Submitted To

Rocky Mountain Rail Authority

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High Speed Rail Feasibility Study Methodology Technical Report

Submitted by

TEMS

Transportation Economics & Management Systems, Inc.

in association with

Quandel Consultants, LLC

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1 Introduction

The purpose of this technical report is to provide a detailed explanation of the methodology and techniques to be used in carrying out the Rocky Mountain Rail Authority Rail Feasibility Study. The aim is to provide a clear understanding of the full range of activities that will be undertaken and how they will be combined to provide the deliverables for the study. The report provides a general overview of the business plan approach TEMS uses to identify the most effective passenger rail option for any corridor. The methodology has been widely used for rail passenger planning and has been extensively peer reviewed by both practitioners, as well as academics. The report will be used to brief both the study RMRA Steering Committee and potential reviewers, and peer panels that will be asked to assess the project.

1.1 Study Background

The Rail Feasibility Study (RFS) will provide an assessment of the feasibility of providing intercity rail service in the I-70 and I-25 corridors as shown in Exhibit 1-1, including secondary corridors to Craig through Steamboat Springs, Aspen, Breckenridge, Winter Park, and Central City. It will specifically address the Federal Railroad Administration's (FRA's) public / private criteria[1] and six feasibility factors that are critical to receiving a FRA High Speed Rail Designation for each project corridor.

By meeting FRA criteria, the RMRA High Speed Rail Feasibility Study provides a mechanism for supporting:

- Designation of Colorado I-70 and I-25 corridors as high-speed rail corridors
- Potential Federal funding (50-80 percent) for a proposed project
- Creation of a high-speed rail project that might be developed as a public/private partnership by the communities of Colorado.

[1] High Speed Ground Transportation for America, USDOT FRA 1997, and Maglev Deployment Program: USDOT FRA, 1999

Exhibit 1-1: Potential Colorado High Speed Rail Corridors

1.2 Project Objectives

The overall objective of the RFS is to complete a fresh, objective assessment of the feasibility of implementing high speed rail service in the Colorado corridors and to identify the next steps that should be pursued by RMRA and partner agencies in the implementation of that service. This will be done by building on previous efforts, coordinating closely with other ongoing relevant studies, surveying stakeholders within the two corridors, and identifying the most effective high-speed rail options for each corridor. This will position the RMRA and Colorado to gain high-speed rail designation from the FRA for one or both of the study corridors.

The FRA public/private partnership criteria are:

1. Positive operating ratio (operating revenue/operating costs)
2. Positive cost benefit ratio

The six FRA high speed rail feasibility factors are as follows:

1. Whether the proposed corridors include rail lines where railroad speeds of 90 miles or more per hour are occurring or can reasonably be expected to occur in the future.

2. The projected ridership associated with the proposed corridors.
3. The percentage of the corridors over which trains will be able to operate at maximum cruise speed, taking into account such factors as topography and other traffic on the line.
4. The projected benefits to non-riders, such as congestion relief on other modes of transportation servicing the corridors.
5. The amount of federal, State and local financial support that can reasonably be anticipated for the improvement of the line and related facilities.
6. The cooperation of the owner of the rights-of-way that can be reasonably expected in the operation of the high-speed rail passenger service in the corridors.

Additional objectives for the RFS are as follow:

1. To identify the most feasible technology(s) that are applicable for Colorado (recognizing that these technologies may vary depending on the corridors).
2. To identify the need for and benefits to Colorado of implementing high speed rail service.
3. To identify opportunities and concerns of local governments within the corridors regarding implementation of high speed rail service.
4. To define potential station locations and pros and cons of each.
5. To identify the opportunity to maximize the use of existing transportation corridors.
6. To identify recent and emerging vehicle and guideway technology innovations that have the potential to minimize cost and environmental impacts, particularly in the mountainous terrain of the studied corridors.
7. To identify systems that are inter-operable in the primary corridors and that could be developed in system phases.

1.3 Peer Review Process

As part of the study plan, it is intended to develop a Peer Review Process that will do two things:

- The initial set of three meetings will provide insight into the study process and methodology including information on technology, engineering, and market alternatives.
- The second set of meetings will provide review and comment on the study findings.

At each panel meeting, the study team will make a PowerPoint presentation of its approach, assumptions, and methodologies, and findings and conclusions. For each meeting, the study team will field its top professionals and one individual will lead the study team’s review. These individuals include:

- Dr. Alexander E. Metcalf (Project Manager) - Ridership, Revenue and Model System
- Dr. Edwin Kraft (Managing Operations Planner) - Alternatives Development and Evaluation
- Mr. Charles Quandel (Deputy Project Manager) - Overall System Design, Cost, Finance and Evaluation

The study team will coordinate its work with the Project Management Consultant (PMC) who will organize and provide logistical support to the Peer Review Panel process. The PMC will provide logistical support for the Peer Review Panels. The study team will work with the PMC to define Peer

Review Panel objectives and agendas and will serve as a resource to each of the panels, providing requested information and meeting with the panels to review study information. Peer Review Panel sessions should be considered to be project milestones for scheduling purposes.

Deliverables: For this task, the study team will prepare for the Steering Committee and PMC review the following:

- Six PowerPoint presentations
- Meeting notes for all official project meetings (excluding RMRA Board and Steering Committee meetings)
- Study team review and response to comments by the Peer Review Panels

1.4 Study Methodology

The study methodology was developed to ensure an appropriate balance between market potential, train operations, and engineering costs for a feasibility study. It provides an understanding of the financial and economic value of selected alternatives and the needs of the implementation process in terms of both the timeline to implement the proposed system and the funding requirements during implementation. The method reflects closely the procedures adopted by the USDOT FRA for high speed rail and maglev planning as defined by their own publications:

- High Speed Ground Transportation of America, USDOT FRA, Sept. 1997
- Maglev Deployment Program, USDOT FRA, 1999

The methodology presented in this technical report has been used by the Study Team in a wide range of studies that have been used to obtain FRA designation of a high speed rail corridor, and has gained peer review approval from both government and the financial sector. These ongoing studies include:

- Midwest Regional Rail Initiative for the states of Wisconsin, Illinois, Minnesota, Michigan, Ohio, Indiana, Missouri, Nebraska, and Iowa – 1994 - 2008
- Ohio Hub Study for the states of Ohio, New York, Michigan, Pennsylvania, and Indiana – 2000 - 2008
- Baltimore-Washington Maglev Study for Maryland DOT/USDOT FRA – 2002 - 2008
- Florida Intercity Passenger Rail “Vision Plan” – 2004 - 2006
- Duluth-Twin Cities Passenger Rail Corridor Business Plan – 2006 - 2008
- Florida Beeline Maglev Study – 2004 - 2008
- New Orleans Maglev Study – 2003 - 2005
- Florida High Speed Rail Authority Study – 2001 - 2002
- New York Intercity Passenger Rail Study – 2001 - 2003
- Indianapolis-Louisville Passenger Rail Corridor Study – 2006 - 2007
- Alberta Investment Grade Ridership and Revenue Study – 2006 - 2007
- Boston Portland Restoration of Rail Service Study – 1994 - 1998
- Windsor-Quebec Passenger Rail Corridor Study – 1994 - 1996

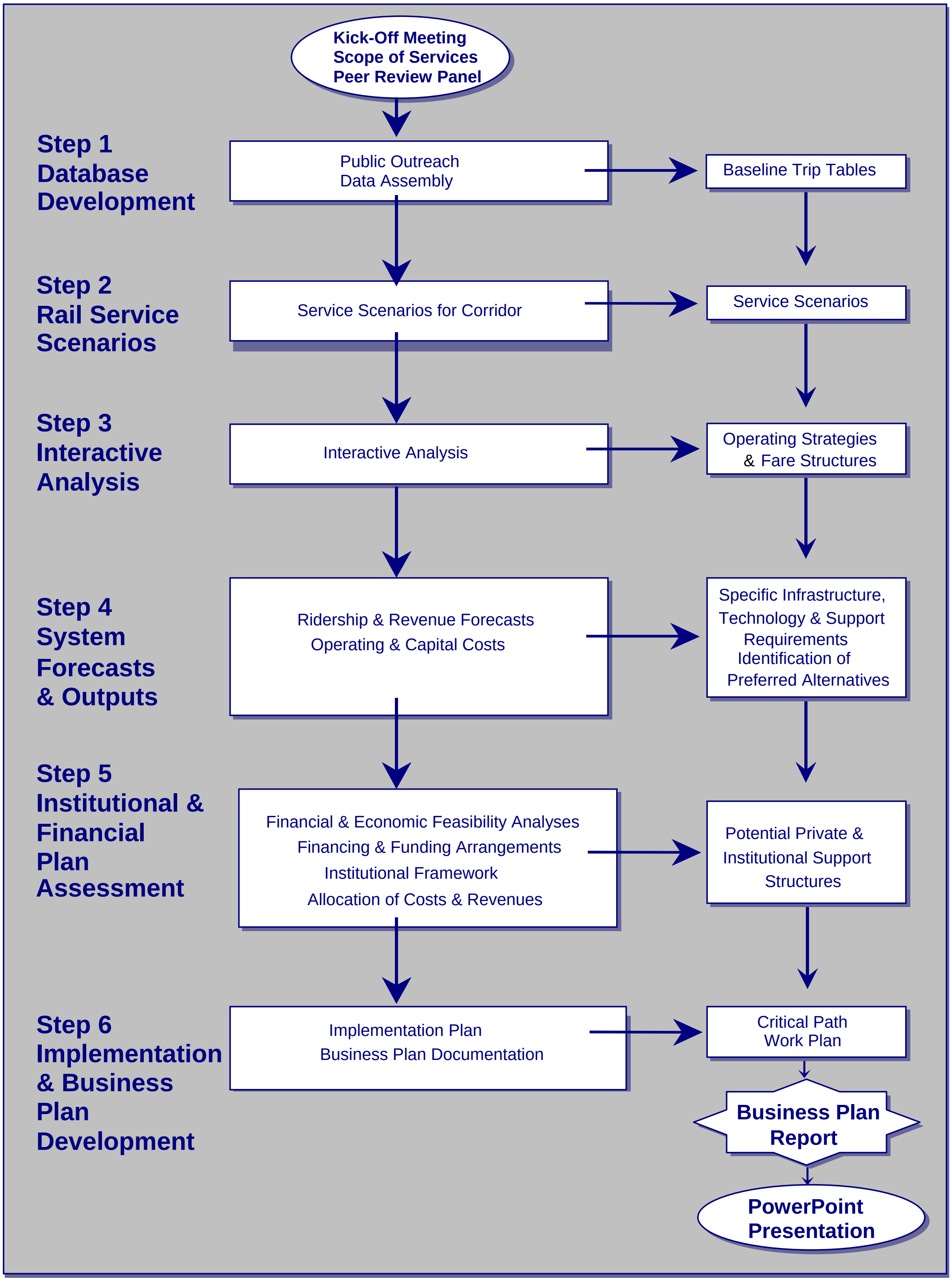
2 Business Plan Approach

To ensure all of the FRA criteria and factors are fully evaluated, the study team will use the Business Plan Approach that TEMS has successfully used in more than thirty states to develop intercity rail, high-speed rail, and maglev plans. As specified by the FRA, the selection of an appropriate high-speed rail system is "market driven." The difference in the selection of one high-speed rail option over another is heavily dependent on the potential ridership and revenue. To ensure the potential is properly measured, the TEMS Business Plan Approach carries out a very detailed and comprehensive market analysis. The output of this market analysis is then used to determine the right rail technology and engineering infrastructure for the corridors. The Business Plan Approach, as shown in Exhibit 2-1, sets out a six-step process for accessing corridors and measuring FRA issues and criteria.

The six steps are:

1. Public Outreach and Database Development – Assembling the engineering, market, operational, technology, and community station data as input to the process.
2. Formulation of Rail Service Scenarios – Setting up the rail/maglev options to be considered for the study.
3. Interactive Analysis – Assessing engineering, market, operational, technology, and land use data to identify and develop the most effective rail/maglev alternatives.
4. System Forecasts and Outputs – For the most effective alternatives, generating ridership, revenue, operating costs, capital costs, and financial and economic feasibility solutions. This includes user and community benefits, as well as FRA criteria.
5. Assessment of Institutional and Financial Plan Options – Developing the institutional framework, and funding plan for developing the Rocky Mountain Rail System.
6. Implementation and Business Plan – Developing both Implementation and Business Plans along with pro forma financial cash flows.

Exhibit 2-1: Business Plan Six-Step Process



3 Technical Activity Descriptions

This section provides an overall description of the method used by TEMS to evaluate the potential for intercity passenger rail service. Three appendices are provided that provide more detail analyses of the three key analysis areas, market analysis, technology and engineering assessment.

3.1 Step 1.1: Public Outreach

The public outreach process is designed to ensure that the rail feasibility study is sensitive to the ideas and concepts of the communities along the I-70, I-25 and secondary corridors and recognizes their needs for improved transportation, as well as their concerns about quality of service, system cost, the environment, and economic development. The aim of this process is to ensure that the communities' voice is heard, and that the high-speed rail feasibility study is designed to maximize their interests. To meet this need the following outreach program needs to be designed.

3.1.1 Scoping

In each of the two primary corridors and secondary corridors specified above, the appropriate local government, MPO, TPR, Transportation District or Authority, Public Land Agency, and the I-70 Coalition will be consulted. The discussion for their jurisdictions will identify how they would prefer passenger rail service to be developed. This will include possible alignments (on-grade or aerial), station and vehicle support facility locations, and vehicle technologies. Particularly, important in the scoping process will be understanding issues and opportunities in the Denver metropolitan area. It is envisioned that the eastern terminus of the east-west I-70 corridor will be DIA, where RTD is advancing a program of urban passenger rail facilities called FasTracks. RMRA will take the lead in facilitating scoping discussions that should at a minimum include CDOT, RTD, the City and County of Denver, the Denver Regional Council of Governments (DRCOG), and DIA. During the Scoping phase, the study team will:

- Coordinate with the I-70 Coalition's County Based Input Teams to participate in one scoping workshop specific to the I-70 corridor.
- Arrange and facilitate one County Based Input Team workshops for the Denver Metropolitan Area.
- Arrange and facilitate one County Based Input Team workshop for the I-25 corridor.

These workshops will explore the following:

- Identification of regional transport needs and the role of high speed rail.
- Identification of potential station locations (note: the I-70 Coalition Land Use Planning Study is expected to provide proposed station locations and potential alignments for the I-70 corridor.)
- Identification of willingness of local governments to implement land use planning and zoning changes necessary to support the rail passenger alignment, location and development of rail stations and associated Transit Oriented Development, and vehicle support facilities.

- Identification of potential Community Social and Economic issues related to the development of high speed passenger rail service.
- Identification of potential impacts to public lands.

All scoping discussions will be summarized by the study team, which will create a corridor scoping report for both the I-70 corridor and I-25 corridor including secondary corridors. Common areas of both agreement and disagreement will be identified and documented in the corridor scoping reports. Through the scoping task, the study team will develop the following:

- Statements of proposed project purpose and need that will guide development of alternatives.
- Proposed study goals and objectives to serve as the basis for the evaluation of alternatives.

Planning issues will be addressed at the corridor level first by the study team, and then by the RMRA Board through the Steering Committee. The RMRA website will be used to facilitate the discussion of this report with local jurisdictions and the general public and capture the requirements for each corridor. The study team will provide information that can be posted to the website, but will not be responsible for maintenance or monitoring of the website.

3.1.2 Coordination of Public Input

Input relating to the rail system alternatives evaluated in the RFS needs to be obtained from RMRA member jurisdictions and Colorado's general public and incorporated into the RFS. The study team will coordinate with business, non-profit and economic development organizations to develop a community partnership program. As part of this program, the study team will develop three communications updates for these organizations to distribute to their members and other interested stakeholders and conduct five community presentations in geographically diverse areas of the study areas. The RFS Final Report will identify the areas of concern, outstanding issues and travel needs identified through this public outreach process. Public and local government input may also help determine the future direction and activities for the RMRA organization.

The study team should leverage similar scoping and public involvement activities being conducted by the I-70 Coalition Land Use Planning Study team. The RMRA does not intend that the RFS will be conducting separate scoping and public involvement in the I-70 corridor, but rather will work closely with the I-70 Coalition to assess the objectives of high-speed rail.

Other activities by the study team will include:

- Media Relations – The study team will develop and maintain a list of media contacts in the study area and develop/distribute up to six (6) news releases or op-ed articles during the study. The study team also will prepare and facilitate three (3) media conference calls in coordination with key milestones (scoping, alternatives development; alternatives analysis). The study team also will reserve five (5) hours per month to respond to unsolicited media inquiries.
- Monthly Project Updates – The study team will develop twelve (12) project updates. These updates will be provided to the RMRA for posting on their website and also distributed to the project stakeholder database.
- Stakeholder and Comment Database – The study team will develop and maintain a database of all stakeholder contacts and comments. This will be done by providing content and form for a

page on the RMRA website that will enable stakeholders to register for project updates and submit comments. The study team will maintain a database of all comments and generate twelve (12) monthly reports summarizing issues identified in the comments.

3.1.3 Technical and Policy Outreach and Decision Making

The study team will coordinate with the I-70 Coalition's County Based Input Teams to participate in two workshops specific to the I-70 corridor. In addition the study team will arrange and facilitate an additional four (4) County Based Input Team workshops, two for the I-25 corridor and two for the Denver Metropolitan Area to gather information on alternatives development and alternatives analysis to allow public and governmental review of each corridor plan and identify areas of potential collaboration.

Step 1.1 Deliverables: For this task, the study team will prepare for Steering Committee and PMC review the following:

- Stakeholder Outreach Approach technical memorandum
- Scoping technical report, including stakeholder meeting results, proposed project purpose and need, and study goals and objectives, that will serve as the basis for identification of alternatives and alternative evaluation measures.

Note: All presentation materials developed by the study team for public presentation will be approved by the Steering Committee and the RMRA for content and format prior to public presentation or release.

3.2 Step 1.2: Data Collection

In the first element of this activity the study team has prepared a methodology technical report (this document) that defines methods for scoping involvement, ridership/revenue forecasts, railroad operations, simulation, alternatives development, and alternatives screening.

In addition, working from existing resources (previously cited studies, railroad records, topographic, GIS and satellite mapping, field inspections and other sources as needed), the study team will develop an existing conditions report. The report will describe previous findings and conclusions relevant to the RFS, and existing conditions relevant to the development of high speed rail service and to the estimation of potential ridership. An inventory of the existing rail system and possible new alignments within the primary and secondary rail corridors being evaluated in the RFS will be prepared, to identify current rail speed limits, geographic and implementation barriers to be overcome for development of new rail or maglev corridors, and current and future capacity. The study team will create a technical report that summarizes these conditions and provides a synopsis of relevant previous planning efforts.

A key element of this task will be engaging freight rail operators in discussion of constraints and opportunities for using existing rail corridors for new or enhanced passenger service. The study team will be responsible for coordinating with CDOT and railroads to gather information regarding existing and future conditions, and specifically will coordinate with CDOT and its consultant for the CDOT Colorado Railroad Relocation Implementation (R2C2) Study.
The analysis will consider both the I-70 corridor from the Utah border to Denver International Airport, and the I-25 Front Range corridor from Wyoming to New Mexico. In addition, the potential for secondary rail corridors from Central City, Winter Park, Breckenridge, Aspen and Craig will also be considered.

Marketing, engineering, technology and station data will be gathered for each corridor/secondary corridor so that analyses can be performed that allow both the short and long-term potential of a corridor to be determined. For example, if a corridor is not feasible in the short term, it is possible that it will be justified by 2020 or 2025.

The data assembly will be oriented toward the specifications of four major data systems. They include:

- Market database
- Engineering database
- Technology database
- Station database

3.2.1 Market Database

The market database will consist of four components – origin/destination data, socioeconomic data, network data and stated preference data. This will allow an Investment Grade methodology to be applied and high quality forecasts of ridership and revenue to be estimated.

- **Origin/Destination Data** – As part of the study, the study team will develop a comprehensive origin/destination database for the study corridors. The data will be drawn from existing MPO and statewide databases including origin destination data, statewide AADT data, bus schedules, and regional traffic flow estimates. The data will be for travel by rail, bus and auto and will be on a trip-purpose basis (business, commuter and social/tourism). The data will be aggregated on a county/sub-county level in rural areas and at an aggregate MPO zone level for urban areas. For this study, the data and zone system will be refined to ensure it properly reflects demand in the I-70 and I-25 Front Range Corridors. It is anticipated that 300 to 400 zones will be used to represent the rail corridors.
- **Socioeconomic Data** – An extensive socioeconomic database will be developed for Colorado. The data will be drawn from state and federal sources as well as private sector sources (e.g., Woods and Poole). It will contain population, employment and income forecasts on a zone basis. These will be reviewed with the PMC and Steering Committee and adjusted to the proposed 300-400 zone system to provide an effective database for the Rocky Mountain Corridors.
- **Network Data** – Comprehensive networks will be developed for each mode of intercity travel (auto, rail and bus). The networks, which will identify access and egress times, and costs, will be built for business and non-business travel. A refined set of networks will be developed for the Rocky Mountain Corridors to show the strength of modal competition and connections in the corridor.
- **Stated Preference Data -** To develop Investment Grade level forecasts, the study team will complete a Stated Preference survey. The survey will be similar to recent high-speed rail surveys completed by TEMS, Inc / Quandel Consultants, LLC in the Midwest (9 states), Ohio (5 states), Gulf (5 states), and Mid Atlantic (4 states). The survey will collect data on Value of Time, Value of Frequency, Value of Access, Value of Reliability, and Modal Attributes. Data will be collected using a quota survey methodology as approved for Investment Grade studies.

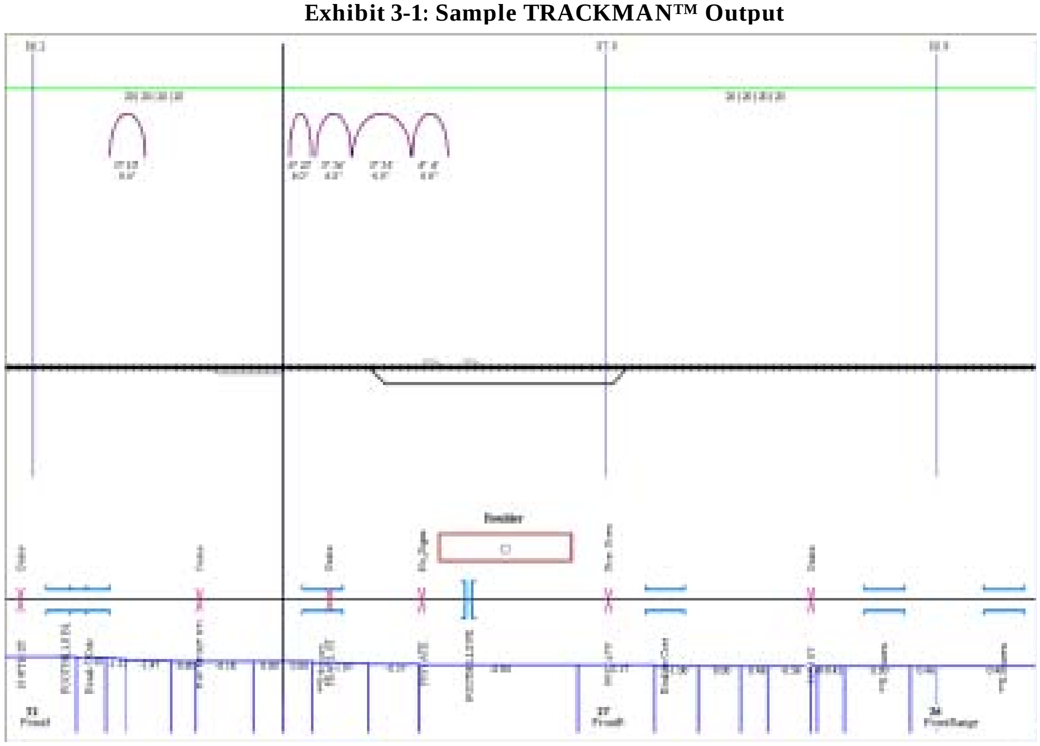
3.2.2 Engineering Database

The engineering database will consider both the east-west corridors and north-south corridors together with potential secondary corridors. In each case, an engineering database will be gathered and where necessary developed, to provide the basis for estimating the likely level of civil engineering costs associated with the proposed rail service.

The TRACKMAN™ Track Management System will be used to provide a milepost-by-milepost record of the rail gradients and track geometry of the current rail rights-of-way as well as proposed upgraded or new rail corridors to be developed. The data will be compiled from existing sources including railroad timetables, track charts, USGS topographic maps, commercially available orthophotography and as-built plans for the I-70 and secondary highways. The data will be reviewed and updated as required. This will be achieved by a field review of the right-of-way and track in the corridor by the engineers and operation planner on the study team. Potential new alignments, track upgrades and improvements for different passenger rail speeds and operations will be assessed and improvements will be identified and listed. Engineering Unit Costs that are consistent with local Colorado conditions and the R2C2 study will be used.

Engineering notes will be developed and coordinated with TRACKMAN™ program and with GIS to provide a clear understanding of basic corridor and track conditions. Particular attention will be given to curves, crossings, grade separation, and competitive uses of the right-of-way by freight railroads, utilities, etc., that may need to be relocated. Sample TRACKMAN™ output is shown in Exhibit 3-1.

Exhibit 3-1: Sample TRACKMAN™ Output



3.2.3 Technology Database

The technology database for the passenger rail speed options will be developed by reviewing the results of previous TEMS studies and soliciting information from manufacturers to update TEMS existing databank. Exhibit 3-2 shows several trains that are representative of the types of equipment that are available for deployment in Colorado rail corridors.

Exhibit 3-2: Representative Generic Rail Equipment Options
(maximum operating speeds)

For developing the technology options for the study, representative technologies will be selected to represent each class of train. These trains will be selected not on the basis that they are necessarily the best in the class, but rather they represent what a range of manufactures will be capable of developing. For example, the choice of Talgo for the 130-mph diesel option provides a cost-effective train that offers a reasonable degree of tilt and a set of good performance characteristics. However, many other manufacturers are also capable of providing an equal (or even faster) train that could also meet those performance specifications.

3.2.4 Property Database: Stations and Rail Right-of-Way

A property database will be developed for the corridors, which will assess existing properties along each corridor. The analysis will identify whether the property is residential, non-residential including commercial, industrial, vacant, agricultural, natural resources. The data will be mapped and an inventory of property values will be derived from state and federal property valuation sources (i.e., Colorado Division of Property Taxation and U.S. Department of Commerce-BEA Statistics).

Step 1.2 Deliverables: For this task, the study team will prepare for Steering Committee and PMC review the following:

- Methodology technical report to be submitted at the start of this task in support of the Peer Review Panel meetings (including outreach, ridership and revenue forecasting, cost estimating, alternatives development, and alternatives analysis)
- Existing Conditions technical report, which will provide a description of the existing markets, technology options, and engineering conditions.

3.3 Step 2: Formulation of Rail Service Scenarios-Define Preliminary Service Scenarios for the I-70 and Front Range Corridors

In this activity, the potential infrastructure and operations alternatives will be assessed in relation to the market demand for services to develop a set of potential alternatives.

3.3.1 Identification of Physical Alternatives

Previous studies have identified a wide range of technology, alignment, and service options as having feasibility for providing improved intercity transit/rail passenger service in Colorado. A major emphasis of this study is to provide a fresh look at the feasibility of previous proposals, and to reflect recent advances in technology that might be applicable for Colorado. The I-70 PEIS alternative analysis demonstrates the advantage of an aerial system over an at-grade system in reducing impacts to the natural and built environments in the mountain corridor. The study team will examine various passenger rail vehicle and guideway technologies, both aerial and at-grade, including class of track and grade crossings; that are best suited for each of the two major corridors. For rail vehicles the intention is to use at least an FRA Tier-I compliant vehicle if possible to permit co-mingling with freight and FasTracks commuter trains in the Denver terminal. But due to the wide range of natural and built environments in each corridor, specific corridor segments may require the examination of unique and specialized vehicle and guideway options that are currently outside FRA compliance including for example, Maglev vehicles.

In this task, preliminary alternatives will be identified and screened with the RMRA prior to beginning detailed evaluation of those alternatives. Elements of alternatives definition will include at a minimum the following:

- **Technology** (considering a broad range of traditional and emerging technologies, and providing verifiable operating characteristics of each of the various rail types and technologies)
- **Alignment** (as needed to optimize use of existing rail facilities and/or to access identified station locations if feasible, and considering both at-grade and elevated vertical alignments with an

approximate or "Concept" level estimate of engineering capital cost for each preliminary alternative.)

- **Need for grade separations** (with existing streets and highways due to increased rail operating speeds.)
- **Service frequency and speed** (train speeds, frequencies, and stops.)
- **Service to critical trip destinations** [e.g., resorts, major employment centers, intermodal transfers (e.g., DIA or DUS).
- **Station location/spacing** (the appropriate level of station spacing for each technology.)
- **Interstate connectivity and rail service assumptions** (the ability and efficiency of connecting between all the different centers of activity.)

In developing the "Concept" level methodology for identifying alternative vehicle and guideway technologies, the study team will identify techniques for ensuring that a reasonable basis for cost estimating (i.e., unit pricing) has been established.

3.3.2 Development of Initial Service Concepts

Once the range of options has been narrowed by the initial screening process, the study team will explore opportunities to attract riders and create greater value and revenue. In addressing this issue, the study team will initially consider two potential levels of service, each targeted to different traveler needs. These include:

- **Base Service Concept** – a base level service operating within the context of a "stand alone" service. A basic fare would be established for this service. The base level service provides a platform against which additional speed improvements can be evaluated in both financial and economic terms. For rail this Base Service Concept would correspond to the implementation of 79-mph intercity rail passenger service using conventional, non-tilting passenger equipment. For Maglev this Base would correspond to the HSST system proposed by Sandia National Laboratories as currently integrated into the I-70 EIS process.
- **Improved Service Concepts** – service improvements that would be associated with a refined level of engineering and operation considerations given the character of the market. Improvements would include changes in travel times due to improved infrastructure, faster equipment technologies, increased frequencies, improved reliability, improved train stopping patterns and higher quality of service. It would also provide for improved transportation access and connections at stations, such as taxis, limos and transit. Fares will be optimized to maximize revenue potential.

3.3.3 Proposed Alternatives Review

Once the range of technologies, infrastructure and service options have been defined a number of reviews will be undertaken to ensure the validity of the proposed alternatives. These include:

- **Public Input Review** – This review will assess the validity of the proposed alternatives with respect to the results of the Public Input Process. The aim is to ensure local needs are met. Areas of concern or conflict will be considered and where possible mitigated by adjustments to the proposed alternatives.
- **Steering Committee Review** – A one-day workshop will be held with the Study Steering Committee to review the range of alternatives to be carried into the evaluation. The results of the technical analysis and Public Input will be presented.

- **Peer Review Evaluation** – The final set of proposals for analysis will be presented to the Peer Panel for review and comment. The results will be presented to the RMRA Steering Committee for final endorsement.

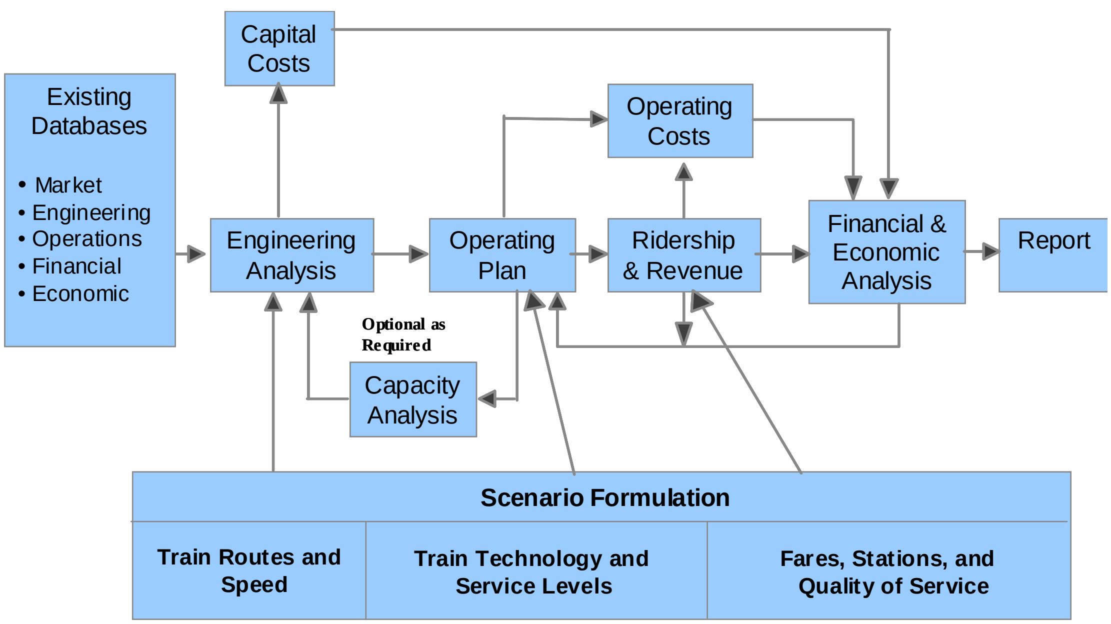
Step 2 Deliverables: For this task, the study team will prepare for Steering Committee and PMC review the following:

- Alternatives Development technical report (including results of Alternatives Development Reviews)

3.4 Step 3: Interactive Analysis

The Interactive Analysis is designed to develop the most efficient and effective alternatives for passenger rail service in the Rocky Mountain Corridors. In these tasks, ridership and revenue are assessed against infrastructure needs and costs, and operating requirements and costs.

Exhibit 3-3: Business Planning Process-Interactive Analysis



3.4.1 Ridership

The introduction of new rail systems, which provide substantially reduced travel times, higher comfort levels, and frequently lower fares has radically changed travel patterns and brought communities closer together. In general, intercity travel is increasing, marked by a substantial increase in travel demand and distances traveled, as well as a significant shift toward rail use as a result of higher gas prices.

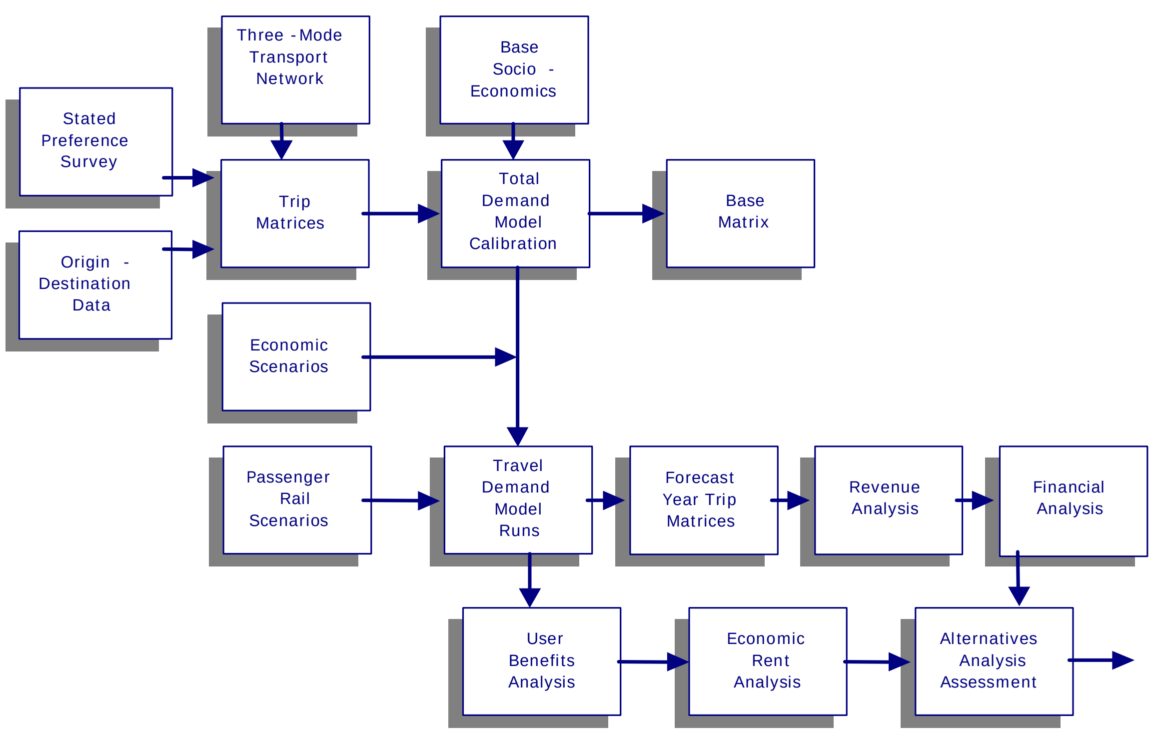
To effectively predict the change pattern and overall rail travel demand levels for new rail systems, models are needed that can accurately forecast the impact of trip making increases and the role of the rail mode. To meet these needs, TEMS developed the COMPASS™ Model System, which is a fundamentally new approach to transportation analysis. It combines existing regional transportation planning techniques with new market research techniques. COMPASS™ has the advantage of having been tested in North America, and Europe on various high speed rail projects as they progressed from planning, to engineering, to implementation. It provides Investment Grade caliber forecasts, and meets Wall Street requirements for ridership and revenue analysis. It provided the foundation for the Midwest, Ohio, Florida, Gulf Coast, Northeast ridership and revenue forecasts, and will be calibrated to reflect conditions in the Rocky Mountain Corridors.

Contrary to conventional methods of analyzing demand on the basis of existing or historical demographic/travel data, the COMPASS™ Model, while including such data in the analysis, subordinates it to a detailed dynamic behavioral assessment of an individual's innate travel characteristics. Using an advanced market research technique, Abstract Mode Trade-Off Analysis, these innate travel characteristics are formulated as preference utilities or demand elasticities, yielding a precise measurement of the responsiveness of travel demand to improvements in the overall level of service and the relative competitive position of alternative modes.

As shown in Exhibit 3-4 below, the COMPASS™ Model includes three key sub-models:

- Total Demand Model
- Induced Demand Model
- Modal Split Model

Exhibit 3-4: COMPASS™ Rail Demand Model Structure



Using the COMPASS™ approach to rail forecasting, the study team will:

- Eliminate the potential shortcomings of other model approaches, which often rely upon historical data that reflects rail's current negative image and tend to underestimate a new and modern rail system.
- Overcome the propensity inherent in conventional planning models to fail to identify accurately the market share for all modes. Typical MPO models are geared to forecasting the dominant mode (auto) and are frequently biased in their calibration procedures to coefficients and parameters that reflect auto travel. Unless a model explicitly represents the response of individuals to the modes other than auto (rail, bus, and air) differently through model coefficients such as the value of time, it is inevitable that the model will not be able to provide effective rail forecasts.

To overcome the limitations of conventional models, the analysis will firstly adjust the local MPO data to a behavioral purpose basis. Instead of using such purposes as Home-Shop or Home-Work, the study team approach will use the behavioral purposes, i.e., business, commuter, shopper, social travel, and tourist travel. Secondly, the COMPASS™ model uses the output of a Stated Preference survey to develop mode and purpose, Values of Time, Values of Frequency, and Values of Accessibility to provide a correct behavioral response to travel options.

3.4.2 Rail Service Analysis

As described above, the determination of appropriate high speed rail service depends for a corridor on balancing the trade-off between revenues and costs for any given route and associated technology. Higher levels of ridership generate higher revenues, which permit a greater level of infrastructure investment, and thus higher speeds. Lower levels of ridership and lower revenues require that infrastructure investment be minimized and/or the use of more sophisticated vehicles (e.g., tilt technology to compensate for inadequate track geometry).

To accommodate these relationships, the study team will employ an Interactive Analysis as the most efficient means of developing an appropriate passenger rail service alternatives and identifying infrastructure needs.

The Interactive Analysis utilizes a number of computer systems, permitting a rapid evaluation and re-evaluation of route, technology, and/or ridership factors as shown in Exhibit 3-5:

- TRACKMAN™ to assess the right-of-way and route improvement options (Example of TRACKMAN™ routes are shown in Exhibit 3-6)
- LOCOMOTION™ Train Performance Calculator to assess the performance of technologies
- COMPASS™ Rail Demand Model to assess ridership and revenue levels

Exhibit 3-5: Interactive Character of the Analysis Process

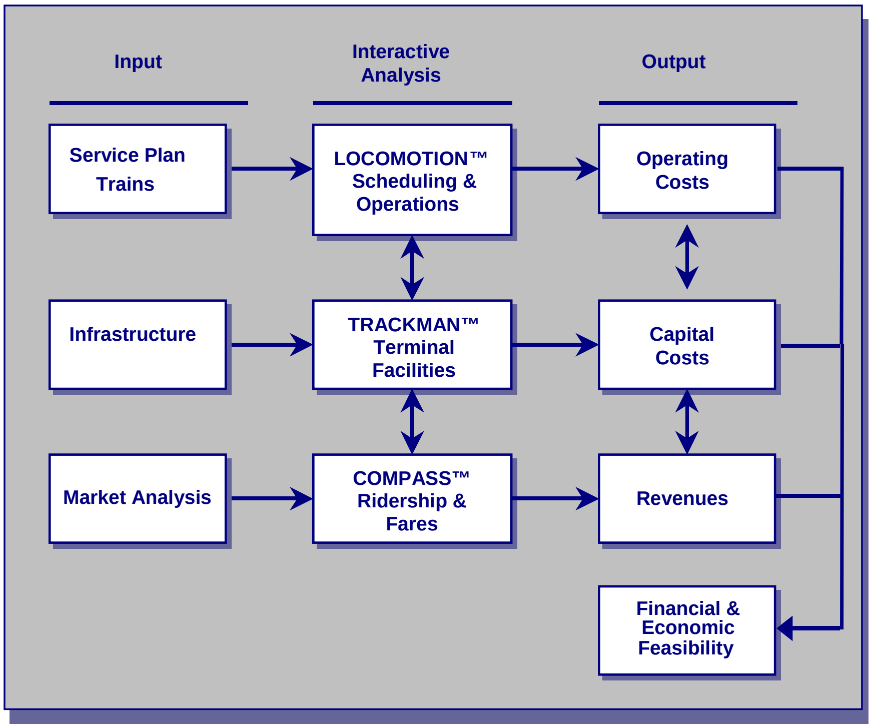
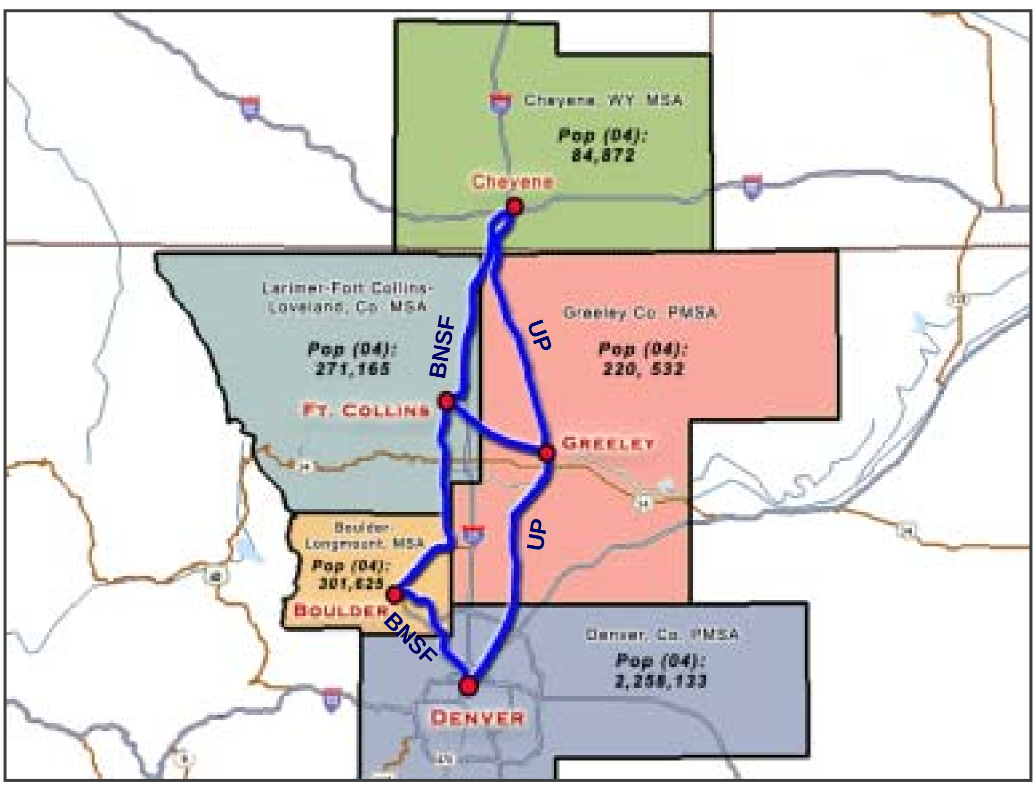


Exhibit 3-6: Possible Northern I-25 Routes: Example UP vs. BNSF Northern Options



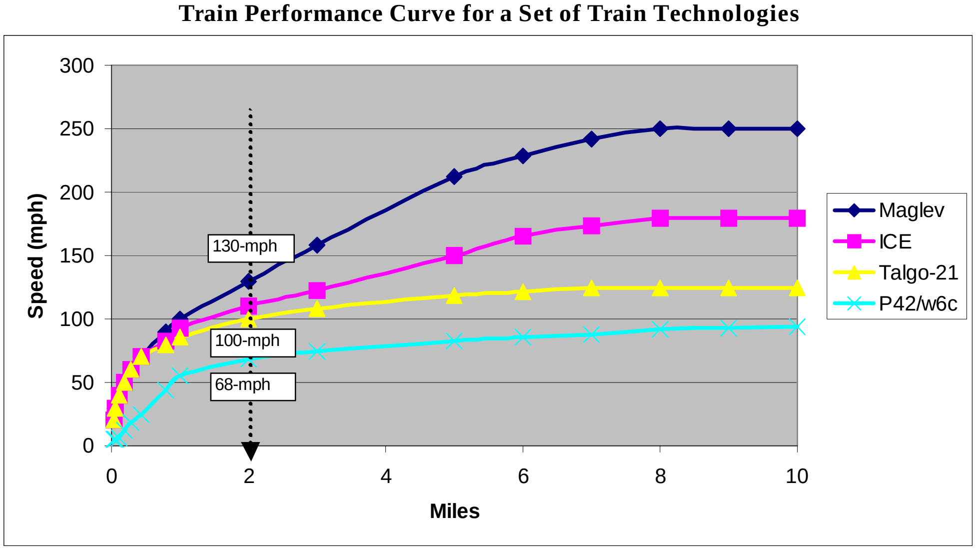
In the Interactive Analysis the assembled Market, Engineering, Operations, Financial and Economic data is used to develop an optimized plan. For a range of alternative train routes (See Exhibit 3-6) different technologies and speeds are evaluated against the base and then upgraded track conditions (curves, grades, bridge constraints, urban running etc.) to identify the potential performance of the technology and its effective commercial speed. For example, a technology with a maximum operating speed of 130-mph may in practice only have a "commercial" speed of 80-90 mph. Once the "commercial" speed is identified, operating plans in terms of train times, frequencies, and possible stopping patterns are established. These timetables are used to estimate ridership levels, which are themselves related to potential fare levels for station to station pairs. A series of iterations of engineering, operating and marketing are then conducted to optimize the potential for each corridor. In carrying out the operating and engineering analysis for the Interactive Analysis consideration will also be given to freight rail operations along the route. Once the character of the potential rail service is defined for any technology, a close review of freight rail interaction is carried out to ensure its needs are fully considered. Finally, the ridership for the alternative will be assessed against various fare levels to identify the appropriate rate or fare per mile to be charged.

In this way the analysis is sensitive to all the key factors that need to be evaluated for the set of options being considered.

The result of the Interactive Analysis is an operating strategy for each route/alternative technology option that optimizes the infrastructure, technology and traffic levels. For the purpose of this study, TEMS unit costs will be used as a basis to generate estimates for improvements. However, these unit costs will be adjusted to local conditions to reflect local labor, materials, and tax conditions.

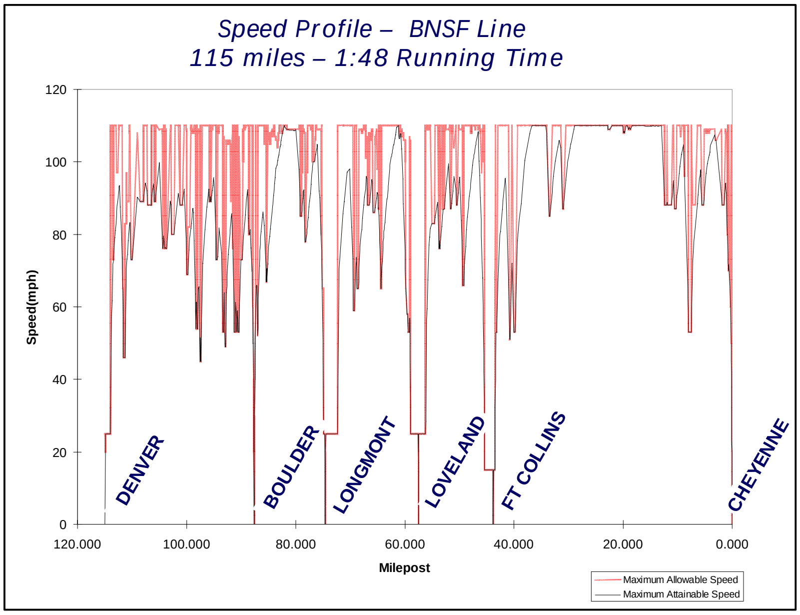
The actual operating speed of the train along the track is calculated using LOCOMOTION™. This is achieved by using performance curves for each technology (See Exhibit 3-7). Output from LOCOMOTION™ will be examined to identify specific bottlenecks, such as bridges, crossings, tunnels and curves that restrict train speeds unnecessarily and reduce the overall timetable performance of a specific technology.

Exhibit 3-7: Example of
Train Performance Curve for a Set of Train Technologies



The output of LOCOMOTION™ provides an assessment of train running times for any given set of infrastructure proposals (See Exhibit 3-8). By reviewing the timetables, the level of infrastructure improvements can be increased or reduced to meet specific timetable and thus specific ridership needs. In this way, the Interactive Analysis will result in the development of an operating strategy for each right-of-way/corridor and technology that best combines infrastructure requirements, operating speeds and frequencies, and potential ridership.

Exhibit 3-8: Example of Train Performance Evaluation for a Given Route



It should be noted that the time saved by removing different types of physical impedances would be different for different train technologies. For example, removing moderate curves is less important than removing bridge speed restrictions for trains with tilting technology. For non-tilt technology, removing curves is the most important factor in maintaining speed.

Where restrictions are found, TRACKMAN™ will be used to identify the cost of upgrading the right-of-way. By using LOCOMOTION™ and TRACKMAN™ together, a priority ranking of improvements can be developed. This consists of a cost per train travel time minutes saved and cost-per-revenue dollar earned.

The Interactive Analysis will identify key bottlenecks that prevent a given technology from achieving its maximum capability, listing the priorities for each train type, and estimating the civil engineering costs to overcome these bottlenecks. The analysis will be used to assess the effect of train speed on ridership levels and the cost of aligning the track to avoid locations with important environmental or cultural characteristics. Equally, the process will be used to evaluate capacity issues where passenger and freight trains commingle. The aim of the analysis in this case is to hold “harmless” the freight operation and to ensure that its future needs are protected in terms of having the capacity to meet the requirements of its future operations. As necessary, additional freight rail infrastructure will be provided. In each case, the required infrastructure improvements will be quantified in terms of the full range of factors that affect infrastructure costs (grading, track quality, signaling, and grade crossing protection.)

3.5 Step 4: Interactive Analysis: Forecasts and Outputs

The output of the Interactive Analysis includes ridership and revenue forecasts, timetables, engineering plans and operating and capital costs.

3.5.1 Rail Service Analysis

Using the rail service scenarios developed in the Interactive Analysis, total demand and market share forecasts for passenger rail traffic on a weekday and weekend basis will be prepared for five-year intervals for the study period 2008-2040. To forecast the impact of regional economic growth on total demand, socioeconomic scenarios will be prepared that identify how the likely changes in income, population, and employment will affect rail ridership and revenue over the study period.

The forecast strategies that will be developed include train frequency, commercial speed, stopping patterns and passenger interchange and access. Using these inputs, as appropriate, alternative strategies will also be prepared for other intercity transportation modes, so that the impact of investment in these modes is incorporated into the overall demand analysis. This task will consider likely MPO investment over the study period and will be carried out in conjunction with the PMC and RMRA Steering Committee.

The rail ridership forecasts will be assigned to show segment volumes, station volumes, and passenger miles and revenues on an annual basis. The forecasts will also be provided on an origin and destination basis and on a corridor, segment, and city pair basis. For each technology option, rail revenues will be generated. Revenues will be based on a fare/tariff structure, which can be compared with fares and costs of competing traffic (auto and bus). This will ensure that the optimum revenue stream is generated for the rail service, and will provide a basis for considering higher fares and lower subsidies for the Rocky Mountain passenger rail service. Revenues will be given in 2008 dollars. The resulting rail ridership and revenue will be benchmarked against comparable intercity corridor volumes and revenues. Benchmarking provides a high level of confidence to Wall Street investors.

3.5.2 Operating and Capital Costs

For each of the technology options, a set of 2008 operating costs will be developed that are based on the operating timetable. The operating unit costs will include the following:

- Track maintenance
- Train crew
- Rolling stock maintenance
- Electrification maintenance
- Signals and communications maintenance
- Energy costs
- Track fees
- Insurance
- Terminal personnel
- Administration
- On-board services
- Operator profit

Capital costs for the passenger rail service include cost for rolling stock, as well as infrastructure costs. Rolling stock costs for the various technologies will be obtained directly from equipment manufactures.

As for infrastructure costs, the study team has a set of unit costs derived from ongoing studies in Midwest, Florida, Mid Atlantic, Ohio, New York, and Gulf Coast, which have been updated to 2008 dollars. It is proposed that these be reviewed and adjusted to reflect specific conditions in the Rocky Mountain Corridors. The infrastructure cost databank will include unit costs for the following:

- Land and right-of-way
- Sub-grade, structures, and guideway
- Track
- Rolling stock
- Signals and communications
- Electrification
- Demolition
- Stations
- Maintenance facilities
- Highway and railroad crossings
- Fencing

3.5.3 Evaluation of Alternatives

The study team will prepare a comprehensive evaluation of all selected alternatives. Because the study must consider feasibility of rail service both in the two primary corridors and in several I-70 secondary corridors, the study team will develop an evaluation structure that allows a broad assessment of secondary corridors as well as more detailed evaluation of alternatives within the primary corridors. At a minimum, alternatives evaluation will consider the following for the various vehicle/guideway combinations:

- Ridership and revenue (annual, peak weekday and peak weekend)
- Cost (capital, including right-of-way, and operating/maintenance costs)
- Inter-operability (technology, etc.) between corridors
- Opportunity for system phasing
- Public acceptance
- Safety
- Local development and institutional issues and opportunities
- Opportunity for achieving FRA high speed objectives

Step 4 Deliverables:

- Ridership and Revenue Forecasts technical report
- Alternatives Analysis technical report (to include technology, operating, and cost assumptions)

3.6 Step 5: Assess both Institutional and Financial Plan Options

The purpose of this task is to provide a clear understanding of the proposed alternatives for the main corridor and secondary corridors in order that the RMRA and other decision-making agencies have a clear picture of the way each option meets financial, economic and FRA requirements. To this end, the study team will not only carry out financial and demand-side economic analyses that are required to meet these objectives, but will also carry out a supply-side analysis that quantifies the employment, property value, and income impacts on communities. The supply-side analysis has proved particularly useful in justifying rail projects to local communities (e.g., Ohio Hub and Florida Statewide Rail Plan).

In this task, the study team will consolidate the results of the preceding tasks to prepare an overall analysis of the feasibility of implementing high speed intercity rail service in the primary and secondary corridors under consideration and will prepare needed documentation of study findings and conclusions suitable for consideration by RMRA and other decision-making agencies. This task primarily consists of financial analysis, overall feasibility assessment, and response to the FRA's public/private criteria and the high speed rail feasibility factors.

To provide a clear understanding of the value of different route investments, the study team will carry out the follow-up analysis:

- Comprehensive financial analysis
- Comprehensive user benefits (consumer surplus) and non-user benefits analysis
- Community analysis (Economic Rent) identifying jobs, income, property values

In addition to the financial and economic plan, the study team will develop institutional and financing agreements for the project. This will include an allocation of costs analysis that shows who pays what to whom.

3.6.1 Financial Analysis

The financial analysis will be based on a detailed cash flow analysis of passenger revenues, operating and maintenance costs, and infrastructure and rolling stock costs (See Exhibit 3-9). The analysis will include the discounting of costs and revenues to an appropriate base year, the establishment of an infrastructure cost implementation program, and the assessment of both Net Present Values and Internal Rates of Return showing the overall worth of the rail service in financial terms.

Exhibit 3-9: Example of Pro forma Cash Flows from Minneapolis-Duluth/Superior Corridor Study

The pro forma cash flows are shown in Exhibit 7.7 and Exhibit 7.8. These present the forecasted total revenues and operating expense projections for 2012 through 2040. Since these projections are based on the *Back Loaded* capital plan, operations can't start before 2012. This plan includes two years of revenue ramp up at 50% and 90% factors for the first and second years, respectively, so the first year of full operations occurs in 2014*.

Exhibit 7.7 Minneapolis to Duluth 110-mph Rail Service: 8-Train Base Plan - Preliminary Operating Statement

Thousands of 2006 $	Total to 2040	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Revenues											
Ticket Revenue	**$1,080,230**	$13,567	$25,107	$28,659	$29,422	$30,185	$30,948	$31,711	$32,474	$33,236	$33,999
On Board Services	**$86,418**	$1,085	$2,009	$2,293	$2,354	$2,415	$2,476	$2,537	$2,598	$2,659	$2,720
Express Parcel Service (Net Rev)	**$54,011**	$678	$1,255	$1,433	$1,471	$1,509	$1,547	$1,586	$1,624	$1,662	$1,700
Total Revenues	**$1,220,660**	$15,331	$28,371	$32,385	$33,247	$34,109	$34,971	$35,833	$36,695	$37,557	$38,419
Train Operating Expenses											
Energy and Fuel	**$75,081**	$2,013	$2,013	$2,013	$2,013	$2,013	$2,013	$2,013	$2,013	$2,542	$2,542
Train Equipment Maintenance	**$204,890**	$5,494	$5,494	$5,494	$5,494	$5,494	$5,494	$5,494	$5,494	$6,937	$6,937
Train Crew	**$96,367**	$3,323	$3,323	$3,323	$3,323	$3,323	$3,323	$3,323	$3,323	$3,323	$3,323
On Board Services	**$80,631**	$1,833	$2,295	$2,437	$2,467	$2,498	$2,528	$2,559	$2,589	$2,620	$2,650
Service Administration	**$147,171**	$5,075	$5,075	$5,075	$5,075	$5,075	$5,075	$5,075	$5,075	$5,075	$5,075
Total Train Operating Expenses	**$604,139**	$17,738	$18,200	$18,342	$18,372	$18,403	$18,434	$18,464	$18,495	$20,497	$20,527
Other Operating Expenses											
Track & ROW Maintenance	**$114,663**	$3,954	$3,954	$3,954	$3,954	$3,954	$3,954	$3,954	$3,954	$3,954	$3,954
Station Costs	**$40,547**	$1,398	$1,398	$1,398	$1,398	$1,398	$1,398	$1,398	$1,398	$1,398	$1,398
Sales & Marketing	**$51,009**	$643	$1,190	$1,358	$1,394	$1,429	$1,465	$1,501	$1,536	$1,572	$1,607
Insurance Liability	**$43,345**	$549	$1,015	$1,158	$1,188	$1,218	$1,248	$1,278	$1,308	$1,338	$1,368
Total Other Operating Expenses	**$249,564**	$6,544	$7,557	$7,868	$7,934	$7,999	$8,065	$8,130	$8,196	$8,262	$8,327
Total Operating Expenses	**$853,703**	$24,283	$25,757	$26,210	$26,306	$26,402	$26,498	$26,594	$26,690	$28,758	$28,854
Cash Flow From Operations	**$366,957**	($8,952)	$2,614	$6,175	$6,941	$7,707	$8,473	$9,239	$10,005	$8,799	$9,565
Operating Ratio	**1.43**	0.63	1.10	1.24	1.26	1.29	1.32	1.35	1.37	1.31	1.33

In addition, a number of ancillary revenue/cost relationships will be defined in the financial analysis, including project profitability (rate of return), operating ratio (cost/revenue relationship), investment standards (investment dollar/passenger mile), and train efficiency (cost/train mile). These will be used to provide a comparative analysis of corridor performance. Pro forma cash flow financial plans will be provided for the preferred alternatives.

3.6.2 Economic Analysis of User and Non-User Benefits

In the economic analysis, transportation user costs and benefits will be assessed in terms of increased user benefits (consumer surplus), increased trip making (regional mobility), reduced journey travel times and congestion (travel time savings), and improved quality of service (maximum service levels). The economic analysis will be based on the flow of economic costs and benefits over time and the impact of the proposed rail service on both users and non-users. This analysis will include resource savings, energy savings, accident savings, and producer surplus. The economic benefits and costs will be discounted to an appropriate base year and evaluated in terms of Net Present Values, Internal Rates of Return, and Cost-Benefit Ratios (See Exhibit 3-10). The analysis will also include a public sector constrained capital assessment.

Exhibit 3-10: Example of the Approved USDOT FRA Cost Benefit Analysis

Benefits	Billions in 1998 dollars
MWRRS User Benefits	
Consumer Surplus	$6.4
(e.g., time savings expressed as dollars)	
System Revenues	$6.8
Other Mode User Benefits	
Airport Congestion Relief	0.7
Highway Congestion Relief	1.3
Resource Benefits	
Air Carrier Operating Cost Reductions	0.4
Emission Reductions	0.3
Total Benefits	$15.9
Costs	
Capital	$4.1
Financing	0.2
Operating and Maintenance	5.0
Total Costs	$9.3
Ratio of Benefits to Costs	1.7

3.6.3 Economic Benefits for Communities

A critical output is the measure of community benefits generated by developing the corridor. This shows the communities the benefits they will get from the implementation of the high speed rail corridors. This has been used successfully in the public outreach program to develop community support (e.g., Ohio Hub, MWRRI, and Florida). TEMS has developed the Economic Rent Analysis as a mechanism for estimating the increase in jobs, income, property values, and the expansion of the tax base, as a result of implementing high speed rail projects (See Exhibit 3.11). The result of this task will be fed into the public outreach process.

Exhibit 3-11: Example of Community Benefits (for different train max operating speeds/frequency)

Economic Rent Factor	110/4	125/4	110/8	125/8
State of Minnesota:				
Employment (# productivity jobs)	5,647	6,409	13,114	13,876
Income (2006$)	$252 mill	$285 mill	$583 mill	$616 mill
State Income Tax 2006$)	$10.6 mill	$12.0 mill	$24.5 mill	$25.9 mill
Federal Income Tax (2006$)	$28.5 mill	$32.3 mill	$66.0 mill	$69.7 mill
Property Value (2006$)	$722 mill	$817 mill	$1,672 mill	$1,767 mill
Property Tax (2006$)	$ 8.4 mill	$ 9.5 mill	$ 19.5 mill	$ 20.6 mill
Average Household Income (2006$)	$167	$189	$384	$406
State of Wisconsin:				
Employment (# productivity jobs)	305	351	719	765
Income (2006$)	$15 mill	$17 mill	$34 mill	$37 mill
State Income Tax (2006$)	$0.5 mill	$0.6 mill	$1.2 mill	$1.3 mill.
Federal Income Tax (2006$)	$1.5 mill	$1.7 mill	$3.5 mill	$3.8 mill
Property Value (2006$)	$45 mill	$52 mill	$106 mill	$113 mill
Property Tax (2006$)	$ 0.8 mill	$ 0.9 mill	$ 1.8 mill	$ 2.0 mill
Average Household Income (2006$)	$102	$117	$240	$255

3.6.4 Financing and Funding Arrangements

Transportation funding across Colorado and the entire nation is deficient for meeting projected travel demand. For this reason, the study team will explore new and independent funding streams that are separate from typical highway funding sources (such as the motor fuel tax) for the construction and operation of the passenger rail system being considered in this study. The development of this funding stream may require legislative action and/or voter approval of a statewide ballot initiative.

For the optimum alternative(s) identified and evaluated in Task 6, the study team will evaluate the financing requirements as they relate to overall feasibility. Assumptions will be developed regarding the timing of program implementation, to establish cash flow requirements, and opportunities for securing private sector financing will be considered. The study team will develop a finance plan for the operating and capital cost of the passenger rail system in an iterative manner. Based upon income streams forecasted for each scenario by the ridership model, two finance plans will be developed, using both high and low economic forecasts. The analysis should clearly identify any needed front-end or ongoing public support that would be required to implement and sustain the operations, and identify potential sources of funding.

The analysis will consider different ways to generate federal, state, local, and private sector support for the rail service. Specific issues to be considered include:

- Federal and state match
- Local funding of stations
- Private sector roles in provision of services and contracting
- Freight railroad contracting and funding options

The analysis will consider the full range of innovative financing proposed by the FRA and evaluate the potential roles of grants, TIFIA loans, Amtrak participation, franchising, GANS and other financial instruments.

3.6.5 Institutional Framework

Given a full understanding of the needs of the rail service, infrastructure costs, operating finances, and the potential role of the private sector, an assessment will be made of the potential institutional arrangements that will need to be developed for implementation of the rail service. The full range of potential arrangements will be assessed and recommendations made on the basis of the roles of different parties, potential financial commitments, cost and revenue sharing, and other organizational and efficiency considerations. Key criteria will include:

- Pro forma cash flows
- Administrative and operating costs
- Legal requirements and related needs (e.g., insurance)
- Ease of implementation
- Transferability
- Pay-off year and financial attributes

3.6.6 Allocation of Costs and Revenues

Revenue and cost allocation procedures will be developed that show the financial responsibilities of each party along with the timeline for finalizing contractual arrangements. Critical issues to be assessed include:

- Cooperative arrangements
- Maximization of private sector opportunities
- Financing mechanisms
- Strengthening institutional capabilities

Consistent with previous direction to make maximum use of existing information, consideration of financing options will begin with review and incorporation of the findings of the recently completed Blue Ribbon Panel on Transportation Finance. However, these finding should not be seen as restricting examination of innovative finance strategies.

3.6.7 Final Evaluation and Recommendation

From the alternatives developed and identified in preceding tasks, the study team will identify an optimum high-speed rail system alternative(s), with a clear rationale for the elimination of screened alternatives, and prepare a final evaluation of the feasibility of those system(s). It is recognized that the feasibility analysis conducted as part of the RFS will contain many contingencies and uncertainties, and that screened alternatives may still be reintroduced for more detailed analysis if desired as part of any follow-up Environmental Impact Study (EIS) process. For this reason, the study team will identify and assess the risks and uncertainties that will influence the project's feasibility as it progresses through further development. For example, examination of the feasibility of rail service in the I-25 corridor must take into account any likelihood for the relocation of rail freight service to a new corridor east of Denver. The final evaluation must clearly identify the risks (e.g., availability of freight railroad trackage and right-of-way) and propose strategies for reducing the impact of those risks.

Because a principal objective of the study is to position the Colorado corridors to be added to the nation's prospective high rail corridors, the final evaluation must provide clear and concise responses to FRA's public/private partnership criteria and the six factors regarding high-speed rail feasibility. During conduct of the study, the study team will coordinate with FRA and CDOT.

Step 5 Deliverables:

- Financial and Economic Analysis
- Institutional Analysis

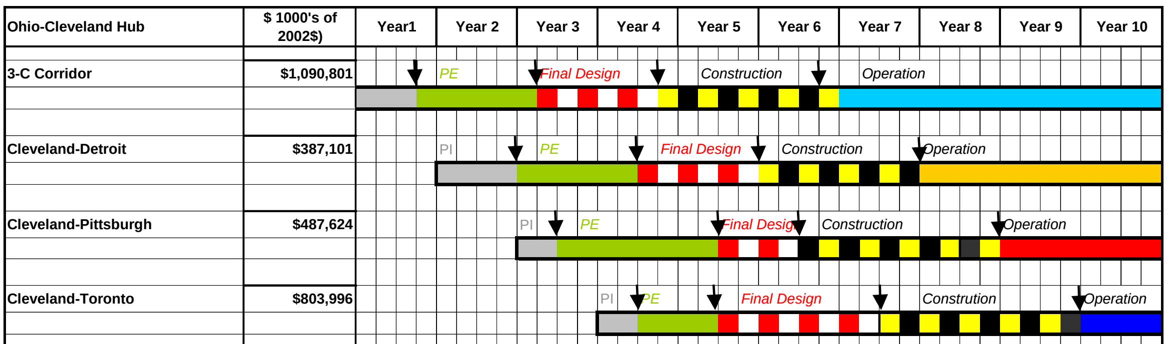
3.7 Step 6: Implementation and Business Plan

For the selected alternative(s), an implementation and business plan will be devised.

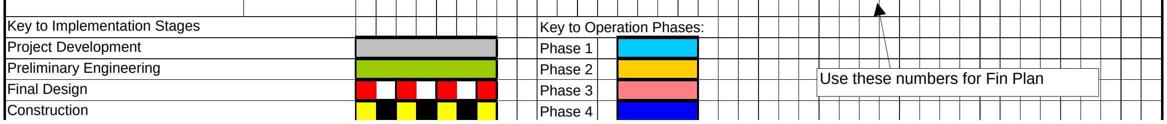
3.7.1 Implementation Plan

Using the outputs of the previous tasks, an implementation plan will be developed that sets goals, timetables, and arrangements for implementing passenger rail service in the Rocky Mountain Corridors. The timeline for planning, environmental analysis, preliminary engineering, final engineering, and construction will be set out in a realistic program to show the implementation milestones and the opening year for passenger rail operations. Alongside the physical implementation process will be a second set of milestones that identify the funding needs and institutional framework for developing the system. Action plans for lead agencies, local communities and private sector partners will be identified in the implementation process. A key element of the plan will be the interaction of physical facility provision, funding, and institutional development. The implementation plan will seek to define authority and responsibility for ensuring the success of the development process. The implementation plan will recommend an action program that sets out the steps that need to be followed to ensure the successful implementation of passenger rail in the Rocky Mountain Corridors (See Exhibit 3-12).

Exhibit 3-12: Example of Implementation Plan



Total Investment Costs by Year		Year1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Planning and Implementation (PI)	$173,095	$68,175	$24,194	$30,477	$50,250						
Preliminary Engineering (PE)	$242,333	$15,908	$69,275	$45,600	$45,815	$54,011	$11,725				
Final Design	$276,952			$54,540	$73,895	$43,736	$64,581	$40,200			
Construction	$2,077,142				$102,263	$445,341	$497,665	$367,106	$438,643	$226,124	
Total Infrastructure	$2,769,522	$84,083	$93,469	$130,616	$272,222	$543,088	$573,971	$407,306	$438,643	$226,124	
Total Land	$233,209				$70,756	$57,930	$47,351	$57,172			
Total Rolling Stock	$322,000						$80,500	$80,500	$80,500	$80,500	
Total Investment	$3,324,731	$84,083	$93,469	$130,616	$342,978	$601,018	$701,822	$544,977	$519,143	$306,624	



3.7.2 Business Plan Documentation

A business plan report will be prepared describing databases, research methods, ridership and revenue forecasts, results of the financial and economic feasibility analyses, proposed institutional framework, financing and funding arrangements, and implementation plan. The report will describe the study results in the context of a corridor implementation program and make recommendations to the RMRA Steering Committee for maximizing the benefits of a passenger rail service in the Rocky Mountain Corridors.

Step 6 Deliverables:

- Business Plan
- Implementation Plan

4 Deliverables Summary

4.1 Deliverables Summary

In this activity, the study team will prepare a wide range of products and reports for the Study Steering Committee and PMC review.

1. Rail Feasibility Report, summarizing the entire RFS process and the conclusions and recommendations of the alternatives evaluation, with particular emphasis on phasing and financing opportunities. (10 draft and 50 final)
2. Project Management Plan (5 draft and 10 final)
3. Technical Reports (10 draft and 25 final)
    a. Scoping
    b. Methodology (including outreach, ridership and revenue forecasting, cost estimating, alternatives development, and alternatives analysis)
    c. Existing Conditions (including opportunity to upgrade existing track to accommodate high speed passenger rail service)
    d. Alternatives Development (including results of the Alternatives Development workshop)
    e. Alternatives Analysis (including technology, operating and cost assumptions)
    f. Ridership and Revenue Forecasts
    g. Implementation Plan
    h. Business Plan
    i. Financing and Funding Plan
4. PowerPoint Progress Reports (12)
5. PowerPoint Peer Review Reports (12)
6. Databases: Market, Engineering, Technology and Station

Appendices

A. Demand Analysis Process

The demand analysis described in this appendix is focused on the development of a statewide multimodal travel demand model that can be used to estimate both the total statewide market for intercity travel, as well as the market shares for auto, bus, rail and air.

A.1 Data Collection and Database Development

In this analysis a set of procedures will be established to identify the available data, identify survey needs, execute needed surveys and build a comprehensive database for the study.

A.1.1 Review Existing Data

A thorough review of existing databases, travel data and modal schedules will be undertaken. These will include previous studies such as the I-70 Corridor PEIS, CDOT databases, such as the Statewide AADT highway counts, Census socioeconomic data, bus and air schedules, and MPO urban and local travel databases.

The review of existing data will seek to identify the completeness of the regional travel data, its mode and trip purpose definitions, potential adjustments and updating needed, as well as new data requirements. Once the basic needs for data are established, the next step will be to identify how the new data will be developed. This will include survey methods, sampling frames, design of questionnaires, survey procedures and locations for the surveys. Once the survey process is established, the next step will be a pilot testing of questionnaires, survey instruments, and survey locations. A minimum of 20 pilot surveys will be conducted to test the relevance of proposed questions for each mode and trip purpose quota group. The results of this process will be reviewed and the survey questionnaires and methods adjusted as necessary.

A.1.2 Stated Preference Surveys

A key input to the study process will be the stated preference surveys. The Investment Grade methodology being used for the study requires that new stated preference surveys are collected. These will be designed to provide insight into the behavior and attitudes of intercity/interurban travelers for each model option and for each trip purpose.

The stated preference surveys will be conducted using a quota sampling approach. The study team has developed the Abstract Mode Stated Preference Attitudinal Survey as a fast and effective way of gathering consumer information on the importance of different modal performance characteristics and the responsiveness of different types of travelers.

A quota sample, as opposed to a random survey or focus groups, is particularly useful in ensuring that all the important modal attributes are measured, which can be a problem when dealing with the "small market share" travel modes of air, rail and bus.

The quota survey, which has been widely used for public opinion surveys, is based on the development of representative “quotas.” As a result, two sets of data are required: data that define the “travel type” quota and data that define the "profile" quota for the individuals surveyed. The profile data are then used in conjunction with origin-destination and census data to ensure that the overall population is properly represented.

In terms of the size of the quota required, it has been shown that statistically (i.e., the result has 95 percent confidence level) a sample as small as 40 individuals is sufficient to define each group. Typically, the team will seek 60 to 100 respondents per quota. The framework of the quota survey will include the following "travel type" data and "personal profile" data –

- **Travel Type Data**
    - Mode: four quota groups – rail, air, bus and auto.
    - Trip purpose: four quota groups – business, commuter, social and tourism.
    - Trip length: two quota groups – less than 100-miles, and more than 100-miles
- **Personal Profile Data**
    - Income: four quota groups
    - Auto ownership: two quota groups
    - Group size: two quota groups

Travel Type Data

- ***Travel Mode:*** One of the major findings of behavioral research is the difference in trade-offs made by individuals using different travel modes. The reason for these differences is the different characteristics of the modes themselves. Air travel is highly regarded while auto and conventional rail travel are typically considered 30 to 40 percent less attractive than air, and bus is the least attractive mode of all, being only 30 percent as attractive as air and only 60 percent as attractive as the auto and rail modes. High-speed rail typically closes the gap with air and for example TGV is usually at least 70 percent as attractive as air.

    The study team has identified this failure to understand the basic difference between modes in a number of studies (including studies for the Departments of Transportation of Illinois, Minnesota, New York, Michigan, Florida, Ontario, Quebec and Alberta) as perhaps the most significant reason why conventional approaches to rail forecasting have failed to provide reasonable demand model calibrations. An understanding of the differences in individuals' attitudes to modal characteristics is essential to effectively modeling high-speed rail travel, particularly if new service options are to be tested.

- ***Trip Purpose:*** A second major segmentation of the travel population is trip purpose. It is well established that the behavioral characteristics of different trip purposes give rise to different trade-offs between different travel attributes. Business travelers are far more concerned with travel time, and the regularity and availability of service; personal business travelers, social travelers and tourists are more concerned with cost than travel time. As such, the segmentation of demand on this basis is essential for the subsequent Trade-Off Analysis. As a result, MPO data will be transformed from typical MPO trip purposes (e.g., home based-work to commuter or work to work trips for business).
- ***Trip Length:*** Recent work by the study team in assessing the behavior of travelers in the Northeast and Chicago-Milwaukee-Twin Cities Corridor has shown that trip length can play a significant part in affecting the behavior of travelers in their decision-making. It was found that travelers making short trips, i.e., less than 100 miles, had fundamentally different trade-offs to those making trips over 100 miles in length. The difference in the way time was valued, for example, was 50 percent higher for longer distance trips than for shorter distance trips. This result held across all modes and trip purposes.

  Given that a whole range of trip lengths are possible in the study corridors, it is proposed that trip length segregation be made as follows:
  - Less than 100 miles
  - Greater than 100 miles

  This segmentation will ensure that shorter "intra-urban" trips are treated differently than longer "intercity" trips.

Personal Profile Data

In its past research, the study team has found that personal factors can play a significant part in demand forecasts. These factors include income, group size and level of auto ownership.

- ***Income:*** Income and occupation factors could well play a role in the two study corridors. For example, in its analysis of rail service between Edinborough and Newcastle in the U.K., the study team found that the demand was lower than expected because the citizens of Edinborough and Newcastle were very different. Edinborough has a middle-class, professional population while Newcastle has a blue collar, working-class population; and the two populations therefore had little reason to mix with each other. As a result, a lower level of interaction was found than would normally be the case. Similar differences were found between Quebec and Toronto. On the other hand, Edmonton and Calgary in Canada exhibited a higher-than-usual level of interaction that boosted the ridership forecast between those two cities.
- ***Group Size:*** Equally, for social and tourism travel, group size can be a significant factor in lowering prices and due to the provision of discount rates. This will have the effect of generating more travel than would otherwise occur.
- ***Auto Ownership:*** The level of auto ownership is also important in determining the potential for use of the auto and the level of trip making that will occur. TEMS has attempted to identify the role of auto ownership in most of its studies but has found that, while it affects overall levels of trip making, it has not proven to be as significant as assumed by many conventional modeling approaches. For example, on the Chicago-Milwaukee-Twin Cities Study, auto ownership was found to affect the way people value time by only 15 to 20 percent. Nonetheless, such a difference

is worth including in the forecasting process and the study team would advise that it be used to segment the behavioral stated preference surveys.

The study team recommends that these following personal profile factors be included in the Stated Preference Attitudinal Survey. The behavioral stated preference analysis will therefore evaluate the following structure:

	Primary Factors	*Secondary Factors*
Quota Segmentation Group	4 travel modes	4 income/occupation groups
	4 trip purposes	2 auto ownership groups
	2 trip lengths	2 travel size groups

The potential stated preference groups include 32 primary groups and a further 16 secondary groups, giving a combined total of 512 groups. However, a number of these groups may not in fact exist in the corridor (e.g., short-distance air commuting). By a careful assessment of group feasibility and "inference" opportunities in the matrix, the effective structure will be reduced. Exhibit A-1 shows that 1,600 observations are required to cover the principle quota categories. Our experience suggests that as many as 2,000 surveys should be collected since the typical response rate is 70 to 80 percent for valid surveys.

Exhibit A-1: Structure for Stated Preference Survey

	Business		**Commuter**		**Social**		**Tourist**	
	S	**L**	**S**	**L**	**S**	**L**	**S**	**L**
Rail	**0**	0	0	0	0	80	80	80
Air	0	80	0	80	0	80	0	80
Bus	0	80	80	80	80	80	0	80
Auto	80	80	80	80	80	80	80	80

S = Short Distance
L = Long Distance

Each group will be asked a series of trade-off questions that will seek to establish the way individuals judge the following factors:

- In-vehicle time
- Frequency
- Access/egress time
- Access/egress cost
- Public transportation fares
- Auto operating costs
- Comfort, convenience and reliability
- Modal prejudice

Questionnaire Design

In developing the questionnaire for the Stated Preference Attitudinal Survey, multiple factors will need to be considered. First, the survey must be designed to simulate the real life situations of which the individual has experience. Otherwise, an individual is only guessing as to what his real response would be. Considerable research exists on the effect of asking questions to which an individual cannot relate. Obviously, the result is misleading answers.

Secondly, any question that is asked concerning choice between say alternatives A and B must be made in such a way that the questions are perfectly clear and understandable. If any part of alternative A or B is not clear, an incorrect response is inevitable.

Thirdly, with respect to any individual's response, it must be validated against the response when the question is asked in a different way. As a result, questions should be "enveloped" to ensure consistent answers. A lack of consistency in answers reflects poor questionnaire design, or irrational behavior on the part of the individual. Either way, the survey is invalid.

As a result, questions will be formulated that describe the real trade-offs that individual’s make and allow individuals to express their values for key transportation characteristics. A typical question could be to ask an individual to choose between two alternatives, i.e., A and B.

Choice A		Choice B	
Travel time	2 hours	Travel time	5 hours
Fare	$120	Fare	$60

The choice of A shows a willingness to pay an extra $60 for a 3 hour savings in travel time, while a choice of B suggests a willingness to spend 3 extra hours traveling to save $60. By asking sufficient questions, the way an individual values time, money, access/egress time, comfort, convenience, modal bias, etc. can be determined. It is typical to find that individuals will spend more money to save time on business trips than on social trips. Business travelers will also spend money to reduce access time, uncertainty, and interchange time, and to improve the comfort and convenience of their trips. Alternatively, social travelers will frequently prefer to spend time rather than money, as they are limited by their own rather than their company's money. The value of all these factors will be included in the stated preference trade-off questions.

To ensure the rigorousness of the choice by individuals with respect to the trade-off questions, a probability scale will be incorporated in the questionnaire format. This will offer an individual not just a choice of alternative A or B, but also a graduated choice. The probability scale will contain five selection levels:

- Strongly prefer A
- Weakly prefer A
- Indifferent
- Weakly prefer B
- Strongly prefer B

The advantage of the scale is that it allows individuals to express their preferences more exactly and it also allows the analyst reviewing the results to see how well the question suited the individual. If an individual always strongly or weakly prefers options, the questions were probably not correctly balanced for that traveler's choices. A review of how each quota group responded can be effective in helping to interpret results.

Survey Method

The Stated Preference Attitudinal Survey will use a self-administered booklet format to be handed out in terminals, rest areas, aboard public vehicles, etc. This is a particularly useful way of administering stated preference surveys for the following reasons:

- It has been found that individuals prefer to answer trade-off questions privately and in a "check-off" format. However, they also like to have an interviewer nearby to answer questions. A self-administered survey in a terminal or public vehicle setting meets both these needs.
- Multiple versions of the questionnaire can be used and which version is given to a particular individual will depend on that individual's circumstances. The study team typically uses eight to ten different versions of the questionnaire. Each version of the questionnaire will contain different question sets reflecting different types of trip characteristics. This will serve to ensure relevance of the questionnaire.
- Upon collection of the booklet, the interviewer can quickly check that all questions have been answered.
- In terms of response rate and accuracy, individuals respond better to personal questions if the information is checked off in a "private" booklet. It is undoubtedly the most comfortable medium for individuals.

Completed booklets will be collected and coded by the survey supervisor, who will add data on location, date, time, and any other non-questionnaire data desired (e.g., sex, age group, etc.). The booklets will then be subjected to a data entry process that involves validating and entering the data in the attitudinal data bank. Validation of the data will include a series of range, logic and consistency checks. The results of the Stated Preference Attitudinal Survey will then be subjected to the Trade-Off Analysis process.

Corridor Databank: A corridor databank will be set up containing both demand and transportation systems network data. All information will be filed, and subjected to data verification assessment whereby crosschecks are made on the basic data to confirm its accuracy. It is anticipated that the database will be based on 300 zones and that urban areas will be disaggregated into a zone system consistent with existing urban planning models, although at a much higher level of aggregation. An expansion process will be used to ensure the "representativeness" of the results by expanding quota samples to the total population by mode and purpose. The PMC and peer review panel will be given every opportunity to inspect and assess the quality of the data assembled for use in the study.

A.2 Ridership Model System Development

While the development of the model will depend largely on the quality of the data that will be gathered and assembled in the study corridor database, it is anticipated that the following methodology will be used to develop the demand forecast models.

At the model specification stage, a range of possible modeling systems will be developed and discussed with the FSSC and peer review panel. These will include various forms of the direct demand, induced demand and modal choice models for regional travel and the specification of the *COMPASS*™ model for statewide travel. It is anticipated that a number of different model structures will be specified for calibration. It is proposed that 2008 be used as the base year for calibration purposes. To this end the socioeconomic, network, origin destination data will be brought to a 2008 base year.

The agreed upon models will be calibrated and the statistical validity of each tested using range, logic and consistency checks. In developing each model system, an interactive assessment will be made of the potential role of variables and the ability of the model to represent travel behavior. The best of the models developed will be presented to the FSSC and peer review panel for their review and approval.

A.2.1 Stated Preference Trade-Off Analysis

Using the data from the stated preference survey, a trade-off analysis will be carried out to identify the relative ranking and values of both “system” and “mode appeal” variables. For the system variables, the analysis will define both the modal elasticity and cross elasticity of demand for travel time, price, and frequency for each mode and trip purpose. The analysis will be a two-stage process using algorithms specially developed by TEMS to provide “preference utilities,” “own and cross elasticities,” and modal bias estimates. For the “mode appeal” variables, specific rankings, market share and generalized cost values will be derived.

The procedures used in trade-off analysis are as follows:

- Travel options are organized in a form enabling respondents to consider trade-offs between desirable travel attributes, such as time, comfort, cost, speed and accessibility. The trade-offs, which include the full range of service options such as first or economy class, on-board facilities, comfort, convenience, reliability, etc., are presented in such a way as to induce individuals to give realistic response to the options without having to specify the mode of travel. This is the key to the successful use of abstract mode trade-off analysis and requires considerable expertise and knowledge to obtain a realistic and balanced response from interviewees. It is also critical in persuading Wall Street that the analysis is reasonable and unbiased.
- Travel attributes and choice factors are then analyzed using a trade-off analysis procedure to provide a ranking that describes the individual's behavior within the trade-off. These rankings are applied to a simulation of the transportation market at different rail service levels to give quantitative estimates of modal choice. In this way, specific modal and cross elasticities are derived to provide the basis for demand forecasting. These elasticities will then be used in the *COMPASS*™ model to provide regional travel forecasts, at ten-year intervals over the study period, of ridership and revenue for different service and fare options.

It should be noted that the study team does not use either classical Monanova or Conjoint analysis techniques for evaluating abstract mode stated preference data. Research by the study team for a number of rail and transit companies and departments of transportation has shown that such techniques, because of scaling problems, produce biased and misleading results. The study team has developed a new approach using a logit model based on utility maximizing theory, which overcomes the scale variance and non-optimizing problems in the Conjoint and Monanova methods.

Model Structures

The general form of the Total Demand and Induced Demand Model used in *COMPASS™* is as follows:

$$T_{ijpm} = e^{B_{op}^{m}} (SE_{ijp})^{B_{1p}^{m}} (U_{ijp})^{B_{2p}}$$

where

T_{ijpm} = Volume of Trips between zones *i* and *j* for trip purpose *p* and mode *m*
SE_{ijp} = Socio-economic variables for zones *i* and *j* for trip purpose *p* and mode *m*
U_{ijp} = All mode Utility of travel expressed in term of the generalized cost of travel for zones *i* and *j* for trip purpose *p*
B_{0p}^{m}, B_{1p}^{m}, B_{2p} = Coefficients for trip purpose *p* and mode *m*

A number of socio-economic variables will be used in the model to identify overall travel market growth. Typically, these include population, employment and household income. It should be noted that the socio-economic forecasts must be made on a zonal basis so that the forecasts consider not just overall corridor growth rates but distributional differences across the state of Colorado. This is particularly important where different growth rates exist between large and small cities and between urban and rural areas. Small differences in socio-economic forecasts can have substantial impacts on the ridership and revenue forecasts (i.e., a 1 percent increase in household income can increase a total market forecast by 30 to 60 percent over 25 to 30 years). As a result, great care must be taken in preparing the socio-economic scenarios, and a range of sensitivities should be tested. The specific format that has proven most successful in previous studies by the study team is as follows:

Trip Purpose	**Socio-economic Variable**
Business	Employment (x) Annual Household Income
Commuting	Population (x) Annual Household Income
Other	Population (x) Annual Household Income

The general form of the Modal Split Model used to estimate market shares is:

$$P_{ijmp} = \frac{e^{U_{ijmp}}}{e^{U_{ijmp}} + e^{U_{ijnp}}}$$

where

P_{ijmp} = Percentage of trips between zones *i* and *j* by mode *m* for trip purpose *p*
U_{ijmp}, U_{ijnp} = Disutility functions of modes *m* and *n* between zones *i* and *j* for trip purpose *p*

A variety of forms of the modal split function can be used in the modal split analysis, ranging from multinomial to hierarchical with different structural orderings. A number of the different structures will be tested. For both of the conventional rail modal split models (hierarchical and multinomial), both stated preference and “revealed behavior” models could be calibrated where rail service exists, (e.g., the Amtrak California Zephyr, and Ski train). However, only stated preference models can be developed for high-speed rail systems, as only stated preference models can effectively evaluate the "new mode" attributes of a high-speed rail service that does not yet exist in the corridor.

Finally, whatever the final structure of modal split model, there is a need to examine different weights, generalized cost relationships, and modal biases. The study team will test base year, forecast year and incremental weights, difference and ratio generalized cost relationships, and a variety of modal bias values that are based on the outcome of the stated preference market research into "mode appeal" variables and their impact on mode selection. Depending on these findings, comfort, reliability and modal biases will be incorporated into the generalized cost function. This will permit the analysis of the direct market share that could be achieved using different high-speed train marketing concepts, e.g., coach, business, first class.

A.3 Model Validation

An important element in the development of Investment Grade studies is the "validation" of the model systems. The study team will use four sets of validation procedures:

- ***Statistical Tests of Significance:*** The study team will use a series of statistical tests to estimate the validity of the total demand and modal choice models that are developed in the modeling process. These will include: analysis of statistical reliability, both of the equation systems and of specific variables used in the equation. These will show the likely level of statistical accuracy of the equations and their validity in the forecasting process.
- ***Total Demand Model Performance:*** The study team will forecast total demand both within a multi-modal context and for individual modes. Experience in previous studies has shown that individual mode forecasts can act as a significant crosscheck on the multi-modal forecast, which is naturally an average of the growth rates of the individual modes. This approach makes it easier to compare the multi-modal forecast with historical trends.
- ***Elasticity Analysis:*** Using the elasticities estimated in the trade-off analysis, a comparative analysis will be made with the elasticities derived by the study team in a range of previous studies carried out in the U.S., Canada, the U.K. and elsewhere. These different studies provide a range of values against which estimates for this study can be compared, contrasted and benchmarked. The study team has found a marked degree of comparability between elasticity values once income, trip length and generalized cost differences are accounted for. Again, close consultation with the PMC project manager and peer review panel at this stage will allow a full discussion and assessment of the elasticity findings. This will be particularly important in validating the forecasts and assuring Wall Street as to the quality of the results.
- ***Cross Model Comparisons:*** The investment banking community is usually very interested in the comparisons of the calibrations of the demand models. Differences in parameter form and function will need to be fully documented and explained. The analysis will show how different variables perform and how the structures of the models are affecting the forecasts. This impact will be essential in developing a forecast risk profile for both CDOT and Wall Street.

A.4 Design of Network Alternatives

The development of Investment Grade forecasts requires that a model system be developed that recognizes the highly competitive character of regional and statewide travel between modes, in particular, between rail, air and bus. Service differences in these modes can radically affect their respective market shares. The development of a high-speed rail system can significantly reduce intercity air travel, and intercity bus travel as its quality of service and its ability to offer different service options to different travelers can result in its becoming the dominant public mode. To ensure that the difference in service is properly represented, it is essential to properly specify the service networks. The networks must include all key behavioral characteristics and, to do this, a generalized cost network structure is needed. The *COMPASS™* model provides this facility. For each competitive mode and purpose of travel, generalized cost networks will be built. At least 16 networks, i.e., at least 4 modes/4 purposes of travel, will be structured to ensure an effective representation of modal competition.

A.4.1 Network Data Elements

Each network will include the following data:

In-Vehicle Time: In-vehicle travel time is defined differently for each mode. For all public modes, in-vehicle time refers to the time spent aboard the intercity travel mode that provides the "line haul" portion of the intercity trip. For the private mode (i.e., auto), in-vehicle time refers to the door-to-door time spent in the vehicle completing the intercity trip, as well as any time spent at a rest area and any time spent refueling during the trip.

Frequency: Frequency refers to the number of departures available for passengers traveling between a specific terminal pair (e.g., Sacramento to San Francisco) on any of the public modes. All frequencies will be calculated using an 18-hour travel day from 6:00 AM to 11:59 PM Monday to Sunday. All trips with boarding and alighting times within this 6:00 AM to 11:59 PM window will be included, as well as those which have only boarding times within the 18-hour window. Trips requiring connections will also be included, provided the connection occurs during the designated 18-hour travel day.

Access/Egress Time: Access/egress time refers to the time associated with accessing and egressing a public mode terminal. Access/egress time includes such factors as time spent on local or commuter transit and/or time spent in private vehicles to access the boarding terminal from the origin zone, plus the time required to get from the alighting terminal to the final destination.

Access/Egress Cost: Access/egress cost refers to the direct cost of accessing and egressing a public mode terminal. This includes such costs as transit and taxi fares, parking costs, and automobile operating costs incurred for making a trip to or from a terminal.

Number of Interchanges and Connect Time: Transfers or interchanges required for intercity travel penalize the traveler due to the inconvenience as well as the time involved. For most trips, no more than two interchanges will occur. However, the total connect time will be calculated for all interchanges. For public modes, interchanges represent the number of times a passenger disembarks a vehicle of the same type in order to complete a scheduled trip. Once an interchange is made, connect time will be calculated by averaging the time spent at the interchange terminal between the arrival of the inbound service and the departure of the outbound service.

Public Transportation Fares: The fare component of travel cost must accurately reflect what the traveler believes he is paying, which may not be the same as the actual ticket cost. In addition to the traveler's perception of fares, there is a very wide variation in actual fares due to a host of discounting schemes and classes of service on the three public modes. In the analysis, it will be important to use values that accurately reflect trip-making behavior on a trip purpose basis.

Auto Operating Costs: Auto operating costs are dependent on trip purpose. Auto operating costs for business travel reflect the average cost of using an auto while, for commuting, tourism and social trip making, only the marginal costs are taken into consideration. These costs will be developed using local AAA data, current gas prices and expected levels of increase.

Comfort, Convenience and Reliability: The comfort, convenience and reliability of travel will be measured for each mode using a scale that ranges from good to bad for each of the three factors. This data will be used to check the relative use of a mode in conjunction with other travel characteristics.

Modal Bias: To assess the hypothesis that strong modal biases exist in the market, individuals will be asked to rate the available modes for the trip they are making. These results will be used in conjunction with the values given for the other travel characteristics to quantify modal bias and compare it with the values typically derived from modal split equations. This assessment will be key to identifying the potential for new high-speed rail service, which typically offers a level of service comparable to air travel.

A.4.2 Network Development

The development of the required networks will be a major element in the study. The COMPASS™ model contains many features for simplifying the process and checking the appropriateness of network characteristics such as restrictions on fares, travel times and trip purposes. To expedite the network process, mechanisms will be developed for utilizing as much existing network data as possible (e.g., MPO and statewide models).

It should be noted that the *COMPASS™* model provides powerful network editing features that allow future year networks to be easily developed from the base year network. For example, an alternative specifying higher gas prices for auto or increased frequency for air can be easily coded using the factoring features of the *COMPASS™* model. As a result, it is envisioned that the development of a large number of future year networks will be a relatively straightforward task. The most difficult element will be the assessment of different high-speed rail station stopping patterns, as this requires fundamental restructuring of zonal access to the rail network. It should be noted that the structuring of zonal access requires a great deal of time and attention as critical behavioral factors such as reluctance to “backtrack” can dramatically affect an individual’s willingness to ride high-speed rail on specific segments.

Working with the FSSC, a number of different high-speed rail strategies will be developed for testing in the models. For high-speed rail alternatives, the study team will consider a range of both "system" and "mode appeal" factors such as train frequencies, speeds, stopping patterns, interchanges, and quality of service. Also included will be an analysis of different station locations, including potential stops at airports. The "mode appeal" analysis will include different types of on-board facilities, services, and comfort levels. By examining the impact of these facilities against fare levels and travel times, evaluations can be made that identify the best train and consist configurations and service provisions. It is on the basis of these strategies that the rail ridership forecasts will be made.

Alternative strategies for other transportation modes will also be developed, so that the impact of investment in other modes or changes in fares and services of other modes is also incorporated into the base year forecasts and sensitivity analyses for the horizon year forecasts. It has been the European experience that competitive modes will have a “competitive response” to the introduction of high-speed rail services. The investment banking community will want this issue explored. This task will be undertaken in conjunction with the PMC and will be subject to the approval of the peer review panel.

In terms of developing daily or annual riderships and the assessment of revenue yield and consumer surplus, *COMPASS*™ provides mechanisms for providing these outputs on an automatic basis. Because *COMPASS*™ has been designed specifically for Investment Grade high-speed rail forecasting, it provides all the financial and economic outputs needed to build a business case acceptable to Wall Street and provide USDOT FRA-approved user benefit data.

B. Engineering Assessment and Capital Cost Methodology

This appendix describes the engineering assessment and capital cost estimating process that will be used in providing input into determining the feasibility of implementing high speed rail service within the I-25 and I-70 west corridors. Additionally, the appendix describes the field review process, the elements that are the basis of the capital cost estimate, and the development of the capital cost database.

B.1 Introduction

The study team will conduct an Engineering Assessment in cooperation with the RMRA, freight railroads, Colorado DOT and in coordination with both the FasTracks and Colorado Freight Rail relocations (R2C2) studies. In addition, study team representatives will attend interim project meetings and will participate in field reviews.

The Engineering Assessment will provide an evaluation of the current condition of the proposed highway, green field, and railroad right-of-way alignments; will identify improvements to existing rail lines needed to support the 79/110mph passenger service scenarios; and will develop estimates for new green field alignments for the 110 mph, 186 mph and 250 mph options.

In addition to the Engineering Assessment, the Capital costing methodology will identify rolling stock (equipment) costs and land costs. Land costs will be presented separately, as a placeholder for access to railroad rights-of-way and for procurement of additional privately owned property, where required to construct new passenger rail infrastructure.

The Engineering Assessment and its findings and recommendations will be preliminary and will not have been discussed in detail with the railroads. As discussed earlier, the study is at a feasibility level, the project is un-funded and formal negotiations with the railroads have not yet been initiated. Future Engineering Assessments will require considerably more discussion to ensure railroad concurrence. Final design concepts and recommended capital plans will depend on detailed operations and capacity analyses, design coordination and in-depth discussions with the freight railroads. As the project moves beyond the feasibility phase, railroad involvement and coordination will become increasingly important.

The Engineering Assessment will be conducted at a feasibility level of detail and accuracy. Exhibit B-1 highlights the levels of accuracy associated with typical phases of project development and engineering design. A low level of accuracy is associated with the evaluation of project feasibility; while the highest level of accuracy is achieved during final design and production of construction documents. The RMRA Feasibility Study is only the first step in the project development process. As shown in Exhibit B-1 the level of accuracy typically associated with a Feasibility Study is +/- 30%. This is intended to be a “Central” range projection with equal probability of the actual cost moving up or down.

Exhibit B-1: Engineering Project Development Phases and Levels of Cost Estimate Accuracy

Development Phases	Approximate Engineering Design Level*	Approximate Level of Accuracy**
Feasibility Study	0%	+/- 30% or worse
Project Definition/Advanced Planning	1-2%	+/- 25%
Conceptual Engineering	10%	+/- 20%
Preliminary Engineering	30%	+/- 15%
Pre-Final Engineering	65%	+/- 15%
Final Design/Construction Documents	100%	+/- 10% or better

*Percent of *Final Design*. **Percent of actual costs to construct.
Table prepared by Quandel Consultants, LLC

B.2 Engineering Assessment and Cost Estimate Process

The first step in the Engineering Assessment is to divide each corridor into segments. Route segments for existing railroad rights of way generally begin and end at major railroad control points or rail stations. For green field alignments, segments will begin and end at station points. Typical corridors are divided into three to five route segments. The segment break points for the RMRA corridors have yet to be determined, because they will depend on the geography of the alignments that are ultimately selected for evaluation. These route segments will be identified on the corridor maps. The corridors that are included in the scope of the RMRA evaluation include:

- Denver-Pueblo-Trinidad
- Denver-Fort Collins-Cheyenne (alternate routes south of Fort Collins)
- Denver to DIA Airport
- Denver to Grand Junction via the general I-70 corridor
- Secondary Corridors to Black Hawk, Winter Park, Aspen and Craig

Field inspections of the corridors have been conducted, and additional field visits will likely be conducted in the future to support the corridor evaluation process.

A systematic engineering planning process is used to conduct an engineering assessment of the rail rights-of-way and green field alignments and to estimate the capital investment required for each route. The initial step in this process is to segment each route and to assess the elements of the infrastructure of each route segment. The elements that are assessed include:

- Guideway and Track Elements
- Stations, Terminals, and Intermodal
- Support Facilities
- Sitework
- Systems
- Right of Way and Land

- Vehicles
- Professional Services & Contingencies

The engineering assessment of these elements is accomplished by conducting field views of each segment. A field view is a limited site verification without detailed surveys and consists of the sampling of critical sites along the track at crossings, bridges and stations. These views are augmented by using satellite photography and GIS data to understand what lies between each view. At each location, engineering notes are compiled and the physical track conditions are compared with the latest track charts and other information provided by the railroads.

Field observations are conducted at highway/railroad crossings, overpasses and parallel roadways. Direct access to railroad right-of-way is not required as part of this field observation. The inspections focus on the condition of the track and the ability to accommodate joint freight and passenger train operations with speeds up to 110 mph. The railroad right-of-way and highway corridors are examined for their ability to accommodate additional tracks for added capacity. Where possible, other existing facilities were observed, including bridge conditions, vertical/horizontal clearances, passenger train facilities, railroad yards and terminal operations. Photographic records are made at many locations and will be included in the corridor reports.

As route segments are examined in the field, general concepts are developed and assumptions made regarding the capacity and operational improvements needed to accommodate future passenger operations. For each potential alternative, design criteria consisting of technology assumptions and geometric and civil design parameters are developed. The primary objective is to conceptualize infrastructure improvements that would improve fluidity and enhance the reliability of both passenger and freight rail operations.

The results of the field inspections are combined with data derived from GIS and railroad track charts to determine more precisely the recommended infrastructure improvements and to estimate the capital costs. Cost estimates are then prepared through the application of appropriate unit costs.

B.2.1 Guideway and Track Elements

B2.1.1 Guideway

During the field views, the condition of the right of way is noted and a determination made relative to the improvements required to accommodate a specific train technology. The limited field views determine the existing track condition, assess its suitability to accommodate joint rail freight and passenger operations based on FRA regulations and track safety standards, and gather sufficient data to identify needed infrastructure improvements. For green field alternatives, the topography of the corridor is noted for future reference to other data sources such as GIS mapping, orthophotography and other information available.

Where passenger and freight are expected to share track, it is generally recommended that the existing track be improved with either a 33% or 66% tie replacement depending on the existing track condition, and planned track speed. Where existing rail conditions are not suitable for passenger operations, the capital cost estimates provide for replacement with 136 lb continuous welded rail (CWR). In single track territory, 10-mile passenger sidings are provided at nominal 50-mile intervals to allow passenger and freight trains to pass. Additional freight sidings are provided between passenger sidings, as needed to support the level of freight operations that are anticipated for the corridor.

A key engineering assumption, adopted for this study, involves the centerline offset between an existing high density freight track and a new FRA Class 6, 110-mph track. Both UP and BNSF requested that new tracks be constructed at a minimum 25-foot centerline offset from the adjacent track, where feasible. However, in order to accommodate possible future capacity expansion especially in congested urban areas, the 25-foot offset will be increased to a 28-foot centerline offset. The 28-foot offset would allow a future siding with 14-foot track centers to be constructed between the new passenger track and the adjacent freight track. Based on the field reviews the costs associated with the 28-foot offset will be estimated and included under the line item "High-Speed Rail (HSR) on New Roadbed and New Embankment."

Wherever the 28-foot centerline offset is not feasible due to railroad right-of-way limitations caused by topographical features and boundaries through commercial and residential areas, new track would be added at the standard 14-foot centerline offset from the adjacent freight track, but the proposed passenger train speed will be limited to a maximum speed of 79-mph.

The highway corridors are examined to determine the feasibility of placing high speed guideways within or near the existing rights of way. The engineering assessment seeks to develop and plot alignments on a scaled map, so as to determine the significant cost elements. The cost of many high speed rail system components in green fields is a direct function of the distance (track, signals, communications, electrification). Other elements, such as roadway crossings, stations, and railroad bridges are specific to the green field alignment and technology evaluated.

Guideway costs for magnetic levitation systems will be developed for at grade, (low level piers), aerial and bridge structures. The guideway system is comprised of a concrete and/or steel guideway to support the vehicles, stator packs, power rails, low-speed switches and high-speed switches.

B.2.1.2 Turnouts and Crossovers

New turnouts and crossovers are provided as necessary for operating the passenger service.

B.2.1.3 Realignment and Superelevation of Curves

Physical forces on the passengers, rolling stock and track serve to limit the speed at which a train can safely or comfortably operate through curves. The overall track standard for mixed freight operations is to increase super-elevation to as much as 4½ inches where necessary to achieve desired passenger speeds. For lines with very light freight operations or for high-speed intermodal trains, additional increases in super-elevation might be possible, but in no case will superelevation exceed the value that balances freight speed at 60 mph or be greater than 6 inches. Where heavy freight operations (e.g., slow coal trains) predominate, lower levels of superelevation must be used. Additionally, realignment of the existing track structure in rural areas is a strategy to increase speeds by "flattening" the curves.

B.2.1.4 Bridges and Tunnels

A complete inventory of bridges is developed for each existing rail route from existing track charts. For estimating the cost of new bridges on either green field alignments or along existing rail beds, conceptual engineering plans and per lineal foot cost estimates developed on previous studies are used for a bridge to carry either single or double tracks over highways, streams, valleys, and rivers.

Some bridges will require rehabilitation on the abutments and superstructure. This type of work includes pointing of stone abutment walls, painting of bridges, and replacement of bearings. Therefore, for existing bridges, many of the bridge cost estimates will be estimated only as placeholders, which will be subject to more detailed engineering analysis in the future.

Any proposed tunnel in the I-70 or I-25 corridor would be constructed on up and down grades in remote areas. The depth of the tunnels below the surface adds additional costs for ventilation and safety requirements, since the distance to the surface is greater. Cost per lineal foot estimates developed on previous studies will be used for shallow and deep tunnels.

B.2.1.5 Highway/Railroad Grade Crossings

The treatment of grade crossings to accommodate 110-mph operations is a major challenge to planning a high-speed rail system. Highway/railroad crossing safety will play a critical role in future project development phases and a variety of devices will be considered to improve safety including roadway geometric improvements, median barriers, barrier gates, traffic channelization devices, wayside horns, fencing and the potential closure of crossings.

The FRA guidelines require the use of four quadrant gates with constant warning time activation at public crossings subject to 110-mph passenger operations. Constant-warning time systems are essential to accommodate the large differential in speed between freight and passenger trains. The treatment and design of improved safety and warning devices will need further development to identify specifications and various approaches that may be advanced as part of an integrated program in Colorado.
There are numerous grade crossings through downtown business areas and residential communities. For many of these, speed restrictions will be assumed, but there are others where high-speed operations are essential to the success of the rail system.

Grade crossing improvements are a significant component of the capital cost estimates for passenger rail service operating up to 100 mph on existing railroad rights-of-way. A variety of unit costs have been developed to address the required improvements. For speeds in excess of 110 mph, the grade crossings will need to be eliminated. The following strategy has been employed to develop the estimates:

- Where speeds do not exceed 79 mph, private crossings will not be affected.
- Where passenger speeds do not exceed 79 mph, public crossings warning systems will be upgraded to standard two quadrant gates, and flashers with constant warning time and remaining private crossings will be upgraded to standard two quadrant gates and flashers.
- Precast panels will be installed at all public crossings.
- Where passenger speeds are at 110 mph 25% of the existing private crossings on the route will be closed.

- Where passenger speeds are at 110 mph, public crossings will be upgraded to four quadrant gates with constant warning time, and remaining private crossings will be upgraded to four quadrant gates.
- Where new track and embankment are constructed, precast panels will be installed and roadway surfaces improved at public crossings.

B.2.2 Stations and Terminals

Stations and parking facilities include platforms, circulation, lighting, security measures, and all auxiliary spaces. Space will be provided for ticket sales, passenger information, station administration, baggage handling, and commercial space. The average cost per station used in this study will be based on cost data from more detailed studies conducted throughout the country.

For existing stations, general recommendations for facility improvements are made to conform to the requirements of a given technology. Based on the selected technology, considerable improvements may be required for the platforms to be compatible with the technology. Additionally, substantial improvements in amenities within the stations are needed. The need for parking is also assessed based on the estimated ridership levels.

Placeholders for the improvements need for existing stations or terminals will be developed based on experience with other high speed rail projects. Costs of the parking facilities will be estimated on the basis of ridership at each station. Additionally, a lump sum cost (placeholder) for new stations and terminals are developed based on previous studies and adjustments for local conditions.

B.2.3 Support Facilities

Support facilities include maintenance facilities and yards, which contain all equipment necessary to properly maintain the fleet of vehicles. The size of the maintenance facility is related to the size of the fleet.

Conceptually, vehicle servicing will be performed at corridor end-points or at other points where trains lay over at night. Specific locations for servicing facilities will not be finalized under this study. Placeholders will be developed and used for layover facilities, heavy maintenance facility based on cost information from other similar studies.

B.2.4 Sitework and Other Conditions

Across the United States, a number of dual use corridors that feature recreational trails along with active rail lines are in service. The construction standards vary widely, particularly with respect to fencing, mode separation distance and common use of bridge structures. A minimum standard commonly accepted around the country is 30 feet from center of track to edge of trail[2]. In Newark, Delaware, a rail-trail has been built at that separation from Amtrak's high-speed northeast corridor tracks, although a greater separation is recommended where practicable[3]. The requirements for vertical and horizontal separation along with the need for fences and barriers for rail-trails will be examined as part of the preliminary engineering and project development process.

[2] See: http://www.fhwa.dot.gov/environment/rectrails/rwt/section5a.htm - fig56
[3] See: http://www.fhwa.dot.gov/environment/rectrails/rwt/section2c.htm and http://www.udel.edu/PR/UDaily/2004/biketrail072403.html

Recreational trails are currently constructed on the Glenwood Springs to Aspen route on the historic railroad grades. Feasibility-level cost estimates presented here for reconstruction of existing rail-trails assume new structures and grade generally within the existing right of way at nominal edge of trail to track centerline of 30-ft. It has been observed that new bike trail construction typically ranges from $20,000 up to $500,000 per mile[4]. The costs of bike trail replacement will be estimated only as placeholder costs for this study. More detailed estimates for trail replacement will need to be developed in later stages of project development.

Sitework and special conditions will include a placeholder for environmental mitigation within a given segment. This placeholder will be developed on the basis of experience on similar projects of this type, and will reflect the experience of the Colorado Department of Transportation in the costs of environmental mitigation for transportation projects.

B.2.5 Systems

Modern train control and communication systems safely coordinate train operations to permit bi-directional use of a track network. On heavily used lines, railroads install Centralized Traffic Control (CTC) to maximize track capacity. CTC is system of signal blocks, track circuits, controlled switches, wayside signals (or cab signals), interlockings and communications to a central control facility that enable trains moving in a common direction to follow closely on a common main track or pass opposite direction traffic on siding tracks. Under CTC, a remotely located dispatcher can set and optimize train routing. However, train speeds are limited to 79-mph.

FRA regulations require that trains operating in excess of 79 mph employ advanced signal systems that provide cab signaling and automatic train protection or automatic train stop functions. Such track circuit based systems in use today are very expensive to construct and maintain. In efforts to develop a more cost effective technology, the FRA and industry have turned to Positive Train Control (PTC), a communication based strategy that does not depend on track circuits to establish train location. Multiple research and development efforts in the United States are currently evaluating advanced train control systems:

- Incremental Train Control System: The Michigan DOT and the FRA, along with Amtrak are advancing a project to implement an Incremental Train Control System (ITCS) in Michigan. The ITCS system, developed by General Electric Transportation Systems, is being tested on a 60-mile portion of the Chicago-Detroit High-Speed Rail Corridor between Kalamazoo and Niles, MI. The system has been in commercial operation since Jan 2002 and speeds have been gradually increased from 79 to 95 mph and are expected to reach 110 mph in January 2008.
- North American Joint PTC Project: The Illinois DOT, the Association of American Railroads (AAR), Union Pacific and the FRA have tested a Positive Train Control Project (PTC) on a 123-mile segment of the Chicago-St. Louis High-Speed Rail Corridor from Mazonia to Springfield, IL. The contractor, Lockheed Martin, successfully demonstrated 110 mph passenger operations in a field trial in 2002. The system has been removed from operation and transferred to AAR's Transportation Technology Center, Inc. in Pueblo, CO for further development[5].

[4] See: http://www.nysphysicalactivity.org/site_beactiveenv/nybc/source_files/6_resources/costdata/states_costest.xls
[5] See: http://www.fra.dot.gov/us/content/605

- BNSF, CSX and NS have developed systems independently to provide PTC functions, principally for freight applications.

The capital cost estimates for this study will include costs to upgrade the train control and signal systems. Under the 79-mph Scenario, capital costs will include the installation of Centralized Train Control (CTC) with interlockings and electric locks on industry turnouts. Under the 110-mph or higher speed Scenarios, the signal improvements include the added costs for a PTC signal system.

The system element for magnetic levitation systems consist of propulsion, control and communications systems including: civil structures for substations and cable trenches; propulsion blocks; propulsion equipment for low, medium, and high power; motor windings; wayside equipment; propulsion maintenance equipment; operation control subsystems for communication and data collection; and associated civil structures.

B.2.6 Right of Way and Land

Since its inception, Amtrak has had the statutory right to operate passenger trains over freight railroad tracks and rights-of-way. When using freight tracks, Amtrak is required to pay only avoidable costs for track maintenance along with some out-of-pocket costs for dispatching.

However, these payments do not cover all of the freight railroads' incremental costs associated with dispatching Amtrak's passenger trains. Railroad costs increase due to delays caused by Amtrak's tightly scheduled trains. Track capacity constraints and bottlenecks create unreliable conditions where train delays often become unavoidable. While federal regulations give passenger trains dispatch priority, railroad dispatchers often encounter congestion where it becomes difficult to control traffic and adhere to Amtrak's timetables. In some cases, Amtrak will offer the railroads a payment to provide on-time passenger train performance. On heavily used line segments, however, these incentive payments only partially compensate a railroad for the costs of increased delay, and some railroads simply refuse to accept incentive payments. On lightly used lines, the economic rationale for making these payments is questionable since passenger trains cause very little delay on such tracks.

Amtrak's payments do not include an access fee for the use of a railroad's tracks or its rights-of-way. Amtrak's federal statutory right-of-access has never required such a payment, and therefore, Amtrak avoids paying a fee or "rent" for occupying space on privately held land and facilities.

While the RMRA may choose a different course, the final determination of what a Colorado passenger rail system will pay host freight railroads for use of their tracks and rights-of-way will ultimately be accomplished through negotiations. A placeholder fee will be included in this report as a shadow cost for what future negotiations might yield.

This study will assume that a cost for access would be included as part of the up-front capital expense, and would be used to purchase the rights to use the underlying railroad rights-of-way for the passenger service. It is assumed that railroads would receive this compensation in cases where the construction of a dedicated high-speed passenger track is on their property. If new track cannot be constructed within the existing railroad rights-of-way, then this cost would fund the possible acquisition of adjacent property.

The outright purchase of land is not the only method whereby railroads could receive compensation for access to railroad rights-of-way. Commuter rail development provides examples of various types of payments for access rights. Some of these projects involved the purchase of the railroad rights-of-way while others provide up-front capital improvements in return for access to a railroad's tracks. The actual methods of payment remain to be determined during negotiations, and may depend on the importance of the track to the freight railroad as well as the level of capital to be invested by the passenger rail authority.

One possible area of concern is the freight railroads' ability to retain operating control over their rights-of-way. Whenever transit systems have paid full price to acquire a freight rail line, as on some commuter rail projects, the transit agencies have assumed operating control over the property. However, in most typical intercity cases the freight railroads insist on retaining dispatching control over these rights-of-way. The railroads would have the right to use the increased capacity provided by the passenger system for its high-speed freight services.

For budgetary purposes, it is proposed that the RMRA study will assume an "over the fence" methodology for appraising the maximum value of railroad rights-of-way. To estimate land values, four land uses alongside each corridor are identified:

- *Rural* (i.e., farmland),
- *Suburban fringe* (i.e., areas in transition from farmland to new suburban development),
- *Suburban* (i.e., low-to-medium density residential and commercial/retail area), and
- *Urban* (i.e., high density residential, commercial, and industrial areas)

The value of a 50-foot wide and 100-foot right-of-way will be established for each land use and the total land cost of the railroad corridor will be estimated.

Right of way land cost will be developed for the green field alternatives using the conceptual alignments and general plan use designations. A 100-foot ROW will be assumed. Where the alignment falls within an existing ROW, such as highway, street, or rail, no cost to the project for that particular ROW will be assumed. Where the geometric requirements take the alignment outside of the public ROW, impacted parcels will be evaluated and a square foot quantity calculated. A unit cost per acre will be developed in conjunction with other studies and discussion with CDOT.

B.2.7 Vehicles

Commercially proven high speed rail technologies include self-propelled diesel electric steel wheel on steel rail train systems and electrically powered steel wheel on steel rail train systems using overhead catenary for electric power distribution. Self-propelled diesel electric systems are generally limited to top speeds of approximately 120 mph, although the FRA and Bombardier have introduced a new gas turbine power locomotive that is expected to provide speeds of approximately 150 mph in commercial service. Electrically powered systems, such as the French TGV, exceed 180 mph. Magnetic levitation systems are under development in Germany, Japan and the United States. Extensive revenue service of high speed magnetic levitation trains has not been fully demonstrated.

In summary, this study considers only proven high speed rail technologies in commercial use including:

- Diesel electric locomotives hauling passenger coaches
- Electric locomotives hauling passenger coaches
- Electric multiple unit trains
- Magnetic levitation systems

Each technology is evaluated on a specific route/alignment developed for the speed and operational characteristics of the technology. The evaluation includes computer simulations to establish travel times and service schedules. The schedules and anticipated passenger volumes combine to establish required fleet sizes or quantities of vehicles.

Unit prices for the vehicles of each proven and commercially viable technology are developed from commercially available data. In the case of the three steel wheel/ steel rail systems, details of vehicle procurements throughout the world are widely reported in the industry media. The data is summarized, averaged and escalated to establish unit prices for use in this study. In the case of the maglev systems, the unit costs are derived from recent comprehensive studies in the United States including Pittsburgh, Baltimore-Washington and the Colorado Maglev Project.

Quantities and unit prices are multiplied to yield the capital cost estimates, subject to appropriate contingencies.

B.2.8 Placeholders

The capital costs include placeholders as conservative estimates for large and/or complex engineering projects that have not been estimated on the basis of unit costs and quantities. At the low end, these include costs for new railroad connections, interlockings and signal improvements; at the high end, these include new highway bridges, river crossings, rail over rail grade separations, along with major capacity improvements in the yards and terminal areas.

Placeholders provide lump sum budget approximations based on expert opinion rather than on an engineering estimate. Placeholders are used where detailed engineering requirements are not fully known. These costs will require special attention during the project development phase. The following list highlights some of the key placeholder costs that are likely to be assumed in this analysis:

- Costs for new stations in densely built-up urban areas, including Denver Union Station improvements and new facilities at Denver International Airport.
- Major tunnel improvements to existing tunnel facilities.
- Constructability issues associated with rail capacity expansion in the Glenwood Canyon.
- Maintenance and Layover Facilities

B.2.9 Contingencies and Professional Services

The unit cost values that will be prepared in the alternative analysis phase will include a contingency line item of 30% + as detailed in the introduction to this section. This contingency will include 15%+ for design contingency and 15%+ for construction contingency.

The project elements that are included in the Professional Services category are design engineering, program management, construction management and inspection, engineering during construction, and integrated testing and commissioning. Professional services and other soft costs required to develop the RMRA project have been estimated as a percentage of the estimated construction cost and will be included as a separate line item. These costs will include:

- Design engineering 7%
- Insurance and Bonding 5%
- Program Management 4%
- Construction management and inspection 6%
- Engineering services during construction 2%
- Integrated Testing and Commissioning 2%

B.2.10 Capital Cost Database

A capital cost database that includes unit costs will be developed in the Alternative Analysis phase as described in Section 3. During this phase, order of magnitude costs for each alternative will be estimated for the infrastructure and system elements identified in Section B.2.

The unit costs needed for this study will be developed using unit cost data from previous studies undertaken by the consultant team and unit costs data from studies undertaken by CDOT in this corridor. The consultant team's previous studies include, but are not limited to the following:

- Midwest Regional Rail Initiative
- Madison Milwaukee High Speed Rail Connection
- Ohio Hub Study
- Florida High Speed Rail – Tampa to Orlando
- Florida High Speed Rail – Orlando to Tampa
- San Diego Maglev Study

Using the methodology described in this section, quantities for each alternative will be developed and the total construction costs will be estimated as a multiple of the estimated quantities and the associated updated unit costs. This activity will take place in the Alternative Analysis phase of the project.

C. Operating Costs Methodology

This appendix describes the various operating costs associated with operating a Colorado passenger rail service and the methods for developing those costs. These costs have been developed as a result of previous studies and will be further refined, enhanced, and validated during the course of this study. Additional cost categories, such as maintenance and energy costs related to electrification, will also be developed and documented during the course of this study. The cost categories listed here are the ones that the study team has extensively used in prior rail studies. The appendix will also describe some of the validation results obtained by comparison to Amtrak and other financial data based on actual operating experience of similar systems.

Operating costs are categorized as variable or fixed. As described below, fixed costs include both Route and System overhead costs. Route costs can be clearly identified to specific train services but do not change much if fewer or additional trains were operated.

- **Variable or Direct costs** change with the volume of activity and are directly dependent on ridership, passenger miles or train miles. For each variable cost, a principal cost driver is identified and used to determine the total cost of that operating variable. An increase or decrease in any of these will directly drive operating costs higher or lower.

- **Fixed costs** are generally predetermined, but may be influenced by external factors, such as the volume of freight tonnage or may include a relatively small component of activity-driven costs. As a rule, costs identified as fixed should remain stable across a broad range of service intensities. Within fixed costs are two sub-categories:
    - **Route** costs such as track maintenance, train control and station expense that, although fixed, can still be clearly identified at the route level.
    - **Overhead or System** costs such as headquarters management, call center, accounting, legal, and other corporate fixed costs that are shared across routes or even nationally. A portion of overhead cost (such as direct line supervision) may be directly identifiable but most of the cost is fixed. Accordingly, assignment of such costs becomes an allocation issue that raises equity concerns. These kinds of fixed costs are handled separately.

Operating costs will be developed based on the following premises:

- Based on results of recent studies, a variety of sources including suppliers, current operators' histories, testing programs and prior internal analysis from other passenger corridors were used to develop the cost data. However, as the rail service is implemented, actual costs will be subject to negotiation between the passenger rail authority and the contract rail operator(s).
- Freight railroads will maintain the track and right-of-way, but ultimately, the actual cost of track maintenance will be resolved through negotiations with the railroads. For this study a track maintenance cost model will be used that reflects actual freight railroad cost data.

- Maintenance of train equipment will be contracted out to the equipment supplier.
- Train operating practices follow existing work rules for crew staffing and hours of service. Operating expenses for train operations, crews, management and supervision were developed through a bottoms-up staffing approach based on typical passenger rail organizational needs.

The costing approach originally developed for the Midwest Regional Rail System (MWRRS) will be adapted for use in this study. Following the MWRRS methodology, nine specific cost areas are applicable to this study.[6] As shown in Exhibit C-1, variable costs include equipment maintenance, energy and fuel, train and onboard (OBS) service crews, and insurance liability. Ridership influences marketing, sales and station costs. Fixed costs include administrative costs, and track and right-of-way maintenance costs. The MWRRS cost model has been updated to reflect current $2006 costs, and also has been validated with recent operating experience based on publicly-data available from other sources, particularly the Northern New England Passenger Rail Authority's (NNEPRA) *Downeaster* costs and new data on Illinois operations that was provided by Amtrak. For the RMRA study it will be brought to a $2008 costing basis and additional cost categories, such as for electrification, added into the model.

Exhibit C-1: Operating Cost Categories and Primary Cost Drivers

Cost Drivers		Cost Categories
Train Miles	→	Equipment Maintenance Energy and Fuel Train and Engine Crews Onboard Service Crews
Passenger Miles	→	Insurance Liability
Ridership and Revenue	→	Sales and Marketing
Fixed Cost	→	Service Administration Track and ROW Maintenance Station Costs

As background, the MWRRS costing framework was developed in conjunction with nine states that comprised the MWRRS steering committee and with Amtrak. In addition, freight railroads, equipment manufacturers and others provided input to the development of the costs.

The original concept for the MWRRS was for development of a new service based on operating methods directly modeled after state-of-the-art European rail operating practice. Along with anticipated economies of scale, modern train technology could reduce operating costs when compared to existing Amtrak practice. In the original 2000 MWRRS Plan, European equipment costs were measured at 40 percent of Amtrak's costs. However, in the final MWRRS plan that was released in 2004, train-operating costs were significantly increased to a level that is more consistent with Amtrak's current cost structure. However, adopting an

[6] This corridor has no planned feeder bus services for which the rail service is financially responsible, and the treatment of operator profit will be discussed in parallel to Service Administration.

Amtrak cost structure for financial planning does not suggest that Amtrak would actually be selected for the corridor operation. Rather, this selection increases the flexibility for choosing an operator without excluding Amtrak, because multiple operators and vendors will be able to meet the broader performance parameters provided by this conservative approach.

The RMRA analysis will be conducted using 2008 constant dollars.

C.1 Variable Direct Costs

These costs include those that directly depend on the number of train-miles operated. They include train equipment maintenance, train crew cost, fuel and energy, onboard service, and insurance costs.

C.1.1 Train Equipment Maintenance

Equipment maintenance costs include all costs for spare parts, labor and materials needed to keep equipment safe and reliable. The costs include periodical overhauls in addition to running maintenance. It also assumes that facilities for servicing and maintaining equipment are designed specifically to accommodate the selected train technology. This arrangement supports more efficient and cost-effective maintenance practices. Acquiring a large fleet of trains with identical features and components, allows for substantial savings in parts inventory and other economies of scale. In particular, commonality of rolling stock and other equipment will standardize maintenance training, enhance efficiencies and foster broad expertise in train and system repair.

The MWRRS study developed a cost of $9.87 per train mile for a 300-seat train in $2002. Before this figure can be used for the RMRA, however, it must be adjusted to provide an option for smaller 200-seat trains that may be used in the early years of the system. Data provided by equipment manufacturers at the original MWRRI 1999 equipment symposium was used to calculate these adjustments. The smaller 200-seat train was estimated to cost $8.95 per train mile in $2002, a savings of 92¢ per train mile over the MWRRS rate. However if only a few trains are operated as compared to MWRRS, using manufacturers' data from the 1999 equipment symposium, equipment costs were adjusted upwards by 25% to reflect the lack of economies of scale, and by an additional 9% for inflation. Therefore the cost of a 200-seat T21 train was estimated as $12.19 per mile in $2006.

The available evidence suggests that the maintenance cost for a 300-seat DMU would be about the same as for a Talgo T21, but for smaller trains DMU costs scale more directly to seating capacity. Accordingly the DMU maintenance cost for a 200-seat train was estimated as two-thirds of the cost for a 300-seat train. With the economies of scale and inflation adjustments, this would come to $8.96 per train mile in $2006. It can be seen that the DMU is substantially more cost effective for smaller trains, and because of its greater flexibility, it allows closer matching of seating capacity to travel demand.

We have data for electric locomotive and EMU costs but still need to perform the detailed calculations to assess the cost projection.

C.1.2 Train and Engine Crew Costs

Crew costs are those costs incurred by the onboard train operating crew. Following Amtrak staffing policies, the operating crew would consist of an engineer, a conductor and an assistant conductor and is subject to federal Hours of Service regulations. Costs for the crew include salary, fringe benefits, training, overtime and additional pay for split shifts and high mileage runs. An overtime allowance is included as well as scheduled time-off, unscheduled absences and time required for operating, safety and passenger handling training. Fringe benefits include health and welfare, FICA and pensions. The cost of employee injury claims under FELA is also treated as a fringe benefit for this analysis. The overall fringe benefit rate was calculated as 55 percent. In addition, an allowance was built in for spare/reserve crews on the extra board. The costing of train crews was based on Amtrak's 1999 labor agreement, adjusted for inflation to 2006.

Crew costs depend upon the level of train crew utilization, which is largely influenced by the structure of crew bases and any prior agreements on staffing locations. Train frequency strongly influences the amount of held-away-from-home-terminal time, which occurs if train crews have to stay overnight in a hotel away from their home base. Since train schedules have continued to evolve throughout the lifetime of this study and a broad range of service frequencies and speeds have been evaluated, a parametric approach was needed to develop a system average per train mile rate for crew costs. Such an average rate necessarily involves some approximation, but to avoid having to reconfigure a detailed crew-staffing plan whenever the train schedules change, an average rate is necessary and appropriate for a planning-level study.

In the previous Ohio Hub study, crew costs varied from $3.42 per train mile for efficient round trips with no need for overnight accommodations, up to $3.94 per train mile if some overnight layovers are required (consistent with the MWRRS result) and rising to $6.60 per train mile because of extremely poor crew utilization in some of the start-up scenarios. For this study, an intermediate value of $3.94 per train mile will be used, which has been raised with inflation to a $2006 value of $4.29 per train mile.

C.1.3 Fuel and Energy

A consumption rate of 2.42 gallons/train-mile was estimated for a 110-mph 300-seat train, based upon nominal usage rates of all three technologies considered in Phase 3 of the MWRRS Study. For each scenario, these costs were scaled to the size of the train and raised to reflect the recent fuel cost increases. For smaller trains, DMU fuel costs scale down more proportionately than they do for locomotive-hauled trains. In the MWRRS plan, a diesel fuel cost of $0.96 per gallon led to a train mile rate of $2.32 per train mile for a 110-mph 300-seat train. A comparable rate in the current study would be $3.94 per train mile, reflecting the roughly 50% increase in the cost of fuel based on the gasoline price in the base year.

The overall model is based on fuel costs that were in effect during the base year of 2006 and that formed the basis of the demand model calibration. This demand model does reflect the ridership gains that occurred nationally, but in particular on the Boston-Portland corridor, largely as a result of the fuel price increases that occurred in 2006. The assumed diesel fuel cost on the operating side is consistent with the level of gasoline prices that were assumed for development of the demand forecasts. It must be noted that fuel costs have remained extremely volatile on practically a day-to-day basis, and have since risen to unprecedented high levels. For the RMRA study, the fuel price projection for both the Operating Cost and Ridership forecasting will not be finalized until later in the study, and then the appropriate factors applied. For electrified options it will also be essential to estimate the delivered price of the electric power.

However, it has been more important to maintain the consistency of the fuel price assumption throughout the study, than to attempt to update the study to reflect every price fluctuation of a highly volatile market. At present, it appears that the fuel price assumption of past studies may be on the low side. However, because the auto and air modes are less energy efficient than rail, any increases to fuel costs tends to increase the revenue of the rail system more than it raises the fuel cost. It is therefore important to keep fuel costs consistent for both the ridership and operating costs assessment.

C.1.4 Onboard Services (OBS)

Onboard service (OBS) costs are those expenses for providing food service onboard the trains. OBS adds costs in three different areas: equipment, labor and cost of goods sold. Equipment capital and operating cost is built into the cost of the trains and is not attributed to food catering specifically. Small 200-seat trains cannot afford a dedicated dining or bistro car. Instead, an OBS employee or food service vendor would move through the train with a trolley cart, offering food and beverages for sale to the passengers. Trains of 300-seats or more may be able to provide as an enhancement a small walk-up café area where the attendant works when not passing through the train with the trolley cart.

The goal of the OBS franchising should be to ensure a reasonable profit for the provider of on-board services, while maintaining a reasonable and affordable price structure for passengers. The key to attaining OBS profitability is selling enough products to recover the train mile related labor costs. If small 200-seat trains were used for start-up, given the assumed OBS cost structure, even with a trolley cart service the OBS operator will be challenged to attain profitability. However, the expanded customer base on larger 300-seat trains can provide a slight positive operating margin for OBS service.

In practice, it is difficult for a bistro-only service to sell enough food to recover its costs. Bistro-only service may cover its costs in Amtrak's northeast corridor that operates very large trains, but it will be difficult to scale down this business model to the Duluth corridor that will, by necessity, operate much smaller 200 to 300-seat trains. While only a limited menu can be offered from a cart, the ready availability of food and beverages at the customer's seat is a proven strategy for increasing sales. Many customers appreciate the convenience of a trolley cart service and are willing to purchase food items that are brought directly to them. While some customers prefer stretching their legs and walking to a bistro car, other customers will not bother to make the trip.

The cost of goods sold is estimated as 50 percent of OBS revenue, based on Amtrak's route profitability reports. Labor costs, including the cost of commissary support and OBS supervision, have been estimated at $1.67 per train mile. This cost is consistent with Amtrak's level of wages and staffing approach for conventional bistro car services. However, this Business Plan recommends that an experienced food service vendor provide food services and use a trolley cart approach.

A key technical requirement for providing trolley service is to ensure the doors and vestibules between cars are designed to allow a cart to easily pass through. Since trolley service is a standard feature on most European railways, most European rolling stock is designed to accommodate the carts. Although convenient passageways often have not been provided on U.S. equipment, the ability to support trolley carts is an important equipment design requirement for the planned service.

C.1.5 Insurance Costs

In the MWRRS study, liability costs were estimated at 1.2¢ per passenger-mile (in $2006). These costs will be inflated to current dollar rates for the purpose of the RMRA study. Federal Employees Liability Act (FELA) costs are not included in this category but are applied as an overhead to labor costs.

As a condition of allowing access to their tracks, the freight railroads have generally required full indemnification for the costs of all accidents. The Amtrak Reform and Accountability Act of 1997 (§161) provides for a limit of $200 million on passenger liability claims. Amtrak carries that level of excess liability insurance, which allows Amtrak to fully indemnify the freight railroads in the event of a rail accident. This insurance protection has been a key element in Amtrak's ability to secure freight railroad cooperation. In addition, freight railroads perceive that the full faith and credit of the United States Government is behind Amtrak, while this may not be true of other potential passenger operators. A recent General Accounting Office (GAO) review[7] has concluded that this $200 million liability cap applies to commuter railroads as well as to Amtrak. If the GAO's interpretation is correct, the liability cap may also apply to potential Duluth corridor franchisees. If this liability limitation were in fact available to potential franchisees, it would be much easier for any operator to obtain insurance that could fully indemnify a freight railroad at a reasonable cost.

C.2 Fixed Direct Costs

This cost category includes those costs that, while largely independent of the number of train-miles operated, can still be directly associated to the operation of specific routes. It includes such costs as train maintenance and station operations.

C.2.1 Track and Right-of-Way Costs

Currently, it is industry practice for passenger train operators providing service on freight-owned rights-of-way to pay for track access, dispatching and track maintenance. The rates for all of these activities will ultimately be based upon a determination of the appropriate costs that result from negotiations between the parties. The purpose here is to provide estimates based on the best available information; however, it is important to recognize that this study is a feasibility-level analysis and that as the project moves forward, additional study and discussions with the railroads will be needed to further refine these costs. Both capital and operating costs will be estimated.

To accommodate passenger trains, Colorado rail corridors require a substantial increase in capacity. Once constructed, these improvements will need to be maintained to FRA standards required for reliable and safe operations. The costing basis assumed in this report is that of *incremental* or *avoidable* costs. Avoidable costs are those that are eliminated or saved if an activity is discontinued. The term *incremental* is used to reference the change in costs that results from a management action that increases volume, whereas

[7] See: http://www.gao.gov/highlights/d04240high.pdf

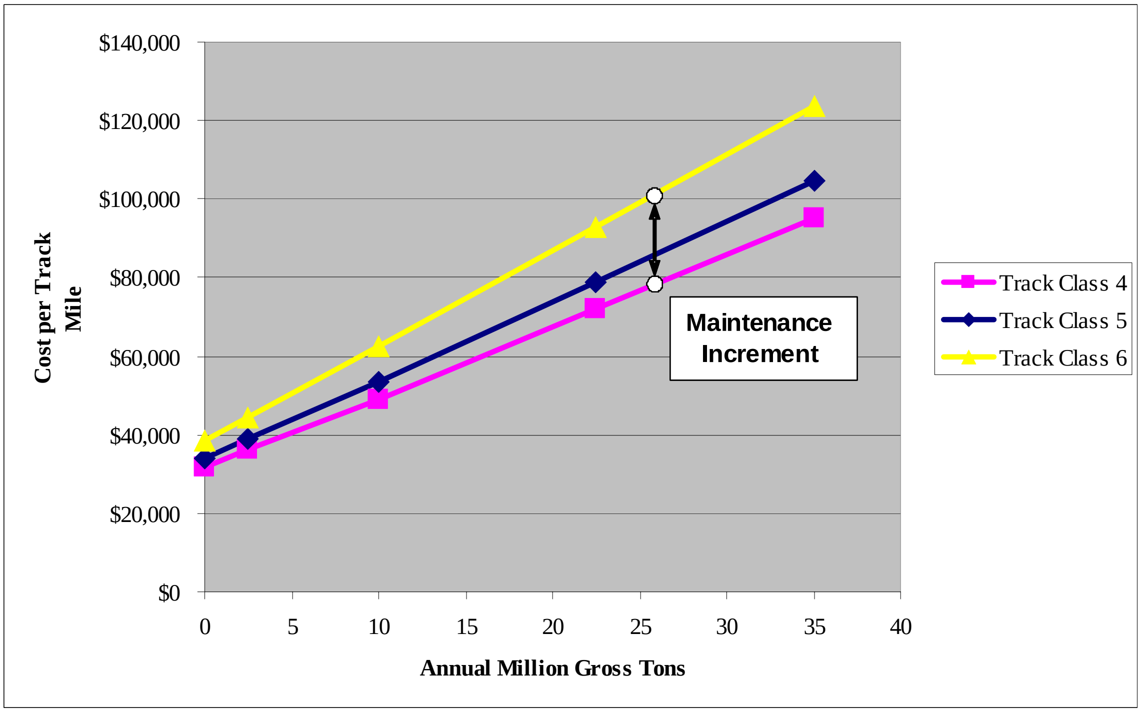
avoidable defines the change in costs that results from a management action that reduces volume. Following the same standard that was established for the MWRRS, the following cost components were included within the Track and Right-of-Way category:

- **Track Maintenance Costs.** Costs for track maintenance will be estimated based on Zeta-Tech's January 2004 draft technical monograph *Estimating Maintenance Costs for Mixed High-Speed Passenger and Freight Rail Corridors*.[8] However, Zeta-Tech's costs are conceptual and are still subject to negotiation with the freight railroads.
- **Dispatching Costs and Out-of-Pocket Reimbursement.** Passenger service must also reimburse a freight railroad's added costs for dispatching its line, providing employee efficiency tests and for performing other services on behalf of the passenger operator. These costs are included as an additive to Track and Right-of-Way Maintenance costs.
- **Costs for Access to Track and Right-of-Way.** Access fees, particularly train mile fees incurred as an operating expense, are specifically excluded from this calculation. Any such payments would have to be calculated and negotiated on a route-specific and railroad-specific basis. Such a calculation would have to consider the value of the infrastructure improvements made to the corridor for balancing up-front capital with ongoing operating payments.[9]

Exhibit C-2 shows the conceptual relationship between track maintenance cost and total tonnage that was calibrated from the earlier Zeta Tech study. It shows a strong relationship between tonnage, FRA track class (4 through 6) and maintenance cost. At low tonnage, the cost differential for maintaining a higher track class is not very large, but as tonnage grows, so too does the added cost. If freight needs only Class 4 track, the passenger service would have to pay the difference, called the "maintenance increment", which for a 25 MGT line as shown in Exhibit C-2, would come to about $25,000 per mile per year. The required payment to reimburse a freight railroad for its added track cost would be less for lower freight tonnage, more for higher freight tonnage.

[8] Zeta-Tech, a subsidiary of Harsco (a supplier of track maintenance machinery) is a rail consulting firm who specializes in development of track maintenance strategies, costs and related engineering economics.
[9] For 110-mph service, the level of infrastructure improvements to the corridor called for in this study should provide enough capacity to allow superior on-time performance for both freight and passenger operations. It is believed that the capacity improvements proposed in the Engineering evaluation provide a reasonable planning basis for establishing costs for this study; but needs to be confirmed by a detailed capacity analysis. The recommended strategy for 110-mph service is to provide enough up-front capital improvement to mitigate not only freight delays, but also the need for providing additional operating incentives that could adversely affect the passenger system's ability to attain a positive operating ratio.

Exhibit C-2: Track Maintenance Cost Function



Please note that Exhibit C-2 shows that the cost of shared track depends strongly on the level of *freight* tonnage, since the passenger trains are relatively lightweight and do not contribute much to the total tonnage, In fact, following the Zeta Tech methodology, a "maintenance increment" is calculated based on *freight tonnage only*, since a flat rate of $1.56 per train mile as used in the Zeta-Tech report was added to reflect the direct cost of added passenger tonnage regardless of track class. This cost, which was developed by Zeta-Tech's TrackShare® model, includes not only directly variable costs, but also an allocation of a freight railroad's fixed cost. Accordingly, it complies with the Surface Transportation Board's definition of "avoidable cost." An allowance of 39.5¢ per train-mile was added for freight railroad dispatching and out-of-pocket costs.

Because passenger trains don't add much tonnage, the added cost for maintaining 110-mph track is largely independent of the number of passenger trains operated. Once the track is built there is an incentive to operate as many trains as possible, for reducing the average unit cost. However, if fewer than eight trains are operated, the average cost goes up since this fixed cost must be spread across a smaller base of passenger train miles.

In addition to an *operating* component of track maintenance cost (which is shown in Exhibit C-2) the track cost methodology also identifies a *capital* cost component. For track maintenance:

- *Operating costs* cover expenses needed to keep existing assets in service and include both surfacing and a regimen of facility inspections.
- *Capital costs* are those related to the physical replacement of the assets that wear out. They include expenditures such as for replacement of rail and ties, but these costs are not incurred until many years after construction. In addition, the regular maintenance of a smooth surface by reducing dynamic loads actually helps extend the life of the underlying rail and tie assets. Therefore,

capital maintenance costs are gradually introduced using a table of ramp-up factors provided by Zeta-Tech (Exhibit C-3). A normalized capital maintenance level is not reached until 20 years after completion of the rail upgrade program.

Exhibit C-3: Capital Cost Ramp-Up Following Upgrade of a Rail Line

Year	% of Capital Maintenance	Year	% of Capital Maintenance
0	**0%**	**11**	**50%**
1	**0%**	**12**	**50%**
2	**0%**	**13**	**50%**
3	**0%**	**14**	**50%**
4	**20%**	**15**	**75%**
5	**20%**	**16**	**75%**
6	**20%**	**17**	**75%**
7	**35%**	**18**	**75%**
8	**35%**	**19**	**75%**
9	**35%**	**20**	**100%**
10	**50%**		

For development of the Business Plan, only the operating component of track maintenance cost is treated as a direct operating expense. Capital maintenance costs are incorporated into the Financial Plan and into the Benefit Cost analysis. Because these capital costs do not start occurring until rather late in the project life, usually they have a very minor effect on the Benefit Cost calculation. These costs can be financed using direct capital grants or from surplus operating cash flow. The latter option has been assumed in this study. Accordingly, maintenance capital expenses only reduce the net cash flow generated from operations; they do not affect the operating ratio calculations.

C.2.2 Station Operations

A simplified fare structure, heavy reliance upon electronic ticketing and avoidance of a reservation system will minimize station personnel requirements. Station costs include personnel, ticket machines and station operating expenses.

- Staffed stations will be assumed at major stations. All stations were assumed open for two shifts. The cost for the staffed stations includes eight positions at each new location.
- The cost for unstaffed stations covers the cost of utilities, ticket machines, cleaning and basic facility maintenance, which is also included in the staffed station cost. Volunteer personnel such as Traveler's Aid, if desired could staff these stations.

This stations cost is practically independent of the number of trains operated or their speed, so running the largest number of trains at the highest speed possible generates the best economies of scale. For the RMRA study, we will not know which stations may justify staffing until the ridership forecasting process in completed.

C.3 System Overhead Costs

The category of System Overhead largely consists of Service Administration or management overheads, covering such needs as the corporate procurement, human resources, accounting, finance and information technology functions as well as call center administration.

While both variable and route-specific costs can be clearly identified, the allocation of corporate overhead to passenger rail services raises a number of issues. A small shift in allocations by Amtrak can have a large and unanticipated impact on subsidy needs. Furthermore, the timing of these shifts in many states' experience has often been disadvantageous, subject to the whims of Federal funding appropriations, as Amtrak has sought to make up its own funding gaps by increasing subsidy demands for state-supported trains, often claiming that trains are paying less than their fully-allocated costs.

Accordingly, states have desired a means for insulating the finances of locally supported rail services from the vagaries of the Federal funding process. In addition, states have desired to protect their ability to recoup at least some portion of the investment that they would be making for development of 110-mph rail services. The system operator, who benefits from large capital investments made by others including state and local matching funds, must pay an appropriate franchise fee for the use of the assets. Without any limitation on the allocation of corporate overheads, an operator would have the ability to confiscate any operating surpluses that may be generated by the system, leaving the sponsoring agency to bear the full load of capital costs all by itself. An alternative institutional structure has been proposed for providing predictability to the financial planning of rail services.

C.3.1 The MWRRS Franchising Model

The Midwest Regional Rail System proposed a franchising model for developing 110-mph rail services:

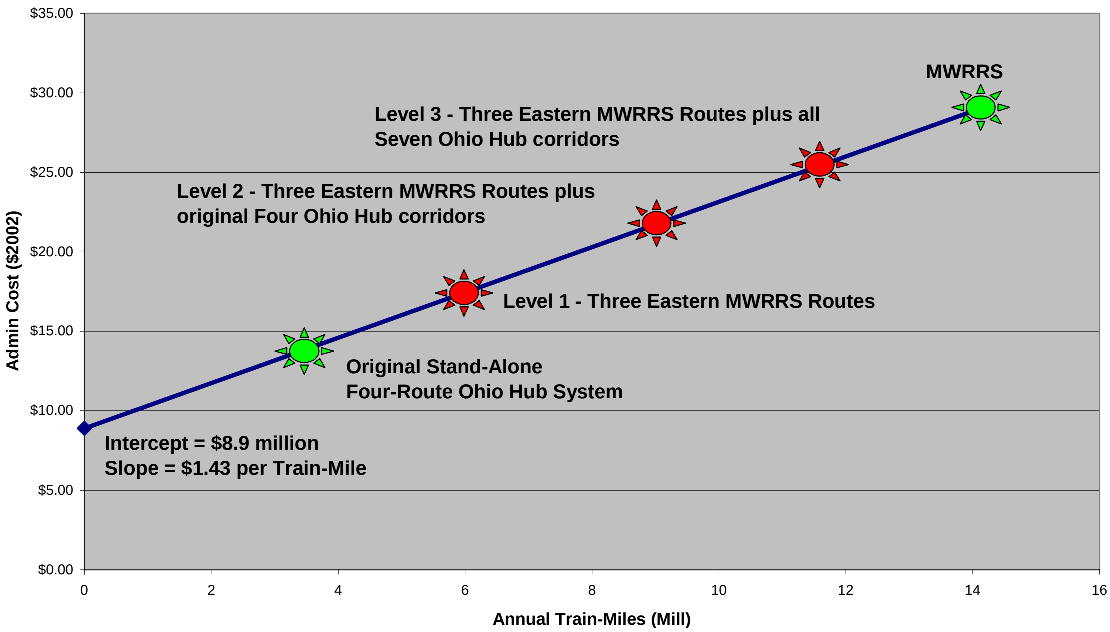
- A public policy board would follow all the normal procedures of a governmental entity by allocating capital for the greatest public benefit, allowing public participation in all decision-making and making complete and detailed financial disclosures.
- A rail service provider would operate in a commercial environment as a private sector, for-profit, business enterprise. The service provider would make its decisions on a commercial basis and would be allowed to protect the confidentiality of its proprietary business data.

In this environment, it is essential to separate the policy board's requirement for service and funding oversight from the operator's business requirements to be profitable. As pointed out by the Amtrak Reform Council in 1997, the current Amtrak structure, by combining governmental and non-governmental functions in a single entity, does not do this. Amtrak might serve as an operator of the system, but the MWRRS Franchising model assumes that authority and control over the allocation of capital dollars will be vested in states rather than the operator.

For development of this institutional structure, it was understood that the system operator would need to have a reasonable allowance not only for its variable costs but also for overheads. In addition, the operator would need to earn a profit margin.[10] Therefore, the MWRRI developed, in conjunction with Amtrak, a hypothetical stand-alone management organization, including a President, Operations supervision, Finance and Marketing structure, including a dedicated call center. This organization was not simply hypothetical – it was intended to reflect an actual management structure that could be capable of administering a network the size of the proposed MWRRS operation. As a result, the system overhead as well as train and route costs all became clearly identifiable.

Later, the Ohio Hub[11] study further refined the organizational structure proposed by the MWRRS to reflect its own needs. This organization reduced the number of staff positions and consolidated the functions of some middle-level managers, to better reflect the needs of a smaller Ohio network. This restructuring converted some of the administrative cost, which had all formerly been considered fixed, into a variable cost based on train miles. As shown in Exhibit C-4, the result was development of a Fixed + Variable cost framework for the implementation of a stand-alone management structure.

Exhibit C-4: Fixed + Variable Administrative Cost Structure



This cost structure for a stand-alone administrative organization had a fixed cost of $8.9 million plus $1.43 per train-mile (in $2002) for added staff requirements as the system grew. Inflated to $2006, this became $9.7 million plus $1.56 per train mile.

[10] The MWRRS operator was assumed to take a 10 percent mark-up on directly-controlled costs, including insurance, stations, sales and marketing, administration, train crew, and energy and fuel. Costs related to track maintenance; on-board service, equipment maintenance and parcel service were out-sourced to other service provider and assumed to include their own profit margins.

[11] The Ohio Hub is a proposed 1,244-mile intercity passenger rail system that would serve over 22 million people in five states and southern Ontario, Canada. Seven rail corridors with 44 stations would connect twelve major metropolitan areas, and many smaller cities and towns. For more information see: http://www.ohiohub.com

However, the Sales and Marketing category also has a substantial fixed cost component for advertising and call center expense, adding another $2.5 million per year fixed cost, plus variable call center expenses of 62¢ per rider.[12] Finally, credit card and travel agency commissions are all variable: 1.8 percent and 1 percent of revenue, respectively. *Therefore, the overall financial model for a Stand-alone organization therefore has $12.2 million ($9.7 + $2.5 million) annually in fixed cost for administrative, sales and marketing expenses.*

- To understand the impact of these fixed costs on the overall financials of the project, the MWRRS and Ohio Hub had 13.8 million and 3.7 million train-miles each. These fixed costs added 88¢ per train-mile to the MWRRS and $3.30 per train-mile to the Ohio Hub, respectively.
- Using the Minneapolis-Duluth/Superior Corridor as an example, would generate 773,760 annual train miles for eight round-trips, or half of that 386,880 for four round-trips. A stand-alone Administrative structure would add an equivalent of $15.77 or $31.53 per train-mile respectively. While a stand-alone administrative organization may be appropriate and affordable for a large multi-route hub system, it is clear that a relatively small operation like Minneapolis to Duluth will need a shared administrative cost structure.

Although the MWRRS Franchising model still remains valid, there is a clear need to assume a shared rather than stand-alone administrative cost structure for the Minneapolis to Duluth corridor. It is therefore necessary to assume that an existing operator who has the experience necessary to implement the rail passenger system will operate the Minneapolis-Duluth/Superior Corridor. Most likely, the successful bidder will also have an established market presence in the Twin Cities area so that its existing management organization can be grown incrementally to support the needs of this service.

For the RMRA study, we do not yet know where this system will fall with respect to needing a shared or dedicated management structure. Most likely, if only one or two lines are built, the RMRA system will need a shared cost structure. If the entire envisioned system is built including the new line up I-70, then most likely a dedicated management structure will prove to be the most cost-effective. We will not know the answer to this question until we get farther along in the work.

C.3.2 Shared Overhead Cost Allocation

Section 403(b) of the National Railroad Passenger Service Act of 1970 (PL 91-518) provided that any state, regional or local agency may request Amtrak to initiate service on new routes or expand service on existing routes if it were willing to reimburse Amtrak just 50 percent of the solely-related cost of providing the service.[13] The Amtrak Reform and Accountability Act of 1997 repealed this provision of the 1970 law; since then, Amtrak's policy has been that all state-supported services need to cover their direct operating losses through a combination of fare box revenues and state support. Implicit in this policy[14] however, is an "embedded" subsidy from Amtrak (and thus from the Federal government) in the form of unallocated overhead and equipment related costs.

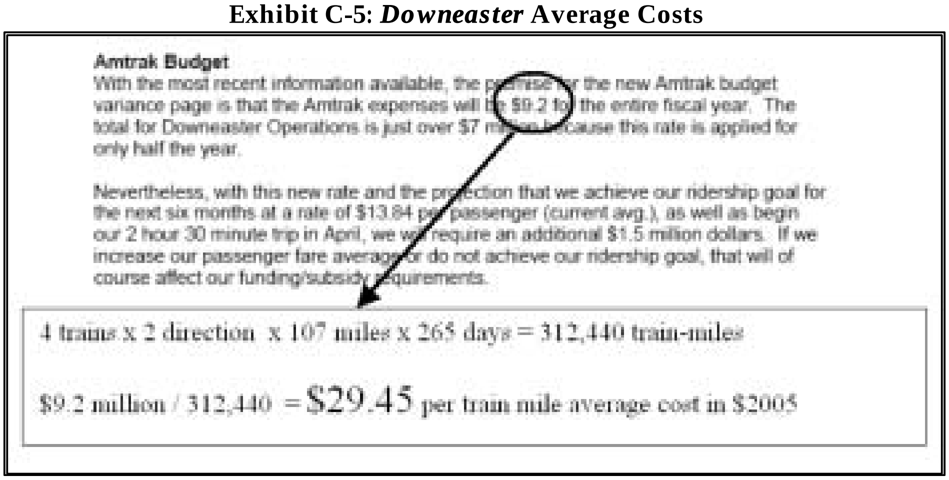
[12] In the MWRRS cost model, call center costs were built up directly from ridership, assuming 40 percent of all riders call for information, and that the average information call will take 5 minutes for each round trip. Call center costs, therefore, are variable by rider and not by train-mile. Assuming some flexibility for assigning personnel to accommodate peaks in volume and a 20 percent staffing contingency, variable costs came to 57¢ per rider. These were inflated to 62¢ per rider in $2006.
[13] See: http://www.fra.dot.gov/downloads/RRDev/reex-may78.pdf
[14] See: http://www.amtrak.com/pdf/strategic06.pdf

However, consistent with the spirit of the original 403(b) law, Amtrak has sometimes been willing to start a service by requiring enough subsidy for direct operating losses only, overlooking some of the overhead costs in the early ramp-up years of the service. While this willingness to give sponsors a "cost break" certainly helps during the ramp-up phase, it has also been Amtrak's practice to seek to recover at least some contribution towards overhead costs after a service gets established. This generally results in an increase in the subsidy requirement after the first few years of operation, if the initial service was not provided under a full-cost agreement. Indeed, according to *Amtrak's Strategic Reform Initiatives and FY05 Grant Request*, Amtrak plans to transition states to full coverage of fully allocated operating losses (excluding interest and depreciation), plus an equipment capital charge, for all corridor trains over a four-year period starting in FY08. This seems to indicate that Amtrak plans an even more aggressive stance towards requiring full-cost recovery for state supported services in the near future.

The rates for overhead cost allocation will ultimately be based upon a determination of the appropriate costs that result from negotiations between the parties. The purpose here is to provide estimates based on the best available information; however, it is important to recognize that this study is a feasibility-level analysis and that as the project moves forward, additional study and discussions with potential operators will be needed to further refine these costs.

However, for assessing a likely level of cost allocation, a benchmarking exercise was conducted based upon Amtrak's most recent subsidy agreement with the Northern New England Passenger Rail Authority (NNEPRA) for the *Downeaster* service as well as other corridor costs. This way, one can get an idea of the likely magnitude of costs that might be expected. Per Exhibit 5.5, Amtrak's subsidy support increased 16% from $29.45/tm in 2005 to $34.11/tm in 2006: an increase of nearly $5 per train mile, which came mostly from an increased allocation of fixed call center and administrative costs as Amtrak sought to move towards full-cost recovery. Adopting this $5 per train mile as the expected allocation of fixed costs, it is interesting to note that the final result of the NNEPRA actual contract comes very close to the $34.13 result we developed for four round trips in the Minneapolis-Duluth/Superior Corridor.

Exhibit C-5: *Downeaster* Average Costs


Amtrak Budget
With the most recent information available, the premise for the new Amtrak budget variance page is that the Amtrak expenses will be $9.2 for the entire fiscal year. The total for Downeaster Operations is just over $7 million because this rate is applied for only half the year.

Nevertheless, with this new rate and the projection that we achieve our ridership goal for the next six months at a rate of $13.84 per passenger (current avg.), as well as begin our 2 hour 30 minute trip in April, we will require an additional $1.5 million dollars. If we increase our passenger fare average or do not achieve our ridership goal, that will of course affect our funding/subsidy requirements.

4 trains x 2 direction x 107 miles x 265 days = 312,440 train-miles

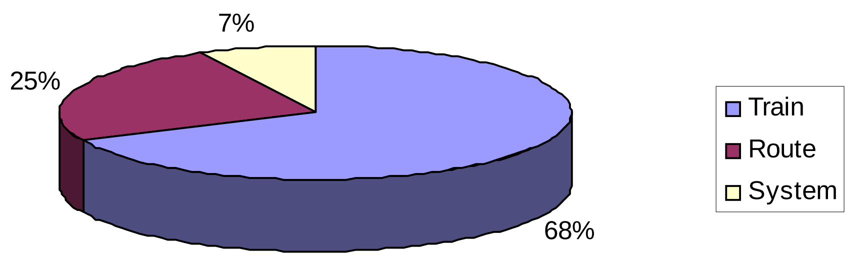
$9.2 million / 312,440 = $29.45 per train mile average cost in $2005

With regard to Amtrak's actual level of administrative costs, the most recent published data that gives this detail is the 1998 report *Intercity Passenger Rail: Financial Performance of Amtrak's Routes* by the U.S.

General Accounting Office.[15] At the time, Amtrak was still detailing its costs by Train, Route and System breakdowns. Appendix II, Table II.4 from the GAO report, summarized in Exhibit C-6, shows that System overhead costs comprised only 7% of the 1998 total cost. However, this 7% factor does not capture all the overhead cost, since reservations and management support computer systems were reported as a Route-level expense.

By comparison, *Downeaster's* estimated overhead rate of $5 per train mile comprises 14.7% of its overall cost. This $5 allowance is also known to include a component of reservations call center cost, and therefore it covers more than just the train's 7% allocated share of System costs. Therefore, this $5 per Train Mile factor is considered to reflect a reasonable estimate of Amtrak's fully allocated overhead cost. Practically, the application of this factor results in overall cost projections that are consistent with corridor results seen elsewhere. The further validation of overhead costs developed by this methodology will be discussed in the next section.

Exhibit C-6: Amtrak Reported Train, Route, and System Cost (1998 data)



C.4 Minneapolis-Duluth/Superior Corridor – Benchmark Cost Results

This section will report the results of a recent cost benchmarking exercise, conducted for the Minneapolis to Duluth rail corridor. Exhibit C-7 summarizes the average cost per train mile results from the variety of scenarios that were evaluated for the Minneapolis-Duluth/Superior Corridor. Train-mile cost results are estimated in a $34-$52 range for 79-mph service; a $33-44 range for 110-mph service[16] and $36-49 for 125-mph service, depending on the number of daily round trips operated. These results reflect the economies from spreading route-level fixed costs over a broader base as the number of train-miles are increased, but assume a fixed allocation of $5 per train-mile for overhead administrative costs.

[15] See: http://ntl.bts.gov/lib/000/300/377/rc98151.pdf

[16] These 110-mph costs show improved economies of scale for operating up to 8 round trips per day.

Exhibit C-7: Projected Average 2010 Costs per Train Mile for Minneapolis-Duluth Options

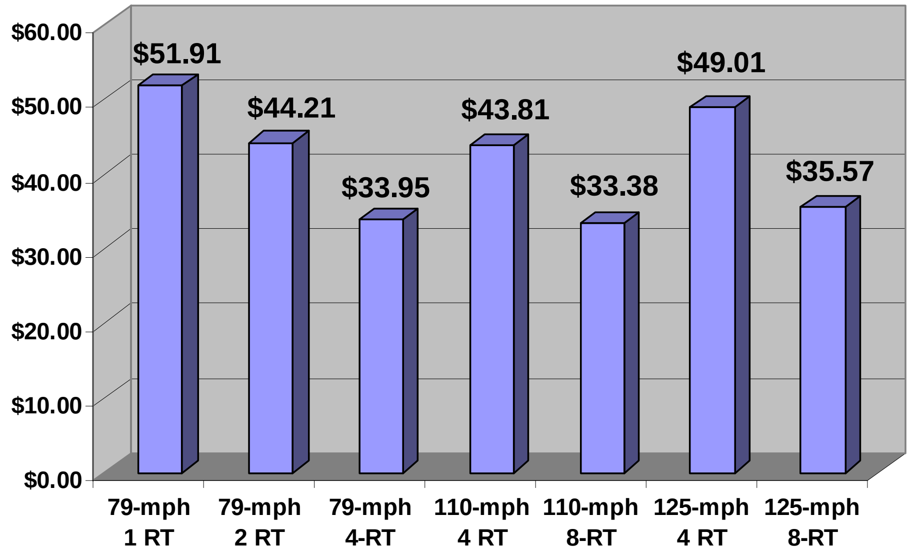


Exhibit C-8 shows the projected cost breakdown for the eight-train a day 110-mph Minneapolis to Duluth in 2025. With a negotiated $5 per train mile contribution to fixed administrative and call center costs, the largest single category of expense would be for train equipment maintenance (24%), followed by track (14%), train crew (11%), administration and management (12%), on board services expense and fuel (9% each) and variable call center costs (7%).

Exhibit C-8: 2025 Operating Cost Breakdown by Expense Type ($2006 Mill)

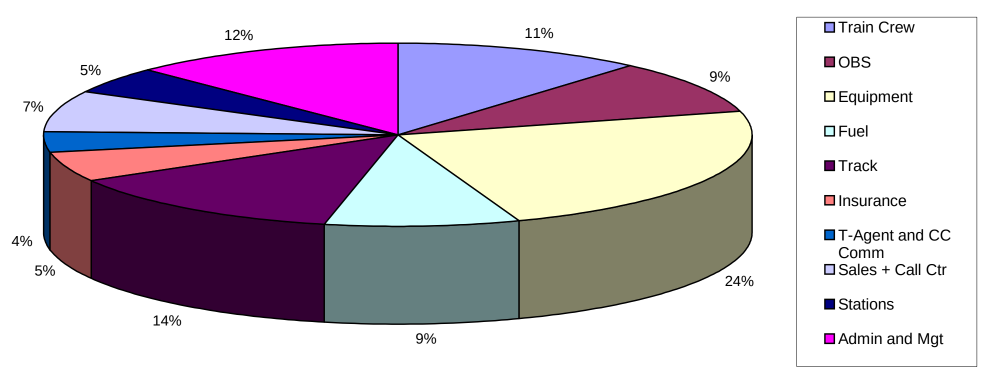


Exhibit C-9 summarizes the operating cost assumptions with typical values as employed by the previous Duluth to Minneapolis rail study. However the actual costs will be customized for the RMRA study to reflect local Colorado conditions.

Exhibit C-9: Summary of Unit Costs

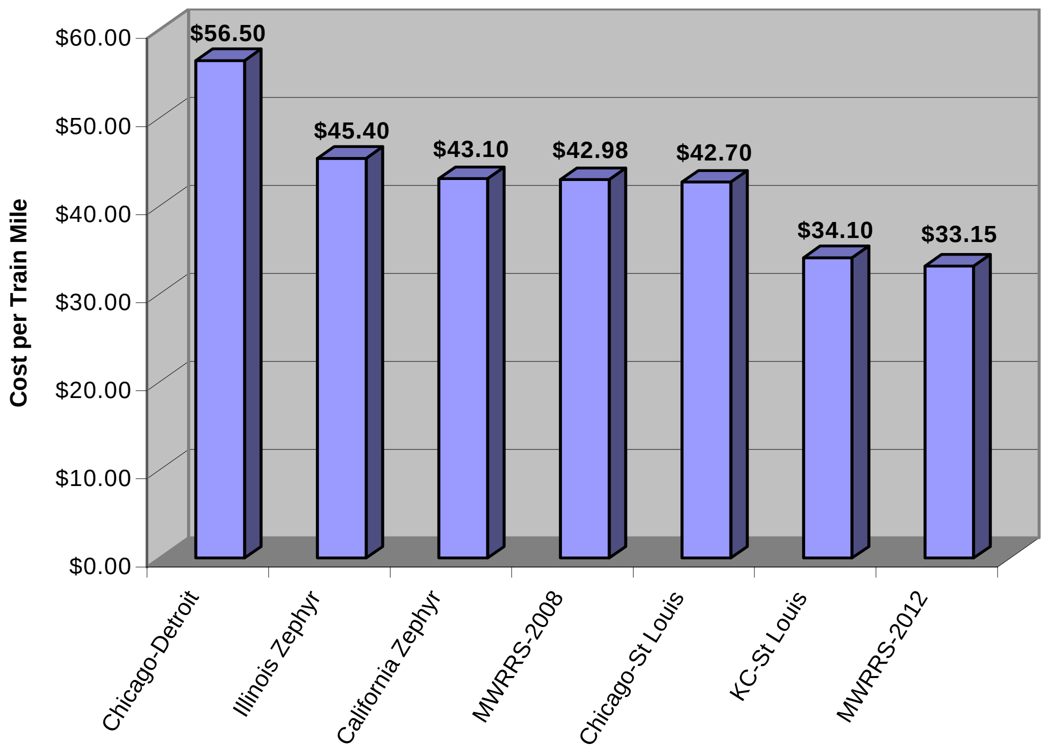
Category	Basis	Type	Cost ($2006)
Equipment Maintenance	Train Miles	Variable Direct	$12.19 (200 Seat Train)
Train Crew	Train Miles	Variable Direct	$4.29
Energy/Fuel	Train miles	Variable Direct	$3.94
OBS	Train Miles + OBS Revenue	Variable Direct	$1.67 (labor) + 50% OBS Revenue
Insurance	Pass-miles	Variable Direct	$0.012
Track/ROW	Train Miles	Fixed Direct	$4.50/TM to $9.00/TM at 110-mph
Station Costs	Passenger	Fixed Direct	$1.52 million
Sales/Mktg	Passenger + Ticket Revenue	Both Fixed and Variable	Allocation of $5 per train mile, plus variable call center expenses of 62¢ per rider
Admin	Train miles	Fixed	

C.5 Validation of Cost Results

This study will use a well-established costing framework that traces its roots back to a number of previous rail studies. However, the current form of the costing model was mainly established as a result of the extensive work that was performed for the Midwest Regional Rail Initiative, with the active support and participation of Amtrak, freight railroads, and a consortium of nine Midwestern States. The MWRRS costing framework was extensively validated at the time when it was first developed. Exhibit 10-22 from the MWRRS report (Exhibit C-10 below) compared model-projected MWRRS costs to Amtrak's fully allocated RPS costs.[17] The Exhibit shows that the level of costs assumed are generally consistent with Amtrak's costs, but adjusted to reflect appropriate economies-of-scale relationships. Economies of scale also explains why the MWRRS average unit costs dropped by nearly 25% from their planned 2008 levels to 2012. Since the MWRRS study, the costing framework has been continuously updated and enhanced as a result of subsequent rail planning projects in Ohio and Florida.

[17] 1997 Amtrak costs adjusted for inflation to 2002, excluding depreciation. Source*: Intercity Passenger Rail: Financial Performance of Amtrak's routes*, U.S. General Accounting Office, May 1998. This validation chart was included in the MWRRS report that was published in 2004.

Exhibit C-10: Comparison: Projected MWRRS vs. Amtrak RPS Costs (in $2002)



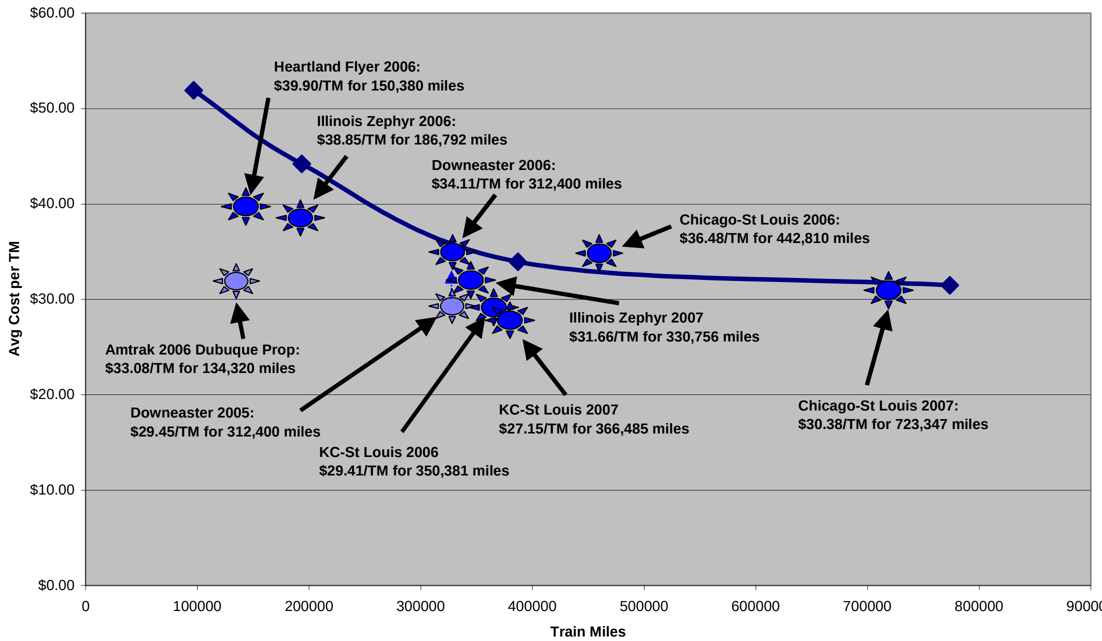
As shown in Exhibit C-10, the model-predicted costs were in the same range as actual Amtrak experience – in fact, projected average cost for the "MWRRS 2008" start-up service of $42.98 came in slightly higher than Amtrak's fully-allocated RPS cost for the Chicago-St. Louis corridor at the time. Amtrak's costs for the Chicago-Detroit corridor were higher because of the high cost of maintaining dedicated passenger track, spread over the relatively few train miles operated.

By 2012, spreading the system's fixed cost over a larger base of train-miles would have reduced the average cost per train mile to $33.15. This cost would have been somewhat lower than most of Amtrak's costs at the time, but still in range of some existing services in the Midwest region; roughly comparable to the level of costs that were then being allocated to the St. Louis-Kansas City route.
The results of the 79-mph costing were then further validated against a number of current Amtrak operations. A combination of RPS data furnished by Amtrak along with published information on the financial performance of other state-supported services was used to establish the benchmark data. Several comparable services were included in the benchmark:

- Downeaster
- Illinois Zephyr
- St Louis to Chicago
- St Louis to Kansas City
- Heartland Flyer
- Rockford, Il (Proposed)

These results, as compared to the cost function calculated for the 79-mph Minneapolis to Duluth service, are summarized in Exhibit C-11.

Exhibit C-11: Benchmark Comparisons of Duluth Projection vs. Amtrak Actual



RPS data furnished by Amtrak showed that the cost per train mile assigned to all of the Illinois corridors, in agreement with the cost model, dropped dramatically as a result of the doubling of train frequencies. A doubling of train frequency (train miles) for the Illinois Zephyr and Chicago-St Louis routes (from one to two trains and three to five trains) reduced the average total cost per train mile from $38.85 and $36.48 down to $31.66 and $30.38, respectively, just as the costing model would have predicted.[18]

For a new service from Chicago to Dubuque as shown in Exhibit C-12, Amtrak recently proposed a cost of $33.08 per train mile to Illinois DOT[19]. This cost seems low in comparison to other corridors of a similar length, raising the question of whether Amtrak is pricing this service at full cost. However, the service would share the same Chicago maintenance base and overhead cost structure with other existing Illinois and Wisconsin state-sponsored services, and therefore as part of a larger system, Amtrak's pricing of the proposed service shows the efficiencies that Dubuque corridor can gain by being part of a larger, multi route Chicago Hub system. Amtrak's pricing of the Dubuque corridor clearly reflects these Hub efficiencies.

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[18] The Chicago to St. Louis line includes a significant stretch (120 miles) of FRA Class VI track from Springfield to Dwight, IL, which is shared with Union Pacific freight trains. This shows that the added maintenance cost for Class VI track shared with freight trains need not be a "deal killer." See: http://www.fra.dot.gov/us/content/648 and http://illinoisissues.uis.edu/features/2002apr/train.html although the signal system and train equipment currently deployed on the Chicago to St. Louis corridor does not permit operation at that speed.

[19] See: http://www.dot.state.il.us/amtrak/RCK_Feasibility.pdf

Exhibit C-12: Proposed Chicago to Dubuque Service

VI. **Summary – Proposed Chicago-Rockford-Dubuque Service**

This section summarizes key elements of each route alternative between Chicago and Dubuque

	Route A UP Belvidere	Route B ICE Airport	Route C CN Direct	Route D ICE-CN Hybrid
Length of Route (miles)	184.0	188.6	182.2	181.0
No. of Rail Carriers	4	5	2	4
Proposed Scheduled Running Time (hours:minutes)	5:25	5:42	5:10	5:22
"Order of Magnitude" Capital Cost ($ millions)	$43.8	$48.9-$55.4	$32.3	$34.5
Estimated Annual Ridership	53,600	44,300	74,500	58,400
Estimated Annual Revenue ($ millions)	$1.1	$1.0	$1.5	$1.2
Estimated Annual Operating Expense ($ millions)	$4.1	$4.1	$4.4	$4.2
Estimated Annual Operating Contract ($ millions)	$3.0	$3.1	$2.9	$3.0

The most direct existing analog to the proposed Minneapolis to Duluth service would be the Heartland Flyer operation from Fort Worth to Oklahoma City, which with 150,380 annual train miles is costing over $6 million a year,[20] an average of $39.90 per train mile. Because of its relative isolation from the rest of the Amtrak system, this corridor has the highest train-mile rate of any of the corridors benchmarked. But the Minneapolis-Duluth/Superior Corridor at 155 miles is even shorter than the Heartland Flyer's 206 miles, and would not even share a common downtown Twin Cities station or maintenance base (as the Heartland Flyer in Fort Worth does.) The Duluth corridor therefore, as a stand-alone operation, would likely be even more expensive to operate than the Heartland Flyer, if priced on a fully allocated basis.

However, even if the cost of a Minneapolis to Duluth 79-mph service could be reduced to the optimistic $33.08 that was quoted for the Dubuque corridor, the one-train a day option at 79-mph would still need a substantial operating subsidy. However, the $51.91 per train mile reflects a more reasonable assessment of the likely full cost for one daily round trip from Minneapolis to Duluth.

If it is decided to negotiate with Amtrak, it is important to understand that Amtrak may offer favorable pricing for a start-up service that could be raised in the future. It is therefore recommended to obtain a long-term commitment to pricing rather than negotiating on a year-by-year basis, and to understand up-front what Amtrak's fully allocated cost position will be.

For the Minneapolis-Duluth/Superior Corridor, most certainly, the best strategy for improving bargaining leverage would be to bundle the corridor into a package of intercity rail services, such as a possible Minneapolis hub system, that would be large enough to support its own dedicated administrative cost structure. The Duluth corridor could then benefit from Hub economies just as the proposed Dubuque operation has. These economies of scale could be achieved by building corridor revenues through an aggressive approach to 110-mph implementation, or possibly by co-developing the service along with the MWRRS or other Twin Cities rail corridors.

[20] See: http://findarticles.com/p/articles/mi_qn4182/is_20010619/ai_n10146131

The RMRA corridors, if all are built, would naturally constitute a nice “bundle” that could give the RMRA improved bargaining leverage for negotiating with potential system operators. If only one or a few of the corridors are actually built, then RMRA will have less leverage. We will not know the recommended strategy until the conclusion of the study.