EXECUTIVE SUMMARY

INTRODUCTION

The purpose of the Tri-State II High-Speed Rail Feasibility Study was to evaluate the potential for high-speed rail service in the Chicago-Milwaukee-Twin Cities corridor. The Midwest Regional Rail Initiative[1] (MWRRI), the Base Case for Tri-State II, evaluated intermediate rail service; this study considered further improvements for a range of high-speed options. The Illinois, Minnesota, and Wisconsin Departments of Transportation and the Federal Railroad Administration (FRA) previously conducted a series of studies on regional rail options.[2] Those studies, in conjunction with MWRRI results, show that high-speed service would be a viable economic investment for the region.

Tri-State II evaluated incremental high speed (110 mph), high speed (150 mph) and very high speed (over 185 mph) train technologies that could be operated on various route alignments. Forecasts of ridership, revenue, operating costs and capital costs were created for the route and technology options using the RightTrack© software package.[3] Ridership and revenue forecasts were developed based on travel characteristics, survey findings, and demographic statistics. After the financial return on investment was identified for each option, a Conceptual Implementation Plan was developed.

TRAIN TECHNOLOGY OPTIONS

MWRRI specified incremental passenger rail service (110 mph) as the base case for study. Straightening track curves to accommodate high-speed passenger trains requires significant capital costs; incremental service typically employs tilt mechanisms for passenger comfort and steerable bogies to maximize speeds around curves at relatively low levels of investment. Tri-State II followed the MWRRI study and evaluated Diesel Multiple Unit (DMU) equipment as the generic representative for incremental (110 mph) service.

The Tri-State II project examined two different 150-mph technologies, electric and gas-turbine power. When these trains operate on mixed-use (i.e., passenger trains and freight operations) rights-of-way, additional infrastructure capacity and safety features are required, and tracks,

---

1 The MWRRI is a collaborative effort among nine Midwest states – Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, Ohio and Wisconsin – the National Railroad Passenger Corporation (Amtrak), and the FRA, to evaluate the potential for an expanded and modern regional intercity passenger rail system.

2 *Tri-State Study of High Speed Rail Service*, May 1991 The study was conducted by Transportation Economics & Management Systems//Benesch, and funded by the Illinois, Minnesota, and Wisconsin Departments of Transportation; C*hicago/Milwaukee Rail Corridor Study*, May 1997 The study was conducted by Envirodyne Engineers, Inc. and funded by the Illinois and Wisconsin Departments of Transportation

3 The RightTrack© software package developed by the Transportation Economics & Management Systems, Inc. includes the COMPASS© Demand Forecasting Model System, GOODS© Freight Forecasting Model, LOCOMOTION© Train Performance Calculator, MONITOR© Maintenance Management System, RENTS© Financial and Economic Analysis Model, and TRACKMAN© Rail Inventory System. A complete description of RightTrack© can be found in Appendix 5.5 of Tri-State II Final Report.

TABLE OF CONTENTS

1.1 OVERVIEW

The purpose of the Tri-State II High-Speed Rail Feasibility Study was to evaluate the potential for various high-speed rail options in the Chicago-Milwaukee-Twin Cities corridor. The options look beyond the Midwest Regional Rail Initiative (MWRRI) implementation, which was presented as the Base Case for this study. The MWRRI evaluated intermediate high-speed (up to 110 mph) service in the Midwest and is currently proceeding into advanced planning stages. This study considers incremental improvements from one speed threshold to another for long-range (five to fifteen-year) planning and implementation. It was designed to provide policymakers with the information needed to evaluate and choose among route/technology alternatives, including the financial and institutional arrangements needed and a realistic timetable for successful implementation. The study frames alternatives that could be used in the development of an Environmental Impact Study (EIS) for the Tri-State Corridor. The next logical step in this planning process is the preparation of a corridor EIS.

In brief, the aim of this study is to assess the steps that should be taken following the implementation of MWRRI. As such the study has taken the MWRRI Phase II report as the foundation for assessing what will be the Base Case by 2010. It should be noted, however, that in the further development of the MWRRI in Phase III, various adjustments were made to the operating plans, revenue and cost assumptions and infrastructure needs. Where possible and appropriate these modifications have been incorporated in the Tri-State Base Case.

1.2 BACKGROUND

In recent years, intercity and inter-regional transportation planning has increasingly focused on the potential for high-speed passenger rail service in major travel corridors. Traditional forms of inter-city travel, such as air and auto, face increasing congestion and cost, while demand continues to grow. The U. S. Department of Transportation has supported the planning and implementation efforts of state departments of transportation by designating a series of high-speed rail corridors connecting major metropolitan areas within various regions across the nation. The Chicago-Milwaukee-Twin Cities corridor has been so designated by the U.S. DOT.

High-speed rail is not expected to replace air and auto travel, but offers a complementary, attractive alternative for trips between 100 and 400 miles. High-speed rail transportation is generally considered the logical choice for the “gap” between standard, short–distance trip lengths for auto travel (0-100 miles) and air travel (400+ miles). As the volume of trips between 100 and 400 miles continues to expand, there is an ever-increasing need for more effective regional transportation systems. Transportation improvements targeted at longer-distance travelers can also provide significant benefits for shorter-distance travel, in the 50 mile to 100 mile range. Higher frequencies and improved travel times for intercity rail service provide an effective alternative to congested highways in areas with significant commuter flows, such as the Milwaukee-Chicago and the Hastings-Twin Cities corridors.

Intercity and inter-regional travelers are interested in “door-to-door” journey times. High-speed rail offers the advantage of downtown-to-downtown access, with minimum time in the terminal. Cost, convenience, frequency and reliability, coupled with door-to-door journey time comparisons, are critical elements that affect travel mode decisions. European and Japanese high-speed rail systems are well utilized and highly regarded by the general population. Rail service improvements in the U.S. Northeast Corridor have resulted in steady increases in ridership and revenues. Several Midwest states have been investing in modest passenger rail service improvements while studying the potential for greater passenger rail opportunities.

1.2.1 Study Context

The Tri-State II Study was conducted within the context of a larger, multi-state analysis of passenger rail, the Midwest Regional Rail Initiative (MWRRI).

Midwest Regional Rail Initiative

The MWRRI is an ongoing effort to develop an improved and expanded passenger rail system in the Midwest. The sponsors of the MWRRI are Amtrak, the Federal Railroad Administration, and the transportation agencies of nine Midwest states - Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin.

Since 1996, the MWRRI advanced from a series of service concepts, including increased operating speeds, train frequencies, system connectivity, and high service reliability, into a well-defined vision to create a 21st Century regional passenger rail system. This system would use existing rail rights-of-way shared with freight and commuter rail connecting nine Midwest states to serve its growing population. System synergies and economies of scale, including higher equipment utilization, more efficient crew and employee utilization, and a multi-state rolling stock procurement, can be realized through a regional system. The Tri-State II study assumes MWRRI implementation in the tri-state corridor as its Base Case for investment, and compares alternative routes, investments, and higher-speed train technologies to that Base Case.

The Tri-State II Study also builds upon the results of two previous corridor studies: the Tri-State High Speed Rail Study, and the Chicago-Milwaukee Rail Corridor Study.

Tri-State High Speed Rail Study

In May 1991, a preliminary assessment of high speed rail options between Chicago, Milwaukee and Twin Cities was released. The *Tri-State High Speed Rail Study*, sponsored by the State DOTs of Illinois, Minnesota and Wisconsin, was a broad-brushed evaluation of the feasibility of high speed ground transportation alternatives between Chicago/Milwaukee and Twin Cities. The *Tri-State Study* concluded that a southern corridor is preferred to a northern corridor for future high speed rail service. The southern corridor generally follows the route of Amtrak's *Empire Builder* through Wisconsin, i.e., the Canadian Pacific Railway's mainline from Chicago to Milwaukee to La Crosse. The study concluded that the potential travel market for high-speed ground transportation services between Chicago and the Twin Cities is a combination of the short-distance Chicago-Milwaukee market and the long-distance Chicago-Twin Cities market.

Chicago-Milwaukee Rail Corridor Study

As an outgrowth of the initial *Tri-State Study*, Wisconsin and Illinois co-sponsored a more detailed feasibility study of high-speed rail options between Chicago and Milwaukee. Begun in 1992, the *Chicago/Milwaukee Rail Corridor Study* was completed in 1997. Phase I identified the

Canadian Pacific Railway and Metra rail corridor as the preferred alignment option, with diesel-electric locomotives as the initial technology of choice. Phase II produced a conceptual plan for reducing the rail travel time from city-center to city-center from 86 to 60 minutes. This conceptual plan has been fully integrated into both the ongoing *Midwest Regional Rail Initiative* and the ongoing *Tri-State II High Speed Rail Study* described below.

According to travel demand forecasts prepared for the corridor study, enhanced passenger rail service operating at speeds up to 110 mph and with a frequency of 12 round trips daily could generate annual passenger revenues sufficient to cover annual operating and maintenance costs, and to finance the acquisition of rolling stock. However, the forecast revenue stream would not be sufficient to finance the costs of the infrastructure improvements required.

The study results indicate that trains powered by diesel-electric locomotives operating at speeds up to 110 mph provide the most cost-effective high speed passenger rail solution for this corridor. Given the corridor's short distance, higher speed scenarios involving trains powered by electricity delivered through overhead wires were not fully developed. The achievable savings in travel time (four minutes) with an electrified system would not justify the minimum additional capital investment required.

The Midwest High Speed Rail Corridor

In 1992, the U.S. Department of Transportation officially designated the Midwest High Speed Rail Corridor (Chicago-Milwaukee, Chicago-Detroit, and Chicago-St. Louis) as a high-speed rail corridor under ISTEA (Intermodal Surface Transportation Act). This designation made it eligible for federal assistance to eliminate hazards at highway-rail grade crossings.

In 1998, the U.S. Department of Transportation designated Milwaukee-Twin Cities as part of the Midwest High Speed Rail Corridor from Chicago/Milwaukee under Transportation Equity Act for the 21st Century (TEA-21). Currently, four of the major rail corridors of the proposed Midwest Regional Rail System have been formally designated by the federal government as high-speed passenger rail corridors of national significance. As such, these corridors are eligible for federal funds to eliminate rail/highway grade crossing hazards on designated high-speed rail corridors. This federal program was created under Section 1010 of *ISTEA* and extended under Section 1103 of *TEA-21*.

The four officially designated corridors comprising the *Midwest HSR Corridor* are:

- Chicago-Detroit;
- Chicago-Indianapolis-Cincinnati;
- Chicago-St. Louis; and
- Chicago-Milwaukee-Twin Cities.

The designation of these corridors has allowed the states of Illinois, Indiana, Michigan and Wisconsin to apply for and receive over $12 million in federal assistance to improve the grade crossing safety in the corridors and more will be awarded during the remaining life of *TEA-21*. In 1999, the state of Ohio formally requested that the Chicago-Toledo-Cleveland corridor be designated as the fifth prong of the *Midwest HSR Corridor*. This request is pending.

Tri-State II High Speed Rail Feasibility Study

The Minnesota and Wisconsin Departments of Transportation commissioned the *Tri-State II High Speed Rail Corridor Study*. A Study Steering Committee of key staff from the Minnesota, Wisconsin and Illinois Departments of Transportation provided ongoing oversight and direction to the consultant team retained to conduct the study. Minnesota Department of Transportation served as Project Coordinator. An Advisory Committee, comprised of elected and appointed representatives from state, local governments and interested organizations reviewed draft materials and provided direction to the Steering Committee.

The *Tri-State II High Speed Rail Corridor Study* defines and analyzes three long-range alternatives for improving high-speed passenger rail service in the Chicago-Milwaukee-Twin Cities corridor, subsequent to implementation of the *Midwest Regional Rail Initiative (MWRRI)*. The study includes Base Case operating plans and technology assessments based on MWRRI

Phase II. The feasibility study compares investment, train speed and service plan alternatives that could be used in the development of an Environmental Impact Study (EIS) for the Tri-State Corridor.

Exhibit 1.1 shows the existing Tri-State Passenger Rail Corridor with CP Railways in yellow and the suggested new right-of-way in magenta.

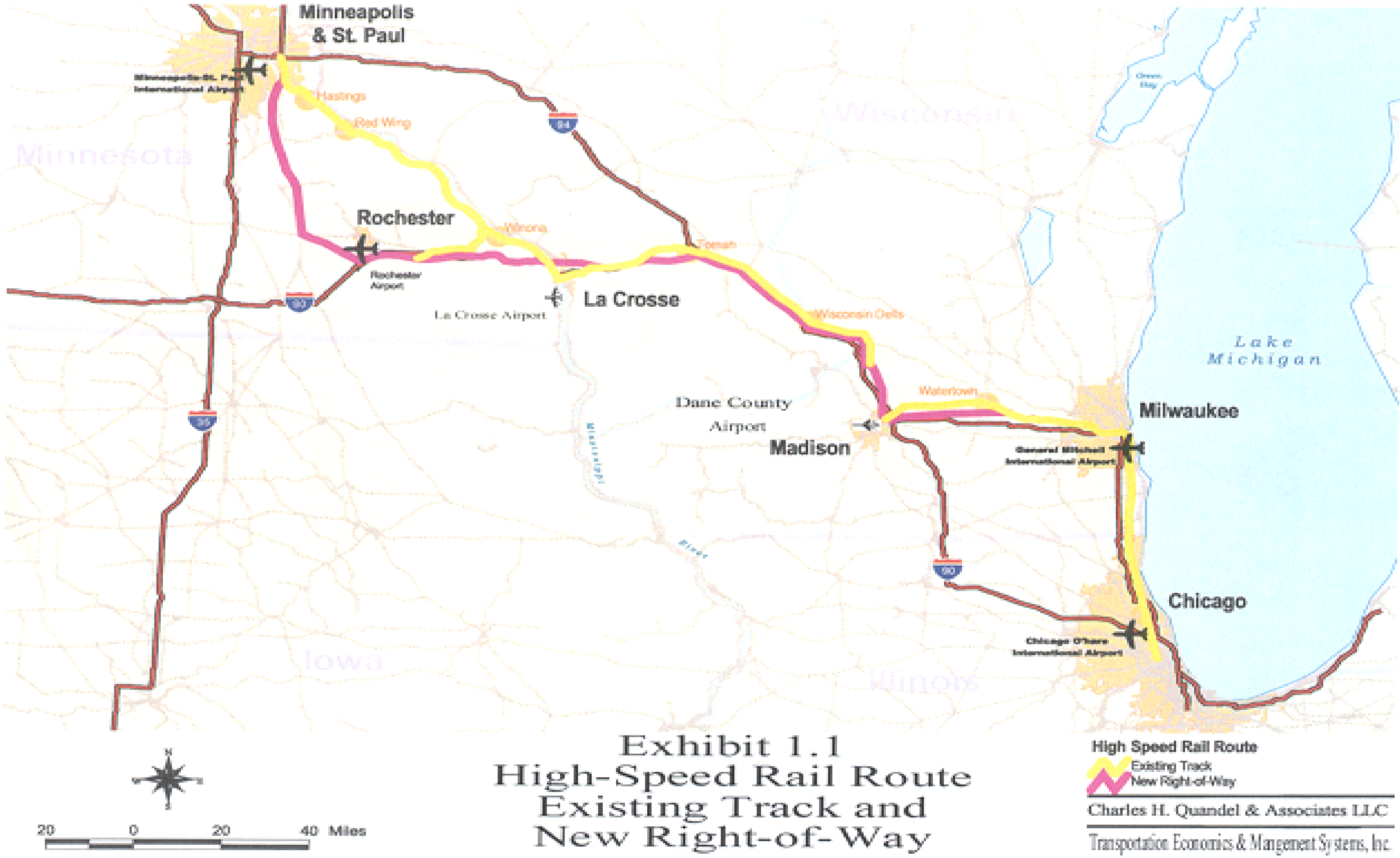
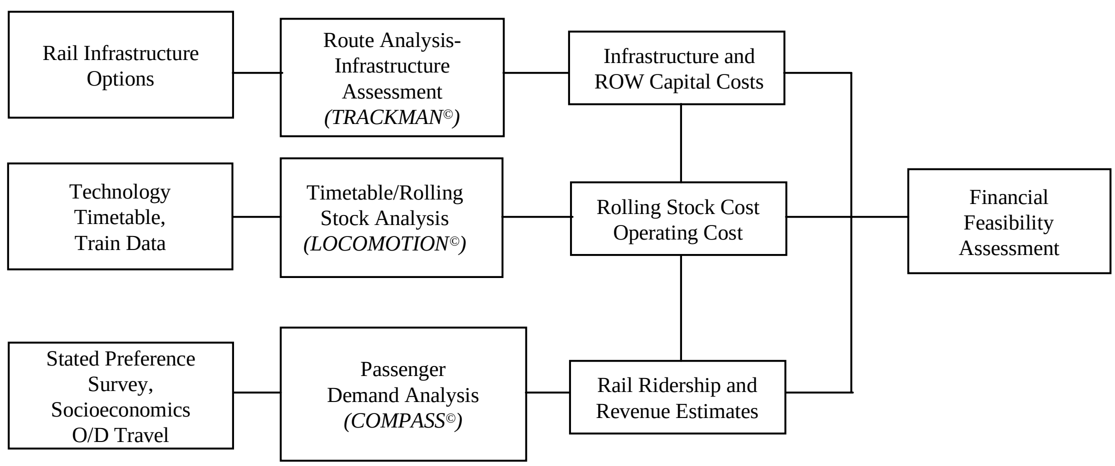


Exhibit 1.1
High-Speed Rail Route Existing Track and New Right-of-Way

1.2.2 Study Process

The study was a highly interactive process, with frequent feedback and adjustments between railroad track issues versus train technology assessments and between operating plan concerns versus user demand assessments. The study process also included a review of potential environmental impacts, a financial feasibility analysis, an evaluation of economic impacts, a review of potential funding sources, and a discussion of institutional issues. Exhibit 1.2 illustrates the process that led up to the financial analysis.

Exhibit 1.2
Interactive Study Process



[*] While the Base Case represents train technology and infrastructure improvements from the MWRRI, inputs and results vary in some instances. The detailed Tri-State model zone improvements and forecasts lead to revised demand forecasts; in some cases frequencies were then revised to better accommodate demand. Operating miles and rolling stock requirements were also revised.

The study investigated the interaction between various routes and train technologies to identify optimum tradeoffs between capital investments in track, signals, other infrastructure improvements, and operating speed. The engineering assessment included aerial and/or ground inspections of significant portions of track and potential alignments, station evaluations, and identification of potential locations and required maintenance facility equipment for each option. As part of the Engineering and Environmental analysis, an environmental review was performed to identify potential environmental issues relating to passenger rail alignments. The review studied issues that could impact implementation of the high-speed rail service and presented a broad-scale evaluation of the impact within the Chicago-Milwaukee–Twin Cities corridor. It should be noted that this environmental review did not provide a level of analysis consistent with an environmental impact statement or an environmental assessment.

TRACKMAN© was used to catalog the base track infrastructure and proposed alternative improvements. *LOCOMOTION*© was used to simulate various train technologies on the track at different levels of track improvement, using train operating characteristics (acceleration, curve capabilities, etc.) developed during the technology assessment.

A comprehensive travel demand model was developed using survey, socioeconomic, origin-destination and extensive network data to test the likely ridership response to rail service improvements over time. The ridership and revenue demand estimates, developed using the *COMPASS*© demand modeling system, are sensitive to trip purpose, frequencies, travel times and other trip attributes. Same-day parcel service and on-board service revenue estimates were also developed.

Selected sets of route and train technology options were analyzed to identify reasonable tradeoffs between capital investments in track, signals, other infrastructure improvements, and operating speeds. Trip frequencies were tested and refined to support and complement the ridership demand forecasts.

The study identified infrastructure costs by segment (e.g., Milwaukee to Watertown) and by type of improvement (e.g., bridge, crossing, etc.) on a unit cost basis necessary to achieve high levels of performance for the train technology options evaluated. Unit operating costs were also demand forecasts. Operating plans, with travel times, stops and frequencies were developed for each technology and applied to the unit operating costs formulated for each technology to estimate operating costs for each option.

Financial and economic consequences were analyzed for each option encompassing a 30-year horizon, and included the effects of staging the investment from the Base Case. The analysis provided a summary of capital costs, revenues, and operating costs for the life of the project, and compared the operating ratio, net present value (NPV), and internal rate of return (IRR) for each option.

Institutional issues were presented to both the Steering and Advisory committees in a workshop held in June 1999. These institutional issues can be numerous and take many forms throughout the planning, engineering, construction and operating phases of any selected option.

Criteria for rank-ordering the most promising rail passenger options were developed by the Study Steering Committee. The conceptual implementation plan includes staging and timing for the phased development, construction and operation of the recommended options.

1. 3 REPORT ORGANIZATION

The report structure follows the study development process. A brief Glossary of technical terms is provided following Chapter 11. Detailed Appendices have been bound separately. Study results are presented with a comprehensive description of the methodology as follows:

Chapter 2. Train Technology: The choice of rail technology brings with it implications for speed, safety and cost of operations; infrastructure requirements; as well as cost and timing of equipment acquisition. This chapter describes how the train technology options were selected for this study. It describes the evaluation of the three technologies in the study, including features that influence travel times.

Chapter 3. Route Assessment and Environmental Review: The initial Tri-State Study recommended that an engineering and environmental analysis be done to evaluate routes, crossings, infrastructure needs, and environmental concerns in greater detail. This chapter details specific engineering and environmental analyses. The engineering portion of the chapter emphasizes route alignments and route and station assessments. The environmental portion of the chapter presents a broad-scale overview of some of the environmental issues that relate to the Chicago-Milwaukee-Twin Cities corridor. The engineering basis for track assessments and infrastructure analysis, including station photographs is detailed in this chapter. Route descriptions within milepost segments, as well as an assessment of environmental, energy, and related impacts in the corridor, are provided in the Appendices to Chapter 3.

Chapter 4. Operating Plan Development: The train operation analysis and development of operational plans for each technology/route option focused on the following:

- Development of train running times
- Train timetable development
- Assessment of freight/commuter rail operations and their interactions with proposed timetables
- Computation of rolling stock requirements.

This chapter provides the plan description, building travel times from the technology/infrastructure assessments and frequencies in conjunction with the demand forecast.

The associated appendices describe the ridership capacity assessment and provide a more detailed service plan for each scenario discussed, including service patterns, rolling stock and maintenance facility requirements. .

Chapter 5. Demand Forecast: This chapter documents the data-gathering effort from primary (*e.g.,* direct survey) and secondary (*e.g.,* U.S. Bureau of the Census) sources and summarizes the results. It also describes the process and major assumptions incorporated in the model. Finally, it presents the process results in terms of preliminary ridership and revenue forecasts for each scenario, based on initial estimates of frequencies and travel times (prior to rationalization and optimization of operating expenses, fare levels and infrastructure investment levels). Processes and assumptions related to ridership and revenue forecast development are detailed, with supplemental appendices for greater detail.

Chapter 6. Operating Revenues and Operating and Capital Costs: This chapter describes the development of the total operating revenues that support system operation. It also details the operating cost derivation and its relationship to the operating plan and demand forecast. Another section briefly explains the development of rolling stock costs based on the technology assessment and operating plan. The final section of the chapter (with extensive appendices) details the engineering assessment cost development. In summary, this chapter translates previous chapters into financial terms, with descriptions of methodologies and assumptions. The engineering cost appendices provide itemized segment details for each route/technology option.

Chapter 7. Financial Analysis: A financial analysis was performed to compare the feasibility of the four route/technology options for the Tri-State Corridor subsequent to implementation of the Base Case. The analysis reviewed the direct merit of each option based on associated financial returns. This chapter discusses the Financial Analysis in detail and transforms Chapter 6 revenues and costs into time-series analysis with net present value and internal rate of return calculations. The incremental analysis of capital cost considers the MWRRI as a “sunk” cost.

Chapter 8: Economic Analysis: A quantitative economic analysis was performed using outputs from the *COMPASS*© demand model. Qualitative benefits were identified. The economic analysis examined each option with respect to benefits to users, benefits to users of other modes, and other benefits.

Chapter 9. Funding Alternatives: Implementation of the Tri-State Corridor will require the states to develop a financing plan to fund the required capital costs. This plan will require a financial commitment from each state participating in the Tri-State system with regard to the agreed institutional arrangement and allocation method. Funding is available from a broad range of transportation revenue streams and will require a coordinated effort to review all potential sources and pursue funding. This chapter explores funding opportunities for rail projects in both the public and private sectors.

Chapter 10. Institutional Analysis: Institutional arrangements involve the nature, organization, and individuals responsible for undertaking or overseeing specific activities. Institutional arrangements, particularly as they relate to multi-state transportation projects, can be numerous and take many forms throughout the planning, engineering, construction, and operating phases of a project. This chapter is intended to be descriptive (not prescriptive) in identifying the most effective institutional arrangements for the Tri-State II High Speed Rail System as it progresses into advanced planning, design, engineering, construction, and implementation. This chapter describes potential institutional arrangements that may be appropriate for various stages of project development. It also describes potential mechanisms for developing allocation agreements between the states.

Chapter 11. Conceptual Implementation Plan: The purpose of this Conceptual Implementation Plan is to identify the next step in rail development in the Chicago-Milwaukee-Twin Cities Corridor following implementation of the MWRRI. The Conceptual Implementation Plan discusses long-term development strategies that have been modeled to provide maximum ridership growth and optimal return on investment. This chapter identifies the recommended staging of development in the corridor to generate maximum ridership and revenue return in the earliest time frame.

Chapter 12. Summary and Conclusions: This chapter summarizes major findings of the Study, and the recommendations for the next steps.

1.4 SUMMARY

High-speed passenger rail travel has been studied in the Chicago-Milwaukee-Twin Cities corridor with the intention of providing a supplement to air and auto travel for trips between 50 and 400 miles.

Four route/technology options were selected for analysis for this study, plus the Base Case of Midwest operations. The interactive study process evaluated infrastructure investment, train technologies, operating scenarios, travel demand, operating revenues, operating costs, and financial and economic returns for the selected alternatives. It also reviewed potential funding and institutional issues associated with the project, and proposed a staged development plan to maximize riders and revenue during the implementation period.

The balance of this report details the study results, along with a set of extensive Appendices.

signals and crossings must also meet higher standards. In addition, electric traction requires a catenary system that significantly increases infrastructure investment.

The highest-speed trains (185 mph) require straight tracks and high levels of super-elevation for curves. For these trains, the FRA mandates no "at-grade" crossings, and - as their rights-of-way are unsuitable for other rail traffic (passenger or freight) - a dedicated right-of-way. Tri-State II evaluated the Tren a Gran Vitesse (TGV) as the generic representative for 185-mph rail.

The following routes and technologies were selected for evaluation:

- Base Case: Chicago-Milwaukee-Madison-Winona-Twin Cities following the Amtrak Empire Builder route; Diesel Multiple Unit (DMU) technology; maximum speed 110 mph.
- Option B-1: Chicago-Milwaukee-Madison-Winona-Rochester-Twin Cities, primarily on existing freight rights-of-way; DMU Technology; maximum speed 110 mph.
- Option B-2: Same course as B-1; American Flyer (gas turbine) technology; maximum speed 150 mph.
- Option C-2: Chicago-Duplainville-Madison-Rochester-Twin Cities, branching off "cross-country" from Ixonia to Madison; American Flyer technology; maximum speed 150 mph.
- D-3: Same route as C-2, but operating on elevated tracks in urban areas; TGV technology; maximum speed 185 mph.

For each of these options, capacity restrictions of the existing Canadian Pacific (CP) Railway freight route through Winona, Red Wing and Hastings, Minnesota were studied. It is clear that freight activity will increase significantly on this route in the next 20 years, affecting passenger rail operations and limiting both frequency of service and speeds.

OPERATING PLAN ALTERNATIVES

Travel times and frequency of service influence ridership and revenue. The LOCOMOTION© Train Performance Calculator was used to develop timetables for each route/technology using both express and local stop trains. Fleet sizes were determined by balancing frequencies against ridership. Following are the key findings. (See Exhibit ES-1 for forecast summary.)

- To make significant improvements in travel times, as recommended by MWRRI, and to service Rochester, Minnesota, 150-mph technology on a new route is necessary.
- Frequency of service should be expanded from six to 18 trains per day between Chicago and the Twin Cities, increasing the base-operating plan by three times.
- A new right-of-way and service to Rochester would eliminate serious train conflicts associated with the CP right-of-way north of Watertown, Wisconsin.
- One hundred eighty-five mph service is fastest, but in urban areas it must be constructed on elevated tracks to avoid conflicts, which is prohibitively expensive.

Exhibit ES.1
Operating Plan and Ridership Forecast Summary for the Year 2020

Option	Route Option	Speed	Express Travel Time	Daily Frequency	Number of Train Sets	Number of Cars	Average Number of Daily Riders	Annual Riders
Base Case	-----	110 MPH	5:27	6	12	82	9,014	2,929,400
Option B1	Rochester	110 MPH	5:34	6	12	87	8,746	2,842,400
Option B2	Rochester	150 MPH	4:59	18	19	147	12,840	4,172,900
Option C2	New Route	150 MPH	4:14	18	19	174	15,219	4,946,100
Option D3	Urban Elevated	185 MPH	3:11	23	21	156	18,175	5,906,900

RIDERSHIP FORECASTS

The COMPASS© demand-forecasting model was used to evaluate the feasibility of high-speed passenger rail service. This was a four-step process: 1) Gather information on market and modal travel patterns. 2) Identify socioeconomic factors that influence the growth of travel demand. 3) Test rail options to identify rail modal-shares. 4) Forecast demand for each option for horizon years. Following are the results of the process:

- The corridor has a very vigorous travel market, and there is extensive travel between the cities in the region.

- Forecasts for income growth are significantly higher than population growth; consequently, travel is expected to increase faster than population or employment.

- The value of time analysis reveals that the travel behavior governing rail use is more similar to air than to auto.

- Rail market shares will increase as frequencies increase and travel times decrease. Shares are estimated at 0.3 percent in the base year; 1.5 percent in 2020 for the 110-mph option through Rochester; 2.2 percent for the 150 mph option through Rochester; and, 3.1 percent for the 185-mph option. Annual ridership estimates range from just under three million in the base year to almost six million for Option D-3 (TGV technology, elevated track in urban areas).

COST AND REVENUE ANALYSIS

Operating costs used in this analysis were based on those generated for the MWRRI analysis. They were calculated from study data, input from manufacturers and/or users of the technology, and subject to sensitivity analysis. Infrastructure costs were estimated using engineering inputs to a unit-cost approach. An infrastructure analysis was performed to identify impediments to optimum operation; track charts and geological gradient maps were reviewed; and, an engineering assessment conducted to measure environmental and energy impacts. The infrastructure costs were subject to capacity analyses, and capital investments were added to the options that utilize the CP track in order to alleviate freight-train constraints. Cost estimates and ridership projections were then used to plan operating timetables.

Revenue analysis assumed optimal fare levels, better-connecting air-passenger services within the corridor, and profit from same-day parcel and on-board services. The assessment assumed no competitive response from air and bus modes. (Exhibit ES.2)

Exhibit ES.2
System Summary Revenues and Costs
($ in Millions)

	Base Case 110 mph	Option B1 110 mph Rochester	Option B2 150 mph Rochester	Option C2 150 mph New Alignment	Option D3 185 mph Elevated
Operating Revenues (2020)	135.2	144.6	294.4	361.7	480.2
Operating Costs (2020)	83.8	89.7	122.4	148.7	170.2
Rolling Stock	117.5	124.2	351.6	416.3	253.2
Infrastructure Investment	822.7	1,138.7	2,752.5	3,242.8	8,017.5

FINANCIAL RETURNS

Financial results were tested using a 30-year horizon. The analysis summarized capital costs, revenues, and operating costs, and then compared them with operating ratio, net present value (NPV) and modified internal rate of return (MIRR). Economic conditions and other influencing factors were addressed in a sensitivity analysis.

It was found that all route/technology options presented are financially viable, replicating previous results. Subsequent to the development of MWRRI, the option projected to have the highest financial return is the Rochester re-route by the year 2012, using the 150-mph alternative and gas turbine technology on a separate right-of-way from the congested CP alignment. Notwithstanding financial return considerations, the capacity analysis showed that an alternative route through Rochester may be necessary in the near future in order to provide reliable high-speed train service under any technology option.

ECONOMIC ANALYSIS

High-speed passenger rail service will benefit both users and non-users of the system. All options will generate significant economic benefits in terms of consumer surplus (benefits to users in excess of what they pay in fares). The net economic benefits would include higher rates of employment, per capita income, commercial property values, rents, and growth in the regional tax base. Employment, income, and property value benefits should not be construed as over and above user benefits, but rather mechanisms by which user benefits will be incorporated into the regional economy. All options project a positive NPV and benefit/cost ratio. Consistent with the Financial Analysis, Option C-2, 150-mph gas-turbine service through Rochester, is projected to provide the best benefit-cost ratio and capital constrained consumer surplus. Projected NPV range from $5.3 million, 1998 dollars, for Option B-1 (Rochester, 150 mph) to $2,673.3 million for Option D-3 (Rochester, urban-elevated, 185 mph). (Exhibit ES.3)

Exhibit ES.3
Financial and Economic Overview
(1998 Dollars in Millions)

Option	Total Costs[1] PV	Revenue PV[1]	Operating Ratio (2020)	Incremental NPV At 5%	Gross Consumer Surplus PV[1]	Project NPV	Benefit Cost Ratio	MIRR (%)
Base Case	---	---	---	---	---	---	---	---
Option B1	$ 484.6	$ 168.8	1.61	$ 0.3	$ 321.2	$ 5.3	1.01	5.0
Option B2	$2,535.8	$2,215.6	2.40	$ 836.2	$1,899.9	$1,579.7	1.62	17.6
Option C2	$3,445.3	$3,158.3	2.43	$1,183.1	$2,628.9	$2,341.9	1.68	18.3
Option D3	$7,892.6	$4,790.0	2.82	$1, 180.0	$5,775.9	$2,673.3	1.34	14.6

[1] Five percent discount rate

FUNDING ALTERNATIVES

Because of the magnitude of the capital requirements and the lack of a proven system of this size in the region, the potential for full private-sector funding of the Tri-State project extremely unlikely. (MWRRI proposed 80 percent federal participation, which would build the Base Case in the state corridor.) It is assumed that each state will fund its own portion of the capital costs using a combination of funding alternatives. Wherever possible, costs allocated to a state should be directly related to the benefits received by that state. Specific funding strategies and structures are outside the scope of this study; however, it is expected that the most likely mechanisms include Federal financial assistance (the U.S. Department of Transportation has designated the Chicago Hub as one of five high-speed corridors throughout the nation, signifying that it is eligible for special funds), cash flow management (TIFIA, GANs), and cost reduction techniques (cross-border leases, COPs).

CONCEPTUAL IMPLEMENTATION PLAN AND SUMMARY

This study was based on the assumption that the improvements recommended in MWRRI will be completed prior to the implementation of Tri-State II. A full EIS must be undertaken (with a focus on 150-mph technology using the new route between Twin Cities and Ixonia) to eliminate potentially-fatal flaws and increase investor confidence in all cost and revenue forecasts.

The Conceptual Implementation Plan represents the most effective strategy to follow subsequent to the implementation of MWRRI. (Exhibit ES.4) Due to the level of freight activity and difficulty in providing access for passenger service along the Mississippi River from La Crosse-Twin Cities, the first steps should be an earlier (rather than later) routing through Rochester. It is recommended that this alignment be developed initially to 150-mph standards to prevent costly rework later when the system can support faster speeds (which are anticipated by 2012). During Phases 1 and 2, the EIS, design and construction for the La Crosse-Rochester and Rochester-Twin Cities routes are likely to require seven years to complete. To commence service by 2012, Phase 1 should begin in 2005.

Phases 3 and 4 would progress south from LaCrosse to Portage, and then from Portage to Madison. Phase 5 recommends improvements to 130 mph for Madison-Watertown. Only minor improvements are proposed for the Watertown-Milwaukee-Chicago segments (Phases 6 and 7); due to the investment required to upgrade the service versus the minimal time-savings achieved, these should be last in funding priority.

Exhibit ES.4
Proposed Implementation Phases

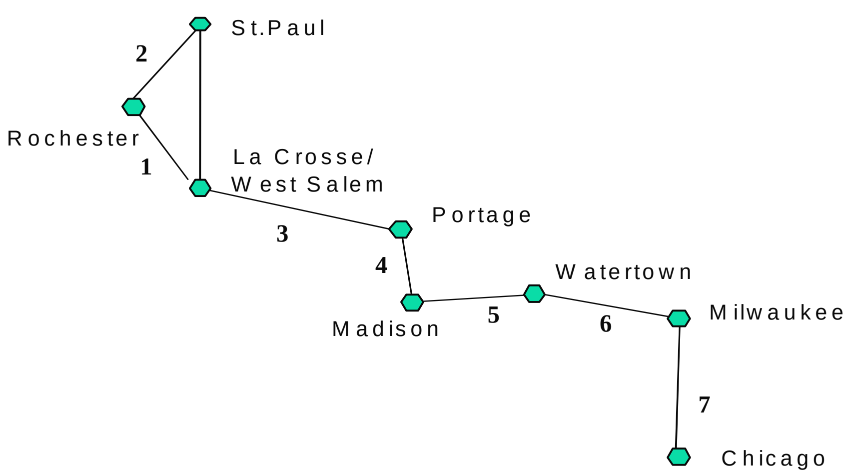


TABLE OF CONTENTS

2.1 OVERVIEW

The choice of rail technology brings with it implications for speed, safety and cost of operations; infrastructure requirements; as well as cost and timing of equipment acquisition. This chapter describes how the train technology options were selected for analysis in this study.

Train equipment technology continues to move forward to meet increasing demands for improved intercity transportation. Extensive research and development by governments and the private sector in Europe, Japan and North America are ongoing. Innovations such as high-speed passenger trains in France, tilting trains in Sweden, advanced freight-tracking systems in the United States, Maglev passenger trains in Germany and Japan (in development), and advanced train signaling and communications systems are being implemented. Increased interest in passenger trains has led to the testing of advanced, high-speed European technologies in the United States, many of which have been tested in revenue service. This testing has included Spanish Talgo Pendular passenger cars (hauled by locomotives) operating in the Portland–Seattle-Vancouver corridor; Adtranz diesel multiple unit (DMU) self-propelled cars that were demonstrated on several Amtrak corridors (including Milwaukee-Chicago); and German ICE and Swedish X-2000 tilt trains that were demonstrated throughout the United States, including revenue service in the Northeast Corridor between Boston and Newport News.

The study scope defined the following three commercial speeds as technology scenarios, which resulted in a spectrum of technology performance, infrastructure investment, travel time, and passenger demand estimates:

- Incremental High Speed (110 mph)
- High Speed (150 mph)
- Very High Speed (185 mph and above).

2.2 TRAIN TECHNOLOGY SELECTION PROCESS

Interviews with manufacturers and train operators addressed operational requirements, consist size and composition, traction options (power and speed), construction materials, passenger accommodations and future technological developments. The analysis also included review of recent literature and specifications available from train manufacturers. The documents that were reviewed are listed in Appendix 2.2. The "long-list" of train technologies considered and the key attributes of each are summarized in Exhibit 2.1. The key attributes of each train technology correspond to the criteria used to select candidate train technologies for detailed analysis in this study.

The technology selection process considered the following criteria in selecting a technology:

- Compliance with U.S. safety requirements
- Top operating speed
- Power source
- Steerable bogies and/or a tilt system.

Note: A bogie is the wheel and axle mechanism of a train. A steerable bogie permits the front and rear wheels on a single bogie to turn independently, rather than operating in fixed formation. This permits higher speed in curves and reduces wear on curved track. A tilt system increases passenger comfort through a high-speed curve by physically tilting the car into the curve to reduce the sensation of "leaning into a curve". Appendix 2.1 discusses these technology issues in detail.

Please note that although specific technologies (by manufacturer) are identified here and throughout this study, there is no intention herein to endorse any specific manufacturer. This study approach is intended as a generic evaluation based on relative speeds, as well as relative operating performance, operating cost, rolling stock cost and associated infrastructure requirements. Any references to specific manufacturers does not constitute an endorsement of such a manufacturer by any member of the Tri-State High-Speed Feasibility Study, its Steering Committee or any other associated parties.

Passenger trains in the United States must meet *Passenger Equipment Safety Standards* [*] set forth by the Federal Railroad Administration (FRA). These standards apply to all equipment placed in service after January 1998. Tier 1 standards affect equipment operated at speeds up to 125 mph and Tier 2 at speeds greater than 125 mph (up to 150 mph). Standards have not yet been approved by the FRA for speeds greater than 150 mph. However, high-speed safety standards were developed and proposed by the FRA in 1998 for a proposed high speed rail project in Florida.

[*] 49 CFR Part 216 et. al.

Exhibit 2.1
Train Technologies Considered

Locomotives/Train-Set	Top Speed MPH	Compliant with U.S. Safety Regulations	Electric Traction	Steering Bogie	Tilt System
GE AMD 103 P40	110	Yes	No	No	No
EMD F59	110	Yes	No	No	No
GE P32-8	110	Yes	No	No	No
Adtranz IC3 DMU	110	Yes *	No	Yes	No
Adtranz IR4 EMU	110	No	Yes	Yes	No
GEC Alice DMU	110	Yes *	No	No	No
ABB Networker DMU	110	No	No	No	No
Duewag VT 610 DMU	110	No	No	No	Yes
RTG III Turboliner HST	125	Yes	No	No	No
F59/Talgo	125	Yes *	Optional	Yes	Yes
Turbine Electric 3600 HST	125	Yes	No	Yes	Yes
Adtranz X2000D HST	125	Yes *	No	Yes	Yes
Adtranz X2000 HST	130	Yes *	Yes	Yes	Yes
Fiat PendoliNo HST	125	No	No	No	Yes
Fiat ETR 460 HST	125	No	Yes	Yes	Yes
SIG Triebkobf 2000 HST	125	No	No	Yes	Yes
Siemens ICT HST	125	Yes*	No	Yes	Yes
GEC Alsthom/Bombardier American Flyer HST (gas turbine)	150	Yes	No	No	Yes
GEC Alsthom TER EMU	140	No	Yes	No	No
GEC Alsthom Class 91	140	No	Yes	No	No
GEC Alsthom/Bombardier American Flyer HST (electric)	150	Yes	Yes	No	Yes
Fiat ETR 500 ***	185	No	Yes	No	No
Siemens ICE ***	175	No	Yes	No	No
GEC Alsthom TGV***	185	Yes ***	Yes	No	Yes

* Not available at present but planned or in design process to be in compliance
** In design process
*** Special regulations to be developed/ negotiated

FRA standards related to buff strength (head-on impact force that a rail vehicle can withstand and not crumple or buckle) and side collision resistance differ significantly from the European standards used by UIC (International Union of Railways) members. Consequently, technologies operated in Europe cannot be operated in the U.S. without FRA waivers or without being redesigned to comply with FRA regulations. Therefore, the technologies selected for analysis comprised trains that could be built for the U.S. market, and that represented generic trains that could meet the desired range of speeds.

Using the criteria discussed above, four of the train technologies listed in Exhibit 2.1 were selected for the detailed analysis of the three service scenarios required by the study scope. The four selected representative technologies are summarized in Exhibit 2.2. The first technology selected, Adtranz IC3 DMU, is capable of operating at speeds up to 110 mph. It not only matches the *Incremental High Speed* scenario specified in the study scope, but also matches the technology option chosen for analysis by the Midwest Regional Rail Initiative in its Phase I study release in August 1998. The second and third technologies selected, GEC Alsthom/Bombardier American Flyer (Gas Turbine) and GEC Alsthom/Bombardier American Flyer (Electric), match the *High Speed* scenario. The fourth technology selected, GEC Alsthom TGV, matches the *Very High Speed* scenario specified in the study scope. All four of the selected train technologies either comply with the FRA safety standards previously cited, or could be designed to do so according to the manufacturers. The first two train technologies are powered by fossil fuels carried on the train. The second two are powered by electricity delivered to the train through overhead wires. All four are capable of being equipped with steerable bogies and/or tilt systems according to the manufacturers.

Exhibit 2.2
Train TechnologiesSelected for Detailed Analysis

Manufacturer	Generic Name	Commercial Speed
ADTRANZ IC3 DMU (Diesel Multiple Unit)	“DMU”	110 mph
GEC Alsthom/Bombardier American Flyer HST (gas turbine)	“High Speed Train Gas Turbine” or “HST-GT”	150 mph
GEC Alsthom/Bombardier American Flyer HST (electric)	“High Speed Train Electric” or “HST-Electric”	150 mph
GEC Alsthom TGV (electric)	“Train Grande Vitesse, Very High Speed Train” or “TGV”	185 mph

2.3 CHARACTERISTICS OF INCREMENTAL HIGH-SPEED (110 MPH) TECHNOLOGY

High speed passenger rail service operating at 110 mph is in place in many parts of the world, particularly in Europe. In the United States, this technology provides an incremental step between traditional passenger rail services (operating at maximum speeds of 79 to 90 mph on unmodified freight rights-of-way) and higher speed passenger rail services (125 mph and above). Under current FRA guidelines, these higher-speed rail services require additional grade crossing treatments, safety features and track improvements.

Some incremental high-speed services incorporate advanced passenger car design, propelled by higher-speed diesel or gas turbine locomotives. Others incorporate self-propelled diesel units, where the propulsion unit is a component of the passenger railcar. Incremental high-speed services typically employ technological advances such as tilt and steerable bogies to maintain high speed when executing curves. In all cases, the trains must transport a fuel supply.

Applications of loco-haul technology include the Talgo Pendular trainset, which is designed and operated in Spain and now being operated in the Portland-Seattle-Vancouver corridor. Applications of self-propelled units include Diesel Multiple Unit (DMU) trains operated by Danish Rail in Denmark (and other European countries) and tested by Amtrak throughout the United States. Within the Midwest, DMUs have been tested between St. Louis-Kansas City and Chicago-Milwaukee.

The DMU was the preliminary technology selected for the MWRRI Phase I evaluation and was therefore included in this study to maintain consistency. Technology has been re-evaluated during Phase III of the MWRRI to also consider alternative technologies such as the Talgo Pendular and the American Flyer Gas Turbine, and ascertain whether the MWRRI could be maintain its cost advantages under more than one technology. The MWRRI determined that all three technologies met the operating requirements for the Midwest. In order to preserve flexibility in the choice of technologies, and to ensure that more than one technology would meet the operating cost, capital cost and operating performance “standards” developed in the MWRRI financial plan, the MWRRI selected the mid-range technology (Talgo) for its Phase III financial assessment. This technology was not reviewed for the Tri-State II Study.

Appendix 2.1 provides additional technical discussion of tilt, steerable bogies, unbalance and super-elevation and the implications for technology selection. Terms used are briefly defined in the Glossary. Appendix 2.2 includes references used in developing this report.

2.3.1 110 MPH Speed Scenario; Diesel Multiple Unit (ADTRANZ IC3 DMU)

2.3.1.1 Overview

The IC3 Diesel Multiple Unit (DMU) was developed in 1991 by ABB (Adtranz) for Danish Railways (DSB). The IC3 and its electric-powered version, IR4 (EMU), have operated in Europe for over seven years and represent state-of-the-art European DMU technology. The IC3 was tested in North America in 1996/1997 in St. Louis-Kansas City and Chicago-Milwaukee. The availability and/or potential for acquiring both steerable bogies and tilt technology is a key selection factor. DMU technology is the option recommended for the initial Midwest Regional Rail System. A more refined technology review for the MWRRI is underway.

2.3.1.2 Propulsion

The DMU uses conventional diesel engines, linking three 420-hp engines (commercial vehicle diesel engines) in each power car. A separate engine provides “hotel” power (air conditioning, heating, lighting, etc.). This type of power contributes to the low weight of the power unit.

The DMU concept is an integral unit with engines under the floor of powered propulsion coaches placed at either end of the consist using a cab-car design. Consequently, the driver’s compartment, which can fold back to allow multiple units to run as a single train, is part of the coach. The center coaches include the “hotel” power. A three or four-car unit is often used as a standard DMU consist. A three-car unit would be P-U-P (Powered car, Unpowered car, Powered car), while a four-car train would typically be P-U-U-P.

2.3.1.3 Construction/Operating Implications

A three-car IC3 train weighs approximately 112 tons, compared to American Flyer at 600+ tons and FOX TGV at 500+ tons. The train is constructed of lightweight materials. The car body is fabricated from aluminum extrusions and all fittings are made of light "sandwich" materials. The low weight enables lower fuel consumption and less track wear. The train also incorporates modular mechanical and electrical components, reducing maintenance time and costs.

The rubber structure on the front of the power cars provides a cushion during the coupling procedure. It takes approximately two minutes to couple units, which reduces operating and turnaround time.[*] An aerodynamic cone designed to reduce wind resistance (fitting over the front of the train) is being developed for intercity operations.

The array of DMU features provides an advantage in terms of operating costs over locomotive-hauled rolling stock. According to Danish Railways, who conducted life cycle comparative tests of DMUs and loco-haul coaches, the operating cost of a six-car IC3 is approximately half that of an equivalent locomotive hauling five coaches.

2.3.1.4 Special Features-Tilt/Steerable Bogies

The FRA is reviewing its standards for unbalance with manufacturers and interested parties such as Amtrak and other passenger rail operators. Increased unbalance permits increased speed on curvature. The DMU can be ordered with an active-tilt mechanism for passenger comfort in tight curves. Steerable bogies can be incorporated to reduce wear on curved track. The use of unbalance, tilt and steerable bogies reduces the need to super-elevate track in curves. If it were necessary to super-elevate all curves to accommodate passenger speeds, slower freight trains might not be able to operate on the track.

[*] Coupling time is not a critical consideration for the Tri-State Corridor, as the operating plan is developed around fairly standard consists.

2.3.1.5 Train Consist

The standard unit is comprised of three cars, providing 152 coach class seats. Higher capacity seating is possible by adding another consist or reducing legroom. However, a loss of passenger comfort is deemed unsuitable for long intercity trips. A four-car consist, consisting of two power cars and two passenger cars, typically provides 204 coach class seats.

2.3.1.6 Passenger Amenities

Seating is fixed and bi-directional; approximately half the seats face forward and half face backward. Group seating is also provided with four seats facing each other. The IC3 provides the following amenities:

- Train interiors are divided into large compartments, providing flexible space for wheelchairs, bicycles, strollers and play areas for children.
- Each seat contains power outlets and connections for laptop computers and other telecommunications purposes.
- Pay phones and fax machines are available in each car.
- Passenger cabin displays provide updated information about arrival and departure times.
- Vibration-absorbing mounting of the modules on the car bodies and extensive soundproofing reduce noise and vibration.

2.4 CHARACTERISTICS OF HIGH SPEED (125-150 MPH) TECHNOLOGY

Option 1: Electrification

Electric traction is provided when high power output or faster acceleration is required and higher-density traffic is encountered. In an intercity context, electric locomotive power is usually delivered via overhead catenary, but can also be provided through a third (powered) rail. Because the locomotive does not haul its own fuel, the power-to-weight ratio is increased; hence, it provides greater acceleration. While this technology can be compatible with existing freight rights-of-way using appropriate safety measures (i.e., sealed corridor), passenger train access at these speeds is generally not permitted. Trains in this category achieve service speeds ranging from 125 mph to 150 mph and are found mainly in Europe and Japan. This higher speed rail service has operated on the Washington/New York segment of Amtrak's Northeast Corridor for several years and will become operational on the northern portion between New York and Boston in the near future.

Option 2: Gas Turbine Engines

Gas turbines are much smaller and lighter than conventional diesel engines and can achieve higher speeds. Early applications of gas turbine technology were inefficient, consuming almost double the fuel of a conventional diesel engine for a similar power output. During the 1990s considerable development of gas turbine technology occurred such that modern turbines offer greater fuel and cost efficiency. While acceleration characteristics are somewhat slower than electric versions, the trade-off of lower infrastructure investment cost makes the technology worthy of investigation.

Both the Seneca Group and GEC Alsthom are currently developing gas turbine-powered locomotives capable of operating at speeds of 150 mph.

2.4.1 150 MPH Scenario; American Flyer High Speed Train-HST (GEC Alsthom and Bombardier – Electric and Gas Turbine)

2.4.1.1 Overview

Amtrak has recently introduced high-speed rail service on the Northeast Corridor from New York to Boston in 2000 using the American Flyer, a variation of TGV technology operating in France. The service has been announced as "Acela." The electric version of the American Flyer has a design speed of 150 mph, which is achieved using an asynchronous drive system powering eight axles and active car body tilt. The active car body tilt system and functional, comfortable interior provide a high degree of passenger comfort.

2.4.1.2 Power

The locomotive can be powered using either gas turbine or electric power; thus, both electric power and gas turbine engines were evaluated for this study. Gas turbine acceleration curves are lower than electric.

The electric American Flyer achieves 12,800 hp using eight traction motors. The power source is overhead electric catenary, as specified for the Northeast Corridor. It accelerates to 150 mph (from a standing stop) in 3.5 minutes or 5.45 miles.

The gas turbine American Flyer is projected to achieve 7,800 hp using an Allied Signal gas turbine engine, with acceleration estimated at 150 mph in 6.6 minutes or 11.9 miles.

2.4.1.3 Construction/Design

The locomotive and coach cars have similar exterior design and aerodynamic characteristics. Car bodies have high-tensile stainless steel extrusions and an integral design for optimum strength and rigidity. The train complies with the FRA Tier 2 construction code, with a primary electric braking system that uses regenerative and rheostatic braking. Power cars are equipped with compressed air operated disc and tread brakes, while passenger cars have three high-powered disc and tread brakes per axle. The train specified for the New York-to-Boston segment of the Northeast Corridor has a high-level platform configuration, with a low-level version anticipated. The train has widened doorways and a wheelchair lift.

2.4.1.4 Special Features – Tilt

The train has active tilt controlled by microprocessors. Acceleration sensors installed in the first bogie of the train-set activate the tilting. A computer system controls the hydraulic cylinders that tilt the car as required, and a car body tilting system is provided on all passenger cars. This has been optimized at 6.5 degrees with a maximum cant deficiency of 9.0 inches.

The tilt system eliminates the effect of approximately 70 percent of centrifugal forces encountered in a curve. This increases potential speed, since the train can negotiate curves 25 to 30 percent faster than a conventional train with no loss of ride quality.

2.4.1.5 Consist

The typical train consist includes two power cars and six to eight coaches per train-set. Two train-sets can operate as a multiple unit, but would have no walk-through connection for passengers or staff. The first class cars can offer open seating compartments for up to six persons, as well as larger conference areas. A typical configuration for a six-car set is based on one first class car, one bistro (food service) car, and four coach class cars. A typical train-set consists of 41 to 42 seats in first class and 260 in coach class.

2.4.1.6 Passenger Amenities

The American Flyer design has a low noise level; its walls are covered with fabric and plastic laminate sheeting. Windows are double-glazed with hardened outer safety glass and a heat-reflecting inner coating. Air-conditioning in each car is controlled by an individual computer. Additional amenities include the following:

- Communication with passengers is accomplished via a public address system and visual display identifying station arrival times and connections.
- Public telephones are provided in the Bistro car.
- Individual headsets at each seat connect to a central music system.
- Laptop computer power and modem connections can be provided.

2.4.1.7 Selection of Gas Turbine Technology for Detailed Route Evaluation

A comparison of travel times between the electric and the gas turbine American Flyer technologies determined that the additional infrastructure investment required to install electric catenary along the corridor was not warranted by the time savings generated.

2.5 CHARACTERISTICS OF VERY HIGH-SPEED (150-185 MPH) TECHNOLOGY

Electric-powered locomotives are capable of commercial speeds up to and exceeding 185 mph. This speed is largely attributable to a very favorable power-to-weight ratio and dedicated track maintained to a very high standard.

Commercial applications of this technology exist mainly in Europe and Japan:

- Japanese Shinkansen or *bullet train* which operates between Tokyo and Osaka (a distance of 310 miles) at a maximum commercial speed of 160 mph.
- French TGVs hubbed in Paris: Atlantique (185 mph); Sud-est (169 mph); Reseau (185 mph/ 200 mph); and Duplex (185 mph/ 200 mph).
- European TGVs: Eurostar (UK/France/Belgium, at 125, 185 and 100 mph); Thalys (France/Belgium/Holland at 185-mph/ 200 mph); AVE (Spain, at 185 mph); and FIAT ETR 500 (Italy at 185 mph).
- The British Electra or Class 91 on the East Coast and West Coast Main Lines with a maximum speed of 160 mph.
- The German Intercity (ICE) train which operates between Munich and Hamburg with a maximum speed of 175 mph.

Future applications include a TGV in Korea (185 mph).

2.5.1 185 mph Scenario; Florida Overland Express Very High Speed Train - TGV (Alsthom and Bombardier -- Electric)

2.5.1.1 Overview

This train is a refinement of the successful TGV Atlantique introduced in France (between Paris and Bordeaux) in 1991. The *Florida Overland Express (FOX) Study* incorporated features from the Eurostar (London, Brussels, Paris) and THALYS (Paris, Brussels, Amsterdam and Cologne) models introduced in 1997 (Modern Railways). The FOX Study incorporated discussions between the FRA and the manufacturers regarding FRA compliance, and is the major reason for its selection for this study. Top train speeds range from 185 mph to 200 mph.* Operating at this speed requires dedicated right-of-way to minimize curvature, elimination of interfaces with other tracks or highways, and maximization of distances between stations.

As mentioned above, the FRA has produced only draft standards for equipment operating at speeds in excess of 150 mph. However, discussions and negotiations during the Florida FOX Study between the project sponsor, manufacturer, and FRA determined that a risk assessment would be required to permit use of the TGV Atlantique and very high speed rail vehicles. The FRA does not currently allow use of a TGV with an existing freight railroad or permit a TGV to share track with other rail vehicles, even if the TGV slowed its operations to 79 mph or 110 mph for the shared portions of track (see Chapter 3). This significantly impacts TGV infrastructure development costs. In addition, the FRA does not permit at-grade crossings for TGV operations at any speed, thus requiring an exclusive dedicated track.

2.5.1.2 Power

Electric traction is used with power supplied by overhead catenary at 25kV-50Hz. This enables the eight synchronous traction motors to develop a maximum power of 8,800kW. The TGV accelerates to 143 mph in 5 miles, to a top speed of 185 mph in 13 miles.

---

* Current models operate commercially at 187 mph. Stage II TGVs are now in design stages and it is anticipated that they will be capable of commercial speeds of 200 mph.

2.5.1.3 Construction/Design

The train's composition is extruded aluminum integral construction. This provides exceptionally strong construction and a lighter weight than the American Flyer. However, it does not meet FRA buff-strength and side-impact standards for use in mixed operation right-of-way.

Speeds in excess of 150 mph require specialized and sophisticated engineering not currently found in U.S. railroad operations. The bogies and suspension system on the TGV are designed for the stresses and unique engineering problems encountered at these high speeds. The pantograph technology is also engineered to reduce wear and tear on the power wire (TGV SNCF). The car design can accommodate either a low or high-level platform scenario.

2.5.1.4 Special Features—Dedicated Right of Way

The unbalance for the train is restricted to 4.25 inches. Consequently, the right-of-way has to incorporate very long, low-angled curves with maximum levels of super-elevation. One advantage of a TGV operation is that grades are not a restricting factor given train weight. Since the TGV generally uses a dedicated right-of-way, no modifications are needed to operate freight or conventional passenger trains. This enables the TGV to operate in a controlled environment and wheel profiling (essential for very high-speed operations) can be accurately achieved.

2.51.5 Consist

The typical train consist is 1-10-1, with a power car at each end and eight powered axles. The train is articulated with a leading car at each end of the consist incorporating a leading bogie, freight/baggage facilities, and a train supervisor's area. The consist used to identify capacity requirements is made up of three first-class cars, one food service car, and six coach-class cars. This configuration provides seating capacity for 485 (116 in first class and 369 in coach class).

2.5.1.6 Passenger Amenities

This train design emphasizes exceptional comfort and convenience unequaled by any other mode. Business passengers can have privacy in a compartment, if desired. Seating is arranged for family groups, with special provisions for children (i.e., play areas and nurseries). The train (as operated in France) is also equipped with additional amenities, including the following:

- Each seat has an individual reading light, air conditioning control, and stereo connection.
- Each first-class seat has a power and computer modem.
- Food Service: First class passengers are provided with catered meals at their seats. The food service car offers coach class passengers hot and cold food and drinks that can be consumed in the dining car or at individual seats. A trolley service is also provided in coach class.
- Each car has electronic notice bulletin boards showing time and station arrival information, as well as the current train speed and other travel information. A similar board exists at the entrance to each car showing the train number, car number and stations served, which can be read from the platform.

2.6 SUMMARY

The selected technologies present a range of choices relative to speed, infrastructure, and investment. They represent examples of the types of equipment that can be acquired, and the advantages and disadvantages associated with each.

For all speed scenarios selected for this study (110 mph, 150 mph and 185 mph), the internal train designs and amenities are geared toward a high level of convenience and passenger comfort. First-class options are available with 150 mph and 185 mph services. Comfortable seats, extensive leg-room, modern communications, video and audio entertainment, and meal services provide passengers with a travel experience they will want to repeat.

Beyond the passenger experience, the technology options provide distinct planning choices. While there is some overlap among the technologies, there are key differences based on desired speed.

As speeds increase over 100 mph in curves on conventional track, a train that tilts is essential for passenger comfort, and steerable bogies are necessary to permit faster speeds in curves and reduce wear on track. Without these technological innovations, significant infrastructure improvements would be required to remove curves or increase super-elevations in order to maintain the highest possible speed. High levels of super-elevation can create operational problems and higher maintenance and rail replacement costs for freight operations.

Trains operating at speeds greater than 125 mph typically require electric traction or modern gas turbine power to provide sufficient power and speed. Electric traction provides an advantage in acceleration characteristics, but the electric catenary requires a significantly higher infrastructure investment. The FRA has higher standards (Tier II) for locomotives and passenger cars at speeds greater than 125 mph. More stringent grade crossing and signal requirements also apply, and impact the infrastructure cost.

Increasing train speed above 150 mph (i.e., 185 mph) requires trains similar to the TGV. To travel at very high speeds, TGVs need very high power output, straight tracks and/or highly developed super-elevation for curves. This makes the right-of-way unsuitable for rail traffic incapable of comparable speeds. In addition, grade crossings must be eliminated for safety reasons. The FRA currently does not permit other rail traffic on routes with trains operating at speeds above 150 mph and mandates no "at grade" crossings. Therefore, a dedicated right-of-way is essential for very high-speed operation.

Key capital, operating and capacity characteristics of the selected technologies are summarized in Exhibit 2.3, Attributes and Estimated Costs of Selected Train Technologies.

Exhibit 2.3
Attributes and Estimated Costs of Selected Train Technologies

Attributes	110 mph DMU	150 mph American Flyer Electric	150 mph American Flyer Gas Turbine	185 mph TGV
Manufacturer	Adtranz	GEC Alsthom/ Bombardier	GEC Alsthom/ Bombardier	GEC Alsthom
Coach Cars per Consist	3	1-6-1**	1-6-1**	1-10-1
Power cars per Consist*	2***	2	2	2
Weight of Power Car	n/a	100 t	108 t	75 t
Weight of Train (tare)	112 t	620 t	635 t	528 t
Length of Power Car	n/a	70'	70'	65'
Length of Train	194'	664'	664'	780'
FRA Tier Code	Tier 1	Tier 2	Tier 2	Tier 2 ***
Motive Power	Diesel	Gas Turbine	Electric	Electric
Total Horsepower	1,260hp	7,800 hp	12,800 hp	12,000hp
Hotel Power	294kW	600kW	600kW	600kW
Max. Operating Speed	110 mph	150 mph	150 mph	185 mph
Distance/Time from Zero to Top Speed	3 miles/ 2.9 min	5.7 miles/ 3.6 min.	11.9 miles/ 7.0 min.	13 miles/ 6.7 min
Unbalance	9"	9"	9"	4.25"
Steerable Bogie	Yes	No	No	No
Type of Tilt System	Active	Active	Active	Active
Seats per Consist	152	302	302	485
Seats per Car (Coach)	51	65	65	61/ 62
Seats per Car (1st Class)	N/A	41/42	41/42	38/39
Est. Price per Consist ∇	$5.7m	$14m	$14m	$20m

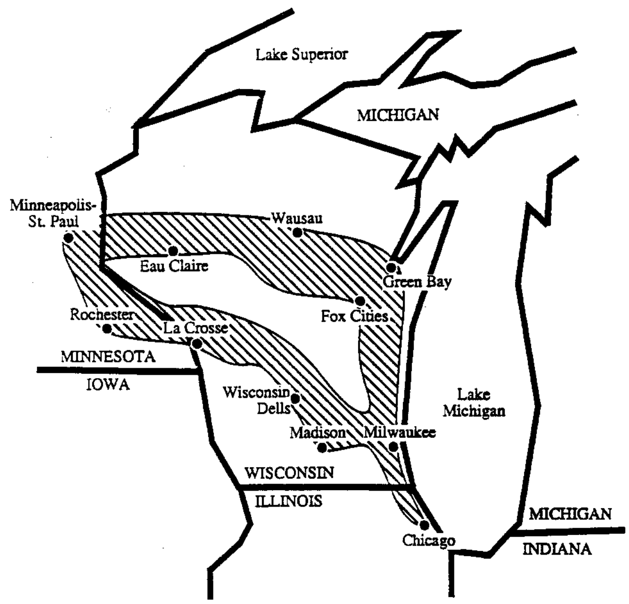
* Consist sizes represent current standard applications, not necessarily those used in this study.
** Includes a diner and bistro car.
*** Two of the coach cars are also powered cars.
**** Special regulations will apply.
∇ To be updated when purchase lot size and timing are better known.

TABLE OF CONTENTS

3.1 OVERVIEW

In 1991, the Minnesota, Wisconsin, and Illinois Departments of Transportation completed the *Tri-State Study of High Speed Rail Service*. This initial study indicated a large potential for high-speed rail service in the Chicago-Milwaukee-Twin Cities corridor. Both northern and southern corridors were evaluated (Exhibit 3.1), with the southern corridor preferred. The initial Tri-State Study recommended that an engineering and environmental analysis be done to evaluate routes, crossings, infrastructure needs, and environmental concerns in greater detail. The Wisconsin and Illinois Departments of Transportation completed a more detailed analysis of the feasibility for high-speed passenger rail service in the Chicago-Milwaukee segment of the Tri-State Corridor (*Chicago/Milwaukee Rail Corridor Study of 1997*). The engineering results stemming from that 1997 study were adopted as the basis for identifying improvements to the segment from Union Station in Chicago to Amtrak Station in Milwaukee. This chapter details these engineering and environmental analyses. The engineering portion of the chapter emphasizes route alignments and route and station assessments. The environmental portion of the chapter presents a broad-scale overview of some of the environmental issues that relate to the Chicago-Milwaukee-Twin Cities corridor. Detailed supporting information is provided in the associated appendices.

Exhibit 3.1
Northern and Southern Corridors
Tri-State Study of High Speed Rail Service



3.1.1 Previous Study Conclusions that Directed the Engineering Analysis

Two conclusions from previous studies provided demarcations to the engineering analysis for the *Tri State II High Speed Rail Feasibility Study*. These recommendations are as follows:

- *The Tri-State High Speed Rail Study of 1991*: The Southern Route Modified on new right-of-way (Madison-Rochester) was preferred for 185-mph technology. The route was described in the study as follows: Chicago (MP0) to Milwaukee (MP85) to Duplainville (MP100) to Madison (MP164) to Portage (MP194) to Minneapolis-Twin Cities (MP435).

- *Chicago/Milwaukee Rail Corridor Study of 1997:* The CP Railway/Metra Corridor was preferred for high-speed passenger rail service. It offers high right-of-way capacities, direct access to downtown Chicago and Milwaukee, and direct access to the General Mitchell International Airport passenger terminal (Exhibit 3.2). The results of this study have been fully integrated into the current study, as well as the MWRRI results. Copies of the Final Report prepared for this study are available from the Wisconsin and Illinois Departments of Transportation.

3.1.2 Tri State II Scenario Development and Selection of Options

The Tri-State Steering Committee is comprised of technical staff from Illinois, Minnesota and Wisconsin Departments of Transportation. An Advisory Committee comprised of elected and appointed representation from state, local governments and interested organizations reviewed draft material and provided direction to the Steering Committee. The Steering Committee established four routes to study within the Southern Corridor to determine the feasibility of implementing high-speed rail service between Twin Cities, Milwaukee, and Chicago. A "Base Case" scenario was established and route/technology options evaluated for subsequent implementation. The Base Case assumes that the Midwest Regional Rail System (MWRRS) has been developed to 110 mph using the planned alignment and improvements identified in the Midwest Regional Rail Initiative. The route/technology options were compared with the Base Case by analyzing the costs and benefits of selected technology (e.g., DMU, American Flyer, TGV) and alignment options (e.g., using current rail rights-of-way vs. new alignments and elevated track).

The Base Case and route/technology options were identified based on the following objectives:

- Minimizing travel time between major cities
- Maximizing regional accessibility
- Minimizing impact of topographical features on the route
- Minimizing environmental constraints
- Minimizing disruption to residential and commercial developments.

The five route/technology options that were selected for analysis are summarized in Exhibit 3.3.

Exhibit 3.2
Proposed Rail Alignment Chicago to Milwaukee

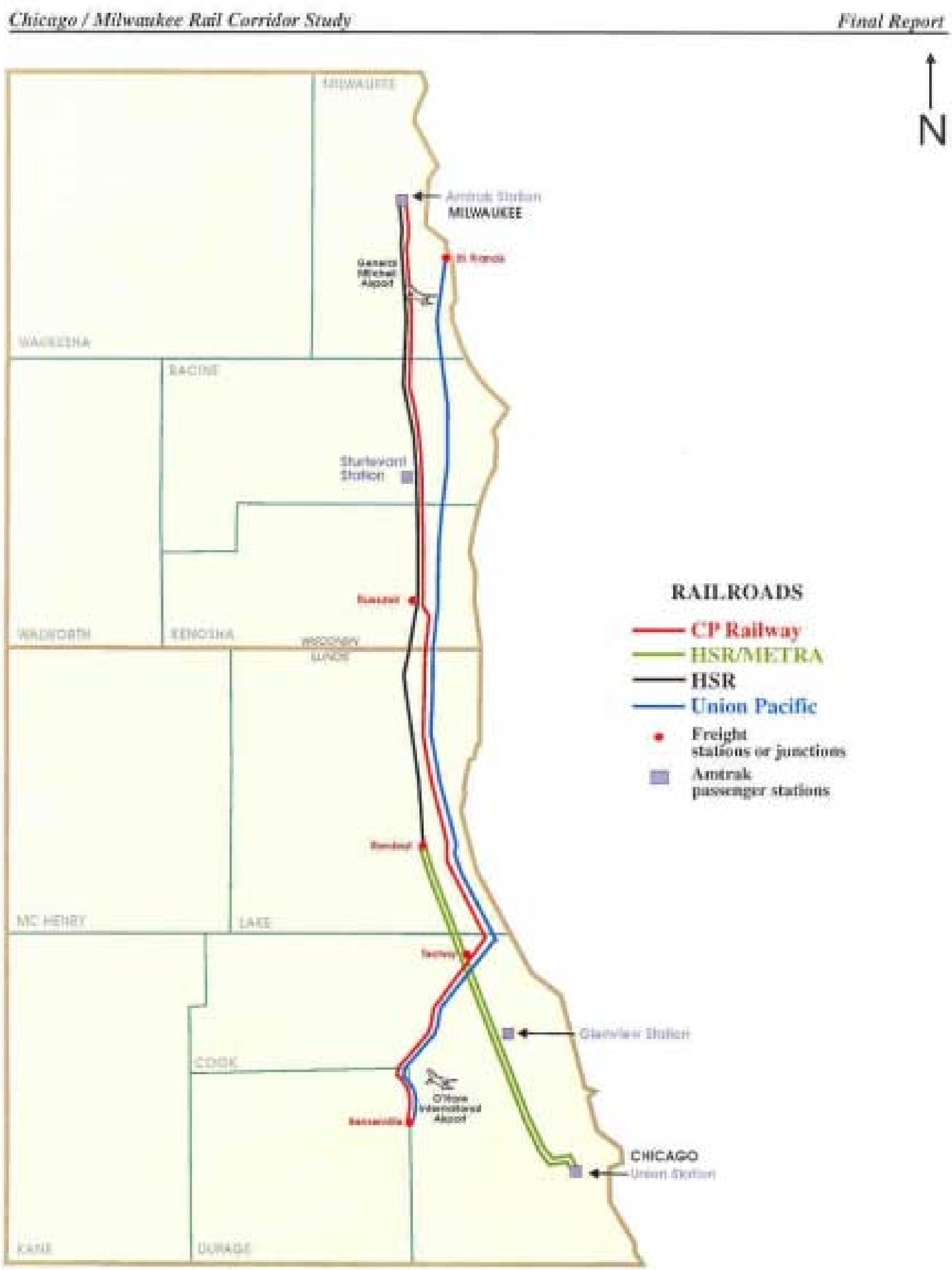


Exhibit 3.3
Route/Technology Options Analyzed

Option	Route	Technology
Base Case: 110 mph – River	Current alignment (with Madison), along river to Winona to Twin Cities (no Rochester)	110 mph DMU (Diesel Multiple Unit)
B-1: 110 mph - Rochester	Current alignment (with Madison) Chicago to Winona, new route to Rochester and Twin Cities	110 mph DMU
B-2: 150 mph - Rochester	Current alignment (with Madison) Chicago to Winona, new route to Rochester and Twin Cities	150 mph American Flyer Gas Turbine
C-2: 150 mph – New Alignment	Current alignment Chicago to Duplainville, new route to Madison to Rochester and Twin Cities	150 mph American Flyer Gas Turbine
D-3: 185 mph - Rochester Elevated	Current alignment Chicago/Milwaukee; elevated track from Milwaukee to Duplainville; existing grade for new route from Duplainville to Madison to Rochester, then to Rosemount; elevated track from Rosemount to Twin Cities.	185 mph TGV (Electric-powered high speed trains in France)

3.2 TRI STATE II ROUTE OPTIONS SELECTED FOR ANALYSIS

The Study Steering Committee analyzed the costs and benefits of selected route/technology options in the southern corridor. Exhibit 3-4 shows each of the scenarios by technology and route.

Exhibit 3.4

Scenario Definition

Alignment	Winona-River Route CP Line	Rochester Routes DM&E line		
		DM&E line	New Alignment At-Grade	New Alignment- Elevated
DMU Technology – 110 mph	Base Case (A-1)	B-1		
Gas Turbine Technology – 150 mph		B-2	C-2	
TGV Technology – 185 mph				D-3

The route/technology evaluation was based on the following objectives:

- Minimize travel time between major cities
- Maximize regional accessibility
- Minimize impact of topographical features on the route
- Minimize environmental constraints
- Minimize disruption to residential and commercial developments.

Based on these objectives, a Base Case and four route/technology options were considered. Routes are designated by letter, and the technology by number (110 mph = 1; 150 mph = 2; 185 = 3). The described mileposts represent the route distance from Chicago Union Station (Milepost 0). Milepost references are preceded by the name of the subdivision (i.e., River Milepost 288). The selection processes for the following route/technology options and speeds are detailed in this report:

- Base Case (A-1) 110 MPH via River
- Route B-1 110 MPH via Rochester
- Route B-2 150 MPH via Rochester
- Route C-2 150 MPH via Rochester, new alignment
- Route D-3 185 MPH via Rochester, new alignment, elevated.

The CP Railway/Metra Corridor (*Chicago/Milwaukee Rail Corridor Study of 1997)* is the route between Chicago and Milwaukee used for 110 mph and 150 mph options. Exhibit 3.5 illustrates a map of the recommended track layout from Milwaukee Amtrak Station to the Wisconsin/Illinois border; Exhibit 3.6 shows the recommended track alignment from the Wisconsin/Illinois border to Chicago Union Station. A general description of the remaining routes from Milwaukee Amtrak Station to Madison to Twin Cities is presented in the following paragraphs for each route alignment.

Exhibit 3.5
Recommended Route
Milwaukee to Illinois/Wisconsin Border

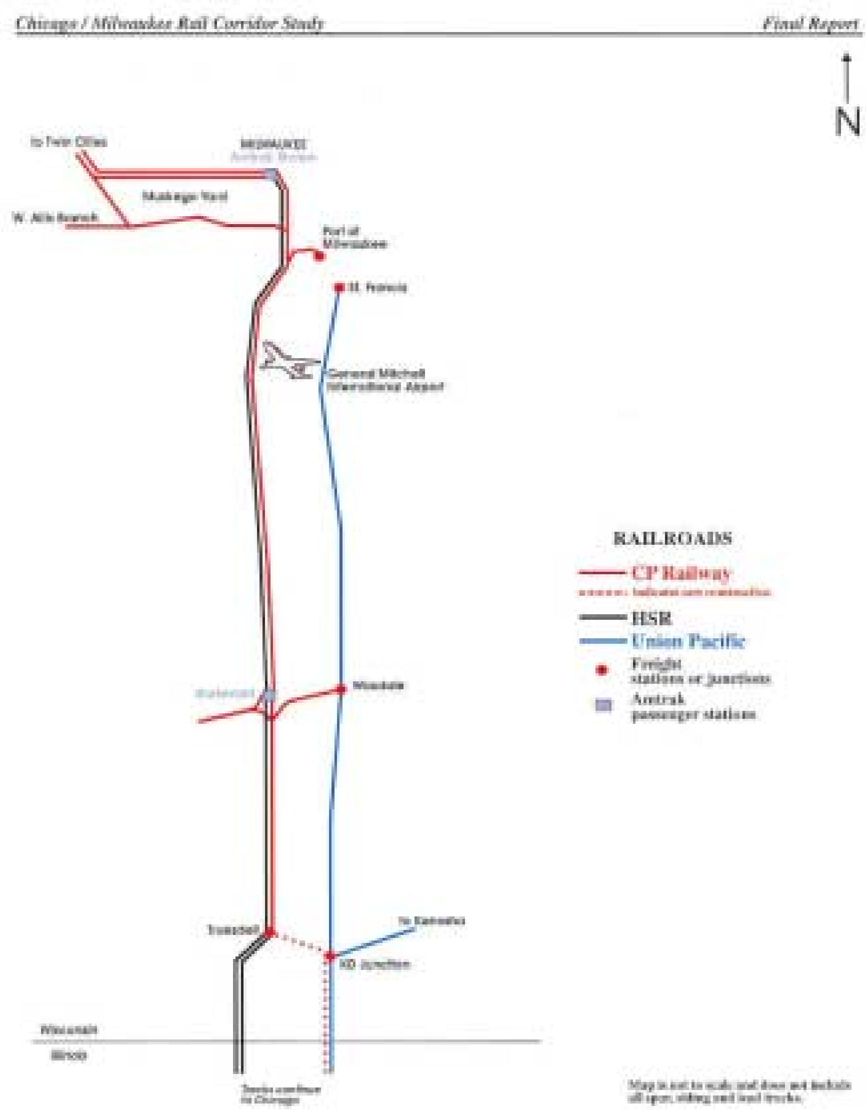
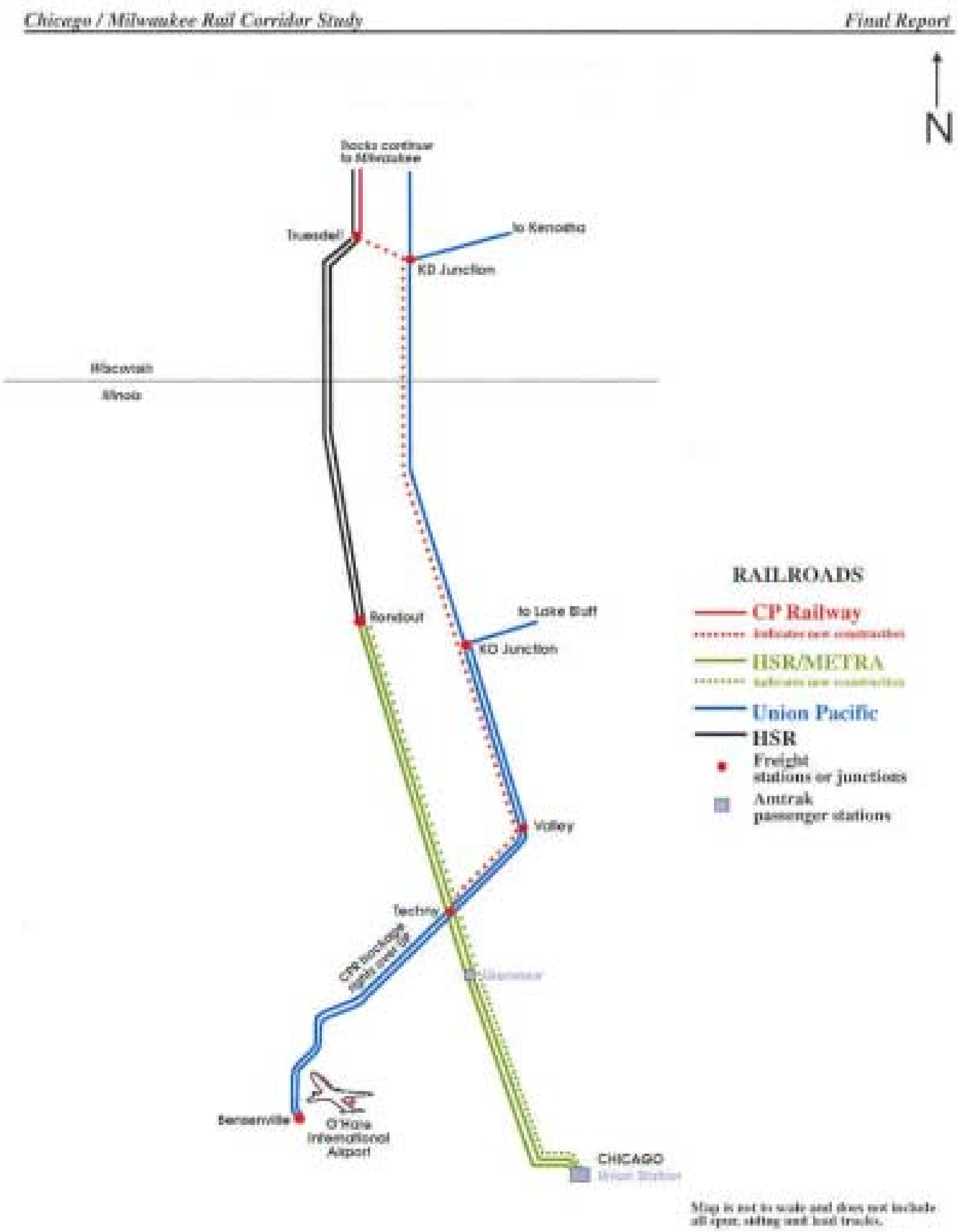


Exhibit 3.6
Recommended Route
Illinois/Wisconsin



The following routes were selected:

- **Route A: Evaluated for 110 mph and 150 mph Technologies**

  This alignment in general follows the route described in the initial Tri-State Study from Chicago to Milwaukee. From Milwaukee, it follows Amtrak's existing route (modified to serve Madison) using right-of-way owned by CP Railway and leased to Wisconsin & Southern Rail Company (WSOR) between Watertown and Madison. The 150 mph technology was considered ineffective on this route due to a lack of significant time savings over the 110 mph technology. Therefore the 110 mph (Base Case – A-1) is the alignment being evaluated in this study. A detailed description of the route follows.

  The Milwaukee Amtrak Station is located immediately south of the downtown area and I-94 and immediately east of the CP Railway's rail yards. From the intersection of State Route 30 and track of Waterloo Subdivision (MP164), a new segment of track needs to be constructed (Airport Subdivision) to Dane County Airport (MP169). The route proceeds on or near CP Railway-owned track (Madison-Portage Subdivision) to Portage (MP202), continuing on CP Railway track (used by AMTRAK) through Wisconsin Dells (MP219) and Tomah (MP264) to LaCrosse, Wisconsin (MP306). It then crosses the Mississippi River and proceeds northerly to Winona (MP332) through Red Wing (MP394) and Hastings (MP415) to St. Paul Union Station (MP434). Please refer to Exhibit 3-7 for details of the A-1 rail route.

- **Route B: Evaluated for 110 mph and 150 mph Technologies**

  This alignment in general follows the route described in the initial Tri-State Study from Chicago to Milwaukee. From Milwaukee, it follows Route A to Winona, Minnesota (described above), where it departs from the existing Amtrak route onto the corridor owned by the Dakota, Minnesota & Eastern Railroad Corporation (DM&E), continuing westerly to the Rochester area and northerly along a new route alignment to Twin Cities.


Minneapolis & St. Paul
Minneapolis-St. Paul International Airport
Rochester
Rochester Airport
La Crosse
La Crosse Airport
Madison
Dane County Airport
Milwaukee
General Mitchell International Airport
Chicago
Chicago O'hare International Airport
Wisconsin
Iowa
Illinois
0 20 40 Miles
Exhibit 3.7
High-Speed Rail Route
Route A-1
High Speed Rail Route
A-1 110 mph via River

- **Routes B-1 and B–2 – 110 MPH and 150 MPH via Rochester**

  This route follows the Base Case route as far as Winona (MP332). At Winona, the route follows CP Railway's track onto track of the DM&E to Minnesota City (MP339) to a point approximately four miles west of St. Charles, Minnesota (MP361). At MP365 the route departs the DM&E corridor onto a new alignment near the I-90 corridor to Rochester Airport (MP380). The alignment from Rochester to Rosement roughly parallels State Highway 56. From the airport, the new route proceeds to Rosemount (MP440). At Rosemount, the route proceeds onto track owned by Union Pacific across the Mississippi River immediately south of the St. Paul Water Treatment Facilities onto track owned by CP Railway and into St. Paul Union Station (MP453). Please refer to Exhibit 3-8 for details of Route B rail route.

- **Route C: 150 MPH Technology**

  This alignment in general follows the route as described in the initial Tri-State Study from Chicago to Milwaukee. From Milwaukee, it follows the existing Amtrak service to Ixonia, Wisconsin and departs the existing track to proceed "cross country" to Madison, Rochester, and Twin Cities. The initial Tri-State Study recommended this alignment as the preferred route for very high-speed technologies in the southern corridor. Details of the alignment follow. Please refer to Exhibit 3-9 for details of the C-2 and D-3 rail routes.

- **Route C-2 – 150 MPH via Rochester (New Alignment)**

  From Milwaukee Amtrak Station (MP86), the route follows the CP Railway track to Ixonia (MP119). From Ixonia, the route proceeds westerly along the Interstate 94 corridor to a point near the interchange of Interstates 90/94 and U.S. Highway 151. It follows the alignment described above for the three routes to Madison Airport (MP166).

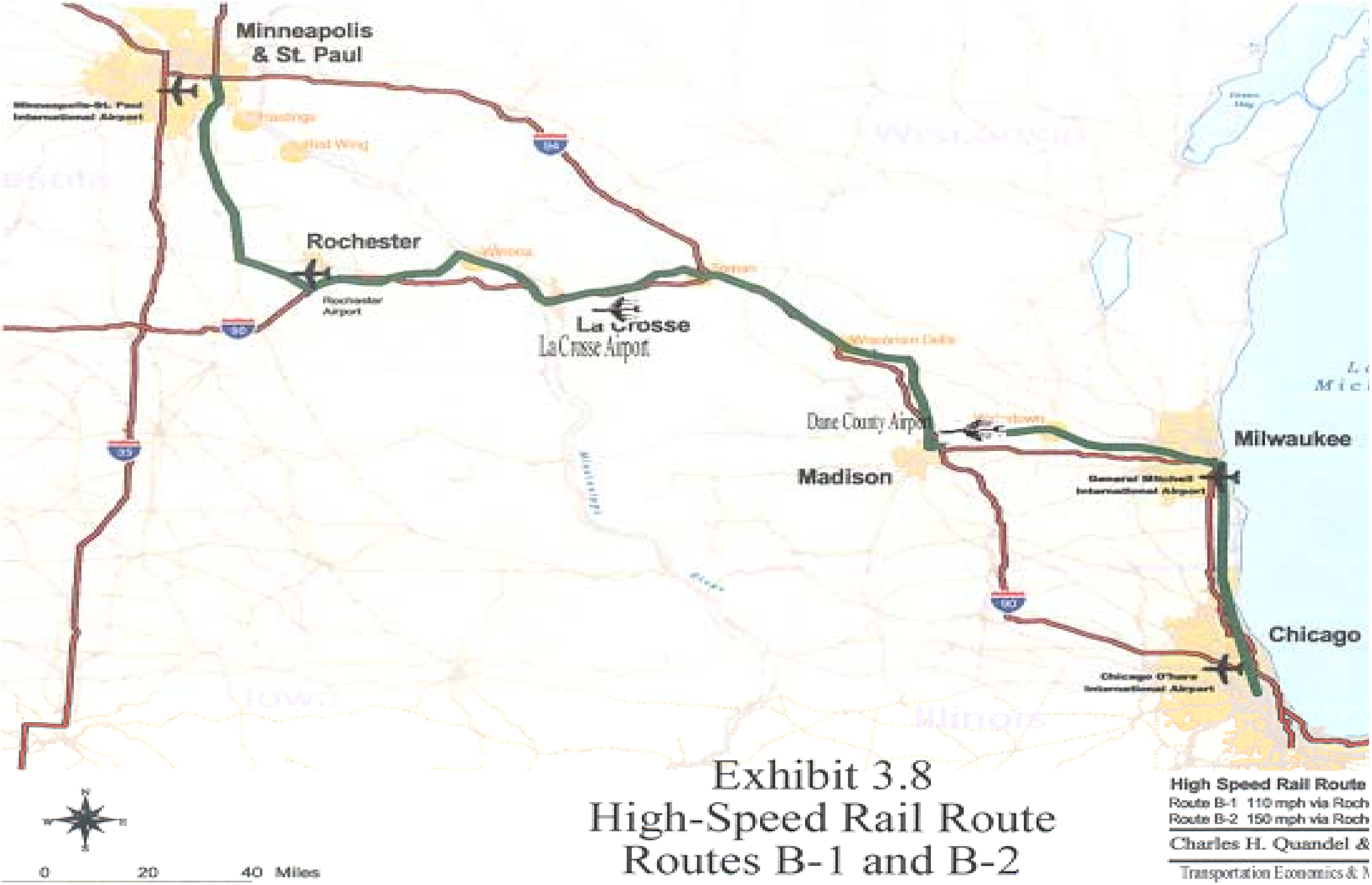


Exhibit 3.8
High-Speed Rail Route
Routes B-1 and B-2

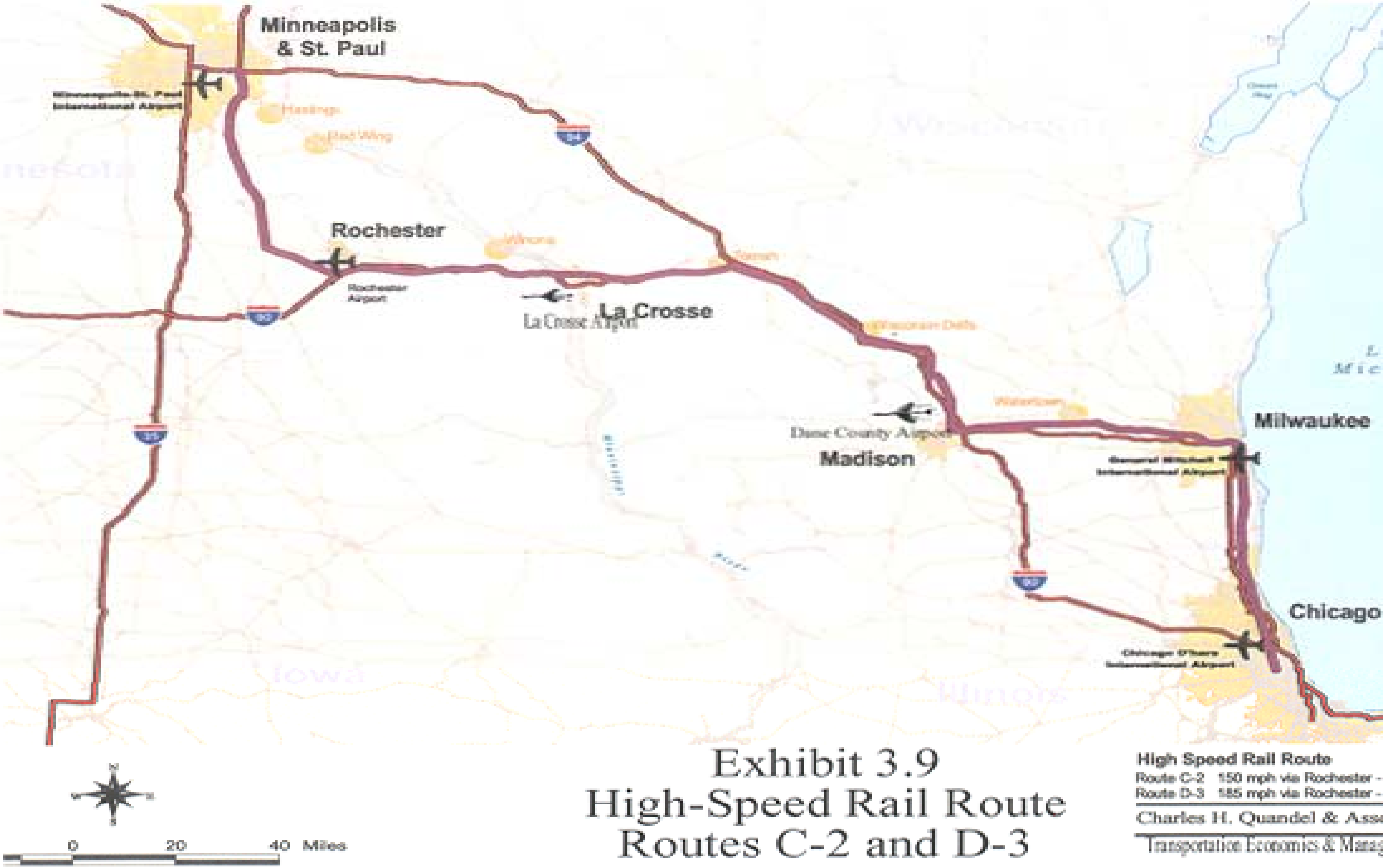


Exhibit 3.9
High-Speed Rail Route
Routes C-2 and D-3

It proceeds to Portage on an alignment along the east side of Portage and then in a westerly direction on an alignment north of I-94 to Wisconsin Dells (MP211). From Wisconsin Dells, it will proceed along the I-94 corridor to an area north of West Salem. The route proceeds through a one-mile tunnel to a point near Onalaska (MP300), crossing the Mississippi River on a six-mile bridge onto a two-mile viaduct to the I-90 corridor in Minnesota. The route proceeds along the Interstate 90 corridor to the Rochester Airport (MP359). From Rochester, it follows the alignment described for Routes B-1 and B-2 to St. Paul Union Station (MP432).

- **Route D: 185 mph Technology**

  This alignment uses an elevated structure in the urban areas of Chicago, Milwaukee, and Twin Cities and otherwise follows Route C. Details of this alignment are as follows.

- **Route D-3 – 185 MPH via Rochester (New Alignment), Elevated**

  This will be the same route as Option C-2, except that the route will be elevated through all urban areas, including the urban areas of Chicago, Milwaukee and Twin Cities, in order to avoid grade crossings and sharing of track with freight rail vehicles (see Chapter 2, *Dedicated Right-of-Way*).

3.3 ENGINEERING ROUTE ASSESSMENTS

For the study process, an engineering assessment was made of existing infrastructure for various route/technology options between Milwaukee and Twin Cities. For existing rights-of-way, this engineering assessment involved visual inspection of existing track and topography along the proposed route. Additionally, track chart information on speeds, alignment, curves, crossings, and bridges was entered into the *TRACKMAN*© management system. An interactive analysis was performed using *LOCOMOTION*© to identify curves that should be reduced or super-elevated for optimum performance of the selected technology. For routes requiring new rights-of-way, an engineering assessment studied United States Geological Surveys and other available aerial photographs and reconnaissance. A detailed engineering description and assessment are provided in Appendix 3.1, including speed profiles illustrating the performance interaction of each segment with the different train technologies.

Appendix 3.2 provides a detailed analysis of different urban area alternative alignments. The alignments detailed are the Twin Cities Airport access, the Madison access alternative and the Milwaukee alternative.

3.4 ENGINEERING STATION ASSESSMENTS

3.4.1 Milwaukee Amtrak Station

Milwaukee Amtrak Station is located immediately south of the downtown area and I-94 and immediately east of CPR's rail yards. There is an access bridge directly south of the station that may require realignment. The facilities at Milwaukee Amtrak Station will require substantial investment. Exhibit 3.10 shows the interior and exterior of the station.

Exhibit 3.10

3.4.2 Brookfield/Watertown Station

A new station is needed to serve the Brookfield/Watertown area (Exhibit 3.11).

Exhibit 3.11

3.4.3 Madison Airport

A new Madison Airport station is needed west of the airport near Madison/Portage Subdivision. Exhibit 3.12 shows the vacant area adjacent to the track of Madison/Portage Subdivision.

Exhibit 3.12

3.4.4 Wisconsin Dells

The present Wisconsin Dells station is a reproduction of a historic station that was located on the site. The original station was destroyed by a train wreck in 1982 and has been rebuilt by local volunteers (Exhibit 3.13). The Amtrak station is approximately one block from the downtown area. Wisconsin Dells is a tourist area with an estimated 50,000 visitors per day during the summer. A Visitors and Conference Center with a large parking area is located within one block of the station, although at this time only a small portion is paved. The ramp or platform is a low-level platform in the area of the rail bed. The station has approximately 600 square feet of floor space.

Exhibit 3.13

3.4.5 Tomah Station

The station at Tomah (Exhibit 3.14) is in very poor condition and needs total replacement. However, the existing station is located in an open area that would allow for a modern station with a high level platform and sufficient parking. The properties adjacent to the station are a lumberyard and the old Soo Line maintenance facility.

Exhibit 3.14

3.4.6 La Crosse Station

The La Crosse Amtrak Station (Exhibit 3.15) is on the National Register of Historic Places. The station was completely restored in 1998 (both interior and exterior) using ISTEA enhancement funding. The station is in full compliance with ADA requirements, with fully accessible restrooms, ticket area, and waiting room. To complete the restoration, a historically correct canopy will be installed on the passenger platform in 1999. The depot has a large paved parking area and is on a scheduled fixed route for the LaCrosse MTU, as well as on-call taxi service. The station is within five minutes of historic downtown LaCrosse and numerous motels, restaurants, and the Mississippi River. This facility would require minimal modifications to meet high-speed standards. However, for Options C-2 and D-3 a new station at La Crosse near the airport will be necessary.

Exhibit 3.15

3.4.7 Winona Station

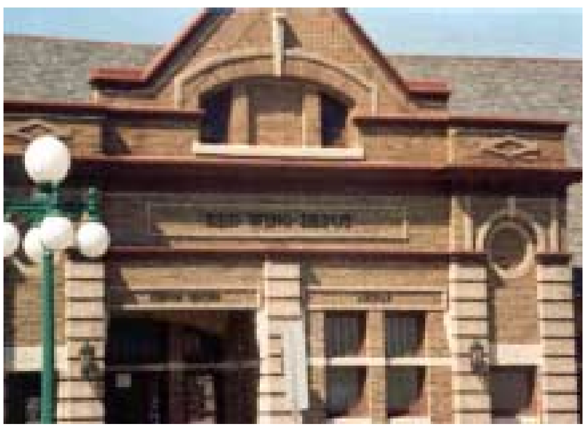
The Winona Station (Exhibit 3.16) requires major renovation work to meet current standards. The station is approximately 50 to 75 feet from the main line track. Parking is very limited in the area, although there is sufficient space adjacent to the station to satisfy parking requirements.

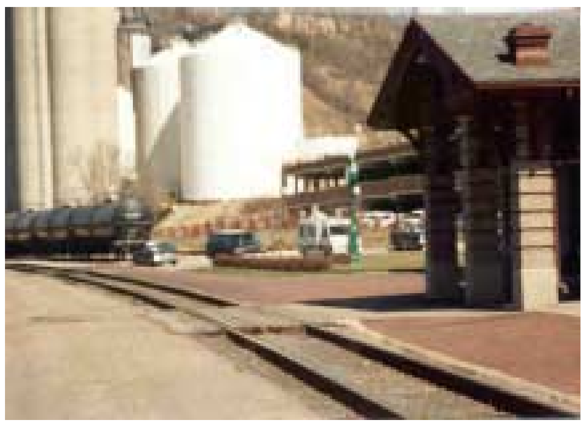
Exhibit 3.16

3.4.8 Red Wing Station

The Red Wing Station (Exhibit 3.17) appears to be in fair-to-good condition with sufficient parking. Moderate renovations are needed to meet current standards and high level platforms are required.

Exhibit 3.17





3.4.9 Hastings Station

Moderate renovations are needed at the Hastings Station to meet current building standards (Exhibit 3.18). Parking is available in the immediate vicinity.

Exhibit 3.18

Exhibit 3.18 is a photograph of Hastings Station and the bridge crossing the Mississippi River immediately north of the station.

3.4.10 St. Paul Union Station

The St. Paul Union Station will require substantial renovation to accommodate high-speed trains. The U.S. Postal Authority currently has operations within the building, along with several commercial uses, including dining on the main floor within the terminal. Exhibit 3.19 shows the front and rear of the St. Paul Union Station.

Exhibit 3.19

3.4.11 Rochester Station

A new station with parking and platforms to accommodate high-speed rail trains is needed south of the Rochester Airport.

The cost associated with station improvements is provided in Chapter 6.

3.5 ENVIRONMENTAL REVIEW

As part of the Engineering and Environmental analysis, an environmental review was performed to identify potential environmental issues relating to passenger rail alignments. The review studied issues that could impact implementation of the high-speed rail service and presented a broad-scale evaluation of the impact within the Chicago-Milwaukee–Twin Cities corridor. This environmental review did not provide a level of analysis consistent with an environmental impact statement or an environmental assessment. It does recognize environmental issues that might be associated with high-speed rail operations in this corridor. This was accomplished by reviewing environmental information from previous high-speed rail reports, as well as a general assessment of relevant data from Wisconsin and Minnesota. The following environmental reports were included:

- Chicago-Milwaukee-Twin Cities: "South Route Modified (Study Route No. 4)" in the *Technical Report 3*, November 16, 1990, *Tri-State Study of High Speed Rail Service*, TMS/Benesch.
- Chicago-Milwaukee: *Chicago-Milwaukee Rail Corridor Study – Task Six Phase II – Environmental Evaluation presented to WisDOT and IDOT*, Envirodyne Engineers, Inc., March 1994.

Information from these reports was used to develop the environmental impacts listed below in Exhibit 3.20 and discussed in Appendix 3.3. The Appendix also provides a summary of federal, state and local regulatory agencies with authority for the corridor.

Exhibit 3.20
Environmental Conditions

<table>
<tr><th>Type of Impact</th><th colspan="3">Environmental Effect</th></tr>
<tr><td rowspan="3">Physical</td><td>Water quality</td><td>Air quality</td><td>Wetlands</td></tr>
<tr><td>Noise</td><td>Energy</td><td>Visual impacts</td></tr>
<tr><td colspan="3">Historical and archeological resources</td></tr>
<tr><td>Biological</td><td colspan="2">Shrinking biological diversity and fragmentation of natural habitats</td><td>Endangered species</td></tr>
<tr><td>Socioeconomic</td><td>Land use</td><td colspan="2">Transportation and traffic impact</td></tr>
<tr><td rowspan="2">Construction</td><td>Air quality</td><td>Construction noise</td><td>Water quality</td></tr>
<tr><td colspan="3">Temporary access</td></tr>
</table>

In general, the anticipated impact (identified via previous studies) depends on the type of condition and the route employed. The following is a brief overview highlighting significant issues. Comprehensive descriptions are provided in Appendix 3.3.

- Reduced automobile use for intercity trips would improve air quality and energy consumption. Train operations will also affect air quality and energy consumption.
- Noise impacts are likely to be minimal. As train frequencies increase on existing corridors, noise from train passage will increase; however, as speeds increase, the duration will be less. As at-grade crossings are eliminated (for some options), the noise impact from whistle-blowing at crossings will be reduced. New alignments will experience increased noise, but it will likely be less than comparable auto traffic.
- Land use impacts will be most noticeable in station vicinities, attracting additional investment and development for a positive impact on the community. High-speed rail service will result in more productive use of travel time and will improve access to important markets and suppliers between Minneapolis and Milwaukee.
- Construction impacts are temporary for the most part and can be mitigated. Such impacts include run-off, water-borne silt and asbestos abatement.
- Impacts on endangered and threatened species can only be identified by additional investigation. In Minnesota, there are 59 endangered animal species (5 federally-listed)

and 138 endangered plant species (four federally-listed), in addition to many special concern and non-listed species. Similarly, in Wisconsin, there are 101 endangered animal species and 138 plant species. Some of these species may be impacted by construction and/or operation of a high-speed passenger rail system in the Milwaukee-Twin Cities corridor.

- Land near the region's historic trade and travel routes may harbor historical and archeological treasures. These are not likely to be encountered or impacted, except where additional right-of-way is needed for grade separation structures or for "cross-country" routes. Site-specific mitigation measures are typically developed when the location and size of such finds are known.

3.6 SUMMARY

A detailed engineering assessment of routes resulted in four routes being selected for analysis: the Base Case (Route A-1) along the river for 110 mph technology; Route B through Rochester primarily on existing freight railroad alignments at 110 and 150 mph; Route C-2 through Rochester on new alignments at 150 mph and Route D-3 through Rochester on new alignment and elevated in urban areas at 185 mph.

An engineering assessment of each route alignment was performed. The assessment included an initial engineering analysis, information from large-scale mapping (e.g., topography) and limited site verification without detailed surveys. Elements of the existing route infrastructure that were assessed include track work, turnouts, bridges (over and under), crossings, signals and curves. An engineering assessment of each station along the routes was performed, with recommendations for new stations at specific locations (Brookfield/Watertown; Madison Airport, Tomah, and Rochester, plus LaCrosse for options C-2 and D-3). Other stations require modest to significant renovations. Maintenance facility requirements and potential sites for each level of technology were defined on a conceptual basis. A broad-scale environmental review was also undertaken as part of this study.

The information gathered in the engineering assessment of the routes and stations of the Chicago-Milwaukee-Twin Cities corridor (as presented in this chapter and associated appendices) provided the basis for the infrastructure cost analysis for each route/technology option found in Chapter 6.

TABLE OF CONTENTS

4.1 OVERVIEW

The train operation analysis and development of operational plans for each technology/route option focused on the following:

- Development of train running times
- Train timetable development
- Assessment of freight/commuter rail operations and their interactions with proposed timetables
- Computation of rolling stock requirements.

Train timetables are determined from running times and are used to calculate rolling stock requirements. Train frequencies and the number of cars required per train are determined via an interactive process using the demand forecast COMPASS© model discussed in Chapter 5. Appendix 4.1 describes the ridership capacity assessment and provides a more detailed service plan for each scenario discussed in this chapter, including service patterns, rolling stock and maintenance facility requirements

4.2 TRAIN RUNNING TIME DEVELOPMENT

The LOCOMOTION© Train Performance Calculator was used to estimate train running times. LOCOMOTION© estimates a train's speed given various types of track geometry, curves, gradients and station-stopping patterns. It then calculates the train running time for each route segment and sums the running times to produce a timetable. LOCOMOTION© assumes a train will accelerate to a maximum possible speed and will only slow down for stations or speed restrictions due to curves, crossings, tunnels or other civil engineering works.

The inputs for LOCOMOTION© consist of milepost-by-milepost data (as fine as 1/10th of a mile) defining gradient and curve conditions along the track. For this study, these data are derived from a condensed profile for existing rail alignments and field inspection data for new routes. To assess the speed of the three technology options (horizontal curve, acceleration, and deceleration), speed constraint graphs (Exhibits 4.2 and 4.3) were derived from data received directly from the manufacturers.

Exhibit 4.2
Horizontal Curve Speed Constraint for 110mph, 150mph, and 185mph Technologies

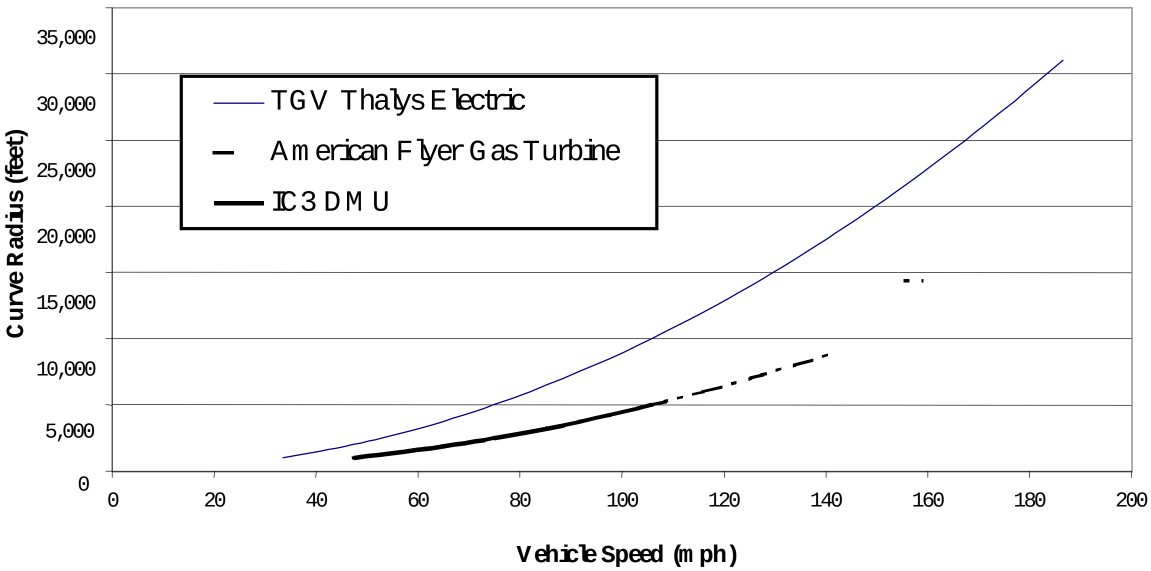
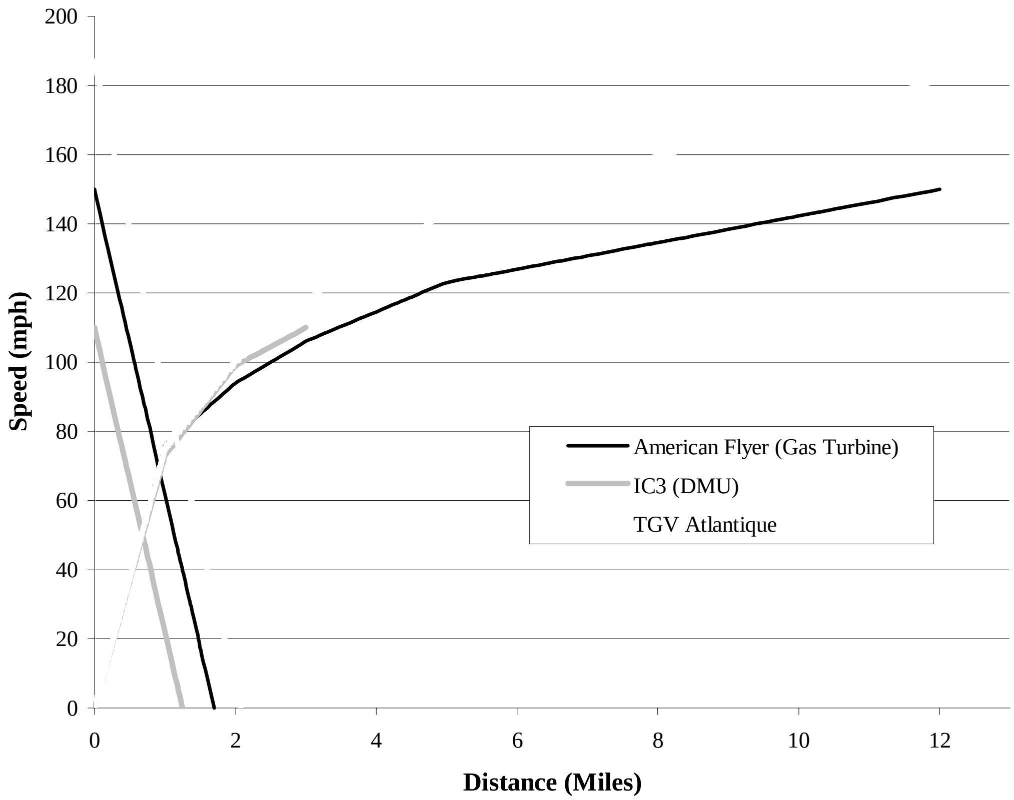


Exhibit 4.3
Acceleration/Deceleration Distance Relationship



The performance of the LOCOMOTION© model was tested with Amtrak's current timetable. The model was calibrated using data reflecting track geometry, station-stopping patterns, and train technology used at current speeds in today's operating environment. Exhibit 4.4 compares the current Amtrak timetable with the LOCOMOTION© results. The results taken from LOCOMOTION© are faster than the actual times, since allowances for slack time and freight or commuter train interference are not incorporated into the train performance analysis. Compensation can be made for such allowances by adjusting dwell times.

Exhibit 4.4
Comparison of Amtrak Timetable and LOCOMOTION© Results

Station/City	Milepost	Schedule Time	
		LOCOMOTION©	Amtrak
Chicago Union	0	0:00	0:00
Glenview	17	0:20	0:24
Milwaukee Union	86	1:22	1:40
Columbus (Madison)	150	2:31	2:50
Portage	178	3:01	3:19
Wisconsin Dells	195	3:21	3:37
Tomah	240	4:01	4:15
La Crosse	281	4:41	4:59
Winona	312	5:16	5:32
Red Wing	375	6:20	6:34
Twin Cities	421	7:17	8:05

4.3 TRAIN RUNNING TIME RESULTS

Timetables were developed for each technology using LOCOMOTION© with express and full stopping patterns. It should be noted that all the train running times incorporated a dwell time of two minutes at each station and an overall recovery or slack time of ten minutes. Exhibit 4.5 shows achievable times for both express and full stopping patterns. Running times for the Base Case vary from the current MWRRI running times because of the difference in technology (DMU versus Talgo) and differences in recovery times.

Exhibit 4.5
Chicago to Twin Cities Service Trip Times

	Express Stop		Full Stop	
	Travel Time	Time Saving	Travel Time	Time Savings
A-1 Base Case: 110 mph Along River	5:27	2:38	6:05	2:00
B-1: 110 mph via Rochester	5:34	2:32	5:58	2:07
B-2: 150 mph via Rochester	4:59	3:16	5:33	2:32
C-2: 150 mph via Rochester (New Alignment)	4:14	3:51	4:42	3:23
D-3: 185 mph Rochester (Elevated)	3:11	4:54	3:47	4:18

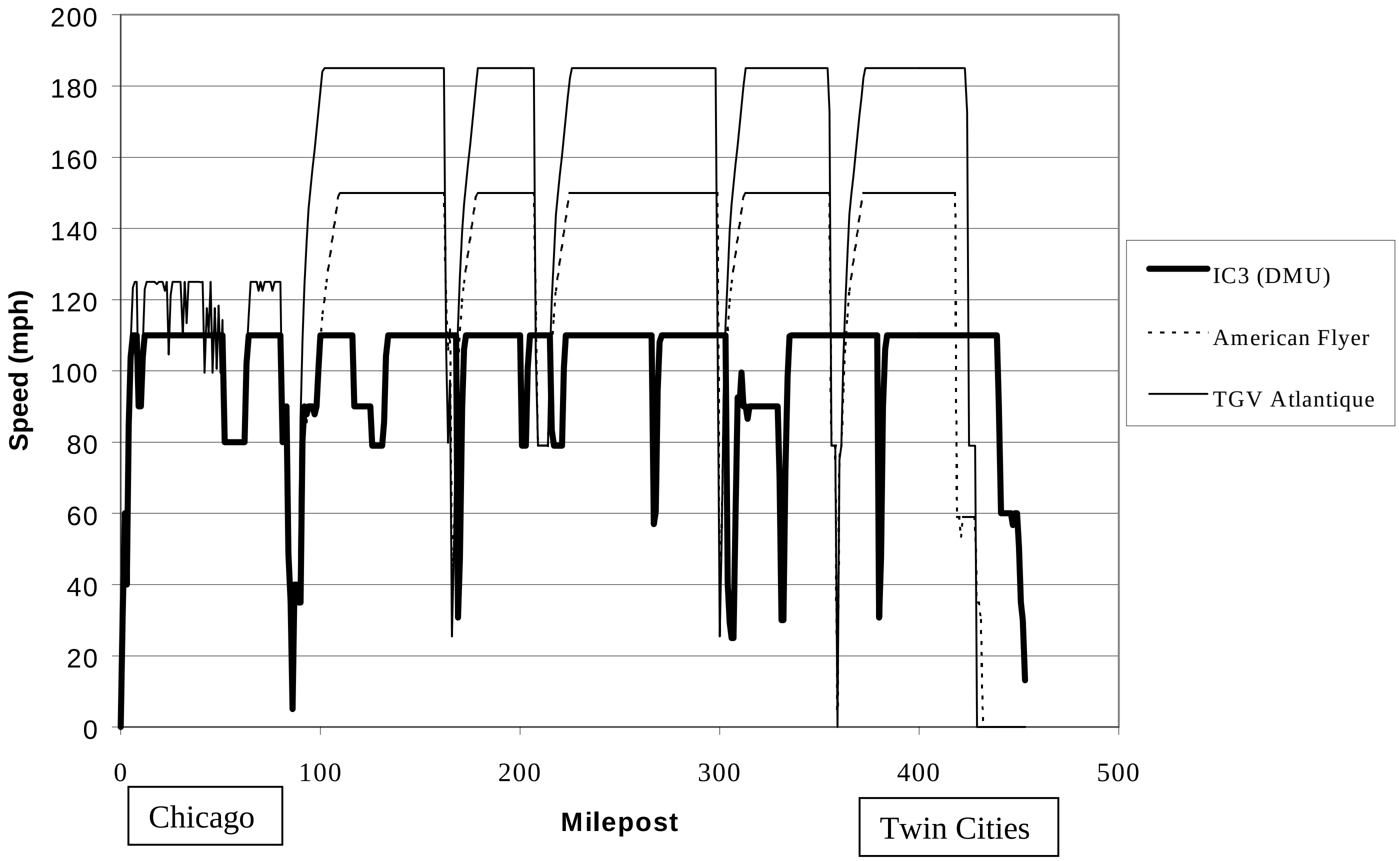
Increasing train speeds from Amtrak's timetable (LOCOMOTION© runs calibrated to Amtrak's timetable) results in time savings in express service between Chicago and Twin Cities ranging from approximately two hours using 110 mph technology to almost five hours using 185 mph technology.

An express stop pattern will save between 28 and 38 minutes in all cases compared to a full stopping pattern. The "110 mph River Route" saves 38 minutes, while the "110 mph Rochester Route" saves 32 minutes because it has fewer local stops.

The 150 mph technology via Rochester shows improvements of approximately 30 minutes (both express and local stopping patterns) over the 110 mph technology. Using a new alignment along the same route results in additional improvements of 30 to 50 minutes respectively for express and local stopping patterns with the 150 mph technology.

The 185 mph Rochester technology runs on the new alignment with additional improvements by elevating the track in large urban areas (see Chapter 2 for details). The time improvements are significantly greater, resulting in an hour time savings for both express and local stopping patterns when compared to the "150 mph Rochester (New Alignment)" option. Time travel characteristics can be illustrated using LOCOMOTION© speed profile graphs. Exhibit 4.6 illustrates a speed profile relationship for all three technologies between Chicago and Twin Cities.

Exhibit 4.6
Technology Performance Profile



4.4 TRAIN TIMETABLE DEVELOPMENT

The timetables developed using LOCOMOTION© were used in an interactive analysis with the demand forecast COMPASS© model, as discussed in Chapter 5. Travel times and frequencies are two of the major variables that influence passengers and resulting revenue. The interactive analysis balances the frequencies and demand characteristics and dictates the car consists required for the schedule. Exhibit 4.7 summarizes the daily frequencies for each scenario to the major corridor stops. The Base Case frequencies correspond to the demand analysis, rather than the current MWRRI frequencies.

Exhibit 4.7
Twin Cities Service Trip Frequencies

Scenario	Chicago-Milwaukee	Chicago-Madison	Chicago-Twin Cities
A-1 Base Case: 110 mph along River	14	10	6
B-1: 110 mph via Rochester	14	10	6
B-2: 150 mph via Rochester	19	19	18
C-2: 150 mph via Rochester (New Alignment)	19	19	18
D-3: 185 mph Rochester (Elevated)	23	23	23

The frequencies increase according to the level of travel time improvement, consistent with increases in demand at higher speeds. The 150 mph and 185 mph technologies have three to four times the daily trips to Twin Cities compared to the 110 mph option due to improved travel times and significant increases in market demand. Stops to Milwaukee and Madison increase moderately at the higher speeds and are generally part of long distance travel to Twin Cities. Daily trips to each major corridor stop are more evenly distributed with the 150 mph and 185 mph technologies. Appendix 4.1 outlines the timetable criteria, service patterns, and maintenance facility assessments developed for each scenario.

4.4.1 Freight and Commuter Rail Operations and Interaction with Timetables

Appendix 4.2 presents the timetables associated with each scenario. These timetables were developed to coordinate with freight and commuter operations from *the 1993 Chicago-Milwaukee Rail Study on Operations and Line Capacity Simulations* prepared by Wilbur Smith & Associates. Otherwise, it is assumed all freight activities for Milwaukee-Twin Cities operate during off-peak hours and will not interfere with the timetables proposed for this study.

4.5 FLEET REQUIREMENTS

With a train timetable developed for each scenario, the fleet size can be determined (appropriate for demand) via an iterative process comprised of testing service frequencies, assessing demand, and refining frequency timetables and consist sizes. Two important factors impacting fleet size are maximum allowable annual mileage and train cleaning/preparation time. Exhibit 4.8 summarizes maintenance criteria, planning assumptions, and rolling stock requirements for each scenario.

Exhibit 4.8
Criteria on Fleet Requirements for Each Scenario

	Maximum Allowable Annual Mileage	Minimum "Turn-Around" Time	Trainsets Required
A-1 Base Case: DMU	300,000	45 Minutes	12
B-1: DMU	300,000	45 Minutes	12
B-2: American Flyer	320,000	45 Minutes	19
C-2: American Flyer	320,000	45 Minutes	19
D-3: TGV	340,000	45 Minutes	21

The maximum annual mileage per train-set averages between 300,000 and 340,000. More details on determining fleet requirements are discussed in Appendix 4.1.

4.6 SUMMARY

This chapter focused on train operation analysis in order to develop operational plans for technologies and route options. The LOCOMOTION© model was used to estimate train running times. Since travel times and frequencies are major variables that influence passengers and revenue, timetables were developed for each technology using express and full stopping patterns. In all cases, an express stop pattern will save time compared to a full stopping pattern. Frequencies increase according to the level of improvement in travel time. With the development of timetables, fleet sizes can also be determined.

TABLE OF CONTENTS

5.1 OVERVIEW

A key element in evaluating the feasibility of high-speed passenger rail service is an accurate assessment of the total travel market in the corridor under study, and how well a new rail service might perform in that market in the future. This assessment was accomplished using a four-step process as described below.

1. Gathered information on the total market and travel patterns in the corridor for auto, air, bus and passenger rail travel.
2. Identified and quantified factors that influence travel choices, including current and forecast socioeconomic characteristics.
3. Built and calibrated a model to test different travel choice scenarios; in particular, identified the likely modal shares under each scenario.
4. Forecasted travel, including total demand and modal shares.

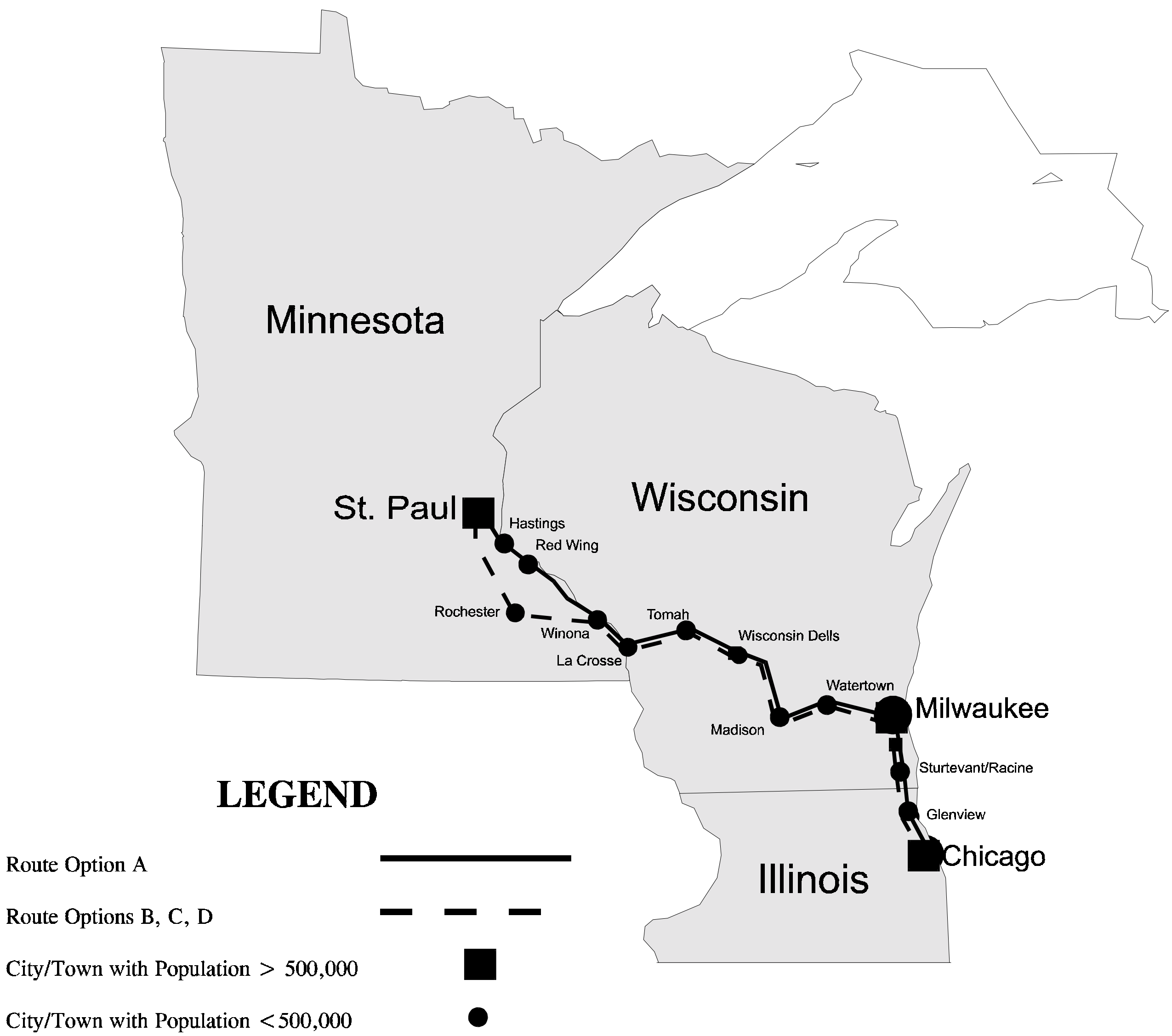
This chapter documents the data-gathering effort from primary (*e.g.,* direct survey) and secondary (*e.g.,* U.S. Census Bureau) sources and summarizes the results. It also describes the process and major assumptions incorporated in the model. Finally, it presents the process results in terms of preliminary ridership and revenue forecasts for each scenario, based on initial estimates of frequencies and travel times (prior to rationalization and optimization of operating expenses, fare levels and infrastructure investment levels).

5.1 Market Definition and Geographic Scope

The Chicago-Milwaukee-Twin Cities corridor represents well-established travel connections and patterns. There are four major city-pairs of travel within the corridor. Over five million trips per year are currently taken across all modes between Milwaukee-Twin Cities, Milwaukee-Madison, and Madison-Twin Cities. About 4.9 million trips per year take place between Chicago-Milwaukee, including almost a quarter of a million rail trips. Civic attractions, such as museums in Chicago, Milwaukee and Twin Cities; major league sports teams; tourist/ shopping attractions such as the Mall of America in the Twin Cities, Wisconsin Dells, and Chicago's Magnificent Mile; and medical specialty centers such as the Mayo Clinic in Rochester, Minnesota, complement business activity and regional interactions. Understanding an area's base travel market is crucial to understanding its potential rail demand.

Exhibit 5.1 depicts the major cities in the corridor and high-speed rail route options being considered. All options follow a similar alignment to LaCrosse but diverge there, with one route going along the river up through Red Wing and Hastings, and other potential alignments going through Rochester to St. Paul. Full route descriptions are found in Chapter 3.

Exhibit 5.1
Major Cities in the Corridor



Socioeconomic forecasts indicate that the region and corridor will continue to enjoy steady growth in employment, population and per capita income, which will lead to increased travel demand. The stated preference survey conducted for rail, bus, air and auto travelers in Wisconsin and Minnesota revealed the following:

- All travelers value speed and frequent service.
- Business travelers place a higher value on time than non-business travelers.
- Air travelers place higher values on time than non-air travelers.

5.2 DATABASE DEVELOPMENT

5.2.1 Zone Definition

A key step in developing a study database (network, socioeconomic and origin-destination) is to construct the fundamental unit of analysis, the zone system. An early step in developing the forecasting tool was upgrading the MWRRI zone system to increase travel accuracy between the origins and destinations in the corridor. The zone system is predominantly county-based, with urban areas subdivided. County-based zones are compatible with the socioeconomic baseline and forecast data (discussed below) derived from the Bureau of Economic Analysis (BEA), which are also county-based. Zones are defined relative to the rail network. As zones move outward from stations, their size transitions from small to larger.

The network zone system developed for the Tri-State II High Speed Rail Feasibility Study was enhanced with finer zone detail in urban and rural areas. The revised zone system contains 103 zones within the study area boundaries plus 16 external zones, compared to 81 zones within the same boundaries in the MWRRI. Further detail on the zone structure and zone map is provided in Appendix 5.1.

5.2.2 Network Data

In transportation analysis, travel desirability is measured in terms of cost and travel time. These variables are incorporated into the basic network elements. Correct representation of the networks is vital for accurate forecasting. Basic network elements are called nodes and links. Each travel mode consists of a database comprised of zones, stations or nodes, and existing connections or links between them in the study area. Each node and link is assigned a set of attributes. The network data assembled for the study included the following attributes for all the zone pairs.

- For public travel modes (air, rail and bus):
  - Access/egress times and costs (e.g., travel time to a station, time/cost of parking, time walking from a station, or time/cost of taking a taxi to the final destination, etc.)
  - Waiting at terminal and delay times
  - In-vehicle travel times
  - Number of interchanges and connection times
  - Fares
  - On-time performance
  - Frequency of service
- For private mode (auto):
  - Travel time, including rest time
  - Travel cost (vehicle operating cost)
  - Tolls

The station stops assumed in the model for each option are identified in Exhibit 5.2. Note that not all trains stop at each station; some trips are designated and modeled as express trips with limited stops.

Exhibit 5.2
Assumed Passenger Rail Station Stops

	A-1	B-1	B-2	C-2	D-3
Chicago-Union	X	X	X	X	X
Glenview	X	X	X	X	X
Sturtevant	X	X	X	X	X
General Mitchell Field	X	X	X	X	X
Milwaukee Union	X	X	X	X	X
Brookfield	X	X	X	X	X
Madison	X	X	X	X	X
Wisconsin Dells	X	X	X	X	X
Tomah	X	X	X	X	X
LaCrosse	X	X	X	X	X
Winona	X	X	X		
Red Wing	X				
Hastings	X				
Rochester		X	X	X	X
St. Paul Union Station	X	X	X	X	X

Note: Not all trains stop at all of the intermediate station stops listed.

The network data were obtained from a variety of sources, including statewide models from IDOT, WisDOT, Twin Cities Metro Council, and CATS (*Chicago Area Transportation Study*). Data on private auto operating costs were obtained from the Federal Highway Administration and American Automobile Association. Public transportation travel time and cost data were derived from Amtrak schedules, the Official Airline Guide, and Russell's Bus Guide.

5.2.3 Socioeconomic Baseline and Forecasts

Socioeconomic forecast growth rate percentages for each state were derived from the Bureau of Economic Analysis, as follows:

- *County Projections to 2040*, US Department of Commerce, Department of Economics and Statistics, BEA, Regional Economic Analysis Division, Washington, D.C., 1992.
- *BEA Regional Projections to 2045*, Volume 1, State Projections, US Department of Commerce, Economics and Statistics Department, BEA, Regional Analysis Division, Washington, DC, August 1995.

- REIS (Regional Economic Information System) 1969-1993, US Department of Commerce, Department of Economics and Statistics, BEA, Regional Economic Measurement Division, Washington, D.C., May 1995.

Using these sources, each zone was treated as an independent unit in the income, population and employment forecast. The detailed socioeconomic forecasts by zone are presented in Appendix 5-2. The forecasts for the zones included in the model have been aggregated by state for Wisconsin, Minnesota, and Illinois. The Illinois data represents only the Chicago region (See Exhibit 5.3).

Exhibit 5.3
Forecast Socioeconomic Characteristics Aggregated by State

Data Item	State	1996	2000	2010	2020	2040	% Change 1996-2040
Population (millions)	Minnesota	5.3	5.5	5.9	6.3	6.9	31.2%
	Wisconsin	5.1	5.4	5.8	6.2	7.0	36.8%
	Illinois	8.1	8.4	9.0	9.6	10.8	33.9%
Employment (millions)	Minnesota	2.9	3.1	3.5	3.6	3.9	35.1%
	Wisconsin	3.0	3.3	3.6	3.7	4.1	36.8%
	Illinois	4.8	5.1	5.7	5.9	6.4	33.2%
Per Capita Income (000s)	Minnesota	18.8	19.8	22.0	23.7	27.6	47.1%
	Wisconsin	16.9	17.8	19.9	21.5	25.5	50.4%
	Illinois	22.3	23.3	25.6	27.4	32.1	43.8%

While the Chicago metropolitan region (as defined) has the largest aggregate numbers for population, employment and per capita income, Exhibit 5.3 reveals Wisconsin as the leader in percentage growth across the three measures. Travel increases are strongly correlated to increases in per capita income, in addition to changes in population and income. Therefore, travel in the corridor is expected to increase faster than the population or employment growth rates, as changes in per capita income outpace population and employment growth.

Other significant findings from Exhibit 5.3 are:

- In 1996 Wisconsin's population was smaller than Minnesota or Chicago, but by 2040 its population is projected to be almost two percent higher than Minnesota.
- While Minnesota's projected population growth rate is the lowest of the three, it surpasses Chicago's employment and per capita income growth rates.
- The Chicago region is larger than Minnesota or Wisconsin in terms of population, employment and per capita income. While its absolute growth in all three measures is also the largest, its percentage increases are smaller.
- The Chicago region's per capita income is largest of the three: 20 percent greater than Minnesota in 1996 and 32 percent higher than Wisconsin in the same period.

5.2.4 Origin Destination Information

TEMS extracted, aggregated and validated data from the following sources in order to estimate base travel between city-pairs. Data were collected by state and by mode. Preliminary estimates of travel were generated based on socioeconomic and trip attribute data, then validated with actual modal data counts. The validation data sources are listed in Exhibit 5.4, with detail about Origin-Destination travel data sources by state provided in Exhibit 5.5.

Exhibit 5.4
Sources of Total Travel Data by Mode

Mode	Data Source	Description	Data Enhancement Required
Rail	Amtrak Ticketing Data	Station-to-station passenger volume	Access/Egress Simulation
Air	Federal Aviation Administration (FAA) 10% Ticket Sample	Airport-to-airport passenger volume	Access/Egress Simulation
Bus	Bus Schedules	Counts to estimate bus load factors, simulate passenger volume	Access/Egress Simulation
Auto	Statewide and Urban Origin-Destination Studies	See below	Trip Simulation for Door-to-Door Movement

Access/egress simulation refers to the need to identify origin and destination zones for trips via rail, air and bus. Otherwise, all non-auto trips would appear to begin at the bus or rail terminal or airport zones. Distribution of access and egress trips to zones was accomplished through origin-destination information garnered from the Stated Preference Surveys conducted for this study and through distribution modeling using socioeconomic data.

Exhibit 5.5
Sources of Origin-Destination Travel Data by State

State	Source
Illinois	Illinois Rail Study (1995)
	Illinois State Highway Model (1987)
	Illinois Rail Passenger Survey (1993)
Minnesota	Highway Traffic Volumes
	Travel Survey for Twin Cities Metro Area
	Tri-State High Speed Rail Study (1991)
Wisconsin	Chicago-Milwaukee Rail Corridor Study (1995)
	Statewide Travel Demand Model
Other Sources:	Amtrak Ticket Count Data
	FAA's 10% Ticket Sample

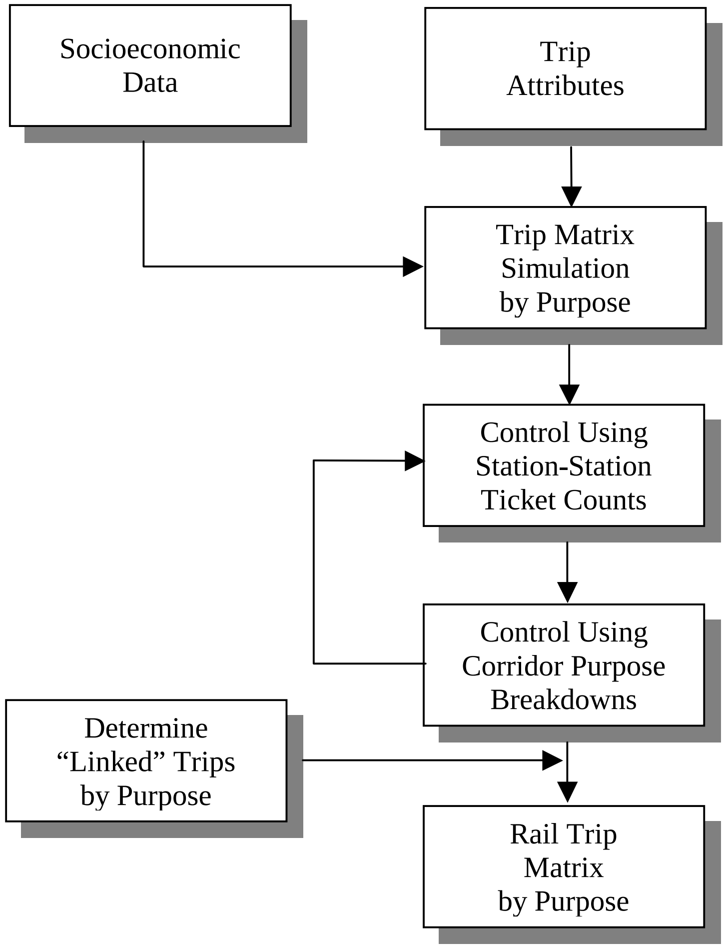
5.2.5 Validation Process for Building Trip Tables

The air, rail, bus and auto data must be placed on a common basis and compared with actual counts (or surrogates of counts). Data from disparate sources that are collected for a multitude of purposes cannot be treated as equal units. There may be differences in time periods (*e.g.,* daily vs. weekly vs. annual estimates), trip definitions (*e.g.,* local vs. long distance) and calculation methods (*e.g.,* raw data vs. expanded data). As noted above, airport, bus and train trips must be distributed to the appropriate access or egress zones.

Exhibit 5.6 depicts the steps that were taken to generate rail mode trips between each city-pair. Similar processes were undertaken for each of the other modes. In essence, socioeconomic data and trip attributes (trip time, cost, and frequency) for a given mode are used to create a simulated trip matrix by trip purpose (business or non-business). The simulated trips generated by the travel forecasting model were compared to actual counts (control totals) to test the accuracy of the simulation, with adjustments to fixed values and coefficients to approximate actual counts as needed. The revised simulated trips were then compared to prior corridor market trip estimates on a trip-purpose basis.

“Linked” trips identify the mode (walk, auto, transit, other) used to “link” the rail, bus or air trip to its origin or terminus point. For this example, the process resulted in a rail trip city-to-city matrix by trip purpose. The primary difference in processes for other modes is the source of the control total. Air travel control totals were based on a ten-percent sample of tickets collected by the airlines for the Federal Aviation Administration (FAA). Highway control totals were based on each state's highway model origin-destination matrix and on actual counts of highway traffic volumes. Bus control totals were based on scheduled bus runs, with assumptions about passenger volumes as a portion of bus capacity. Previous studies have identified average bus occupancy for intercity trips; these averages were used for the current study.

Exhibit 5.6
Rail Trip Matrix Generation and Validation



5.2.6 Origin-Destination Flows by City Pair

Cities within the Tri-State Corridor are closely linked through extensive travel, with approximately 17.3 million trips per year between major cities in the corridor, and approximately 560 million trips throughout the Minnesota, Wisconsin, and Chicago regions. Exhibit 5.7 presents the current city-to-city trips within the study area, also known as internal trips. Trips represent two-way movements (*i.e.*, "Chicago-Milwaukee" also includes "Milwaukee-Chicago" movements). The ridership forecasts generated for all of the route/technology options selected for analysis for the Chicago-Milwaukee-Twin Cities corridor also assume that conventional passenger rail service from Milwaukee to Green Bay (79 mph) would exist. From a travel demand modeling perspective, the Milwaukee to Green Bay train service would function as a feeder service. The travel demand forecasts for the Tri-State Corridor also presume the existence of the entire Midwest Regional Rail System as set forth in the initial Business Plan prepared for the Midwest Regional Rail Initiative. The exhibit includes major cities and the total trip movements by mode (totals include short trips); full zone to zone trip details by mode and trip purpose are available on diskette by request. These trips and modal shares provided the basis for the forecast of ridership by mode.

Exhibit 5.7
Base Year (1996) City-to-City Annual Trips within the Study Area by Mode

Origin	Destination	Auto	Air	Bus	Rail	Total
Milwaukee	Chicago	4,517,562	39,706	74,556	228,927	4,860,750
Milwaukee	Madison	3,827,053	583	58,231	-	3,885,867
Twin Cities	Chicago	1,133,237	1,026,480	6,683	35,658	2,202,058
Rochester	Twin Cities	2,014,799	9,346	2,985	-	2,027,129
Madison	Chicago	1,125,757	26,723	20,085	-	1,172,565
Milwaukee	Green Bay	869,621	138	3,611	-	873,370
Twin Cities	Milwaukee	632,087	142,435	5,245	6,893	786,660
Twin Cities	Madison	325,293	24,021	1,748	-	351,062
Madison	Green Bay	280,493	31	607	-	281,131
Rochester	Chicago	225,158	25,877	679	-	251,714
Green Bay	Chicago	228,644	14,329	2,236	-	245,209
Rochester	Milwaukee	142,572	1,009	525	-	144,106
Twin Cities	Green Bay	119,316	13,708	849	-	133,873
Rochester	Madison	82,369	123	242	-	82,734
Rochester	Green Bay	13,345	289	81	-	13,715
City Sum	Internal Zones	15,537,305	1,324,798	178,361	271,478	17,311,943
Total Trips	Internal Zones	557,091,521	1,904,044	686,442	384,037	560,876,043
(Total trips includes short trips, from one zone to another)						

Key points to note in Exhibit 5.7 are:

- Trips between Milwaukee and Chicago represent about 4.9 million trips per year, or approximately 28 percent of the major-city to major-city trips within the region.
- Trips between Twin Cities-Milwaukee and Twin Cities-Chicago represent about 3.0 million trips per year, or 17 percent of major-city to major-city trips within the region.

- Trips between Madison-Milwaukee, Madison-Chicago, and Madison-Twin Cities represent about 5.4 million trips, or over 31 percent of major-city to major-city trips within the region.
- Trips between Rochester-Twin Cities, Rochester-Madison, Rochester-Milwaukee, and Rochester-Chicago represent about 2.5 million trips per year, or over 14 percent of the major-city to major-city trips within the region.

The Chicago-Milwaukee-Twin Cities corridor has been shown in several studies as a desirable location for high-speed rail. Among its attractive features is the very high volume of travel among the regional cities, such as Rochester-Madison and other city-pairs. Further detail on base year trips is found in Appendix 5.3, including travel disaggregated by trip purpose, market shares by mode, and the volume of trips to major cities in external zones (outside the corridor).

5.3 DEVELOPMENT OF VALUES OF TIME AND VALUES OF FREQUENCY

A key step in determining how travelers in the Twin Cities-Milwaukee-Chicago corridor will react to the enhanced passenger rail service options is to quantify the monetary values placed on travel time and frequency or convenience of service. An attitudinal survey using "stated preference" techniques was undertaken in November 1997 to identify the travel behavior characteristics of individuals making trips in the Tri-State corridor. The results of the survey were used to derive time and frequency values for groups of travelers by mode and trip purpose (*e.g.,* air business travel, bus non-business travel, etc.).

Value of time is defined as the amount of money (dollars/hour) an individual is willing to pay to save a given amount of travel time. Value of frequency is the amount of money (dollars/hour) that an individual is willing to pay to reduce the time between departures when traveling on public transportation.

5.3.1 Study Approach: Stated Preference Analysis

The essence of the stated preference technique is to ask people making trips in the corridor to make a series of trade-off choices based on different combinations of travel time, frequency and cost. Stated preference analysis has been used extensively by TEMS to assess new travel options relating to time, fares, frequency, comfort and reliability for rail, air, and bus services. Tests of the technique in a series of before and after evaluations in North America and Europe have produced exceedingly good results. In particular, these tests found that the use of "abstract mode" questions in conjunction with "trade-off analysis" produced reliable results.

Two specific trade-offs were analyzed and used for this study:

- Choices between travel times and travel costs to derive incremental Values of Time for all modes.
- Choices between headway times (frequency of service) and travel costs to derive incremental Values of Frequency for rail, air and bus.

Appendix 5.4 provides detail on the survey design, rationale, administration, and sample size achieved, plus samples of the questionnaire form.

5.3.2 Trip Purpose

Survey findings differentiate between business and non-business travelers for rail, bus, air and auto riders, and include a comparison with results from similar studies.

5.3.3 Value of Time by Trip Purpose and Mode

Exhibits 5.8 and 5.9 illustrate the different values of time expressed by business and non-business travelers in the various modes. Exhibit 5.9 supplements the graphic representation with detail by trip length (short trips are defined as <130 miles; long trips = >130 miles).

Exhibit 5.8
Value of Time by Trip Purpose and Mode

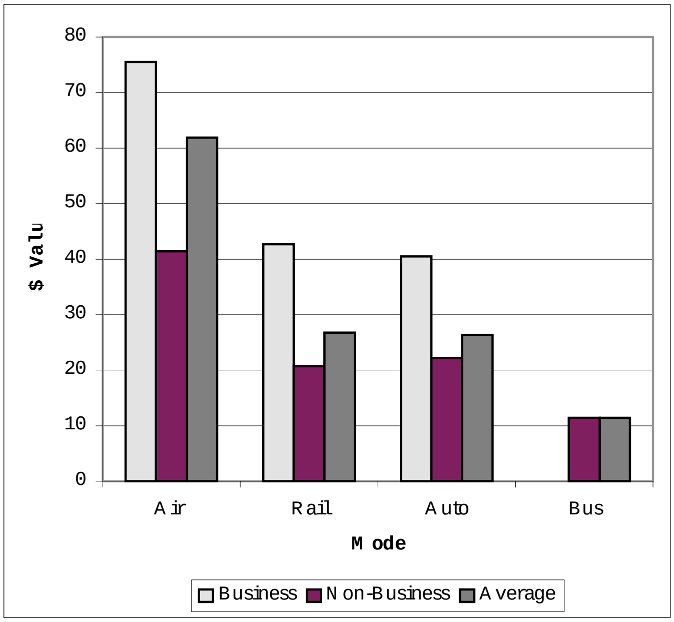


Exhibit 5.9
Value of Time by Trip Purpose, Trip Length and Mode

Mode	Long	Short	Average
Air- Business	75.50	N/A	75.50
Air- Non-Business	41.42	N/A	41.42
Average Air	**61.88**	N/A	**61.88**
Auto- Business	38.13	42.59	40.42
Auto- Non-Business	18.77	28.11	22.19
Average Auto	**22.33**	**32.35**	**26.34**
Average Bus	**11.40**	**13.09**	**11.54**
Rail- Business	27.85	45.51	42.62
Rail- Non-Business	17.38	22.88	20.70
Average Rail	**18.81**	**30.76**	**26.80**

Note: Value of Time is expressed in Dollars/Hour

As shown in Exhibit 5.9:

- Business travelers place a higher value on time than do non-business (primarily pleasure or personal business) travelers for all modes.
- A mode comparison indicates air travelers (particularly business) place the highest premium on time. This suggests that attracting business travelers from air to rail would require a comparable total trip time for a given city-pair or a significantly lower fare.
- Values of time by auto and rail travelers are very similar for both business and non-business travel.
- Bus travelers place the lowest value on time (approximately one-third the value for business travelers and one-half the non-business value, compared to auto and rail).
- Bus is the only mode with a “medium” length trip; the value for that is $10.79. As expected, there were insufficient bus business travelers to form a sample group.
- Short-distance travelers tend to place a higher value on time than longer-distance travelers.

5.3.4 Value of Frequency by Trip Purpose and Mode

Exhibits 5.10 and 5.11 illustrate the different values of frequency expressed by travelers in the public modes of rail, air and bus.

Exhibit 5.10
Value of Frequency by Trip Purpose and Mode

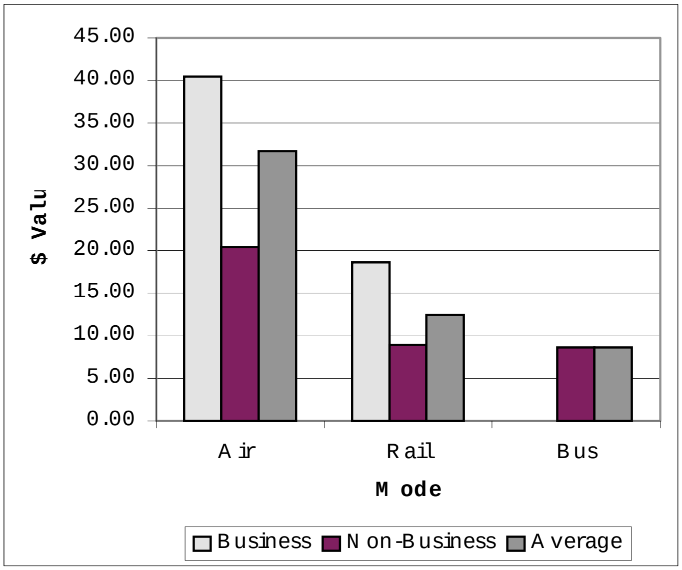


Exhibit 5.11
Value of Frequency by Trip Purpose, Trip Length and Mode

Mode	Long	Short	Average
Air- Business	40.45	N/A	40.45
Air- Non-Business	20.45	N/A	20.45
Average Air	**31.73**	**N/A**	**31.73**
Average Bus	**9.46**	**7.56**	**8.67**
Rail- Business	12.97	19.97	18.62
Rail- Non-Business	6.27	11.10	8.93
Average Rail	**7.59**	**15.15**	**12.46**

As shown in Exhibit 5.11:

- Air and short-distance rail passengers value frequency at roughly half the value of time.
- Long-distance rail passengers value frequency approximately 60 percent less than they value time. With "reasonable" levels of frequency, passengers are accustomed to scheduling their trips for intercity travel; those travelers who require immediate or emergency service are likely to use an automobile.
- On average, bus travelers value frequency almost as much as rail travelers, and only about 25 percent less than they value time.
- The average value of frequency for a medium-distance bus traveler is 8.40. Bus was the only mode to include a medium-distance trip designation.
- Short-distance rail travelers value frequency almost twice as much as long-distance rail travelers.

Values of time and frequency by mode and trip purpose were incorporated into the model.

5.3.5 Comparison with Other Studies

Exhibits 5.12 and 5.13 provide a comparison of values of time by mode and trip purpose for this study with the values generated for the MWRRI and the original Tri-State Study. It is noted that values of time for this study are higher than those for the MWRRI, but are quite consistent with the original Tri-State Study. Current values are slightly higher than the original Tri-State Study for air travel, slightly lower for auto travel, and higher for rail business and lower for rail non-business travelers. Changing conditions in air market competition in the corridor, countered by the relative stability of automobile operating costs and rail fares over time, are the likely sources of the variations.

Exhibit 5.12
Value of Time by Trip Purpose and Mode: Comparison with Other Studies

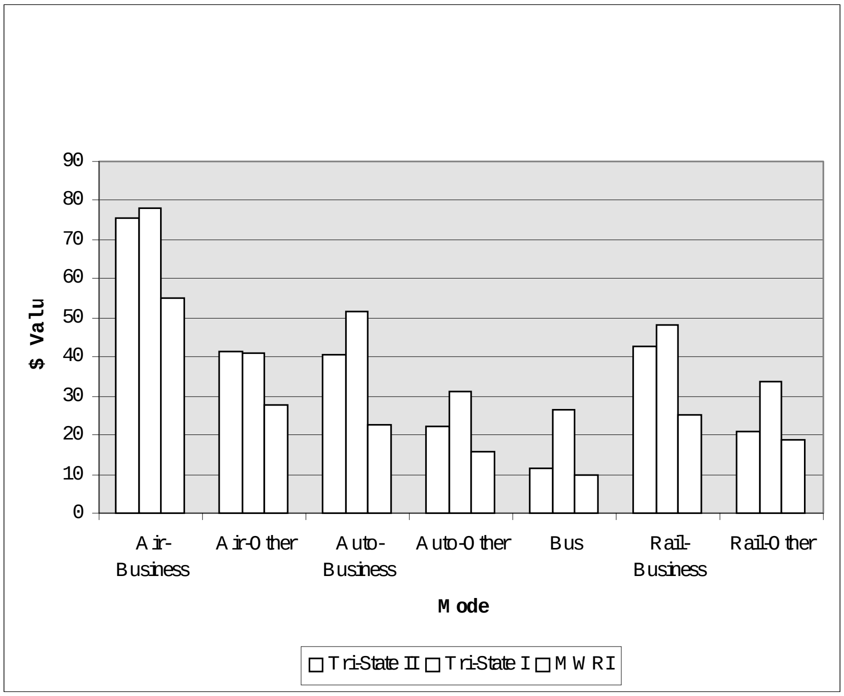


Exhibit 5.13
Values of Time Generated by Three Studies
(1998 Dollars)

	Current Tri-State Study		Midwest Regional Rail Initiative		Original Tri-State Study	
Mode	**Business**	**Non-Business**	**Business**	**Non-Business**	**Business**	**Non-Business**
Air	75.50	41.42	55.12	27.56	78.07	40.96
Auto	40.42	22.19	22.58	15.86	51.80	31.08
Bus	12.93	11.44	N/A	9.66	N/A	26.26
Rail	42.62	20.70	25.22	18.61	48.07	33.73

The values of time computed for this study are very consistent with the other studies in the relationships across modes. The patterns across all three surveys and modes demonstrate that business travelers place a much higher value on time than do non-business travelers. A significant study finding revealed that values of time for business rail travelers were more than double values of time for non-business rail travelers. Prior studies indicated a relationship between business and non-business travelers at about a 40 percent differential. The values of time for air mode (adjusted to 1997 dollars) are virtually the same from Tri-State I to Tri-State II. The values of time shown in Exhibit 5.12 for the Midwest Regional Rail Initiative are composite values for the entire nine-state Midwest region and reflect values generated through surveys taken at many sites throughout the region. In many of the travel corridors, no-frills, low-fare airline service is provided. In all three surveys, values of time for air mode are significantly higher than auto or rail. Values of time for bus are consistently the lowest. Values of time for auto and rail are similar within each survey, with differences in values ranging from 5 to 15%.

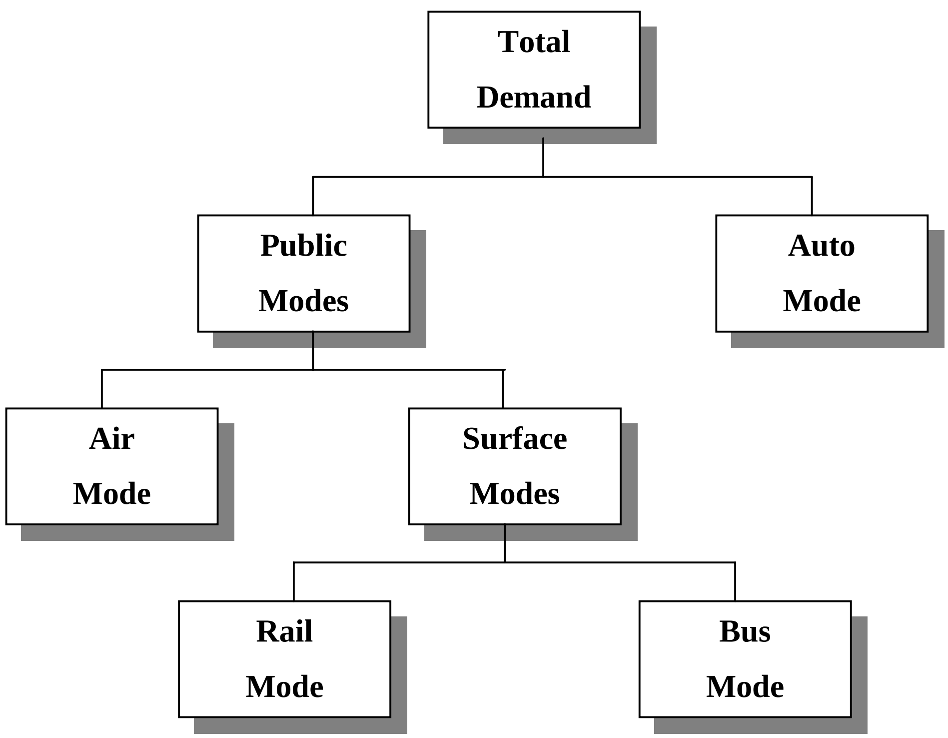
5.4 BASIC STRUCTURE OF THE COMPASS© MODEL

The *COMPASS©* Multimodal Demand Forecasting Model is a flexible demand forecasting tool used to compare and evaluate alternative rail network and service scenarios. It is particularly useful to assess the introduction or expansion of public transportation modes such as air, rail or bus into new markets. It is built from an existing travel network and tests the sensitivity of future travel demand to such parameters as elasticities, Values of Time, and Values of Frequency. Specific Values of Time and Frequency are developed from results of the stated preference surveys conducted in the study region. Stated preference market analysis techniques provide an accurate assessment of likely choices individual travelers will make when faced with trade-offs of time and money or frequency and money. The *COMPASS©* program is described briefly, with a more comprehensive description (including formulas) provided in Appendix 5.5.

The *COMPASS©* Model structure incorporates two principal models: a Total Demand Model and a Hierarchical Modal Split Model. These two models are calibrated separately for each trip purpose, *e.g.*, business, commuter and "other" (personal, social, and tourism). In each case, the models are calibrated for origin-destination trip-making internal to the region. The Total Demand Model provides a mechanism for replicating and forecasting the total travel market. The total number of trips between any two zones for all modes of travel, segmented by trip purpose, is a function of (1) the socioeconomic characteristics of the two zones and (2) the travel opportunities provided by the overall transportation system that exists (or will exist) between the two zones. Typical socioeconomic variables include household income, employment, and population. The quality of the transportation system is measured in terms of total travel time, travel cost, and worth of travel by all modes for a given trip purpose.

The role of the *COMPASS*© Modal Split Model is to estimate relative modal shares of travel given the estimation of the total market by the Total Demand Model. The relative modal shares are derived by comparing the relative levels of service offered by each of the travel modes. Three levels of binary choice are typically calibrated (Exhibit 5.14). The first level of the hierarchy separates private auto travel, with its perceived spontaneous frequency, low access/egress times, and highly personalized characteristics, from public modes (*i.e.*, bus, rail and air). The second structure level separates air, the fastest and most expensive public mode, from rail and bus surface modes. The lowest level of the hierarchy separates rail, a potentially faster, more reliable, and more comfortable mode, from the bus mode. The model forecasts changes in riders, revenue and market share based on changes travel time, frequency and cost for each mode.

Exhibit 5.14
Hierarchical Structure of the Modal Split Model



5.5 RIDERSHIP AND REVENUE FORECAST RESULTS

Rail ridership forecasts for the five high-speed rail technology and corridor options were generated using the 103-zone system presented in Appendix 5.2. The five forecast options are described in Exhibit 5.15.

Exhibit 5.15
Options Evaluated

Option	Route	Technology
Base Case: 110 mph - River	Current alignment (with Madison), no Rochester	110 mph DMU
B-1: 110 mph - Rochester	Current alignment (with Madison) Chicago to Winona, new route to Rochester and Twin Cities	110 mph DMU
B-2: 150 mph - Rochester	Current alignment (with Madison) Chicago to Winona, new route to Rochester and Twin Cities	150 mph American Flyer Gas Turbine
C-2: 150 mph - New Alignment	Current alignment Chicago to Duplainville, new route to Madison to Rochester and Twin Cities	150 mph American Flyer Gas Turbine
D-3: 185 mph - Rochester elevated	Current alignment Chicago-Milwaukee; elevated track from Milwaukee to Duplainville; existing grade for new route from Duplainville to Madison to Rochester, then to Rosemount; elevated track from Rosemount to Twin Cities.	185 mph TGV

As described in Appendix 5.5, schedule frequency, travel time, and cost are three of the key inputs to the *COMPASS*© model. The ridership forecasts presented in this chapter are based on the frequencies, travel times and fare levels identified in Exhibit 5.16. Complete operating timetables are provided in conjunction with Chapter 4, *Operating Plan.*[1] This study corresponds to standard industry practices in that ridership and revenue forecast accuracy is expected to be within ±20 percent of the stated value, within the parameters of socioeconomics and other stated assumptions. That is, if the growth estimates for population, income, and employment occur as assumed, and if transportation growth continues to correlate with these and other assumed factors, then the forecast will be accurate with an 80% confidence level.

[1] Base case travel times differ from current MWRRI times because the Tri-State II times were developed using the DMU train technology, and the assumptions on recovery time from late 1998. Likewise, the frequencies for the base case reflect that earlier MWRRI scenario.

Exhibit 5.16
Key Variable Inputs to Final Forecast

Item	Detail	110 mph River	110 mph Rochester	150 mph Rochester	150 mph New Alignment	185 mph Rochester Elevated
Daily Train Frequency (from Chicago)	to Milwaukee	14	14	19	18	23
	to Madison	10	10	19	19	23
	to Twin Cities	6	6	18	18	23
Express Running Time	to Milwaukee	1h.	1h.	55m.	55m.	55m.
	to Twin Cities	5h.27m.	5h. 34m.	4h. 49m.	4h. 04m.	3h.40m.
Avg. Fare/ Passenger Mile	to Milwaukee	$.322	$.326	$.327	$.337	$.363
	Milw-Madison	$.265	$.272	$.283	$.284	$.306
	Madison-Twin Cities	$.209	$.217	$.224	$.224	$.240
Avg. Fare/ Passenger Trip	to Milwaukee	$26.71	$27.52	$27.56	$27.65	$29.98
	Milw-Madison	$20.18	$21.47	$23.60	$22.86	$25.01
	Madison-Twin Cities	$53.06	$54.82	$63.52	$65.48	$73.59

Fares were optimized to increase the revenue yield to approximately 40 percent more than the revenue yield produced by the base fare. Fares are the same for each option; the average fare per trip and per mile changes as the proportion of business and non-business travelers changes. Average fares per mile and per trip represent the weighted average of business and non-business fares for each alternative. Non-business fares are discounted at 75 percent of business fares, representing senior citizen, student and child fares, and discounts for advance purchases. Exhibit 5.17 displays the fares between major city pairs.

Exhibit 5.17
Fares Between Major Cities

	Base	Non-Business	Business
Chicago-Milwaukee	$22.51	$24.78	$33.04
Milwaukee- Twin Cities	$63.00	$76.50	$102.00
Chicago- Twin Cities	$83.52	$100.44	$133.92

Exhibit 5.18 graphically portrays the ridership forecast generated by each option, associated with the frequencies, running times and fares described above. The TGV attracts the greatest number of trips due to its high speed and high frequency.

Exhibit 5.18
Ridership Forecast Results

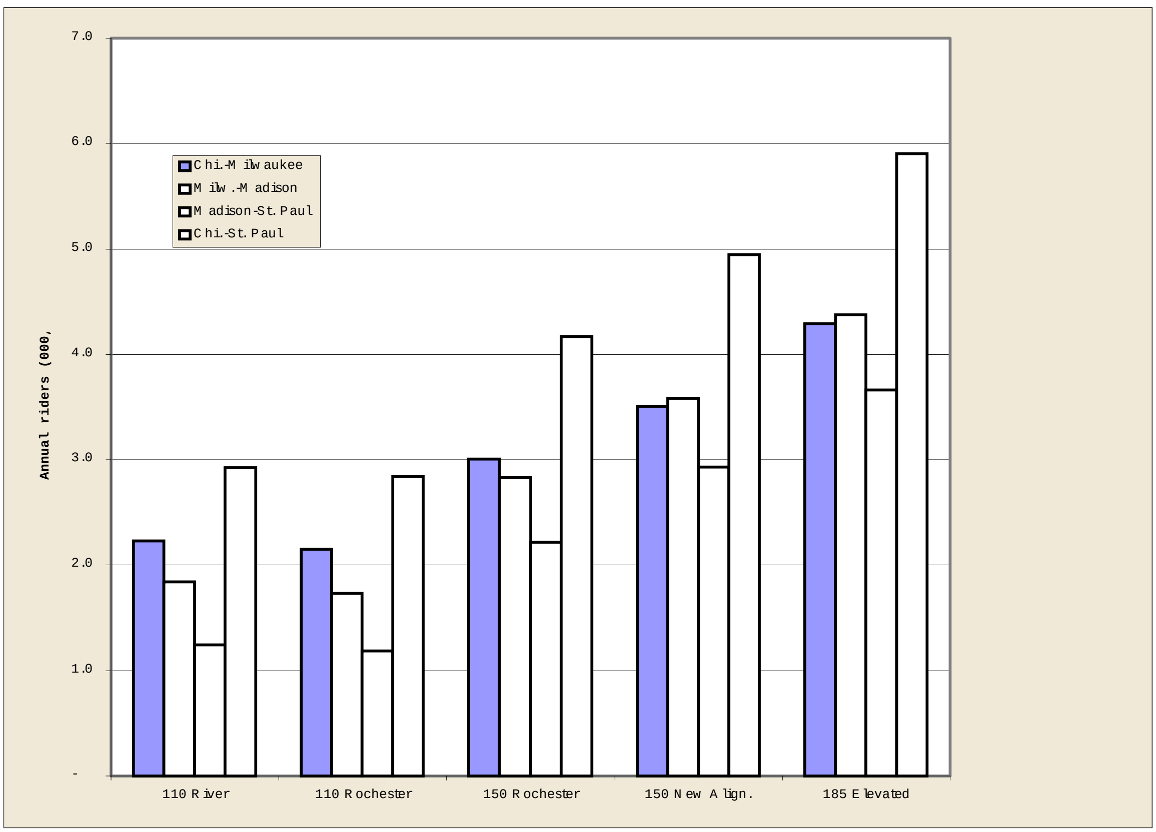


Exhibit 5.19 provides the detailed ridership forecast for the study year 2020. Key findings of the forecast are as follows:

- Each increase in speed and frequency generates more riders, with the TGV options garnering the most.
- Services in Milwaukee-Twin Cities carry fewer riders than the Chicago-Milwaukee link (for non-Chicago-based trips), but due to current limited service, increases over the base year ridership (Exhibit 5.7) are much greater. Note that the total riders between Chicago and Twin Cities represents linked trips and is therefore less than the sum of the riders on each "leg."

Exhibit 5.19
Annual Ridership Forecast for 2020 by Scenario Option
(Thousands)

	IC3 - 110 mph - River	IC3 - 110 mph - Rochester	AF - 150 mph - Rochester	AF - 150 mph - New Alignment	TGV - 185 mph - Elevated
Chicago-Milwaukee	2,233.1	2,150.2	3,007.5	3,506.3	4,292.3
Milwaukee-Madison	1,842.0	1,734.2	2,832.5	3,583.2	4,376.9
Madison-Twin Cities	1,243.8	1,188.3	2,216.8	2,933.2	3,664.1
Total System	**2,929.4**	**2,842.4**	**4,172.9**	**4,946.1**	**5,906.9**
Non-ChicagoTrips[2]	696.3	692.2	1,165.4	1,439.8	1,614.6
% of Trips Not Based in Chicago	23.8%	24.4%	27.9%	29.1%	27.3%

[2] Trips between Milwaukee, Madison, and Twin Cities not including trips originating or terminating in Chicago.

- The number and percentage of riders proceeding to Madison or Twin Cities without a Chicago origin increases steadily with the change in speed and technology. This indicates that travelers in the region are more inclined to look to rail for their intermediate-length journeys (i.e., Milwaukee to Twin Cities or Madison to Rochester) as speeds and frequencies increase. Chicago remains a key origin and destination through all options, but its importance becomes less pronounced at higher speeds.
  - In the base year (not shown), 93 percent of rail riders traveling to and from the Twin Cities begin or end the trip in Chicago, reflecting the long-distance perception of the service. Only seven percent do not start or end their trip in Chicago.
  - For the 110 mph options, approximately 24 percent of all riders use only the Milwaukee-Twin Cities leg.
  - Almost 30 percent of all riders are drawn from within the Milwaukee-Twin Cities corridor for the TGV 185 mph option.

Exhibit 5.20 summarizes average daily passenger volumes by segment and alternative for the study year 2020. The table demonstrates the impact of speed and frequency on riders. The TGV alternative attracts roughly double the passengers of the 110 mph options. The 150 mph Rochester route on the 110 mph alignment is approximately at the mid-point of the 110 and the 185 mph scenarios in terms of passenger volume.

Exhibit 5.20
2020 Average Daily Passenger Volumes

	110 mph River	110 mph Rochester	150 mph Rochester	150 mph New Alignment	185 mph Elevated
Chicago-Milwaukee	6,118	5,891	8,240	9,606	11,760
Milwaukee-Madison	5,047	4,751	7,760	9,817	11,992
Madison-Twin Cities	3,408	3,256	6,073	8,036	10,039
Chicago-Twin Cities	8,026	7,787	11,433	13,551	16,183

Exhibit 5.21 compares the market shares for each mode for the base year and in the year 2020 for the region. Bus remains relatively constant across all alternatives. Air increases its market

share in the forecast year over the base as travel between Chicago/ Milwaukee and Twin Cities becomes more prominent in the region. Although auto continues to dominate, rail attracts a portion of the market under each alternative, roughly doubling its market share between the 110 mph and 185 mph options. Market share detail for individual city pairs for the base year is provided in Appendix 5-3, Exhibit 5.3.2.

Exhibit 5.21
Base Year and 2020 Market Share Percentages by Mode and Alternative

	Base Year	110 mph River	110 mph Rochester	150 mph Rochester	150 mph New Alignment	185 mph Elevated
Auto	97.8	96.0	96.0	95.4	95.1	94.6
Air	1.6	2.1	2.1	2.1	2.0	2.0
Bus	0.3	0.3	0.4	0.3	0.3	0.3
Rail	0.3	1.6	1.5	2.2	2.6	3.1

5.6 SUMMARY

The Tri-State region exhibits a very vigorous travel market, with extensive trip-making among the cities in the region. The economic forecasts for per capita income growth are significantly higher than regional population growth. Consequently, travel is expected to increase faster than population or employment growth. The survey conducted to update regional values of time and frequency was generally comparable to other studies.

A key difference from previous studies was that the value of time for business rail travelers was almost double that of non-business rail travelers. This suggests that the relationship between business and non-business rail travelers is more similar to air travelers than auto. The ridership forecasts predict that market shares for rail will increase steadily, with increased frequency and decreased travel times. Rail market share is estimated at 0.3 percent in the base year, 1.5 percent in 2020 at 110 mph through Rochester, 2.2 percent at 150 mph through Rochester (current alignment), and 3.1 percent at 185 mph. Projected ridership in 2020 ranges from 2.5 million for 110 mph service, to 3.7 million for 150 mph, and to 5.2 million for 185 mph service. Average daily ridership combining the various segments between Chicago-Twin Cities ranges from about 7,800 at 110 mph to about 16,000 at 185 mph.

TABLE OF CONTENTS

6.1 OVERVIEW

Chapter 6 describes the development of the total operating revenues that support system operation. It also details the operating cost derivation and its relationship to the operating plan and demand forecast. The next section briefly explains the development of rolling stock costs based on the technology assessment and operating plan. The final section of the chapter (with extensive appendices) details the engineering assessment cost development.

6.2 OPERATING REVENUE ANALYSIS

Total operating revenues include revenues generated by fares, on-board and parcel services. Chapter 5 details the process that was used to estimate passenger demand and fares. In this chapter on-board and parcel service revenues are detailed, as well as potential air-connect traffic revenues outside the region. Exhibit 6.1 summarizes passenger revenue estimates by scenario for the year 2020. Revenues for the base case and Option B-1 reflect MWRRS assumptions as of November, 1999.

All options include an estimate for air-connect revenues, based on the MWRRS analysis for 110 mph service. Current and expected air travel patterns and fares within the region are considered part of the intercity travel market. A portion of the rail ridership and revenue included in the forecasts represents air travelers diverted to high-speed rail. The current study did not consider the potential for air passengers traveling to and from locations outside the region to use high-speed rail to connect to their ultimate origin or destination within the region. That level of analysis, which examines national and international air travel markets and their connections to the Tri-State region, was not included as part of the study scope. Due to expressed interest, however, potential "air connect" revenue was estimated based on the MWRRS air connect analysis. The one percent fare revenue increase associated with the MWRRS air connect 110 mph analysis for the Chicago-Milwaukee-Twin Cities corridor was applied to the other corridor options.

Exhibit 6.1
Fare Revenue Forecast by Scenario Option for 2020
(1998 Dollars in Millions)

	Base Case 110 mph River	B-1 110 mph Rochester	B-2 150 mph Rochester	C-2 150 mph NewAlign	D-3 185 mph Elevated
Chicago-Milwaukee	45,104	46,526	83,720	97,924	129,975
Milwaukee-Madison	28,110	29,276	67,510	82,739	110,560
Madison-Twin Cities	44,344	46,714	116,496	146,432	198,526
Total System	**117,558**	**122,516**	**267,726**	**327,095**	**439,061**

6.2.1 Fare Box

6.2.1.1 On-Board Service Revenue

It is assumed that on-board services (OBS) will be provided on a contract basis by the operator (Amtrak is currently the only U.S. intercity operator) or private provider. It is anticipated that improved services and passenger volumes will enable OBS to cover the full cost of operations, including contractor's profit. Therefore, the revenues depicted in Exhibits 6.2 and 6.3 are exactly equal to the OBS costs reported in the Operating Cost section, which also describes the method used to calculate those costs.

6.2.1.2 Parcel Revenue

Same-day parcel service has a high probability of increasing revenues with very few incremental costs. Same-day service represents a very small (about one percent), but rapidly growing courier service segment. Overnight and second-day services provided by Federal Express, UPS, Airborne Express, and the U.S. Postal Service encompass much larger segments. Overnight services represent about 54 percent of the market, while second-day and longer services represent about 45 percent. However, same-day services are becoming increasingly important and can be very lucrative. Items such as bank clearings, legal documents, organs, tissues and other bio-medical products, broadcasting and media equipment, convention materials, production parts and last-minute modifications represent major time-sensitive categories.

It would be feasible for a high-speed rail operation to form a partnership with one or more courier services (e.g., one in each major city), or make space available for courier service packages, with pick-up and drop-off the courier's responsibility. Station-to-station services (similar to Greyhound or "next plane out" services offered by airlines and open to the public) are additional options. Amtrak, Greyhound, and commercial airlines all offer to carry packages. The airlines have had the highest success via relationships with ground courier companies.

The Tri-State area has many courier services, some offering both inter-city and intra-city deliveries. The Tri-State parcel system has more likelihood of success (both politically and operationally) by working with and supporting existing couriers, rather than competing. Courier services that operate both locally and nationally would likely be receptive to a reliable and economical alternative to air services between Chicago, Milwaukee, Twin Cities and points between. Rochester, for instance, could be a potential market for bio-medical deliveries to the Mayo Clinic. Services limited to a single city could expand to other cities by establishing separate local partnerships.

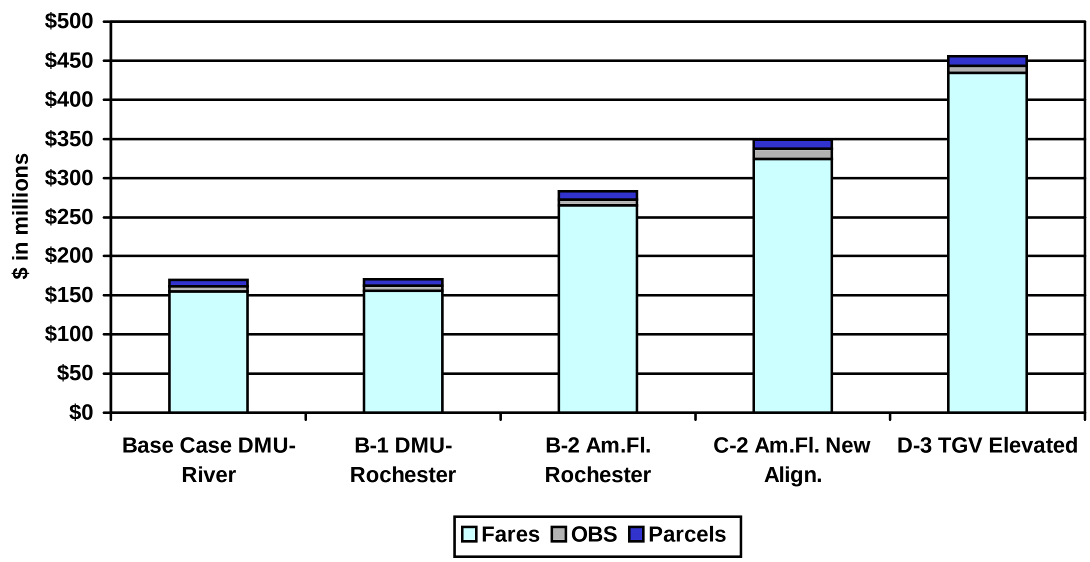
The development of special "freight" cars is not expected for parcel services. For DMU trains, American Flyer and TGV, each baggage compartment would likely accommodate one parcel service container. "Brute" containers (approximately six feet high, six feet long, three feet wide, and on wheels that lock down when the train is in motion) are used extensively in Europe. These containers are geared toward parcels and letters and can be moved easily by forklift.

Revenue estimates have been developed for parcel services based on market estimates, container capacity, train frequencies, and price per package.[1] Estimates were validated using 1993

[1] Price per package of $30. Estimate 4 parcels per cubic foot, capacity of 432 parcels per Brute, Brutes are used to 20 percent of capacity (estimated market share), with ten percent of gross revenue claimed as profit and reported as revenue.

"Commodity Flow Data" for Minnesota, Wisconsin and Illinois.[2] Growth factors for the market are estimated based on the MWRRI rates of growth for parcel service as of November, 1999. Exhibit 6.2 provides a graphic representation of operating revenue estimates for each scenario for the year 2020 in millions of dollars. Exhibit 6.3 summarizes passenger fares, on-board services, and parcel revenue data for 2020 in tabular form (in thousands of dollars). Air connect revenue estimates are included with fare revenues for each option, for the Tri-State study, based on the proportional increase in revenues developed in the MWRRS analysis.

Exhibit 6.2
Tri-State Revenue – Year 2020
(1998 Dollars in Millions)



[2] The validation examined the "Parcel, USPS and Courier" category in each state from the 1992 Census of Transportation, Communications and Utilities, produced by the Bureau of the Census. Total parcel revenue for each state was first factored to eliminate packages of less than 50 miles and more than 500 miles, and factored again to eliminate shipments of more than 100 pounds. Data for each state were factored again by the percentage of total goods with a destination in one of the three states. The result was multiplied by one percent for the estimated "same day" market for parcels.

Exhibit 6.3
Operating Revenue Forecasts for 2020
(1998 Dollars in Thousands)

	Base Case 110 mph River	B-1 110 mph Rochester	B-2 150 mph Rochester	C-2 150 mph NewAlign	D-3 185 mph Elevated
Fare Revenue	117,558	122,516	267,726	327,095	439,061
OBS Revenue	5,730	9,370	9,104	17,146	21,527
Parcel Revenue	11,927	12,737	17,532	17,532	19,672
Total System	**135,214**	**144,624**	**294,362**	**361,772**	**480,260**

6.3 OPERATING COST ANALYSIS

Operating costs for this study were developed using unit operating costs from recent studies. These costs were fine-tuned to increase sensitivity, and then applied to the timetables, number of stations, passenger volumes and other cost factors developed specifically for the Tri-State II Study. Many unit costs are consistent with MWRRS methodology, such as track ROW cost per mile. Cost factors that vary by technology, such as fuel usage and equipment maintenance, were developed from discussions with manufacturers and/or users of the technology. The cost development approach was used to focus on and fine-tune those items with the greatest potential variability and impact on the bottom line.

- The Phase I MWRRS calculated train crew cost on a per-mile basis. This was reasonable for a limited-speed range of technologies and the level of detail required for the estimates. However, for 110 mph to 185 mph technologies in this study, an evaluation based on train hours and crew scheduling requirements provided a more accurate assessment and comparison of the scenarios.

- For the MWRRS, most costs were based on train miles, with an “add-on” for train equipment and fuel costs for a four or six-car train, compared to a three-car train. The Tri-State corridor exhibits greater travel demand than many of the other MWRRS corridors, which can skew certain “average” costs. Therefore, it was decided to base certain costs on car miles rather than train miles, and build the estimated costs based on appropriate consist scheduling. This permits operating cost estimates to reflect the fine-tuning of train consists to estimated demand for different trip segments and time periods.

- The MWRRS based annual train miles on a direct schedule, as if week-day service were operated seven days a week. This was appropriate for the level of detail in the MWRRS analysis. For this study, a cost model was built to reflect the detailed and varying week-day and weekend services, in order to test schedule change impacts on annual miles, hours and operating costs.

- The MWRRS estimated station costs per corridor on a per-passenger allocation. This study uses the same per-staffed and per-unstaffed station costs as the MWRRS, but bases the cost estimate on the actual number of stations in the corridor.

- Programmed "policy costs" such as marketing and telephone support use the same assumption per passenger as those developed for the MWRRS, since no direction has been received to assume otherwise. Similarly, without full discussions with Amtrak or potential operators and the three states on appropriate administrative structure and profit definition, this study assumes the same ten percent multipliers and surcharges to particular items as the MWRRS.

Exhibit 6.4 provides a unit cost comparison among technologies. This is followed by a more detailed explanation of each of the unit costs.

Exhibit 6.4
Unit Cost Comparison among Technologies

Item	Unit Basis for Calculation	DMU- IC3 110 mph	Am.Flyer- 150 mph	TGV- 185 mph
Crew Cost	Shifts/day * rates/hour * multiplier	2.5 multiplier	2.5	2.5
On Board Services	Train mile	$1.60	$1.60	$1.60
Track & ROW Maintenance	Train mile	$4.50	$4.50	$4.50
Train Equipment Maintenance	Train mile	$4.67/train mile	$4.68/train mile	$3.81/train mile*
Fuel & Energy	Car mile/train mile	$1.20/car mile	$2.17/train mile	$1.86/train mile
Station cost/station	Staffed: $250K/yr Unstaffed: $ 40K/yr Chicago: $3.2M/yr			
Sales/Marketing	Passengers	$2.45	$2.98	$2.90
Insurance	Passenger miles	$.01	$.01	$.01
Administration	Costs except insurance	10%	10%	10%
Operating Profit	Direct costs: train crew, energy/fuel, station costs, sales & marketing, administration, insurance	10%	10%	10%

6.3.1 Units of Service and Related Cost Items and Assumptions

- Operating hours and train miles are based on the schedule developed for weekdays, Saturdays and Sundays for each technology/route option.

- Train miles are calculated based on the number of round trips per weekday, Saturday and Sunday, times the number of days, times segment miles, times one percent for deadhead. Timetable development, which is the basis for assessing train miles, car miles and operating hours, is described in Chapter 4, *Operating Plan Development*.

- Train miles are the basis for estimating track and ROW maintenance charges, on-board service crews and related on-board costs.

- Car miles are based on the anticipated consist for each service, with multiple consist adjustments possible to increase capacity as necessary. For example, for the 110 mph scenario from Chicago to Milwaukee, four express trips can be operated using four-car consists. In year 2010, two trips could be made using three-car consists, with seven trips in year 2020 using four-car consists (if necessary).

  – Fuel and train equipment maintenance costs are directly variable with car miles of service.

  – Fuel and train equipment maintenance vary for each technology based on weight, fuel type and operating characteristics.

- Operator hours are based on the scheduled service for each trip type (e.g., express vs. local) for each day type, rounded to whole or half shifts, times the number of days for each day type.

  – Train crew costs are estimated by multiplying operator hours times a factored unit cost that includes multipliers for fringe benefits, absenteeism (spare crews), and supervision.

- Passengers and passenger miles are based on COMPASS© output. The COMPASS© program and method of forecasting demand is described in Chapter 5.

  – Sales and marketing costs are estimated based on passengers.

  – Insurance costs were estimated for a base year using passenger miles for compatibility with Amtrak and other service providers. The aggregate figure for insurance was then converted to a "per passenger" cost for simplicity.

- Staffed versus unstaffed stations are distinguished on a minimum threshold basis of 100,000 passengers to required staff per year (based on the number of staffed and unstaffed stations in the MWRRI Study and passenger counts by station for 2010).

Exhibit 6.5 identifies the number of staffed and unstaffed stations for each option in 2020.

Exhibit 6.5
Comparison of Staffed and Unstaffed Stations by Option

	Base Case	B-1	B-2	C-2	D-3
Staffed	3	3	4	6	6
Unstaffed	11	10	9	6	6
Total	14	13	13	12	12

- Other: Administration and operating profit are estimated using the same categories and definitions as was done under the MWRRS.
  - Administration: 10% of all costs except insurance
  - Operating Profit: Built on directly-managed costs (train crew, station costs, sales and marketing, energy and fuel, administration and insurance), not items anticipated to be subcontracted.

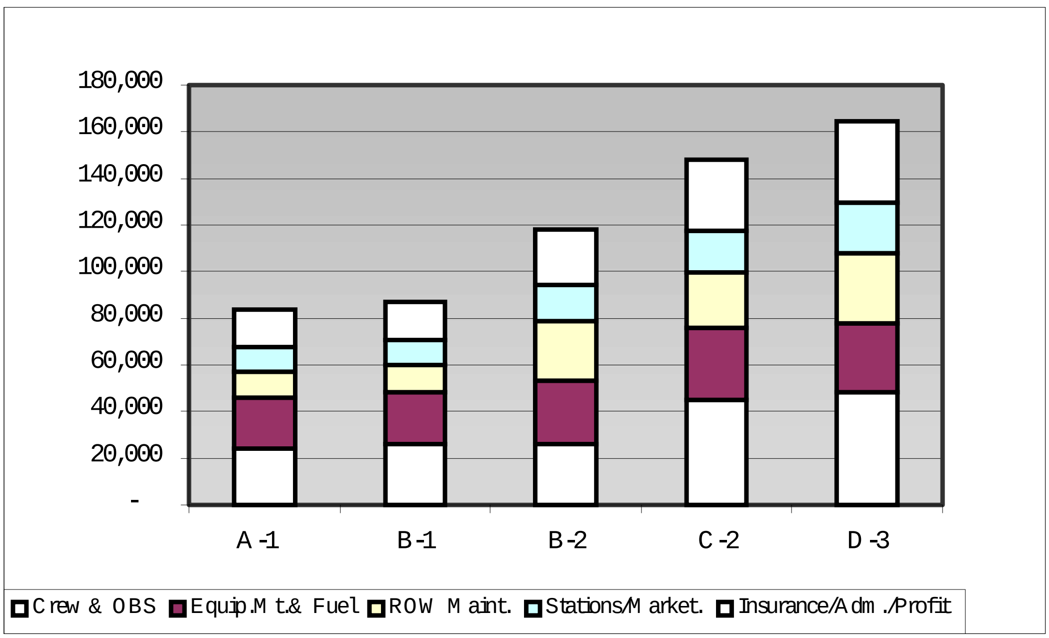
Exhibit 6.6 summarizes the 2020 operating cost for each alternative by cost category. Exhibit 6.7 summarizes operating cost by major category in graphic form.

Exhibit 6.6
Annual Operating Cost Summary
(1998 Dollars in Thousands)

Year 2020	Base Case 110 mph - River	B-1 110 mph - Rochester	B-2 150 mph - Rochester	C-2 150 mph – New Alignment	D-3 185 mph - Elevated
Train Crew	11,817	13,289	11,430	19,200	19,214
On-Board Service	5,730	6,370	9,104	17,146	21,527
Energy & Fuel	4,297	4,964	12,324	13,324	13,297
Equip. Maint.	16,723	18,493	21,236	23,460	25,594

Track/ROW Maint.	16,115	16,164	25,580	24,087	30,242
Terminal/Station Costs	5,493	4,350	4,560	4,940	4,940
Insurance	4,600	5,927	10,051	12,234	15,309
Sales & Marketing	10,456	8,909	12,427	14,984	19,154
Administration	4,418	7,254	9,666	11,711	8,442
Operator Profit	4,108	3,969	6,046	7,637	13,315
Total	**83,757**	**89,689**	**122,426**	**148,695**	**170,220**

Exhibit 6.7
Annual Operating Cost by Alternative for 2020
(1998 Dollars in Thousands)



All options examined for this study are forecast to have higher operating revenues than operating costs. The relationship between cost and revenue is fully discussed in Chapter 7, *Financial Analysis.*

6.4 ROLLING STOCK COST ANALYSIS

Train technology and costs per car are discussed in Chapter 2. The Operating Plan (Chapter 4) describes the train miles and train sets required to accommodate the passenger demand estimates. Exhibit 6.8 presents the number of train-sets, cars, cost per car, and rolling stock cost estimates related to each scenario. Rolling stock costs for the Base Case differ from current MWRRI estimates because the MWRRS is now based on the Talgo rather than DMU technology.

Exhibit 6.8
Rolling Stock Cost Estimate by Scenario Option
(1998 Dollars in Millions)

	Base Case 110 mph River	B-1 110 mph Rochester	B-2 150 mph Rochester	C-2 150 mph NewAlign	D-3 185 mph Elevated
# of Trainsets	12	12	19	19	21
# of Passenger Cars	82	87	147	174	156
Est. Cost/Car*	$1.43	$1.43	$2.39	$2.39	$1.62
Est. Rolling Stock	**$117.5**	**$124.2**	**$351.6**	**$416.3**	**$253.2**

* Cost per car adjusted to include cost of locomotives for 150 mph and 185 mph options.

6.5 INFRASTRUCTURE COST ANALYSIS

A capital investment estimate was developed by major segments for each route by applying specific unit costs to infrastructure elements estimated on the basis of conceptual planning for each route/technology option. Quantities were developed from initial engineering analysis, existing large scale mapping, and limited site verification without detailed surveys.

The unit costs for track infrastructure were derived primarily from the *Chicago/Milwaukee Rail Corridor Study of 1997* and *The Chicago to St. Louis High Speed Rail Capital Cost Estimates of 1993* completed for the Wisconsin and Illinois Departments of Transportation by Envirodyne Engineers, Inc. in association with Price-Waterhouse. These unit costs were validated by a subsequent study of high-speed rail operations in the Chicago to St. Louis corridor completed for the Illinois Department of Transportation by DeLeuw Cather & Co. in association with Sverdrup Civil, Inc. These unit costs also compared favorably to the infrastructure cost developed for the *Texas Triangle High Speed Rail Study* conducted by the Texas Turnpike Authority in 1989.

The specific unit costs are listed below by infrastructure element. A detailed estimate of the unit costs is included in Appendix 6.1. As shown, these unit costs included 7% for engineering and 15% for contingencies. For this study, the 1993 costs were increased by 2% per year for inflation to 1998.

Additionally, the following items were included in the unit costs:

- 3% for a Program Manager and/or a General Engineering Consultant.
- 4% for construction inspection/management during construction.
- 2% for owner management costs (i.e., alternative analyses and environmental studies).

6.5.1 Selected Route/Technology Options

From the range of possible investment scenarios for each technology option, an interactive analysis determined the optimum infrastructure investment for each technology. The optimum infrastructure investment was refined for the following routes and technology:

- Base Case 110 MPH via River
- Route B-1 110 MPH via Rochester
- Route B-2 150 MPH via Rochester
- Route C-2 150 MPH via Rochester (new alignment built to TGV standards, curves, separations)
- Route D-3 185 MPH via Rochester (new alignment, elevated).

6.5.1.1 Infrastructure Elements

A conceptual planning process was used to estimate the capital investment required for a route to support a given technology. The initial step was to identify the elements of the existing route infrastructure. The following are elements identified in this process: (1) track work; (2) stations, terminals, and maintenance facilities; (3) turnouts; (4) bridges – under; (5) bridges – over; (6) crossings; (7) signals; (8) curves.

Each infrastructure element includes several items requiring upgrading or construction to meet the route requirements of the selected high-speed rail technology. The specific unit costs for each item of work are listed below for each infrastructure element. The detail behind these unit costs is presented in Appendix 6.1.

Track Work

Item		Unit	Unit Cost Thousands of 1998 Dollars
1.0	Track work		
1.1	HSR on Existing Roadbed	Per Mile	$873
1.2	HSR on New Roadbed (Existing ROW)	Per Mile	$932
1.2A	HSR on New Roadbed (New ROW)	Per Mile	$1,376
1.2B	HSR on New Roadbed (Double Track)	Per Mile	$2,308
1.3	Timber & Surface w/ 33% Tie Replacement	Per Mile	$136
1.4	Timber & Surface w/ 66% Tie Replacement	Per Mile	$224
1.5	Relay Track w/ 136# CWR	Per Mile	$329
1.6	Siding	Per Mile	$802
1.7	Fencing	Per Mile	$49
1.8	Electrification	Per Mile	$991
1.9	Other Track Work Chicago to Milwaukee	Lump Sum	$212,917
1.10	Land Acquisition Madison	Per Mile	$5,000
1.11	Land Acquisition Urban	Per Mile	$294
1.12	Land Acquisition Rural	Per Mile	$98

Stations

Item		Unit	Unit Cost Thousands of 1998 Dollars
2.0	Stations		
2.1	Full Service – New	Each	$1,000
2.2	Full Service – Renovated	Each	$500
2.3	Terminal – New	Each	$2,000
2.4	Terminal – Renovated	Each	$1,000
2.5A	Maintenance (150 MPH technology)	Each	$86,000
2.5B	Maintenance (185 MPH technology)	Each	$162,000
2.6	Stations Chicago to Milwaukee	Lump Sum	$20,428

Turnouts

Item		Unit	Unit Cost Thousands of 1998 Dollars
4.0	Turnouts		
4.1	New #33 - 136# High Speed	Each	$555

Bridges - Under

Item		Unit	Unit Cost Thousands of 1998 Dollars
5.0	Bridges – Under		
5.1	Four Lane Urban Expressway	Each	$4,848
5.2	Four Lane Rural Expressway	Each	$4,036
5.3	Two Lane Highway	Each	$3,062
5.4	Rail	Each	$3,062
5.5	Minor River	Each	$812
5.6	Major River	Each	$8,118
5.7	Mississippi River	Lump Sum	$234,000
5.8	Interstate 90 Dakota River Valley Structure	Lump Sum	$74,000
5.9	Elevated Structure Milwaukee	Per Mile	$39,000
5.10	Elevated Structure St Paul	Per Mile	$39,000
5.11	Elevated Structure Chicago to Milwaukee	Per Mile	$39,000
5.12	Bridges Chicago to Milwaukee	Lump Sum	$97,152

Bridges-Over

Item		Unit	Unit Cost Thousands of 1998 Dollars
6.0	Bridges – Over		
6.1	Four Lane Urban Expressway	Each	10,516
6.3	Two Lane Highway	Each	1,971
6.4	Rail	Each	6,572
6.6	Tunnel (East and West Bound)	Per LF	10

Crossings

Item		Unit	Unit Cost Thousands of 1998 Dollars
7.0	Crossings		
7.1	Private Closure	Each	60
7.2	Rural w/ Quadrant Gates	Each	274
7.4	Full Width Barrier	Each	550
7.5	Crossings Chicago to Milwaukee	Lump Sum	71,510

Signals

Item		Unit	Unit Cost Thousands of 1998 Dollars
8.0	Signals		
8.1	High Speed Turnout	Each	1,098
8.2	System Installation for HSR (110MPH)	Per Mile	150
8.2A	System Installation for HSR (150MPH)	Per Mile	350
8.2B	System Installation for HSR (185MPH)	Per Mile	980
8.3	Signal Costs Chicago to Milwaukee	Lump Sum	46,877

Curves

Item		Unit	Unit Cost Thousands of 1998 Dollars
9.0	Curves		
9.1	Elevate & Surface Curves	Per Mile	42
9.2	Curvature Reduction	Per Mile	284
9.3	Elastic Fasteners	Per Mile	59

6.5.1.2 Capacity Analysis

A capacity analysis was performed to identify the likely impact of increased passenger train activity on the freight railroads, and what steps would be required to mitigate that impact. The freight railroads provided schedule and train data, field surveys were conducted to visually confirm freight bottlenecks, and an extensive computer simulation program was designed to identify the optimal locations for additional sidings to accommodate both freight and passenger train "meets". The study determined that passenger trains would have significant impacts on heavily-used freight lines in the long term. In particular, the rail corridor north of Madison is expected to be very congested, with the section along the river north of La Crosse experiencing the greatest capacity constraints.

To compensate for this constrained capacity, it was determined that substantial additional infrastructure investment would be required, beyond that planned in the original MWRRS analysis.

- The additional investment would apply to the Base Case and to B-1 (the 110 mph options). The investment consists of six ten-mile passing sidings, signal improvements, and additional track improvements at stations to permit passing on unimproved double-track segments. The incremental cost of this investment is estimated at $70 million. The Base Case infrastructure cost is now estimated at $822.7 million.
- For the B-2 150 mph option, with higher speeds and additional frequencies, it was determined that allowance should be made for an entire single track between La Crosse and Portage to accommodate passenger train operations. This represents an increase of $500 million from earlier estimates.

6.5.1.3 Infrastructure Cost

The infrastructure cost analysis was performed by applying the unit cost for an item of work to the physical quantity associated with each item of work. The estimated infrastructure cost by category is presented in Exhibit 6.9 by route and major category. Appendix 6.3 shows how the cost of each category is calculated.

Exhibit 6.9
Infrastructure Cost Estimate
(1998 Dollars in Millions)

	Base Case 110 mph River	B-1 110 mph Rochester	B-2 150 mph Rochester	C-2 150 mph New Align	D-3 185 mph Elevated
Track Work & Curves	$413.4	$562.6	$827.6	$1,020.9	$1,507.8
Bridges	110.9	264.1	999.9	1,839.2	5,886.6
Crossings	155.4	172.6	131.9	99.4	11.3
Stations & Maintenance Facilities	38.9	39.9	115.9	116.4	192.4
Signals & Communications	104.1	29.3	177.1	166.9	419.4
Freight Capacity*		70.2	500.0		
Total Estimated Cost	**$822.7**	**$1,138.7**	**$2,752.5**	**$3,242.8**	**$8,017.5**
Route Miles	426	451	451	429	429

*The freight capacity improvements are included within the Track and Signal & Communications categories for the Base Case in this Exhibit and in Appendices 6.2 and 6.3. The freight capacity costs are included in the financial analysis (Chapter 7) for B-1 and B-2 but are not disaggregated by category or included in the Appendices 6.2 and 6.3.

Appendix 6.2 contains complete details on improvements required for each route and for a given technology on a milepost basis or by coordinates. Appendix 6.2 is divided by route into the following sub-appendices: 6.2.1 (Base Case); 6.2.2 (B-1); 6.2.3 (B-2); 6.2.4 (C-2); 6.2.5 (D-3). Appendix 6.3 presents the following engineering computations for each route:

- Cost of each item of work by route.
- Cost of each item of work by segment for each route.
- Items of work for track by milepost and by segment for each route.

- Items of work for stations and maintenance facilities for each route.
- Items of work for bridges identified by mileposts or coordinates for each route.
- Items of work for crossings identified by mileposts or coordinates for each route.
- Items of work for curves identified by mileposts for each route.

Appendix 6.4 provides conceptual engineering bridge plans, and Appendix 6.4 details track improvements and alignment issues.

6.6 SUMMARY

This chapter detailed the development of the various revenues and associated costs for that support system operation.

Revenue sources include fares, with estimates for air-connect revenue, on-board service revenue, and parcel revenue. Operating unit costs were refined from other studies to reflect Tri-State Study requirements, while retaining most MWRRS assumptions for the Base Case. In all cases, all options examined for this study are forecast to have higher operating revenues than operating costs.

Estimated rolling stock costs were developed based on the technology assessment and the operating requirements. The infrastructure cost analysis describes the unit cost approach to the assessment, and provides segment and unit cost detail in extensive Appendices. It also describes the interactive approach used to determine the optimum infrastructure investment for each technology.

Exhibit 6.10
System Summary Costs
($ in Millions)

	Base Case 110 mph River	B-1 110 mph Rochester	B-2 150 mph Rochester	C-2 150 mph NewAlign	D-3 185 mph Elevated
Operating Revenue (2020)	**135.2**	**144.6**	**294.4**	**361.8**	**480.3**
Operating Cost (2020)	**83.8**	**89.7**	**122.4**	**148.7**	**170.2**
Rolling Stock	**117.5**	**124.2**	**351.6**	**416.3**	**253.2**
Infrastructure Investment	**822.7**	**1,138.7**	**2,752.5**	**3,242.8**	**8,017.5**

TABLE OF CONTENTS

7.1 OVERVIEW

Financial and economic analyses were performed to compare the feasibility of the four route/technology options for the Tri-State Corridor subsequent to implementation of the Base Case. The analyses reviewed the direct merit of each option based on associated financial and economic returns. The results provide an excellent case for developing a high-speed rail system in the Tri-State Corridor. This chapter discusses the Financial Analysis in detail. Chapter 8 discusses the Economic Analysis.

7.1.2 Structure of Financial Analysis

The financial analysis was performed using the *RENTS*© financial model, which has been widely used to analyze rail, air and port projects throughout North America. The financial analysis included the following components:

- Development of a financial model for the Tri-State Corridor, incorporating revenues, capital costs, and operating/maintenance costs (in 1998 dollars) over the forecast period.
- Cash flow projections for revenues, capital costs, and operating/maintenance costs for the forecast period, including the impact of debt financing.
- Net cash flow analysis for each of the four options using the following financial measures:
  - Internal Rate of Return (IRR), which measures return on investment.
  - Net Present Value (NPV), which measures financial surplus associated with any given investment.
- Sensitivity analyses of key factors that could impact the financial results.

7.2 FINANCIAL MODEL DEVELOPMENT

In order to evaluate the longer-term development of high-speed rail for the Tri-State Corridor, the financial analysis explored the advantages of developing four route/technology options (Options B-1, B-2, C-2 and D-3) subsequent to the Base Case. With regard to these incremental options, the infrastructure capital costs reflect the consequential benefits (cost savings) that would result from the implementation of the Base Case. The following route/technology options were analyzed:

Base Case:

- Route A-1 110 MPH via River

Incremental Options:

- Option B-1 110 MPH via Rochester
- Option B-2 150 MPH via Rochester
- Option C-2 150 MPH via Rochester, new alignment
- Option D-3 185 MPH via Rochester, new alignment, elevated

7.2.1 Revenue and Operating and Capital Cost Assumptions

The financial model expressed operating costs and revenues in constant 1998 dollars by calendar year. All interest rates used are real rates. The analysis projected travel demand, farebox revenue, and operating and maintenance costs for 2003, 2010, 2020, 2030 and 2035. Operating costs and revenues in intervening years were projected on the basis of interpolations, reflecting projected ridership growth. Uncertainties associated with fluctuations in economic conditions and other factors may cause material variations and are addressed as part of this chapter in the sensitivity analysis, Section 7.5.

7.2.2 Ridership and Revenue Forecasts

Ridership and revenue forecasts were prepared for each option for the agreed forecast horizons: 2003 (Base Case), 2010, 2020, 2030 and 2035. Annual data was interpolated from these figures, including revenue from passenger fares, onboard services and priority parcel service. A six-month transition period is anticipated during which ridership increases from zero to approach the passenger level forecasts. The economic scenario for the ridership forecasts assumed existing socioeconomic trends for income, population and employment growth would continue throughout the region. The competitive market analysis assumed current trends in auto, air and bus modes would also continue.

7.2.3 Operating Expenses

The operating and maintenance expense categories were defined as equipment, track and right-of-way maintenance, administration, fuel and energy, train crew, and other relevant expenses. A profit factor was included for all expenses, including the primary work of the system operator.

7.2.4 Capital Costs

Capital costs included costs to acquire rolling stock and to make infrastructure improvements such as track, fencing, signaling, grade crossings, maintenance facilities, and stations. Capital costs were based on projected construction costs and rolling stock requirements, and estimated requirements for additional capacity for the Base Case and Options B-1 and B-2, from the freight capacity analysis.

7.2.5 Conceptual Implementation Period

The financial analysis incorporated revenue and cost assumptions according to the assumed year of implementation: In 2003 - Base Case; in 2012 - Incremental Options. Full service with respect to operating expense is assumed to begin on “day one” and increase over time relative to growing equipment requirements caused by increased demand. As noted above, revenues for the first year will be approximately one-half the full expected value, representing the ridership transition. It was also necessary to identify financial requirements during the construction period for each option. Rolling stock was assumed to be purchased the year before operations begin so that commissioning, testing and training could occur in a timely manner. Assumptions made for the financial analysis regarding project implementation are shown in Exhibit 7.1.

Exhibit 7.1
Implementation Assumptions
Base Case and Incremental Options

		Base Case	Option B-1	Option B-2	Option C-2	Option D-3
Timing Data						
Construction & Testing Duration		3 Years	3 Years	3 Years	5 Years	5 Years
First Year of Construction		2000	2009	2009	2007	2007
First Year of Operation		2003	2012	2012	2012	2012
Construction Phasing Percent Per Year		25/50/25	33/34/33	33/34/33	20/20/20/ 20/20	20/20/20/ 20/20
Capital Costs (Millions of 1998 $)						
Incremental Infrastructure		$ 822.7	$ 456.14	$ 2,252.20	$ 2,742.54	$ 7,966.09
Rolling Stock		117.53	124.22	351.56	416.26	253.24
Total		$ 940.23	$ 580.36	$ 2,603.76	$ 3,158.80	$ 8,219.33

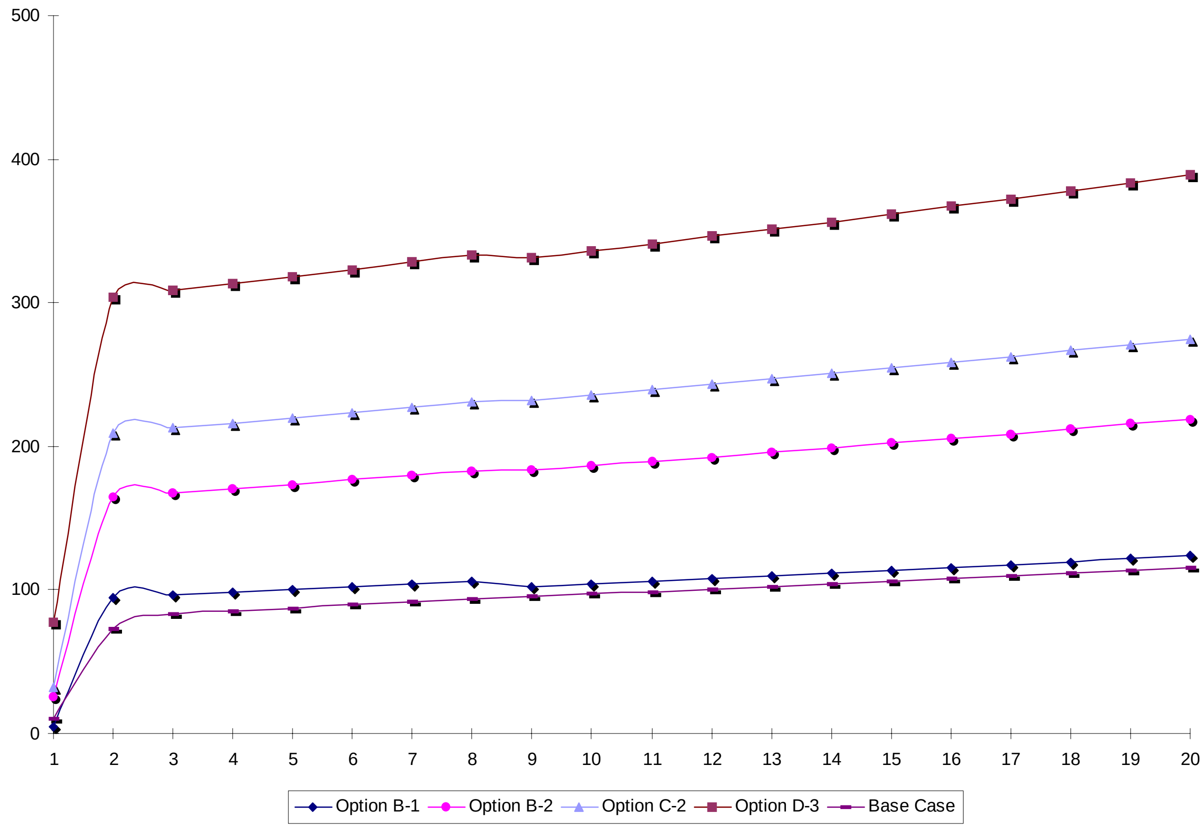
7.3 CASH FLOW PROJECTIONS

7.3.1 Results of Operations

Appendix 7.1 provides a detailed Pro Forma Statement of Operations (7.1.1), Cash Flows from Financing (7.1.2), and Pro Forma Cash Flows (7.1.3) for each option for the forecast period.

Applying the assumptions discussed previously, the financial analysis forecasts that all options considered for the Tri-State Corridor will become profitable on an operating basis in the first year of service. These projections assume all fixed and non-volume-related operating costs for each corridor segment as fully incurred, beginning in the year the option is implemented. Therefore, while volume-related expenses increase due to increased passenger levels, the overall operating cost ratio for each option improves as the Tri-State Corridor matures. Exhibit 7.2 shows net cash flow from operations for the first 20 years of operation for the Base Case and incremental options.

Exhibit 7.2
Net Cash Flows from Operations
Base Case and Incremental Options



7.3.1.1 Operating Cost Ratio

The ratio of annual revenues to annual operating costs denotes the financial merits of each option considered for the Tri-State Corridor. The revenue and operating cost estimates indicate that these options will likely generate a substantial operating surplus from the onset and such operating surplus will grow strongly as the system matures. Thus, it is highly unlikely the options will require operating subsidies. Exhibit 7.3 displays the operating cost ratio for each option in 2020.

Exhibit 7.3
Operating Cost Ratios Forecast for 2020

Option		Operating Cost Ratio
Base Case	110 mph via River	1.61
Option B-1	110 mph via Rochester	1.61
Option B-2	50 mph via Rochester	2.40
Option C-2	150 mph via Rochester, new alignment	2.43
Option D-3	185 mph via Rochester, new alignment, elevated	2.82

7.3.2 Analysis of Debt Financing

This section provides the key assumptions related to debt financing, a discussion of procedures used to analyze them, and the results of that analysis. Like most infrastructure projects, the large amount of capital investment required for each option dictates long-term financing. No allowance was included in the financial projections for residual value at the end of the forecast period. Detailed schedules of cash flows from debt financing are included in Appendix 7.1.2.

7.3.2.1 Financing Assumptions

Bonds are the principal source of financing for state matching funds considered in this analysis. Depending on the chosen operating structure, taxable or tax-exempt debt would fund a portion of the capital costs of the proposed Tri-State Corridor. The financing alternative incorporated in the financial analysis was based on tax-exempt revenue bonds and related interest rates. It was assumed that bonds would be issued as necessary to meet the state capital funding required by the implementation plan and, additionally, that federal funds would be allocated on the basis of equal payments for each year of the implementation period. It was also assumed that cash flows from operations would not be the source of bond repayment.

The analysis also incorporated the effect of two cash management techniques. One technique, delayed/tapered state match, can be negotiated with the federal agency funding the project. The second technique is the issuance of grant anticipation notes (GANs), as discussed in Chapter 8. GANs are incorporated in the projections to provide for any cash shortfalls that may occur between the level of federal funding and the requirements for funding the capital investment in rolling stock and infrastructure.

7.3.2.2 Estimated Level of Debt

The size of the bond issue is based on the projected capital requirements under the implementation plan. It is assumed that 80 percent of the projected capital requirements will be funded by public funds (i.e., federal grants) and the balance funded by the states through the issuance of bonds. Additional factors included in determining the amount of the bonds are issuance costs, debt service reserve fund requirements, and interest earned on the reserve funds. The bonds are combined with GANs and other public funding to meet the annual capital cost and financing requirements during the project's construction and implementation phases.

7.3.2.3 Borrowing Term

Debt service on capital cost financing is calculated on a level debt service basis over 25 years commencing in 2002 for the Base Case and 2011 for the four options. Bond issuance is assumed to take place on January 1st of the relevant year with principal repayments beginning 12 months after the option is entered into service.

7.3.2.4 Borrowing Rates

Bond rates were based on a review of historical interest rates and the most recent general obligation bond ratings for the three states, which are centered around an "AA" rating. The bond market is currently priced at historically low levels. Therefore, projected interest rates were based on a market analysis of revenue bonds and their relationships to 30-year U.S. Treasury bonds over the last five years. Based on this analysis, the revenue bond rate is assumed to be 5.5 percent (real), and the rate on the GANs is set at 4.0 percent (real).

7.3.2.5 Reinvestment Rates

It was assumed that debt service reserve and surplus funds will be reinvested based on the following rates. The short-term reinvestment rate is 1.5 percent (real). This is a conservative assumption reflecting lending rates over the past two years. The long-term reinvestment rate is 3 percent (real).

7.3.2.6 Issuance Fees

The cost of issuing bonds was assumed to be 1.5 percent of the total bond issue, which includes all standard issuance fees. Issuance costs on the GANs were projected at 1.0 percent.

7.3.2.7 Debt Service Reserve Fund

Debt service reserve funds equal to 100 percent of annual debt service (principal and interest) are maintained. There are no debt service reserve fund requirements for the GANs.

The major financing assumptions described above are summarized in Exhibit 7.4.

Exhibit 7.4
Financing Assumptions

Category	Assumptions
Bond Issuance	2002 – Base Case 2011 – All remaining options
Capital Funding	Based on implementation plan
Investment Rate	1.5% short-term/3% long-term (real)
Term	25 years, annual payments
Principal Deferment on Bonds	None
Issuance cost	Bonds – 1.5% of issuance amount GANs – 1.0% of issuance amount
Interest Rates Revenue Bonds (Tax-exempt) Grant Anticipation Notes (GANs)	 5.0% (real) 4.0% (real)

7.4 CASH FLOW ANALYSIS

Using the data and assumptions discussed, financial projections were developed to evaluate the incremental route/technology options. The analysis used a Discounted Cash Flow analysis and the financial model established for the study. The projections were used to examine projected cash flows for each incremental option based on the implementation schedule and projected financing requirements.

7.4.1 Cash Flow Projections

The estimated revenue and cost figures were incorporated into a schedule for each route/technology option. Net revenues were defined as farebox, onboard, and priority parcel revenues, less operating and maintenance costs. The projected cash flow also assumed that five percent of positive net cash flow from operations on a system-wide basis would be transferred to a capital reserve account and used for system expansion or other purposes. The balance of positive cash flows would be disbursed to participating states based on an agreed-upon allocation method. However, the flow of funds depicted in the cash flow statements does not reflect any distribution of system net revenues to participating states. Cash flows for each option were compared to the Base Case, generating an incremental cash flow analysis.

The net cash flow analysis for each of the route/technology options produced two financial measures to ensure that financial viability was effectively represented in the financial analysis. These financial measures are the Modified Internal Rate of Return (MIRR), which measures return on investment over the forecast period, and Net Present Value (NPV), which measures the financial surplus or deficit associated with the net cash flows for any given cost of funds. MIRR is employed, rather than IRR, due to the nature of the cash flows and changing signs (positive-negative-positive.) For the MIRR, the reinvestment of funds is conservatively estimated at 5%.

7.4.2 Financial Model

The *RENTS*© Financial Model is based on an analysis of Discounted Cash Flow (DCF). The DCF is an extended stream of cash flows and can be written as:

$$PV = \sum C_t / (1 + r)^t$$

where

PV	=	Present value
C_t	=	Cash flow
r	=	Opportunity cost of capital (discount rate)
t	=	Time period

7.4.3 Discount Rate

The discount rate is the financial return foregone by investing a given amount of funds in a project (such as the Tri-State Corridor) rather than securities. A 3.5 to 5.0 percent real rate is normally used for government transportation projects. For this study, a real rate of 5.0 percent was used as the discount rate.

7.4.4 Measures of Financial Performance

From the Discounted Cash Flow formula, Net Present Value (NPV) and Modified Internal Rate of Return (MIRR) were calculated. Net Present Value measures the combined worth of all cash flows (positive and negative) associated with a project at a given point in time. For this study, the NPV included incremental revenues, operating and maintenance costs, and finance costs for capital.

Net Present Value, stated in terms of cash flow, is:

$$NPV = C_O + PV$$

where

C_0 = Initial cash outflow (capital)

PV = Present value of cost and revenue streams that result from the operation of the project (discounted to the first year of the project)

A positive NPV shows that an investment generates more income than it costs; a negative NPV shows that it costs more than the income it generates.

The Modified Internal Rate of Return is defined as the rate of interest that makes Net Present Value equal to zero. Reinvestment of funds is set at 5%. As such, the Modified Internal Rate of Return achieved should be judged against the required discount rate, which was set at five percent for the Tri-State II Study. An MIRR value above the discount rate is defined to mean the project would be financially viable, while an MIRR below the discount rate means a project would not achieve the desired financial return.

7.4.5 Results of the Financial Analysis

The financial analysis presented a very strong case for developing high-speed rail for the Tri-State corridor beyond the MWRRI base of 110 mph. Service through Rochester is clearly warranted, as service along the river cannot be developed effectively beyond 110 mph. Highlights of the analysis are as follows:

- The financial results demonstrate that Option C-2 (150 mph through Rochester on a new alignment) presents the greatest net present value (NPV), and the highest internal rate of return.
- Service through Rochester offers an additional advantage of bypassing the CP Railway line along the river, which is projected to have increased freight volume as railroad consolidations continue.
- The investment in track right-of-way and infrastructure improvement necessary for 150 mph technology (Option C-2) would result in increased ridership and revenues.
- Option B-2 (150 mph technology on current alignment) is less effective than C-2, because it cannot take full advantage of potential speed due to congestion, extensive deceleration/acceleration for curves, and other track and right-of-way conditions. This is demonstrated by a lower NPV and MIRR.

The financial results for the route/technology options are summarized in Exhibit 7.5.

Exhibit 7.5
Results of Financial Analysis
(Discount Rate 5% Real)
Millions of 1998 $

Route/Tech. Options	Revenues	O&M	Operating Income	Interest Cost	Net Cash Flow (NPV)	MIRR
Option B-1	$ 168.8	$ 33.1	$ 135.7	$ 135.4	$ 0.3	5.0%
Option B-2	$ 2,215.6	$ 504.2	$ 1,711.4	$ 607.4	$ 836.2	17.6%
Option C-2	$ 3,158.3	$ 869.1	$ 2,289.2	$ 736.8	$ 1,183.1	18.3%
Option D-3	$ 4,790.0	$ 1,131.9	$ 3,658.1	$ 1,917.3	$ 1,180.0	14.6%

The financial evaluation shows that Option C-2 has the highest Modified Internal Rate of Return, followed by Option B-2. In terms of Net Present Value (NPV - the criterion more commonly used when comparing options), Options C-2 and D-2 have almost identical results. As a result, it can be concluded that once the MWRRI investment is made, there is a good case by 2012 to include the Rochester reroute for the corridor. Furthermore, if funds are available, the development of the corridor to 150 mph using the American Flyer gas turbine technology on a separate right of way from the congested CP Railway freight line would make good sense. The capacity analysis confirms this conclusion.

7.5 SENSITIVITY ANALYSIS

In order to assess the impact of different factors contained in the financial analysis, a sensitivity analysis was performed on key factors. These include capital cost, interest rates, revenues and Operating and Maintenance (O&M) costs.

It should be noted that the capital costs for this project have been estimated to a ±30 percent level. As a result, analysis has been made of costs varying by this level of error. Since a fall in capital would only improve the performance of the project, the estimate has been made to only the downside risk of increasing capital costs by 30 percent.

Variations in revenue and ridership are extremely important and emphasize the need for further forecast refinement. A sensitivity analysis was conducted on revenue using the assumption that revenue per passenger remains constant. This passenger revenue analysis assessed the impact of different fare structures and operation schedules. Should ridership decrease or increase, any purchases of rolling stock would likely be deferred or increased.

The risk related to prevailing interest rates is two-fold: Interest rates during the construction phase and during the period of debt repayment. Post-construction risk can be reduced using fixed rate debt. In addition, given the reliance placed on state-issued bonds for developing the Tri-State Corridor, any adverse legislative or regulatory changes related to such financing would have a significant impact on the cost, availability and financing terms.

Various sensitivity analyses were conducted and the following conditions were evaluated:

± 50 percent on interest rates

± 30 percent on capital costs

± 25 percent on revenue estimates

± 25 percent on operating and maintenance costs

The detailed schedules resulting from the financial analysis (Appendix 7.2) illustrate the sensitivity of variations in revenue, operating and capital cost. Exhibit 7.6 summarizes the results of particular sensitivity assessments for the incremental route/technology options. In terms of sensitivity to operating cost and revenue items, the financial analysis results are more sensitive to changes in revenues than specific types of operating costs

The results presented in Exhibit 7.6 indicate how variations to the underlying assumptions affect the results of the financial analysis. Both public and private sector contributions toward projected capital costs (*e.g.,* stations) can have a significant impact on cash flow requirements of the financing alternative selected, since these contributions would affect the amount of debt required to be financed.

Exhibit 7.6
Incremental Sensitivity Analysis
(Millions of 1998 Dollars)

		Base Case		Capital Costs ±30%		Interest Rates ±50%		Revenue ±25%		O & M Costs ±25%	
		MIRR	NPV	MIRR	NPV	MIRR	NPV	MIRR	NPV	MIRR	NPV
Option B-1 Incremental	Plus	1.6%	$ (11.6)	-9.7%	$ (45.5)	-14.2%	$ (62.1)	8.8%	$ 19.9	0.3%	$ (17.8)
	Minus			9.9%	$ 22.2	11.7%	$ 38.9	-10.6%	$ (43.0)	3.2%	(5.4)
Option B-2	Plus	17.3%	$ 729.5	15.4%	$ 565.3	15.9%	$ 502.9	19.1%	$ 1,142.8	16.8%	$ 635.5
Incremental	Minus			19.5%	$ 893.8	18.4%	$ 956.1	14.2%	$ 316.2	17.8%	$ 823.6
Option C-2	Plus	17.8%	$ 1,034.3	15.9%	$ 832.2	16.6%	$ 759.4	19.5%	$ 1,623.5	17.1%	$ 872.2
Incremental	Minus			19.9%	$ 1,236.5	18.7%	$ 1,309.2	14.6%	$ 445.1	18.3	$ 1,196.5
Option D-3	Plus	14.2%	$ 1,069.2	11.2%	$ 571.1	10.6%	$ 353.9	16.5%	$ 1,962.8	13.5%	$ 858.1
Incremental	Minus			17.0%	$ 1,567.4	16.1%	$ 1,784.6	8.7%	$ 175.6	14.9%	$ 1,280.4

7.6 SUMMARY

The results of the financial analysis reveal a sound case for high-speed rail in the Tri-State Corridor. The financial returns suggest that the immediate implementation of the Base Case can easily be supported, along with the incremental implementation of Option C-2 (150 mph via Rochester). In strict financial terms, there is little doubt that the Tri-State Corridor offers a significant opportunity for high-speed rail investment.

As this financial analysis demonstrated, the critical issues are the investment costs and potential revenue enhancement. The current evaluation suggests that service through Rochester is warranted by 2012 and that this should be provided using the 150 mph option with a separate alignment. The value of the 150 mph option is that it builds an entirely separate right of way for passenger rail and alleviates the need to use the CP Railway freight line, which will undoubtedly become an increasingly significant freight route. As demonstrated in the capacity analysis, an alternative alignment through Rochester may be necessary in the near future in order to provide reliable high-speed train service under any technology alternative.

TABLE OF CONTENTS

8.1 OVERVIEW

Implementation of the Tri-State System will provide a wide range of benefits that will contribute to economic growth within the three states. The system would strengthen the growing manufacturing, service, and tourist industries in the region through increased mobility and connectivity between large and small urban areas.

Regardless of the financing source, an investment in high-speed rail will be advantageous to both current users and non-users of the system. It should be noted that the economic benefits identified in this analysis were specific to high-speed rail and did not take into account those benefits that could be generated via alternative transportation investments. Other investments (airports, highways, etc.) would also produce economic returns that could be larger or smaller than those identified in this high-speed rail analysis.

8.1.1 Structure of Economic Analysis

A quantitative economic analysis was performed using outputs from the *COMPASS©* demand model. Qualitative benefits were identified consistent with the FRA study, *"High Speed Ground Transportation in America."* The economic analysis examined each option with respect to benefits to users, benefits to users of other modes, and other benefits, as follows:

- Quantification of user benefits by means of consumer surplus calculation, including definition of NPV, benefit/cost ratio, and capital constrained consumer surplus.
- Qualitative analysis of benefits to users of other modes (air, bus, highway, and commuter and long-distance passenger rail users), resource benefits, and environmental benefits.

An analysis was performed using the *RENTS©* model that quantified the economic costs of the passenger rail system in terms of user benefits. This type of analysis focuses on user, rather than community benefits, avoiding "double counting" of benefits. It also provides a reasonably accurate estimate of the probable monetary return to the communities served by the passenger rail system, and is consistent with FRA requirements for economic analysis. Additional community benefits are discussed in qualitative, rather than quantitative terms.

8.2 USER BENEFITS

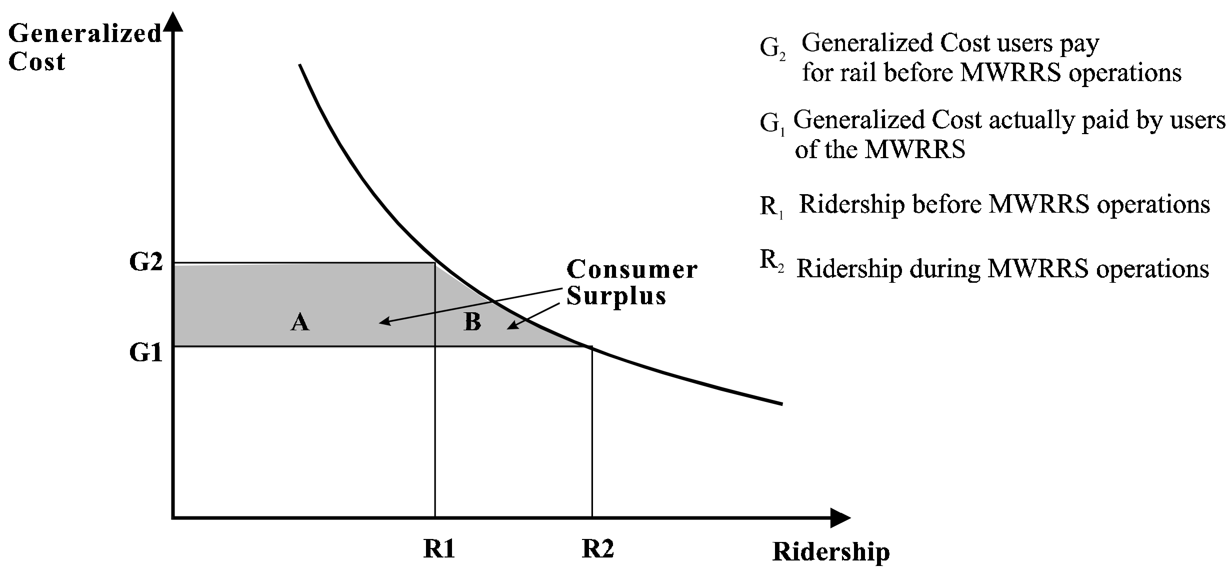
Benefits to users of the Tri-State Corridor are measured by calculating the consumer surplus, which is the “surplus” benefit individuals receive from the purchase of a given commodity or service. Consumer surpluses exist because individuals receive “more” benefit (surplus) from a product or service than they pay in fares. The same consumers will also pay for the system through taxes. Consumer surplus measures the effect of a transportation improvement (i.e., a new passenger rail system) by estimating the user benefits in terms of reduced travel time and costs (Exhibit 8.1). These user benefits apply to both existing and new rail travelers who are induced (made no prior trips) or diverted (previously used a different mode) to the new passenger rail system.

The user benefit analysis for the Tri-State Corridor was based on the Values of Time used in the *COMPASS*© demand model for the ridership and revenue forecasts. These Values of Time are well within a realistic range, giving estimates that reflect average wage rates in the Tri-State area. This finding is consistent with previous academic and empirical research on values of time.

The equation for consumer surplus is as follows:

$$\text{Consumer Surplus} = (G_2 - G_1) * R_1 + (G_2 - G_1) * (R_2 - R_1) / 2$$

Exhibit 8.1
Consumer Surplus Concept



The *COMPASS*© demand model estimates consumer surplus by calculating the increase in regional mobility (*i.e.*, induced traffic) and traffic diverted to rail (Area B in Exhibit 8.1), and the reduction in travel cost measured in terms of generalized cost for existing rail users (Area A). The reduction in generalized cost is the increase in the passenger rail user benefit.

The improvement in generalized cost for high-speed rail includes both time and fare savings; i.e., improvements in time and frequency for existing rail users; lower fares for current air travelers; improved times for bus and auto users. In some cases, individuals may pay higher fares (i.e., existing rail users), but the improvement in time more than compensates given the Values of Time and Frequency that individuals in the Tri-State Corridor use to make travel decisions.

If the Gross Consumer Surplus is measured in constant 1998 dollars for the project life, the present value of the economic benefits can be determined by discounting at an appropriate value. For this analysis, present values were determined by discounting at a real rate of 5.0 percent, which is a conservative assumption given current conditions of historically low interest rates.

Capital Constrained Consumer Surplus measures the return relative to capital invested. All options generate a positive return on capital per dollar invested. Capital investments in the Base Case not requiring replication were considered as "sunk costs;" the incremental infrastructure investment was calculated for NPV, benefit/cost ratio, etc. The results of this analysis are shown in Exhibit 8.2.

Exhibit 8.2
Incremental Economic Analysis Results for Route/Technology Options
(1998 Dollars in Millions)

Route/ Technology Option	Gross Consumer Surplus PV(1)	Additional Revenue PV(1)	Total Capital & Operating Costs(1)	Project NPV	Benefit/ Cost Ratio	Capital Constrained Consumer Surplus(2)
Option B-1	$321.2	$168.8	$ 484.6	$5.3	1.01	0.01
Option B-2	$1,899.9	$2,215.6	$ 2,535.8	$1,579.7	1.62	0.78
Option C-2	$2,628.9	$3,158.3	$ 3,445.3	$2,341.9	1.68	0.91
Option D-3	$5,775.9	$4,790.0	$7,892.6	$2,673.3	1.34	0.40

(1) *Discount Rate 5% real, Millions of 1998 $*
(2) *Ratio of NPV benefit to total capital costs*

The Benefit/Cost Ratio analysis shows the ratio of benefits to costs is greater than 1 for all options, a clear indication that the Tri-State II High Speed Rail corridor investments will have a very positive impact on the regional economy.

- Option C-2 yields the highest Benefit/Cost Ratio and Capital Constrained Consumer Surplus ratio. It yields the second-highest Project Net Present Value. This suggests that the second investment phase beyond the MWRRI should include a new alignment route to Rochester and use American Flyer technology.
- The DMU technology in Option B-1 (as demonstrated by the Benefit/Cost Ratio and Capital Constrained Consumer Surplus) provides limited value as a fallback option to the American Flyer on a new alignment. It is close to the Base Case in the characteristics of riders, revenues, costs, and benefits, so the incremental benefit is limited.
- TGV technology, which involves high urban infrastructure costs, provides the best project NPV despite its high capital cost. It could well prove to be a good third phase of investment after 2020.

8.3 OTHER BENEFITS

As noted in the FRA study, "*High Speed Ground Transportation in America*," there is a series of additional benefits attributable to implementing a passenger rail system. These include benefits to users of other modes, resource benefits, enhancements to commuter and long-distance passenger rail services, environmental benefits, and rail transportation safety and productivity improvements.

8.3.1 Benefits to Users of Other Modes

In addition to the user benefits generated by the Tri-State Corridor, travelers using other modes also benefit from system implementation. The Gross Consumer Surplus measured in this analysis considered only rail travelers. Air, bus and auto travelers would also benefit from reduced congestion and delays at airports/terminals and on highways. An evaluation of these benefits would require a detailed appraisal of each mode, which is beyond the scope of this study.

8.4 RESOURCE BENEFITS

Implementing any transportation project impacts resources used by travelers. The introduction of the Tri-State Corridor and ensuing reduction in airport congestion will result in resource savings to airline operators and reduced air pollutant emissions for all non-rail modes. These savings will be offset (at least partially) by the increased use of resources by the rail system.

8.4.1 Commuter and Long Distance Passenger Rail

Infrastructure improvements will enable long-distance passenger rail services (both commuter rail and Amtrak) to achieve faster schedules where track is shared with the Tri-State Corridor. This will generate time-savings for existing passengers, as well as attract new riders.

8.4.2 Environmental Benefits

Using the Tri-State Corridor instead of current dominant travel modes (auto and air) may promote numerous environmental benefits in addition to those previously mentioned. These benefits include:

- More efficient land use
- Decreased noise pollution
- Conservation of hydrological characteristics
- Maintaining visual landscape
- Preservation of natural flora and fauna

8.4.3 Rail Transportation Safety and Productivity Improvements

Improvements to the Tri-State Corridor infrastructure will increase rail safety and productivity both internally and for regional commuter, long-distance, and freight rail services. Improved railway crossings and signaling systems will also result in increased highway safety.

8.5 SUMMARY

The economic analysis provided a strong case for high-speed rail service in the Tri-State Corridor. Most of the technology/route options in the economic analysis generated significant economic benefits in terms of consumer surplus. The net economic benefits (economic profit) produced by the Tri-State Corridor include substantial growth in employment and per capita income, commercial property values and rents, and regional tax base increases. These benefits in employment, income and property values should not be construed as over and above the user benefits, but rather are the mechanisms by which user benefits will be incorporated into the regional economy.

All options have a positive NPV and a Benefit Cost Ratio greater than one. Option C-2, 150-mph service through Rochester on a new alignment has a project NPV second only to the 185-mph option. It demonstrates the highest benefit/cost ratio and the highest capital-constrained value or NPV compared to capital cost.

TABLE OF CONTENTS

9.1 OVERVIEW

Implementation of the Tri-State Corridor will require the states to develop a financing plan to fund the required capital costs. This plan will require a financial commitment from each state participating in the Tri-State system with regard to the agreed institutional arrangement and allocation method. Funding is available from a broad range of transportation revenue streams and will require a coordinated effort to review all potential sources and pursue funding.

9.2 FUNDING ALTERNATIVES

Many innovative financing concepts for transportation projects are being proposed and achieved at state and local levels throughout the U.S. These projects include privatization or turnkey operations (i.e., design-build-operate projects), public/private partnerships, incorporating federal funds and federal credit enhancements in state and local projects, and establishing state infrastructure banks. In addition, bond issuance and leasing are options for increasing or leveraging funds to finance the required state contributions.

9.3 FEDERAL FUNDING PROGRAMS

There are currently a number of Federal programs administered by the Federal Transit Administration (FTA) and the Federal Railroad Administration (FRA) that fund passenger rail research, planning, and corridor development. Many of these programs originated with the Intermodal Surface Transportation and Efficiency Act (ISTEA) and the Swift Rail Development Act. In June 1998, President Clinton signed into law the Transportation Equity Act for the 21st Century (TEA-21). This law refined existing programs and created new programs, such as the Transportation Infrastructure Finance and Innovation Act of 1998 (TIFIA).

9.3.1 Federal Transit Programs

The FTA funds capital and operating programs for public transit services throughout the U.S. There are two major types of FTA grant programs: *formula grants*, which fund operations/maintenance and capital programs (predominately for system preservation), and *discretionary grants*, which fund larger capital projects such as new starts, system rehabilitation, and system expansion. Discretionary grants, particularly for major fixed guideway projects, are limited to available funding, and many transit agencies compete for these funds. Typically, the total funds requested by transit agencies for capital purposes greatly exceed available funding. Grants are awarded partially on the basis of relative cost-effectiveness, level of state/local funding contributions, and other quantitative performance factors.

9.3.2 Major Capital Investment Program

The Capital Investment Grants and Loans Program is included under federal transit programs in TEA-21 (Section 3009). This funding program is for construction of new fixed guideway (rail, bus) projects and extensions to existing fixed guideway systems. Funding is reserved annually by Congress based on the authorization/reauthorization process. Grants made to states and local agencies fund up to 80 percent of new project costs, based on negotiations between federal and state/local agencies. Projects must compete for funding using federal criteria to justify the major investments involved. Competition for this program funding is intense. The potential to receive Section 3009 funds improves as the cost-effectiveness of the project improves and as the level of state/local funding for the project increases above the 20 percent minimum, with federal funding levels decreasing proportionately.

9.3.3 Flexible Highway Funds

TEA-21 continues the 1991 ISTEA provision that enables state and local governments to transfer a portion of federal highway funds to transit use based on local needs. Federal highway funds, which can be transferred and used for transit purposes, include the Surface Transportation Program (STP) and the Congestion Mitigation and Air Quality Improvement Program (CMAQ).

- STP is the largest category of flexible funds and may be used for all projects eligible for funding under current FTA grant programs except Formula Grants. STP funds can be used to upgrade facilities that support local/regional commuter rail or connecting transit services. Presently, however, the funds cannot be used for intercity passenger rail projects, so funding for the Tri-State Corridor under this program may depend on capital investments meeting the requirements. Safety set-aside funds equivalent to FY 1991 funds for the Hazard Elimination and Railway-Highway Crossing Programs (23 USC 130 and 152) may not be transferred.

- CMAQ funds, which are used to support transportation projects that result in improvements within air quality non-attainment areas, may also be applicable in funding the Tri-State Corridor. A CMAQ project must contribute to the attainment of the national ambient air quality standards by reducing pollutant emissions from transportation sources. Eligible activities include transit improvement and travel demand management strategies.

9.3.4 High-Speed Rail Programs

TEA-21 contains provisions for two funding categories relating to passenger and high-speed rail programs. These programs include Section 7201 High-Speed Rail and Section 1103(c) High-Speed Rail Grade Crossings.

9.3.4.1 High-Speed Rail

The TEA-21 high-speed rail provisions extend appropriation authorizations for the existing high-speed rail assistance program created in the Swift Rail Development Act of 1994 (49 USC 26101 et seq.). An important modification to the definition of "high-speed rail" was made in TEA-21, Section 7201. High-speed rail is now defined as train units that are "reasonably expected to reach" 125 mph or more. In ISTEA, the definition of high-speed rail was more absolute, requiring train sets to achieve at least 125 mph or more. This broader definition may make elements of the Tri-State Corridor eligible to pursue funding under this TEA-21 provision.

The U.S. Secretary of Transportation is authorized to provide financial assistance under Section 7201 for up to 50 percent of the publicly financed cost of corridor planning activities and up to the full cost of technology improvements. These funds provide financial assistance to public agencies for high-speed rail corridor planning activities and certain other pre-construction activities, including right-of-way acquisition.

TEA-21 authorizes planning and pre-construction funding, including annual right-of-way acquisition at $10 million. Up to 50 percent of a project's cost is contributed by the federal government and the remaining 50 percent is provided by local governments. Section 7201 also provides funding to any United States business, educational institution, state or local government, public authority, or federal agency to support the development of high-speed rail technology improvements. There is no local matching requirement when funds are used for technology development purposes. Although TEA-21 establishes a multi-year authorization level, the amount of available funds is determined by the annual appropriations process.

9.3.4.2 High-Speed Grade Crossing Program (Section 1103(c))

Section 1103(c) extends and expands the program established under Section 1010 of ISTEA for the elimination of grade crossing hazards in designated high-speed rail corridors. The U.S. Secretary is authorized to provide financial assistance to states (or authorities designated by one or more states) to fund crossing improvements ranging from improved warnings to physical closure or grade separation.

This two-part program first designates funding eligibility for passenger rail corridors, and then provides funds in response to applications for specific highway-rail grade crossing improvements. To be eligible for this designation, a corridor must be a rail line where speeds of at least 90 miles per hour are occurring or can be reasonably expected to occur in the future. This provision enables grade-crossing improvements identified as part of the Tri-State Corridor to be eligible for this funding program. Corridors currently eligible under TEA21 include the Chicago Hub linking St. Louis, Minneapolis, Milwaukee and Detroit. TEA21 also mandates that $250,000 of set-aside be available per fiscal year for the Twin Cities-Chicago segment of the Midwest High-Speed Rail Corridor.

The federal share of improvement costs funded under Section 1103(c) may be up to 100 percent of engineering and construction. However, fund allocations will consider the extent to which other private, state, local, and federal entitlement (e.g., Surface Transportation Program) funds are being committed to corridor improvements in conjunction with these funds.

9.4 FEDERAL CREDIT PROGRAMS

TEA-21 creates two credit programs to assist in funding passenger and high-speed rail projects. These programs include Rail Passenger Eligibility under the Transportation Infrastructure Finance and Innovation Act (TIFIA) and Railroad Rehabilitation and Improvement Financing (RRIFP). The strategic goal under both programs is the use of credit rather than grants to help advance projects of national significance. As such, funding under the programs are loans and must be repaid.

9.4.1 Transportation Infrastructure Finance and Innovation Act (TIFIA)

The Transportation Infrastructure Finance and Innovation Act (TIFIA) was created by TEA-21 and provides federal assistance in the form of credit, rather than grants, to help fund major transportation investments of critical regional or national importance. The TIFIA credit program is designed to fill funding gaps and leverage substantial private co-investment by providing supplemental and subordinate capital in the form of long-term loans.

The TIFIA credit program consists of three different types of financial assistance designed to address varying requirements throughout the project life cycle:

- *Secured loans* are direct federal loans to project sponsors offering flexible repayment terms. These provide combined construction and permanent financing of capital costs. The interest rate is “not less than” the yield on marketable Treasury securities of similar maturity on the execution date of the loan agreement.

- *Loan guarantees* ensure a federal government full-faith-and-credit guarantee to institutional investors making a loan to a project.

- *Standby lines of credit* represent secondary sources of funding in the form of contingent federal loans that may be drawn upon to supplement project resources (if needed) during the first ten years of project operations.

Projects eligible for federal financial assistance under surface transportation programs (Title 23 or Chapter 53 of Title 49) are eligible for the TIFIA program. In addition, projects of regional or national significance, such as inter-city passenger rail facilities and vehicles (including Amtrak and magnetic levitation systems), publicly-owned intermodal freight facilities on the National Highway system, border crossing infrastructure, and other large infrastructure projects, could also qualify under the TIFIA umbrella. The Tri-State Corridor is the type of project that would meet TIFIA eligibility requirements.

The U.S. Secretary of Transportation has developed criteria to guide the selection of TIFIA-candidate projects. These criteria include:

- The extent to which the project is nationally or regionally significant in terms of generating economic benefits, supporting international commerce, or otherwise enhancing the national transportation system.

- The creditworthiness of the project, including a determination by the Secretary that any project financing has appropriate security features (i.e., rate covenant) to ensure repayment.

- The extent to which the project will foster innovative public-private partnerships and attract private debt or equity investment.

- The likelihood that assistance would enable the project to proceed at an earlier date than the project would otherwise be able to proceed.

- The extent to which the project uses new technologies, including Intelligent Transportation Systems (ITS), that enhance the efficiency of the project.
- The amount of budget authority required to fund the federal credit instrument.
- The extent to which the project helps to maintain or protect the environment.
- The extent to which assistance would reduce the federal grant contribution to the project.

A corporation, joint venture, partnership, or governmental entity may provide investment funds. The amount of federal credit assistance may not exceed 33 percent of total project costs. The Secretary must require each project applicant to provide a preliminary rating opinion letter from at least one rating agency indicating that the project's senior obligations have the potential to achieve an investment-grade rating.

The secured TIFIA loan must be payable, in whole or in part, from tolls, user fees, or other dedicated revenue sources; and include a rate covenant, coverage requirement, or similar security feature supporting the project obligations; and may have a lien on revenues. The Secretary establishes a repayment schedule for each secured loan based on the projected cash flow from project revenues and other repayment sources. Scheduled repayments of principal or interest shall begin not later than 5 years after the date of substantial completion of the project, and the final maturity date of the secured loan shall be no later than 35 years after the date of the substantial completion of the project.

9.4.2 Railroad Rehabilitation and Improvement Financing (RRIF)

The Railroad Rehabilitation and Improvement Financing Program (Section 7203 of TEA-21) is intended to make funding available through loans and loan guarantees for railroad capital improvements. No direct federal funding is authorized in TEA-21; however, the Secretary is authorized to accept a commitment from a non-federal source to fund the required credit risk premium.

The Secretary is authorized to provide direct loans and loan guarantees to state and local governments, government-sponsored authorities and corporations, railroads, and joint ventures that include at least one railroad. Funds are to be used to acquire, improve, develop or rehabilitate intermodal or rail equipment or facilities, including track, bridges, yards and shops. The Secretary is to prioritize those projects that enhance public safety and the environment, promote economic development, enable U.S. companies to be more competitive in international markets, are endorsed in state and local transportation plans, or preserve/enhance rail or intermodal service to small communities or rural areas.

The Secretary is allowed to accept a commitment from a non-federal source to fund, in whole or in part, the required credit risk premium. Credit risk premiums fund the costs associated with a potential default on the loan/loan guarantee. Private commitments can be used in lieu of or in combination with any appropriations of federal funds for this purpose that might be provided in the future. The Secretary (in consultation with the Congressional Budget Office) determines the amount required for credit risk premiums for each loan/loan guarantee on the basis of the circumstances of the applicant, including collateral offered, the proposed schedule for disbursing the funds, historical data on the repayment history of similar borrowers, and any other relevant factors.

No federal funds are made available in TEA-21 to fund credit risk premiums nor is there an authorization of appropriations for this program. The term of any loan may not exceed 25 years; the assistance must be justified by the present and probable future demand for rail services or intermodal facilities; the applicant must provide reasonable assurance that the facilities or equipment to be acquired, rehabilitated or established will be economically and efficiently utilized; and the obligation must be reasonably expected to be repaid, taking into account an appropriate combination of credit risk premiums and borrower collateral.

9.5 STATE AND LOCAL FUNDING

Federal funding under the grant programs described above usually requires a minimum local match of 20 percent at the state and local levels. In addition, several provisions are included in TEA-21 that provide greater flexibility to states and local governments in satisfying the non-federal matching requirements of a project.

9.5.1 Delayed or Tapered State/Local Match

TEA-21 permits grantees to defer payment of the state/local share of transit projects. The Secretary may allow the federal share to vary up to 100 percent on individual progress payments on a project, as long as the final contribution of federal funds does not exceed the maximum federal share authorized for the project. The states may wish to delay the application of their matching funding, particularly if they are trying to maximize the use of available state/local funds. This could occur because the funds are invested in a short-term security, for example, or otherwise encumbered. However, there may also be a situation where the grantee is seeking to arrange construction period financing or some other innovative financing mechanism, which could be facilitated through an uneven expenditure of Federal and matching funds.

The FTA grant process is generally based on a level outflow for a specific project. For example, for every 20 percent expended by the state/locality, 80 percent in federal funds are expended. Little value can be added to such a cash stream through the assistance of private capital markets. However, if the federal dollars are expended first (*e.g.*, for 100 percent of the design, engineering or environmental reviews), then the construction period can be financed with some private participation. In this instance, state/local funds can be "banked" or pledged as additional security for the construction period financing. This is all possible because there are no arbitrage concerns with state/local funds as there might be with the federal funds. The benefit of a delayed state/local match is that it may help assure the smooth progress of a major transit infrastructure project without any increase in federal outlays.

9.5.2 Credit for Acquired Land

TEA-21 expands the law relating to donated property to also allow the fair market value of land lawfully obtained by the state or local government to be applied to the non-federal share of project costs.

9.5.3 Local Funding

Financial support for the system may also come from local sources, which at present typically contribute a share of certain costs of surface transportation projects (*e.g.*, freeway interchanges). In the case of the Tri-State Corridor, endorsement of local funding for station construction or improvements (*e.g.,* part of an urban renewal or downtown development program) can be justified given the economic benefits that will accrue to new development in station areas because of the increased ridership in the Tri-State Corridor.

Local communities frequently encourage businesses to enhance station facilities activities such as travel agencies, convenience stores, restaurants and cafes. In addition, some communities have used their stations as transportation multimodal hubs with integrated bus and taxi operations. For these reasons, it is likely that funding for station facilities could be obtained from local communities.

9.6 PRIVATE SECTOR CONTRIBUTIONS

Private sector contributions may also be used to partially fund public works projects. The level of contribution depends on the willingness of private parties to participate. Private developers may be willing to provide cash and in-kind contributions to support transportation improvements from which they expect to benefit. Businesses and individuals may have a strong interest in promoting certain types of development and may be willing to contribute money, property, or services to enhance the feasibility of the project. Special benefits may accrue to private contributors in the form of projects sited near property owned by the developer, the creation of access points between the developer's property and the project, zoning concessions, development rights, or public recognition.

9.6.1 Joint Development

Joint development involves adjoining facilities shared by the public and private developers, such as a transit station adjoining office or retail space. Developers may be granted development rights for stations in exchange for contributions toward funding a transportation project. Contributions could include on-time payments toward the transit project or annual payments that can be applied to project costs or operating costs. Project viability depends on real estate market conditions and the ability of the public agency to provide necessary inducements for development. Inducements may include land, favorable zoning changes, lower financing costs, or improved public access to the developer's property.

9.6.2 Freight Railroads

Freight railroads will be major recipients of benefits because of infrastructure investments in track, signaling and rights-of-way for the Tri-State Corridor. As a result, they may experience substantial productivity gains within their operations and significantly lower track maintenance and renewal costs. Therefore, the freight railroads may contribute to the costs of implementing the Tri-State Corridor, although the match potential and form of benefit cannot be estimated at the present time.

9.7 DEBT FINANCING

The use of debt financing provides the ability to advance project implementation by borrowing against projected future revenues. Several forms of debt financing are discussed below.

9.7.1 Bond Issuance

The issuance of bonds and availability of up-front bond proceeds enables projects like the Tri-State Corridor to proceed in an uninterrupted fashion since project funding is secure.

Additionally, the use of bond financing allows major capital projects, which are long-lived assets, to be paid for over their useful lives rather than by current users. Tax-exempt debt represents bonds issued by a public agency or authority and backed by a specified source of revenue. Taxable debt represents bonds issued under structures in which the project costs are not eligible under the Internal Revenue Code for funding by tax-exempt bonds. Taxable debt would be issued at an interest rate approximately 1.5 to 3.0 percentage points higher than tax-exempt debt, because the interest income from these bonds would be subject to federal, state, and local income taxes, which in turn affect investor returns. The basic structure of bonds is the same, whether tax-exempt or taxable.

9.7.1.1 Tax-Exempt Bonds

There are two major categories of tax-exempt bonds -- general obligation and revenue. The full faith and credit of the issuer with taxing power secures general obligation bonds. Revenue bonds are payable from specific revenue sources and do not permit bondholders to force taxation or legislative appropriation of funds not pledged for payment of debt service. Revenue bonds are non-recourse to the taxing power of the state in which the issuing authority is located. The only sources of repayment and security for bondholders are the specific revenues that are pledged under the bond indenture.

Under certain conditions (as defined in the Internal Revenue Code), state agencies and authorities would be able to issue tax-exempt "governmental use bonds" for a project. Exemption of the interest income on the bonds from federal taxes will lower the interest costs of the bonds, because investors can achieve the same effective return on tax-exempt bonds issued with a lower interest rate as they would achieve on taxable bonds at higher rates. For the bonds to obtain tax-exempt status, certain criteria must be met. Funded assets must be publicly owned. The operating contract must be a short-term contract that satisfies certain conditions, including termination rights by the public authority, and compensation cannot be based on a percentage of gross or net revenues. If a long-term operating contract is employed and the operating contract conditions discussed above are not met, tax-exempt governmental use bonds cannot be issued.

For different reasons (defined in the Internal Revenue Code), a second type of state-issued, federal tax-exempt bond, the "private activity bond," cannot be used for the 110-mph options. Under current law, these bonds may generally be used in private concessions for high-speed rail projects, except for the acquisition of rolling stock, for a system with operating speeds that meet a 150 mph minimum speed threshold. Thus, the Tri-State Corridor may qualify for "private activity bonds" for the American Flyer and TGV options, where its operating speeds are expected to meet or exceed the 150 mph requirements.

9.7.1.2 Use of Proceeds and Source of Repayment

The revenues that are pledged to repay debt generally include portions of a state's motor fuel taxes, motor vehicle registration fees, motor vehicle license or permit fees, and sometimes a portion of the state's sales tax. While net revenues from the operation of the proposed system could be pledged to repay the bonds, the interest rate for an untested entity such as the Tri-State Corridor would probably be substantially higher than those available to the individual states.

9.7.1.3 Establishment of New or Expanded Debt

States have constitutional or legislative restrictions on the issuance of debt. In addition, the enactment of a transportation bond program may require legislative action to establish the size of the program, identify existing or new revenue sources that will be pledged over a multi-year period to repay debt, and develop guidelines for the types of projects to be financed. The development of each new or expanded financing program must be tailored to meet specific legal, political and financial constraints. In this study, it has been assumed that each state will have (or will secure) the necessary bonding capability.

9.7.1.4 Structuring Considerations

Tax-exempt bonds can be structured as long-term, fixed-rate debt where the interest rate is established at the time of sale. Potential investors and the rating agencies carefully evaluate the credit strength of a bond issue. The key credit factor is the expected strength and stability of the pledged revenues.

9.7.2 Grant Anticipation Notes

Grant Anticipation Notes (GANs), or similar instruments, offer states an additional mechanism to raise up-front capital on the basis of receiving future federal funds. The term GAN refers to a debt financing instrument that permits its issuer to pledge future FTA funds to repay investors. GANs are generally short term, usually less than one year to maturity but sometimes as long as two to three years to maturity, and intended only to meet short-term financial needs.
When the GAN is issued, the main form of security backing this debt financing instrument is the state's obligation of future federal aid apportionment based on a Letter of Intent or a Full Funding Agreement from the FTA. Short-term GANs are defined as notes backed by future obligations of a currently authorized Full Funding Agreement. Therefore, assuming that a state issued the GAN in the second year of a five-year authorization period, the term of the notes (or at least that portion backed by federal funds) could not exceed four years.

Federal tax law presently prohibits tax-exempt bonds from being directly or indirectly guaranteed by the federal government (*i.e.,* Full Funding Agreement). Therefore, to enhance the credit rating of the issuance, additional security for the GANs is often required. Because of the shorter maturity and the additional security pledged, GANs usually are issued at a rate that is approximately one percent less than that for general obligation bonds. Accordingly, they could be a potential source of funding during the construction period, when the amount of funds received from federal grants does not meet the capital requirements of the construction program.

9.7.3 Leasing

There are two potential funding mechanisms for financing rolling stock and possibly maintenance facilities. One option is off-shore or cross-border leasing and the other is the issuance of Certificates of Participation (COPs). There must be a separation of federal and state interest in the equipment or facility in order to use cross-border leases or COPs to leverage additional funds, or when using short-term lending or debt subordination where arbitrage issues could be involved. For example, the portion of a fleet or facility without federal interest could be financed and the proceeds used to earn interest or act as a credit enhancement on a bond issue supporting a major investment, thus generating savings for the state. Any legislative package proposed for the Tri-State Corridor should include the powers necessary to enter into such leases.

9.7.3.1 Off-Shore or Cross-Border Leasing

Off-shore or cross-border leasing is a mechanism by which the state purchases rolling stock, such as railcars, then simultaneously sells them to a non-U.S. investor who would be allowed to take investment tax credits or tax depreciation write-offs on the value of the equipment. The investor in turn leases them back to the state, and the tax benefits are shared with the state through reduced leased costs. The foreign investor pays the state an up-front consideration usually ranging from five to ten percent of the cost or value of the vehicles. The balance of the proceeds is deposited in a trust account to prepay the lease payments. Cross-border leasing is an ideal market for railcars because of their long life and “resalebility.” The market has a proven advantage; however, it is volatile with uncertainties as to the availability and amount of savings. At a given point in time there may be more demand than supply.

9.7.3.1 Certificates of Participation

Certificates of Participation (COPs) are methods of issuing debt, similar to bonding, secured by the value of the vehicles and/or facilities of the project. The investors become the technical owners of the vehicles/facilities and “lease” them back to the state. The lease payments become the service on the debt and, at the end of the lease period, the debt is retired and ownership reverts back to the state or issuing agency. COPs represent an interest in the payments the issuer has promised to make, but which are subject to annual appropriation by the issuer’s governing body. The issuer must actually appropriate the funds each year; therefore, there is an element of risk not present in bonds. Although COPs can be insured, the interest rate is usually higher because of the increased risk.

9.8 FUNDING SUMMARY

Many states are exploring opportunities to involve the private sector more completely in the implementation of rail projects. Both the magnitude of the Tri-State system capital requirements and the lack of a proven system of this size in the region would make the potential for full private sector participation extremely difficult. At this time, it is assumed that each state will fund its portion of the capital costs separately using one or a combination of the project funding alternatives discussed above. Specific funding strategies and structures based on the funding requirements and abilities of the individual states are outside the scope of this study. However, it is expected that the most likely mechanisms include:

- Federal Financial Assistance
- Cash flow management (TIFIA, GANs)
- Cost reduction techniques (cross-border leases, COPs)

The MWRRS proposes 80 percent federal participation for the entire Midwest system, which would build the Base Case in the Tri-State Corridor. Different funding mixes are likely to be required beyond the Base Case.

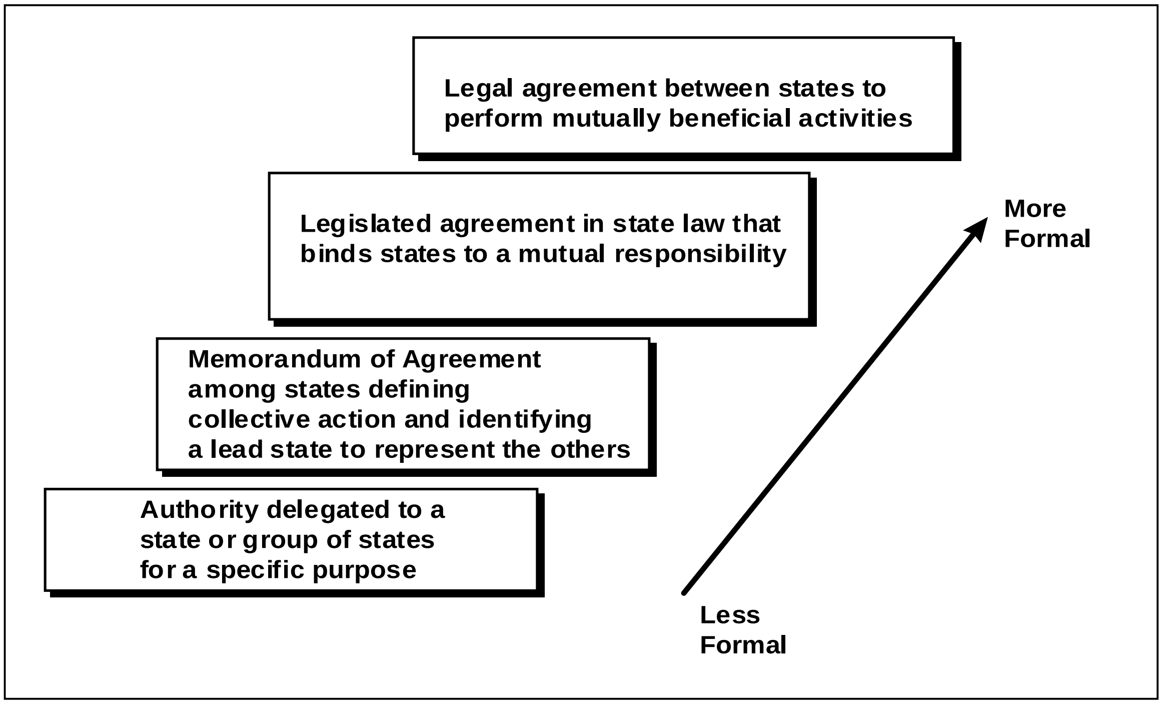
TABLE OF CONTENTS

10.1 OVERVIEW

Institutional arrangements involve the nature, organization, and individuals responsible for undertaking or overseeing specific activities. Institutional arrangements, particularly as they relate to multi-state transportation projects, can be numerous and take many forms throughout the planning, engineering, construction, and operating phases of a project. This chapter is intended to be descriptive (not prescriptive) in identifying the most effective institutional arrangements for the Tri-State II High Speed Rail System as it progresses into advanced planning, design, engineering, construction, and implementation. Many activities will require that arrangements between the states, federal agencies, railroad owners, operators and contractors be defined.

In many instances, informal arrangements between states could suffice in achieving a project-related objective. Other activities might require more formal multi-state agreements. As the project progresses from planning to engineering and construction, the complexity of the project and the level and types of project funding will become more complex. At this stage, institutional arrangements will most likely become more formalized in terms of defining individual and joint state responsibilities in areas such as funding, policy, and operations. The form of arrangement used will depend on the nature and duration of the objectives, and the number and type of parties involved. Since multi-state cooperation is pervasive in the Midwest, there is a strong basis and tradition for joint undertakings. These undertakings will serve as valuable models in formulating the institutional arrangements necessary to advance the Tri-State II High Speed Rail Project. The following Exhibit 10.1 illustrates examples of institutional arrangements.

Exhibit 10.1
Continuum of Institutional Arrangements



Guiding principles will prove valuable when determining the institutional arrangements necessary to support project-related activities. Foremost among these is designing arrangements that minimize intrusion on current authorities, arrangements, powers, and immunities enjoyed by each state. While the form of arrangement is important, equal attention should be given to identifying the need for multi-state arrangements and the necessary authorities, in order for the planning and implementation to proceed efficiently.

The Tri-State II High Speed Rail System is an incremental step that follows the operation of 110 mph passenger rail service throughout nine Midwest states. In essence, the system will upgrade a portion of the Midwest Regional Rail System from 110 mph to 150 mph; thus, many institutional arrangements will already be in place or used at varying phases of the MWRRS. Consequently, they will provide a strong basis and context from which advanced planning, funding, implementation, and ultimately operation of the high-speed rail system can be launched.

10.2 ACTIVITIES WHEN ARRANGEMENTS MIGHT PROVE APPROPRIATE

Activities and institutional issues requiring arrangements for the Tri-State II High Speed Rail System fall into three categories: Project planning, business arrangements, and operational oversight.

10.2.1 Project Planning

Arrangements for project planning must support joint funding and collective oversight between the states. An institutional arrangement defined and formulated by a jointly-signed letter or Memorandum of Understanding by each participating state might be sufficient to proceed with the system project planning. Planning activities may include hiring consultants, project planning oversight, environmental considerations, and garnering stakeholder/grassroots project support.

10.2.2 Business Arrangements

Business arrangements entail contractual agreements with lending institutions, investors, suppliers, and contractors, as well as negotiating track access and higher operating speeds with freight railroads and communities. Consideration should be given to provisions that protect the interest of states, define fiduciary responsibilities, and achieve objectives according to a schedule and within affordability limits. Likewise, investors and contractors will seek clarity regarding project and financing responsibility. In particular, the federal Government will require the states to name a Designated Recipient. The Designated Recipient would be responsible for submitting grant applications, accepting grant funds, and protecting and maintaining federal assets that are part of the Tri-State II High Speed Rail System. Examples of business activities include:

- Issuance and retirement of state debt
- Procurement of rolling stock and equipment
- Applying and receipt of federal funding
- Contracting with the operator
- System construction

On several existing major transportation projects, a single entity responsible for the collective oversight project activities, particularly during construction, has enhanced project oversight effectiveness and provides efficient comprehensive project management. These functions can be fulfilled by either a contract between the states or a multi-state compact.

10.2.2.1 State-to-State Contract

States could enter into agreements among themselves to make the necessary contractual arrangements to achieve intercity and interstate service. These agreements could be established without precise form or content and may not require separate enactment by participating states. Cooperative agreements have been authorized in many states. When entering such agreements, participating states need assurance that all required legislation and regulations will be enacted.

Advantages of contracts include speed and flexibility in establishing structure agreement when legislative approval is not required, and a contract's ability to hold a state harmless from legal liability. A contract disadvantage is that it might not fully reflect the collective good and credibility that might be achieved with a more formal agreement.

10.2.2.2 Interstate Compact

Congress has periodically agreed to allow states, or agencies/authorities created by states, to enter into specific agreements involving interstate commerce. The most recent consent was in blanket form as part of the Amtrak Reform and Privatization Act of 1997. This Act granted the consent of Congress to states to enter into interstate compacts to promote the intercity passenger rail service provision, including:

" (1) Retaining existing service or commencing new service;
(2) Assembling rights-of-way; and
(3) Performing capital improvements, including:
 (A) Construction and rehabilitation of maintenance facilities and intermodal passenger facilities;
 (B) Purchase of locomotives, and
 (C) Operational improvements, including communications, signals, and other systems."

Compact terminology for the Tri-State II High Speed Rail System could provide that the states join together to establish a system which would operate across state lines, and cooperate and share jointly the administrative and financial responsibilities of implementing the system operation. For example, a Tri-State II High Speed Rail Compact could describe the manner of Compact adoption by the states and provide broad authority to implement a business plan. It could describe the institutional framework, such as a Policy Board consisting of members from each of the participating states directing the rail operator. It could also identify the terms of enactment, such as providing for the Compact to become effective upon the adoption or enactment into law by two or more participating states.

The agreed-upon Compact language must be identical for each state. However, each state would most likely enact its own enabling legislation conforming or accommodating formation of a Compact. This enabling legislation may include, but not be limited to, zoning, insurance, bonding authority, rates, tariffs, and fares, labor, safety and the environment.

10.2.2.3 Compacts and Sovereign Immunity

States enjoy sovereign immunity, although some states have waived part of their sovereign immunity in order to conduct business. Waiving of immunity is usually tailored to a specific action, such as contracts, provision of public services, or certain types of torts. For example, many transit authorities waive sovereign immunity with respect to transit operations and liability, since the public would probably not use the service unless the transit authority assumed liability for safety infractions (e.g., accidents).

The nature and extent of liability related to a compact depends on the content of the compact agreement and the level of liability (if any) the state would assume. The amount of sovereign immunity waived is dictated by the terms of the compact. For example, a state's indemnification limits can be proportional to its financial contribution to operating and capital or other factors. In the Washington Metropolitan Area Transportation Authority (WMATA) Compact, the states assume no direct liability, but assume responsibility for financing the organization. As a result, each state pays for portions of the liability indirectly. A compact for the Tri-State II High Speed Rail System could join the states together in a structure recognized by Congress to seek federal funding for significant infrastructure improvements. The compact would provide states with a formal structure to join together to establish the Tri-State II HSR, which would operate across state lines, cooperate, and share jointly the administrative and financial responsibilities of implementing the system. One disadvantage of a compact is the time frame and requirements for state legislative approval.

State-to-state Contracts or a Compact arrangement could be required within three years and would need to continue throughout the "life" of the Tri-State II High Speed Rail System. In addition, should the MWRRS result in a multi-state compact, the Tri-State II High Speed Rail agreement between the three states could become a subset of the MWRRS Compact.

10.2.3 Operational Oversight

The arrangement would identify state responsibilities in deciding Tri-State II High-Speed Rail policy and broad service delivery issues. It would also outline management responsibilities for rail operator oversight, including periodic review of operating and contractor performance. Operational oversight could include: train operators, infrastructure development, operations policy, receipt of revenue/payment of subsidies, system expansion/preservation, and funding.

10.2.3.1 Policy Governance

The establishment of a Policy Oversight Committee or more formal structure (e.g., Policy Board) with operational oversight functions would also be an appropriate arrangement. The Policy Board's authority could be derived from the multi-state contract or Compact between the member states. It could also be a subset of a MWRRS Policy Board should one be created. The Policy Board would interact with the rail operator through the required funds provision and service plan specification. The rail operator would operate strictly as a private sector, for-profit business in a commercial environment. The Board might be comprised of a member from each state representing its views and interests, and ex-officio members, such as operator or rail right-of-way owners.

10.3 COMMITTEES AND ORGANIZATIONAL INVOLVEMENT

The Tri-State II High Speed Rail System project will go through numerous stages as it progresses from planning to advanced planning, into engineering and construction, and ultimately into operations. At each of these stages, consideration should be given to the various planning, funding, implementation, and policy activities required and the appropriate level of staff needed. For instance, in the conceptual planning stages a Steering Committee comprised of planning agency staff is appropriate to discuss project elements and potential planning issues, and define upcoming project stages. During the advanced planning and subsequent stages when political decisions (including funding considerations) are issues of concern, consideration should be given to shifting the main thrust of project direction/involvement to individuals responsible for policy development, and perhaps even political-related issues.

This is not to imply that the planning Steering Committee should cease to be involved in the project. It is important to recognize, however, that while technical issues do require close scrutiny and diverse input, moving projects forward into implementation phases often requires active involvement by pertinent individuals. These individuals would be responsible for policy and have the capacity to direct or influence other agencies or stakeholders to support the project and/or undertake particular actions relating to the future of the project.

10.4 ALLOCATION OF COSTS AND REVENUES

As the Tri-State II High Speed Rail System enters more advanced stages, particularly the operating phase, state agreements should be considered with regard to allocating costs and revenues. Wherever possible, costs and revenues allocated to a state should be directly related to the benefits received by that state. Costs requiring allocation principles might include infrastructure, right-of-way, rolling stock, stations and maintenance facilities, and operating costs and revenues.

Infrastructure and right-of-way capital costs could be identified as system-level improvements and be apportioned among all the participating states. Conversely, corridor and segment improvements could be apportioned among specific states. Likewise, the three states should consider the allocation of funds required to match federal funding contributing to the planning, design, engineering, and construction of the high speed rail project.

The states need to consider how operating losses and revenue surpluses should be allocated with regard to system operations and related costs. There are many examples nationwide that involve multi-state sharing of transit deficits and surpluses (e.g., the interstate agreement involving the Washington Metropolitan Area Transit Authority). Common factors used in allocating operating losses and revenue surpluses include service area population within a jurisdiction, miles of service operated, ridership levels, and level of service provided. Whatever allocation method is determined, it is incumbent upon the states to agree upon the variables comprising the operating cost allocation formulas and the factors used to weigh these variables. Examples of cost variables that could be considered in devising an allocation formula are provided in the following Exhibit 10.2.

Exhibit 10.2
Examples of Operating Cost Allocation Variables

Operating Variable	Allocation Factor
Track and Right-of-Way Maintenance	Train Miles
Train Equipment Maintenance	Train Miles
Energy	Train Miles
Train Crew	Train Miles
On-Board Services Crew	Train Miles
Station Costs	Passengers
Sales & Marketing	Passengers
Insurance	Passengers

The development of an appropriate allocation method for the Tri-State II High Speed Rail System is complicated, and no single method is likely to prove flexible enough to satisfy each situation. The states will need to coordinate and agree upon an appropriate method for allocating financial responsibility as was done for the Chicago-Milwaukee corridor. The methodology chosen to allocate operating revenue surpluses or losses in a multi-state agreement should also be considered as the method used to allocate infrastructure and rolling stock capital costs.

10.5 SUMMARY

There are many options for institutional arrangements available to the states as the Tri-State Project progresses throughout the planning, engineering, construction and operating phases of the project. Arrangements between states may be informal agreements or formal multi-state arrangements. The activities and institutional issues that may require arrangements could be: project planning, business arrangements and operational oversight. During all stages of the process, and particularly as the project enters more advanced stages, state agreements need to be in place which allocate costs and revenues to a state based on the benefits received by that particular state. This chapter does not recommend but simply outlined the available examples of institutional arrangements.

TABLE OF CONTENTS

11.1 OVERVIEW - CONCEPTUAL IMPLEMENTATION PLAN

The purpose of this Conceptual Implementation Plan is to identify the next step in rail development in the Chicago-Milwaukee-Twin Cities Corridor following implementation of the MWRRI. The Conceptual Implementation Plan discusses long-term development strategies that have been modeled to provide maximum ridership growth and optimal return on investment. The Conceptual Implementation Plan includes staging and timing for the phased development, construction and operation of the preferred options.

11.2 RATIONALE FOR SELECTION OF IMPLEMENTATION OPTIONS

Criteria for rank-ordering the most promising rail passenger options were developed by the Study Steering Committee. Each option was first rated on its environmental impact: physical, biological, socioeconomic, construction, and environmental justice. A weight was assigned to each factor, and a weighted average rating for each option was developed (see Exhibit 11-1). Each option was then ranked for financial and economic performance, based on the analyses presented in Chapters 7 and 8. See Exhibit 11-2. The combined environmental, financial and economic rankings indicate that the 150 mph new alignment through Rochester represents a reasonable "next step" after implementation of the MWRRS.

The financial analysis (Chapter 7) presented a strong case for developing high-speed rail for the Tri-State corridor beyond the MWRRS base of 110 mph. Service through Rochester is clearly warranted, as service along the river cannot be developed effectively beyond 110 mph. Service through Rochester offers an additional advantage of bypassing the CP Railway line along the river, which is projected to have increased freight volume as railroad consolidations continue. The investment in track right-of-way and infrastructure improvement necessary for 150 mph technology (Option C-2) would result in increased ridership and revenues.

Option B-2 (150 mph technology on current alignment) is less effective than C-2, because it cannot take full advantage of potential speed due to congestion, extensive deceleration/acceleration for curves, and other track and right-of-way conditions. This is demonstrated by a lower NPV and MIRR.

EXHIBIT 11.1

ENVIRONMENTAL WEIGHTED EVALUATION MATRIX

Criteria Ranking	Weight	A-1		B-1		B-2		C-2		D-3	
		Rating	Wt. Rate	Rating	Wt. Rate	Rating	Wt. Rate	Rating	Wt. Rate	Rating	Wt. Rate
Physical Impact*	5	3	15	3	15	3	15	4	20	4	20
Biological Impact	8	5	40	4	32	3	24	2	16	1	8
Socioeconomic Impact	10	1	10	3	30	2	20	5	50	4	40
Construction Impact	6	5	30	4	24	3	18	2	12	1	6
Environmental Justice	10	4	40	3	30	2	20	5	50	1	10
	39		135		131		97		148		84
Weighted Average			**3.46**		**3.36**		**2.49**		**3.79**		**2.15**
* Physical impact can be mitigated											
5=Best - Least impact											
1=Worst - Most impact											
Results:	C-2	150 mph	3.79								
	A-1	110 mph	3.46								
	B-1	110 mph	3.36								
	B-2	150 mph	2.49								
	D-3	185 mph	2.15								

EXHIBIT 11.2

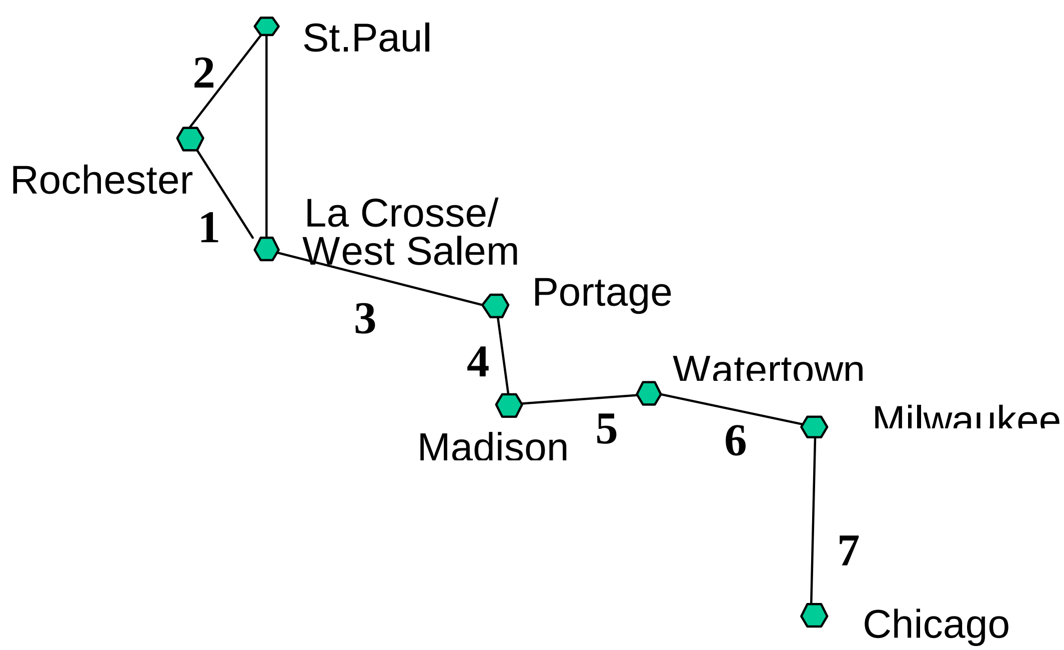
EVALUATION FRAMEWORK AND RANKING

Option	Financial		Economic			Environmental	
	MIRR	NPV	Benefit/Cost	NPV	Constrained Capital	Weighted Score	Rank
B-1 - 110 mph Rochester	4	4	4	4	4	3.4	2
B-2 - 150 mph Rochester	2	3	2	3	2	2.5	3
C-2 - 150 mph New Alignment	1	1	1	2	1	3.8	1
D-3 - 185 mph Elevated	3	2	3	1	3	2.2	4

11.3 DEVELOPMENT SCHEDULE

If the states agree to go beyond the MWRRI and implement 150 mph service, and if necessary funding is secured, then a recommended implementation strategy would be as described on the following pages. Exhibit 11.3 provides a graphic representation of the proposed development phases.

EXHIBIT 11.3
PROPOSED DEVELOPMENT PHASES



11.3.1 Development Phases 1 and 2: Rochester Reroute

The financial and economic analyses in the Tri-State II Study present a convincing case for diverting the current alignment to Rochester during Development Phase 2. For example, Options B-2 (110 mph) and C-2 (150 mph), both routed through Rochester, indicate very positive financial and economic returns. There are two important elements to consider with regard to this positive return. First, given the level of freight activity and difficulty in providing access for passenger rail services along the river route (La Crosse/West Salem-Twin Cities), consideration should be given to an earlier routing of the rail corridor through Rochester. Second, since a strong case exists for the 150-mph option on its own right-of-way by 2012, it is recommended that the Rochester reroute be built at the 150-mph standard, even if trains initially run on the reroute at 110 mph. Accordingly, it is recommended that the Rochester reroute at 150 mph (see Exhibit 11.2) be built as Development Phase 1. In particular, it is proposed that La Crosse/West Salem-Rochester be implemented as Segment 1 and Rochester-Twin Cities as Segment 2. The capital cost for these two segments is $1.5 billion. While this represents a substantial investment, it would improve both travel times and ridership significantly and enable Rochester to become an important component of the Chicago–Milwaukee–Twin Cities Corridor.

11.3.2 Development Phase 3: West Salem – Portage

Following the connection of Rochester to the Twin Cities, the next phase will improve speeds between La Crosse/West Salem-Portage (approximately 130 miles). This will reduce travel times and increase ridership between Twin Cities, Rochester and the remainder of the Tri-State Corridor. Development Phases 1, 2 and 3 (in combination) will provide 250 miles of 150-mph right of way and reduce travel time from Twin Cities and Rochester to Madison, Milwaukee and Chicago by one hour (over and above the MWRRS timesaving). Development Phase 3 is estimated at $587 million.

11.3.3 Development Phases 4 and 5

The next goal in developing high-speed rail in the Tri-State Corridor would upgrade service speeds in the Madison reroute. As part of the MWRRI, speeds on the reroute (Watertown-Portage, see Exhibit 11.1) were improved to 110 mph. These speeds would now be increased to maximum capacity, or 150 mph for Madison-Portage (Development Phase 4) and 130 mph for Madison-Watertown (Development Phase 5). These improvements would reduce travel time only 15 minutes at a cost of $560 million. However, they are worthwhile in terms of providing three-hour service to Milwaukee and four-hour service to Chicago-Twin Cities.

11.3.4 Development Phases 6 and 7: Watertown to Milwaukee and Chicago

Very little improvement is proposed in the Watertown-Milwaukee and Chicago segments beyond the basic MWRRI 110-mph option. The reason for this is that very large investments are required to provide very small time savings. When the time saving is minimal (e.g., less than 5 minutes), it is usual to discount the value of the time saved to the traveling public. It is widely held that when time saved is small, it should be valued at a very low level (i.e., 50 percent). A further time saving analysis should be undertaken for these segments before any further investment is made to ensure that travelers will respond to the level of time saved.

11.4 SUMMARY - DEVELOPMENT PROGRAM SCHEDULE AND COST

Exhibit 11.4 summarizes the timing and the full and incremental costs for the proposed build-out if 150 mph technology is implemented.

EXHIBIT 11.4
PRIORITY BUILD-OUT SCHEDULE FOR 150 MPH TECHNOLOGY

Priority	Segment	Years for Design/EIS	Years for Construction	Cost in 1998 ($000)	In-Place (Base Case)	Net Cost 1998 $
1	West Salem, WI to Rochester, MN	4	3	$843,161		$843,161
2	Rochester to Twin Cities	3.5	2	$646161		$646,161
3	Madison Airport to Portage, WI	1	2	$285,150	$47,565	$237,585
4	Watertown, WI to Madison Airport	1	2	$344,399	$31,361	$313,038
5	Portage to West Salem	3	3	$587,960		$587,960
6	Milwaukee to Watertown	1	1	$87,140	$40,033	$47,107
7	Chicago to Milwaukee	2	3	$448,884	$448,884	$0
	Total Cost of Infrastructure			$3,242,855	$567,843	$2,675,012

The MWRRI proposed that improvements between Milwaukee and Twin Cities be completed in three segments by Year 7 of MWRRI Implementation (Year 7 currently corresponds to 2006), with Milwaukee-Chicago improvements completed by Year 10. Exhibit 11-5 illustrates the MWRRI schedule for the Chicago-Twin Cities corridor.

In terms of the Tri-State Implementation Program (Exhibit 11.6), it is likely that the Environmental Impact Study (EIS), design and construction work for Development Phases 1 and 2 would take approximately seven years to complete. The most expensive and complex elements will be the La Crosse/West Salem-Rochester segment, which includes bridging the Mississippi. The next complex segment will be Portage-La Crosse/West Salem (six years) due to its length and the need for a comprehensive EIS. Since it is proposed that operations will begin in 2012, work should begin in 2005 on development of the Rochester reroute.

Exhibit 11.5

MIDWEST REGIONAL RAIL INITIATIVE IMPLEMENTATION SCHEDULE FOR TRI-STATE BASE CASE

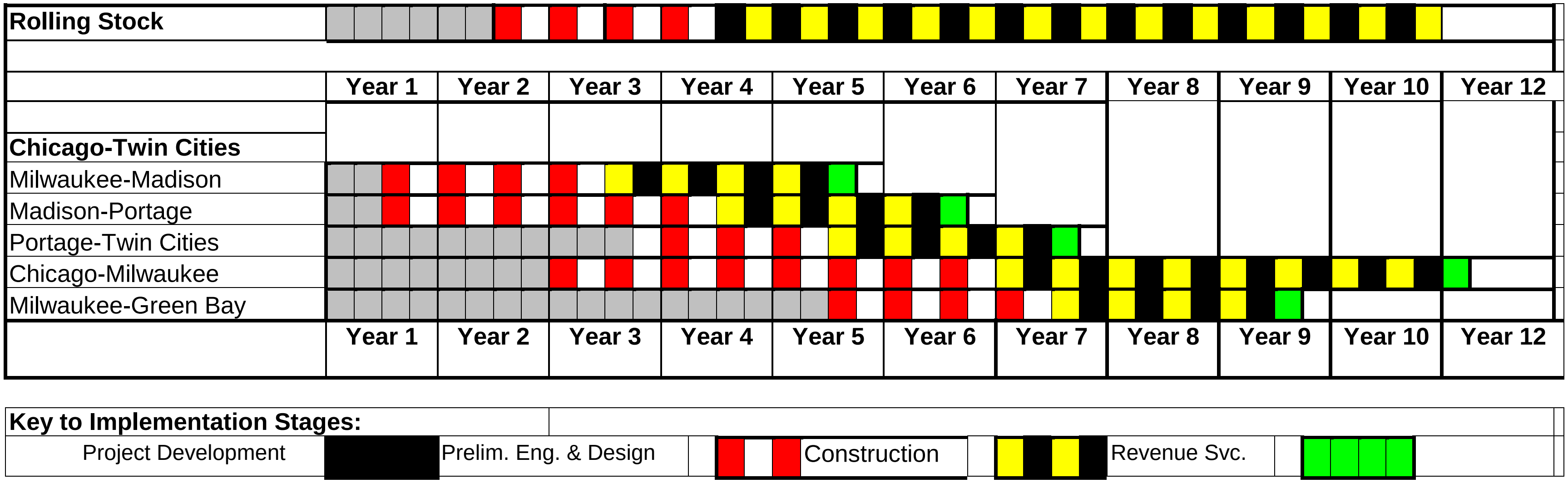


EXHIBIT 11.6
TRI-STATE II DEVELOPMENT PROGRAM FOR 150 MPH SERVICE

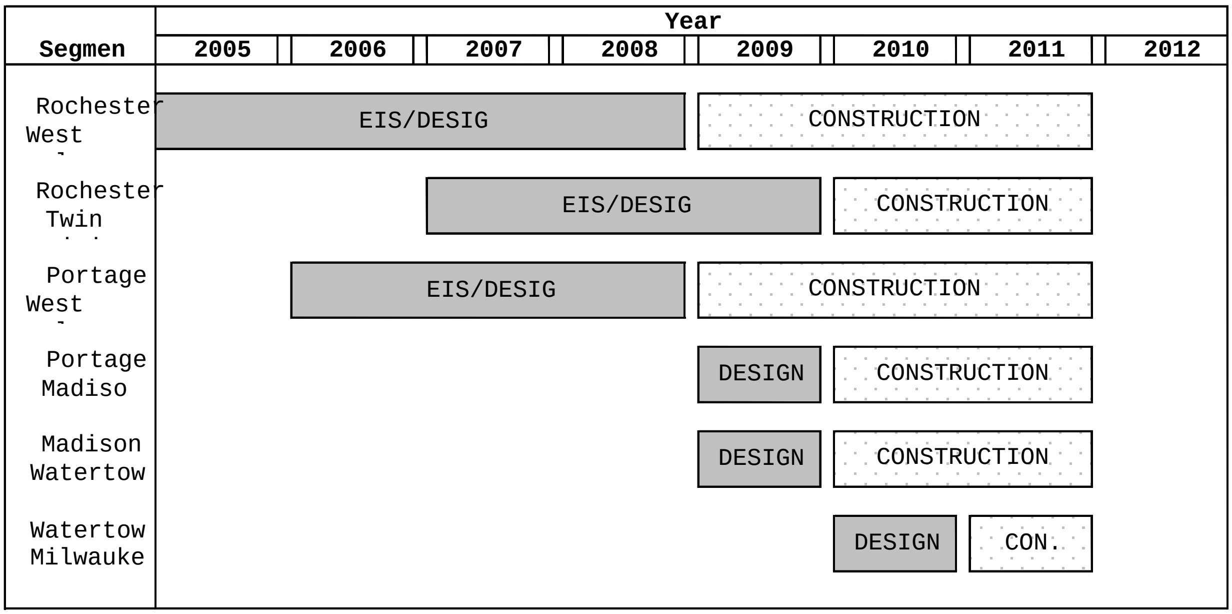


TABLE OF CONTENTS

12.1 OVERVIEW

The purpose of the Tri-State II High-Speed Rail Feasibility Study was to evaluate the potential for various high-speed rail options in the Chicago-Milwaukee-Twin Cities corridor. The options look beyond the Midwest Regional Rail Initiative (MWRRI) implementation, which was presented as the Base Case for this study. The MWRRI evaluated intermediate high-speed (up to 110 mph) service in the Midwest and is currently proceeding into advanced planning stages. This study considers incremental improvements from one speed threshold to another for long-range (five to fifteen-year) planning and implementation. It was designed to provide policymakers with the information needed to evaluate and choose among route/technology alternatives, including the financial and institutional arrangements needed and a realistic timetable for successful implementation. The study frames alternatives that could be used in the development of an Environmental Impact Study (EIS) for the Tri-State Corridor. The next logical step in this planning process is the preparation of a corridor EIS.

In brief, the aim of this study is to assess the steps that should be taken following the implementation of MWRRI. As such the study has taken the MWRRI Phase II report as the foundation for assessing what will be the Base Case by 2010. It should be noted, however, that in the further development of the MWRRI in Phase III, various adjustments were made to the operating plans, revenue and cost assumptions, and infrastructure needs. Where possible and appropriate these modifications have been incorporated in the Tri-State Base Case. These updates are documented throughout the report and this summary chapter.

This study presents clear choices in long range development. The study's operations analysis revealed that service on the CP line along the river is not likely to be suitable for higher-frequency and higher-speed operations, much beyond initial MWRRI operation. It suggests that operations through Rochester on current and new alignments will preserve long-range operational capacity and flexibility. The financial analysis suggests that the corridor will warrant 150 mph service in the not-too-distant future, and it therefore makes sense to develop the track to 150 mph standards as the project proceeds. The next logical step is an Environmental Impact Analysis for the corridor, which will more comprehensively determine the existence and potential threat to endangered species, historical sites, or other factors that would significantly impact the cost or the potential operation of the high speed service.

12.2 TRAIN TECHNOLOGIES

The study evaluated three technologies, representing choices in speed and initial capital investment. The three technologies do not represent a choice of manufacturer or even train design, but rather provide a range of generic options for improving passenger rail service in the Tri-State corridor. The selected technologies present a range of choices relative to speed, infrastructure, and investment. They represent examples of the types of equipment that can be acquired, and the advantages and disadvantages associated with each.

For all speed scenarios selected for this study (110 mph, 150 mph and 185 mph), the internal train designs and amenities are geared toward a high level of convenience and passenger comfort. Comfortable seats, extensive legroom, modern communications, video and audio entertainment, and meal services provide passengers with a travel experience they will want to repeat.

Beyond the passenger experience, the technology options provide distinct planning choices. While there is some overlap among the technologies, there are key differences based on desired speed.

As speeds increase over 100 mph in curves on conventional track, a train that tilts is essential for passenger comfort, and steerable bogies are necessary to permit faster speeds in curves and reduce wear on track. The DMU was adopted as the preliminary technology for the MWRRI Phase I and Phase II evaluations and was therefore included as the Base Case 110 mph technology in this study to maintain consistency. However, the choice of technology for MWRRI has been re-evaluated during Phase III, which considered technologies such as the Talgo Pendular and the American Flyer Gas Turbine, as well as the DMU technology. For various reasons, the MWRRI selected the mid-range technology for its financial assessment. This technology was not reviewed for the Tri-State Study. Therefore, the 110 mph operating plans developed for the Tri-State, as well as the operating costs and rolling stock costs, reflect the DMU technology.

Trains operating at speeds greater than 125 mph typically require electric traction or modern gas turbine power to provide sufficient power and speed. Electric traction provides an advantage in acceleration characteristics, but the electric catenary requires a significantly higher infrastructure investment. The 150-mph gas turbine technology was therefore recommended for a more detailed evaluation. The FRA has higher standards (Tier II) for locomotives and passenger cars at speeds greater than 125 mph. More stringent grade crossing and signal requirements also apply, and impact the infrastructure cost.

Increasing train speed above 150 mph (i.e., 185 mph) requires trains similar to the TGV. To travel at very high speeds, TGVs need very high power output, straight tracks and/or highly developed super-elevation for curves. This makes the right-of-way unsuitable for rail traffic incapable of comparable speeds. In addition, grade crossings must be eliminated for safety reasons. The FRA currently does not permit other rail traffic on routes with trains operating at speeds above 150 mph and mandates no “at grade” crossings. Therefore, a dedicated right-of-way is essential for very high-speed operation.

12.3 ENGINEERING AND ENVIRONMENTAL ASSESSMENTS

A detailed engineering assessment of routes resulted in 4 routes being selected for analysis: the Base Case (Route A-1) along the river for 110 mph technology; Route B through Rochester primarily on existing freight railroad alignments at 110 and 150 mph;

Route C-2 through Rochester on new alignments at 150 mph and Route D-3 through Rochester on new alignments and elevated in urban areas at 185 mph.

An engineering assessment of each route alignment was performed. The assessment included an initial engineering analysis, information from large-scale mapping (e.g., topography) and limited site verification without detailed surveys. Elements of the existing route infrastructure that were assessed include track work, turnouts, bridges (over and under), crossings, signals and curves. An engineering assessment of each station along the routes was performed, with recommendations for new stations at specific locations (Brookfield/Watertown; Madison Airport, Tomah, and Rochester; plus LaCrosse for options C-2 and D-3). Other stations require modest to significant renovations. Maintenance facility requirements and potential sites for each level of technology were defined on a conceptual basis. A broad-scale environmental review was also undertaken as part of this study.

The information gathered in the engineering assessment of the routes and stations of the Chicago-Milwaukee-Twin Cities corridor (as presented in Chapter 3 and associated appendices) provided the basis for the infrastructure cost analysis for each route/technology option found in Chapter 6.

12.4 OPERATIONS ANALYSIS

A train operation analysis was performed to develop operational plans for technologies and route options. The LOCOMOTION© model was used to estimate train running times. Since travel times and frequencies are major variables that influence passengers and revenue, timetables were developed for each technology using express and full stopping patterns. In all cases, an express stop pattern will save time compared to a full stopping pattern. Frequencies increase according to the level of improvement in travel time. With the development of timetables, fleet sizes can also be determined.

This study uses the DMU technology for the 110 mph services: the Base Case and option B-1, which is consistent with the MWRRI Phase II analysis.

12.5 DEMAND ANALYSIS

The Tri-State region exhibits a very vigorous travel market, with extensive trip making among the cities in the region. The economic forecasts for per capita income growth are significantly higher than regional population growth. Consequently, travel is expected to increase faster than population or employment growth. The survey conducted to update regional values of time and frequency was generally comparable to other studies. A key difference from previous studies was that the value of time for business rail travelers was almost double that of non-business rail travelers. This suggests that the relationship between business and non-business rail travelers is more similar to air travelers than auto. The ridership forecasts predict that market shares for rail will increase steadily, with increased frequency and decreased travel times. The study area rail market share is estimated as follows:

- 0.3 percent in the base year,
- 1.5 percent in 2020 at 110 mph through Rochester,
- 2.2 percent at 150 mph through Rochester (current alignment), and
- 3.1 percent at 185 mph.

Projected ridership in 2020 ranges from 2.5 million for 110 mph service, to 3.7 million for 150 mph, and to 5.2 million for 185 mph service. Average daily ridership combining the various segments between Chicago-Twin Cities ranges from about 9,000 at 110 mph to about 18,000 at 185 mph.

In considering these results it should be noted that the ridership forecasts presented in this chapter are based on the frequencies, travel times and fare levels identified in the agreed operating plan. As such, travel times for the 110 mph options are based on DMU technology used in the Phase II MWRRI plan.

Finally, the results of this study correspond to standard industry practices in that ridership and revenue forecast accuracy is expected to be within ±20 percent of the stated value. That is, if the growth estimates for population, income, and employment occur as assumed, and if transportation growth continues to correlate with these and other assumed factors, then the forecast will be accurate with an 80 percent confidence level.

12.6 OPERATING REVENUES, OPERATING AND CAPITAL COSTS

Revenue sources include fares, with estimates for air-connect revenue, on-board service revenue, and parcel revenue. Operating unit costs were refined from other studies to reflect more detailed Tri-State Study requirements, while retaining most MWRRI assumptions for the Base Case. In all cases, all options examined for this study are forecast to have higher operating revenues than operating costs.

Estimated rolling stock costs were developed based on the technology assessment and the operating requirements. The infrastructure cost analysis describes the unit cost approach to the assessment, and provides segment and unit cost detail in extensive Appendices. It also describes the interactive approach used to determine the recommended infrastructure investment for each technology.

Exhibit 12.1
System Summary Costs
($ in Millions)

	Base Case 110 mph River	B-1 110 mph Rochester	B-2 150 mph Rochester	C-2 150 mph NewAlign	D-3 185 mph Elevated
Operating Revenue	135.2	144.6	294.4	361.8	480.3
Operating Cost	83.8	89.7	122.4	148.7	170.2
Rolling Stock	117.5	124.2	351.6	416.3	253.2
Infrastructure Investment	822.7	1,138.7	2,752.5	3,242.8	8,017.5

It should be noted that infrastructure costs have been updated from the Phase II and Phase IIIA MWRRI analyses to include the corridor requirements identified for MWRRI Phase IIIB.

12.7 FINANCIAL ANALYSIS

The financial analysis demonstrated that the critical issues for performance of each option are the investment costs and potential revenue enhancement. The current evaluation suggests that service through Rochester is warranted by 2012 and that this should be provided using the 150 mph option with a separate alignment. The value of the 150-mph option is that it builds an entirely separate right of way for passenger rail and alleviates the need to use the CP Railway freight line, which will undoubtedly become an increasingly significant freight route. As demonstrated in the capacity analysis, an alternative alignment through Rochester may be necessary in the near future in order to provide reliable high-speed train service under any technology alternative.

The results of the financial analysis reveal a sound case for high-speed rail in the Tri-State Corridor. The financial returns suggest that the immediate implementation of the Base Case can easily be supported, along with the incremental implementation of Option C-2 (150 mph via Rochester). In strict financial terms, there is little doubt that the Tri-State Corridor offers a significant opportunity for high-speed rail investment.

12.7.1 Sensitivity Analysis

In order to assess the impact of different factors contained in the financial analysis, a sensitivity analysis was performed on key factors.

The following conditions were evaluated:

- ± 50 percent on interest rates
- ± 30 percent on capital costs
- ± 25 percent on revenue estimates
- ± 25 percent on operating and maintenance costs

In terms of sensitivity to operating cost and revenue items, the financial analysis results are more sensitive to changes in revenues than specific types of operating costs. Both public and private sector contributions toward projected capital costs (*e.g.*, stations) can have a significant impact on cash flow requirements of the financing alternative selected, since these contributions would affect the amount of debt required to be financed.

12.8 ECONOMIC ANALYSIS

The economic analysis provided a strong case for high-speed rail service in the Tri-State Corridor. Most of the technology/route options in the economic analysis generated significant economic benefits in terms of consumer surplus. The net economic benefits (economic profit) produced by the Tri-State Corridor include substantial growth in employment and per capita income, commercial property values and rents, and regional tax base increases. These benefits in employment, income and property values should not be construed as over and above the user benefits, but rather are the mechanisms by which user benefits will be incorporated into the regional economy.

12.9 FUNDING SUMMARY

Many states are exploring opportunities to involve the private sector more completely in the implementation of rail projects. Both the magnitude of the Tri-State system capital requirements and the lack of a proven system of this size in the region would make the potential for full private sector participation extremely difficult. At this time, it is assumed that each state will fund its portion of the capital costs separately using one or a combination of the project funding alternatives discussed. Specific funding strategies and structures based on the funding requirements and abilities of the individual states are outside the scope of this study. However, it is expected that the most likely mechanisms include:

- Federal Financial Assistance
- Cash flow management (TIFIA, GANs)
- Cost reduction techniques (cross-border leases, COPs)

The MWRRI proposes 80 percent federal participation for the entire Midwest system, which would build the Base Case in the Tri-State Corridor. Different funding mixes are likely to be required beyond the Base Case.

12.10 INSTITUTIONAL ARRANGEMENTS

There are many options for institutional arrangements available to the states as the Tri-State Project progresses throughout the planning, engineering, construction and operating phases of the project. Arrangements between states may be informal agreements or formal multi-state arrangements. The activities and institutional issues that may require arrangements could be: project planning, business arrangements and operational oversight.

During all stages of the process, and particularly as the project enters more advanced stages, state agreements need to be in place which allocate costs and revenues to a state based on the benefits received by that particular state. The study does not recommend a specific institutional or allocation arrangement but simply outlines the available examples of both.

12.11 DEVELOPMENT PLAN

If the states agree to go beyond the MWRRI and implement 150 mph service, and if necessary funding is secured, then a recommended implementation strategy is as described in Chapter 11 and summarized in the following paragraphs.

The MWRRI proposed that improvements between Milwaukee and Twin Cities be completed in three segments by Year 7 of MWRRI Implementation (Year 7 currently corresponds to 2006), with Milwaukee-Chicago improvements completed by Year 10.

In terms of the Tri-State Implementation Program, it is likely that the Environmental Impact Study (EIS), design and construction work for West Salem, WI to Rochester to

Twin Cities would take approximately seven years to complete. The most expensive and complex element will be the La Crosse/West Salem-Rochester segment, which includes bridging the Mississippi. The next complex segment will be Portage-La Crosse/West Salem (six years) due to its length and the need for a comprehensive EIS. Since it is proposed that operations will begin in 2012, work should begin in 2005 on development of the Rochester reroute.

12.12 NEXT STEPS

The Tri-State II study is predicated on the foundation of the MWRRI. Therefore, MWRRI planning, construction and vehicle procurement should continue on its current course towards implementation. Next, an EIS should be commissioned to examine detailed alignments and potential environmental impacts for the 150 mph corridor. As noted, even if implementation through Rochester begins at 110 mph, segments should be developed to 150 mph standards to avoid expensive re-work.