



**SOUTHWEST**  
transitway

green means go.

## **Southwest LRT**

### **Technical Memorandum No. 7B**

# **OPERATING COST EVALUATION**

PRELIMINARY  
FOR REVIEW ONLY

September 9, 2009





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## 1.0 OPERATING AND MAINTENANCE COSTS (O&M)

Operating and Maintenance Costs (O&M) are defined as the ongoing annual costs to operate and maintain each LRT alternative. The O&M costs are presented for the operation of the Southwest LRT Build alternatives as a stand alone estimate and for the total transit system. The System Wide Transit O&M costs are utilized in the calculation of cost effectiveness. All costs are stated in 2008 dollars. The System Wide O&M costs are based on 2030 transit service levels and assume a peak service is six hours in length and off-peak service is 13 hours in length.

O & M costs consist of the ongoing costs associated with operating, maintaining, and managing the transit system. These costs typically include:

- Labor costs
- Fuel and electricity
- Parts and materials
- Non-labor operating costs to maintain support facilities (stations, bus stops, transit centers, maintenance facilities, etc.)
- Administrative costs including labor, supplies, building operations, communications, etc.
- Insurance

The methodology used in this memorandum is based on the Central Corridor LRT Project Technical Memorandum: O&M Cost Methodology & Results September 2, 2008. The Central Corridor project developed a cost model that assigns O&M costs to categories in order to define basic unit costs to calculate O&M costs that vary with the level of operations. These are considered variable costs. Variable costs are those where the cost of the function is dependent on the volume of activity. For example, the cost of operating a bus is stated in a unit of \$3.01 per mile. As the total miles of bus service change, the associated cost of that activity or function can be adjusted. Fixed costs are those that do not directly change with service levels. These costs include costs such as administrative salaries, offices, basic insurance, and administrative offices. Tables 3-1 and 3-2 display the variable cost categories and the unit costs assigned to each for bus and rail operations.

Table 3-1-Variable Cost Drivers, Bus

Category	Unit Cost
Annual Revenue Miles of Service	\$ 3.01
Annual Revenue Hours of Service	\$ 48.20
Peak Buses	\$ 35,254.00

Variable costs of the bus operations are 80% of the total O&M costs. Therefore, fixed cost are 20% (Total variable costs/.80 = total costs. Total costs – variable costs = fixed cost).

Table 3-2 Variable Cost Drivers, Rail

Category	Unit Cost
Annual Revenue Car Miles	\$ 1.93
Annual Revenue Train Hours	\$ 98.45
Peak Cars	\$ 49,805.00
Directional Track Miles	\$ 137,446.00
Stations	\$ 204,295.00

Category	Unit Cost
Vehicle Maintenance and Storage Facility / vehicle	\$73,148

Variable costs of the rail operations are 86% of the total O&M costs. Therefore, fixed costs are 14% (Total variable costs/.86 = total costs. Total costs – variable costs = fixed cost).

The Central Corridor O&M methodology assigned a variable cost of \$1,755,556 to the Vehicle Maintenance & Storage Facility (VMSF). For the estimate of O&M costs for the Southwest LRT Build alternatives, this value was converted to a cost per vehicle in order to account for the differences in fleet size associated with the alternatives. The calculation to determine the VMSF cost per vehicle is:

$$\frac{\$1,755,556 \times 2 \text{ yards}}{48 \text{ vehicles}} = \$73,148 \text{ per vehicle}$$

When calculating the system wide O&M costs, the cost per VMSF value was used.

For purposes of calculating the O&M costs for the Southwest LRT Build alternatives, it was assumed that the Southwest LRT and Central Corridor would interline and that the hours and levels of service (peak, off-peak frequency) established by the Central Corridor would apply to Southwest LRT. It was also assumed that Southwest LRT would be responsible to account for all costs of operation from the Intermodal station to the end of line for each Build alternative and that all trains would consist of 2 cars.

The base value of miles and hours of service are calculated for an average weekday. In order to convert these average daily values to annualized values it is necessary to multiply the average daily values by an Annualization factor. The Annualization factor used in bus O&M cost analysis is 299; the annualization factor used in rail O&M cost analysis is 349. This is consistent with Metro Transit guidelines.

## 1.1 Southwest LRT Project Results

The calculation of the light rail vehicles or cars required for the various Build alternatives is displayed in Table 3-3.

Table 3-3 Southwest Light Rail Vehicle Fleet

	1A + Central Corridor	3A + Central Corridor	3C-1	3C-2 + Central Corridor	Central Corridor only
One-way trip time (minutes)	65.5	71	39.5	80.3	39.5
Two-way Trip Time (minutes)	131	142	79	160.6	79
Layover (minutes)	19.65	21.3	11.85	24.09	11.85
Two-way w/Layover (minutes)	150.65	163.3	90.85	184.69	90.85
Peak Headway (minutes)	7.5	7.5	7.5	7.5	7.5
Trains Required	21	22	13	25	13
Cars Required (2-car Trains)	42	44	26	50	26

	1A + Central Corridor	3A + Central Corridor	3C-1	3C-2 + Central Corridor	Central Corridor only
Southwest Peak Cars	16	18	26	24	
Peak Cars + 15% spare	19	21	30	28	

The annual revenue train hours and annual revenue car miles for each of the Build alternatives is displayed in Table 3-4.

Table 3-4 Annual Train Hours/ Car Miles

Factor	1A + Central	3A + Central	3C-1 + Central	3C-2 + Central
SW Transit round trip time + 15% layover (minutes)	59.8	72.5	90.9	93.8
Peak period round trips	36	36	36	36
Mid-day round trips	42	42	42	42
Off peak round trips	34	34	34	34
Total daily round trips	112	112	112	112
Annualization	349	349	349	349
Annual Revenue Train Hours	38,958	47,199	59,186	61,134
EOL to EOL Track-Miles	24.76	26.79	38.91	28
SWEOL to Intermodal Station Track-Miles	13.76	15.79	n/a	17
SW EOL to Nicollet Ave. EOL	n/a	n/a	16.6	n/a
Peak Revenue miles of service (round trip distance)	991	1137	1195	1224
Midday Revenue miles of service (round trip distances)	1404	1611	1693	1734
Off-Peak revenue miles of service (round trip distance)	688	790	830	850
Daily Total SW Train Revenue Miles	3082	3537	3735	3808
Daily Revenue Car-Miles	6164	7074	7470	7616
Annualization Factor	349	349	349	349
Annual Revenue Car Miles	2,151,404	2,468,798	2,607,030	2,657,984

The O&M cost for each alternative is calculated by applying the operating characteristics, described in Tables 3-3 and 3-4, to the variable cost drives described in Table 3-2. The resulting O&M costs are summarized in Table 3-5 through 3-9.

Table 3-5 2008 O&amp;M Costs for LRT 1A

Variable	Assigned Costs	Units	Unit Cost	% of Total
Annual Revenue Car-Miles	\$ 4,152,209	2,151,404	\$ 1.93	21%
Annual Revenue Train Hours	\$ 3,835,386	38,958	\$ 98.45	20%
Peak Cars	\$ 796,880	16	\$ 49,805.00	4%
Directional Track-Miles	\$ 3,782,514	27.52	\$ 137,446.00	19%
Stations	\$ 2,860,130	14	\$ 204,295.00	15%
Maintenance Yards	\$ 1,389,812	19	\$ 73,148.00	7%
Fixed	\$ 2,737,640	LS	\$ 2,737,640.00	14%
<b>Total</b>	<b>\$19,554,571</b>			<b>100%</b>

Table 3-6 2008 O&amp;M Costs for LRT 3A

Variable	Assigned Costs	Units	Unit Cost	% of Total
Annual Revenue Car-Miles	\$ 4,764,780	2,468,798	\$ 1.93	21%
Annual Revenue Train Hours	\$ 4,646,718	47,199	\$ 98.45	20%
Peak Cars	\$ 896,490	18	\$ 49,805.00	4%
Directional Track-Miles	\$ 4,340,545	31.58	\$ 137,446.00	19%
Stations	\$ 3,473,015	17	\$ 204,295.00	15%
Maintenance Yards	\$ 1,536,108	21	\$ 73,148.00	7%
Fixed	\$ 3,094,261	LS	\$ 3,094,261.00	14%
<b>Total</b>	<b>\$ 22,751,917</b>			<b>100%</b>

Table 3-7 2008 O&amp;M Costs for LRT 3C-1

Variable	Assigned Costs	Units	Unit Cost	% of Total
Annual Revenue Car-Miles	\$5,031,568	2,607,030	\$ 1.93	19%
Annual Revenue Train Hours	\$5,826,837	59,186	\$ 98.45	22%
Peak Cars	\$1,294,930	26	\$ 49,805.00	5%
Directional Track-Miles	\$4,563,207	33.20	\$ 137,446.00	17%
Stations	\$4,085,900	20	\$ 204,295.00	15%
Maintenance Yards	\$2,194,440	30	\$ 73,148.00	8%
Fixed	\$3,743,678	LS	\$ 3,743,678.00	14%
<b>Total</b>	<b>\$26,740,560</b>			<b>100%</b>



Table 3-8 2008 O&M Costs for LRT 3C-2

Variable	Assigned Costs	Units	Unit Cost	% of Total
Annual Revenue Car-Miles	\$5,129,909	2,657,984	\$ 1.93	18%
Annual Revenue Train Hours	\$6,018,606	61,134	\$ 98.45	21%
Peak Cars	\$1,195,320	24	\$ 49,805.00	4%
Directional Track-Miles	\$4,673,164	34	\$ 137,446.00	16%
Stations	\$5,720,260	28	\$ 204,295.00	20%
Maintenance Yards	\$2,048,144	28	\$ 73,148.00	7%
Fixed	\$4,034,833	LS	\$ 4,034,833.00	14%
Total	\$28,820,236			100%

Table 3-9 Southwest LRT 2008 O&M Costs

Alternatives	2008 O & M Cost	Cost per train mile of Service	Cost per train revenue mile of service
Alternative 1A	\$19,554,571	\$18.18	\$501.94
Alternative 3A	\$22,751,917	\$21.15	\$482.04
Alternative 3C-1	\$26,740,560	\$20.51	\$451.81
Alternative 3C-2	\$28,820,236	\$21.69	\$471.43

## 1.2 System Wide O&M Costs

System wide O&M costs for the 2030 operating transit networks, including bus and all rail lines, are calculated in 2008 dollars utilizing the variable cost drivers stated in Tables 3-1 and 3-2.

Table 3-10 summarizes the average weekday vehicle hours and miles of travel for the Baseline or Transportation System Management (TSM) and the four Build alternatives as derived from the Metropolitan Council's travel forecast model. The forecast utilizes the May 1, 2009 socio/economic and demographic data and the 2030 transportation networks.

Table 3-10 System Wide Vehicle Miles and Vehicle Hours of Operation

	TSM		1A		3A		3C-1		3C-2	
	Vehicle Hours of Travel	Vehicle Miles of Travel	Vehicle Hours of Travel	Vehicle Miles of Travel	Vehicle Hours of Travel	Vehicle Miles of Travel	Vehicle Hours of Travel	Vehicle Miles of Travel	Vehicle Hours of Travel	Vehicle Miles of Travel
Off peak - Bus	5,015	77,035	4,943	75,313	4,947	75,390	4,930	75,123	4,940	75,394
Peak -Bus	4,921	87,945	4,871	86,803	4,875	86,879	4,864	86,708	4,859	86,640
Off peak - rail	176	3,360	231	5,094	242	5,345	259	5,442	262	5,522
Peak -rail	150	3,102	191	4,423	200	4,621	213	4,688	215	4,749
Daily - Bus	9,937	164,979	9,814	162,116	9,822	162,270	9,794	161,831	9,800	162,035
Daily - rail	326	6,462	422	9,517	442	9,965	472	10,130	477	10,272

Table 3-11 displays the System Wide Annual Bus O&M Costs in 2008 dollars. The following factors are used in these calculations:

- Unit Costs per Table 3-1
- Annualization Factor of 299
- Peak Buses assumes 1 bus for each 39,000 annual miles of service
- Variable costs =80% total costs

Table 3-11 System Wide Annual Bus O&M Costs

	TSM	1A	3A	3C-1	3C-2
Bus Miles	49,328,755	48,472,568	48,518,603	48,387,417	48,448,343
Unit Cost	\$ 3.01	\$ 3.01	\$ 3.01	\$ 3.01	\$ 3.01
Annual Revenue Miles Cost	\$ 148,479,553	\$ 145,902,428	\$ 146,040,996	\$ 145,646,125	\$ 145,829,514
Bus Hour+ 15% Layover	3,416,830	3,374,542	3,377,303	3,367,834	3,369,608
Unit Cost	\$ 48.20	\$ 48.20	\$ 48.20	\$ 48.20	\$ 48.20
Annual Bus Hours Cost	\$ 143,209,755	\$ 141,437,330	\$ 141,553,043	\$ 141,156,184	\$ 41,230,518
Peak Buses	1,281	1,263	1,263	1,261	1,262
Fleet Costs	\$ 5,169,764	\$ 44,385,764	\$ 44,427,918	\$ 44,307,792	\$ 44,363,582
Variable Cost Subtotal	\$ 336,859,072	\$ 331,725,522	\$ 332,021,957	\$ 331,110,101	\$ 331,423,614
Gen admin 20%	\$ 84,214,768	\$ 82,931,380	\$ 83,005,489	\$ 82,777,525	\$ 82,855,903
<b>Bus Total</b>	<b>\$ 421,073,841</b>	<b>\$ 414,656,902</b>	<b>\$ 415,027,446</b>	<b>\$ 413,887,626</b>	<b>\$ 414,279,517</b>

Table 3-12 displays the System Wide Rail O&M Costs in 2008 dollars. The following factors are used in these calculations:

- Unit costs per Table 3-2
- Average Daily volumes per Table 3-10
- Annualization Factor of 349
- Peak Cars equal 50 cars for Hiawatha LRT and Central Corridor plus the peak cars for the Build alternatives from Table 3-3
- Direction Track miles equals 43 miles for Hiawatha LRT and Central Corridor lines plus the directional track miles for the Build alternatives from Tables 3-5 through 3-8
- Stations equals 33 for the Hiawatha LRT and Central Corridor lines plus the stations for Southwest LRT Build alternatives from Tables 3-5 through 3-8
- VMSF assumes a cost per facility of \$1,755,556 and that Southwest LRT Build project will require one additional facility.
- Variable costs account for 86% of the total O&M costs therefore the fixed costs are 14% of the total costs.

Table 3-12 System Wide Rail O&M

Variable Cost Units	TSM	1A	3A	3C-1	3C-2
Car Miles (2car)	4510560	6642754	6955807	7070433	7169605
Unit Cost	\$ 1.93	\$ 1.93	\$ 1.93	\$ 1.93	\$ 1.93
Car Mile Cost	\$8,705,380	\$12,820,516	\$13,424,708	\$13,645,935	\$13,837,337
Train Hours + 15% layover	130,682	169,292	177,311	189,340	191,270
Unit Cost	\$ 98.45	\$ 98.45	\$ 98.45	\$ 98.45	\$ 98.45
Train Hours Cost	\$12,865,666	\$ 16,666,808	\$ 17,456,276	\$18,640,478	\$ 18,830,535
Peak Cars	50	66	68	76	74
Unit Cost	\$ 49,802	\$ 49,802	\$ 49,802	\$ 49,802	\$ 49,802
Car Cost	\$ 2,490,100	\$ 3,286,932	\$ 3,386,536	\$3,784,952	\$ 3,685,348
Directional track miles	43	70.52	74.58	76.20	77.00
Unit Cost	\$ 137,446	\$ 137,446	\$ 137,446	\$ 137,446	\$ 137,446
Track Cost	\$ 5,910,178	\$ 9,692,692	\$10,250,723	\$10,473,385	\$10,583,342
Stations	33	47	50	53	54
Unit Cost	\$ 204,295	\$ 204,295	\$ 204,295	\$ 204,295	\$ 204,295
Station Cost	\$ 6,741,735	\$ 9,601,865	\$10,214,750	\$10,827,635	\$11,031,930
Maintenance facility	2	3	3	3	3
Unit Cost	\$1,755,556	\$1,755,556	\$1,755,556	\$1,755,556	\$1,755,556
Maintenance Facility Costs	\$3,511,112	\$5,266,668	\$5,266,668	\$5,266,668	\$5,266,668
Total Variable costs	\$40,224,171	\$57,335,481	\$59,999,661	\$62,639,053	\$63,235,160

Variable Cost Units	TSM	1A	3A	3C-1	3C-2
Fixed Cost @14% of Total Costs	\$6,548,121	\$9,333,683	\$9,767,387	\$10,197,055	\$10,294,096
Total Rail O&M	\$46,772,292	\$66,669,163	\$69,767,047	\$72,836,108	\$73,529,255

Table 3-13 summarizes the System Wide O&M costs for the Baseline or TSM and four Build alternatives. This table also shows the 2008 costs escalated to 2015 dollars and the costs reported in the AA for the retained alternatives.

Table 3-13 System O&amp;M Costs

	TSM	1A	3A	3C-1	3C-2
System Wide Bus O&M 2008	\$ 421,073,841	\$ 414,656,902	\$ 415,027,446	\$ 413,887,626	\$ 414,279,517
System Wide Rail O&M 2008	\$ 46,772,292	\$ 66,669,163	\$ 69,767,047	\$ 72,836,108	\$ 73,529,255
Total System O&M 2008	\$ 467,846,133	\$ 481,326,066	\$ 484,794,493	\$ 486,723,734	\$ 487,808,772
Rail O&M Cost per Train Revenue Mile	\$ 20.74	\$ 20.07	\$ 20.06	\$ 20.60	\$ 20.51
System Wide Costs/ Pass. Mile	\$ 186.60	\$ 188.95	\$ 188.59	\$ 190.45	\$ 189.45
Rail Operating Cost per Revenue Hour	\$ 357.91	\$ 393.81	\$ 393.47	\$ 384.69	\$ 384.43