Technical Memorandum #8 – O&M Cost Methodology

Introduction

This Technical Memorandum documents the methodology used to develop planning-level operating and maintenance (O&M) cost estimates for the Illinois High-Speed Rail Feasibility Study. O&M costs represent the recurring expenditures required to support safe, reliable, and continuous high-speed rail service across each evaluated route between Chicago and East St. Louis.

Costs were developed for all potentially feasible route options to allow consistent comparison of financial performance across alignments. The methodology reflects a combination of:

- Unit cost benchmarking from comparable high-speed rail studies
- Corridor-specific service levels and train-mile calculations
- Standardized operational assumptions

The resulting O&M estimates represent full operating service conditions following commencement of revenue operations.

O&M Cost Development Methodology

Approach

Operating and maintenance costs were estimated using a train-mile–based cost framework. Under this approach, total annual train-miles operated on each corridor are multiplied by a standardized per train-mile unit cost to generate annual systemwide O&M expenditures.

This methodology is commonly applied in early-stage high-speed rail feasibility studies where detailed workforce modeling and facility-level cost estimating are not yet warranted.

For each route option, total annual train-miles were calculated as:

Route length × daily train movements × 356 operating days

This process was applied consistently across all routes to ensure comparability of results.

Cost Components

The adopted unit cost reflects a comprehensive range of operating and maintenance activities typically incurred by high-speed rail systems, including:

- Train and onboard crew labor
- Dispatching and system operations
- Energy and traction power consumption
- Rolling stock preventive and heavy maintenance
- Track, power, and signal infrastructure maintenance
- Station operations and passenger services
- Insurance and regulatory compliance
- Administrative and systemwide overhead

Unit Cost Benchmarking

Three studies were evaluated for unit cost benchmarking: California High-Speed Rail, Colorado Department of Transportation (CDOT) Interregional Connectivity Study (ICS), and the NEC FUTURE. These studies are discussed below.

California High-Speed Rail O&M Costs

The O&M Cost Model presented in the California High-Speed Rail Authority (CAHSRA) 2024 Business Plan Technical Supporting Document: Operations and Maintenance Cost Model Documentation is a bottom-up forecasting model designed to estimate the full annual cost of operating the future high-speed rail system. The O&M model is organized into a series of functional cost categories that collectively represent the full cost of operating the system. These categories include:

- Train operations
- Dispatching
- Rolling stock maintenance
- Infrastructure maintenance
- Station operations and cleaning
- Police and security
- Commercial functions
- General administration
- Insurance
- Contingency
- Startup and commissioning costs

The methodology is heavily driven by operating assumptions and workforce requirements. Personnel needs are calculated using operating metrics such as annual train-hours, train-miles, maintenance cycles, facility sizes, and service frequencies. The model assumes that most positions are staffed with full-time employees and generally avoids reliance on overtime in the base operating scenario.

Service planning assumptions are a major driver of the O&M cost model. The analysis uses detailed timetable and operating assumptions incorporating train frequencies, trip times, deadhead movements, and blended operations with existing rail operators such as Caltrain and Metrolink. The model assumes full planned service levels begin immediately upon startup rather than ramping up gradually over time.

Train operations costs are based on staffing levels required for onboard crews, including train engineers, conductors, and assistant conductors. Staffing requirements are derived from annual train operating hours and include allowances for operational inefficiencies and crew scheduling constraints. Dispatching and control costs are developed separately and include staffing for operations control centers, line dispatchers, depot dispatchers, planning personnel, and system performance management staff.

Rolling stock maintenance costs are developed using inspection and overhaul cycles tied to train mileage and FRA regulatory requirements for inspection and testing. Personnel include mechanical and electrical technicians, supervisors, laborers, and storehouse employees.

Station operations are treated as a separate O&M cost category and include customer service staffing, station management, cleaning, utilities, security coordination, and facility maintenance. The model assumes that staffing and operating requirements vary by station type, passenger activity, and

operational role within the system, with larger terminal and turnback stations requiring higher staffing levels and more intensive operations support. Station utility and maintenance costs are tied to estimated building size, platform areas, service levels, and hours of operation, providing a scalable framework that reflects the operational complexity of different station types.

Infrastructure maintenance costs are estimated separately for track, structures, signals, communications systems, overhead catenary systems, and facilities. For blended operating segments owned by other agencies, the model assumes track access charges rather than direct maintenance responsibility by the California High-Speed Rail Authority.

The methodology also includes detailed estimates for traction power, facility electricity consumption, station utilities, water usage, and sewer costs. Energy assumptions are based on industrial utility tariffs, projected train energy consumption per mile, annual train mileage, and maintenance facility square footage.

Commercial and administrative costs are also included in the model. These costs include marketing, advertising, fare collection, customer service, environmental compliance, insurance, bus feeder operations, and general administration. The model assumes that feeder bus operations transition to a fully electric fleet consistent with California zero-emission bus policies.

Finally, the CAHSRA O&M model incorporates contingency and risk analysis to account for uncertainty associated with long-term operations forecasting. The model includes both allocated and unallocated contingency allowances and utilizes Monte Carlo risk analysis techniques to evaluate the sensitivity of future operating costs to uncertainty in labor, maintenance, insurance, and energy assumptions.

The 2026 Business Plan updated the O&M cost values (in 2033 dollars) as follows:

- $155.0M to $175.6M annually for the Merced-Bakersfield segment

The O&M cost per train mile in 2033 dollars is:

- $155.21 to $175.84 for the Merced-Bakersfield segment

The O&M cost per train mile in 2025 dollars is:

- $128.28 to $145.33 for the Merced-Bakersfield segment

CDOT Interregional Connectivity Study O&M Costs

The CDOT ICS Study's O&M cost methodology uses a spreadsheet-based planning model developed to estimate the annual cost to operate, maintain, and administer each high-speed rail alternative. The model is built around the assumption that O&M costs scale with measurable system characteristics such as service levels, infrastructure size, and fleet size. The principal operating variables used as cost drivers are:

- Annual revenue train-hours
- Annual revenue train-miles
- Annual revenue car-miles
- Fixed guideway route miles
- Number of major and minor stations
- Number of peak service rail cars

The methodology relied heavily on benchmarking because there were no comparable U.S. high-speed rail systems. As a result, the model used actual operating cost data from conventional commuter rail systems and adjusted those values where necessary to reflect high-speed rail operations and technology differences.

The CDOT O&M model organized expenses into three major functional categories:

- **Operations** includes administration, train operations, and station operations.
- **Maintenance** includes administration, vehicle maintenance, and right-of-way maintenance
- **General Administration** represents Executive management, legal, finance, HR, IT, customer service, safety, and other support functions

For each category, the model separately estimated labor and non-labor costs. Labor costs were calculated using:

- Wage/salary assumptions by job classification,
- Productivity rates tied to operating variables,
- Staffing assumptions,
- Fringe benefits equal to 40% of wages

Non-labor costs included:

- Propulsion power
- Vehicle parts and materials
- Contracted cleaning and security
- Station maintenance
- Utilities
- Insurance
- Miscellaneous supplies and services

The methodology also incorporated uncertainty ranges because many assumptions were based on limited precedent data. Each line item was assigned an uncertainty factor of 15%, 25%, or 50% depending on confidence in the estimate. The largest uncertainty factors were applied to propulsion and insurance costs. The model produced a low range O&M estimate based on base assumptions and a high-range estimate incorporating uncertainty adjustments.

Using this methodology, the study estimated the annual O&M cost per train mile ranging approximately (in 2017 dollars):

- $74.6M to $97.9M for Alternative 1,
- $65.4M to $93.7M for Alternative 2,
- $81.5M to $114.8M for Alternative 3

The O&M cost per train mile in 2017 dollars is:

- $34.79 to $45.65 for Alternative 1,
- $33.07 to $47.38 for Alternative 2,
- $32.74 to $46.13 for Alternative 3

Escalating using Construction Cost Indices, the O&M cost per train mile in 2025 dollars is:

- $98.07 to $128.67 for Alternative 1,
- $93.21 to $133.54 for Alternative 2,

- $92.27 to $130.03 for Alternative 3

NEC FUTURE O&M Costs

NEC FUTURE is a comprehensive plan for the Northeast Corridor from Washington, D.C. to Boston, MA. The NEC FUTURE 2015 O&M methodology uses a unit-cost forecasting approach that begins with actual railroad O&M costs and scales them to future service plans based on changes in service levels, infrastructure, and ridership. The methodology was developed specifically for feasibility-level analysis and was intended to produce order-of-magnitude estimates suitable for comparing alternatives rather than preparing a detailed operating budget.

The model relied primarily on historical cost data from Amtrak operations on the Northeast Corridor, which is a mixed-use passenger rail corridor that also supports significant freight operations over portions of the route, supplemented by commuter rail agency data from the National Transit Database and maintenance cost information developed for the California High-Speed Rail program. Existing costs were organized into major cost categories consistent with Federal railroad Administration (FRA) and U.S. Department of Transportation (USDOT) best practices, including train crews, energy, stations, rolling stock maintenance, railroad infrastructure maintenance, and general and administrative functions.

Costs were grouped into two broad categories: infrastructure-related costs and transportation-related costs. Infrastructure costs included maintenance of way, traction power, dispatching, station maintenance, police and security functions, and other corridor-wide activities. Transportation-related costs included train crews, onboard services, equipment maintenance, fuel consumption, marketing, customer service, and administrative functions.

The NEC FUTURE model then assigned each cost category to a specific cost driver that reflected the factor most responsible for creating the expense. Examples included train-miles, train-hours, route-miles, track-miles, train frequency, ridership, ticket revenue, crew labor hours, and fleet size. Unit costs were calculated by dividing actual historical costs by the corresponding operating metric. For example, track maintenance costs were converted to a cost per track-mile, while train crew costs were converted to a cost per labor hour, and station costs were tied to passenger activity levels.

Future operating costs were estimated by applying these unit costs to projected service characteristics developed through the study's service planning, engineering, and ridership analyses. Projected train frequencies, train-miles, train-hours, fleet requirements, route lengths, and ridership forecasts were used to calculate future operating and maintenance expenses for each alternative.

For new dedicated high-speed rail infrastructure and next-generation trainsets, the analysis used maintenance unit costs derived from California High-Speed Rail experience rather than existing Northeast Corridor operations. These costs were adjusted to Northeast labor markets and integrated into the broader model for alternatives containing new high-speed segments.

Finally, the NEC FUTURE model compared projected operating costs with forecasted passenger revenues to estimate annual net operating contribution. This allowed the study to evaluate not only the relative operating cost of each alternative, but also whether projected revenues would be sufficient to cover operating and maintenance expenses.

Using this methodology, the study estimated the O&M cost per train mile for intercity services (in 2015 dollars) is:

- No Action - $101.07
- Alternative 1 - $92.32
- Alternative 2 - $53.89
- Alternative 3.1 - $46.91
- Alternative 3.2 - $47.41
- Alternative 3.3 - $49.17
- Alternative 3.4 - $50.06

Escalating using Construction Cost Indices, the O&M cost per train mile for intercity services in 2025 dollars is:

- No Action - $145.00
- Alternative 1 - $132.45
- Alternative 2 - $77.32
- Alternative 3.1 - $67.31
- Alternative 3.2 - $68.02
- Alternative 3.3 - $70.54
- Alternative 3.4 - $71.82

Selected Unit Cost

The high end of the California High-Speed Rail O&M costs per train mile were relatively high compared to the other two studies. The NEC FUTURE O&M costs per train mile were high for the No Action alternative and low for Alternatives 2, 3.1, 3.2, 3.3, and 3.4. The high end of the CDOT ICS O&M costs per train mile were similar to the low end of the California High-Speed Rail O&M costs per train mile. Because freight trains operate over the NEC, the O&M costs are not appropriate for the IL HSR Feasibility Study. For the purposes of this study, the average of the high end of the CDOT ICS O&M costs per train mile and the low end of the California High-Speed Rail O&M costs per train mile was used to estimate the O&M costs.

Service and Operating Assumptions

The following planning-level assumptions were applied consistently across all route options:

- Base service frequency of 32 trains per day (16 round trips)
- All-day service operated 356 days per year
- Uniform fleet configuration and operating philosophy across corridors
- O&M unit cost applied uniformly per train-mile

O&M Costs

As expected under a train-mile–driven framework, annual O&M costs scale directly with total corridor length and service mileage. Longer route options generate higher annual O&M expenditures due to increased train-miles operated, while shorter and more direct alignments exhibit lower systemwide operating cost requirements. The resulting O&M estimates for each route option for a 16 round trip operating plan are summarized in Table 1.

Route Option	Route Miles	Frequency	Days/Year	Annual Train Miles	Cost per Train-Mile (2025$)	Annual O&M Cost (2025$, millions)
1 – I-55 Corridor	295	32	354	3,353,088	$128.48	$434
2 – Greenfield via Bloomington and Joliet	286	32	354	3,194,496	$128.48	$413
3 – I-57/I-72/I-55 Corridor	306	32	354	3,443,712	$128.48	$445
4 – Greenfield via Champaign/Urbana and University Park	304	32	354	3,511,680	$128.48	$454
5 – Greenfield and County Road via Champaign/Urbana and Joliet	304	32	354	3,579,648	$128.48	$463
6 – Interstate Adjacent and County Road via Champaign/Urbana and Joliet	316	32	354	3,466,368	$128.48	$448
7 – I-55/I-155/I-74 Corridor	317	32	354	3,602,304	$128.48	$466
8 – Greenfield via Peoria and Joliet	315	32	354	3,466,368	$128.48	$448
9 – Interstate Median and County Road via Champaign/Urbana and Joliet	318	32	354	3,602,304	$128.48	$466
10 - Interstate Median and Greenfield via Champaign/Urbana and University Park	307	32	354	3,477,696	$128.48	$450
11 - Interstate Median and Greenfield/County Road via Champaign/Urbana and Joliet	308	32	354	3,489,024	$128.48	$451
12 - Interstate Median and Greenfield via Champaign/Urbana and University Park	307	32	354	3,477,696	$128.48	$450

Table 1- O&M Costs, 16 RT

Summary

The O&M analysis demonstrates that:

- Differences in operating cost across corridors are primarily a function of route length
- Service frequency remains the dominant cost driver
- Alignment geometry has limited impact on O&M at the feasibility level

O&M costs alone are not expected to serve as a primary corridor selection criterion; rather, they provide necessary inputs to operating ratio and long-term financial sustainability evaluation. The adopted train-mile–based O&M methodology provides a realistic and defensible planning-level estimate of operating and maintenance costs for the Illinois High-Speed Rail Feasibility Study. By benchmarking against established high-speed rail cost models and applying consistent service assumptions across all route options, the analysis enables transparent comparison of financial performance while maintaining alignment with best practice.

Further refinement of O&M costs will be appropriate in subsequent project phases of the project.