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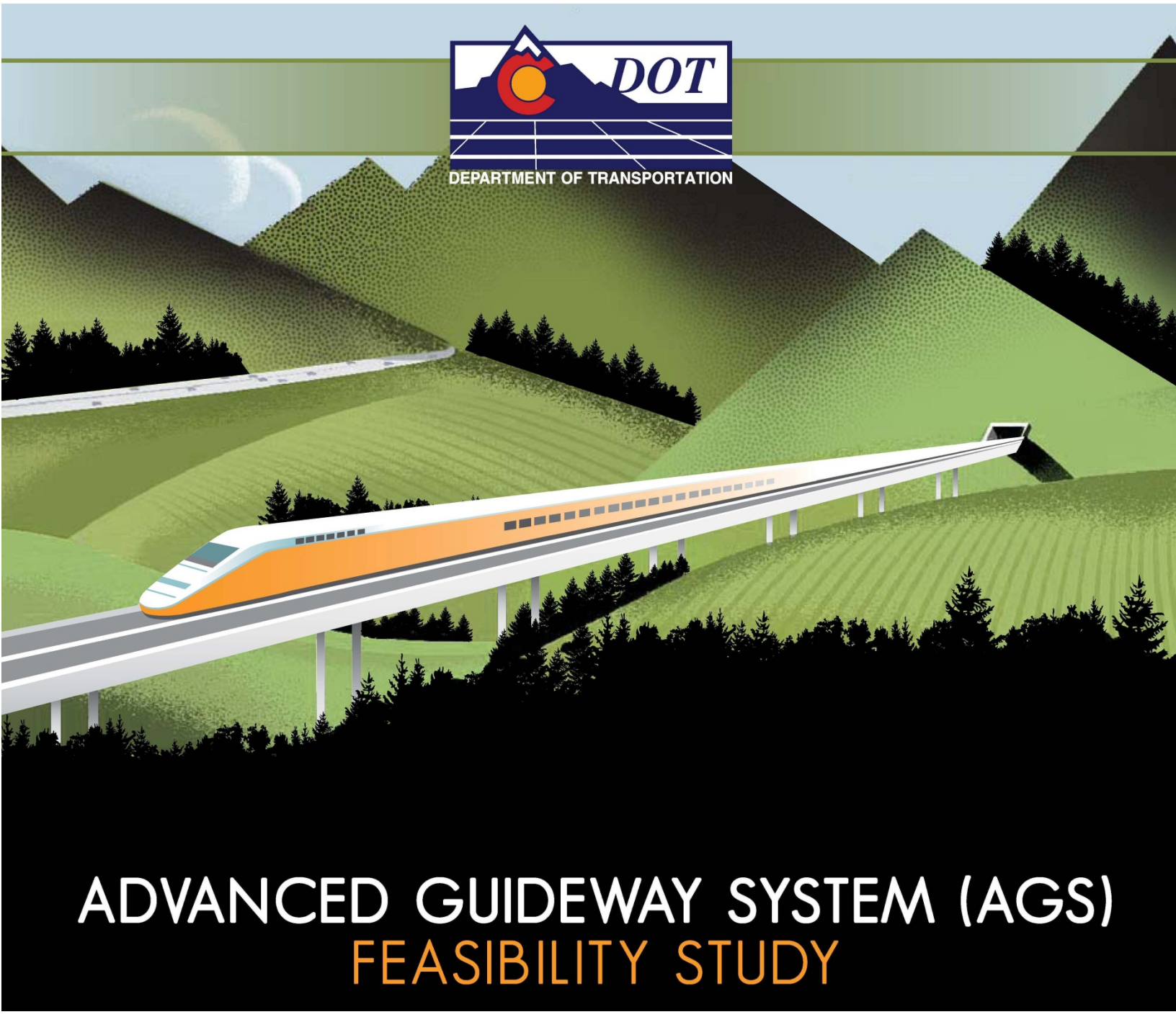

APPENDIX G
OPERATIONS AND MAINTENANCE COST ESTIMATION MODEL

Operations and Maintenance Cost Methodology and Results

The Colorado Department of Transportation is conducting an Advanced Guideway System Feasibility Study (AGS Feasibility Study or Project) to evaluate technology, alignment and financing options related to a proposed high-speed transit system for the 120-mile segment of the I-70 Mountain Corridor from C-470/Jefferson County Government Center light rail station to Eagle County Regional Airport.

In addition, the AGS Feasibility Study interfaces directly with CDOT's concurrent Interregional Connectivity Study (ICS), which is responsible for identifying and evaluating high-speed rail options between the eastern boundary of the AGS study area and DIA as well as integration with the Regional Transportation District's FasTracks system, and alignments, technologies and stations for high-speed rail along Colorado's Front Range between Fort Collins and Pueblo.

At this point in the AGS Project, the technologies identified for evaluation are: High Speed Steel Rail (HS Rail), High Speed Magnetic Levitation (High Speed Maglev) and Low Speed Magnetic Levitation (120-mph Maglev).

This report describes methods used to estimate annual operating and maintenance costs for the alternatives under evaluation and resulting cost estimates for AGS Project alternatives.

1. General Methodology

An operating and maintenance (O&M) cost model estimates the annual cost to operate, maintain and administer a transit system for a given set of service indicators. O&M costs are expressed as the annual total of employee earnings and fringe benefits, contract services, materials and supplies, utilities, and other day-to-day expenses incurred in running a transit system. In general, the steps of the O&M cost estimating process are:

1. Develop methodology for estimating O&M costs;
2. Develop appropriate cost model(s) to evaluate alternatives;
3. Generate operating plans and statistics for each study alternative; and
4. Estimate annual O&M costs for each study alternative.

The methodology for O&M costing of the AGS Feasibility Study alternatives is based on the principal assumption that annual operating and maintenance costs vary according to labor productivity, consumption rates, and system characteristics related to service and facilities. The system and service (also called supply) variables selected to describe the AGS study alternatives are:

Annual Revenue Train-Hours: The hours that trains travel while in revenue service over the entire fiscal year. Revenue train-hours include layover and schedule recovery but exclude time for deadhead, operator training and maintenance testing.

Annual Revenue Train-Miles: The miles that trains travel while in revenue service over the entire fiscal year. Revenue train-miles exclude deadhead, operator training and maintenance testing.

Annual Revenue Car-Miles: The miles that passenger cars travel during a year of revenue service. Revenue car-miles exclude deadhead, operator training and maintenance testing.

Fixed Guideway Route Miles: The end-to-end mileage over which trains travel in revenue service, which excludes staging or storage tracks. From a maintenance perspective, the guideway includes all buildings and structures dedicated to the operation of transit including track, tunnels, bridges and wayside electrical elements.

Number of Major Stations: Major stations are defined where particularly high volumes of passengers and/or connections to other major transportation services occur. For the AGS study corridor, the West Suburban station is defined as a major station. DIA would also be considered a major station.

Number of Minor Stations: The stations that do not have unusually high passenger activity or connect to other major transportation services are considered minor stations. The majority of the AGS stations are identified under this category.

Number of Peak Cars: The maximum number of passenger service vehicles in simultaneous operation.

Typical development of an O&M cost model involves developing productivity ratios with actual expenses and system characteristics from established systems. However, very scant information is available due to the limited application or lack of AGS study technologies currently operating revenue service in the United States. Therefore, the O&M cost model builds on actual O&M costs and data available for more traditional rail systems, tailoring specific line items to account for technology differences. Information on traditional rail systems included Utah Transit Authority for their commuter rail service, as they have been able to maintain lower O&M costs relative to other properties. Information provided by Transrapid International-USA, Inc. (TRI) and American Maglev Technology, Inc. (AMT) was incorporated as applicable.

2. O&M Cost Spreadsheet Models

Operating and maintenance spreadsheet cost models were developed as Excel worksheets containing a series of line items that can be applied across all AGS study alternatives and also to the ICS study alternatives. The expense categories and line items represent a simplified version of the 'chart of accounts' used by the Federal Transit Administration for the National Transit Database but with added detail for station operation and facilities maintenance.

Expense Line Items

The project cost models organize typical O&M expenses among three functional areas: Operations, Maintenance, and General Administration. Sub functions within each of these functional areas are as follows:

- **Operations** includes Administration, Train Operations and Station Operations.
- **Maintenance** includes Administration, Vehicle Maintenance, and Right-of-Way (ROW) Maintenance.
- **General Administration** represents the Rail Director and staff supporting overall program functions such as Legal, Accounting, Finance, Human Resources, Marketing, Customer Service, IT, Purchasing, Safety and Risk Management.

Each of these functions identifies separate labor and non-labor expenses, which enables the models to incorporate various assumptions on annual earnings, productivity, staffing, annual earnings, and non-labor consumption rates.

Look-Up Codes

The models use two Labor Codes with formulas that reference wage and productivity rates.

Labor Code 1 references wage and salary assumptions derived from various information sources and presented in Table 1. This look-up table contains the annual wages or salaries assumed for all of the job classifications that are modeled. Most of them represent multiple jobs that are combined in the model and their earnings averaged for purposes of cost-estimating consistency among the study alternatives.

Labor Code 2 references labor productivity rates used to estimate staffing levels. Table 2 displays the look-up information for this code, including an expanded list of job classifications by type of technology. Job classifications with productivity designated as "Fixed" represent staffing levels that are assumed to remain constant regardless of rail system size. For the job classifications with variable productivity rates, Table 2 shows how the model makes those calculations. The productivity and staffing level assumptions were derived with information compiled from various sources, and are intended to represent differences among the alternative technologies. Many of these labor productivity rates were developed by first estimating a productivity rate for conventional commuter rail, and then adjusting when appropriate to account for HS Rail and Maglev technologies.

The model's non-labor items are for estimating the annual cost of contract services, materials and supplies, utilities, insurance, and other miscellaneous expenses incurred in the day-to-day operation of a transit system. The model's **Non-Labor Code** column references the look-up information shown as Table 3.

Table 1
LABOR CODE 1 – WAGE/SALARY ASSUMPTIONS

Job Classification	Lookup Code	USE Annual Wages
Operations		
Administration		
Operations Manager	10.0	$140,000
Administrative Assistant	11.0	$50,000
Train Operations		
Supervisors/Controllers	12.0	$75,000
Operators	13.0	$60,000
Train Attendants	14.0	$40,000
Training Instructors	15.0	$75,000
Station Operations		
Station Managers	16.0	$75,000
Station Attendants	17.0	$40,000
Maintenance		
Administration		
Maintenance Director	20.0	$140,000
Administrative Assistant	21.0	$50,000
Vehicle Maintenance		
Veh Maint Supervisors	22.0	$75,000
Rail Car Technicians	23.0	$60,000
Veh Maint Parts Clerks	24.0	$50,000
ROW Maintenance		
Track/Guideway Manager	25.0	$75,000
Track/Guideway Technicians	26.0	$60,000
CTC/Train Control Manager	27.0	$75,000
CTC/Train Control Technicians	28.0	$60,000
Facil Maint Materials Clerks	29.0	$40,000
General Administration		
Rail Director	40.0	$200,000
Rail Service Adminisration	41.0	$75,000

Table 2
LABOR CODE 2 – PRODUCTIVITY/STAFFING ASSUMPTIONS

Job Classification	Lookup Code	Productivity Rate	Productivity Driver
Operations			
Administration			
Operations Manager	10.1	Fixed	1 position
Administrative Assistant	11.1	Fixed	1 position
Train Operations			
Supervisors/Controllers	12.1	7,000	Rev. Train-Hrs/FTE
Operators	13.1	1,400	Rev. Train-Hrs/FTE
Train Attendants	14.1	1,400	Rev. Train-Hrs/FTE
Training Instructors	15.1	Fixed	1 position
Station Operations			
Station Managers	16.1	4.00	Total Stations/FTE
Station Attendants			
Major Stations	17.1	0.22	Major Stations/FTE
Minor Stations	17.2	0.44	Minor Stations/FTE
Maintenance			
Administration			
Maintenance Director	20.1	Fixed	1 position
Administrative Assistant	21.1	Fixed	1 position
Vehicle Maintenance			
Veh Maint Supervisors			
High Speed Rail	22.4	1,066,667	Rev. Car-Mi./FTE
120-mph Maglev	22.5	5	Rev. Car-Mi./FTE
High Speed Maglev	22.6	5	Rev. Car-Mi./FTE
Rail Car Technicians			
High Speed Rail	23.4	213,333	Rev. Car-Mi./FTE
120-mph Maglev	23.5	1.0	Peak Car/FTE
High Speed Maglev	23.6	1.0	Peak Car/FTE
Veh Maint Parts Clerks			
High Speed Rail	24.4	2,133,333	Rev. Car-Mi./FTE
120-mph Maglev	24.5	10.0	Peak Car/FTE
High Speed Maglev	24.6	10.0	Peak Car/FTE
ROW Maintenance			
Track/Guideway Manager			
High Speed Rail	25.4	25.0	Route Mi./FTE
120-mph Maglev	25.5	25.0	Route Mi./FTE
High Speed Maglev	25.6	25.0	Route Mi./FTE
Track/Guideway Technicians			
High Speed Rail	26.4	5.0	Route Mi./FTE
120-mph Maglev	26.5	5.0	Route Mi./FTE
High Speed Maglev	26.6	5.0	Route Mi./FTE
CTC/Train Control/Power Manager			
High Speed Rail	27.4	5.0	Route Mi./FTE
120-mph Maglev	27.5	8.0	Route Mi./FTE
High Speed Maglev	27.6	8.0	Route Mi./FTE
CTC/Train Control/Power Technicians			
High Speed Rail	28.4	1.0	Route Mi./FTE
120-mph Maglev	28.5	1.6	Route Mi./FTE
High Speed Maglev	28.6	1.6	Route Mi./FTE
Facil Maint Materials Clerks	29.1	25	Route Mi./FTE
General Administration			
Rail Director	40.1	Fixed	1 position
Rail Service Adminisration	41.11	25.0	Route Mi./FTE
Rail Service Adminisration	41.12	2.5%	FTE's

Table 3
NON-LABOR CODE – ASSUMPTIONS

Non-Labor Cost Item	Look-Up Code	Unit Rate	Driver
Operations			
Administration			
Miscellaneous	100.1	5.0%	of Ops Admin Labor Wages
Train Operations			
Train Propulsion			
High Speed Rail - Distribution	101.41	$116,870	Route Miles
High Speed Rail - Consumption	101.42	$0.28	Rev. Train-Mi.
120-mph Maglev - Distribution	101.51	$111,548	Route Miles
120-mph Maglev - Consumption	101.52	$0.26	Rev. Train-Mi.
High Speed Maglev - Distribution	101.61	$100,393	Route Miles
High Speed Maglev - Consumption	101.62	$0.46	Rev. Train-Mi.
Train Security Contract Services	102.1	$12.00	Rev. Train-Hr.
Miscellaneous	103.1	5.0%	of Train Ops Labor Wages
Station Operations			
Station Security Contract Services			
Major Stations	104.1	$60,000	Major Station
Minor Stations	104.2	$30,000	Minor Station
Station Maint. Contract Services			
Major Stations	105.1	$100,000	Major Station
Minor Stations	105.2	$50,000	Minor Station
Station Utilities			
Major Stations	106.1	$30,000	Major Station
Minor Stations	106.2	$15,000	Minor Station
TVM Maintenance			
Major Stations	107.1	$20,000	Major Station
Minor Stations	107.2	$10,000	Minor Station
Miscellaneous	108.1	5.0%	of Station Ops Labor Wages
Maintenance			
Administration			
Miscellaneous	200.1	5.0%	of Maint. Admin. Labor Wages
Vehicle Maintenance			
Vehicle Parts, Materials			
High Speed Rail	201.4	$0.31	Rev. Car-Mile
120-mph Maglev	201.5	$0.31	Rev. Car-Mile
High Speed Maglev	201.6	$0.31	Rev. Car-Mile
Car Cleaning Contract Services			
High Speed Rail	202.4	$5,000	Peak Car
120-mph Maglev	202.5	$5,000	Peak Car
High Speed Maglev	202.6	$10,000	Peak Car
Locomotive Maint. Contract Services	203.1	$1.61	Rev. Train-Mile
Miscellaneous	204.1	5.0%	of Veh. Maint. Labor Wages

Table 3 (continued)
NON-LABOR CODE – ASSUMPTIONS

Non-Labor Cost Item	Look-Up Code	Unit Rate	Driver
ROW Maintenance			
Materials & Supplies			
High Speed Rail	205.4	$5,200	Route Mile
120-mph Maglev	205.5	$5,200	Route Mile
High Speed Maglev	205.6	$5,200	Route Mile
ROW Maint. Contract Services			
High Speed Rail	206.4	$6,600	Route Mile
120-mph Maglev	206.5	$6,600	Route Mile
High Speed Maglev	206.5	$6,600	Route Mile
Miscellaneous	207.1	5.0%	of ROW Maint. Labor Wages
General Administration			
Insurance	400.11	$5,000,000	Fixed
Insurance	400.12	$20,000	Route Mile
Materials & Supplies	401.1	$10,000	Route Mile
Utilities	402.1	$1.26	Rev. Train-Mi.
Miscellaneous	403.1	5.0%	of G&A Admin. Wages

Some of the key labor productivity rates shown in Table 2 reflect the following assumptions:

Operations

Train Operators are staffed at one for every 1,400 revenue train-hours for all study modes, Supervisor/Controllers at one for every five operators, and one Train Attendant for every operator (i.e., two-person train crews).

One Station Manager is assumed for every four stations. There is one Station Attendant per shift for each minor station (two shifts per minor station), with staffing doubled for major stations.

Vehicle Maintenance

One Supervisor is assumed for every five Rail Car Technicians, and one Parts Clerk for every 10 Rail Car Technicians, for all study modes.

One Rail Car Technician is estimated for every 213k revenue car-miles of High Speed Steel Rail; one per peak car for both Maglev technologies.

ROW Maintenance

Managers (Track/Guideway and Train Control/Power) are staffed at one for every five technicians for all study modes.

Track/Guideway Technicians are modeled as one for every 5.0 route miles, assumed consistent for all study modes.

Train Control/Power Technicians are assumed to be staffed as the rate of one per route mile for High Speed Steel Rail, and one per 1.6 route miles for both Maglev technologies.

The model assumes two Facilities Maintenance Clerks for every 50 route miles, with two maintenance facilities for the Full-Build scenarios.

Administration

All specific administration job classifications are modeled as fixed positions. The aggregated administrative support functions are staffed as one for every 20 route miles (with a minimum of five positions) plus 2.5% of the number of FTEs estimated for the line functions of operations and maintenance.

Supply Variable Unit Costs

For purposes of designing a methodology that would distinguish major differences among alternative modes, some expense items are modeled with consistent unit cost assumptions that apply regardless of mode. Fringe benefits are set at 40% of all wages and salaries, and for all study modes. For expenses with consistent unit costs based directly on a supply (system or service) variable, the line item totals may differ by alternative, but only because the number of driving units change (e.g., more or fewer stations, route miles). Functions modeled with consistent unit costs are:

- Operations Administration and Maintenance Administration
- Train crews (one operator and one train attendant, calculated based on the number of train-hours of service)
- Station operations and maintenance costs (calculated based on the number of stations)
- On-board and station security (assumed to be contracted services)
- Vehicle cleaning (assumed to be a contracted service)
- General Administration

The spreadsheet cost models distinguish primary differences among modes with variable unit costs related to propulsion power, vehicle maintenance, and ROW maintenance. Propulsion power is driven primarily by route miles (distribution) as opposed to usage (consumption). The lookup codes presented in Tables 2 and 3 are used to identify the assumed supply variable unit cost.

Staffing Levels

The model estimates the number of full-time equivalent (FTE) employees for specific job classifications by combining labor productivity assumptions, supply variable unit cost rates and the cost driver values associated with each test alternative. The number of staff estimated is multiplied by the assumed salary to calculate a line item labor cost. The lookup codes presented in Table 2 are used to determine the labor productivity rate that calculates staffing levels.

Cost Ranges

The AGS Project O&M cost models calculate two cost estimates for any modeled alternative, providing a planning contingency for items with little or no actual operating data. The model features used for the expense range are:

Low-Range Cost Estimate for each line item, calculated by applying the unit cost to the quantity of the identified driving variable for each study alternative. A model's total estimated annual O&M cost is calculated by summing all line items, and expressed in 2013 dollars.

Uncertainty Factors that acknowledge there may be a notable variance from calculated O&M costs since some line items must rely heavily on assumptions when actuals are not available. Uncertainty factors of 15%, 25% or 50% were applied to each line item cost. The highest uncertainty (50%) was assigned to propulsion and insurance for High Speed Steel Rail and Maglev technologies.

High-Range Cost Estimates which apply line item uncertainty factors to the low-range cost estimate. Again, the total estimated annual O&M cost based on integrating the uncertainty factor is calculated by summing all line items.

Project Alternatives

3. Project O&M Cost Estimates

After establishing appropriate unit costs, an O&M cost model requires the development of operating statistics that are based on service plans for each alternative. For the AGS Project, there basically are two alternatives to evaluate for each mode: a Full-Build alternative and a Minimum Operating Segment (MOS). The HS Rail alternative has a different alignment, operating plan and travel speed than the Maglev alternatives. As previously noted, there are two different types of Maglev alternatives – high speed and 120 mph. The two Maglev alternatives have different runtimes and an added station for the 120 mph Maglev due to differences in achievable maximum speeds and corresponding differences in curvature/alignment.

All alternatives are based on an 18-hour daily span of service, seven days a week. For highest-demand days (considered Thursday through Sunday for the AGS corridor), hourly service is assumed for 12 hours of the day and 30-minute frequencies during six hours of the day. For lighter days (Monday through Wednesday), an hourly frequency is assumed for the bulk of the day. Station and service plan assumptions are as follows:

- Full-Build Maglev: Trains are assumed to operate between Golden (Suburban West) and Eagle County Regional Airport (ECRA), with intermediate stations at Idaho Springs, Keystone, Breckenridge, Copper Mountain (for 120 mph maglev only), Vail, and Avon. The basic operating plan assumes 24 round trips daily from Thursday through Sunday, and 15 round trips daily from Monday through Wednesday.

- Full-Build Maglev to DIA: For this alternative, trains operate between DIA and Eagle County Regional Airport, thereby adding stations at DIA and I-76/72nd Avenue in the metro Denver area. This alternative was tested only for the high speed maglev technology. The operating plan assumes 24 round trips daily from Thursday through Sunday, and 15 round trips daily from Monday through Wednesday.

- Full-Build HS Rail: The HS Rail alternative is only able to serve Breckenridge with a separate branch so there are two line patterns. The main line serves Jefferson County, Idaho Springs, Lakeside, and Vail, terminating at Eagle County Regional Airport. The spur line proceeds from Jefferson County Station to Idaho Springs, Lakeside and Breckenridge. There would be 24 round trips operated Thursday through Sunday (18 on mainline, 6 on branch), and 15 round trips Monday through Wednesday (9 on mainline, 6 on branch).

- MOS: Trains would operate between Suburban West and Breckenridge. There would be four stations for all modes. For the basic operating plan, Thursday through Sunday trains would operate 24 round trips and Monday through Wednesday 15 round trips would be provided. An MOS alignment scenario has been defined for both High Speed Rail and Maglev.

Differences among the modes include the capacity of passenger cars and the make-up of train consists, both of which have implications for annual operating costs. In an attempt to be as consistent as possible for cost estimating, train consist assumptions were made as follows:

- High Speed Steel Rail would operate 10 passenger cars per train, providing a capacity of 450 passengers per train.

- High Speed Maglev would operate five passenger cars per train, providing a capacity of 410 passengers per train.

- 120-mph Maglev trains operate as two-car married pairs with a capacity of 186 passengers per married pair train. Two scenarios were evaluated for 120-mph Maglev: 24 trips per day, Thursday through Sunday, for ***equivalent level of train service*** as other alternatives (i.e., 30-minute average peak period frequencies), and 48 trips per day, Thursday through Sunday, for ***comparable passenger capacity*** as the other alternatives (i.e., 15-minute average peak period frequencies).

Tables 3 and 4 summarize O&M cost model results for the full corridor alternatives as well as the MOS alternatives.

- For service from Golden to ECRA, operating costs range from $45 million to $73 million annually when accounting for low versus high estimates. The highest O&M operating costs are associated with the high speed steel rail alternative.

- Due to its greater mileage and associated longer travel time, the high speed maglev alternative from DIA to ECRA has an annual O&M cost ranging from $59 million to $78 million.

- For the MOS options from Golden to Breckenridge, O&M costs range from $26 million to $48 million. Again, the highest O&M operating cost estimates are associated with the high speed steel rail alternative.

Figures 1 and 2 illustrate the break out of costs (labor and non-labor and by type of cost) for each alternative (full-build and MOS). Propulsion power costs are the largest single component of the O&M cost estimates, with power consisting of 20 to 30 percent of an alternative's total estimated O&M cost. Power cost estimates were previously determined for AGS alternatives in a technical paper that took into consideration high speed rail and Maglev power consumption and distribution requirements and Xcel energy rates. Information from this prior analysis was incorporated into this project's O&M cost estimates. Insurance costs are also a significant portion of the O&M cost estimates. As noted earlier, a high level of uncertainty has been assigned to both of these cost items in the high range of cost estimates.

Finally, it should be noted that O&M costs are based on the defined service plan that assumes 24 round trips per day on high-volume days. Preliminary analysis of ridership forecasts suggests that more frequent service may be needed during peak use. While much of the demand can be accommodated by scheduling more of the 24 round trips during peak periods, it may be advisable to add more trips overall, thereby increasing the estimated O&M costs.

Operating plan tables for each project alternative are provided in Appendix A of this document. Detailed cost estimate tables are provided in Appendix B.

Table 3:
Full-Build System Annual O&M Cost Estimates

Service Characteristics & O&M Cost Categories		High Speed Steel Rail Low	High Speed Steel Rail High	High Speed Maglev Low	High Speed Maglev High	120 mph Maglev 30 min Low	120 mph Maglev 30 min High	120 mph Maglev 15 min Low	120 mph Maglev 15 min High	High Speed Maglev to DIA Low	High Speed Maglev to DIA High
Service Statistics	Revenue Train-Hours	21,290	21,290	22,540	22,540	29,420	29,420	58,850	58,850	28,170	28,170
	Revenue Train-Miles	1,307,600	1,307,600	1,712,800	1,712,800	1,695,600	1,695,600	3,389,500	3,389,500	2,240,700	2,240,700
	Revenue Car-Miles	13,080,600	13,080,600	8,563,300	8,563,300	3,389,500	3,389,500	6,779,000	6,779,000	11,196,300	11,196,300
	Route Miles	108	108	116	116	115	115	115	115	152	152
	Major Stations	1	1	1	1	1	1	1	1	3	3
	Minor Stations	5	5	6	6	7	7	7	7	6	6
	Peak Cars	40	40	30	30	16	16	32	32	35	35
ANNUAL O&M COST ESTIMATE (2013$)											
Operations	Administration	$276,000	$318,000	$276,000	$318,000	$276,000	$318,000	$276,000	$318,000	$276,000	$318,000
	Train Operations	$15,857,000	$22,810,000	$15,505,000	$22,226,000	$17,229,000	$24,500,000	$21,498,000	$29,598,000	$20,101,000	$28,863,000
	Station Operations	$1,881,000	$2,232,000	$2,160,000	$2,562,000	$2,381,000	$2,826,000	$2,381,000	$2,826,000	$3,102,000	$3,683,000
	Total	$18,014,000	$25,360,000	$17,941,000	$25,106,000	$19,886,000	$27,644,000	$24,155,000	$32,742,000	$23,479,000	$32,864,000
Maintenance	Administration	$276,000	$318,000	$276,000	$318,000	$276,000	$318,000	$276,000	$318,000	$276,000	$318,000
	Vehicle Maintenance	$11,447,000	$14,086,000	$6,580,000	$8,114,000	$2,994,000	$3,685,000	$5,988,000	$7,369,000	$8,135,000	$10,036,000
	ROW Maintenance	$15,645,000	$19,111,000	$12,190,000	$14,902,000	$11,980,000	$14,647,000	$11,980,000	$14,647,000	$15,738,000	$19,240,000
	Total	$27,368,000	$33,515,000	$19,046,000	$23,334,000	$15,250,000	$18,650,000	$18,244,000	$22,334,000	$24,149,000	$29,594,000
General Administration		$10,000,000	$14,007,000	$10,222,000	$14,322,000	$10,077,000	$14,146,000	$10,295,000	$14,397,000	$11,484,000	$16,023,000
TOTAL O&M COST ESTIMATE		**$55,382,000**	**$72,882,000**	**$47,209,000**	**$62,762,000**	**$45,213,000**	**$60,440,000**	**$52,694,000**	**$69,473,000**	**$59,112,000**	**$78,481,000**

Note: Low estimate is base cost as calculated by resource build-up O&M cost model.
High estimate incorporates uncertainty factors to account for scant availability of actuals for operating data and costs.

Figure 1:
Full-Build System Annual O&M Cost Estimates