadways within the corridor. It was assumed that there is a 22-foot difference in elevation between roadways that cross one another. Additionally, it was assumed that along the length of various roadways there is a transition in height from one crossing level to another and a varied height above the existing ground elevation to various crossing roadway elevations.

The length, width and height determinations were combined to arrive at cubic volumes of earthwork for each roadway segment. The segments were totaled and assumption was made that 60 % of the total volume of earthwork was on filled embankment and 40% of the total volume of earthwork was existing ground to be excavated.

Of the excavated earthwork volume 15% was assumed to be rock excavation. Of the excavated material deemed to be non-rock excavation or earth excavation, 5% of the earth excavation was assumed to be contaminated with hydrocarbon deposits and 0.5% was assumed to be hazardous waste containing PCB deposits.

The excavation and redistribution of on-site (waste) earthwork materials is generally considered to be less expensive by volume than the location, hauling and placement of off-site (borrow) earthwork materials. Proper handling, treatment and disposal of

contaminated and hazardous earth materials can be very expensive, especially in a historically active manufacturing city such as Waterbury.

At this early stage of alternative development, details concerning the existence of rock, contaminated and hazardous soils, unsuitable materials (muck), and borrow quantities versus waste quantities, are not available. In order to provide a conservative buffer of potential project costs, volumes of these expensive items were assumed to be present and required.

Drainage and hydraulic items include the construction of new closed drainage systems, expansion and renovation of existing closed drainage systems, and the construction of new and/or extended cross culverts. Based on the Departments estimating procedure, costs for new and expanded drainage systems are based on overall square foot surface areas of the roadway pavement. Similar length and width calculations were made as described in the earthwork text above. New roadways were assumed to require new drainage systems and widened or resurfaced existing roadways were assumed to require expansion and renovation of existing drainage systems.

Pavement and subgrade items include bituminous pavement, formation of subgrade (fine grading and accurate surveying of top of embankment), subbase (processed aggregate material between the top of earth embankment and bottom of bituminous pavement) and concrete pavement. Quantities for the various pavement and sub-grade items were developed similar to the earthwork items described above.

Traffic signals and traffic safety features such as pavement markings and signage were quantified based on specific intersection requirements and overall area calculations measured from the various Conceptual Alternatives.

Roadside safety items including concrete median barrier, curbing and guiderail were calculated using the overall lengths of various roadways and professional judgment as to the extent of usage. Median barrier was assumed to be required on 15% of the overall length of mainline roadways. Curbing was assumed to be required the length of all turning roadways, ramps and local streets. Guiderail was assumed to be required on 20% of the overall length of all roadway segments.

Costs for busses and bus shelters were quantified using planning level cost data from ConnDOT.

Stage construction, maintenance of traffic and work zone safety refers to the planned transition of construction from existing facility to newly completed facility and vice versa. Transitional traffic cross-overs, temporary paved embankments, and interim lane configurations are included under this item. Proper barricades, physical barriers and warning devices provide work zone safety to the contractors' manpower and equipment. A lump sum cost was assigned to each Conceptual Alternative based on anticipated construction complexity and professional engineering judgment. Estimated stage

construction values in Year 2005 dollars were approximated at \$7.9 million, \$68.8 million, and \$27.6 million for Conceptual Alternatives 6, 7 and 8, respectively.

Impact mitigation refers to the set aside of dollars for the mitigation of unavoidable environmental and/or social impacts attributed to the construction of each alternative. It is anticipated that even with the most sensitive and responsible approach to the development of this project corridor some level of unavoidable impact will result to one or more protected resources. A conservative lump sum value was estimated based on anticipated construction complexity, anticipated footprint and professional engineering judgment. Estimated mitigation values were approximated at \$300 thousand, \$1 million, and \$1million for Conceptual Alternatives 6, 7 and 8, respectively.

Unit costs for the civil highway costs are described in Table 5-1 below.

**Table 5-1: Civil Highway Items, Units of Measure and Unit Prices**

Item Description	Units	UNIT
		Price
<b>Highway Items</b>		
Earth Excavation	CY	\$20.00
Rock Excavation	CY	\$50.00
Unsuitable Material Excavation (Muck)	CY	\$10.00
Contaminated Soil Excavation (Hydrocarbons)	CY	\$70.00
Hazardous Waste Excavation (Pcb's)	CY	\$450.00
Borrow	CY	\$18.00
New Drainage System	SY	\$20.00
Existing Drainage Upgrade	SY	\$7.00
Superpave	TON	\$70.00
Concrete Base Course Widening	CY	\$260.00
Milling of Bituminous Concrete (0 To 4")	SY	\$4.00
Concrete Pvmt. Replacement For Roadway (Full Depth)	CY	\$580.00
Subbase	CY	\$28.00
Major Pipe Culverts	LF	\$750.00
Concrete Box Culverts	LF	\$975.00
Concrete Median Barrier	LF	\$50.00
Concrete Sidewalk	SY	\$65.00
Major Traffic Signal Modifications	EA	\$50,000
New Traffic Signal	EA	\$70,000
Roadway Lighting (Expressway & Ramps)	LF	\$55.00
Concrete Curbing	LF	\$28.00
Guiderail	LF	\$48.00
Buses	Ea	\$500,000
Bus Shelters	Ea	\$50,000
Signing & Striping (Estimated)	LS	Varies*
Stage Construction Items (Estimated)	U	Varies*
Impact Mitigation (Estimated)	U	Varies*

\* Estimated item costs vary from one alternative to another based on the extent and complexity of the proposals.

### 5.1.2 Structural Costing Assumptions and Justification

For each of the three Conceptual Alternatives, costs were developed for proposed bridges, retaining walls, miscellaneous and temporary structures, demolition, and repair. The results are summarized in Table 5-2, and are discussed further in the following narrative.

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**Summary of Conceptual Alternative Costs by Major Cost Items**

	<b>Conceptual Alternative 6</b>	<b>Conceptual Alternative 7</b>	<b>Conceptual Alternative 8</b>
<b>Civil Highway Costs</b>	\$72,356,575	\$224,702,833	\$245,560,209
<b>Structural Bridge Costs</b>	<u>\$154,068,190</u>	<u>\$636,864,853</u>	<u>\$572,962,498</u>
<b>Subtotal A</b>	<b>\$226,424,765</b>	<b>\$861,567,686</b>	<b>\$818,522,707</b>
<b>Lump Sum Items</b>	<u>\$66,795,306</u>	<u>\$254,162,468</u>	<u>\$241,464,199</u>
<b>Subtotal B</b>	<b>\$293,220,070</b>	<b>\$1,115,730,154</b>	<b>\$1,059,986,906</b>
<b>Additional Items</b>	<u>\$67,660,616</u>	<u>\$256,617,935</u>	<u>\$243,796,988</u>
<b>Total Cost</b>	<b>\$360,880,686</b>	<b>\$1,372,348,089</b>	<b>\$1,303,783,894</b>
<b>Total Cost (Rounded)<sup>1</sup></b>	<b>\$360,900,000</b>	<b>\$1,372,300,000</b>	<b>\$1,303,800,000</b>
<b>Total Cost based on an assumed 2025 year of construction<sup>2</sup></b>	<b>\$588,112,000</b>	<b>\$2,236,259,000</b>	<b>\$2,124,633,000</b>

<sup>1</sup> Year 2006 dollars

<sup>2</sup> Year 2025 dollars based on a 2.75% inflation rate provided by ConnDOT

#### Proposed Bridges

A raw structure cost of \$260 per square foot of deck area was used for the majority of the proposed bridges. Bridges that were deemed difficult to construct due to limited access, as well as the flyover ramp structures, were assessed a higher cost per square foot of deck area. These costs were based on several sources, namely, the Connecticut Department of Transportation Preliminary Cost Estimating Guidelines dated January 2005, bid tabulations for the recently awarded New Haven Harbor Crossing Improvements Contract C2, past experience, and professional judgment.

The 2005 ConnDOT Preliminary Cost Estimating Guidelines state that new bridges should be estimated at \$210 per square foot. However, it should be noted that this number has not changed from the 2002 Guidelines. Adjusting for inflation from 2002 at 5% per year results in \$255 per square foot. Actual individual items may have had a higher inflationary cost (chiefly fuel, Portland cement, and structural steel).

Bid tabulations for Contract C2 resulted in structure costs between approximately \$250 and \$475 per SF. The ramp structures varied between \$280 and \$475 per square foot, while the mainline single span structure was \$250 per square foot.

### Retaining Walls

Based on current projects that are in the design phase, as well as past experience and judgment, a raw unit cost of \$140 per square foot of exposed face of wall was used for the proposed retaining walls.

### Miscellaneous & Temporary Structures

These structures include primarily temporary bridge structures that may be required to maintain traffic during reconstruction of the interchange. Since the scope of this study did not allow for evaluating the maintenance and protection of traffic and construction staging in detail, a lump sum cost for each Conceptual Alternative was assumed based on professional judgment and past experience.

### Demolition

Demolition cost was estimated as \$65 per square foot of deck area. The 2005 ConnDOT Preliminary Cost Estimating Guidelines state that Removal of Superstructure should be estimated at approximately \$50 per square foot for removal over water or rail, which constitutes the majority of the structures to be removed. An additional \$10 per square foot was estimated for substructure demolition, and \$5 per square foot was added for inflation to 2006 costs.

### Repair

A prior phase of this study investigated a condition assessment for all existing structures associated with the general area of this interchange, and assigned required repairs to each structure. In this phase, costs were assigned to each repair type based on broad assumptions.

Repair types were classified as Routine Maintenance, Deck Patching, Deck Replacement, Substructure Patching, Complete Painting, Spot Painting, Bearing Replacement, Repair Impact Damage to Beams, Safety Walk Retrofit, and Seismic Retrofit. Estimates of costs for significant repair types such as Deck Patching, Deck Replacement, Complete Painting, Spot Painting, and Safety Walk Retrofit were developed, while nominal costs

per square foot were assigned for the other types of repairs based on past experience and professional judgment.

- Deck Patching – the 2005 ConnDOT Guidelines suggest using \$2000 per cubic yard for full depth patching. \$2100 per cubic yard was used for this study, which includes \$100 per cubic yard for inflation to 2006 costs. Assuming an 8” thick deck, this translates into approximately \$52 per square foot of deck area.
- Deck Replacement – the 2005 ConnDOT Guidelines suggest using \$100 per square of deck area. \$105 per square foot was used for this study, which includes \$5 per square foot for inflation to 2006 costs.
- Complete Painting – based on experience, the 2005 cost for this item was estimated to be approximately \$20 per square foot of painted area. For this study, \$21 per square foot was used, which includes \$1 per square foot for inflation to 2006 costs. This cost includes containment required for lead-based paints. A typical 5’ deep steel plate girder with 18” wide flanges represents approximately 14.5 square foot of painted area; adding 20% to account for details results in 17.4 square foot of painted area; using a typical 8.5’ spacing yields roughly two square feet of painted area per square foot of deck area. Therefore a cost of \$42 per square foot of deck area was used.
- Spot Painting – this was estimated to be 5% of the area of complete painting, resulting in a cost of \$2 per square foot of deck area.
- Safety Walk Retrofit – based on recent weighted unit bid prices, this retrofit item is approximately \$170 per linear foot. For a typical 50’ wide bridge with two parapets, this translates to a 2005 unit cost of approximately \$7 per square foot of deck area. For this study, \$7.50 per square foot was used, which includes \$0.50 per square foot for inflation to 2006 costs.

### 5.1.3 Conceptual Lump Sum Items and Additional Items

For each Conceptual Alternative, costs were developed for Lump Sum Items including the following:

- Clearing And Grubbing (2% Of Subtotal A);
- Maintenance & Protection Of Traffic (3% Of Subtotal A);
- Mobilization (7.5% Of Subtotal A);
- Minor Items (15% Of Subtotal A); and
- Health And Safety Support Costs (2% Of Subtotal A).

Subtotal A refers to the sub total of all described roadway and structural costs assigned to each Conceptual Alternative. Maintenance & Protection of Traffic refers to the costs associated with providing proper traffic delineation thru the use temporary pavement markings, signage, development of safe work zones and traffic policing.

Additionally, for each of the three Conceptual Alternatives, costs were also developed for Additional Items including the following:

- Incidentals (7% Of Subtotal B);
- Contingencies (5% Of Subtotal B);
- Preliminary Engineering (8% Of Subtotal B);
- Utility Cost (3% Of Subtotal B); and
- Right-Of-Way (Estimated).

Subtotal B refers to the sub total of all applicable Lump Sum Items assigned to each Conceptual Alternative. Professional judgment was used to estimate right of way costs at this time.