RETURN ON INVESTMENT ON FREIGHT RAIL CAPACITY IMPROVEMENT

Requested by:

American Association of State Highway
and Transportation Officials (AASHTO)

Standing Committee on Planning

Prepared by:

David Hunt
Cambridge Systematics, Inc.
Chevy Chase, Maryland

April 2005

The information contained in this report was prepared as part of NCHRP Project 08-36, Task 43, National Cooperative Highway Research Program, Transportation Research Board.

ACKNOWLEDGMENT OF SPONSORSHIP

This study was requested by the American Association of State Highway and Transportation Officials (AASHTO), and conducted as part of National Cooperative Highway Research Program (NCHRP) Project 08-36. The NCHRP is supported by annual voluntary contributions from the state departments of transportation (DOTs). Project 08-36 is intended to fund quick-response studies on behalf of the AASHTO Standing Committee on Planning. The report was prepared by David Hunt of Cambridge Systematics, Inc. (CS) with assistance from Andreas Aeppli of Reebie Associates, Inc. (Reebie). Other contributors included James Blair (Reebie), Daniel Hodge (CS), Alex Lu (Reebie), Gary Maring (CS), and Donald Vary (CS). The work was reviewed by Mary Lynn Tischer of the Virginia DOT, James Badgley of the New Jersey DOT, John Bell of the New York State DOT, Jane Bachner of the Federal Railroad Administration (FRA), Craig Rockey of the Association of American Railroads (AAR), and David Williams of Parametrix, Inc. The project was managed by Ronald D. McCready, NCHRP Senior Program Officer.

DISCLAIMER

The opinions and conclusions expressed or implied are those of the research agency that performed the research and are not necessarily those of the Transportation Research Board or its sponsors. This report has not been reviewed or accepted by the Transportation Research Board's Executive Committee or the Governing Board of the National Research Council.

final report

NCHRP 08-36, Task 43
Return on Investment on Freight Rail Capacity Improvement

prepared for

National Cooperative Highway Research Program

prepared by

Cambridge Systematics, Inc.
4445 Willard Avenue, Suite 300
Chevy Chase, Maryland 20815

and

Reebie Associates, Inc.

April 2005

Table of Contents

List of Tables

List of Figures

Executive Summary

Executive Summary

The rail industry, unlike other modes of transportation, operates over infrastructure largely owned and maintained by private corporations. Like any business, railroads are motivated by shareholder value, and have therefore focused capital investments in the most profitable traffic lanes and rationalized unprofitable track. The result is a more efficient network that operates closer to capacity limits. While this may be a good business model, the rail industry is not well positioned to accommodate the anticipated growth in freight traffic and expanded role desired by much of the public sector.

The implications of this situation and potential solutions were examined in the American Association of State Highway and Transportation Officials' (AASHTO's) 2002 *Freight-Rail Bottom Line Report* (FRBL). The report made a first-order approximation of investment needs over and above what the industry can generate from private sources of capital. It further presented three public policy options, ranging from status quo – an investment strategy based almost wholly on private investment – to varying degrees of public-sector involvement that could go as far as supporting an increase in the proportion of intercity goods handled by rail. However, in order to determine the appropriate level of public involvement in the freight rail industry, it is necessary to better understand what the public receives in return.

The research objective of this study is stated as (bold type added):

> "There are a number of issues that must be considered in evaluating the need for and the means of increasing public investment in rail freight capacity. **The one on which this task is to be focused is how to demonstrate what the public obtains in terms of benefits from its investment in rail capacity improvement(s).** Even with a strong case that the railroad industry will need strategic public investments in order to perform the economic role required of it, Federal and state decision-makers will still require a clear means of demonstrating how these investments will generate the public benefits for which they were intended."[1]

[1] "Research Problem Statement," National Cooperative Highway Research Program, NCHRP 8-36, Task 43, FY 2003.

This report addresses the research objective by:

- Exploring the current practice of evaluating benefits attributable to public investments in freight rail projects though a set of 11 case studies (Chapter 2.0);
- Describing the methods and software models that have been developed and adapted to freight rail projects (Chapter 3.0);
- Discussing the potential funding mechanisms for public investment in freight rail (Chapter 4.0); and
- Combining current practice and methods with future funding requirements to develop a framework for establishing public benefits accruing from investments in freight rail capacity (Chapter 5.0).

■ ES.1 Case Studies

The case studies include a mixture of completed projects and projects still under consideration. Some are specific large-scale projects; for example, the Mid-Atlantic Rail Operations Study (MAROps) and Chicago Region Environmental And Transportation Efficiency (CREATE) Study. Some are programs highlighting specific applications; for example, the Federal Railroad Administration (FRA) Benefit-Cost Methodology developed for the Local Rail Freight Assistance (LRFA) Program and the Congestion Mitigation and Air Quality Improvement Program (CMAQ). Interesting case studies that were completed without detailed quantification of public benefits are also included; for example, Alameda Corridor and Shellpot Bridge.

The public benefits identified in the case studies can be divided into five broad areas:

- **Economic –** Reduction in highway maintenance costs due to lower truck vehicle miles of travel (VMT) and reduction in shipper logistics costs were the two most frequently mentioned economic benefits in the case studies. Also important were avoiding new highway construction costs and retaining existing businesses and jobs.
- **Environmental –** Air quality improvements were quoted as public benefits in 10 of the case studies. Reductions in fuel usage was also a commonly cited public benefit, though this benefit is partially offset by reduction in revenue from fuel taxes. Changes in noise levels were not quantified in any of the case studies.
- **Safety/Security –** Safety was another commonly cited public benefit. In some of the case studies, safety benefits were converted into dollar savings associated with reductions in fatalities, injuries, and property damage. Security, while certainly an area of concern, was only mentioned in one case study and that was in the context of improving security through creating a strong alternative freight network.

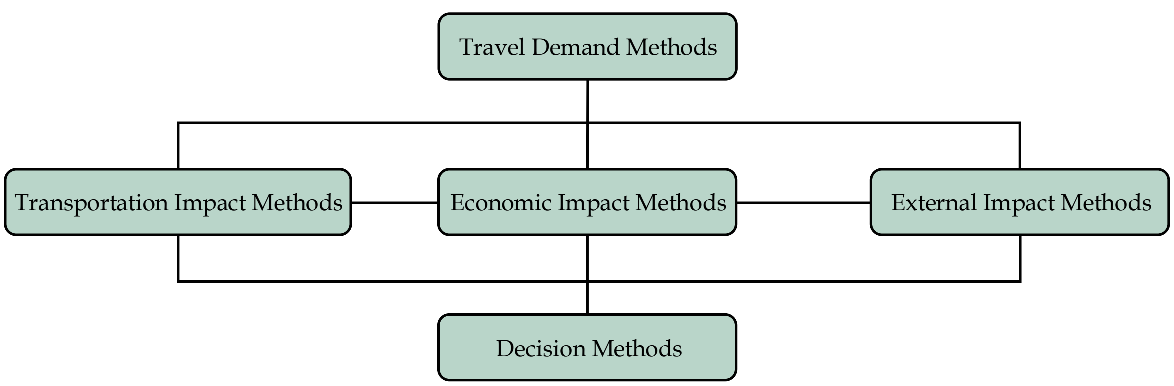
- **Transportation –** Removing heavy trucks from the roadways was the only public benefit mentioned in every case study. In most case studies, the reduction in trucks was converted into other benefits (reduced highway maintenance, reduced roadway delay, etc.). Reduction in delays on both highways and freight rail lines, along with improvements in carrier efficiency, were quoted as public benefits in more than half of the case studies. Upgrading to industry standards (e.g., 286,000-pound railcars) was only mentioned in two case studies, but this is principally due to the nature of the case studies and not the importance of this criteria.

- **Other –** Another criterion used in several of the case studies, which has implications for Federal funding, is public designation as a project of "national significance."

ES.2 Methods and Software Models

The interrelationship of the various methods used to evaluate transportation investments is depicted in Figure ES.1.

Figure ES.1 Framework for Evaluating Transportation Investments



This figure represents an idealized structure that can be applied to all transportation investments. It is idealized in the sense that several models do not fit neatly within a single box. It does, however, provide a convenient way to describe how freight rail investments can be converted into public benefits. The individual boxes contain:

- **Travel Demand Methods –** Includes both the traditional four-step models (trip generation, trip distribution, mode split, traffic assignment) and current efforts at freight modeling. Of special importance are truck-rail diversion methods.

- **Transportation Impact Methods –** Determines the transportation-related benefits from the proposed improvements. These can include reduced highway maintenance costs, reduced operating costs, reduced shipper costs, etc. This also includes hybrid models that blend multiple methods together to address specific needs.

- **External Impact Methods –** Includes non-transportation benefits attributable to transportation improvements. These include land use, safety, security, and environmental.

- **Economic Impact Methods –** Converts the various impact measures into direct and indirect economic benefits. This includes input/output, regional simulation, and regression models used to estimate economic expansion.

- **Decision Methods –** Includes methods such as benefit-cost and internal rate of return, used to evaluate and help determine the best allocation of public investments.

Most of the models used for evaluating freight rail investments are being adapted to uses outside of their original designs. Travel demand models are largely adapted from passenger models. Economic models have been adapted to transportation uses. Railroad impact models were developed to examine strategic investments or operational changes, not to determine public benefits. This has created a situation where, ironically, like the multimodal systems they model, connections and data transfers between these models create significant bottlenecks in the analysis. Models are being used and pieced together in ways not intended by the designers, leading to simplifying assumptions and data manipulation challenges.

ES.3 Funding for Freight Rail Projects

A first approximation from the AASHTO FRBL report suggests that the freight rail system needs an additional investment of $2.6 to $4.0 billion annually and that this investment is likely to be shared among the railroads, state and local governments, and the Federal government. The AASHTO report also suggests, as we look forward, that the states and local agencies in cooperation with the private sector can look at the following finance mechanisms for investing in freight rail improvements:

- **Grants from surface transportation programs –** Give states and the Federal government the best control over the use of funds. At the Federal level, these include the Federal Highway Administration (FHWA) Section 130 Rail-Highway Grade Crossing Program (for safety improvements only), the CMAQ (for air quality non-attainment regions only), and discretionary programs such as the Corridors and Borders Programs and a proposal for a Program for Projects of National Significance.

- **Loan and credit enhancement programs –** Such as Transportation Infrastructure Finance and Innovation Act (TIFIA), Railroad Rehabilitation and Improvement Financing (RRIF), and State Infrastructure Banks (SIBs).

- **Tax-expenditure financing programs –** Including accelerated depreciation, investment tax credits, tax-exempt bond financing, and tax-credit bond financing.

Large-scale projects may need to utilize funding from multiple sources, thus necessitating a broad range of demonstrated public benefits. Freight rail projects demonstrating a realistic and cost-effective expansion of freight capacity while reducing highway costs will have the most options for pursuing Federal funding. Improving safety will continue to be an important criterion for justifying public expenditures in freight rail projects, as will demonstrating economic expansion at state and regional levels, and demonstrating air quality benefits. Economic benefits attributable to retention of existing businesses and jobs will be important, while shipper and carrier cost reductions will likely play less of a role in securing public funding for rail capacity expansion.

ES.4 Conclusion

There are a good collection of methods available to the analyst, though as previously discussed, these have largely been adapted from other uses and data transfers remain a bottleneck. Methods that address engineering concerns (e.g., capacity, delays, new construction, maintenance costs) are more developed than behavioral methods predicting shipper and carrier responses to investments in rail capacity. High-level, or sketch, planning tools for freight rail lag similar development efforts for highways.

What is missing is a comprehensive framework to help facilitate decisions on strategic public investments in rail freight capacity. Section 5.5 of this report presents a Freight Rail Investment Framework to assist planners evaluate freight rail investments. This was modeled after the successful hybrid methods used for evaluating highway and intelligent transportation systems (ITS) investments. This framework could take the form of a suite of interconnected software packages that provide quick and seamless analysis capabilities, or simply a guidebook providing procedural guidance. It would encompass linkages to travel demand models, transportation, external and economic analysis, standard project costs, and decision models.

The AASHTO FRBL report demonstrated that railroads will be unable to privately fund the capacity expansions necessary to keep pace with the demand for intercity freight transport. Recent efforts, such as CREATE, Alameda Corridor, and MAROps, have shown a willingness on the part of government agencies and the freight railroads to work together in solving the nation's growing freight crisis. Before public investment are made, we need assurances that public benefits will follow.

1.0 Introduction

1.0 Introduction

The continued importance of the rail freight industry as part of the U.S.'s transportation infrastructure is undisputed. Most high-volume bulk commodities such as coal, grain, and chemicals travel by rail, and many manufactured goods are handled intermodally by rail during part of their journeys. In 2000, railroads accounted for 28 percent of all ton-miles, 40 percent of intercity ton-miles, and 16 percent of tonnage moving domestically. For a period of almost 20 years following economic deregulation in 1980, the railroad industry was able to absorb a modestly growing demand for its services by consuming available excess capacity. However, with continued economic growth, changes in logistics practices, and geographic shifts in sourcing, it is doubtful that the freight railroads will be able to maintain market share as demand continues to grow. This growth is anticipated to be substantial, amounting to 57 percent between 2000 and 2020.[1]

In contrast to the other domestic modes of transport, U.S. rail service is provided over infrastructure largely owned and maintained by private corporations. Efforts to expand physical capacity commensurate with expected growth are costly to implement and maintain on a continuing basis. Such investments are also highly illiquid, and of little value if the traffic does not materialize at the expected volumes and profitability. Private investors consider such investments highly risky, and require levels of return that often cannot be justified on a wholly private basis. As a result, railroads are unable to privately fund the capacity expansion that will be needed to keep up with the public desire for growth in intercity freight rail transport.

The implications of this situation and potential solutions were examined in the American Association of State Highway and Transportation Officials' (AASHTO's) 2002 *Freight-Rail Bottom Line Report* (FRBL). The report made a first-order approximation of investment needs over and above what the industry can generate from private sources of capital. It further presented three public policy options, ranging from status quo – an investment strategy based almost wholly on private investment – to varying degrees of public-sector involvement that could go as far as supporting an increase in the proportion of intercity goods handled by rail. However, in order to determine the appropriate level of public involvement in the freight rail industry, it is necessary to better understand what the public receives in return.

Activity in this area includes National Cooperative Highway Research Program (NCHRP) Project 8-42, *Rail Freight Solutions to Roadway Congestion*. Currently underway, NCHRP 8-42 examines the suitability of freight rail to help alleviate roadway congestion, and

---

[1] Statistics drawn from the *Freight-Rail Bottom Line Report*, American Association of State Highway and Transportation Officials, 2002.

develops a decision-making framework.[2] However, the benefits from freight rail investment can be much broader. If designed well, a freight rail investment can serve to increase transportation capacity and provide other direct and indirect benefits. This report, NCHRP 8-36 Task 43, examines public benefits accruing from freight rail investments, especially the quantification of benefits, by focusing on three principal questions:

1. What methods have been used to determine public benefits of freight rail investments?
2. What methods and models for determining public benefits are currently available?
3. What methods and models are needed in the future?

Question 1 is directly answered by examining a set of 11 case studies in Chapter 2.0. These cases range from large-scale projects to smaller projects and include specific applications of programs. The cases focus on quantitative methods, but some interesting qualitative assessments are also included.

Question 2 is directly answered by describing some of the available methods and models for quantifying public benefits in Chapter 3.0. Models are divided into five categories: travel demand methods, transportation impacts, external impacts, economic impacts, and decision methods. Travel demand methods estimate current and future volumes, while the impact models translate the volumes into project system impacts and infrastructure requirements. Transportation impacts include: transportation cost and efficiency changes, and shipper accessibility changes. External impacts may be environmental, community or land use based, or related to safety and security. Economic impact models, for the purpose of this report, include both econometric tools for estimating direct and indirect economic benefits, and any methods used to convert a transportation-sector change into a monetary public benefit. Decision methods provide a defensible procedure for selecting projects based on the direct and indirect impacts of a potential investment.

Question 3 is addressed in Chapter 5.0, using information from Chapters 2.0, 3.0, and 4.0. Chapter 4.0 looks at potential funding sources for freight rail projects, including both existing and potential Federal sources and a sampling of state programs. The funding source often dictates the nature of the benefits analysis. Chapter 5.0 uses information from the earlier chapters to first develop a matrix showing types of public benefits mapped against the case studies. This matrix illustrates which benefits were considered, and distinguishes between quantitative and qualitative analysis. The benefit types are then mapped against available models and methods to determine where there are techniques for quantifying impacts and where there are gaps. These same benefits are then mapped against potential revenue sources to identify the analyses most helpful when applying for project funding. Finally, an evolving framework for quantifying freight rail investments is presented, tied into a comparison of the three matrices, to identify existing methods and gaps in the analysis.

Chapter 6.0 draws some summary conclusions and recommends areas of future research.

---

[2] See http://www4.trb.org/trb/crp.nsf/All+Projeccts/NCHRP+8-42 for more details on this project.

2.0 Publicly Supported Freight Rail Projects – Case Studies

2.0 Publicly Supported Freight Rail Projects – Case Studies

This chapter presents a series of case studies, with a focus on justification for the projects through quantification of public benefits. The case studies include a mixture of completed projects and projects still under consideration. Some are specific large-scale projects; for example, the Mid-Atlantic Rail Operations Study (MAROps) and Chicago Region Environmental And Transportation Efficiency (CREATE) Study. Some are programs highlighting specific applications; for example, the Federal Railroad Administration (FRA) Benefit-Cost Methodology and the Congestion Mitigation and Air Quality Improvement Program (CMAQ). Interesting case studies that were completed without detailed quantification of public benefits are also included (e.g., Alameda Corridor and Shellpot Bridge). Each case study description consists of three sections: introduction, benefits methodology, and results.

In all, 11 projects are profiled as case studies:

- Alameda Corridor Transportation Project;
- Chicago Region Environmental And Transportation Efficiency Study;
- Congestion Mitigation and Air Quality Improvement Program;
- Federal Railroad Administration Benefit-Cost;
- *Freight-Rail Bottom Line Report*;
- I-81 Marketing Analysis for Virginia;
- Mid-Atlantic Rail Operations Study;
- New York Cross Harbor Study;
- Northern Ohio Corridor Study;
- Palouse River and Coulee City Railroad; and
- Shellpot Bridge.

2.1 Alameda Corridor Transportation Project

Introduction[1]

The Alameda Corridor is a 20-mile freight rail expressway between the neighboring ports of Los Angeles and Long Beach and the transcontinental rail yards and railroad mainlines near downtown Los Angeles. The centerpiece is the Mid-Corridor-Trench, a below-ground railway that is 10 miles long, 30 feet deep, and 50 feet wide.

Project Objectives

The project has two main objectives: 1) by consolidating 90 miles of branch rail lines into a high-speed expressway, the Alameda Corridor eliminated conflicts at more than 200 at-grade railroad crossings where cars and trucks previously had to wait for long freight trains to slowly pass; and 2) it also cut by more than half, to approximately 45 minutes, the time it takes to transport cargo containers by train between the ports and downtown Los Angeles.

Sources of Funding

The project was constructed at a cost of $2.4 billion by the Alameda Corridor Transportation Authority – a joint powers agency known as ACTA and governed by the cities and ports of Los Angeles and Long Beach and the Los Angeles County Metropolitan Transportation Authority. The Alameda Corridor opened on time and on budget on April 15, 2002. It was funded through a unique blend of public and private sources, including $1.16 billion in proceeds from bonds sold by ACTA; a $400 million loan by the U.S. Department of Transportation (DOT); $394 million from the ports; $347 million in grants administered by the Los Angeles County Metropolitan Transportation Authority; and $130 million in other state and Federal sources and interest income. Debts are retired with fees paid by the railroads for transportation of cargo into and out of the region.

Through May 2003, ACTA has assessed the railroads approximately $60.9 million on 4.6 million 20-foot equivalent container units (TEUs). These figures are consistent with financial projections made before bonds were sold to help finance construction. The railroads pay TEU-based fees for cargo transported on the Alameda Corridor as well as for cargo departing or arriving in the five-county Southern California region by rail, regardless of whether the cargo actually traverses the Alameda Corridor.

---

[1] Adapted from the Alameda Corridor Transportation Authority Internet site at http://www.acta.org/.

National Significance

About 35 percent of all waterborne container cargo in the United States depends on the San Pedro Bay ports to reach market. In 2003, the ports together handled close to 11.9 million TEUs. Projections of growth estimate a tripling of container cargo by 2020.

Since the start of operations on April 15, 2002, the Alameda Corridor has handled an average of 35 train movements per day – a figure consistent with earlier projections for this stage of operations. Usage is projected to increase steadily as the volume of international trade through the ports grows. The ports project the need for more than 100 train movements per day by 2020. The Alameda Corridor can accommodate approximately 150 train movements per day. The Alameda Corridor is intended primarily to transport cargo arriving at the ports and bound for destinations outside of the five-county Southern California region (imports) or originating outside the region and shipped overseas via the ports (exports). This accounts for approximately half of the cargo handled by the ports. The other half of the cargo handled by the ports is bound for or originates in the region, and is transported primarily by truck.

Benefits Methodology

There was no formal benefit-cost methodology used for the Alameda Corridor project. Benefits reported below were estimated using various qualitative approaches. No formal post evaluation has been done to assess actual benefits.

Results

The primary benefits of this project were: 1) eliminated conflicts at more than 200 at-grade railroad crossings; and 2) reduction by half of the time it takes to transport cargo containers by train between the ports and downtown Los Angeles.

More specifically, the benefits of the Alameda Corridor project were estimated to be as follows:[2]

- **Reduce Highway Traffic Delays.** It is estimated that upon opening of the Alameda Corridor, traffic delays affecting cars and trucks would be reduced by 90 percent (more than 15,000 hours of vehicle delay will be eliminated every day) by consolidating rail traffic and eliminating highway grade crossings.

[2] National Cooperative Highway Research Program Project 8-39, *Financing and Improving Land Access to U.S. Cargo Hubs*, 2002.

- **Improve Safety.** Safety would be improved by eliminating more than 200 street-level railroad crossings. Delays to emergency vehicles will be significantly reduced. Motor carrier and railroad accidents and toxic spills can be more effectively managed.

- **Improve Access Capacity and Maintain Competitiveness of Ports.** The Alameda Corridor is intended to meet the port rail access requirements to 2020 and thereby make it possible for the San Pedro Bay ports to remain as the major cargo hub and gateway for a competitive port system for the United States and its international trade partners.

- **Improve Rail Operations.** Average train speed along the corridor is estimated to increase to approximately 30 to 40 miles per hour (mph) from five to 20 mph. Upon opening of the Corridor, locomotive hours of operation were reduced by 30 percent. Assisted by state-of-the-art technology in centralized traffic control systems, the double-track corridor reduced the number of times trains have to stop and wait for other trains to pass by 75 percent.

- **Reduce Environmental Impact.** This project was expected to reduce railroad emissions by 28 percent, and auto and truck idling emissions associated with grade crossing delays by up to 54 percent. There is a benefit realized by the consolidation of rail traffic itself to a primarily industrial corridor, by reducing exposure of residential neighborhoods to noise and vibration. The construction of tracks in the below-grade trench, track construction on new base material, and the use of continuous welded track will help to promote a quieter operation. Also, sound walls will be provided, where appropriate, to mitigate vehicle noise along Alameda Street, in residential neighborhoods, and other sensitive areas.

- **Promote Economic Development.** The project was estimated to create 10,000 construction jobs. Improved traffic circulation and the elimination of grade crossings also create enhanced development opportunities along the corridor. In addition, more efficient international cargo flows benefit consumers and shippers throughout the nation.

- **Reduce Construction Impacts.** Right-of-way needed for a consolidated corridor is reduced in comparison to several routes as is the existing situation, resulting in the fewest number of displaced persons and businesses as a result of the construction.

2.2 Chicago Region Environmental And Transportation Efficiency Project

Introduction

CREATE was conceived as a package of critically needed improvements to the Chicago region's rail infrastructure. The project is being advanced by a consortium consisting of the Illinois DOT, Chicago DOT, the six largest North American freight railroads (Union Pacific or UP, Burlington Northern Santa Fe or BNSF, Norfolk Southern or NS, Canadian Pacific or CP, Canadian National or CN, and CSX Transportation), and Metra, Chicago's regional passenger railroad. Physically, CREATE calls for rationalization, reconstruction, and upgrade of five cross-town corridors in Chicago: Belt Railway of Chicago East-West Connector; UP/CSX/NS Western Avenue Corridor; CSX/Indiana Harbor Belt Beltway Corridor; Metra South West Service Passenger Express Corridor; and a new Central Corridor connecting CN-Wisconsin Central with Eastern Class I railroads.

Project Goals

The project has two main goals: 1) reduce highway-rail conflicts by rerouting rail traffic in such a way as to avoid grade-crossing prone lines and physically separating rail lines crossing high-volume roadways at selected locations; and 2) upgrade logical corridors to create through routes and additional capacity in Chicago, transcending historical ownership barriers. As part of this systemwide upgrade, three main stakeholder groups will benefit: freight shippers through additional routes and capacity; passenger rail traffic from the new express corridor and other capacity improvements (signaling, switches, and flyovers); and highway users through reduced congestion due to grade separation and more efficient rail traffic routing.[3]

Sources of Funding

The disparate sources of funding for this project reflect the multiple purposes of the project. Traditionally, railroads make investment decisions individually. Under CREATE, railroads are making investment decisions based on what is best for the overall network. The Federal government will fund the public benefits resulting from the project through a variety of mechanisms, and the state and local governments will provide matching funds. The private freight railroads will pay for the business benefits they each gain from the improvements, amounting to $212 million out of a total projected investment of $1.5 billion. This contribution was analyzed and validated by the Chicago DOT, which declared it "commensurate with the industry's potential economic benefits." The

[3] For a full discussion, see John P. Mick, II, *Why Chicagoland needs the Chicago Regional Environmental and Transportation Efficiency Program*, Proceedings of the Metropolitan Conference on Public Transportation Research (MCPTR), Illinois Institute of Technology, 2004.

methodology was based on productivity increases (i.e., projected cost reductions) to the railroads from a more fluid network and additional capacity, pitted against time savings and other benefits derived by highway and passenger rail users.

National Significance

One-third of America's rail and truck cargo moves to, from, or through the Chicago region.[4] The Chicago rail network not only serves Illinois and the Midwest, but also the rest of the United States and North America. After Illinois, the four states most economically dependent on Chicago's rail system are California, Texas, Ohio, and New Jersey.[5] The magnitude of the Chicago region's trade activity is such that improvements in rail efficiency can have large impacts on businesses and consumers throughout the nation. In addition, seven rail lines entering Chicago are part of the Strategic Rail Corridor Network – rail lines identified as critical to national defense. CREATE is considered so important to national infrastructure needs that an unprecedented interdepartmental team in the U.S. DOT, comprised of representatives from the FRA, Federal Transit Administration (FTA), and Federal Highway Administration (FHWA), was created to oversee it on a national level.

Benefits Methodology

A variety of analyses were performed to examine various aspects of the CREATE project. The *Freight Rail Futures for the City of Chicago* study focused on the economic benefits of retaining and upgrading the rail freight infrastructure in Chicago. The framework helped city and state officials assess the ways that changes in a region's freight transportation system would affect employment, gross regional product (GRP), and other economic indicators in the future. The core of the study was a multisector, regional economic analysis based on an input-output (I/O) model that showed how economic activity in the City, the inner suburbs, and the region would be affected by various possible scenarios concerning rail activity.

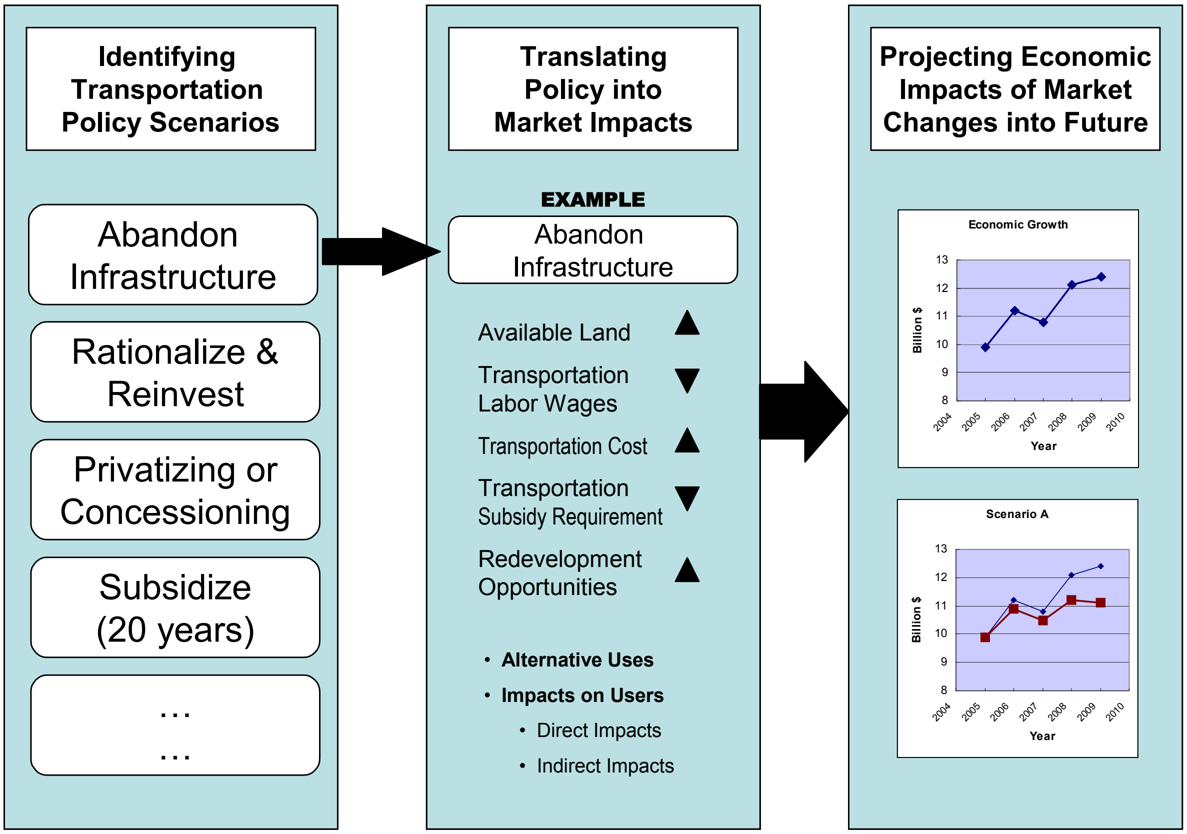
In the *Chicago Freight Futures* study, modeling the impact of transportation or investment with a regional economic model involved three steps: 1) create a number of plausible alternative scenarios in transportation or investment policy; 2) translate the proposed transportation or investment policy into changes in demand supply, or cost, in all relevant markets; and 3) use the supply-demand changes, combined with an economic forecast, to predict differentially the economic benefits on the various industrial sectors and the regional economy as a whole. Figure 2.1 is a diagram representing the main steps in the transportation-economic benefits analysis. These benefits are indicators of cost effectiveness of public investment in terms of GRP, which are measures of individual surpluses or utility.

---

[4] CREATE publicity material generated from TRANSEARCH.

[5] Analysis based on value of goods transported by rail, and their loading on the general economy (based on an industry-specific I/O table).

Figure 2.1 Main Steps in the CREATE Transportation-Economic Benefits Analysis



The first step (column) of Figure 2.1, Identifying Transportation Policy Scenarios, requires an analysis and understanding of the regional transportation strategy. Highway information was gathered from the state highway plan. Other important information considered included the highway system maintenance strategy, designated major routes, and related development and zoning plans. Corridor plans, available in some areas, were also helpful. In some states or municipalities, the detailed plan did not exist; in those cases, stakeholder outreach and some degree of long-range planning was required from planners before the economic model could be used to predict its effects. This is essentially a qualitative policy analysis task, requiring analysts with good local knowledge but also creativity to imagine a number of different visions for uses of existing infrastructure and future funding. For CREATE, the base-case scenario assumed that railroads will continue to improve on the infrastructure independently, without making major systemwide investments.

The second step (column) of Figure 2.1 translated the qualitative visions into quantitative market impacts. This is a difficult and sometimes subjective step, requiring different analytical techniques depending on the local circumstances and the scenarios chosen. For example, if certain infrastructure will be abandoned and redeveloped in a particular scenario, care is required in assessing the direct and indirect impacts of such abandonment, and making reasonable assumptions with respect to potential and timing for redevelopment. Professionals with transportation operations and/or real estate project evaluation experience are needed for this task. Data sources used in the CREATE study included extensive freight flow market data from Reebie Associates' TRANSEARCH® database, ad-hoc shipper survey data, stakeholder outreach (focus group data), and historical commodity, labor, and real estate price data obtained from real estate experts.

The final step (column) in Figure 2.1 entailed estimating the regional economic impacts of the proposed investment, using a driving economic forecast such as those provided by the Bureau of Economic Analysis (BEA), national I/O account tables, and a regional economic model. For the *Chicago Freight Futures* study, Regional Economic Models, Inc.'s (REMI) model was used (see Section 3.4).

Results

In the *Chicago Freight Futures* study, this type of analysis was used to evaluate four categories of impacts: 1) jobs generated (direct and indirect); 2) change in GRP; 3) change in real income; and 4) regional sales development. In addition, rationalization of railroad infrastructure will lead to vacating tracts of land, which may be redeveloped for commercial and residential purposes, which in turn have economic and job benefits.

In quantitative terms (see Table 2.1), the CREATE analyses found redevelopment to be a significant economic component of this project – leading to the creation of about 20,000 jobs in 2020 versus 8,500 jobs without the redevelopment component. The impact of redevelopment from the standpoint of GRP was even greater, ranging from a low of $1.2 billion without re-use to $2.8 billion with re-use in 2020.[6] The highway delay reduction component of grade-separation was also found to be significant, while the rail capacity improvement accounted for only 14 percent of measured benefits.

[6] Reebie Associates, *Freight Rail Futures for the City of Chicago*, March 2004, p. 81.

Table 2.1 CREATE Rationalization and Redevelopment Scenario

Benefit Type	2002 Value	2012 Value	2020 Value
Jobs Created	189	1,694	19,740
Gross Regional Product Changes	$0	$0.2 billion	$2.8 billion
Rail Yard Acreage Re-Used	0 acres	320 acres	400 acres
Grade Crossings Eliminated	0	25	25
Railcars Handled per Day	37,500	N/A	67,000
Annual Public Benefits (Safety and Delay Reduction)	$0	N/A	$500 million

Sources: "Freight Rail Futures for the City of Chicago," Reebie Associates, Economic Development Research Group; Publicity material from Association of American Railroads and Federal Railroad Administration.

The broader effects of CREATE fall into a number of categories:

1. Safety and delay reductions resulting from rail-highway grade separation;
2. Indirect benefits from reducing delays, such as better highway emergency response and reduced pollution;
3. Increased rail capacity resulting in a reduction of commuter rush-hour delays and freight congestion, more efficient interchanges, and faster freight transit times;
4. Secondary effects from changed operating patterns, such as leveraging previously unused capacity, resulting in better efficiency; and
5. Redevelopment of underutilized and/or abandoned infrastructure into more productive uses.

The redevelopment impacts, and the benefits from safety improvements and delay reductions have been quantified into monetary values. The other impacts have not been quantified into dollars of public benefits at this time.

2.3 Congestion Mitigation and Air Quality Improvement Program – Iowa Example

Introduction

CMAQ distributes $1.5 billion annually to states and metropolitan planning organizations (MPOs) for funding transportation projects demonstrating an improvement in air quality. Originating in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) as a program for air quality non-attainment areas, the program was expanded in the Transportation Equity Act for the 21st Century (TEA-21) to include maintenance areas. CMAQ is not exclusive to rail projects; in fact, rail projects are not explicitly stated, which originally led to some hesitancy on the part of states and MPOs to allocate these funds to private-sector freight rail projects. As more and more freight rail projects have been funded and shown to lead to air quality improvements, this hesitancy has dissipated.

Auburn, Maine

One example of a successful application of CMAQ funds for a freight rail project occurred in Auburn, Maine. The City of Auburn set a long-term goal of becoming the multimodal transportation center for the State of Maine. Rail service is provided by the St. Lawrence & Atlantic Railroad (SLR – a subsidiary of the Genesee and Wyoming) from Portland, Maine, through Auburn and on into New Hampshire, Vermont, and Quebec, where the SLR connects with CN near Montreal. Because Auburn was an air quality non-attainment area, the City was able to obtain CMAQ funding to construct an Intermodal Freight Transfer Facility based on projected reductions in long-haul truck traffic and the corresponding decrease in vehicle emissions. The 16-acre facility opened in September 1994 financed with 80 percent Federal CMAQ funds and 20 percent from the City of Auburn. The facility proved so successful that a 19-acre expansion was completed in 2001. Though not a requirement for CMAQ funding, the Intermodal Freight Transfer Facility has been an economic boon to the Auburn-Lewiston area, creating jobs directly at the facility, plus two trucking companies have relocated to the area, additional warehouse space has been constructed, and a chemical plant has been built near the facility.

Delaware Valley Regional Planning Commission

Another successful application of CMAQ funding to freight rail projects occurred at the Delaware Valley Regional Planning Commission (DVRPC). DVRPC solicits applications for CMAQ funds from public agencies, private firms, and non-profit entities. A CMAQ subcommittee (comprised of county, state, and transit operator planners, and citizen representatives of environmental, biking, transit, and business interests) is formed to evaluate submitted applications. In April 2003, the DVRPC Board selected 24 projects to receive Federal CMAQ funding totaling $11.7 million. Three of these were rail freight projects. The rail freight projects encourage reduced truck emissions and promote rail freight as an alternative to long-haul trucks. These projects were amended into the Transportation Improvement Program (TIP) to be eligible for Federal CMAQ funding.

The State of Iowa

CMAQ has also been used as a funding mechanism for several freight rail projects in Iowa. The next two sections discuss the methodology and the results for three projects in Iowa.

Benefits Methodology

Through Iowa's Clean Air Attainment Program, the Iowa DOT allocates CMAQ funding for transportation projects to cities, counties, and other eligible applicants in non-attainment areas. Examples of three projects are:

- **Iowa City Interchange Relocation[7] –** Relocate the interchange track used by the Iowa Interstate Railroad and the Cedar Rapids and Iowa City Railway from south Iowa City to a rural location. This relocation project will lead to significant improvements in arterial street traffic flow, which will lead to reductions in vehicle emissions.

- **Mason City 12th Street NW Underpass[8] –** Create an underpass for 12th Street NW, a major east-west thoroughfare with continuous alignment across Mason City, and the UP rail line. This project will reduce arterial street traffic congestion, improve traffic safety, and improve air quality.

- **Rock Island Arsenal Bridge Clearance Improvement[9] –** This bridge spans the Mississippi River between the cities of Davenport, Iowa, and Rock Island, Illinois. The improvement will allow the bridge to accommodate double-stack container trains, thus allowing the Iowa Interstate Railroad to not only maintain existing market share, but also increase service to the Maytag Corporation. Without the clearance improvements, Maytag was expected to utilize more 53-foot trucks to serve their Regional Distribution Center.

The first two projects will improve air quality through reductions in idling time for vehicles waiting for trains to clear at-grade intersections. The third project is similar to the Auburn, Maine, and DVRPC examples of improving air quality through reductions in long-haul truck traffic.

---

[7] City of Iowa City, Application for Iowa Clean Air Attainment Program Funds, September 1996.

[8] City of Mason City, Application for Iowa Clean Air Attainment Program Funds, 12th Street NW at Union Pacific Railroad Tracks, September 1997.

[9] Rock Island Arsenal Bridge Clearance Improvement, collection of documents obtained from the Iowa Department of Transportation mostly dated in 1995.

Despite the different focus of the three projects, the method used to quantify the benefits is the same.

1. Estimate the change in vehicle minutes of delay (VMD) or vehicle miles of travel (VMT);
2. Convert VMD and/or VMT into emission savings; and
3. Determine the cost effectiveness of the project.

Focusing on the Iowa City and Mason City examples, the first step is to calculate the minutes of reduction in vehicle idling time due to the improvements. This involves estimating the difference between current VMD (base) and projected post-improvement VMD (alternative).[10] Conversion of the reduction in VMT to grams per minute of emissions was done using the U.S. Environmental Protection Agency's (EPA) MOBILE6 model (see Section 3.3). MOBILE6 is an emission factor model for predicting gram per mile emissions of Hydrocarbons (HC), Carbon Monoxide (CO), Nitrogen Oxides (NO_x), Carbon Dioxide (CO_2), Particulate Matter (PM), and toxics from cars, trucks, and motorcycles under various conditions.[11] Iowa uses the estimates for CO, NO_x, and Volatile Organic Compounds (VOC, which is HC). The grams per vehicle minute are extrapolated first into grams of daily emissions and then into kilograms of annual emission savings.

The final step is to calculate the cost effectiveness of the project by dividing the total project cost by the emissions reduction of each pollutant by the design life of the project. This provides a cost-benefit ratio where costs are measured in dollars and benefits are measured in kilograms of pollutant. The dollars per kilogram metric provides a benchmark for comparing the effectiveness of an application against prior approved and rejected project applications.

The Rock Island Arsenal Bridge project uses the same basic methodology, but uses changes in VMT as the basis for estimates of reduced air quality emissions. The comparison is between the estimated number of long-haul trucks on the road without (base) and with (alternative) the double-stack clearance improvement. In both the base and alternative, the net emissions are calculated by subtracting the increase in locomotive emissions from the decrease in truck emissions.

Results

The cost effectiveness calculations for the three Iowa projects are displayed in Table 2.2.

---

[10] Iowa calculates the change in VMD using the queuing bottleneck formula found in the *Transportation and Traffic Engineering Handbook*, 2nd Edition, pp. 467-468.

[11] For more information, visit the U.S. Environmental Protection Agency MOBILE6 Internet site at http://www.epa.gov/ otaq/m6.htm.

Table 2.2 Cost Effectiveness of Example Iowa CMAQ Applications

Project	Total Project Cost	Project Life (Years)	CO ($/kg)	VO_x ($/kg)	NO_x ($/kg)
Iowa City Interchange Relocation	$1,509,500	30	$3.04	$25.12	$8,386.11
Mason City 12th Street NW Underpass	$5,600,000	50	$1.01	$8.45	$136.09
Rock Island Arsenal Bridge Clearance Improvement	$500,000	20	$3.12	$32.90	$2.05

This methodology provides a sound basis for comparing potential air quality projects, and has the advantage of providing equal comparisons across the various modes of transportation. Because the only benefits required for CMAQ allocations are air quality improvements, this methodology adequately meets its goal. The methodology does, however, have some shortcomings that would make it difficult to incorporate into a larger benefits framework. These include:

- Cannot easily be combined with other potential benefits (e.g., safety, reduced highway maintenance costs, jobs);
- Sensitive to assumptions about project life; and
- Subjective comparisons across cost-effectiveness values (e.g., Is Mason City project better or worse than Rock Island project? Mason City is has a higher NO_x benefit, but Rock Island has higher CO and VOC benefits.).

2.4 Federal Railroad Administration Benefit-Cost Methodology

Introduction

The bankruptcy of several northeastern railroads in the early 1970s, most notably the Penn Central, lead to an intervention by the Federal government and states to preserve rail service. The Regional Rail Reorganization (3R) Act of 1973 and its successor the Railroad Revitalization and Regulatory Reform (4R) Act of 1976 initiated much of the public-sector rail planning occurring today. State DOTs became more involved in freight rail planning and support and AASHTO established a Standing Committee on Rail Transportation (SCORT).

The 4R Act authorized considerable financial aid for Conrail, Amtrak, commuter services, and the regional and short-line railroads that resulted from the bankruptcies. As Conrail stabilized, and passenger services found other sources of funding, Federal and state programs became focused more on short-line preservation. The 4R Act was amended by the Local Rail Service Assistance (LRSA) Act of 1978, and the Omnibus Budget Reconciliation Act of 1981. The LRSA program provided funding on a Federal/local matching share basis for four types of projects: rehabilitation, new construction, substitute service, and acquisition. The LRSA Program permitted states to provide funds on a grant or loan basis. The Local Rail Service Reauthorizing Act of 1989 established the Local Rail Freight Assistance (LRFA) program and revised the criteria for lines eligible to receive assistance. Funds for the program were dramatically reduced in the 1990s, and congressional appropriations ceased in 1995.

Throughout this process, it became necessary to develop an objective methodology for allocating public funding to the railroads. The basis for this became a benefit-cost methodology established by the FRA and described in "Benefit-Cost Guidelines Rail Branch Line Continuation Program" (February 1980) and "FRA Simplified Benefit-Cost Methodology" (May 1982). This methodology was updated for the LRFA program in July 1990 in the FRA document "Benefit-Cost Methodology for the Local Rail Freight Assistance Program."

Benefits Methodology

The Local Rail Service Reauthorizing Act of 1989 required:

"The Secretary, no later than July 1, 1990, shall establish a methodology for calculating the ratio of benefits to costs of projects … taking into consideration the need for equitable treatment of different regions of the United States and different commodities transported by rail."[12]

The task of developing this benefit-cost methodology fell to the FRA, which developed a nine-step process.[13] The first three steps are 1) establish the project alternatives; 2) determine the project costs of the alternatives; and 3) establish a null (do nothing) alternative. The null alternative represents the best estimate of the future if improvements are not undertaken. Steps 4 and 5 involve using FRA standards for the planning horizon (LRFA specifies a 10-year horizon) and discount rate, respectively. The FRA published an annual discount rate based upon the Federal government cost of borrowing (determined by the interest rate on 10-year obligations) less inflation expectations, thereby allowing all benefit-costs to be reported in constant dollars.

---

[12] Federal Railroad Administration, *Benefit-Cost Methodology for the Local Rail Freight Assistance Program*, July 1990.

[13] Federal Railroad Administration, *Benefit-Cost Methodology for the Local Rail Freight Assistance Program*, July 1990.

Transportation efficiency benefits are determined in Step 6 and secondary benefits are determined in Step 7. For the transportation efficiency benefits, the railroads and/or shippers are expected to provide the direct benefits associated with the project. There are multiple comparison possibilities, but the two most common are: a) a comparison of the project with a null alternative of abandonment; and b) a comparison of the project with a null alternative of continued operations "as is." The direct transportation benefits categories are:

i. Difference between rates charged for service by alternate mode and rates charged for rail service on traffic that will move under both alternatives.

ii. Shipper business profits, on traffic that would not move without project.

iii. Branch line projected operating profit or loss.

iv. Labor output that would be lost without project.

v. Cost of moving businesses, if move would occur without project.

vi. Present value of stream of lease payments.

vii. Salvage value at the end of planning horizon.

The transportation efficiency benefits of Step 6 are benefits accruing to the railroads and shippers. Public benefits are calculated in Step 7 as secondary benefits from indirect consequences of the project. These benefits should be developed on a statewide basis, because, for example, shifting of jobs from one locality in a state to another is not a statewide benefit. Care must be taken when calculating secondary benefits not to double count. Secondary benefits outlined by the FRA include:

viii. Relocation expenses – if line improvements prevent a business from incurring relocation costs necessitated by locating nearer to an alternate transportation source.

ix. Unemployment – if line improvements prevent loss of jobs, then wages earned are a benefit for the expected amount of time the employees would have been unemployed.

x. Highway impacts – if not completing the project would lead to a significant diversion of traffic from rail to truck, then avoided increases in road maintenance and repair are a benefit. This also leads to an increase in air pollution, because trucks generally produce at least three times more NO_x and particulates than trains on a per-ton basis. These benefits need to be offset by any increase in trucking employment, fuel tax revenue, vehicle registration fees, and other road use tax revenues.

Of the 10 benefits listed above, the first eight are directed toward the railroads and shippers. It is only the last two, avoided unemployment and highway impacts, that begin to address the greater societal benefits of freight rail. The emphasis on carrier and shipper benefits can in part be attributed to the fact that the funding source was dedicated to freight rail projects, so it was possible to place more emphasis on the projects providing the most transportation efficiencies.

The final two steps in the nine-step process involve calculating the salvage value at the end of the planning horizon (Step 8), which becomes an additional benefit, and dividing the sum of all benefits by the total costs (Step 9).

Results

In 1995, the congressional appropriations for the LRFA program ceased, thus removing any Federal requirement for states to continue identifying and prioritizing freight rail projects. Many states that allocated LRFA funding through a loan program still have money remaining and continue to follow this benefit-cost guidelines. Other states continue to use the FRA benefit-cost methodology, and its variations, for allocation of state and other funds to the freight railroads.

New Jersey Department of Transportation Example

The New Jersey DOT has provided state funding to eligible freight rail projects since 1983. The New Jersey State Rail Assistance Program, administered by the New Jersey DOT Bureau of Freight Services, currently has a $10 million budget allocated toward three forms of rail assistance: 1) Acquisition Assistance; 2) Rehabilitation Assistance; and, 3) Facility Construction Assistance.

Projects are evaluated for the New Jersey DOT's State Rail Assistance Program with the following list of goals and objectives:[14]

- Economic Goal:
  - Minimize negative employment impacts of abandonments;
  - Increase employment potential with new/improved facilities;
  - Minimize increases in transportation costs for industries; and
  - Protect the Core Rail System's rights-of-way.
- Efficient Freight Distribution Goal:
  - Support rail and intermodal services that exhibit long-term viability; and
  - Support competitive freight transportation services.

[14] *FY-2002/2003 Update: Report of the New Jersey State Rail Planning Process*, Bureau of Freight Services, New Jersey Department of Transportation, Trenton, New Jersey, September 1, 2002.

- Energy Goal:
  - Support energy-efficient aspects of rail freight and intermodal transportation.
- Environmental Goal:
  - Support rail freight and intermodal services that minimize detrimental environmental impacts and support the goals of the Clean Air Act.
- Responsive Freight Transportation System Goal:
  - Provide transportation facilities that satisfy the requirements of freight shippers and the industries they serve; and
  - Promote joint private and public funding of rail freight and intermodal improvement projects.
- Highway Congestion Mitigation Goal:
  - Support the development of team tracks with freight distribution and storage facilities; and
  - Support the development of transload facilities, intermodal services.

To receive funding, all projects must pass a basic two-step process. First, each project must be declared eligible. To be eligible, an analysis must yield a benefit/cost ratio greater than one and there must be sufficient commitment on the part of the public, private, or local sponsor. Commitment is in the form of matching funds (usually 10 percent) and a guarantee of continued freight service for a period of at least five years over the properties involved in the investment. The second step is that the project must be programmed to receive funding assistance.

Discussions with the New Jersey DOT indicate that the project prioritization process is also a two-step process. First, a benefit/cost analysis is performed to provide a quantitative measure of the projects. While it would be desirable to incorporate a comprehensive quantitative measure encompassing the six goals listed above, for practical reasons the Economic Goal is the only measure used in the benefit/cost analysis. More specifically, the benefits are calculated as average wages times the number of permanent jobs in New Jersey over a five-year planning horizon. An adjustment is made for the number of jobs displaced in the trucking industry resulting from truck shipments diverted to rail. The second step is to take all projects with a benefit/cost greater than one and rank them using a qualitative methodology based on all six goals (economic, efficient freight distribution, energy, environmental, responsiveness, and highway congestion mitigation).

It is possible to quantify more than just the Economic Goals, but for the types of projects funded through the New Jersey State Rail Assistance Program, jobs are the key factor. The expenses associated with data collection and analysis currently outweigh the incremental value of additional quantification.

■ 2.5 Freight-Rail Bottom Line Report

Introduction

The purpose of AASHTO's FRBL report was to determine whether the capacity of the nation's freight rail transportation system will be able to keep pace with economic growth through 2020. Between 2000 and 2020, projected increases in truck volumes of 62 percent and rail freight volumes of 44 percent will strain the U.S. freight transportation system. Shippers favor trucks for speed and reliability, but increasing truck traffic will aggravate highway congestion and create significant social, economic, and environmental problems. Railroads provide shippers with cost-effective freight transportation, especially for long-distance trips, and heavy and bulky commodities. Deferring investment in rail network capacity could result in a freight rail system that cannot maintain pace with the economy if current trends continue.

Project Goals

AASHTO was concerned that trucks would continue to erode rail market share, placing even greater demands on an already overburdened highway system. AASHTO commissioned the FRBL report to explore the issues, costs, public benefits, and policy options for investing in the rail network. The project had three main goals: 1) analyze the freight rail industry's benefits to the United States; 2) estimate the industry's investment needs and its capacity to meet them; and 3) quantify the consequences of not investing in the freight rail system, including impacts on highways and shippers. As a nationwide strategic study, the evaluation focused on benefits to shippers, the economy, the environment, and others outside the rail industry.

Funding Shortfall

The FRBL report found an additional investment of $2.6 to $4.0 billion annually is required create adequate freight rail capacity. This was estimated to be too large a burden for the railroads to fund through existing revenue streams, so there would need to be a sharing between railroads, the states, and the Federal government.

National Significance

The FRBL report evaluated the benefits of freight rail investment from a national perspective. The combination of economic deregulation and efficiency improvements in the rail sector over the last 20 years have brought a reduction in freight rail costs of 29 percent in real terms. If commodities currently shipped throughout the United States by rail were moved to truck, the net cost to shippers would be $69 billion annually – excluding secondary impacts such as environmental externalities and negative economic impacts. In addition, $64 billion of highway investment would be needed to create the freight capacity that is currently handled by railroads. Investment in railroad infrastructure is clearly an issue of national significance.

Benefits Methodology

The FRBL report assessed benefits in a variety of ways, depending upon the type of benefit and the assumptions made regarding how future economic development will occur and freight movement patterns will change.

To assess the value of rail freight service to the nation's shippers, rail and truck rate models were developed. Based on traffic levels in 2000, the shipper cost of moving all rail freight by truck was calculated. The benefit to the shipper is then the difference between rail cost and truck cost. The methodology intentionally did not account for other economic changes that would result from the elimination of freight rail services. This would have required a national macroeconomic model to evaluate the societal benefit of the transportation-dependent industries that would not exist if freight rail were eliminated. Thus, benefits were understated, because societal benefits should include shipper benefits as well as any consumer surplus derived.

To estimate the amount of investment required in the nation's highway system if freight rail were unavailable to provide transportation capacity, the FHWA Highway Economics Requirements System (HERS, see Section 3.2) was used to estimate highway funding needs. Traffic currently carried on railroads was converted to equivalent truck-VMT in specific corridors, and results were input in HERS, which projected the resulting congestion and additional capital requirements. Costs not captured by HERS, such as needs for new roads, bridge improvements, and local roads, were independently evaluated and added to the total cost.

It is difficult to estimate freight rail's contribution to international trade, as it is only one component of a multimodal logistics chain. More than $94 billion of international trade is moved annually by rail, although in this study no attempts were made to quantify the societal benefits of this traffic.

Environmental benefits also are difficult to estimate. The FRBL study assumed that trucks emitted six to 12 times more pollutants per ton-mile than railroads; from this heuristic it was possible to estimate the increase in pollutants emitted if freight rail were unavailable. However, it is difficult to calculate the monetary damages of these additional pollutants. Methodologies have been developed by academics and activists alike.[15] One strategy is to assume the equivalent amount of pollutant must be removed from the atmosphere by the cheapest means; so the cost of CO_2 pollution from discontinuing rail freight service could

[15] For more information, see the relevant environmental engineering literature, such as Bishop, R.C., et al., Chapter 9: Contingent Valuation – Incorporating Nonmarket Values, in *Better Environmental Decisions*, Island Press, Washington, D.C. (1999).

be equivalent to the cost of installing and maintaining CO_2 scrubbers at a number of coal-fired power plants. Other methods use climate and health-impact models to estimate the economic damages done by a rapidly deteriorating environment.

Other benefits that FRBL did not evaluate in full were the rail network's role in providing surge capacity for military and other purposes in the case of a catastrophic highway network failure, and its advantages in the safe transportation of hazardous goods. Risk management and mitigation methodologies are well developed in this area, and documented in standard textbooks.[16]

Results

The FRBL report concluded that railroads and their potential public-sector supporters are at a crossroads; railroads may continue to be financed as they are today and perhaps do adequately from the standpoint of the private investor community, but the role of rail in proportion to the national economy will steadily diminish. Alternately, if railroads can gain greater access to capital, their role may be maintained or enlarged, and lead to a series of public benefits that otherwise may not accrue.

Four scenarios were investigated. First, with minimal Class I investment, the freight rail system could carry only modest increases over today's volumes. The proportion of freight handled by rail versus truck would continue to shift towards truck, with substantial cost burdens on shippers, highway users, and public infrastructure owners. Second, a constrained investment scenario would result in a system that could handle roughly half of the forecasted growth in freight rail tonnage. Additional growth in volumes would shift to highway, representing shipper, user, and highway costs in excess of $410 billion over a 20-year timeframe. Third, with higher investment levels from railroads and public-sector participation, the freight rail system could maintain its share of traffic and accommodate forecasted rail volume growth. Truck freight volumes would still increase significantly, however. Fourth, the most aggressive scenario assumed even higher investments ($205 to $225 billion over 20 years) in freight rail, allowing a greater proportion of the total increases in freight volumes to be absorbed by the railroad system and resulting in substantial savings in combined shipper, highway, and user costs.

The FRBL report showed that public investment in freight railroads will result in clear benefits for shippers of freight, highway users, highway infrastructure, local industry competitiveness, and economic vitality. Four futures, encompassing vastly differing levels of rail service, were presented. The public must now decide.

[16]See, for example, Molak, V. and V. Molak, *Fundamentals of Risk Analysis and Risk Management*, Lewis Publishers, Inc., 1996.

2.6 I-81 Marketing Analysis for Virginia

Introduction

Throughout the day on I-81, about every third vehicle is a commercial truck. This volume is roughly double the design standard for the road. To address issues of roadway safety, congestion, and reliability, the Commonwealth of Virginia is exploring many options, including: additional lanes on I-81; a dedicated truck toll road next to I-81; and enhanced capacity on the parallel NS route. Between 2000 and 2002, the Virginia Legislature commissioned three separate studies to determine the extent to which highway freight could be shifted to rail intermodal. The most recent analysis, The Northeast – Southeast – Midwest Corridor Marketing Study, represented the most comprehensive of these analyses, and developed quantitative benefits in terms of potential traffic diversions and costs in terms of required rail infrastructure expansion.

Project Goals

The collective analyses of I-81 suggested that the opportunity to divert heavy truck traffic to rail intermodal would provide significant positive benefits to the Commonwealth of Virginia, but such a diversion could not be accomplished without substantial corridor-wide investments in the parallel rail infrastructure. The Northeast – Southeast – Midwest Corridor Marketing Study sought to determine whether the Commonwealth should change the current calculus of transportation investment by committing public capital to expand competitive rail intermodal service for the I-81 corridor. Specifically, the Study sought to determine: 1) is there a marketplace demand for improved intermodal service in the corridor; 2) what type of service offering will generate the greatest diversion benefit to the corridor; and 3) what level of public investment in rail intermodal will materially impact the level of commercial traffic on I-81?

National Significance

Virginia plays a key role in the North American transportation network, linking the enormous consumer markets in the Northeast with the fast growing manufacturing economies of the Southeast, Southwest, and Mexico. This role is played out daily through the massive movements of freight over four major north-south highway and railroad corridors. Crossing the Commonwealth are two of the most heavily traveled Interstate Highways, I-81 and I-95, and the main rail lines of NS and CSX. These routes move in excess of 450 million tons annually, comprising some 3.2 percent of the total freight movements in the nation, and more than seven percent of long-haul freight.

Serving as a conduit of the nation's north-south trade activity is not without cost. More than 42 percent of the truck traffic is comprised of "through-traffic," neither originating nor terminating in the Commonwealth. Roads such as I-81 and I-95 are among the most heavily traveled in the nation, and the expense of maintenance and expansion along these routes is immense. The future prospects of congestion relief are bleak, as recent FHWA

Forecasts suggest a 90 percent increase in truck traffic on these routes between 1998 and 2020.

Rail intermodal transportation has not historically been a strong competitor for traffic between the Northeast and Southeast. A number of factors have contributed to this circumstance, including a historical railroad bias towards long-haul east-west routes, and until recently, a relatively uncongested north-south freeway network. For example, between Chicago, Illinois, and New York, New York, the rail intermodal share of the combined total truck and rail intermodal market is 25 percent, while for the similar distance Harrisburg, Pennsylvania, to Atlanta, Georgia, lane, rail intermodal only gets 5.3 percent of the volume. Another factor in the low percentage of north–south rail shipments is the well-documented height restrictions preventing double-stack containers from moving on track parallel to I-95.

Benefits Methodology

Four primary tasks comprised the Study: 1) conduct surveys and interviews with shippers and network motor carriers, to determine the level of marketplace interest in and performance criteria for competitive rail intermodal service in the corridors; 2) investigate service design alternatives and identify the right combination of rail intermodal product, cost, and performance features for the demands of the marketplace; 3) perform detailed diversion analysis to determine the rate, magnitude, and composition of projected modal shifts accruing to the introduction of an improved intermodal service; and 4) define the level and location of capital investment required to support the projected modal shift.

Surveys and Interviews

Primary market research was conducted among the freight users of Commonwealth highway corridors. Users fell into two general categories: shippers whose goods travel in Virginia on their way to market, and motor and rail carriers. The results of this analysis suggested that both shippers and carriers are willing to shift traffic to rail intermodal if their cost and service demands are routinely satisfied. These demands included: 1) a rail intermodal technology less restrictive to the current mix of highway trailers; 2) a single-driver[17] truck competitive rail service that includes frequent service departures and 95 to 98 percent on-time delivery, door to door; and 3) a significant economic incentive to offset the added complexity and coordination of rail intermodal operations.

---

[17] The way most trucks are operated is with a single driver. The length of the work day for the single driver strongly influences how quickly standard truck shipments can be delivered, along with speed limits and some other factors. To say intermodal is competitive with single driver service means it can perform as well as the standard service offered by motor carriers.

Service Alternatives

Intermodal services are supposed to be based on compatibility between rail and highway transportation. However, many kinds of truck equipment cannot be handled by traditional rail, and other kinds often need special modification. This is a major flaw in conventional intermodal services, which can be eliminated by a newer generation of railcar. This railcar (already in regular use in Canada) employs an open style of technology that can carry almost any of the truck trailers moving on today's highways. The Study adopted this railcar technology to help establish compatibility between railroads and trucking, and thus increase the size of the addressable market for intermodal. Motor carriers acting in partnership with rail ultimately can reduce their cost of operation without special investment or sacrifice in performance. Shippers can receive the service they seek and reduce freight rates.

Estimating Diversion Potential

Highway diversions in the Study are further aided by two network effects. First is the confluence of large volumes of through truck traffic in Virginia, where the national highway system is channeled between the mountains and sea. This channeling causes traffic to concentrate into trainload quantities for sustained distances, which appropriately positioned rail intermodal terminals and service designs can exploit. Second, as its geographic scope, north-south interconnection and service frequency expand, the rail intermodal network begins to duplicate the fleet balance motor carriers achieve, providing railroads with significant efficiency gains.

The rail system impacts public investment could initiate – service improvement, capacity and system expansion, equipment availability, and lower cost-to-market – were incorporated in a quantitative process to project traffic diversions in the I-81 corridor. The estimation techniques were based on detailed competitive analysis and patterns of historical preference that have been successfully tested in previous freight studies. The diversion results mirror the representations of shippers and carriers who operate in the corridor: combining service parity with strong cost reductions will generate meaningful mode shifts.

Required Infrastructure Improvements

Capital investments in the rail corridor are required to improve service speeds, terminal access, and expand capacity to handle diverted traffic. The proposed improvements were designed to support the full volume of rail traffic projected in the long-range diversion analyses. Improvements included multiple tracks and passing sidings, signaling systems raising the frequency and speed at which trains can be safely run, and new larger intermodal terminals to transfer loads between highway and rail. Improvements were proposed on both NS and CSX rights-of-way, in Virginia and other states.

The states included in the corridor-wide analysis are those impacted by the current and future I-81 congestion, and/or those deriving off-corridor benefits through the conversion of highway traffic to rail intermodal. These include Texas, Louisiana, Mississippi, Alabama, Tennessee, Georgia, North Carolina, South Carolina, Virginia, West Virginia, Maryland, Pennsylvania, and New Jersey.

Results

The results of market research and detailed competitive analysis completed for this Study suggest that public investment in rail intermodal infrastructure can produce material relief for highway traffic in the I-81 corridor, and that this impact can be made to occur in a practical timeframe.

A three- to five-year investment of approximately $2.7 billion across the entire corridor produces highway diversions of nearly 700,000 annual truckloads. One out of seven trucks is removed from I-81 in Virginia, and the percentage of trucks in its traffic stream drops from every third vehicle to every fourth. Over another 10 to 12 years, a cumulative investment of approximately $7.3 billion builds highway diversions to nearly 3.0 million truckloads annually. Two out of seven trucks are removed from I-81 in Virginia, and the percentage of trucks in its traffic stream holds steady at 25 percent, despite strong commercial growth.

The Study does not translate truck diversions into monetary benefits in terms of travel time delay reduction, air quality improvements, and accident reduction. The focus of this study was to quantify the number of trucks that could be removed from I-81. The removal of trucks, or preventing additional truck volume growth, is seen as a concrete benefit by the Virginia legislature and their constituents. This detailed truck-rail diversion analysis provides a solid foundation for potential future benefits studies.

■ 2.7 Mid-Atlantic Rail Operations Study – Initial Benefits Assessment

Introduction

MAROps is a joint initiative of the I-95 Corridor Coalition, five member states (New Jersey, Pennsylvania, Delaware, Maryland, and Virginia), and three railroads (Amtrak, CSX, and NS). The FRA and FHWA participated as advisors. Over a two-year period, the MAROps participants crafted a 20-year, $6.2 billion program of rail improvements aimed at improving the competitiveness of north-south rail transportation for both passengers and freight in the Mid-Atlantic region and helping reduce growing pressures on the region's already overburdened highway system.

The MAROps Summary Report and Appendices documented existing conditions in the study area (demographics, transportation facilities, passenger and freight flows, future forecasts, etc.) and defined a three-phased program of improvements to eliminate key bottlenecks in the rail system over the entire five-state study region. The report also presented order-of-magnitude cost estimates for the various projects; while these estimates will need to be supported by more detailed engineering, they are useful for general planning purposes. Finally, the report identified a number of anticipated benefits in qualitative terms, including:

- Transportation benefits from reduced need for highway travel by trucks and autos;
- Economic benefits associated with reduced freight transportation costs due to improved availability of rail; and
- Improved overall rail system capacity, reliability, and performance for freight and passengers due to the elimination of key chokepoints.

Benefits Methodology

This Initial Benefit Assessment was designed to provide "first cut" estimates of the program's benefits to support ongoing policy and planning discussions. Comprehensive rail-network capacity and operations models are not available for the Mid-Atlantic rail system. The individual railroads have built models for portions of the network, but a complete, integrated, comprehensive set of models does not yet exist. Consequently, the Initial Benefits Assessment was done without the use of rail network and operations models and should therefore be considered a first approximation of the program's benefits.

As a starting point, two alternative futures were defined:

- The *Without MAROps* 2025 scenario assumes rail maintains its current overall volume, but does not grow its business. Rail is assumed to grow its volume in certain commodity lanes, but "de-market" in others, resulting in little or no growth in overall rail tonnage. Trucking grows its share of the market as it absorbs some share of diverted traffic.
- The *With MAROps* 2025 scenario assumes rail maintains its current overall share; that is, rail grows its business consistent with the unconstrained national base-case forecasts (from the FHWA Freight Analysis Framework). In addition, rail increases its share of intermodal traffic relative to trucking up to 10 percent, for containerizable commodities moving 400 miles or more. This produces a very small percentage loss for truck volumes, but a substantial percentage gain for rail.

The actual amount of tonnage and VMT associated with these scenarios was determined using the TRANSEARCH dataset. The *With MAROps* scenario reduces 2025 truck VMT by 3.6 billion miles over the national highway system; around 33 percent of this reduction is in the MAROps states.

The public benefits generated by the proposed $6.2 billion investment were developed by:

1. Estimating the direct cost savings to freight shippers who can use freight rail instead of trucks, based on differences in freight rates, with appropriate discount factors.

2. Estimating the direct cost savings to highway users (trucks, autos) using HERS based on a reduction in truck VMT (which is shifted to the rail system). HERS is a simulation model that estimates the benefits and costs of highway investments on the Federal-aid highway system.

3. Using an economic impact model of the economies of the five MAROps states, leased from REMI, to estimate how changes in transportation costs translate into increases in productivity and reductions in the cost of doing business, generating "multiplier" benefits throughout the economy in terms of GRP.

It was estimated that 33 percent of 2025 VMT benefit associated with MAROps would accrue within the physical boundaries of the MAROps region and 67 percent of the benefit would accrue to other regions and states. This comparison highlights the national significance of the MAROps program, which, because of the volume of freight traffic flowing into, out of, and through the Mid-Atlantic market, creates benefits for the nation as well as the immediate region.

Freight shippers benefit if they can shift freight from truck to rail at comparable service levels because rail shipments are less costly. Nationally, trucking costs average two to four times rail costs on a per-mile basis. Shippers can realize substantial cost savings by switching from truck to rail provided that:

1. Shippers' commodities are "rail-friendly" commodities, where the relative need for speed, reliability, and frequency of service is adequately met by rail;

2. Shippers have physical access to Class I or short-line railroad, either directly or by way of cost-effective drayage; and

3. Rail service is offered at a competitive price.

The forecasts diverted only "rail friendly" commodities from truck to rail, ensuring that the first criterion was met. The other criteria must be determined on a case-by-case basis, which was beyond the scope of MAROps. For the benefits analysis, it was assumed that a portion of shippers would have reasonable access to rail service and that the railroads would provide competitive pricing in most cases.

Results

Table 2.3 presents the direct shipper cost benefits of shifts from truck to rail as facilitated by the MAROps rail improvements.

Table 2.3 MAROps Benefits – Shipper Costs

	2025 Truck Ton-Mileage Reduction	$ per Ton-Mile (Millions, Current)		Cumulative Savings (Millions, Current), Accruing 2005-2025	
		Truck ($0.08)	**Rail ($0.045)**	**Non-Adjusted (100%)**	**Adjusted (50%)**
Truck – Dry Van	16,691	$1,335	$751	$5,842	$2,921
Truck – Other	33,315	$2,665	$1,499	$11,660	$5,830
Total United States	**50,007**	**$4,001**	**$2,250**	**$17,502**	**$8,751**
Adjusted for MAROps States Only (33% of Total Benefit)				***$5,776***	***$2,888***

Source: Cambridge Systematics analysis using Reebie Associates' TRANSEARCH data, American Association of State Highway and Transportation Officials' *Freight-Rail Bottom Line Report*, and Surface Transportation Board Carload Waybill Sample information.

For purposes of this analysis, it was considered appropriate to discount the economic value of shipper benefits by 50 percent. This reflects the fact that a substantial amount of these benefit are associated with rail unit train movements that may not be significantly impacted by improvements – or failure to make improvements – to the north-south rail network. It also reflects the fact that under the *Without MAROps* condition, certain shippers may have to pay more for transportation services (due to the unavailability of a rail option), but there are certain benefits – increased speed, reliability, etc. – that may provide an offsetting monetary value to the shipper.

Table 2.4 presents a summary of all estimated benefits, including full economic impacts. Overall, this analysis finds strong positive benefits totaling $12.8 billion for the MAROps program, significantly larger than the estimated $6.2 billion cost of the program. However, the full net present value of the benefits and costs must be estimated before an accurate benefit-cost ratio can be calculated. Nevertheless, this assessment supports a preliminary conclusion that the MAROps program could return positive benefits. Benefits include:

- Direct shipper benefits of $2.9 billion due to reduced costs;
- Savings of $6.3 billion for vehicles still on the road – $0.8 billion for trucks, $0.7 billion for business-related auto trips, and $4.8 billion for non-work auto trips – due to reduced highway congestion and related impacts; and
- Other economic benefits of $3.7 billion generated by these savings throughout the economy.

Table 2.4 Summary of Estimated Benefits to the MAROps Region from MAROps Improvements, 2005-2025

Benefit Category	Direct Benefit ($ Millions, Current)	Plus Additional Benefit from I/O Model ($ Millions, 2003)	Total Benefit ($ Millions)
Shipper Cost	$2,888	$3,198	$6,086
Highway User Cost (Truck)	$778	$263	$1,041
Highway User Cost (Auto, Business Related)	$659	$221	$880
Highway User Cost (Auto, Non-Business Related)	$4,831	–	$4,831
Grand Total	**$9,156**	**$3,682**	**$12,838**

2.8 New York Cross Harbor Goods Movement Environmental Impact Statement

Introduction

The Cross Harbor Goods Movement Environmental Impact Statement (EIS) for the New York City Economic Development Corporation is a project to assess the impacts of a new freight rail tunnel from New Jersey (or Staten Island) to Brooklyn, along with other rail line improvements and an intermodal rail yard in Queens. The mode directly affected is freight rail, with completely new infrastructure (the tunnel and intermodal yard) and enhanced existing infrastructure (the current rail lines in Brooklyn and Queens). In addition, it is expected that highway congestion and traffic will also be affected by this project, even though no major highway improvements are envisioned. One of the goals of the project is to divert freight from trucks to rail, thereby reducing the number of trucks on the metropolitan New York City highways and, in particular, reducing truck traffic on the bridges. The total cost of the project is estimated to be roughly $3.9 billion for a single tunnel alternative, and $6.4 billion for a double tunnel system. If the project moves forward, the most likely financing scenario will include a combination of Federal and state/local government along with more innovative sources such as tolls/surcharges for the tunnel and bridges, and possibly private investment at the Queens intermodal yard. Other major government stakeholders include: FRA, FHWA, Port Authority of New York/New Jersey (PANYNJ), New York State DOT, and New Jersey DOT.

National Significance

This project is expected to have significant local, regional, and national effects. Local impacts include enhanced freight rail service to locations east of the Hudson, including all of Long Island, and a new intermodal yard in Queens along with projected increases in warehousing/distribution activity. Regional impacts are expected to include shifts in mode from truck to rail for various commodity movements to/from east of Hudson locations; reductions in highway congestion and truck traffic in greater New York and New Jersey; and reduced freight transportation costs for regional businesses and spillover economic benefits. National impacts are also expected because various long-distance goods movement trips that currently use trucks may switch to rail, thereby reducing truck volumes on national highways. In addition, freight moves that have origins and destinations outside of the metropolitan New York City area but will benefit based on the new rail tunnel are expected to experience reduced shipping costs.

Benefits Methodology

A number of sophisticated transportation and economic benefit models were developed and applied as part of the Cross Harbor project. Models and their associated data include:

- **Shipper choice model –** Customized model developed through a series of carefully constructed surveys of businesses in the local area to understand the conditions under which freight could switch from trucks to rail. The model was calibrated using TRANSEARCH commodity flow data.

- **Highway network model –** Travel demand model for the New York City metropolitan area (including parts of New Jersey and Connecticut) maintained by the New York Metropolitan Transportation Council (NYMTC), including data for trucks and auto trips on speed, trip patterns, volumes, etc.

- **User benefits model from STEAM –** Adapted user benefits model from the Surface Transportation Efficiency Analysis Model (STEAM, see Section 3.2), including values of time, and parameters for operating costs, emissions, and accident rates.

- **Land use business attraction/retention model –** A customized spreadsheet model was developed to estimate the potential for business attraction/retention due to greatly enhanced freight rail service and a new intermodal yard. Data included land use data by parcel (size, zoning, building square feet), real estate data from a commercial vendor regarding vacant land and utilization rates at existing industrial sites, and conversion factors to estimate employment potential based on square feet.

- **Business cost savings model –** A customized spreadsheet model to allocate benefits to highway and rail users by industry sectors for input into a regional economic impact model.

- **Regional economic impact model –** A 14-region economic simulation and forecasting model obtained from REMI to estimate full economic impacts to the region and nation.

- **Benefit-cost analysis model –** A customized spreadsheet model to track benefits and costs, discount to present value, and calculate benefit-cost ratios. The full benefit-cost framework is displayed below.

Results

Three types of direct economic benefits based on travel efficiency were estimated:

- New rail trips using the tunnel would lessen the number of truck trips. (The dollar-based estimate of the cost savings derived by diverting a truck trip to rail takes into account travel time and reliability differences.)

- Existing rail trips that benefit from using the tunnel. The monetized benefits to shippers would accrue from reduced travel time and cost and improved reliability for trips using the tunnel in comparison to the Selkirk Bridge (near Albany).

- Business-oriented highway trips (truck and business-auto) would benefit from reduced highway congestion as a result of reduced truck trips. The dollar-based estimate for business-oriented highway trips includes benefits from accident cost savings, vehicle operating cost savings, and travel time savings due to a reduction in the number of trucks on the highway system.

The analysis also included the potential to induce new (or retain existing) warehousing and manufacturing activity in Brooklyn/Queens. These direct economic effects were used as inputs to the REMI model to estimate regional economic benefits in terms of GRP, employment, and personal income. In addition, non-freight benefits were estimated in terms of personal highway travel (from reduced truck trips), and social benefits such as reduced emissions from trucks and reduced future infrastructure costs on the national highway system from reduced truck VMT.

Note that in this project, like many other large prospective projects, the distribution of benefits is a key component. While additional warehousing activity could be a gain for the New York City economy, it's primarily a local benefit, and could compete with other nearby regions. Plus, the time and cost savings for freight trips impacted by the new tunnel were allocated to regions based on the origin-destination (O-D) patterns of commodity flows, reflecting the fact that the true benefit of enabling a freight trip to be more efficient accrues to the shippers and receivers of freight.

The following three tables show the results from the economic benefits analysis. Table 2.5 shows the travel efficiency benefits by category for the single tunnel system with the New Jersey alignment (there was also a Staten Island alignment considered). Table 2.6 displays the estimated business attraction/retention impact for east of the Hudson areas, largely based on new railyard activity. Table 2.7 shows the full economic impacts projected for each single tunnel alignment based on total employment and personal income.

Table 2.5 Travel Efficiencies and Cost Savings for the Single Tunnel System (New Jersey Tunnel Alignment) in 2025*

Benefit	Metropolitan New York Region	New York State	New Jersey	United States
Personal Highway Travel**	$10.4	$4.7	$9.4	$15.9
New Rail Trips Using the Tunnel, Diverted from Truck Trips	$11.2	$12.1	$0.4	$27.7
Existing Rail Trips that Benefit from Using the Tunnel	$0.6	$0.6	$0.0	$1.1
Business-Oriented Highway Trips Benefiting from Reduced Highway Congestion due to Reduced Truck Trips	$3.2	$1.5	$3.0	$5.8
Total	**$25.4**	**$18.9**	**$12.8**	**$50.5**

Notes: * All figures are shown in millions of 2002 dollars. Columns are mutually exclusive (e.g., an increase in net jobs in the New York region would not be a net increase in the United States if those jobs were relocating from another state).

** Personal (non-business) highway travel benefits are not inputs for the regional economic impact analysis, which takes into account only business cost savings. However, estimates of personal highway travel benefits are included in the total benefits used in the benefit-cost analysis.

Table 2.6 Net Business Attraction by Region for the Single Tunnel System in 2025

Region	Net Job Creation – New Jersey Alignment	Net Job Creation – Staten Island Alignment
Bronx	3,040	2,830
Queens	1,800	1,670
Kings	2,740	2,600
Long Island	1,060	1,000
Total	**8,640**	**8,100**

Table 2.7 Results of the REMI Regional Economic Impact Analysis, Single Tunnel System, 2025

Benefit	Metropolitan New York Region	New York State	New Jersey	United States
New Jersey Tunnel Alignment				
Employment (in Thousands)	16,900	16,850	1,200	0
Personal Income (in Millions)	$890	$850	$120	$205
Staten Island Tunnel Alignment				
Employment (in Thousands)	15,530	15,440	1,040	0
Personal Income (in Millions)	$820	$780	$100	$170

Source: Regional Economic Models, Inc.

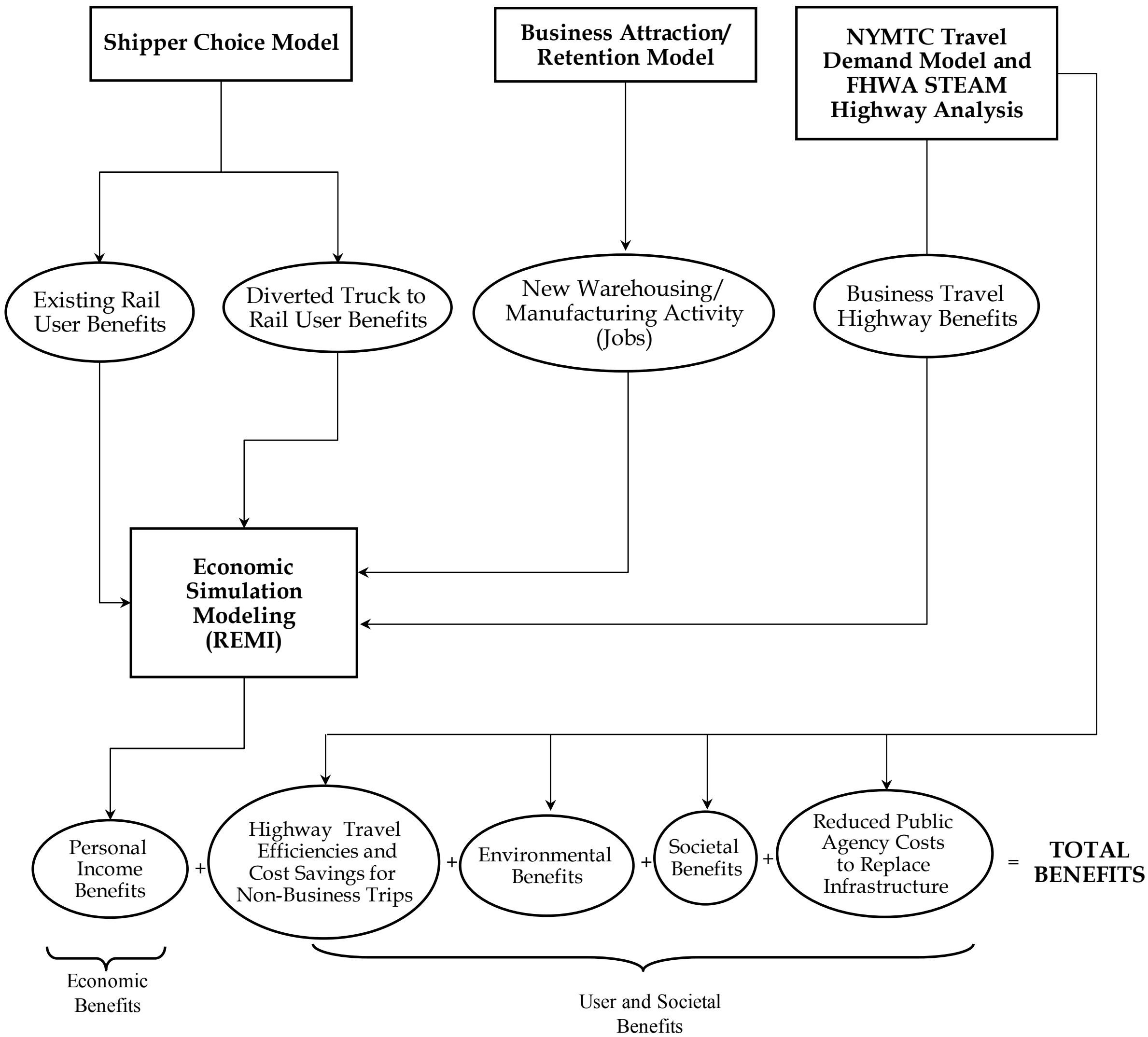
In terms of benefit-cost analysis, the return to the Metropolitan New York region is in the range of a benefit-cost ratio of 2.0, while it is lower for the United States as a whole (between 0.7 and 1.0 depending on the alternative). The reason the results are more impressive for the New York region is because some of the benefits are expected to include relative competitiveness factors (e.g., business attraction) that have no net benefit for the United States as a whole.

Gaps in the Analysis

Though this analytical modeling methodology was relatively comprehensive, the key gap was that the results presented here do not reflect adjustments related to the financing options considered, which include tolls for both rail usage of the tunnel and tolls on area bridges to encourage use of and help fund the rail tunnel. The final EIS will likely consider the implications to the economic returns based on tolling/surcharge scenarios.

Figure 2.2 shows the Cross Harbor benefit methodology as a flow chart.

Figure 2.2 New York Cross Harbor Benefit-Cost Analysis Framework



2.9 Northern Ohio Corridor Study

Introduction

Faced with increasing congestion on Ohio's northern corridor (I-80 and I-90 and parallel routes), the Ohio DOT sought to determine the extent truck traffic moving across the highway could be diverted to rail intermodal.

Project Goals

The Northern Ohio Rail Highway Corridor Study sought to address two important issues in Ohio's statewide transportation planning. First, is it possible, and feasible, to lessen the number of trucks traveling on the Ohio Turnpike and parallel alternate routes through public investment in private rail infrastructure or in economic incentives to shippers and rail carriers? Second, can such an initiative – even if practical – be controlled and managed within the geographic scope of the state borders of Ohio?

National Significance

In 1998, Ohio's Northern Corridor served as the primary gateway for nearly 14 million loads of freight. This volume represents 3.3 percent of the total national freight tonnage. More than 48 percent of the total traffic is through-traffic for Ohio, neither originating nor terminating in the State.

The analysis determined that the Northern Corridor's top 20 O-D freight flows represented 33 percent of all truck traffic on the corridor, connecting many of the nation's largest commercial markets including Boston, New York, Philadelphia, Baltimore, Pittsburgh, Chicago, and Detroit. The concentration of volumes among these large, external market players signifies the need for Ohio to coordinate its ongoing Northern Corridor planning efforts with neighboring states and Federal agencies.

Benefits Methodology

The Northern Ohio Corridor Study employed a multilayered analysis that included the following: 1) the demographic identification of commercial vehicle traffic on the Turnpike and the parallel routes; 2) the comparison of motor carrier economics for the Turnpike and various parallel route alternatives; 3) the quantification of traffic volume (in tractor-trailer units and VMT) that might be attracted to an improved rail intermodal solution at various rate and service levels; and 4) the identification of barriers to rail intermodal traffic growth in the Northern Corridor.

Traffic Demographics

Starting with TRANSEARCH data, all traffic moving along the parallel highway segments that comprise Ohio's Northern Corridor was selected for analysis. The county-to-county flow data were based on highway routings developed using a custom version of the Oak Ridge National Laboratory's (ORNL) highway routing model.

A limitation with this approach is the inability to alter segment impedances to manipulate flow traffic over multiple parallel routes. Thus, the analysis required that the TRANSEARCH data be precisely allocated to the Ohio Turnpike and over alternate routes. This was accomplished using truck traffic count data supplied by the Ohio DOT. The analysis further adjusted allocations based on selected motor carrier interviews that revealed the size of the carrier, the driver relationship, the commodity hauled, and equipment used all factored into the decision of which of the available parallel routes was selected.

Identification of Candidate Lanes

The flows identified in the resultant Northern Corridor dataset were then analyzed to determine what portion of the traffic – if any – exhibited characteristics favorable for diversion to rail intermodal transportation.

Intermodal market penetration is a function of two primary factors: 1) relative length of haul; and 2) concentration of volume in traffic lanes. As the distance between the origin and the destination increases and lane volume (density) grows, intermodal service becomes more competitive relative to highway as its cost advantage increases. A statistical mode diversion model was employed to estimate the opportunity to shift highway traffic to rail intermodal in the Northern Corridor.

The quantification of potential mode shifts was centered on an evaluation of specific individual traffic lanes (one origin linked to one destination). The lanes were analyzed based on projections for improved intermodal service resulting from hypothetical investments in infrastructure, the volumes of highway traffic, the likelihood that diversions would be successful, and the potential of such traffic to contribute to intermodal train volumes.

Estimating Diversion Potential

The assessment of potential rail intermodal gains employs a series of tools and techniques, developed for use in Interstate Commerce Commission and Surface Transportation Board railroad merger proceedings. These involve weighing competitive alternatives against conceptual rail intermodal offerings made viable through changes in rail operating costs. In particular, the analysis determines the relative changes in modal shares that should result from cost and service changes arising from the benefits of proposed investments on a lane-by-lane basis.

The mode diversion model examines current modal shares and then correlates those to the underlying changes in the rail carriers' estimated operating costs. The model also requires the examination of service competition to assure that the proposed intermodal service offering would meet or exceed market standards. For those O-D pairs passing the service and cost hurdles, the model determines diversions in four steps:

1. Categorize lane density;

2. Calculate the change in differential between old rail costs versus highway and new rail costs versus highway;

3. Multiply the change in differential by the relevant coefficient from a proprietary market share model; and

4. Apply the multiplied differentials to present intermodal market shares, yielding the new intermodal share of the market and the volume diverted.

Validation

In addition to the lane-specific analysis from the mode diversion model, interviews were conducted with select motor carriers and intermodal service providers to identify service improvement opportunities that could improve the likelihood of mode conversion.

Results

The diversion analysis and interviews provided the Ohio DOT with a detailed analysis of the corridors and volumes of traffic most susceptible to modal conversion and a series of policy recommendations for promoting rail intermodal services in the corridor. For each of these opportunities, the analysis provided the number of daily and annual loads diverted, and the corresponding VMT impact of the diversions (Table 2.8).

Table 2.8 Impact of Rail Intermodal Cost Adjustments for Northern Ohio Corridor

Reduction in Rail Operating Costs	Annual Diverted Loads (Thousands)	Diverted Annual Total VMTs (Millions)	Diverted Ohio VMTs (Millions)	Daily Loads	Percent of Daily Dry Van Loads	Percent of All Truck Loads
-0.05%	10	5.3	0.95	34	0.1%	0.1%
-1.0%	50	36.4	16.1	166	2.4%	0.4%
-5.0%	202	149	64	674	9.8%	1.5%
-10.0%	306	229	94	1,020	14.8%	2.2%

Source: "Freight Impact on Ohio's Roadway System," pp. 4-31.

Using the VMT and unit calculations from the Northern Ohio Rail Highway Corridor Study, the Ohio DOT was then able to project public benefits in several category areas including:

1. Reduced highway maintenance expense;
2. Postponed highway expansion;
3. Reduced traffic congestion;

4. Reduced HC emissions; and
5. Reduced highway fatalities.

Quantifying Highway Benefits

Though not done as an official part of this study, the overall impacts due to truck VMT changes on Ohio's roadways were quantified using the HERS model. Impacts include measures for reductions in travel delays, crashes, pollution, maintenance costs, and new highway construction costs. The highway impacts associated with each of the rail operating cost scenarios is presented in Table 2.9.

Table 2.9 Highway Impacts Associated with Reductions in Rail Operating Cost

Scenario for Reduction in Rail Operating Costs	-0.05%	-1.0%	-5.0%	-10.0%
Ohio VMT Avoided per Year (Million VMTs)	0.95	16.1	64.2	94.2
Congestion Avoided (Hours)	0.003	0.055	0.22	0.33
Crash Costs Avoided (Million $/Year)	$0.1	$2.4	$9.5	$13.9
Air Pollution Costs Avoided (Million $/Year)	$0.03	$0.5	$2.0	$3.0
Pavement Maintenance Avoided (Thousand $/Year)	$6.0	$103	$408	$598
New Capacity Costs Avoided (Thousand $/Year)	$8.7	$148	$590	$866

Source: Reebie Associates and Cambridge Systematics, based on results from the Highway Economics Requirements System model.

2.10 Palouse River and Coulee City Railroad[18]

Introduction

The Palouse River and Coulee City Railroad (PCC) is the second longest rail system in Washington State, with 410 route miles (370 in Washington, and 40 in Oregon and Idaho).

[18] This case study was developed principally from *Purchase and Rehabilitation of the Palouse River and Coulee City Railroad Track: Assessment of Economic and Community Benefits*, Washington State Department of Transportation, May 2004.

PCC provides freight rail service to more than 70 rail-dependent businesses in eastern Washington. Eighty percent of its million annual tons of cargo is wheat, lentil, and other agriculture-related products.

The PCC was pieced together from branch line track owned by the BNSF and the UP. The railroads began downgrading the track in the 1980s and eventually sold it to WATCO, Inc., a Kansas-based railroad holding company, in the mid-1990s. By this time, the track had a considerable backlog of deferred maintenance needs and WATCO was unable to invest the necessary capital to upgrade and properly maintain the track. WATCO submitted a letter to the Governor stating it would abandon approximately one-half of the track, impacting approximately one-half of the businesses, unless the State provided support. This prompted the Washington State DOT to evaluate the public benefits of continued operations on the existing PCC.

Benefits Methodology

Chapter 47.76 of the Revised Code of Washington authorizes the state's freight rail assistance program and defines the requirements for assessing proposed assistance. The primary requirement is that the proposed project must show a positive net benefit to the State. Based on analysis directed by the Washington State DOT, it was determined that the combined PCC projects generated total discounted benefits of $62 million. When compared to the $33 million total costs, this produced a benefit-cost ratio of 1.86 and met the statutory requirement.

The benefits calculations followed the FRA benefit-cost guidelines [discussed in a prior case study in this report]. The specific items considered were:[19]

- Shipper' savings on transportation costs;
- Reduced future costs to repair state and local highways due to less truck VMT;
- Jobs saved at rail-dependent industries;
- Environmental protection in the form of less fuel usage and air pollution; and
- Increased safety of trains through improved track quality.

Shipper' Savings

Abandonment of approximately one-half of the PCC would force shippers to seek other transportation modes for moving their goods to market. This would alter the transportation costs and service quality, making these goods less competitive. A study commissioned by the Washington State DOT found that continued service by the PCC would save

[19] From the Washington State Department of Transportation Internet site at http://www.wsdot.wa.gov/Projects/ PCC_Acquisition/.

Washington shippers between $1.8 and $2.3 million in average annual transportation costs. For grain, which competes in a very price-sensitive international market, this is a significant five to seven cents per bushel.

These savings were derived by first estimating the quantity and type of goods that would no longer be able to use the PCC. Diversion estimates were prepared to determine the most likely new transportation method, truck and/or barge. Average rates for rail, truck, and barge were then applied to shipments moving over the existing network, and also to shipments forced to divert in an alternative scenario. Shipper savings were calculated as the net difference between costs in the alternative and base scenarios. These costs were reported as average annual savings in current dollars.

Reduced Future Highway Costs

Not only do diversions from rail to truck increase transportation costs for shippers, the additional truck traffic can have a significant economic impact on highway maintenance costs. A reduction of 8,000 to 10,000 carloads per year on the PCC would add approximately 29,000 additional full truckloads to eastern Washington's secondary highways. This was determined by estimating the likely mix of trucks required to haul the diverted traffic, and then converting from railcars to tons to truck load equivalents (TLE). A seven-axle truck, for example, can haul approximately 35 net tons for a TLE of 3.17.

The next step was to project the likely routes taken by the trucks and to determine the type and thickness of the roadways. Deterioration rate curves were used to project damage to the roadways, and this was converted into annual maintenance costs. The estimated annual roadway maintenance savings to the Washington State DOT from the PCC purchase was $4.2 to $4.8 million annually.[20]

Jobs Saved

An analysis of job impacts yielded the following results:

- Loss of approximately 30 PCC jobs with an average hourly wage of $11.38.
- Potential closure of Green Giant asparagus canning, impacting 60 full-time and 1,100 seasonal jobs.
- Potential closure of feed mill and feedlot impacting 60 jobs in Creston, a town with total population of fewer than 300 people. This plant was estimated to be worth $1.5 million per year to the area's economy.

---

[20] Tolliver, Denver, *Modeling Cross-Modal Benefits from Local Rail Service: State of the Art and Future Needs*, presented at the 84th Transportation Research Board Meetings, Washington, D.C., January 12, 2005.

- Job losses at various fuel and chemical loading/unloading facilities.
- Impacts to 350 jobs in a Spokane County industrial park.
- Closure of a grain elevator in Coulee City, the last major private employer in the town.

According to the FRA benefit-cost methodology, preservation of jobs can be considered a benefit for the length of time a worker is expected to be unemployed.

Environmental Protection

On average, railroads are three times more fuel efficient than trucks.[21] Diverting freight from truck to rail will lead to environmental improvements due to reduced fuel usage, and corresponding improvements in air quality. Although this is a public benefit and was considered in this analysis, it was not formally quantified for inclusion in the benefit-cost analysis.

Improved Safety

Improved safety can take two forms. One is reduced truck accidents as a result of fewer trucks on the roads. The other form is improved safety on the railroad by observing proper maintenance. The improvements in railroad safety were specifically cited as a benefit of this project, but were not formally quantified for inclusion in the benefit-cost analysis.

Results

This discussion is focused on quantification of benefits, but the decision to invest public funds considers additional factors. A more complete list is:[22]

- **FRA Benefit-Cost Analysis –** Described in Section 2.4.
- **Operational Analysis –** Is the level of rail service required to obtain benefits operationally feasible?
- **Marketing Analysis –** What changes can be expected in volumes of existing and new business?
- **Line Condition Study –** Three line inspections to verify condition and needs.

---

[21] Association of American Railroads, *Overview of U.S. Freight Railroads*, September 2004.

[22] Uznanski, Kenneth, *Regional Grain-Gathering Networks: Lessons Learned from Washington State*, presented at the 84th Transportation Research Board Meetings, Washington, D.C., January 12, 2005.

- **Rehabilitation Needs –** Establish target-based results of marketing analysis.
- **Public Outreach –** Build upon the existing strong community support.
- **Risk Assessment –** What are the risks from factors such as: dependency on connection to Class I railroads; declines in agriculture business; relationship between private operator and public-owned infrastructure; environmental hazards liability; and railroad grade crossing liabilities?

Based on this analysis, the Washington State Legislature approved a 10-year strategy for addressing large freight rail assistance projects in the 2003 Transportation Funding Package. This included $33.4 million for PCC-related projects, including:

- Acquisition of the PCC right-of-way for $7.028 million;
- Rehabilitation of the northern PCC lines for $21.089 million; and
- Rehabilitation of the southern lines for $5.313 million.

State law allows for rehabilitation grants when the public owns the right-of-way. It was therefore necessary for the Washington State DOT to acquire the track and land of the PCC. The former owner has signed a lease with the Washington State DOT to continue rail operations. Rather than collecting a rent for use of the track, the agreement between the Washington State DOT and WATCO requires WATCO to provide quality service to shippers in eastern Washington and to provide annual funding for track maintenance at $6,000 per track mile in current dollars (WATCO had been investing at a rate of $3,100 per track mile).

The Washington State DOT's analysis demonstrated the PCC purchase and rehabilitation was viable, met the requirements of the Revised Code of Washington, provided economic and community benefits, and was strongly supported by eastern Washington communities. The quantification of benefits yielding a 1.86 benefit-cost ratio was necessary for the project to move foreword and one of the principal factors leading to its approval.

■ 2.11 Shellpot Bridge

Introduction

The Shellpot Bridge is a swing-style railroad drawbridge spanning the Christiana River near the Port of Wilmington, Delaware. It was originally constructed in 1888 on timber piers and upgraded to a concrete foundation in 1951. Conrail discontinued service over the bridge in December 1994 when the foundation could no longer support heavy freight trains. This forced freight trains serving the Port of Wilmington onto Amtrak's Northeast Corridor track through the Wilmington Transit Center and then back down to the Port.

Because the freight trains could not interfere with Amtrak's passenger service, this arrangement added delay and limited the times trains could enter and exit the Port.

In an effort to enhance the competitiveness of the Port of Wilmington and improve rail freight service to the Delmarva Peninsula, the State of Delaware, acting through the Delaware DOT, and NS (which took over this track from Conrail) reached a unique agreement for the rehabilitation of the Shellpot Bridge. Under the terms of the agreement, Delaware funded the $13.5 million cost of restoring the bridge for train service with $5.0 million coming from grant appropriations and the remainder from state tax-exempt bonds. NS is compensating the State over a 20-year period through a fee for each rail car that crosses the Shellpot Bridge. This project was completed in 2003, providing the Port of Wilmington with greater flexibility to schedule inbound and outbound train service.

Benefits Methodology

There was no formal benefit methodology used for the Shellpot Bridge project, though the Delaware DOT expects to be fully repaid for their investment through car fees paid by NS. The full agreement is contained in a contract signed on May 3, 2002, between the Delaware DOT, NS, and Pennsylvania Lines LLC (a Delaware limited liability company). The contract contains the following key provisions:

- NS is responsible for designing all improvements.
- NS will not abandon or discontinue use of the Shellpot Line for 20 years.
- NS is responsible for all Shellpot Line and Bridge maintenance.
- Upon NS and the Delaware DOT agreement on the engineering design, the DOT will request the necessary funding from the State of Delaware for the amount above the $5.0 million already appropriated.
- NS is responsible for the construction, subject to Delaware DOT inspections.
- NS will annually pay a per car fee for use of the Shellpot Bridge of:
  - $35 per car for each of the first 5,000 railcars;
  - $20 per car for each of the next 15,000 railcars;
  - $15 per car for each of the next 15,000 railcars;
  - $10 per car for each of the next 15,000 railcars; and
  - $5 per car for each car in excess of 50,000 railcars.

- NS will guarantee minimum annual payments in the amount of:
  - $150,000 per year for years 1 through 5;
  - $200,000 per year for years 6 through 10;
  - $250,000 per year for years 11 through 15; and
  - $300,000 per year for years 16 through 20.
- Both the annual payment and the minimum guaranteed payment will be adjusted using a formula in the contract for the additional Delaware authorized funding above the original $5.0 million. [Thus, the numbers above will be increased by 1.3077.]
- The number of railcars crossing the Shellpot Bridge shall be determined by NS using an automatic equipment identification (AEI) reader or similar device. Each railroad freight car (including standard flat cars not exceeding 96 feet in length) shall count as a single railcar. Articulated cars count as one railcar for every four axles. A single Roadrailer unit shall count as one-half railcar.

Results

Though not quantified, benefits of this project include reduced truck traffic at the Port of Wilmington and lower transportation rates resulting from increased competition. Reducing truck traffic lowers congestion delays, and improves safety and environmental quality. Improving competition between truck and rail leads to lower transportation rates, allowing the Port to remain competitive against Baltimore, Philadelphia, New York/New Jersey and other eastern seaports.

Reopening the Shellpot Bridge also has benefited rail operations in the region. NS can now base most northern Delaware local freight shipments at Edgemoor Yard, eliminating the need to inefficiently scatter shipments to different locations. Because the freight trains serving the Port no longer have to move through the passenger station, there are less potential delays to passenger trains. Finally, the Shellpot Bridge repairs include upgrading the weight limit to accommodate 286,000-pound railcars, which has benefited a number of industries near Edgemoor Yard that previously could not ship at these higher car weights.

Recent discussions with representatives from both the Delaware DOT and NS have indicated that both sides are very pleased with the agreement.[23] Traffic volumes are currently running above anticipated levels, benefiting both parties.

[23] January 2005.

3.0 Methods for Establishing and Evaluating Benefits

3.0 Methods for Establishing and Evaluating Benefits

This chapter focuses on the available methods used to establish public benefits obtained from freight rail investments. This is not intended to be a comprehensive list of methods and software, but rather descriptions and evaluations of the methods used in the case studies, plus a few others that seem relevant for freight rail project evaluation.

One way to think about the interrelationship of the various methods used to evaluate transportation investments is depicted in Figure 3.1.

Figure 3.1 Framework for Evaluating Transportation Investments

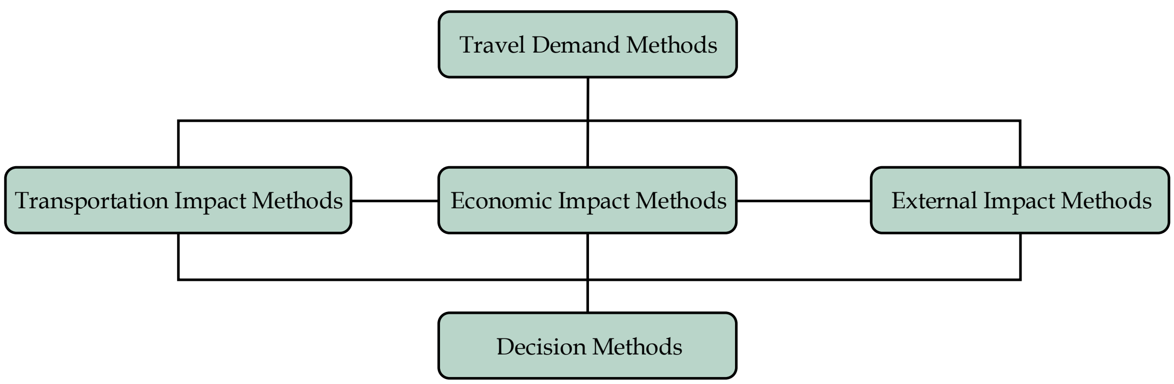


Figure 3.1 represents an idealized framework that can be applied to all transportation investments. It is idealized in the sense that several models do not fit neatly within a single box. It does, however, provide a convenient framework for describing how freight rail investments can be converted into public benefits. Organizationally, this chapter contains sections covering each of the five boxes of Figure 3.1.

- **Travel Demand Methods –** Includes the traditional four-step models (trip generation, trip distribution, mode split, traffic assignment), with special attention paid to truck-rail diversions. Also includes some of the current thinking on freight models.

- **Transportation Impact Methods –** Determines the transportation-related benefits from the proposed improvements. These can include reduced highway maintenance costs, reduced operating costs, reduced shipper costs, etc. This section also includes hybrid models that blend multiple methods together to address specific needs.

- **External Impact Methods –** Includes non-transportation benefits attributable to transportation improvements. These include land use, safety, security, and environmental.
- **Economic Impact Methods –** Converts the various impact measures into direct and indirect economic benefits. This includes I/O, regional simulation, and regression models.
- **Decision Methods –** Includes methods such as benefit-cost and internal rate of return, used to evaluate and help determine the best allocation of public investments.

For purposes of this discussion, "model" generally refers to a mathematical formulation often incorporated into a software tool. A "method" incorporates both models and simpler procedures, more in the vein of "back of the envelope" or "rule of thumb."

3.1 Travel Demand Methods

Travel demand methods attempt to place the right traffic volume, on the right transportation mode, on the right network link (roadway, rail line, etc.). Without an accurate depiction of existing and future traffic conditions, the value of all subsequent outputs is diminished. Travel demand methods form the foundation for nearly all transportation benefits calculations.[1]

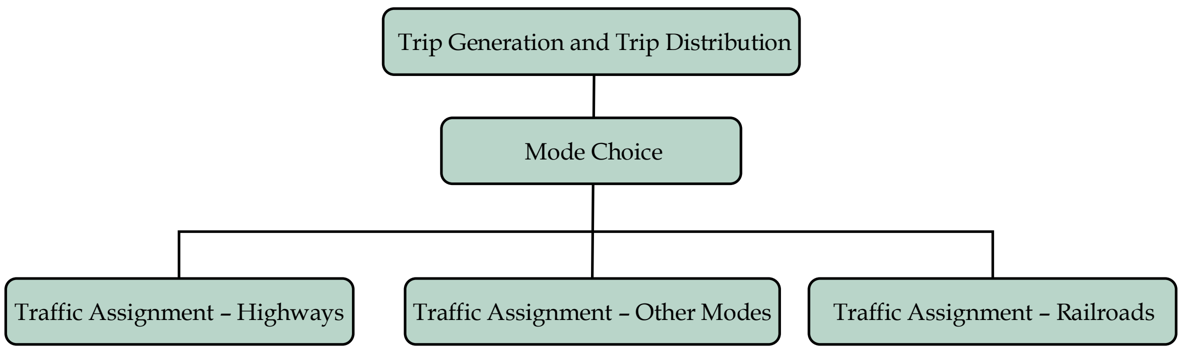
The standard travel demand model follows the four-step process: trip generation, trip distribution, mode choice, and traffic assignment. Trip generation and trip distribution can be combined, as would be the case in a survey, to create an O-D matrix. The travel demand process is incorporated into several software packages, with two of the more widely used being TransCAD and Citilabs' TP+ (with freight adaptation – Cube Cargo). Most development in travel demand methods have been focused on passenger travel. As growth in freight volumes continues to outpace growth in passenger trips, freight modeling has been receiving more attention.

A typical procedure is to use a survey or other source of data to calibrate a travel demand model; i.e., replicate existing conditions. From this base case, changes can be made to the network and/or traffic volumes, and the resulting travel time changes and other performance measures recalculated. If a bottleneck on a rail line is removed, how does that impact travel times, reliability, and costs? How do these changes impact the modal shares and traffic on both the rail lines and roadways?

[1] For a current and detailed review of transport demand methods, see D.A. Hensher and K.J. Button, *Handbook of Transport Modeling*, Pergamon (2002).

Trip generation, trip distribution, and mode choice are generic across all modes of travel. After the data have been divided by mode, then modal differences are seen in traffic assignment and transportation impacts. This is shown in Figure 3.2. Most of the focus and literature has been on highway modeling, but rail also has a well-developed set of methods that have been applied to service design and merger analysis. Other modal assignments (air, water, pipeline) are not addressed in this document.

Figure 3.2 Travel Demand Methods



The following is intended to provide a broad overview of travel demand methods, highlighting the importance of and connection to establishing the benefits of investments in freight rail capacity improvements.

Trip Generation and Trip Distribution

Trip generation and distribution methods are used to estimate the production and consumption of goods, and their movement between geographic zones. The data include an origin, destination, commodity, volume, and sometimes value. This is the most basic data for determining the impacts and benefits of freight rail projects, but it is often the most cumbersome and difficult to obtain due to private-sector confidentiality concerns. Rail origin, destination, and commodity data are generally available to state DOTs through the Surface Transportation Board (STB) Carload Waybill Sample, though its use is restricted. Obtaining trucking industry data are much more difficult. Many of the benefits attributable to freight rail are a direct function of changes in highway traffic volumes – reduced highway congestion and travel time, improved safety and environmental quality, reduced highway maintenance and construction costs, and reduced shipper costs are examples. Without accurate truck movement information, the ability to establish public benefits associated with rail capacity improvements is greatly diminished.

Trip generation is defined as estimating the quantity of freight flowing into or out of a zone. Trip distribution is defined as estimating the freight flowing between zones. The size of the zones is dependent on the nature of the study and the availability of data.

Typical zones include counties or specialized transportation analysis zones (TAZs). Special generators (seaports, airports, intermodal facilities) are often treated as independent zones. The data are usually in either tons or units (trucks, trailers, containers, railcars), with conversions done as needed.[2]

There are some methods that can combine the two steps of trip generation and distribution by directly determining the O-D matrix. These include:

- **Surveys –** Mail-out or telephone surveys of carriers and shippers, truck intercept surveys, truck stop interviews, rail yard surveys, electronic data capture (rail electronic data interchange (EDI), truck global positioning systems (GPS)), etc. The I-81 case study (Section 2.6) contained an example of a combined mail-out/telephone survey.

- **Public or Commercial Data Providers –** Bureau of Transportation Statistics (BTS) and Bureau of the Census Commodity Flow Survey, TRANSEARCH freight flow database, STB Carload Waybill Sample, FHWA Freight Analysis Framework, etc. The methods used to create these data sources can vary from shipper surveys, to carrier surveys, to estimates from industry outputs, to fusion of multiple sources. It is common to start with one of these available data sources and supplement it with more detailed traffic data supplied by a DOT or obtained through a small survey.

When direct determination of O-D matrix is not possible, trip generation should be done as a separate step, using one of the following methods or data sources:[3]

- **Commodity-Based Trip Generation –** Transforms employment data by industry into freight tonnages using a regression equation. Employment data are often stratified by Standard Industrial Classification (SIC) codes and used with multipliers taken from sources such as the *Quick Response Freight Manual* (FHWA, 1996). For example: Agricultural Production Tons = 45.96 x Farm Employment.

- **Truck-Based Trip Generation –** Is identical to commodity-based trip generation, except that the output is number of trucks rather than tonnage.

- **Industry Association Production Data –** Some industry associations collect and publish production data by region.

---

[2] For more information on converting data between different units, changing geographic granularity, and other similar data manipulation techniques, see "Tutorials in Data Manipulation Techniques" in National Cooperative Highway Research Program Project 8-43 *Methods for Forecasting Statewide Freight Movements*, Final Report Appendix.

[3] For more details on data sources for production and consumption data, as well as other sources of commodity O-D data, see "Task 10: Data Sources" in National Cooperative Highway Research Program Project 8-42 *A Guidebook for Rail Freight Solutions to Roadway Congestion*, and "4.2: Freight Databases" in National Cooperative Highway Research Program Project 8-43 *Methods for Forecasting Statewide Freight Movements*, Interim Report.

- **Government Census Data –** The U.S. Census Bureau provides an Annual Survey of Manufacturers, which includes production data by region and by commodity. Other government sources are available for specific commodities such as coal production data from the Department of Energy.

- **Econometric Methods –** Consumption of commodities are typically related to economic activity. Commercially available local economic data (e.g., REMI, Global Insight), industrial establishment databases (e.g., InfoUSA, Dun & Bradstreet, ZipInfo, Harris), or government sources (e.g., Bureau of Economic Analysis or BEA) can be used to model consumption.

Once production and consumption are determined, the origins and destinations must be linked in the trip distribution step, generally using one of the following methodologies:[4]

- **Gravity Models –** This type of model assumes the likelihood of products being attracted to a consumption center is inversely proportional to the square of the distance.

- **Mileage Minimizing Models –** This type of model uses a linear program to match production and consumption of goods through minimizing the cost to satisfy all demands.

Two more recent approaches developed specifically for freight include logistics chain modeling and tour-based truck modeling.[5]

- **Logistics Chain Models –** Attempt to simulate logistics choices throughout the entire supply chain for specific industries. One approach is to combine an economic I/O model that calculates supply and demand for each economic sector with an assignment of goods to logistics families to determine the spatial distribution patterns. Another approach is to define a set of activity types, which are linked together to describe either a logistical chain or a set of stops on a vehicle tour.

- **Tour-Based Models –** Focus on the tour characteristics of truck trips and are less concerned about the commodities in the vehicle. This is accomplished through microsimulation of urban goods movement. For each vehicle tour, a series of choice models are employed in order to determine the type of vehicle that will be used, the purpose of each stop, and the location of the next stop.

---

[4] See *Virginia I-81 Freight Diversion Model Case Study*, Reebie Associates, 2004, for a detailed description on how these types of models can be applied in practice.

[5] Fischer, Michael, Maren Outwater, Lihung Luke Cheng, Dike Ahanotu, and Robert Calix, *An Innovative Framework for Modeling Freight Transportation in Los Angeles County*, Transportation Research Board 2005, Annual Meeting CD-ROM.

Mode Choice (Truck-Rail Diversions)

A mode choice, or diversion, model is used to determine the extent to which mode shares change, given a change in any of the transportation service attributes. Mode choice for freight shipments is based on three primary factors: goods characteristics; modal characteristics; total logistics costs and supply chain design. The factors each impact the feasibility of freight rail diversion in different ways:

- **Goods characteristics –** Shipment size, package characteristics, shipment shelf life, shipment value, shipment density. Some goods are simply not suited to rail carriage (e.g., pharmaceuticals), while others are not suited to highway carriage (e.g., coal). These goods characteristics dictate the requirements of modal characteristics, and there are many commodities where truck-rail competition is not practical.

- **Modal characteristics –** Capacity, trip time, reliability, equipment availability, customer service and handling quality, modal cost. These characteristics, some of which can be changed through rail freight investment, interact with the goods characteristics to determine the most likely modal choice.

- **Total logistics costs and supply chain design –** Even if the goods are well suited to rail transport and rail service is available, the design of the supply chain may be such that other modes provide better service. This might be because of inventory carrying costs of expensive goods or an environment requiring short lead times. A supply chain optimized for one mode can be an impediment to traffic diversions.

Successful rail freight diversion in a given lane requires three elements: highway traffic congestion, rail technical feasibility, and economic realism.[6] The modal choice models aim to capture these characteristics and predict the rail and truck market shares based on O-D commodity-flow inputs. The four basic types of mode choice models are:

- **Market Segmentation Method –** Assign fixed mode share by commodity and O-D, with the length of haul as the most important input parameter. This is essentially a "look-up table" based on flow and commodity characteristics. A rule of thumb used in the Northern Ohio Corridor Case Study (Section 2.9) was that 10 percent of truck traffic with length of haul of more than 500 miles can be diverted to rail.

- **Logit Discrete Choice Model[7] –** Is a disaggregate model that calculates the probability of a shipment using each of a limited number of feasible transportation options. A logit model might return probabilities of 0.5 for rail, 0.4 for truck, and 0.1 for water.

---

[6] See National Cooperative Highway Research Program Project 8-42, Task 3-4-5-6 Interim Report, for more details regarding this framework, and circumstances under which rail freight diversion is likely to occur.

[7] The classic reference text on this subject is Moshe Ben-Akiva and Steven Lerman, *Discrete Choice Analysis – Theory and Application to Travel Demand* (MIT Press, Cambridge, 1985).

The model could either allocate a percentage of the shipment to each mode, in relation to the probabilities, or assign the entire shipment to the mode with the highest probability in a post-processor step. The logit model uses a set of independent variables (e.g., cost, distance, etc.) that are calibrated with existing modal shares developed from survey data. A key assumption of the logit model is the selections made for each shipment are independent of all other shipments. The New York Cross Harbor Case Study (Section 2.8) was based on a logit model. A logit model also formed the basis for ALK Associates' Advanced Traffic Diversion Model used to estimate post-merger railroad traffic volumes for merger applications before the STB. The ALK logit considered independent variables such as total route distance, track quality, yard efficiencies, and number of interchanges when determining rail-to-rail diversions.

- **Probit Model[8] –** Is also a probability model, based on a multivariate normal distribution. Whereas the logit assumed independence between choices, the probit incorporates a variance-covariance matrix that models shipment dependencies. This increases both the computational and data burden, making the probit model less desirable than the logit.

- **Elasticity Method –** Differs from the other models by predicting *changes* in existing mode share based on incremental cost (or service) changes. The logit and probit disregard prior modal shares. The elasticity method is based on the econometric concept of demand elasticity. This method translates changes in prices of transportation services to the changes in demand and, therefore, changes in traffic levels. At the heart of the elasticity model is a matrix of cross-elasticities (η), which is calibrated from historical time-series cost and traffic data. The elasticities can be obtained by calibration of the model against proprietary transportation carrier data, or other publicly available data. An elasticity model is the basis for the Reebie Intermodal Diversion Model (RIDM), a truck-rail diversion model used in numerous railroad merger proceedings before the STB.

All of these mode choice methods rely on historical data and, therefore, may do a poor job of projecting modal shifts due to new service offerings or improved technology. Services optimized for a company's supply-chain strategy, for example, may capture more market share than a standard mode choice model, which would estimate modal shares based on changes to the underlying costs or reliability.

Implementations of Truck-Rail Diversion Models

Two implementations of mode choice models designed specifically for truck-rail diversions are the Intermodal Transportation and Inventory Cost (ITIC) and RIDM.

[8] For more information, see Martland, C.D., Cook, P. and Aeppli, A.E., *Indian Railways Long-Range Decision Model – a Probit Approach* (A&L Associates, Inc., 1998).

Intermodal Transportation and Inventory Cost Model

ITIC is a mode choice model recently development by the FHWA Office of Freight Management and the FRA.[9] The model replicates the decision-making tradeoffs made by a logistics manager and is used for analysis of modal diversion or the assessment of economic benefits associated with changes in transportation policy or infrastructure. The FRA developed ITIC-IM, a specialized version of ITIC that provides estimates of diversion of highway freight traffic to rail intermodal service.[10]

The ITIC is a disaggregate demand model that chooses one of the transportation alternatives available on the basis of minimum total logistics costs. This is repeated for each of a large number of disaggregate observations from a representative sample of shipper movements. Statistics are then computed on the resulting choices and the mode and shipment size shares. The model was first developed in 1995 under a joint effort by the U.S. DOT Office of the Secretary (OST), FRA, FHWA, and BTS.[11] A previous version of this model was used in the U.S. DOT's *Comprehensive Truck Size and Weight Study*, which was submitted to Congress in 2000. ITIC should provide analysts with an improved ability to estimate changes in truck-rail modal shares, based on changes in the underlying cost and service structure.

Reebie Intermodal Diversion Model

Another mode choice modal used extensively in truck-rail diversion studies is RIDM. This model uses an element of the STB's Uniform Rail Costing System (see Section 3.2 on costs) adapted for rail intermodal movements, TRANSEARCH commodity-flow database, and a demand elasticity model calibrated from historical carrier price and volume data – based on vehicle type, service plan, traffic type, geographic region, and commodity group. The output is a list of freight flows that would likely be diverted to rail given a new set of intermodal service lanes or changes to railroad productivity. The model was first developed in the 1980s in response to railroad deregulation and subsequently used to support railroad merger applications to the STB. More recently, the model has been applied to assess the impact of publicly-funded intermodal investments and sponsored train starts.

Traffic Assignment

Traffic, or route, assignment is the act of assigning the O-D matrix to individual network links. When estimating factors such as capacity issues, travel delays, and road or rail

---

[9] Adapted from *Intermodal Transportation and Inventory Cost Model: Highway-to-Rail Version, User's Manual*, U.S. Department of Transportation, Federal Railroad Administration, and Federal Highway Administration, December 2004.

[10] More information on ITIC-IM can be found at http://www.fra.dot.gov/us/content/1543.

[11] Transmode Consultants, Inc., *Truck-Rail, Rail-Truck Diversion Model: User Manual*, developed for the U.S. Department of Transportation, Federal Railroad Administration, Washington, D.C., 1995.

deterioration rates, knowing how goods are moving is as critical as knowing how many goods are moving.

Methods for trip generation, trip distribution, and mode split are essentially the same for highway, rail, water, and air travel. Modal differences become important at the traffic assignment step, as trucks typically follow least-cost paths and pick-up/delivery patterns, while trains adhere to blocking plans. This traffic assignment section is divided into a highway and a railroad section.

Highway Assignment

Even if the origin, destination, and mode of travel are known (as might be the case with an extensive survey), it is unlikely the exact route taken by the truck will be known. Given a set of origins, destinations, and mode of travel, the traffic assignment step predicts the likely route for each shipment. There are two principal classes of assignment models:

- Fixed-Path Assignment; and
- Dynamic Path Assignment.

In a fixed-path assignment, routings are provided in a routing table. These tables can be developed in a dynamic traffic assignment from another source, calibrated against actual counts, or provided by the carriers.

An advantage of fixed-path assignments is it is usually more accurate, because it is calibrated with real data or provided by the carriers. It also does not require the user to acquire or maintain a network with current costs (impedances) for accurate routings. The disadvantage is that a fixed-path assignment cannot evaluate changes to the network structure or the underlying impedances often necessary for "what-if" analysis. For this reason, dynamic paths are generally preferred for analysis.

In a dynamic path assignment, the routes are generated with a shortest-path algorithm (i.e., least impedance). Using dynamic assignments, the underlying network can be altered and the impacts on traffic volumes observed. There are four basic types of dynamic path assignment techniques:

- **All or Nothing Assignment –** Freight traffic is assigned to the network without recalculating times or costs attributable to congestion and capacity constraints as volumes increase. Between a given O-D pair, the least impedance route receives all of the traffic, and all other routes receive nothing.

- **Stochastic Assignment –** Calculates all likely paths and distributes the traffic among the probable routes. This accounts for factors not imbedded into impedances and for essentially least-cost paths.[12]

- **Multiclass Assignment –** Provides separate impedances for different classes of traffic for use with an "all or nothing" assignment. On a highway, this might include different classes for passenger vehicles, heavy trucks, oversize shipments, and hazardous materials.

- **User Equilibrium –** Performs an "all or nothing" assignment, updates network impedances based on new traffic volumes, performs another "all or nothing" assignment, and continues this process until equilibrium is obtained. The FHWA's Freight Analysis Framework was based on a user equilibrium assignment.

ORNL provides a public-domain shortest-path model for use by planners. The Oak Ridge Model (ORM) takes as its input an O-D matrix, and routes traffic by the shortest path based on fixed impedances that are dependent on link type (i.e., interstates, U.S. highways, and secondary routes). The datasets that underlie ORM are downloadable on the Internet.[13] The ORM data include impedances for route segments, which are manipulated with a custom program to generate shortest paths, or with a commercial geographic information systems (GIS) package such as ArcInfo and TransCAD.[14] ORNL also maintains a publicly available rail network.

Railroad Assignment

The railroad equivalent to the traffic assignment model are blocking and scheduling algorithms. These tend to fall under the general category of service design. Service design models are used by railroads to manage their networks and develop operating plans. They typically incorporate "what-if" capabilities and provide users with an assortment of graphical and reporting tools for measuring the effects of changes to a service plan, including impacts on dwell times, transit and arrival times, car schedules, arrival commitments, train sizes, yard workloads, and traffic routings. This can lead to cost savings by:

---

[12] For more on essentially-least-cost paths see David Hunt and Alain Kornhauser, *"Assigning Traffic Over Essentially-Least-Cost Paths," Transportation Research Record* 1556, Transportation Research Board, National Research Council, Washington, D.C., 1996, pages 1-7.

[13] Center for Transportation Analysis, Oak Ridge National Laboratory at http://www-cta.ornl.gov/transnet/Index.html.

[14] A good description of the issues associated with traffic assignment in large-scale networks can be found in Frank Southworth and Bruce Peterson, "Intermodal and International Freight Network Modeling," *Transportation Research*, Part C, 2000, pp. 147-166.

- Reduction in car-hire cost;
- Reduction in car cycle time;
- Reduced number of locomotives;
- Reduced train annulments and extras;
- Reduction in crew costs; and
- Reduction in intermediate car handlings.

These products are not designed for determining public benefits and provide much more information than needed for this purpose. One of the best-known service planning models is MultiRail® by MultiModal Applied Systems, Inc. A good survey of the algorithms developed for train routing and scheduling is contained in Cordeau, Toth, and Vigo.[15]

A simpler approach is to use a Multiclass assignment method. In this method, an "all or nothing" assignment is performed for each class of traffic. The rail network used in the processing of the STB Carload Waybill Sample maintains four impedance classes representing the different routings for general merchandise, intermodal, multilevel auto carriers, and bulk unit trains.

■ 3.2 Transportation Impact Methods

Transportation impact analyses are used to compare the relative benefits of prospective alternative transportation investments. Impacts may be measured in several ways, but transportation *efficiency analysis* is perhaps the most appropriate and widely-accepted framework for impact analyses. Transportation efficiency analysis measures agency infrastructure or policy costs against transportation user benefits, which typically include savings in travel time, operating and maintenance costs, out-of-pocket costs, and at least some component of accident costs. Environmental costs, which affect both users and non-users, are an example of external impacts, which also may be accounted for in the comparison of costs and benefits. Typically, travel time savings are a very significant component of total benefits. Hence, removing heavy trucks from the highways, which reduces delays for passenger vehicles, is frequently cited as a public benefit (e.g., this was used in MAROps, Section 2.7).

In regional scale analyses, such as those involving freight flows, travel demand models are used to calculate the expected savings in VMT and vehicle hours of travel (VHT) associated with a new or proposed project or program. To these savings are applied an assumed value of driver time (per hour) and an assumed value of vehicle operating costs

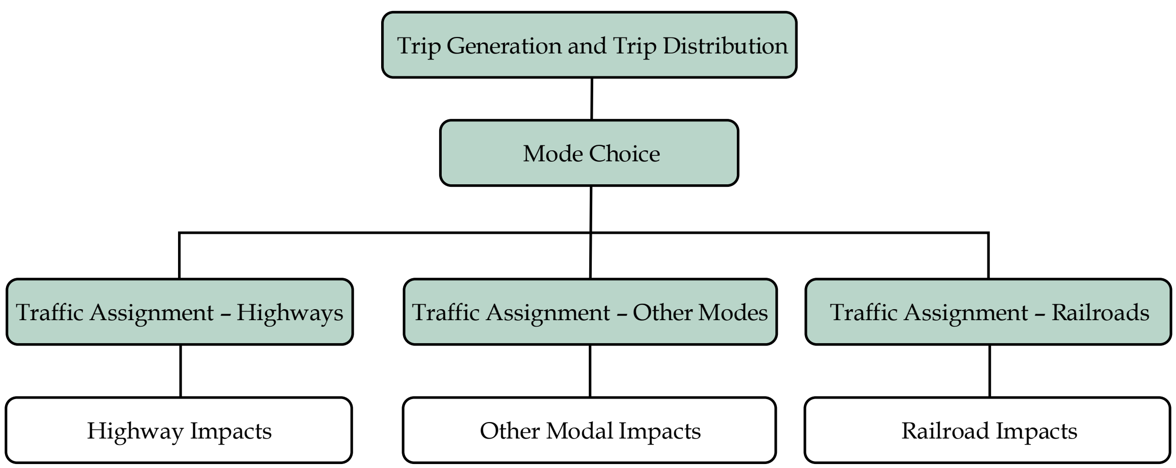
[15] Cordeau, Jean-Francois, Paolo Toth, and Daniele Vigo, "A Survey of Optimization Models for Train Routing and Scheduling," *Transportation Science*, Volume 32, Number 4, November 1998.

(per mile). More detailed analyses produce estimates of vehicle operating costs using a multivariate regression (so costs have both a per minute and a per mile component), to capture the effects of delays and idling. This is especially important for truck travel because vehicle operating costs are a significant component of total truck costs.

The transportation impacts due to railroad investments are not as well developed, especially for adaptation to public-sector planning. Tools developed for railroad service design, rail merger analysis, and rail capacity studies are available, but they require substantial quantities of private-sector data and were not designed for evaluation of public-sector impacts.

Figure 3.3 builds onto Figure 3.2 by adding transportation impact methods. This section will discuss current practices for determining highway and rail impacts.

Figure 3.3 Transportation Impact Methods



Highway Operations and Impacts

Highway Capacity Manual

For decades, the Highway Capacity Manual has been the authoritative reference for estimating roadway capacity and quality of service. The manual and the companion software provide guidance and worksheets for evaluating the performance of roadway segments with distinct operational characteristics, such as intersections, freeways, freeway ramps, two-lane rural roads, and urban arterials. On many of these roadway types, the composition of the traffic stream, and especially the percentage of trucks, is a highly significant variable in the calculation of capacity during periods of peak demand.

"User Benefit Analysis for Highways" (the Red Book)

The AASHTO "User Benefit Analysis for Highways" (commonly referred to as the Red Book) is a manual of user benefit analysis for highways that provides tools and guidance to evaluate the costs and benefits associated with transportation improvement projects. The Red Book provides suggested values and calculation methods associated with determining changes in values of time, operating costs, and accident costs for a wide range of highway improvements. The highway improvements covered include adding additional lanes, constructing new highways, adding traffic control devices, adding intelligent transportation systems (ITS) improvements, making safety improvements, and the impacts of pricing and regulatory policy changes. These improvements are structured around benefit-cost calculations.

Several software tools draw from the Red Book.[16]

- MicroBENCOST was developed at the Texas Transportation Institute (TTI) as an implementation of the Red Book. It can evaluate additional lanes, bypasses, intersections, interchanges, pavement and shoulder improvements, bridges, safety improvements, railroad crossings, and high-occupancy vehicle (HOV) lanes. The measures returned include traffic delay times, user operating costs, user discomfort costs, accident costs, and construction related delays.

- ROADSIDE implements the AASHTO "Roadside Design Guide" and includes estimates of benefits and costs associated with roadside safety improvements.

- SPASM is a sketch-planning tool for evaluating multiple transportation improvements at the corridor level. These include transit system improvements, highway capacity improvements, HOV lanes, and auto use disincentives.

- HDM4 was developed by the World Bank for benefit-cost analysis of roadway improvements around the world. It provides estimates of user delay costs, accident costs, and operating expenses.

- StratBENCOST is a sketch-planning level tool that includes a travel demand model, a default value of time, and operating cost data. It estimates accident-related costs, environmental effects, and construction-related costs.

- STEAM, ITS Deployment Analysis System (IDAS), and HERS also draw from the Red Book. These models are profiled in more detail below.

[16]Source: *User Benefit Analysis for Highways*, American Association of State Highway and Transportation Officials, August 2003. Many of these software products can be ordered through McTrans, hosted by the University of Florida at http://mctrans.ce.ufl.edu/.

The Red Book and all the above software tools are specific to highways. There is a focus on passenger vehicles, but most of the software incorporates heavy trucks either directly or indirectly. There is no comparable Red Book for railroad analysis.

Surface Transportation Efficiency Analysis Model

STEAM is a Federally-supported software tool for transportation efficiency analysis. Using transportation networks and O-D flows for build and no-build scenarios, which typically are produced by a regional travel demand model, STEAM estimates user and non-user benefits for an entire study region, or at a subregional level that is defined by the user. These benefits are compared to project costs supplied by the user to produce estimates of net benefits and benefit-cost ratios. Default unit costs for values of time, operating, out-of-pocket expenses, and many other parameters can be adjusted by the user. Travel demand can be stratified into separate markets, such as transit or truck, each with its own set of network volumes, O-D flows, and unit values for travel time and other costs.

ITS Deployment Analysis System

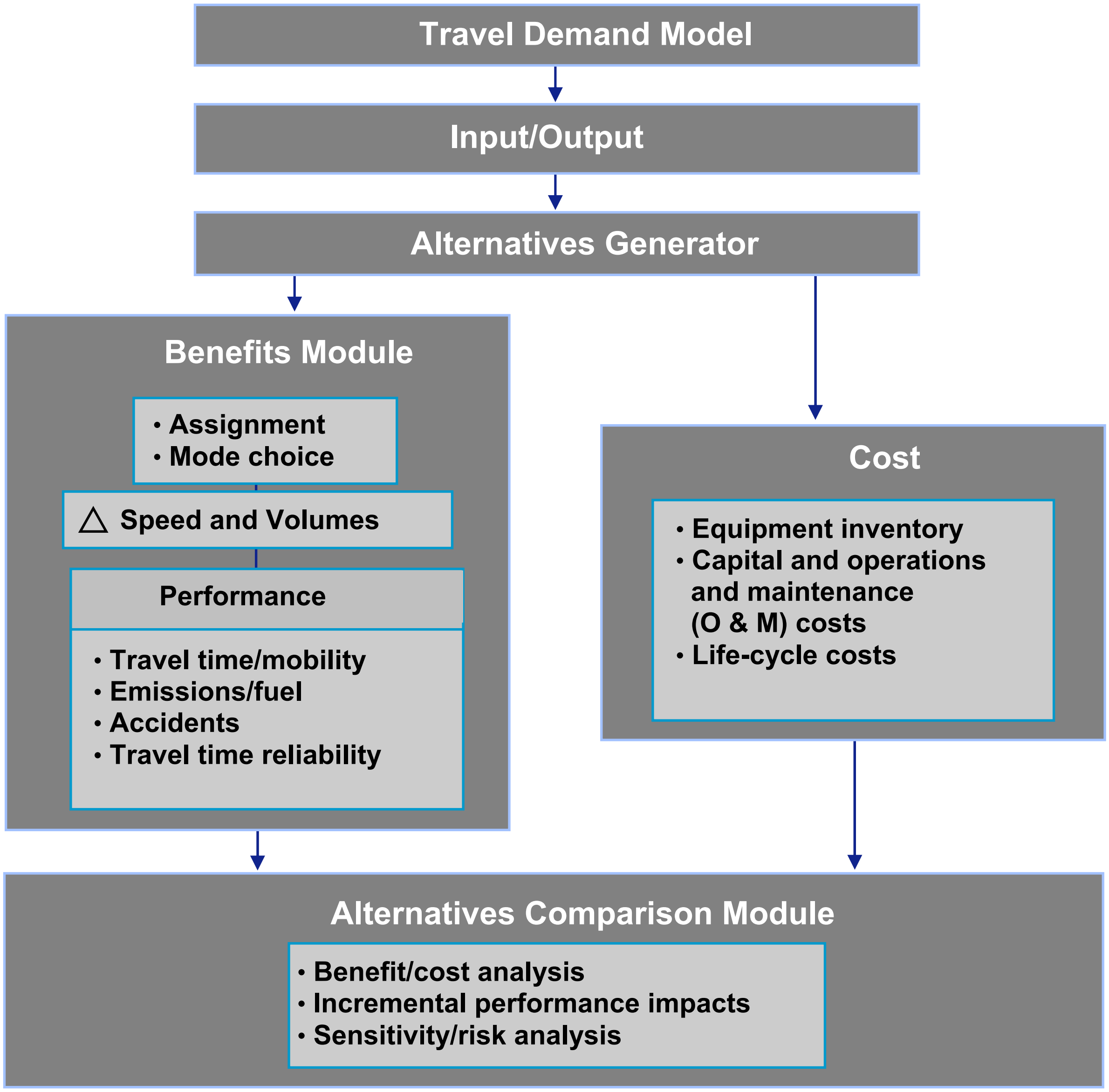
IDAS is an ITS sketch-planning tool that estimates the impacts, benefits, and costs of alternative ITS investment packages. IDAS estimates the changes in modal, route, and temporal decisions of travelers resulting from ITS implementations with an internal modal split and traffic assignment capability. The set of impacts evaluated by IDAS include changes in user mobility, travel time/speed, travel time reliability (non-recurring congestion duration), fuel costs, operating costs, accident costs, emissions, and noise. The performance of selected ITS options can be viewed by market sector (mode), facility type, and district. IDAS produces outputs in a benefit-cost summary report and performance summary reports. IDAS also has an internal cost-estimating module that estimates life-cycle expenditures by year and the average annual costs for ITS improvements. IDAS is an interesting example because it contains narrowly focused components from all five methods profiled in this section (travel demand, transportation impacts, external impacts, economic impacts, and decision methods). Figure 3.4 contains an overview of IDAS.

A travel demand model is not part of IDAS, but IDAS interfaces with standard travel demand models through the Input/Output Interface to extract network definitions, zonal definitions, O-D matrices, and other initial conditions and convert them into a format for input into the IDAS analysis modules.

The Alternatives Generator is a graphical user interface allowing users to directly enter technology enhancements to specific locations in a regional network through both geographical and tabular formats. The result is a post-improvement alternative scenario that can be compared to the before control case.

The Benefits Module estimates the impacts of the improvements through a series of measures, including travel time, travel time reliability, throughput, safety, emissions, energy consumption, and noise. Using data from the control and alternative cases, the Benefits Module performs a series of analyses to generate performance differences between scenarios.

Figure 3.4 Overall Structure of the ITS Deployment Analysis System



The Cost Module estimates the life-cycle expenditures by year and the average annual costs for the ITS improvements. These are drawn from a library of more than 60 technology enhancements.

The final IDAS module is the Alternatives Comparison Module. The performance measures developed in the Benefits Module are converted to monetary units and compared to the costs to produce benefit-cost analyses of the proposed changes. This module also contains a risk analysis component allowing users to evaluate alternatives under a variety of future outcomes. The final result of IDAS is a regional analysis of the benefit-costs tradeoffs associated with implementation of one or more ITS strategies.

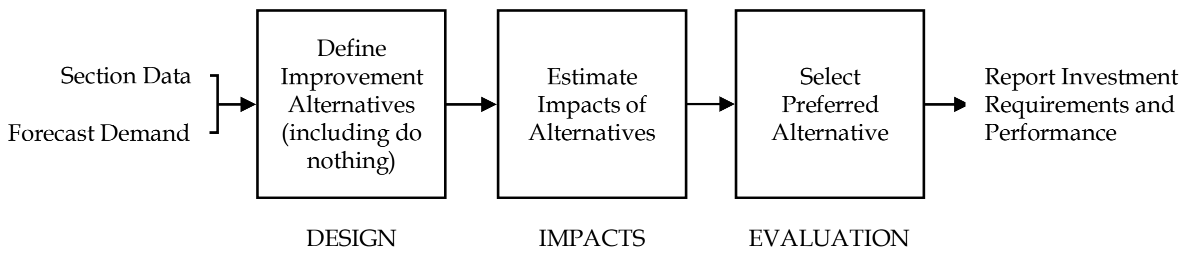
Highway Economic Requirement System

HERS is a Federally-supported highway investment analysis tool using transportation engineering and economic analysis concepts to estimate total highway funding needs. HERS uses highway condition and performance data supplied by all states to identify deficiencies, evaluate and select potential improvements, and report the costs and benefits of a series of highway investments that occur over a given time period. The analysis time-frame is typically 20 years, divided into four separate five-year analysis periods. HERS analyzes and predicts pavement conditions, the capacity and operational adequacy of roadways, and evaluates the potential benefits of widening, reconstruction, rehabilitation, or repaving individual roadway segments to address deficiencies. It does not evaluate the benefits of new roadways on new rights-of-way because it lacks network modeling capabilities. For each roadway segment, HERS determines the optimal improvement available based upon benefit-cost criteria. The benefits evaluated and reported by HERS include travel time, operating, and internal safety cost savings. Emissions and non-internal safety costs are evaluated as well. User costs include separate values of time and operating costs for truck and passenger vehicles, which permits a separate accounting of impacts to these two user groups for regional economic analyses. HERS has been used for many years to provide Congress with data for the preparation of FHWA's annual *Condition and Performance Report*.

Figure 3.5 contains an overview of the primary HERS components. For input, HERS uses a database of highway condition and performance data supplied by states, called the Highway Performance Monitoring System (HPMS). The HPMS contains volume and capacity data for a representative sample of all rural and urban roadway sections with functional classifications of minor arterial and minor collector and above, respectively. The HPMS provides the Federally-sanctioned source of VMT to which transportation models used for regional air quality conformity analysis must be validated. The model moves through a Design Module where alternatives are defined and an Impacts Module that generates performance measures and costs for items such as travel delays, accidents, and pavement maintenance. In the Evaluation Module, HERS optimizes benefits based on an "objective function" chosen by the user. The program can be configured to select projects with the greatest incremental benefit-cost ratio, and to report total costs. HERS can select projects that provide the greatest benefit under a budget constraint. It can also assess the cost of maintaining current conditions. The final output is a report with highway investment recommendations and supporting performance measures and costs.

It is primarily the Impacts Module that has been useful for evaluating the benefits attributable to rail freight investments. By comparing existing conditions (or a future alternative) to the reduction in truck VMT a rail capacity project would create, HERS calculates monetary values associated with safety, maintenance reduction, travel time delays, and other factors. For a small number of road segments, these values can be calculated individually (as was done for the Palouse River and Coulee City Railroad case study profiled in Section 2.10). HERS is valuable for large-scale studies (as was done for MAROps profiled in Section 2.7). HERS is strictly a highway model; it does not consider railroad network investments or impacts.

Figure 3.5 Overview of the Highway Economic Requirement System



National Italian Freight Model

From an international perspective, the National Italian Freight Model (NIFM) was developed at the University of Naples with a European Union grant. It was specifically developed to estimate the effect of various transportation infrastructure improvements and policy changes on the Napoli Province in Southern Italy. NIFM is a two-stage integrated model that predicts economic performance, and then transportation demand based on the business performance. Uniquely, transportation demands and costs are fed back into the economic performance model and iterated until equilibrium is obtained. This ensures the transportation predictions explicitly reflect the link between transportation investment, economic development, and land use planning. In this model, most of the choices are simulated using logit models, including transportation mode choice and choice of production levels and location of production facilities. In one study using NIFM, it was discovered that subsidizing rail rates to Southern Italy would increase both rail and truck volumes because of increased production, with the trucking sector growing more than the rail sector because of better levels of service.[17]

Rail Operations and Impacts

Railroad operations models are used to identify blocking plans, schedules, capacity problems, bottlenecks, and overall system performance. There are two basic classes of models: service design models and simulation models. The service design models were discussed in the Travel Demand Methods section.

---

[17] A full description of this work is found in Ennio Cascetta and Pierluigi Coppola's paper *Modeling Long-Term Effects on Travel Demand*, presented at the European Transport Forum, September 9-11, 2001. More information about this project can be found on Hague Consulting Group's web site at http://www.hcg.nl/projects/trace/trace2.htm.

Railroad Simulation Models

Railroad simulation models are used to evaluate track configurations, signal systems, and operating plans. These models generally mimic train dispatcher logic and are used to evaluate infrastructure and/or operational changes. A common use is to evaluate the running of passenger and freight trains over the same track to identify bottlenecks and capacity constraints. Most models produce schedules, string line displays, and various performance measures permitting comparison of alternative scenarios. These simulation models do not provide a pure measurement of capacity, but are used to identify potential capacity problems in an operational sense.

This class of models is designed to simulate the decisions made by train dispatchers. They do not, in general, contain optimization or other decision-making components. They do follow a set of fixed rules governing train priorities and a train performance calculator to model train physics (acceleration and deceleration). By providing track configuration, signal systems, and operating plans as input, an experienced user can evaluate the outputs to determine bottlenecks and conflicts. Adjustments are made to the inputs to resolve these conflicts (typically adding and/or lengthening a siding, double tracking, or adjusting train schedules).

There are several railroad simulation models, each with different features and logic. These include:

1. Rail Traffic Controller (RTC), which is commonly called the "Berkeley Model," is owned by Berkeley Simulation Software. RTC is popular with the freight railroads and is used by many of the large railroads. The RTC logic routes the highest priority train through the network, then the second highest, then third, etc. When there are conflicts, the logic seeks alternative routes for the lower priority train.

2. RAILS 2000 is owned by CANAC, which was purchased in 2004 by Savage Industries. RAILS 2000 uses a rule-based methodology to attempt a global look at routing trains through a network, rather than the priority scheme used by RTC.

3. FastTrack II is owned by MultiModal Applied Systems. FastTrack II can only handle single corridors – it cannot model corridors where the dispatcher has multiple routing options.

4. RAILSIM is owned by Systra. It can identify conflicts (i.e., two trains wanting to occupy the same space), but it does not have the logic to resolve these conflicts.

In addition to the simulation models, there has been recent interest in developing parametric rail capacity models. These models develop capacity curves for various operating characteristics and, based on the operating plan profile of a rail line, identify areas with capacity constraints. They are much less data intensive than the simulation models.

Parametric models can help identify capacity "hot spots," which would then need to be further explored with simulation.[18]

Railroad operation and impact models tend to be very data and labor intensive. They are used internally by the railroads and for large-scale projects and mission-critical analysis. Because of the effort and cost of these specialty models, they are more appropriate for a detailed design phase than a preliminary benefits phase. There is a need for simpler, sketch-planning rail models to answer a few questions at a high level:

- How many trains will run through my town?
- Will this project improve freight rail service?
- Will other investments be needed to fully achieve the benefits?

RailDec 2.0

RailDec 2.0, along with its predecessor RailDec 1.0, was developed for the FRA as a rail and rail-related investment decision-support system. The software model forecasts the transportation and non-transportation effects of rail enhancement projects and estimates the economic value over the useful project life. RailDec was used in the New York Cross Harbor Study (Section 2.8) and the Auburn, Maine, intermodal facility study (briefly described in the CMAQ discussion in Section 2.3).

RailDec is no longer supported by the FRA for two primary reasons. First, public scrutiny of the software during the New York Cross Harbor project resulted in discovery of a software coding error in the emissions calculations. Second, the FRA was not able to identify suitable methods to estimate rail demand for the software's intended customer base: state and local governments. The FRA concluded that RailDec did provide a valuable "proof of concept" for this methodology.[19] A similar decision-support system for evaluating highway-rail grade crossing investments, GradeDec, is available and supported by the FRA.[20]

Despite the fact that RailDec is no longer supported, it is useful to examine the structure of the software. RailDec 2.0 is comprised of a set of model components that receive as input a change in rail service and produce as output benefits in the form of reductions in

---

[18] For a more detailed description of parametric capacity models, see Harald Krueger, *Parametric Modeling in Rail Capacity Planning*, Proceedings of the 1999 Winter Simulation Conference. Also see Federal Railroad Administration, *Parametric Analysis of Railway Line Capacity*, August 1975, Report No. FRA-OPPD-75-1.

[19] Personal communications with the Federal Railroad Administration.

[20] For more information on GradeDec, visit http://www.fra.dot.gov/us/content/1195.

shipping costs, vehicle emissions, travel times, vehicle accidents, and vehicle operating costs. [21] The model components are:

1. Demand Estimation – Is not part of RailDec 2.0. The documentation suggests that the estimation of truck to rail diversions generated by improvements in the rail system can be estimated by either experience of similar facilities or by a mode split model.

2. User Benefits – Subdivided into two categories.

   – Direct User Benefits – Include those accruing to both freight and passenger uses of rail. The freight benefit is shipper savings (change in modal demands multiplied by the modal shipping rate differentials) and the passenger benefit is travel time reduction (reduction in passenger rail travel time multiplied by the value of time).[22]

   – Indirect User Benefits – Are based on changes in modal split between truck and freight rail shipments. This includes changes in highway congestion levels (measured as travel time savings), changes in highway accidents (converted to accident cost savings), and changes in vehicle operating costs (based on fuel, oil, tire, maintenance, and related costs).[23]

3. Non-User Benefits – Resulting from a more efficient transportation network are based on improvements in air quality and reductions in highway maintenance costs.[24] Air quality is a net value, subtracting increases in locomotive emissions resulting from additional rail volumes.[25]

4. Reduced Train Delay Benefits – Include reductions in rail labor costs, operating costs, locomotive emissions, train delay, and average passenger value of time resulting from increased train speeds through capacity expansion or bottleneck reduction projects.

---

[21] The nine model components are contained in *Model Documentation for RailDec v. 2.0*, by Hickling Lewis Brod Inc., Silver Spring, Maryland.

[22] Travel time costs are taken from *Technical Report, Highway Economic Requirements System (HERS)*, Jack Faucett Associates, Bethesda, Maryland, 1991.

[23] Vehicle operating costs are drawn from *Technical Memorandum for NCHRP 7-12*, Texas Transportation Institute, 1990, and *Technical Report, Highway Economic Requirements System (HERS)*, Jack Faucett Associates, Bethesda, Maryland, 1991.

[24] Emissions are converted into monetary units based on *Vehicle Operating Costs, Fuel Consumption, and Pavement Type and Condition Factors*, Federal Highway Administration, June 1982, and Transportation Research Board Paper No. 951046, *Monetary Values of Air Pollution Emissions in Various U.S. Cities*, 1995.

[25] Locomotive emissions are derived from *Procedures for Emission Inventory Preparation*, Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, Michigan, 1992.

5. Grade Crossing Accident Savings – Is the projected monetary savings of property damage, injuries, and fatalities resulting from lowering the rate of vehicle-train collisions at grade crossings.[26]

6. Project Costs – The user is required to input all construction costs, include the both the public and private shares.

7. Financial Analysis – Is performed on the expected operating expenses and the operating revenues for both freight and passenger to assess the long-term financial viability of the project. The net after-tax revenue is calculated by subtracting debt service, taxes, and facility operating and maintenance costs from pre-tax revenues.

8. Economic Evaluation Criteria – Calculates several criteria, including net present value, internal rate of return, breakeven point, first-year benefits, and benefit-cost ratio.

9. Risk Analysis – Is an optional step that develops ranges around key input data items, which are converted into probability distributions and used to determine the sensitivity of the results.

Overall, RailDec 2.0 incorporated many of the benefit streams used in the case studies profiled in Chapter 2.0. The incorporation of long-term economic viability through analysis of operating costs and revenue streams was novel and not seen in the case studies. RailDec does indeed offer a valuable "proof of concept" that will be beneficial for any future efforts.

Logistics Costs

Logistics cost models are used to identify the *economic costs* of moving products from manufacturers to markets. Costs are distinct from *rates*, which are the monies charged by the carrier to the shipper, and are close to marginal costs in competitive markets but higher than average costs in monopoly or oligopoly markets. When studying transportation benefits, it is important to measure the economic costs, including the fully-allocated overhead costs as well as any costs-of-capital, rather than rates, which can be a function of a shipper's bargaining power.

Carrier savings can result from reduced congestion (and therefore lower crew and equipment costs), and also improved rail network capability (e.g., ability to take larger cars, or more direct routes). Determination of carrier savings resulting from capacity investments often involve rail operations models, because improved cost efficiencies show up on the carrier's balance sheet only after the project is completed and the operating plan is altered to take advantage of the new infrastructure.

---

[26] Accident costs are derived from *The Cost of Highway Crashes*, The Urban Institute, Washington, D.C., 1988.

Shipper savings can occur in a number of circumstances with rail capacity improvement, even without rate changes. If the shipper owns its own railcars, then car utilization and productivity may increase as transit times decrease, resulting in savings. Lower transit times also lead to a decrease in inventory carrying costs, which is especially important for high-valued goods. If increased rail capacity makes it economically feasible to divert rail commodities that have historically traveled by highway, total logistics costs will decrease. Investment decisions should be based on actual productivity increases, not rate changes.

Consideration of railroad costs and profitability is a complex discipline. The analyst must be aware of the difference between engineering and accounting costs, and between average and marginal costs, and be able to choose the appropriate costs for calculating benefits for the investment scenario.[27]

Uniform Rail Costing System

The STB's Uniform Rail Cost System (URCS) can be used to evaluate changes in productivity that may occur with an infrastructure investment. This model uses empirical measures of carrier system average accounting cost data and performance measures to estimate the cost of providing service. If a facility improvement increases car miles per day through improved train velocity in a congested corridor, the impacts can be translated into shipper savings per car or per ton-mile. Using truck rate models, shipper savings from switching from highway haulage to rail haulage can also be estimated. It is possible to override the system average default information with lane-specific costs, when available.

Additional analyses will be required to determine total logistics cost savings. Using the travel time estimates from either the operations model or the cost model, the time savings can be calculated. The shipper's production schedule then could be analyzed to see whether the decreased lead time and travel time can translate into lower inventory levels. If this is not possible, the value of time in transit is termed "incapturable," because it will result in no actual savings. In most cases, this value is retained as a benefit by the shipper who could choose to lower its inventory levels (safety stock) if rail service became more reliable or less congested. However, if this results in an upstream supplier increasing its inventory levels, the net national benefit may be zero or insignificant.

In the case of diversion from truck to rail, the value of inventory in transit will in most cases increase because of lengthened journey time and larger lots associated with freight rail delivery. However, in those cases, the savings attained from the difference in cost between rail and truck transportation will more than overcome the time cost of inventory. If it does not, freight rail diversion will not occur.

---

[27] For more information, refer to the costing discussions in Jose A. Gomez-Ibanez, William B. Tye, and Clifford Winston, *Essays in Transportation Economics and Policy: A Handbook in Honor of John R. Meyer* (Brookings Institution, Washington D.C., 1999).

Shipper Accessibility Impacts

Modern freight rail capacity enhancement schemes often feature rationalization of track layout, signaling systems, and other features. The rationalization of track layouts, typically done to shift capital from shrinking to growing markets or to improve flows of long-distance traffic, can impact shipper accessibility. Sometimes, circuitous and constrained local infrastructure is entirely by-passed, resulting in greater mainline capacity but problems for local shippers if the local track is allowed to deteriorate. Even when no track mileage is being abandoned, conversion of an industrial siding into an additional main track or removal of track switches connecting industrial spurs may lead to a reduction in rail access difficult to restore at a later date.

The impact of lost accessibility is sometimes difficult to quantify. The loss first has to be identified. Usually, the sites facing loss of rail access would not have been actively served for some time, and planners may not realize that an opportunity for future rail development is being forsaken. Occasionally, an increase in capacity and throughput can result in shorter window periods available for switching local industries. Typically, analysis of proposed track alterations is required. Where the situation demands, a rail operations model (described above) should be used to determine whether accessibility can be preserved after re-signaling or other changes.

Secondly, once accessibility losses are identified, costs are not always clear. The shipper may have to construct a new connection to the main line, relocate its facility, or convert to truck, resulting in higher transportation costs. The "value" of rail accessibility can be assessed economically, and this is often dealt with as part of the regional economic assessment (see Section 3.4 on Economic Methods). In the CREATE case study (see Section 2.2), the value of rail access to the City of Chicago was explicitly enumerated with an economic model.

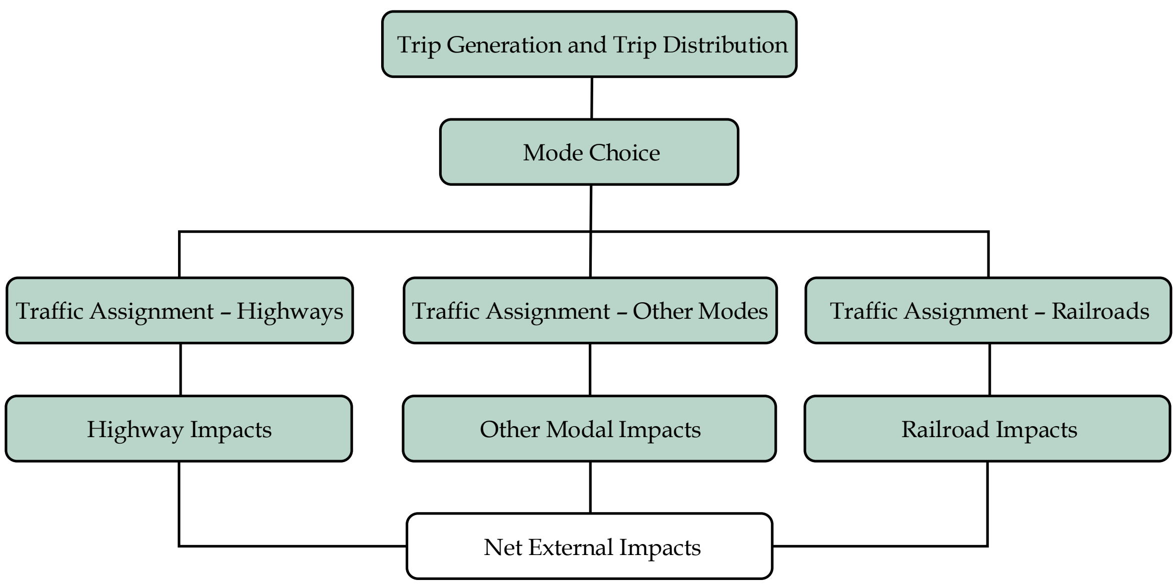
One precedent for this analysis is abandonment requests filed with the STB. The railroad must address the impacts such as: shippers facing no rail service, additional trucks on the roads, and potential jobs lost. This is typically not done through extensive analytical methods, especially for branch lines. Another precedent is loss of competition at the "two-to-one" points attributable to railroad mergers where there is overlap between the systems. The applicant railroad must address impacts to shippers going from competitive rail service to captive rail service.

Although shipper accessibility is not directly measured in any particular type of model or determined by any specific method, it is nonetheless an important consideration when evaluating the benefits of a freight rail capacity improvement scheme. In most cases, new infrastructure will lead to increased accessibility for sites that were not previously rail accessible but, where old infrastructure is by-passed, a loss in accessibility (and higher shipping costs) could result. These costs and benefits must be enumerated and considered as part of the benefit-cost and evaluation of capacity improvement schemes.

■ 3.3 External Impact Methods

External impact methods are used to quantify non-transportation consequences of alternative and prospective transportation investments. This includes environmental, land use, safety, security, and community impacts. Technically, accident reduction qualifies as an "externality," because accidents can affect not only the operator but also non-transportation users. In this section, we consider the impact of transportation system investments on other systems with which it must coexist. Figure 3.6 is an extension of Figure 3.3, showing external impacts.

Figure 3.6 External Impact Methods



Generally, in terms of rail freight investment, negative external impacts are inevitable, but public investment in these system often cite avoidance of potential negative impacts that *would* occur if the freight rail investment were *not* made. For example, additional highway construction or widening, which may have external impacts that are worse, or may require higher congestion mitigation costs than the rail freight option (e.g., Alameda Corridor described in Section 2.1, or I-81 in Section 2.6). It is therefore in the interest of the freight rail advocate to document the external impacts and to demonstrate they are lower than providing equivalent highway capacity. In some cases, freight rail investment is justified in its capability to reduce external impacts alone (e.g., CMAQ, Section 2.3).

Environmental Impacts

Detailed discussions of the environmental benefits of transportation investment appear in a prior NCHRP 8-36 Task.[28] Although rail freight is not discussed specifically, the benefits documented are applicable to many freight rail capacity improvement schemes. In this section, environmental impacts will be examined, focusing specifically on methodologies and how they relate to rail freight capacity improvements.[29]

Air Quality

On average, the railroads are three times more fuel efficient than trucks on a ton-mile basis. Thus, improvements in air quality are frequently reported as a public benefit when investments in rail infrastructure lead to a diversion of truck freight. This single measure is the only requirement for allocating CMAQ funding to rail projects (see Section 2.3). Determining the saving attributable to lower truck VMT can be accomplished through software tools, such as MOBILE6 described below. Establishing the net air quality savings is more difficult because there is no comparable product for projecting increased emissions from increased locomotive usage. This is usually accomplished through either approximate estimates derived from tables of average locomotive emission rates, applying the rough 3:1 ratio mentioned above, or ignoring the increases in locomotive use.

MOBILE6 was designed by the U.S. EPA to provide estimates of current and future emissions from highway motor vehicles.[30] The model calculates emission rates under various conditions (e.g., ambient temperatures, average traffic speeds) for 28 vehicle types. MOBILE models have been used by the EPA to evaluate highway mobile source control strategies; by states and local and regional planning agencies to develop emission inventories and control strategies for State Implementation Plans under the Clean Air Act; by MPOs and state transportation departments for transportation planning and conformity analysis; by academic and industry investigators conducting research and developing EISs; and, for determining CMAQ funding eligibility.

The latest in a series of MOBILE models dating back to 1978, MOBILE6 calculates average in-use fleet emission factors for:

---

[28] National Cooperative Highway Research Program Project 8-36, Task 22, Working Paper 2 *Environmental Benefits of Transportation Investment* (Cambridge Systematics, 2002) discusses how transportation investments lead to reduced air pollution, noise pollution, water pollution, light pollution, and can also provide improved wetlands protection, brownfields reclamation, and historical and ecological preservation benefits.

[29] A passenger and freight rail perspective can be found in Thomas G. Carpenter, *The Environmental Impact of Railways,* John Wiley & Sons, 1994.

[30] Adapted from *User's Guide to MOBILE6.1 and MOBILE6.2*, U.S. Environmental Protection Agency, EPA420-R-03-010, August 2003. Available at http://www.epa.gov/otaq/m6.htm.

- Three criteria pollutants: HC, CO, and NO_x;
- Gas, diesel, and natural-gas-fueled cars, trucks, buses, and motorcycles; and
- Calendar years between 1952 and 2050.

The descriptive and spreadsheet outputs from MOBILE6 report emission rates in grams or milligrams of pollutant per VMT (g/mi or mg/mi). Database output can be reported as g/mi or grams per vehicle per unit time (day or hour). The change in emission rates for a given vehicle category over time is due to fleet turnover, through which older vehicles built to less stringent emission standards are replaced by newer vehicles built to comply with more stringent standards. Emission rates from MOBILE can be combined with estimates of travel activity (total VMT), which also change over time, to develop highway vehicle emission inventories expressed in terms of tons per hour, day, month, season, or year. MOBILE6 also allows users to calculate and report emissions by roadway type, time of day, vehicle category, and other characteristics that allow for very detailed modeling of specific local situations.

As noted in the FRBL case study (Section 2.5), monetary benefits from air quality are difficult to estimate. The amount of pollutants avoided or the quantity non-rail alternatives would generate can be calculated, but it is difficult to establish the monetary damages done by them. One strategy is to assume that any increase in pollutants must be mitigated by removing equivalent amounts from the atmosphere by the cheapest practical means. However, if these costs are not currently being expended, it is difficult to argue that the reduction in emissions achieved by a rail freight scheme *avoids* further future need to do so at power plants and other polluter sites. Other methods use climate and health-impact models to estimate the economic damages done by a rapidly deteriorating environment.

Another problem with air quality modeling is that some of the air quality benefits are global (such as concerning the greenhouse effect), while others are very local in nature (e.g., PM and NO_x). The current air quality and environmental quality models do not generally address dispersion issues and the life-cycle pollution footprint of the technology. Railroad electrification programs may have the effect of removing diesel smoke from urban areas but may create increased electricity demands and pollution from power plants, or generate incremental nuclear waste. Similarly, conversion of trucks or locomotives to hydrogen fuel or natural gas will have environmental benefits as well as costs. Much research has been done in these areas by environmental scientists.[31]

Noise Levels

Noise analyses range from basic screening tools to complicated, computerized noise-modeling techniques. Noise is usually defined as any unwanted sound. In terms of freight rail capacity upgrades, what generally matters is the aggravation that noises associated with increased train density may cause neighboring residents versus noise reductions due to

[31] For example, see *Vehicles of Change*, Scientific American, October 2002.

fewer trucks on the roadways. Also, because railroads tend to pass through impoverished neighborhoods, economic justice is sometimes a concern.

People have varying tolerances for and perceptions of noise; sound level and pitch are basic physical factors, but perception adds a psychological component making quantitative analyses somewhat difficult.

The main sources of noise to consider in railroad operations are rolling noise (wheel/rail interaction), traction noise (engines and fans), aerodynamic noise, and whistle noise. Some advanced noise models have the capability to categorize vehicles, and methods for separating the contributions from wheels and track and traction noise. A list of currently available noise models is given here:

- **RWNM 3.1:** This noise model, termed RailWay Noise Model (RWNM) is developed by the University of Central Florida (UCF) Community Noise Lab.[32]
- **Noise Mapping Techniques:** The advent of high-powered GIS-based databases has accelerated the sophistication of noise mapping. Some of the noise mapping software, when properly calibrated, has predictive capabilities.
- FRA has a Train Noise Model and a Horn Noise Model used typically in noise complaints relating to grade crossings in urban areas and rural townships.
- **Harmonoise/IMAGINE:** Harmonoise is the current state-of-the-practice model used in Europe for transportation noise calculations. The IMAGINE project is developing new calculation methods for railway, road, industrial, and aircraft noise. IMAGINE will also provide guidelines on how to use these methods for noise mapping and noise action plans in Europe.[33]
- **TNMLook:** A noise level look-up table developed by the FHWA as a screening tool.
- **STAMINA 2.0:** A highway noise prediction model.
- **OPTIMA:** A noise-barrier design program.

These noise models do not output a dollar value that can be directly used in a benefit-cost evaluation methodology. A noise model will provide an idea of how much energy is dissipated as noise and in which part of the sound spectrum, but it may not predict a neighborhood's reaction to it, and certainly would not be able to put a dollar value or

[32] It is available from http://www-cee.engr.ucf.edu/labs/noise/softdev.htm.

[33] See http://www.imagine-project.org/ for more details. Project IMAGINE is led by AEA Technologies in Derby, England (formerly BR Research), and "Harmonoise" is the name of the noise model.

"cost" on the economic externality. Thus, any change in noise due to freight rail infrastructure upgrades are typically treated as a qualitative impact.[34]

Visual Quality

Visual quality can be difficult to assess. Transportation facilities often generate visual impacts in proportion with their sizes, thus freight rail capacity enhancements that consist solely of mainline re-signaling do not typically generate adverse visual impacts; however, expansion of yard capacity or grade-separation projects can have substantial visual impacts. On the other hand, when designed sensitively with respect to local aspirations, the visual impacts of rail freight projects can be minimized.

Freight rail projects also can have positive visual impacts by freeing up land at strategic locations for redevelopment into something more visually satisfying, or by avoiding future investment in truck facilities that also generate adverse visual impacts. Sometimes the benefit of moving visually obtrusive facilities to a different (rail-served) location where it is out of sight can strengthen the case for a rail-served distribution center. Another approach mitigating the visual impact of transportation is to improve facility utilization. Capacity upgrades to allow higher utilization of existing infrastructure instead of constructing new infrastructure is an ideal way to reduce the visual impact while attaining other benefits. Improved asset utilization may eventually allow facilities to downsize and reduce their footprints, although any decision to downsize must be made with the utmost care as not to exclude future expansion options.

In the Chicago CREATE project (Section 2.2), rationalization of rail corridors within the City, and sale of surplus land, will enhance the visual quality of the former rail-yard brownfield sites after redevelopment. This aspect of benefits is usually assessed qualitatively, with local surveys and focus groups; when a dollar value is required, economic modeling or regression analysis of impacts to real estate values should be considered.[35]

Land Use Patterns and Community Impacts

It is important to realize that the impacts of freight rail capacity and related infrastructure investments can be broad and immense. Some programs appear like urban renewal and revitalization projects, but also provide grade separation and sorely needed rail freight capacity to support economic and industrial growth. Others seem like straightforward

---

[34] Methodologies to evaluate the socioeconomic impacts of transportation noise are extensively discussed in National Cooperative Highway Research Program Report 456, Section 9 in a highway context. Most of the methods discussed are applicable to railroad noise provided one of the rail noise models is used instead of a highway noise model.

[35] A discussion of this methodology appears in Chapter 11 of National Cooperative Highway Research Program Report 456, *Guidebook for Assessing Social and Economic Impacts of Transportation Projects*.

realignments or by-passes of constraining and slow-running trackage in the downtown core but in fact provide substantial benefits in urban regeneration by allowing vacated brownfields to be redeveloped. These transportation-land use links are fundamental and must be recognized by promoters of rail freight capacity enhancement schemes. Simply moving more trains per hour is too narrow an objective, and measures of benefits of rail operations alone are insufficient.

Land Use

Effective land use planning can have a tremendous impact on regional economic and social development. A common argument for development of new transportation infrastructure is that it will lead to new business attraction and expansion opportunities. The literature on industrial site location commonly cites transportation infrastructure and access to markets as key determinants of business location. Most transportation-based analysis methods, however, are not designed to evaluate the business attraction potential attributable to highway or railroad investments.[36]

To evaluate such benefits, a scenario analysis is required. One land use strategy might be to concentrate industries on a single strip served by a high-capacity freight rail facility; another might be to disperse industries throughout the area and rely entirely on trucks for transportation service. If there is an existing strategy, the capacity enhancement must be assessed in light of how it might contribute or detract from the current land use plan. In some cases, regional economic modeling tools could be used to simulate and forecast the effect of choosing one scenario or another. In areas not already substantially developed, the choice in strategy may be a matter of opinion and may depend on having a strong local vision and effective leadership, rendering rigorous analysis unnecessary or even undesirable.

It is important to appreciate that land use strategy choices will have long-term impacts. When a land use strategy is already chosen or evolved, reinforcement of that strategy may be seen as a benefit of the investment; on the other hand, for metropolitan areas wishing to change development patterns, the infrastructure investment may be an important catalyst. In those cases, the benefit of the investment can be assessed in terms of "how much would it cost to achieve the land-use program goals *if* the freight rail investment were not in place?" Alternative methods of achieving program goals may involve zoning solutions, land-banking and hoarding, and other investments. Sometimes, the freight rail investment can generate benefits in terms of "future investment costs avoided."

A land use strategy also can have important implications for economic efficiency, environmental enhancement, quality of life, and future infrastructure costs. This is sometimes characterized as "smart growth" versus unrestricted development. Although some of the

[36] Some formal methodologies for evaluating the land use impact of transportation are discussed in National Cooperative Highway Research Program Report 423A: *Land Use Impacts of Transportation: A Guidebook*.

benefits are difficult to quantify, and may not be directly attributable to a freight rail capacity expansion scheme, these benefits should still be assessed in some manner.

An effort at modeling the land use impacts of highway construction was conducted as part of the North Country Transportation Study (NCTS) in New York State.[37] Local interviews and surveys, state business attraction and retention trend analysis, and a specially designed business attraction model were used to quantify the impacts of transportation investment on this economically declining region. The business attraction model utilized available data on industry employment and trends, competitive costs for labor and utilities, industry-specific transportation usage, and accessibility impacts to generate business attraction estimates by industry and transportation corridor.

Community Cohesion

Some discussion of the social and community benefits of transportation investment appear in prior NCHRP reports, although they are more focused on highway and passenger transportation.[38] Here a brief discussion of how these benefits relate to freight rail capacity programs is presented.

The term "community cohesion" is used to describe patterns of social networking within a community. The effects of large-scale infrastructure projects on community cohesion "may be beneficial or adverse, and may include splitting neighborhoods, isolating a portion of a neighborhood or an ethnic group, generating new development, changing property values, or separating residents from community facilities..."[39] Displacement of businesses and residences resulting from a transportation project is an important related effect.[40]

It is well documented that high-capacity transportation facilities can adversely affect community cohesion. In general, these issues relate mostly to the existence of infrastructure, but also to an extent their operations. A new grade-separated highway-rail interchange might greatly enhance safety, but could adversely affect a formerly cohesive small town by bifurcating neighborhoods. A town may have to tradeoff economic development

---

[37] Hodge, Daniel J., Glen Weisbrod, and Arno Hart, "Do New Highways Attract Businesses?," *Transportation Research Record* 1839, Paper No. 03-4148.

[38] National Cooperative Highway Research Program Project 8-36, Task 22, Working Paper 3 *Community and Social Benefits of Transportation Investment* (Cambridge Systematics, 2002); National Cooperative Highway Research Program Report 456, *Guidebook for Assessing Social and Economic Impacts of Transportation Projects*.

[39] Federal Highway Administration, *Guidance for Preparing and Processing Environmental and Section 4(F) Documents*, Technical Advisory T 6640.8A (October 30), Washington, D.C., U.S. Department of Transportation, 1987.

[40] For more details on community cohesion and related issues, see National Cooperative Highway Research Program Report 456, *Guidebook for Assessing Social and Economic Impacts of Transportation Projects*.

potential against rail traffic impacts when deciding whether to allow rail capacity upgrades. Planning professionals should be aware of the adverse impacts transportation facilities can have on local communities, and design freight rail schemes with these externalities in mind.

There isn't a generally accepted model or method of quantifying community cohesion or the benefits arising from better community interaction due to infrastructure investment. This aspect of (external) benefits of investment is thus usually treated qualitatively; however, it remains an important part of any analysis.

A possible approach for quantifying community cohesion is through the value of real estate and business and residential migration patterns, some of which can be assessed quantitatively with demand models for land and building space. Many anecdotal examples have been noted where "urban flight" has occurred after poorly planned transportation projects, with observed devaluation of real estate. These effects should not be ignored as costs or benefits simply because they may be difficult to measure.

Safety Impacts

It is often possible to use a quick risk assessment methodology, based on historical accident statistics, to evaluate the safety impact of rail capacity improvements. Increased train densities will often cause increased grade-crossing accident risk, especially at crossings that have historically seen very few trains. In some cases, the diversion impact from trucks will offset this risk by lowering truck volumes and any corresponding highway accidents. In other cases, increased risks resulting from higher train densities will be offset by decreased risks elsewhere on the rail system through rail-rail diversion. In cases where a crossing risk becomes unacceptably high because of rerouting decisions, grade separation or other barrier methods should be considered as part of the capacity enhancement scheme.[41]

Changes in traffic control technology on rail lines may affect safety. Such risks are often assessed by simulating the expected traffic patterns using one of the rail operations models described above, and then performing a risk assessment. Although models exist, they tend to be specialized and require calibration for use in a given case. Risk assessment

---

[41] For example discussion on risk management methods in rail operations, see C.D. Martland, Y. Zhu, Y. Lahrech, and J.M. Sussman, "Risk And Train Control: A Framework for Analysis," *Transportation Research Record*, issue 1742 [2001], pp. 25-33. See also A.I. Barnett, C.D. Martland, A.R. Odoni, and J.M. Sussman, "Efficacy of Safety-Related Investments to Reduce Fatalities on the East Japan Railway," *Transportation Research Record* 1691, National Academies of Sciences, Washington, D.C. (1999).

methodologies are described in Report GE/GN8561, Guidance on the Preparation of Risk Assessments within Railway Safety Cases.[42]

Risk assessment methodologies in general assume the probability of an accident at a crossing is directly proportional to the number of trains and roadway vehicles using the crossing per day. More sophisticated models may incorporate such elements as time-based biasing, type-of-crossing effects, train-speed effects, and length-of-train effects. Sometimes, especially at low-risk or low-volume crossings, accident statistics from many crossings of the same type in a wider geographical area will be aggregated. For more complex schemes, such as signaling upgrades, consideration of train-train collisions and hazardous cargo spillages will be required.

Average annual accident rate should be calculated from as much data as possible, preferably using highway-rail accident reports since the date of the last significant engineering work on the crossing that changed its geometry or type of protection.[43] Grade-separated crossings are not accident free, though, as an occasional vehicle may run off the bridge if the grade separation has poor geometry.

Safety improvements on highways related to reductions in heavy trucks is well studied and imbedded into several software packages, such as HERS (see Section 3.2, Transportation Impact Methods). These methods often assume a linear relationship between truck accident rates and truck VMT.

One final safety-related topic is routing of hazardous materials. Software routing packages are available that establish routes minimizing societal risks by reducing the probability of an incident (avoiding routes that traverse historically high-accident/incident areas) and minimizing population exposure. This raises the question of who should bare the costs associated with routing shipments over anything other than the minimum cost route?[44]

---

[42] Although the document was aimed at the former British Rail companies and issued by Rail Safety Ltd., the risk assessment methodologies described therein are applicable to railroads in the United States. It serves as a good primer of risk assessment concepts in a railroad environment, especially Section B6 "What is a safety risk assessment?" This document is available on the Internet from http://www.rgsonline.co.uk/docushare/dsweb/Get/Rail-5110/Gn8521.pdf.

[43] The Federal Railroad Administration maintains extensive rail accident and incident statistics available free of charge at http://safetydata.fra.dot.gov/officeofsafety/.

[44] Glickman, T. S., E. Erkut, "What Price Safety? The Tradeoffs Associated with Responsible Routing of Tank Cars," *The Newsletter of the Rail Applications Special Interest Group, The Institute for Operations Research and the Management Sciences*, Volume 3, Number 1, Spring 1996.

Security Impacts

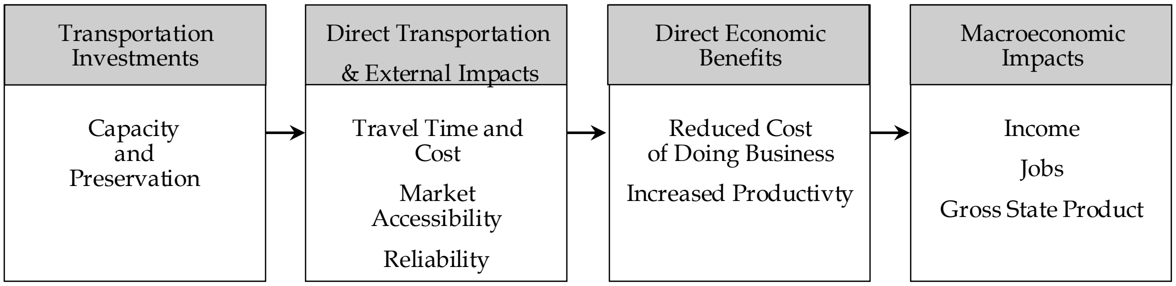
Rail and highway transport clearly present different security risk exposures. However, the extent of these risks is not well understood. In general, moving from highway to rail will change the risk profile for a shipment. Rail operations, by design, occur in a loosely supervised environment where ensuring cargo accountability is more difficult; in instances where direct rail service is not available, transloading will be required, which is inherently less secure than a single truck movement. However, trucks are more mobile, and it is far easier to disrupt truck operations than train operations. Hijacking a train is practically impossible, whereas it is much more feasible to intercept truck shipments. Railcars also tend to carry far larger quantities, which make it easier to keep track of a block of cars versus multiple truck movements, but it also makes railcars (especially those carrying hazardous materials) more desirable targets. Thus, diversion to rail will change the security risk profile – creating different types of risks. It is not clear which mode will be more secure, but it is possible to mitigate the risks associated with both modes through staff training, advanced technology, and other security enhancements.

AASHTO's FRBL report suggested that: "a nationwide rail network connecting U.S. cities, states, and seaports provide a measure of system redundancy that affords needed insurance against the loss of highway capacity for both freight and passengers. Rail plays a critical emergency-related service role by providing efficient connections between military facilities. The U.S. armed forces depend on rail as a critical element in the logistics chain." Clearly, strategic security benefits are afforded by a rail system with high available capacity and free of bottlenecks. However, it is very difficult to quantitatively assess these benefits and security impacts should be seen as a bi-product of freight rail capacity investment, and not a concrete benefit gained that can be assessed as part of a benefit-cost framework.

■ 3.4 Economic Impact Methods

Estimating the economic impacts of transportation investments typically follows the flow of concepts depicted in Figure 3.7. The previous sections focused on estimating the direct transportation and externality impacts of investment on freight rail capacity. This section concentrates on estimates of direct economic benefits to industries and the broader societal macroeconomic impacts of jobs, income, and gross state (or domestic) product.

Figure 3.7 Economic Impact Analysis Framework



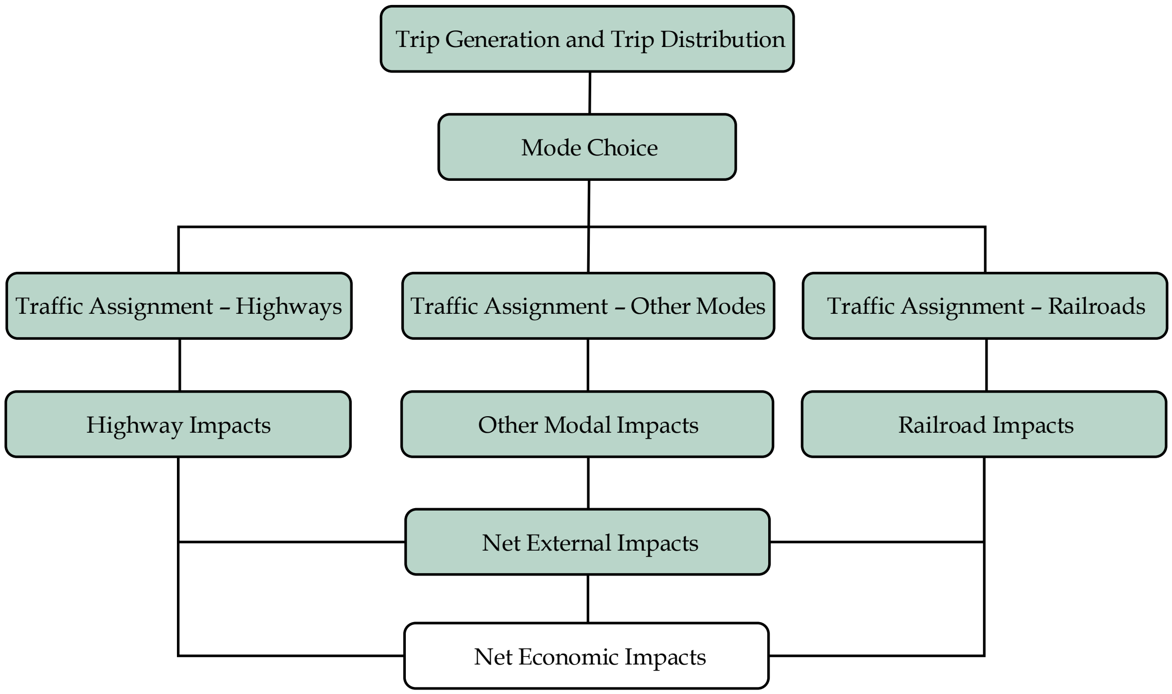
Macroeconomic models are generally simulation models with economic forecasts that predict industry growth based on demographic trends (birth, death, and migration), differences in industry costs among regions (both materials and labor, demand and supply), and exogenous factors (such as international trade). Forecasts for regional economies are typically derived from a combination of a national economic forecast drivers (e.g., Bureau of Labor Statistics (BLS) provides long-run industry forecasts) and regional competitive strengths and weaknesses. Baseline economic forecasts are especially important for transportation analyses because the construction of and benefits from transportation investments are expected to occur over a number of years. Macroeconomic models are more sophisticated than a simple trend evaluation as they attempt to simulate the effect of cost differentials over time rather than simply assuming that short-term growth in a region or sector will continue at the same pace.[45] Figure 3.8 shows how economic impact methods work with the other methods.

The types of economic methodologies reviewed in this section include:

- Direct Economic Benefits;
- I/O Models;
- Regional Economic Simulation Models; and
- Multiple Regression and Econometric Models.

[45] A good general reference is National Cooperative Highway Research Program Project 8-36, Task 22, Working Paper 1: *Economic Benefits of Transportation Investment,* Cambridge Systematics, 2002.

Figure 3.8 Economic Impact Methods



Direct Economic Benefits

Although there are many ways to capture the direct economic benefits of investments in freight rail capacity, this discussion highlights a few methodologies and issues. First, because benefits such as travel time or cost savings are often estimated at the network level, it's necessary to assign benefits to geographic regions. Rather than allocating benefits based on where a travel improvement occurs, standard economic practice uses estimates of the O-D pattern of the affected trips. This methodology ensures that the benefits are allocated to the shippers and receivers of goods. Though some studies may concentrate the benefits on either the shipper or receiver, a lack of definite research on this subject often leads to the simplifying assumption that 50 percent of the benefit should be allocated to the shipping region and 50 percent to the receiving region. O-D data for goods movement are most commonly found from commercial or public data sources, or by other methods as described in Section 3.1, Travel Demand Methods.

Second, converting transportation impacts (e.g., travel time savings, modal diversion) into monetary economic impacts is a crucial step for accurate economic analysis. Traditionally, especially for highway analysis, factors to convert travel time savings, operating costs, and accident reductions into monetary terms have been imbedded within hybrid models like HERS, STEAM, and IDAS. While these are very useful, they have deficiencies when applied to freight rail investment analyses. In particular, they do not account for the actual goods being shipped (no variation by commodity) or the benefit to the shippers and receivers of freight.[46] Instead, they are more focused on carrier costs. Also, traditional user benefit models lack information directly relevant to freight rail such as the differential in freight shipping costs by rail and trucks. The AASHTO FRBL report results are largely based on this type of analysis (see Section 2.5).

Finally, another key aspect of determining direct economic effects is allocating benefits to industries. There are two basic approaches commonly used to link transportation benefits to industries. The first method relies on commodity data of the affected trips and links commodities to the industries that ship and receive those goods. This is a sound approach if detailed commodity flow data were available, but it does present some challenges. Though it is safe to assume that a shipment of lumber originates from a lumber or wood product-related industry, it is more difficult to estimate the receiver of the goods. Is it the construction industry, a furniture manufacturer, a wholesaler, or a retailer? How does this vary by mode? With sound economic analysis using I/O tables to determine industry demand, reasonable estimates can be developed.

A simple approach is to use the Transportation Satellite Accounts (TSAs) data, developed jointly by the BTS and BEA. These data provide coefficients of industry average transportation needs – how much trucking, rail, water, or air transportation does each industry use in its production process to produce $1.00 worth of goods or services? When combined with industry output data by region (to factor in the size of each industry), estimates of likely transportation benefits by industry can be derived. The TSAs are especially useful for studies with truck-related impacts because they capture the share of trucking that is conducted by for-hire trucking services versus in-house fleets of trucks.

Input/Output Models

I/O models capture the interindustry linkages of a regional economy and estimate economic multipliers. Standard economic multipliers estimate two kinds of secondary impacts from direct changes to an economy, namely indirect and induced, both of which manifest themselves in the medium term. Direct changes to an economy are usually represented by employment, sales, or purchases (spending) due to changes in demand, supply, or investment (for instance, business attraction or expansion, change in tourism). In the case of a transportation capital investment, direct regional impacts exist in the form of employment and wages in construction and related firms. These are short-term impacts. Longer-term direct benefits are captured by businesses that realize cost savings from the transportation improvement. Indirect impacts result from the intermediate purchases necessary to operate a business. To the extent that local firms buy from local suppliers, then the indirect impact will be larger. Induced effects stem from the re-spending of

[46] A good reference for how transportation costs are experienced by shippers and receivers and how this varies by commodity is covered in Weisbrod, G., *Issues in Assigning an Appropriate Value of Time*, Working Paper 03–04, Economic Development Research Group (September 2003).

wages in the local area earned by workers affected by the direct and indirect activity. In other words, if a new firm were attracted to the local area, the employees of that firm will spend some proportion of their earnings at local shops, restaurants, etc.

I/O models will not forecast how jobs will be created directly or retained by a transportation improvement; rather, with some expectations on the number of jobs retained or created, I/O models will estimate associated indirect and induced effects. The projections of anticipated jobs created or retained can be the product of some other analysis approach such as interviews with local businesses and economic development experts.

Often, decision-makers anticipate that large transportation projects or new policies or programs will trigger long-term changes in the competitive strength of the affected region vis-à-vis the rest of the state or the rest of country. Transportation is expected to play a catalytic role in reorganizing the production and distribution systems and changing prevalent technology use.[47] It is beyond I/O models to capture such long-term effects with substitutability among production factors because they assume a constant level of technology. On the contrary, regional simulation models discussed later in this section are better suited to portray technology changes in regional or metropolitan contexts.

The most commonly used I/O models are IMPLAN and RIMS II. (The REMI model is sometimes termed a dynamic I/O model but has enough additional functionality not to be considered a straight I/O model. It is fully discussed in a later section on economic simulation models.) The IMPLAN model is privately produced by Minnesota IMPLAN Group, Inc., and can be applied to any county or group of counties in the country.[48] The RIMS II model is produced by the BEA with geographic specificity down to the county level.[49] Both models are reasonably priced ($200 to $600) and fairly easy to use. The RIMS II model simply produces multipliers by industry, while IMPLAN allows a bit more flexibility and provides direct calculations of total employment, output, and income impacts. The TELUS model (Transportation, Economic, Land Use System) also has an I/O model imbedded within it and is profiled below in the subsection on integrated land use models.

---

[47] J.D. Kasarda discusses this theme more thoroughly in "Transportation Infrastructure for Competitive Success," *Transportation Quarterly*, 50, 35-50, 1996.

[48] Further information about the IMPLAN model can be obtained through their web site at http://www.implan.com/.

[49] RIMS II information can be obtained at http://www.bea.doc.gov/bea/regional/rims.

Economic Multiplier Approach	
Inputs/Data Requirements	Direct business attraction/retention employment or sales data; changes to tourism patterns; construction spending
Software	IMPLAN and RIMS II (cost effective); REMI (relatively sophisticated/ expensive)
Output	Short- and medium-term direct, indirect, and induced economic impacts in terms of employment, output, income

I/O models are one of the more frequently used approaches for assessing economic impacts of transportation policy decisions. This methodology traces its roots to research sponsored by the NCHRP in the early 1980s.[50] It applies equally to all modes of transportation as well as to multimodal situations. It can assist in evaluating the economic merit of the whole spectrum of decisions made by transportation decision-makers, from policies and regulations affecting the operation of the transportation system, to individual transportation improvement projects of local significance during the TIP process and all the situations in between.

The economic multiplier approach is most applicable to transportation projects that directly impact business attraction/expansion/retention, or tourism. Examples include new rail sidings that could be catalysts for industrial recruitment or retention. In addition, economic multiplier approaches can be used to analyze the expected impacts from the construction of transportation facilities or the purchase of transportation equipment. However, it should be cautioned that use of economic multiplier tools will only produce the effects of spending, regardless of on what the dollars are spent. In other words, it is not a matter of in the nature of the investment; transportation or any other investment, economic multiplier tools typically produce commensurate impacts.

Regional Economic Simulation Models

Many areas have used commercially produced economic simulation models to analyze the expected economic impacts of transportation investments. Perhaps the most widely used economic simulation model for transportation work is the REMI dynamic I/O model.[51] There are two primary reasons why this model is often a preferred choice: First, while it has an I/O component to capture interindustry linkages, it is also a dynamic model,

[50] *State Input-Output Models for Transportation Impact Analysis*, by Benjamin H. Stevens, George I. Treyz, David J. Ehrlich, and James R. Bower, Discussion Paper No. 128, Regional Science Research Institute, Amherst, Massachusetts, 1981.

[51] Information about Regional Economic Models, Inc.'s model can be obtained through their web site at http://www.remi.com.

meaning that it estimates impacts over time. Second, unlike many I/O models, it readily handles impacts typical of transportation investments, such as changes to industry production costs and productivity, as well as direct job and sales impacts. Another key aspect of the REMI model is its sensitivity to factors such as population migration, effects of business operating costs on the location of industry, detailed changes in wages by occupation, business mix shifts, technological changes, and allowance for substitution between capital, labor, and fuel. A REMI model was used in the CREATE, MAROps, and New York Cross Harbor case studies.

Similar to the REMI model, the Economic Development Research Group has developed a model called the Transportation Economic Development Impact System (TREDIS). Unlike REMI, it's currently limited to single-corridor or single-region applications, but similar to REMI, it can estimate the full economic effects of transportation cost changes. In addition, it incorporates a module called the Local Economic Assessment Package (LEAP) that estimates potential business attraction effects from accessibility improvements.[52]

Like I/O models, the REMI simulation model applies equally to all modes of transportation as well as to multimodal situations. It can assist in evaluating the economic merit of the whole spectrum of decisions made by transportation decision-makers, from policies and regulations affecting the operation of transportation systems, to individual transportation improvement projects of local significance during the TIP process and all the situations in between. The REMI model is preferred over I/O modeling for long-range planning due to its dynamic nature and ability to account for productivity changes that may develop as a result of transportation decisions over a 20- to 30-year planning horizon.

A common approach for calculating the economic impacts of transportation investments is to use an economic simulation model in combination with a travel demand model. For given projects, the travel model calculates changes in travel costs. These time savings are translated into user benefits (in dollar terms) based on values of time and shipping costs, and are further translated into production cost savings and productivity enhancing benefits to enter into an economic simulation model, such as REMI. The REMI model then calculates the direct, indirect, and induced effects in terms of employment, income, population, and many other variables. If a transportation investment is likely to generate net business attraction/expansion impacts or tourism impacts, those can also be exogenously estimated and input into REMI.

REMI has recently developed a transportation-specific version of its model called TranSight. It links travel model output to REMI inputs, based on changes in VHT, VMT, emissions, etc., to estimate total economic impacts on gross state product (GSP), employment, income, and other economic and demographic measures. TranSight takes

[52] For more information, contact Economic Development Research Group at http://www.edrgroup.com.

advantage of economic geography principles within REMI and is partially-based on research from an NCHRP project on the economic impacts of congestion.[53]

The economic effects of transportation construction spending are considered to be short-term, temporary impacts. In addition, it is likely that spending an equal number of dollars on another project (transportation or otherwise) would produce similar economic results. Similarly, Federal dollars used for a local project could have gone elsewhere. This investment represents additional spending in the local area and creates economic impacts that would not have occurred there otherwise. However, additional spending (or economic benefits) at the national level is not addressed.

Economic Simulation Model	
Inputs/Data Requirements	Project-specific user benefits (travel time savings, etc.) and cost savings; business attraction impacts; tourism impacts; construction spending
Software	REMI, TREDIS, or other model specifically developed for a region
Output	Aggregate short-term and long-term economic impacts in terms of employment, output, income, population, etc.

Multiple Regression and Econometric Models

Multiple regression models are a frequently-used statistical tool to infer causal relationships between a dependent variable, such as employment, land values, or building square footage, and various explanatory variables, including the existence of a transit investment or a new highway improvement. Regression models can be considered a sketch-planning tool because they ‘‘sketch’’ out a statistical relationship between transportation infrastructure and economic activity using local and non-local data. The elasticities (or impact factors or coefficients) can then be applied to estimate the expected future impact of highways and transit investments on growth in the region.[54]

There are two common approaches to incorporating econometric techniques into the economic analysis of transportation. First, historical time series data sets filled with transportation investment, public infrastructure levels, and economic data are used to determine the historical contribution of transportation to economic growth (often measured by productivity). Second, hedonic pricing models (a form of multiple regression) are

---

[53] Weisbrod, Glen, and George Treyz, *Economic Implications of Congestion*, National Cooperative Highway Research Program Report 463, 2001.

[54] Regression and econometric models are typically developed by trained statisticians, but their techniques are common enough in the transportation field that it is worth some familiarity with this analysis tool.

used to determine the property value impacts of transportation investments, most notably for transit.

The first approach is typically performed at the macroeconomic level (national and sometimes state) so it is less relevant for regional analysis. A common analytical approach uses variables such as the growth in labor and private capital in comparison to total economic growth to determine the share of growth attributed to productivity enhancements. Further statistical refinements determine transportation's share of productivity growth.[55] Regression estimates of the contribution of transportation investments to economic growth can then be extrapolated and applied to approximate the effect of future investments.

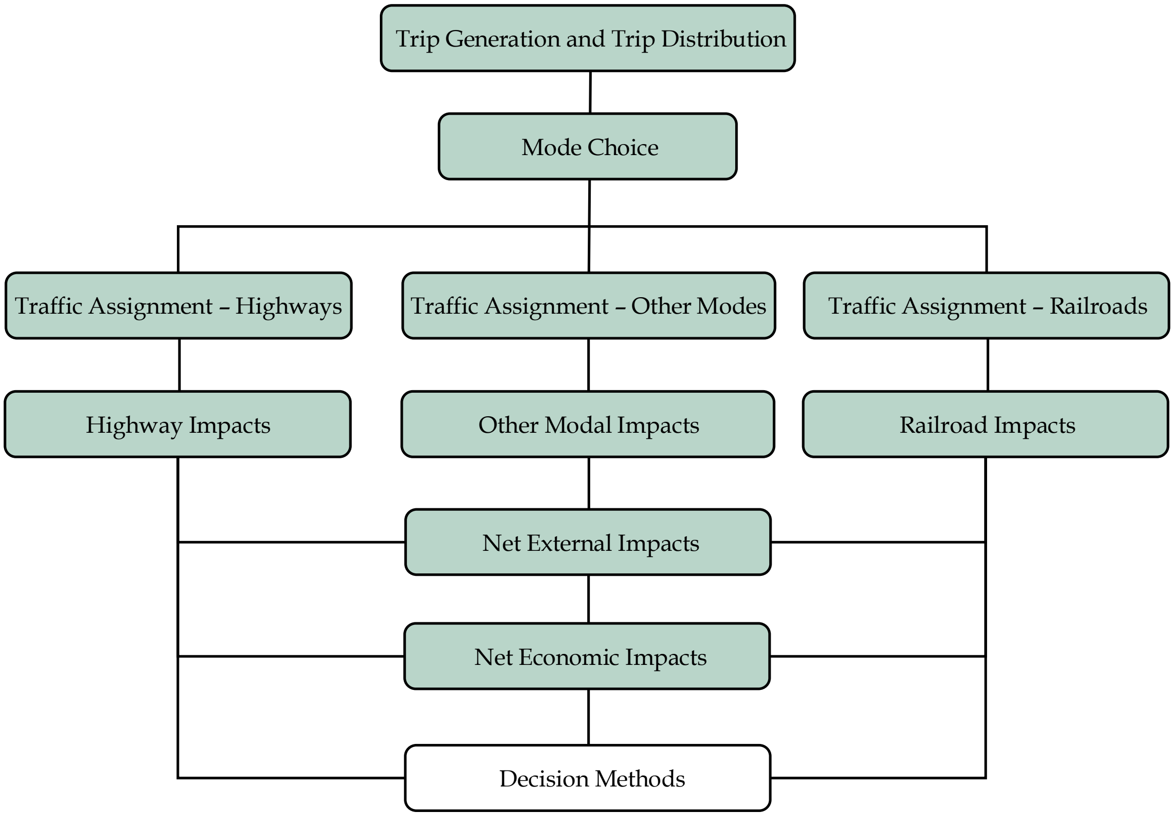
3.5 Decision Methods

Once benefits have been identified, and where possible quantified, it is necessary to convert this information into investment decisions. While there is an element of subjectivity in this process, it is best to establish a defensible, repeatable decision procedure where possible. In many cases, this is required by the funding source, as is often the case of state or Federal funds with CMAQ being a prime example. In Figure 3.9, the Decision Method forms the final step in the framework used throughout this chapter.

In general, an alternatives analysis is the best method for evaluating large-scale projects, with the smaller elements within the alternative being justified individually using a financial methodology (e.g., benefit-cost ratio or internal rate of return or IRR). A capital plan then offers a good framework to deliver the vision created during the alternatives analysis planning process. These topics are addressed below.

[55] A recent study that used this general approach was *The Economic Impact of Maryland Highway Investment* study, prepared for the Maryland State Highway Administration by RESI Research and Consulting at Towson University, Towson, Maryland, November 1998.

Figure 3.9 Decision Methods



Alternatives Analysis Method/Environmental Impact Statement

The Alternatives Analysis framework was first developed as a response to the Massachusetts Environmental Policy Act of 1967 (later extended at the Federal level as the National Environmental Policy Act (NEPA) of 1969), which required government agencies to study the environmental consequences of their actions. It also requires them to take all feasible measures to avoid, minimize, and mitigate damage to the environment – by studying alternatives to the proposed project, and developing enforceable mitigation commitments.[56] The same act required the publication of an Environmental Impact Report (EIR) or EIS and solicitation of public comments concerning the project.

It is a framework under which the benefits and costs of a project are evaluated, and an opportunity is offered to advocates and stakeholders, who may bear some of the cost of

[56] Massachusetts Environmental Policy Act Office, http://www.mass.gov/envir/mepa/.

externalities, to be consulted.[57] This often leads to a substantial improvement in the project as externalities are mitigated by design changes that produce an acceptable outcome for stakeholders. The initial designer necessarily has a goal in mind that may not produce the optimal outcome for everyone involved; EIS processes that are well executed can often influence the public's perception favorably, and build political support for the project. Although this process may increase the monetary cost of the project, it also has the potential to turn many negative externalities into positive benefits. Especially when public funding is involved, this is a critical step to ensuring the project's success. "Political goodwill" may in turn translate into concrete benefits for the facility operator, in the long run.

Some practitioners in the industry feel that alternatives analysis is not much of an evaluation process – instead it is part of the design and implementation process started after a desktop evaluation has determined the project's benefits exceed costs. This is not correct, for a number of reasons:

1. Although operational benefits and other direct transportation benefits could be studied using models and methods, many intangible and quality of life benefits mentioned in Section 3.2 have proved difficult to calculate in a desktop exercise. In some freight rail capacity improvement schemes, these qualitative benefits could be substantial and are ultimately used to justify government funding.

2. Political support is the best evaluation for many projects, provided constituents are making well-informed decisions. If all involved agree the proposed infrastructure investment is a great idea, then the investment must be a great idea and requires no further evaluation!

3. Intangible benefits depend to an extent on perception and acceptance, therefore outreach exercises (within the community, and with operating staff) is a required part of the evaluation process. Many methods to evaluate intangibles involve estimating real estate economic impacts, which in turn is strongly tied to public perception and attitude. An appropriate outreach process may well influence these values and increase beneficial impacts while decreasing the "disutility" felt by the losers.

Alternatives analysis is better described as a framework rather than a method. It may incorporate any of the financial evaluations listed in the section below – or rarely it may result in agreement amongst stakeholders that the qualitative benefits are so immense that the project can move forward without formal analysis of quantifiable benefits.

---

[57] Standard urban planning textbooks discuss this methodology and surrounding issues in great detail, as well as some of the process requirements. For example, see Meyer, Michael, and Eric Miller, *Urban Transportation Planning, 2nd Edition* (McGraw-Hill, 2000); Gakenheimer, Ralph, *Transportation as Response to Controversy* (MIT Press, 1976); Jay M. Stein, *Classic Readings in Urban Planning* (APA Planners Press, 2004); and Peter Hall, *Urban and Regional Planning, 4th Edition* (Routledge, 2002).

Benefit and Cost Allocation/Shared Asset Methods

When evaluating benefits or planning a capital investment program based on shared capital contributions from many stakeholders (Federal and local government, private operators and landowners), especially in a public-private partnership framework, it is important to define not only *what* are the benefits and *how big* are the benefits, but also *to whom* they accrue. Successful programs are drawn up in such a way that benefits accrued are consummate with costs incurred and capital contributed. For freight capacity improvements, Chicago's CREATE scheme and California's Alameda Corridor both employed this type of methodology to distribute the benefits. More importantly, where passenger and freight traffic employ one shared corridor, there needs to be some way of sharing the benefits and burdens equitably and ensuring reasonable capacity sharing after construction.

For external economic benefits, it is usually quite clear to whom benefits accrue. Methods for evaluating externalities are presented in a prior section. Where local landowners or developers are contributing to the cost of freight rail capacity enhancement, this is usually a matter of negotiation between the carrier and the developer, and determined by willingness to pay rather than allocation based on benefit derived. Fair sharing is often critical where capacity must be shared between freight and passenger trains, which have different systems requirements and capacity utilization patterns.

Failure to agree how to share new capacity can lead to a situation where the anticipated benefits are not realized even after construction is completed. Higher capacity in itself is not a benefit; the benefit is realized when delay is reduced. When evaluating benefits, potential conflicts must be taken into account. Realizable benefits can depend on infrastructure control; if dispatching control were assigned to a single party, it is likely that party will achieve greater delay-reduction benefit than others in the coalition.

Rail capacity models (discussed in a prior section) have in the past been used to resolve such conflicts. Additional analysis is often required, and common methods include:

- An approach that allocates benefits based on usage (actual capacity consumed by planned operations) – but this approach does not take into account of "spare" capacity and benefits from delay recovery.

- Allocation based on maintenance burden (actual assets consumed by operations) – although attractive from a capital depreciation standpoint, in a highly constrained situation the value in the investment lies with "train slots," and not in the physical assets.

- Allocation based on asset control – generally a poor strategy, but is often used for the purposes of cost allocation.

Benefit-Cost Analysis Method

Benefit-cost analysis compares the present value of the benefits of an investment against the present value of the costs of a proposed investment.[58] There are two fundamental results from performing a benefit-cost analysis: 1) net present value (NPV); and 2) benefit-cost ratio.

The "Present Worth" of a project is commonly referred to as its NPV. The NPV of the project is obtained by summing the discounted benefits and costs for each year using a discount rate *i* = Minimum Acceptable Rate of Return (MARR). Discounted (or present value) costs are subtracted from benefits to produce the NPV. Discounting is conducted to compare benefits and costs, which typically occur over different timeframes, in the same context. Generally, projects that attain an NPV > 0 are worthy investments, with the benefits outweighing the costs over the life of the project.[59]

A benefit-cost ratio is estimated simply by dividing the present value of benefits by the present value of costs. A benefit-cost ratio greater than 1.0 is consistent with a project having a NPV > 0. A benefit-cost ratio of 1.0 represents the lowest value that should be considered for a transportation investment if no other non-monetary factors were considered, and if there were no uncertainty in the analysis. These conditions never exist in reality.

Discounting compensates for differences in the timing of costs (which tend to be front loaded during the construction period), and benefits (which tend to accumulate over time). A cost or benefit is more heavily discounted as it occurs further into the future, with the result that its equivalent present dollar value is reduced. Discounting thus reflects the time value of money – that is, a dollar in hand today has greater value than one received in five years, even after adjusting for inflation, because the dollar in hand can be invested.

The determination of discount rate is vital. A low discount rate favors very large projects with distant benefits; using very low discount rates will lead to ignoring current needs. Very high discount rates favor present needs and can prevent worthwhile and large-scale projects from being undertaken. The discount rate should be determined by considering the opportunity cost of capital; if public capital were being expended, the discount rate does not necessarily equal the low interest rate of government bonds: perhaps

---

[58] For an additional description, see *Economic Analysis Primer*, U.S. Department of Transportation, Federal Highway Administration, Office of Asset Management, August 2003.

[59] More information on engineering economics and life-cycle cost analyses can be found in Sullivan, Wicks, and Luxhoj *Engineering Economy*, Prentice Hall, 2002; Lee, Douglas, Fundamentals of Life Cycle Cost Analysis, in *Transportation Research Record* 1812, Paper No. 02-3121, National Academy Press, Washington, D.C., 2002; or Carl D. Martland, MIT OpenCourseWare *1.011 Project Evaluation Course Notes*, available at http://ocw.mit.edu/OcwWeb/Civil-and-Environmental-Engineering/1-011Project-EvaluationSpring2003/CourseHome/index.htm.

government capital can achieve a higher rate of return when invested in other projects. On the other hand, the involvement of private sector does not necessarily mean that the discount rate should be high. The public sector can provide loan guarantees to lower the discount rate required for analysis and enable large-scale projects to take place.

Generally, when a number of competing projects are being considered, the project with the largest NPV should be chosen as it represents the greatest net benefit. However, all projects having NPV of greater than zero are worthwhile, and should receive investment should funds be available. When considering mutually exclusive alternatives, the alternative with the highest NPV should be selected.

Benefit-cost analysis can be extended as a methodology to rank different projects, all of which may have NPV of greater than zero and therefore are theoretically worthwhile. In a capital-constrained situation, it is not possible to invest in every project with a positive NPV, and therefore a way to prioritize is required. The benefit-cost ratio is a measure of return on investment – "bang for the buck." For the same benefits, it is always better to invest in projects with smaller costs (higher benefit-cost ratio) than projects with larger costs, even though both projects may have a positive NPV and are therefore worthwhile.

Cost effectiveness is another term often used in relation to benefit-cost analysis. Technically, it has two similar but different definitions. First, cost effectiveness can be used when two or more alternative investments that will achieve a desired outcome are being compared, whereby benefits cannot be measured or differentiated. Therefore, cost effectiveness simply indicates that the lower cost alternative should be chosen. Second, cost-effectiveness measures are sometimes used in transportation to indicate how much benefit (in non-monetary terms) can be derived per dollar of investment. For example, the State of Iowa CMAQ case study (Section 2.3) compared projects based on dollars spent per kilogram reduction in air pollutants.

When using the benefit-cost method, perspectives are critical. To assess the economic benefits and costs of proposed freight rail infrastructure investments, the benefits and costs assessed must exclude all "transfers" of funds between stakeholders.[60] In other words, the evaluation of benefits and costs must be summed over all stakeholders – and the analyst must take a global, system-optimal view.

Internal Rate of Return

The IRR is the discount rate that makes the NPV of all cash flows equal zero. It is particularly useful for investments that require and produce a number of cash flows over time. Technically, IRR is a discount rate: the rate at which the present value of a series of investments is equal to the present value of the returns on those investments. As such, it

[60] This is an important issue and one often ignored by special interest groups seeking to justify projects that are not economically rational. The problem is discussed in detail in Gomez-Ibanez, Tye, and Small, *Essays in Transportation Economics and Policy*, Brookings Institute Press, 1999.

can be found not only for equal, periodic investments but also for any series of investments and returns. This makes IRR an attractive approach in the private sector. However, this method is problematic, as it assumes that all of the intermediate cash flows can be discounted/reinvested at the IRR. This is particularly unrealistic when the IRR is very high. This method is also sensitive to the sequencing and timing of investments and returns.

Capital Budget Model

Capital budget models are incorporated into decision-support systems to assist managers maximize the return on a series of investments. The concept is that an investment is expected to produce a return (cash, lower costs, public benefits, etc.). Investments are constrained by items such as: budget limits; project dependencies; and cash flow restrictions. With only a handful of investment decisions, a manager can easily select the combination expected to provide the highest return. Once the number of options grows to a few dozen (or several hundred as is often the case), it becomes exceedingly difficult to check every possible combination by hand. A capital budget model can evaluate every feasible combination to maximize the return on investment.

One of the primary users of capital budget models is the U.S. military. The military consumes a large portion of the U.S. annual budget and needs to insure that the money is spent effectively. In the early 1960s, Secretary of Defense Robert McNamara introduced a five-year budget procedure that relied on analytical justification. This procedure is still the basis for current defense budgets. The capital budget model has been used for everything from aircraft, to helicopters, to bombs, to space-based assets.[61]

Another application of a capital budget model is the Pontis® Bridge Management System.[62] Pontis is used by most state DOTs to manage the inspections, budgeting, and project development for bridge assets. This software uses a probability model (Markov decision process) to assess the uncertainty of deterioration rates of the bridges and a capital budgeting model to determine the optimal investment levels and timing for maintenance and improvement.[63] Pontis is owned and licensed by AASHTO.

---

[61] Brown, Gerald, and Robert Dell, "Optimizing Military Capital Planning," *Interfaces*, Volume 34, No. 6, November-December 2004, pp. 415-425.

[62] For more information, see http://www.camsys.com/ponti03.htm.

[63] Golabi and Shepard, "Pontis: A System for Maintenance Optimization and Improvement of U.S. Bridge Networks," *Interfaces* 27:1, January-February 1997, pp. 71-88.

Capital Plan or Program

The capital plan or program approach allows infrastructure improvement to be completed in a piecemeal fashion and the investment capital required to be spread out over many years. In addition, it provides a framework for prioritizing a series of projects that, if completed in sequence, could achieve an overarching goal and a set of favorable outcomes.

Typically, a capital plan approach seeks to optimize the cash flow over a planning horizon by focusing on projects that are most "leveraged" first. A highly leveraged project requires minimal capital, delivers many benefits, and does not depend on other items in the capital plan to show substantial progress towards the goal. By moving the highly cost-effective elements forward and deferring the less cost-effective investments, this program sequence achieves a much higher NPV than if the whole program of projects were carried out at the same time.

For example, for a piece of track with poor geometry, one of the most cost-effective investments is likely to be the welding of jointed rail into continuous welded rail. This gives rise to an immediate speed increase and lower maintenance costs. Further realignments of track onto a new trackbed or removal of trackside buildings would be scheduled later, once the benefits of the welded rail have begun to "pay back" some of the investment capital.

However, a capital plan must be an evolving document. The less cost-effective enhancements that are deferred may become more critical as new information becomes available, or could cease to be relevant because of developments that were unanticipated when the capital plan was first written. In addition, each project within the program of works must also satisfy individual benefit-cost criteria.

3.6 Summary

This chapter has provided a brief overview of the most relevant methods and software available for establishing the public return on investment on freight rail capacity improvements. It has discussed how the travel demand methods generate the necessary underlying data that are translated into public benefits by the transportation, external, and economic impact methods, and how various decision methods are available to help the planner make informed choices. It has shown the importance of both highway and rail models in this process. It has also shown that there are many methods and software products available.

This chapter has also illustrated an evolving decision-making framework being used by planners evaluating large and small-scale freight rail projects (completed in Figure 3.9). While there are many methods available for use in this framework, they have generally not been developed for this purpose. This has forced many of the methods to be adapted to uses beyond their intended design. Different methods are also being combined in new ways, usually through manual data transfers and simplifying assumptions.

Finally, this chapter has presented a wide range of benefits that can be used to justify freight rail projects to decision-makers and the general public. For example, a grade-crossing program can benefit urban regeneration, reduce highway congestion, or create a rail superway providing transportation network expansion and redundancy for security purposes. A new intermodal yard can be sold as catalyst for a logistics park or as a way to redevelop underutilized land.

4.0 Program Sources for Freight Rail Investment

4.0 Program Sources for Freight Rail Investment

The freight rail challenge as highlighted in the AASHTO FRBL report[1] is that "Without coordinated public and private action, congestion and capacity constraints will weaken the freight industry, the economy, local communities, and the environment."

A first approximation from the FRBL report suggests that the freight rail system needs an additional investment of $2.6 to $4.0 billion annually and that this investment is likely to be shared among the railroads, state and local governments, and the Federal government. The AASHTO report also suggests, as we look forward, that the states and local agencies in cooperation with the private sector can look at the following finance mechanisms for investing in freight rail improvements:

1. **Grants from surface transportation programs.** Grants give states and the Federal government the best control over the use of funds. Funds can be targeted to specific projects that solve freight and passenger rail needs. At the Federal level, the long-standing FHWA Section 130 Rail-Highway Grade Crossing Program provides dedicated funding to improve safety at rail grade crossings. CMAQ, created in ISTEA, has benefited passenger and freight rail intermodal projects where there is an air quality benefit. There are also discretionary grant programs such as the Corridors and Borders Programs in TEA-21 and a proposal for a Program for Projects of National Significance is included in reauthorization bills.

2. **Loan and credit enhancement programs** such as Transportation Infrastructure Finance and Innovation Act (TIFIA), Railroad Rehabilitation and Improvement Financing (RRIF), and State Infrastructure Banks (SIBs).

   – TIFIA provides loans, loan guarantees, and lines of credit for large projects. The program is modeled after a loan provided for the Alameda Corridor Transportation Project.[2] To qualify for assistance under TIFIA, a project needs a source of revenue to cover debt service costs; the total project must be valued at more than $100 million or 50 percent of the state's annual Federal-aid highway apportionments, whichever is less; the Federal TIFIA loan cannot exceed one-third of the total project cost; and the project's senior debt obligations must receive an

[1] *Freight-Rail Bottom Line Report*, American Association of State Highway and Transportation Officials, 2002.

[2] The Alameda Corridor Transportation Project was profiled in a case study in Chapter 2.0.

investment-grade rating from at least one of the major credit rating agencies. These factors limit its applicability, and private rail projects are not eligible today (although eligibility is proposed for reauthorization); but TIFIA is an important tool that can be used for financing joint highway and rail projects that meet the program guidelines.

– RRIF is a loan and credit enhancement program for freight rail. It seems particularly oriented to needs of regional and short-line railroads. The program has been slow to catch on because of features such as "lender of last resort" and a requirement that project recipients assume the credit risk premium.

– SIBs are designed to complement traditional Federal-aid highway and transit grants by providing states increased flexibility for financing infrastructure investments. Approximately 32 states have SIBs that provide loans for highway and in some cases transit improvements. Expanded SIB authority in reauthorization could provide states with a mechanism to provide revolving loans and possibly credit enhancement for freight rail improvements in the future. State-only SIBs are another possibility, such as Pennsylvania's initiation of a new state SIB for freight rail.

3. **Tax-expenditure financing programs**, including accelerated depreciation, tax-exempt bond financing, and tax-credit bond financing. Expansion of tax-exempt private activity bonds for surface transportation has been proposed in the Administration's TEA-21 reauthorization bill; these could potentially be beneficial for rail investment. Tax-credit bond financing is a new form of Federally subsidized debt financing, where the investor receives a Federal tax credit in lieu of interest payments on the bonds. From the borrower's perspective, it provides a zero-interest-cost loan. These programs can be used to provide targeted, income-tax benefits for investments made to improve the efficiency or increase the capacity of the freight rail system. They have the potential to elevate the rail system's rate of return and simultaneously reduce its cost of capital.

States and local agencies will likely want to explore all of these tools including new or expanded ones that may be included in TEA-21 reauthorization, tailoring them to projects that produce public and systemwide benefits. Section 4.1 focuses on current and proposed Federal sources of funding for freight rail-related projects and Section 4.2 looks at several state programs supporting freight rail.

■ 4.1 Federal Programs

Federal funding for freight rail to date has been limited to rail highway grade crossing safety enhancements and projects that benefit air quality. ISTEA and TEA-21 limit the types of intermodal projects eligible for Federal highway programs. In general, a non-highway project serving intermodal freight (for example, a rail line to a port) is ineligible unless the project could be shown to reduce pollutant emissions in a region that is not in compliance with air quality standards. In this case, the project might be eligible for CMAQ funds.

The AASHTO FRBL report lists the following Federal sources for intermodal funding in Appendix C:

- **Section 130 Rail-Highway Grade Crossing Program**
  Under this program, the entire cost of construction of projects for the elimination of hazards of rail-highway crossings can be funded. Funding under this program must be applied to safety improvements; capacity expansion projects are not eligible.

- **National Highway System (NHS) Program**
  Provides funding to improve highway links on the NHS network, or designated highway connectors to intermodal terminals.

- **Surface Transportation Program (STP)**
  Provides funding for roadway improvements over any Federal-aid highway, including improvements that benefit freight rail movement such as lengthening or increasing vertical clearances on highway bridges, or improving at-grade rail crossings.

- **CMAQ**
  Provides funding for transportation projects that improve air quality in designated non-attainment areas. Intermodal freight facility improvements are eligible, and funded projects have included rail yards, branch lines, and clearance improvements.

- **TIFIA**
  Provides credit assistance (up to one-third of project cost) for major transportation investments of national significance, including international bridges and tunnels, intercity passenger rail facilities, and publicly owned intermodal freight rail facilities on or adjacent to the NHS.

- **RRIF**
  Provides loans and credit assistance for public and private sponsors of intermodal and rail projects, including Class I and short-line railroads.

- **National Corridor Planning and Development (NCPD) and Coordinated Border Infrastructure (CBI) Programs**
  Provides funding for planning, project development, construction, and operation of projects that serve border regions near Canada and Mexico and for high-priority corridors throughout the United States. These programs are for highway corridors and border projects but a few projects were funded that benefited rail; e.g., FAST corridor in Washington State.

Table 4.1 summarizes the current Federal programs that can potentially benefit freight rail and shows freight-related reauthorization proposals that are included in one or more bills.

Table 4.1 Current and Proposed Federal Funding Programs for Freight Rail-Related Investment

Current and Proposed Federal Programs	Current Eligibility for Freight Rail-Related Improvements	Impediments	Proposed Reauthorization Changes
NHS	Can fund highway intermodal connectors to rail terminals.	Connectors are normally lower priority on NHS system and there is no eligibility for rail improvements.	All reauthorization bills propose set-asides for intermodal connectors.
STP (including Section 130 Rail-Highway Grade Crossing Program)	Section 130 funds rail-highway grade crossing safety improvements. STP in general can fund improvements to accommodate freight rail, under certain circumstances. Work allowed includes: "…lengthening or increasing vertical clearances of bridges, adjusting drainage facilities, lighting, signage, utilities, or making minor adjustments to highway alignment…"*	STP normally can't fund freight rail other than highway grade crossings, which must have safety benefit.	Increased funding for Section 130 in Safe, Accountable, Flexible, and Efficient Transportation Equity Act (SAFETEA) and Transportation Equity Act: A Legacy for Users (TEA-LU); Administration and SAFETEA makes all STP funds eligible for publicly owned intermodal facilities including rail.
CMAQ	Can fund any transportation project that improves air quality including operations for up to 3 years.	Air quality oriented, not for capacity improvements.	No change for freight.
TIFIA	Provides loans and credit assistance for highway and public intermodal rail facilities.	Private rail not eligible. Current project minimum $100 million.	Administration and SAFETEA proposes to make private rail eligible. Project minimum reduced to $50 million. Requires a revenue stream.
RRIF	Provides loans and credit assistance to private railroads.	Applicant must provide Credit Risk Premium. "Lender of last resort" provision has caused some concern.	No changes proposed.
GARVEEs	The Grant Anticipation Revenue Vehicle (GARVEE) bond is a financing instrument with principal and/or interest repaid with future Federal-aid highway funds.	Eligibility is constrained by the underlying Federal-aid highway programs.	Same as for SIBs, underlying Federal program eligibility carries through into GARVEEs.

Table 4.1 Current and Proposed Federal Funding Programs for Freight Rail-Related Investment (continued)

Current and Proposed Federal Programs	Current Eligibility for Freight Rail-Related Improvements	Impediments	Proposed Reauthorization Changes
Borders and Corridors	Border and corridor programs are for improvements to highway trade corridors and border crossings and have been used for rail grade crossings; e.g., FAST.	Very limited eligibility for rail; highway needs dominate.	Administration proposes eligibility for multistate, multimodal corridor planning; SAFETEA and TEA-LU propose expanded funding with current eligibilities. All bills separate borders and corridors.
Rail Modernization	Public transit program – can fund commuter rail improvements that have associated benefits for freight.	Must have primarily passenger benefit.	Likely source for flyover projects benefiting commuter rail.
High-Priority Projects	Rail Intermodal Projects occasionally earmarked by Congress, such as Detroit rail intermodal terminal in TEA-21.	Normally focused on large highway projects.	This source and new program for "Projects of Regional and National Significance."
Projects of Regional and National Significance	Proposed program.		TEA-LU proposes new discretionary program for "Projects of Regional and National Significance" that could include freight rail projects.
Private Activity Bonds	Allows private sector access to tax-exempt debt. Currently not available for surface transportation.		Administration and SAFETEA propose $15 billion private activity bond volume for highway and rail projects. This would allow railroads to participate in tax-exempt borrowing along with city and state.
Tax Credit Bonds	Tax-credit bond financing is a new form of Federally subsidized debt financing, where the investor receives a Federal tax credit in lieu of interest payments on the bonds. Currently not available for transportation.		AASHTO proposes a Transportation Investment Corporation to issue $80 billion in tax credit bonds, a portion to benefit intermodal freight. An institutional mechanism, Bonds for America, has been proposed in SAFETEA but no funding has been provided.

Note: * Federal Highway Administration Information Memo entitled *Use of Federal-Aid Highway Funds for Improvements to Rail Facilities*, dated February 9, 1993, and signed by Anthony R. Kane.

The most beneficial Federal programs for freight rail to date have been the FHWA Section 130 grade crossing and CMAQ programs, and the FTA Rail Modernization Program (which has funded commuter rail improvements that have been indirectly beneficial to freight rail). For the future, the proposed changes for TEA-21 reauthorization noted in Table 4.1 all have the potential to spur additional investment in freight rail projects. For large-scale projects, the proposed program for Projects of Regional and National Significance is of most interest along with the Section 130 grade crossing program or its successor. CMAQ remains as another eligible funding source. The TIFIA loan and credit enhancement program offers possibility if a revenue stream is identified. RRIF will likely continue as the program of choice for smaller regional and short-line railroads.

Private Activity Bonds and Tax Credit Bonds present two interesting funding possibilities on the horizon. Private activity bonds could give private railroads access to tax-exempt financing for rail improvements, thus significantly reducing the cost of capital. This could allow the railroads, states, and the cities to jointly pursue tax-exempt borrowing. The Tax Credit Bond initiative, as proposed by AASHTO, would set aside a portion of the proceeds for intermodal improvements such as freight rail that could be distributed as grants, loans, or credit enhancements. The tax credit bond option continues to be explored among constituency groups and on Capital Hill. An institutional mechanism, Bonds for America, has been proposed in reauthorization but no funding has been provided.

■ 4.2 State Programs

In addition to Federal funding, many states provide funding for freight rail projects. State programs were in most cases initiated by the Federal rail service assistance program established by the 4R Act, and amended by the LRSA Act of 1978. The LRSA program provided funding on a Federal/local matching share basis for four types of projects: rehabilitation, new construction, substitute service, and acquisition. The LRSA Program permitted states to provide funds on a grant or loan basis. LRSA was updated in 1990 to the LRFA program and the criteria for lines eligible to receive assistance was revised. Funds for the program were dramatically reduced in the 1990s, and congressional appropriations ceased in 1995.

Despite the lack of Federal funds, many states have continued their freight rail assistance programs through remaining LRFA funds (repaid loans) or through apportionment of state funds. The objectives of most of these programs have been job retention, economic development, and safety. More recently, benefits accrued to highway congestion mitigation and avoided highway costs are being considered.

While there are many similarities in state programs, there are also significant differences. These include:

- **Number and type of programs –** Some states have one pool of funds for rail projects, while others have multiple sources. For example, track rehabilitation/upgrade, industrial rail access, and grade crossing improvements may or may not come from the same source of funds, and in some cases are administered by different departments within the DOT.

- **Source of funds –** Sources can be an annual or biannual appropriation, or they can be tied to a revenue source such as sales tax, fuel tax, or even lottery proceeds. Some states will provide special appropriations for specific projects with significant value to the state. A good example is the money appropriated by the Commonwealth of Pennsylvania for double-stack clearance across the State.

- **Program type –** Some programs are loans and others are grants. Most require a matching percentage, though the percentages can vary greatly.

- **Class I eligibility –** LRFA was designed for the nation's short-line railroads and many state programs remained focused on the short-line operators.

Table 4.2 provides a sampling of some state freight rail programs.

Table 4.2 Sampling of State Freight Rail Programs[1]

State	Program	Program Type	Administrative Agency	Funding Source	Status[2]	Class I Eligibility
Illinois	Rail Freight Program	Revolving Loan	Illinois DOT – Bureau of Railroads	General Funds	Have $3.0 million available from State and $1.0 million from Federal.	State – Yes Federal – No
Indiana	Industrial Rail Service Fund	Grant (75% State) and Loan	Indiana DOT – Rail Section	4/100s of 1% of State sales tax receipts	About $1.3 million from tax, plus additional from load repayments.	No
Indiana	Passive Grade Crossing Improvement Fund	Grant	Indiana DOT – Rail Section	General Fund	Typically $500,000 (cut to $465,000 in 2003).	No
Iowa	Rail Assistance Program	Grant or Loan	Iowa DOT – Office of Rail Transportation	Appropriation	No new funds. Funds almost depleted.	Yes
Iowa	Rail Economic Development Program	Grant	Iowa DOT – Office of Rail Transportation	Appropriation	No new funds. Funds almost depleted.	Yes
Iowa	Intermodal Pilot Project	Loan	Iowa DOT – Office of Rail Transportation	Exxon Settlement via Department Natural Resources	$700,000 total (no projects selected yet).	Yes
Iowa	Rail Revolving Loan Fund	Loan	Iowa DOT – Office of Rail Transportation	Appropriation	2002 balance was $130,000.	Yes
Maine	Industrial Rail Access Program	Grant (50% State)	Maine DOT – Office of Freight Transportation	Legislative Bond Package	$2.0 million over 5 years.	No Class I railroads in Maine
Maine	Bonds for Matching Federal Programs	Grant (used in conjunction with CMAQ)	Maine DOT – Office of Freight Transportation	State Bonds	As needed (has been used mostly for Amtrak's Downeaster).	No Class I railroads in Maine
New Hampshire	Rail Line Revolving Loan Fund	Revolving Loan	New Hampshire DOT	General Fund Appropriation	$150,000 ($4.0 million total in program).	No
New Jersey	New Jersey Rail Assistance Program	Grant (90% State)	New Jersey DOT – Bureau of Freight Services	State Transportation Trust Fund, CMAQ	$8.0 million – Trust, $2.0 million – CMAQ.	Yes
Ohio	Spur and Rail Rehabilitation Program	Grant	Ohio Rail Development Commission and Ohio Department of Development	General Fund Appropriations	$3.0 to $4.0 million for 2001-2002 shared across 3 programs.	Yes

Table 4.2 Sampling of State Freight Rail Programs[1] (continued)

State	Program	Program Type	Administrative Agency	Funding Source	Status[2]	Class I Eligibility
Ohio	Acquisition Program	Grant and Loan	Ohio Rail Development Commission	General Fund Appropriations	$3.0 to $4.0 million for 2001-2002 shared across 3 programs.	N/A
Ohio	Railroad Rehabilitation Program	Loan	Ohio Rail Development Commission	General Fund Appropriations	$3.0 to $4.0 million for 2001-2002 shared across 3 programs.	N/A – for lines divested by Class I
Ohio	Rail Grade Separation Program	Grant	Ohio DOT and Ohio Rail Development Commission	Federal Section 130	Approximately $20 million (part of 10-year, $200 million effort).	Yes
Oregon	State Rehabilitation Fund	Grant (with railroad match)	Oregon DOT	State Lottery money from the General Fund	$2.0 million for 2001-2002.	No
Oregon	Grade Crossing Protection Account	Grant	Oregon DOT	State Highway Fund – portion of registration and driver license fees	$300,000 annually ($200,000 for Federal matching, $100,000 for maintenance).	Yes
Pennsylvania	Rail Freight Assistance Program	Grant	Pennsylvania DOT – Bureau of Rail Freight, Ports, and Waterways	General Fund Appropriations	$4.0 million (2002 was unusual, before and after years closer to $8.0 million).	No, due to Pennsylvania DOT policy
Washington	Freight Rail Program	Grant and Loan	Washington State DOT	Multimodal Account – rental car tax, new and used vehicles sales tax	$4.0 million for 2001-2003 biennium. A total of $61.29 million for 2003-2013, with $48.89 dedicated to 13 specific projects.	Yes, but has not been done
Washington	Grain Train Program	Purchase	Washington State DOT	Originally received $750,000 in Stripper Well overcharge funds. Program now self-sustaining through car-hire payments.	N/A	N/A

Notes: [1] This table was developed for the National Cooperative Highway Research Program Project 8-42, "Rail Freight Solutions for Roadway Congestion."

[2] Table was developed in second quarter of 2003.

5.0 A Framework for Quantifying Public Benefits from Investment in Freight Rail

5.0 A Framework for Quantifying Public Benefits from Investment in Freight Rail

This chapter contains summaries of the case studies, methods, and potential funding sources by the public benefits criteria most commonly cited. These criteria do not reflect a comprehensive list of public benefits, but they do represent the criteria observed in the case studies and are representative of current thinking. The criteria are organized into five topical areas: economic; environmental; security/safety; transportation; and other.

It is also worth noting that this report does not provide a definition of "public benefit." Most people would agree improving air quality or reducing accidents are public benefits. It is less clear if reducing shipper costs or improving carrier efficiencies should be categorized as public benefits. This topic of what is and is not a legitimate public benefit is left for future work. There is also considerable overlap between criteria, leading to potential "double counting" of benefits. Criteria such as "Heavy Trucks Removed from Highways," for example, is a driver of many of the other criteria, but it has also been used as a criteria on its own. Sifting through this double counting is not relevant to the conclusions of this study, but it is an important analytical issue.

■ 5.1 Public Benefits versus Case Studies

Figure 5.1 contains a summary of the case studies from Chapter 2.0 mapped against the criteria cited as public benefits. A dark shaded box indicates a quantitative analysis was performed. A lighter shading indicates the criteria was considered in a more subjective way.

Figure 5.1 Summary of Case Studies by Public Benefits Criteria

Quantitative Analysis – Black Shading, Qualitative Analysis – Gray Shading

Criteria	Alameda Corridor	CREATE	CMAQ Iowa	FRA B/C	FRBL	I-81 Virginia	MAROps	NY Cross Harbor	Ohio Turnpike	Palouse River & Coulee City	Shellpot Bridge
Economic											
Attracts New Business		■					▒	■			▒
Avoids Business Relocation Costs		■		■							
Avoids or Delays New Highway Construction					■	▒	■		■		
Creates New Jobs - Direct		■						■			
Creates New Jobs - Indirect		■						■			
Keeps or Expands Existing Business		■		■			■	■			
Expands Regional/National Economy		▒					■	■			
Increases Revenue (Recurring Stream or Taxes)	▒										▒
Reduces Highway Maintenance Costs				■		▒	■	■	■	■	▒
Reduces Shipper Logistics Costs				■	■		■	■		■	▒
Retains Existing Jobs				■			■	■		■	
Environmental											
Improves Air Quality	▒	▒	■	■	▒	▒	■	■	■	▒	
Lowers Noise Levels	▒										
Reduces Fuel Usage			■			▒	■			▒	
Safety/Security											
Improves HazMat Safety/Security											
Improves Security					▒						
Reduces Accidents	▒	▒	▒			▒	■	■	■	▒	
Upgrade to Meet Safety/Security Standards											
Transportation											
Eliminates Bottleneck							▒				▒
Heavy Trucks Removed From Highways	▒	▒	■	▒	■	■	■	■	■	■	▒
Improves Competitiveness	▒						▒	■		▒	▒
Improves Carrier Efficiencies, Reduces Costs	▒	▒		■			■	■		▒	▒
Improves Service Reliability							▒				▒
Increases Capacity	▒	▒				▒	■				▒
Reduces Highway Delays	▒	▒	■			▒	■	■	■		
Reduces Passenger Rail Delays											▒
Reduces Freight Rail Delays	▒	▒					■	■		▒	▒
Upgrade to Meet Industry Standards										▒	▒
Other											
Has National Significance	▒	▒				▒		■			
Minimizes Community/Construction Impacts	▒										

Within the economic criteria, reduction in highway maintenance costs and reduction in shipper logistics costs were the two most frequently mentioned benefits in the case studies. Reduction of highway maintenance costs are usually quantified based on reductions in truck VMT, either through available pavement deterioration tables or through software such as HERS. This is an easy-to-understand benefit, but it is dependent on a correct estimation of truck-rail diversions. The next most cited benefit was reduction in shipper logistics costs, usually reported as savings based on the differential between truck and rail rates for diverted traffic. Though largely believed to be a public benefit (through business expansion, job creation, increased taxes on higher revenues, lower consumer prices for goods), the linkages between shipper savings and public benefits are not well understood. Appearing in four cases studies each were avoiding new highway construction costs and retaining exiting businesses and jobs. Creating new jobs (both direct and indirect) surprisingly only factored into two of the case studies. The value of job creation can be difficult to establish, especially at a national level, because it often involves relocation of businesses to regions with improved transportation systems rather than creating new jobs.

Air quality improvements were quoted as public benefits in 10 of the case studies and were quantified in five. Reductions in fuel usage is also a commonly cited public benefit, though conversion into monetary measures is not usually done. Environmental benefits from reductions in fuel use are partially offset by reductions in revenues from fuel taxes. Changes in noise levels were not quantified in any of the case studies.

Accident reduction was another common benefit. For three of the case studies, accident reduction was converted into dollar savings associated with reductions in fatalities, injuries, and property damage. Security, while certainly an area of concern, was only mentioned in the FRBL report as a public benefit. This was in the context of improving security through creating a strong alternative freight network for military movements and delivery of essential goods during times of national emergency. The typical security projects (e.g., video surveillance, improved lighting, increased inspection and security) are largely outside the scope of the projects reviewed in this study.

Removing heavy trucks from the roadways, found in the transportation criteria, was the only public benefit mentioned in every case study. In cases such as MAROps and PCC, the analysis converted this reduction in trucks into other benefits (reduced highway maintenance, reduced roadway delay, etc.). In the Virginia I-81 case study, the purpose of the analysis was to identify the potential truck to rail diversions. Reduction in delays on both highways and freight rail lines, along with improvements in carrier efficiency, were quoted as public benefits in more than half of the case studies. Upgrading to industry standards (e.g., 286,000-pound railcars) was only mentioned in two case studies, but this is principally due to the nature of the case studies and not the importance of this criteria.

Another popular criteria, which has implications for Federal funding, is whether the project has national significance. The New York Cross Harbor project attempted to quantify this by generating results for the New York Metropolitan Region, the State of New York, the State of New Jersey, and the entire United States (see Tables 2.5 and 2.7). In general, "national significance" is not a well-defined criteria.

The criteria most often quantified in the case studies were heavy trucks removed from the highways, reductions in highway maintenance costs, reductions in shipper logistics costs, and job retention. The criteria most often sited as subjective benefits were improvements in air quality and improvements in safety.

5.2 Public Benefits versus Methods

Figure 5.2 contains a summary of the methods from Chapter 3.0 mapped against the public benefit criteria identified in the case studies and used in Figure 5.1. In this figure, a dark shaded box indicates that a method generates a benefit calculation. A lighter shading indicates that a method supports a benefit calculation. For example, trip generation and trip distribution support the calculation of trucks removed from the roadways, but mode choice models actually perform the calculation. Decision Methods are not included in this figure because they are relevant after the determination of the benefits.

What is immediately obvious from looking at Figure 5.2 is that transportation impact and economic impact methods are the most useful for quantifying public benefits attributable to investments in freight rail, and that travel demand methods provide the foundation for much of the analysis.

Travel demand methods have been studied extensively in passenger planning and are constantly being improved for freight planning, though rail modeling still lags highway tools. Economic impact modeling stems from early work in macroeconomics and, because of the link between freight movement and economic geography, it is readily applicable to freight planning. They are general models not designed specifically for transportation-related evaluations; however, products such as REMI have started adding enhancements directed at the economic consequences of transportation investments.

Transportation impact modeling has been generally the domain of engineers. There have also been successful applications of "hybrid models," such as HERS and IDAS, which integrate many classes of models into a single framework for planning purposes. These hybrid models have not incorporated freight rail. One reason is that large amounts of private-sector data are required for rail operations models (traffic by freight station, blocking schemes, freight schedules, passenger schedules, track charts, signal designs, etc.).

There has been substantial work in environmental modeling, but those have typically been done by environmental scientists and have not generally used in freight rail transport planning on a routine basis, with the EPA's MOBILE6 being an exception. Land use impacts have been modeled from a municipal tax and economic standpoint, and are becoming more useful for establishing business attraction and retention estimates.

Figure 5.2 Summary of Methods by Public Benefits Criteria

Calculates Benefits – Black Shading, Supports Benefits Calculations – Gray Shading

Criteria	Travel Demand			Transportation Impacts			External Impacts				Economic Impacts		
	Trip Gen. Trip Dist.	Mode Split	Traffic Assignment	Highway Operations	Rail Operations	Logistics Costs	Environmental Impacts	Land Use Impacts	Safety Impacts	Security Impacts	Input/ Output	Regional Simulation	Regression
Economic													
Attracts New Business						Gray		Black			Black	Black	Gray
Avoids Business Relocation Costs						Gray		Gray					
Avoids or Delays New Highway Construction	Gray	Gray	Black	Black									
Creates New Jobs - Direct													
Creates New Jobs - Indirect											Black	Black	Black
Keeps or Expands Existing Business						Gray		Gray			Black	Black	Black
Expands Regional/National Economy						Gray		Gray			Black	Black	Black
Increases Revenue (Recurring Stream or Taxes)	Gray	Gray	Black					Gray				Black	Gray
Reduces Highway Maintenance Costs	Gray	Gray	Gray	Black									
Reduces Shipper Logistics Costs	Gray	Gray				Black							
Retains Existing Jobs											Black	Black	Gray
Environmental													
Improves Air Quality	Gray	Gray	Gray	Black			Black						
Lowers Noise Levels	Gray	Gray	Gray				Black						
Reduces Fuel Usage	Gray	Gray	Gray	Black	Black		Black						
Safety/Security													
Improves HazMat Safety/Security	Gray	Gray	Gray	Gray	Gray				Black	Black			
Improves Security	Gray	Gray	Gray	Gray	Gray				Gray				
Reduces Accidents	Gray	Gray	Gray	Black	Gray				Black				
Upgrade to Meet Safety/Security Standards													
Transportation													
Eliminates Bottleneck	Gray	Gray	Black	Black	Black								
Heavy Trucks Removed From Highways	Gray	Black	Black										
Improves Competitiveness				Gray	Gray	Gray						Black	
Improves Carrier Efficiencies, Reduces Costs	Gray	Gray	Black	Black	Black	Black							
Improves Service Reliability				Black	Black								
Increases Capacity	Gray	Gray	Gray	Black	Black								
Reduces Highway Delays	Gray	Gray	Gray	Black									
Reduces Passenger Rail Delays	Gray	Gray	Gray		Black								
Reduces Freight Rail Delays	Gray	Gray	Gray		Black								
Upgrade to Meet Industry Standards													
Other													
Has National Significance							Gray			Gray	Black	Black	
Minimizes Community/Construction Impacts	Gray	Gray	Gray				Gray	Gray					

It is interesting to note that many of these models have been developed outside of the usage described here. Travel demand models are largely adapted from passenger models. Economic models have been adapted to transportation uses. Highway and railroad impact models were developed to examine strategic investments or operational changes, not determining public benefits.

It is also interesting to note that, ironically like the multimodal systems they model, connections and data transfers between these models create the most significant bottlenecks in the analysis. Models are being used and pieced together in ways not intended by the designers, leading to simplifying assumptions and creating data manipulation headaches.

■ 5.3 Public Benefits versus Revenue Sources

Figure 5.3 contains a summary of the potential funding sources from Chapter 4.0 mapped against the criteria cited in the case studies and used in Figures 5.1 and 5.2. A dark shaded box indicates that an analysis of that criteria is required to apply for funding. A lighter shading indicates that the criteria is an important consideration, but not required.

CMAQ and STP are the only two funding sources that have required benefits criteria. To apply for CMAQ funding, it is necessary to show a reduction in air pollution, usually measured as a reduction in truck emissions (see Section 2.3). To obtain STP-Section 130 funding for grade crossing improvements, it is necessary to show an improvement in safety or anticipated reduction in accidents.

The “gray boxes” are arrived at more subjectively, but they do represent the researchers’ best approximation of the types of benefits needed to secure public funding for freight rail projects. With that caveat in mind, the first observation is that, at a Federal level, justifying investments in freight rail based on overall improvements to the transportation system and improved safety will be more important than showing economic benefits. This is especially true when the economic benefits are directed at reductions in shipper and carrier costs.

The FHWA Freight Analysis Framework helped raise awareness that the movement of goods will nearly double in most parts of the country in the next 20 years. This will contribute to severe congestion and unacceptable levels of service on many of the nation’s roadways. Projects that can demonstrate a realistic and cost-effective expansion of freight capacity will have the most options for pursuing Federal funding. Freight rail capacity expansion projects will likely be able to draw from one or more of the cited Federal programs as potential funding sources. Elimination of bottlenecks in the transportation system should also have many funding opportunities.

Figure 5.3 Summary of Potential Funding Sources by Public Benefits Criteria

Required Criteria – Black Shading, Important Criteria – Gray Shading

(■ = black shading; ▒ = gray shading)

Criteria	NHS	STP Sec. 130	CMAQ	TIFIA	RRIF	SIB	GARVEE	Borders & Corridors	Rail Modernization	High-Priority Projects	Regional & National Significance	Private Activity Bonds	Tax Credit Bonds	Typical State Rail Assistance
Economic														
Attracts New Business											▒			
Avoids Business Relocation Costs														
Avoids or Delays New Highway Construction			▒						▒					
Creates New Jobs - Direct	▒									▒	▒			▒
Creates New Jobs - Indirect											▒			▒
Keeps or Expands Existing Business														▒
Expands Regional/National Economy	▒							▒		▒	▒		▒	
Increases Revenue (Recurring Stream or Taxes)				▒									▒	
Reduces Highway Maintenance Costs														▒
Reduces Shipper Logistics Costs	▒							▒						
Retains Existing Jobs														▒
Environmental														
Improves Air Quality		▒	■					▒						
Lowers Noise Levels		▒	▒											
Reduces Fuel Usage		▒	▒											
Safety/Security														
Improves HazMat Safety/Security											▒			
Improves Security								▒			▒			
Reduces Accidents	▒	■			▒			▒	▒	▒	▒			
Upgrade to Meet Safety/Security Standards		▒												
Transportation														
Eliminates Bottleneck			▒					▒	▒	▒	▒	▒	▒	
Heavy Trucks Removed From Highways			▒											▒
Improves Competitiveness								▒			▒			
Improves Carrier Efficiencies, Reduces Costs														
Improves Service Reliability	▒							▒	▒		▒			▒
Increases Capacity	▒	▒		▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	
Reduces Highway Delays		▒	▒					▒						
Reduces Passenger Rail Delays									▒					
Reduces Freight Rail Delays		▒			▒				▒					▒
Upgrade to Meet Industry Standards					▒									▒
Other														
Has National Significance	▒							▒		▒	▒			
Minimizes Community/Construction Impacts														

Improving safety will continue to be an important criteria for justifying public expenditures in freight rail projects. Separating freight and passenger travel, eliminating or improving grade crossings, reducing the risk associated with hazardous material shipments, and improvements to high accident locations and corridors will have several funding options.

Demonstrating economic benefits will continue to be important for states and regions, with a major driver being retention of existing businesses and jobs.

5.4 What We Have, What We Need

Figure 5.4 provides a comparison of the applications from Section 5.1, the methods from Section 5.2, and the potential funding sources from Section 5.3. The "Criteria" column contains the same criteria used in Figures 5.1 through 5.3. The "Case Studies," "Methods," and "Funding" columns use three gradations of shading to illustrate the relative importance of that criteria. A darker shading indicates a criteria of greater importance, while a lighter shading is a criteria of lower importance. For "Case Studies," the shadings reflect the frequency that a criteria was observed in the studies. For "Methods," the shadings indicate the availability of methods, with some adjustments to account for the completeness of the method. In the "Funding" column, the shadings illustrate the importance of a criteria, as measured by the robustness of the criteria across different potential funding sources.

After a few minutes of reflection, Figure 5.4 does begin to reveal some patterns. Historically, as seen in the case studies, there has been a reliance on benefits to shippers and carriers through reduced logistics costs, improvements to competitiveness, and reductions in carrier costs. These will be less important public benefits for securing future funding, while improved capacity and economic expansion will become more significant. Improvements in safety and environmental quality remain important, and security concerns will continue to gain importance.

There are a good collection of methods available to the analyst, though as previously discussed, these have largely been adapted from other uses and data transfers remain a bottleneck. Methods that address engineering concerns (e.g., capacity, delays, new construction, maintenance costs) are more developed than behavioral methods predicting shipper and carrier responses to investments in rail capacity. High-level, or sketch, planning tools for freight rail lag similar development efforts for highways.

Overall, though, there are a good collection of methodologies that have historically been applied and continue to be refined for future use. What is missing is a coherent framework for combining these methods.

Figure 5.4 Comparison of Criteria versus Applications, Methods, and Funding

Criteria	Case Studies	Methods	Funding
Economic			
Attracts New Business	Medium	Medium	Low
Avoids Business Relocation Costs	Low	Low	Low
Avoids or Delays New Highway Construction	Medium	High	Medium
Creates New Jobs - Direct	Low	Low	High
Creates New Jobs - Indirect	Low	High	Medium
Keeps or Expands Existing Business	Medium	Medium	Low
Expands Regional/National Economy	Medium	High	High
Increases Revenue (Recurring Stream or Taxes)	Low	High	Medium
Reduces Highway Maintenance Costs	High	High	Low
Reduces Shipper Logistics Costs	High	High	Medium
Retains Existing Jobs	Medium	Low	Low
Environmental			
Improves Air Quality	High	Medium	High
Lowers Noise Levels	Low	Medium	Medium
Reduces Fuel Usage	Medium	High	Medium
Safety/Security			
Improves HazMat Safety/Security	Low	Medium	Low
Improves Security	Low	Low	Medium
Reduces Accidents	High	Medium	High
Upgrade to Meet Safety/Security Standards	Low	Low	Low
Transportation			
Eliminates Bottleneck	Low	High	High
Heavy Trucks Removed From Highways	High	Medium	Medium
Improves Competitiveness	High	Medium	Medium
Improves Carrier Efficiencies, Reduces Costs	High	Medium	Low
Improves Service Reliability	Low	Medium	High
Increases Capacity	Medium	High	High
Reduces Highway Delays	High	High	High
Reduces Passenger Rail Delays	Low	High	Low
Reduces Freight Rail Delays	High	High	High
Upgrade to Meet Industry Standards	Low	Low	Medium
Other			
Has National Significance	Medium	Medium	High
Minimizes Community/Construction Impacts	Low	Low	Low

Legend

High
Medium
Low

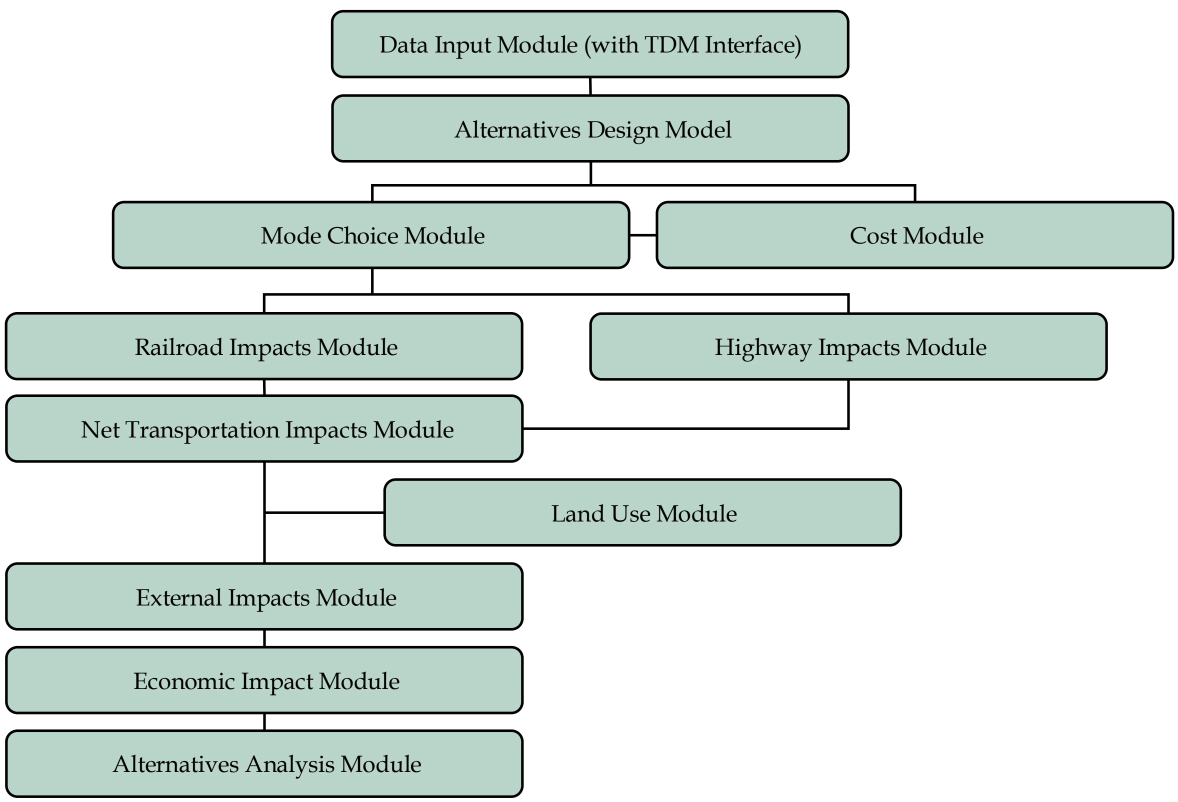
Shading Indicates:
Case Studies - Frequency
Methods - Availability
Funding - Importance

■ 5.5 Freight Rail Investment Framework

With the exceptions of CMAQ and Section 130, no funding source will depend solely on one benefit criteria. It is therefore necessary to think about a framework that captures multiple impacts attributable to public investments in freight rail capacity improvements. A series of flowcharts in Chapter 3.0, culminating in Figure 3.9, initiated such a framework for freight rail. Other frameworks have been developed for similar purposes, albeit focusing on different types of transportation investments, such as the FTA's New Start Program for transit services and some on the hybrid transportation impact models described in Section 3.2.

Combining elements of the combined freight rail benefit stream (Figure 3.9), with a generic structure for evaluating transportation investments (represented by Figures 3.5), leads to Figure 5.5. This type of hybrid method can provide a solid framework for evaluating potential public investments in freight rail capacity projects. By focusing on freight rail projects, this framework can incorporate the necessary features from the travel demand, transportation impacts, external impacts, economic analysis, and decision methods presented in Chapter 3.0. For simplicity, this framework will be referred to as the Freight Rail Investment Framework (FRIF).

Figure 5.5 A Potential Freight Rail Investment Framework



While it is feasible to capture much of this framework in a software tool (similar to IDAS), there are aspects that would be difficult to include. For that reason, FRIF is intentionally referred to as a framework, rather than a model. The advantages of a framework are that it helps guide the analyst into a comprehensive study, while providing flexibility to combine existing models and data with new, creative concepts. The advantages of a software tool are that it makes analysis simpler by standardizing data transfers and storing results, and it allows for faster and easier comparisons across different alternatives and projects.

Regardless of whether it is a framework to guide the analyst or a comprehensive software suite, it would need to have the following modules:

- Data Input Module, with a travel demand model interface to obtain networks, O-D matrices, and other standard information or to load other data, such as a public or commercial O-D freight database.
- Alternatives Design Module to allow the user to make network-level changes representing the proposed project and to override any default values.
- Mode Choice Module is one of the more critical components, because it drives many of the benefits. This is separate from the travel demand module because it will need to be iteratively applied to achieve an equilibrium as times and costs change in the transportation impacts modules.
- Highway, Rail, and Net Transportation Impacts Modules require a rudimentary capacity and performance measurement capability. Highway would be modeled after IDAS, but enhanced for freight. Rail would likely utilize a simplified parametric model based on track configuration. Waterborne and other modes would be useful additions for areas where these are legitimate options.
- Land Use Module captures benefits attributable to new business attraction and changes in property values.
- External Impacts considers air quality, safety, and other similar benefits.
- Economic Impacts Module adds secondary benefits and converts other benefits into measures of economic growth.
- Cost Module incorporates average default costs for standard solutions (e.g., double tracking, siding, four-quadrant gates, grade crossing separation) allowing preliminary what-if scenarios. The user would need the ability to override the defaults.
- Alternatives Comparison Module converts to net present value and divides the public benefits by the estimated costs to establish a benefit-cost ratio. This module could also incorporate internal rate of return, capital budgeting, risk analysis, or other decision methods.

NCHRP 8-42, *Rail Freight Solutions to Roadway Congestion*

NCHRP Project 8-42 *Rail Freight Solutions to Roadway Congestion* contemplates just such a decision-support framework for freight rail investment. The 8-42 decision-support model enables planners to identify whether freight rail is a true solution to urban congestion in a particular situation – where the focus is on resolving highway congestion and benefits are defined in terms of congestion mitigation. It identifies situations where freight rail may be part of a multimodal solution. However, as the extensive review of benefits in Chapter 3.0 has demonstrated, the impacts of freight rail are much broader. The framework shown in Figure 5.5 aims to capture the many other potential benefits that could result from freight rail capacity investments – where at least part of the focus is to relieve congestion on the highway network.

In summary, the 8-42 framework answers the question: "Will freight rail investment lead to decreased highway congestion in this corridor?" In grappling with that question, 8-42 considers many of the issues in freight rail diversion and shipper benefits, but it does not directly address the *other* public benefits that may be available from a freight rail investment plan, particularly the quality-of-life impacts that do not directly relate to highway congestion. The FRIF is designed to answer the question: "Will investments to improve freight rail capacity and relieve highway congestion lead to public benefits, as a whole, in this locality?"

6.0 Conclusions and Future Research

6.0 Conclusions and Future Research

The research objective, as contained in the Research Problem Statement, was:

> "There are a number of issues that must be considered in evaluating the need for and the means of increasing public investment in rail freight capacity. The one on which this task is to be focused is how to demonstrate what the public obtains in terms of benefits from its investment in rail capacity improvement(s). Even with a strong case that the railroad industry will need strategic public investments in order to perform the economic role required of it, Federal and state decision-makers will still require a clear means of demonstrating how these investments will generate the public benefits for which they were intended."[1]

This report addressed the research objective by:

- Exploring the current practice of evaluating benefits attributable to public investments in freight rail projects though a set of 11 case studies (Chapter 2.0);
- Describing the travel demand, transportation impacts, external impacts, economic impacts, and decision methods that have been developed and adapted to freight rail projects (Chapter 3.0);
- Discussing the potential funding mechanisms for public investment in freight rail (Chapter 4.0); and
- Combining current practice and methods with future funding requirements to develop a framework for establishing public benefits accruing from freight rail investments (Chapter 5.0).

Section 6.1 provides some conclusions derived from the key findings of this study. Section 6.2 suggests some areas for future research.

---

[1] "Research Problem Statement," National Cooperative Highway Research Program, NCHRP 8-36, Task 43, FY 2003.

6.1 Conclusions

The impacts of rail freight capacity and related infrastructure investments – just like highway programs – can be broad and immense. Enhanced transportation capacity is merely one facet of the enormous package of positive impacts that a large-scale investment project can bring in revitalizing an urban area or proving economic opportunities to impoverished regions. The range of benefits attributable to freight rail expansion includes:

- **Transportation:** Eliminate bottlenecks; remove heavy trucks from roads; improve competitiveness; improve carrier efficiencies; improve reliability; increase capacity; reduce highway delays; reduce passenger and freight rail delays; and maintain modern standards.
- **Economic:** Attract new businesses; avoid business relocations; avoid or delay new highway construction; create direct and indirect jobs; retain and expand existing businesses; expand local, regional, and national economy; increase tax revenue; generate recurring revenue streams; reduce highway maintenance costs; reduce shipper logistics costs; and retain existing jobs.
- **Environmental and Quality of Life:** Air quality improvements; noise reductions; reductions in fossil fuel use; environmental justice and equity by reducing adverse impacts in impoverished neighborhoods; urban redevelopment and economic regeneration through positive land use impacts; and restore community cohesion through synergies between rail upgrades and urban redesign.
- **Safety and Security:** Accident reductions; reduction of hazardous materials shipment risks; increased security by monitoring single trains rather than hundreds of trucks; increased security by providing freight network redundancies; and maintain modern safety and security technologies.
- **Regional and National Significance:** Expand national and regional economy; enhance interstate commerce; improve nationwide reliability by eliminating local bottlenecks; and expand nationwide transportation capacity.

The methods and software packages available to estimate public benefits are largely in place though, much like the freight networks they model, there are gaps and bottlenecks. Computerized travel demand methods have now been used for decades and are well developed. These methods form the foundations for most benefit analysis, for without a good understanding of the trucks on the highways and trains on the rail lines, a public benefits assessment amounts to little more than guesswork. These travel demand models have largely been designed and developed by engineers for passenger vehicles, with methods for freight movements lagging behind. Methods addressing freight rail lag even further behind.

Externalities (safety, environmental, security, land use, etc.) and economic impact methods have been developed by environmentalist and economists and, like travel demand methods, are generally adaptable to freight transportation analysis. Recently, integrated "hybrid" methods have been developed to link travel demand models with transportation, external, and economic impacts into comprehensive decision-support systems. Examples of this include HERS and STEAM, which were used for MAROps and New York Cross Harbor, even though they are highway models.

There should be several Federal sources available to fund rail freight capacity improvements in the future. Unlike previous dedicated Federal funding (such as the LRFA program), these source are general pots of money, thus forcing freight rail projects to compete against highway, airport, and waterway projects. This places an even greater burden to show public benefits obtained from investments into the privately held railroad industry.

Single-purpose programs, CMAQ and STP-Section 130, are the only freight rail funding sources currently requiring specific benefits criteria. In contrast, large-scale projects may need to utilize multitier funding from multiple sources, thus necessitating a broad range of demonstrated public benefits. At the Federal level, justifying investments in freight rail based on overall improvements to the transportation system, regional economic expansion, and improved safety will have more significance than the benefits to shippers and carriers that were contained in several of the case studies. The emphasis on capacity expansion and bottleneck reduction is due in part to the FHWA Freight Analysis Framework, which helped raise awareness that the movement of goods will contribute to severe congestion and unacceptable levels of service on many of the nation's roadways.

Section 5.5 of this report presented an FRIF to assist planners evaluate freight rail investments. This was modeled after the successful hybrid methods described in Section 3.2. FRIF could take the form of a suite of interconnected software packages that provide quick and seamless analysis capabilities, or simply a guidebook prescribing procedural guidance. It would encompass linkages to travel demand models, transportation, external and economic analysis, standard project costs, and a decision model.

The AASHTO FRBL report demonstrated that railroads will be unable to privately fund the capacity expansions necessary to keep pace with the demand for intercity freight transport. Recent efforts, such as CREATE, Alameda Corridor, and MAROps, have shown a willingness on the part of government agencies and the freight railroads to work together in solving the nation's growing freight crisis. Before public investments are made, we need assurances that public benefits will follow.

■ 6.2 Future Research

While continuous improvement is useful in all aspects of benefits assessment, the following list highlights the greatest needs:

- **Consistent, flexible framework –** To allow comparisons of benefits from freight rail projects competing for the same source of funds, likely following the practice developed for evaluation of urban transit investment.

- **Improved integration of methods –** To allow simpler, faster analysis of public benefits. This could be a suite of interconnected software products, or a guidebook incorporating procedures and supporting information similar to the AASHTO *User Benefits Analysis for Highways* ("The Red Book").

- **High-level sketch-planning methods for freight rail –** Especially capacity and bottleneck analysis, and service improvements.

- **Improved integration of land use impacts –** These are not well understood, but potentially have enormous public benefits.

- **Improved understanding of carrier behavior –** Will carriers respond with service levels and prices that deliver the projected benefits?

- **Improved understanding of shipper behavior –** Will shipper savings ultimately be passed on to the consumers who paid for the freight rail project through their tax dollars?

- **Improved understanding of cost sharing –** Especially for projects investments occurring in one location, but benefiting other locations. Also, between public-private entities, and between freight and passenger shared-use track and facilities.

- **Improved definitions –** What exactly constitutes a "public benefit" and how to avoid double counting them? What does "national significance" mean?

- **Methods to demonstrate regional competitiveness –** Will investment in freight rail enhance the economic competitiveness of a region, and how is this best measured?