



## 10.0 CAPITAL COSTS

This chapter describes the methodology employed to develop order-of-magnitude capital cost estimates for the Rush Line Corridor AA. This methodology produced cost estimates and cost categories consistent with the FTA's Standard Cost Categories, and could be readily incorporated into progressively more detailed design (e.g. preliminary engineering and final design). **Appendix K** presents detailed calculations of this analysis.

### 10.1 Format

This methodology uses a modified Construction Specifications Institute (CSI) format to allow development of comparative cost estimates which is suitable for an Alternatives Analysis. The capital cost estimates developed in this format were later ordered and summarized into major cost categories consistent with FTA's Standard Cost Categories and appropriate to the phase of project definition. Cost categories can be expanded or reduced as needed to provide appropriate levels of detail.

### 10.2 Estimate Development

Estimates of project capital costs were developed in three general steps under this methodology. First, alignment alternatives identified during the second level of screening were sufficiently defined to enable the necessary analysis and conceptual engineering to be performed for cost estimating purposes. Second, project components, consistent with the application of unit costs and appropriate to the level of definition, were identified. Quantities and appropriate unit cost data were then developed. Finally, the quantities were assembled into the modified CSI format, selective unit costs applied, and summed into the major cost categories defined later in this document to complete the order-of-magnitude capital cost estimates.

#### 10.2.1 Alignment Segments

All four BRT alternatives have the segment of I-35 north of Forest Lake in common. The two Commuter Rail alternatives share the same alignment north of White Bear Lake. Finally, the two LRT alternatives have the same alignment south of White Bear Lake at CSAH 96. Capital costs were developed and summarized in the various cost categories and for each individual as well as common segment. The total capital cost for a particular alignment alternative was determined by adding the individual segments together that make up the alignment. This approach provided added flexibility in comparing and evaluating the cost consequences of the different alignment alternatives.

## 10.2.2 Unit Costs

Unit costs appropriate to the level of alignment definition were developed to support this methodology. Unit costs were developed from selected historical data including final engineer's estimates, local and national projects (e.g. Norfolk light rail, Northstar Commuter Rail), the Minnesota Department of Transportation's bid information from 2007, standard estimating manuals, and standard estimating practices. Unit costs included allowances for contractor's margins such as profit and overhead and insurance costs.

## 10.2.3 Cost Categories

Cost categories were used to summarize the project component costs into a comprehensive total estimate for each alternative. The major cost categories are listed on the right hand side of this page and described later in this chapter. There were seven fixed facilities cost categories, five systemwide cost categories, and two dependent cost categories. Right-of-way cost and/or the cost of lease agreement with railroads will be determined during the Preliminary Engineering phase of Project.

Fixed facility categories encompass site-specific project component costs. Capital costs for these categories are typically calculated by using known unit costs and measured quantities for each component. Systemwide costs are calculated on an alignment length instead of from measured quantities. A per route-foot unit cost was developed from historical data to apply to the route length of each section.

The professional services and contingency categories were dependent on the fixed facility and systemwide cost categories. The sum of the categories listed above was the total capital cost estimate for an alignment segment.

### *Capital Cost Categories*

- Civil Construction
- Utility Relocation Allowance
- Trackwork
- Structures
- Stations
- Park-and-Ride Facilities
- Fare Collection
- Maintenance Facility Allowance
- Traction Power
- Signal System and Communications
- Professional Services
- Contingency
- Transit Vehicles.

## 10.3 Management of Costs

Project costs can often be underestimated in the early planning stages and costs tend to grow as project development progresses. The methodology employed in the Rush Line Corridor project took steps to guard against the underestimation of project costs and attempted to reduce this problem. Steps included comparing unit costs to historical unit cost bid estimates and construction costs for comparable work; and identifying the specific year-of-expenditure. For this Alternatives Analysis, the year-of-expenditure used was year 2008.

### 10.3.1 Cost Data Sources

The sources of data used to develop unit costs must be suitable for the type of work, local conditions and scale of the work proposed for this Alternatives Analysis. Historical competitive bid data for comparable work is a reliable source. Recent information is the most reliable because it does not require escalation assumptions. Contract as-built prices are the most comprehensive sources because they include the total cost of construction at project closeout and acceptance. This methodology relied on

recent cost information, typically contractors bid information or engineer's estimates for recent transit projects. Unit costs were estimated in Year 2008 U.S. Dollars.

## **10.4 Project Cost Categories**

This section describes each of the major capital cost categories that were used to assemble the estimates, together with specific assumptions.

### **10.4.1 Civil Construction**

This category included the capital costs for basic infrastructure improvements necessary for the Build Alternatives considered, i.e. BRT, Commuter Rail, and LRT. The capital costs for Civil Construction included excavation, landscaping, driveway reconstruction, curb and gutter, traffic signals, street closure, street reconstruction, roadway construction, sidewalk construction, signing and striping, lighting, drainage. Measurements were by unit cost or route foot for the following types of Civil Construction: In-Street, Shoulder Running, Grade-Separated, and Exclusive Transitway. This category encompassed the BRT, Commuter Rail, and LRT alignments. Units of measurements used in this task are detailed as Appendix J.

### **10.4.2 Utility Relocation Allowance**

This category includes a cost allowance for the relocation, upgrade or adjustment of all public or private utilities that may become the responsibility of the project during construction. During conceptual design, it was assumed that all utilities within the immediate transitway envelope will be relocated. For this Alternatives Analysis, four levels of utility relocations were measured: High (urban), medium (suburban), low (rural), and existing corridor (i.e. rural or freeway). The nature and age of the three main corridors under consideration in this Alternatives Analysis – i.e. County Regional Railroad Authority right-of-way, existing freight railroad right-of-way, and I-35E/I-35 right-of-way – and comparison to similar projects support the predominate use of the existing corridor utility relocation allowance. Measurement was on route-foot basis.

### **10.4.3 Transitway**

- BRT Busway – Busway construction items were included under Civil Construction.
- Commuter Rail Trackwork – This category applied to the two Commuter Rail alternatives and included capital cost for procurement and installation of commuter rail tracks, fasteners, special trackwork, ties, crossovers, turnouts, track crossings, welding, ballast and miscellaneous track items. Three types of trackwork were measured on a track-foot basis for this methodology, described as follows:
  - Standard (ballasted) new mainline trackwork consists of 136 RE continuously welded rail installed on concrete ties and ballast
  - Embedded trackwork consists of girder rail with to a concrete slab and embedded in concrete between raised curbs
  - Direct fixation trackwork is typically used on aerial structures longer than 350 feet or for special cases of at-grade construction, and consists of standard direct fixation fasteners on a concrete base.

- LRT Trackwork – This category applied to the two LRT alternatives and included capital cost for procurement and installation of LRT tracks, fasteners, special trackwork, ties, crossovers, turnouts, track crossings, welding, ballast and miscellaneous track items. Three types of trackwork were measured on a track-foot basis for this methodology, described as follows:
  - Standard (ballasted) trackwork consists of 115 RE continuously welded rail installed on concrete ties and ballast
  - Embedded trackwork consists of girder rail with electrical isolation fastened to a concrete slab and embedded in concrete between raised curbs
  - Direct fixation trackwork is typically used on aerial structures longer than 350 feet or for special cases of at-grade construction, and consists of standard direct fixation fasteners on a concrete base.

This category included capital costs for park-and-ride facilities including curbs, sidewalks, paving, grading, drainage, storm water detention and treatment, lighting, striping, landscaping and the amenities associated with them. This category also included adjacent street and access improvements. Unit cost and measurement were by the parking stall. A cost was developed for each park-and-ride facility based on the number of proposed parking stalls. For this level of effort, generally, a minimum of 200 parking spaces were assumed at each station north of St. Paul, consistent with ridership modeling assumptions. Bus transit centers were also included in this category, with the following elements – vehicle access into and out of the facility, shelters and bus island. Measurement was directly related to number of parking stalls. As previously mentioned, the cost of right-of-way was not included at this level of analysis.

#### **10.4.4 Structures**

This category included the capital costs for major structures including bridges, retaining walls, over passes and underpasses. The capital cost for structures included temporary support, structural excavation, form work, structural materials, installation and finishes. It included any temporary structures to maintain traffic during construction of the structure. Retained fill and associated earthwork were also included in this category. Major structures were estimated on a unit cost basis or lump sum, depending on the nature of the structure. Retaining walls were measured on the basis of a square foot of contact area and by height.

#### **10.4.5 Stations**

This category included the capital costs for fixed facilities and amenities for transit stations for BRT, Commuter Rail, or LRT. The capital costs for stations included platforms, shelters, lighting, signage, landscaping, furnishings and sidewalks for pedestrian access. The following types of rapid transit stations were measured by this methodology: Center (bi-directional) platform and side platform (incorporated into the sidewalk).

#### **10.4.6 Fare Collection**

This category included capital costs for fare collection equipment for each station including structural and electrical provisions, equipment, and installation. Moreover, the Build Alternatives under consideration assume a self-service, proof-of-payment fare collection system. Measurement was by the number of fare vending equipment used for each station (two per station).

#### **10.4.7 Maintenance Facility Allowance**

This category included an allowance for maintenance facilities and equipment needed to support each BRT, Commuter Rail, or LRT alternative. This category included buildings, equipment, trackwork (Commuter Rail and LRT), traction power system (LRT), signals (Commuter Rail and LRT) and civil construction as needed. Non-revenue and maintenance vehicles were also included. Additionally, because of increase to bus fleet that were proposed for the BRT alternatives a maintenance facility allowance was included for such alternatives.

#### **10.4.8 Traction Power Subsystems (LRT)**

This category applied to LRT alternatives and included capital costs for the system to support electrical power to the light rail vehicles. The system consisted of traction power substations and the associated overhead contact system (OCS). This category included installation and testing of the system equipment. Measurement was by the route-foot. Pole foundations, conduit and corrosion protection were included as part of the Traction Power category.

#### **10.4.9 Signal System and Communications**

This category included capital costs for the wayside signal and train control system, and consisted of track switch control equipment, signal poles, cables, train detection equipment, and signal buildings. Measurement was by the route-foot. Cost of pole foundations and conduit were included as part of the Civil Construction category under road crossings. This category included an allowance for communications elements such as fiber optic cable and field and central control equipment to remotely monitor and control track switches, signals, traction power substations, fare collection and other systems equipment. Measurement was by the route-foot.

#### **10.4.10 Professional Services**

This category included the costs for engineering, administration and construction management services. Costs for these services were based on a percentage of the total cost of all direct capital cost categories. Cost items for this category were as follows:

- Preliminary Engineering: 4 percent
- Final Design: 6 percent
- Project Management for Design Construction: 5 percent
- Construction Administration and Management: 8 percent
- Insurance: 2 percent
- Legal (permits and review fees by other agencies, cities, etc.): 3 percent
- Survey, Testing, Investigation, Inspection: 3 percent
- Start-Up Costs and Agency Force Account Work: 1 percent.

The total percentage applied to all capital cost categories except contingencies was 32 percent.

#### **10.4.11 Contingencies**

This cost category accounted for the uncertainties inherent in project definition and conceptual design at the Alternatives Analysis phase. A contingency was added to the project cost as a percentage of all the capital cost categories except Professional Services. Contingency costs were calculated as 30 percent

for all capital costs. Contingency should reflect the degree of risk associated with the level of design detail available and the characteristics of the design component. The contingency for future design stages will be reduced as the design process progresses.

#### **10.4.12 Vehicles**

This category included capital costs for procuring BRT, Commuter Rail, and light rail vehicles, additional base fleet buses for the bus provider (e.g. Metro Transit) as part of the No-Build and TSM alternatives, required spare parts and non-recurring costs. The number of vehicles was based on the proposed operating plans.

### **10.5 General Design Assumptions**

Each of the corridors chosen for the alignments in this study for BRT, Commuter Rail, and LRT have unique requirements requiring slight variations with the assumptions made in this study. The following outlines the general design assumptions used for this cost analysis.

#### **10.5.1 BRT**

- The downtown St. Paul segment of all four BRT alternatives would use the infrastructure currently in place, i.e. operate in mixed traffic. Most significant improvements will be to traffic signals through the use of Transit Signal Priority (TSP) to optimize BRT operations. North of downtown, all four BRT alignments receive designated lanes.
- Alternatives 1A and 1B run along I-35E/I-35 Corridor and can be broken into two segments: From downtown St. Paul to I-694 and north of I-694 to Hinckley. The segment south of I-694 includes a new 14-foot lane for BRT that can also be used as a HOT Lane.
  - 14-foot travel lanes consisting of 12-inch concrete and 6-inch Class V
  - 10-foot shoulder included on the right side and median shoulder is left as-is. Allowance for additional bypass lane at Maryland and Larpenteur Stations.
  - 14-foot bituminous shoulders are conservatively allocated for full depth construction with 6-inch of Class V. Existing 10-foot shoulders may be suitable for modifications in some areas allowing for a reduction in cost for shoulder enhancements north of I-694.
  - Bridge structures modifications (widening) as allocated were reasonably possible. New structures are allocated for structures that are not practical for modifications south of I-694. No bridge modifications were allocated north of I-694. This may require the BRT vehicle to reenter traffic lane under some structures.
  - Signal modifications and enhancements were limited to the downtown St. Paul portion of these alternatives.
  - Landscape allowance accounts for clearing, and grubbing, seeding, and some plantings.
- Alternatives 2A and 2B alignments utilize the existing Rush Line Corridor and impacts existing multi-use trail through a good portion of alignment. This entails relocation and reconstruction of the existing bike trail within the County Regional Railroad Authority right-of-way.
  - 14-foot travel lanes consisting of 12-inch concrete and 6-inch Class V.

- 10-foot bike trail with 2.5-inch bituminous and 4-inch Class V is allocated for full replacement based on assumption that it will need to be shifted to one side of the ROW to allow for BRT path. Chain link fence is added for a safety barrier between the trail and BRT transitway.
- Crossing of intersections are expected to entail reconstruction to account for grade transitions. Intersection reconstruction includes removals, concrete, Class V, and excavation.
- New signal systems needed to handle additional traffic lane (BRT) at intersections. These signal systems vary in size according to intersection.
- From Buerkle Road to 145th Street: BRT to be shoulder-running and would require shoulder rehabilitation to accommodate 14-foot bituminous shoulder.
- Landscape allowance accounts for clearing, and grubbing, seeding, and some plantings.

### **10.5.2 Commuter Rail**

- Alternative 1A (East Alignment): This alternative follows County Regional Railroad Authority rights-of-way, Minnesota Commercial right-of-way (BNSF) and St. Croix Valley Railroad right-of-way to Hinckley.
  - Mainline track is assumed to require complete rehabilitation throughout the length of the corridor to meet standards applicable to commuter rail use at desired speeds. Two tracks are allocated south of the Forest Lake Transit Center. Construction accounts for CWR 135 rail, concrete ties, ballast. Earthwork allowance is added for segments receiving an additional track.
  - Embedded trackwork was used at all at grade crossings and consist of girder rail fastened to a concrete slab and embedded in concrete.
  - Direct fixation trackwork was applied to all aerial structures and consists of standard direct fixation fasteners on a concrete base.
  - Grade crossings where railroad crossings do not currently exist have an allocation to rebuild the intersection and signals as a rail crossing will need to be reestablished. Intersection rebuilds include removals, concrete, Class V, and excavation.
  - Existing 10-foot bituminous bike trail to be reconstructed at edge of right-of-way for segments of alignment currently containing trail. No allowance is made for segments that currently do not include a bike trail within the right-of-way.
  - Landscape allowance accounts for clearing, and grubbing, seeding, and some plantings.
- Alternative 1B (West Alignment): This alternative the existing Canadian Pacific Railway right-of-way that currently has an active line between downtown St. Paul and Hugo. Similar to Commuter Rail Alternative 1A, this alignment follows County Regional Railroad Authority rights-of-way and the St. Croix Valley Railroad right-of-way to Hinckley.
  - Mainline track is assumed to require complete rehabilitation throughout the corridor to meet standards applicable to commuter rail use at desired speeds. Two tracks are allocated south of Forest Lake transit center. Construction accounts for CWR 135 rail, concrete ties, ballast. Earthwork allowance is added for segments receiving an additional track.
  - Embedded trackwork was used at all at grade crossings and consist of girder rail fastened to a concrete slab and embedded in concrete between raised curbs.

- Direct fixation trackwork was applied to all aerial structures and consists of standard direct fixation fasteners on a concrete base.
- Current at-grade crossings are expected to need minimal crossing adjustments due to previously established grade transitions. Grade crossings were railroad crossings do not currently exist have an allocation to rebuild the intersection and signals as a rail crossing will need to be reestablished. Intersection rebuilds include removals, concrete, Class V, and excavation.
- Existing 10-foot bituminous bike trail to be reconstructed at edge of ROW for segments of alignment currently containing trail. This allowance was measured per route foot and includes removals, new bit, Class V, and earthwork. No allowance is made for segments that currently do not include a bike trail within the right-of-way.
- Landscape allowance accounts for clearing, and grubbing, seeding, and some plantings.

### 10.5.3 LRT

- LRT Alternatives 1A and 1B both follow the existing Ramsey County Regional Railroad Authority right-of-way up to approximately Maplewood, and would capitalize on the existing ROW. This estimate assumes two tracks and replacement of existing bike trail with a fence separating LRT tracks from trail users.
- Trackwork consist of 115 RE continuously welded rail, concrete ties, and ballast. Traction power, communication, and signal systems are separate cost from trackwork.
- At grade crossings received embedded trackwork consisting of girder rail with electrical isolation fastened to a concrete slab and embedded in concrete between raised curbs.
- Direct fixation trackwork was applied to all aerial structures and consists of standard direct fixation fasteners on a concrete base.
- Grade crossings have an allocation to rebuild the intersection and signals as a rail crossing will need to be reestablished. Intersection rebuilds include removals, concrete, Class V, and excavation.
- Existing 10-foot bituminous bike trail to be reconstructed at edge of right-of-way for segments of alignment currently containing trail. This allowance was measured per route foot and includes removals, new bit, Class V, and earthwork. No allowance is made for segments that currently do not contain a bike trail within the right-of-way.
- Landscape allowance accounts for clearing, and grubbing, seeding, and some plantings.

## 10.6 Summary of Results

**Table 10-1** presents the summary of the capital cost estimates developed for the No-Build, TSM, BRT, Commuter Rail and LRT alternatives. The two Commuter Rail alternatives have the highest capital cost because they span the longest distance and account for major infrastructure modifications that are anticipated to traverse the two wyes adjacent to the Union Depot in downtown St. Paul. Similarly, BRT 1A is the costliest BRT alternative because it serves the entire 80-mile Rush Line Corridor.

**Table 10-1: Summary of Capital Cost Estimates (Year 2008 Dollars)<sup>1</sup>**

<b>Alternative</b>	<b>Length (miles)</b>	<b>Capital Cost (\$ million)</b>	<b>Cost per Mile (\$ million)</b>
No-Build	N/A	\$ 18.8	N/A
TSM	N/A	39.1	N/A
BRT 1A	79.9	510.7	\$ 6.4
BRT 1B	26.3	189.3	7.2
BRT 2A	9.9	120.6	12.2
BRT 2B	21.5	173.4	8.1
Commuter Rail 1A	75.8	758 – 903	10.0 – 11.9
Commuter Rail 1B	77.4	814 – 959	10.5 – 12.4
LRT 1A	7.1	270.1	37.9
LRT 1B	10.9	407.1	37.5
LRT Modified 1B <sup>2</sup>	10.9	441.2	40.6

The most expensive elements of the No-Build and TSM alternatives are the purchase of new buses and construction of new park-and-ride facilities and transit centers.

<sup>1</sup> Right-of-way costs will be determined in subsequent phase of the project.

<sup>2</sup> Sharing tracks with Central Corridor is assumed to result in minimal additional track-related capital cost. Difference in capital cost related to LRT Alternative 1B is mostly attributable to change in LRT fleet requirements, i.e. seven additional LRV's for Modified LRT 1B. There maybe some addition costs associated with sharing tracks that will need to be examined further in the Advanced Alternatives Analysis.

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